National Park Service
George Washington Memorial Parkway
Stream Monitoring Program
2008 Annual Report

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ACKNOWLEDGEMENTS

We would like to express our gratitude to Ann Brazinski for her devotion in creating the George Washington Memorial Parkway Stream Monitoring Program. We would like to acknowledge and thank Erik Oberg for his knowledge and dedication to the George Washington Memorial Parkway Stream Monitoring Program (and for hiring us!). We also thank Brent Steury for continuing his support of the program and for his brave demeanor upon battling the dreaded Mile-a-minute. More thanks goes to Ben Helwig for his time with us in the field navigating to the sampling stations and for his help updating the site sampling location maps, and also to John Paul Schmit for helping with statistical analysis. Additional thanks goes to all employees and interns within the Natural Resources Division and throughout the GWMP for making our summer experience with the National Park Service memorable!

ABSTRACT

Benthic macroinvertebrate data was collected in the summer of 2008 for the completion of a sixth year of stream water quality monitoring. Mine Run and Difficult Run consistently received “acceptable” year-round health scores according to the Virginia Save Our Streams (VASOS) protocol. The remaining seven monitored streams received “unacceptable” seasonal average scores. Dead Run and Windy Run received the lowest average rating during the entirety of the 2008 monitoring program. Spout Run, the most impacted stream, received the lowest average rating during the entirety of the six year monitoring program. Its highly urbanized watershed may be an indication that development and associated pollutants can have a significant effect on stream health.

Monitoring also included two streams, Donaldson Run and Gulf Branch, which were contaminated by a pesticide spill in 2001. Lack of appropriate data from past years prohibits a proper statistical analysis regarding the actual improvement of species density/ (richness). There is no data to support whether a recovery to pre-contamination conditions has occurred for Donaldson Run and Gulf Branch. The 2008 season also marked the second year of monitoring at Windy Run and Difficult Run. According to a statistical analysis of stream score trends, Difficult Run was the only stream to show a significant improvement between 2007 data and 2008 data. Continual monitoring will account for annual variation in health scores and aid in determining changes in stream water quality over time.

INTRODUCTION

The George Washington Memorial Parkway (GWMP), a unit of the National Park Service (NPS), is responsible for preservation of natural and historic property along the Potomac River. This includes protection of the Potomac River shoreline and watersheds within park boundaries. The Natural Resource Management Division is responsible for all concerns regarding the relationship between wildlife and habitat within the park. This responsibility, coupled with concern for the Potomac River watershed, led to establishment of a program to monitor water quality of streams that feed into this important and historic waterway.

The Northern Virginia suburbs of Washington D.C., particularly Fairfax and Arlington Counties, have experienced remarkable urban and suburban development. Appendix 17 depicts the amount of square footage that has been added from 2002-2006 in Arlington County. Appendices 18 and 19 show the amount of land used and planned to be used as of 2004 in Fairfax County. Increased land development and associated impervious surface cover puts a strain on storm water management (Figure 28). Rainwater is not readily absorbed, increasing potential for destabilization of soils within watersheds and increased sediment runoff into streams (USEPA 1997). Sediment and pollutants carried by storm water runoff can adversely affect biological stream communities, and present the need for stream protection and restoration (Storm Water Management Branch 2001).

In response to this need, the Fairfax County Department of Public Works and Environmental Services established the Stream Protection Strategy in 2000, in cooperation with the Northern Virginia Soil and Water Conservation District (NVSWCD). NVSWCD established the Volunteer Stream Monitoring Program, a local, regional, and statewide effort of stream data consolidation. This program uses Virginia Save Our Streams (VASOS) protocol, developed by the Izaak Walton League of America and later modified by a two-year study at Virginia Tech. In an effort to share data and work cooperatively with local jurisdictions the GWMP stream monitoring program adopted the VASOS protocol and began contributing data to Fairfax County's Stream Monitoring Program database in 2001.

The VASOS protocol is a method of stream monitoring that evaluates stream health through collecting and identifying benthic macroinvertebrates, sampling water chemistry and basic water quality parameters, and conducting habitat assessments. Benthic macroinvertebrates are an important component of the freshwater stream ecosystem as they aid in decomposition of organic material and are vital organisms in the food chain. Each order of benthic macroinvertebrates has a specific level of tolerance to environmental stresses. This, coupled with their quick response to environmental stressors, and relative ease of identification, makes benthic macroinvertebrates excellent indicators of water quality and environmental health (Storm Water Management Branch, 2001). VASOS protocol uses type and abundance of benthic macroinvertebrates found in each stream to calculate statistical metrics, from which a health score is determined based on a multimetric index. Beginning in 2007, the stream data collected was entered into the online VASOS multimetric index calculator, and was the tool used to derive the stream health ratings.

PROJECT SITE

The GWMP's Surface Water Quality Monitoring Program was initiated to establish baseline water quality data that will aid in long-term protection of park streams. Monitoring efforts began in summer of 2001 and focused on seven of ten perennial piedmont streams running through park property: Mine Run, Pimmit Run, Gulf Branch, Turkey Run, Dead Run, Donaldson Run, and Spout Run (Figure 1). Monitoring continued in 2002, 2003, 2006, 2007, and 2008 focusing on the same seven streams sampled in 2001. In 2007 and 2008, Difficult Run and Windy Run were added to the stream monitoring program.

METHODS

Stream monitoring was conducted from May 27, 2008 to July 29, 2008. A total of nine streams were monitored in the 2008 season (Figures 2-10). Three rounds were completed for Mine Run, Pimmit Run, Gulf Branch, Turkey Run, Dead Run, Donaldson Run, and Spout Run. Beginning in mid-July Difficult Run and Windy Run were monitored for a total of two rounds each. Global Positioning System (GPS) coordinates for each stream station are listed in Appendix 12. Each stream was sampled at three stations, with a minimum distance of twenty meters between each sample station. The time of day in which sampling took place remain consistent with previous sampling times to the extent possible. Sampling times for 2008 can be found in Appendix 10.

Benthic Macroinvertebrate Collection

At each station, sampling occurred in riffles. Riffles are a section of stream characterized by shallow, fast-moving water flowing over cobbles. The station furthest downstream was sampled first to prevent duplicate collection of macroinvertebrates and alterations in water chemistry. In accordance with VASOS protocol, benthic macroinvertebrate samples were taken using a 3'x 3' kick-seine net (1/16-inch mesh) placed perpendicular to water flow immediately downstream of the sampling area. The net was angled approximately forty-five degrees, or greater, to the streambed. Prior to disturbance, rocks were placed along the net bottom to prevent macroinvertebrates from escaping under the net. One member of the monitoring team held the net in place and recorded elapsed time while another member scrubbed and removed large rocks from the riffle within the designated sample area. The scrubbing team member then vigorously churned the streambed area in front of the net by shuffling their feet. Churning time depended on the area sampled: 90 seconds for a 3'x 3' area, 60 seconds for a 3'x 2' area, and 30 seconds for a 3'x 1' area.

When time expired, rocks that held the bottom of the net were scrubbed. The net was then carefully lifted out of the water in a scooping motion, to avoid sample loss, and laid on a table for sorting. The riffle was then returned to its original state prior to sampling. All macroinvertebrates were removed from the net with forceps and placed in ice cube trays filled with stream water. Each piece of detritus was carefully searched for clinging macroinvertebrates. Each benthic macroinvertebrate collected was identified by common name and tallied on the Virginia Save Our Streams Benthic Macroinvertebrate Tally Sheet (Appendix 1). After all macroinvertebrates were counted, they were released back into the stream. The process was repeated until at least 200 macroinvertebrates were identified or four net samples were taken. Total number of individuals present in each net was counted, regardless of whether or not the total exceeded 200. If specimens were unidentifiable, they were taken back to headquarters for positive identification. Merritt and Cummins (1996), and Thorp (1991) were used as identification guides.

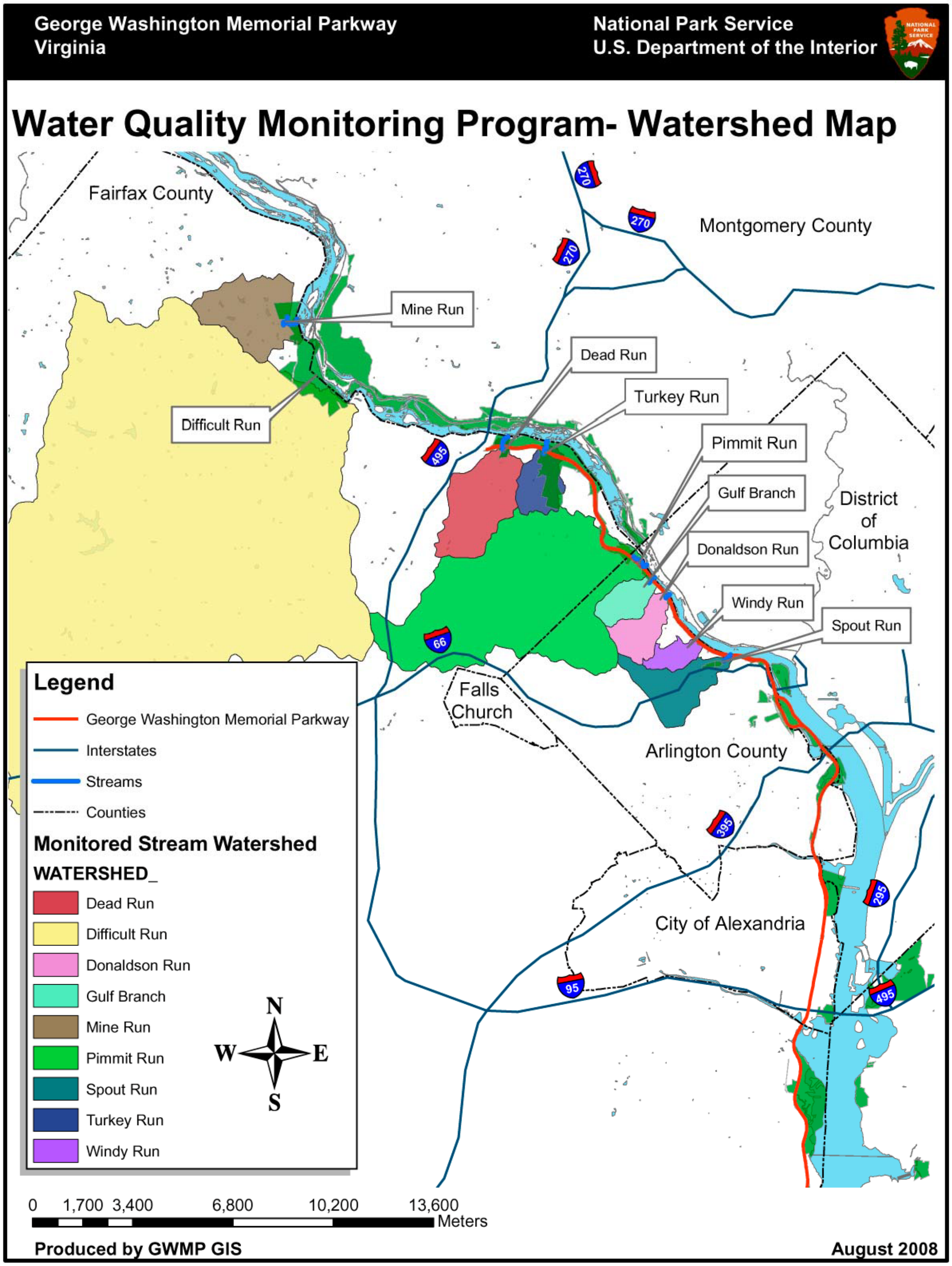


Figure 1: Water Quality Monitoring Streams and Watersheds

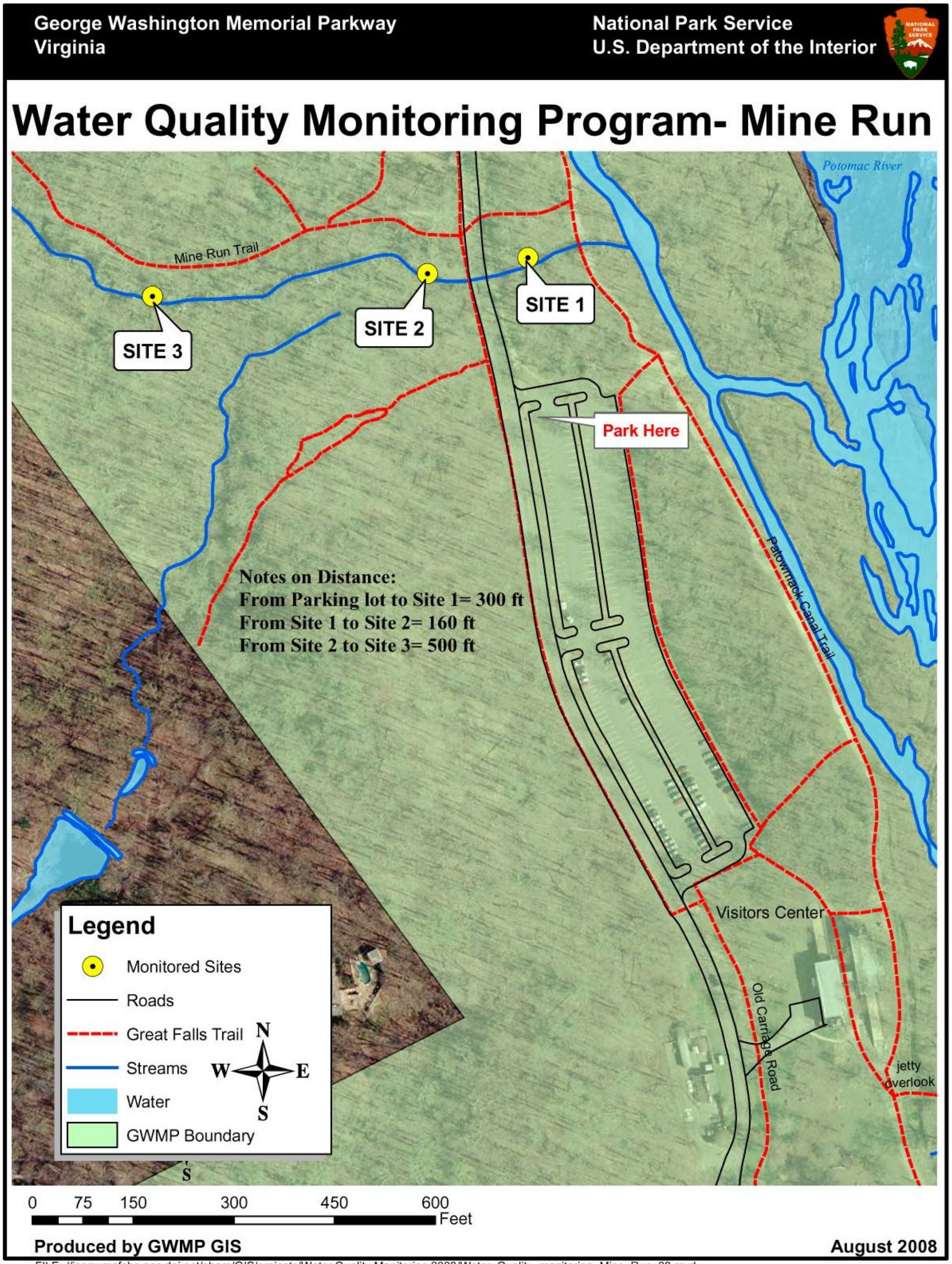


Figure 2: Site Sampling Locations: Mine Run

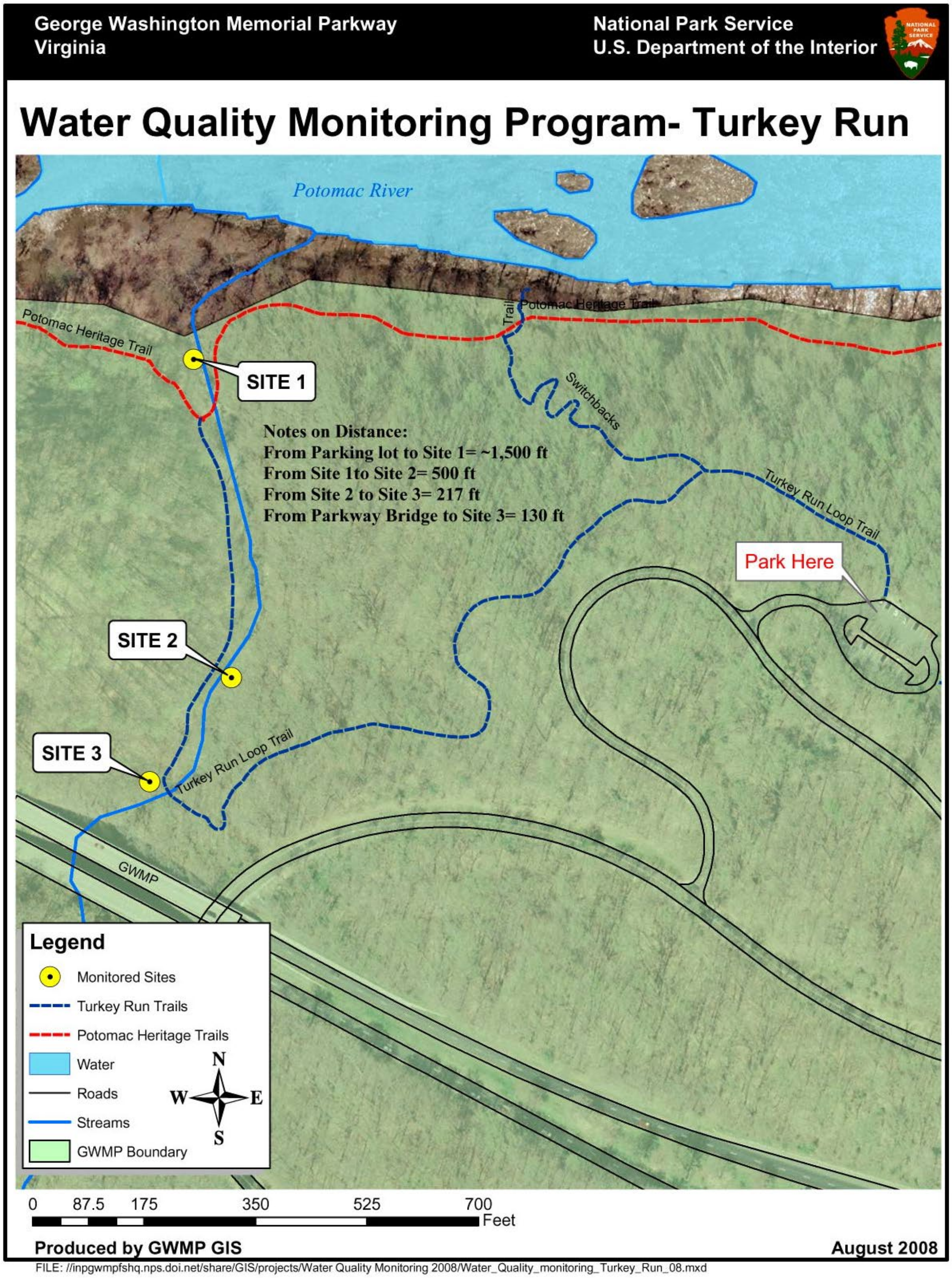


Figure 3: Site Sampling Locations: Turkey Run

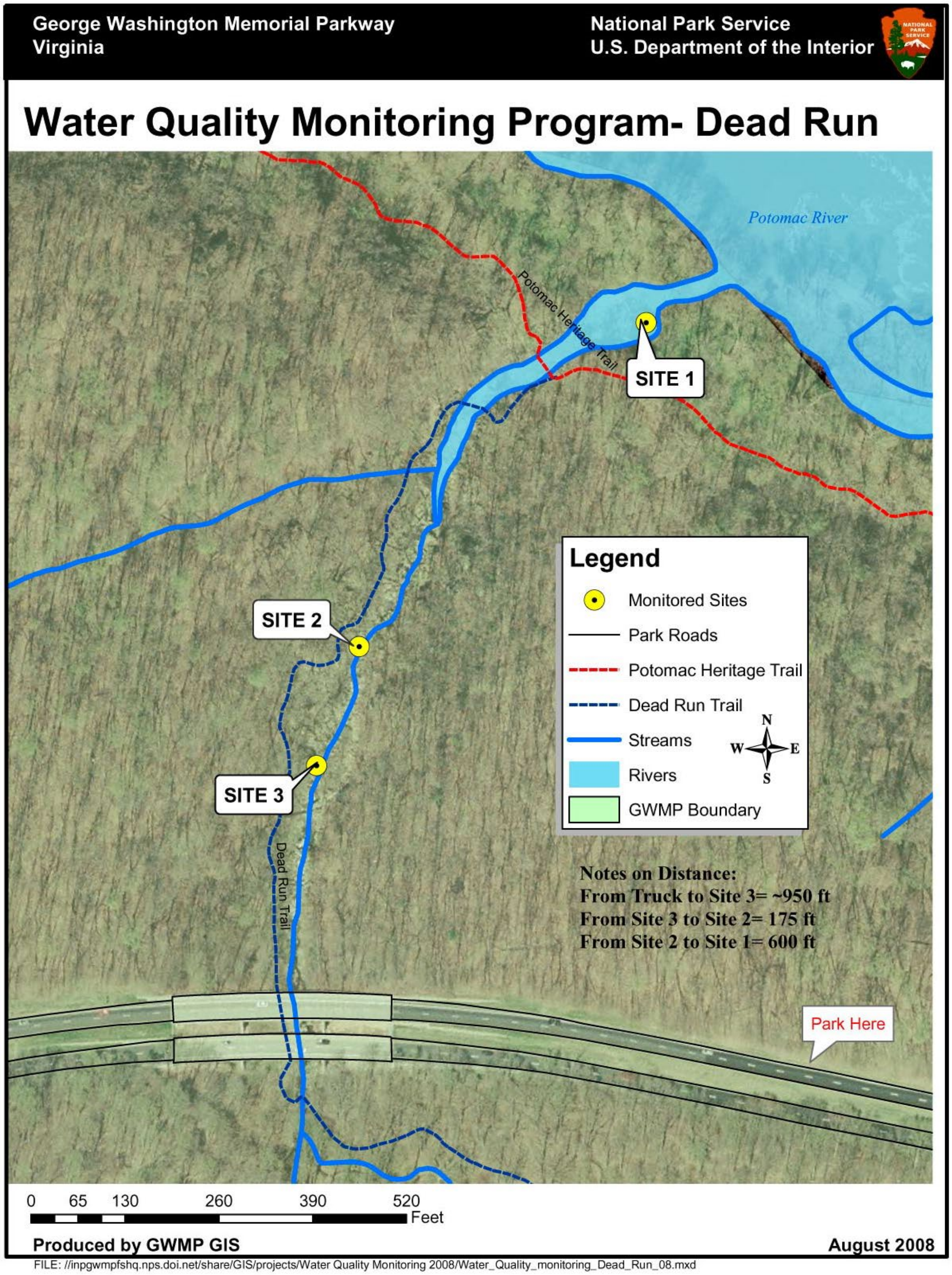


Figure 4: Site Sampling Locations: Dead Run

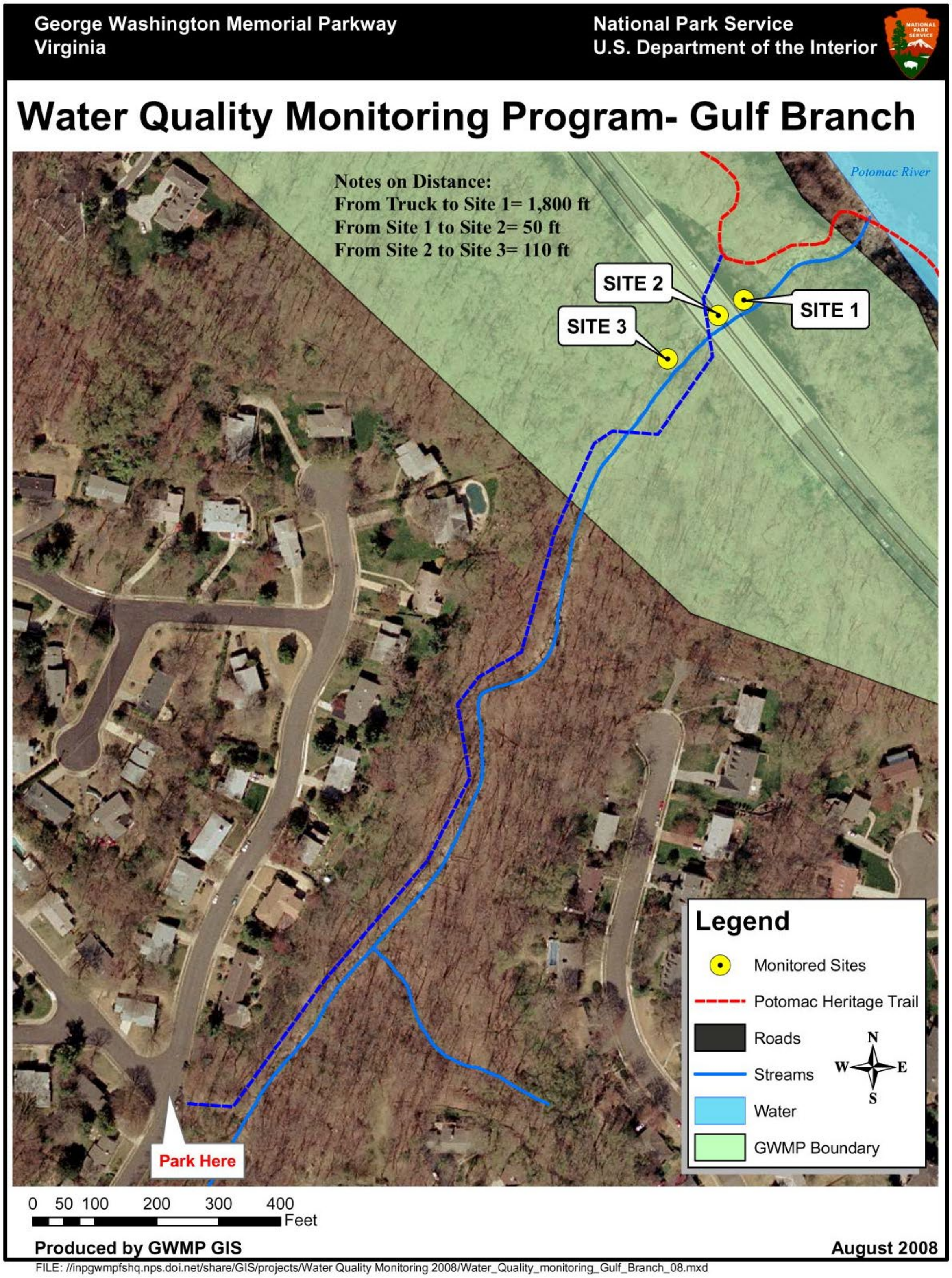


Figure 5: Site Sampling Locations: Gulf Branch

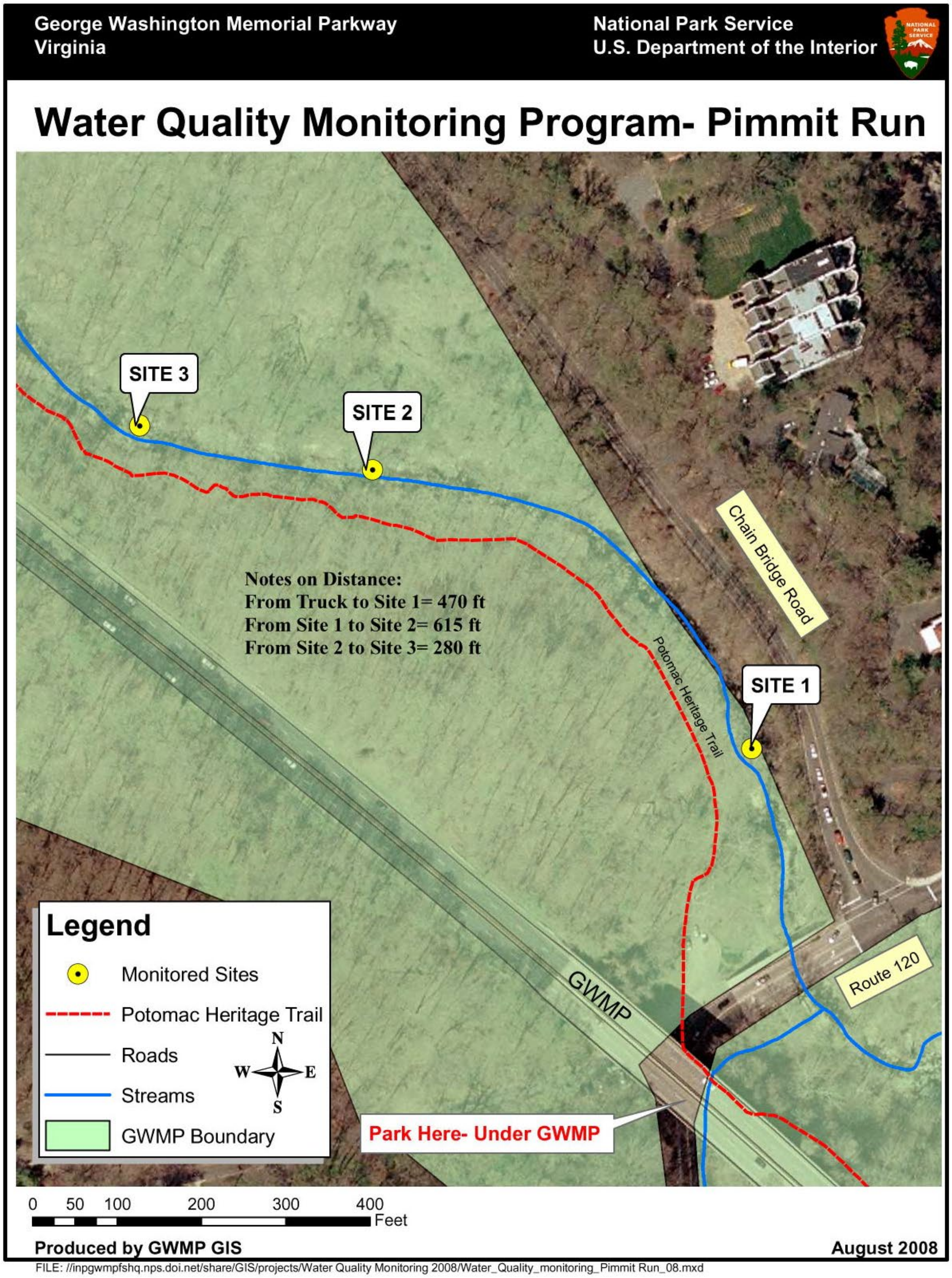


Figure 6: Site Sampling Locations: Pimmit Run

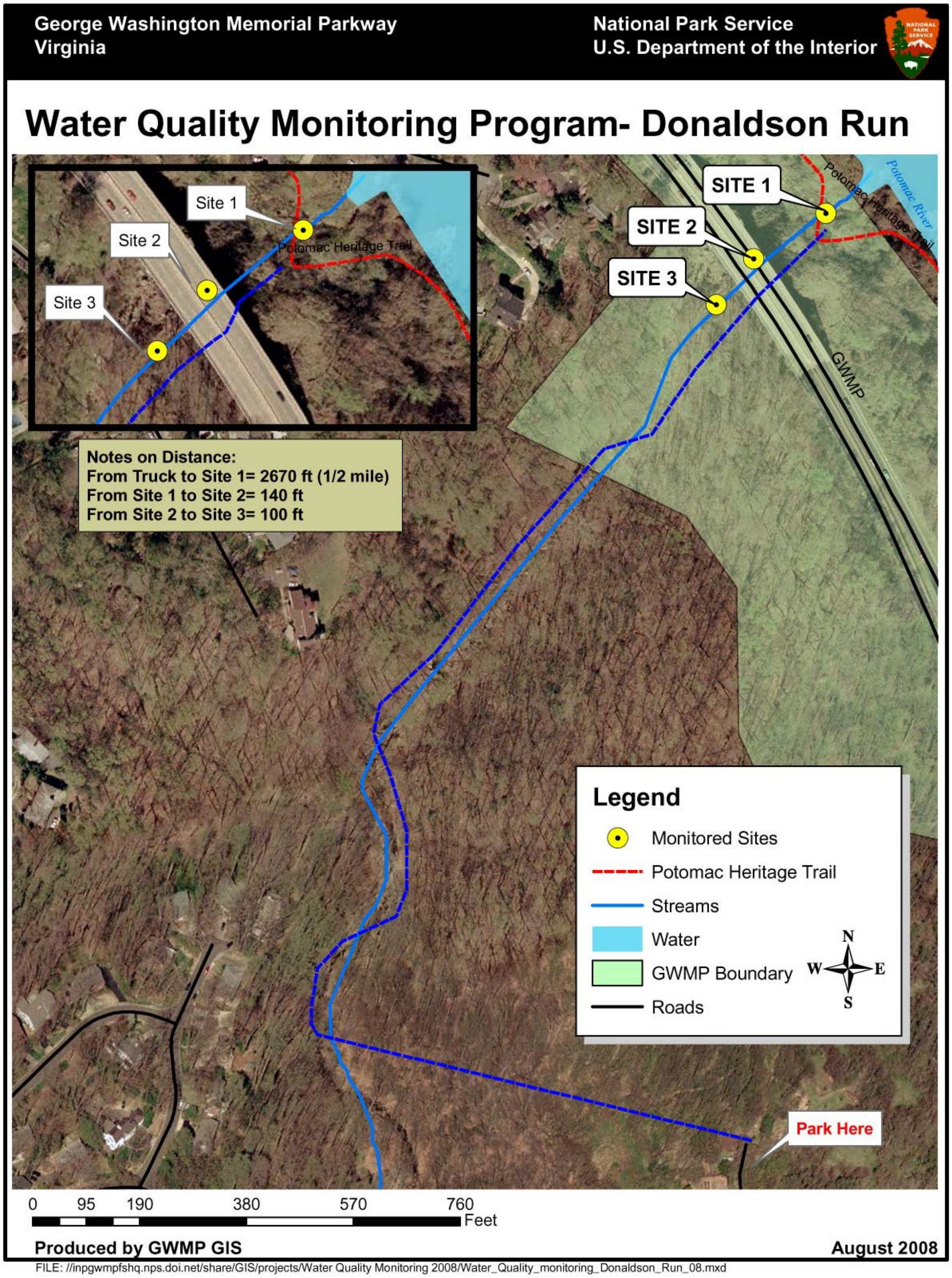


Figure 7: Site Sampling Locations: Donaldson Run

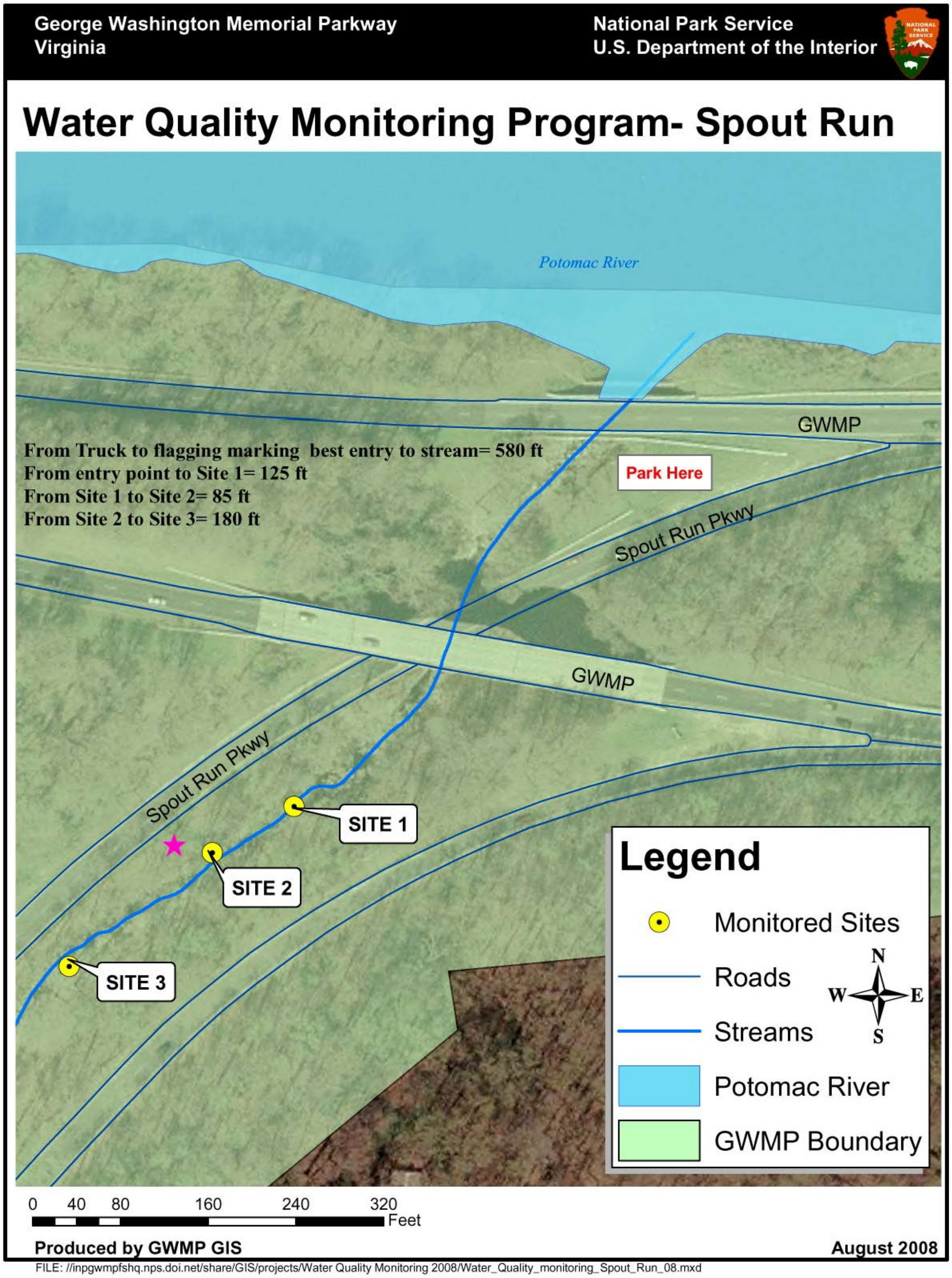


Figure 8: Site Sampling Locations: Spout Run

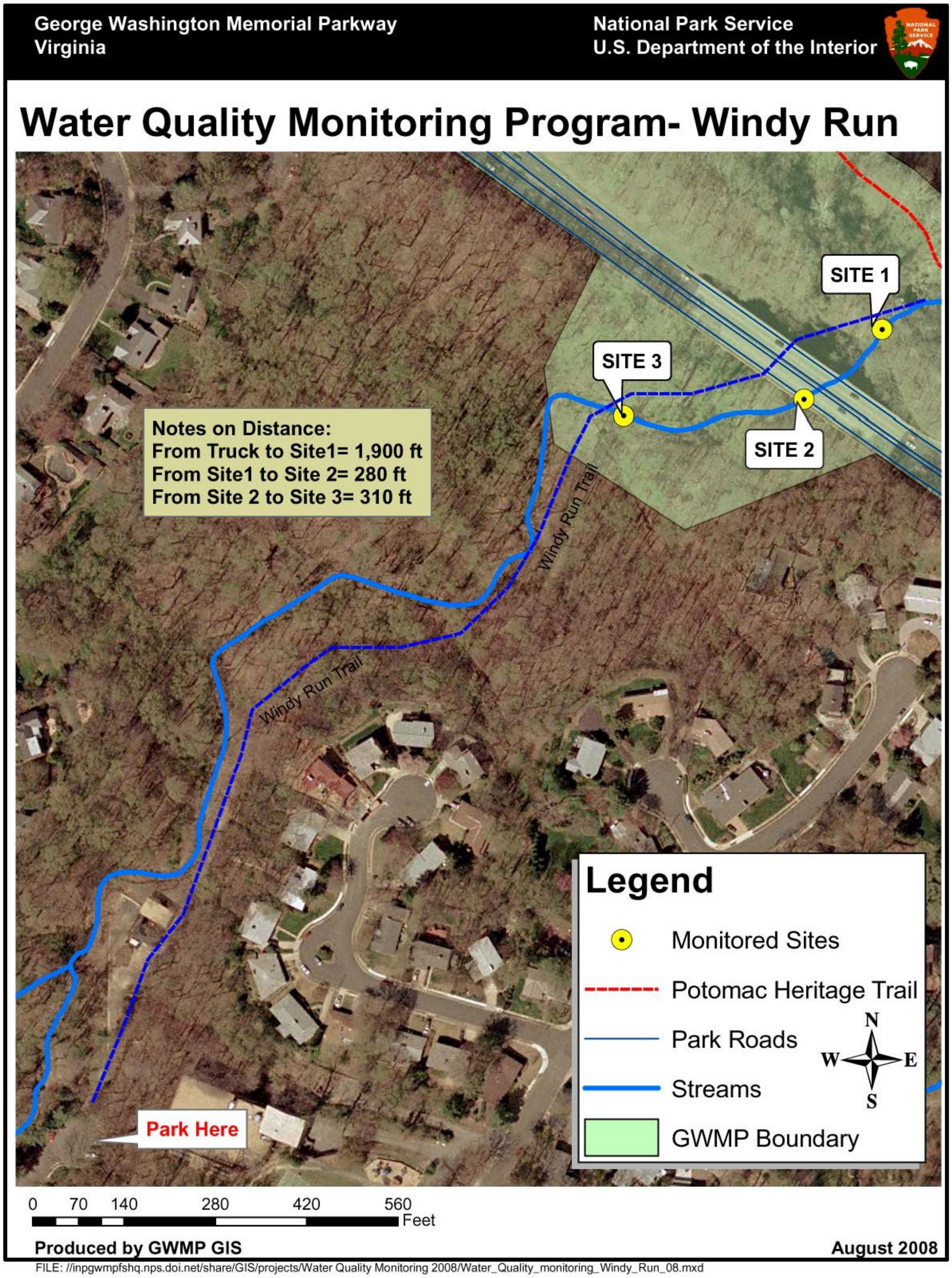


Figure 9: Sampling Location- Windy Run

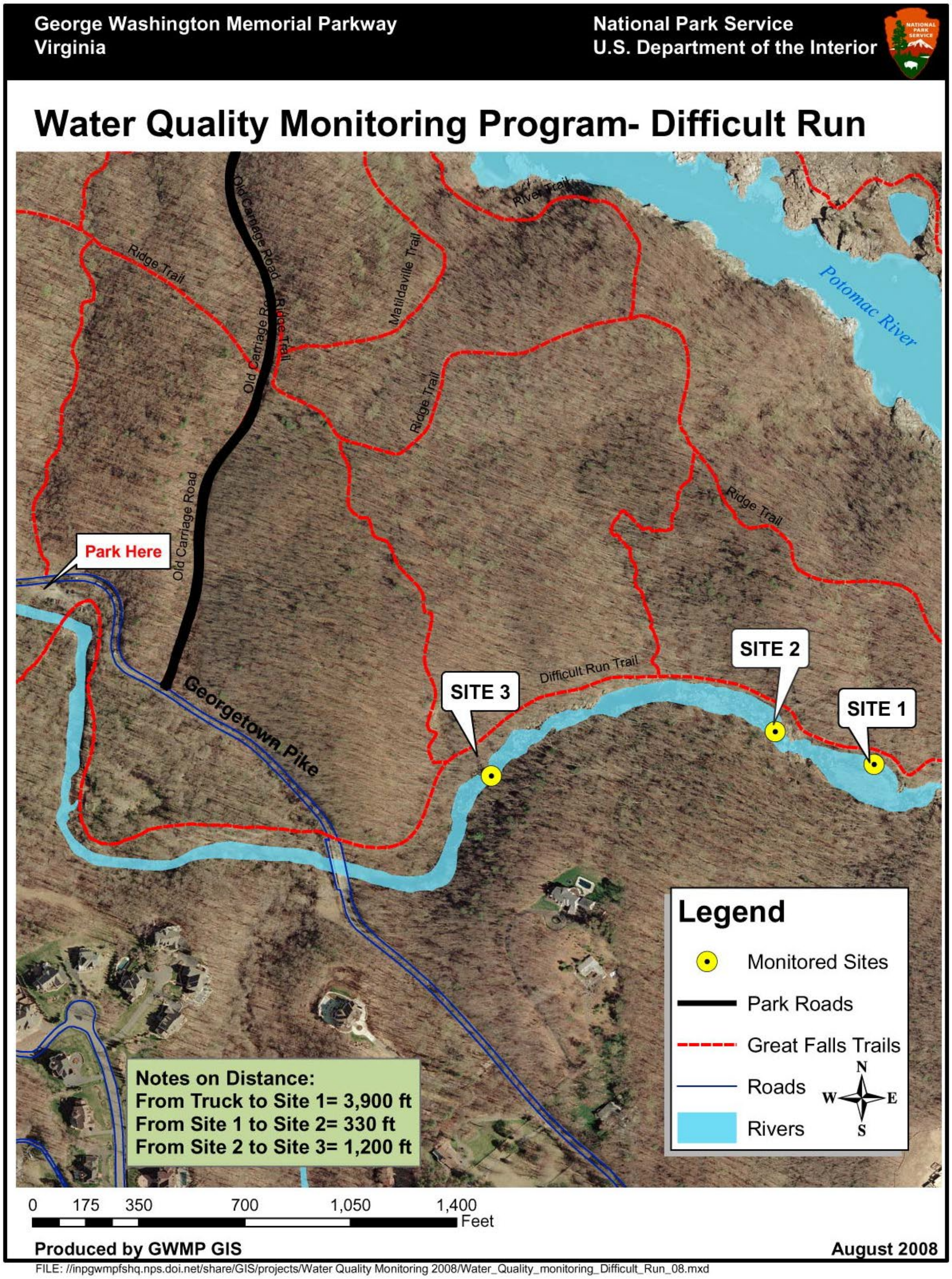


Figure 10: Site Sampling Locations: Difficult Run

In accordance with VASOS protocol, stream health scores were calculated using the new online (VASOS Data Entry) multimetric index score that compare proportion of pollution-tolerant species collected to proportion of pollution-intolerant species collected. Percentages of mayflies, stoneflies, caddisflies, common netspinners, lunged snails, beetles, non-insects, and tolerant species were calculated (Appendix 2) and assigned metric values based on their percentage value (Appendix 3). The metric values were then automatically added for each stream station and produced a score on a scale of zero to twelve. An "acceptable" rating received a score of 7.00 or greater, while an "unacceptable" rating was given for a score of 6.99 or less.

Water Chemistry and Basic Water Quality Parameters

Each station was tested for dissolved oxygen, conductivity, pH, nitrate, nitrite, water temperature, salinity, and turbidity. YSI Meter, model 85, was used to measure dissolved oxygen, water temperature, and conductivity (Appendix 4). Dissolved oxygen is the amount of oxygen freely available in water, necessary for aquatic life and oxidation of organic materials. Intolerant benthic macro-invertebrates require aquatic environments with high oxygen concentrations. Low dissolved oxygen can often be the result of various biotic and abiotic conditions, some of which may arise via human action. Prolonged exposure to low levels of dissolved oxygen will increase an aquatic organism's susceptibility to other environmental stresses. Organisms are especially susceptible during summer when warmer temperatures raise their metabolic rate, increasing their need for oxygen. The potential loss of canopy and runoff from warm, impervious surfaces upstream of the study sites will increase water temperature, decreasing available dissolved oxygen (USEPA 1997). Many physical, chemical, and biological characteristics of a waterway are directly linked to water temperature. Lower water temperatures hold more oxygen and higher water temperatures increase aquatic organism's metabolic rate and need for oxygen. Increased temperature from urban runoff can cause stress to stream organisms leaving them susceptible to other environmental stresses (USEPA 1997). Conductivity measures the ability of water to pass an electrical current and depends on the quantity of dissolved ions in water. High conductivity may indicate presence of elevated levels of metals or salts. High conductivity measurements could be indicative of runoff from a variety of sources, possibly anthropogenic (USEPA 1997).

YSI meter, model 60, was used to measure pH of stream water and water temperature (Appendix 5). The pH of stream water reflects hydrogen ion concentration, or how acidic or alkaline the water is. It is measured on a scale of one to fourteen. Acidic pH is less than seven, and an alkaline pH is greater than seven. Aquatic life is generally sustained at neutral pH levels of 6.5-8. Sources like acid rain can move stream pH levels outside this normal range and make pollutants more readily available for uptake, causing physiological damage to aquatic organisms (USEPA 1997).

LaMotte turbidity kit was used to measure turbidity (Appendix 6). Turbidity is a measure of suspended solids in a liquid, or clarity of water. Some sources of turbidity include soil erosion, waste discharge, urban runoff, and algal growth. Turbid water can absorb more heat, decrease light, and clog respiration apparatuses of aquatic organisms. As turbidity increases, water can lose its ability to support aquatic organisms (USEPA 1997).

Industrial Test Systems "Waterworks" water quality test strips were used to measure nitrate and nitrite levels (Appendix 7). Nitrogen is an important nutrient for plants and animals and is found naturally in waterways; however, excessive levels cause large amounts of algal growth and deplete available oxygen. Nitrogen was tested for in the form of nitrate (NO_3) and nitrite (NO_2). Common sources of nitrogen include sewage, fertilizer, agricultural waste, and nutrient runoff from soil (Storm Water Management Branch 2001).

Stream Habitat Assessment and Physical Characteristics

Stream habitat assessment involved surveying for presence of aquatic vertebrates including fish, salamanders, and eels. Other parameters assessed were: surface water and streambed appearance, streambed stability, presence of algae, odor, color, amount of stream channel shade and stream bank erosion, plant coverage of stream bank sides and top, and presence of trash. Physical characteristics of each stream such as: stream width, channel width, flow rate, riffle water depth, and average stream depth were measured and recorded on the Virginia Save Our Streams: Stream Quality Survey form (Appendix 8). Physical habitat characteristics can have influences on water chemistry, and is another link in the assessment of stream health scores.

RESULTS

Benthic Macroinvertebrates and Stream Health Scores

Water quality sampling occurred between May 27 and July 29 for the 2008 season. There was a 31% increase in sampling for the 2008 season compared to the 2007 season. The complete multimetric index scores and chemical data collected can be found in Appendix 10, and all other field data collected can be found in Appendix 9, including the type and abundance of macroinvertebrates. The multimetric scores for the 2008 season can also be seen in Figure 11. The average yearly health scores, as seen in Table 1 and Figure 12, show that Mine Run and Difficult Run were the only two streams to receive an average "acceptable" score of seven or greater for the season (Mine received an 8.56 and Difficult received a 9.33). Mine Run received acceptable scores for all sampled sites during all three rounds. Difficult Run was only sampled for two rounds, but it also received acceptable scores for all sampled sites. Turkey Run, Windy Run, Dead Run, Pimmit Run, Gulf Branch, Donaldson Run, and Spout Run all received "unacceptable" yearly average scores, with Dead Run being the only stream to receive consistent "unacceptable" scores for all sampled sites. Dead Run and Windy Run received the lowest average score for the 2008 season with a 4.67.

Table 1: Average Yearly Health Scores

	Mine Run	Turkey Run	Dead Run	Pimmit Run	Gulf Branch	Donaldson Run	Spout Run	Windy Run	Difficult Run
2001	8.75	6.25	6.00	6.40	6.67	5.50	5.29		
2002	8.00	2.83	4.00	3.30	4.17	4.20	3.50		
2003	7.89	4.13	4.50	4.00	4.25	4.78	3.43		
2006	8.83	5.83	4.50	5.30	5.00	4.17	3.50		
2007	7.50	4.50	5.00	7.50	4.50	5.00	3.67	5.00	7.10
2008	8.56	4.89	4.67	5.44	5.22	5.67	5.11	4.67	9.33
Average	8.26	4.74	4.78	5.32	4.97	4.89	4.08	4.84	8.22

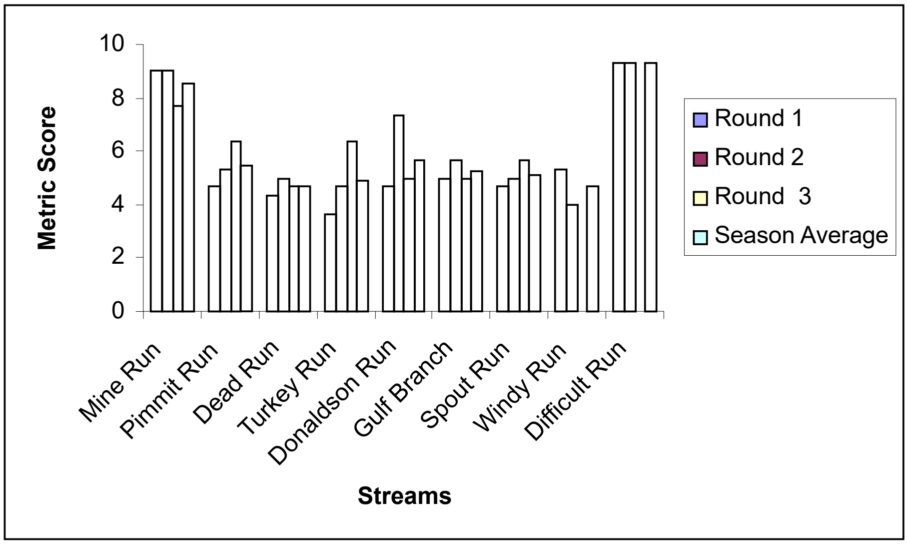


Figure 11: Stream Health Score 2008

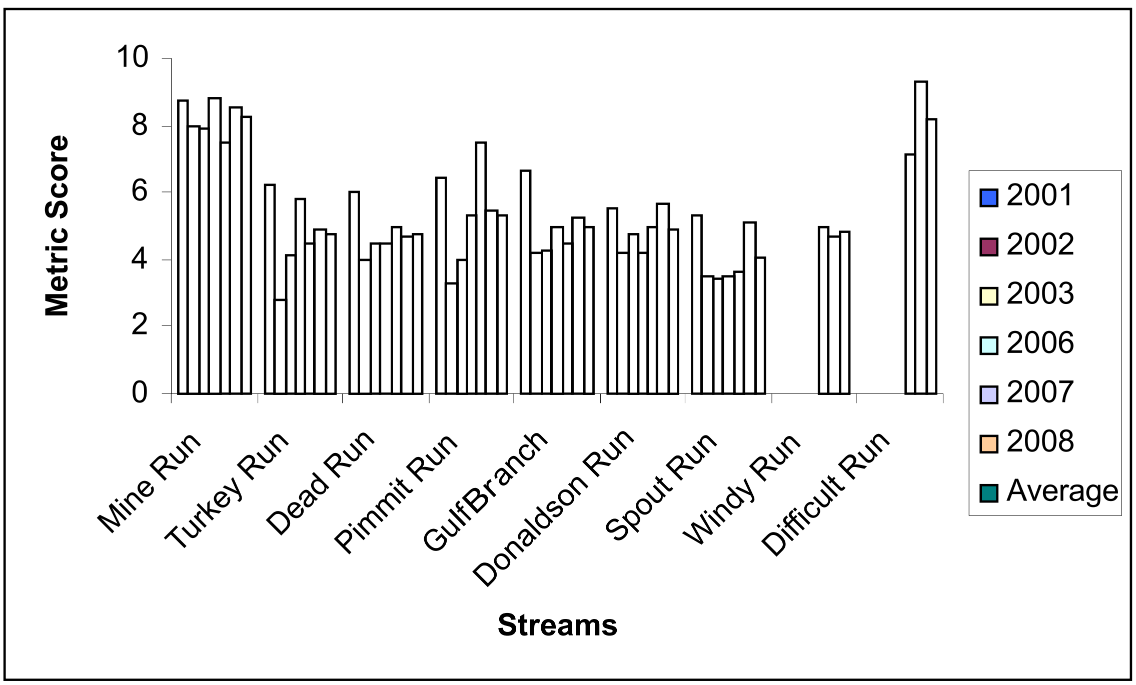


Figure 12: Average Yearly Health Scores

While the multimetric scores from 2008 seem to be improving, data collected in previous years statistical analysis shows that only Difficult Run has significantly improved:

> Trends in the Stream Health Scores were analyzed using a Daniels Test for Trend (Conover, 1999). In this test, each stream is analyzed separately. For each stream both the year that the stream was sampled and the stream health scores were converted to ranked data. The correlation between the rank of the year and the rank of the scores determines the trend in steam health. This correlation between two sets of ranked data is referred to as a "Spearman's ranked correlation" or a "Spearman's ρ (=rho)". A positive

correlation indicates an improving stream health while a negative correlation indicates declining stream health. The larger the absolute value of the correlation, the stronger the trend. A p-value of 0.05 or less is used to assess statistical significance. Windy Run and Difficult Run have only 2 years of data. While some stream showed improvement and others showed decline, only at Difficult Run, *with only two years of data*, was the trend were significant (Table 2). (John Paul Schmitt, Quantitative Ecologist, NPS Center for Urban Ecology).

Table 2: Daniels Test for Trend (Conover, 1999)

Stream	Spearman's ρ	p-value
Mine Run	-0.078	0.62 (n.s.)
Dead Run	-0.077	0.64 (n.s.)
Turkey Run	0.092	0.57 (n.s.)
Pimmit Run	0.130	0.39(n.s.)
Gulf Branch	0.169	0.35(n.s.)
Donaldson Run	0.198	0.23(n.s.)
Spout Run	0.126	0.43(n.s.)
Windy Run	-0.092	0.81 (n.s.)
Difficult Run	0.702	0.011

As previously mentioned, both Mine Run and Difficult Run received the highest scores for the 2008 season. A statistical test was run between the streams in order to compare their scores:

A Kruskal-Wallis test was used on the Stream Health scores from 2008 to determine if stream health differs between streams. A significant difference in stream health among streams was detected (H=39031, df=8, p<0.0011, adjusted for ties). As illustrated in Figure 13, Difficult Run, Mine Run have higher health scores than the other 7 streams (John Paul Schmitt, Quantitative Ecologist, NPS Center for Urban Ecology).

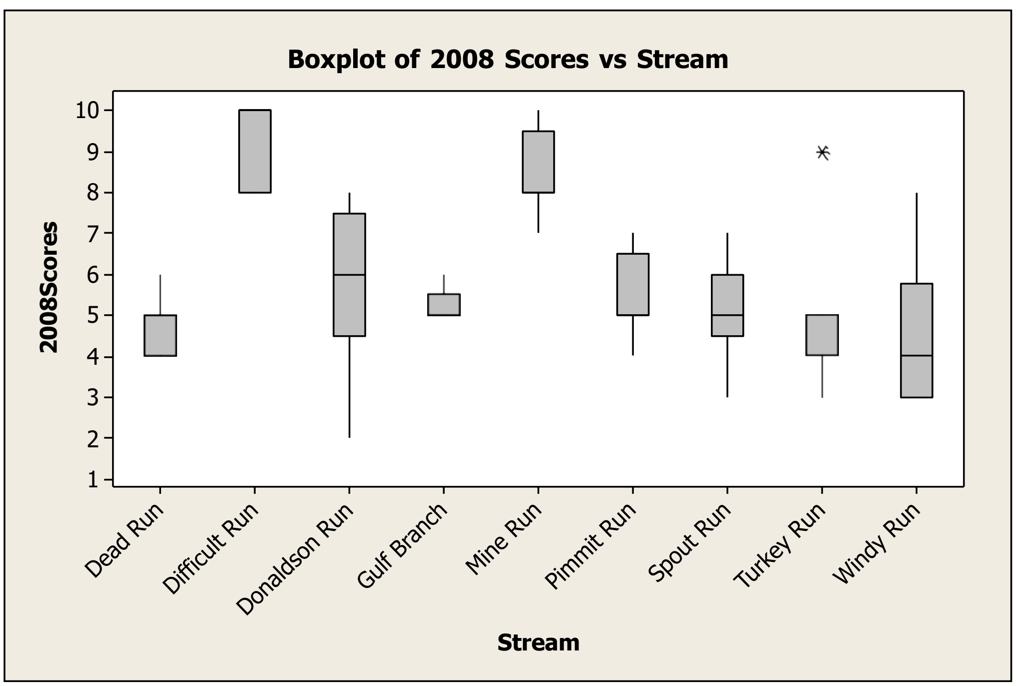


Figure 13. Box-plot of Steam Health Scores from 2008.

The multimetric scores are based on biological indications found by comparing the presence of pollution tolerant and intolerant macroinvertebrates. Figure 14 shows the percentage of intolerant benthic macroinvertebrates collected in 2008. Intolerant benthic macroinvertebrates are more sensitive to environmental stressors like increased turbidity, higher water temperatures, and lower dissolved oxygen, so they are unlikely to live in polluted streams. Percent intolerant data reflects VASOS metric data. VASOS metric data relies on relative proportion of all tolerance levels, and integrates tolerant and moderately tolerant taxonomic groups into final health scores.

Both Mine Run and Difficult Run have high percentages of pollution intolerant species. These streams also received the highest multimetric scores for the season. Pollution intolerant species include mayflies, stoneflies, beetles, gilled snails, hellgrammites, and most caddisflies. Other species such as common netspinners, crayfish, damselflies, dragonflies, scud, and sowbugs may be indicators of an "acceptable" stream as they are somewhat intolerant to pollution. However, aquatic and flat worms, black flies, clams, leeches, lunged snails, midges, and most true flies are tolerant to pollution. The presence of these species can alter data towards an "unacceptable" score. In turn, the presence of pollution intolerant species may shift towards an "acceptable" score. For example, during round one sampling of Windy Run, station two received a multimetric score of 8. This score seems high considering station one and three of round one received scores of 5 and 3 respectively. However looking at the percent of pollution intolerant species, station two had 40% intolerant species present. This percentage is greater than the amount found at either station one, with only 23% intolerant species or station three with 20% intolerant species. Also note that at station three, there were five lunged snails present. Lunged snails are pollution tolerant and indicators of a stressed environment, lowering the multimetric score.

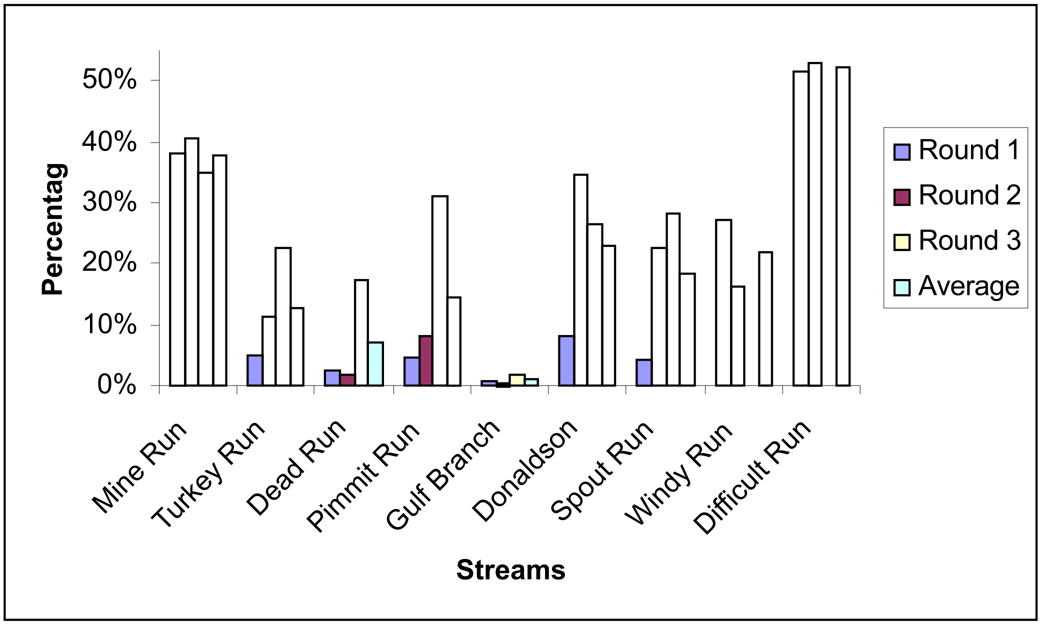


Figure 14: Percent Pollution Intolerant Benthic Macroinvertebrates 2008

Water Chemistry and Basic Water Quality Parameters

Water chemistry data collection is another form of water quality monitoring. During the 2008 season, basic water quality parameters and water chemistry data were collected. This data includes nitrates, pH, water temperature, conductivity, salinity, turbidity, and dissolved oxygen, and can be found in Appendix 10 for each sampled site. Nitrates and nitrites were tested for during the sampling process; however no nitrite was present in any of the testing sites. Figure 15 shows the variations of nitrate levels found for each round with Spout Run having the highest average of nitrate levels at 4.67 ppt.

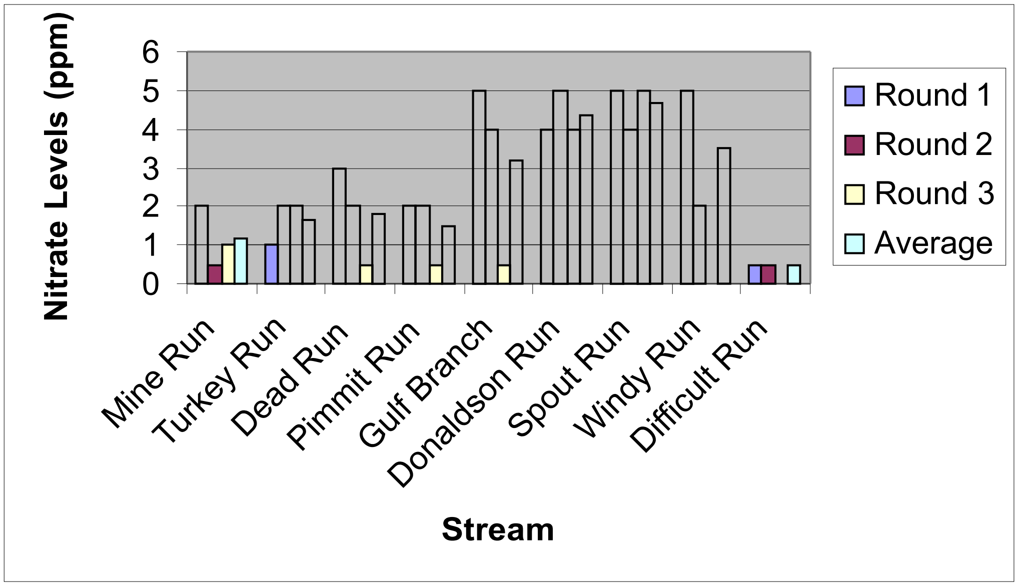


Figure 15: 2008 Nitrate Levels in Streams

Potential hydrogen (pH) was monitored for the 2008 season, with stream averages ranging from 7.42 (Gulf Branch) to 7.89 (Turkey Run). This range is within the basic measurement of pH. The pH values for each round and seasonal averages of the streams can be viewed in Figure 16.

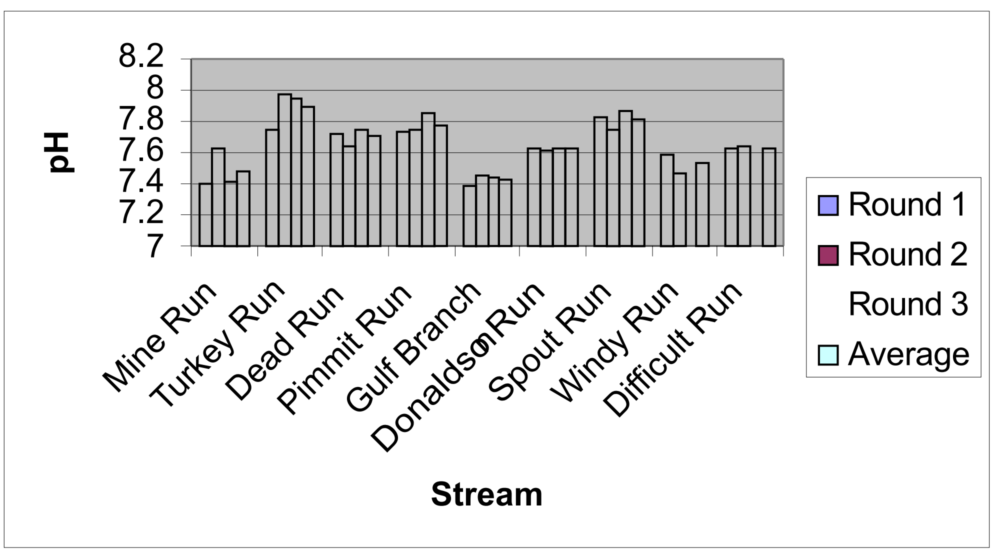


Figure 16: 2008 pH Levels of Streams

Water temperature is another important parameter to monitor in streams. The water temperatures of the monitored streams remained within a range of 18.9 ºC to 24.1 ºC. From looking at the average temperatures between the three rounds, there seems to be a slight increase from round one to round two, and from round two to round three. The temperatures for each round and the season average can be viewed in Figure 17.

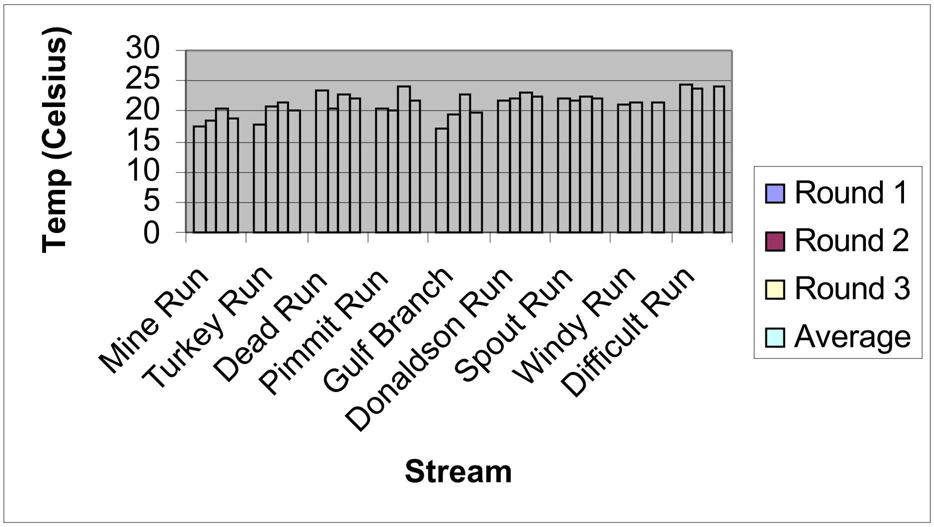


Figure 17: 2008 Stream Water Temperatures

The presence of dissolved oxygen is important in streams, and the amount can affect its biota in different ways. For the 2008 season, dissolved oxygen (DO) was measured by percentage and mg/L. This data can be viewed in Figures 18.1 and 18.2.

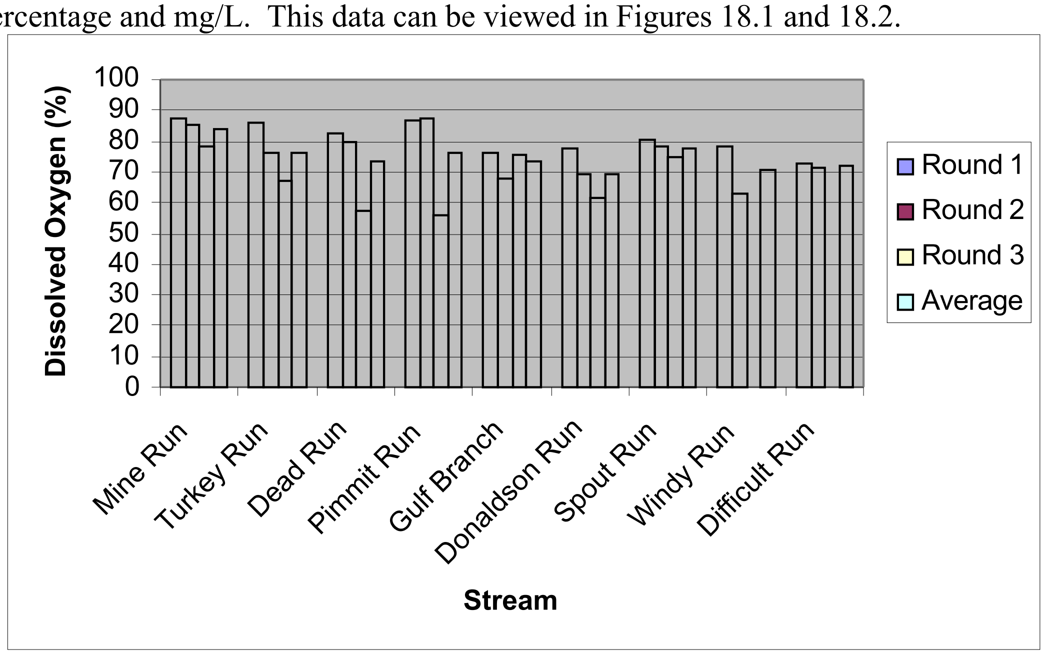


Figure 18.1: 2008 Measurements of Dissolved Oxygen (%)

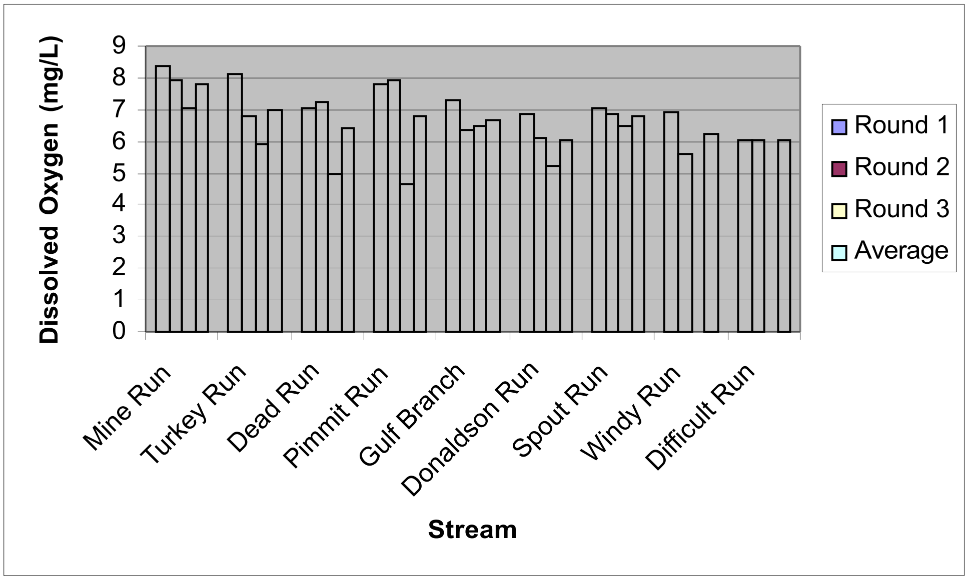


Figure 18.2: 2008 Measurements of Dissolved Oxygen (mg/L)

Conductivity is a measurement of the water's ability to conduct electrical current. Conductivity is measured in micro Siemens (uS). The highest conductivity measurements were taken at Spout Run with a seasonal average of 516.49 uS. The lowest conductivity measurements were taken at Mine Run with a seasonal average of 119.20 uS. The conductivity measurements at each round and the seasonal averages can be viewed in Figure 19.

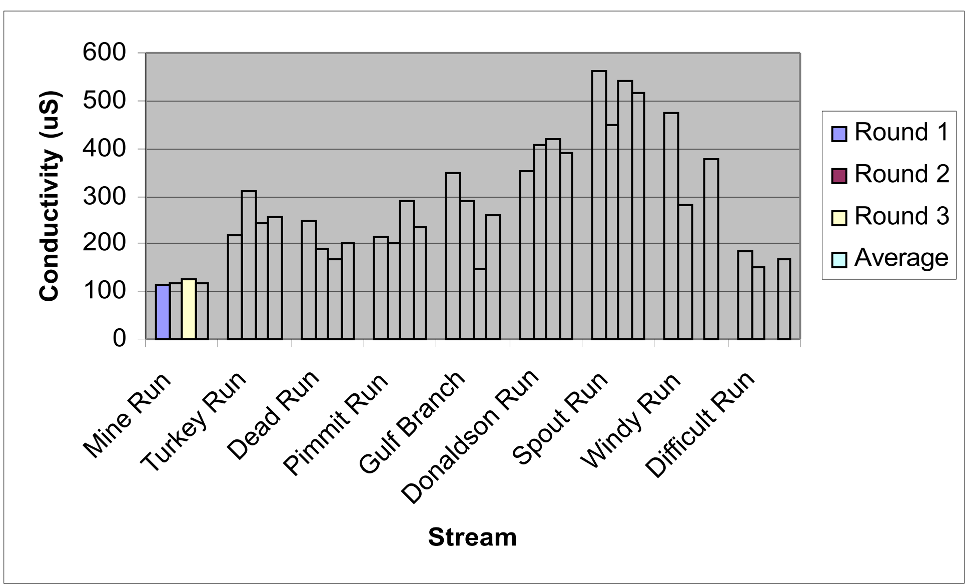


Figure 19: 2008 Stream Conductivity Measurements

Salinity is a measurement of the dissolved salt content of water. The highest measurements for salinity were found at Spout Run with an average of 0.27 ppt, and the lowest measurements were found at Mine Run, Dead Run, and Difficult Run with averages of 0.1 ppt. Salinity measurements of the three rounds and the seasonal average can be found in Figure 20.

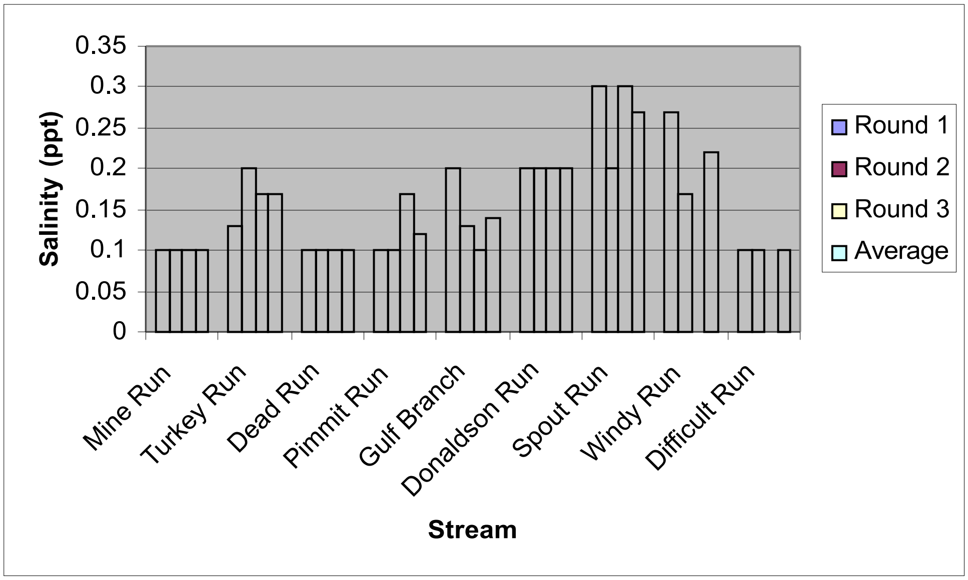


Figure 20: 2008 Salinity Measurements

Turbidity, written in Jackson Turbidity Units (JTUs), is a measurement of the suspended solids in water. Streams that are very turbid will often appear cloudy. For the 2008 season, the turbidity levels can be viewed in Figure 21.

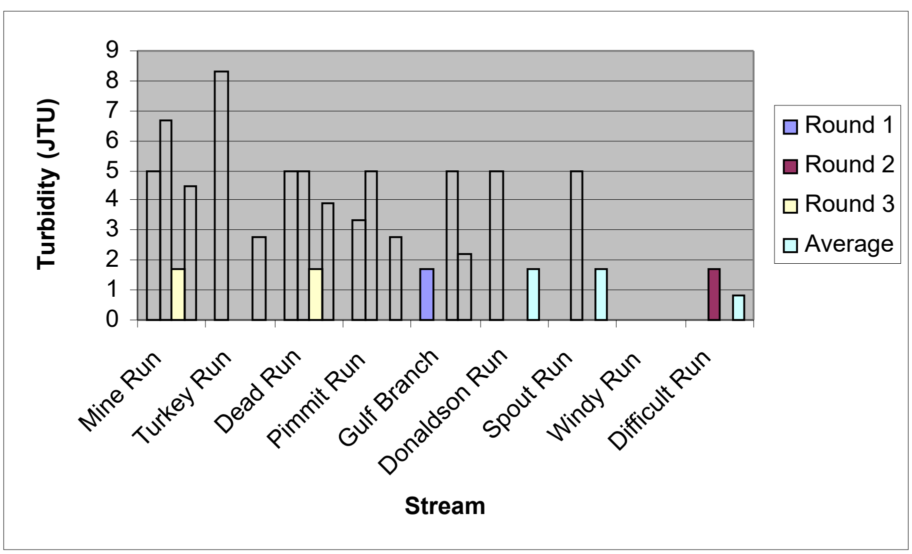


Figure 21: 2008 Turbidity Measurements

Habitat Assessment and Physical Characteristics

Appendix 9 shows habitat assessment and physical characteristics data. Barriers to fish movement, surface water appearance, stream bed deposit, odor, stability of stream bed, stream bank coverage, algae, algae color, stream channel shade, and stream bank erosion were visually assessed and categorized according to the Virginia Save Our Streams Stream Quality Survey Form (Appendix 8).

There were a number of wildlife sightings during the 2008 season. Fish were observed at seven of the nine monitored streams: Turkey Run, Dead Run, Donaldson Run, Difficult Run, Mine Run, Gulf Branch, and Pimmit Run. Waterfalls or large rocks were the main barriers to fish movement. Salamanders were observed at Turkey Run, Mine Run, and at Dead Run. Two eels were found this summer at Donaldson Run, which had historically been known as a tributary with eels. In 2001 a pesticide spill seemed to have eradicated the eels, and this may be the first written documentation of eel sightings on Donaldson since the spill. Also, at Donaldson there was a sighting of a groundhog near the bank of the stream. Horsehair worms (from the group Nemotomorpha) were found in Turkey Run, Gulf Branch, and Donaldson Run. Deer were spotted at Mine Run, Difficult Run, Pimmit Run, and Gulf Branch. There was also a snake spotted in the water at Difficult Run; however it was unable to be identified. It should be noted that copperheads are frequent in the Great Falls area, and that *all* snakes can swim (it is one method of thermoregulation).

Surface water appearance was described as “clear” at the majority of sample stations in 2008. The stream bed deposit was described as “brown/tan,” “silty,” “sandy,” and “muddy” during all three rounds at the majority of sample stations. The stream bed was termed stable for all stream stations, except for Dead Run, Turkey Run, Donaldson Run, and Pimmit Run. There were a number of occurrences of a sewage odor at Spout Run, Mine Run, Pimmit Run, Dead Run, Turkey Run, and Donaldson Run. Both Pimmit Run and Mine Run have sewer lines running nearby which may account for the odor, but it remains unknown whether there are sewer lines near the remaining streams.

Erosion potential of the stream banks varied from stream to stream. Most sites had severe or high erosion potential (25%-49%). Difficult Run was seen as having only moderate erosion potential. It is difficult to compare the changes in erosion potential between the years, as there are no exact guidelines to what each category means. For the sampling of 2008, any sites with large boulders and "beach" like areas, trees with roots partially or fully exposed, or steep undercut banks were deemed as "severe". Stream channel shade also varied from stream to stream. Most sites were moderately shaded (25%-49% of the channel was shaded), but Mine Run, Donaldson Run, Gulf Branch, Dead Run, Turkey Run, Spout Run, and Windy Run had one or more sites with high shade coverage (50%-74%). Difficult Run is the only stream to have been documented as having slight shade covering (1%-14%) for the 2008 season. Again, all data is subjective to human opinion. The shade may change depending on what time of day sampling is taken, and this is another reason maintaining a consistent sampling time is important.

Most sample stations contained some percentage of algae during all rounds of sampling. The algae were in the form of dark green, brown-coated, and/or matted on the stream bed. Difficult Run had the most algae of any stream, with documentation of having brown coated, dark green, and hairy algae. Water flow rates were noted as relatively normal, except for after storms when they would become high. This is another measurement which is difficult to remain precise over the years because of personal opinion as to what is seen as "normal" or "high".

Land Use

The USGS National Land Cover Data system was used to categorize land use in each of these watersheds (Figure 26a). The NLCD is a 21-class land cover classification system with a data resolution of thirty meters. Of the twenty-one land cover classifications fifteen were identified in the watersheds of these seven streams. In this report these fifteen land cover types were grouped into the following seven sets; Forest (evergreen forest, deciduous forest, mixed forest); Water Bodies (open water, emergent herbaceous wetlands, woody wetlands); Agriculture (pasture/hay, row crops); Urban Grasses (urban/recreational grasses); Other (transitional); Residential (low intensity residential, high intensity residential); Commercial (commercial/industrial/transportation); and rock (bare rock/sand/clay, quarries/strip mines/gravel pits). For a detailed description of these classifications see Appendix 13.

Figures 17-25 show land use in the watershed of each of the nine streams. Figure 26a shows the percentages of each type of land use as of 1993. Mine Run consists of 63.0% forested land and 28.8% agricultural land. Turkey Run watershed consists of 74.7% forested land and 18.4% residential/commercial land making it the most forested watershed and the second least residentially/commercially developed. Dead Run and Gulf Branch had similar percentages of residentially/commercially developed land with 48.6% and 47.6% respectively. Donaldson had a smaller percentage of residential/commercial land development with 30.0%. Pimmit Run has the second highest percentage of residentially/commercially developed watershed land with 54.6%. Finally, Spout Run contains the highest percentage of residentially/commercially developed watershed land with 79.2%, thus being subject to large amount of runoff from impervious surfaces.

DISCUSSION

The average health scores for each stream vary throughout the monitoring years. There does not seem to be a definite trend, with the exception of Difficult Run. As mentioned before, Difficult Run is the only stream to have seen significant improvement between last year (the first year it was monitored) and this year. It is important to also acknowledge the lack of data on the stream prior to 2007. The only alternative data obtained for this report on Difficult Run was listed in a 303(d) EPA document in which it was listed for PCBs in Fish Tissue, E. Coli, Benthic Macroinvertebrates, and Heptachlor Epoxide (US EPA 2006). Mine Run and Pimmit Run were also included on the 303(d) EPA document. Mine Run was listed for E. Coli, and Pimmit Run was listed for fecal coliform, PCBs in fish tissue, chlordane, and heptachlor epoxide. Mine Run remains with Difficult Run as being the only two streams at an “acceptable” level of health for the 2008 season.

Studies have shown that runoff from impervious surfaces is recognized as a significant cause of stream degradation (Stormwater, p.ES-8, 2001); therefore, it is crucial to note watershed land use in order to understand and thoroughly assess current and future impacts on stream health. Typically, watersheds with high percentages of impervious cover, such as buildings and paved surfaces, would contain streams with lower health scores than watersheds with less impervious surfaces, like forests or agricultural land. Mine Run contains the lowest percentage of highly impervious cover of the nine watersheds and, as expected, its health scores are among the highest with an average 8.56 in 2008 and a six year average (’01-’03, ’06-‘08) of 8.26. Turkey Run watershed is the most forested watershed and second least residentially/commercially developed, with a health score of 4.89 in 2008. Mine Run and Turkey Run have similar percentages of forested land but Mine Run has a larger percentage of agricultural coverage and

Turkey Run has a larger percentage of residential/commercial coverage. Even though there are similarities between these two watersheds, the scores of Turkey Run are very similar to the other five streams. This may be an indication that residential/commercial development may have a larger impact on stream health than agricultural development in this area. Dead Run and Gulf Branch had health scores of 4.67 and 5.22 respectively in 2008, and both have similar percentages of residentially/commercially developed land. Donaldson has a smaller percentage of residential/commercial land development and a stream health score of 5.67. Pimmit Run has the second highest percentage of residentially/commercially developed watershed land and received a score of 5.44 in 2008. Spout Run has the lowest average health score of 4.08 for the six year average, and contains the highest percentage of residentially/commercially developed watershed land (See Figures 24-33).

While the multimetric scores focus on the macroinvertebrates, the water chemistry data collected also plays an important role in identifying the health and concerns of the streams. Nitrate is an oxidized form of Nitrogen, and is an important nutrient in healthy environments. The presence of Nitrates can occur naturally in streams from eroding rocks, soils, and animal and plant wastes. Nitrate can also enter the stream through human activity from "wastewater treatment plants, runoff from fertilized agricultural lands, lawns, and golf courses, runoff from grazing animals, and commercial cleaning activities (*Heal the Bay*, 2008)." Increased nitrogen levels can cause algal blooms, which deplete the water of dissolved oxygen upon decay. The US EPA Maximum Contaminant Level (MCL) of Nitrate found in streams is 10.0 ppm. Throughout sampling season, the Nitrate tests for the all of the streams remained below the MCL with a range of 0.5 ppm to 5.0 ppm. Analysis of season averages for Nitrate levels shows that the streams near residential areas (Spout Run, Windy Run, Donaldson Run, and Gulf Branch) maintained average of 3.0 ppm and above, higher levels of Nitrate than the other streams.

Conductivity is the measure of how well water passes an electric current and indirectly measures the presence of inorganically dissolved solids (salts and metals such as nitrate and sodium). An increase in conductivity indicates an increase of the levels of dissolved solids. Too many dissolved solids cause water balance problems and decrease the level of dissolved oxygen. The healthy conductivity range for fresh waters is 10-500uS (Mackie, 2004). All streams, except for Spout Run, maintained a score in the range. The conductivity season average for Spout Run is 516.49 uS. The high levels of nitrate found in Spout Run may attest for the higher conductivity reading (See Figure 22).

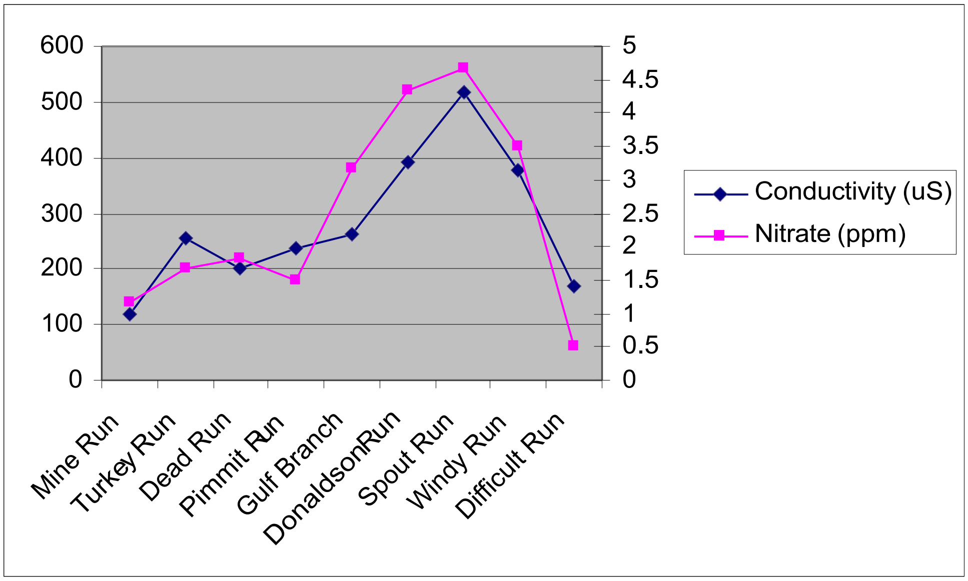


Figure 22: 2008 Conductivity and Nitrate Comparison

Salinity is a measurement of sodium found in the streams, and sodium is another inorganically dissolved compound that is measured by conductivity. Again, Spout Run contained the greatest average measurement of salinity, another possible explanation as to the high conductivity readings for the season (See Figure 23).

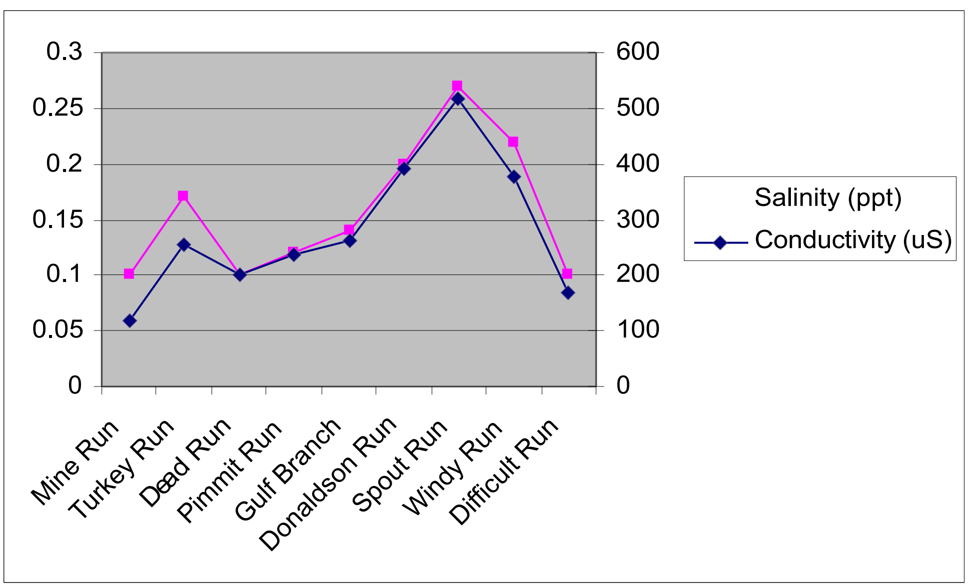


Figure 23: 2008 Conductivity and Salinity Comparison

For life to exist in streams, the water quality parameters must be within certain ranges. The optimal range of pH that aquatic organisms will tolerate is 6.5 to 8.2, all relatively neutral. Extreme alkalinity or acidity can disrupt biochemical reactions necessary for the life processes of organisms. In 2008, the pH at every site was slightly basic and fell in this range.

Dissolved Oxygen is essential for the survival of benthic macroinvertebrates. Levels less than 3mg/L are stressful for the organisms, and a healthy stream is considered to be 90-100% saturated (Murdock 2001). Dissolved oxygen levels are affected by temperature; stream flow, presence of aquatic plants, and dissolved or suspended solids. Stream shade also affects dissolved oxygen; more light increases the temperature of the water, which then decreases the dissolved oxygen. All dissolved oxygen levels measured in 2008 were below those of a healthy stream but all of the sites had adequate (3 or higher) levels in mg/L. Algae were present during the 2008 season in most of the streams, and may have affected the dissolved oxygen concentrations. “Green plants release oxygen underwater during photosynthesis. Maximum amounts of DO are produced with the energy of the late afternoon sun. (*Heal the Bay*, 2008).” Depending on the time of day the sample was taken, concentrations of DO may vary.

Turbidity is the measure of the amount of suspended solids in the water, or how cloudy the water is. Suspended solids can increase the temperature of water, block/absorb light, and clog the gills of organisms. The increase of temperature then depletes the amount of dissolved oxygen. Water becomes turbid because of plankton, soil as a result of erosion, and other solids in the water. These solids can carry nutrients and pesticides, which decrease the water quality. In 2008, turbidity was always low (See Appendix 9).

Figure 24: Watershed Land-Use

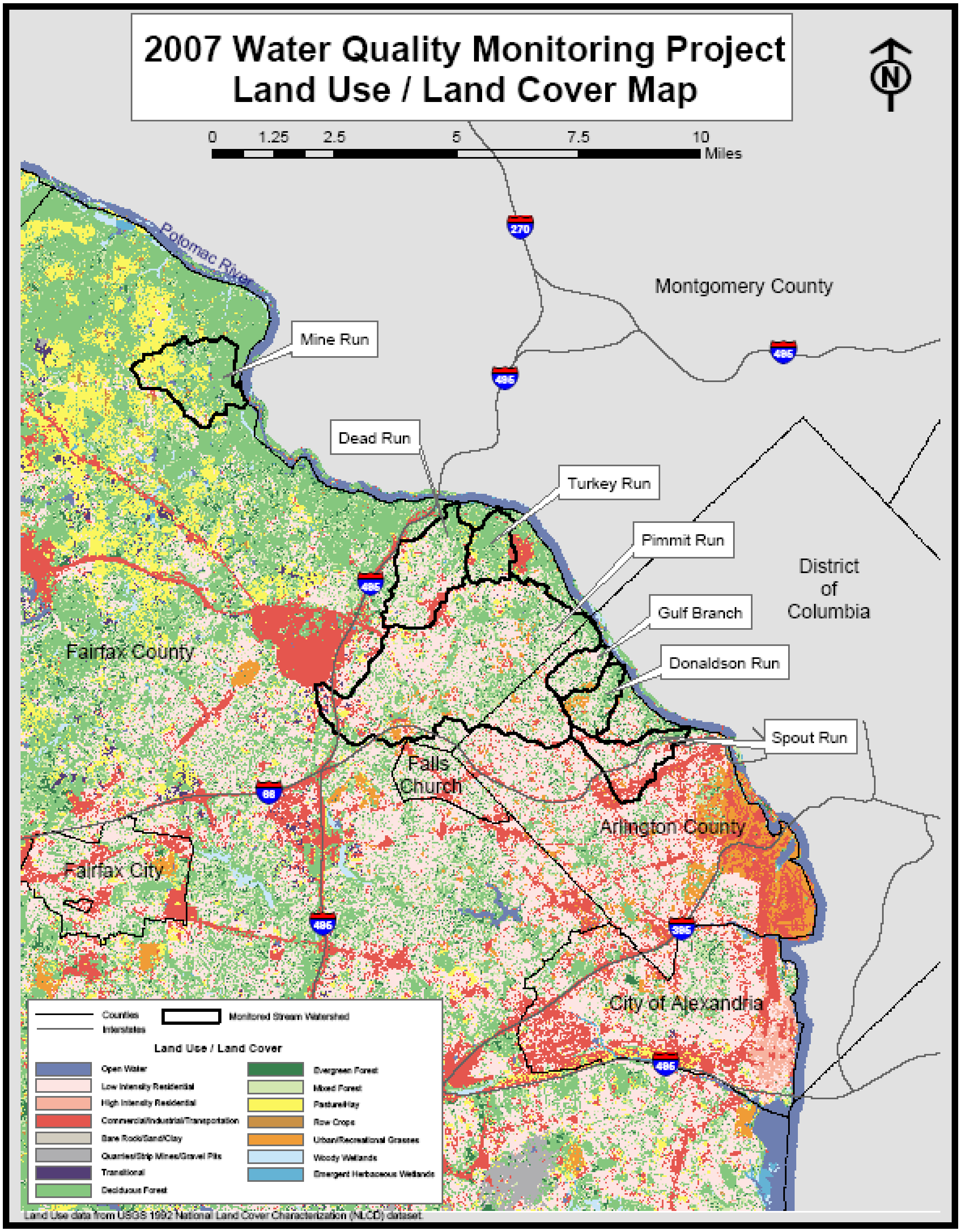


Figure 25: Watershed Land-Use: Mine Run

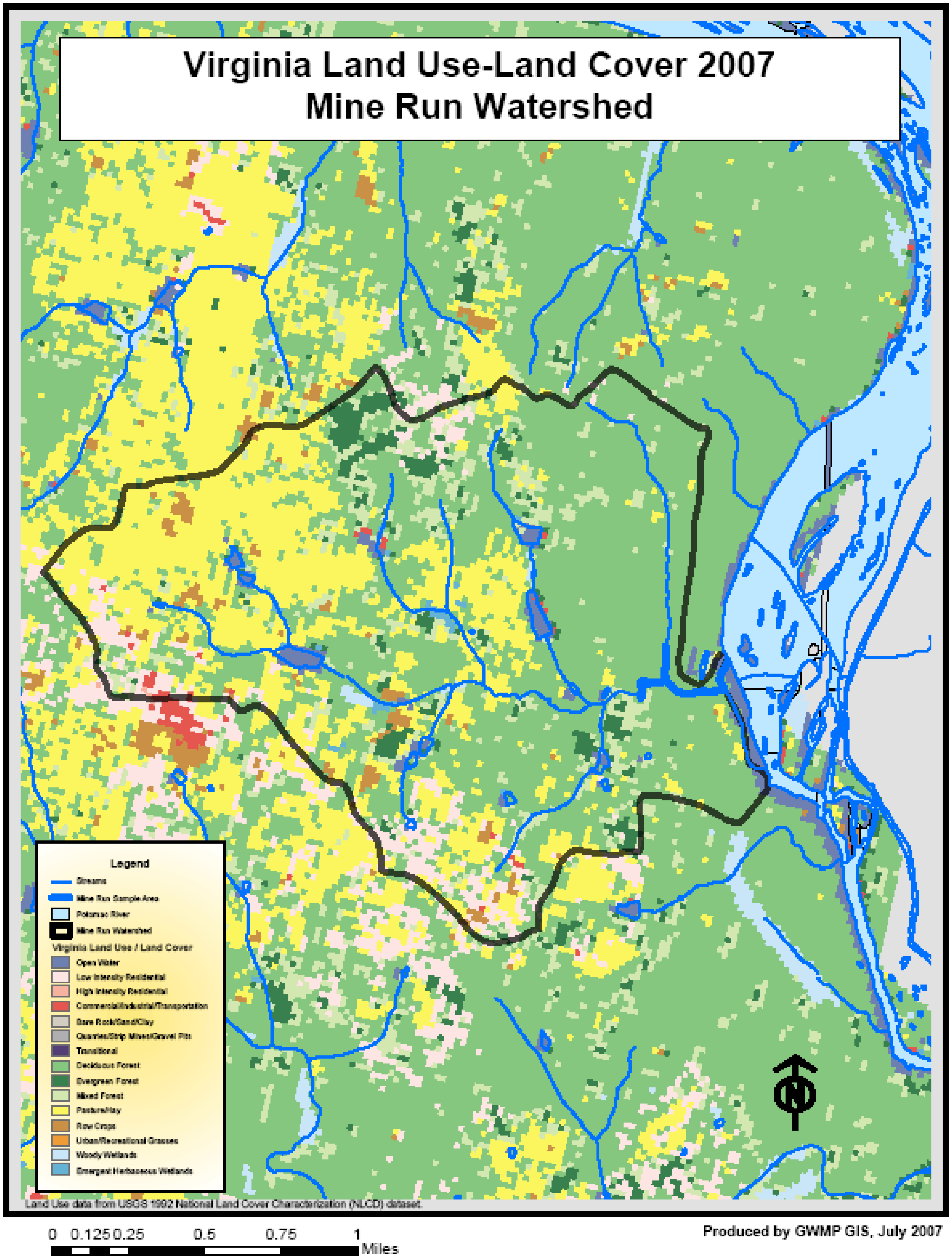


Figure 26: Watershed Land Use: Turkey Run

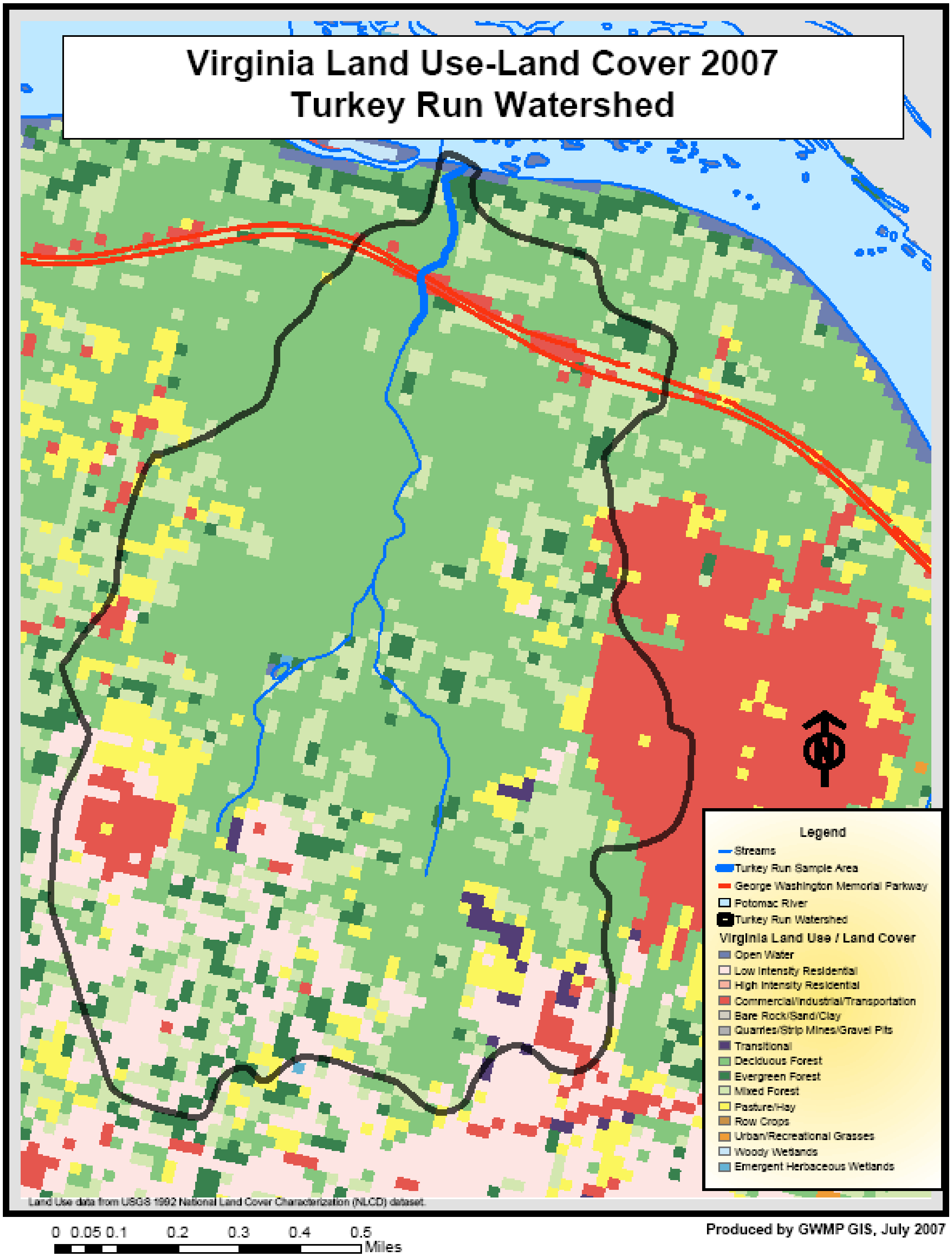


Figure 27: Watershed Land Use: Dead Run

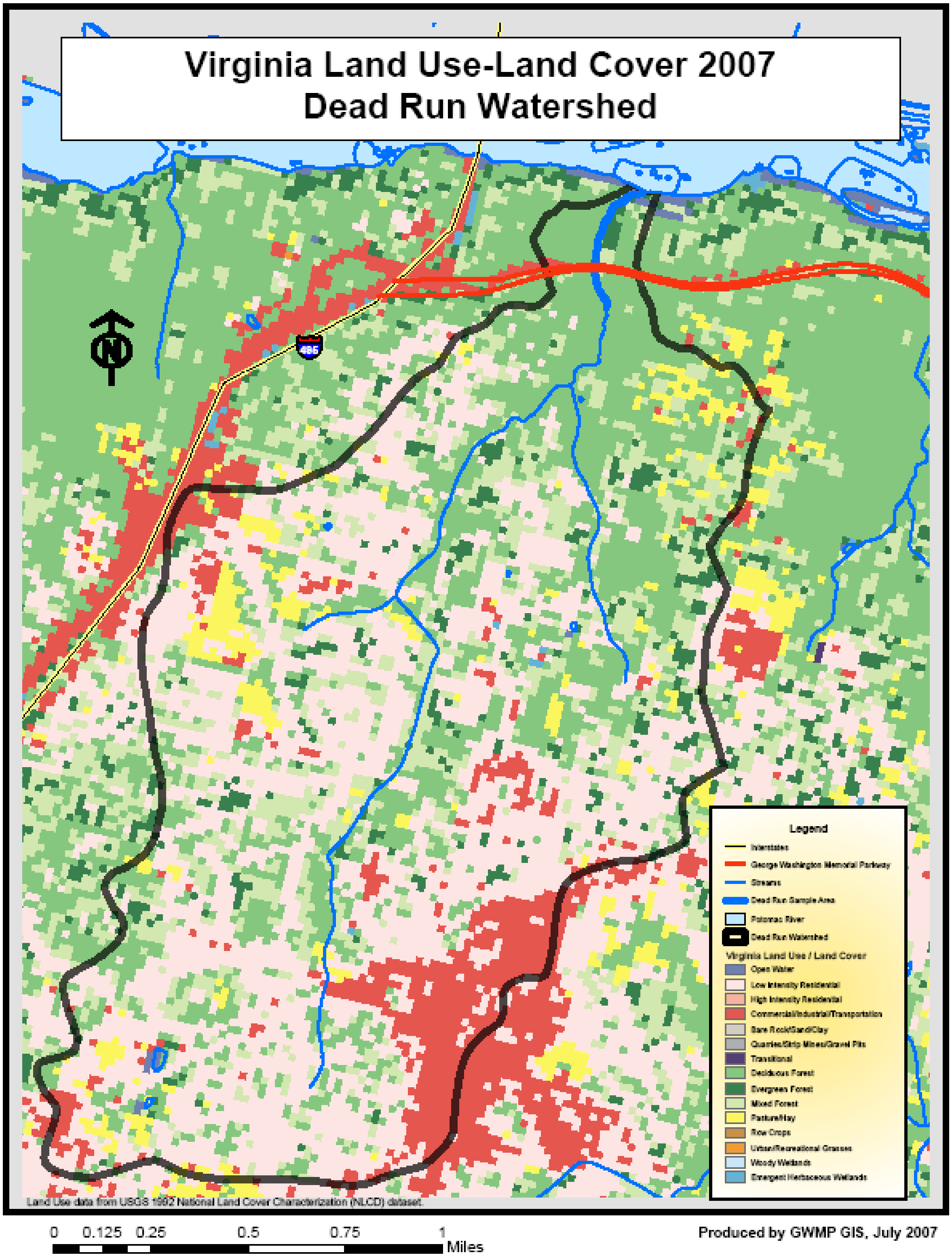


Figure 28: Watershed Land Use: Pimmit Run

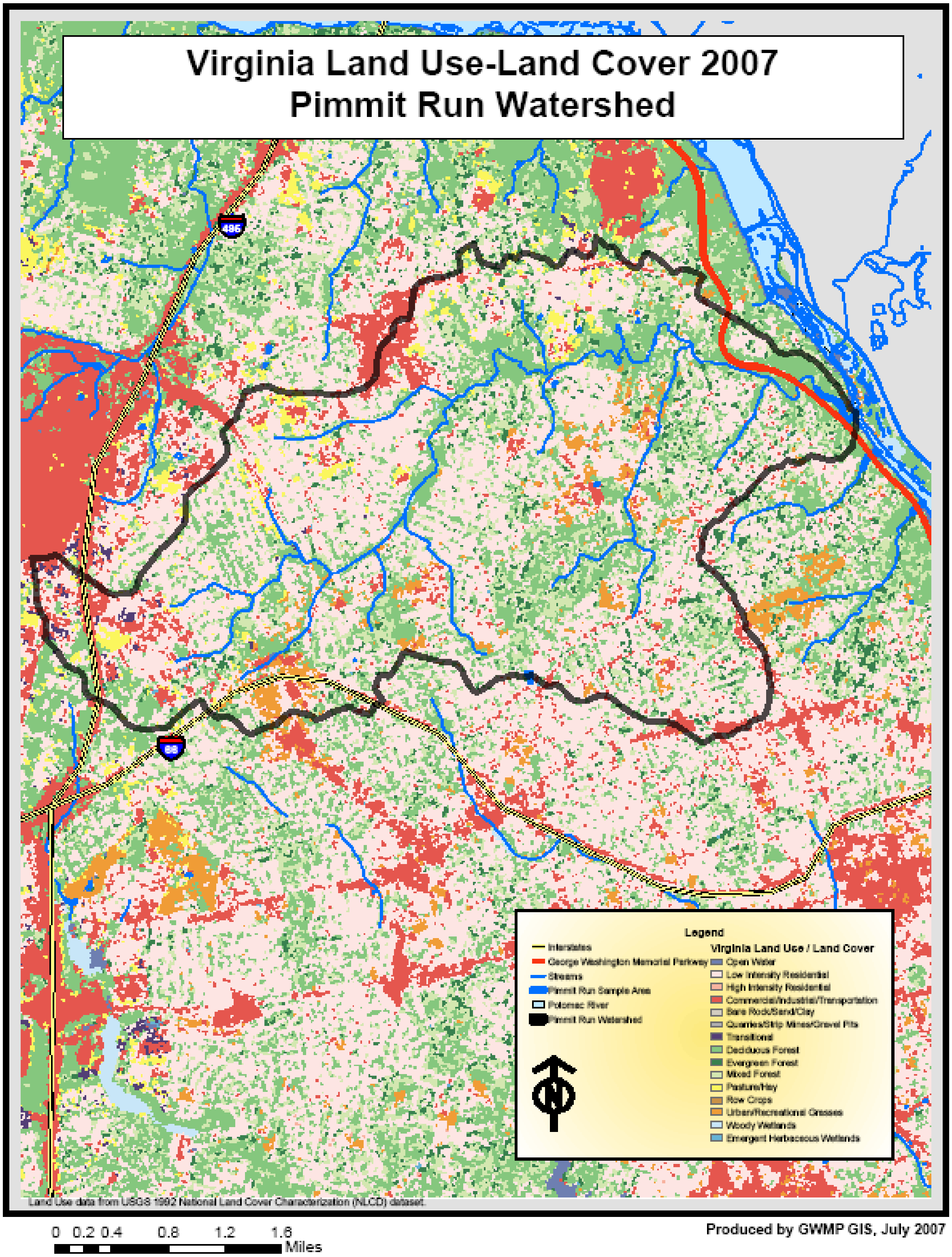


Figure 29: Watershed Land Use: Gulf Branch

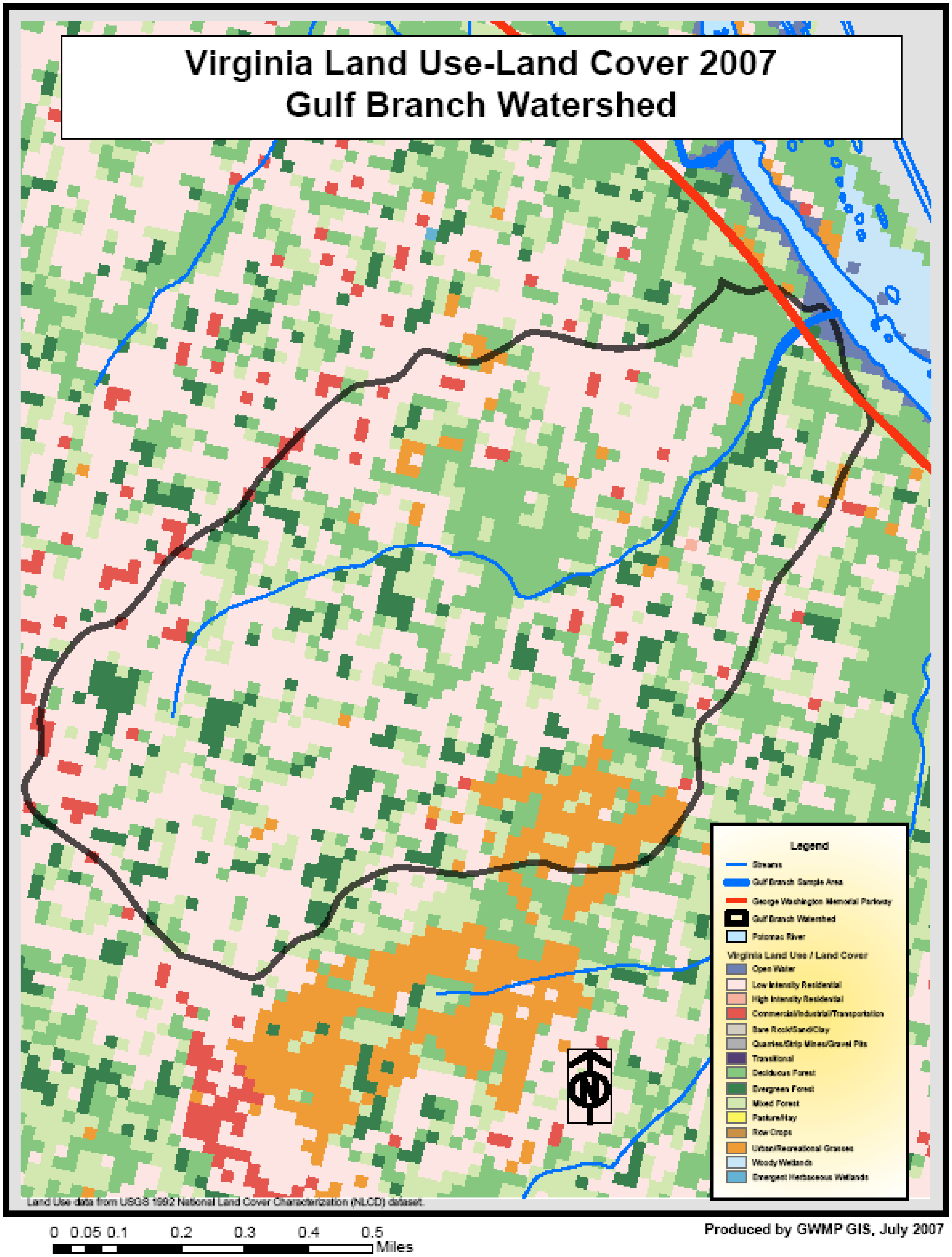


Figure 30: Watershed Land Use: Donaldson Run

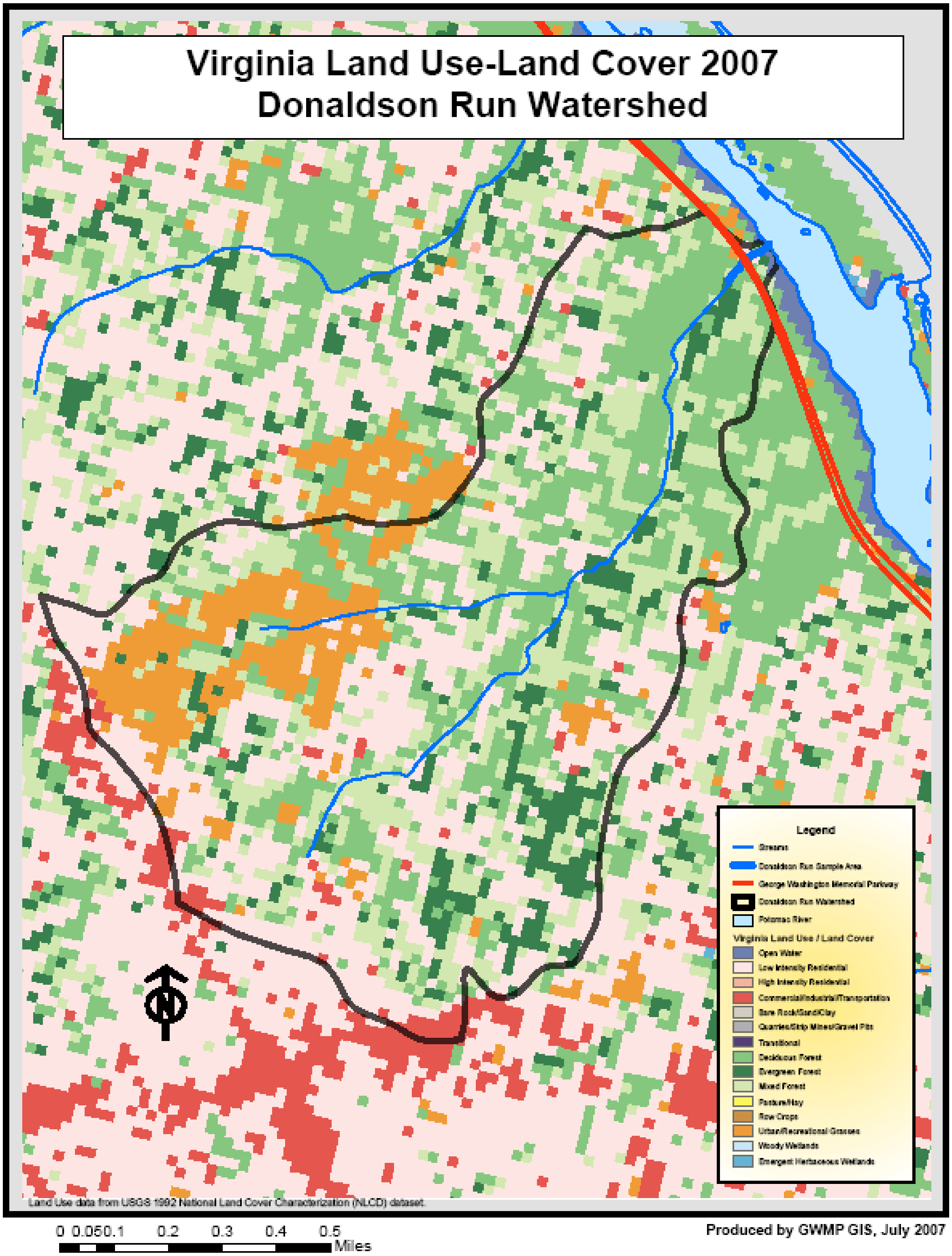


Figure 31: Watershed Land Use: Spout Run

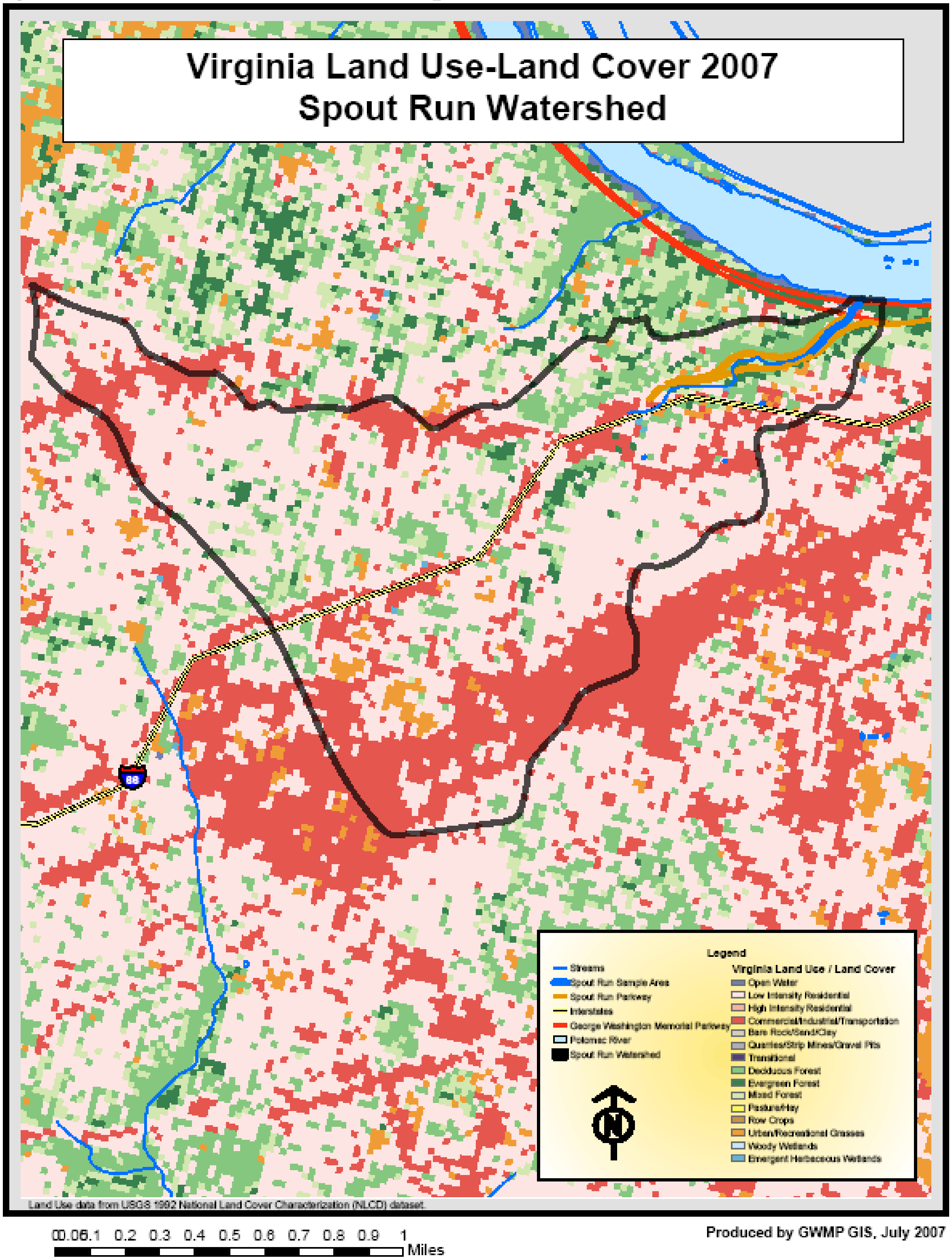


Figure 32: Watershed Land Use: Windy Run

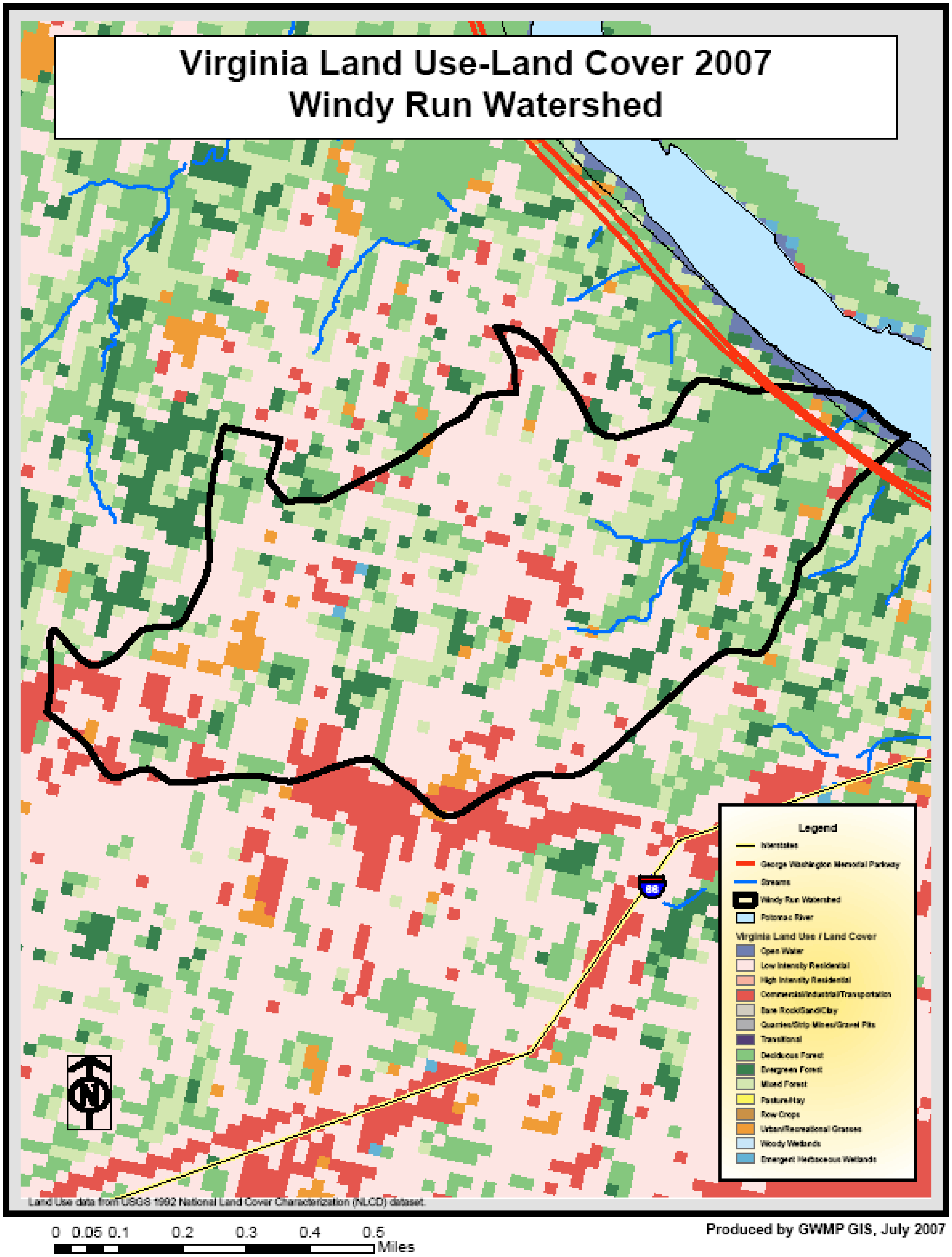


Figure 33: Watershed Land Use: Difficult Run

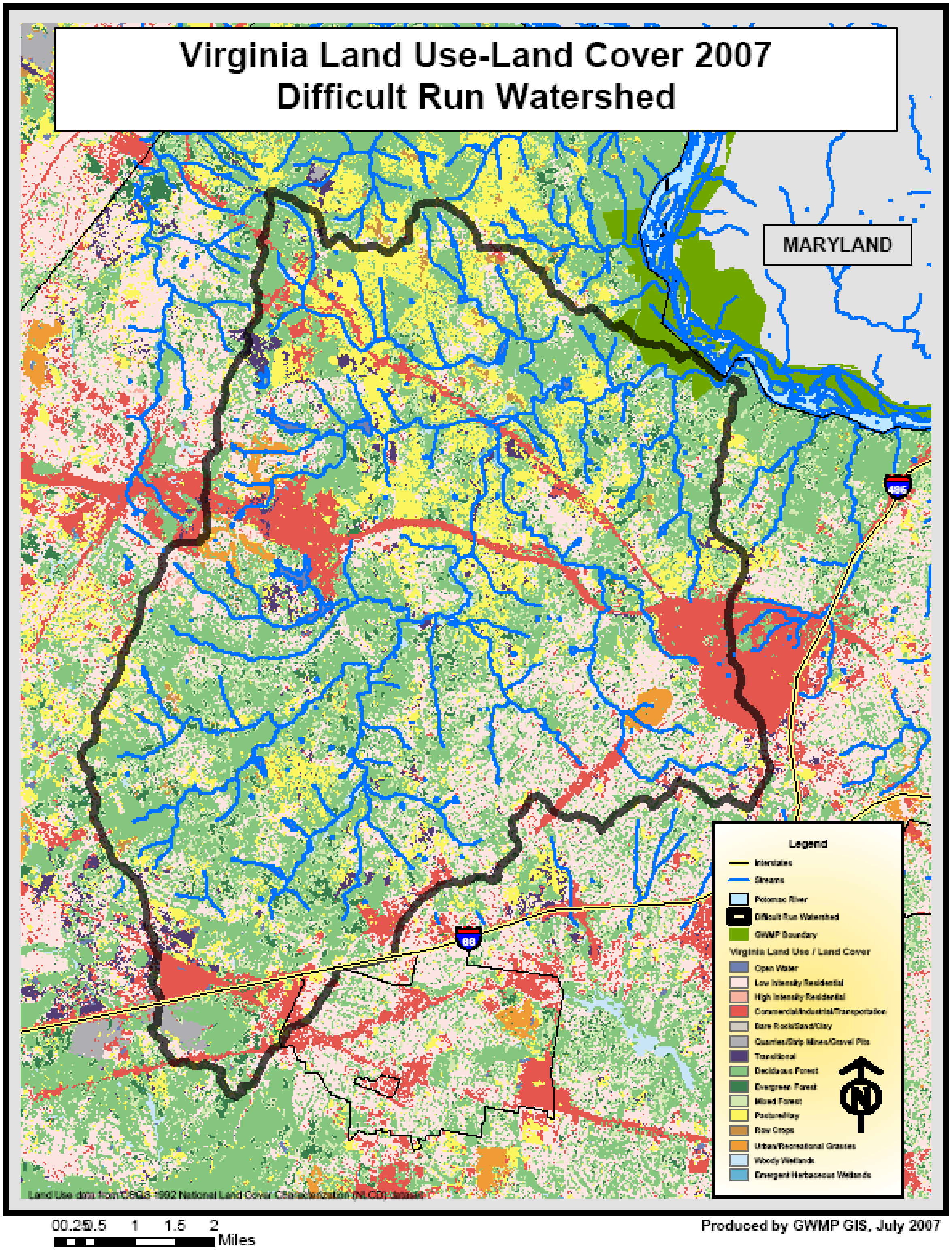


Figure 34a: Watershed Land Use

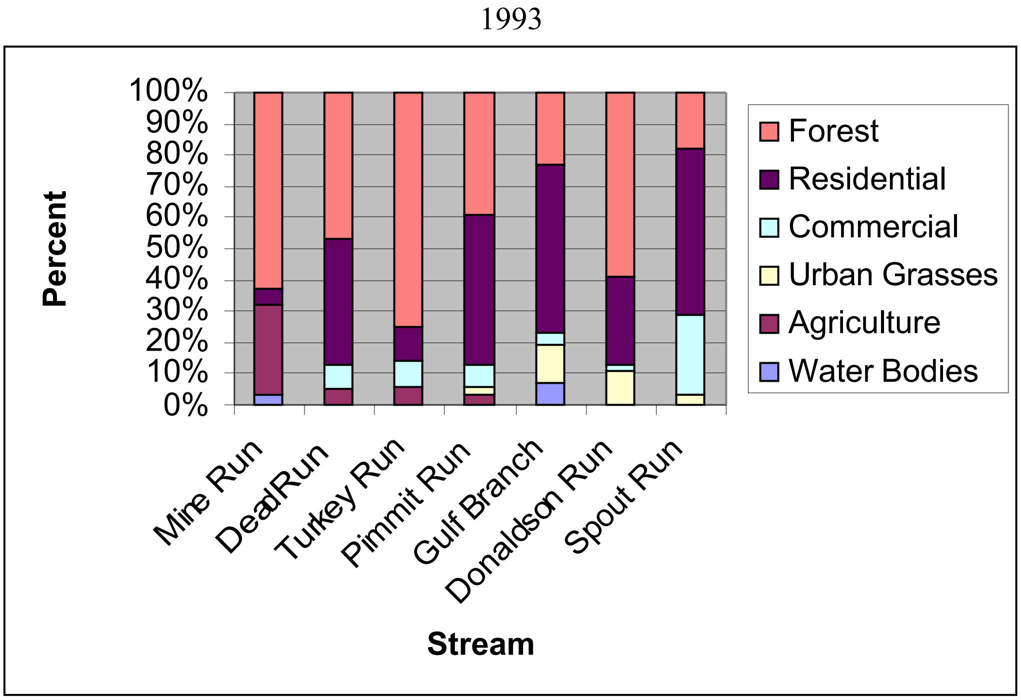


Figure 34b: Watershed Land Use

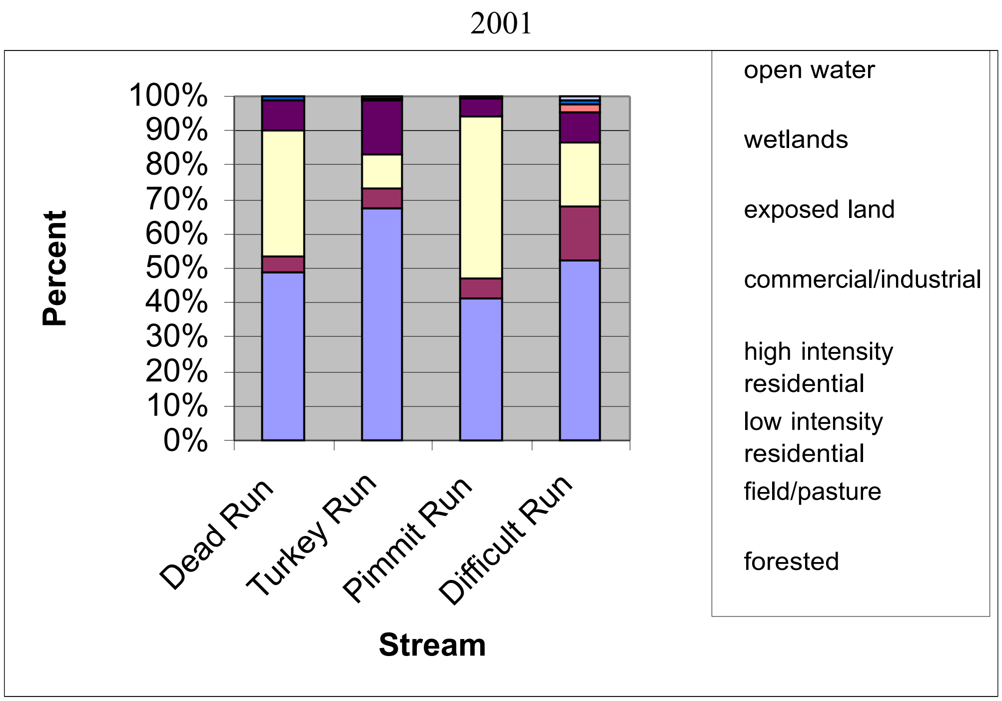
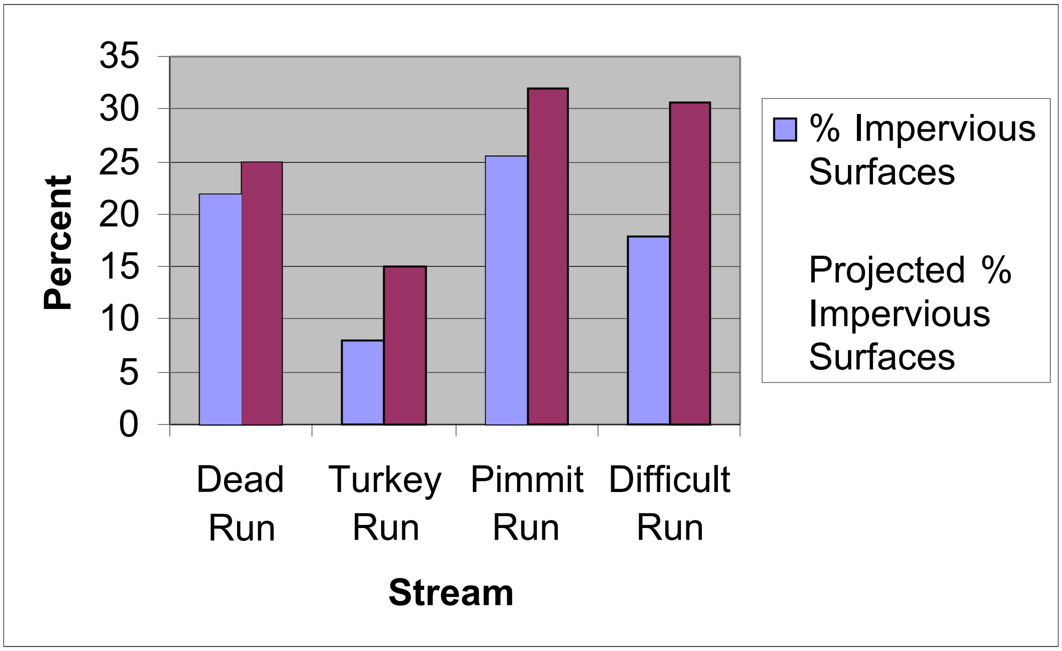


Figure 35: Impervious Surfaces in Fairfax County Watersheds (2001)



Effects of 2001 Pesticide Spill on Gulf Branch and Donaldson Run

On August 23, 2001 Donaldson Run and Gulf Branch were contaminated with pesticide runoff from a neighboring golf course, killing fish and macroinvertebrates. Two rounds of samples had been collected pre-contamination and one round post-contamination provided valuable data prior to and after impact. Data from rounds one and two, pre-contamination, for Donaldson Run revealed macroinvertebrate density / (richness) of 23.93 / (13) and 4.20 / (13). Round three, post-contamination, data revealed a density / (richness) of 0.03 / (2). The minimal number of macroinvertebrates (200) were not present at Donaldson Run during round two, stations two and three, and all stations in round three (Table 2). Gulf Branch recorded 20.80 / (14), 2.42 / (9), and 0.98 / (3) for density / richness per round in 2001. Only round one had statistically valid counts for Gulf Branch. Data from 2001 revealed significant impacts between sampling rounds, and of valid samplings, pre-contamination health scores were 5.50 and 6.67 for Donaldson Run and Gulf Branch respectively.

In 2002 density / (richness) were recorded as 26.17 / (11), and 17.85 / (10) for rounds one and two of Donaldson Run. Gulf Branch density / (richness) were 21.56 / (13) and 18.04 / (17). Donaldson Run round two, station two was the only sampling event that had less than the required 200 macroinvertebrates. Stream health scores were 4.20 for Donaldson Run and 4.17 for Gulf Branch.

In 2003, Gulf Branch and Donaldson Run were monitored for three rounds, two years after pesticide contamination. Density / (richness) of benthic macroinvertebrates collected during 2003 at Donaldson Run was approximately 14.30 / (13), 26.30 / (10), and 28.37 / (13) during rounds one, two, and three, while Gulf Branch density / (richness) were 1.86 / (11), 3.54 / (9), and 13.84 / (11). In 2003, Donaldson Run received an average health score of 4.78, and Gulf Branch received an average health score of 4.25. At least 200 individuals were collected at Donaldson Run making all samples for Donaldson Run statistically valid. At Gulf Branch five of nine samplings produced less than 200 individuals.

Density / (richness) values for Donaldson Run in 2006 were 52.11/ (8) and 58.85 / (12) for rounds one and two, with an average health score of 4.17. Density / (richness) values for Gulf Branch were 16.53 / (12) and 113.86 / (12) for rounds one and two, with a health score of 5.00 for 2006.

Density / (richness) values (macroinvertebrates per square foot / (number of species found)) for Donaldson Run in 2007 were 59.4/ (12) and 42.23/ (13) for rounds one and two, with an average health score of 5. Density / (richness) values for Gulf Branch in 2007 were 11.67/ (12) and 26.795/ (11) for rounds one and two, with an average health score of 4.5.

Density/ (richness) values at Donaldson Run in 2008 were 28.94/ (11) [Round 1], 98.00/ (11) [Round 2], and 72.17/ (11) [Round 3]. The 2008 season average health score for Donaldson Run is 5.67. The density/ (richness) values at Gulf Branch in 2008 were 65.07/ (13) [Round 1], 82.00/ (10) [Round 2], and 145.67/ (10) [Round 3]. The 2008 season average health score for Gulf Branch is 5.22.

There is no data to support whether a recovery to pre-contamination conditions has occurred for Donaldson Run and Gulf Branch. Past species density / (richness) calculations were not explained in previous reports. Prior to the sampling season of 2007 the sampling technique used did not produce statistically valid results for many sampling sites because less than 200 macroinvertebrates were collected. Therefore, a statistical analysis comparing data collected for each season prior to 2007 would not be valid for most sites. It is impossible to statistically analyze the density/ (richness) data for the years 2001-2008, and therefore no claim can be made on whether the species density / (richness) has returned to pre-contamination levels.

EDUCATION AND OUTREACH

During the summer of 2008, there were two educational programs given. The first education program was given on May 31st, 2008 during the Riverbend Festival located outside of the visitor center at Riverbend Park in Great Falls, VA. The Riverbend Festival was centered around water recreation and water quality. They had a number of programs such as fishing, kayaking, a puppet show teaching kids about the importance of healthy streams and animal habitats. There were also tables with representatives from REI, The Nature Conservancy, among others. John Callow of Fairfax County had asked Joanna Cornell to provide a water quality monitoring demonstration during the festival. She contacted us, and asked that we would lead the demonstration for the festival. We provided samples of benthic macroinvertebrates from the GWMP's collection, and led two groups of children and adults through the process of sampling in the stream. Each group was taught an overview of what a watershed is and how humans affect it, as well as how the watershed inversely affects humans. Approximately 25 people participated in this program.

The second educational program was on July 8th, 2008 at George Mason University. Beth Murphy, a teacher for a summer program for children at GMU, had asked for help with presenting a demonstration of water sampling techniques to children at the camp. The children who were attending the camp were between 10 and 12 years of age, 24 people total. The campers made connections with pollution and its effects on wildlife and human health. The camp is geared at having children understand the importance of water quality in their watershed. Techniques on sampling with the kick-seine net were shown, and two sample nets were taken from the small creek that ran through the campus. The samples were laid out on two portable tables, allowing the students to pick the macroinvertebrates from the net using tweezers and paint brushes. Three field microscopes and many viewing boxes were laid out for them to use. There were two species that the kids really enjoyed. The first was the snail, and the second a leech. The demonstration seemed to have made a lasting impression on some of the campers and focused them for the next section of the camp.

Over the 2008 season of the water quality monitoring program, a number of guests and volunteers were able to join us in the field. The first guest was Nick Horrock, a local Fairfax County newspaper reporter, who met with us at Gulf Branch in Arlington, VA. Nick Horrock was interested in the water quality monitoring program for a series of articles on watersheds and water quality for *The Connection Newspapers*. He did write two articles which included information about the water quality monitoring program. Tyler Fox was the second guest to come into the field with us. Tyler worked for the Episcopalian Diocese in Virginia, and was interested in volunteering with us for a day at Mine Run to learn the process of sampling. By volunteering with us, he gained the knowledge of monitoring that he needed in order to incorporate a water monitoring program for a summer camp. The last guest we had in the field was Daniel Parr, a fellow Student Conservation Association intern who was interested in documenting our field work for the SCA headquarters. Daniel met with us on Difficult Run, and took a series of photographs as we shared stories about the SCA program and experiences in the field. Over the 2008 season, roving contacts were made during field days and amounted to over 125 people. Most roving contacts were met at Donaldson Run, Pimmit Run, Gulf Branch, Windy Run, and Turkey Run. There were no roving contacts at either Spout Run or Dead Run.

SOURCES OF ERROR

In this study, there are many things that could have caused error in the data. The sites are not always the same from year to year. As water levels change, riffle positions also change. Some sites from previous years are no longer fit to be sampled, so other nearby riffles are chosen. Also, the amount of time between rounds at each site varied as well as the intensity of the shuffling for each sample. This could have had an effect on the data. These variants are very difficult to avoid because of weather and human inconsistencies.

There are also many sources for human error in this study. Human error is hard to prevent when using qualitative tests, for example when testing for nitrate/nitrite and evaluating turbidity. Both tests involve color comparisons, which introduce error because they are not exact measurements and may not be consistent. It is similar when it comes to judging stream flow rate; for example, what was considered "normal" this year may have been "low" last year. Without knowledge of stream-flow regularity, it remains difficult to assess the stream flow rate.

RECOMMENDATIONS

From the data collected we can see there is a possible link between increased human development outside of GWMP and stream health scores. Most development occurs outside the park boundaries. Active communication and partnerships with the park and its watershed neighbors are needed to develop management strategies that reduce their impact on these streams. Public awareness programs could be implemented further in order to inform local landowners, community leaders and policy makers on the health status of their watershed, making people aware of their environment and suggesting ways to improve its health status. One way this could be done is by putting up signs indicating watershed boundaries and the presence of stream monitoring sites (Fairfax County Storm Water Planning Division, 2001). More specifically, hazardous waste collection and disposal methods could be publicized throughout communities within the watersheds and community stream cleanups could be organized. Also, future renovation or development projects need to consider environmentally friendly storm water management and land use practices, such as riparian revegetation and tree planting (Fairfax County, 2001). This would help to prevent or diminish impacts on these and other Potomac tributaries.

Water chemistry parameters are affected by the sunlight which drives the fluctuations of photosynthesis and respiration of the algae. These processes have affects on dissolved oxygen. For this reason it is suggested that the times of the water chemistry tests remain constant at each site, every round. If all times are constant and the readings are relatively constant every time at every site, then it is possible to identify changes taken place by something other than natural fluctuations.

Nitrate levels and conductivity levels may spike during rainy periods. For this reason it is a good idea to keep track of daily rainfall (Appendix 13). A storm the day before a sampling period may account for a spike in nitrate or conductivity levels. Otherwise, a spike in these parameters may indicate human interference.

To help identify more specific sources of pollution, sites could be added to upstream tributaries. In the case of Dead Run, adding site three up to a tributary south of the George Washington Memorial Parkway could help clarify the magnitude of the impact the parkway has on the stream. Adding site one of Pimmit Run south to the Glebe Road tributary could also help in the same way. Adding these new sites could be considered if time permits.

Collections of beetles, where present, were taken at each station during the 2008 season. This collection was the beginning of a Parkway-wide beetle survey. A comprehensive beetle survey is scheduled for the near future.

During the 2008 season, a strange discoloration of water entering Pimmit Run was noted. The discoloration may be due to a presence of red algae. It was recommended that water samples be taken in order to run an IC anion scan and to test for E. coli. The Aquatic Ecologists at the Center for Urban Ecology have suggested that the samples be sent to an independent lab (EnvioChem). Additional funds should be dedicated for laboratory testing of suspicious sites.

There is a concern about stream bank loss due to erosion for the GWMP. Stream bank erosion is monitored using the VASOS data protocol, however it is a subjective test and is not quantitative. To keep track of this stream bank loss more accurately, it is recommended that bank to bank measurements at each sampling station are conducted.

In regards to future water quality monitors, there are several recommendations we can offer to better the summer experience. Remain consistent with previous sampling times (Appendix 10). Also, because community outreach is vital to this program and its efforts, it may be wise to begin making contacts early on in the season. Joanna Cornell is a key contact, and should provide a source for more community opportunities and involvement. Perhaps a press release would be beneficial in addressing the outside community, and provide an invitation for volunteers to join the monitors in the field (Note that all press releases must go through Dana Dierkes/Public Relations). It would be beneficial to include an orientation/seminar session with *Bridging the Watershed* early on in the summer experience.

CONCLUSIONS

The George Washington Memorial Parkway Stream Monitoring Program efforts have provided valuable baseline data and have proven to be useful in identifying health trends of the seven monitored streams. Unlike past seasons, no streams received consistent acceptable health scores. Furthermore, Dead Run, Turkey Run, Pimmit Run, Gulf Branch, Donaldson Run, and Spout Run have consistently been rated as “unhealthy” streams during all monitoring seasons. These monitoring efforts have also proven to be useful in identifying impacts; such as the case with the 2001 contamination of Gulf Branch and Donaldson Run. Gathering data from streams that have never been monitored is also important for evaluating the water quality in a large area.

Continuation of this stream monitoring program will account for annual variation and improve estimates of stream health. Furthermore, the data collected during the stream monitoring program will continue to be shared with local agencies to aid in future stream protection and restoration efforts. These efforts allow the George Washington Memorial Parkway to work with its upstream neighbors to better protect water resources, both inside and outside park boundaries.

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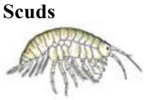
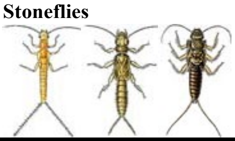
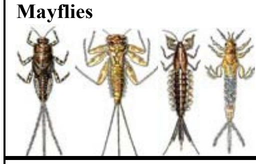
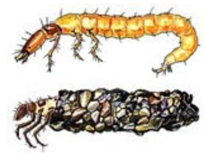
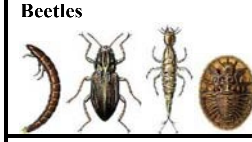
Appendix 1: Virginia Save Our Streams Macroinvertebrate Tally Sheet

Macroinvertebrates	Tally	Count
Worms 		
Flat Worms 		
Leeches 		
Crayfishes 		
Sowbugs 		
Scuds 		
Stoneflies 		
Mayflies 		
Dragonflies and Damselflies 		
Hellgrammites, Fishflies, and Alderflies 		

Illustrations from: Voshell, J. R., Jr. 2001. Guide to the Common Freshwater Invertebrates of North America. MacDonald and Woodward Publishing Co. With permission of the author.

Macroinvertebrates	Tally	Count
Common Netspinner Caddisfly 		
Most Caddisflies 		
Beetles 		
Midges 		
Black Flies 		
Most True Flies 		
Gilled Snails 		
Lunged Snails 		
Clams 		
Other		
Total number of organisms in the sample		

Appendix 2: Individual Category Metrics

Metric	Number		Total number of organisms in the sample		Percent
Mayflies + Stoneflies + Most Caddisflies		Divide by		Multiply by 100	
Common Netspinners		Divide by		Multiply by 100	
Lunged Snails		Divide by		Multiply by 100	
Beetles		Divide by		Multiply by 100	

% Tolerant

Taxon	Number
Worms	
Flatworms	
Leeches	
Sowbugs	
Scuds	
Dragonflies and Damselflies	
Midges	
Black Flies	
Lunged Snails	
Clams	
Total Tolerant	
Total Tolerant divided by the total number of organisms in the sample	
Multiply by 100	

% Non-Insects

Taxon	Number
Worms	
Flatworms	
Leeches	
Crayfish	
Sowbugs	
Scuds	
Gilled Snails	
Lunged Snails	
Clams	
Other non-insects (organisms without 6 jointed legs)	
Total Non-Insects	
Total Non-Insects divided by the total number of organisms in the sample	
Multiply by 100	

Appendix 3: Save Our Streams Multimetric Index

Determine whether each metric should get a score of 2, 1, or 0. Write your metric value from the previous page in the 2nd column (Your Metric Value). Put a check in the appropriate boxes for 2, 1, or 0. Then calculate the subtotals and Save Our Streams Multimetric Index score and determine whether the site has acceptable or unacceptable ecological condition.

Metric	**Your Metric Value**	**2**	**1**	**0**
% Mayflies + Stoneflies + Most Caddisflies		Greater than 32.2	16.1 – 32.2	Less than 16.1
% Common Netspinners		Less than 19.7	19.7 – 34.5	Greater than 34.5
% Lunged Snails		Less than 0.3	0.3 – 1.5	Greater than 1.5
% Beetles		Greater then 6.4	3.2 – 6.4	Less than 3.2
% Tolerant		Less than 46.7	46.7 – 61.5	Greater than 61.5
% Non-Insects		Less than 5.4	5.4 – 20.8	Greater than 20.8
		Total # of 2s:	Total # of 1s:	Total # of 0s:
Subtotals:		Multiply by 2:	Multiply by 1:	Multiply by 0:

Now add the 3 subtotals to get the Save Our Streams Multimetric Index score:________________

_____Acceptable ecological condition (7 to 12)   _____Unacceptable ecological condition (0 to 6)

Appendix 4: YSI, Model 85, Meter Instructions (YSI, 1996)

When storing the YSI meter always **keep the probe in the storage chamber**. Always **keep the circular sponge damp** using three to six drops of distilled water to moisten it.

Calibrating for Dissolved Oxygen

1. Calibrate for dissolved oxygen before each use.

2. Keep the small round sponge wet with three to six drops of distilled water. Put the sponge inside calibration/storage chamber. Insert the probe into the calibration chamber.

3. Turn the YSI on by pressing the **ON/OFF** button. Once the YSI is on, press **MODE** until dissolved oxygen is displayed in **mg/L** or **%**. Now wait ~15 minutes to allow the unit to warm up and for the readings to stabilize.

4. Find out the approximate altitude of the region in which you are located.

5. Press the **up** and **down arrow keys** simultaneously. Enter your altitude in hundreds of feet using the **up** and **down arrow keys** to increase or decrease the altitude. For example: Entering the number 2 indicates 200 feet. Once you have found the appropriate altitude hit **ENTER**.

6. The screen should now display CAL in the lower left corner of the display, the calibration value should be displayed in the lower right of the display and the current % reading (before calibration) should be on the main display. If the current % reading (large display) is stable, press **ENTER**. The YSI should read **SAVE**. Calibration of dissolved oxygen is now complete.

Calibrating for Conductivity

1. Calibrate for conductivity every couple of months.

2. Turn the YSI on and allow it to warm up for ~15 minutes.

3. Fill a glass beaker with at least 3 inches of freshwater conductivity solution.

4. Push the **MODE** button until it displays a conductivity reading.

5. Insert the probe into the beaker so that the oval shaped hole in covered. Make sure to keep the probe at least ¼ inch above the bottom of the beaker.

6. Allow the temperature reading to stabilize.

7. Move the probe in the solution to dislodge any air bubbles.

8. Push the **UP** and **DOWN ARROW** buttons simultaneously until the **CAL** symbol appears at the bottom left corner.

9. Use the **UP** or **DOWN ARROW** button to adjust the reading until it matches the value of the calibration solution. Then hit the **ENTER** button. The word **SAVE** will flash across the screen and calibration for conductivity is complete.

Changing the Membrane Cap

1. Change once a month if YSI is used frequently.
2. Unscrew and remove the probe sensor guard.
3. Unscrew and remove the old membrane cap.
4. Rinse the sensor tip with distilled water.
5. Prepare the electrolyte according to the direction on the KCL bottle.
6. Hold the membrane cap and fill it at least ½ full with the electrolyte solution.
7. Screw the membrane cap onto the probe moderately tight. A small amount of electrolyte should overflow.
8. Screw the probe sensor guard on moderately tight.

YSI Meter Operating Instructions

1. After calibrating for dissolved oxygen, remove probe from calibration chamber.
2. Put probe in water making sure the entire probe must be covered in water, particularly the two holes at the top of the probe, which measure conductivity.
3. Scroll through options by pressing MODE. Dissolved oxygen is displayed in mg/L or %, conductivity is displayed in μS, specific conductivity is displayed with a flashing μS.

Take readings only when the YSI meter readings have stabilized.

Appendix 5: YSI 60 Meter Instructions (YSI, 1998)

Instructions for a 1- point pH Calibration

It is recommended to calibrate the instrument frequently, especially if high accuracy is required.

1. Turn the instrument on by pressing the on/off key. If the instrument was already on press the MODE key until pH is displayed.

2. Rinse the probe with deionized or distilled water, then carefully dry the probe (or rinse it with some of the pH buffer solution to be used with calibration).

3. Place 30-35 mL of pH buffer you have chosen to calibrate the system with (pH 7 or 6.86) in the 100 mL graduated cylinder (provided with the model 60). The graduated cylinder minimizes the amount of solution needed. Immerse the probe making sure that both the pH and temperature sensors are covered by the solution.

4. To enter the calibration menu, use two fingers to press and release the UP ARROW and DOWN ARROW keys at the same time. The model 60 display will show CAL at the bottom, STAND will be flashing and the main display will show 7.00 (the buffer to be used to adjust the offset).

5. Press the ENTER key. The model 60 display will show CAL at the bottom, STAND will stop flashing and the pH calibration value is shown with the middle decimal point flashing.

6. When the reading is stable (does not change by 0.01 pH in ten seconds), the decimal point will stop flashing. Press and hold the ENTER key to save the calibration point. The model 60 will flash SAVE on the display along with OFS to indicate the offset value has been saved.

7. SLOPE will now appear on the display and be flashing. This indicates that the slope is ready to be set using a second pH buffer. The system is now calibrated at a single point. Press the MODE key to return to normal operation.

8. Rinse the probe with deionized and distilled water, and then carefully dry the probe.

pH Meter Operating Instructions

After the system has been set up and the pH has been calibrated, it is ready to make measurements. Simply insert the probe into the sample, shake gently to remove any trapped air bubbles, and wait for the readings to stabilize (approximately 60 seconds). The first reading after storage and buffers make take longer to stabilize (5-10 minutes), therefore, the probe should be stored in the transport chamber when making field measurements. It is important that the probe be inserted into sample far enough so that both the pH sensor and the temperature sensor be covered by the sample (Thank you Captain Obvious).

The Model 60 has 3 modes:
1. pH-- displays pH and temperature (degrees Celsius).
2. Recall-- allows previously stored data to be displayed.
3. Erase All-- allows all previously stored data to be deleted.

To change between the model 60 modes, press and release the MODE key.
NOTE: when the model 60 is first turned on, it is in the pH mode. To save data when on the pH mode hold down ENTER. To recall data, press MODE and then press ENTER.

Appendix 6: Turbidity Kit Instructions (LaMotte, 2000)

Turbidity is the measure of the cloudiness of water. It is important because it is a measure of the sediment flow coming downstream after storms.

Remember: It is more accurate to perform the test immediately at streamside. To do so, you must take along a small bottle of tap water.

1. Fill one of the cylinders to the 50 mL mark with stream water and the other with tap water. If the water appears very turbid/cloudy, fill the cylinders only to the 25 mL mark.

2. SHAKE the bottle of Standard Turbidity Reagent vigorously to re-suspend the latex particles in the reagent.

3. To the cylinder containing TAP WATER, use the dropper to add Standard Turbidity Reagent in the 0.5 mL increments–(NOT drop-by-drop). Add 1 squirt of 0.5 mL Reagent, and then use the plastic stirring rod to mix.

4. Compare the fuzzy appearance of the black dot at the bottom of the tap water cylinder with the dot in the stream water cylinder (**DO NOT** try to match the color- the latex particles are white and will never match the brownish or greenish tint of most stream water). The goal is to add enough of the Standard to the tap water so that the cloudiness (as judged by the appearance of the black dots) of the tap water is made to match that of the stream water.

5. Count the number of squirts required to get a match. Read the turbidity (in units called JTU) off the chart on the kit's package insert/directions. Make sure you read off the correct column–one column is for use with a 50 mL volume, the other column is for a 25 mL volume.

6. On the reporting sheet, fill in the result and the number of squirts and test volume used. Examples: 15 JTU (3 squrts/50 mL) or 30 JTU (3 squirts/25 mL)

7. If the stream water looks just as clear as the tap water, report the result as "less than 2.5 JTU."

8. If the stream water looks a little cloudier than the tap water at the start, but when you add 1 squirt of turbidity reagent it looks like the tap water column becomes much cloudier than the stream water, report the result as "about 2.5 JTU."

Tip: If you are not sure if you have a match, add another squirt of turbidity reagent. If you can see that you've "gone over," you can feel sure that the previous number of squirts was indeed the correct number.

Note: Since the turbidity measurement is only an estimate, you may interpolate your result, if you wish. For example, if the match seems like it was between squirts 2 and 3 for a 50 mL volume, you could report the result as "~12.5 JTU" (which means "about half-way between 10 and 15 JTU".)

Disposal: The cylinders full of water and its accompanying turbidity reagent can be disposed of at the stream station.

Appendix 7: Water Works Nitrate/Nitrite Test Strip Instructions

1. Dip a strip into the water for 2 seconds and remove. Do not shake excess water from the test strip.

2. Hold the strip level, with pad side up, for 60 seconds. Compare the NITRITE test pad, the pad closest to your fingers, to the color chart on the bottle.

3. Simultaneously compare the NITRATE test pad, the pad closest to the edge away from your fingers, to the color chart. Estimate results if the color on the test pad falls between two color blocks.

4. Note: The nitrate test actually measures the sum of both nitrate and nitrite nitrogen present in the sample.

*It is important to keep the cap on tightly between uses.

Appendix 8: Stream Quality Survey Form
Fairfax County Volunteer Stream Monitoring Program
Coordinated by the Northern Virginia Soil and Water Conservation District

For Office Use Only
Name of Reviewer______________________________
Date Reviewed______________________________
Data Sent To______________________________

VA Save Our Streams
Stream Quality Survey
Rocky Bottom Method

The purpose of this form is to aid you in gathering and recording important data about the health of your stream. By keeping accurate and consistent records of your observation and data from your macroinvertebrate count, you can document changes in water quality. When conducting rocky bottom sampling, select a riffle where the water is not running too fast, the water depth is between 3-12 inches, and the bed consists of cobble-sized stones (2 to 10 inches) or larger.

Stream Station # # of Participants

County State Latitude Longitude

Location (please be specific)___________

Names of Participants_________________

Name of Certified Monitor_____________

Weather Conditions Last 72 Hours____

Date______________________ Stream (water) width________ _______ft Channel (bank-to-bank) width_________ __ _____ft

Start Time________________End Time________Stream Flow Rate: High____________Normal__________Low____________Negligible________

Water depth in riffle__________in. Average stream depth___________in Water temp___________ºF or ºC Air temp__________ºF or ºC

Biological Monitoring Collection Times

Collection Time:

Net 1:________sec **Area sampled:___________**

Net 2:________sec **Area sampled:___________**

Net 3:________sec **Area sampled:___________**

Net 2:________sec **Area sampled:___________**

Comments Related to Sampling:

____
____
____
____
____

pH:____________ Conductivity____________µs Oxygen:_________________%,______________mg/l

Chemical Tests (refer to NVSWCD instructions as needed):

Nitrite/Nitrate Test Strip Results (circle)	LaMotte Kit **Turbidity** Results, JTU (circle)
Nitrite Nitrogen, ppm (mg/L): 0 0-0.15 0.15 0.15-0.3 0.3 >0.3 Nitrate Nitrogen, ppm (mg/L): 0 0-1 1 1-2 2 2-5 5 >5	Vol: 25 or 50 mL <2.5 ~2.5 5 10 15 20 # squirts:______ 25 30 35 other: ______

Are there any discharging pipes? ϒ No ϒ Yes If yes, how many? _________

What types of pipes are they? ϒ Sewage treatment ϒ Runoff (field or stormwater) ϒ Industrial: type of industry ________________

Describe types of trash in and around the stream.

____

Provide comments to indicate what you think are the current and potential future threats to your stream's health. Feel free to attach additional pages or photographs to better describe the condition of your stream. ________________________________

____

Appendix 9: 2008 Data Collection

Round 1					
Stream	Latitude	Longitude	Description	Date	Certified Monitor
Mine Run P1	38.99983	77.255833	5m downstream from road	5/27/2008	Rachel Buedel Megan Bauer
Mine Run P2	39	77.256	15m upstream from road	5/27/2008	Rachel Buedel, Megan Bauer
Mine Run P3	39.00001667	77.25633	25m upstream from road	5/29/2008	Rachel Buedel, Megan Bauer
Turkey Run P1	37.966	77.1567	base of Switchback trail	5/28/2008	Rachel Buedel, Megan Bauer
Turkey Run P2	37.9648	77.1567	100m downstream from GW Pkwy	6/5/2008	Rachel Buedel, Megan Bauer
Turkey Run P3	37.9638	77.157	50m downstream from GW Pkwy	6/10/2008	Rachel Buedel, Megan Bauer
Dead Run P1	38.967	77.1725	15-20m upstream from mouth	6/10/2008	Rachel Buedel, Megan Bauer
Dead Run P2	38.96633	77.173167	50 m downstream	6/10/2008	Rachel Buedel, Megan Bauer
Dead Run P3	38.965167	77.173667	70m downstream of GW Pkwy bridge, below falls	6/10/2008	Rachel Buedel, Megan Bauer
Pimmit Run P1	38.92933	77.118667	30 meters upstream Glebe Road Route 123 Bridge	6/2/2008	Rachel Buedel, Megan Bauer
Pimmit Run P2	38.929833	77.118667	50 meters upstream Glebe Road, Route 123 Bridge	6/2/2008	Rachel Buedel, Megan Bauer
Pimmit Run P3	38.9301667	77.119	80 meters upstream Glebe Road, Route 123 Bridge	6/2/2008	Rachel Buedel, Megan Bauer
Gulf Branch P1	38.925167	77.113667	50m downstream from GW Pkwy	5/30/2008	Rachel Buedel, Megan Bauer
Gulf Branch P2	38.925	77.114167	directly under bridge	6/3/2008	Rachel Buedel, Megan Bauer
Gulf Branch P3	38.9245	77.114667	15 m upstream from bridge	6/3/2008	Rachel Buedel, Megan Bauer
Donaldson P1	38.919836	77.1078389	10m upstream from mouth	6/11/2008	Rachel Buedel, Megan Bauer
Donaldson P2	38.919667	77.108167	beneath GW Parkway bridge	6/11/2008	Rachel Buede, Megan Bauer
Donaldson P3	38.9195	77.10833	15m upstream from GW parkway	6/13/2008	Rachel Buedel, Megan Bauer
Spout Run P1	38.9013	77.0835	next to drainage pipe, off Spout Run Pkwy, under GW	6/16/2008	Rachel Buedel, Megan Bauer
Spout Run P2	38.9003	77.0847	200 m upstream from P1	6/16/2008	Rachel Buedel, Megan Bauer
Spout Run P3	38.8983	77.086	below Spout Run, ~50 m upstream of 2nd drainage pipe	6/16/2008	Rachel Buedel, Megan Bauer
Windy Run P1	N 38° 54' 20.34"	W 077° 05' 39.08"	After 2nd crossing of stream	7/11/2008	Rachel Buedel, Megan Bauer
Windy Run P2	N 38° 54' 19.31"	W 077° 05' 40.62"	Below GWMP Bridge	7/11/2008	Rachel Buedel, Megan Bauer
Windy Run P3	N 38° 54' 19.09"	W 077° 05' 44.13"	After GWMP bridge, located at the third crossing of the stream.	7/11/2008	Rachel Buedel, Megan Bauer
Difficult Run P1	N 38° 58' 36.27"	W 077° 14' 23.40"		7/17/2008	Rachel Buedel, Megan Bauer
Difficult Run P2	N 38° 58' 37.42"	W 077° 14' 27.50"		7/17/2008	Rachel Buedel, Megan Bauer
Difficult Run P3	N 38° 58' 36.03"	W 077° 14' 39.40"		7/18/2008	Rachel Buedel, Megan Bauer

Appendix 9: 2008 Data Collection

Round 1					
Stream	**Avg stream width**	**Average stream depth**	**Flow rate (High/Normal/Low/Negligible)**	**Weather last 72 hours**	**Water Temp**
Mine Run P1	12.7	2.2	HIgh	Humid, cloudy, light rain	18.5
Mine Run P2	10	3.75	high	hot, humid, light rain	18.9
Mine Run P3	13.3	2.95	Normal	Day before Rainy in AM, Today cool	14.8
Turkey Run P1	23.75	2.6	Normal	Light rain, cooler temps today, Yesterday was super humid and muggy	16.1
Turkey Run P2	10.1	3.8	High	Severe Thunderstorms, Tornado Watch, Heavy Rain and Wind	18
Turkey Run P3	22.8	2.9	High	Severe thunderstorms, tornado watch, heavy rain and wind	19.3
Dead Run P1	9.55	7.7	Normal	Thunderstorms, hot, humid	22.4
Dead Run P2	12.9	7	Normal	hot, humid	23
Dead Run P3	12.4	3.7	Normal	Hot, Humid	24.4
Pimmit Run P1	33.9	8.91	High	Heavy Rain and Thunderstorms	18.3
Pimmit Run P2	23.85	4.65	High	Heavy Rain, Thuderstorms	20.8
Pimmit Run P3	40.9	6.4	High	Heavy Rain, Thunderstorms	22.6
Gulf Branch P1	13.4	2.95	normal	Cooler, Humid	15.9
Gulf Branch P2	13.9	3.7	Normal	Light rain, windy, partly cloudy	16.6
Gulf Branch P3	11	4.05	Normal	Light Rain, Windy, Partly Cloudy	18.6
Donaldson P1	35	7	Normal	hot, humid, thunderstorms	21.9
Donaldson P2	35	5.6	Normal	hot, humid, thunderstorms	22.2
Donaldson P3	15	8.4	Normal	Humid, warm	20.9
Spout Run P1	11.6	7.4	Normal	hot and humid	23.1
Spout Run P2	9.1	6.6	Normal	Hot, humid	21.2
Spout Run P3	11.5	6.2	Normal	hot humid	22
Windy Run P1	5.6	4.8	Normal	Rain, Humid	21.5
Windy Run P2	6.6	4	Normal	Hot, light rain, humid	20.4
Windy Run P3	13	1.7	Normal	rain, hot temps	21
Difficult Run P1	52	7.4	high	Sun	24.4
Difficult Run P2	81.7	9.4	High	Sun	25.3
Difficult Run P3	58.3	15	High	Hot & Humid	23.8

Appendix 9: 2008 Data Collection

Round 1					
Stream	**Collection Time (net1)**	**Collection Time (net2)**	**Collection Time (net3)**	**Collection Time (net4)**	**First Page Comments**
Mine Run P1					3x2 sample area
Mine Run P2					We sampled an area of 3' x 2' because of previous data showing a large number of macroinvertebrates.
Mine Run P3	30				
Turkey Run P1	90	90			Light/slow flow, hard to find a good site for sampling. A few big species present. but alot of little guys be careful when walking, very slippery and lots of spots.
Turkey Run P2	90				Sampled Directly across from flag
Turkey Run P3	90	30			We saw a broad-winged hawk and two salamanders!
Dead Run P1	90	90			
Dead Run P2	90	90			
Dead Run P3	90	90			Found a salamander
Pimmit Run P1	90				Right next to heavily used road
Pimmit Run P2	90	90			Very little life
Pimmit Run P3	90				
Gulf Branch P1					
Gulf Branch P2	90				
Gulf Branch P3	90				3x2 Net
Donaldson P1	90	60			
Donaldson P2	90				
Donaldson P3	90				
Spout Run P1	90				
Spout Run P2	90				
Spout Run P3	90				
Windy Run P1	60				
Windy Run P2	60				
Windy Run P3	60				
Difficult Run P1	30				We saw a deer on the hill and a snake in the water.
Difficult Run P2	30				
Difficult Run P3	30				

Appendix 9: 2008 Data Collection

Round 1									
Stream	**Worms**	**Flatworms**	**Leeches**	**Crayfish**	**Sowbugs**	**Scuds**	**Stoneflies**	**Mayflies**	**Dragonflies and Damselflies**
Mine Run P1	3	4	0	0	4	0	36	4	0
Mine Run P2	22	8	0	2	8	4	71	12	2
Mine Run P3	61	1	0	3	5	3	75	17	3
Turkey Run P1	109	3		4		9	2	4	
Turkey Run P2	130	0	0	1	2	0	1	1	0
Turkey Run P3	50	1	1	5	0	1	3	3	0
Dead Run P1	23	0	0	0	0	2	0	0	0
Dead Run P2	69	1	0	0	0	0	0	2	0
Dead Run P3	43	0	0	0	0	0	0	4	0
Pimmit Run P1	33				2	1		4	
Pimmit Run P2	51	0	0	0	14	1	0	17	0
Pimmit Run P3	54	1	0	0	0	0	0	13	0
Gulf Branch P1	78	3				3		1	
Gulf Branch P2	40	6	1	1	0	0	0	3	0
Gulf Branch P3	21	1	0	0	0	0	0	0	0
Donaldson P1	63	1	0	0	0	2	0	15	0
Donaldson P2	26	1	1	0	0	0	0	6	0
Donaldson P3	48	5	0	0	0	0	0	51	0
Spout Run P1	35	7	0	0	0	3	0	7	0
Spout Run P2	24	2	0	0	0	0	0	25	0
Spout Run P3	41	1	0	0	0	7	0	22	0
Windy Run P1	70	14	0	0	0	0	0	27	0
Windy Run P2	52	15	0	0	0	0	0	86	0
Windy Run P3	88	1	0	0	0	0	0	52	0
Difficult Run P1	6	56	2	0	0	5	0	32	1
Difficult Run P2	8	20	1	0	0	4	0	42	0
Difficult Run P3	9	53	1	2	0	1	0	21	0

Appendix 9: 2008 Data Collection

Round 1									
Stream	**Hellgrammites, Fishflies, and Alderflies**	**Common Netspinners**	**Most Caddisflies**	**Beetles**	**Midges**	**Blackflies**	**Most True Flies**	**Gilled Snails**	**Lunged Snails**
Mine Run P1	2	177	22	103	54	68	24	0	0
Mine Run P2	3	93	13	82	60	16	31	0	0
Mine Run P3	1	48	8	46	87	2	8		
Turkey Run P1		13			74	10	14		
Turkey Run P2	1	29	0	2	80	8	6	0	1
Turkey Run P3	1	86	16	5	109	4	28	0	1
Dead Run P1	0	8	5	0	165	3	8	0	0
Dead Run P2	0	14	2	1	170	4	0	0	0
Dead Run P3	0	9	2	1	148	4	9	0	1
Pimmit Run P1		8			174	8	1		
Pimmit Run P2	0	23	1	0	140	13	7		
Pimmit Run P3	0	19	2	0	207	17	6	0	0
Gulf Branch P1	1		3		438	66	20		
Gulf Branch P2	1	2	0	0	551	178	3	0	1
Gulf Branch P3	0	1	1	0	280	50	3		
Donaldson P1	0	111	4	0	222	12	3	0	1
Donaldson P2	0	33	0	0	140	12	3	0	0
Donaldson P3	0	27	0	0	160	3	4	0	1
Spout Run P1	0	24	0	0	451	0	0	0	1
Spout Run P2	0	14	0	0	292	0	4	0	0
Spout Run P3	0	12	0	0	256	2	6	0	3
Windy Run P1	0	71	47	0	74	12	1	0	0
Windy Run P2	0	51	19	0	31	4	4	0	0
Windy Run P3	0	53	4	0	58	23	0	0	5
Difficult Run P1	0	268	373	165	63	3	0	0	0
Difficult Run P2	1	32	29	55	62	1	3	0	0
Difficult Run P3	2	323	169	125	9	11	7	0	0

Appendix 9: 2008 Data Collection

Round 1									
Stream	**Clams**	**Other Organisms**	**Define Other Organism**	**Total Organisms**	**Metric 1 - Percent Mayflies, Stoneflies, and Most Caddisflies**	**Metric 2 - Percent Common Netspinners**	**Metric 3 - Percent Lunged Snails**	**Metric 4 - Percent Beetles**	**Metric 5 - Percent Tolerant**
Mine Run P1	1			502	12.350598	35.258964	0	20.517928	26.693227
Mine Run P2	3	0		430	22.325581	21.627907	0	19.069767	28.604651
Mine Run P3				368	27.173913	13.043478	0	12.5	44.021739
Turkey Run P1				242	2.4793388	5.3719008	0	0	84.710744
Turkey Run P2	0			262	0.7633588	11.068702	0.3816794	0.7633588	84.351145
Turkey Run P3	0			314	7.0063694	27.388535	0.3184713	1.5923567	53.184713
Dead Run P1	0			214	2.3364486	3.7383178	0	0	90.186916
Dead Run P2	0			263	1.5209125	5.3231939	0	0.3802281	92.775665
Dead Run P3	0			221	2.7149321	4.0723982	0.4524887	0.4524887	88.687783
Pimmit Run P1				231	1.7316017	3.4632035	0	0	94.372294
Pimmit Run P2				267	6.741573	8.6142322	0	0	82.022472
Pimmit Run P3	0	0		319	4.7021944	5.9561129	0	0	87.460815
Gulf Branch P1				613	0.6525285	0	0	0	95.921697
Gulf Branch P2	0			787	0.3811944	0.2541296	0.1270648	0	98.729352
Gulf Branch P3				357	0.280112	0.280112	0	0	98.59944
Donaldson P1	0			434	4.3778802	25.576037	0.2304147	0	69.354839
Donaldson P2	0			222	2.7027027	14.864865	0	0	81.081081
Donaldson P3	0			299	17.056856	9.0301003	0.3344482	0	72.575251
Spout Run P1	0	0	0	528	1.3257576	4.5454545	0.1893939	0	94.128788
Spout Run P2	0	0		361	6.9252078	3.8781163	0	0	88.088643
Spout Run P3	0	0	0	350	6.2857143	3.4285714	0.8571429	0	88.571429
Windy Run P1	0			316	23.417722	22.468354	0	0	53.797468
Windy Run P2	0			262	40.076336	19.465649	0	0	38.931298
Windy Run P3	0			284	19.71831	18.661972	1.7605634	0	61.619718
Difficult Run P1	2			976	41.495902	27.459016	0	16.905738	14.139344
Difficult Run P2	1			259	27.413127	12.355212	0	21.235521	37.451737
Difficult Run P3	0			733	25.920873	44.065484	0	17.053206	11.459754

Appendix 9: 2008 Data Collection

Round 1					
Stream	**Metric 5 - Percent Tolerant**	**Metric 6 - Percent Non-Insect**	**Score**	**Ecological Conditions**	**Fish Water Quality Indicators**
Mine Run P1	26.693227	2.3904382	8	Gray Zone	
Mine Run P2	28.604651	10.930233	9	Acceptable	No Fish
Mine Run P3	44.021739	19.836957	10	Acceptable	
Turkey Run P1	84.710744	51.652893	4	Unacceptable	Scattered Individuals
Turkey Run P2	84.351145	51.145038	3	Unacceptable	Scattered Individuals
Turkey Run P3	53.184713	18.789809	4	Unacceptable	Scattered Individuals
Dead Run P1	90.186916	11.682243	5	Unacceptable	No Fish
Dead Run P2	92.775665	26.61597	4	Unacceptable	No Fish
Dead Run P3	88.687783	19.909502	4	Unacceptable	Scattered Individuals
Pimmit Run P1	94.372294	15.584416	5	Unacceptable	no fish
Pimmit Run P2	82.022472	24.719101	4	Unacceptable	No Fish
Pimmit Run P3	87.460815	17.241379	5	Unacceptable	No Fish
Gulf Branch P1	95.921697	13.7031	5	Unacceptable	
Gulf Branch P2	98.729352	6.2261753	5	Unacceptable	No Fish
Gulf Branch P3	98.59944	6.162465	5	Unacceptable	No Fish
Donaldson P1	69.354839	15.437788	4	Unacceptable	Scattered Individuals/Scattered Schools
Donaldson P2	81.081081	12.612613	5	Unacceptable	Scattered Individuals
Donaldson P3	72.575251	18.060201	5	Unacceptable	Scattered Individuals
Spout Run P1	94.128788	8.7121212	5	Unacceptable	No Fish
Spout Run P2	88.088643	7.2022161	5	Unacceptable	No Fish
Spout Run P3	88.571429	14.857143	4	Unacceptable	No Fish
Windy Run P1	53.797468	26.582278	5	Unacceptable	No Fish
Windy Run P2	38.931298	25.572519	8	Acceptable	No Fish
Windy Run P3	61.619718	33.098592	3	Unacceptable	No Fish
Difficult Run P1	14.139344	7.2745902	10	Acceptable	Scattered Individuals
Difficult Run P2	37.451737	13.127413	10	Acceptable	Scattered Individuals
Difficult Run P3	11.459754	9.0040928	8	Acceptable	Scattered Individuals

Appendix 9: 2008 Data Collection

Round 1						
Stream	**Barriers to Fish Movement**	**Surface-water appearance**	**Stream Bed Deposit**	**Odor**	**Stability of stream: Bed sinks beneath your feet**	**Algae Color(Light green/Dark green/Brown coated/Matted on streambed/Hairy)**
Mine Run P1	No Barriers	Clear	Brown	No odor	no spots	none
Mine Run P2	No Barriers	Clear	Brown/Rocky	no odor	no spots	
Mine Run P3	No Barriers	Clear	Brown/Silt	No odor	No Spots	
Turkey Run P1	No Barriers	Clear	Brown/silt	Other	Many Spots	
Turkey Run P2	No Barriers	Clear but tea colored	Brown/Silt/Sand	No Odor	Many Spots	
Turkey Run P3	No Barriers	Clear but tea-colored	brown/silty/sandy	No odor	A Few Spots	
Dead Run P1	No Barriers	Clear	Brown/Sandy	No Odor	No Spots	
Dead Run P2	Waterfalls	Clear	Brown/Sandy	Musky	No Spots	
Dead Run P3	No Barriers	Clear	Brown/Silt/Sand	Musky	A few spots	
Pimmit Run P1	No barriers	clear	brown,silt,sand	none	no spots	
Pimmit Run P2	No Barriers	Clear	Brown, silt, sand	None	no spots	
Pimmit Run P3	No Barriers	Clear	Brown, silt, sand	no odor	no spots	
Gulf Branch P1	No Barriers	Clear	Brown	No odor	No spots	
Gulf Branch P2	No Barriers	Clear	Brown,silt,sand	musky,sewage	no spots	
Gulf Branch P3	No Barriers	Clear	Broan/Silty/Sand	Musky	No Spots	
Donaldson P1	Waterfalls	Clear	Brown/Silt/Sand	Sewage and Rotting carcasses	A Few Spots	
Donaldson P2	Waterfallas	Clear	Brown/Silty/Sandy	Sewage, rotting fish	A Few Spots	
Donaldson P3	Waterfalls	Clear	Brown/Silt/Sand	No Odor	A Few Spots	Brown Coated/ Matted on streambed
Spout Run P1	Rocks	Clear	Brown/Tan/Sandy	Sewage	No Spots	Dark Green
Spout Run P2	Rocks	Clear	Brown/Tan/Sand	Sewage	No Spots	Dark Green
Spout Run P3	Rocks	Clear	Brown/Tan/Sandy	Sewage	No Spots	Dark Green
Windy Run P1	Waterfalls	Clear	Brown/Sandy	No Odor	No Spots	Dark Green, Brown Coated
Windy Run P2	No Barriers	Clear	Brown, Sandy	No Odor	No Spots	Dark Green, Brown Coated
Windy Run P3	No Barriers	Clear	Brown/ Sandy	No Odor	No Spots	Dark Green
Difficult Run P1	Waterfalls	Clear	Brown/Tan	No Odor	No Spots	Brown Coated
Difficult Run P2	Waterfalls	Clear	Brown/Tan	No Odor	No Spots	Brown Coated/Darkgreen/ Matted On Streambed/ Hairy
Difficult Run P3	Waterfalls	Clear	Brown/tan	No Odor	No Spots	Dark Green/ Brown Coated/ Matted

Appendix 9: 2008 Data Collection

Round 1							
Stream	Algae located(In Spots/Everywhere)	Percent algae	Stream channel shade	% Silt	% Sand	% Gravel	% Cobbles
Mine Run P1		0	Full	0	20	40	40
Mine Run P2			High	2	3	35	60
Mine Run P3			Full	15	20	45	20
Turkey Run P1			High	30	5	50	15
Turkey Run P2			Moderate	60	10	25	5
Turkey Run P3			High	75	10	8	7
Dead Run P1			Full	0	5	20	75
Dead Run P2			High	0	5	20	75
Dead Run P3			High	10	40	10	40
Pimmit Run P1			Moderate	0	40	40	20
Pimmit Run P2			Full	5	45	40	10
Pimmit Run P3			High	5	40	15	40
Gulf Branch P1			Full	0	0	35	45
Gulf Branch P2			Full	0	10	20	70
Gulf Branch P3			Full	0	10	50	40
Donaldson P1			Moderate	10	10	50	30
Donaldson P2			Moderate	10	50	20	20
Donaldson P3	In Spots		High	5	0	60	35
Spout Run P1	In Spots	50	Moderate	0	15	45	40
Spout Run P2	In Spots	50	High	0	10	45	45
Spout Run P3	In Spots	40	High	0	25	30	45
Windy Run P1	In Spots	60	Moderate	5	15	40	40
Windy Run P2	In Spots	70	High	0	0	0	100
Windy Run P3	In Spots	35	Moderate	0	20	30	50
Difficult Run P1	Everywhere	100	Moderate	0	0	0	100
Difficult Run P2	Everywhere	100	Moderate	0	0	0	100
Difficult Run P3	Everywhere	100	Moderate	0	0	0	100

Appendix 9: 2008 Data Collection

Round 1					
Stream	**Stream channel erosion potential**	**Area 1**	**Area 2**	**Area 3**	**Area 4**
Mine Run P1	high	2x3			
Mine Run P2	Severe to High				
Mine Run P3	High	3x3			
Turkey Run P1	Severe	3x3	3x3		
Turkey Run P2	High	3x3			
Turkey Run P3	High	3X3	3X2		
Dead Run P1	High	3X3	3x3		
Dead Run P2	Severe	3x3	3x3		
Dead Run P3	Severe	3x3	3x3		
Pimmit Run P1	Severe	3x3			
Pimmit Run P2	Severe	3x3	3x3		
Pimmit Run P3	Severe	3x3			
Gulf Branch P1	Severe	3x3			
Gulf Branch P2	Severe	3x3			
Gulf Branch P3	Severe	3x2			
Donaldson P1	Severe	3x3			
Donaldson P2	Severe	3x3			
Donaldson P3	Severe	3x3			
Spout Run P1	High	3x3			
Spout Run P2	Severe	3x3			
Spout Run P3	High	3x3			
Windy Run P1	Severe	3x2			
Windy Run P2	Severe	3x2			
Windy Run P3	Severe	3x2			
Difficult Run P1	Severe	3x1			
Difficult Run P2	High	3x1			
Difficult Run P3	Severe	3x1			

Appendix 9: 2008 Data Collection

Round 2					
Stream	Latitude	Longitude	Description	Date	Certified Monitor
Mine Run P1	39	77.26	5m downstream from road	6/19/2008	Rachel Buedel, Megan Bauer
Mine Run P2	39	77.26	15m upstream from road	6/19/2008	Rachel Buedel, Megan Bauer
Mine Run P3	39	77.26	25m upstream from road	6/20/2008	Rachel Buedel, Megan Bauer
Turkey Run P1	38	77.16	base of Switchback trail	6/23/2008	Rachel Buedel, Megan Bauer
Turkey Run P2	38	77.16	100m downstream from GW Pkwy	6/23/2008	Rachel Buedel, Megan Bauer
Turkey Run P3	38	77.16	50m downstream from GW Pkwy	6/24/2008	Rachel Buedel and Megan Bauer
Dead Run P1	39	77.17	15-20m upstream from mouth	6/25/2008	Rachel Buedel and Megan Bauer
Dead Run P2	39	77.17	50 m downstream	6/25/2008	Rachel Buedel and Megan Bauer
Dead Run P3	39	77.17	70m downstream of GW Pkwy bridge, below falls	6/27/2008	Rachel Buedel and Megan Bauer
Pimmit Run P1	39	77.12	30 meters upstream Glebe Road Route 123 Bridge	6/17/2008	Rachel Buedel and Megan Bauer
Pimmit Run P2	39	77.12	50 meters upstream Glebe Road, Route 123 Bridge	6/20/2008	Rachel Buedel, Megan Bauer
Pimmit Run P3	39	77.12	80 meters upstream Glebe Road, Route 123 Bridge	6/17/2008	Rachel Buedel, Megan Bauer
Gulf Branch P1	39	77.11	50m downstream from GW Pkwy	6/20/2008	Rachel Buedel, Megan Bauer
Gulf Branch P2	39	77.11	directly under bridge	6/25/2008	Normal
Gulf Branch P3	39	77.11	15 m upstream from bridge	6/24/2008	Normal
Donaldson P1	39	77.11	10m upstream from mouth	6/27/2008	Rachel Buedel and Megan Bauer
Donaldson P2	39	77.11	beneath GW Parkway bridge	6/30/2008	Rachel Buedel and Megan Bauer
Donaldson P3	39	77.11	15m upstream from GW parkway	6/30/2008	Rachel Buedel and Megan Bauer
Spout Run P1	39	77.08	next to drainage pipe, off Spout Run Pkwy, under GW	7/1/2008	Rachel Buedel and Megan Bauer
Spout Run P2	39	77.08	200 m upstream from P1	7/1/2008	Rachel Buedel and Megan Bauer
Spout Run P3	39	77.09	below Spout Run, ~50 m upstream of 2nd drainage pipe	7/1/2008	Rachel Buedel and Megan Bauer
Windy Run P1	N 38° 54' 20.34"	W 077 05' 39.08"	After 2nd crossing of stream	7/24/2008	Rachel Buedel and Megan Bauer
Windy Run P2	N 38° 54' 19.31"	W 077 05' 40.62"	Below GWMP Bridge	7/24/2008	Rachel Buedel and Megan Bauer`
Windy Run P3	N 38° 54' 19.09"	W 077 05' 44.13"	After GWMP bridge, located at the third crossing of the stream.	7/24/2008	Rachel Buedel and Megan Bauer
Difficult Run P1	N 38° 58' 36.27"	W 077 14' 23.40"		7/28/2008	Rachel Buedel and Megan Bauer
Difficult Run P2	N 38° 58' 37.42"	W 077 14' 27.50"		7/28/2008	Rachel Buedel and Megan Bauer
Difficult Run P3	N 38° 58' 36.03"	W 077 14' 39.40"		7/28/2008	Rachel Buedel and Megan Bauer

Appendix 9: 2008 Data Collection

Round 2									
Stream	**Avg stream width**	**Average stream depth**	**Flow rate**	**Weather last 72 hours**	**Temp**	**Collection Time (net1)**	**Collection Time (net2)**	**Collection Time (net3)**	**Collection Time (net4)**
Mine Run P1	13	3.7	High	cool temps, thunderstorms	17.4	60			
Mine Run P2	10	4	High	cool temps, rain, thunderstorms	18.5	30			
Mine Run P3	15	3.2	Normal		20	30			
Turkey Run P1	24	2.2	Normal	Rain, Thunderstorms, Overcast	20.5	60			
Turkey Run P2	18	4	Normal	Rain, Thunderstorms, Overcast	21.3	60			
Turkey Run P3	16	5.4	Normal	Humid, Thunderstorms	20.3	60			
Dead Run P1	10	8.4	Normal	Hot and Humid	19.4	90			
Dead Run P2	14	3.8	Normal	Hot and Humid	20.4	90			
Dead Run P3	18	3	Normal	Hot and Humid	21.9	90			
Pimmit Run P1	37	11	High	Rain and Thunderstorms	23.1	90			
Pimmit Run P2	24	5	Normal	Rain, Cool temps, Cloudy	18.5	90			
Pimmit Run P3	34	7.5	High	rain, thunderstorms, cool temps	18.3	90			
Gulf Branch P1	16	5.2	Normal	Cool temps, Rain	18	60			
Gulf Branch P2		3.1	Normal	hot, humid	21.2	60			
Gulf Branch P3		3.6	Normal	Hot, Humid, Thunderstorms	19.2	60			
Donaldson P1	7	4.8	Normal	Hot and Humid	21.9	60			
Donaldson P2	12	4	High	Thunderstorms	21.4	60			
Donaldson P3	4	3.9	High	Thunderstorms	22.9	30			
Spout Run P1	8	8.4	Normal	Rain, Thunderstorms, Cool Temps	20.9	60			
Spout Run P2	9	6	Normal	Rain, Thunderstorms, Cool Temps	21.9	30			
Spout Run P3	18	3.8	Normal	Rain, Thunderstorms, Cool Temps	22.6	60			
Windy Run P1	7	4.7	High	humid, heavy rain and thunderstorms	20.9	90	90	60	
Windy Run P2	8	6.3	High	humid, heavy rain, thunderstorms	21.6	90	90		
Windy Run P3	14	7	High	humid, heavy rain, thunderstorms	22	90			
Difficult Run P1	44	8.8	High	Thunderstorms, hot and humid	23	30			
Difficult Run P2	70	13.8	High	Thunderstorms, hot and humid	23.7	30	30		
Difficult Run P3	65	10.2	High	thunderstorms, hot and humid	24	30			

Appendix 9: 2008 Data Collection

Round 2									
Stream	**Worms**	**Flatworms**	**Leeches**	**Crayfish**	**Sowbugs**	**Scuds**	**Stoneflies**	**Mayflies**	**Dragonflies and Damselflies**
Mine Run P1	10	6	0	0	3	2	35	4	4
Mine Run P2	44	11	0	0	2	2	33	1	0
Mine Run P3	16	0	0	0	1	1	17	11	0
Turkey Run P1	49	0	0	2	0	0	0	10	0
Turkey Run P2	66	2	0	0	0	3	0	6	1
Turkey Run P3	27	0	0	0	0	0	2	9	0
Dead Run P1	17	0	0	1	0	2	0	1	0
Dead Run P2	14	1	0	0	0	2	0	2	0
Dead Run P3	159	1	0	0	0	0	0	7	0
Pimmit Run P1	63	5	0	0	6	0	0	8	0
Pimmit Run P2	40	0	0	0	1	0	2	22	0
Pimmit Run P3	17	1	0	0	0	1	0	15	0
Gulf Branch P1	55	3	0	0	1	0	0	0	0
Gulf Branch P2	9	5	0	0	0	0	0	5	0
Gulf Branch P3	16	0	0	0	2	1	0	0	0
Donaldson P1	72	4	0	0	0	0	0	61	0
Donaldson P2	42	5	0	0	0	0	0	196	0
Donaldson P3	23	1	0	0	0	0	0	131	0
Spout Run P1	130	37	0	0	1	6	0	57	0
Spout Run P2	23	2	0	0	0	0	0	72	0
Spout Run P3	46	2	0	1	0	15	0	131	0
Windy Run P1	70	5	0	0	3	0	0	45	0
Windy Run P2	60	15	0	1	4	0	0	23	0
Windy Run P3	94	1	0	0	3	0	0	23	0
Difficult Run P1	2	11	0	0	0	7	0	124	0
Difficult Run P2	5	22	2	2	0	9	0	70	
Difficult Run P3									

Appendix 9: 2008 Data Collection

Round 2									
Stream	**Hellgrammites, Fishflies, and Alderflies**	**Common Netspinners**	**Most Caddisflies**	**Beetles**	**Midges**	**Blackflies**	**Most True Flies**	**Gilled Snails**	**Lunged Snails**
Mine Run P1	6	428	175	152	147	19	10	0	0
Mine Run P2	0	198	179	87	51	3	1	0	0
Mine Run P3	0	71	8	64	80	5	1	0	0
Turkey Run P1	0	66	30	2	177	5	3	0	0
Turkey Run P2	0	40	29	6	125	18	8	0	0
Turkey Run P3	0	22	3	4	180	1	3	0	0
Dead Run P1	0	2	0	0	214	1	0	0	0
Dead Run P2	0	72	8	0	297	0	3	0	0
Dead Run P3	0	52	4	0	324	3	6	0	0
Pimmit Run P1	0		31	1	342	59	4	0	0
Pimmit Run P2	0	75	31	2	242	5	4	0	0
Pimmit Run P3	0	20	3	0	336	3	0	0	0
Gulf Branch P1	0	7	1	0	311	8	3	0	0
Gulf Branch P2	0	4	0	0	369	110	3	0	0
Gulf Branch P3	0	6	0	0	480	76	1	0	0
Donaldson P1	0	186	49	0	154	64	9	0	1
Donaldson P2	0	114	39	0	118	12	7	6	0
Donaldson P3	0	78	25	0	58	9	4	1	0
Spout Run P1	0	108	0	0	184	1	3	0	0
Spout Run P2	0	26	0	0	107	0	1	0	0
Spout Run P3	0	40	0	0	116	0	6	0	44
Windy Run P1	0	77	12	0	26	12	6	0	1
Windy Run P2	0	63	9	0	35	10	2	0	1
Windy Run P3	0	67	3	0	24	5	3	0	0
Difficult Run P1	0	191	83	70	23	0	0	0	0
Difficult Run P2	3	35	52	82	25	0	2	0	2
Difficult Run P3	1	108	41	18	22	1	3	0	0

Appendix 9: 2008 Data Collection

Round 2									
Stream	Clams	Other Organisms	Define Other Organism	Total Organisms	Metric 1 - Percent Mayflies, Stoneflies, and Most Caddisflies	Metric 2 - Percent Common Netspinners	Metric 3 - Percent Lunged Snails	Metric 4 - Percent Beetles	Metric 5 - Percent Tolerant
Mine Run P1	2			1003	21.335992	42.671984	0	15.154536	19.242273
Mine Run P2	7			619	34.410339	31.987076	0	14.054927	19.386107
Mine Run P3	2			277	12.99639	25.631769	0	23.104693	37.906137
Turkey Run P1	0			344	11.627907	19.186047	0	0.5813953	67.151163
Turkey Run P2	0			304	11.513158	13.157895	0	1.9736842	70.723684
Turkey Run P3	0			251	5.5776892	8.7649402	0	1.5936255	82.868526
Dead Run P1	0			238	0.4201681	0.8403361	0	0	98.319328
Dead Run P2	0	0	0	399	2.5062657	18.045113	0	0	78.696742
Dead Run P3	0			556	1.9784173	9.352518	0	0	87.589928
Pimmit Run P1	0	0		614	6.3517915	15.472313	0	0.1628664	77.361564
Pimmit Run P2	0			424	12.971698	17.688679	0	0.4716981	67.924528
Pimmit Run P3	0			396	4.5454545	5.0505051	0	0	90.40404
Gulf Branch P1	0			389	0.2570694	1.7994859	0	0	97.172237
Gulf Branch P2	0			505	0.990099	0.7920792	0	0	97.623762
Gulf Branch P3	0			582	0	1.0309278	0	0	98.797251
Donaldson P1	0			600	18.333333	31	0.1666667	0	49.166667
Donaldson P2	0			539	43.599258	21.150278	0	0	32.83859
Donaldson P3	1			331	47.129909	23.564955	0	0	27.794562
Spout Run P1	0			527	10.815939	20.493359	0	0	68.121442
Spout Run P2	0			231	31.168831	11.255411	0	0	57.142857
Spout Run P3	0			401	32.668329	9.9750623	10.972569	0	55.610973
Windy Run P1	0			257	22.178988	29.961089	0.3891051	0	45.525292
Windy Run P2	0			223	14.349776	28.251121	0.4484305	0	56.053812
Windy Run P3	0			223	11.659193	30.044843	0	0	56.950673
Difficult Run P1	0			511	40.508806	37.377691	0	13.69863	8.4148728
Difficult Run P2	0			313	38.977636	11.182109	0.6389776	26.198083	21.405751
Difficult Run P3	0			236	24.576271	45.762712	0	7.6271186	20.338983

Appendix 9: 2008 Data Collection

Round 2				
Stream	**Metric 6 - Percent Non-Insect**	**Score**	**Ecological Conditions**	**Fish Water Quality Indicators**
Mine Run P1	2.2931206	9	Acceptable	Scattered Individuals
Mine Run P2	10.662359	10	Acceptable	Scattered Individuals
Mine Run P3	7.2202166	8	Acceptable	Scattered Individuals
Turkey Run P1	14.825581	5	Unacceptable	Scattered Individuals
Turkey Run P2	23.355263	4	Unacceptable	Scattered Individuals/Scattered School
Turkey Run P3	10.756972	5	Unacceptable	Scattered Individuals
Dead Run P1	8.4033613	5	Unacceptable	Scattered Individuals
Dead Run P2	4.2606516	6	Unacceptable	Scattered Individuals
Dead Run P3	28.776978	4	Unacceptable	Scattered Individuals
Pimmit Run P1	12.052117	5	Unacceptable	No Fish
Pimmit Run P2	9.6698113	5	Unacceptable	No Fish
Pimmit Run P3	4.7979798	6	Unacceptable	No Fish
Gulf Branch P1	15.167095	5	Unacceptable	No Fish
Gulf Branch P2	2.7722772	6	Unacceptable	No Fish
Gulf Branch P3	3.2646048	6	Unacceptable	Scattered Individuals
Donaldson P1	12.833333	6	Unacceptable	No Fish
Donaldson P2	9.8330241	8	Acceptable	No Fish
Donaldson P3	7.8549849	8	Acceptable	No Fish
Spout Run P1	33.017078	3	Unacceptable	No Fish
Spout Run P2	10.822511	7	Acceptable	No Fish
Spout Run P3	26.932668	5	Unacceptable	No Fish
Windy Run P1	30.7393	5	Unacceptable	No Fish
Windy Run P2	36.32287	3	Unacceptable	No Fish
Windy Run P3	43.946188	4	Unacceptable	No Fish
Difficult Run P1	3.9138943	10	Acceptable	Scattered Individuals
Difficult Run P2	13.41853	10	Acceptable	Scattered Individuals
Difficult Run P3	10.169492	8	Acceptable	Scattered Individuals

Appendix 9: 2008 Data Collection

Round 2						
Stream	**Barriers to Fish Movement**	**Surface-water appearance**	**Stream Bed Deposit**	**Odor**	**Stability of stream**	**Algae Color**
Mine Run P1	No Barriers	Clear	Brown/Tan	No Odor	No Spots	Brown Coated
Mine Run P2	No Barriers	Clear	Brown/Tan	Sewage	No Spots	Brown Coated
Mine Run P3	No Barriers	Clear	Brown/Tan/Sandy	No Odor	No Spots	Brown Coated
Turkey Run P1	No Barriers	Clear	Brown/Tan/Silty	No Odor	A Few Spots	Dark Green/Brown Coated
Turkey Run P2	No Barriers	Clear	Brown/Tan/Silty/Sandy	No Odor	A Few Spots	Dark Green/Brown Coated
Turkey Run P3	No Barriers	Clear	Brown/Tan/Silty	No Odor	A Few Spots	Brown Coated
Dead Run P1	Waterfalls	Clear	Brown/Tan/Sandy	No Odor	A Few Spots	Brown Coated
Dead Run P2	Waterfalls	Clear	Black/Brown/Tan/Sandy	No Odor	No Spots	Brown Coated
Dead Run P3	Waterfalls	Clear	Brown/Tan/Sandy	No Odor	A Few Spots	Brown Coated
Pimmit Run P1	None	Clear	Brown/Tan/Sandy	No Odor	No Spots	Dark Green and Brown Coated
Pimmit Run P2	No Barriers	Clear	Brown/Tan/Sandy	No Odor	No Spots	Brown Coated
Pimmit Run P3	No Barriers	Clear	Brown/Tan/Sandy	No Odor	No Spots	Brown Coated
Gulf Branch P1	Waterfalls	Clear	Brown/Tan/Sandy	No Odor	No Spots	Brown Coated
Gulf Branch P2	No Barriers	Claer	Brown/Tan/Sandy	No Odor	No Spots	Brown Coated
Gulf Branch P3	No Barriers	Clear	Brown/Tan/Sandy	No Odor	No Spots	Brown Coated
Donaldson P1	Waterfalls	Clear	Brown/Tan	No Odor	A Few Spots	Brown Coated
Donaldson P2	Waterfalls	Clear	Brown/Tan	No Odor	A Few Spots	Dark Green & Brown Coated
Donaldson P3	Waterfalls	Clear	Brown/Tan	No Odor	No Spots	Dark Green & Brown Coated
Spout Run P1	Waterfalls	Clear	Brown/Tan	No Odors	No Spots	Brown Coated
Spout Run P2	None	Clear	Brown/Tan	No Odor	No Spots	Brown Coated
Spout Run P3	No Barriers	Clear	Brown/Tan	No Odor	No Spots	Brown Coated
Windy Run P1	Waterfalls	Clear	Brown/Tan/Sandy	No Odor	No Spots	No Algae
Windy Run P2	Waterfalls	Clear	Brown/Tan	No Odor	No Spots	No Algae
Windy Run P3	Waterfalls	Clear	Brown/Tan	No Odor	No Spots	None
Difficult Run P1	Waterfalls	Cloudy/Turbid	Brown/Tan	No Odor	No Spots	Brown Coated
Difficult Run P2	Waterfalls	Cloudy/Turbid	Brown/Tan	No Odor	No Spots	Dark Green/Hairy
Difficult Run P3	Waterfalls	Cloudy/Turbid	Brown/Tan	No Odor	No Spots	Brown Coated

Appendix 9: 2008 Data Collection

Round 2						
Stream	**Algae located**	**Percent algae**	**Stream shade**	**% Silt**	**% Sand**	**% Gravel**
Mine Run P1	In Spots	30	Moderate	0	0	30
Mine Run P2	In spots	30	Moderate	0	0	30
Mine Run P3	In Spots	20	Moderate	0	10	70
Turkey Run P1	In Spots		Moderate	30	30	15
Turkey Run P2	In Spots	45	Moderate	30	35	20
Turkey Run P3	In Spots	10	Moderate	25	5	20
Dead Run P1	In Spots	60	Moderate	0	10	20
Dead Run P2	Everywhere		Moderate	0	0	0
Dead Run P3	In Spots	30	Moderate	0	0	50
Pimmit Run P1	In Spots	50	Full	0	10	25
Pimmit Run P2	In Spots	45	Moderate	0	10	45
Pimmit Run P3	in spots	30	Full	0	10	60
Gulf Branch P1	In Spots	40	Moderate	0	25	40
Gulf Branch P2	In Spots	50	Moderate	0	0	0
Gulf Branch P3	In Spots	50	Moderate	0	10	50
Donaldson P1	In Spots	20	Moderate	0	0	10
Donaldson P2	In Spots	60	Moderate	0	0	50
Donaldson P3	In Spots	50	High	0	35	35
Spout Run P1	In Spots	50	High	0	0	10
Spout Run P2	In Spots	50	High	0	0	5
Spout Run P3	In Spots	70	Moderate	0	0	10
Windy Run P1			High	0	10	70
Windy Run P2			Full	0	5	10
Windy Run P3			Full	0	0	0
Difficult Run P1	Everywhere		High	0	0	0
Difficult Run P2	In Spots	50	Slight	0	0	0
Difficult Run P3	Everywhere		Slight	0	0	100

Appendix 9: 2008 Data Collection

Round 2					
	% Cobbles	Stream channel erosion potential	Area 1	Area 2	Area 3
Mine Run P1	70	Moderate	3x2		
Mine Run P2	70	Moderate	3x1		
Mine Run P3	20	High	3x1		
Turkey Run P1	25	High	3x2		
Turkey Run P2	15	High	3x2		
Turkey Run P3	50	High	3x2		
Dead Run P1	70	High	3x3		
Dead Run P2	70	High	3x3		
Dead Run P3	50	High	3x3		
Pimmit Run P1	65	Severe	3x3		
Pimmit Run P2	45	Severe	3x3		
Pimmit Run P3	30	Severe	3x3		
Gulf Branch P1	35	High	3x3		
Gulf Branch P2	100	High	3x2		
Gulf Branch P3	40	High	3x2		
Donaldson Run P1	90	Severe	3x2		
Donaldson Run P2	50	Severe	3x2		
Donaldson Run P3	30	High	3x1		
Spout Run P1	90	Severe	3x2		
Spout Run P2	95	Severe	3x1		
Spout Run P3	90	Severe	3x2		
Windy Run P1	20	High	3x3	3x3	3x2
Windy Run P2	85	Severe	3x3	3x3	
Windy Run P3	100	High	3x3		
Difficult Run P1	100	High	3x1		
Difficult Run P2	100	High	3x1	3x1	
Difficult Run P3	100	High	3x1		

Appendix 9: 2008 Data Collection

Round 3					
Stream	**Latitude**	**Longitude**	**Description**	**Date**	**Name of Certified Monitor**
Mine Run P1	39	77.26	5m downstream from road	7/2/2008	Rachel Buedel, Megan Bauer
Mine Run P2	39	77.26	15m upstream from road	7/2/2008	Rachel Buedel and Megan Bauer
Mine Run P3	39	77.26	25m upstream from road	7/7/2008	Rachel Buedel and Megan Bauer
Turkey Run P1	38	77.16	base of Switchback trail	7/15/2008	Rachel Buedel and Megan Bauer
Turkey Run P2	38	77.16	100m downstream from GW Pkwy	7/15/2008	Rachel Buedel and Megan Bauer
Turkey Run P3	38	77.16	50m downstream from GW Pkwy	7/15/2008	Rachel Buedel and Megan Bauer
Dead Run P1	39	77.17	15-20m upstream from mouth	7/16/2008	Rachel Buedel and Megan Bauer
Dead Run P2	39	77.17	50 m downstream	7/16/2008	Rachel Buedel and Megan Bauer
Dead Run P3	39	77.17	70m downstream of GW Pkwy bridge, below falls	7/29/2008	Rachel Buedel and Megan Bauer
Pimmit Run P1	39	77.12	30 meters upstream Glebe Road Route 123 Bridge	7/22/2008	Rachel Buedel and Megan Bauer
Pimmit Run P2	39	77.12	50 meters upstream Glebe Road, Route 123 Bridge	7/29/2008	Rachel Buedel and Megan Bauer
Pimmit Run P3	39	77.12	80 meters upstream Glebe Road, Route 123 Bridge	7/29/2008	Rachel Buedel and Megan Bauer
Gulf Branch P1	39	77.11	50m downstream from GW Pkwy	7/14/2008	Rachel Buedel and Megan Bauer
Gulf Branch P2	39	77.11	directly under bridge	7/14/2008	Rachel Buedel and Megan Bauer
Gulf Branch P3	39	77.11	15 m upstream from bridge	7/14/2008	Rachel Buedel and Megan Bauer
Donaldson P1	39	77.11	10m upstream from mouth	7/21/2008	Rachel Buedel and Megan Bauer
Donaldson P2	39	77.11	beneath GW Parkway bridge	7/21/2008	Rachel Buedel and Megan Bauer
Donaldson P3	39	77.11	15m upstream from GW parkway	7/21/2008	Rachel Buedel and Megan Bauer
Spout Run P1	39	77.08	next to drainage pipe, off Spout Run Pkwy, under GW	7/25/2008	Rachel Buedel and Megan Bauer
Spout Run P2	39	77.08	200 m upstream from P1	7/25/2008	Rachel Buedel and Megan Bauer
Spout Run P3	39	77.09	below Spout Run, ~50 m upstream of 2nd drainage pipe	7/25/2008	Rachel Buedel and Megan Bauer

Appendix 9: 2008 Data Collection

Round 3									
Stream	**Avg stream width**	**Average stream depth**	**Flow rate**	**Weather last 72 hours**	**Water Temp**	**Collect. Time (net1)**	**Collect. Time (net2)**	**Collection Time (net3)**	**Collection Time (net4)**
Mine Run P1	12	1.9	Normal	Rain, today very pleasant and sunny	19.5	30			
Mine Run P2	10	3.4	Normal	Rain	20.6	30			
Mine Run P3	16	2.8	High	humid, thunderstorms	21.6	30			
Turkey Run P1	24	1.7	Normal	Rain two days ago, now nice weather	20.1	60			
Turkey Run P2	8	2.4	Normal	rain heavy on 7/13; now sunny and cool temps	22.3	30			
Turkey Run P3	13	3.3	Normal	Rain heavy 7/13; today sunny with cool temps	22	30			
Dead Run P1	9	6.2	High	Sun	22	60	90		
Dead Run P2	15	3.7	Normal	Sun	23.7	90			
Dead Run P3	3	3	Normal	hot, humid, light rain	22.2	90			
Pimmit Run P1	26	7.1	Normal	hot, humid	24.3	30			
Pimmit Run P2	22	5	Normal	hot, humid, light rain	23.6	30			
Pimmit Run P3	29	6.2	Normal	hot, humid, light rain	24.8	30			
Gulf Branch P1	14	5.4	High	Rain, Thunderstorms	22.5	30			
Gulf Branch P2	9	3	High	Rain, Thunderstorms	22.6	30			
Gulf Branch P3	8	5.2	High	Rain, Thunderstorms	23.2	30			
Donaldson P1	31	5	Normal	Hot & Humid	23.1	30			
Donaldson P2	9	5.3	Normal	hot & Humid	23	30			
Donaldson P3	4	3.9	Normal	Hot and Humid	23.5	60			
Spout Run P1	12	8.2	Normal	Humid, heavy rain & thunderstorms	21.4	90			
Spout Run P2	10	5.2	Normal	humid, heavy rain, thunderstorms	22.4	30	60		
Spout Run P3	18	6.6	Normal	humid, heavy rain and thunderstorms	23.8	90	90		

Appendix 9: 2008 Data Collection

Round 3										
Stream	**First Page Comments**	**Worms**	**Flatworms**	**Leeches**	**Crayfish**	**Sowbugs**	**Scuds**	**Stoneflies**	**Mayflies**	**Dragonflies and Damselflies**
Mine Run P1		15	11	0	0	1	2	10	13	3
Mine Run P2	Salamanders!	7	4	0	2	2	1	37	12	6
Mine Run P3	Downstream from Flag; salamander	56	5	0	1	1	6	28	19	3
Turkey Run P1		34	1	0	0	0	2	1	26	0
Turkey Run P2		48	0	0	3	0	6	1	33	0
Turkey Run P3		7	0	0	2	0	2	3	18	0
Dead Run P1		47	0	0	0	1	2	0	57	0
Dead Run P2		45	0	0	1	0	1	0	7	0
Dead Run P3		42	1	0	0	1	0	0	4	0
Pimmit Run P1		131	70	0	0	3	1	0	83	0
Pimmit Run P2		27	12	0	0	1	0	0	36	0
Pimmit Run P3		18	23	0	0	4	1	0	22	0
Gulf Branch P1		26	8	0	0	2	1	0	19	0
Gulf Branch P2	Horsehair worm found in net	31	23	0	0	6	1	0	3	0
Gulf Branch P3		33	12	0	0	1	0	0	0	0
Donaldson P1		83	7	0	1	0	0	0	59	0
Donaldson P2	Horse hair worms collected; and when cleaning net a dragonfly nymph swam into net	43	30	0	1	0	2	0	94	0
Donaldson P3	Saw a really big eel under the waterfall!	87	8	0	0	0	2	0	29	0
Spout Run P1		61	68	0	0	2	2	0	136	0
Spout Run P2		41	46	0	0	0	8	0	38	0
Spout Run P3		14	2	1	0	2	1	0	85	0

Appendix 9: 2008 Data Collection

Round 3											
Stream	**Hellgrammites, Fishflies, and Alderflies**	**Common Netspinners**	**Most Caddisflies**	**Beetles**	**Midges**	**Blackflies**	**Most True Flies**	**Gilled Snails**	**Lunged Snails**	**Clams**	**Other Organisms**
Mine Run P1	3	202	81	58	45	53	6	0	1	0	
Mine Run P2	8	145	25	59	6	3	3	0	1	5	
Mine Run P3	8	63	8	35	87	0	8	0	0	0	
Turkey Run P1	0	320	41	3	52	2	9	0	0	0	
Turkey Run P2	0	90	9	6	142	0	3	0	0	0	
Turkey Run P3	0	74	126	1	78	37	6	0	0	0	
Dead Run P1	0	46	4	4	137	2	10	0	6	0	
Dead Run P2	0	36	1	0	140	8	1	0	0	0	
Dead Run P3	0	70	57	0	29	9	4	0	2	0	
Pimmit Run P1	1	100	101	0	40	22	3	0	0	0	
Pimmit Run P2	0	186	32	1	7	0	5	0	1	0	
Pimmit Run P3	0	196	112	2	12	0	3	0	0	0	
Gulf Branch P1	0	5	0	0	133	15	5	0	0	0	
Gulf Branch P2	0	8	0	0	376	52	3	0	1	0	
Gulf Branch P3	0	18	0	0	379	149	0	0	1	0	
Donaldson P1	0	103	27	0	21	16	4	0	0	0	
Donaldson P2	0	56	19	0	33	0	4	0	0	0	
Donaldson P3	0	50	2	0	47	0	6	0	32	0	0
Spout Run P1	0	183	1	0	50	0	5	0	1	0	
Spout Run P2	0	44	0	0	25	0	3	0	0	0	
Spout Run P3	0	61	0	0	33	1	4	0	2	0	

Appendix 9: 2008 Data Collection

Round 3										
Stream	**Define Other Organism**	**Total Organisms**	**Metric 1 - Percent Mayflies, Stoneflies, and Most Caddisflies**	**Metric 2 - Percent Common Netspinners**	**Metric 3 - Percent Lunged Snails**	**Metric 4 - Percent Beetles**	**Metric 5 - Percent Tolerant**	**Metric 6 - Percent Non-Insect**	**Score**	**Ecological Conditions**
Mine Run P1		504	20.634921	40.079365	0.1984127	11.507937	25.992063	5.952381	8	Acceptable
Mine Run P2		326	22.699387	44.478528	0.3067485	18.09816	10.736196	6.7484663	7	Acceptable
Mine Run P3		328	16.768293	19.207317	0	10.670732	48.170732	21.036585	8	Acceptable
Turkey Run P1		491	13.849287	65.173116	0	0.610998	18.533605	7.5356415	5	Unacceptable
Turkey Run P2		341	12.609971	26.392962	0	1.7595308	57.478006	16.715543	5	Unacceptable
Turkey Run P3		354	41.525424	20.903955	0	0.2824859	35.028249	3.1073446	9	Acceptable
Dead Run P1		316	19.303797	14.556962	1.8987342	1.2658228	61.708861	17.721519	4	Unacceptable
Dead Run P2		240	3.3333333	15	0	0	80.833333	19.583333	5	Unacceptable
Dead Run P3		219	27.853881	31.96347	0.913242	0	38.356164	21.004566	5	Unacceptable
Pimmit Run P1		555	33.153153	18.018018	0	0	48.108108	36.936937	7	Acceptable
Pimmit Run P2		308	22.077922	60.38961	0.3246753	0.3246753	15.584416	13.311688	5	Unacceptable
Pimmit Run P3		393	34.096692	49.872774	0	0.5089059	14.75827	11.704835	7	Acceptable
Gulf Branch P1		214	8.8785047	2.3364486	0	0	86.448598	17.28972	5	Unacceptable
Gulf Branch P2		504	0.5952381	1.5873016	0.1984127	0	97.222222	12.301587	5	Unacceptable
Gulf Branch P3		593	0	3.0354132	0.1686341	0	96.964587	7.925801	5	Unacceptable
Donaldson P1		321	26.791277	32.087227	0	0	39.563863	28.34891	6	Acceptable
Donaldson P2		282	40.070922	19.858156	0	0	38.297872	26.950355	7	Acceptable
Donaldson P3	0	263	11.787072	19.011407	12.1673	0	66.920152	49.04943	2	Unacceptable
Spout Run P1		509	26.915521	35.952849	0.1964637	0	36.149312	26.32613	5	Unacceptable
Spout Run P2		205	18.536585	21.463415	0	0	58.536585	46.341463	5	Unacceptable
Spout Run P3		206	41.262136	29.61165	0.9708738	0	27.184466	10.679612	7	Acceptable

Appendix 9: 2008 Data Collection

Round 3					
Stream	Fish Water Quality Indicators	Barriers to Fish Movement	Surface-water appearance	Stream Bed Deposit	Odor
Mine Run P1	Scattered Individuals	No Barriers	Clear	Brown/Tan	Sewage off and on
Mine Run P2	Scattered Individuals	No Barriers	Clear	brown/tan	occasional sewage
Mine Run P3	Scattered Individuals	No Barriers	Clear	Brown/Tan	No Odor
Turkey Run P1	Scattered Individuals	None	Clear	Brown/Tan/Silty/Muddy	None
Turkey Run P2	Scattered Individuals/ Scattered Schools	No Barriers	Clear	Brown/Tan/Sandy	No Odor
Turkey Run P3	Scattered Individuals	No Barriers	Clear	Brown/Tan/Sandy	No Odor
Dead Run P1	Scattered Individuals	None	Clear, but tea-colored	Brown/Tan/Sandy	None
Dead Run P2	Scattered Individuals	No Barriers	Clear But Tea Colored	Brown/tan/Black/Silty/Muddy	No Odor
Dead Run P3	Scattered Individuals	Waterfalls	Clear but tea-colored	Brown/Tan/Sandy	No Odor
Pimmit Run P1	Scattered Individuals	No Barriers	Clear	Brown/Tan	No Odor
Pimmit Run P2	Scattered Individuals	No Barriers	Clear	Brown/Tan/Sandy	No Odor
Pimmit Run P3	Scattered Individuals	No Barriers	Clear	Brown/Tan/Sandy	No Odor
Gulf Branch P1	No Fish	Waterfalls	Clear but tea-colored	Brown/Tan	No Odor
Gulf Branch P2	No Fish	Waterfalls	Clear but tea-colored	Brown/Tan	No Odor
Gulf Branch P3	No Fish	Waterfalls	Clear but tea colored	Brown/Tan	No Odor
Donaldson P1	Scattered Individuals	Waterfalls	Clear	Brown/Tan	No Odor
Donaldson P2	Scattered Individuals	Waterfalls	Clear	Brown/Tan	No Odor
Donaldson P3	Scattered Individuals	Waterfalls	Clear	Brown/Tan/Sandy	No Odor
Spout Run P1	No Fish	Waterfalls	Clear	Brown/Tan	No Odor
Spout Run P2	No Fish	Waterfalls	Clear	Brown/Tan	No Odor
Spout Run P3	No Fish	No Barriers	Clear	Brown/Tan	Sewage

Appendix 9: 2008 Data Collection

Round 3									
Stream	Stability of stream	Algae Color	Algae located	Percent algae	Stream shade	% Silt	% Sand	% Gravel	% Cobbles
Mine Run P1	No Spots				High	0	0	25	75
Mine Run P2	no spots	brown coated	everywhere		Full	0	0	30	70
Mine Run P3	No Spots	Brown Coated	Everywhere	100	Moderate	0	0	50	50
Turkey Run P1	A Few Spots	Brown Coated	In Spots	35	High	0	30	40	30
Turkey Run P2	A Few Spots	Brown Coated	In Spots	10	Moderate	0	0	70	30
Turkey Run P3	A Few Spots	Matted on Stream Bed/Brown Coated	In Spots	25	High	0	0	50	50
Dead Run P1	A Few Spots	Brown Coated	In Spots	40	High	0	0	30	70
Dead Run P2	A Few Spots	Brown Coated	Everywhere	100	High	0	20	70	10
Dead Run P3	A Few Spots	Brown Coated	In Spots	70	High	0	30	20	50
Pimmit Run P1	No Spots	Brown Coated	In Spots	30	Moderate	0	0	20	80
Pimmit Run P2	A Few Spots	Brown Coated	Everywhere	80	High	0	10	40	50
Pimmit Run P3	A Few Spots	Brown Coated	Everywhere	70	High	0	0	20	80
Gulf Branch P1	No Spots	Dark Green	In Spots	20	High	0	0	0	100
Gulf Branch P2	No Spots	Dark Green	In Spots	35	High	0	0	40	60
Gulf Branch P3	No Spots	Dark Green	In Spots	20	High	0	0	0	100
Donaldson P1	No Spots	Brown Coated	In Spots	10	High	0	0	30	70
Donaldson P2	No Spots	Brown Coated	In Spots	10	High	0	0	60	40
Donaldson P3	A Few Spots	Brown Coated	In Spots	5	High	0	0	80	20
Spout Run P1	No Spots	Brown Coated	In Spots	50	Full	0	0	0	100
Spout Run P2	No Spots	Brown Coated	In Spots	95	Full	0	0	20	80
Spout Run P3	No Spots	Brown Coated	Everywhere	100	HIgh	0	0	50	50

Appendix 9: 2008 Data Collection

Round 3					
Stream	**Stream channel erosion potential**	**Area 1**	**Area 2**	**Area 3**	**Area 4**
Mine Run P1	Severe	3x1			
Mine Run P2	Severe	3x1			
Mine Run P3	Severe	3x1			
Turkey Run P1	Severe	3x2			
Turkey Run P2	Severe	3x1			
Turkey Run P3	Severe	3x1			
Dead Run P1	Severe	3x2	3x3		
Dead Run P2	Severe	3x3			
Dead Run P3	High	3x3			
Pimmit Run P1	Severe	3x1			
Pimmit Run P2	Severe	3x1			
Pimmit Run P3	Severe	3x1			
Gulf Branch P1	high	3x1			
Gulf Branch P2	Severe	3x1			
Gulf Branch P3	High	3x1			
Donaldson P1	Severe	3x1			
Donaldson P2	Severe	3x1			
Donaldson P3	Severe	3x2			
Spout Run P1	Severe	3x3			
Spout Run P2	Severe	3x1	3x2		
Spout Run P3	Severe	3x3	3x3		

Appendix 10: Water Chemistry Data
Round 88, Summer 2008

Stream Site	Day	Time	Nitrate	Nitrite	pH	Temp	DO %	DO mg/L	Cond. uS	Salinity (ppt)	Turbidity (JTU)	Score
Mine P1	5/27/08	9:00 AM	2.0	0	7.36	18.5	86.1	8.06	117.9/ 134.5	0.1	5	8
Mine P2	5/27/08	1:20 PM	2.0	0	7.38	18.9	84.7	7.81	118.2/ 132.7	0.1	5	9
Mine P3	5/29/08	7:30 AM			7.47	14.8	91.9	9.31	107.7/ 133.8	0.1	5	10
Pimmit P1	6/2/08	7:45 AM	2.0	0	7.66	18.3	86.8	8.16	219.6/ 252.0	0.1	5	5
Pimmit P2	6/2/08	10:00 AM	2.0	0	7.78	20.8	85.8	7.68	234.2/ 254.8	0.1	5	4
Pimmit P3	6/2/08	12:30 PM	2.0	0	7.75	22.6	86.7	7.49	192.9/ 202.1	0.1	0	5
Dead P1	6/9/08	*8:40 AM	5.0	0	7.79	22.4	84.4	7.33	244.7/ 257.9	0.1	5	5
Dead P2	6/10/08	7:50 AM	2.0	0	7.73	23	81.0	6.94	247.0/ 256.6	0.1	5	4
Dead P3	6/10/08	11:15 AM	2.0	0	7.63	24.9	82.8	6.92	253.4/ 256.4	0.1	5	4
Turkey P1	5/28/08	1:00 PM	2.0	0	7.88	16.1	86.3	8.37	290.2/ 350.8	0.2	5	4
Turkey P2	6/5/08	**8:00 AM	0.5	0	7.65	18	89.4	8.45	172.9/ 199.3	0.1	10	3
Turkey P3	6/5/08	**11:30 AM	0.5	0	7.69	19.3	82.4	7.56	188.4/ 210.4	0.1	10	4
Donald.P1	6/11/08	8:00 AM	5.0	0	7.62	21.9	75.4	6.60	329.5/ 350.5	0.2	5	4
Donald.P2	6/11/08	11:30 AM	2.0	0	7.61	22.2	73.3	6.38	335.9/ 355.1	0.2	5	5
Donald.P3	6/13/08	8:00 AM	5.0	0	7.64	20.9	84.7	7.56	390.0/ 423.5	0.2	5	5
Gulf P1	5/30/08	8:30 AM	5.0	0	7.42	15.9	78.5	7.76	335.9/ 406.8	0.2	5	5
Gulf P2	6/3/08	8:00 AM	5.0	0	7.36	16.6	74.6	6.97	353.9/ 403.9	0.2	0	5
Gulf P3	6/3/08	11:30 AM	5.0	0	7.37	18.6	76.1	7.12	351.4/ 400.6	0.2	0	5
Spout P1	6/13/08	11:30 AM	5.0	0	7.88	23.1	82.4	7.04	570.0/ 591.0	0.3	0	5
Spout P2	6/16/08	8:30 AM	5.0	0	7.74	21.2	78.4	6.95	551.0/ 595.0	0.3	0	5
Spout P3	6/16/08	11:30 AM	5.0	0	7.84	22.0	81.0	7.06	563.0/ 596.0	0.3	0	4
Windy P1	7/9/08	9:00 AM	5.0	0	7.66	21.5	74.3	6.55	458.1/ 491.3	0.2	0	5
Windy P2	7/11/08	8:00 AM	5.0	0	7.60	20.4	82.4	7.32	479.0/ 524.0	0.3	0	8
Windy P3	7/11/08	11:00 AM	5.0	0	7.52	21.0	77.4	6.90	484.0/ 525.0	0.3	0	3
Difficult P1	7/17/08	9:00 AM	0.5	0	7.81	24.4	78.5	6.56	184.3/ 186.7	0.1	0	10
Difficult P2	7/17/08	12:30 PM	0.5	0	7.76	25.3	81.1	6.66	188.8/ 187.7	0.1	0	10
Difficult P3	7/18/08	8:00 AM	0.5	0	7.30	23.8	57.8	4.88	184.6/ 188.9	0.1	0	8

Appendix 10: Water Chemistry Data
Round 89, Summer 2008

Stream Site	Day	Time	Nitrate	Nitrite	pH	Temp	DO %	DO mg/L	Cond. uS	Salinity ppt	Turbidity (JTU)	Score
Mine P1	6/19/08	7:30 AM	0.5	0	7.44	17.4	85.0	8.15	112.4/ 131.4	0.1	10	9
Mine P2	6/19/08	11:00 AM	0.5	0	7.66	18.5	83.8	7.84	116.0/ 132.2	0.1	10	10
Mine P3	6/20/08	1:00 PM	0.5	0	7.77	20.0	86.4	7.86	123.6/ 136.7	0.1	0	8
Pimmit P1	6/17/08	1:30 PM	2.0	0	7.73	23.1	85.8	7.34	164.0/ 170.1	0.1	10	5
Pimmit P2	6/20/08	11:00 AM	2.0	0	7.80	18.5	91.4	8.56	250.9/ 286.4	0.1	0	5
Pimmit P3	6/18/08	8:00 AM	2.0	0	7.69	18.3	84.9	7.97	187.9/ 215.2	0.1	5	6
Dead P1	6/25/08	8:00 AM	2.0	0	7.69	19.4	76.5	7.07	168.3/ 188.4	0.1	5	5
Dead P2	6/25/08	11:00 AM	2.0	0	7.64	20.4	84.3	7.63	172.1/ 188.9	0.1	5	6
Dead P3	6/27/08	12:00 PM	2.0	0	7.60	21.9	79.0	6.92	227.9/ 242.5	0.1	5	4
Turkey P1	6/23/08	**8:00 AM	2.0	0	7.97	20.5	83.8	7.54	312.7/ 342.2	0.2	0	5
Turkey P2	6/23/08	**11:00 AM	2.0	0	8.03	21.3	73.5	6.51	326.8/ 351.7	0.2	0	4
Turkey P3	6/24/08	**1:00 PM	2.0	0	7.91	20.3	71.9	6.42	288.9/ 317.4	0.2	0	5
Donald. P1	6/27/08	8:00 AM	5.0	0	7.53	21.9	54.0	4.72	412.2/ 437.8	0.2	0	6
Donald. P2	6/30/08	8:30 AM	5.0	0	7.64	21.4	73.0	6.45	399.5/ 428.6	0.2	0	8
Donald. P3	6/30/08	12:30 PM	5.0	0	7.65	22.9	80.8	7.06	408.6/ 433.8	0.2	0	8
Gulf P1	6/20/08	8:30 AM	5.0	0	7.57	18.0	82.2	7.78	360.3/ 416.3	0.2	0	5
Gulf P2	6/25/08	2:00 PM	5.0	0	7.41	21.2	58.5	5.38	281.5/ 304.3	0.1	0	6
Gulf P3	6/24/08	9:50 AM	2.0	0	7.36	19.2	63.5	5.86	221.7/ 249.2	0.1	0	6
Spout P1	7/1/08	8:15 AM	2.0	0	7.69	20.9	80.3	7.16	408.5/ 442.8	0.2	5	3
Spout P2	7/1/08	11:15 AM	5.0	0	7.76	21.9	77.5	6.79	483.0/ 513.0	0.2	5	7
Spout P3	7/1/08	1:00 PM	5.0	0	7.78	22.6	77.3	6.67	451.0/ 473.2	0.2	5	5
Windy P1	7/24/08	8:30 AM	2.0	0	7.50	20.9	72.7	6.49	205.0/ 222.6	0.1	0	5
Windy P2	7/24/08	11:30 AM	2.0	0	7.54	21.6	70.6	6.22	299.9/ 230.9	0.2	0	3
Windy P3	7/24/08	1:30 PM	2.0	0	7.38	22.0	46.0	4.02	343.9/ 364.8	0.2	0	4
DifficultP1	7/28/08	8:00 AM	0.5	0	7.74	23.0	59.3	5.08	112.7/ 117.2	0.1	0	10
DifficultP2	7/28/08	11:00 AM	0.5	0	7.74	23.7	75.4	6.37	170.2/ 174.4	0.1	0	10
DifficultP3	7/28/08	1:45 PM	0.5	0	7.44	24.0	79.4	6.69	171.1/ 174.7	0.1	5	8

Appendix 10: Water Chemistry Data
Round 90, Summer 2008

Stream Site	Day	Time	Nitrate	Nitrite	pH	Temp	DO %	DO mg/L	Cond. uS	Salinity ppt	Tubidity (JTU)	Score
Mine P1	7/2/08	8:00 AM	2.0	0	7.54	19.5	80.6	7.41	123.5/ 138.1	0.1	0	8
Mine P2	7/2/08	12:30 PM	0.5	0	7.60	20.6	78.0	7.02	126.3/ 138.1	0.1	0	7
Mine P3	7/7/08	**8:00 AM	0.5	0	7.09	21.6	76.8	6.76	127.2/ 135.9	0.1	5	8
Pimmit P1	7/22/08	8:00 AM	0.5	0	7.92	24.3	48.3	4.04	310.1/ 314.2	0.2	0	7
Pimmit P2	7/29/08	11:30 AM	0.5	0	8.00	23.6	56.5	4.78	250.5/ 257.2	0.1	0	5
Pimmit P3	7/29/08	12:45 PM	0.5	0	7.63	24.8	62.2	5.17	309.1/ 311.8	0.2	0	7
Dead P1	7/16/08	10:00 AM	0.5	0	7.76	22.0	46.3	4.04	162.4/ 172.1	0.1	0	4
Dead P2	7/16/08	1:00 PM	0.5	0	7.72	23.7	80.3	6.79	174.7/ 178.9	0.1	0	5
Dead P3	7/29/08	8:00 AM	0.5	0	7.76	22.0	46.3	4.04	162.4/ 172.1	0.1	5	5
Turkey P1	7/15/08	8:00 AM	2.0	0	7.78	20.1	42.4	3.86	209.8/ 231.9	0.1	0	5
Turkey P2	7/15/08	10:30 AM	2.0	0	8.04	22.3	83.6	7.39	299.1/ 321.2	0.2	0	5
Turkey P3	7/15/08	1:30 PM	2.0	0	8.02	22.0	74.6	6.51	308.5/ 326.5	0.2	0	9
Donald. P1	7/21/08	8:00 AM	5.0	0	7.47	23.1	56.5	4.83	418.7/ 434.5	0.2	0	6
Donald. P2	7/21/08	9:30 AM	5.0	0	7.68	23.0	60.0	5.14	417.1/ 433.5	0.2	0	7
Donald. P3	7/21/08	11:05 AM	2.0	0	7.73	23.5	67.1	5.70	419.1/ 431.5	0.2	0	2
Gulf P1	7/14/08	8:00 AM	0.5	0	7.52	22.5	75.4	6.52	126.3/ 132.6	0.1	5	5
Gulf P2	7/14/08	10:30 AM	0.5	0	7.40	22.6	77.4	6.68	147.5/ 154.6	0.1	5	5
Gulf P3	7/14/08	12:30 PM	0.5	0	7.41	23.2	73.2	6.25	171.2/ 177.1	0.1	5	5
Spout P1	7/25/08	8:30 AM	5.0	0	7.81	21.4	73.2	6.45	526.0/ 564.0	0.3	0	5
Spout P2	7/25/08	10:30 AM	5.0	0	7.87	22.4	76.9	6.67	540.0/ 568.0	0.3	0	5
Spout P3	7/25/08	12:30 PM	5.0	0	7.92	23.8	74.7	6.30	556.0/ 569.0	0.3	0	7
Windy P1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Windy P2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Windy P3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Difficult P1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Difficult P2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Difficult P3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(*) Were times that we couldn't agree on an estimated time, but the time was taken from sampling done in 2007.

(**) Were times that were not written down, but were able to be estimated.

Appendix 11: Land Cover Classification Description

1. *Open Water* – all areas of open water, generally with less than 25% cover of vegetation/land cover.
2. *Low Intensity Residential* – Includes areas with a mixture of constructed materials and vegetation. Constructed materials account for 30-80 percent of the cover. Vegetation may account for 20 to 70 percent of the cover. These areas most commonly include single-family housing units. Population densities will be lower than in high intensity residential areas.
3. *High Intensity Residential* – Includes highly developed areas where people reside in high numbers. Examples include apartment complexes and row houses. Vegetation accounts for less than 20 percent of the cover. Constructed materials account for 80 to100 percent of the cover.
4. *Commercial/Industrial/Transportation* – Includes infrastructure (e.g. roads, railroads, etc.) and all highly developed areas not classified as High Intensity Residential.
5. *Transitional* – Areas of sparse vegetative cover (less than 25 percent of cover) that are dynamically changing from one land cover to another, often because of land use activities. Examples include forest clearcuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (e.g. fire, flood, etc.).
6. *Deciduous Forest* – Areas dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to seasonal change.
7. *Evergreen Forest* – Areas dominated by trees where 75 percent or more of the tree species `maintain their leaves all year. Canopy is never without green foliage.
8. *Mixed Forest* – Areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.
9. *Pasture/Hay* – Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.
10. *Row Crops* – Areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.
11. *Urban/Recreational Grasses* – Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.
12. *Woody Wetlands* – Areas where forest or shrubland vegetation accounts for 25-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.
13. *Emergent Herbaceous Wetlands* – Areas where perennial herbaceous vegetation accounts for 75-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

Appendix 12: Location Data

Monitoring: Summer 2008

Stream	Station	County	State	Latitude	Longitude
Turkey	1	Fairfax	VA	N 38 57.56.15	W 77 9.24.91
Turkey	2	Fairfax	VA	N 38 57.51.20	W 77 9.24.25
Turkey	3	Fairfax	VA	N 38 57.49.60	W 77 9.25.9
Dead	1	Fairfax	VA	N 38 58.00.955	W 77 10.20.20
Dead	2	Fairfax	VA	N 38 57.56.62	W 77 10.25.34
Dead	3	Fairfax	VA	N 38 57.54.98	W 77 10.26.11
Pimmit	1	Fairfax	VA	N 38 55.46.92	W 77 7.5.49
Pimmit	2	Fairfax	VA	N 38 55. 50.26	W 77 7.11.12
Pimmit	3	Fairfax	VA	N 38 55.50.81	W 77 7.14.59
Gulf Branch	1	Arlington	VA	N 38 55.29.00	W 77 6.50.86
Gulf Branch	2	Arlington	VA	N 38 55.20.07	W 77 6.52.44
Gulf Branch	3	Arlington	VA	N 38 55.29.76	W 77 6.51.39
Donaldson	1	Arlington	VA	N 38 55.11.84	W 77 6.27.20
Donaldson	2	Arlington	VA	N 38 55.11.06	W 77 6.28.84
Donaldson	3	Arlington	VA	N 38 55.10.26	W 77 6.29.71
Mine	1	Fairfax	VA	N 38 59.59.47	W 77 15.22.95
Mine	2	Fairfax	VA	N 38 59.59.25	W 77 15.24.85
Mine	3	Fairfax	VA	N 38 59.58.98	W 77 15.30.06
Spout	1	Arlington	VA	N 38 54.4.46	W 77 5.1.73
Spout	2	Arlington	VA	N 38 54.4.05	W 77 5.2.69
Spout	3	Arlington	VA	N 38 54.3.05	W 77 5.4.36
Difficult	1	Fairfax	VA	N 38 58.36.27	W 77 14.23.40
Difficult	2	Fairfax	VA	N 38 58.37.42	W 77 14 27.50
Difficult	3	Fairfax	VA	N 38 58.36.03	W 77 14.39.40
Windy	1	Arlington	VA	N 38 54.20.34	W 77 5.39.08
Windy	2	Arlington	VA	N 38 54.19.31	W 77 5.40.62
Windy	3	Arlington	VA	N 38 54.19.09	W 77 5.44.13

Monitoring: Summer 2008

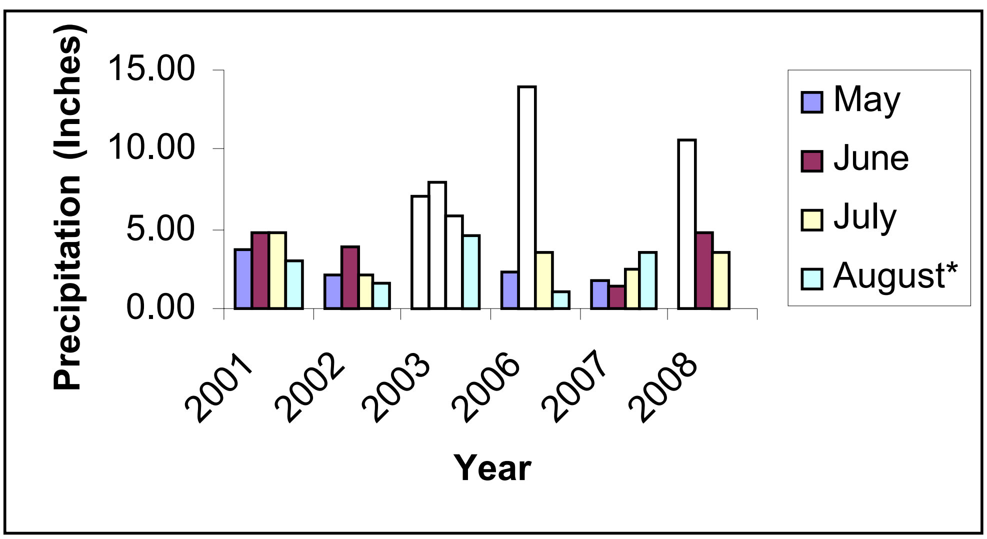
Stream	Station	Location
Turkey	1	at the base of the switchback trail
Turkey	2	100m downstream from GWMP, 40m upstream from site 1
Turkey	3	50m downstream from GWMP, 20m upstream from site 2
Dead	1	15-20m upstream from mouth
Dead	2	50m upstream from site 1, 10-20m upstream from large waterfalls
Dead	3	70-80 downstream of GWMP bridge, below waterfalls
Pimmit	1	70m upstream of Glebe Rd (123 bridge)
Pimmit	2	90m upstream of Glebe Rd (123 bridge)
Pimmit	3	120m upstream of Glebe Rd, at start of a bend in the run
Gulf Branch	1	20m downstream of GWMP, the edge of the GW closest to Potomac
Gulf Branch	2	Directly below GWMP on edge closest to Potomac
Gulf Branch	3	20m upstream of site 2, 10-15m from GWMP's inland edge
Donaldson	1	10m upstream from mouth
Donaldson	2	beneath GWMP bridge
Donaldson	3	15m upstream from GWMP, below the 6ft waterfalls
Mine	1	5m downstream from road
Mine	2	15m upstream from road

Mine	3	25m upstream from road
Spout	1	next to drainage pipe off Spout Run Parkway
Spout	2	100m upstream from site 1
Spout	3	50m upstream of second drainage pipe
Difficult	1	Near island,. When stream widens
Difficult	2	by a brush pile on large rocks (probably wont be there next season)
Difficult	3	
Windy	1	Upstream near the large dropoff
Windy	2	Right under GWMP
Windy	3	Right near the stream crossing

Appendix 13: Daily Rainfall: Summer 2008

Date	rainfall	Date	Rainfall	Date	Rainfall	Date	Rainfall	Date	Rainfall
May 26th	--	June 9th	0.00	June 23rd	0.14	July 7th	0.00	July 21st	0.00
May 27th	--	June 10th	0.33	June 24th	0.00	July 8th	0.00	July 22nd	0.04
May 28th	--	June 11th	0.00	June 25th	0.00	July 9th	0.01	July 23rd	1.09
May 29th	--	June 12th	0.00	June 26th	0.00	July 10th	0.00	July 24th	0.00
May 30th	--	June 13th	0.00	June 27th	0.09	July 11th	0.00	July 25th	0.00
June 2nd	0.00	June 16th	0.88	June 30th	0.16	July 14th	0.00	July 28th	0.01
June 3rd	0.79	June 17th	0.00	July 1st	0.09	July 15th	0.00	July 29th	0.00
June 4th	1.49	June 18th	0.00	July 2nd	0.00	July 16th	0.00		
June 5th	0.04	June 19th	0.00	July 3rd	0.00	July 17th	0.00		
June 6th	0.00	June 20th	0.00	July 4th	0.07	July 18th	0.00		

Figure 28: Monthly Rainfall at Ronald Reagan National Airport: 2001-2003, 2006-2008.



*Monthly precipitation total for August 2008 could not be determined as data was unavailable.

Appendix 14:Net New Development 2002-2006					
Arlington County, VA					
Year	**Office SF**	**Retail SF**	**Other SF**	**Residential Units**	**Hotel Rooms**
2002	956,983	195,595	8,184	1,959	350
2003	330,029	88,723	148,562	1,092	0
2004	-3,628	7,934	471,547	432	0
2005	524,613	114,422	72,104	1,121	0
2006	1,321,168	75,481	193,588	1,339	4
Total	3,129,165	482,155	893,985	5,943	354

Source: Arlington County Department of Community Planning Housing and Development, Planning Research and Analysis Team.
All data is reported in Square Feet (SF) unless noted.

Appendix 15: Acres of Land by General Land Use Category		
Fairfax County, January 2004		
Existing Land Use	Total Acres	Percent of Total
Residential	130,903	57.5
Industrial	9,389	4.1
Commercial	9,990	4.4
Parks and Recreation	28,108	12.3
Public	23,657	10.4
Vacant and Natural Uses	25,712	11.3
Fairfax County	227,759	100

Appendix 16: Acres of Land by Planned Land Use Category		
Fairfax County, January 2004		
Planned Land Use	Total Acres	Percent of Total
Residential	143,496	63
Industrial	8,290	3.6
Commercial/Retail Office	5,259	2.3

Public Facilities and Mixed Use	26,725	11.7
Parks, Recreation, and Floodplains	43,852	19.3
Fairfax County	227,622	100

Appendix 17: Percent Impervious Surfaces, Stream Protection Strategy, January 2001

Stream	% Impervious Surfaces	Projected % Impervious Surfaces
Dead Run	21.9	25
Turkey Run	8	15
Pimmit Run	25.53	32
Difficult Run	17.89	30.58

Appendix 18: Statistically Invalid Sampling Data '01-'07

Table 2: Statistically Invalid Sampling Data (<200 macroinvertebrates): 2001-2007

2001				
Of 63 Stations	Stream	Round	Station	Total # of macroinvertebrates
	Dead	1	1	174
	Dead	1	2	99
	Dead	1	3	175
	Turkey	1	1	175
	Turkey	1	2	175
	Dead	2	2	174
	Dead	2	3	144
	Turkey	2	3	91
	Gulf Branch	2	1	64
	Gulf Branch	2	2	84
	Gulf Branch	2	3	113
	Donaldson	2	2	70
	Donaldson	2	3	183
	Spout	2	3	24
	Mine	3	2	141
	Turkey	3	2	57
	Turkey	3	3	187
	Gulf Branch	3	1	41
	Gulf Branch	3	2	23
	Gulf Branch	3	3	42
	Donaldson	3	1	1
	Donaldson	3	2	2
	Donaldson	3	3	0
	Spout	3	1	154
2002				
Of 45 Stations	Stream	Round	Station	Total # of macroinvertebrates
	Donaldson	2	2	81
2003				
Of 63 Stations	Stream	Round	Station	Total # of macroinvertebrates
	Gulf Branch	1	1	32
	Gulf Branch	1	2	109
	Gulf Branch	1	3	66
	Gulf Branch	2	1	105
	Gulf Branch	2	2	74
	Spout	2	1	172
	Spout	2	2	88
	Dead	3	2	136
2006				
Of 45 Stations	Stream	Round	Station	Total # of macroinvertebrates
	Gulf Branch	1	2	160
2007				
Of 57 Stations	Stream	Round	Station	Total # of macroinvertebrates
	Dead	1	2	130

Appendix 19: Driving Directions

Mine Run

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Take I-495 South exit
3. Stay in right lane merging onto I-495 and take Langley/Great Falls exit
4. Turn right at 1st light onto west 193 and go approximately 4 miles
5. Turn right at 1st light onto Old Dominion
6. Continue straight to pay booth and into Great Falls Park
7. Pass visitor center and proceed to the end of the first long parking lot and park closest to the road
8. Mine Run will be in the forested gap between the two parking lots

Comments: green signs also present for direction to Great Falls Park

To Return to Headquarters:

1. Take Old Dominion back towards 193
2. Turn left at stoplight onto 193 and proceed approximately 4 miles
3. Go through first stoplight and stay in the left lane
4. Turn left at second stoplight onto I-495 North
5. Stay in right-most lane and take first exit onto GWMP
6. Turn left into parkway headquarters

Dead Run

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Drive past Turkey Run Park sign
3. Drive past 1st I-495 North/South exit sign
4. At 2nd I-495 South sign turn on hazard lights and slow
5. Turn off the parkway and onto the shoulder immediately after white arrow signs, park on grass just before Dead Run sign
6. Walk towards bridge and down the slope, stream is at the bottom of the hill

Comments: use caution when walking down the hill, it's a steep grade covered in loose dirt

To Return to Headquarters:

1. Turn on hazard lights and wait for an opening in traffic
2. Merge in to traffic headed North and merge immediately into the left lane
3. At a service road on the left, turn hazard lights on again and complete a U-turn
4. Proceed Southbound on GWMP
5. Turn left into parkway headquarters

Turkey Run

1. Exit through back entrance of parkway headquarters
2. Turn left at bottom of hill
3. Drive past parking lot C-3 (on left) and C-2 (on right) and enter lot C-1 (on right)
4. Park by interpretive wayside in near left corner
5. Follow trail downhill towards Potomac River, stay to the right
6. At the trailhead at the bottom of the hill, turn left
7. Turkey Run will be about 300 yards down the trail

To Return to Headquarters:

1. Hike back up trail
2. Turn left out of the parking lot
3. Follow loop back to headquarters

Pimmit Run

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Take 1st exit, Turkey Run Park (Washington exit)
3. Follow loop around and to the left and merge into GWMP Southbound
4. Take 123 North exit (Chain Bridge/Washington exit)
5. Take right at light (onto North Glebe)
6. Go straight under bridge and park behind "Dead End" sign
7. Hiking back the way you drove, find trail on left shoulder
8. Follow trail to the left towards Pimmit Run

To Return to Headquarters:

1. Follow trail back up the hill
2. Turn left/straight out of parking lot onto Glebe Rd (towards Chain Bridge)
3. Turn left onto Chain Bridge Rd
4. Turn right onto GWMP North
5. Turn right into parkway headquarters

Gulf Branch

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Take 1st exit, Turkey Run Park (Washington exit)
3. Follow loop around and to the left and merge into GWMP Southbound
4. Take 123 North exit (Chain Bridge/Washington exit)
5. Take right at light (onto North Glebe)
6. Take Military Road exit
7. Follow signs to Military Road (2 left's after exit)
8. Turn left onto 36th Road (not 36 Street)
9. Drive approximately 0.1-0.2 miles and park at trail head (across Nelson Street intersect)
10. Hike to bottom of stairs and turn left onto trail
11. Proceed to station locations

To Return to Headquarters:

1. Hike trail back to vehicle
2. Turn around, back towards Military Rd
3. Watch for sign for 120 North and turn right toward Chain Bridge
4. Merge on to N. Glebe Rd. heading down the hill
5. At the bottom of the hill, turn left onto Chain Bridge Rd
6. Turn right onto GWMP West
7. Turn right into parkway headquarters

Donaldson Run

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Take 1st exit, Turkey Run Park (Washington exit)
3. Follow loop around and to the left and merge into GWMP Southbound
4. Take 123 North exit (Chain Bridge/Washington exit)
5. Take right at light (onto North Glebe Rd)
6. Take Military Road exit
7. Follow signs to Military Road (2 left's after exit)
8. Turn left onto Marcey Road
9. Drive back to Donaldson Run Park HQ and park just beyond HQ building, if full then park in lot outside HQ driveway entrance
10. Walk to the end of the paved road and find trail heading downhill

11. At the trailhead at the bottom of the hill, take the trail to the right
12. Proceed to station locations

To Return to Headquarters:

1. Hike back to vehicle
2. Drive out on Marcey Rd
3. Turn right onto Military Rd
4. Watch for sign for 120 North and turn right toward Chain Bridge
5. Merge on to N. Glebe Rd. heading down the hill
6. At the bottom of the hill, turn left onto Chain Bridge Rd
7. Turn right onto GWMP West
8. Turn right into parkway headquarters

Spout Run

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Take 1st exit, Turkey Run Park (Washington exit)
3. Follow loop around and to the left and merge into GWMP Southbound
4. Take GWMP (South) to Ronald Reagan National Airport, go into Airport and fallow signs for GWMP North toward Washington (This may seem far to drive, but it is very simple and less stressful.)
5. Merge into left lane near TRI, and turn on hazard lights just after 1st Spout Run Parkway exit sign
6. Take Spout Run Parkway exit, slowing to prepare to pull off the road.
7. Enter exit in the right lane and park on grassy shoulder just behind the exit sign
8. Walk up side of road and cross when it is safe to do so
9. There is a storm drain just beyond the bridge on the left side of the road
10. Carefully walk through the brush and vegetation over the storm drain down into the stream

Comments: This is the most dangerous of the streams to sample. Be sure to wear orange vests when walking along the road and be sure to watch your footing while climbing down into the stream

To Return to Headquarters:

1. Return to vehicle as safely as possible
2. Turn on hazard lights and merge on to Spout Run Parkway
3. Stay in right lane of parkway and turn right at stoplight on Lorcom Ln
4. Turn right at the bottom of the hill onto Nelly Custis Dr
5. Nelly Custis Dr. becomes Military Rd
6. Watch for sign for 120 North and turn right toward Chain Bridge
7. Merge on to N. Glebe Rd. heading down the hill
8. At the bottom of the hill, turn left onto Chain Bridge Rd
9. Turn right onto GWMP North
10. Turn right into parkway headquarters

Difficult Run

1. Turn right from parkway headquarters (front entrance) onto GWMP
2. Take I-495 South exit
3. Stay in right lane merging onto I-495 and take Langley/Great Falls exit
4. Turn Right at the light onto 193.
5. Take a left into the gravel parking lot of Difficult Run Valley Park.
6. Hike downstream (to the left) to sites.

To Return to Headquarters:

7. Turn Right onto 193.
8. Go through first stoplight and stay in the left lane
9. Turn left at second stoplight onto I-495 North
10. Stay in right-most lane and take first exit onto GWMP
11. Turn left into parkway headquarters

Windy Run

1. Turn Right out of Parkway Headquarters
2. Take 1st exit, Turkey Run Park (Washington exit)
3. Follow loop around and to the left and merge into GWMP Southbound
4. Stay in the right lane and take the exit for 123 Chain Bridge Rd. North
5. Turn right at the light onto Glebe rd.
6. Take exit for Military road and turn left onto Military Road.
7. Follow Military Road and keep left onto Nelly Custis Drive
8. Turn Left onto Lorcom Ln.
9. Take the next left onto Kenmore St. Follow it down to the end and park.
10. Follow sign to Potomac Heritage Trail and proceed to sites.

To Return to Headquarters:

1. Turn Right onto Lorcom Ln.
2. Turn Right onto Nelly Custis Drive. This becomes Military Road.
3. Watch for sign for Chain Bridge. Turn right onto ramp and merge onto N. Glebe road (120).
4. Turn Left at the light onto Chain Bridge Road
5. Turn right at sign for GWMP West.
6. Turn right into Parkway Headquarters.

Dick's Sporting Goods (For uniform)

1. Turn right from parkway headquarters front entrance onto GWMP
2. Take I-495 South exit towards Richmond/Alexandria
3. Take exit #49 onto I-66 West toward Front Royal/Manassas
4. Take exit #55/VA-7100 onto John F Herrity PKY(VA-7100) toward Herndon/Reston
5. Turn right on Fair Lakes PKY
6. Turn right on Fair Lakes Cir
7. Arrive at, Fairfax, on the left

Pants-Convertible Zip-off Quick Dry pants ~$20-30.

Shirts-2 or 3 navy blue T-shirts (previously purchased at Wal-Mart) ~$20 for 3.

To Return to Headquarters:

1. Turn right out of the parking lot
2. Turn right onto Fair Lakes Pkwy
3. Turn left onto West Ox Rd. / VA 608 N
4. Merge on to 50 East towards I-66
5. Merge left onto I-66 East towards Washington
6. Merge onto I-495 North towards Baltimore
7. Merge onto GWMP
8. Turn left into parkway headquarters

Closest Wal-Mart

1. Start out going WEST on GEORGE WASHINGTON MEMORIAL PKWY N / GW PKWY N.
2. Start out going WEST on GEORGE WASHINGTON MEMORIAL PKWY N / GW PKWY N.
3. Merge onto I-66 W via EXIT 49 toward MANASSAS / FRONT ROYAL.
4. Take the FAIRFAX CO PKY / VA-7100 exit- EXIT 55- toward RESTON / HERNDON / SPRINGFIELD.
5. Merge onto VA-7100 N / FAIRFAX COUNTY PKWY / JOHN F JACK HERRITY PKWY via EXIT 55B toward RESTON / HERNDON.
6. Turn LEFT onto FAIR LAKES PKWY.
7. Turn LEFT onto FAIR LAKES SHOPPING CTR.
8. Turn RIGHT to stay on FAIR LAKES SHOPPING CTR.
9. End at Wal-Mart:
   13059 Fair Lakes Shopping Ctr, Fairfax, VA 22033, US

Total Est. Time**:** 25 minutes Total Est. Distance: 19.02 miles

REI sporting goods

1. Start out going WEST on GEORGE WASHINGTON MEMORIAL PKWY N / GW PKWY N.
2. Merge onto I-495 S / CAPITAL BELTWAY toward ALEXANDRIA / RICHMOND.
3. Merge onto I-66 W via EXIT 49 toward MANASSAS / FRONT ROYAL.
4. Merge onto US-50 E / LEE JACKSON MEMORIAL HWY via EXIT 57A toward FAIRFAX.
5. Keep RIGHT at the fork to continue on US-50 E / LEE JACKSON MEMORIAL HWY.
6. Turn RIGHT onto WAPLES MILL RD / VA-665 S.
7. Turn RIGHT onto RANDOM HILLS RD.
8. Turn LEFT onto RANDOM WALL WAY.
9. Turn RIGHT onto GRAND COMMONS AVE.
10. End at REI: 11950 Grand Commons Ave, Fairfax, VA 22030, US

Total Est. Time: 24 minutes Total Est. Distance: 17.82 miles

Appendix 20: Supplies

Always consult report for previous year's notes on the sample stations.
(i.e. Number of Macro- invertebrates, location of site, etc.)

1. Motorola Hand-held Radio (For emergency contact and weather updates)
2. 3'x 3' kick-seine net (1/16-inch mesh)
3. Waders
4. Two backpacks
5. Collapsible table
6. Uniform
7. Two collapsible seats
8. Timer
9. Field first aid kit
10. Meter stick
11. Magnifying glass
12. Collection vial
13. Pens/Pencils
14. Measuring tape (100ft)
15. Brush
16. Forceps
17. Two ice cube trays
18. Virginia Save Our Streams benthic macroinvertebrate tally sheets (Appendix 1)
19. YSI meter, model 85
20. YSI meter, model 60
21. LaMotte turbidity kit
22. Squirt bottle
23. Water bottle
24. Hand sanitizer
25. Flagging
26. Cell phone for emergencies
27. Sunscreen and bug spray
28. Hach water quality test strips
29. Virginia Save Our Streams stream quality survey form (Appendix 8)
30. Digital Camera
31. Laminated Map Set

Calibration Chemicals Ordering Information:

YSI Meter
YSI Inc.: 937-767-7241 Fax: 937-767-9353
1700/1725 Brannum Lane
Yellow Springs, OH 45387

Nitrate.Nitrite Strips
Industrial Test Systems Inc.: 803-329-9712 Fax: 803-329-9743
1875 Langston St.
Rock Hill, SC 29730

Appendix 21: Sampling Procedure

1. At each station, as a team, choose the sample area with best sampling conditions:
    a. Riffle of desired area (e.g. 3'x 3', 3'x 2', or 3'x 1').
    b. Mixture of small, medium, and moderately large cobbles with moderate flow, approximately 3-5 inches deep.
    c. Area with directional flow of water, or construct boundaries to direct flow.
2. Place kick-seine net perpendicular to water flow immediately downstream of sampling area.
3. Angle the net approximately 45 degrees, or greater, to streambed to allow capture of dislodged macroinvertebrates.
4. Place rocks along net bottom to prevent loss of macroinvertebrates.
5. The holding team member of the monitoring team keeps net in place and records elapsed time while the kicking team member scrubs and removes large rocks from the sample area.
6. When ready, the kicking team member vigorously churns the designated sample area by shuffling their feet.
7. Churning time depends on area of sample: 90 seconds for a 3'x 3' net, 60 seconds for a 3'x 2' net, and 30 seconds for a 3'x 1' net.
8. When time expires, rocks that held the bottom of the net are scrubbed and removed.
9. The net is then carefully lifted out of the water in a scooping motion to avoid sample loss.
10. The holding team member lays out the net on a table for sorting, while the kicking team member returns the riffle back to its original state.
11. All visible macroinvertebrates are removed from the net with forceps and placed in ice cube trays filled with stream water.
12. Each piece of detritus is carefully searched for clinging macroinvertebrates.
13. The net is picked until macroinvertebrates become difficult to find.
14. The net is then rolled from each side while the side facing the table is checked for macroinvertebrates.
15. Once the net is rolled up it is placed aside.
16. Macroinvertebrates on the table are then tallied and table is washed.
17. The net is then placed back on the table and steps 11-16 are repeated once.
18. At the end of the tally the net and table are washed clean for the next sample.

Appendix 22: Orientation Duties

1. Acquire and organize sampling equipment
2. Conduct calibration of water chemistry devices
3. Review previous report
4. Become certified as stream monitor
   Contact: Joanna A. Cornell (jcornell@gmu.edu)
5. Obtain uniform
6. Complete online security training
7. Obtain login/password information for use of office computers
8. Complete first-aid/CPR training
9. Navigate to stream stations (same stations as previous years) using
   GPS unit and flag for future sampling
10. Attend a Bridging the Watershed orientation/seminar
11. Visit the Center for Urban Ecology and meet with the Water Resource Specialists

Appendix 23: Points of Interest

All directions from Brookmont housing:
6201 Broad St.
Bethesda, MD 20816

Safeway Food and Drug

1. Head Northwest from Broad St. (go 0.2 mi.)
2. Turn right at Maryland Ave. (go 0.1 mi.)
3. Turn right at MacArthur Blvd. (go 0.2 mi.)
4. Turn hard left at Sangamore Rd. (go 353 ft.)
5. Continue on Brooks Ln. (go 0.3 mi.)
6. Arrive at Safeway

U.S. Post Office

1. Head Northwest from Broad St. (go 0.2 mi.)
2. Turn right at Maryland Ave. (go 0.1 mi.)
3. Turn right at MacArthur Blvd. (go 0.6 mi.)
4. Bear left at MacArthur Blvd. NW (go 0.3 mi.)
5. Turn left at Loughboro Rd. NW (go 1.1 mi.)
6. Bear left at Nebraska Ave. NW (go 1.0 mi.)
7. Turn right at Van Ness St. NW (go 0.2 mi.)
8. Turn right at Wisconsin Ave. NW (go 0.2 mi.)
9. Arrive at U.S. Post Office *(4005 Wisconsin Ave. NW, Washington D.C, 20016)*

Gas Station

1. Head Northwest from Broad St. (go 0.2 mi.)
2. Turn right at Maryland Ave. (go 0.1 mi.)
3. Turn right at MacArthur Blvd. (go 0.4 mi.)
4. Arrive at Hilltop Exxon

Sibley Memorial Hospital

1. Head Northwest from Broad St. (go 0.2 mi.)
2. Turn right at Maryland Ave. (go 0.1 mi.)
3. Turn right at MacArthur Blvd. (go 0.6 mi.)
4. Bear left at MacArthur Blvd. NW (go 0.3 mi.)
5. Turn left at Loughboro Rd. NW (go 0.1 mi.)
6. Arrive at Sibley Memorial Hospital (*5255 Loughboro Rd NW, Washington, DC 20016)*