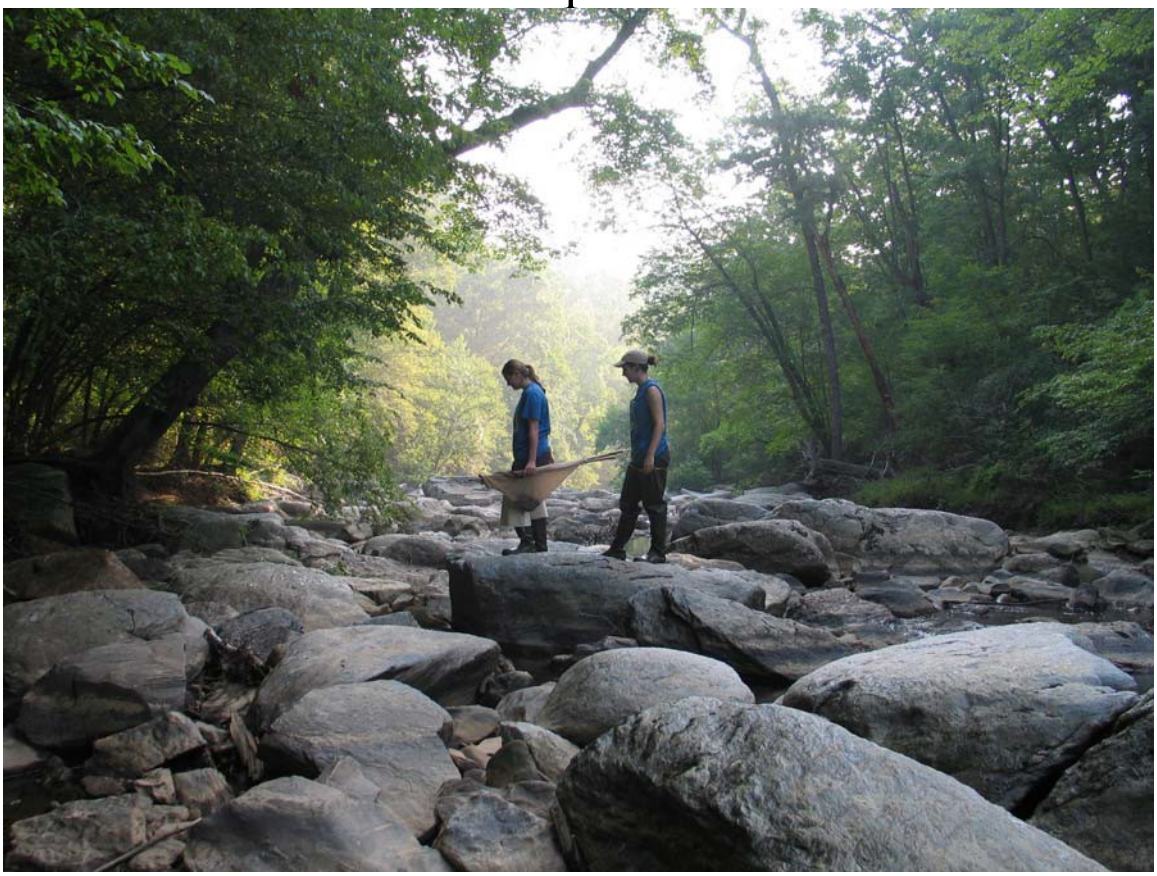
National Park Service
George Washington Memorial Parkway
Stream Monitoring Program

2007 Annual
Report



Hilary Becker, SCA Natural Resource Assistant
Laura Pendleton, SCA Natural Resource Assistant
Erik Oberg, Natural Resource Specialist
Brent Steury, Natural Resource Program Manager

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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 also thank Joanna Cornell who contributed her time to train and certify us as stream monitors, and Ben Helwig for producing the maps in this report. We would especially like to acknowledge Erik Oberg and Brent Steury for continuing this project after Ann's absence, for their constant support and advice, and for all of the other accommodations they provided us. We would also like to take this opportunity to thank Melissa Kangas for hiring us and giving us this opportunity. We truly appreciate the opportunity to participate in this project and would like to thank the entire staff of the George Washington Memorial Parkway for helping us have an enjoyable experience with the National Park Service.

ABSTRACT

Benthic macroinvertebrate data was collected in the summer of 2007 for the completion of a fifth year of stream water quality monitoring. Mine Run, the least impacted of the seven streams, and Difficult Run, a stream newly added to the study, consistently received "acceptable" year-round health scores according to the Virginia Save Our Streams (VASOS) protocol. Pimmit Run was not consistent, but it did average an "acceptable" score. The remaining streams consistently scored "unacceptable" yearly health scores. Spout Run, the most impacted stream, received the lowest average rating during the entirety of this 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 confident decision regarding the actual improvement of species density/ (richness). Results indicate species richness and density have improved since the impact; however, stream health scores have not recovered to pre-contamination conditions. Results from 2007 show that these two streams are as healthy as the other nearby streams. 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 and storm water Management Branch 2001). Sediment and pollutants carried by storm water runoff can adversely affect biological stream communities, and present the need for stream protection and restoration (USEPA, 1997 and 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, we started entering our stream data into the online VASOS multimetric index calculator and using this tool to derive our 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 (Figure 1). Difficult Run, Windy Run, and an unnamed tributary referred to as Wisteria Run, were not monitored due to unfavorable sampling conditions in 2001. Monitoring continued in 2002, 2003, 2006, and 2007 focusing on the same seven streams sampled in 2001. Starting in 2007, Difficult Run and Windy Run were added to the streams being monitored. Monitoring staff were trained and certified in VASOS protocol by NVSWCD prior to data collection.

METHODS

Stream monitoring was conducted from June 11, to August 10, 2007. Seven streams were sampled in the order of, Turkey Run, Dead Run, Pimmit Run, Gulf Branch, Donaldson Run, Mine Run, and Spout Run (Figures 2-8) in round one. Difficult Run and Windy Run were monitored after round two (Figures 9-10). Global Positioning System (GPS) coordinates for each stream station are listed in Appendix 14. Each stream was sampled at three stations, with a minimum distance of twenty meters between each sample station. In 2007, three rounds of sampling occurred at Turkey Run and Pimmit Run, and two rounds of sampling were conducted

at Dead Run, Gulf Branch, Donaldson Run, Spout Run, Mine Run, and Difficult Run. Windy Run was sampled only once.

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 2'x 2' area, and 30 seconds for a 1'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

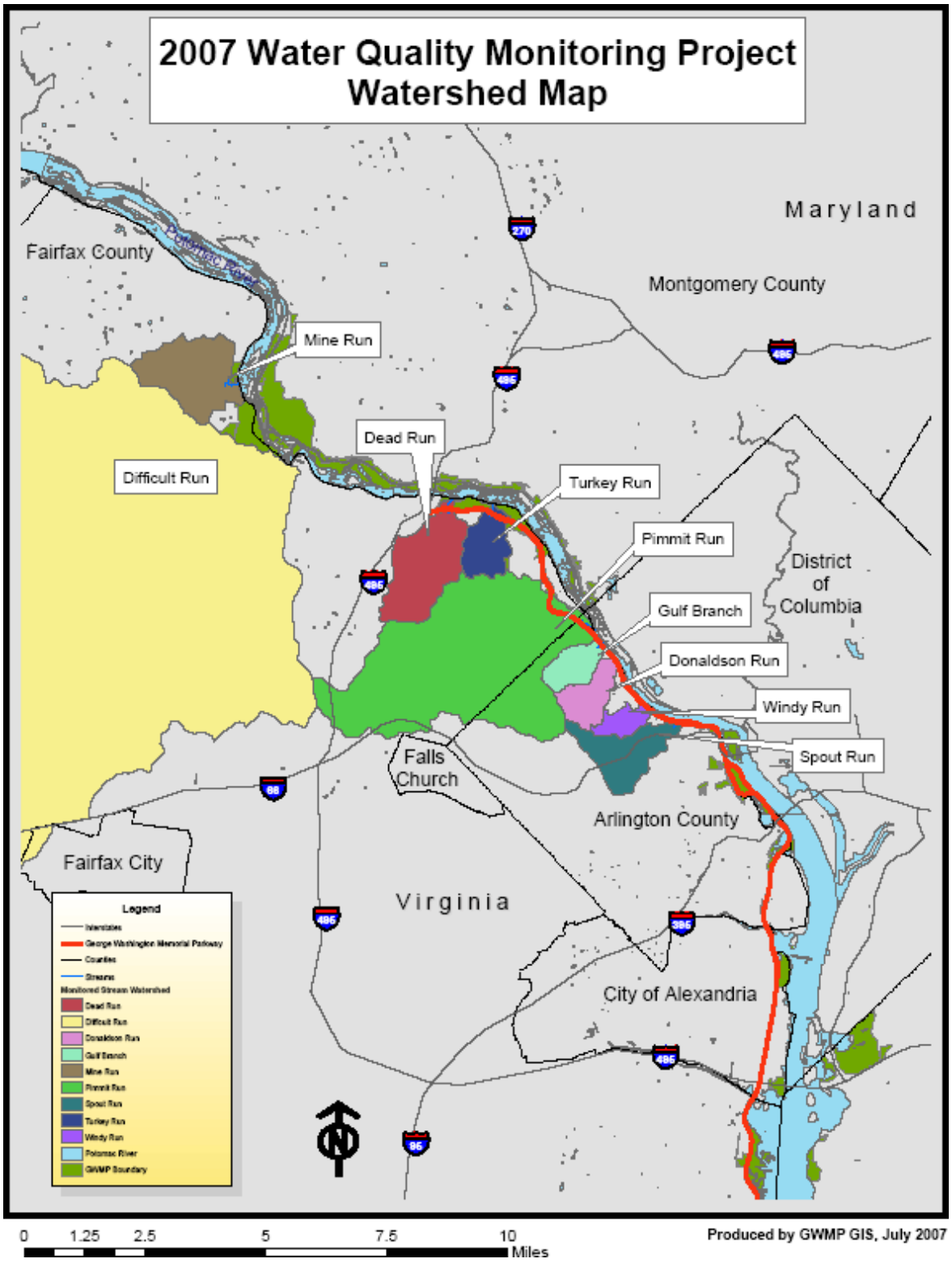


Figure 2: Site Sampling Locations: Mine Run

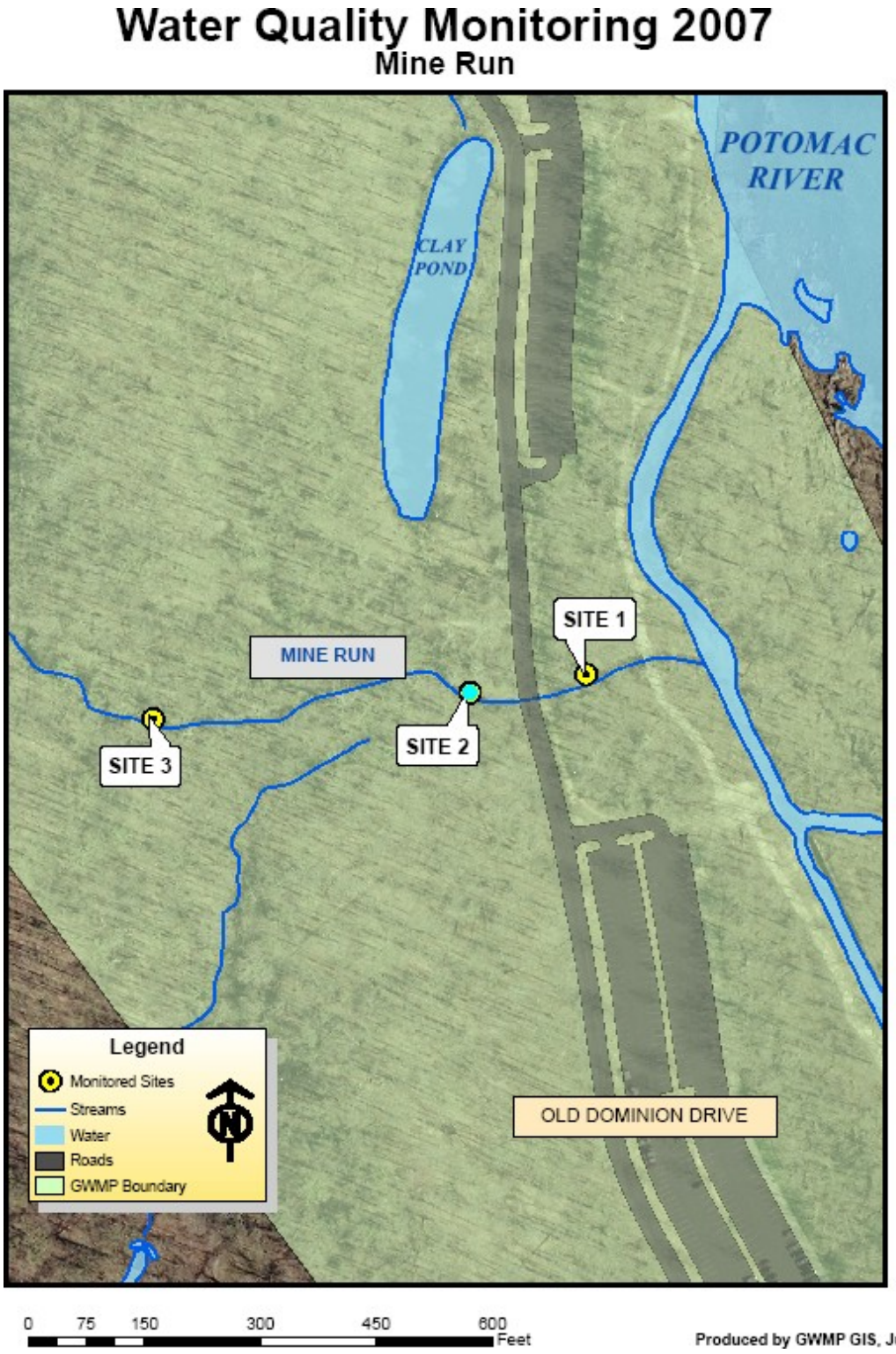


Figure 3: Site Sampling Locations: Turkey Run

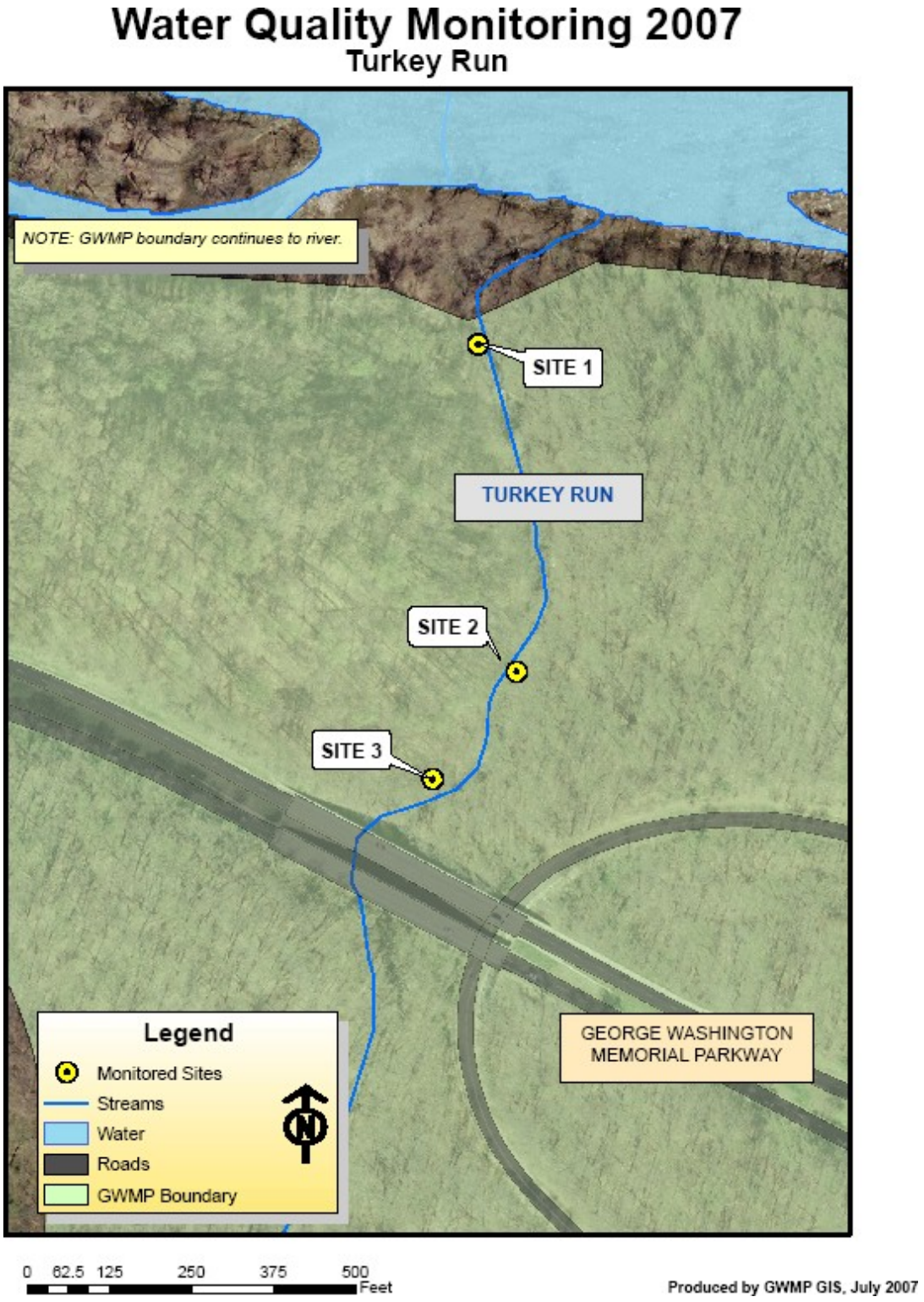


Figure 4: Site Sampling Locations: Dead Run

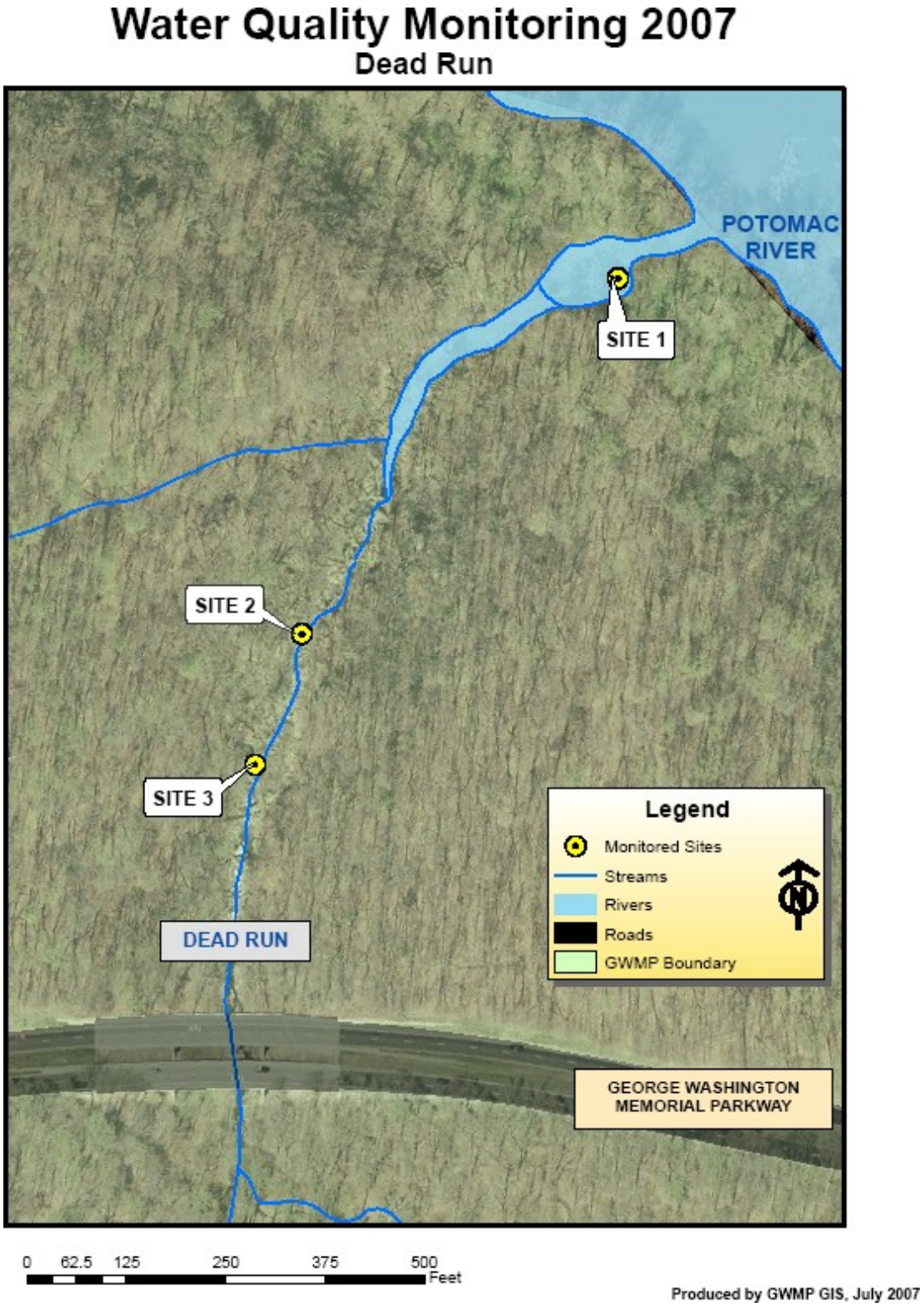


Figure 5: Site Sampling Locations: Gulf Branch

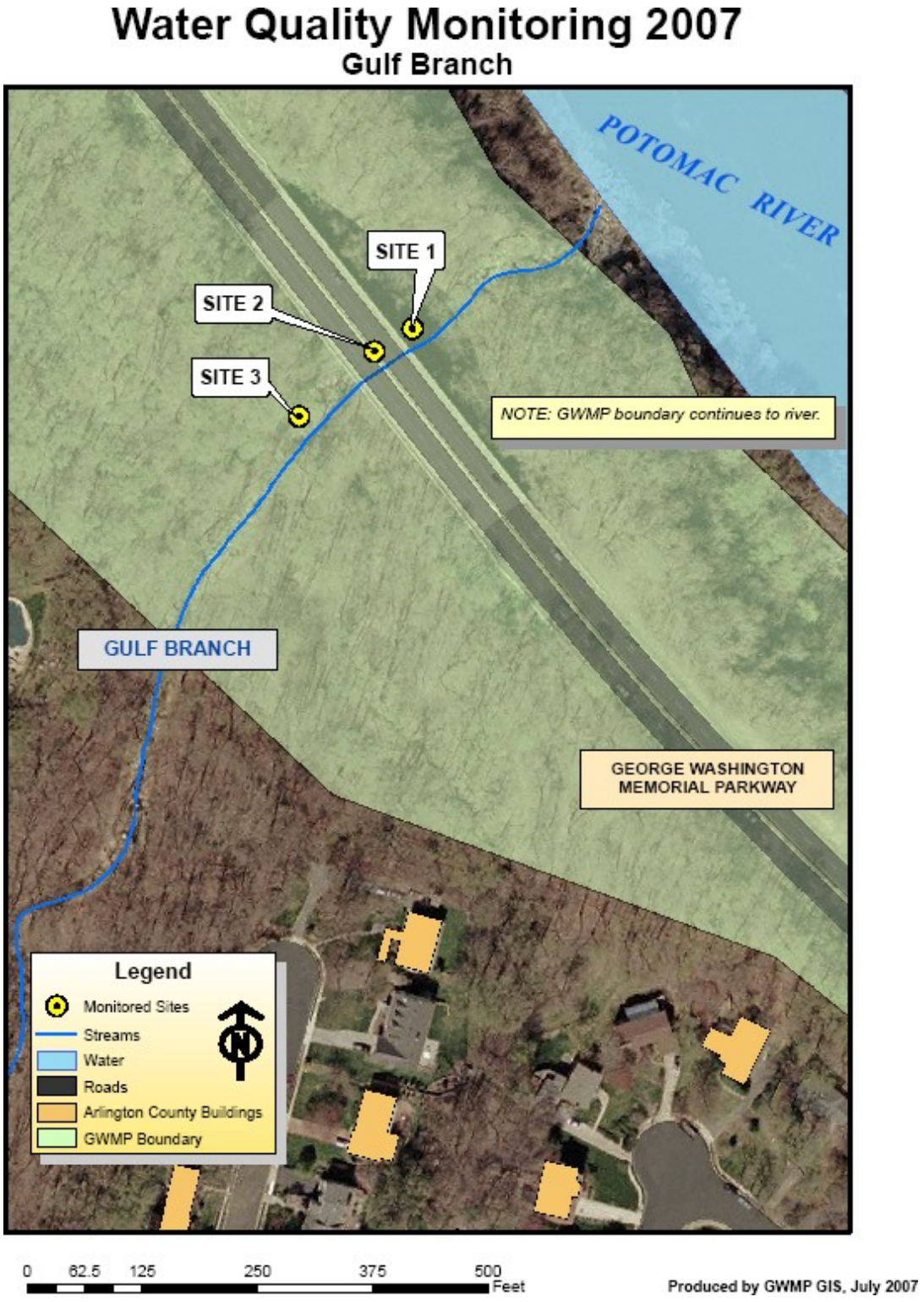


Figure 6: Site Sampling Locations: Pimmit Run

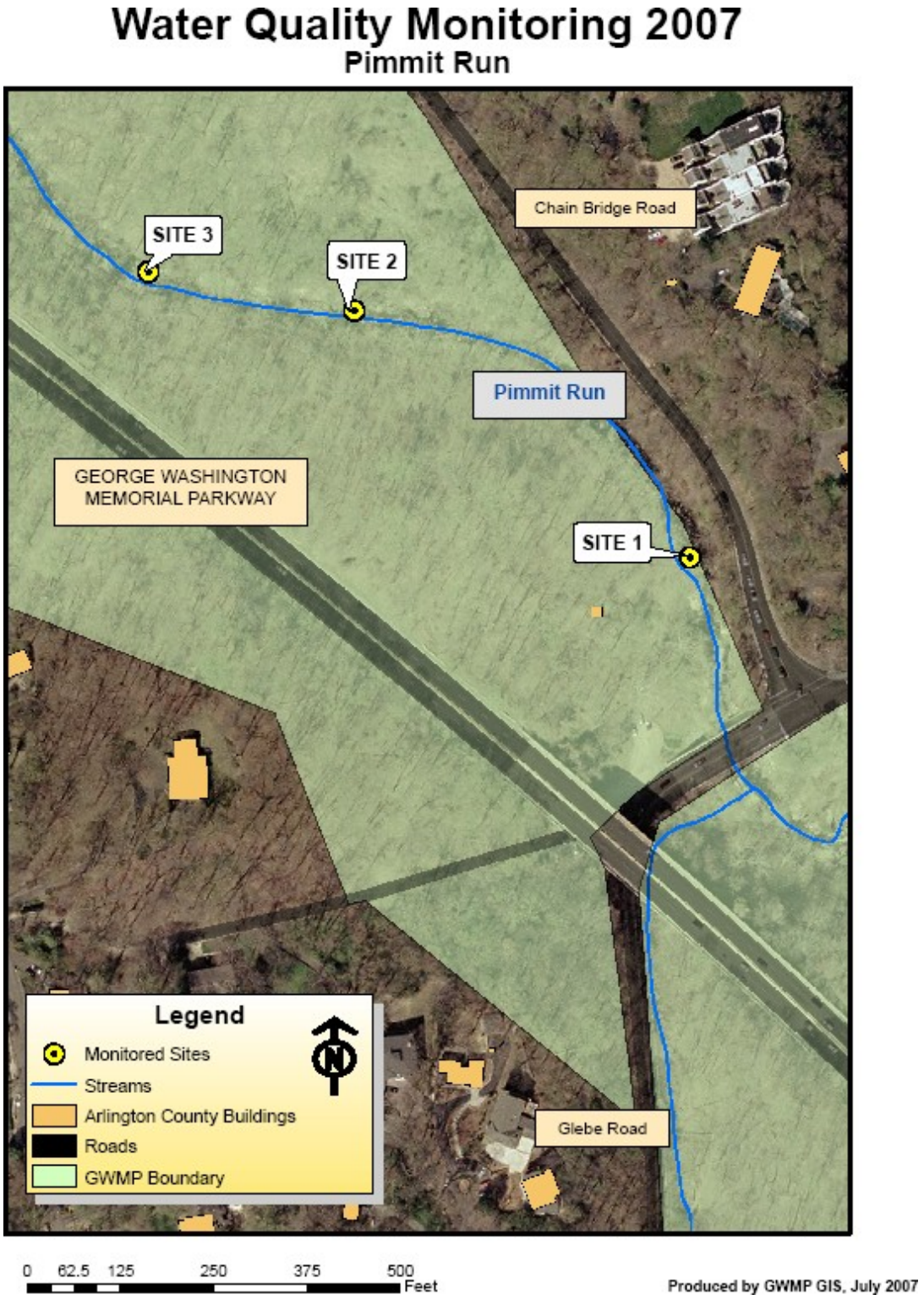


Figure 7: Site Sampling Locations: Donaldson Run

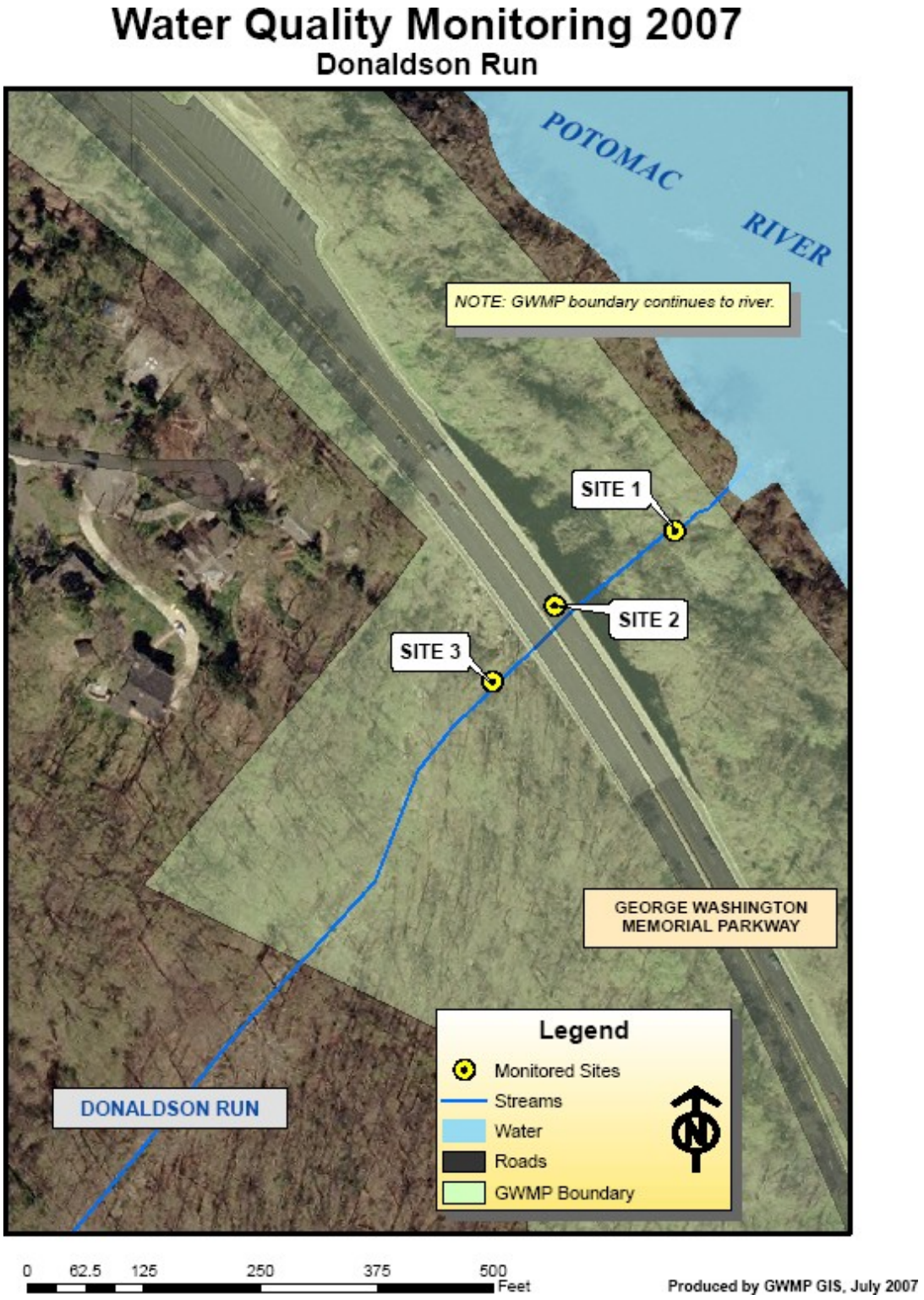


Figure 8: Site Sampling Locations: Spout Run

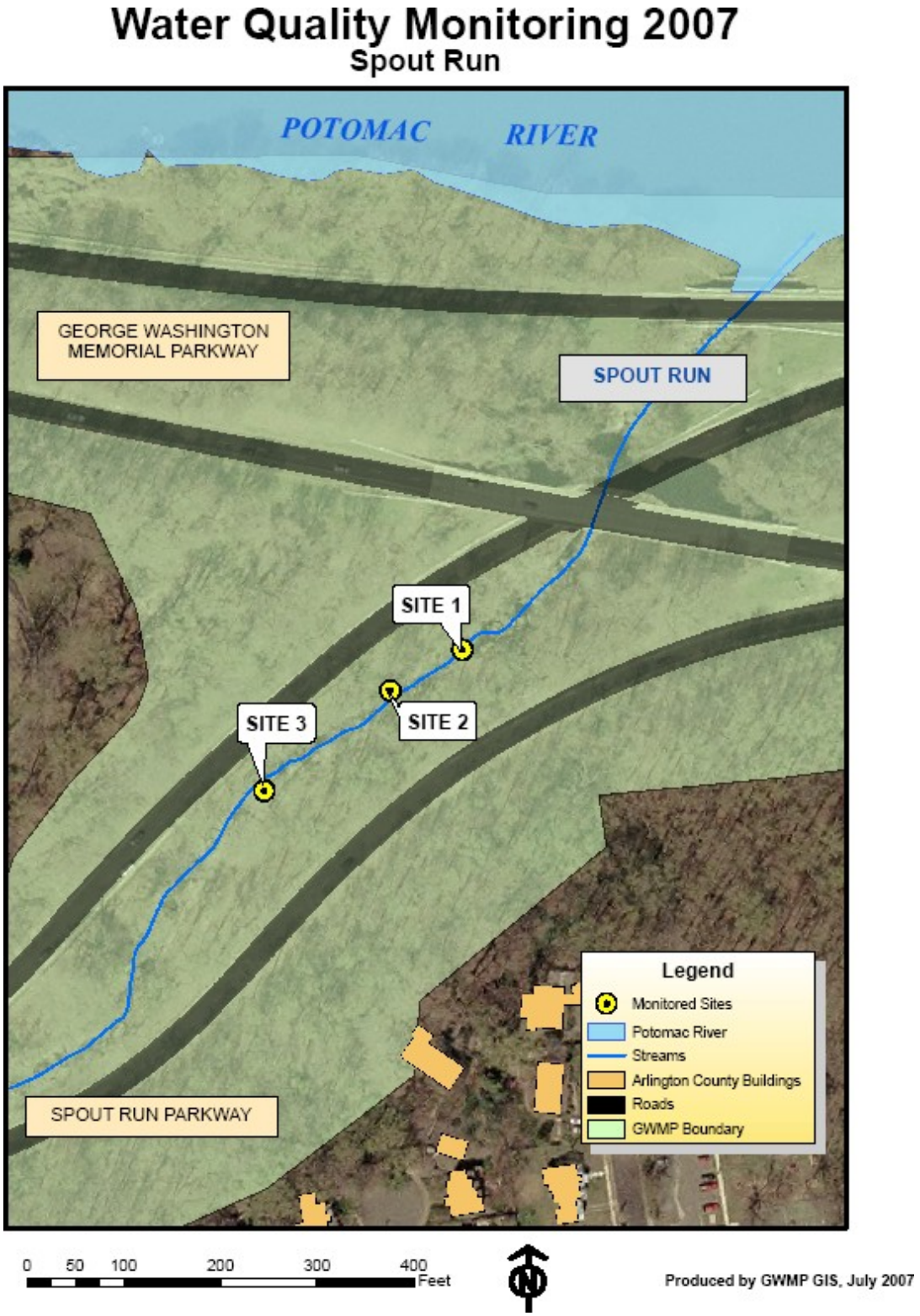


Figure 9: Site Sampling Locations: Windy Run

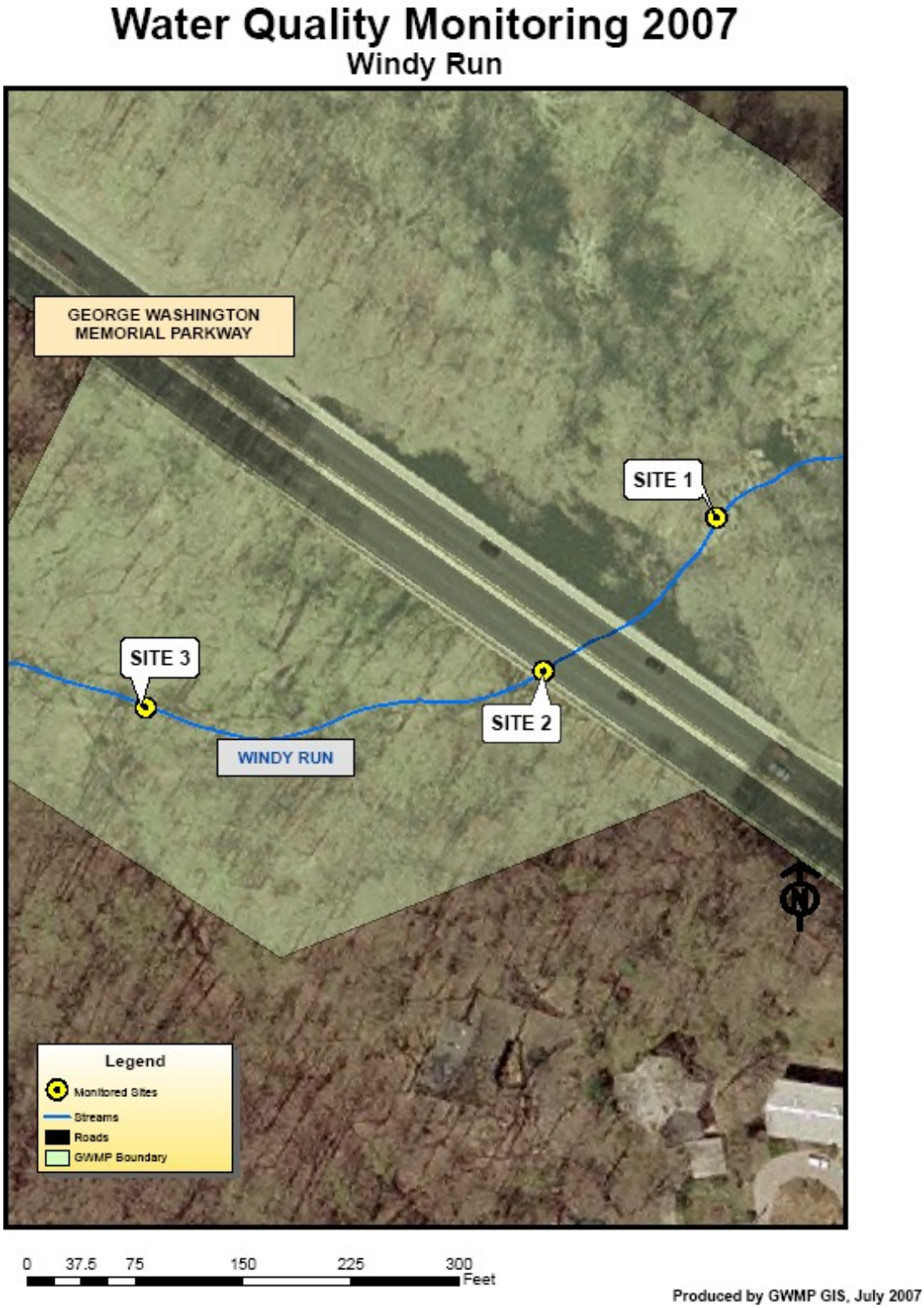
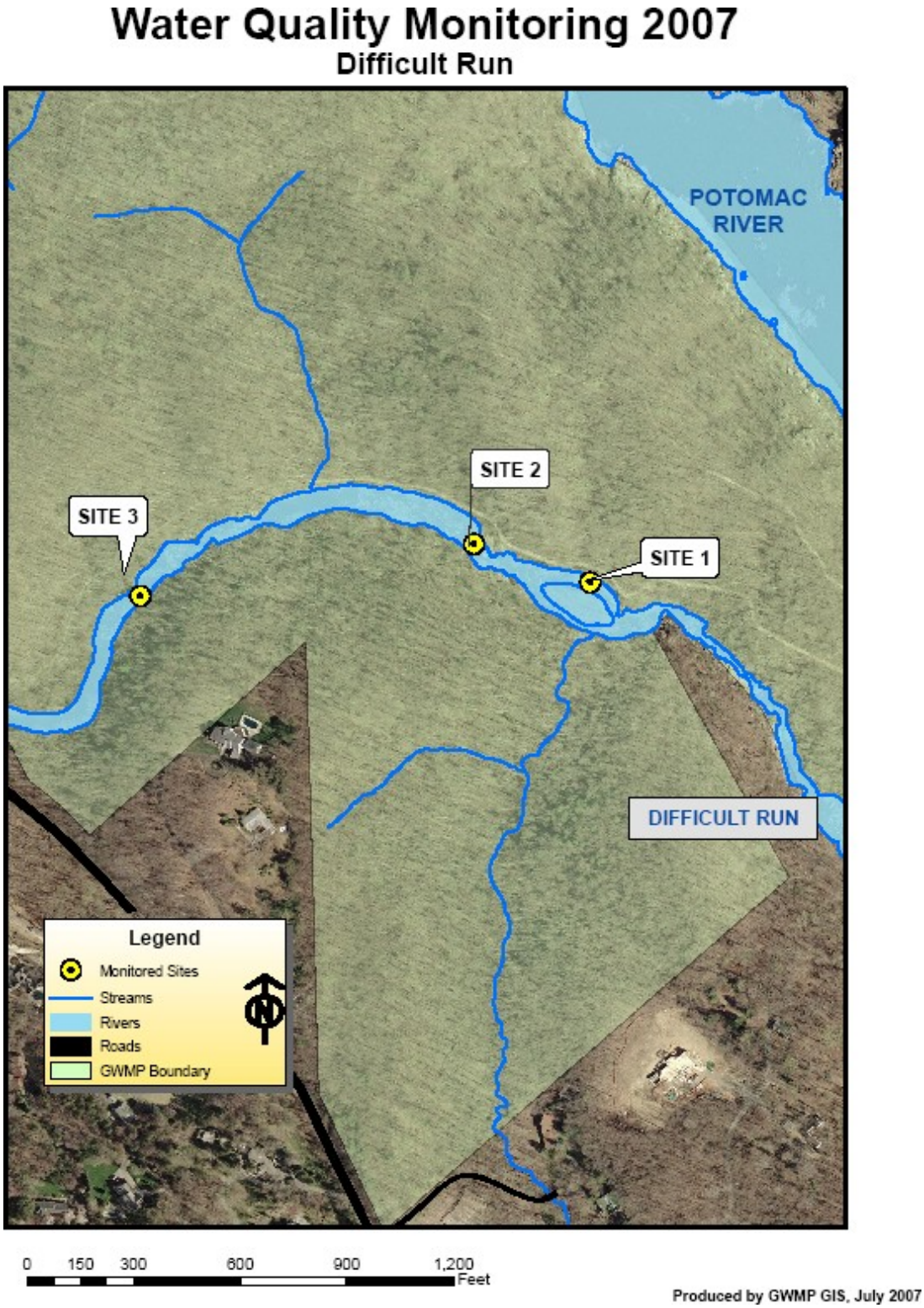


Figure 10: Site Sampling Locations: Difficult Run



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 seven or greater, while an "unacceptable" rating was given for a score of six or less.

Water Chemistry and Basic Water Quality Parameters

Each station was tested for dissolved oxygen, conductivity, pH, nitrate, nitrite, air and water temperature, 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 macroinvertebrates 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).

Hanna Instruments pH Meter (Model 9025) was used to measure pH of stream water and air 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, with alkaline 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 fish and salamanders, surface water and streambed appearance, stream bed stability, presence of algae, 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

Sampling occurred between June 11, 2007 and August 10, 2007. Appendix 9 shows the complete multimetric index scores along with type and abundance of macroinvertebrates collected at each sample station. In past years, Mine Run has been consistently received "acceptable" scores, whereas this year it received two "unacceptable" ratings. None of the

streams consistently received an "acceptable" score of seven or greater during all samplings in 2007. In 2007, stream health scores ranged from station scores of nine at Mine Run, Pimmit Run, and Turkey Run to the lowest score of two at stations in Windy Run, Spout Run, and Donaldson Run. Health scores by round and year are presented in Figure 12 and Table 1. Two of seven streams in round one (Gulf Branch and Donaldson Run) received an unacceptable score at every sample station, while four of the seven in round two (Turkey Run, Dead Run, Donaldson Run, and Spout Run) received unacceptable scores at every sample station. Mine Run scores ranged from six to nine, Dead Run scores ranged from three to seven, Turkey Run scores ranged from three to nine, Pimmit Run scores ranged from four to nine, Gulf Branch scores ranged from three to seven, Donaldson Run scores ranged from two to six, Spout Run scores ranged from two to seven, Windy Run scores ranged from two to seven, and Difficult Run scores ranged from six to nine. Stream health scores were the highest for all streams in 2001 except for Pimmit Run, whose score in 2007 was higher than 2001. The 2006 health scores are greater than those of 2002 and 2003 in all streams with the exception of Donaldson Run. In 2007, Dead Run, Pimmit Run, and Donaldson Run had a higher score than in 2006, and Turkey Run, Mine Run, and Gulf Branch had a score less than 2006. Between 2006 and 2007, Spout Run overall remained the same. None of the streams except Donaldson Run, which was "unacceptable", had a consistent rating of either "acceptable" or "unacceptable." Table 2 presents stream stations where the minimal number benthic macroinvertebrates (200) were not collected since the entirety of this monitoring program. Stream health scores calculated from these samplings were not used in analysis.

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	6.4	6.67	5.5	5.29		
2002	8	2.83	4	3.3	4.17	4.2	3.5		
2003	7.89	4.125	4.5	4	4.25	4.78	3.43		
2006	8.83	5.83	4.5	5.3	5	4.17	3.5		
2007	7.5	4.5	5	7.5	4.5	5	3.67	5	7.1
Average	8.194	4.707	4.8	5.3	4.918	4.73	3.878	5	7.1

Figure 13 shows the percentage of intolerant benthic macroinvertebrates collected in 2007. 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.

Figure 11: Stream Health Score 2007

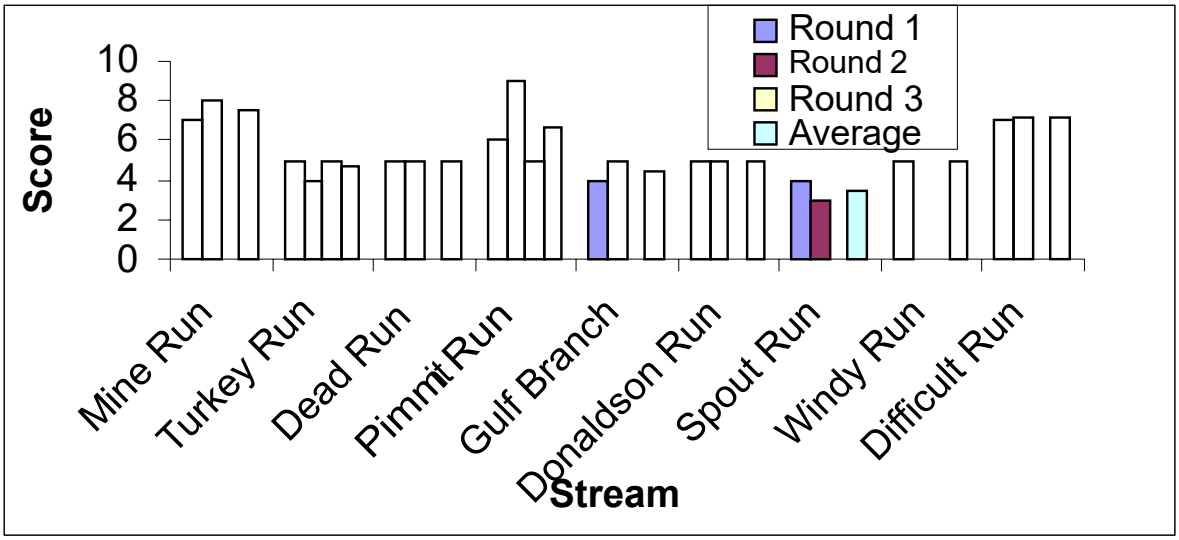


Figure 12: Average Yearly Health Scores

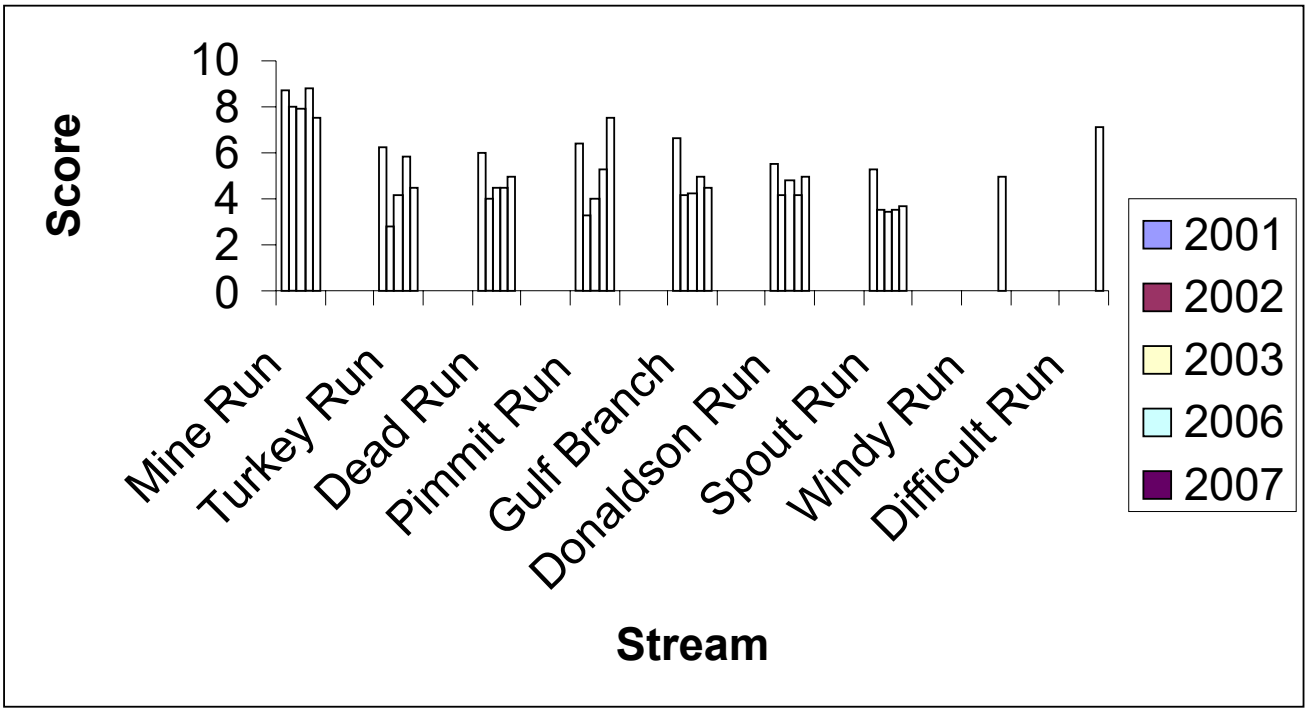
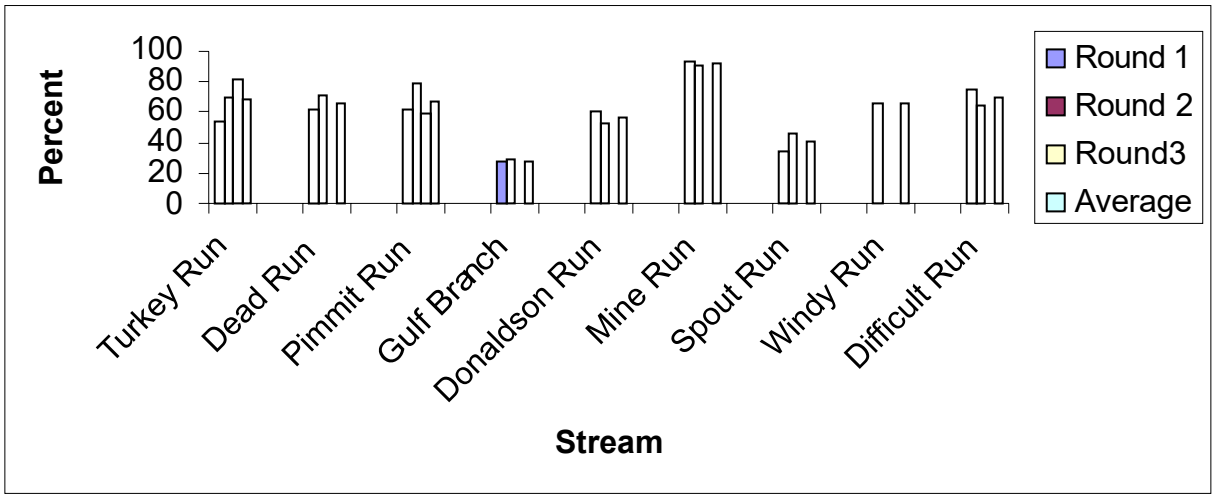


Table 2: Statistically Invalid Sampling Data (<200 macroinvertebrates): 2001-2007				
2001				
Of 63 Stations	Stream	Round	Station	Total # of macroinvertebrates
	Dead	1	1	174
	Dead	1	2	99
	Dead	1	3	175
	Turkey	1	1	175
	Turkey	1	2	175
	Dead	2	2	174
	Dead	2	3	144
	Turkey	2	3	91
	Gulf Branch	2	1	64
	Gulf 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

Figure 13: Percent Intolerant Benthic Macroinvertebrates 2007



2006 Statistical Analysis Method

Stream health scores collected from 2001 to 2007 were analyzed using Wilcoxon Matched-Pairs Signed-Ranks Test. A Bonferroni correction was made for multiple comparisons. With a selected alpha of 0.05 and *n* equaling the number of between-stream comparisons, p-values ≤ alpha / *n* ≤ 0.05 / 28 ≤ 0.0017 were considered significant. Values used and a calculation example of the Wilcoxon Matched-Pairs Signed Ranks-Test are presented in Appendix 10. Matched pairs that contained statistically invalid data were omitted from the analysis. Since an alpha of ≤ 0.0017 was considered significant, Wilcoxon Signed-Ranks critical value tables were not used due to the level of significance needed; exact p-values were calculated using an online statistical program. (http://fonsg3.let.uva.nl/Service/Statistics/Signed_Rank_Test.html). The Wilcoxon test results show that there is not a single significant (p-values ≤ 0.0017) difference between any of the stream health score comparisons.

2007 Statistical Analysis Method

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

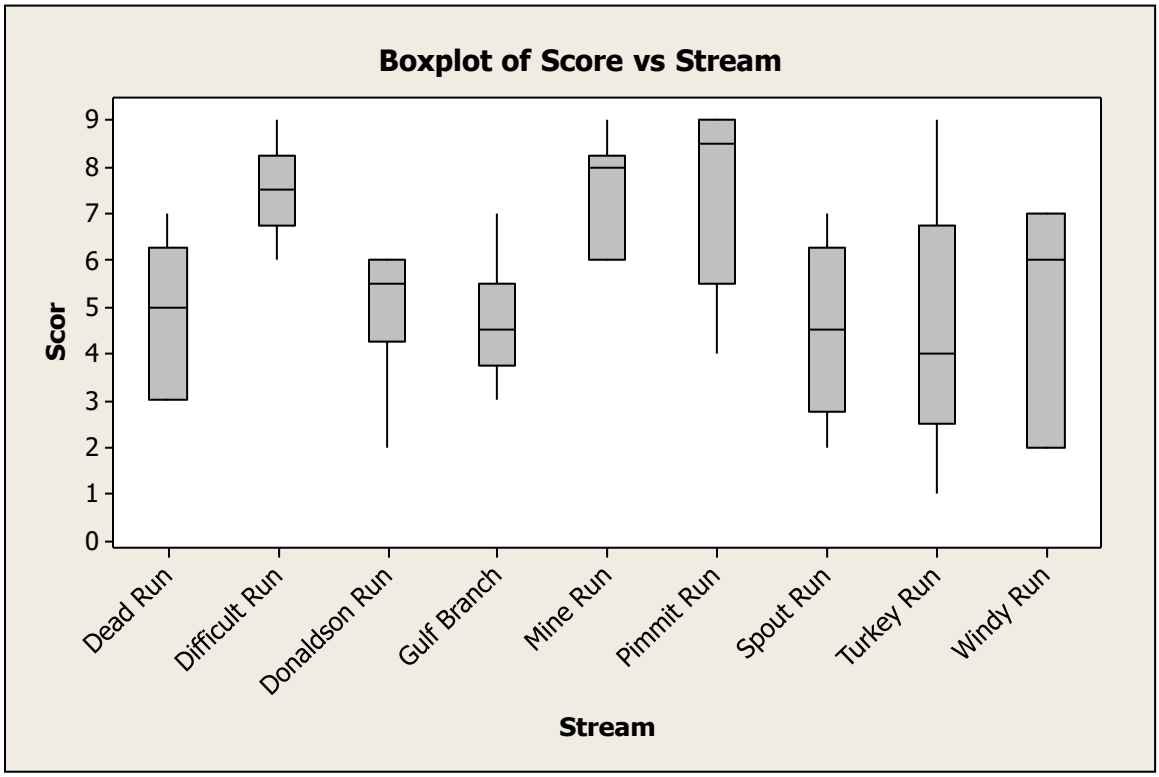
correlation between two sets of ranked data is referred to as a "Spearman's ranked correlation" or a "Spearman's rho". A positive correlation indicates an improving stream health while a negative correlation indicates declining stream health. The larger the absolute value of the correlation, the stronger the trend. A p-value of 0.05 is used to assess statistical significance. Data from Windy Run and Difficult Run were excluded from this analysis as there was only one year of data from these streams. While some streams showed improvement and others showed decline, none of the trends were significant (Table 1)

Table 3: Daniels Test for Trend

Stream	Spearman's rho	p-value
Mine Run	-0.211	n.s.
Dead Run	-0.114	n.s.
Turkey Run	0.070	n.s.
Pimmit Run	0.116	n.s.
Gulf Branch	-0.102	n.s.
Donaldson Run	0.017	n.s.
Spout Run	-0.108	n.s.

A Kruskal-Wallis test was used on the Stream Health scores from 2007 to determine if stream health differs between streams. A significant difference in stream health among streams was detected ($H=20.55$, $df=8$, $p=0.008$, adjusted for ties). As illustrated in Figure 1, Difficult Run, Mine Run and Pimmit Run have higher health scores than the other 6 streams. (Conover 1999)

Figure 14: Box-plot of Steam Health Scores from 2007



Water Chemistry and Basic Water Quality Parameters

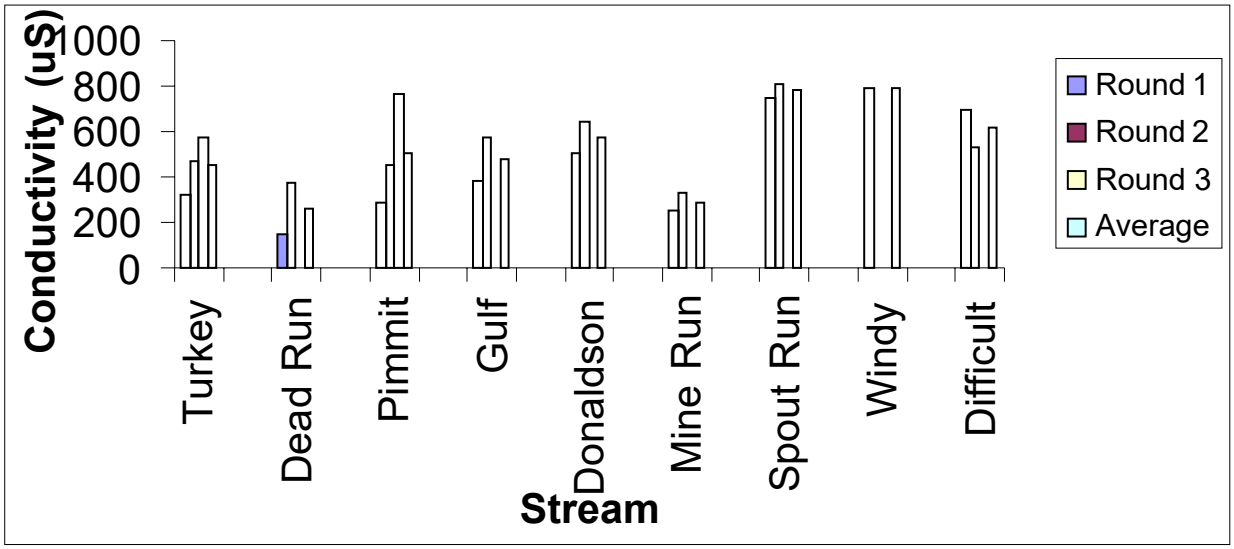
Appendix 11 shows water chemistry and basic water quality parameter data at each sample station. Water pH remained basic throughout the sampling period for all sampling points with an average of 7.65. A high of 8.1 was recorded at Turkey Run during round two, and a low of 7.15 was recorded at Gulf Branch during round one. Dissolved oxygen ranged from a calculated value of 100% (9.52 mg/l at 24.9 ºC) at Spout Run during round two, to 55.9% (5.15 mg/l at 23.3 ºC) at Pimmit Run during round three. Conductivity ranged from 829 micro Siemens (uS) at Windy Run during round one to 139.4 uS at Dead Run during round one. Dead Run registered the lowest average conductivity for 2007 at 259.84 uS, and Spout Run registered the highest average at 778.55 uS (Figure 14). Turbidity was less than 2.5 Jackson Turbidity Units (JTU) in every sample. In general, low levels of nitrate and nitrite were detected at all stream stations with nitrate levels ranging from 0 ppm to 5 ppm. Nitrite readings were 0 ppm at every sample station in 2007.

Habitat Assessment and Physical Characteristics

Appendix 12 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).

Fish were observed at one or more stations in Pimmit Run and Turkey Run for all three rounds of sampling and in Dead Run and Mine Run during two rounds of sampling. Fish were also found at two stations in Difficult Run. Waterfalls or large rocks were the main barriers to fish movement occurring in every stream at one or more sample stations. Salamanders were found only in Mine Run and Turkey Run at a total of five sites.

Figure 15: Conductivity 2007



Surface water appearance was described as "clear" at the majority of sample stations in 2007. The stream bed deposit was described as "brown/tan," "silty," and "muddy" during all three rounds at the majority of sample stations. The stream bed was consistently termed stable for most stream stations. Dead Run, station one, was not as stable and was very muddy. A sewage odor was observed only at Spout Run (June 26-28) Pimmit Run (June 15), and Dead Run (June 13) during round one of sampling. A musky odor was noticed at Difficult Run (August 10) during round two at one site.

Erosion potential of the stream banks varied from stream to stream. Most sites had moderate erosion potential (25%-49%). Sites with banks consisting of mainly bedrock and boulders had only a slight erosion potential (1%-24%), but sites at Donaldson Run, Dead Run, and Windy Run had highly eroded banks, posing a high erosion potential (50%-74%). At these sites there were many exposed tree roots and a high potential for soil and silt to fall into the water. 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, and Windy Run had one or more sites with high shade coverage (50%-74%). All three sites at Difficult Run had only slight shade covering (1%-24%), along with sites at Dead Run, Donaldson Run, Mine Run, and Spout Run.

Few sample stations contained some percentage of algae during all rounds of sampling. The algae were in the form of dark green, benthic algae or were brown-coated. Difficult Run had the most algae of any stream, growing everywhere. Water flow rates were relatively normal for the sites during the first round of sampling, but as the drought continued, flow rates decreased. Dead Run could not be sampled a third time because of the lack of water. Average stream depth ranged from 3.9 to 10.0 inches. Average sample depth was between 1 and 7 inches.

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.

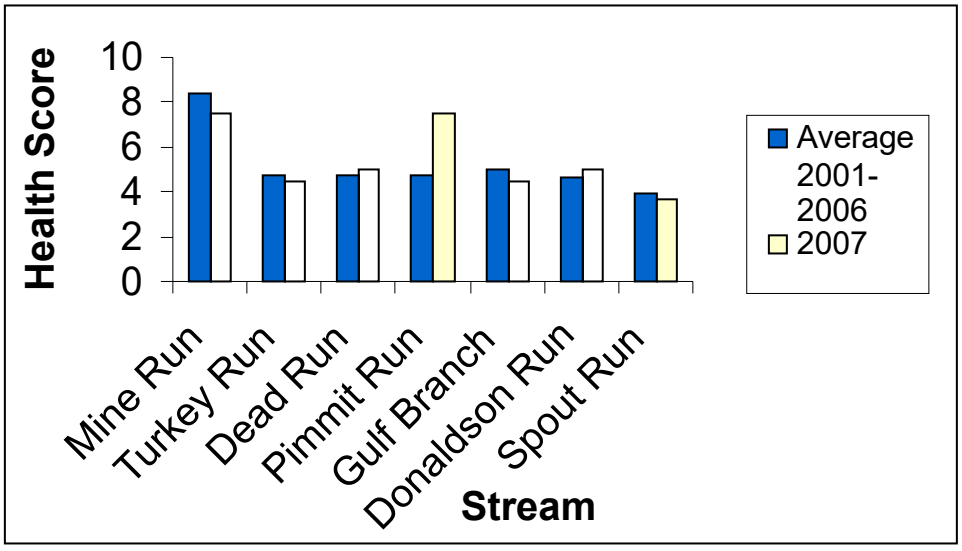
Figures 17-25 show land use in the watershed of each of the nine streams. Figure 26a shows the percentages of each type of land use as of 1993. Mine Run consists of 63.0% forested land and 28.8% agricultural land. Turkey Run watershed consists of 74.7% forested land and 18.4% residential/commercial land 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. The average scores of 2001, 2002, 2003, and 2006 were averaged together and then compared with the average scores of 2007. The average score of 2007 is only 1.43 points higher than the average score of previous years. Based on this comparison, it can be concluded that there may have been a slight increase in health score from the beginning of the project to 2007. Figure 15 illustrates the comparison of 2007 with all previous years. The variation between years could be due to many factors (such as weather and sampling problems), and the data lead to no definite conclusion as to the cause.

Figure 16: Average Health Scores Comparison



Weather

This summer the entire Washington D.C. Metropolitan area experienced a drought. As of August 3, Washington Reagan National Airport reported rainfall totals to be 5.25 inches below normal for the year and 5.08 inches below normal for May, June, and July. May received 1.75 inches, 2.07 inches below normal. June received 1.38 inches of rain, 1.75 inches below normal. July received 2.4 inches of rain, 1.26 inches below normal (Figure 27). This lack of rainfall has had an observable impact on sampling. For example, Dead Run's riffles were almost completely dry when a third round of sampling was being attempted. The lack of rain may have contributed to decreased runoff. This may have increased the quality of the water in the streams. On the other hand, the decrease of water in the streams may have increased the concentration of suspended solids as indicated by conductivity levels.

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 the highest with an average 7.5 in 2007 and a five year average ('01-'03, '06-'07) of 8. Turkey Run watershed is the most forested watershed and second least residentially/commercially developed, with a health score of 4.89 in 2007. 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 4.8 and 4.67 respectively in 2007, 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 5.0. Pimmit Run has the second highest percentage of residentially/commercially developed watershed land yet received the second highest score of 7.0 in 2006. Spout Run had the lowest average health score of 3.83 in

2007 and contains the highest percentage of residentially/commercially developed watershed land.

From land use data we would also predict that water chemistry parameters would reflect variation in land use. However, percent/concentration of dissolved oxygen, pH, nitrate, nitrite, and turbidity were not considerably altered in watersheds with high impacts verses watersheds with low impacts. High levels of conductivity seemed to have an inverse relationship with stream health scores. Conductivity (Figure 14) was highest for Spout Run, which produced the lowest stream health score in 2007. Lack of direct reflection of stream health scores to most water chemistry and land-use data show the usefulness of benthic macroinvertebrates as biotic indicators of transient impacts. These impacts can occur and have lasting effects on stream biota, but they are often missed when gathering water chemistry data.

Figure 17: Watershed Land-Use

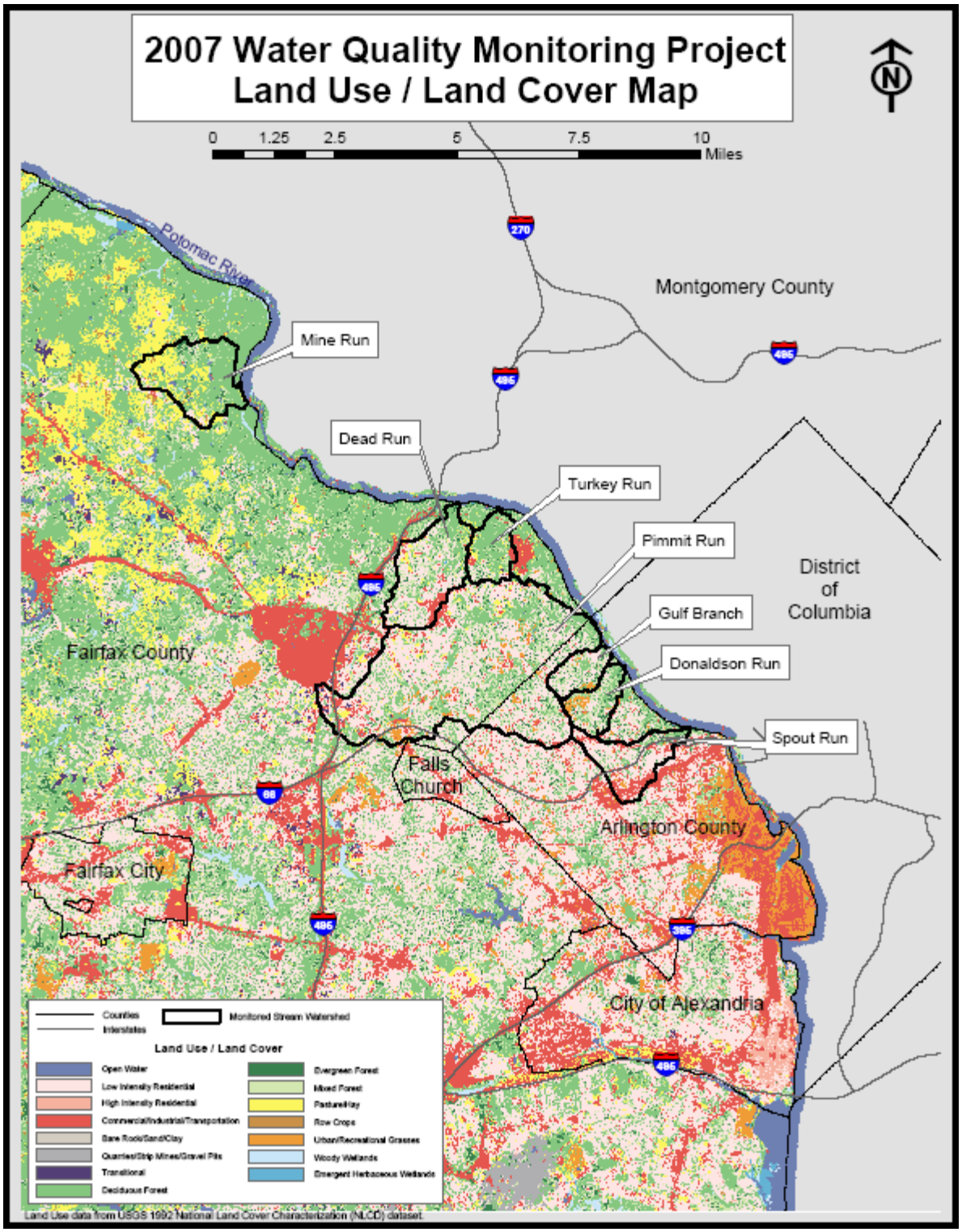


Figure 18: Watershed Land-Use: Mine Run

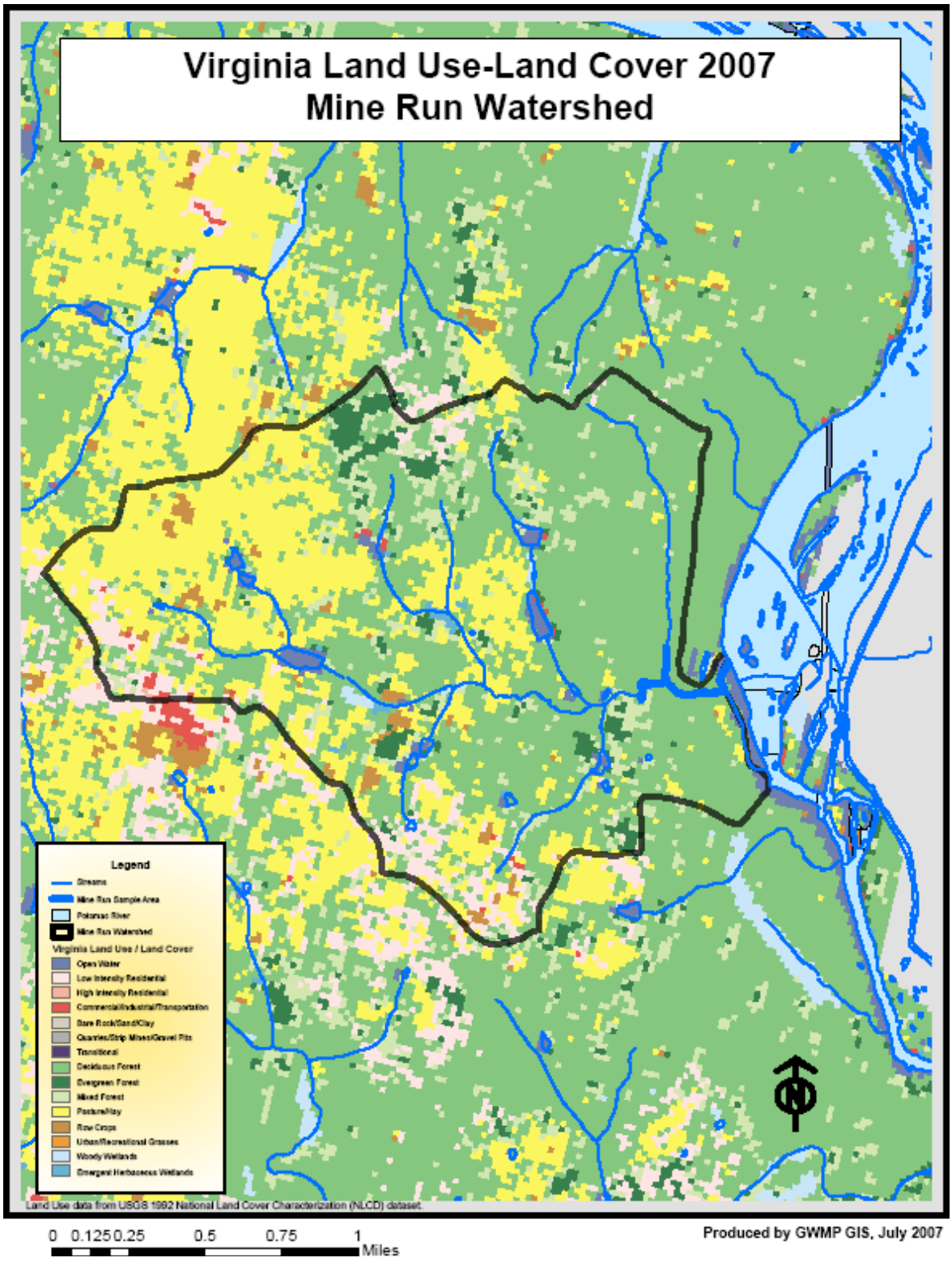


Figure 19: Watershed Land Use: Turkey Run

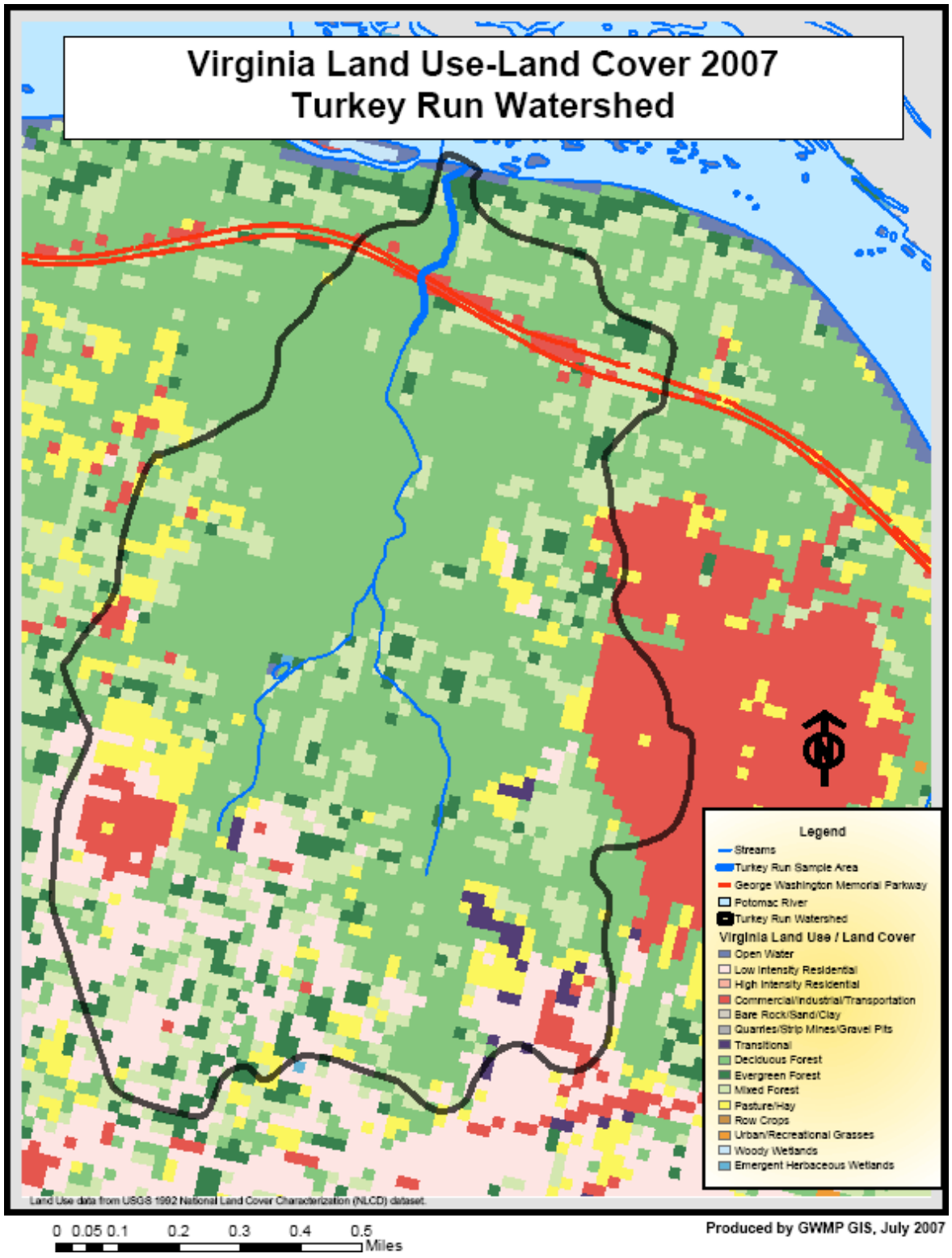


Figure 20: Watershed Land Use: Dead Run

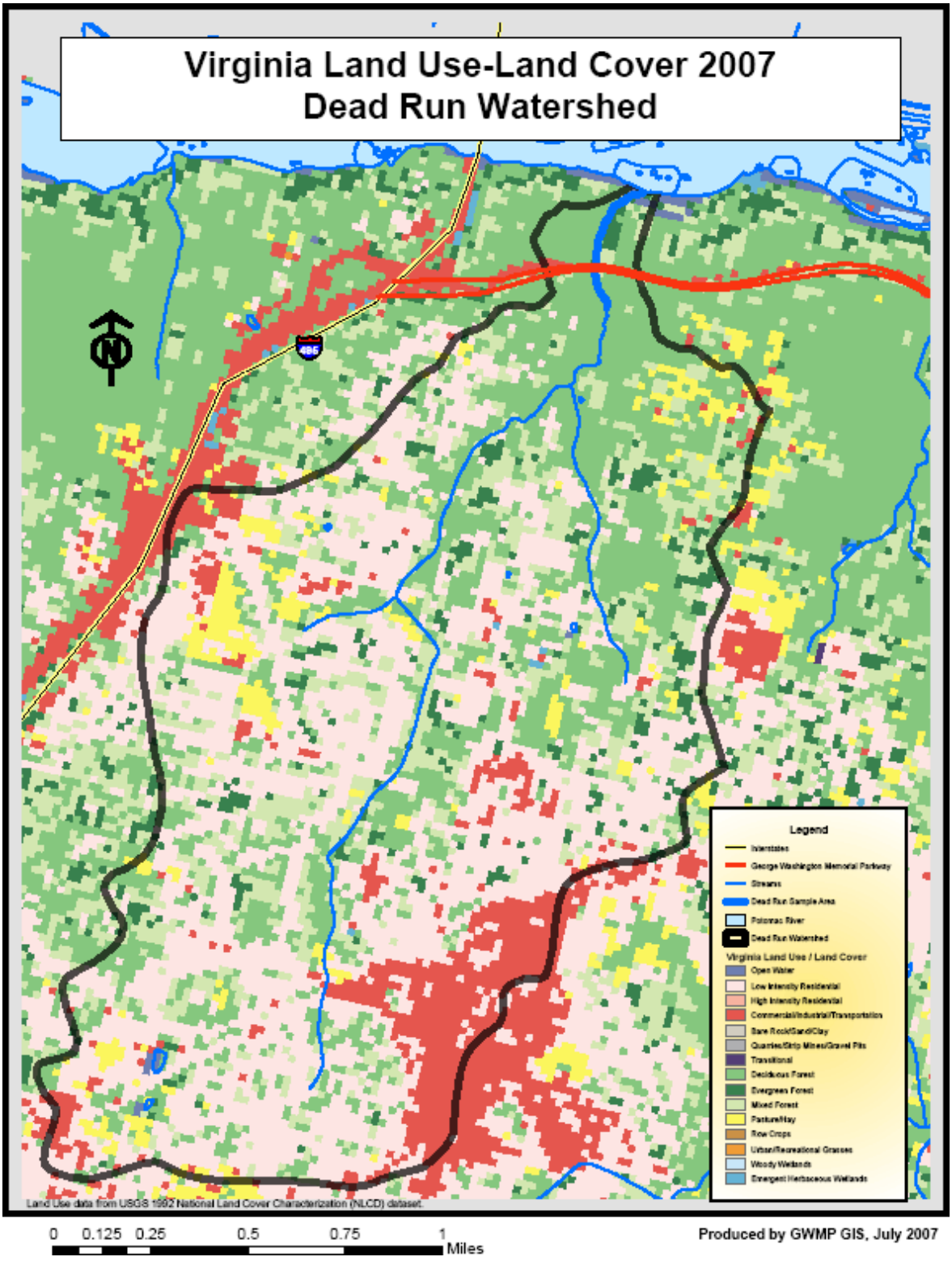


Figure 21: Watershed Land Use: Pimmit Run

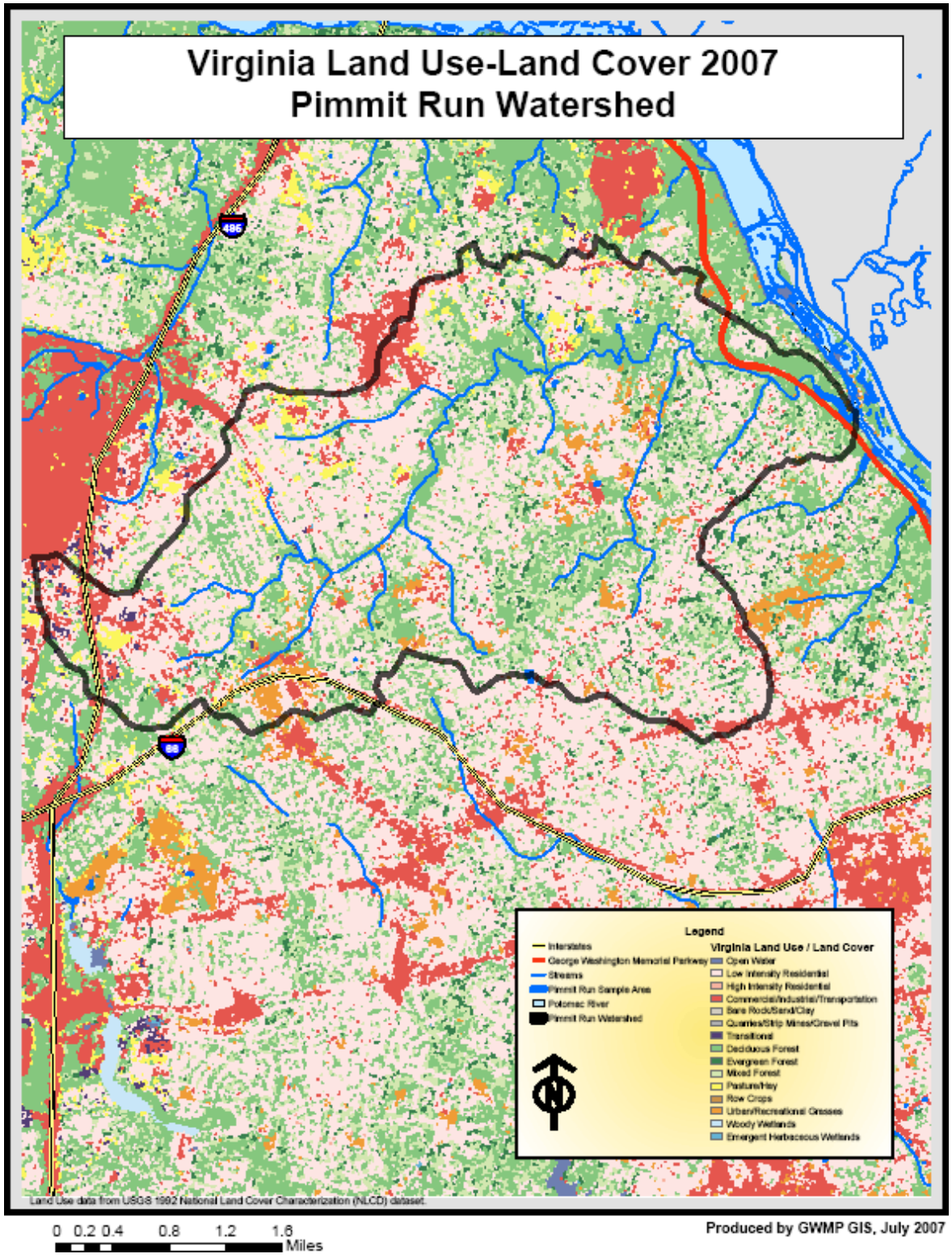


Figure 22: Watershed Land Use: Gulf Branch

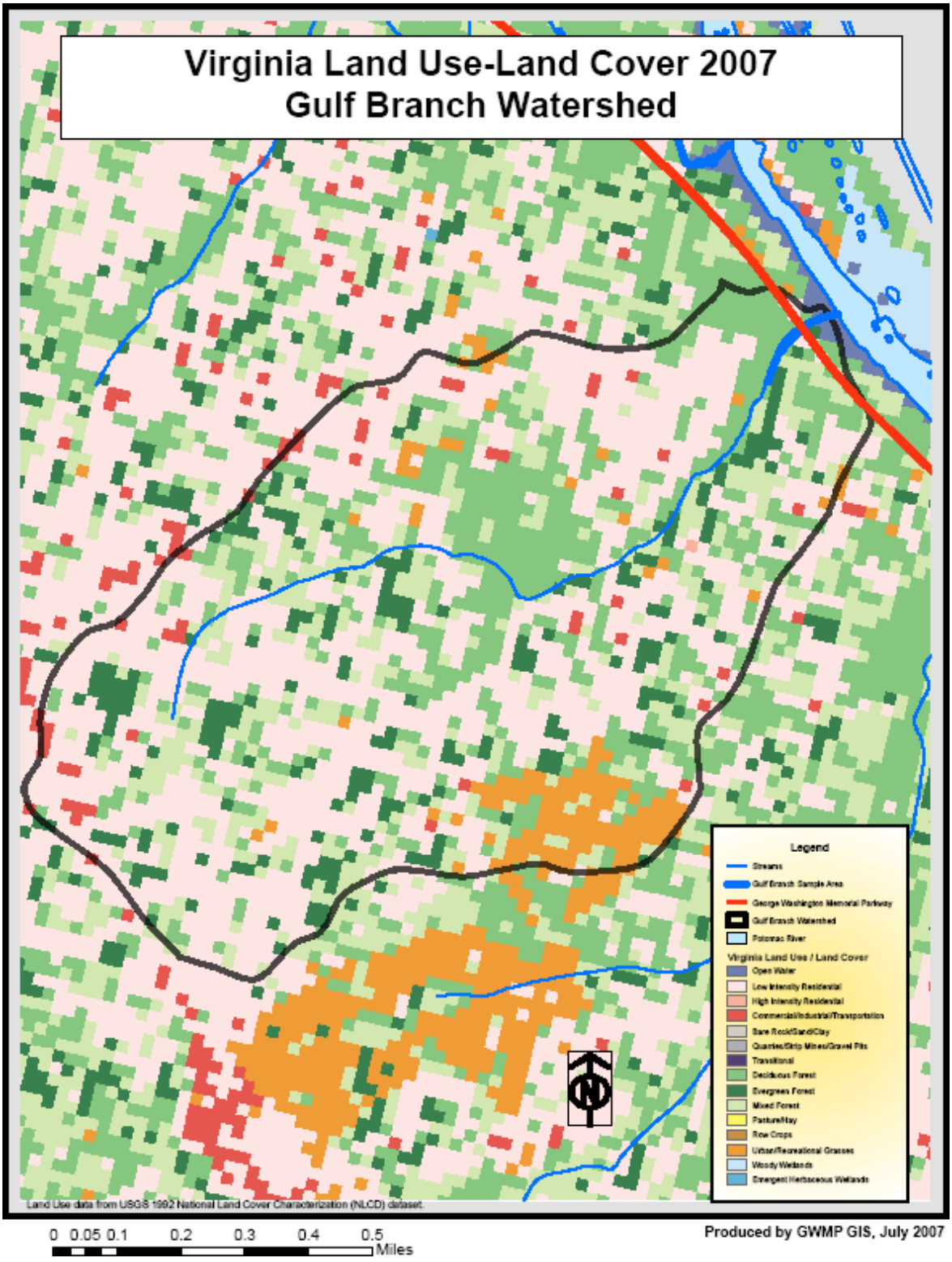


Figure 23: Watershed Land Use: Donaldson Run

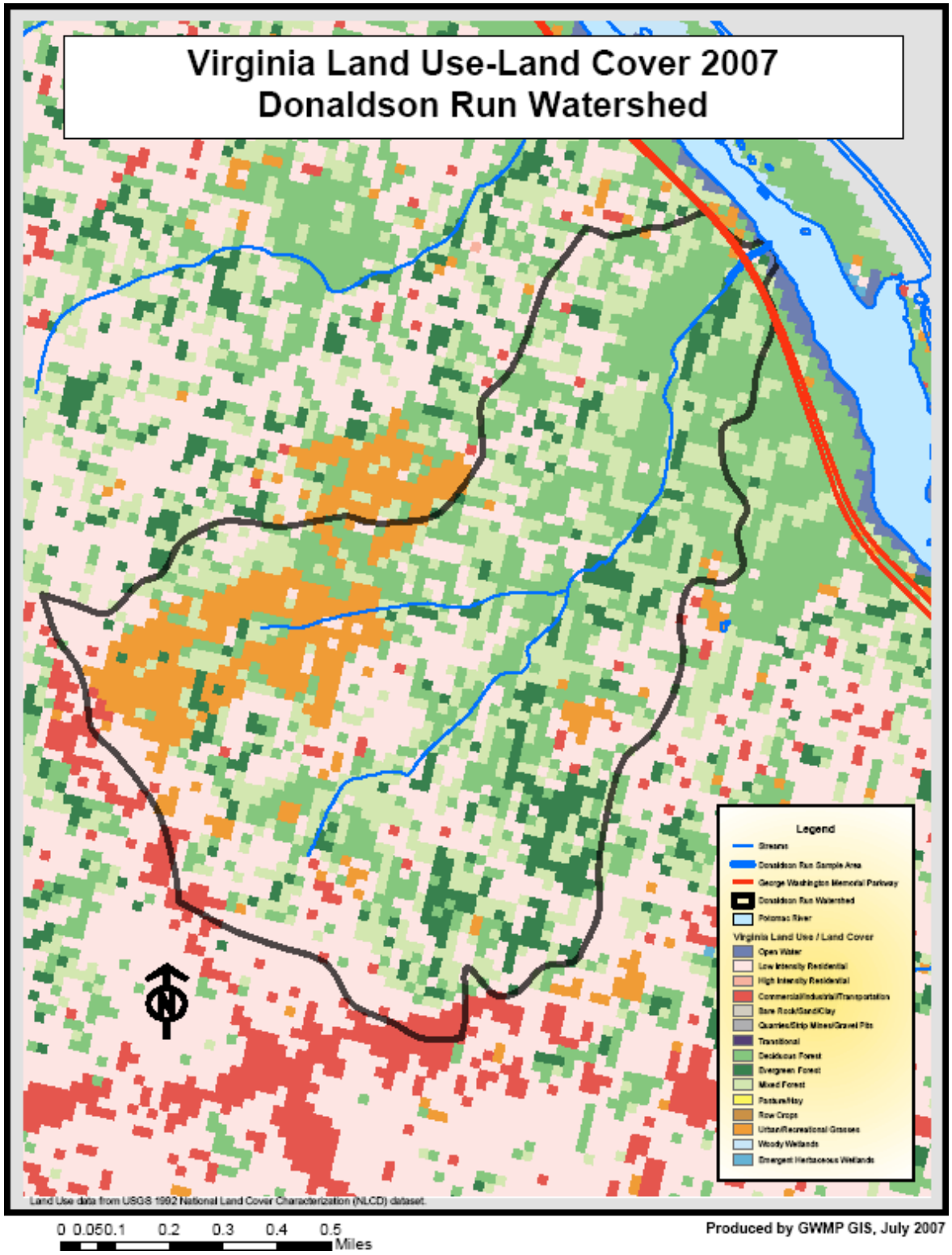


Figure 24: Watershed Land Use: Spout Run

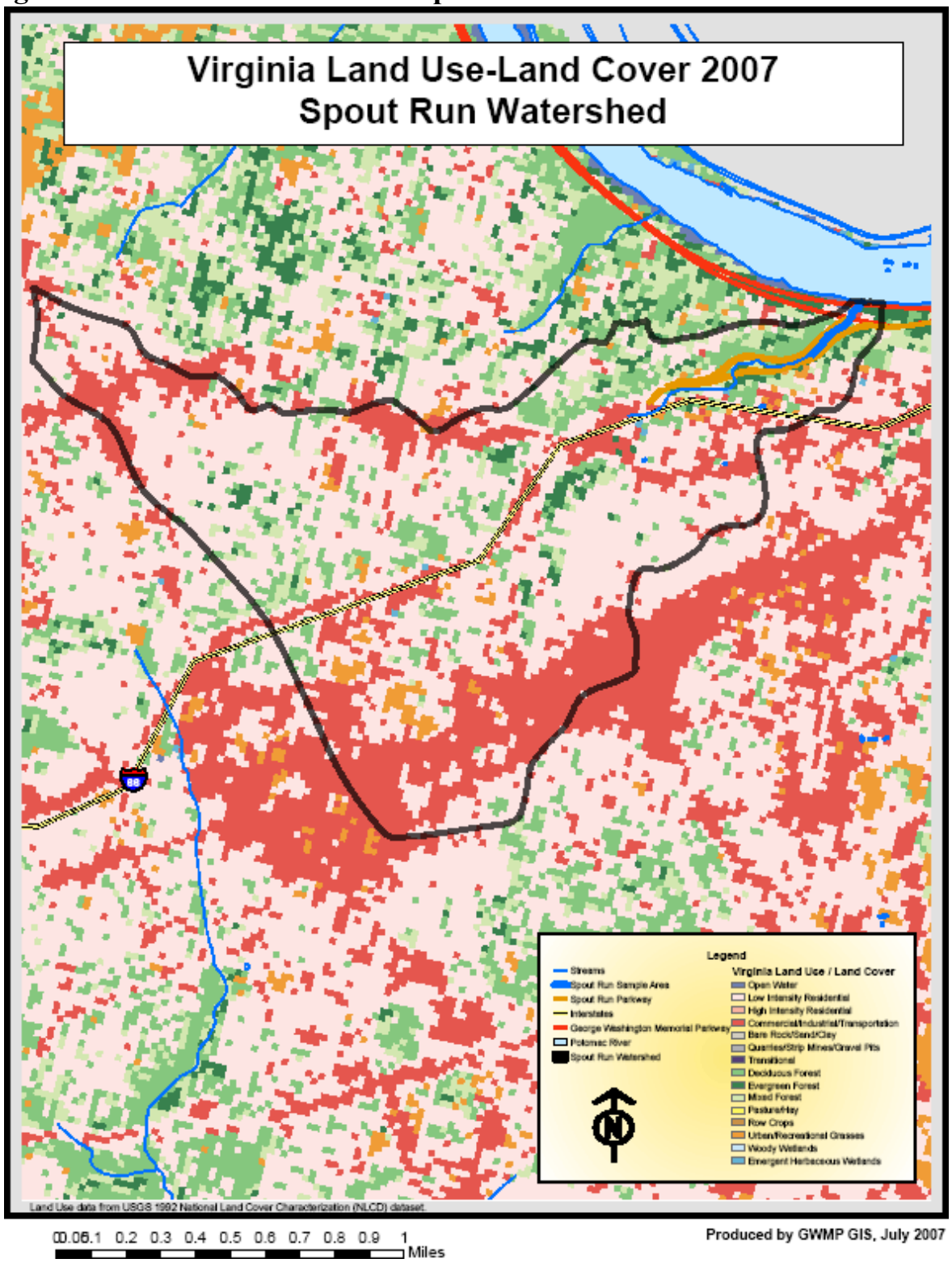


Figure 25: Watershed Land Use: Windy Run

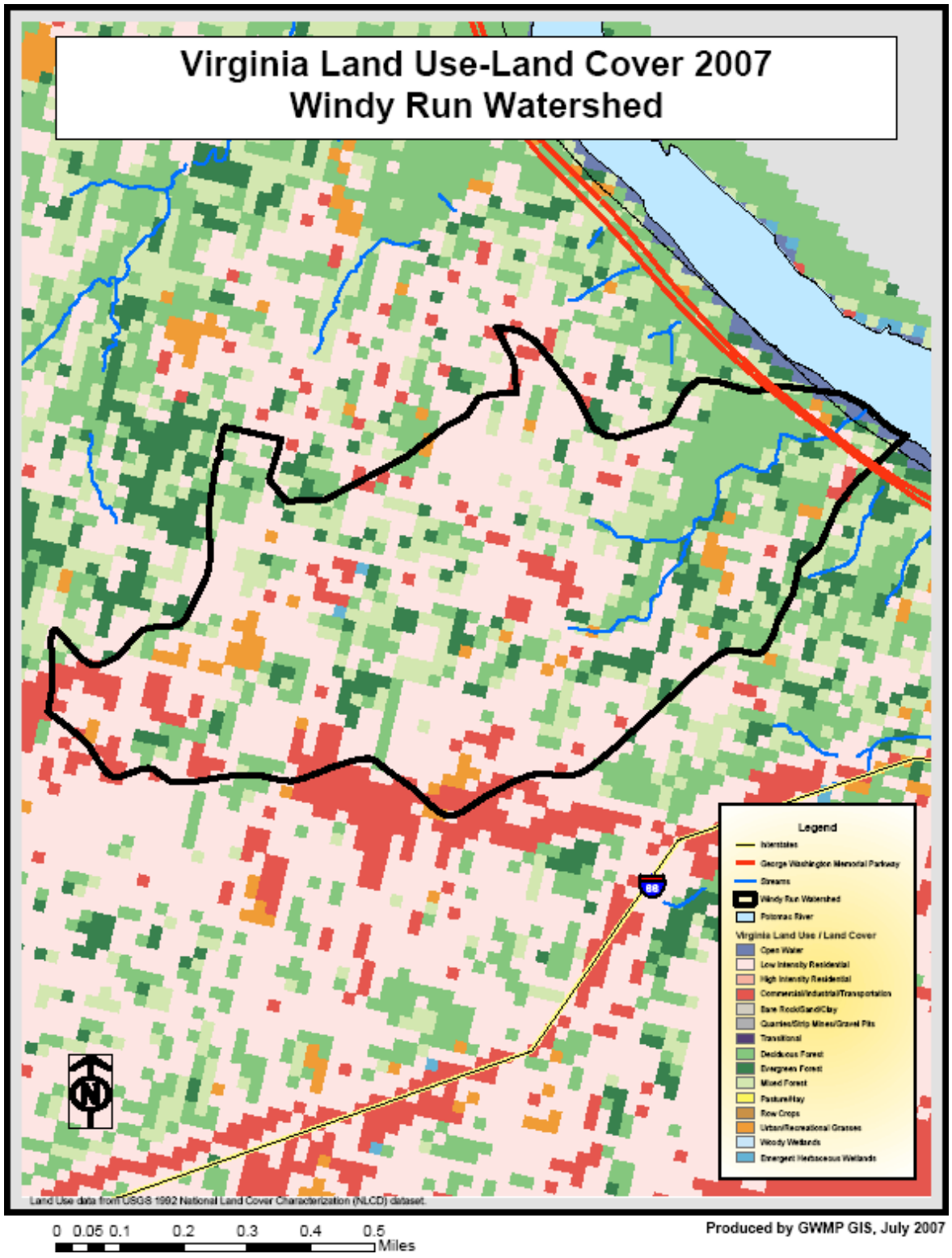


Figure 26: Watershed Land Use: Difficult Run

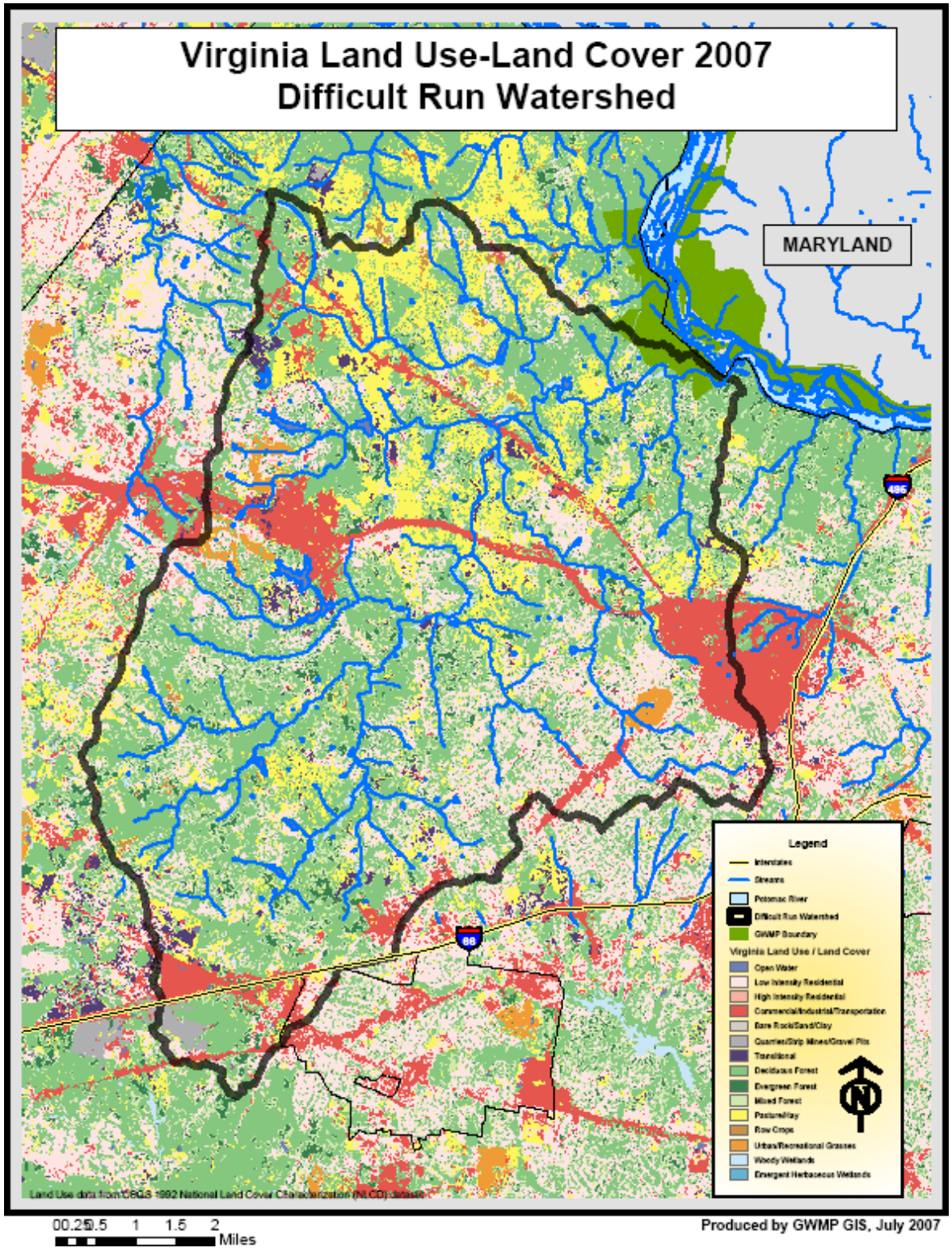


Figure 27a: Watershed Land Use

1993

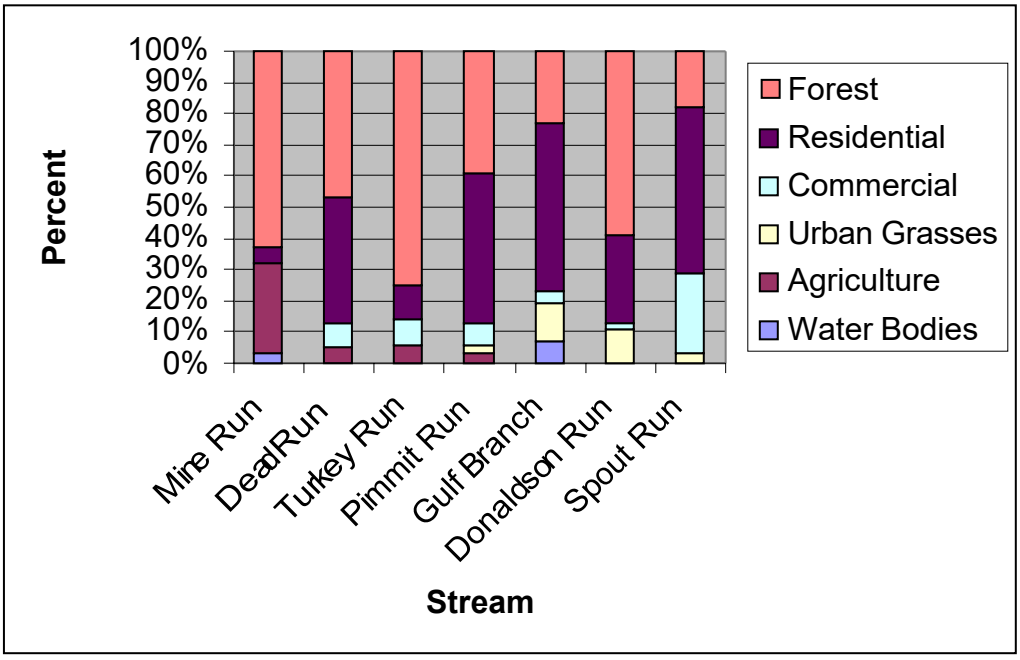


Figure 27b: Watershed Land Use

2001

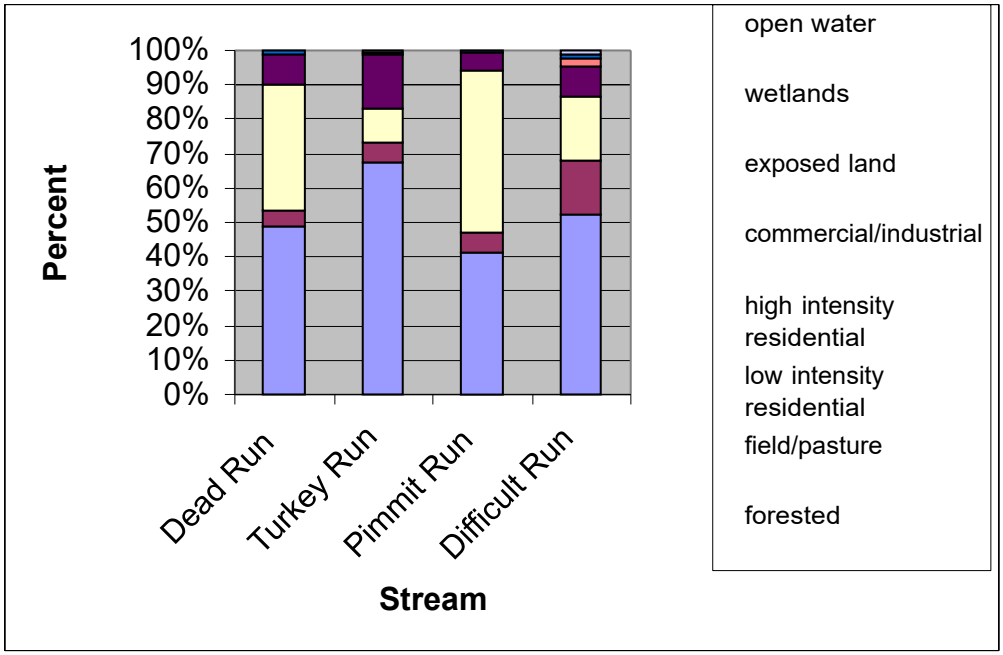


Figure 28: Monthly Rainfall at Ronald Reagan National Airport: 2001-2003, 2006-2007.

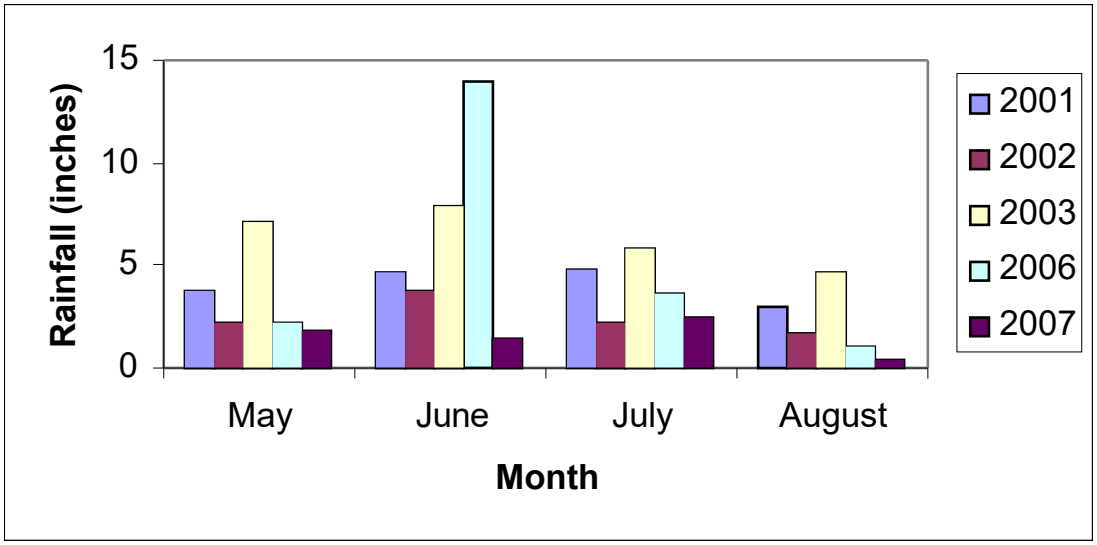
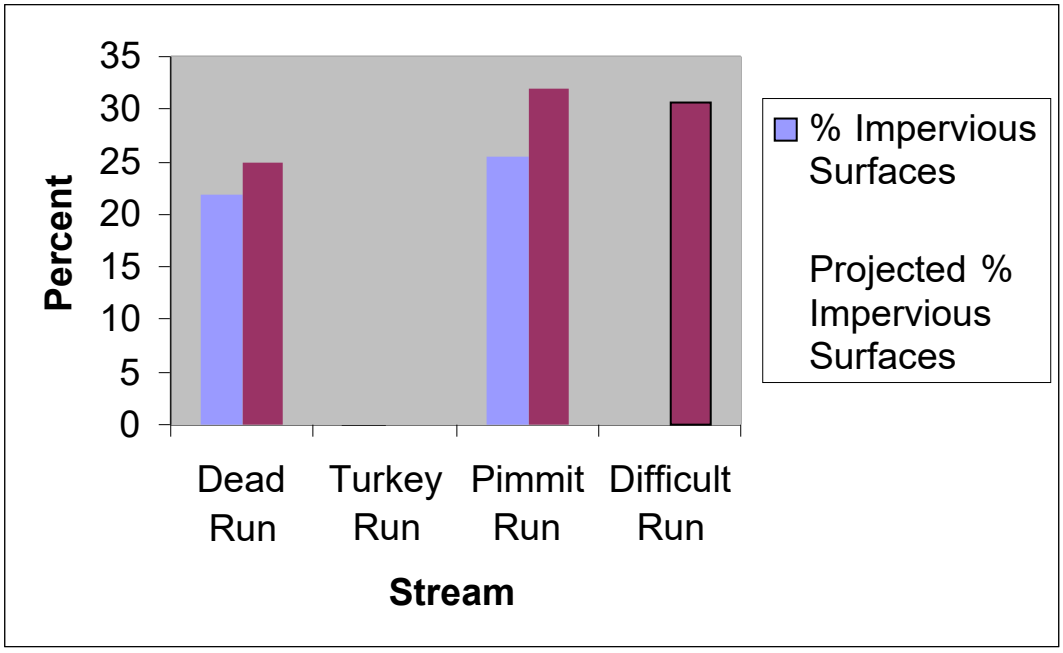


Figure 29: Impervious Surfaces in Fairfax County Watersheds (2001)



Water Chemistry Data and Basic Water Quality Parameters

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 2007, 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 174). 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. Most dissolved oxygen levels measured in 2007 were below those of a healthy stream but all of the sites had adequate (3 or higher) levels in mg/L.

Conductivity is the measure of how well water passes an electric current and indirectly measures the presence of salts and metals. 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. Conductivity was greatest at Spout Run, which indicates that it had the greatest amount of dissolved metals and salts. 2007 had higher levels of conductivity than the past years. These high levels of conductivity may have been a result of the drought this summer; because there was less water in the stream, the salts and metals in the water were more concentrated.

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 2007, turbidity was always low.

Nitrogen in the forms of nitrite and nitrate is naturally found in stream water, but large amounts are indicative of pollution. Nitrate and nitrite pollution comes from animal wastes, fertilizers, and sewage. Increased nitrogen levels can cause algal blooms, which deplete the water of dissolved oxygen upon decay. The highest acceptable level of nitrate is 10 ppm, and of nitrite is 1.0 ppm. All of the readings taken in 2007 fell below those levels.

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 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.

The data show that macroinvertebrate richness has recovered to pre-contamination conditions for both Donaldson Run and Gulf Branch. Past species density / (richness) calculations were not explained in previous reports. The calculations done on a sample where only one net was taken could be interpreted; the total number of organisms was divided by the total sample area. Our calculations for a sample in which multiple nets of different sizes were taken were not consistent with the density / (richness) values of 2006. Therefore, it is hard to compare this year's calculations with past years, because of lack of data and explanation of calculations. This makes it hard to say for sure if the species density / (richness) has returned to pre-contamination levels. The health scores have been improving since the spill but the streams have not received a health score higher than pre-contamination scores.

PROGRAMS GIVEN

Along with the sampling being done this summer, four educational programs were conducted. The purpose of these educational talks was to inform others of the work we are doing and the water monitoring program that is taking place. Two of our educational talks were given to groups of teachers (July 19th and 26th). Each group was about 15-20 people, who were participating in *Bridging the Watershed* workshops. These workshops were to prepare the teachers for bringing their classes out into the streams. They were interested in our work because it gave them insight as to what it was like to do this type of sampling method for several months at a time. This information was then presented to park rangers and other interns at the National Park Service headquarters on August 7th, 2007. On August 13th, employees (7) from Fairfax County Park Authority gathered to hear our educational as well, and gave us some useful information and suggestions to include in our report.

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 time of day the samples were taken. This could have had an effect on the data. These inconsistencies are very difficult to avoid because of weather.

There are also many sources for human error in this study. During round two, what was thought to be site two at Turkey Run was not a site at all, yet it was marked; this may explain the lack of ideal riffles and incredibly low health score at that site. Also, human error is hard to prevent when using qualitative tests, like 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. Although these things should be kept constant, it is nearly impossible to do so.

RECOMMENDATIONS

From the data collected we can see there is a possible link between increased development of watershed land 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, 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 possible 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 16). 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.

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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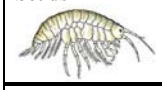
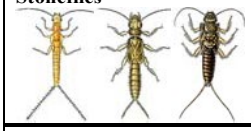
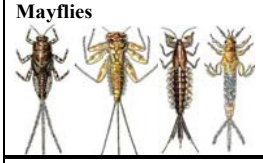
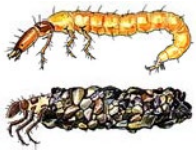
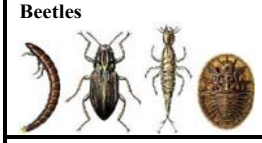
Appendix 1: Virginia Save Our Streams Macroinvertebrate Tally Sheet

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: Hanna Instruments pH Meter 9025 Instructions (Hanna, 1997)

pH Calibration

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

1. Pour small quantities of pH 7.01 and pH 4.01 (or pH 10.01 for alkaline measurements) into two clean beakers. For accurate calibration use two beakers for each buffer solution, the first one for rinsing the electrode and the second one for calibration. This minimized contamination of the buffers.

2. Immerse the pH electrode into a pH buffer solution (e.g. pH 7.01) and stir gently. The electrode should be submerged approximately 4 cm into the solution, with the temperature probe located as close to it as possible.

3. Press the **CAL** key. The **CAL** and a beaker symbol will be displayed.

4. One of the 5 buffers choices will be displayed (4.01, 6.86, 7.01, 9.18, 10.01). Press the **°C** or **°C** key until the display changes to the desired buffer.

5. Once the electrode is submerged in the buffer solution, the LCD will notify the user if the reading is not stable by an intermittent **NOT READY**. Only when the reading is stable, will it change to a blinking **READY** and **CON**.

6. Press the **CON** key to confirm the calibration. If the reading is not close to the selected buffer, **WRONG** will blink. If the reading is close to the selected buffer, the meter stores the reading (and adjusts the offset point). The buffer value is then displayed on the primary LCD and the secondary LCD will display another buffer value.

7. Immerse the pH electrode into the second buffer solution (10.01) and stir gently.

8. Select the second buffer value on the secondary display by pressing the **°C** or **°C** key. When **READY** and **CON** symbols blink on the display, the reading is stable and the calibration can be confirmed.

9. Press the **CON** key. If the reading is not close to the selected buffer solution **WRONG** will blink. If the reading is close to the selected buffer, the slope and the offset are calibrated. The values will be stored in memory and the meter will return to the operation mode.

Disposal: Disposal of the buffer solutions can be done by pouring them down the drain with running water.

pH Meter Operating Instructions

1. Connect the pH electrode and the temperature probe to the BNC and temperature sockets on the top of the instrument.

2. The temperature probe can be used independently to take temperature measurements, or it can be used in conjunction with the pH electrode to utilize the meter's ATC capability. If the probe is disconnected, temperature can also be set manually with the **UP** and **DOWN** keys

3. To switch the instrument on, press and hold the **ON/OFF** key for a second. The meter has a built-in protection against electromagnetic interference and the delayed response of the keys assures that the commands are not mistaken for stray signals.

4. Remove the protective cap and submerge the tip of the electrode and temperature probe 1 ½ inches (4cm) into the sample to be tested.

5. Allow for the electrode to adjust and stabilize.

6. The electrode must always be kept wet and rinsed thoroughly with the sample to be measured before use.

The pH reading is directly affected by temperature, so the temperature probe and electrode must be located as close to each other as possible.

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. _____

_____

HABITAT ASSESSMENT
NORTHERN VIRGINIA SOIL AND WATER CONSERVATION DISTRICT
VOLUNTEER STREAM MONITORING PROGRAM

Fish:
- ☐ scattered individuals
- ☐ scattered schools
- ☐ trout (pollution sensitive)
- ☐ bass (somewhat sensitive)
- ☐ catfish (pollution tolerant)
- ☐ carp (pollution tolerant)

Barriers to Fish Movement:
- ☐ beaver dams
- ☐ man-made dams
- ☐ waterfalls (>1ft)
- ☐ other
- ☐ none

Stream: _____

Station #: _____

Date: _____

Surface Water Appearance:
- ☐ clear
- ☐ clear, but tea-colored
- ☐ colored sheen (oily)
- ☐ foamy
- ☐ milky
- ☐ cloudy/turbid
- ☐ muddy
- ☐ other _____

Stream Bottom Deposit:
- ☐ gray
- ☐ orange/red
- ☐ yellow
- ☐ black
- ☐ brown/tan
- ☐ silty/muddy
- ☐ sandy
- ☐ other _____

Odor:
- ☐ rotten eggs
- ☐ musky
- ☐ oil
- ☐ sewage
- ☐ other _____
- ☐ none

Stability of Stream Bed:
Bed sinks beneath feet in:
- ☐ no spots
- ☐ a few spots
- ☐ many spots

Algae Color (if present):
- ☐ light green
- ☐ dark green
- ☐ brown coated
- ☐ matted on stream bed
- ☐ hairy/filamentous

Algae Located:
- ☐ everywhere
- ☐ in spots

____% of bed covered

Stream Channel Shade:
- ☐ > 75% Full
- ☐ 50 – 74% High
- ☐ 25 – 49% Moderate
- ☐ 1 – 24% Slight

Riffle Composition (=100%)
- __% silt (mud)
- __% sand (1/64" - 1/4"grains)
- __% gravel (1/4" - 2" stones)
- __% cobbles (2" - 10" stones)

Stream Bank Composition:
- ☐ % Trees
- ☐ % Shrubs
- ☐ % Grass
- ☐ % Bare Soil
- ☐ % Rocks

Stream Bank Erosion Potential:
- ☐ >75% severe
- ☐ 50% - 75% high
- ☐ 25% - 49% moderate
- ☐ <25% slight

Land Uses in the Watershed:

Look at a map. Walk your stream in your area. Record all land uses in the watershed area upstream and surrounding your site. Indicate whether these land uses have a High (H), Moderate (M), Slight (S), or No (N) potential (even if present) to impact the quality of your stream. If the land use is not present in your watershed, record NP for Not Present. Leave blank if unsure.

____ Housing Developments
____ Forest
____ Logging
____ Urban Uses
____ Sanitary Landfill
____ Active Construction
____ Cropland
____ Recreation
____ Trash Dump
____ Fields
____ Livestock Pasture
____ Other _____
_____

Appendix 9: Benthic Macroinvertebrate and Metric Data

Biological Monitoring: Summer 2007: Round 1

Stream	Station	Date	Worms	Flatworms	Leeches	Crayfish	Sowbugs	Scuds	Stoneflies	Mayflies
Turkey	1	6/11	8	1	0	0	1	198	0	0
Turkey	2	6/11	3	0	0	0	0	7	1	12
Turkey	3	6/12	7	0	0	4	5	55	0	22
Dead	1	6/13	16	1	1	10	0	112	0	8
Dead	2	6/12	2	0	0	0	0	0	0	5
Dead	3	6/14	6	1	0	0	0	0	0	0
Pimmit	1	6/15	39	38	8	0	1	3	0	14
Pimmit	2	6/15	29	7	0	0	0	0	0	22
Pimmit	3	6/15	14	23	0	0	4	0	4	73
Gulf Branch	1	6/19	45	47	16	0	0	42	0	24
Gulf Branch	2	6/19	12	24	1	1	0	37	0	0
Gulf Branch	3	6/20	27	13	0	0	0	4	0	0
Donaldson	1	6/21	167	20	43	0	1	17	0	70
Donaldson	2	6/21	19	7	4	0	0	3	0	101
Donaldson	3	6/22	30	25	9	1	1	5	0	331
Mine	1	6/25	8	7	0	9	1	7	74	42
Mine	2	6/25	3	25	0	1	0	1	23	9
Mine	3	6/26	11	0	0	2	0	4	13	7
Spout	1	6/26	22	19	4	0	0	29	0	72
Spout	2	6/27	18	3	4	0	0	24	0	65
Spout	3	6/28	64	6	18	0	0	36	0	29
Windy	1	7/30	37	34	0	0	0	0	0	21
Windy	2	7/30	14	2	0	0	0	0	0	144
Windy	3	7/30	44	1	0	0	0	0	0	22
Difficult	1	8/1	9	12	1	2	0	41	0	61
Difficult	2	8/1	4	71	2	0	0	47	0	28
Difficult	3	8/1	2	125	7	2	1	7	0	13

Biological Monitoring: Summer 2007: Round 2

Stream	Station	Date	Worms	Flatworms	Leeches	Crayfish	Sowbugs	Scuds	Stoneflies	Mayflies
Turkey	1	7/2	10	3	1	0	0	67	0	24
Turkey	2	7/2	13	2	2	1	0	65	0	14
Turkey	3	7/2	2	0	11	6	0	67	0	21
Dead	1	7/10	6	1	0	0	0	47	0	27
Dead	2	7/12	16	1	2	1	0	1	0	2
Dead	3	7/12	8	0	0	0	0	0	0	3
Pimmit	1	7/3	42	120	6	0	5	1	0	230
Pimmit	2	7/9	17	35	0	0	0	0	0	65

Pimmit	3	7/9	7	41	0	0	6	0	0	41
Gulf Branch	1	7/13	79	56	9	0	0	21	0	54
Gulf Branch	2	7/13	29	37	0	0	0	15	0	131
Gulf Branch	3	7/16	12	27	0	1	0	4	0	1
Donaldson	1	7/17	38	14	0	0	0	11	0	47
Donaldson	2	7/17	160	55	1	0	0	3	0	87
Donaldson	3	7/20	38	45	0	2	0	6	0	208
Mine	1	7/18	2	15	0	3	0	1	48	28
Mine	2	7/18	4	10	0	0	0	19	48	12
Mine	3	7/18	8	19	0	1	0	9	84	45
Spout	1	7/23	18	98	0	0	0	20	0	67
Spout	2	7/23	29	2	0	0	0	37	0	62
Spout	3	7/23	91	4	4	0	0	7	0	41
Difficult	1	8/9	6	7	0	2	0	26	0	16
Difficult	2	8/10	2	80	0	0	0	18	0	12
Difficult	3	8/8	4	175	4	3	0	39	0	49
Biological Monitoring: Summer 2007: Round 3										
Stream	Station	Date	Worms	Flatworms	Leeches	Crayfish	Sowbugs	Scuds	Stoneflies	Mayflies
Turkey	1	7/24	3	11	0	2	0	39	0	22
Turkey	2	7/24	2	0	0	1	0	23	2	27
Turkey	3	7/24	4	0	0	20	0	20	0	35
Pimmit	1	8/2	144	376	0	0	7	0	0	54
Pimmit	2	8/2	20	97	0	0	1	2	0	34
Pimmit	3	8/3	34	197	0	0	0	0	0	26

Appendix 9: Benthic Macroinvertebrate and Metric Data

Biological Monitoring: Summer 2007: Round 1

Stream	Station	Date	Dragonflies/Damselflies	Hellgrammites	Common Netspinners	Most Caddisflies	Beetles	Midges	Blackflies
Turkey	1	6/11	0	0	45	37	1	67	10
Turkey	2	6/11	1	0	61	0	25	50	21
Turkey	3	6/12	1	0	326	28	5	70	6
Dead	1	6/13	0	0	60	22	0	127	3
Dead	2	6/12	1	0	45	0	0	31	10
Dead	3	6/14	0	0	272	67	0	22	7
Pimmit	1	6/15	0	0	44	34	0	16	3
Pimmit	2	6/15	0	0	70	41	1	93	2
Pimmit	3	6/15	0	0	85	90	1	97	9
Gulf Branch	1	6/19	0	0	24	0	0	32	0
Gulf Branch	2	6/19	0	0	70	0	0	50	0

Gulf Branch	3	6/20	0	0	40	0	1	195	0
Donaldson	1	6/21	0	0	180	15	0	24	28
Donaldson	2	6/21	0	0	58	3	0	38	8
Donaldson	3	6/22	0	0	113	33	0	33	11
Mine	1	6/25	3	11	672	73	78	29	1
Mine	2	6/25	0	1	984	13	31	4	0
Mine	3	6/26	0	1	127	9	16	6	0
Spout	1	6/26	0	0	34	4	0	40	3
Spout	2	6/27	0	0	25	2	0	20	1
Spout	3	6/28	0	0	20	1	0	28	1
Windy	1	7/30	0	0	27	97	0	0	27
Windy	2	7/30	0	0	79	24	0	0	15
Windy	3	7/30	0	0	87	2	1	5	13
Difficult	1	8/1	3	0	255	27	150	12	0
Difficult	2	8/1	0	0	72	73	71	11	0
Difficult	3	8/1	0	0	7	80	344	4	0

Biological Monitoring: Summer 2007: Round 2

Stream	Station	Date	Dragonflies/Damselflies	Hellgrammites	Common Netspinners	Most Caddisflies	Beetles	Midges	Blackflies
Turkey	1	7/2	0	1	293	85	4	76	4
Turkey	2	7/2	0	0	94	7	3	27	2
Turkey	3	7/2	0	0	478	27	0	17	6
Dead	1	7/10	0	0	71	5	0	70	0
Dead	2	7/12	1	0	138	36	0	18	8
Dead	3	7/12	0	0	150	21	0	13	13
Pimmit	1	7/3	0	0	23	537	1	100	27
Pimmit	2	7/9	0	0	156	178	1	37	0
Pimmit	3	7/9	0	0	74	195	0	13	1
Gulf Branch	1	7/13	0	0	13	0	0	9	37
Gulf Branch	2	7/13	0	0	18	0	0	26	41
Gulf Branch	3	7/16	0	0	38	0	0	42	385
Donaldson	1	7/17	0	0	72	3	2	4	10
Donaldson	2	7/17	0	0	26	2	0	4	13
Donaldson	3	7/20	0	0	90	31	1	5	3
Mine	1	7/18	1	11	438	25	60	11	0
Mine	2	7/18	10	2	165	0	29	0	1
Mine	3	7/18	1	13	292	1	84	1	0
Spout	1	7/23	0	0	86	1	0	22	13
Spout	2	7/23	0	0	75	0	0	18	8
Spout	3	7/23	0	0	108	2	0	15	2
Difficult	1	8/9	0	0	36	22	78	4	0

Difficult	2	8/10	1	0	17	49	22	20	0
Difficult	3	8/8	0	0	47	235	323	22	0
Biological Monitoring: Summer 2007: Round 3									
Stream	Station	Date	Dragonflies/Damselflies	Hellgrammites	Common Netspinners	Most Caddisflies	Beetles	Midges	Blackflies
Turkey	1	7/24	0	0	114	1	7	3	3
Turkey	2	7/24	0	1	92	8	14	16	4
Turkey	3	7/24	0	0	191	6	0	2	0
Pimmit	1	8/2	0	0	32	86	5	13	1
Pimmit	2	8/2	0	0	112	205	1	13	0
Pimmit	3	8/3	0	0	618	324	2	5	0

Appendix 9: Benthic Macroinvertebrate and Metric Data

Biological Monitoring: Summer 2007: Round 1

Stream	Station	Date	True Flies	Gilled Snails	Lunged snails	Clams	Total
Turkey	1	6/11	16	1	2	0	387
Turkey	2	6/11	28	0	0	0	209
Turkey	3	6/12	61	0	2	0	592
Dead	1	6/13	18	0	2	0	380
Dead	2	6/12	30	5	1	0	130
Dead	3	6/14	7	0	1	0	383
Pimmit	1	6/15	10	0	1	0	211
Pimmit	2	6/15	17	0	1	0	283
Pimmit	3	6/15	11	0	0	0	412
Gulf Branch	1	6/19	11	1	1	0	243
Gulf Branch	2	6/19	11	0	0	0	206
Gulf Branch	3	6/20	6	0	0	0	286
Donaldson	1	6/21	18	0	15	0	598
Donaldson	2	6/21	6	0	8	0	255
Donaldson	3	6/22	30	0	131	0	752
Mine	1	6/25	67	0	3	2	1087
Mine	2	6/25	22	0	2	0	1119
Mine	3	6/26	31	0	0	1	230
Spout	1	6/26	2	0	1	0	228
Spout	2	6/27	1	0	62	0	225
Spout	3	6/28	4	0	180	0	387
Windy	1	7/30	6	0	1	0	250
Windy	2	7/30	3	0	35	0	316
Windy	3	7/30	3	0	27	0	205

Difficult	1	8/1	14	0	3	0	590
Difficult	2	8/1	3	1	4	0	387
Difficult	3	8/1	0	0	1	3	596
Biological Monitoring: Summer 2007: Round 2							
Stream	Station	Date	True Flies	Gilled Snails	Lunged snails	Clams	Total
Turkey	1	7/2	35	0	1	0	604
Turkey	2	7/2	15	0	7	0	252
Turkey	3	7/2	17	0	2	0	654
Dead	1	7/10	10	0	1	0	238
Dead	2	7/12	11	0	0	0	235
Dead	3	7/12	5	0	0	0	213
Pimmit	1	7/3	10	0	1	0	1103
Pimmit	2	7/9	9	0	0	0	498
Pimmit	3	7/9	2	0	1	0	381
Gulf Branch	1	7/13	6	0	1	0	285
Gulf Branch	2	7/13	8	0	0		305
Gulf Branch	3	7/16	11	0	1	0	522
Donaldson	1	7/17	5	0	0	0	206
Donaldson	2	7/17	2	0	0	0	353
Donaldson	3	7/20	2	0	108	0	539
Mine	1	7/18	12	0	0	0	655
Mine	2	7/18	10	0	0	0	310
Mine	3	7/18	8	0	1	1	568
Spout	1	7/23	12	0	0	0	337
Spout	2	7/23	1	0	99	0	331
Spout	3	7/23	7	0	58	0	339
Difficult	1	8/9	4	1	12	1	215
Difficult	2	8/10	2	0	1	0	224
Difficult	3	8/8	6	0	0	7	914
Biological Monitoring: Summer 2007: Round 3							
Stream	Station	Date	True Flies	Gilled Snails	Lunged snails	Clams	Total
Turkey	1	7/24	20	0	0	0	244
Turkey	2	7/24	16	0	0	0	206
Turkey	3	7/24	12	0	0	0	290
Pimmit	1	8/2	4	0	0	0	722
Pimmit	2	8/2	4	0	0	0	489
Pimmit	3	8/3	3	0	0	0	1209

Appendix 9: Benthic Macroinvertebrate and Metric Data

Individual Category Metrics: Summer 2007: Round 1

Stream	Station	Date	% Mayflies, Stoneflies, Most Caddisflies	% Common Netspinners	%Lunged Snails	% Tolerant	% Non-Insects	% Beetles
Turkey	1	6/11	9.56	11.63	0.52	0.26	74.16	54.52
Turkey	2	6/11	6.22	29.19	0	11.96	39.23	4.78
Turkey	3	6/12	8.45	55.07	0.34	0.84	24.66	12.33
Dead	1	6/13	7.89	15.79	0.53	0	68.95	37.37
Dead	2	6/12	3.85	34.62	0.77	0	34.62	6.15
Dead	3	6/14	17.49	71.02	0.26	0	9.66	2.09
Pimmit	1	6/15	22.75	20.85	0.47	0	51.66	42.65
Pimmit	2	6/15	22.26	24.73	0.35	0.35	46.64	13.07
Pimmit	3	6/15	18.00	21.90	0	23.60	15.82	10.95
Gulf Branch	1	6/19	9.88	9.88	0.41	0	75.31	62.55
Gulf Branch	2	6/19	0	33.98	0	0	60.19	36.41
Gulf Branch	3	6/20	0	13.99	0	0.35	83.57	15.38
Donaldson	1	6/21	14.21	30.10	2.51	0	52.68	43.98
Donaldson	2	6/21	40.78	22.75	3.14	0	34.12	16.08
Donaldson	3	6/22	48.27	15.03	17.42	0	32.58	26.86
Mine	1	6/25	17.39	61.82	0.28	7.18	5.61	3.40
Mine	2	6/25	4.02	87.94	0.18	2.77	3.13	2.86
Mine	3	6/26	33.04	14.78	0.43	0	51.30	32.61
Spout	1	6/26	12.72	55.70	0	7.02	9.65	7.89
Spout	2	6/27	29.78	11.11	27.56	0	58.67	49.33
Spout	3	6/28	7.75	5.17	46.51	0	86.05	78.55
Windy	1	7/30	47.2	10.8	.4	39.6	28.79	0
Windy	2	7/30	53.16	25	11.07	20.88	16.13	0
Windy	3	7/30	11.7	42.43	13.17	43.9	35.12	.49
Difficult	1	8/1	14.92	43.22	0.51	13.73	11.53	25.42
Difficult	2	8/1	26.10	18.6	1.03	35.92	33.33	18.35
Difficult	3	8/1	15.6	1.17	0.17	25.17	24.83	57.72

Individual Category Metrics: Summer 2007: Round 2								
Stream	Station	Date	% Mayflies, Stoneflies, Most Caddisflies	% Common Netspinners	%Lunged Snails	% Tolerant	% Non-Insects	% Beetles
Turkey	1	7/2	18.05	48.51	0.17	0.66	26.82	13.58
Turkey	2	7/2	8.33	37.30	2.78	1.19	46.83	35.711
Turkey	3	7/2	7.34	73.09	0.31	0	16.06	13.46
Dead	1	7/10	13.45	29.83	0.42	0	52.52	23.11
Dead	2	7/12	16.17	58.72	0	0	20	8.94
Dead	3	7/12	11.27	70.42	0	0	15.96	3.76
Pimmit	1	7/3	69.54	2.09	0.09	0.09	27.38	15.87
Pimmit	2	7/9	69.54	31.33	0	0.20	17.87	10.44
Pimmit	3	7/9	61.94	19.42	0.26	0	18.11	14.44
Gulf Branch	1	7/13	18.95	4.56	0.35	0	74.39	58.25
Gulf Branch	2	7/13	42.95	5.90	0	0	48.52	26.56
Gulf Branch	3	7/16	0.19	7.28	0.19	90.23	8.62	0
Donaldson	1	7/17	24.27	34.95	0	37.37	30.58	0.97
Donaldson	2	7/17	25.21	7.37	0	66.86	62.04	0
Donaldson	3	7/20	44.34	16.7	20.04	38.03	36.92	0.19
Mine	1	7/18	15.42	66.87	0	4.58	3.21	9.16
Mine	2	7/18	19.35	53.23	0	14.19	10.65	9.35
Mine	3	7/18	22.89	51.41	0.18	7.04	6.87	14.79
Spout	1	7/23	20.18	25.52	0	50.74	40.36	0
Spout	2	7/23	18.73	22.66	29.91	58.31	50.45	0
Spout	3	7/23	12.68	31.86	17.11	53.39	48.38	0
Difficult	1	8/9	17.67	16.74	5.58	26.05	25.58	36.28
Difficult	2	8/10	27.23	7.59	.45	54.46	45.09	9.82
Difficult	3	8/8	31.07	5.14	0	27.5	25.4	35.33
Individual Category Metrics: Summer 2007: Round 3								
Stream	Station	Date	% Mayflies, Stoneflies, Most Caddisflies	% Common Netspinners	%Lunged Snails	% Tolerant	% Non-Insects	% Beetles

Turkey	1	7/24	10.22	50.67	0	26.22	24.44	3.11
Turkey	2	7/24	17.96	44.66	0	21.84	12.62	6.8
Turkey	3	7/24	14.14	65.86	0	8.97	15.17	0
Pimmit	1	8/2	19.39	4.43	0	74.93	72.99	0.69
Pimmit	2	8/2	48.88	22.90	0	27.20	24.54	0.20
Pimmit	3	8/3	28.95	51.12	0	19.52	19.02	0.17

Appendix 9: Benthic Macroinvertebrate and Metric Data

Multimetric Index: 2007: Round 1

Stream	Station	% Mayflies, Stoneflies, Most Caddisflies	% Common Netspinners	%Lunged Snails	% Tolerant	% Non-Insects	% Beetles
Turkey	1	0	2	1	2	0	2
Turkey	2	0	1	2	2	0	1
Turkey	3	0	0	1	2	0	2
Dead	1	0	2	1	2	0	2
Dead	2	0	0	1	2	0	1
Dead	3	1	0	1	2	1	0
Pimmit	1	1	1	1	2	0	2
Pimmit	2	1	1	1	2	0	2
Pimmit	3	1	1	2	2	1	2
Gulf Branch	1	0	2	1	2	0	2
Gulf Branch	2	0	1	2	2	0	2
Gulf Branch	3	0	2	2	2	0	2
Donaldson	1	0	1	0	2	0	2
Donaldson	2	2	1	0	2	0	2
Donaldson	3	2	2	0	2	0	2
Mine	1	1	0	2	2	1	1
Mine	2	0	0	2	2	2	0
Mine	3	2	2	1	2	0	2
Spout	1	0	0	2	2	1	2
Spout	2	1	2	0	2	0	2
Spout	3	0	2	0	2	0	2
Windy	1	2	2	1	2	0	0
Windy	2	2	1	0	2	1	0
Windy	3	0	0	0	2	0	0
Difficult	3	0	0	1	2	1	2
Difficult	2	1	2	1	2	0	2
Difficult	1	0	2	2	2	0	2

Multimetric Index: 2007: Round 2							
Stream	Station	% Mayflies, Stoneflies, Most Caddisflies	% Common Netspinners	%Lunged Snails	% Tolerant	% Non-Insects	% Beetles
Turkey	1	1	0	2	2	0	2
Turkey	2	0	0	0	2	0	2
Turkey	3	0	0	1	2	1	2
Dead	1	0	1	1	2	0	2
Dead	2	1	0	2	2	1	2
Dead	3	0	0	2	2	1	1
Pimmit	1	2	2	2	2	0	2
Pimmit	2	2	1	2	2	1	2
Pimmit	3	2	2	2	2	1	2
Gulf Branch	1	1	2	1	2	0	2
Gulf Branch	2	2	2	2	2	0	2
Gulf Branch	3	0	2	2	0	1	0
Donaldson	1	1	0	2	1	0	0
Donaldson	2	1	2	2	0	0	0
Donaldson	3	2	2	0	0	2	0
Mine	1	0	0	2	2	2	2
Mine	2	1	0	2	2	1	2
Mine	3	1	0	2	2	1	2
Spout	1	1	1	2	1	0	0
Spout	2	1	1	0	1	0	0
Spout	3	0	1	0	1	0	0
Difficult	1	1	2	0	2	0	2
Difficult	2	1	2	1	1	0	2
Difficult	3	1	2	2	2	0	2
Multimetric Index: 2007: Round 3							
Stream	Station	% Mayflies, Stoneflies, Most Caddisflies	% Common Netspinners	%Lunged Snails	% Tolerant	% Non-Insects	% Beetles
Turkey	1	0	0	2	2	0	0
Turkey	2	1	0	2	2	1	2
Turkey	3	0	0	2	2	1	0
Pimmit	1	1	2	2	0	0	0
Pimmit	2	2	2	2	2	0	0
Pimmit	3	1	0	2	2	1	0

Appendix 9: Benthic Macroinvertebrate and Metric Data			
Multimetric Index: 2007: Round 1			
Stream	Station	Multimetric Index Score	Ecological Condition
Turkey	1	3	unacceptable
Turkey	2	9	acceptable
Turkey	3	4	unacceptable
Dead	1	3	unacceptable
Dead	2	4	unacceptable
Dead	3	7	acceptable
Pimmit	1	4	unacceptable
Pimmit	2	6	unacceptable
Pimmit	3	9	acceptable
Gulf Branch	1	3	unacceptable
Gulf Branch	2	4	unacceptable
Gulf Branch	3	5	unacceptable
Donaldson	1	2	unacceptable
Donaldson	2	6	unacceptable
Donaldson	3	6	unacceptable
Mine	1	9	acceptable
Mine	2	6	unacceptable
Mine	3	6	unacceptable
Spout	1	7	acceptable
Spout	2	4	unacceptable
Spout	3	2	unacceptable
Windy	1	7	Acceptable
Windy	2	6	unacceptable
Windy	3	2	unacceptable
Difficult	3	6	Unacceptable
Difficult	2	8	Acceptable
Difficult	1	8	Acceptable
Multimetric Index: 2007: Round 2			
Stream	Station	Multimetric Index Score	Ecological Condition
Turkey	1	6	unacceptable
Turkey	2	1	unacceptable
Turkey	3	4	unacceptable
Dead	1	3	unacceptable
Dead	2	6	unacceptable

Dead	3	6	unacceptable
Pimmit	1	9	acceptable
Pimmit	2	8	acceptable
Pimmit	3	9	acceptable
Gulf Branch	1	4	unacceptable
Gulf Branch	2	7	acceptable
Gulf Branch	3	5	unacceptable
Donaldson	1	5	unacceptable
Donaldson	2	5	unacceptable
Donaldson	3	6	unacceptable
Mine	1	8	Acceptable
Mine	2	8	Acceptable
Mine	3	8	acceptable
Spout	1	5	Unacceptable
Spout	2	3	Unacceptable
Spout	3	2	unacceptable
Difficult	1	7	acceptable
Difficult	2	7	acceptable
Difficult	3	9	acceptable
Multimetric Index: 2007: Round 3			
Stream	Station	Multimetric Index Score	Ecological Condition
Turkey	1	4	Unacceptable
Turkey	2	8	Acceptable
Turkey	3	5	Unacceptable
Pimmit	1	5	Unacceptable
Pimmit	2	7	Acceptable
Pimmit	3	6	Unacceptable

Appendix 10: Wilcoxon Test Data and Example Calculation

Comparison		Wilcoxon Test Example			
Turkey Run	Gulf Branch	Xa-Xb	| Xa-Xb |	Rank	Rank w/sign
7	6	1	1	4.5	4.5
1	4	-3	3	14	-14
3	4	-1	1	4.5	-4.5
2	4	-2	2	11	-11
3	4	-1	1	4.5	-4.5
4	5	-1	1	4.5	-4.5
4	4	0	0	-	-
4	5	-1	1	4.5	-4.5
4	4	0	0	-	-
5	3	2	2	11	11
6	5	1	1	4.5	4.5
6	4	2	2	11	11
6	5	1	1	4.5	4.5
6	4	2	2	11	11
8	6	2	2	11	11
5	6	-1	1	4.5	-4.5
W+ and W- values are used to determine critical values and approximate					
				W+ = 57.5	W- = 47.5
significance levels based on N				N = 14	

Ranking System Calculations					
| Xa-Xb |	Rank 1 (Ties)	Rank 2 (Ties)	Rank 3 (No Ties)	Final Rank	Rank w/sign
1	1			4.5	4.5
3			14	14	-14
1	2			4.5	-4.5
2		9		11	-11
1	3			4.5	-4.5
1	4			4.5	-4.5
0				-	-
1	5			4.5	-4.5
0				-	-
2		10		11	11
1	6			4.5	4.5
2		11		11	11
1	7			4.5	4.5
2		12		11	11
2		13		11	11
1	8			4.5	-4.5
Sum	36	55			

Tied ranks are summed and averaged	Sum	# of Ties	Average
Rank 1 (Ties)	36	8	4.5
Rank 2 (Ties)	55	5	11
Average of Rank 1 (Ties) are assigned to all 1's			
Average of Rank 2 (Ties) are assigned to all 2's			
W+ = The sum of the ranks with a positive sign			
W- = The sum of the ranks with a negative sign			
N = The number of non-tied pairs			

Appendix 10: Wilcoxon Test Data and Example Calculation									
Data Set									
Year	Mine Run	Dead Run	Turkey Run	Pimmit Run	Gulf Branch	Donaldson Run	Spout Run	Windy Run	Difficult Run
2001	9	-	-	6	9	4	7	-	-
	7	-	-	6	5	6	7	-	-
	10	-	7	4	6	8	7	-	-
	10	5	8	3	-	4	6	-	-
	8	-	7	6	-	-	2	-	-
	9	-	-	6	-	-	-	-	-
	9	5	3	9	-	-	-	-	-
	-	7	-	9	-	-	4	-	-
	8	7	-	9	-	-	4	-	-
2002	9	3	1	2	4	4	7	-	-
	9	5	3	2	4	4	2	-	-
	7	3	2	5	4	4	2	-	-
	9	3	3	3	4	4	4	-	-
	7	5	4	4	5	-	3	-	-
	7	5	4	4	4	5	3	-	-
2003	4	6	2	3	-	5	4	-	-
	6	5	5	5	-	2	5	-	-
	8	2	4	5	-	5	5	-	-
	9	4	5	5	-	3	-	-	-
	9	5	4	2	-	4	-	-	-
	9	5	4	2	5	5	3	-	-
	8	5	4	5	4	6	3	-	-
	9	-	5	5	3	7	2	-	-
	9	4	6	4	5	6	2	-	-
2006	9	3	6	3	4	4	3	-	-
	7	3	4	5	-	6	3	-	-
	9	4	6	3	5	4	3	-	-
	11	4	6	6	4	4	4	-	-
	9	7	8	7	6	3	5	-	-
	8	6	5	8	6	4	4	-	
2007	9	3	3	4	3	2	6	7	6
	6	4	9	6	4	6	7	6	8
	6	7	4	9	5	6	4	2	8
	8	3	6	9	4	5	5		7
	8	6	1	8	7	5	3		7
	8	6	4	9	5	6	2		9

Appendix 11: Water Chemistry Data

Monitoring: Summer 2007: Round 1

Stream	Station	Nitrite(ppm)	Nitrate(ppm)	Turbidity(JTU)	pH	DO(%)	DO(mg/l)	Conductivity(uS)
Turkey	1	0	2	~2.5	7.9	*76*	6.93	322
Turkey	2	0	2	~2.5	7.86	*96.6*	8.6	328.4
Turkey	3	0	2	<2.5	7.77	*100*	9.45	316.5
Dead	1	0	5	<2.5	7.78	*100*	9.75	139.4
Dead	2	0	5	<2.5	7.91	*98.6*	8.6	142.5
Dead	3	0	2	<2.5	7.5	*87*	8.1	149.1
Pimmit	1	0	2-5	<2.5	7.65	*100*	9.52	301.7
Pimmit	2	0	2	<2.5	7.74	97	9.2	266.7
Pimmit	3	0	5	<2.5	7.5	*92.8*	8.6	283.5
Gulf Branch	1	0	5	<2.5	7.15	88.7	7.74	457
Gulf Branch	2	0	5	<2.5	7.37	*93.8*	8.18	452.2
Gulf Branch	3	0	2	<2.5	7.15	*91.4*	7.83	242
Donaldson	1	0	5	<2.5	7.43	*87.6*	7.95	457
Donaldson	2	0	2	<2.5	7.5	*91.5*	8.15	479
Donaldson	3	0	5	<2.5	7.7	*89.9*	8.33	572
Mine	1	0	.5-2	<2.5	7.56	96	8.88	250.5
Mine	2	0	2	<2.5	7.62	83.1	7.59	241.1
Mine	3	0	2	<2.5	7.54	82.5	7.47	260.1
Spout	1	0	5	<2.5	7.81	91	7.43	728.3
Spout	2	0	5	<2.5	7.82	84.2	7.15	758
Spout	3	0	5	<2.5	7.87	81.2	6.98	770
Windy	1	0	1-2	<2.5	7.42	61	5.31	789
Windy	2	0	0-1	<2.5	7.4	61.8	5.57	768
Windy	3	0	1-2	<2.5	7.31	59.5	5.15	829
Difficult	1	0	0-1	<2.5	7.51	65	5.65	689
Difficult	2	0	0-1	<2.5	7.51	67.2	5.72	698
Difficult	3	0	0-1	<2.5	7.3	68.7	5.65	702

Monitoring: 2007: Round 2

Stream	Station	Nitrite(ppm)	Nitrate(ppm)	Turbidity(JTU)	pH	DO(%)	DO(mg/l)	Conductivity(uS)
Turkey	1	0	.5 to 2	<2.5	7.94	91	8.84	466
Turkey	2	0	0.5	<2.5	8.1	85	7.9	469
Turkey	3	0	2	<2.5	7.82	87.6	8.18	475
Pimmit	1	0	0.5	<2.5	7.83	83.4	7.74	446.9
Pimmit	2	0	0.5	<2.5	7.52	82	7.1	448.2
Pimmit	3	0.5	0-20	<2.5	7.52	79	6.82	467
Dead	1	0	0.5	<2.5	7.62	57.5	4.9	371.2
Dead	2	~~~	~~~	<2.5	7.77	65.6	8.84	358
Dead	3	~~~	~~~	<2.5	7.79	65.4	5.75	398.8
Gulf Branch	1	~~~	~~~	<2.5	7.57	64.1	5.73	573
Gulf Branch	2	~~~	~~~	<2.5	7.57	64.1	5.86	586
Gulf Branch	3	0	2	<2.5	7.42	63.4	5.49	573
Donaldson	1	0	2	<2.5	7.56	62	5.47	620
Donaldson	2	0	2-5	<2.5	7.65	66.5	5.77	657
Donaldson	3	0	2-5	<2.5	7.66	67.3	5.4	645
Mine	1	0	1-2	<2.5	7.70	65.4	5.76	326.5
Mine	2	0	0-1	<2.5	7.43	61.9	5.42	332
Mine	3	0	0-1	<2.5	7.47	62.8	5.37	329.4

Spout	1	0	2-5	<2.5	7.94	68	6.11	800
Spout	2	0	5	<2.5	8.04	65.8	5.75	804
Spout	3	0	2-5	<2.5	7.98	72.6	6.3	811
Difficult	1	0	.5	<2.5	7.53	-	-	-
Difficult	2	0	.5	<2.5	7.65	80.5	6.5	462
Difficult	3	0	.5	<2.5	7.3	53.5	4.35	600
Monitoring: 2007: Round 3								
Stream	Station	Nitrite(ppm)	Nitrate(ppm)	Turbidity(JTU)	pH	DO(%)	DO(mg/l)	Conductivity(uS)
Turkey	1	0	1-2	<2.5	8.00	73.1	6.85	573
Turkey	2	0	2	<2.5	7.91	67.2	6.17	577
Turkey	3	0	1-2	<2.5	7.87	69.4	6.27	571
Pimmit	1	0	0-1	<2.5	7.66	55.9	5.15	779
Pimmit	2	0	0-1	<2.5	7.68	62.2	5.36	780
Pimmit	3	0	.5	<2.5	7.67	61	5.1	733
*Italics indicated calculated, not observed, value								

Appendix 12: Stream Habitat Assessment Data

Monitoring: Summer 2007: Round 1

Stream	Station	Water Width(ft)	Bank to Bank (ft)	Stream Flow Rate	Riffle Depth	Stream Depth	Water Temp ºC	Air Temp	Fish Water Quality Indicators
Turkey	1	19.7	33.5	normal	3	3.9	19.9		scattered individuals
Turkey	2	8.2	30.8	normal	4.7		21.1		scattered individuals
Turkey	3	15.7	40.7	normal	5.9	7	18.6	21.3	none
Dead	1	18.5	74.6	normal			20.7	21.7	none
Dead	2	8	22.8	normal	7.9		22.2	29.1	scattered individuals
Dead	3	12.8	63.8	normal		8	19.1	17	none
Pimmit	1	26	70	normal	5	10	17.8	16.8	scattered schools
Pimmit	2	23.2	52.2	normal		7	18.1	17.8	scattered individuals
Pimmit	3	22.3	69	normal		10	18.9	19.7	none
Gulf Branch	1	15.7	34.5	normal		6	21.7	23.6	none
Gulf Branch	2	15.7	45	normal		7	22.3	26.3	none
Gulf Branch	3	11.8	34	normal		6	22.5	22.6	none
Donaldson	1	42	69.5	normal			19.5	18.5	none
Donaldson	2	13	30	normal			21	25	none
Donaldson	3	10.8	34	normal			19.4	19.8	none
Mine	1	5.5	16	normal	2	4	20.3	23.2	none
Mine	2	21.3	32	normal	2		21	24.9	scattered individuals
Mine	3	10.8	33.5	normal	6	8	21.2	22.3	scattered individuals
Spout	1	11.3	39	normal	6	8	23.6	29.4	none
Spout	2	12	31	normal	6	8	23.5	27.3	none
Spout	3	17.5	30	normal	3	9	23.7	27.2	none
Windy	1	10.5	30.5	Normal	3	5	22.9	24.7	None
Windy	2	10.5	28.5	Normal	2.5	4	22.6	23.7	None
Windy	3	12.5	33.5	normal	3	6	23.5	27.5	none
Difficult	1	113.7	124.5	normal	4	12	22.9	21.7	Scattered indivisuals
Difficult	2	61	80	normal	4	12	23.8	24.5	Scattered individuals
Difficult	3	50	72	normal	4	8	26.1	30.6	None

Monitoring: 2007: Round 2									
Stream	Station	Water Width(ft)	Bank to Bank (ft)	Stream Flow Rate	Riffle Depth	Stream Depth	Water Temp	Air Temp	Fish Water Quality Indicators
Turkey	1	19.7	33.5	low	1.5	2.5	17.3	17.7	scattered individuals
Turkey	2	8.2	30.8	low	5	5	17.6	20.1	no fish
Turkey	3	15.7	40.7	low	2	9	19.5	22.8	no fish
Pimmit	1	26	70	normal	3	7	19.1	19.1	no fish
Pimmit	2	23.2	53.3	normal	3	4	22.7	23	scattered individuals
Pimmit	3	22.3	69	normal	1	10	23.5	26	no fish
Dead	1	18.5	74.6	low	2		23.6	25.5	scattered schools
Dead	2	8	22.8	normal	3	5	21.6	21	scattered individuals
Dead	3	12.8	63.8	normal	3	5	22	23.2	scattered individuals
Gulf Branch	1	15.7	34	normal	1.5	7.5	21.1	20.3	no fish
Gulf Branch	2	15.7	45	normal	5	8	21.9	25.4	no fish
Gulf Branch	3	11.8	34	normal	2	5.5	22.6	25.1	No fish
Donaldson	1	42	69.5	low	2	3	22.7	26.5	No fish
Donaldson	2	13	30	low	3	6	22.8	26.6	No fish
Donaldson	3	10.8	34	Low	3	5	22.3	23.2	No fish
Mine	1	5.5	16	normal	2	4	22.6	25.6	Scattered individuals
Mine	2	21.3	32	normal	3	5	23	25.6	Scattered individuals
Mine	3	10.8	33.5	normal	3	6	23.9	27.8	Scattered individuals
Spout	1	11.3	39	normal	6	8	21.2	20.8	No fish
Spout	2	12	31	Normal	7	8	22.5	25.8	No fish
Spout	3	17.5	30	normal	4	9	23.1	27.9	No fish
Difficult	1	113.7	124.5	low	3	10	26.4	25.9	No fish
Difficult	2	61	80	normal	3	12	26.1	25.2	No fish
Difficult	3	50	72	Normal	4	10	26.3	27.9	No fish
Monitoring: Summer 2007: Round 3									
Stream	Station	Water Width(ft)	Bank to Bank (ft)	Stream Flow Rate	Riffle Depth	Stream Depth	Water Temp	Air Temp	Fish Water Quality Indicators
Turkey	1	21.4	33.5	low	2	4	19.1	22	Scattered schools
Turkey	2	6	30	low	2	4	20.2	24.5	Scattered schools
Turkey	3	15.7	40.7	low	2	4	21.2	25.5	Scattered schools
Pimmit	1	26	70	Normal	2	6	23.3	23.5	Scattered schools
Pimmit	2	23.2	53.3	normal	2	4	24.8	27.1	No fish
Pimmit	3	22.3	69	normal	3	5	24.1	23.2	Scattered individuals

Appendix 12: Stream Habitat Assessment Data						
Monitoring: 2007: Round 1						
Stream	Station	Barriers to Fish Movement	Salamanders	Surface Water Appearance	Stream Bed Deposit	Odor
Turkey	1	Small waterfalls, rocks	none	Clear	Brown/tan, silty, muddy, sandy	None
Turkey	2	waterfalls	none	Clear	Brown/tan, silty, muddy, sandy	none
Turkey	3	waterfalls	Yes	Clear	Silty, muddy, sandy	None
Pimmit	1	Rocks	None	Clear	Brown/tan, sandy	None
Pimmit	2	Some rocks	None	Clear	Brown/tan, sandy	None

Pimmit	3	none	None	Clear	Sandy, rocky	Sewage
Dead	1	Waterfalls	None	Clear but tea-colored	Brown/tan, silty, muddy, rocky	Sewage
Dead	2	Waterfalls	None	Clear	Silty, muddy	None
Dead	3	waterfalls	None	Clear but tea-colored	Sandy, rocky	None
Gulf Branch	1	Rocks	None	Clear	Brown/tan, sandy	None
Gulf Branch	2	Rocks	None	Clear	Sandy, rocky	None
Gulf Branch	3	Rocks, waterfalls	None	Clear	Sandy, rocky	None
Donaldson	1	Rocks, waterfalls	None	Clear	Brown/tan, silty, muddy, sandy	None
Donaldson	2	Rocks, waterfalls	None	Clear	Brown/tan, silty, muddy, sandy	None
Donaldson	3	Rocks, waterfalls	None	Clear	Brown/tan, silty, muddy, sandy	None
Mine	1	None	Yes	Clear	Silty, muddy, sandy	None
Mine	2	None	None	Clear	Silty, muddy, sandy	None
Mine	3	Waterfalls, rocks	None	Clear	Silty, muddy, sandy	None
Spout	1	Rocks, waterfalls	None	Clear	Sandy, rocky	Sewage
Spout	2	Rocks, waterfalls	None	Clear	Sandy, rocky	Sewage
Spout	3	Rocks, waterfalls	None	Clear	Silty, muddy, rocky	Sewage
Windy	1	Rocks, waterfalls	None	Clear	Sandy	None
Windy	2	Rocks	None	Clear	Sandy	None
Windy	3	None	none	clear	Sandy, silty	none
Difficult	1	none	none	clear	brown	none
Difficult	2	none	none	clear	brown	None
Difficult	3	waterfalls	none	clear	brown	None
Monitoring: 2007: Round 2						
Stream	Station	Barriers to Fish Movement	Salamanders	Surface Water Appearance	Stream Bed Deposit	Odor
Turkey	1	rocks	none	Clear	Brown/tan, silty, muddy, sandy	None
Turkey	2	none	none	Clear	Brown/tan, silty, muddy	none
Turkey	3	rocks	none	Clear	Silty, muddy, sandy	None
Pimmit	1	none	None	Clear	Silty, muddy, sandy	None
Pimmit	2	none	None	Clear	Brown/tan, sandy	None
Pimmit	3	rocks	None	Clear	Sandy, rocky	None
Dead	1	Waterfalls, rocks	None	Clear	Brown/tan, silty, muddy, rocky	None
Dead	2	Waterfalls, rocks	None	Clear	Silty, muddy	None
Dead	3	Waterfalls, rocks	None	Clear	Sandy, rocky	None
Gulf Branch	1	Rocks, waterfalls	None	Clear	Brown/tan, sandy	None

Gulf Branch	2	Rocks, waterfalls	None	Clear	Sandy, rocky	None
Gulf Branch	3	none	none	clear	Silty, muddy	none
Donaldson	1	Waterfalls, rocks	none	clear	Silty, sandy	none
Donaldson	2	Waterfalls, rocks	none	clear	Silty, muddy	none
Donaldson	3	Waterfalls, rocks	none	clear	Siltym muddy	none
Mine	1	none	yes	clear	Silty, muddy	none
Mine	2	none	yes	clear	Silty, muddy	none
Mine	3	rocks	none	clear	Silty, muddy	none
Spout	1	Rocks	None	Clear	Sandy	None
Spout	2	Waterfalls	None	Clear	Sandy	None
Spout	3	waterfalls	none	Clear	sandy	none
Difficult	1	none	none	Clear but tea colored	Brown/tan	none
Difficult	2	waterfalls	none	milky	Brown/tan	musky
Difficult	3	Waterfalls, rocks	None	Milky	Brown/tan	None
Monitoring: 2007: Round 3						
Stream	Station	Barriers to Fish Movement	Salamanders	Surface Water Appearance	Stream Bed Deposit	Odor
Turkey	1	rocks	no	clear	Silty, sandy, muddy	None
Turkey	2	Waterfalls, rocks	no	clear	Silty, sandy, muddy	None
Turkey	3	Waterfalls, rocks	yes	clear	Silty, sandy	none
Pimmit	1	Rocks	No	Clear	Brown/tan, silty, sandy	None
Pimmit	2	rocks	no	clear	silty, sandy	None
Pimmit	3	waterfalls	no	clear	Brown/tan	none

Appendix 12: Stream Habitat Assessment Data

Monitoring: Summer 2007: Round 1

Stream	Station	Stability of stream: Bed sinks beneath your feet in	Algae Color	Algae located	% algae	Stream channel shade	Stream channel Erosion Potential
Turkey	1	a few spots	none	nowhere	0	25% - 49% Moderate	25% - 49% Moderate
Turkey	2	no spots	none	none	0	25% - 49% Moderate	25% - 49% Moderate
Turkey	3	a few spots	none	none	0	25% - 49% Moderate	25% - 49% Moderate
Dead	1	few spots	dark green	in a few spots	5	25% - 49% Moderate	25% - 49% Moderate
Dead	2	no spots	dark green	in spots	10	25% - 49% Moderate	1% - 24% Slight
Dead	3	a few spots	none	none	0	25% - 49% Moderate	25% - 49% Moderate
Pimmit	1	few spots	none	none	0	25% - 49% Moderate	25% - 49% Moderate
Pimmit	2	no spots	none	none	0	25% - 49% Moderate	25% - 49% Moderate
Pimmit	3	no spots	none	none	0	25% - 49% Moderate	25% - 49% Moderate
Gulf Branch	1	no spots	none	none	0	25% - 49% Moderate	25% - 49% Moderate
Gulf Branch	2	no spots	none	none	0	25% - 49% Moderate	25% - 49% Moderate
Gulf Branch	3	no spots	none	none	0	25% - 49% Moderate	25% - 49% Moderate
Donaldson	1	few spots	none	none	0	25% - 49% Moderate	50%-74% High
Donaldson	2	few spots	light and	in spots	10	50%-74% High	25% - 49% Moderate

			dark green				
Donaldson	3	few spots	light/ dark green	in spots	20	25% - 49% Moderate	25% - 49% Moderate
Mine	1	no spots	none	none	0	25% - 49% Moderate	1% - 24% Slight
Mine	2	a few spots	none	nowhere	0	25% - 49% Moderate	1% - 24% Slight
Mine	3	no spots	light/dark matted on rocks	in spots	20	25% - 49% Moderate	1% - 24% Slight
Spout	1	no spots			0	25% - 49% Moderate	25% - 49% Moderate
Spout	2	no spots	none		0	25% - 49% Moderate	25% - 49% Moderate
Spout	3	no spots	none	nowhere	0	25% - 49% Moderate	50%-74% High
Windy	1	No spots	None	Nowhere	0	25% - 49% Moderate	50%-74% High
Windy	2	No spots	None	Nowhere	0	50%-74% High	50%-74% High
Windy	3	No spots	none	nowhere	0	50%-74% High	25% - 49% Moderate
Difficult	1	No spots	brown	everywhere	98	1% - 24% Slight	1% - 24% Slight
Difficult	2	No spots	Brown	Everywhere	98	1% - 24% Slight	1% - 24% Slight
Difficult	3	No spots	Brown	Everywhere	98	1% - 24% Slight	1% - 24% Slight
Monitoring: 2007: Round 2							
Stream	Station	Stability of stream: Bed sinks beneath your feet in	Algae Color	Algae located	% algae	Stream channel shade	Stream channel Erosion Potential
Turkey	1	few spots	none	none	0	25% - 49% Moderate	25% - 49% Moderate
Turkey	2	few spots	none	nowhere	0	25% - 49% Moderate	25% - 49% Moderate
Turkey	3	few spots	none	nowhere	0	50%-74% High	25% - 49% Moderate
Dead	1	no spots	brown coated	everywhere		1% - 24% Slight	25% - 49% Moderate
Dead	2	no spots	Brown coated, matted on streambed	in spots	20	25% - 49% Moderate	50%-74% High
Dead	3	no spots	Brown coated, matted on streambed	in spots	20	50%-74% High	1% - 24% Slight
Pimmit	1	few spots	brown, matted on stream bed	in spots	10	25% - 49% Moderate	1% - 24% Slight
Pimmit	2	no spots	none	nowhere	0	25% - 49% Moderate	25% - 49% Moderate
Pimmit	3	no spots	brown coated	in spots	10	25% - 49% Moderate	25% - 49% Moderate
Gulf Branch	1	no spots	none	nowhere	0	50%-74% High	25% - 49% Moderate
Gulf Branch	2	no spots	none	nowhere	0	25% - 49% Moderate	25% - 49% Moderate
Gulf Branch	3	No spots	none	nowhere	0	50%-74% High	25% - 49% Moderate
Donaldson	1	No spots	None	Nowhere	0	25% - 49% Moderate	50%-74% High
Donaldson	2	Few spots	none	nowhere	0	50%-74% High	25% - 49% Moderate
Donaldson	3	No spots	Light green	In spots	5	1% - 24% Slight	25% - 49% Moderate
Mine	1	Few spots	none	nowhere	0	50%-74% High	1% - 24% Slight
Mine	2	Few spots	none	nowhere	0	25% - 49% Moderate	1% - 24% Slight
Mine	3	No spots	none	nowhere	0	1% - 24% Slight	1% - 24% Slight
Spout	1	No spots	none	Nowhere	0	1% - 24% Slight	1% - 24% Slight

Spout	2	No spots	none	Nowhere	0	25% - 49% Moderate	25% - 49% Moderate
Spout	3	No spots	none	nowhere	0	1% - 24% Slight	25% - 49% Moderate
Difficult	1	No spots	brown	everywhere	98	1% - 24% Slight	1% - 24% Slight
Difficult	2	No spots	Brown coated, dark green	everywhere	90	1% - 24% Slight	1% - 24% Slight
Difficult	3	No spots	Brown coated	Everywhere	98	25% - 49% Moderate	1% - 24% Slight
Monitoring: 2007: Round 3							
Stream	Station	Stability of stream: Bed sinks beneath your feet in	Algae Color	Algae located	% algae	Stream channel shade	Stream channel Erosion Potential
Turkey	1	Few spots	None	nowhere	0	25% - 49% Moderate	50%-74% High
Turkey	2	No spots	None	Nowhere	0	25% - 49% Moderate	25% - 49% Moderate
Turkey	3	No spots	none	Nowhere	0	25% - 49% Moderate	25% - 49% Moderate
Pimmit	1	Few spots	None			25% - 49% Moderate	25% - 49% Moderate
Pimmit	2	Few spots	Brown coated	In spots	25	25% - 49% Moderate	25% - 49% Moderate
Pimmit	3	No spots	none	nowhere	0	25% - 49% Moderate	50%-74% High

Appendix 13: 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 14: Location Data

Monitoring: Summer 2007

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 2007

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 15: Miscellaneous Data

Monitoring: Summer 2007: Round 1

Stream	Station	Names of Certified Monitors	Weather last 72 hours
Turkey Run	1	Hilary Becker, Laura Pendleton	little rain, warm, humid
Turkey Run	2	Hilary Becker, Laura Pendleton	
Turkey Run	3	Hilary Becker, Laura Pendleton, Erik Oberg	light rain 48 hours ago
Dead Run	1	Hilary Becker, Laura Pendleton	rain last 24 hours
Dead Run	2	Hilary Becker, Laura Pendleton	rain 48 hours ago
Dead Run	3	Hilary Becker, Laura Pendleton	thunderstorms, heavy rain
Pimmit Run	1	Hilary Becker, Laura Pendleton	thunderstorms last 72 hours
Pimmit Run	2	Hilary Becker, Laura Pendleton	thunderstorms/heavy rain, cool
Pimmit Run	3	Hilary Becker, Laura Pendleton	thunderstorms/heavy rain, cool
Gulf Branch	1	Hilary Becker, Laura Pendleton	hot, humid, sunny
Gulf Branch	2	Hilary Becker, Laura Pendleton	hot, humid, sunny
Gulf Branch	3	Hilary Becker, Laura Pendleton	hot, humid, sunny, rain last night
Donaldson Run	1	Hilary Becker, Laura Pendleton	hot, sunny, rain 48 hours ago
Donaldson Run	2	Hilary Becker, Laura Pendleton	hot, sunny, rain 48 hours ago
Donaldson Run	3	Hilary Becker, Laura Pendleton	hot, humid, light rain
Mine Run	1	Hilary Becker, Laura Pendleton	hot,humid, possible light rain
Mine Run	2	Hilary Becker, Laura Pendleton	hot, humid, possible light rain
Mine Run	3	Hilary Becker, Laura Pendleton	hot, humid, light rain

Spout Run	1	Hilary Becker, Laura Pendleton	hot, humid, light rain
Spout Run	2	Hilary Becker, Laura Pendleton	hot, humid, light rain
Spout Run	3	Hilary Becker, Laura Pendleton	
Windy Run	1	Hilary Becker, Laura Pendleton	Rain, humid
Windy Run	2	Hilary Becker, Laura Pendleton	Rain, humid
Windy Run	3	Hilary Becker, Laura Pendleton	Rain, humid
Difficult	1	Hilary Becker, Laura Pendleton	Hot, humid
Difficult	2	Hilary Becker, Laura Pendleton	Hot, humid
Difficult	3	Hilary Becker, Laura Pendleton	Hot, humid
Monitoring: Summer 2007: Round 2			
Stream	Station	Names of Certified Monitors	Weather last 72 hours
Turkey Run	1	Hilary Becker, Laura Pendleton	hot, sunny
Turkey Run	2	Hilary Becker, Laura Pendleton	sunny, warm
Turkey Run	3	Hilary Becker, Laura Pendleton	warm, sunny
Dead Run	1	Hilary Becker, Laura Pendleton	hot, humid
Dead Run	2	Hilary Becker, Laura Pendleton	hot, humid, some rain
Dead Run	3	Hilary Becker, Laura Pendleton	hot, humid, some rain
Pimmit Run	1	Hilary Becker, Laura Pendleton	warm, sunny
Pimmit Run	2	Hilary Becker, Laura Pendleton	hot, humid
Pimmit Run	3	Hilary Becker, Laura Pendleton	hot, humid
Gulf Branch	1	Hilary Becker, Laura Pendleton	hot, humid, rain
Gulf Branch	2	Hilary Becker, Laura Pendleton	hot, humid, some rain
Gulf Branch	3	Hilary Becker, Laura Pendleton	hot, humid
Donaldson Run	1	Hilary Becker, Laura Pendleton	hot, humid
Donaldson Run	2	Hilary Becker, Laura Pendleton	hot, humid
Donaldson Run	3	Hilary Becker, Laura Pendleton	hot, humid, rain
Mine Run	1	Hilary Becker, Laura Pendleton	hot, humid
Mine Run	2	Hilary Becker, Laura Pendleton	hot, humid
Mine Run	3	Hilary Becker, Laura Pendleton	hot, humid
Spout Run	1	Hilary Becker, Laura Pendleton	hot, humid
Spout Run	2	Hilary Becker, Laura Pendleton	hot, humid, sunny
Spout Run	3	Hilary Becker, Laura Pendleton	warm, sunny
Difficult	1	Hilary Becker, Laura Pendleton	Hot, humid
Difficult	2	Hilary Becker, Laura Pendleton	Hot, humid, rain
Difficult	3	Hilary Becker, Laura Pendleton, Erik Oberg	Hot, humid
Monitoring: Summer 2007: Round 3			
Stream	Station	Names of Certified Monitors	Weather last 72 hours
Turkey Run	1	Hilary Becker, Laura Pendleton	hot, sunny
Turkey Run	2	Hilary Becker, Laura Pendleton	hot, sunny
Turkey Run	3	Hilary Becker, Laura Pendleton	hot, sunny
Pimmit Run	1	Hilary Becker, Laura Pendleton	Hot, humid
Pimmit Run	2	Hilary Becker, Laura Pendleton	Hot, humid
Pimmit Run	3	Hilary Becker, Laura Pendleton	Hot, humid, hazy

Appendix 15: Miscellaneous Data

Monitoring: Summer 2007: Round 1

Stream	Station	Date	Stream Flow Rate	Number Nets	Net 1 Area	Net 2 Area	Net 3 Area	Net 4 Area
Turkey Run	1	6/11/2007	Normal	1	3x3			

Turkey Run	2	6/11/2007	Normal	2	3x3	1x1		
Turkey Run	3	6/12/2007	Normal	2	3x3	3x3		
Dead Run	1	6/13/2007	Normal	3	3x3	3x3	3x3	
Dead Run	2	6/12/2007	Normal	4	3x3	3x3	3x3	3x3
Dead Run	3	6/14/2007	Normal	1	3x3			
Pimmit Run	1	6/15/2007	Normal	2	3x3	1x1		
Pimmit Run	2	6/15/2007	Normal	1	3x3			
Pimmit Run	3	6/15/2007	Normal	1	3x3			
Gulf Branch	1	6/19/2007	Normal	4	3x3	3x3	3x3	3x3
Gulf Branch	2	6/19/2007	Normal	2	3x3	3x3		
Gulf Branch	3	6/20/2007	Normal	1	3x3			
Donaldson Run	1	6/21/2007	Normal	1	3x3			
Donaldson Run	2	6/21/2007	Normal	1	3x3			
Donaldson Run	3	6/22/2007	Normal	1	3x3			
Mine Run	1	6/25/2007	Normal	1	3x3			
Mine Run	2	6/25/2007	Normal	1	2x2			
Mine Run	3	6/26/2007	Normal	1	2x2			
Spout Run	1	6/26/2007	Normal	2	3x3	3x3		
Spout Run	2	6/27/2007	Normal	1	3x3			
Spout Run	3	6/28/2007	Normal	1	3x3			
Windy Run	1	7/30/2007	normal	1	3x3			
Windy Run	2	7/30/2007	Normal	1	3x3			
Windy Run	3	7/30/2007	normal	2	3x3	2x2		
Difficult Run	1	8/1/2007	normal	1	3x3			
Difficult Run	2	8/1/2007	Normal	1	2x2			
Difficult Run	3	8/1/2007	Normal	1	2x2			
Monitoring:Summer 2007: Round 2								
Stream	Station	Date	Stream Flow Rate	Number Nets	Net 1 Area	Net 2 Area	Net 3 Area	Net 4 Area
Turkey Run	1	7/2/2007	Low	1	3x3			
Turkey Run	2	7/2/2007	Low	1	3x3			
Turkey Run	3	7/2/2007	Low	1	3x3			
Dead Run	1	7/10/2007	Low	1	3x3			
Dead Run	2	7/12/2007	Normal	4	3x3	1x1	2x2	3x3
Dead Run	3	7/12/2007	Normal	3	3x3	3x3	1x4	
Pimmit Run	1	7/3/2007	Normal	1	3x3			
Pimmit Run	2	7/9/2007	Normal	1	3x3			
Pimmit Run	3	7/9/2007	Normal	1	2x2			
Gulf Branch	1	7/13/2007	Normal	3	3x3	3x3	3x1.5	
Gulf Branch	2	7/13/2007	Normal	2	3x3	1x1		
Gulf Branch	3	7/16/2007	Normal	1	3x3			
Donaldson Run	1	7/17/2007	Low	1	2x2			
Donaldson Run	2	7/17/2007	Low	2	3x3	2x2		
Donaldson Run	3	7/20/2007	Low	1	3x3			
Mine Run	1	7/18/2007	Normal	1	2x2			
Mine Run	2	7/18/2007	Normal	2	1x1	1x1		
Mine Run	3	7/18/2007	Normal	1	2x2			
Spout Run	1	7/23/2007	Normal	1	2x4			
Spout Run	2	7/23/2007	Normal	1	3x3			

Spout Run	3	7/23/2007	Normal	1	3x3			
Difficult	1	8/9/2007	low	2	1x1	1x1		
Difficult	2	8/10/2007	normal	2	1x1	1x1		
Difficult	3	8/8/2007	Normal	1	3x3			
Monitoring:Summer 2007: Round 3								
Stream	Station	Date	Stream Flow Rate	Number Nets	Net 1 Area	Net 2 Area	Net 3 Area	Net 4 Area
Turkey Run	1	7/24/2007	Low	1	3x3			
Turkey Run	2	7/24/2007	Low	1	2x4			
Turkey Run	3	7/24/2007	Low	1	3x3			
Pimmit Run	1	8/2/2007	normal	1	2x2			
Pimmit Run	2	8/2/2007	normal	2	1x1	2x2		
Pimmit Run	3	8/3/2007	normal	2	2x2	3x3		
Gulf Branch	1							

Appendix 15: Miscellaneous Data		
Monitoring: Summer 2007: Round 1		
Stream	Station	Briefly Describe litter
Turkey Run	1	not much, but a few water bottles and cans
Turkey Run	2	none
Turkey Run	3	
Dead Run	1	bottles, cans, plastic
Dead Run	2	bottles, cans, plastic bags
Dead Run	3	plastic bottles, cans, other plastic, glass bottles
Pimmit Run	1	none
Pimmit Run	2	some bottles, cans
Pimmit Run	3	cans, bottles (not many)
Gulf Branch	1	cans, plastic, cartons
Gulf Branch	2	plastic bags, bottles, metal rods
Gulf Branch	3	plastic, bottles, metal rods, canine feces
Donaldson Run	1	plastics, metal rods
Donaldson Run	2	not very much; plastic
Donaldson Run	3	plastic, bottles,cans
Mine Run	1	none
Mine Run	2	none
Mine Run	3	glass
Spout Run	1	lots of trash, bottles, cans, plastic, metals, wrappers, trash can lid…
Spout Run	2	lots of litter, plastic, cans, bottles, clothes, wrappers, metals
Spout Run	3	a lot of litter; cans, plastic bags, glass, wrappers, clothing
Windy Run	1	Can, wrappers
Windy Run	2	Wrappers
Windy Run	3	No trash
Difficult Run	1	None
Difficult Run	2	None
Difficult Run	3	none
Monitoring: Summer 2007: Round 2		
Stream	Station	Briefly Describe litter
Turkey Run	1	little litter, plastic bags

Turkey Run	2	little litter
Turkey Run	3	little litter
Dead Run	1	not too much litter, but some cups, cans, plastic, a slide
Dead Run	2	some litter; cans, bottles
Dead Run	3	some litter; cans, bottles
Pimmit Run	1	none
Pimmit Run	2	slight litter, can
Pimmit Run	3	not much litter
Gulf Branch	1	not much; plastic, cardboard
Gulf Branch	2	not much
Gulf Branch	3	some glass
Donaldson Run	1	cans, some plastic, not too much litter at all
Donaldson Run	2	cans..not too much litter
Donaldson Run	3	plastic, bottles
Mine Run	1	no litter
Mine Run	2	none
Mine Run	3	none
Spout Run	1	many plastic bags, cans, wires, bottles, clothes, metal pieces…
Spout Run	2	many plastic bags, cans, wires, metal pieces, bottles
Spout Run	3	many plastic bags, cans, bottles, wires, metal pieces
Difficult	1	none
Difficult	2	Beer can
Difficult	3	none
Monitoring: Summer 2007: Round 3		
Stream	Station	Briefly Describe litter
Turkey Run	1	a few cans, very little trash
Turkey Run	2	no litter
Turkey Run	3	none
Pimmit Run	1	None
Pimmit Run	2	none
Pimmit Run	3	Glass, a bottle

Appendix 15: Miscellaneous Data		
Monitoring: Summer 2007: Round 1		
Stream	Station	Brief Comments
Turkey Run	1	sample taken 25 ft downstream of 2006 sample
Turkey Run	2	got many dead common netspinners/pieces of them
Turkey Run	3	28.2 feet downstream of 2006 sample 1 salamander found
Dead Run	1	went all the way to the mouth for a decent riffle; no other good riffles to choose from
Dead Run	2	no good sampling sites, har to access safely, no cobbly riffles to choose from
Dead Run	3	more water than normal because of rain; not too many riffles to choose from
Pimmit Run	1	samples taken downstream from flag (2006) 78ft, 2in and 44ft, 9in
Pimmit Run	2	variety of rock sizes and many riffles to choose from
Pimmit Run	3	none
Gulf Branch	1	site 1 samples take near site 2
Gulf Branch	2	sample site moved a bit upstream, but still under bridge
Gulf Branch	3	none

Donaldson Run	1	
Donaldson Run	2	
Donaldson Run	3	
Mine Run	1	Great riffle; tons of critters
Mine Run	2	sample taken at riffle downstream; original site is now a large pool
Mine Run	3	
Spout Run	1	tons of trash, plastics,cans, bottles, wrappers
Spout Run	2	
Spout Run	3	
Windy	1	
Windy	2	
Windy	3	Site in middle of trail crossing
Difficult	1	
Difficult	2	In middle of channel near brush pile
Difficult	3	On far side of channel
Monitoring: Summer 2007: Round 2		
Stream	Station	Brief Comments
Turkey Run	1	26 feet downstream from flag
Turkey Run	2	42 feet downstream from flag
Turkey Run	3	
Dead Run	1	sample taken about 100ft downstream of flag
Dead Run	2	not many riffles to choose from; samples taken from different spots; one taken 69.5ft upstream of flag
Dead Run	3	no good riffles to choose from; mostly bedrock bottom
Pimmit Run	1	downstream of flag, lots of gravel-sized rocks in riffle
Pimmit Run	2	
Pimmit Run	3	no good riffles to choose from in area; new nitrite strips used; measure in ppm(mg/L).
Gulf Branch	1	
Gulf Branch	2	
Gulf Branch	3	
Donaldson Run	1	
Donaldson Run	2	
Donaldson Run	3	
Mine Run	1	
Mine Run	2	
Mine Run	3	
Spout Run	1	
Spout Run	2	
Spout Run	3	
Difficult	1	
Difficult	2	Error- YSI DO and Conductivity meter is not working quite right
Difficult	3	
Monitoring: Summer 2007: Round 3		
Stream	Station	Brief Comments
Turkey Run	1	
Turkey Run	2	large tree recently fallen upstream of sample site
Turkey Run	3	
Pimmit Run	1	
Pimmit Run	2	
Pimmit Run	3	First net taken at bad riffle, not much was caught

Appendix 16: Daily Rainfall: Summer 2007

Date	rainfall	Date	Rainfall	Date	Rainfall	Date	Rainfall	Date	Rainfall	Date	Rainfall	Date	Rainfall
June 13th	0.06	June 22th	0	July 2nd	0	July 12th		July 22th	0	August 1st	0	August 11th	
June 14th	0.03	June 23th	0	July 3rd		July 13th	0	July 23th	0	August 2nd	0	August 12th	0
June 15th	0	June 24th		July 4th	0.03	July 14th		July 24th	0.05	August 3rd	0	August 13th	0
June 16th	0	June 25th		July 5th	0.11	July 15th		July 25th		August 4th	0		0
June 17th	0	June 26th	0	July 6th		July 16th	0	July 26th		August 5th	0		
June 18th	0	June 27th		July 7th	0	July 17th	0	July 27th	0	August 6th	0.09		
June 19th		June 28th	0.04	July 8th	0	July 18th		July 28th	0.02	August 7th	0.22		
June 20th	0.01	June 29th		July 9th	0	July 19th	0	July 29th	0.02	August 8th	0		
June 21th	0.04	June 30th		July 10th	0.73	July 20th	0	July 30th	0.98	August 9th	0		
		July 1st		July 11th	0.4	July 21th	0	July 31th	0	August 10th	0.1		

Appendix 17: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 18: 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 19: 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 20: 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 21: 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
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 22: Supplies

1. 3'x 3' kick-seine net (1/16-inch mesh)
2. Waders
3. Two backpacks
4. Collapsible table
5. Uniform
6. Two collapsible seats
7. Timer
8. Field first aid kit
9. Meter stick
10. Magnifying glass
11. Collection vial
12. Pens/Pencils
13. Measuring tape (100ft)
14. Brush
15. Forceps
16. Two ice cube trays
17. Virginia Save Our Streams benthic macroinvertebrate tally sheets (Appendix 1)
18. YSI meter, model 85 and associated calibration chemicals
19. Hanna Instruments pH meter (model 9025) and associated calibration chemicals
20. LaMotte turbidity kit
21. Squirt bottle
22. Water bottle
23. Hand sanitizer
24. Flagging
25. Cell phone for emergencies
26. Sunscreen and bug spray
27. Hach water quality test strips
28. Virginia Save Our Streams stream quality survey form (Appendix 8)

Calibration Chemicals Ordering Information:

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

Hanna Instruments pH Meter
Cole-Parmer Instrument Company: 847-549-7600 Fax: 847-247-2929
625 East Bunker Ct.
Vernon Hills, IL 60061
www.coleparmer.com

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

Appendix 23: 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', 2'x 2', or 1'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 2'x 2' net, and 30 seconds for a 1'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 24: 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. Tour Arlington cemetery
11. Tour Clara Barton House
12. Tour Dyke Marsh
13. Tour Theodore Roosevelt Island
14. Become familiar with Turkey Run trails

Appendix 25: 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)*