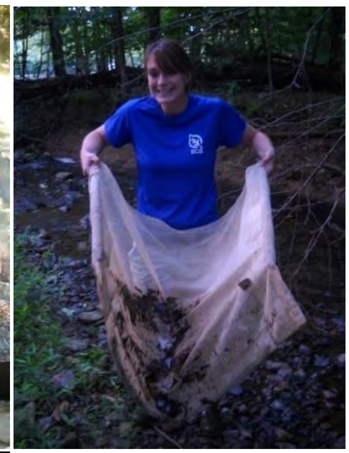
# National Park Service
# George Washington Memorial Parkway
# Stream Monitoring Program
# 2010 Annual Report





Rita DuMais, SCA Natural Resource Assistant
Nina Wester, SCA Natural Resource Assistant
Erik Oberg, Natural Resource Management Specialist
Brent Steury, Natural Resource Program Manager
8/10/10

TABLE OF CONTENTS

LIST OF TABLES



LIST OF FIGURES

APPENDICES

ACKNOWLEDGEMENTS

We would like to express our gratitude to Ann Brazinski for her devotion in creating the George Washington Memorial Parkway Stream Monitoring Program. We would also like to thank Ben Helwig for producing the maps in this report and providing us with important advice. To Brent Steury, thank you for providing us many opportunities to work alongside you on your various projects. We especially want to thank Erik Oberg for being an excellent mentor and advisor to us throughout this internship. In addition, we would like to acknowledge Geoff Sanders for producing and revising our database, Marian Norris and her hydrologic technicians Jim Pieper and Tonya Watts for their expertise in assessing pollution, and John Paul Schmit for his statistical analysis. 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 2010 for the completion of the ninth year of stream water quality monitoring. Mine Run and Difficult Run were the only streams to average a consistently healthy score according to the Virginia Save Our Streams Multimetric Index. The remaining eight streams averaged scores classified as "unacceptable". Once again, Spout Run received the lowest average rating for the entire nine year testing period. However, Donaldson Run received the lowest average rating for the 2010 season. Both streams have highly urbanized watersheds, which may be an indication that development and associated pollutants can have a significant effect on stream health.

Additionally, Donaldson Run was one of two streams that were contaminated by a pesticide spill in 2001, which could be another reason why the rating was low in the 2010 season. Gulf Branch was the other stream affected by this pesticide spill. Lack of prior data prevents us from determining whether the two streams have recovered to pre-contamination conditions. The 2010 season also marked the fourth year of monitoring at Windy Run and Difficult Run and the second year of monitoring at CIA Run. The 2010 season had three streams that showed significant improvement through statistical analysis of stream data: Pimmit Run, Difficult Run and CIA Run. However, these statistics also showed a noteworthy decline in stream health for Mine Run and Gulf Branch. 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) is a unit of the National Park Service (NPS) responsible for preserving natural and historic property along the Potomac River. The areas protected by the Parkway include streams and their respective watersheds which reside within the park's boundary. The Natural Resource Management Division of the GWMP manages and protects the wildlife and habitats within the park. Concern in recent decades over the deterioration of stream quality within the Parkway inspired a continuous monitoring program that now identifies the health of ten streams flowing through the Parkway en route to the Potomac River.

The Northern Virginia suburbs of Washington D.C., particularly Fairfax and Arlington Counties, have experienced remarkable urbanization within the past several years. The conversion of natural areas into new commercial and residential sectors has deteriorated the health of streams adjacent to those areas. Appendix 11 shows the amount of residential and commercial square footage that has been added from 2002-2006 in Arlington County. Appendices 12 and 13 show the amount of land used and planned to be used as of 2004 in Fairfax County. Growing urban development and impervious surface cover puts a strain on storm water management (Figure 35). Rainwater is not easily absorbed by impervious surfaces. The excess storm water floods into nearby streams, which are not designed to accommodate such high flood stages, and causes sediment overload and destabilization of soils. Pollutants carried by storm runoff may also adversely affect biological stream communities (USEPA, 1997 and storm water Management Branch, 2001).

In response to stream health concerns, 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. 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. It was developed by the Izaak Walton League of America and later modified by a two-year study at Virginia Tech (VASOS). Benthic macroinvertebrates are an important component of the freshwater stream ecosystem as they aid in the decomposition of organic matter and are a vital food source for species at higher trophic levels in the food chain. Each taxonomic order of macroinvertebrates has a specific level of tolerance to environmental stress. This, coupled with their quick response to environmental stressors and relative ease of identification, makes benthic macroinvertebrates ideal indicators of water quality and environmental health (Storm water Management Branch, 2001). Certain macroinvertebrates, such as aquatic worms and leeches, are tolerant to many forms of pollution while others, like hellgrammites or beetle larvae, are not. Examining the abundance of less tolerant macroinvertebrates, as well as the species diversity in general, helps assess the health of the stream ecosystem. VASOS protocol uses type and abundance of benthic macroinvertebrates found in each stream to calculate a multimetric index, from which a health score is determined. Beginning in 2009, a ruggedized laptop computer was used to collect and store data into the stream monitoring program and calculate a multimetric score. 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. However, in the future this program will transition to the Maryland Biological Stream Survey protocol. Using MBSS protocol will make the GWMP's data comparable to many other regional water quality testing programs. The new chemical testing methods used in 2010 are already part of the Maryland Biological Stream Survey protocol. These tests are more thorough and allow for detection of possible contamination by municipal waters.

Assessing the stream and riparian habitat was another tool used when examining the health of the ecosystem. A healthy riparian habitat should have many plants to prevent erosion and to absorb runoff. We took note of the composition of the stream bank at each site as well as the potential for erosion. The condition of the water, the odor and the color were also noted. Any abnormal odors or coloration in the water is an indicator of pollution. If algae were present, the type and abundance was noted. A high level of algae can indicate eutrophic conditions in the water which is harmful to many stream organisms. Finally, stream channel shade, stream bank stability and fish abundance were all noted as well. These parameters can cause differences in what lives at each site.

Finally, we examined the chemical properties of the water as part of the health assessment. In the 2010 season, a more robust examination of water chemistry was introduced to the program to address recent suspicions that municipal waters have been leaking into local streams. The water temperature, conductivity, pH, and dissolved oxygen level were examined on site with a YSI meter. Potential loss of canopy and runoff from warm, impervious surfaces upstream of the study sites will increase water temperature, and decrease the available dissolved oxygen (USEPA 1997).

Many physical, chemical, and biological characteristics of a waterway are directly linked to water temperature. Higher water temperatures increase aquatic organisms' metabolic rate and can leave them susceptible to other environmental stresses (USEPA 1997). The pH of stream water reflects hydrogen ion (H+) concentration, or how acidic the water is. It is measured on a scale of one to fourteen. Acidic pH is less than seven, and an alkaline pH is greater than seven. Aquatic life is generally sustained at neutral pH levels of 6.5-8. Sources like acid rain can move stream pH levels outside this normal range and make pollutants more readily available for uptake, causing physiological damage to aquatic organisms (USEPA 1997). The conductivity, or the ability of the water to pass an electrical current, is affected by the presence of dissolved inorganic solids (U.S. Environmental Protection Agency, 2006). Naturally, conductivity can vary with water temperature and local geology. However, high conductivity may indicate presence of elevated levels of metals or salts, which may come from anthropogenic runoff, such as sewage drainage (USEPA 1997).

A low dissolved oxygen level can also indicate such pollution. In addition to inorganic solids, wastewater from sewage plants contains a high level of organic materials. Microorganisms in the stream break down these nutrients, and in the process they use oxygen for respiration. Increasing the amount of nutrients in the water increases the biological oxygen demand from these microorganisms, and in turn decreases the amount of available dissolved oxygen. 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 by human activities. Prolonged exposure to low levels of dissolved oxygen will increase an aquatic organisms' susceptibility to other environmental stresses. Organisms are especially susceptible during summer when warmer temperatures raise their metabolic rate, increasing their need for oxygen.

Water samples from each stream were taken to the lab at the Center for Urban Ecology to test for nitrate, phosphorus, chlorine, and acid neutralizing capacity. Nitrate and phosphorus are both nutrients that may come from man-made sources like municipal waters, fertilizer runoff, animal manure, and industrial wastes. Both can lead to algae blooms and eutrophication of streams. Natural levels of nitrate are below 1 mg/L, but water contaminated with municipal pollution can contain as much as 30 mg/L (U.S. Environmental Protection Agency). Nitrate is more water-soluble than many other nutrients, so it will appear in the water system sooner after a leak. A change in the nitrate level of the stream is a good early indicator of a problem. Acid neutralizing capacity (ANC) is the measure of alkalinity in a stream, or the amount of acid the water can hold without a significant change in pH (Water Quality Association, 2000). Thus the ANC is a good measure of how sensitive a stream is to acid inputs.

## METHODS

### 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 began in summer of 2001 and originally focused on seven perennial piedmont streams running through Parkway property (Figure 1): Mine Run, Dead Run, Turkey Run, Pimmit Run, Gulf Branch, Donaldson Run, and Spout Run. Monitoring continued thereafter every summer, focusing on the same seven streams. Beginning in 2007, Difficult Run and Windy Run were added to the roster of stream monitoring. In 2009, CIA Run was added. Global Positioning System (GPS) coordinates for each stream station are listed in Appendix 10. All ten streams were monitored from June 2, 2010, to July 27, 2010 (Figures 2-10). The seven core streams were sampled three times. The additional three streams were sampled twice. Each stream was sampled at three stations, with a minimum distance of twenty meters between each sample station. The day which sampling took place remains consistent with previous sampling times to the extent possible. Sampling date and times for the 2010 season can be found in Appendix 34.

### Benthic Macroinvertebrate Collection

At each site, the team sampled riffles, which are shallow sections of fast-moving water flowing over cobble sized rocks. The site furthest downstream was sampled first to preserve accurate water chemistry and to prevent organisms that are washed down to be collected twice. The VASOS protocol used a 3 by 3 feet kick-seine net (1/16-inch mesh) that was held down in the substrate with rocks by one person directly below the intended sample area. Rocks were placed along the bottom of the net to prevent organisms from escaping beneath. The net was angled roughly forty-five degrees to the streambed or greater, where possible. It was useful to remove protrusions in the substrate to make a smooth seal against the bottom. One member held the net in place while another member scrubbed and removed large rocks from the riffle within the designated sample area. The scrubbing member then vigorously churned the streambed area in front of the net by shuffling their feet while the member with the net proceeded to begin timing. 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 the time expired, rocks that held the bottom of the net were scrubbed. The net was lifted out of the water in a scooping motion, to avoid sample loss, and laid on a table for sorting. The riffle was returned to its original state prior to sampling. All macroinvertebrates were removed from the net with forceps and sorted in ice cube trays filled with stream water. We counted larger organisms, such as crayfish or salamanders, first and returned them back to the stream. We then closely examined the leaf litter and detritus in the net for organisms. After one side was searched, we flipped the net and searched the other side. After that we searched on the table. Each benthic macroinvertebrate was identified by common name and tallied on the VASOS 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. When taking extra nets, all organisms caught in the net were counted, regardless of whether the requisite 200 organisms were exceeded. If specimens were unidentifiable, they were taken back to headquarters for positive identification. LaMotte and Izaak Walton ID cards were used as reference.

In 2009, the Natural Resource Management department received a new ruggedized laptop, an XPLORE model iX104 $C^3$ Plus. Geoff Sanders developed a database for use in the field to store the collected data. This database was designed to simplify data entry and calculations. In addition to storing data, the database collected and calculated stream health scores for each stream and automatically uploaded the data to the VASOS online database. The VASOS multimetric protocol was used to compare the proportion of pollution-tolerant and intolerant species collected. Percentages of mayflies, stoneflies, caddisflies, common netspinners, lunged snails, beetles, non-insects, and tolerant species were calculated (Appendix 2) and assigned metric values based on their percentage value (Appendix 3). The metric values were then automatically added for each stream station and produced a score on a scale of zero to twelve. An "acceptable" rating received a score of 7.00 or greater, while an "unacceptable" rating was given for a score of 6.99 or less.

## Water Chemistry and Basic Water Quality Parameters

Starting in the 2010 season, GWMP's water quality testing program switched to the Maryland Biological Stream Survey method of chemical testing. After each round, water samples were collected from the streams visited. They were all collected at once because water samples must be tested within two days of being collected. The samples were then taken to the Center for Urban Ecology (CUE) and tested for nitrates, total phosphorus, chlorine content, and acid neutralizing capacity (see Appendix 26A-C for specific instructions).

While in the field, a YSI Professional *Plus* probe was used to measure water temperature, pH, conductivity, and dissolved oxygen (Appendix 4). Dissolved oxygen is the amount of oxygen freely available in water, necessary for aquatic life and oxidation of organic materials. Dissolved oxygen content varied greatly within the same area of a stream depending on whether it was sampled in fast or slow moving water. To keep consistency, we continually tested oxygen content in shallow, fast moving riffles. Faster moving water has a much higher oxygen content then slower moving pools, due to a higher turnover rate and surface area. These factors increase the amount of oxygen the water can hold. Because the macroinvertebrates thrive with more oxygen, they are more likely to live in the fast moving riffles, which is why sampling takes place at these specific locations.

## Stream Habitat Assessment and Physical Characteristics

Stream habitat assessment involved surveying for presence of aquatic vertebrates including fish, salamanders, and eels. Other parameters assessed were: surface water and streambed appearance, streambed stability, presence of algae, odor, and irregular water color. We also estimated the level of stream channel shade and stream bank erosion. Additionally, we assessed the stream bank and riffle composition. Physical characteristics of each stream such as stream width, flow rate, and average water depth were measured and recorded in the water quality monitoring database. Physical habitat characteristics can have influences on water chemistry, and is another link in the assessment of stream health scores.

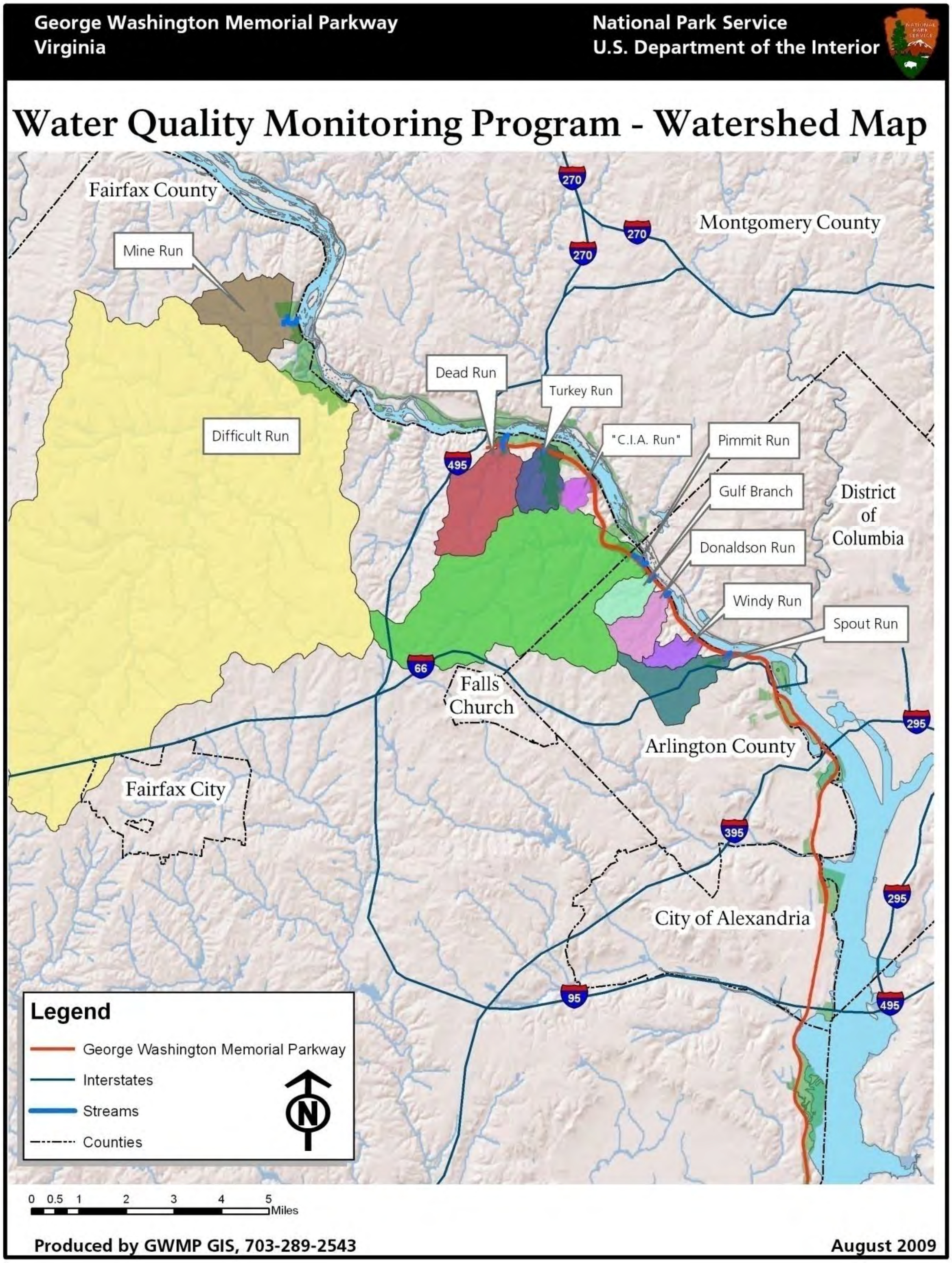



**Figure 1: Water Quality Monitoring Streams and Watersheds**

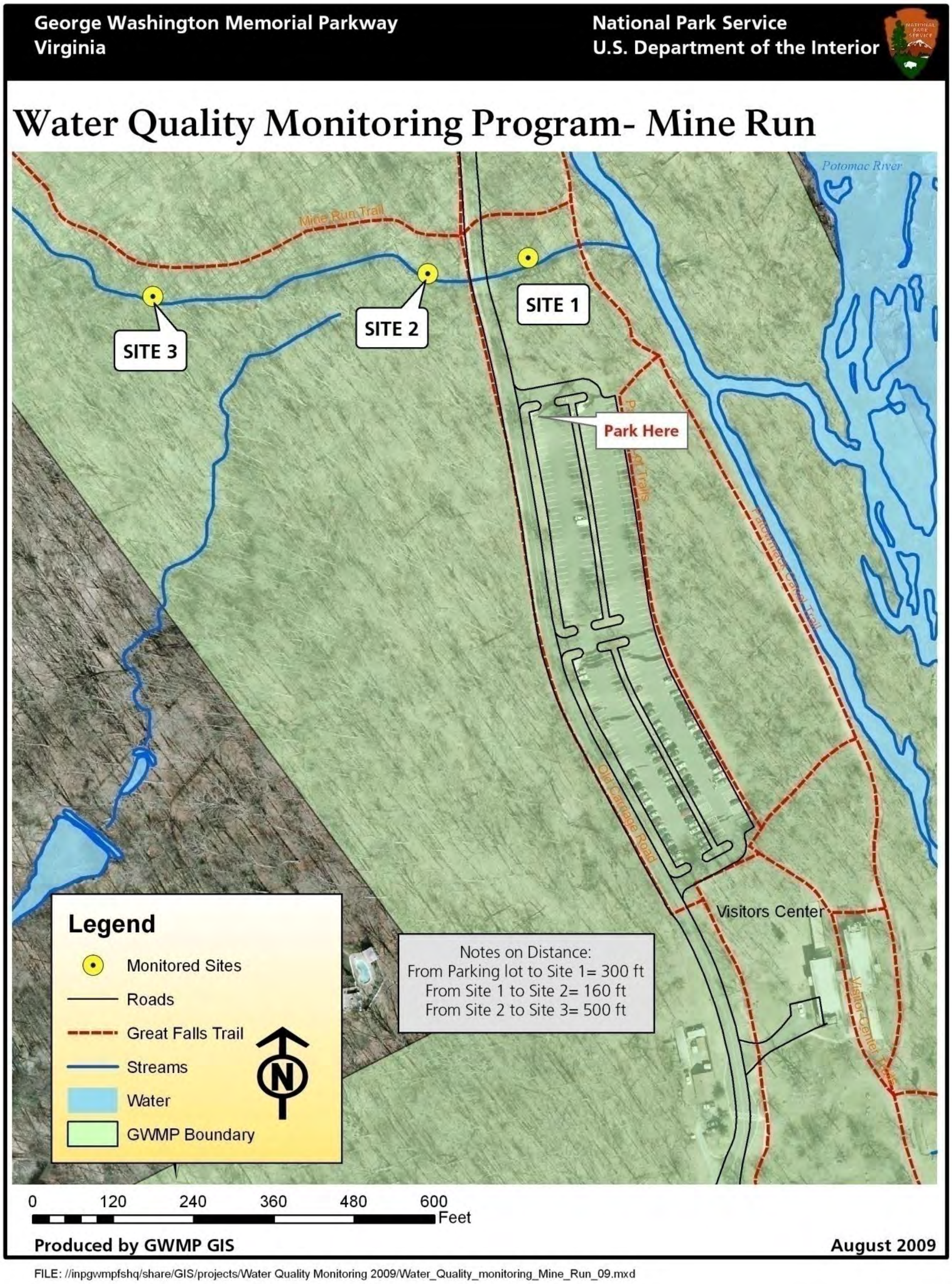
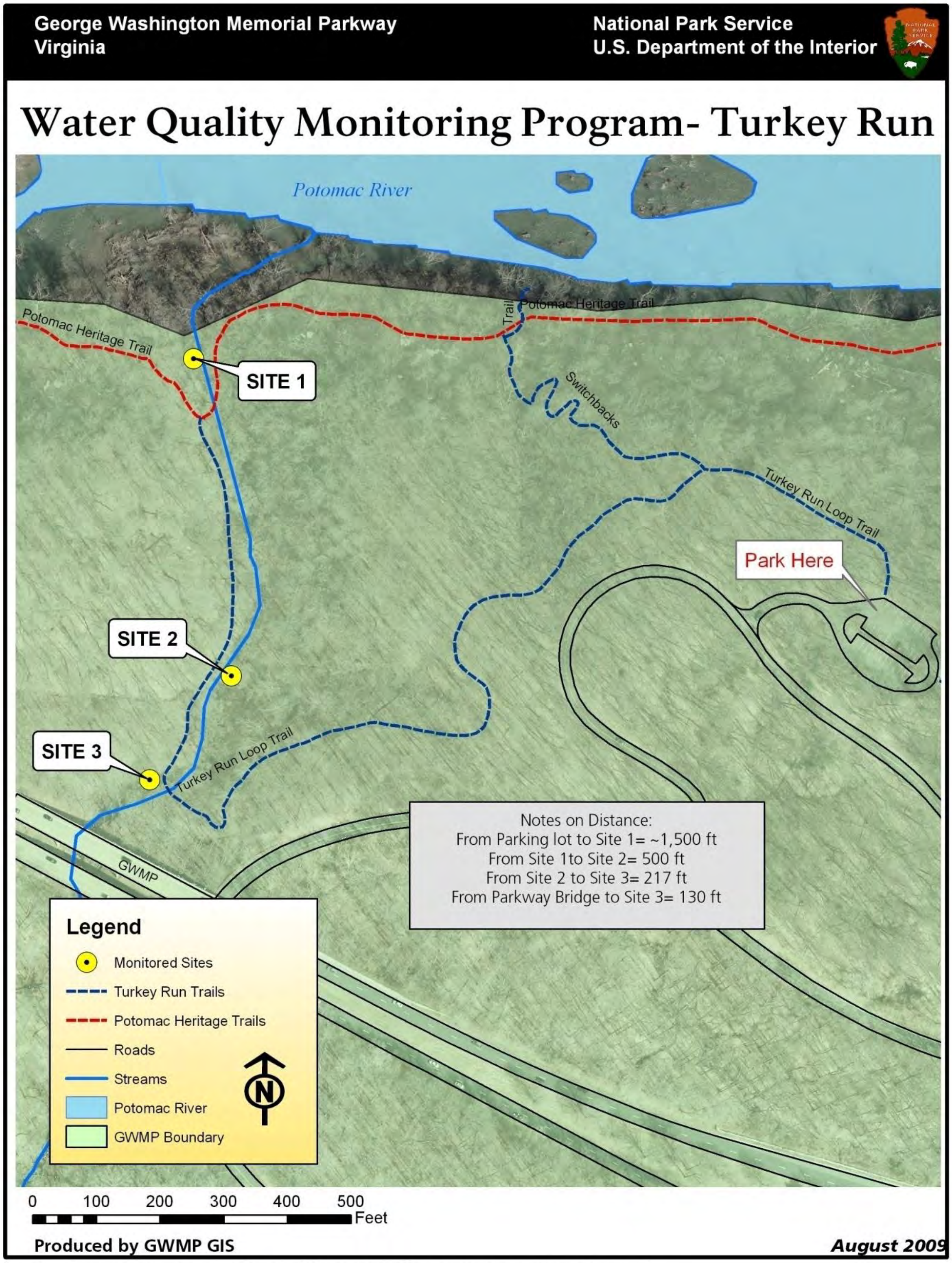



**Figure 2: Site Sampling Locations: Mine Run**




FILE: //inpgwmpfshq/share/GIS/projects/Water Quality Monitoring 2009/Water_Quality_monitoring_Turkey_Run_09.mxd

**Figure 3: Site Sampling Locations: Turkey Run**

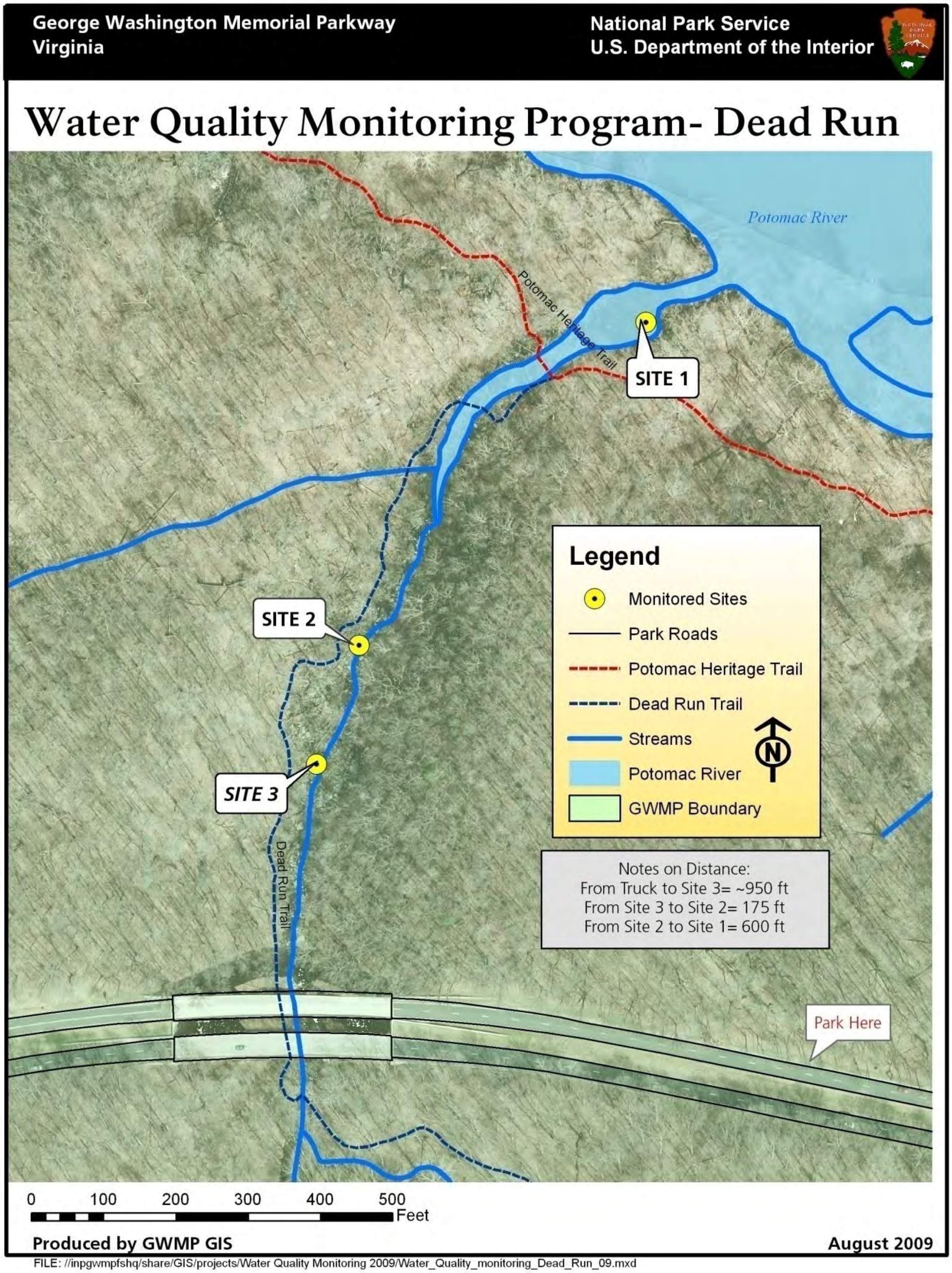



**Figure 4: Site Sampling Locations: Dead Run**

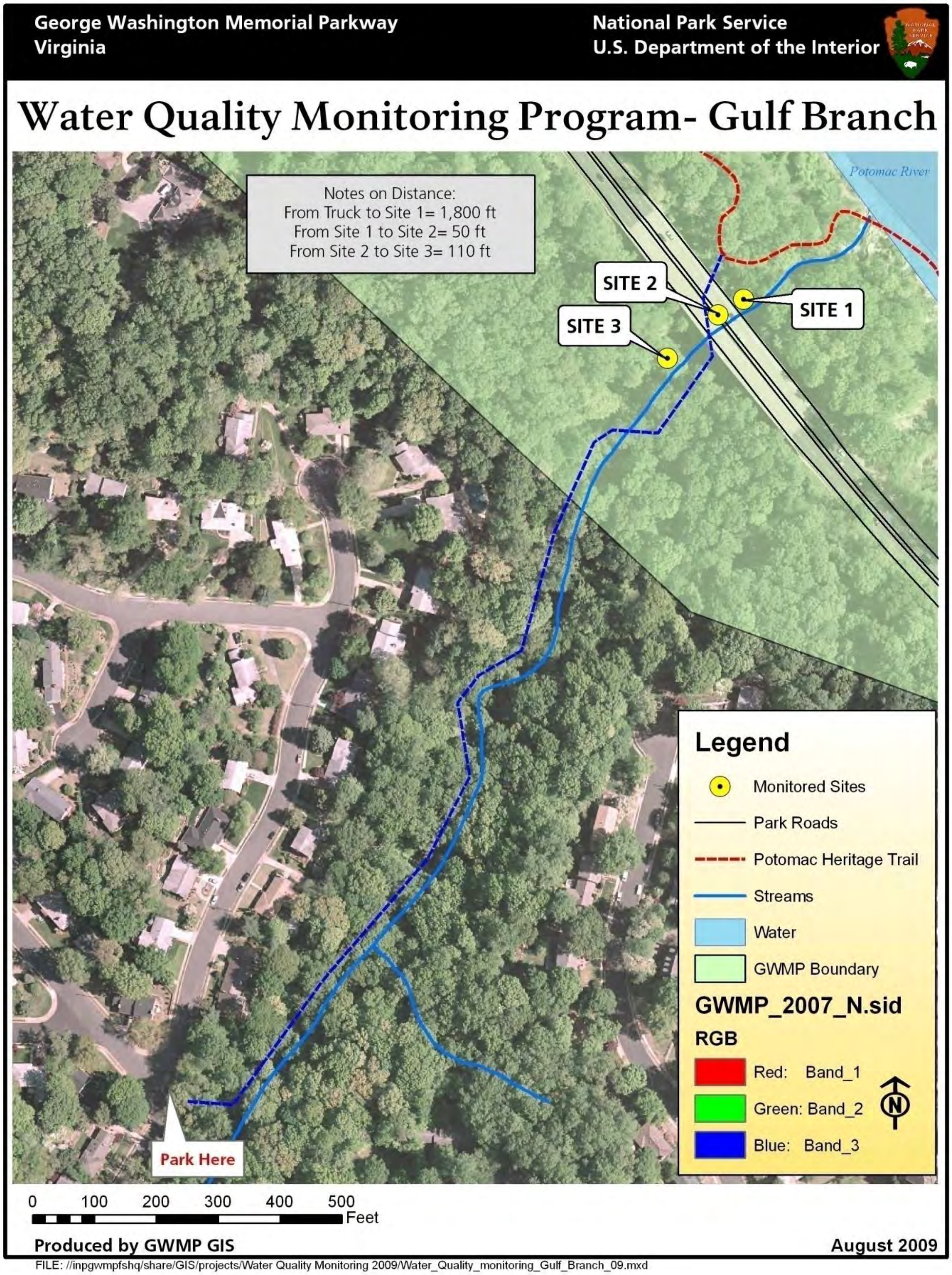



**Figure 5: Site Sampling Locations: Gulf Branch**

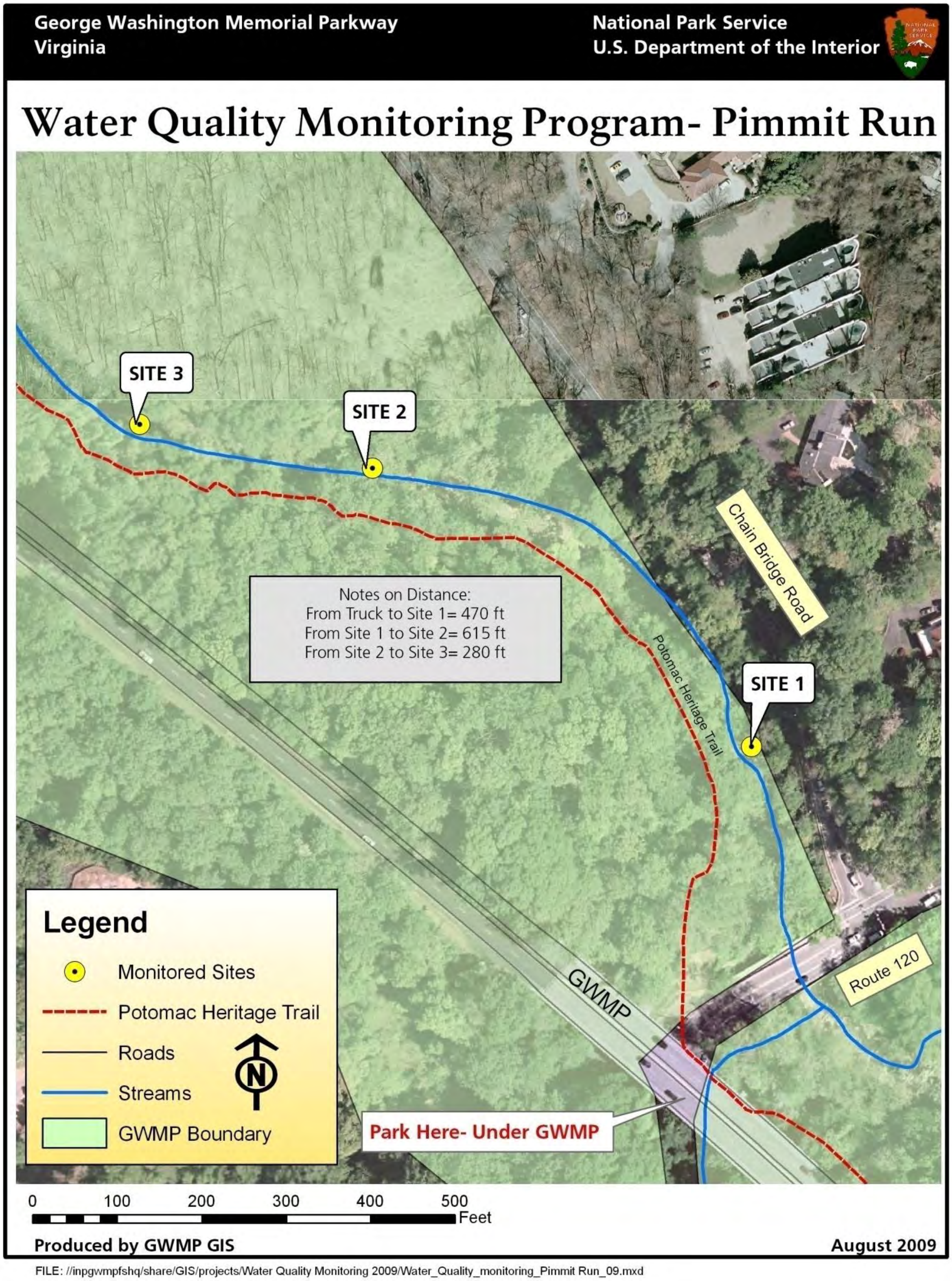



**Figure 6: Site Sampling Locations: Pimmit Run**

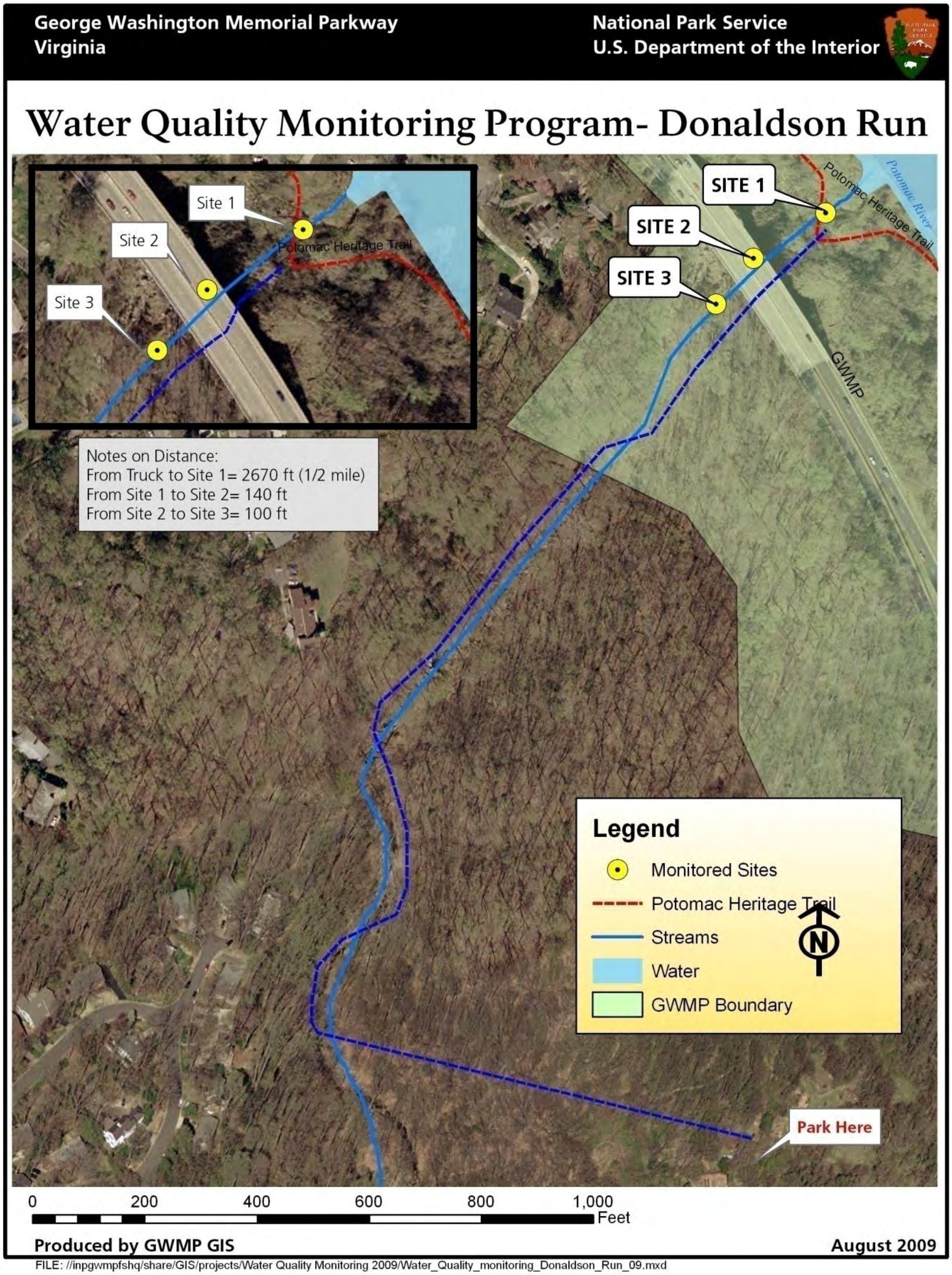



**Figure 7: Site Sampling Locations: Donaldson Run**

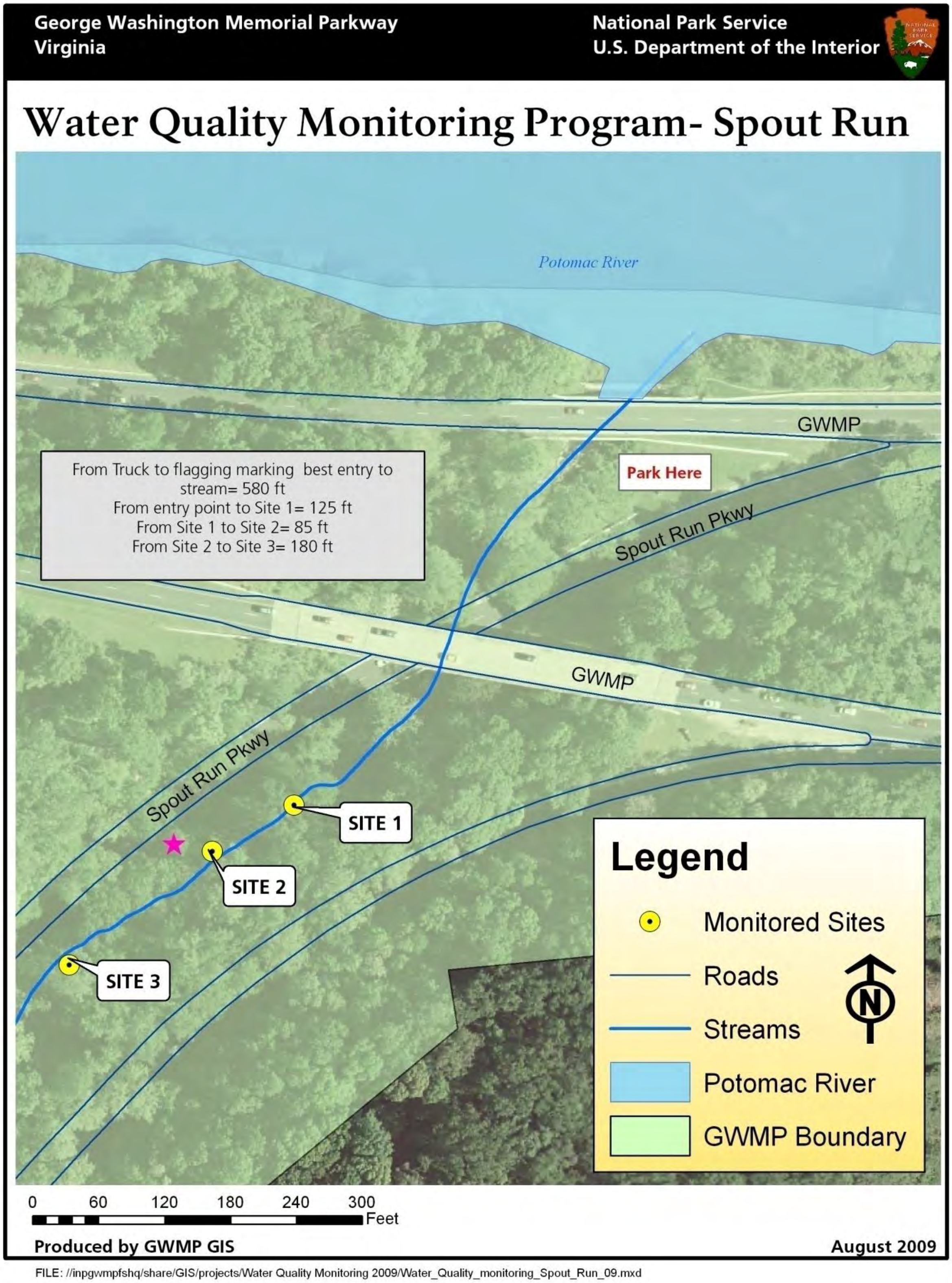



**Figure 8: Site Sampling Locations: Spout Run**

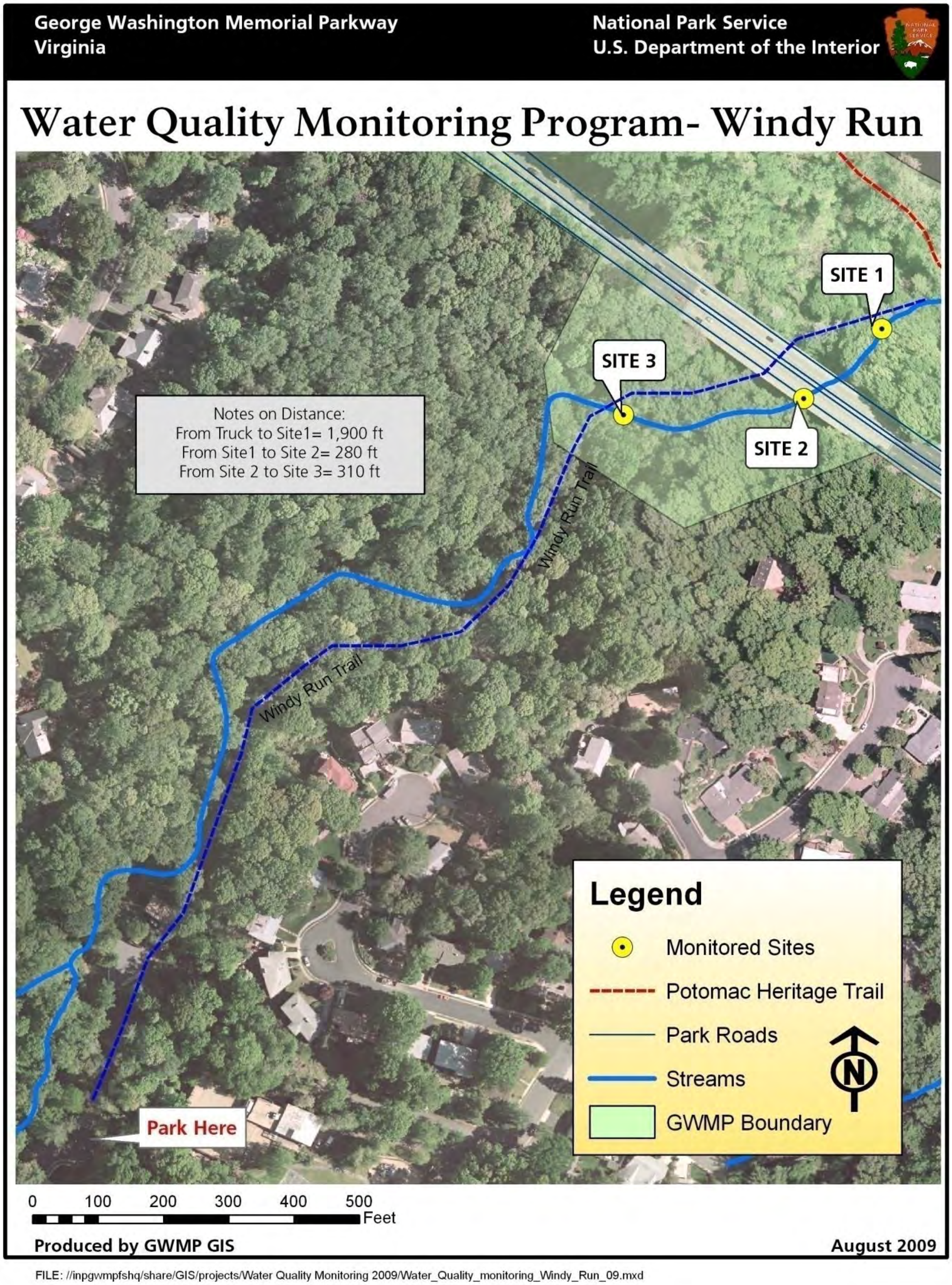



**Figure 9: Sampling Location- Windy Run**

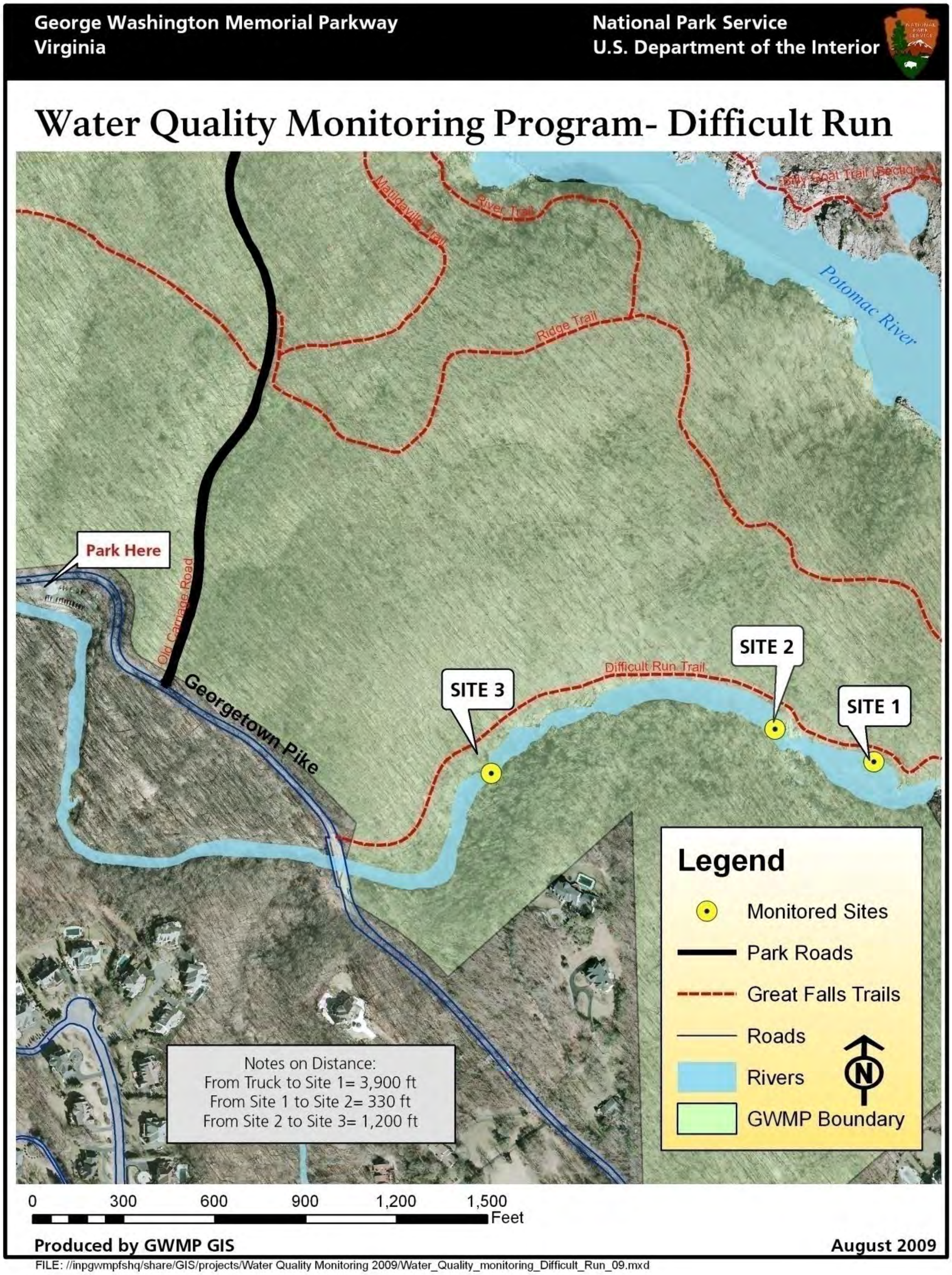



**Figure 10: Site Sampling Locations: Difficult Run**

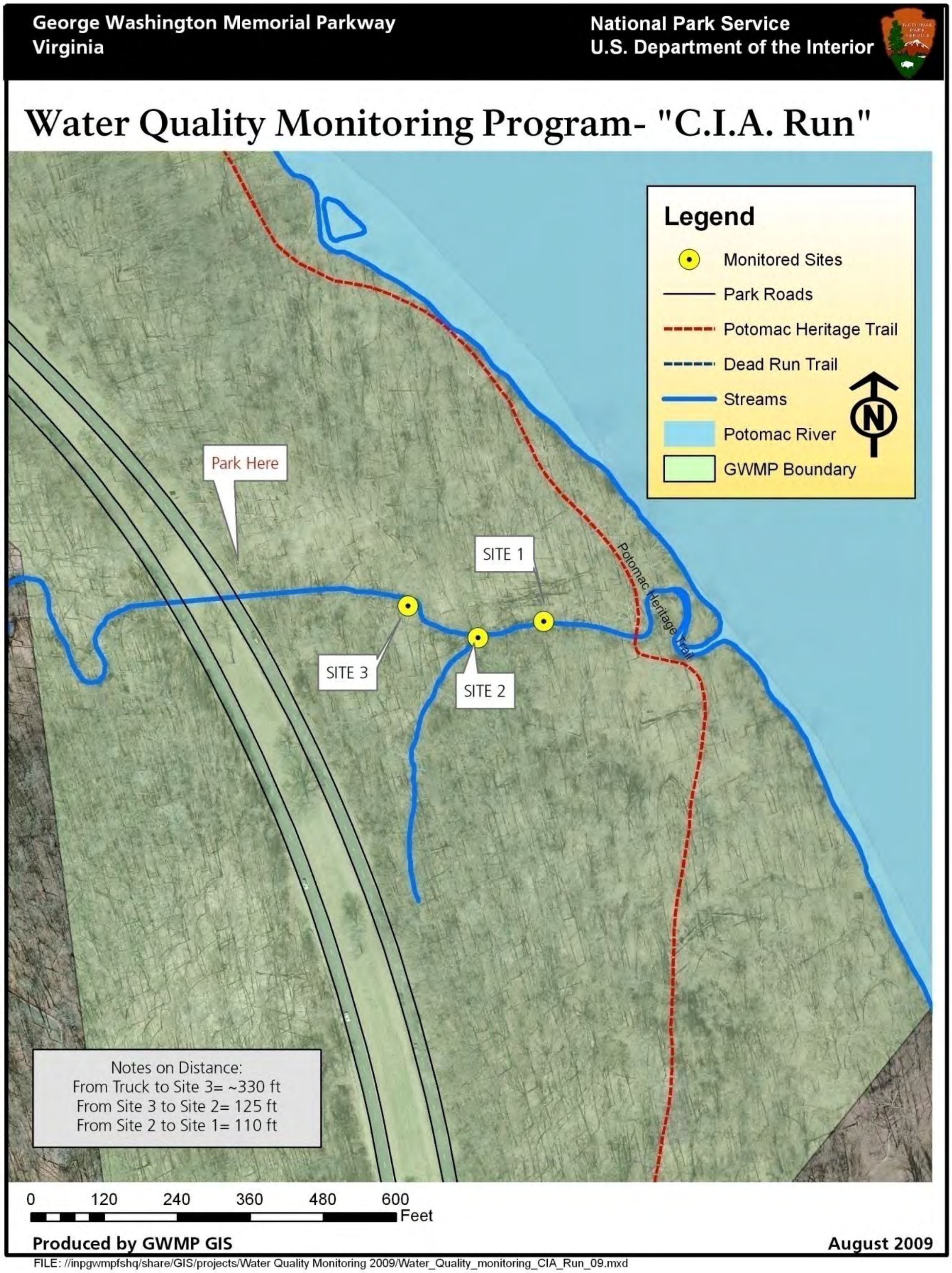



**Figure 11: Site Sampling Locations: CIA Run**

# RESULTS

Benthic Macroinvertebrates and Stream Health Scores

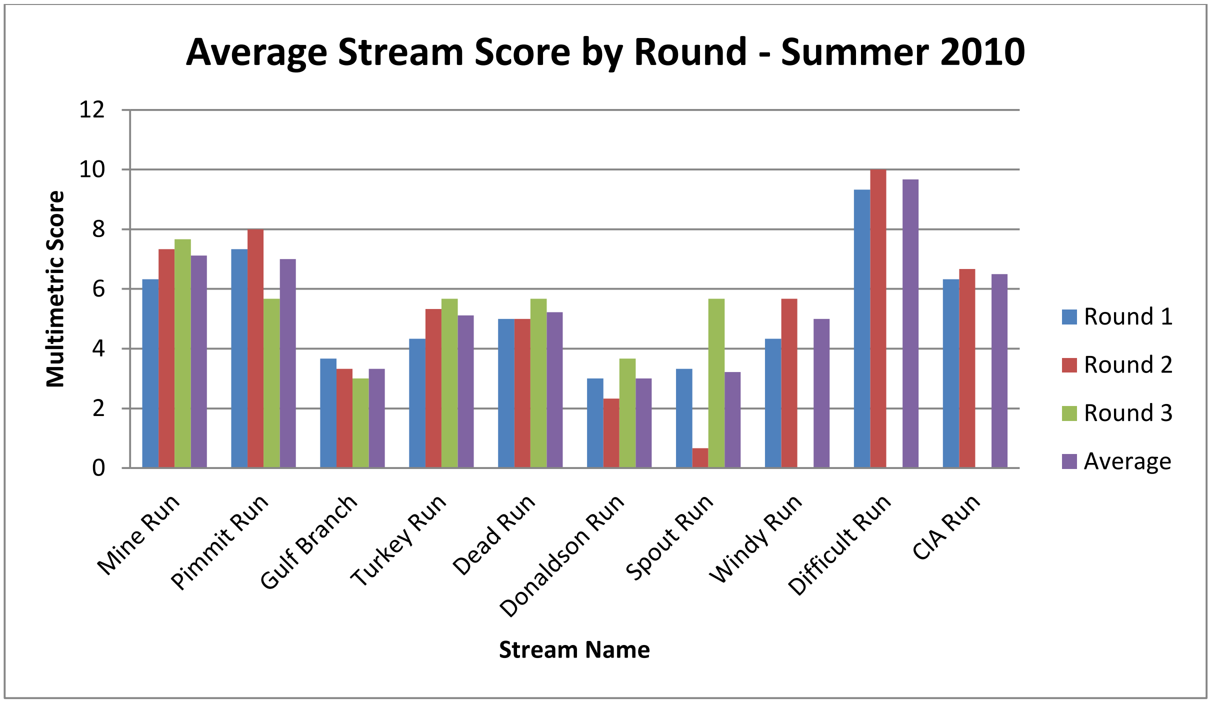
Appendix 6 shows the complete multimetric index scores along with type and abundance of macroinvertebrates collected at each sample station. Only one stream, Difficult Run, consistently received an "acceptable" score throughout the year, averaging 9.67. Mine Run received an acceptable score but was inconsistent throughout the year scoring a low of 6 and a high of 9. Pimmit Run received a score of 7 which allowed for the stream to be rated "acceptable" in the 2010 season. Although Pimmit is "acceptable" this year, the stream's average rating from 2001-2010 is 5.67. The other six streams sampled all received unacceptable scores between 2 and 6.99. CIA Run, Turkey Run, Dead Run and Gulf Branch all received scores between four and six. Although they are all rated relatively close together, CIA Run appeared to be healthier than the other three streams, which shows great improvement from the low rating that it received the previous year. The unhealthiest stream sampled was Donaldson Run, which received an average score of 3. Dead, Turkey, Pimmit, Windy, Spout, and CIA Run all increased in average health scores from 2009. The rest decreased in score, with Donaldson replacing Spout as the lowest scoring stream.

The new database program had the option to compile the cumulative macroinvertebrate count of each stream and assess the bulk data as one large sample, rather than separate sites and rounds. This kind of analysis has not been done in previous years and can give a different multimetric health score. In order to be consistent, we chose to calculate the multimetric index as done in previous years.

**Table 1: Average Yearly Health Scores**

| | Mine Run | Difficult Run | Dead Run | Turkey Run | Pimmit Run | Gulf Branch | Donaldson Run | Windy Run | Spout Run | CIA Run |
|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 8.75 | | 6.00 | 6.25 | 6.40 | 6.67 | 5.50 | | 5.29 | |
| 2002 | 8.00 | | 4.00 | 2.83 | 3.30 | 4.17 | 4.20 | | 3.50 | |
| 2003 | 7.89 | | 4.50 | 4.13 | 4.00 | 4.25 | 4.78 | | 3.43 | |
| 2006 | 8.83 | | 4.50 | 5.83 | 5.30 | 5.00 | 4.17 | | 3.50 | |
| 2007 | 7.50 | 7.10 | 5.00 | 4.50 | 7.50 | 4.50 | 5.00 | 5.00 | 3.67 | |
| 2008 | 8.56 | 9.33 | 4.67 | 4.89 | 5.44 | 5.22 | 5.67 | 4.67 | 5.11 | |
| 2009 | 7.56 | 10.33 | 4.00 | 4.67 | 6.44 | 4.11 | 4.67 | 3.67 | 3.00 | 3.66 |
| 2010 | 7.12 | 9.67 | 5.22 | 5.12 | 7.00 | 3.33 | 3.00 | 5.00 | 3.22 | 6.50 |
| Average | 8.03 | 9.12 | 4.74 | 4.78 | 5.67 | 4.66 | 4.62 | 4.59 | 3.84 | 5.08 |

**Figure 12: Stream Health Score 2010**




This figure shows the score for each round and the average of those rounds for the summer of 2010. Note that Windy, Difficult and CIA Run do not have a Round 3 (green) bar because they were only tested twice.

In comparison with the last 4 years, there were significant trends detected for the 2010 season. There were major improvements in three streams, yet two noteworthy declining trends.

> Trends in the Stream Health Scores were analyzed using a Daniels Test for Trend (Conover, 1999). In this test, each stream is analyzed separately. For each stream both the year that the stream was sampled and the stream health scores were converted to ranked data. The correlation between the rank of the year and the rank of the scores determines the trend in steam health. This correlation between two sets of ranked data is referred to as a "Spearman's ranked correlation" or a "Spearman's ρ (=rho)". A positive correlation indicates an improving stream health while a negative correlation indicates declining stream health. The larger the absolute value of the correlation, the stronger the trend. A p-value of 0.05 or less is used to assess statistical significance. Unlike previous years, several significant trends were detected. CIA Run, Difficult Run and Pimmit Run showed significant improvement, while Mine Run and Gulf Branch showed significant decline. The other streams showed no significant trends.
> (John Paul Schmit, Quantitative Ecologist, NPS Center for Urban Ecology).

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

| Stream | Spearman's ρ | p-value |
|---|---|---|
| Mine Run | -0.289 | 0.023 |
| Dead Run | 0.002 | 0.99 (n.s.) |
| Turkey Run | 0.083 | 0.54 (n.s.) |
| Pimmit Run | 0.302 | 0.016 |
| Gulf Branch | -0.405 | 0.003 |
| Donaldson Run | -0.225 | 0.092 (n.s.) |
| Spout Run | -0.163 | 0.22 (n.s.) |
| Windy Run | 0.109 | 0.61 (n.s.) |
| Difficult Run | 0.468 | 0.021 |
| CIA Run | 0.794 | 0.002 |

As previously mentioned, both Mine Run and Difficult Run received the highest scores for the 2010 season. A statistical test was run between the streams in order to compare their scores:

> A Kruskal-Wallis test was used on the Stream Health scores from 2010 to determine if stream health differs between streams. A significant difference in stream health among streams was detected ($H=52.59$, $df=9$, $p<0.0001$, adjusted for ties). As illustrated below, Difficult Run has higher health scores than the other 8 streams.
> (John Paul Schimt, Quantitative Ecologist, NPS Center for Urban Ecology).

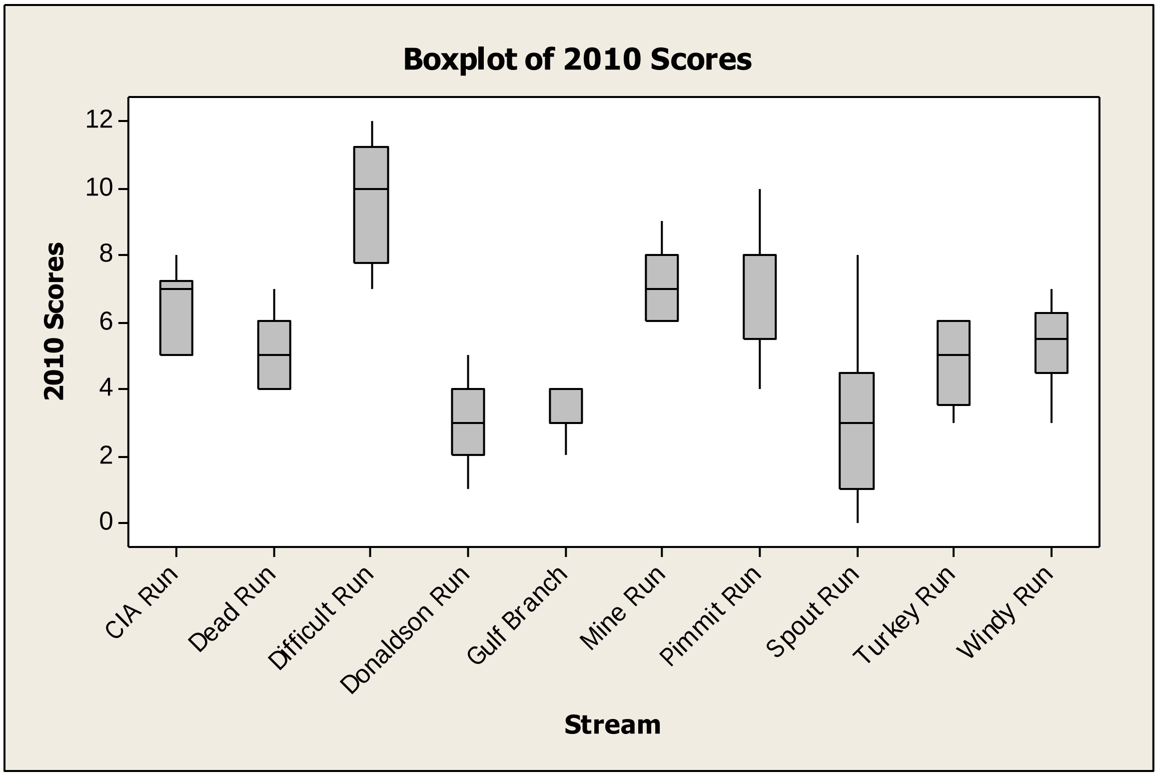



**Figure 13. Box-plot of Steam Health Scores from 2010.**

The multimetric scores are based on biological indications found by comparing the presence of pollution tolerant and intolerant macroinvertebrates. Figure 14 shows the percentage of tolerant benthic macroinvertebrates collected in 2010. Intolerant benthic macroinvertebrates are more sensitive to environmental stressors like higher water temperatures and lower dissolved oxygen, so they are unlikely to live in polluted streams. VASOS metric data relies on the relative proportion of organisms of different tolerance levels, and it integrates tolerant and moderately tolerant taxonomic groups into final health scores.

Both Mine Run and Difficult Run had lower percentages of pollution tolerant species. These streams also received the highest multimetric scores for the season. Pollution intolerant species include mayflies, stoneflies, beetles, gilled snails, hellgrammites, and most caddisflies. Other species such as common netspinners, crayfish, damselflies, dragonflies, scud, and sowbugs may be indicators of an “acceptable” stream as they are somewhat intolerant to pollution. However, aquatic and flat worms, black flies, clams, leeches, lunged snails, midges, and most true flies are tolerant to pollution. The presence of these species can skew data towards an “unacceptable” score.  In turn, the presence of pollution intolerant species may skew towards an “acceptable” score.

The VASOS multimetric is also sensitive to a few particular species. For example lunged snails are very pollution tolerant and only found where there is poor water quality. The metric takes this into account and catching just a few snails (1%) can dramatically drop your score by two points. On the other hand, beetles are very intolerant of pollution and having only a few beetles can boost your score easily.

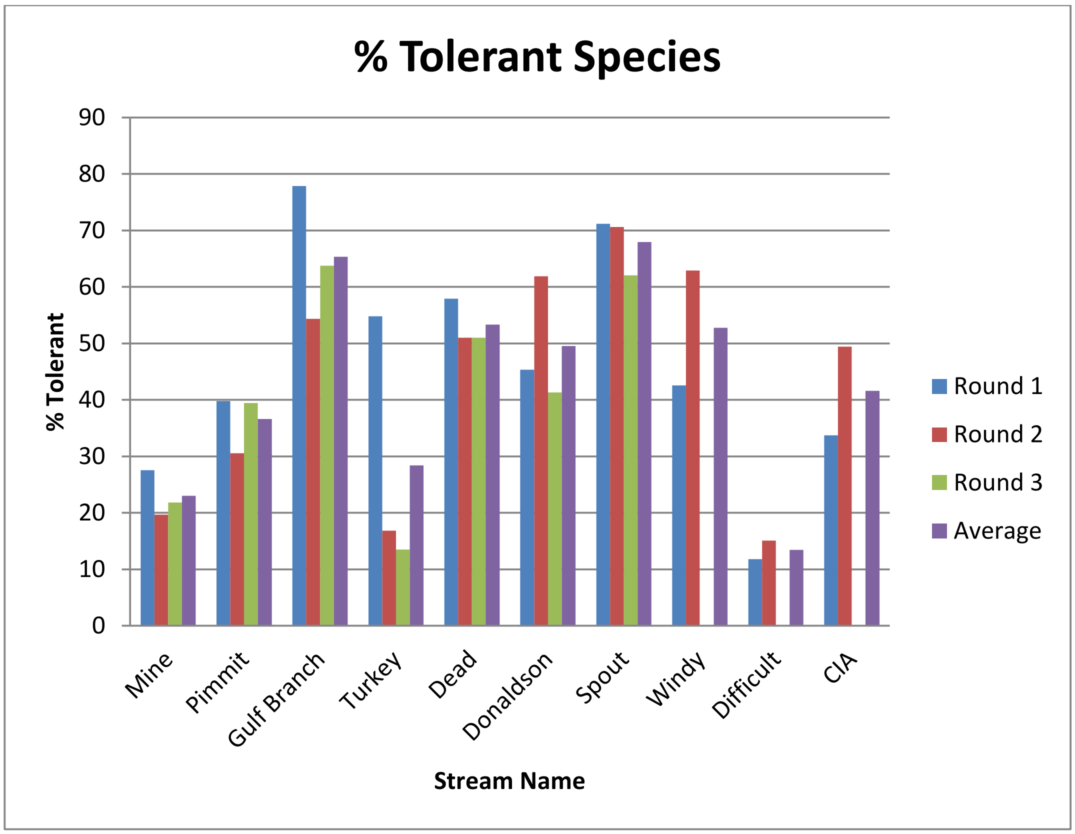



**Figure 14: Percent Pollution Tolerant Benthic Macroinvertebrates 2010**

Water Chemistry and Basic Water Quality Parameters

Water chemistry data collection is another form of water quality monitoring.  During the 2010 season, basic water quality parameters and water chemistry data were collected.  This data includes pH, water temperature, conductivity, and dissolved oxygen in addition to nitrate, phosphorus, chlorine and acid neutralizing capacity.  This information can be found in Appendix 10 for each sampled site.  The average pH of all the streams was somewhat basic at 7.65, the percentage of dissolved oxygen was 90.41 % and in 7.86 Mg/L was and the average conductivity across all the streams was 408.12.

Potential hydrogen (pH) stream averages ranging from 7.425 (Windy Run) to 7.836 (Spout Run). This range is relatively neutral although slightly skewed towards the basic side. The pH values for each round and seasonal averages of the streams can be viewed in Figure 15.

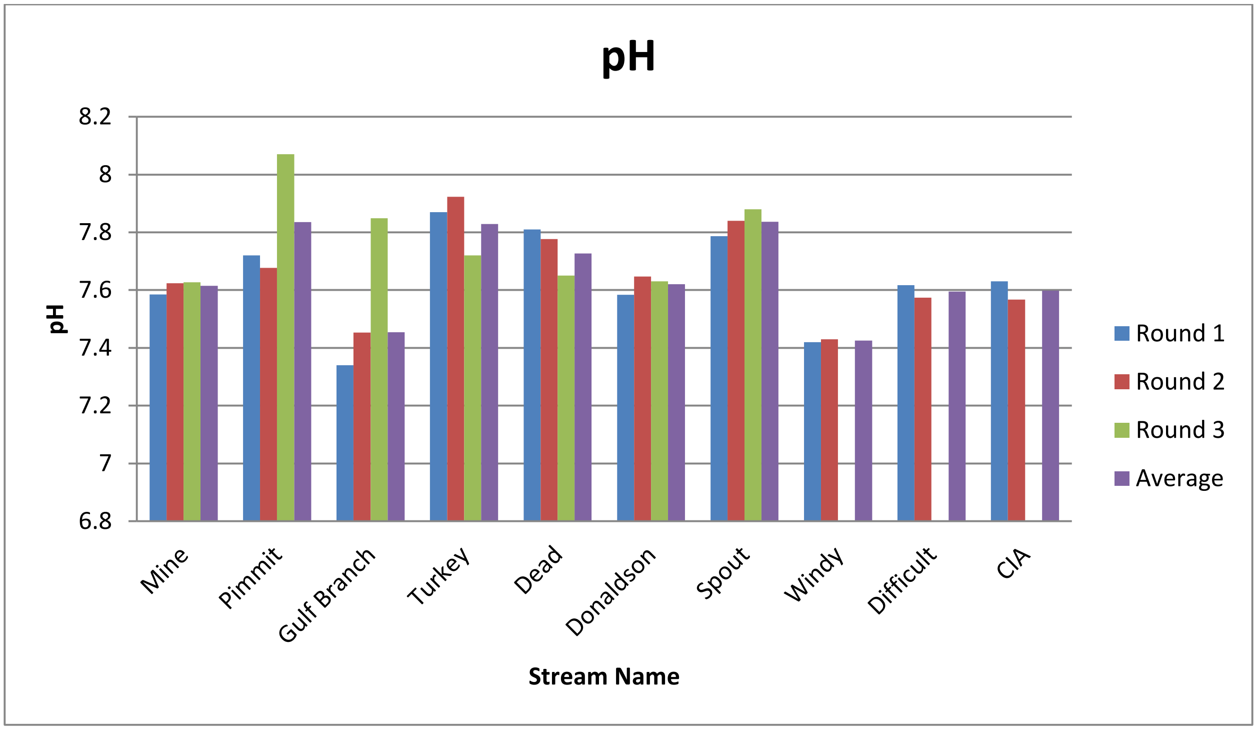



**Figure 15: 2010 pH Levels of Streams**

The water temperatures of the monitored streams remained within a range between 17.46 (CIA) and 26.17 (Pimmit). From looking at the average temperatures between the three rounds, there seems to be a slight increase from round one to round two, and from round two to round three. The temperatures for each round and the seasonal average can be viewed in Figure 16.

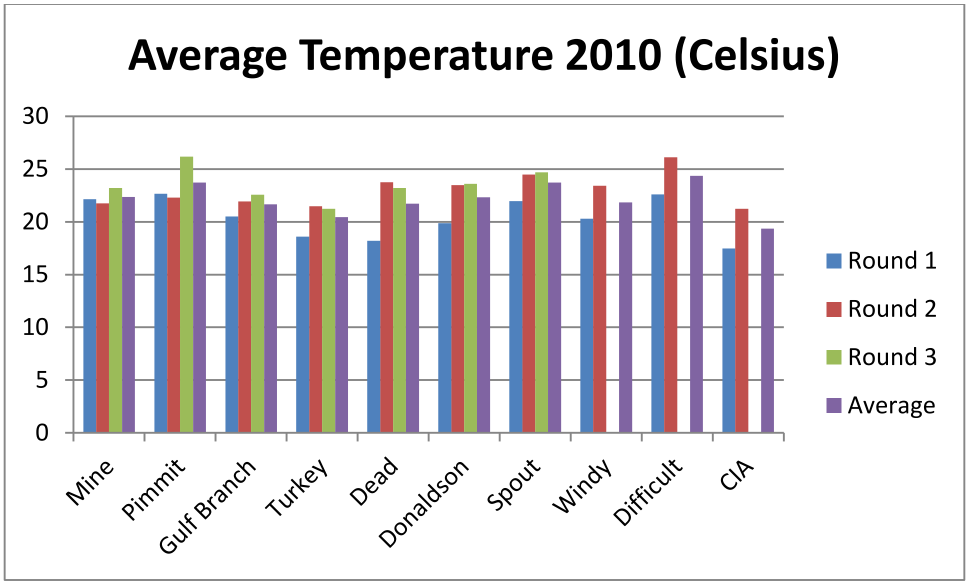



**Figure 16: 2010 Stream Water Temperatures**

For the 2010 season, dissolved oxygen (DO) was measured by both percentage and mg/L. This data can be viewed in Figures 17.1 and 17.2. There were no prominent variations between DO levels among the streams. The highest percent DO was at Pimmit which had an average of 95.44% while the lowest percent was at Windy which had an 84.5% average.

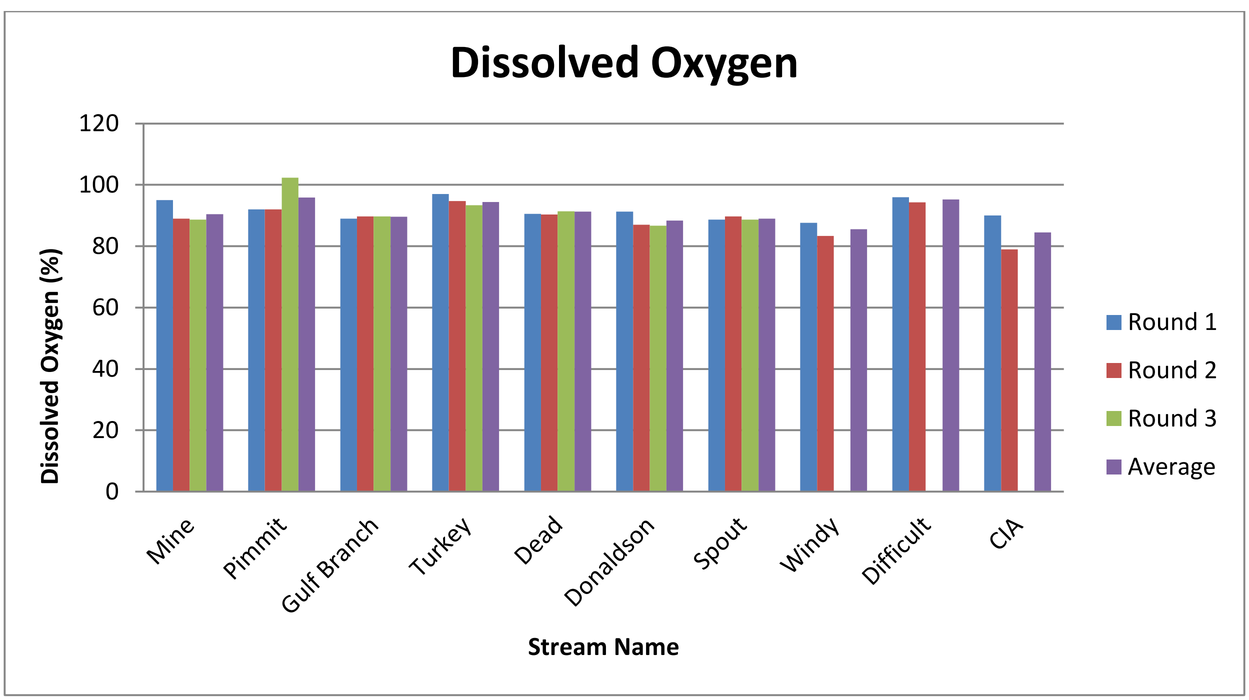



**Figure 17.1: 2010 Measurements of Dissolved Oxygen (%)**

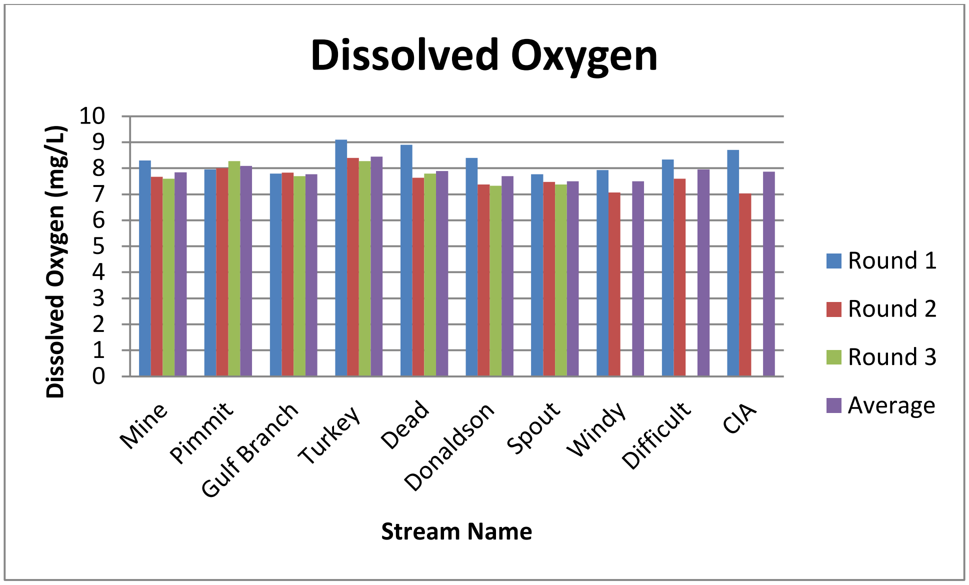



**Figure 17.2: 2010 Measurements of Dissolved Oxygen (mg/L)**

Conductivity is a measurement of the water's ability to conduct electrical current. Conductivity is measured in micro Siemens (uS). The highest conductivity measurement was taken at CIA Run, at 826.83 uS. The lowest conductivity measurement was taken at Mine Run being 150.34 uS. The conductivity averages for each round and the seasonal averages can be viewed in Figure 18.

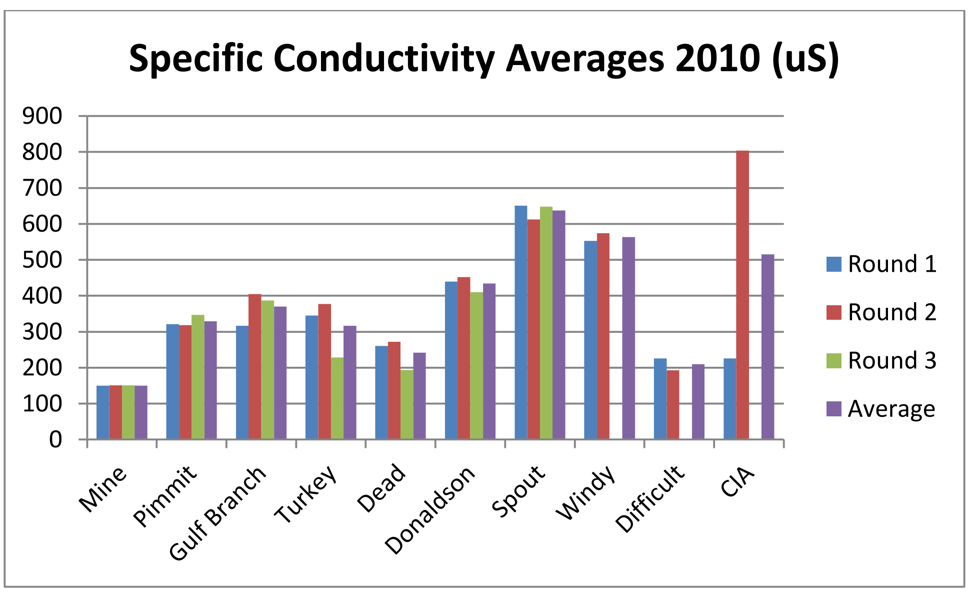



**Figure 18: 2010 Stream Conductivity Measurements**

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 ($NO_3$). Common sources of nitrogen include sewage, fertilizer, agricultural waste, and nutrient runoff from soil (Storm Water Management Branch 2001). Due to lack of supplies, nitrite was not measured for the 2010 season. Following the new method of testing using Maryland Biological Stream Survey protocol, nitrate was testing using a colorimeter and various acids. More information on chemical test procedures can be found in Appendix 26. Windy had the highest average nitrate level with 3.45 mg/L while Mine had the lowest with 1.33.

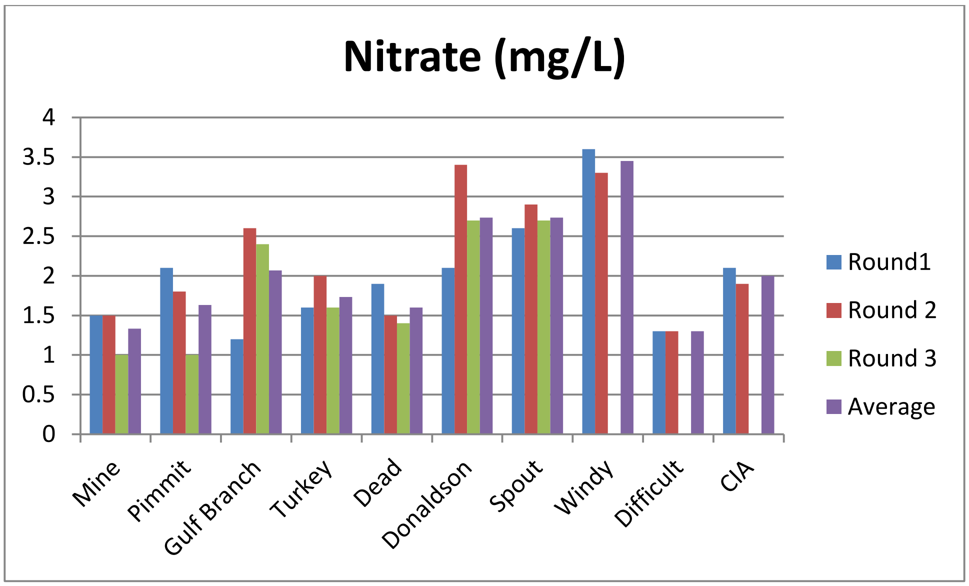



**Figure 19: 2010 Nitrate Measurements**

Phosphorus is similar to nitrate in the way it affects stream conditions. Synthetic phosphorus sources include fertilizers, septic system and commercial cleaning products. Phosphorus can also naturally enter a stream from rocks and soil. Mine had the lowest average level of phosphorus 0.22 mg/L, and Spout had the highest average 0.66 mg/L.

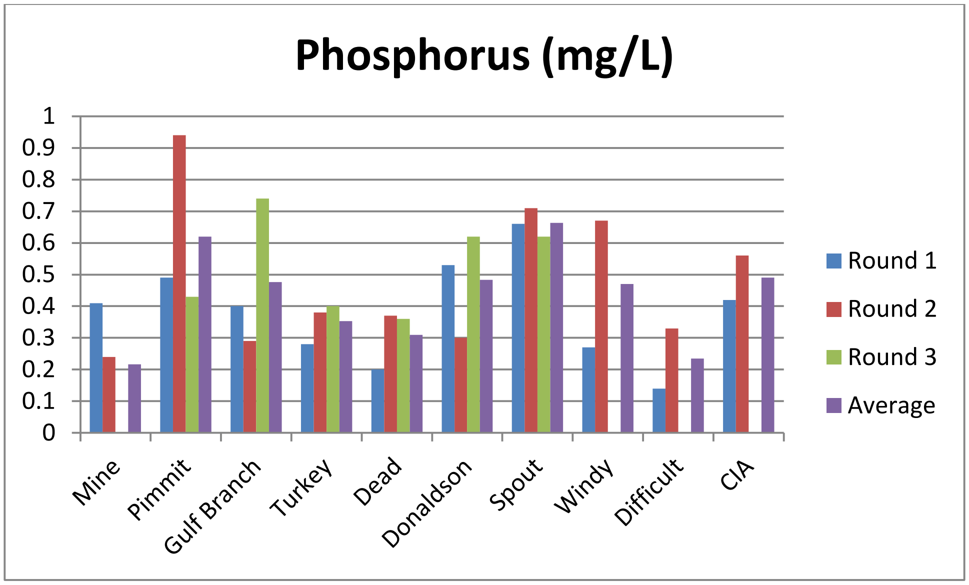



**Figure 20: 2010 Phosphorus Measurements**

Alkaline buffers (carbonates/bicarbonates) exist in water to increase the stream's acid neutralizing capacity (ANC.) ANC is the water's ability to counteract acid and keep the acidic pH low. The alkaline buffers remove H+ ions, typically by combining with them to make new compounds that do not affect the pH. The ANC is useful in observing a stream's capability to neutralize acid rainfall or pollution (EPA, 2006). An indication that all the buffers are used up is when the water's pH begins to become acidic. In the 2010 season, the stream with the highest ANC was Spout Run at 83.6 mg/L. The lowest ANC came from Mine Run at 40.9 mg/L.

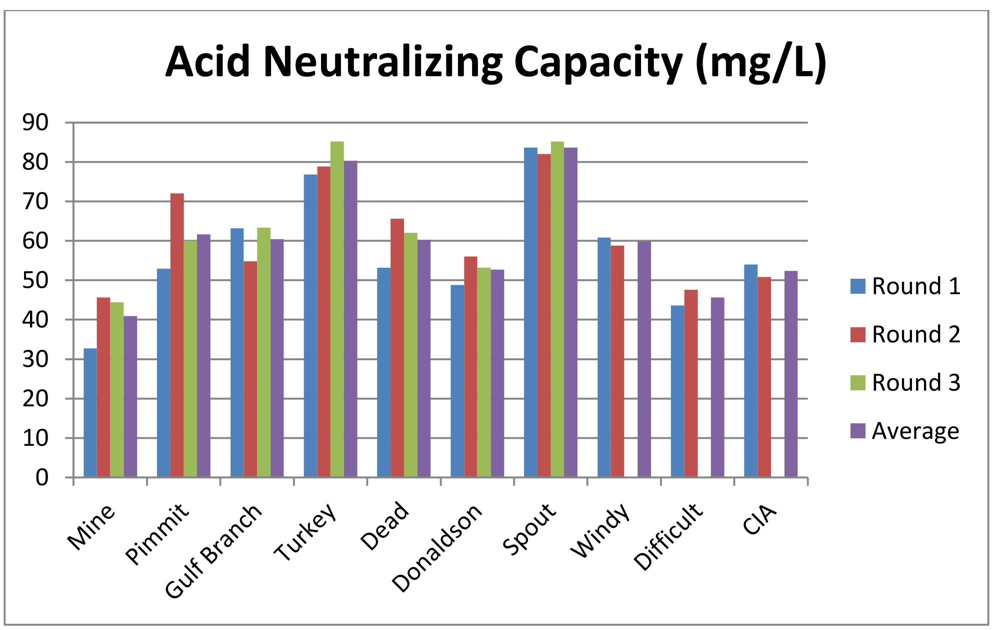


**Figure 21: 2010 ANC Measurements**

Chlorine is essential in disinfecting water, but can be harmful in excessive amounts. For instance, it is known to react with certain organic compounds and form possible carcinogens called trihalomethanes. The testing done in the 2010 season is measured in mg/L. Donaldson Run had the highest average chlorine, measured at 0.085. The lowest amount of chlorine measured occurred in CIA Run, where that was zero chlorine found. This could be due to the county's wishes to switch from chlorine to monochloramine as the main disinfecting solution in tap water.

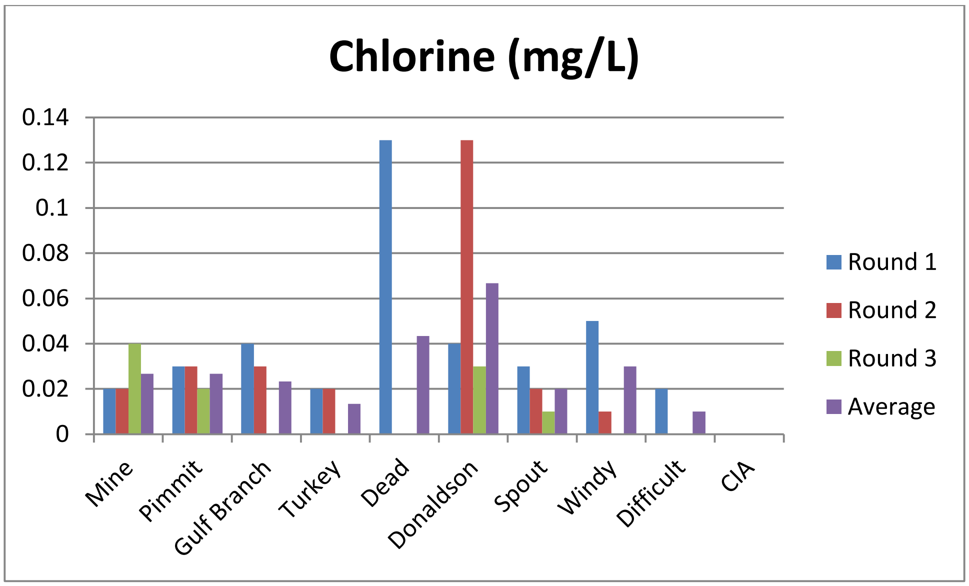



**Figure 22: 2010 Chlorine Measurements**

**Habitat Assessment and Physical Characteristics**

Appendix 6 shows habitat assessment and physical characteristics data. Barriers to fish movement, surface water appearance, stream bed deposit, odor, stability of stream bed, algae, algae color, stream channel shade, and stream bank erosion were visually assessed and categorized according to the VASOS Stream Quality Survey Form (Appendix 5).

There were a number of wildlife sightings during the 2010 season. Fish were observed at eight of the ten monitored streams: Turkey Run, Dead Run, Donaldson Run, Difficult Run, Mine Run, Gulf Branch, Pimmit Run and CIA Run. Waterfalls and large rocks were the main barriers to fish movement. Salamanders were observed at Mine and Turkey Run. Many eels were found in the 2010 season. They were observed at Donaldson Run, which had historically been known as a tributary for eels. Additionally, eels were found at Pimmit Run and Turkey Run. In 2001 a pesticide spill was thought to have eradicated the eels from both Donaldson and Gulf Branch, but this is the third year in a row that an eel has been caught at Donaldson Run and the first year that eels were caught in other streams. These observations are a good indicator that stream health is rebounding. In 2008, during scheduled maintenance repairs and construction in Spout Run, the interns and GWMP Natural Resource Management Specialist captured and relocated 23 American Eels. Horsehair worms (from the group Nemotomorpha) were found in Pimmit Run. A deer and a fox were spotted at Turkey Run. There was also a snake spotted in the water at Gulf Branch; however it was unable to be identified. It should be noted that copperheads are frequent in the Great Falls area, and that *all* snakes can swim (it is one method of thermoregulation).

Surface water appearance was described as "clear" at the majority of sample stations in 2010. The stream bottom deposit was described as a combination of "brown/tan," "silty," "sandy," and "muddy" during all three rounds at all of the sample stations. At most sites the stream bed was found to sink in "a few spots," with the only streams with "many spots" being Dead Run, Difficult Run and CIA Run. There where were a number of occurrences of a sewage odor at Spout Run and Mine Run. Both of these streams have sewer lines running nearby which may account for the odor. It should also be noted that a sewage line at Spout Run was found to have been leaking raw sewage into Spout Run during the end of the 2009 season.

Erosion potential of the stream banks varied from stream to stream. Most sites had high or severe erosion potential (50-100%). Difficult Run was seen as having only moderate erosion potential. It is difficult to compare the changes in erosion potential between the years, as there are no exact guidelines to what each category means. For the sampling of 2010, any sites with large boulders and "beach" like areas, trees with roots partially or fully exposed, or steep undercut banks were deemed as "severe" and had large portions of the stream with those conditions. Stream channel shade also varied from stream to stream. Most sites had either high or full stream shade cover (50-100%). Pimmit, Donaldson and Difficult Run were the only streams that had sites which we categorized as slight-moderate shade cover. Again, all data is subjective to human opinion. The shade may change depending on what time of day sampling is taken, and this is another reason maintaining a consistent sampling time is important.

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

Land Use

The USGS National Land Cover Data system was used to categorize land use in each of these watersheds (Figure 23). 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 9.

Figures 24-33 show land use in the watershed of each of the ten streams. Figure 34a 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. Difficult Run had the largest watershed and most varied land use. 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. CIA Run was the smallest watershed. Because it drained a large area of the CIA, it contained 61.8% commercial land use. Dead Run, Gulf Branch, and Windy Run had similar percentages of residentially/commercially developed land with 48.6%, 47.6%, and 60.4% 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%. 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.

Figures 23 and 35 show the land use and impervious surface coverage. This information is dated but is the most current available.

DISCUSSION

The average health scores for each stream vary throughout the monitoring years. As in 2009, Difficult Run and Mine Run received the two highest rankings. CIA Run, Pimmit Run, and Difficult Run all showed significant positive trends, indicating that these streams are improving in quality. However it is important to also acknowledge the lack of data on the newly added streams. CIA Run has only been monitored for two years, so it is difficult to assess the trends in its data. Difficult Run has only been observed since 2007, so, again, the trend data is less reliable. The only alternative data obtained for this report on Difficult Run was listed in a 303(d) EPA document in which it was listed for PCBs in Fish Tissue, E. Coli, Benthic Macroinvertebrates, and Heptachlor Epoxide (US EPA 2006). Mine Run and Pimmit Run were also included on the 303(d) EPA document. Mine Run was listed for E. Coli, and Pimmit Run was listed for fecal coliform, PCBs in fish tissue, chlordane, and heptachlor epoxide. Although it received the second highest average score, Mine Run showed a significant decline compared to previous years. Mine and Gulf Branch were the only two streams to exhibit declining trends. 30% of the streams in this study received an average health score that qualified them as in "acceptable" health. This is an improvement over 2009 when only 20% of streams received an "acceptable" score. In fact, when comparing all data from 2001 on, only 20% of streams received an "acceptable" score. Hopefully the number of "acceptable" scores will continue to rise into the future.

Studies have shown that runoff from impervious surfaces is recognized as a significant cause of stream degradation (Stormwater, p.ES-8, 2001). Typically, watersheds with high percentages of impervious cover, such as buildings and paved surfaces, contain streams with lower health scores than watersheds with forests or agricultural land. Mine Run contains the lowest percentage of highly impervious cover of the ten watersheds and its health scores are the second highest, with an average 7.56 in 2009 and a seven year average ('01-'03, '06-'09) of 8.16. Turkey Run watershed is the most forested watershed and second least residentially/commercially developed, with a health score of 4.67 in 2009. 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 six streams. This may be an indication that residential/commercial development may have a larger impact on stream health than agricultural development in this area. Pimmit Run has the second highest percentage of residentially/commercially developed watershed land yet received a score of 5.12 in 2010. Spout Run had the second lowest average health score of 3.22 in 2010 and contains the highest percentage of residentially/commercially developed watershed land.

While the multimetric scores focus on the macroinvertebrates, the water chemistry data collected also plays an important role in identifying the health and concerns of the streams. Nitrate is an oxidized form of nitrogen, and is an important nutrient in healthy environments. The presence of nitrates can occur naturally in streams from eroding rocks, soils, and animal and plant wastes. Nitrate can also enter the stream through human activity from "wastewater treatment plants, runoff from fertilized agricultural lands, lawns, and golf courses, runoff from grazing animals, pets, and commercial cleaning activities" (*Heal the Bay*, 2010). Increased nitrogen levels can cause algal blooms, which deplete the water of dissolved oxygen upon decay. According to the EPA, the natural level of nitrates in a stream is below 1 mg/L. All of the streams included in this study had nitrate levels at or above 1 mg/L. Donaldson, Spout, and Windy Run all had particularly high averages (above 2.5 mg/L). This could be an indication that there are municipal wastes or fertilizer runoff contaminating these streams. In the past, nitrate levels show that the streams near residential areas (Spout Run, Windy Run, Donaldson Run, and Gulf Branch) maintained average of 3.0 ppm and above, which is higher than levels of nitrate for the other streams.

Chlorine is another chemical that may turn up in stream water from anthropogenic sources. Arlington County used to add chlorine to disinfect their drinking water. Since 2000, the county has used a combination of chlorine and chloramine for the majority of the year. Chloramine is a combination of chlorine and ammonia. These chemicals are added to the water at the treatment plant to kill bacteria. Every year, the county switches back to using just chlorine for a short period to flush the system and clean the pipes. In 2010, this flush treatment took place from February first to May 17. This switch from chlorine back to a chlorine/chloramines mix may explain why less traces of chlorine were found at the end of the summer. In the first round of chemical testing, all streams but CIA had a small amount of chlorine present. However by the third round of chemical testing, six out of ten streams had a .00 level of chlorine.

When measuring conductivity, too many dissolved solids cause water balance problems and decrease the level of dissolved oxygen. The healthy conductivity range for fresh waters is 10-500uS (Mackie, 2004). All streams, except for Spout Run, Windy Run, and CIA Run, maintained a score in the range. The highest conductivity was found at one site in CIA run where the SPC was 831uS. However, their dissolved oxygen levels were not significantly lower than other streams.

Dissolved Oxygen is essential for the survival of benthic macroinvertebrates. Levels less than 3mg/L are stressful for the organisms, and a healthy stream is considered to be 90-100% saturated (Murdock 2001). Dissolved oxygen levels are affected by temperature; stream flow, presence of aquatic plants, and dissolved or suspended solids. Stream shade also affects dissolved oxygen; more light increases the temperature of the water, which then decreases the dissolved oxygen. Half of the streams monitored displayed an average DO percent of 90 or above. All of the sites had DO levels in mg/L that were much higher than 3. Algae were present during the 2009 season in most of the streams, and may have affected the dissolved oxygen concentrations. "Green plants release oxygen underwater during photosynthesis. Maximum amounts of DO are produced with the energy of the late afternoon sun" (*Heal the Bay*, 2010). Depending on the time of day the sample was taken, concentrations of DO may vary.

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. Extreme alkalinity or acidity can disrupt biochemical reactions necessary for the life processes of organisms. In 2010, the pH at every site was slightly basic but fell within this range.

Turbidity is the measure of suspended solids in the water. 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 water quality. Due to lack of supplies, turbidity was not measured during the 2010 field season. Based on visual inspection during our habitat assessment, the water appeared turbid only after a recent storm.

The weather in the summer of 2010 was extremely hot and humid. May and June's recorded precipitation rates both were below the average amount predicted. In contrast with 2009, there was more precipitation as the summer progressed. In July, which is a traditionally dry month, 5.17 inches of precipitation was observed, while the average is about 3.66 inches.

There was a noticeable decrease in the invertebrate population during times of heavy rain. The first and second rounds of sampling were directly affected by storms in the 2010 season. See Appendix 35 for rainfall data.

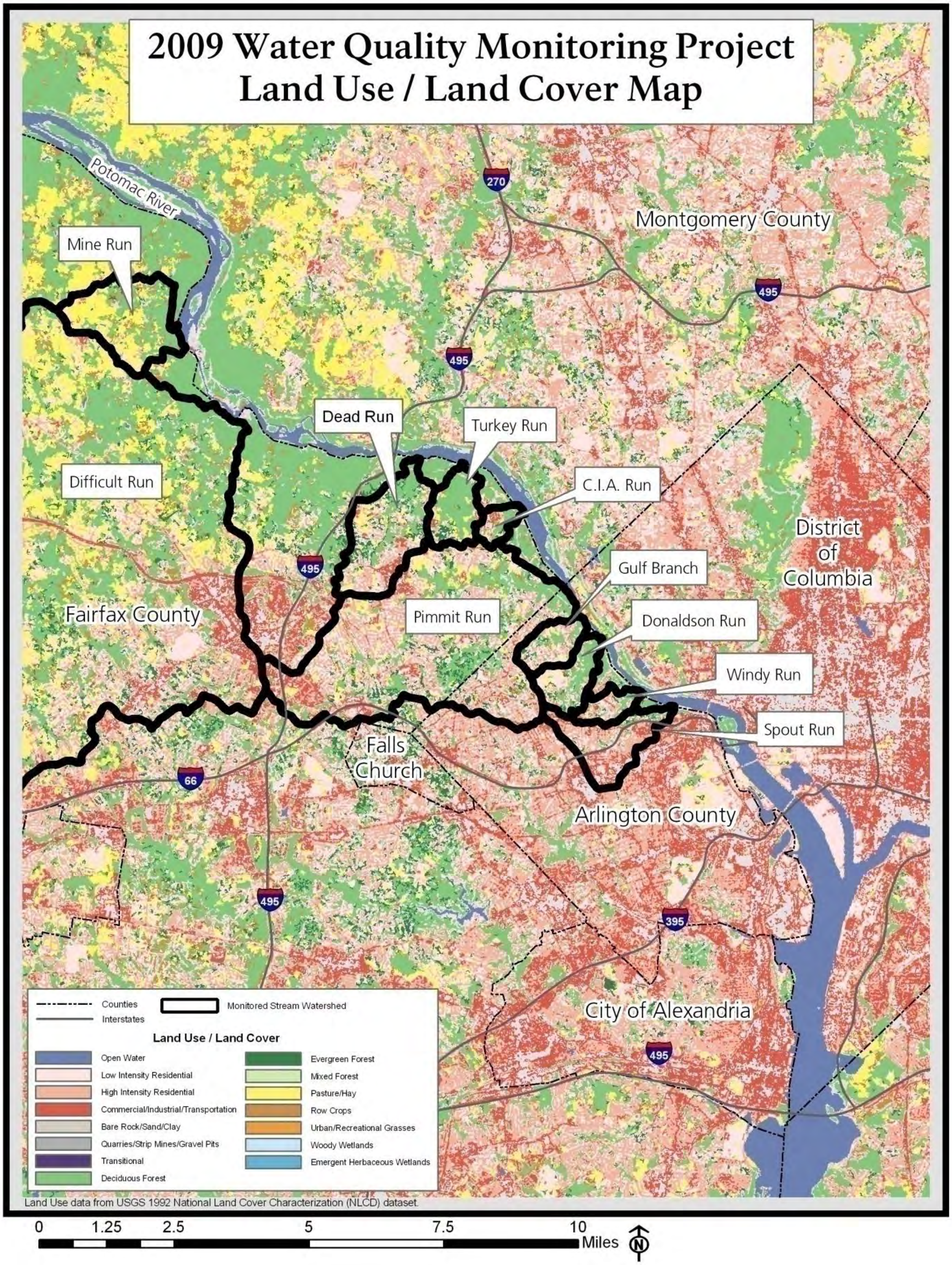



Figure 23: Watershed Land-Use

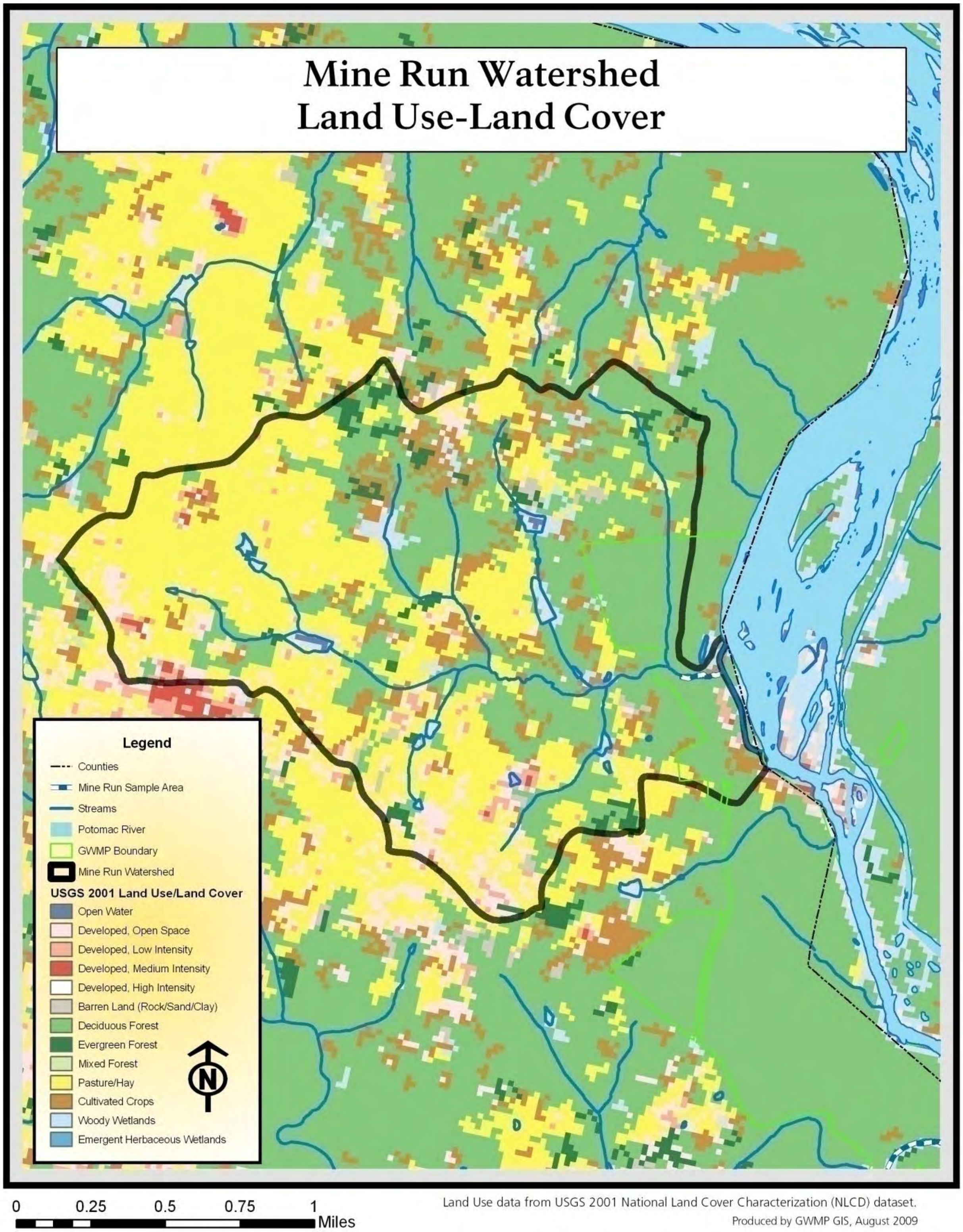



Figure 24: Watershed Land-Use: Mine Run

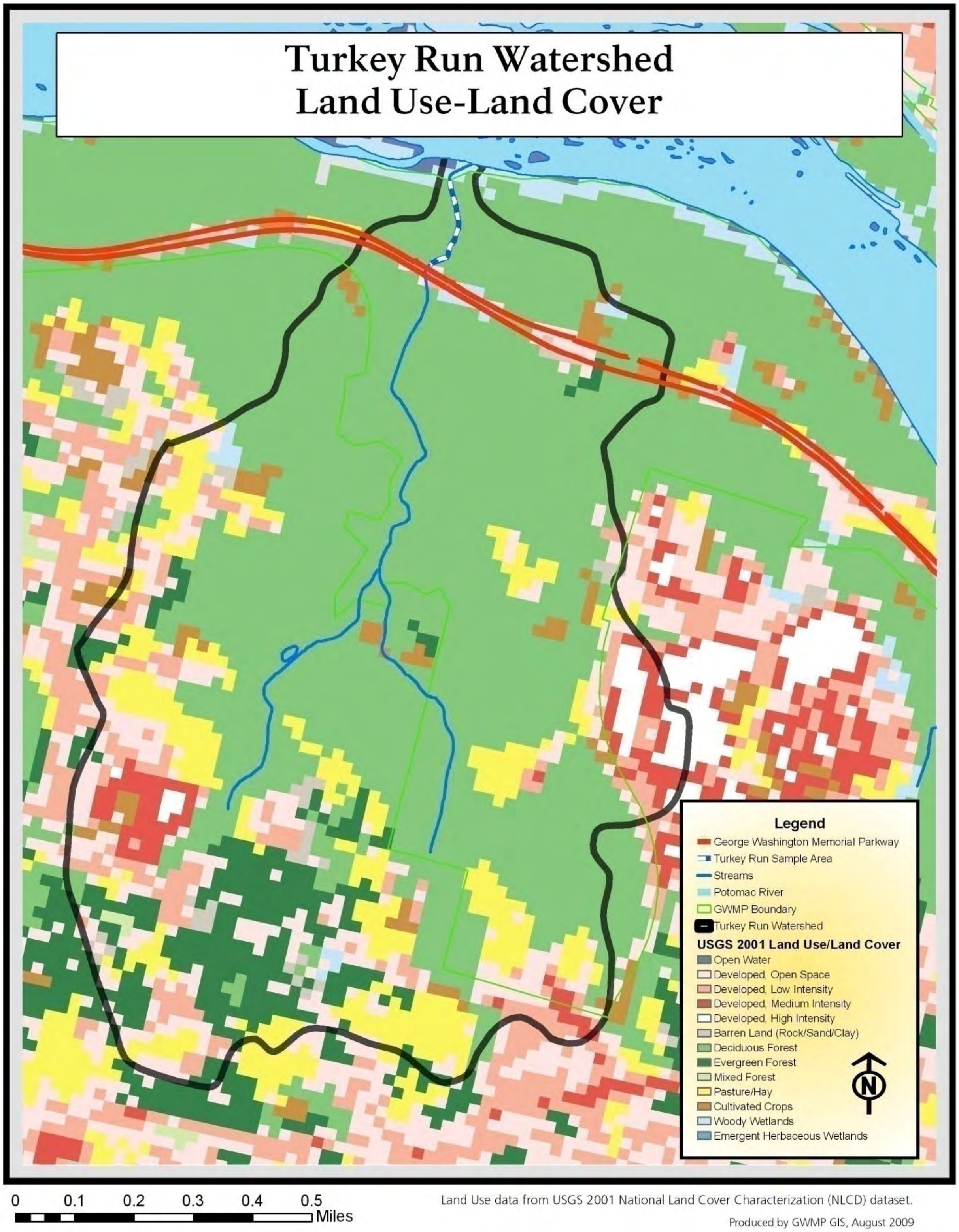



Figure 25: Watershed Land Use: Turkey Run

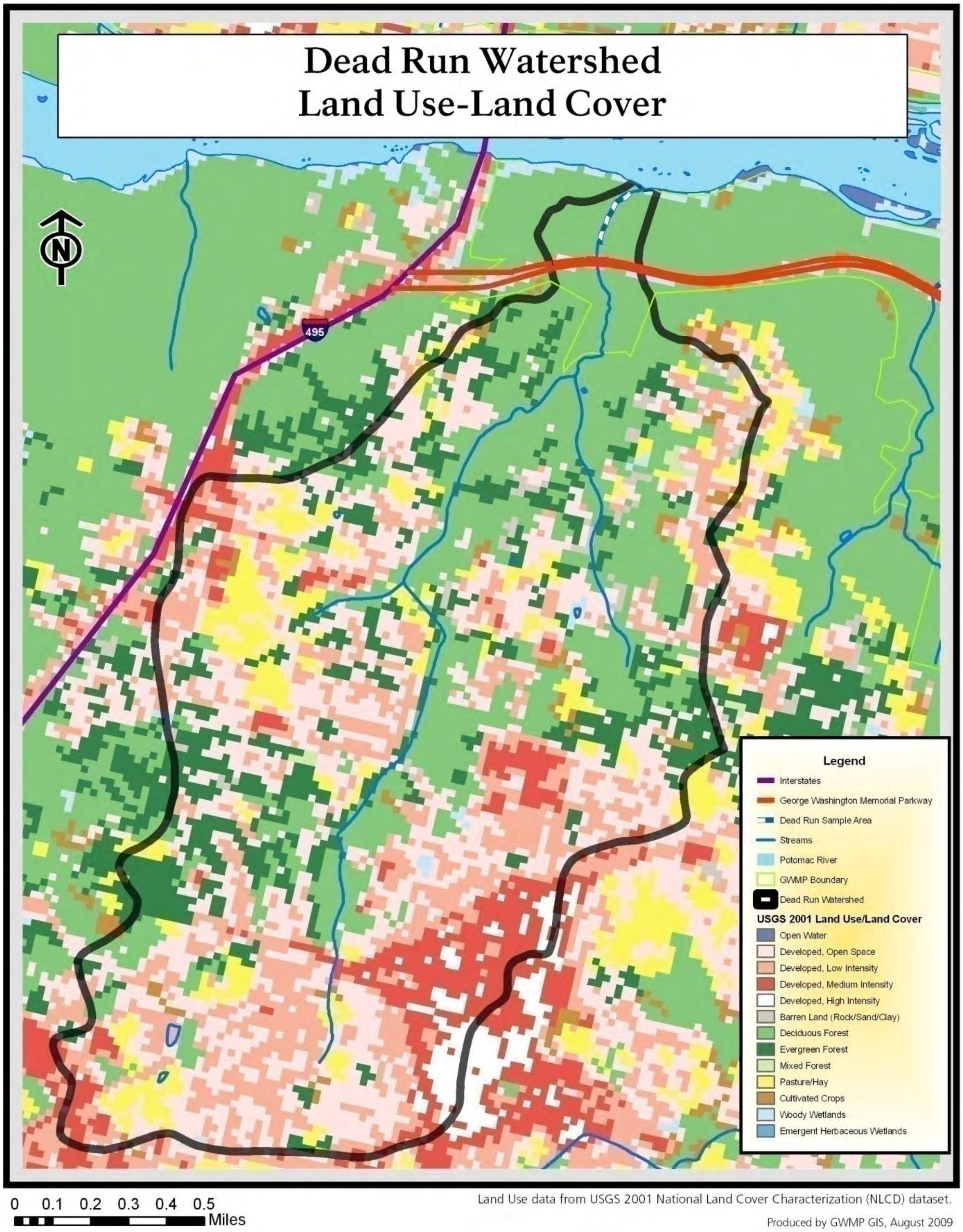



Figure 26: Watershed Land Use: Dead Run


Figure 27: Watershed Land Use: Pimmit Run

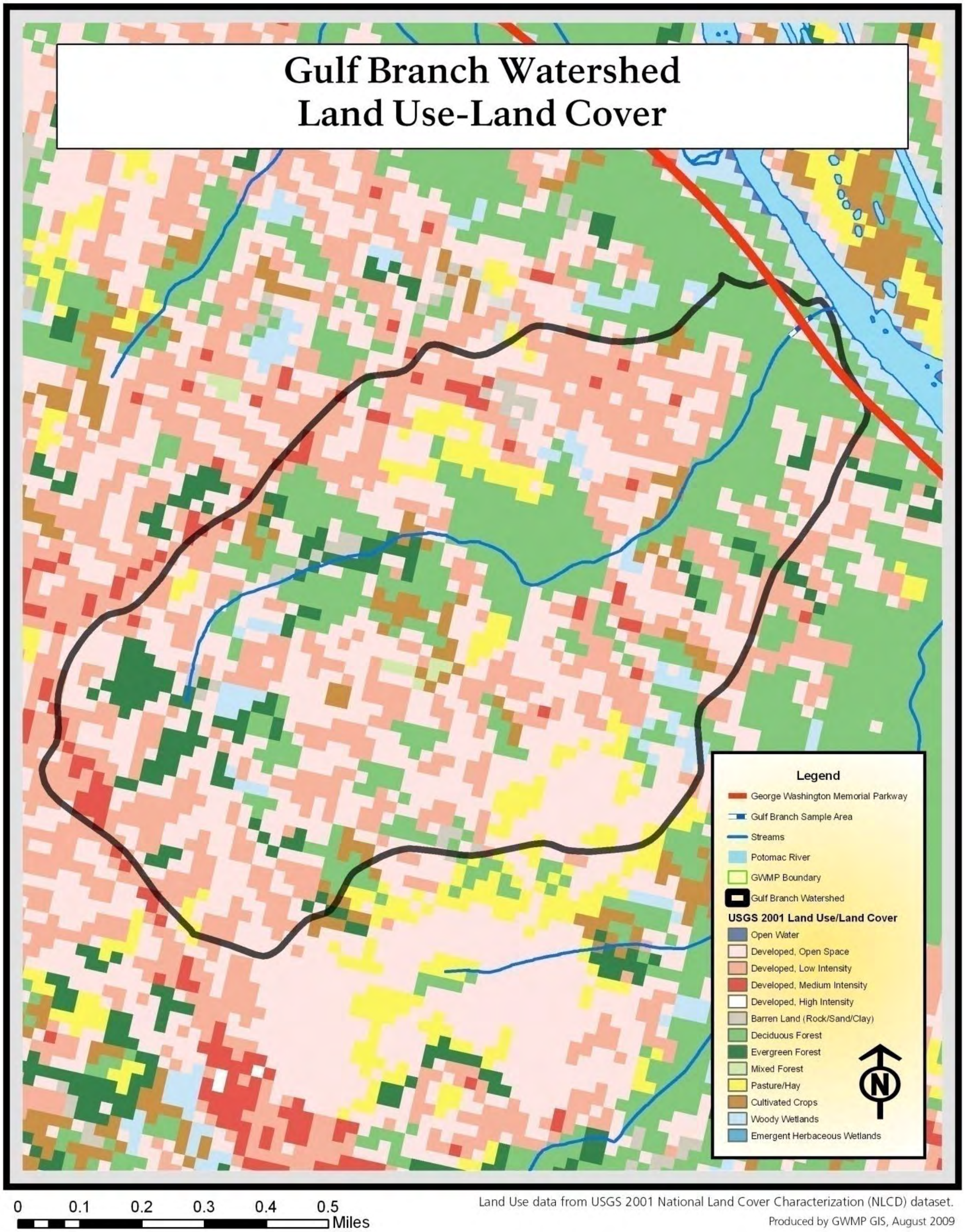



Figure 28: Watershed Land Use: Gulf Branch

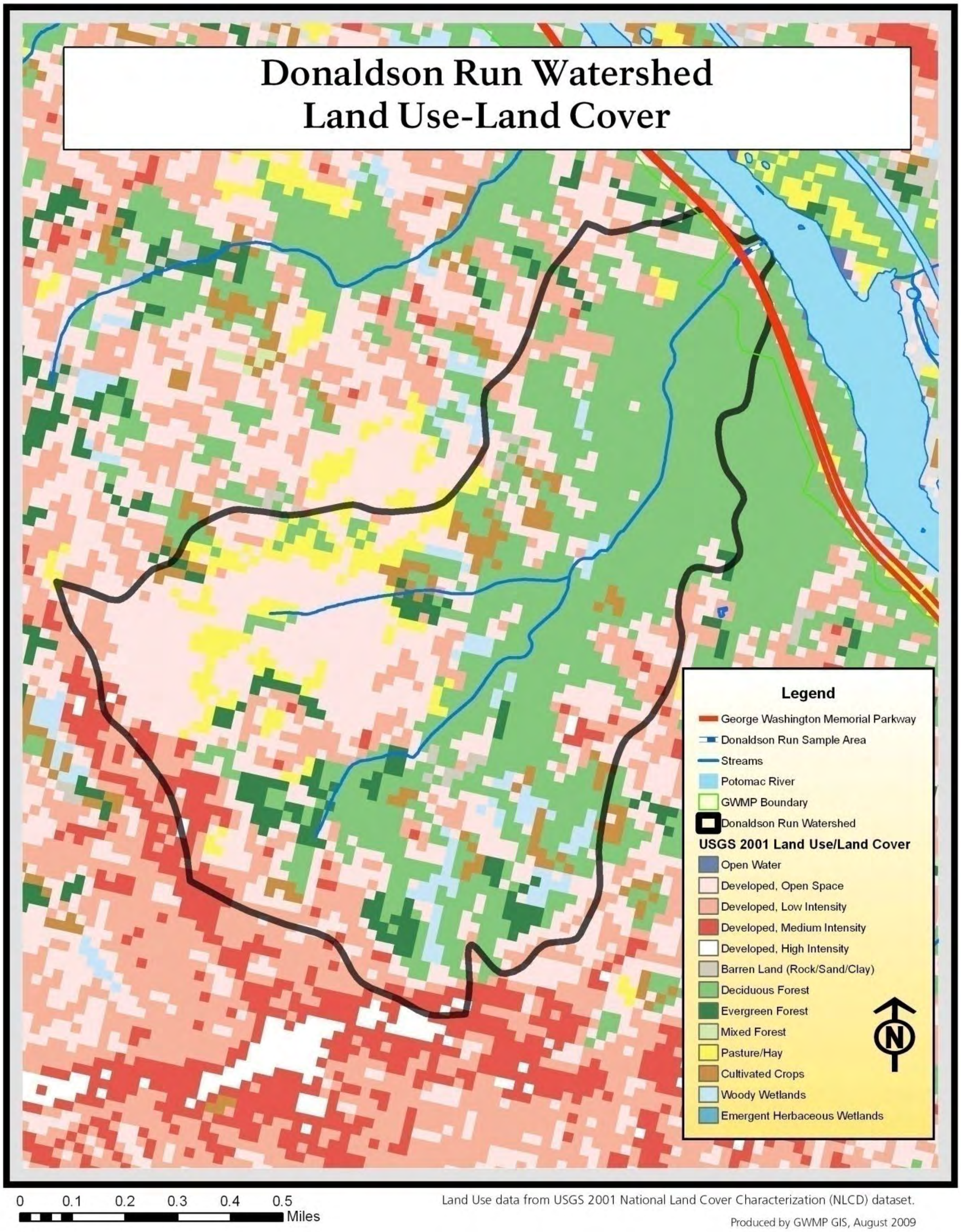



Figure 29: Watershed Land Use: Donaldson Run

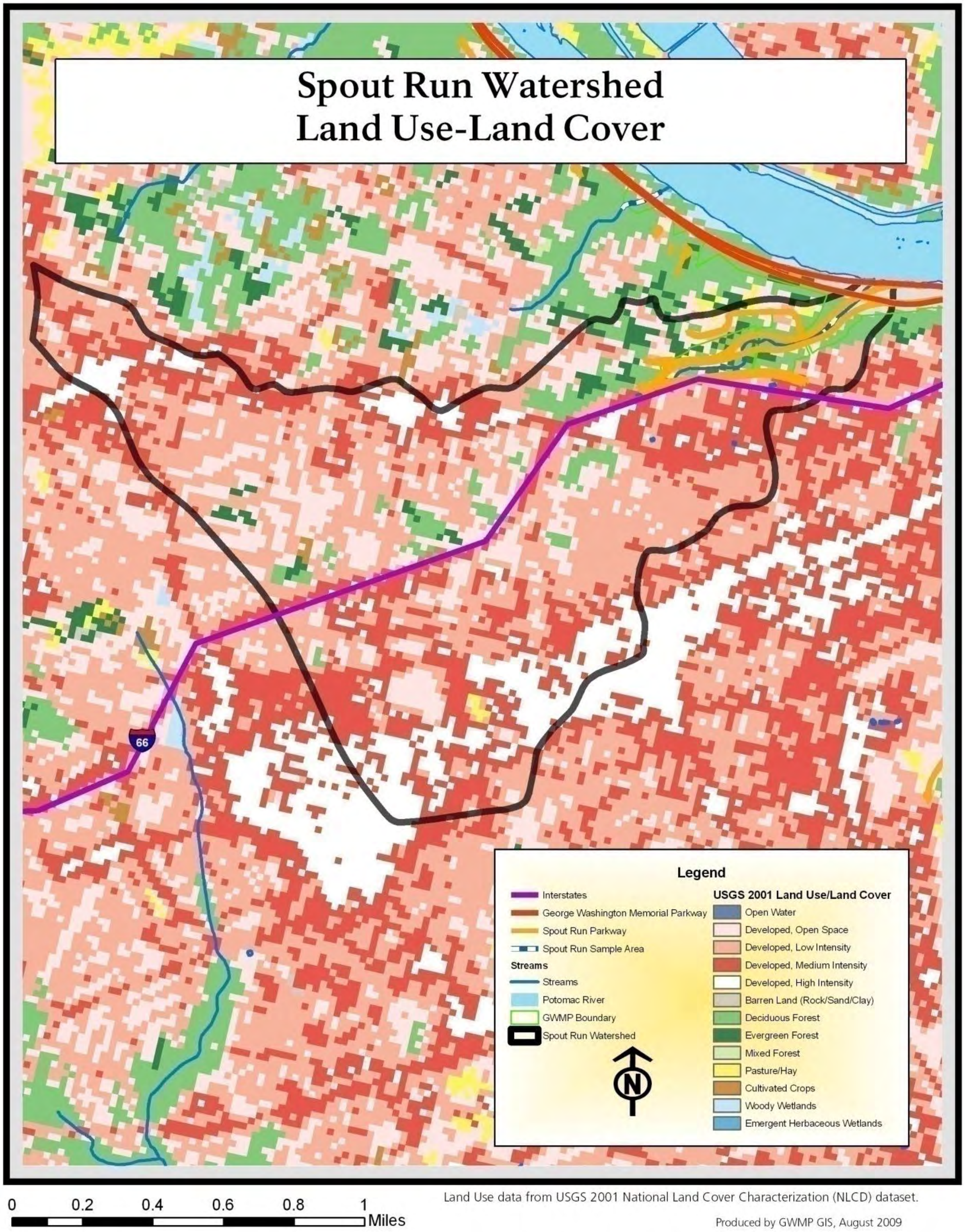



Figure 30: Watershed Land Use: Spout Run

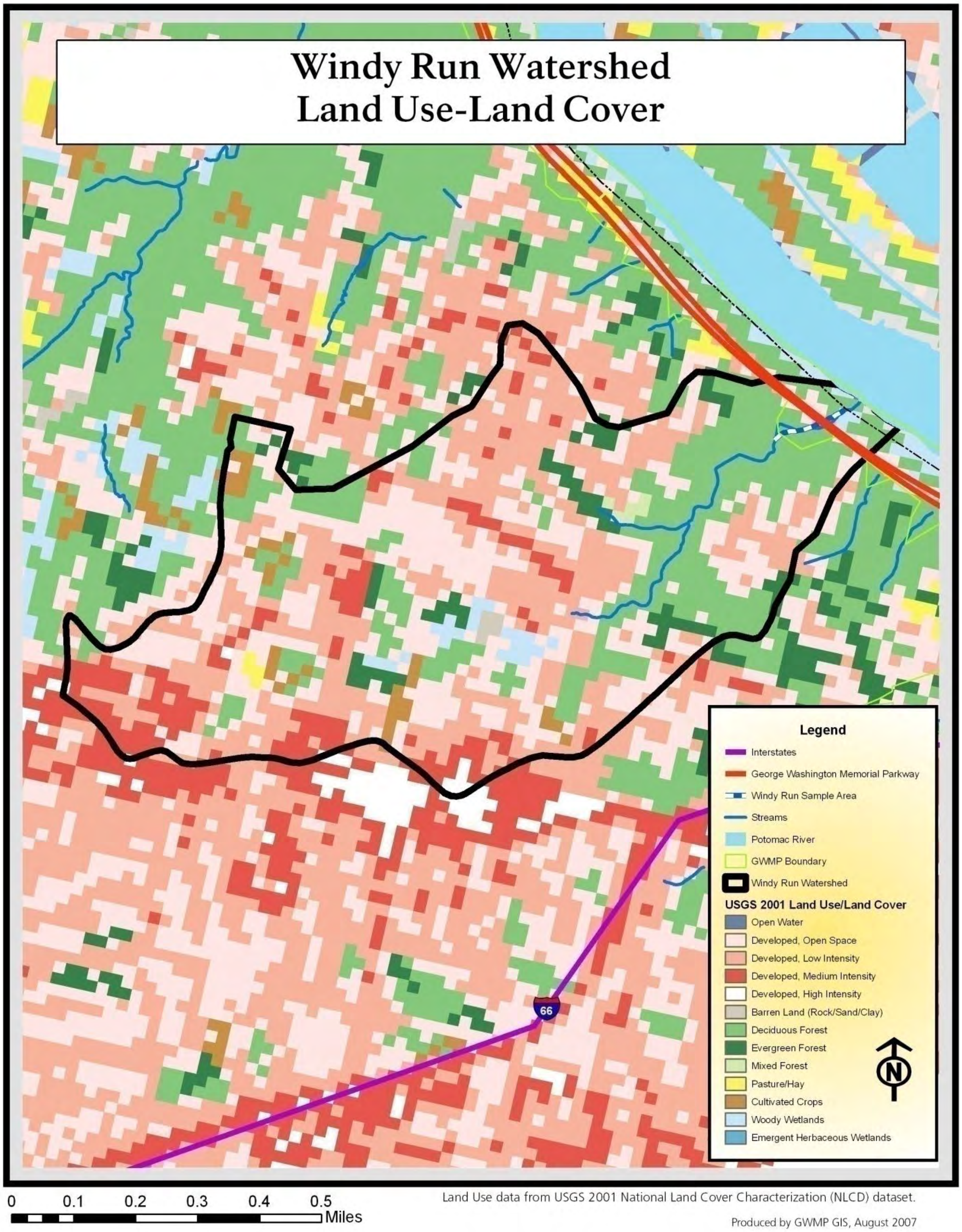



Figure 31: Watershed Land Use: Windy Run

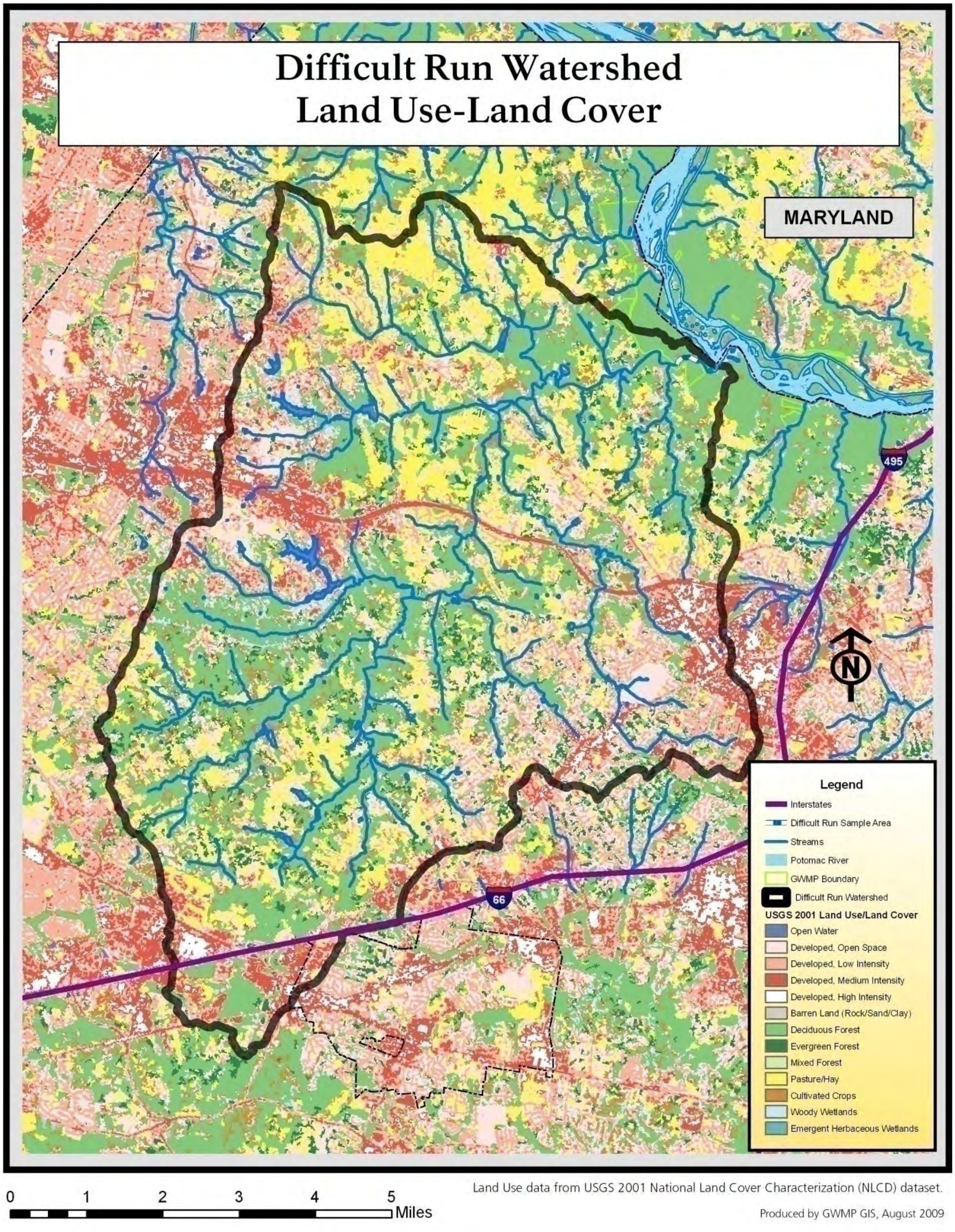



Figure 32: Watershed Land Use: Difficult Run

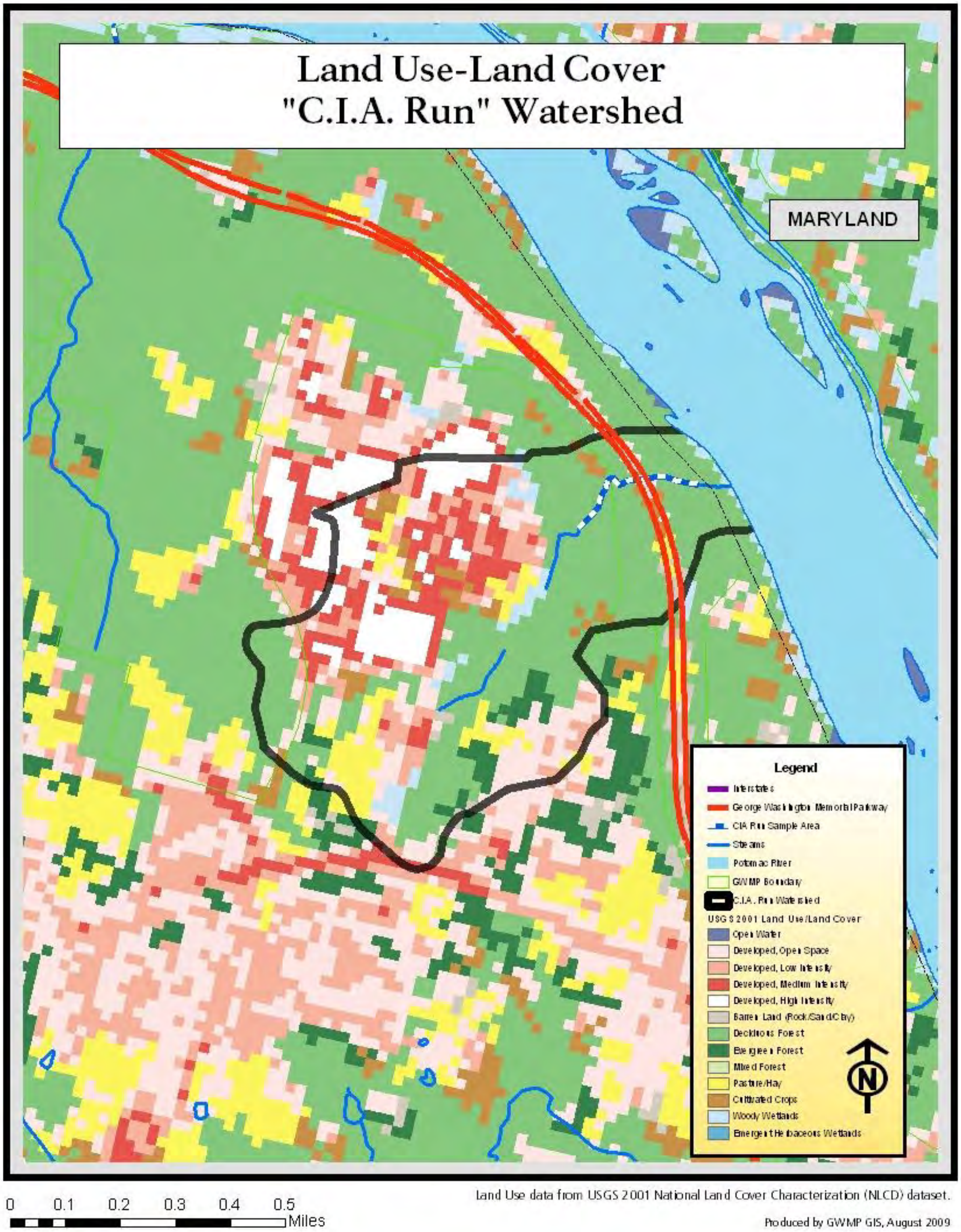
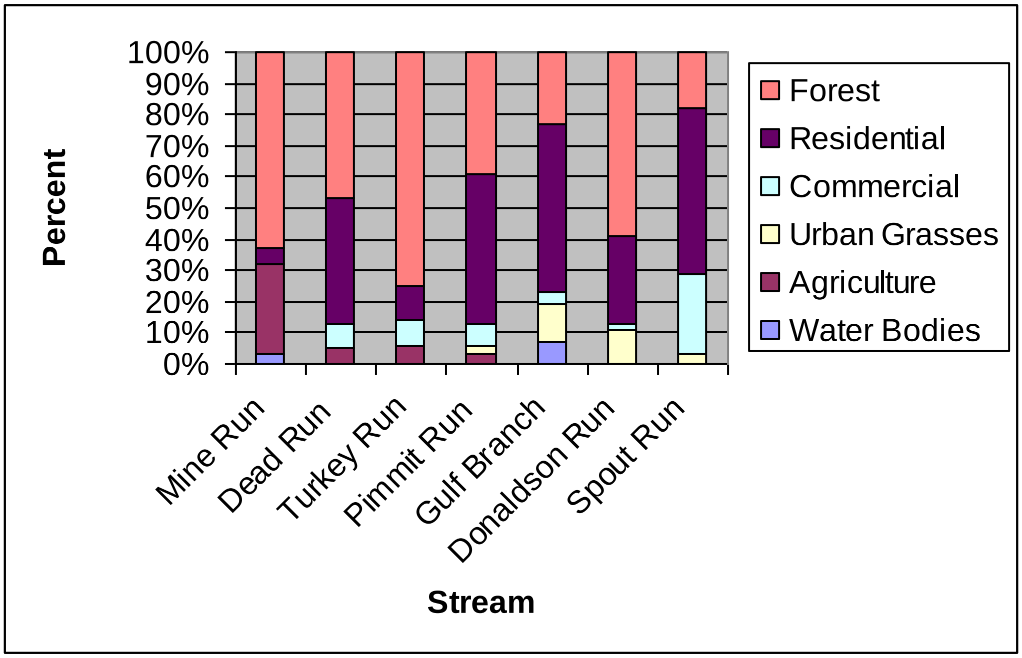



Figure 33: Watershed Land Use: CIA Run

## Figure 34a: Watershed Land Use

1993




## Figure 34b: Watershed Land Use

2001

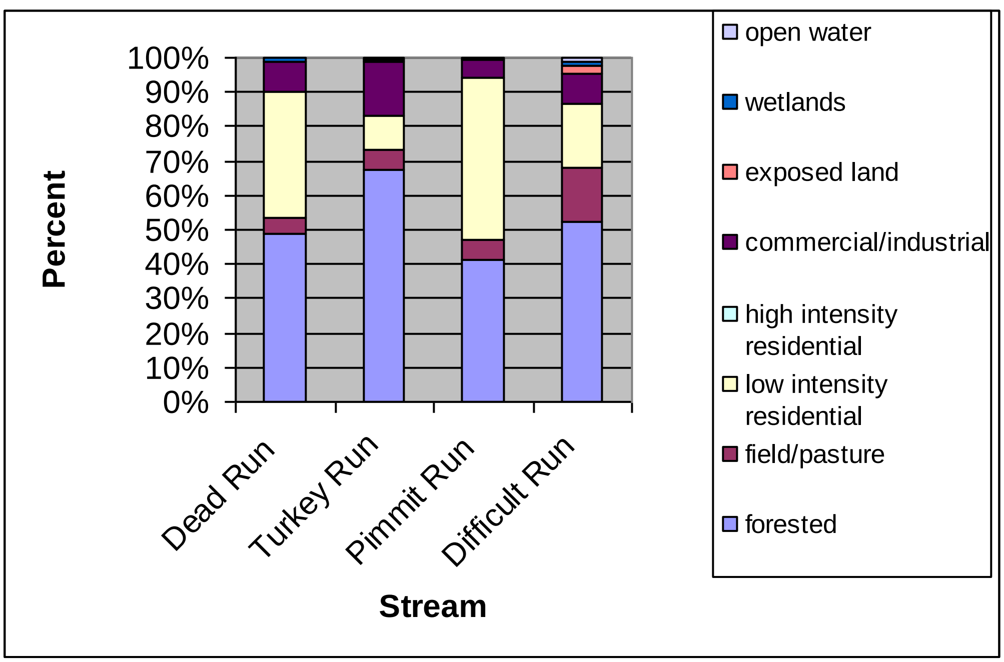
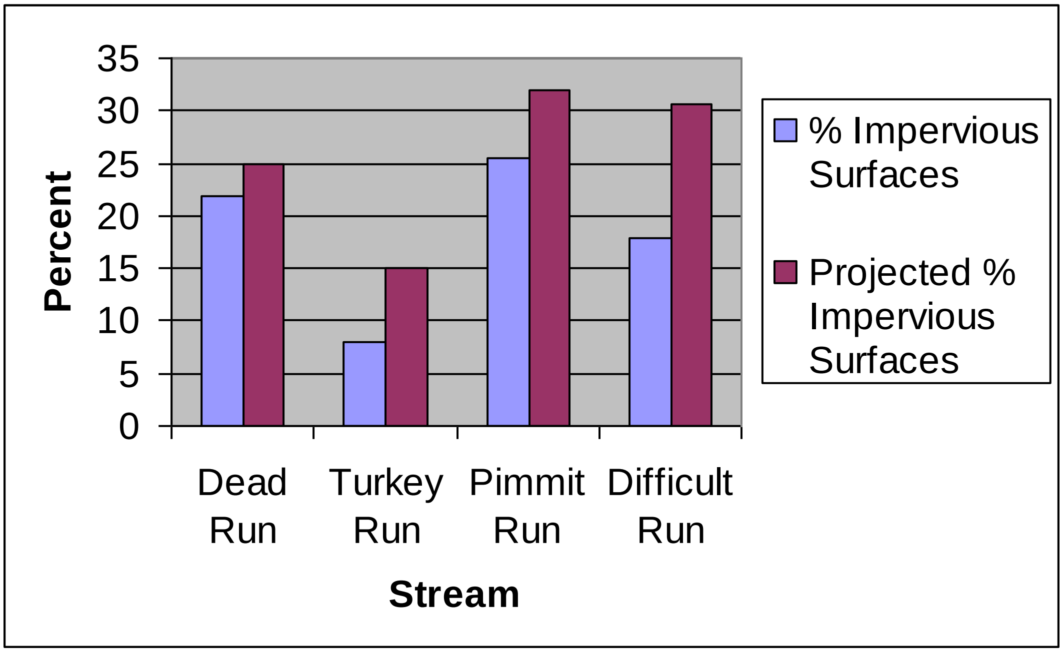


**Figure 35: Impervious Surfaces in Fairfax County Watersheds (2001)**




Effects of 2001 Pesticide Spill on Gulf Branch and Donaldson Run

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

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

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

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

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

Density/ (richness) values at Donaldson Run in 2008 were 28.94/ (11) [Round 1], 98.00/ (11) [Round 2], and 72.17/ (11) [Round 3]. The 2008 season average health score for Donaldson Run is 5.67. The density/ (richness) values at Gulf Branch in 2008 were 65.07/ (13) [Round 1], 82.00/ (10) [Round 2], and 145.67/ (10) [Round 3]. The 2008 season average health score for Gulf Branch is 5.22. For 2010, the average health score for Donaldson was only 3.00, while the average health score for Gulf Branch was only 3.33. However, species density was not tested for the 2010 season.

There is no data to support whether a recovery to pre-contamination conditions has occurred for Donaldson Run and Gulf Branch. Past species density / (richness) calculations were not explained in previous reports. Prior to the sampling season of 2007, the sampling technique used did not produce statistically valid results for many sampling sites because less than 200 macroinvertebrates were collected. Therefore, a statistical analysis comparing data collected for each season prior to 2007 would not be valid for most sites. It is impossible to statistically analyze the density/ (richness) data for the years 2001-2010, and therefore no claim can be made on whether the species density / (richness) has returned to pre-contamination levels.

SOURCES OF ERROR

There are many causes of error. 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 were chosen. Also, the amount of time between rounds at each site varied some due to scheduling constraints. Streams were sampled in the same order as in 2008, but the 2009 researchers sampled the streams in a different order. We attempted to line up dates as closely as possible, but exact matches were next to impossible due to weekends or other arrangements. The greatest potential for human error arises from the subjectivity of the habitat assessment. Estimating the riffle composition, stream bank erosion and shade cover vary from person to person. It is similar when it comes to judging stream flow rate; for example, what was considered “normal” this year may have been “low” last year. Without knowledge of stream-flow regularity, it remains difficult to assess the stream flow rate.

We also want to recognize that there was also chance for human error while conducting chemistry testing in the lab. Although we followed protocol as closely as possible, there is always a small chance that the samples may get contaminated somehow. For example, the chlorine testing produced highly varying results. Our results showed that many streams had no chlorine at all; though this may be due to the change from chlorine to chloramine in tap water as mentioned above. However, there were also two different samples (Dead Run round 1, and Donaldson Run round 2) that had chlorine levels of .13 which seems unusually high.

RECOMMENDATIONS

From the data collected we can see there is a possible link between increased human development outside of GWMP and stream health scores. Most development occurs outside the park boundaries. Active communication and partnerships with the park and its watershed neighbors are needed to develop management strategies that reduce their impact on these streams. Public awareness programs could be implemented further to inform local landowners, community leaders and policy makers on ways to improve watershed health. Signage at monitoring sites and watershed boundaries could increase awareness (Fairfax County Storm Water Planning Division, 2001). Hazardous waste collection and disposal methods could be publicized throughout communities. Another means is to promote the "Adopt a Stream" program, which promotes stewardship between residents and their local watershed. 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 sunlight, which regulates photosynthesis and respiration of the algae and in turn affect levels of dissolved oxygen. We suggest continuing to match the times of day, the dates, and the intervals when sampling is done. Furthermore, sites should be monitored the same day or should not be spread out more than one day. Nitrate, turbidity, and conductivity levels may spike during rainy periods. For this reason it is a good idea to keep track of rainfall (Appendix 35). A storm the day before a sampling period may account for a spike in nitrate, turbidity or conductivity levels. If monitors come across unusual readings in the field on the YSI meter, it is a good idea to take a water sample back to headquarters. For example, if the conductivity or pH is way out of the normal range, a sample should be brought back so that thorough chemical testing can be performed.

Collections of beetles, where present, were taken at each station during the 2009 season. This collection was the beginning of a Parkway-wide beetle survey continuing into 2010. Studies such as this could be performed on different groups of organisms to get a better idea of the diversity and condition of the riparian habitat.

There is a concern about stream bank loss due to erosion for the GWMP. Stream bank erosion is monitored using the VASOS data protocol; however it is a subjective, rather than quantitative, test. To keep track of this stream bank loss more accurately, it is recommended that bank to bank measurements at each sampling station are conducted and site photos be taken every year. These pictures can then be compared to determine if the problem is getting worse. By improving erosion monitoring, we can better inform park managers where to anticipate infrastructure stabilization and prevent large-scale erosional damage. This could result in significant cost savings. The procedure for gauging stream bank composition is unclear. Vegetation measurement parameters should be clarified.

There are a few changes to the database would be beneficial to future years. The habitat assessment only allows the user to select one description for surface appearance of the water; it would be beneficial if multiple selections could be made because the options are not mutually exclusive. There could be a section added that allowed one to record wildlife sightings such as deer, groundhogs, etc. Precipitation and temperature are important. There should be a section similar to "current weather" to record more detailed information about previous weather events. Since turbidity is no longer tested and nitrate strips are no longer used, that section of the database could be taken out. It would be useful if a new section including the chemicals we now test for was put in so that chemistry test results could be recorded with other data.

For future water quality monitors, there are several recommendations we can offer to better the summer experience. This year we were not able to organize much in the way of education and outreach. School was out for summer, and it was difficult to find other parties that would be interested. Previous years suggest the Langley School, Gulf Branch Nature Center, and Potomac Overlook Regional Park, and the Bridging the Watershed program as possible avenues for demonstrations or talks. We recommend trying to organize such events early, since the sampling and writing the report can be very time consuming as the summer progresses. The end-of-season presentation should be completed with enough time to present to park management, GWMP sites, and other organizations (Gulf Branch Nature Center, Potomac Overlook Regional Park).

There were significant changes made to the chemistry testing regimen in 2010. Whereas previous years tested for only nitrite/nitrate and turbidity, we tested nitrate, phosphorus, acid-neutralizing capacity, and chlorine. Due to safety restrictions, chemical testing should NOT be done in the office. All testing should be done at the CUE lab. It would be useful for future interns to receive a more thorough orientation to the lab testing procedures as well as an orientation to all safety guidelines. Since the county changed from using chlorine to chloramines in the tap water, we suggest switching to a chloramine test next year. Additional testing is recommended for streams that show high ion concentrations or high levels of phosphorus or nitrates.

Starting in 2011, there is a possibility that this program would use three SCA interns instead of two. A third intern would be helpful to get more education and outreach activities done. We suggest that one intern stay back while the other two go out to do field work. The person who stays back can rotate everyday or every couple of days. The person in the office would work on finding outreach activities and/or updating the report and data entry. This could make the whole process much more efficient and may leave time for further research later in the summer. For example, with a little more time Windy, Difficult, and CIA Run could be tested three times instead of two.

## 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 original monitored streams as well as providing data on three additional streams. 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.

## SOURCES CITED

Arlington Department of Community Planning, Housing, and Development. [online] Accessed on 14 August 2007. Available at: http://www.arlingtonva.us/Departments/CPHD/Planning/data_maps/CPHDPlanningDataandMapsPIR.aspx#development

Conover, W.J. 1999. Practical nonparametric statistics. Third Edition. John Wiley & Sons, Inc. New York. 584p.

"Current Land Use." [online] Accessed 14 August 2007. Last Modified: 5 July 2005. Available at: http://www.fairfaxcounty.gov/demogrph/demrpts/report/section10.pdf

"Environmental Services: Water System." *Arlington, Virginia*. Arlington County, 18 MAY 2010. Web. 10 Aug 2010. <www.arlingtonva.us/departments/environmentalservices/uepd/wquality/EnvironmentalServicesClmnfaqs.aspx>.

Fairfax County Storm Water Planning Division. "Fairfax County Stream Protection Strategy Baseline Study." January 2001. [online] Last Modified: 9 May 2007. Accessed: 16 August 2007. http://www.fairfaxcounty.gov/dpwes/environmental/sps_pdf.htm

Hanna Instruments. 1997. Instruction manual for portable waterproof pH meters. http://www.hannainst.com.

*Heal the Bay*. "Water Chemistry." [Internet]. S. Mark Taper Foundation. 2010 July [cited 2010 August 6]. Available from: <http://www.healthebay.org/streamteam/chem/>.

Jordan, B. M. 1997. Prince William Forest Park Resource Management Division Benthic Macroinvertebrate Reference Collection Guideline. Prince William Forest Park, Dumfries, Virginia.

LaMotte Company. 2000. Procedure for turbidity in water test kit. LaMotte Company, Chestertown, Maryland.

Mackie, Gerald. 2004. *Applied Aquatic Ecosystem Concepts*, second ed. Kendall/Hunt Publishing Company, Dubuque, Iowa.

Merritt, R.W. and K.W. Cummins. 1996. An Introduction to the Aquatic Insects of North America, 3rd ed. Kendall/Hunt Publishing Company, Dubuque, IA.

McCafferty, P.W. 1981. Aquatic Entomology the Fisherman's Guide to Insects and Their Relatives. Jones and Bartlett Publishers, Boston, Massachusetts.

Murdock, C.H. and M. Cheo. 2001. *Streamkeeper's Field Guide*. The Adopt a Stream Foundation, Everett, WA

National Weather Service: Weather Forecast Office Baltimore/Washington. August 2010. http://www.weather.gov/climate/index.php?wfo=lwx

"Planned Land Use." [online] Accessed 14 August 2007. Last Modified: 5 July 2005. Available at: http://www.fairfaxcounty.gov/demogrph/demrpts/report/section10.pdf

Schmit, John Paul. Quantitative Ecologist, Center for Urban Ecology, National Park Service. Personal email correspondence. 7 August 2010.

Stormwater Management Branch, Stormwater Planning Division, Department of Public Works and Environmental Services. 2001. Fairfax County Stream Protection Strategy Baseline Study.

Thorp, J. H. and A. P. Covich. 1991. Ecology and classification of North American freshwater invertebrates. Academic Press, Incorporated, New York.

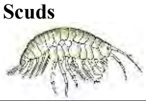
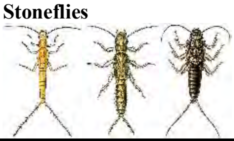
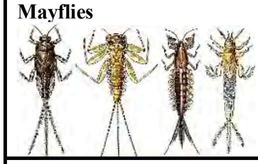
US EPA. 1997. Volunteer Stream Monitoring: A Methods Manual. EPA 841-B-97-003. November. http://www.epa.gov/owow/monitoring/volunteer/stream/

US EPA. September 2006. Water Quality Assessment Integrated Report. EPA 305(b)/303(d). Available at: http://www.deq.state.va.us/wqa/ir2006.html.

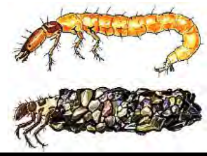
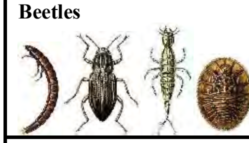
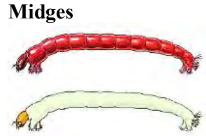
Virginia Save Our Streams Data Entry Page. Modified Method (Rocky Bottom) Data Entry Form. http://www.vasos.org/dataentry.htm

YSI Incorporated.1996. Handheld Oxygen, Conductivity, Salinity, and Temperature System Operations Manual. YSI Incorporated, Yellow Springs, Ohio.

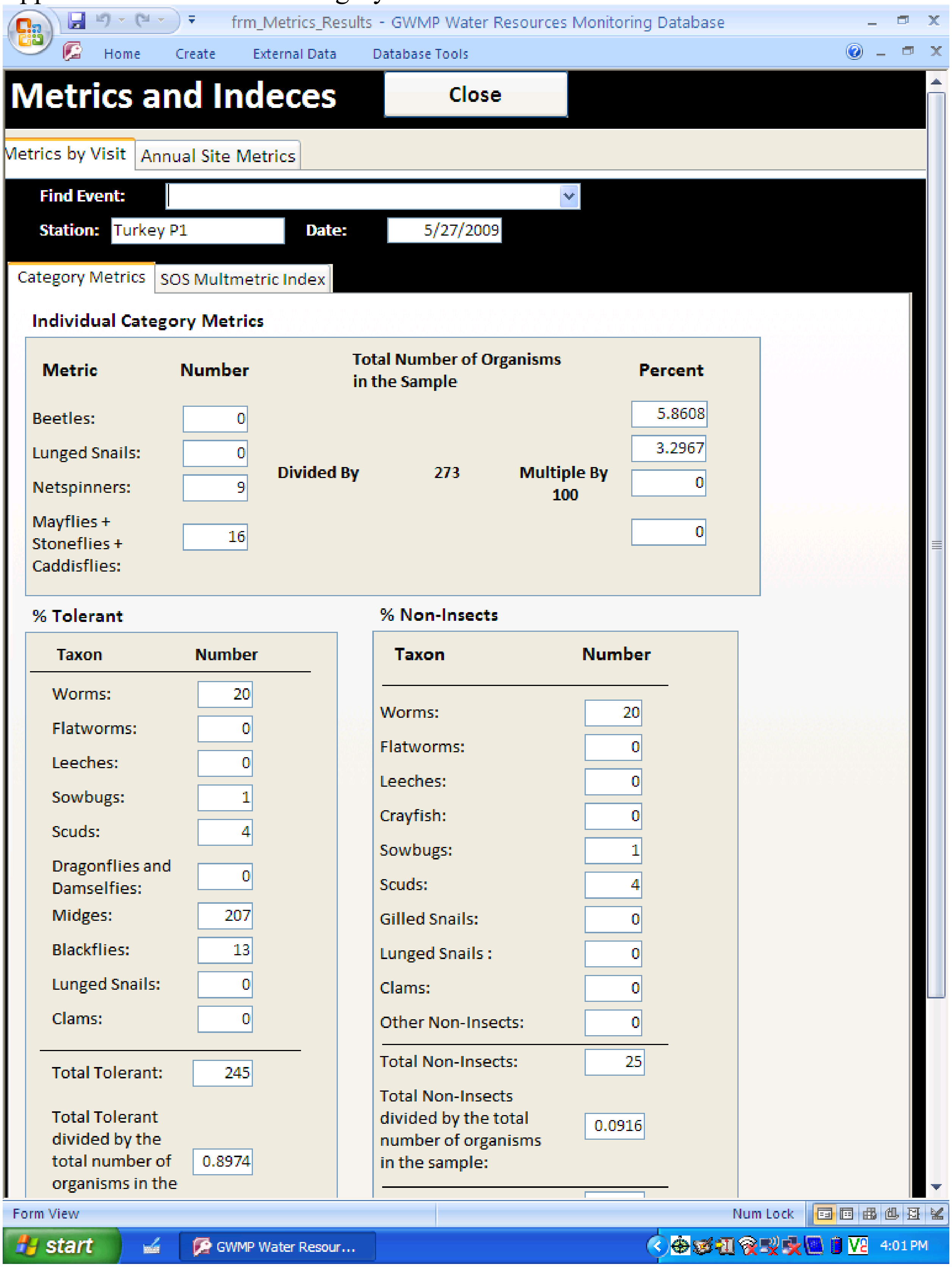
## Appendix 1: Virginia Save Our Streams Macroinvertebrate Tally Sheet

| 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 2a: Individual Category Metrics Screen Shot



frm_Metrics_Results - GWMP Water Resources Monitoring Database

Home Create External Data Database Tools

**Metrics and Indeces** Close

Metrics by Visit | Annual Site Metrics

**Find Event:**

**Station:** Turkey P1 **Date:** 5/27/2009

Category Metrics | SOS Multmetric Index

**Individual Category Metrics**

| Metric | Number | | Total Number of Organisms in the Sample | | Percent |
|---|---|---|---|---|---|
| Beetles: | 0 | | | | 5.8608 |
| Lunged Snails: | 0 | | | | 3.2967 |
| Netspinners: | 9 | Divided By | 273 | Multiple By 100 | 0 |
| Mayflies + Stoneflies + Caddisflies: | 16 | | | | 0 |

**% Tolerant**

| Taxon | Number |
|---|---|
| Worms: | 20 |
| Flatworms: | 0 |
| Leeches: | 0 |
| Sowbugs: | 1 |
| Scuds: | 4 |
| Dragonflies and Damselfies: | 0 |
| Midges: | 207 |
| Blackflies: | 13 |
| Lunged Snails: | 0 |
| Clams: | 0 |
| Total Tolerant: | 245 |
| Total Tolerant divided by the total number of organisms in the | 0.8974 |

**% Non-Insects**

| Taxon | Number |
|---|---|
| Worms: | 20 |
| Flatworms: | 0 |
| Leeches: | 0 |
| Crayfish: | 0 |
| Sowbugs: | 1 |
| Scuds: | 4 |
| Gilled Snails: | 0 |
| Lunged Snails : | 0 |
| Clams: | 0 |
| Other Non-Insects: | 0 |
| Total Non-Insects: | 25 |
| Total Non-Insects divided by the total number of organisms in the sample: | 0.0916 |

Form View Num Lock

start GWMP Water Resour... 4:01 PM

## Appendix 2b: Individual Category Metrics Data Sheet

| 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 | |

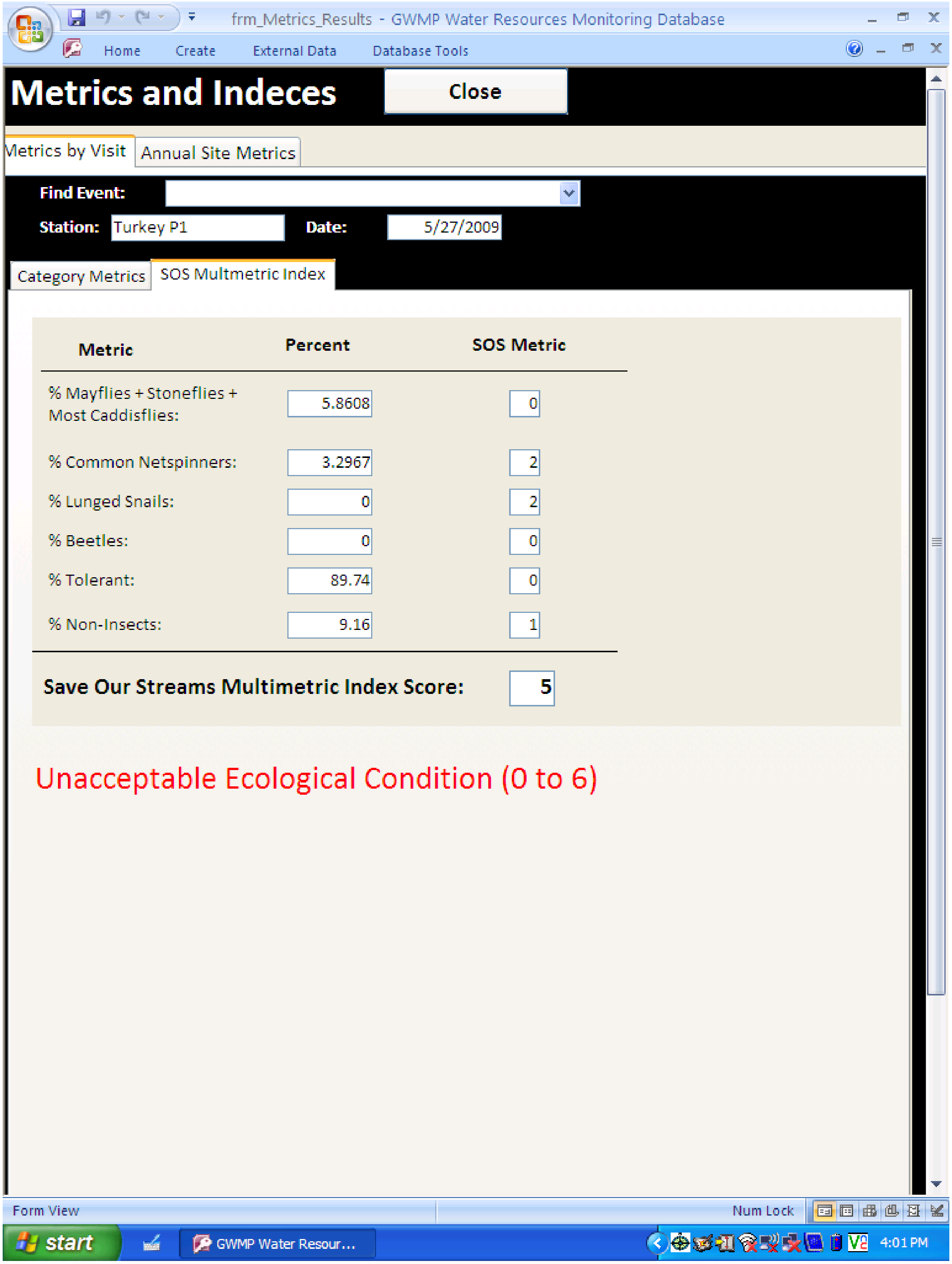
% Tolerant

| 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 3a: Save Our Streams Multimetric Index Screen Shot



## Appendix 3b: Save Our Streams Multimetric Index Sheet

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, Pro Plus, Meter Instructions (YSI, 1997)

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.

### *Calibration for Dissolved Oxygen*

CALIBRATION - DISSOLVED OXYGEN

The Pro Plus offers several options for calibrating dissolved oxygen: DO% in water saturated air, DO mg/L and DO ppm in a solution of known dissolved oxygen determined by a Winkler Titration, and a Zero point. If performing a zero point calibration, you must also perform a %, mg/L, or ppm calibration following the zero calibration. For both ease of use and accuracy, YSI recommends performing the following 1-point DO % water saturated air calibration:

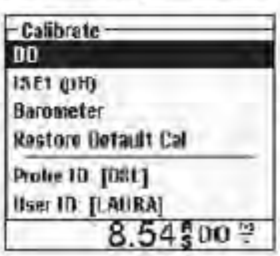
> *It is not necessary to calibrate in both % and mg/L or ppm. Calibrating in % will simultaneously calibrate mg/L and ppm and vice versa.*

Calibrating DO % in Water Saturated Air:
**1-Point Calibration**

The supplied sensor storage container (a grey sleeve for a single port cable or a screw on plastic cup for the dual-port and Quatro cables) can be used for DO calibration purposes.

Moisten the sponge in the storage sleeve or plastic cup with a small amount of clean water. The sponge should be clean since bacterial growth may consume oxygen and interfere with the calibration. If using the cup and you no longer have the sponge, place a small amount of clean water (1/8 inch) in the plastic storage cup instead.

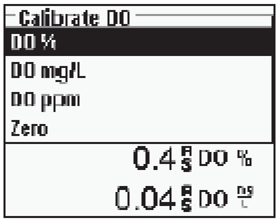
Make sure there are no water droplets on the DO membrane or temperature sensor. Then install the storage sleeve or cup over the sensors. The storage sleeve ensures venting to the atmosphere. If using the cup, screw it on the cable and then disengage one or two threads to ensure atmospheric venting. Make sure the DO and temperature sensors are not immersed in water. Turn the instrument on and wait approximately 5 to 15 minutes for the storage container to become completely saturated and to allow the sensors to stabilize.



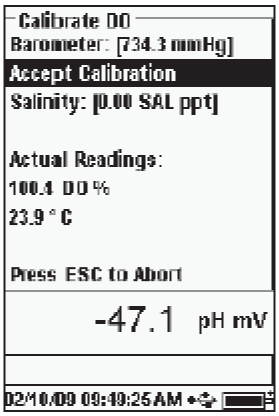

Press Cal. Highlight Probe ID or User ID if you wish to add, select, edit, or delete an ID. Probe ID must be enabled in the System GLP menu to appear in the Calibrate menu. User ID will appear automatically. Select 'None' if you do not want a User ID stored with the calibration. When enabled, these IDs are stored with each calibration record in the GLP file.

27

After selecting your User ID and/or Probe ID if appropriate, highlight DO and press enter.




Highlight **DO %** and press enter to confirm.




The instrument will use the internal barometer during calibration and will display this value in brackets at the top of the display. Highlight **Barometer** and press enter to adjust it if needed. If the barometer reading is incorrect, it is recommended that you calibrate the barometer. Note - the barometer should be reading "true" barometric pressure (see Barometer section for more information on "true" barometric pressure). If the value is acceptable, there is no need to change it or perform a barometer calibration.

The Salinity value displayed near the top of the screen is either the salinity correction value entered in the Sensor menu or the Salinity value as measured by the conductivity sensor in use and enabled. If you are not using a conductivity sensor, the Salinity correction value should be the salinity of the water you will be testing. Highlight **Salinity** and press enter to modify this setting if necessary. See the **Salinity Correction** section of this manual for more information.

Wait for the temperature and DO% values under "Actual Readings" to stabilize, then highlight **Accept Calibration** and press enter to calibrate. Or, press Esc to cancel the calibration. If User Field 1 or 2 are enabled in the GLP menu, you will be prompted to select these inputs and then press Cal to complete the calibration. The message line at the bottom of the screen will display "Calibrating Channel..." and then "Saving Configuration...".

## Calibrating DO% in Water Saturated Air:
## **2-Point Calibration with Zero Solution**

Place the sensor in a solution of zero DO.

A zero DO solution can be made by dissolving approximately 8 - 10 grams of sodium sulfite ($Na_2SO_3$) into 500 mL tap water or DI water. Mix the solution thoroughly. It may take the solution 60 minutes to be oxygen-free.

Press Cal. Highlight Probe ID or User ID if you wish to add, select, edit, or delete an ID. Probe ID must be enabled in the System GLP menu to appear in the Calibrate menu. When enabled, these IDs are stored with each calibration record in the GLP file.

After selecting the Probe ID and/or User ID if appropriate, highlight DO and press enter. Highlight **Zero** and press enter. Wait for the temperature and DO% values under "Actual Readings" to stabilize, then press enter to **Accept Calibration**. If User Field 1 or 2 are enabled, you will be prompted to select the fields and then press Cal to complete the calibration. The screen will then prompt for a follow-up second point calibration.

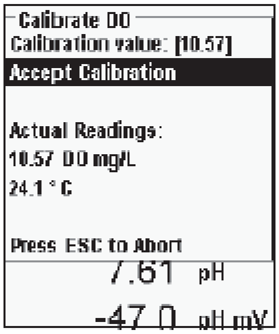
Highlight **DO%** and press enter to continue with the next calibration point. Rinse the sensor of any zero oxygen solution using clean water. Then follow the steps under Calibrating DO % in Water Saturated Air to complete the second point.

## Calibrating in mg/L or ppm as a Titration:
## **1-Point Calibration**

Place the sensor into an adequately stirred sample that has been titrated to determine the dissolved oxygen concentration. Allow the sensor to stabilize.

Press Cal. Highlight Probe ID or User ID if you wish to add, select, edit, or delete an ID. Probe ID must be enabled in the System GLP menu to appear in the Calibrate menu. When enabled, these IDs are stored with each calibration record in the GLP file.

After selecting the Probe ID and/or User ID if appropriate, highlight DO and press enter. Highlight **DO mg/L or ppm** and press enter.




Highlight **Calibration value** and press enter to manually input the sample's dissolved oxygen value. Highlight **Accept Calibration** and press enter once the temperature and Dissolved Oxygen readings stabilize. Or, press Esc to cancel the calibration. If User Field 1 or 2 are enabled in the GLP menu, you will be prompted to select the fields after selecting **Accept Calibration**. After making your selection, press Cal to complete the calibration. After completing the calibration, the message line will display "Calibrating Channel..." and then "Saving Configuration...".

## Calibrating in mg/L or ppm as a Titration: **2-Point Calibration with Zero Solution**

Place the sensor in a solution of zero DO.

A zero DO solution can be made by dissolving approximately 8 - 10 grams of sodium sulfite ($Na_2SO_3$) into 500 mL tap water. Mix the solution thoroughly. It may take the solution 60 minutes to be oxygen-free.

Press Cal . Highlight Probe ID or User ID if you wish to add, select, edit, or delete an ID. Probe ID must be enabled in the System GLP menu to appear in the Calibrate menu. When enabled, these IDs are stored with each calibration record in the GLP file.

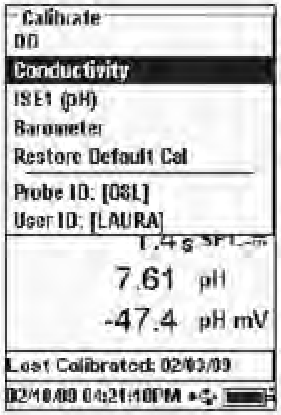
After selecting the Probe ID and/or User ID if appropriate, highlight DO and press enter. Highlight **Zero** and press enter. Wait for the temperature and DO% values under "Actual Readings" to stabilize, then press enter to **Accept Calibration**. If User Field 1 or 2 are enabled, you will be prompted to select the fields and then Press Cal to complete the calibration. The screen will then prompt for a follow-up second point calibration.

Highlight the desired calibration units (mg/L or ppm) and press enter to continue with the next point. Rinse the sensor of any zero oxygen solution using clean water. To complete the second calibration point, follow the steps under Calibrating in mg/L or ppm as a Titration: **1-Point Calibration**.

## Calibrating for Conductivity

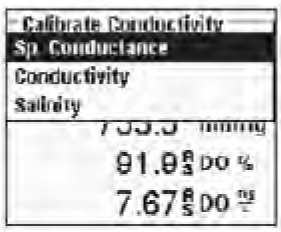
### CALIBRATION - CONDUCTIVITY

> ⓘ *The 6051030 ISE/conductivity cable has a specialized calibration container that resembles a large test tube. This calibration chamber can be used to calibrate the conductivity sensor with an ISE sensor installed. A ring-stand should be used to support this chamber.*




Press Cal. Highlight Probe ID or User ID if you wish to add, select, edit, or delete an ID. Probe ID must be enabled in the System GLP menu to appear in the Calibrate menu. User ID will appear automatically. Select 'None' if you do not want a User ID stored with the calibration. When enabled, these IDs are stored with each calibration record in the GLP file.

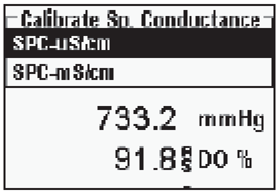
After selecting the User ID and/or Probe ID if appropriate, highlight **Conductivity** and press enter.



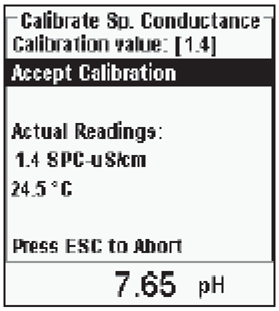

Highlight the desired calibration method; **Sp. Conductance, Conductivity**, or **Salinity** and press enter. YSI recommends calibrating in specific conductance for greatest ease.

### Calibrating in Specific (Sp.) Conductance or Conductivity

Place the sensor into a fresh, traceable conductivity calibration solution. The solution must cover the holes of the conductivity sensor that are closest to the cable. Ensure the entire conductivity sensor is submerged in the solution or the instrument will read approximately of half the expected value!



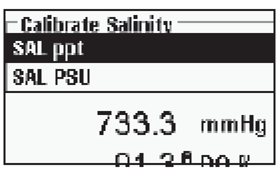

Choose the units in either **SPC-us/cm, C-us/cm** or **SPC-ms/cm, C-ms/cm** and press enter.



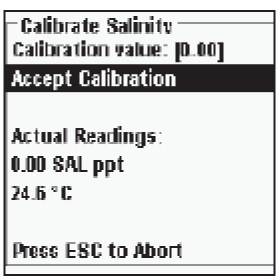

Highlight **Calibration value** and press enter to input the value of the calibration standard. Then, once the temperature and conductivity readings stabilize, highlight **Accept Calibration** and press enter. Or, press Esc to cancel the calibration. If User Field 1 or 2 are enabled in the GLP menu, you will be prompted to select the fields and then press Cal to complete the calibration. After completing the calibration, the message line at the bottom of the screen will display "Calibrating Channel..." and then "Saving Configuration...".

## Calibrating in Salinity

Place the sensor into a salinity calibration solution. The solution must cover the holes of the conductivity sensor that are closest to the cable. Ensure the entire conductivity sensor is submerged in the solution or the instrument will read approximately of half the expected value!




Select **SAL ppt** or **SAL PSU** and press enter.




Highlight **Calibration value** and press enter to input the value of the calibration standard. Then, once the temperature and conductivity readings stabilize, highlight **Accept Calibration** and press enter. Or, press Esc to cancel the calibration. If User Field 1 or 2 are enabled, you will be prompted to select the fields and then press Cal to complete the calibration.

37

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.

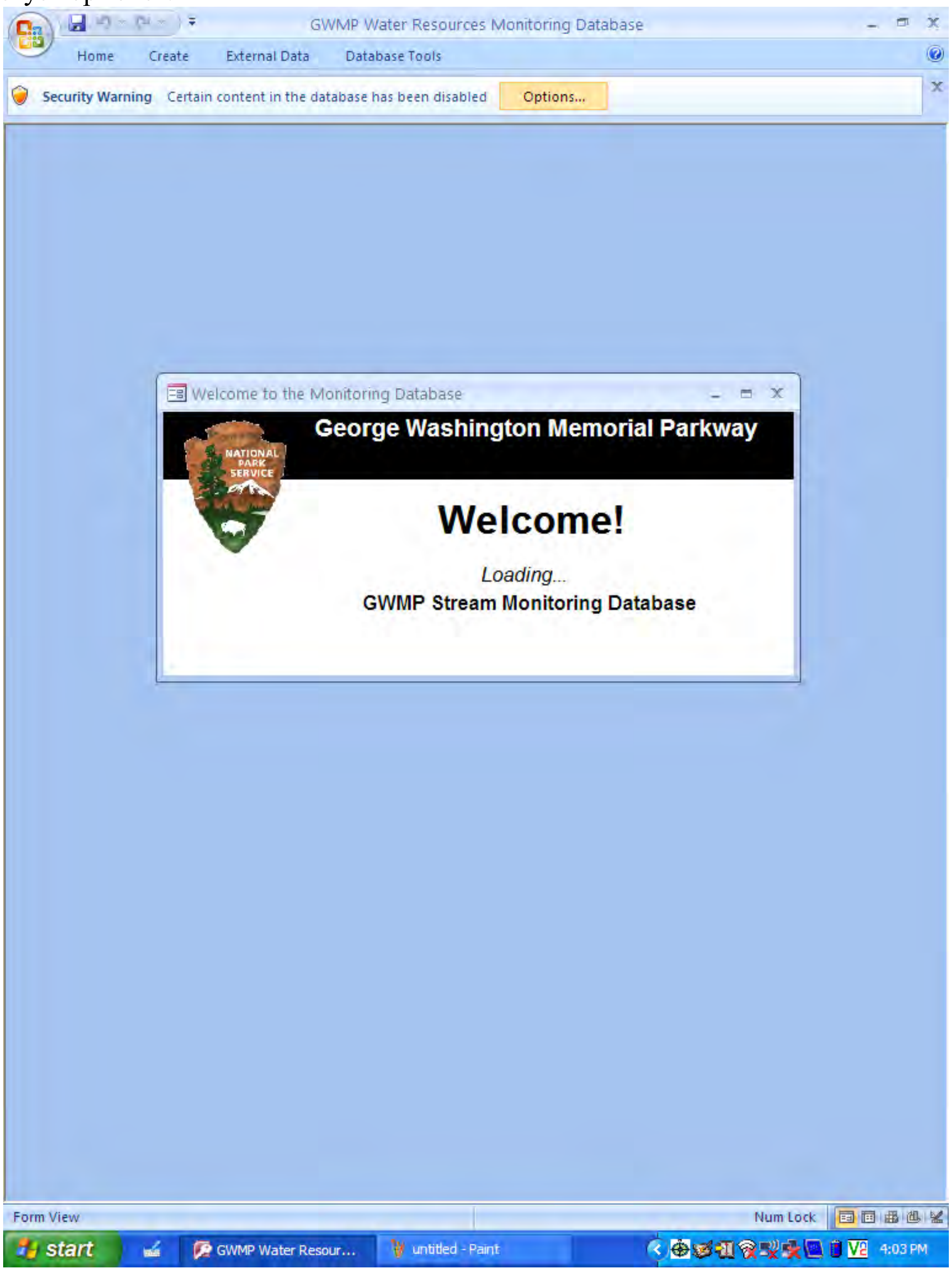
Take readings only when the YSI meter readings have stabilized

Appendix 5: Water Quality Monitoring Database & Field Laptop

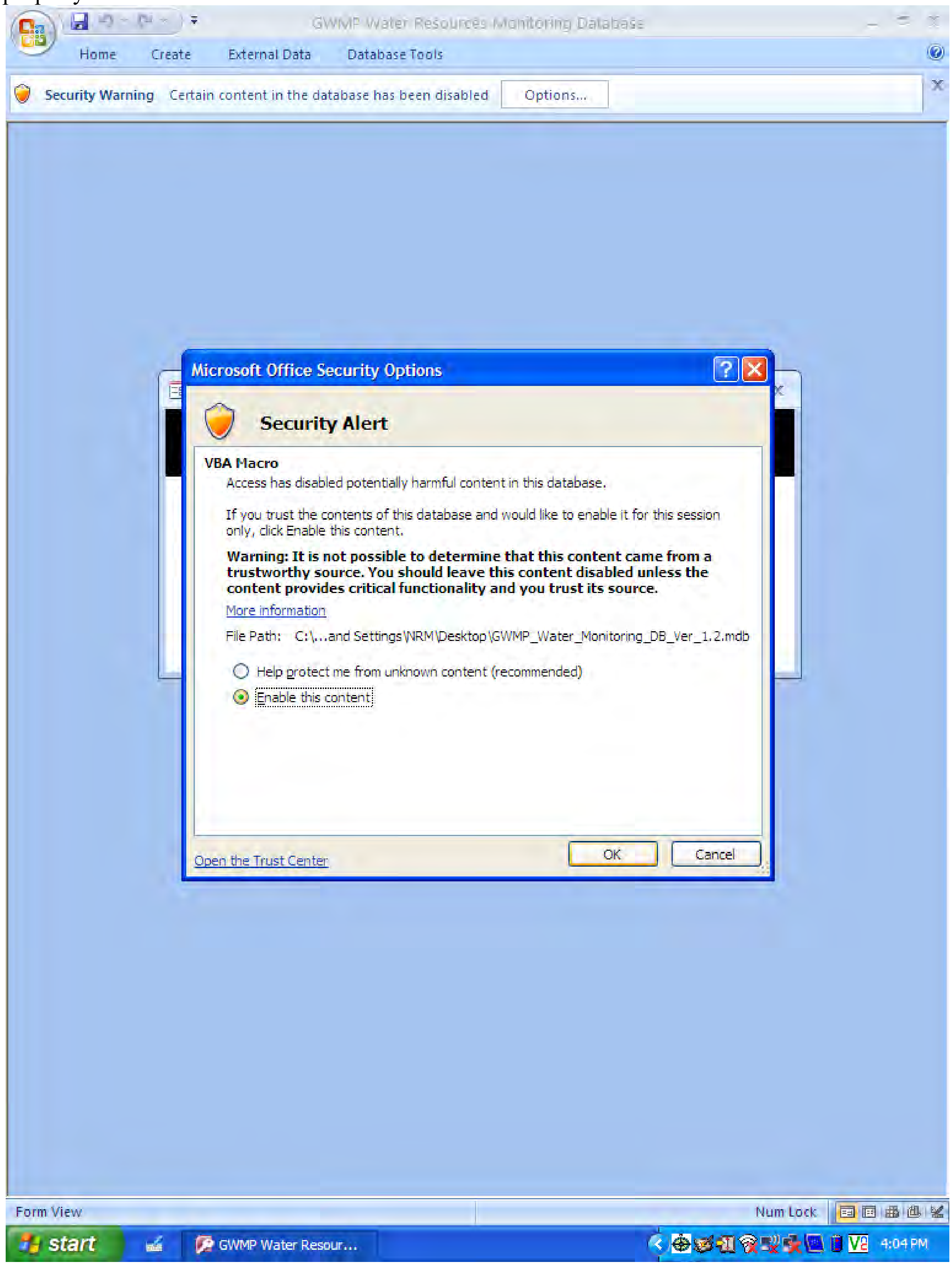
For the 2010 year a database was produced by Geoff Sanders for the stream monitoring program. Below is a short introduction on how to use the database.

Opening the Database

Every time the database opens it needs permission to load. You must click on the top button that says "options".



Next you must click the button that says enable content, and then the database should load properly.



Linking the back end

The database consists of two separate files, the “backend” file and the database. The backend is what stores all the data and the database file is the user interface. After the back end file is moved or when installing a new database the files must be linked together. Open the database and if you try and access any of the information stored you will get an error message. Once you click “ok” it should automatically open a window to link the tables. Click the browse button and locate the back end file on the computer and click ok. The browse window should close and you can then click the link table’s button. A small window should open telling you that the tables are now linked.

Adding Field Data

To add field data, click the “add field data” button on the switchboard in the database. Before you can enter any data into the form you must select a station name which is the stream you are visiting. You can then fill out the forms. The Database is set up in tabs, each tab labeled with the information that it contains.

A very useful tool to use while entering data is the built in database calculator. This calculator is accessed by clicking the square button with the table on it next to the end time box, on the top right of the window. Once open you must click in the box you wish the numbers to go into. The “target” field in the calculator will display where you have selected. Now you can type away on the calculator. When you want to insert a number into the selected box, click the right hand arrow next to the number. If you would like to use the addition or subtraction function on the calculator, select the field, type your first number, hit the function you would like the calculator to perform then hit the calc button. If adding more than two numbers the calc button must be clicked after each number is input.

The first time a user accesses the database and tries to enter field data they will have to create their information. This is done by opening field data and selecting your station. Immediately in the first tab click the add personnel. Enter your First name, last name and email address. You can then click the close button; only click the new record button if there is another person that needs to enter their data. Once done your last and first names should appear in the” data collected by” drop down menu in the database.

Improving the accuracy of the mouse pen

To recalibrate the mouse pen, click the [Start Menu] and click [Control Panel]. Go to [Tablet and Mouse Settings]. Under the <Calibration> title, hit the [Calibrate…] button. Hit the middle of the crosshairs as *slowly and precisely as possible*. Click [OK] and you’re done.

Tips with the Input Panel (where you write stuff)

You can open it up permanently with the< keyboard icon> next to the [Start Menu].

It recognizes cursive.

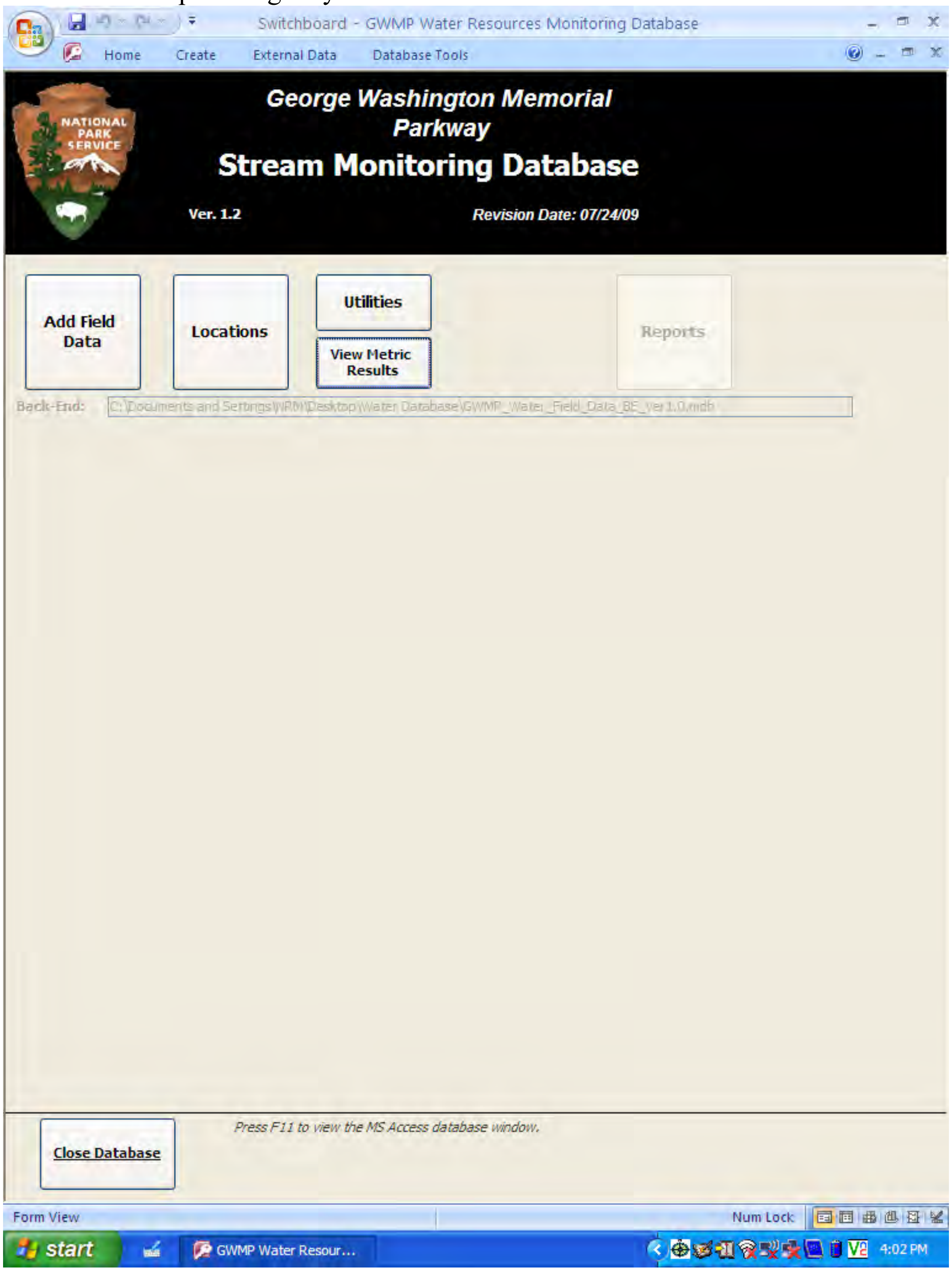
You can delete text by crossing it out with about 3 horizontal lines (strikethroughs) without lifting your pen, but it might take some practice.

There are three modes: the freestyle, boxed letters, and normal keyboard; you can change them on the left.

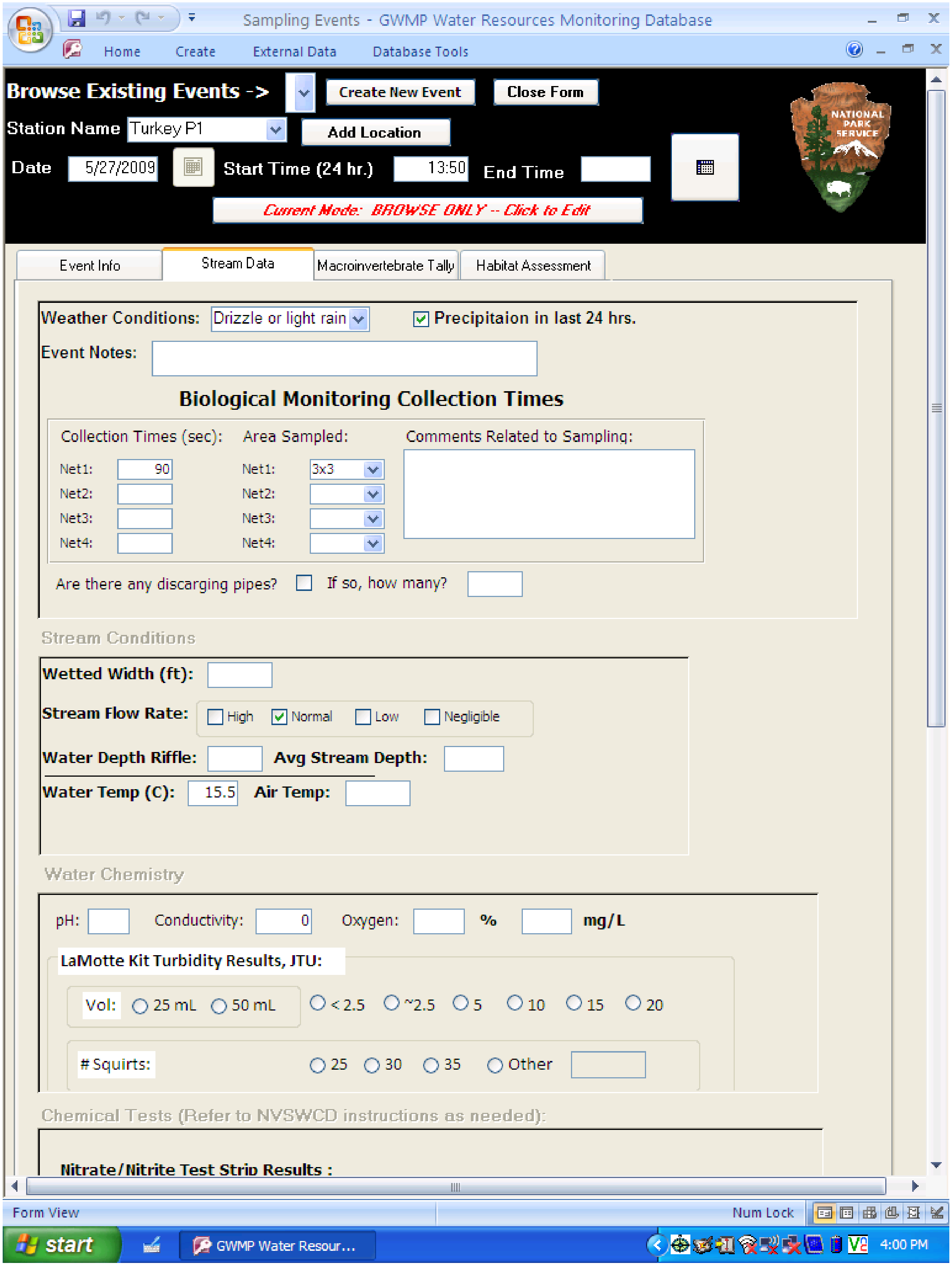
The Input Panel sometimes freezes. So does the calculator.

Viewing the Data

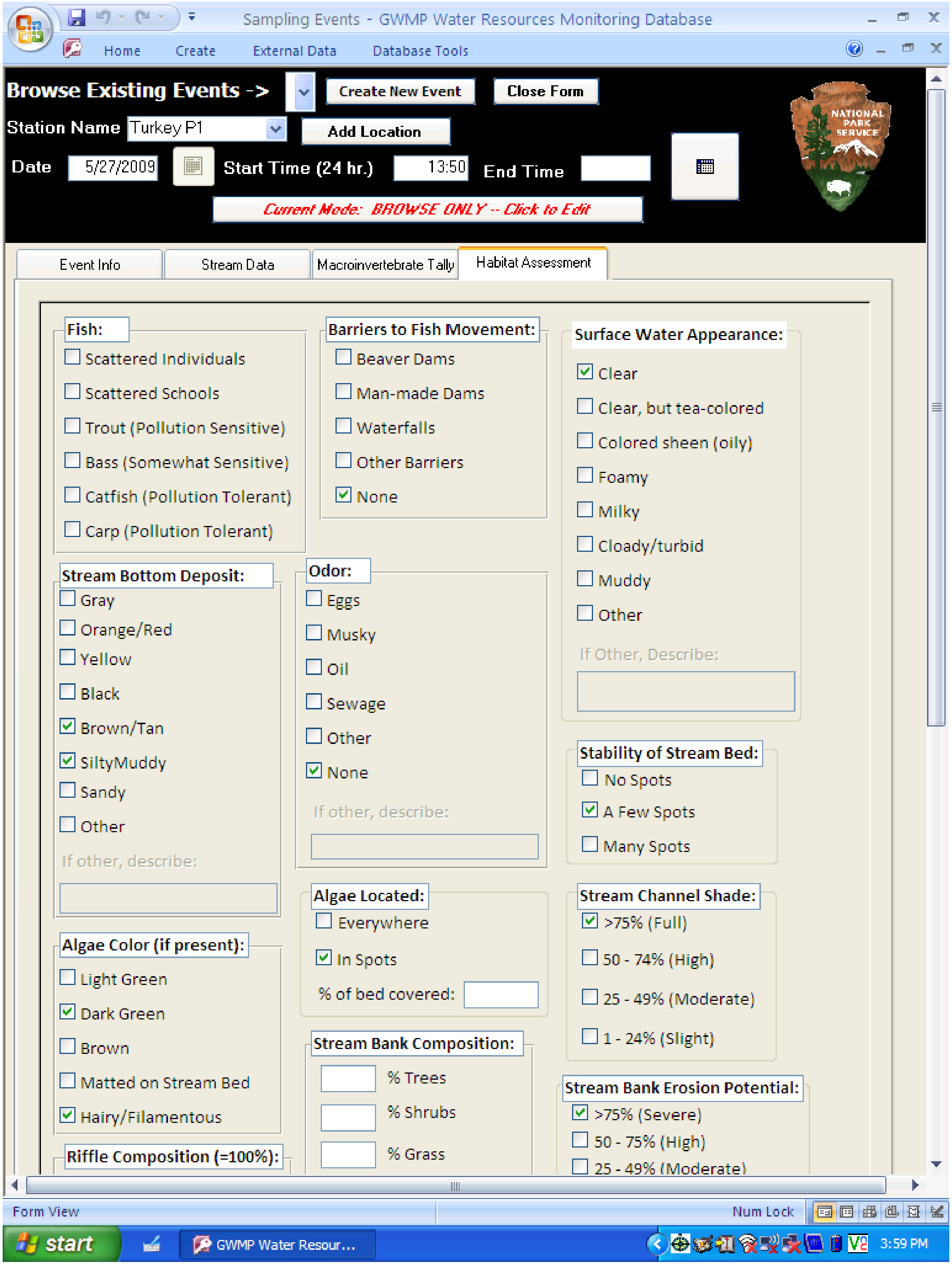
Once field data is collected it is automatically stored in the database. The form can now be closed which brings you back to the switchboard. Click on view metric results. This will open a new window. In the drop down menu select the event that you would like to view. You can now you the category metrics, or if you click the "SOS Multimetric" tab it will display the score the stream received for that event. However if you would like to cumulatively view the score the stream received over all the events you have to scroll up and click on the "annual site metric" tab. You will have to select a stream and a year. Now the database will cumulatively view all the sites as one sample and give you one number.



The Switchboard view, with buttons to access different parts of the database.



The stream data section of the database.



The Habitat assessment of the database.

# Appendix 6: 2010 Data Collection

| Round 1 | | | | | |
|---|---|---|---|---|---|
| Stream | Latitude | Longitude | Description | Date | Certified Monitor |
| Mine Run P1 | 38.99983 | 77.255833 | 5m downstream from road | 6/2/2010 | Rita duMais Nina Wester |
| Mine Run P2 | 39 | 77.256 | 15m upstream from road | 6/2/2010 | Rita duMais, Nina Wester |
| Mine Run P3 | 39.00001667 | 77.25633 | 25m upstream from road | 6/3/2010 | Rita duMais, Nina Wester |
| Pimmit Run P1 | 38.92933 | 77.118667 | 30 meters upstream Glebe Road Route 123 Bridge | 6/3/2010 | Rita duMais, Nina Wester |
| Pimmit Run P2 | 38.929833 | 77.118667 | 50 meters upstream Glebe Road, Route 123 Bridge | 6/32010 | Rita duMais, Nina Wester |
| Pimmit Run P3 | 38.9301667 | 77.119 | 80 meters upstream Glebe Road, Route 123 Bridge | 6/4/2010 | Rita duMais, Nina Wester |
| Gulf Branch P1 | 38.925167 | 77.113667 | 50m downstream from GW Pkwy | 6/4/2010 | Rita duMais, Nina Wester |
| Gulf Branch P2 | 38.925 | 77.114167 | directly under bridge | 6/4/2010 | Rita duMais, Nina Wester |
| Gulf Branch P3 | 38.9245 | 77.114667 | 15 m upstream from bridge | 6/3/2010 | Rita duMais, Nina Wester |
| Turkey Run P1 | 37.966 | 77.1567 | base of Switchback trail | 6/9/2010 | Rita duMais, Nina Wester |
| Turkey Run P2 | 37.9648 | 77.1567 | 100m downstream from GW Pkwy | 6/9/2010 | Rita duMais, Nina Wester |
| Turkey Run P3 | 37.9638 | 77.157 | 50m downstream from GW Pkwy | 6/8/2010 | Rita duMais, Nina Wester |
| Dead Run P1 | 38.967 | 77.1725 | 15-20m upstream from mouth | 6/10/2010 | Rita duMais, Nina Wester |
| Dead Run P2 | 38.96633 | 77.173167 | 50 m downstream | 6/10/2010 | Rita duMais, Nina Wester |
| Dead Run P3 | 38.965167 | 77.173667 | 70m downstream of GW Pkwy bridge, below falls | 6/10/2010 | Rita duMais, Nina Wester |
| Donaldson P1 | 38.919836 | 77.1078389 | 10m upstream from mouth | 6/11/2010 | Rita duMais, Nina Wester |
| Donaldson P2 | 38.919667 | 77.108167 | beneath GW Parkway bridge | 6/11/2010 | Rita duMais, Nina Wester |
| Donaldson P3 | 38.9195 | 77.10833 | 15m upstream from GW parkway | 6/112010 | Rita duMais, Nina Wester |
| Spout Run P1 | 38.9013 | 77.0835 | next to drainage pipe, off Spout Run Pkwy, under GW | 6/14/2010 | Rita duMais, Nina Wester |
| Spout Run P2 | 38.9003 | 77.0847 | 200 m upstream from P1 | 6/14/2010 | Rita duMais, Nina Wester |
| Spout Run P3 | 38.8983 | 77.086 | below Spout Run, ~50 m upstream of 2nd drainage pipe | 6/14/2010 | Rita duMais, Nina Wester |
| Windy Run P1 | N 38° 54' 20.34" | W 077° 05' 39.08" | After 2nd crossing of stream | 6/30//2010 | Rita duMais, Nina Wester |
| Windy Run P2 | N 38° 54' 19.31" | W 077° 05' 40.62" | Below GWMP Bridge | 6/30/2010 | Rita duMais, Nina Wester |
| Windy Run P3 | N 38° 54' 19.09" | W 077° 05' 44.13" | After GWMP bridge, located at the third crossing of the stream. | 6/30/2010 | Rita duMais, Nina Wester |
| Difficult Run P1 | N 38° 58' 36.27" | W 077° 14' 23.40" | | 7/1/2010 | Rita duMais, Nina Wester |
| Difficult Run P2 | N 38° 58' 37.42" | W 077° 14' 27.50" | | 7/1/2010 | Rita duMais, Nina Wester |
| Difficult Run P3 | N 38° 58' 36.03" | W 077° 14' 39.40" | | 7/1/2010 | Rita duMais, Nina Wester |
| CIA Run P1 | | | | 7/2/2010 | |
| CIA Run P2 | | | | 7/2/2010 | |
| CIA Run P3 | | | | 7/2/2010 | |

| Stream | Average stream width (ft) | Average stream depth (in) | Flow rate (High/Normal/Low/Negligible) | Weather last 24 hours | Water Temp |
|---|---|---|---|---|---|
| Mine Run P1 | 9.0 | 4.6 | Normal | Humid, sunny, hot | 20.1 |
| Mine Run P2 | 12.4 | 2.5 | Normal | Humid, sunny, hot | |
| Mine Run P3 | 12.3 | 7 | Normal | Humid, sunny, hot | |
| Pimmit Run P1 | 27.4 | 6 | Normal | Humid, sunny, hot | 23.7 |
| Pimmit Run P2 | 37.1 | 11 | Normal | Thunderstorm, heavy rain, sunny | |
| Pimmit Run P3 | 30 | 6.4 | Normal | Thunderstorm, heavy rain, sunny | 21.6 |
| Gulf Branch P1 | 17.8 | 9 | Low | Thunderstorms, hot, humid | 20.5 |
| Gulf Branch P2 | 15 | 4.9 | Normal | | |
| Gulf Branch P3 | 20.2 | 7.4 | Normal | | |
| Turkey Run P1 | 20.8 | 3.2 | Normal | Cloudless. Humid, hot | |
| Turkey Run P2 | 15.15 | 4.3 | Normal | | |
| Turkey Run P3 | 15.7 | 3 | Low | | 18.6 |
| Dead Run P1 | 13.6 | 5.9 | Normal | Heavy Rain, Sunny, Humid | 20.5 |
| Dead Run P2 | 12.8 | 15.0 | Normal | Heavy Rain, Sunny, Humid | 18.8 |
| Dead Run P3 | 17.5 | 6.3 | Normal | Heavy Rain, Sunny, Humid | 18.2 |
| Donaldson P1 | 24.0 | 4.4 | Normal | Hot, Humid, Cloudless | 19.2 |
| Donaldson P2 | 11.3 | 10 | Normal | Hot, Humid, Cloudless | 20.0 |
| Donaldson P3 | 16.6 | 5.3 | Normal | Humid, warm | 20.4 |
| Spout Run P1 | 11.8 | 5.8 | Normal | hot and humid | 21.5 |
| Spout Run P2 | 11.8 | 4.3 | Normal | Hot, humid | 21.9 |
| Spout Run P3 | 15.7 | 7.0 | Normal | hot humid | 22.5 |
| Windy Run P1 | 6.7 | 6.8 | Normal | Partly Cloudy | 19.8 |
| Windy Run P2 | 12.9 | 7.4 | Normal | Partly Cloudy | 20.5 |
| Windy Run P3 | 9.1 | 4 | Low | Partly Cloudy | 20.6 |
| Difficult Run P1 | 48.8 | 7.6 | Normal | Sun | 21.9 |
| Difficult Run P2 | 36 | 12.5 | Normal | Sun | 22.7 |
| Difficult Run P3 | 60.5 | 1.7 | Normal | Sun | 23.2 |
| CIA Run P1 | 5.8 | 2.3 | Low | Sun | 17 |
| CIA Run P2 | 8.3 | 3.3 | Normal | Sun | 17.3 |
| CIA Run P3 | 6.4 | 3.9 | Low | Sun | 18.1 |

# Appendix 6:  2010 Data Collection

| Round 1 | | | | | | |
|---|---|---|---|---|---|---|
| Stream | Collection Time (net1) | Collection Time (net2) | Collection Time (net3) | Collection Time (net4) | First Page Comments | Net Area |
| Mine Run P1 | 90 | | | | | 3x3 |
| Mine Run P2 | 60 | | | | | 3x3 |
| Mine Run P3 | 60 | | | | | 2x3 |
| Pimmit Run P1 | 90 | | | | | 3x3 |
| Pimmit Run P2 | 90 | | | | | 3x3 |
| Pimmit Run P3 | 90 | | | | | 3x3 |
| Gulf Branch P1 | 90 | | | | | 3x3 |
| Gulf Branch P2 | 90 | | | | | 3x3 |
| Gulf Branch P3 | 90 | | | | | 3x3 |
| Turkey Run P1 | 90 | | | | Saw deer and fox; salamander got caught in net | 3x3 |
| Turkey Run P2 | 90 | | | | | 3x3 |
| Turkey Run P3 | 90 | | | | | 3x3 |
| Dead Run P1 | 90 | 90 | | | | 3x3 |
| Dead Run P2 | 90 | 30 | | | | 3x3 |
| Dead Run P3 | 90 | | | | | 3x3 |
| Donaldson P1 | 90 | | | | | 3x3 |
| Donaldson P2 | 90 | | | | | 3x3 |
| Donaldson P3 | 90 | | | | | 3x3 |
| Spout Run P1 | 90 | | | | | 3x3 |
| Spout Run P2 | 90 | | | | | 3x3 |
| Spout Run P3 | 90 | 90 | | | | 3x3 |
| Windy Run P1 | 90 | 90 | | | | 3x3 |
| Windy Run P2 | 90 | | | | | 2x3 |
| Windy Run P3 | 90 | 90 | 90 | | | 2x3 |
| Difficult Run P1 | 90 | | | | | 3x3 |
| Difficult Run P2 | 60 | | | | | 2x3 |
| Difficult Run P3 | 60 | | | | | 3x3 |

# Appendix 6: 2010 Data Collection

| Round 1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stream | Worms | Flatworms | Leeches | Crayfish | Sowbugs | Scuds | Stoneflies | Mayflies | Dragonflies and Damselflies |
| Mine Run P1 | 17 | 2 | 0 | 0 | 0 | 11 | 23 | 2 | 1 |
| Mine Run P2 | 70 | 0 | 0 | 0 | 0 | 3 | 18 | 0 | 1 |
| Mine Run P3 | 53 | 0 | 0 | 2 | 1 | 20 | 14 | 2 | 29 |
| Pimmit Run P1 | 22 | 4 | 2 | 0 | 7 | 1 | 8 | 17 | 0 |
| Pimmit Run P2 | 6 | 1 | 0 | 0 | 10 | 1 | 0 | 58 | 0 |
| Pimmit Run P3 | 1 | 3 | 0 | 0 | 4 | 0 | 0 | 141 | 0 |
| Gulf Branch P1 | 10 | 5 | 27 | 0 | 0 | 20 | 0 | 9 | 0 |
| Gulf Branch P2 | 11 | 1 | 6 | 0 | 32 | 6 | 0 | 2 | 0 |
| Gulf Branch P3 | 15 | 0 | 39 | 0 | 0 | 7 | 0 | 3 | 0 |
| Turkey Run P1 | 5 | 1 | 0 | 0 | 0 | 26 | 1 | 53 | 0 |
| Turkey Run P2 | 1 | 0 | 0 | 0 | 1 | 6 | 0 | 12 | 0 |
| Turkey Run P3 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 17 | 0 |
| Dead Run P1 | 8 | 0 | 34 | 1 | 0 | 34 | 0 | 28 | 1 |
| Dead Run P2 | 14 | 0 | 2 | 1 | 0 | 5 | 0 | 50 | 0 |
| Dead Run P3 | 65 | 0 | 5 | 0 | 0 | 1 | 0 | 15 | 0 |
| Donaldson P1 | 75 | 2 | 34 | 0 | 0 | 51 | 0 | 82 | 0 |
| Donaldson P2 | 2 | 3 | 35 | 1 | 0 | 4 | 0 | 69 | 0 |
| Donaldson P3 | 2 | 1 | 27 | 0 | 0 | 2 | 0 | 17 | 0 |
| Spout Run P1 | 15 | 7 | 15 | 0 | 0 | 67 | 0 | 86 | 0 |
| Spout Run P2 | 26 | 9 | 25 | 0 | 0 | 42 | 0 | 55 | 0 |
| Spout Run P3 | 35 | 17 | 47 | 1 | 1 | 29 | 0 | 27 | 0 |
| Windy Run P1 | 7 | 21 | 34 | 0 | 2 | 0 | 0 | 29 | 0 |
| Windy Run P2 | 8 | 12 | 44 | 4 | 3 | 0 | 0 | 48 | 0 |
| Windy Run P3 | 4 | 17 | 35 | 1 | 2 | 0 | 0 | 27 | 0 |
| Difficult Run P1 | 3 | 4 | 4 | 0 | 0 | 17 | 0 | 35 | 0 |
| Difficult Run P2 | 1 | 12 | 2 | 1 | 0 | 14 | 0 | 13 | 2 |
| Difficult Run P3 | 1 | 31 | 1 | 0 | 0 | 7 | 5 | 22 | 0 |
| CIA Run P1 | 4 | 0 | 8 | 0 | 3 | 19 | 0 | 0 | 0 |
| CIA Run P2 | 2 | 1 | 10 | 2 | 1 | 19 | 0 | 5 | 0 |
| CIA Run P3 | 0 | 0 | 6 | 0 | 2 | 0 | 0 | 3 | 0 |

# Appendix 6: 2010 Data Collection

| Round 1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stream | Hellgrammites, Fishflies, and Alderflies | Common Netspinners | Most Caddisflies | Beetles | Midges | Blackflies | Most True Flies | Gilled Snails | Lunged Snails |
| Mine Run P1 | 0 | 192 | 49 | 20 | 6 | 0 | 38 | 1 | 0 |
| Mine Run P2 | 1 | 271 | 39 | 16 | 13 | 0 | 16 | 0 | 0 |
| Mine Run P3 | 0 | 26 | 1 | 10 | 3 | 0 | 43 | 0 | 0 |
| Pimmit Run P1 | 0 | 16 | 9 | 0 | 115 | 3 | 8 | 0 | 1 |
| Pimmit Run P2 | 0 | 49 | 24 | 0 | 50 | 3 | 2 | 0 | 0 |
| Pimmit Run P3 | 0 | 17 | 5 | 1 | 69 | 1 | 2 | 0 | 0 |
| Gulf Branch P1 | 0 | 19 | 0 | 0 | 89 | 14 | 15 | 0 | 0 |
| Gulf Branch P2 | 0 | 12 | 3 | 0 | 153 | 3 | 4 | 2 | 0 |
| Gulf Branch P3 | 0 | 52 | 9 | 0 | 75 | 32 | 31 | 0 | 1 |
| Turkey Run P1 | 0 | 127 | 6 | 5 | 30 | 2 | 7 | 0 | 0 |
| Turkey Run P2 | 0 | 132 | 2 | 1 | 54 | 1 | 7 | 1 | 0 |
| Turkey Run P3 | 0 | 177 | 5 | 2 | 11 | 2 | 0 | 0 | 0 |
| Dead Run P1 | 0 | 37 | 3 | 0 | 54 | 0 | 2 | 0 | 0 |
| Dead Run P2 | 0 | 25 | 16 | 0 | 101 | 1 | 7 | 0 | 0 |
| Dead Run P3 | 0 | 123 | 17 | 1 | 110 | 9 | 9 | 0 | 0 |
| Donaldson P1 | 0 | 35 | 7 | 0 | 75 | 5 | 12 | 0 | 49 |
| Donaldson P2 | 0 | 242 | 9 | 0 | 76 | 19 | 23 | 0 | 9 |
| Donaldson P3 | 0 | 133 | 6 | 0 | 48 | 10 | 8 | 0 | 10 |
| Spout Run P1 | 0 | 4 | 0 | 0 | 129 | 0 | 10 | 1 | 3 |
| Spout Run P2 | 0 | 20 | 1 | 0 | 80 | 2 | 0 | 0 | 8 |
| Spout Run P3 | 0 | 42 | 0 | 0 | 51 | 1 | 2 | 0 | 3 |
| Windy Run P1 | 0 | 83 | 15 | 0 | 29 | 1 | 5 | 0 | 0 |
| Windy Run P2 | 0 | 60 | 4 | 0 | 14 | 8 | 7 | 0 | 1 |
| Windy Run P3 | 0 | 101 | 8 | 0 | 38 | 7 | 3 | 0 | 6 |
| Difficult Run P1 | 2 | 103 | 144 | 122 | 20 | 2 | 2 | 0 | 1 |
| Difficult Run P2 | 0 | 104 | 101 | 49 | 9 | 1 | 1 | 0 | 0 |
| Difficult Run P3 | 1 | 293 | 76 | 91 | 9 | 8 | 0 | 0 | 0 |
| CIA Run P1 | 0 | 64 | 36 | 0 | 41 | 7 | 18 | 0 | 0 |
| CIA Run P2 | 0 | 79 | 11 | 0 | 60 | 2 | 15 | 0 | 0 |
| CIA Run P3 | 0 | 135 | 43 | 0 | 23 | 0 | 5 | 0 | 0 |

# Appendix 6: 2010 Data Collection

| Round 1 | | | | | | |
|---|---|---|---|---|---|---|
| Stream | Clams | Total Organisms | Metric 1 - Percent Mayflies, Stoneflies, and Most Caddisflies | Metric 2 - Percent Common Netspinners | Metric 3 - Percent Lunged Snails | Metric 4 - Percent Beetles |
| Mine Run P1 | 3 | 365 | 20.747 | 52.6027 | 0 | 5.4795 |
| Mine Run P2 | 3 | 448 | 12.7232. | 60.4911 | 0 | 3.5714 |
| Mine Run P3 | 1 | 205 | 8.2927 | 12.6829 | 0 | 4.878 |
| Pimmit Run P1 | 0 | 213 | 15.9624 | 7.5117 | 0.4695 | 0 |
| Pimmit Run P2 | 0 | 204 | 40.1961 | 24.0196 | 0 | 0 |
| Pimmit Run P3 | 0 | 244 | 78.4314 | 7.8431 | 0 | 0 |
| Gulf Branch P1 | 0 | 218 | 4.3296 | 9.1346 | 0 | 0 |
| Gulf Branch P2 | 0 | 202 | 2.1277 | 5.1064 | 0 | 0 |
| Gulf Branch P3 | 0 | 221 | 4.5455 | 19.697 | 0.3788 | 0 |
| Turkey Run P1 | 0 | 263 | 48.289 | 0 | 0 | 1.9011 |
| Turkey Run P2 | 0 | 218 | 1.9455 | 10.1167 | 0.7782 | 0.7782 |
| Turkey Run P3 | 0 | 219 | 10.2599 | 24.3502 | 0 | 0.9576 |
| Dead Run P1 | 0 | 201 | 15.3465 | 18.3168 | 0 | 0 |
| Dead Run P2 | 0 | 222 | 29.7297 | 11.2613 | 0 | 0 |
| Dead Run P3 | 0 | 355 | 9.0141 | 34.6479 | 0 | 0.2817 |
| Donaldson P1 | 0 | 430 | 20.8431 | 8.1967 | 11.4754 | 0 |
| Donaldson P2 | 0 | 492 | 15.8537 | 49.187 | 1.8293 | 0 |
| Donaldson P3 | 0 | 264 | 8.7121 | 50.3788 | 3.7879 | 0 |
| Spout Run P1 | 0 | 337 | 25.5193 | 1.1869 | 0.8902 | 0 |
| Spout Run P2 | 0 | 311 | 20.8955 | 7.4627 | 2.9851 | 0 |
| Spout Run P3 | 0 | 256 | 10.5469 | 16.4062 | 1.1719 | 0 |
| Windy Run P1 | 0 | 226 | 19.469 | 36.7257 | 0 | 0 |
| Windy Run P2 | 0 | 206 | 24.4131 | 28.169 | 0.4695 | 0 |
| Windy Run P3 | 0 | 249 | 14.0562 | 40.5622 | 2.4096 | 0 |
| Difficult Run P1 | 2 | 461 | 38.8286 | 22.3427 | 0.2169 | 26.4642 |
| Difficult Run P2 | 0 | 310 | 36.7742 | 33.5484 | 0 | 15.8065 |
| Difficult Run P3 | 1 | 546 | 18.8645 | 53.663 | 0 | 16.6667 |
| CIA Run P1 | 0 | 200 | 18 | 32 | 0 | 0 |
| CIA Run P2 | 0 | 206 | 7.7295 | 38.1643 | 0 | 0 |
| CIA Run P3 | 0 | 223 | 21.1982 | 62.212 | 0 | 0 |

# Appendix 6: 2010 Data Collection

| Round 1 | | | | | |
|---|---|---|---|---|---|
| Stream | Metric 5 - Percent Tolerant | Metric 6 - Percent Non-Insect | Score | Ecological Conditions | Fish Water Quality Indicators |
| Mine Run P1 | 10.96 | 9.32 | 7 | Acceptable | Scattered Individuals |
| Mine Run P2 | 19.42 | 16.29 | 6 | Unacceptable | Scattered Individuals |
| Mine Run P3 | 52.2 | 37.56 | 6 | Unacceptable | Scattered Individuals |
| Pimmit Run P1 | 72.77 | 17.37 | 4 | Unacceptable | Scattered Schools |
| Pimmit Run P2 | 34.8 | 8.82 | 8 | Acceptable | Scattered Individuals |
| Pimmit Run P3 | 11.76 | 3.92 | 10 | Acceptable | Scattered Schools |
| Gulf Branch P1 | 79.33 | 29.81 | 4 | Unacceptable | Scattered Individuals |
| Gulf Branch P2 | 90.21 | 24.68 | 4 | Unacceptable | Scattered Individuals |
| Gulf Branch P3 | 64.02 | 23.48 | 3 | Unacceptable | Scattered Individuals |
| Turkey Run P1 | 24.33 | 12.17 | 6 | Unacceptable | Scattered Individuals |
| Turkey Run P2 | 79.38 | 47.47 | 3 | Unacceptable | Scattered Individuals |
| Turkey Run P3 | 60.74 | 21.07 | 4 | Unacceptable | Scattered Individuals |
| Dead Run P1 | 64.85 | 38.12 | 4 | Unacceptable | Scattered Individuals |
| Dead Run P2 | 55.41 | 9.91 | 7 | Acceptable | Scattered Individuals |
| Dead Run P3 | 53.52 | 20 | 4 | Unacceptable | Scattered Individuals |
| Donaldson P1 | 68.15 | 49.41 | 3 | Unacceptable | Scattered Individuals |
| Donaldson P2 | 30.08 | 10.98 | 3 | Unacceptable | Scattered Individuals |
| Donaldson P3 | 37.88 | 15.91 | 3 | Unacceptable | Scattered Individuals |
| Spout Run P1 | 70.03 | 32.05 | 4 | Unacceptable | Scattered Individuals |
| Spout Run P2 | 71.64 | 41.04 | 3 | Unacceptable | Scattered Individuals |
| Spout Run P3 | 71.88 | 51.95 | 3 | Unacceptable | Scattered Individuals |
| Windy Run P1 | 41.59 | 28.32 | 5 | Unacceptable | No Fish |
| Windy Run P2 | 42.25 | 33.80 | 5 | Unacceptable | Scattered Individuals |
| Windy Run P3 | 43.78 | 26.1 | 3 | Unacceptable | Scattered Individuals |
| Difficult Run P1 | 11.50 | 6.72 | 10 | Acceptable | Scattered Individuals |
| Difficult Run P2 | 13.23 | 9.68 | 10 | Acceptable | Scattered Individuals |
| Difficult Run P3 | 10.62 | 7.51 | 8 | Acceptable | Scattered Individuals |
| CIA Run P1 | 41 | 17 | 7 | Acceptable | No Fish |
| CIA Run P2 | 45.89 | 16.91 | 5 | Unacceptable | No Fish |
| CIA Run P3 | 14.29 | 3.69 | 7 | Acceptable | Scattered Individuals |

# Appendix 6: 2010 Data Collection

| Round 1 | | | | | | |
|---|---|---|---|---|---|---|
| Stream | Barriers to Fish Movement | Surface-water appearance | Stream Bed Deposit | Odor | Stability of stream: Bed sinks beneath your feet | Algae Color(Light green/Dark green/Brown coated/Matted on streambed/Hairy) |
| Mine Run P1 | No Barriers | Clear | Silty/Muddy | No odor | no spots | none |
| Mine Run P2 | No Barriers | Clear, but tea-colored | Brown/Silt/Sand | no odor | no spots | |
| Mine Run P3 | Waterfalls | Clear | Brown/Silt | No odor | No Spots | Dark Green |
| Pimmit Run P1 | None | Clear | Silty/Muddy | None | Few Spots | Light and Dark Green |
| Pimmit Run P2 | Waterfalls | Clear | Brown/Silt/Sand | No Odor | Many Spots | |
| Pimmit Run P3 | Waterfalls | Clear | brown/silty/sandy | No odor | A Few Spots | Light/Dark Green |
| Gulf Branch P1 | Waterfalls | Foamy | Brown/silty/sandy | No Odor | No Spots | |
| Gulf Branch P2 | Other | Clear, but tea-colored | Brown/Silt/Sand | None | Few Spots | Dark Green/ Matted |
| Gulf Branch P3 | Other | Clear | Silty/Sandy | None | No Spots | Dark Green/Matted |
| Turkey Run P1 | No barriers | clear | Brown/silty | none | Few Spots | |
| Turkey Run P2 | No Barriers | Clear | Brown/silt/sand | None | Few Spots | |
| Turkey Run P3 | No Barriers | Clear | Brown/silt/ sand | no odor | Few Spots | |
| Dead Run P1 | Waterfalls | Clear, but tea-colored | Brown/Silt | No odor | Many Spots | Light and Dark Green/Brown/ Matted/Hairy |
| Dead Run P2 | No Barriers | Clear, but tea-colored | Brown/Silt | None | Few Spots | Dark Green/Brown/Matted/Hairy |
| Dead Run P3 | Waterfalls | Clear | Brown/Silty/Sand | Musky | No Spots | Dark Green/Matted |
| Donaldson P1 | Waterfalls | Clear | Brown/Silt/Sand | None | No Spots | Dark Green/Matted |
| Donaldson P2 | Waterfalls | Clear, but tea-colored | Brown/Silty/Sandy | None | A Few Spots | Light/Dark Green/ Matted |
| Donaldson P3 | Waterfalls | Clear, but tea-colored | Brown/Silt/Sand | No Odor | No Spots | |
| Spout Run P1 | Waterfalls | Clear | Brown/Silt/Sandy | Sewage | Few Spots | Dark Green/Brown/Matted/Hairy |
| Spout Run P2 | None | Oily | Brown/Silty | Sewage | Few Spots | Dark Green |
| Spout Run P3 | Waterfalls | Oily | Brown/Silty | Sewage | Few Spots | Dark Green/Brown/Matted/Hairy |
| Windy Run P1 | Waterfalls | Clear | Brown/Silt/Sand | No Odor | Few Spots | Dark Green/Matted |
| Windy Run P2 | No Barriers | Clear | Brown/Silt/Sand | No Odor | Few Spots | Dark Green/Brown/Matted |
| Windy Run P3 | No Barriers | Clear | Brown/ Silty | No Odor | Few Spots | Light and Dark Green/Matted |
| Difficult Run P1 | None | Clear, but tea-colored | Brown/Silty | No Odor | Few Spots | Dark Green/Brown/Matted |
| Difficult Run P2 | Waterfalls | Clear | Brown/Silty | No Odor | Few Spots | Dark Green/Brown/Matted |
| Difficult Run P3 | Waterfalls | Clear | Brown/Silt/Sand | No Odor | Many Spots | Dark Green/ Brown Coated/ Matted/Hairy |
| CIA Run P1 | None | Oily | Brown/Silt/Sand | No Odor | Many Spots | Dark Green/ Brown Coated/ Matted/Hairy |
| CIA Run P2 | None | Oily | Brown/Silt/Sand | No Odor | Many Spots | Dark Green/ Brown Coated/ Matted/Hairy |
| CIA Run P3 | None | Clear, but tea-colored | Brown/Silty | No Odor | Few Spots | Dark Green/ Brown Coated/ Matted/Hairy |

# Appendix 6: 2010 Data Collection

| Round 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Stream | Algae located(In Spots/Everywhere) | Percent algae | Stream channel shade | % Silt | % Sand | % Gravel | % Cobbles |
| Mine Run P1 | In Spots | 5 | High | 0 | 20 | 30 | 50 |
| Mine Run P2 | | | High | 10 | 0 | 30 | 60 |
| Mine Run P3 | In Spots | 5 | High | 0 | 0 | 30 | 70 |
| Pimmit Run P1 | In Spots | 3 | Moderate | 1 | 1 | 8 | 90 |
| Pimmit Run P2 | In Spots | 40 | Full | 10 | 5 | 15 | 70 |
| Pimmit Run P3 | | | Slight | 10 | 50 | 10 | 30 |
| Gulf Branch P1 | | | High | 0 | 60 | 10 | 30 |
| Gulf Branch P2 | In Spots | 5 | High | 10 | 20 | 30 | 40 |
| Gulf Branch P3 | In Spots | 3 | High | 0 | 10 | 80 | 10 |
| Turkey Run P1 | In Spots | 20 | Full | 0 | 25 | 30 | 45 |
| Turkey Run P2 | | | Full | 0 | 80 | 15 | 5 |
| Turkey Run P3 | | | Full | 2 | 8 | 50 | 40 |
| Dead Run P1 | In Spots | 40 | Full | 5 | 10 | 10 | 75 |
| Dead Run P2 | In Spots | 40 | Full | 5 | 10 | 10 | 75 |
| Dead Run P3 | In Spots | 3 | High | 10 | 10 | 0 | 80 |
| Donaldson P1 | In Spots | 5 | High | 2 | 8 | 10 | 80 |
| Donaldson P2 | In Spots | 30 | Moderate | 0 | 10 | 30 | 60 |
| Donaldson P3 | | | Moderate | 0 | 5 | 15 | 80 |
| Spout Run P1 | In Spots | 25 | High | 0 | 5 | 55 | 40 |
| Spout Run P2 | In Spots | 5 | Full | 0 | 10 | 0 | 90 |
| Spout Run P3 | In Spots | 10 | Slight | 0 | 10 | 35 | 55 |
| Windy Run P1 | In Spots | 10 | High | 10 | 20 | 40 | 30 |
| Windy Run P2 | In Spots | 20 | Full | 5 | 15 | 40 | 40 |
| Windy Run P3 | In Spots | 30 | Full | 5 | 5 | 30 | 60 |
| Difficult Run P1 | Everywhere | | Moderate | 25 | 0 | 0 | 75 |
| Difficult Run P2 | Everywhere | | Slight | 20 | 0 | 40 | 40 |
| Difficult Run P3 | Everywhere | | Slight | 0 | 10 | 30 | 60 |
| CIA Run P1 | Everywhere | | Full | 5 | 5 | 45 | 45 |
| CIA Run P2 | Everywhere | | Full | 5 | 25 | 30 | 40 |
| CIA Run P3 | Everywhere | | Full | 10 | 20 | 40 | 30 |

Appendix 6: 2010 Data Collection

| Round 1 | | | | | | |
|---|---|---|---|---|---|---|
| Stream | Stream channel erosion potential | % Trees | % Shrubs | % Grass | % Bare Soil | % Rocks |
| Mine Run P1 | Slight | 10 | 10 | 0 | 50 | 30 |
| Mine Run P2 | Moderate | 5 | 0 | 5 | 90 | 0 |
| Mine Run P3 | Slight | 20 | 20 | 0 | 10 | 50 |
| Pimmit Run P1 | High | 50 | 20 | 0 | 0 | 30 |
| Pimmit Run P2 | High | 50 | 20 | 0 | 0 | 30 |
| Pimmit Run P3 | High | | | | | |
| Gulf Branch P1 | High | 20 | 30 | 0 | 0 | 50 |
| Gulf Branch P2 | Severe | 30 | 30 | 0 | 0 | 40 |
| Gulf Branch P3 | High | 10 | 0 | 0 | 60 | 30 |
| Turkey Run P1 | High | 10 | 40 | 0 | 50 | 0 |
| Turkey Run P2 | Severe | 10 | 90 | 0 | 0 | 0 |
| Turkey Run P3 | High | 80 | 10 | 0 | 0 | 10 |
| Dead Run P1 | Severe | 10 | 0 | 0 | 5 | 85 |
| Dead Run P2 | Severe | 10 | 0 | 0 | 5 | 85 |
| Dead Run P3 | High | 20 | 10 | 0 | 20 | 50 |
| Donaldson P1 | Moderate | 10 | 0 | 5 | 0 | 85 |
| Donaldson P2 | Slight | 10 | 90 | 0 | 0 | 0 |
| Donaldson P3 | Slight | 20 | 30 | 0 | 0 | 50 |
| Spout Run P1 | High | 20 | 50 | 0 | 0 | 30 |
| Spout Run P2 | Moderate | 5 | 10 | 5 | 10 | 70 |
| Spout Run P3 | Slight | 20 | 80 | 0 | 0 | 0 |
| Windy Run P1 | Moderate | 40 | 10 | 10 | 20 | 20 |
| Windy Run P2 | Severe | 20 | 10 | 5 | 60 | 5 |
| Windy Run P3 | High | 20 | 20 | 0 | 50 | 10 |
| Difficult Run P1 | Moderate | 30 | 0 | 20 | 20 | 30 |
| Difficult Run P2 | Moderate | 60 | 0 | 10 | 0 | 30 |
| Difficult Run P3 | Moderate | 10 | 60 | 20 | 0 | 10 |
| CIA Run P1 | High | 15 | 5 | 0 | 80 | 0 |
| CIA Run P2 | High | 40 | 0 | 0 | 40 | 20 |
| CIA Run P3 | High | 25 | 5 | 0 | 65 | 5 |

# Appendix 6: 2010 Data Collection

| Round 2 | | | | | |
|---|---|---|---|---|---|
| Stream | Latitude | Longitude | Description | Date | Certified Monitor |
| Mine Run P1 | 39 | 77.26 | 5m downstream from road | 6/17/2010 | Rita duMais, Nina Wester |
| Mine Run P2 | 39 | 77.26 | 15m upstream from road | 6/17/2010 | Rita duMais, Nina Wester |

| | | | | | |
|---|---|---|---|---|---|
| Mine Run P3 | 39 | 77.26 | 25m upstream from road | 6/17/2010 | Rita duMais, Nina Wester |
| Pimmit Run P1 | 38 | 77.16 | base of Switchback trail | 6/18/2010 | Rita duMais, Nina Wester |
| Pimmit Run P2 | 38 | 77.16 | 100m downstream from GW Pkwy | 6/18/2010 | Rita duMais, Nina Wester |
| Pimmit Run P3 | 38 | 77.16 | 50m downstream from GW Pkwy | 6/18/2010 | Rita duMais and Nina Wester |
| Gulf Branch P1 | 39 | 77.17 | 15-20m upstream from mouth | 6/22/2010 | Rita duMais and Nina Wester |
| Gulf Branch P2 | 39 | 77.17 | 50 m downstream | 6/22/2010 | Rita duMais and Nina Wester |
| Gulf Branch P3 | 39 | 77.17 | 70m downstream of GW Pkwy bridge, below falls | 6/22/2010 | Rita duMais and Nina Wester |
| Turkey Run P1 | 39 | 77.12 | 30 meters upstream Glebe Road Route 123 Bridge | 6/23/2010 | Rita duMais and Nina Wester |
| Turkey Run P2 | 39 | 77.12 | 50 meters upstream Glebe Road, Route 123 Bridge | 6/23/2010 | Rita duMais, Nina Wester |
| Turkey Run P3 | 39 | 77.12 | 80 meters upstream Glebe Road, Route 123 Bridge | 6/23/2010 | Rita duMais, Nina Wester |
| Dead Run P1 | 39 | 77.11 | 50m downstream from GW Pkwy | 6/24/2010 | Rita duMais, Nina Wester |
| Dead Run P2 | 39 | 77.11 | directly under bridge | 6/24/2010 | Normal |
| Dead Run P3 | 39 | 77.11 | 15 m upstream from bridge | 6/25/2010 | Normal |
| Donaldson P1 | 39 | 77.11 | 10m upstream from mouth | 6/25/2010 | Rita duMais and Nina Wester |
| Donaldson P2 | 39 | 77.11 | beneath GW Parkway bridge | 6/25/2010 | Rita duMais and Nina Wester |
| Donaldson P3 | 39 | 77.11 | 15m upstream from GW parkway | 6/28/2010 | Rita duMais and Nina Wester |
| Spout Run P1 | 39 | 77.08 | next to drainage pipe, off Spout Run Pkwy, under GW | 6/29/2010 | Rita duMais and Nina Wester |
| Spout Run P2 | 39 | 77.08 | 200 m upstream from P1 | 6/29/2010 | Rita duMais and Nina Wester |
| Spout Run P3 | 39 | 77.09 | below Spout Run, ~50 m upstream of 2nd drainage pipe | 6/29/2010 | Rita duMais and Nina Wester |
| Windy Run P1 | N 38° 54' 20.34" | W 077 05' 39.08" | After 2nd crossing of stream | 7/23/2010 | Rita duMais and Nina Wester |
| Windy Run P2 | N 38° 54' 19.31" | W 077 05' 40.62" | Below GWMP Bridge | 7/23/2010 | Rita duMais and Nina Wester` |
| Windy Run P3 | N 38° 54' 19.09" | W 077 05' 44.13" | After GWMP bridge, located at the third crossing of the stream. | 7/23/2010 | Rita duMais and Nina Wester |
| Difficult Run P1 | N 38° 58' 36.27" | W 077 14' 23.40" | | 7/26/2010 | Rita duMais and Nina Wester |
| Difficult Run P2 | N 38° 58' 37.42" | W 077 14' 27.50" | | 7/26/2010 | Rita duMais and Nina Wester |
| Difficult Run P3 | N 38° 58' 36.03" | W 077 14' 39.40" | | 7/26/2010 | Rita duMais and Nina Wester |
| CIA Run P1 | | | | 7/27/10 | Rita duMais and Nina Wester |
| CIA Run P2 | | | | 7/27/10 | Rita duMais and Nina Wester |
| CIA Run P3 | | | | 7/27/10 | Rita duMais and Nina Wester |

## Appendix 6: 2010 Data Collection

| Round 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stream | Average stream width | Average stream depth | Flow rate | Weather last 24 hours | Temp | Collection Time (net1) | Collection Time (net2) | Collection Time (net3) | Collection Time (net4) |
| Mine Run P1 | 10.6 | 3.2 | Normal | Cloudless | 21.1 | 90 | | | |
| Mine Run P2 | 12.5 | 2.8 | Normal | Cloudless | 21.6 | 90 | | | |
| Mine Run P3 | 13.2 | 7.7 | Normal | Cloudy or Partly Cloudy | 22.5 | 90 | 60 | | |
| Pimmit Run P1 | 20 | 5.8 | Normal | Cloudless | 21 | 90 | 30 | | |
| Pimmit Run P2 | 20.2 | 6 | Normal | Cloudless | 21.8 | 90 | | | |
| Pimmit Run P3 | 16.3 | 7 | Normal | Cloudless | 24.1 | 90 | | | |
| Gulf Branch P1 | 12.4 | 3.6 | Low | Cloudless | 21.6 | 90 | | | |
| Gulf Branch P2 | 9.9 | 11.1 | Low | Cloudless | 21.9 | 90 | 90 | | |
| Gulf Branch P3 | 19.6 | 2 | Low | Cloudless | 22.3 | 90 | 60 | | |
| Turkey Run P1 | 23.4 | 1.5 | Low | Cloudless | 21 | 90 | | | |
| Turkey Run P2 | 8.7 | 2.4 | Low | Cloudless | 21.3 | 90 | | | |
| Turkey Run P3 | 15.2 | 2.6 | Low | Cloudless | 22.1 | 90 | | | |
| Dead Run P1 | 7.25 | 3.7 | Low | Cloudy or Partly Cloudy | 24.9 | 90 | 60 | 60 | |
| Dead Run P2 | 15.8 | 3 | Low | Cloudy or Partly Cloudy | 23.1 | 90 | 90 | | |
| Dead Run P3 | 15.2 | 7.4 | Low | Cloudy or Partly Cloudy | 23.2 | 90 | | | |
| Donaldson P1 | 25.3 | 3.9 | Normal | Cloudy or Partly Cloudy | 23.1 | 90 | | | |
| Donaldson P2 | 11 | 4 | Normal | Cloudless | 24.2 | 90 | | | |
| Donaldson P3 | 9.9 | 5.2 | Normal | Cloudy or Partly Cloudy | 23.1 | 90 | | | |
| Spout Run P1 | 12.5 | 9.3 | Normal | Overcast | 23.5 | 90 | 90 | 90 | |
| Spout Run P2 | 16.9 | 12.5 | Normal | Cloudy or Partly Cloudy | 24.9 | 90 | 90 | 60 | |
| Spout Run P3 | 13.1 | 5 | Normal | Cloudy or Partly Cloudy | 25 | 90 | 90 | 90 | 60 |
| Windy Run P1 | 8.4 | 8.7 | Normal | Cloudless | 22.7 | 90 | 90 | | |
| Windy Run P2 | 10.5 | 3.5 | Normal | Cloudless | 23.4 | 90 | 60 | | |
| Windy Run P3 | 13.5 | 2.6 | Normal | Cloudless | 24.1 | 90 | | | |
| Difficult Run P1 | 47.1 | 6.1 | High | Cloudy or Partly Cloudy | 25.9 | 60 | | | |
| Difficult Run P2 | 62 | 16 | High | Cloudy or Partly Cloudy | 26.1 | 30 | | | |
| Difficult Run P3 | 64.2 | 11.6 | High | Cloudy or Partly Cloudy | 26.3 | 30 | | | |
| CIA Run P1 | 20.9 | 6.0 | Normal | Cloudless | 20.9 | 90 | 90 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CIA Run P2 | 10.2 | 2.0 | Normal | Cloudy or Party Cloudy | 21.1 | 90 | 90 | | |
| CIA Run P3 | 7.7 | 5.3 | Normal | Overcast | 21.7 | 90 | | | |

# Appendix 6: 2010 Data Collection

| Round 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stream | Worms | Flatworms | Leeches | Crayfish | Sowbugs | Scuds | Stoneflies | Mayflies | Dragonflies and Damselflies |
| Mine Run P1 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Mine Run P2 | 33 | 6 | 10 | 1 | 4 | 4 | 37 | 9 | 2 |
| Mine Run P3 | 26 | 3 | 29 | 0 | 1 | 10 | 41 | 9 | 10 |
| Pimmit Run P1 | 13 | 25 | 3 | 1 | 15 | 4 | 0 | 55 | 0 |
| Pimmit Run P2 | 21 | 6 | 6 | 0 | 15 | 0 | 0 | 38 | 1 |
| Pimmit Run P3 | 3 | 20 | 4 | 0 | 29 | 2 | 0 | 214 | 0 |
| Gulf Branch P1 | 14 | 2 | 14 | 0 | 3 | 25 | 0 | 10 | 0 |
| Gulf Branch P2 | 12 | 2 | 25 | 0 | 2 | 5 | 0 | 8 | 0 |
| Gulf Branch P3 | 28 | 2 | 28 | 0 | 3 | 0 | 0 | 0 | 0 |
| Turkey Run P1 | 0 | 1 | 9 | 0 | 1 | 21 | 0 | 14 | 0 |
| Turkey Run P2 | 6 | 0 | 18 | 0 | 0 | 0 | 0 | 6 | 0 |
| Turkey Run P3 | 6 | 0 | 7 | 0 | 1 | 3 | 0 | 32 | 0 |
| Dead Run P1 | 6 | 1 | 25 | 2 | 0 | 26 | 0 | 6 | 0 |
| Dead Run P2 | 10 | 0 | 8 | 1 | 0 | 11 | 0 | 11 | 0 |
| Dead Run P3 | 3 | 1 | 3 | 1 | 0 | 1 | 0 | 11 | 0 |
| Donaldson P1 | 13 | 0 | 17 | 0 | 0 | 50 | 0 | 30 | 0 |
| Donaldson P2 | 30 | 0 | 48 | 2 | 0 | 1 | 0 | 26 | 0 |
| Donaldson P3 | 4 | 4 | 51 | 0 | 2 | 6 | 0 | 18 | 0 |
| Spout Run P1 | 9 | 9 | 17 | 0 | 10 | 2 | 0 | 0 | 0 |
| Spout Run P2 | 2 | 5 | 44 | 0 | 5 | 5 | 0 | 0 | 0 |
| Spout Run P3 | 4 | 16 | 47 | 1 | 4 | 6 | 0 | 0 | 0 |
| Windy Run P1 | 9 | 44 | 8 | 5 | 2 | 0 | 0 | 18 | 0 |
| Windy Run P2 | 7 | 18 | 8 | 2 | 0 | 0 | 0 | 7 | 0 |
| Windy Run P3 | 14 | 69 | 12 | 1 | 0 | 0 | 0 | 10 | 0 |
| Difficult Run P1 | 10 | 36 | 5 | 0 | 0 | 17 | 1 | 40 | 0 |
| Difficult Run P2 | 1 | 1 | 3 | 0 | 0 | 6 | 0 | 9 | 0 |
| Difficult Run P3 | 0 | 14 | 0 | 0 | 0 | 5 | 0 | 17 | 0 |
| CIA Run P1 | 4 | 0 | 3 | 20 | 1 | 15 | 1 | 9 | 0 |
| CIA Run P2 | 3 | 0 | 9 | 25 | 1 | 9 | 0 | 9 | 0 |
| CIA Run | 0 | 0 | 3 | 6 | 0 | 0 | 0 | 1 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| P3 | | | | | | | | | |

# Appendix 6: 2010 Data Collection

| Round 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stream | Hellgrammites, Fishflies, and Alderflies | Common Netspinners | Most Caddisflies | Beetles | Midges | Blackflies | Most True Flies | Gilled Snails | Lunged Snails |
| Mine Run P1 | 0 | 142 | 53 | 36 | 8 | 0 | 14 | 0 | 0 |
| Mine Run P2 | 2 | 383 | 63 | 20 | 25 | 7 | 17 | 0 | 0 |
| Mine Run P3 | 2 | 73 | 13 | 24 | 13 | 4 | 40 | 0 | 0 |
| Pimmit Run P1 | 0 | 46 | 28 | 2 | 44 | 5 | 1 | 0 | 0 |
| Pimmit Run P2 | 0 | 69 | 72 | 1 | 17 | 1 | 2 | 0 | 0 |
| Pimmit Run P3 | 0 | 120 | 12 | 1 | 27 | 0 | 1 | 0 | 0 |
| Gulf Branch P1 | 0 | 70 | 3 | 0 | 71 | 20 | 11 | 0 | 1 |
| Gulf Branch P2 | 0 | 58 | 0 | 1 | 63 | 5 | 21 | 0 | 2 |
| Gulf Branch P3 | 0 | 71 | 0 | 0 | 23 | 6 | 40 | 0 | 0 |
| Turkey Run P1 | 0 | 192 | 8 | 3 | 33 | 2 | 6 | 0 | 0 |
| Turkey Run P2 | 0 | 189 | 1 | 5 | 19 | 3 | 4 | 0 | 0 |
| Turkey Run P3 | 0 | 399 | 22 | 2 | 21 | 5 | 0 | 0 | 0 |
| Dead Run P1 | 0 | 106 | 24 | 0 | 26 | 8 | 1 | 0 | 0 |
| Dead Run P2 | 0 | 60 | 24 | 0 | 111 | 0 | 10 | 0 | 0 |
| Dead Run P3 | 0 | 84 | 4 | 1 | 123 | 5 | 8 | 0 | 0 |
| Donaldson P1 | 0 | 19 | 7 | 0 | 53 | 3 | 2 | 0 | 15 |
| Donaldson P2 | 0 | 108 | 6 | 0 | 49 | 3 | 18 | 0 | 9 |
| Donaldson P3 | 0 | 35 | 7 | 0 | 24 | 0 | 7 | 0 | 44 |
| Spout Run P1 | 0 | 71 | 0 | 0 | 70 | 0 | 3 | 0 | 10 |
| Spout Run P2 | 0 | 69 | 0 | 2 | 52 | 2 | 5 | 0 | 8 |
| Spout Run P3 | 0 | 21 | 0 | 0 | 58 | 2 | 0 | 0 | 6 |
| Windy Run P1 | 0 | 43 | 59 | 0 | 25 | 2 | 3 | 0 | 0 |
| Windy Run P2 | 0 | 28 | 27 | 0 | 109 | 0 | 3 | 0 | 0 |
| Windy Run P3 | 0 | 25 | 5 | 0 | 62 | 3 | 0 | 0 | 0 |
| Difficult Run P1 | 4 | 126 | 355 | 170 | 5 | 0 | 0 | 0 | 1 |
| Difficult Run P2 | 3 | 60 | 159 | 62 | 6 | 0 | 1 | 0 | 0 |
| Difficult Run P3 | 0 | 105 | 5 | 54 | 56 | 0 | 0 | 0 | 0 |
| CIA Run P1 | 0 | 38 | 36 | 1 | 75 | 0 | 5 | 0 | 0 |
| CIA Run | 1 | 53 | 23 | 1 | 70 | 0 | 6 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| P2 | | | | | | | | | |
| CIA Run P3 | 0 | 25 | 53 | 2 | 122 | 0 | 6 | 0 | 0 |

# Appendix 6: 2010 Data Collection

| Round 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Stream | Clams | Total Organisms | Metric 1 - Percent Mayflies, Stoneflies, and Most Caddisflies | Metric 2 - Percent Common Netspinners | Metric 3 - Percent Lunged Snails | Metric 4 - Percent Beetles | Metric 5 - Percent Tolerant |
| Mine Run P1 | 1 | 276 | 21.7391 | 51.4493 | 0 | 13.0435 | 8.33 |
| Mine Run P2 | 9 | 622 | 17.2468 | 60.6013 | 0 | 3.1646 | 15.82 |
| Mine Run P3 | 13 | 290 | 20.3226 | 23.5484 | 0 | 7.7419 | 34.84 |
| Pimmit Run P1 | 0 | 242 | 34.2975 | 19.0083 | 0 | 0.8264 | 45.04 |
| Pimmit Run P2 | 0 | 248 | 44.1767 | 27.7108 | 0 | 0.4016 | 26.91 |
| Pimmit Run P3 | 0 | 333 | 52.194 | 27.7136 | 0 | 0.2309 | 19.63 |
| Gulf Branch P1 | 0 | 244 | 5.3279 | 28.6885 | 0.4098 | 0 | 61.48 |
| Gulf Branch P2 | 0 | 204 | 3.9216 | 28.4314 | 0.9804 | 0.4902 | 56.86 |
| Gulf Branch P3 | 0 | 201 | 0 | 35.3234 | 0 | 0 | 44.78 |
| Turkey Run P1 | 2 | 292 | 7.5342 | 65.7534 | 0 | 1.0274 | 23.63 |
| Turkey Run P2 | 0 | 251 | 2.7888 | 75.2988 | 0 | 1.992 | 18.33 |
| Turkey Run P3 | 0 | 498 | 10.8434 | 80.1205 | 0 | 0.4016 | 8.63 |
| Dead Run P1 | 3 | 234 | 12.8205 | 45.2991 | 0 | 0 | 40.6 |
| Dead Run P2 | 0 | 246 | 14.2276 | 24.3902 | 0 | 0 | 56.91 |
| Dead Run P3 | 0 | 245 | 6.1224 | 34.2857 | 0 | 0.4082 | 55.51 |
| Donaldson P1 | 0 | 209 | 17.7033 | 9.0909 | 7.177 | 0 | 72.25 |
| Donaldson P2 | 0 | 300 | 10.6667 | 36 | 3 | 0 | 46.67 |
| Donaldson P3 | 0 | 202 | 12.3762 | 17.3267 | 21.7822 | 0 | 66.83 |
| Spout Run P1 | 0 | 201 | 0 | 35.3234 | 4.9751 | 0 | 63.18 |
| Spout Run P2 | 0 | 200 | 0 | 34.5 | 4 | 1 | 62 |
| Spout Run P3 | 0 | 219 | 0 | 12.7273 | 3.6364 | 0 | 86.67 |
| Windy Run P1 | 0 | 218 | 35.3211 | 19.7248 | 0 | 0 | 41.28 |
| Windy Run P2 | 0 | 209 | 16.2679 | 13.3971 | 0 | 0 | 67.94 |
| Windy Run P3 | 0 | 201 | 7.4627 | 12.4378 | 0 | 0 | 79.6 |
| Difficult Run P1 | 13 | 783 | 50.5747 | 16.092 | 0.1277 | 21.7114 | 11.11 |
| Difficult Run P2 | 4 | 315 | 53.3333 | 19.0476 | 0 | 19.6825 | 4.76 |
| Difficult Run P3 | 0 | 253 | 8.5938 | 41.0156 | 0 | 21.0938 | 29.3 |
| CIA Run P1 | 0 | 208 | 22.1154 | 18.2692 | 0 | 0.4808 | 47.12 |
| CIA Run P2 | 0 | 210 | 15.2381 | 25.2381 | 0 | 0.4762 | 43.81 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CIA Run P3 | 0 | 218 | 24.7706 | 11.4679 | 0 | 0.9174 | 57.34 |

# Appendix 6: 2010 Data Collection

| Round 2 | | | | |
|---|---|---|---|---|
| Stream | Metric 6 - Percent Non-Insect | Score | Ecological Conditions | Fish Water Quality Indicators |
| Mine Run P1 | 5.43 | 8 | Acceptable | Scattered Individuals |
| Mine Run P2 | 10.6 | 6 | Unacceptable | Scattered Individuals |
| Mine Run P3 | 26.63 | 8 | Acceptable | Scattered Individuals |
| Pimmit Run P1 | 25.21 | 8 | Acceptable | Scattered Individuals |
| Pimmit Run P2 | 19.28 | 8 | Acceptable | Scattered Individuals |
| Pimmit Run P3 | 13.39 | 8 | Acceptable | Scattered Individuals |
| Gulf Branch P1 | 24.18 | 3 | Unacceptable | Scattered Individuals |
| Gulf Branch P2 | 23.53 | 3 | Unacceptable | Scattered Individuals |
| Gulf Branch P3 | 30.35 | 4 | Unacceptable | Scattered Individuals |
| Turkey Run P1 | 11.64 | 5 | Unacceptable | Scattered Individuals |
| Turkey Run P2 | 9.56 | 5 | Unacceptable | Scattered Individuals |
| Turkey Run P3 | 3.41 | 6 | Unacceptable | Scattered Individuals |
| Dead Run P1 | 26.92 | 4 | Unacceptable | Scattered Individuals |
| Dead Run P2 | 12.2 | 5 | Unacceptable | Scattered Individuals |
| Dead Run P3 | 3.67 | 6 | Unacceptable | Scattered Individuals |
| Donaldson P1 | 45.45 | 3 | Unacceptable | Scattered Individuals |
| Donaldson P2 | 30 | 2 | Unacceptable | Scattered Individuals |
| Donaldson P3 | 54.95 | 2 | Unacceptable | Scattered Individuals |
| Spout Run P1 | 28.36 | 0 | Unacceptable | No Fish |
| Spout Run P2 | 35 | 0 | Unacceptable | No Fish |
| Spout Run P3 | 50.91 | 2 | Unacceptable | No Fish |
| Windy Run P1 | 31.19 | 7 | Acceptable | No Fish |
| Windy Run P2 | 16.75 | 6 | Unacceptable | No Fish |
| Windy Run P3 | 47.74 | 4 | Unacceptable | No Fish |
| Difficult Run P1 | 10.47 | 11 | Acceptable | Scattered Individuals |
| Difficult Run P2 | 4.76 | 12 | Acceptable | Scattered Individuals |

| | | | | |
|---|---|---|---|---|
| Difficult Run P3 | 7.42 | 7 | Acceptable | Scattered Individuals |
| CIA Run P1 | 20.67 | 7 | Acceptable | Scattered Individuals |
| CIA Run P2 | 22.38 | 5 | Unacceptable | Scattered Individuals |
| CIA Run P3 | 4.13 | 8 | Acceptable | No Fish |

# Appendix 6: 2010 Data Collection

| Round 2 | | | | | | |
|---|---|---|---|---|---|---|
| Stream | Barriers to Fish Movement | Surface-water appearance | Stream Bed Deposit | Odor | Stability of stream | Algae Color |
| Mine Run P1 | No Barriers | Clear | Brown/Tan/Silty/Muddy | No Odor | No Spots | None |
| Mine Run P2 | No Barriers | Clear | Brown/Tan/Silty/Sandy | No Odor | No Spots | None |
| Mine Run P3 | Waterfalls | Muddy | Silty/Sandy | No Odor | A Few Spots | Dark Green |
| Pimmit Run P1 | No Barriers | Clear | Sandy | No Odor | No Spots | None |
| Pimmit Run P2 | No Barriers | Clear | Brown/Tan/Sandy | No Odor | A Few Spots | Dark Green/Brown Coated |
| Pimmit Run P3 | Waterfalls | Clear | Brown/Tan/Silty/Sandy | No Odor | A Few Spots | Light Green/Dark Green |
| Gulf Branch P1 | Waterfalls | Clear but tea colored | Brown/Tan/Silty/Sandy | No Odor | A Few Spots | None |
| Gulf Branch P2 | Waterfalls | Clear but tea colored | Brown/Tan/Silty/Sandy | No Odor | A Few Spots | Dark Green |
| Gulf Branch P3 | Waterfalls | Clear but tea colored | Brown/Tan/Silty/Sandy | No Odor | A Few Spots | Dark Green/Brown Coated |
| Turkey Run P1 | Waterfalls | Clear | Brown/Tan/Silty | No Odor | A Few Spots | Light Green/Dark Green |
| Turkey Run P2 | Waterfalls | Clear | Silty/Sandy | No Odor | Many Spots | Dark Green |
| Turkey Run P3 | No Barriers | Clear | Brown/Tan/Silty/Sandy | No Odor | No Spots | Light Green/ Dark Green |
| Dead Run P1 | Waterfalls | Clear but tea colored | Brown/Tan/Silty | No Odor | A Few Spots | Dark Green |
| Dead Run P2 | Waterfalls | Clear but tea colored | Brown/Tan/Silty/Sandy | No Odor | A Few Spots | Dark green/Brown Coated |
| Dead Run P3 | Waterfalls | Clear but tea colored | Brown/Tan/Silty | No Odor | A Few Spots | Dark Green/Brown Coated |
| Donaldson P1 | Waterfalls | Clear | Brown/Tan/Silty | No Odor | A Few Spots | None |
| Donaldson P2 | Waterfalls | Clear | Brown/Tan/Silty/Sandy | No Odor | A Few Spots | Dark Green |
| Donaldson P3 | Waterfalls | Clear but tea colored | Brown/Tan/Silty/Sandy | No Odor | A Few Spots | Light Green/Dark Green/Brown |
| Spout Run P1 | Waterfalls | Oily | Brown/Tan/Sandy | No Odor | Many Spots | Dark Green/Brown |
| Spout Run P2 | Waterfalls | Clear but tea colored | Brown/Tan/Silty | Musky | A Few Spots | Dark Green/Brown |
| Spout Run P3 | Waterfalls | Clear but tea colored | Brown/Tan/Silty/Sandy | No Odor | Many Spots | Dark Green/Brown |
| Windy Run P1 | Waterfalls | Clear | Brown/Tan/Sandy | No Odor | No Spots | None |
| Windy Run P2 | None | Clear | Brown/Tan/Sandy | No Odor | A Few Spots | Dark Green/Matted |
| Windy Run P3 | None | Clear | Brown/Tan/Sandy | No Odor | No Spots | None |
| Difficult Run P1 | Waterfalls | Muddy | Brown/Tan/Silty | No Odor | Many Spots | Brown/Matted/Hairy |
| Difficult Run P2 | Waterfalls | Muddy | Brown/Tan/Silty | No Odor | Many Spots | Light Green/Dark Green/Brown/Matted/Hairy |
| Difficult Run P3 | Waterfalls/High water flow | Muddy | Brown/Tan/Silty | No Odor | Many Spots | Brown/Matted/Hairy |
| CIA Run P1 | No Barriers | Oily | Brown/Tan/Silty | No Odor | Many Spots | Dark Green/Brown/Matted |
| CIA Run P2 | No Barriers | Oily | Brown/Tan/Silty | No Odor | No Spots | None |

| | | | | | | |
|---|---|---|---|---|---|---|
| CIA Run P3 | No Barriers | Foamy | Brown/Tan/Silty | No Odor | Many Spots | Brown/Matted |

| Round 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stream | Algae located | Percent algae | Stream shade | % Silt | % Sand | % Gravel | % Cobbles | Stream channel erosion potential |
| Mine Run P1 | None | 0 | High | 30 | 10 | 40 | 20 | Slight |
| Mine Run P2 | None | 0 | High | 15 | 20 | 35 | 40 | High |
| Mine Run P3 | In Spots | 10 | Moderate | 0 | 30 | 50 | 20 | Moderate |
| Pimmit Run P1 | None | 0 | Moderate | 0 | 30 | 50 | 20 | Moderate |
| Pimmit Run P2 | In Spots | 10 | Slight | 5 | 15 | 60 | 20 | Moderate |
| Pimmit Run P3 | In Spots | 40 | High | 10 | 5 | 15 | 70 | High |
| Gulf Branch P1 | None | 0 | Moderate | 0 | 5 | 10 | 85 | High |
| Gulf Branch P2 | In Spots | 3 | Moderate | 0 | 30 | 40 | 30 | Moderate |
| Gulf Branch P3 | In Spots | 50 | Moderate | 0 | 30 | 40 | 30 | High |
| Turkey Run P1 | In Spots | 10 | Full | 20 | 5 | 50 | 25 | High |
| Turkey Run P2 | In Spots | 80 | Full | 0 | 40 | 20 | 40 | High |
| Turkey Run P3 | in spots | 10 | Full | 5 | 20 | 45 | 30 | High |
| Dead Run P1 | Everywhere | 100 | High | 10 | 10 | 40 | 40 | High |
| Dead Run P2 | In Spots | 25 | High | 0 | 10 | 10 | 80 | Moderate |
| Dead Run P3 | In Spots | 40 | Full | 20 | 10 | 50 | 20 | High |
| Donaldson P1 | None | 0 | Full | 10 | 20 | 60 | 10 | Moderate |
| Donaldson P2 | In Spots | 50 | Slight | 0 | 10 | 10 | 80 | Moderate |
| Donaldson P3 | In Spots | 40 | High | 5 | 5 | 60 | 30 | Moderate |
| Spout Run P1 | In Spots | 40 | Moderate | 0 | 10 | 50 | 40 | High |
| Spout Run P2 | In Spots | 20 | Slight | 10 | 10 | 20 | 60 | High |
| Spout Run P3 | In Spots | 10 | Slight | 5 | 20 | 65 | 10 | Severe |
| Windy Run P1 | N/A | 0 | Full | 0 | 10 | 30 | 60 | Severe |
| Windy Run P2 | In Spots | 30 | Full | 0 | 10 | 10 | 80 | Severe |
| Windy Run P3 | N/A | 0 | Full | 0 | 0 | 10 | 90 | Severe |
| Difficult Run P1 | Everywhere | 100 | Moderate | 0 | 0 | 20 | 80 | High |
| Difficult Run P2 | Everywhere | 100 | Slight | 0 | 0 | 10 | 90 | High |
| Difficult Run P3 | Everywhere | 100 | Slight | 0 | 0 | 5 | 95 | Severe |
| CIA Run P1 | Everywhere | 100 | Full | 0 | 10 | 20 | 70 | Severe |
| CIA Run P2 | N/A | 0 | High | 20 | 20 | 20 | 40 | Severe |
| CIA Run P3 | In Spots | 50 | Full | 0 | 2 | 8 | 90 | Severe |

| Round 2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Area 1 | Area 2 | Area 3 | % Trees | % Shrubs | % Grass | % Bare Soil | % Rocks |
| Mine Run P1 | 3x3 | | | 5 | 20 | 20 | 55 | 0 |
| Mine Run P2 | 3x3 | | | 30 | 5 | 5 | 60 | 0 |
| Mine Run P3 | 3x3 | 3x3 | | 10 | 0 | 30 | 20 | 40 |
| Pimmit Run P1 | 3x3 | 3x3 | | 40 | 0 | 0 | 10 | 50 |
| Pimmit Run P2 | 3x3 | | | 20 | 0 | 5 | 60 | 15 |
| Pimmit Run P3 | 3x3 | | | 20 | 20 | 20 | 20 | 20 |
| Gulf Branch P1 | 3x3 | | | 10 | 20 | 0 | 70 | 0 |
| Gulf Branch P2 | 3x3 | 3x3 | | 10 | 0 | 40 | 10 | 40 |
| Gulf Branch P3 | 3x3 | 2x3 | | 20 | 0 | 30 | 30 | 20 |
| Turkey Run P1 | 3x3 | | | 20 | 10 | 0 | 60 | 10 |
| Turkey Run P2 | 3x3 | | | 30 | 0 | 0 | 60 | 10 |
| Turkey Run P3 | 3x3 | | | 20 | 40 | 10 | 25 | 5 |
| Dead Run P1 | 3x3 | 2x3 | 2z3 | 10 | 10 | 0 | 5 | 75 |
| Dead Run P2 | 3x3 | 3x3 | | 10 | 10 | 5 | 70 | 5 |
| Dead Run P3 | 3x3 | | | 10 | 0 | 10 | 0 | 80 |
| Donaldson P1 | 3x3 | | | 30 | 25 | 5 | 0 | 40 |
| Donaldson P2 | 3x3 | | | 5 | 75 | 0 | 5 | 15 |
| Donaldson P3 | 3x3 | | | 10 | 75 | 0 | 0 | 15 |
| Spout Run P1 | 3x3 | 3x3 | 3x3 | 5 | 20 | 0 | 15 | 40 |
| Spout Run P2 | 2x3 | 2x3 | 2x3 | 20 | 10 | 10 | 10 | 50 |
| Spout Run P3 | 2x3 | 2x3 | 2x3 | 10 | 0 | 0 | 80 | 10 |
| Windy Run P1 | 3x3 | 3x3 | | 20 | 50 | 0 | 30 | 0 |
| Windy Run P2 | 3x3 | 3x3 | | 30 | 20 | 0 | 50 | 0 |
| Windy Run P3 | 3x3 | | | 30 | 15 | 0 | 50 | 5 |
| Difficult Run P1 | 3x3 | | | 20 | 5 | 5 | 35 | 35 |
| Difficult Run P2 | 2x3 | | | 10 | 0 | 5 | 5 | 80 |
| Difficult Run P3 | 2x3 | | | 50 | 5 | 5 | 10 | 30 |
| CIA Run P1 | 3x3 | 3x3 | | 40 | 10 | 0 | 50 | 0 |
| CIA Run P2 | 3x3 | 2x3 | | 25 | 5 | 0 | 50 | 20 |
| CIA Run P3 | 2x3 | | | 25 | 20 | 0 | 50 | 5 |

# Appendix 6:  2010 Data Collection

| Round 3 | | | | | |
|---|---|---|---|---|---|
| Stream | Latitude | Longitude | Description | Date | Name of Certified Monitor |
| Mine Run P1 | 39 | 77.26 | 5m downstream from road | 7/7/2010 | Rita duMais, Nina Wester |
| Mine Run P2 | 39 | 77.26 | 15m upstream from road | 7/7/2010 | Rita duMais and Nina Wester |
| Mine Run P3 | 39 | 77.26 | 25m upstream from road | 7/7/2010 | Rita duMais and Nina Wester |
| Pimmit Run P1 | 38 | 77.16 | base of Switchback trail | 7/8/2010 | Rita duMais and Nina Wester |
| Pimmit Run P2 | 38 | 77.16 | 100m downstream from GW Pkwy | 7/8/2010 | Rita duMais and Nina Wester |
| Pimmit Run P3 | 38 | 77.16 | 50m downstream from GW Pkwy | 7/8/2010 | Rita duMais and Nina Wester |
| Gulf Branch P1 | 39 | 77.17 | 15-20m upstream from mouth | 7/12/2010 | Rita duMais and Nina Wester |
| Gulf Branch P2 | 39 | 77.17 | 50 m downstream | 7/12/2010 | Rita duMais and Nina Wester |
| Gulf Branch P3 | 39 | 77.17 | 70m downstream of GW Pkwy bridge, below falls | 7/12/2010 | Rita duMais and Nina Wester |
| Turkey Run P1 | 39 | 77.12 | 30 meters upstream Glebe Road Route 123 Bridge | 7/13/2010 | Rita duMais and Nina Wester |
| Turkey Run P2 | 39 | 77.12 | 50 meters upstream Glebe Road, Route 123 Bridge | 7/13/2010 | Rita duMais and Nina Wester |
| Turkey Run P3 | 39 | 77.12 | 80 meters upstream Glebe Road, Route 123 Bridge | 7/13/2010 | Rita duMais and Nina Wester |
| Dead Run P1 | 39 | 77.11 | 50m downstream from GW Pkwy | 7/15/2010 | Rita duMais and Nina Wester |
| Dead Run P2 | 39 | 77.11 | directly under bridge | 7/15/2010 | Rita duMais and Nina Wester |
| Dead Run P3 | 39 | 77.11 | 15 m upstream from bridge | 7/16/2010 | Rita duMais and Nina Wester |
| Donaldson P1 | 39 | 77.11 | 10m upstream from mouth | 7/16/2010 | Rita duMais and Nina Wester |
| Donaldson P2 | 39 | 77.11 | beneath GW Parkway bridge | 7/16/2010 | Rita duMais and Nina Wester |
| Donaldson P3 | 39 | 77.11 | 15m upstream from GW parkway | 7/20/2010 | Rita duMais and Nina Wester |
| Spout Run P1 | 39 | 77.08 | next to drainage pipe, off Spout Run Pkwy, under GW | 7/20/2010 | Rita duMais and Nina Wester |
| Spout Run P2 | 39 | 77.08 | 200 m upstream from P1 | 7/20/2010 | Rita duMais and Nina Wester |
| Spout Run P3 | 39 | 77.09 | below Spout Run, ~50 m upstream of 2nd drainage pipe | 7/20/2010 | Rita duMais and Nina Wester |

# Appendix 6: 2010 Data Collection

| Round 3 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Stream | Average stream width | Average stream depth | Flow rate | Weather last 24 hours | Water Temp | Collect. Time (net1) | Collect. Time (net2) |
| Mine Run P1 | 10.4 | 4.2 | Normal | Cloudless | 22.5 | 60 | |
| Mine Run P2 | 12 | 2.6 | Normal | Cloudless | 22.9 | 30 | |
| Mine Run P3 | 8.5 | 3.4 | Normal | Cloudless | 24.2 | 60 | |
| Pimmit Run P1 | 9 | 6.4 | Normal | Cloudless | 25.2 | 90 | |
| Pimmit Run P2 | 25.9 | 5.4 | Normal | Cloudless | 26.0 | 90 | |
| Pimmit Run P3 | 23.0 | 4.8 | Normal | Cloudless | 27.3 | 90 | |
| Gulf Branch P1 | 11.1 | 4.9 | Normal | Cloudy/Partly Cloudy | 22.2 | 90 | 90 |
| Gulf Branch P2 | 11.6 | 6.5 | Normal | Overcast | 22.7 | 90 | 90 |
| Gulf Branch P3 | 16.2 | 2.88 | Normal | Overcast | 22.8 | 90 | |
| Turkey Run P1 | 12.3 | 10.0 | Normal | Drizzle/Light Rain | 21.2 | 90 | |
| Turkey Run P2 | 8.6 | 2.2 | High | Overcast | 21.2 | 90 | |
| Turkey Run P3 | 15.1 | 4.4 | Normal | Overcast | 21.3 | 90 | |
| Dead Run P1 | 6.7 | 10.1 | High | Cloudy/Partly Cloudy | 22.9 | 90 | 60 |
| Dead Run P2 | 13 | 4.2 | High | Cloudy/Partly Cloudy | 23.2 | 90 | |
| Dead Run P3 | 13.1 | 9.8 | Normal | Cloudy/Partly Cloudy | 23.5 | 90 | |
| Donaldson P1 | 24.6 | 4.3 | Normal | Cloudless | 23.6 | 90 | 30 |
| Donaldson P2 | 12.5 | 6.5 | Normal | Cloudy/Partly Cloudy | 24.2 | 90 | 60 |
| Donaldson P3 | 7.2 | 4.9 | Normal | Cloudy/Partly Cloudy | 23.0 | 90 | |
| Spout Run P1 | 14.3 | 10.2 | Normal | Overcast | 24.2 | 90 | |
| Spout Run P2 | 13.1 | 7.7 | Normal | Cloudy/Partly Cloudy | 24.6 | 90 | |
| Spout Run P3 | 15.0 | 6.6 | Normal | Cloudy/Partly Cloudy | 25.3 | 90 | 60 |

# Appendix 6: 2010 Data Collection

| Round 3 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Stream | First Page Comments | Worms | Flatworms | Leeches | Crayfish | Sowbugs | Scuds | Stoneflies | Mayflies | Dragonflies and Damselflies |
| Mine Run P1 | Found two salamanders and one fish in net | 24 | 10 | 2 | 1 | 1 | 3 | 46 | 3 | 2 |
| Mine Run P2 | Found two salamanders and one fish in net | 19 | 6 | 0 | 3 | 0 | 2 | 66 | 1 | 1 |
| Mine Run P3 | Found one salamander in net | 7 | 0 | 10 | 3 | 4 | 12 | 41 | 6 | 16 |
| Pimmit Run P1 | | 11 | 79 | 2 | 0 | 15 | 3 | 0 | 23 | 0 |
| Pimmit Run P2 | Found 2 horsehair worms, 2 Fish, and 1 eel. Also, there is a notable algae bloom occurring near this site. | 15 | 58 | 1 | 0 | 6 | 1 | 0 | 3 | 0 |
| Pimmit Run P3 | | 2 | 86 | 0 | 0 | 5 | 0 | 0 | 17 | 1 |
| Gulf Branch P1 | | 2 | 2 | 43 | 0 | 0 | 21 | 0 | 19 | 0 |
| Gulf Branch P2 | | 53 | 1 | 21 | 1 | 8 | 19 | 0 | 15 | 0 |
| Gulf Branch P3 | | 29 | 2 | 16 | 0 | 4 | 0 | 0 | 0 | 0 |
| Turkey Run P1 | | 4 | 0 | 4 | 1 | 0 | 8 | 0 | 8 | 0 |
| Turkey Run P2 | The water is extremely cloudy From thunderstorms from last night. | 5 | 1 | 11 | 4 | 0 | 7 | 1 | 5 | 0 |
| Turkey Run P3 | Found 2 salamanders in net | 4 | 0 | 3 | 4 | 0 | 6 | 0 | 21 | 0 |
| Dead Run P1 | Saw toad on rock | 3 | 0 | 7 | 2 | 1 | 5 | 0 | 8 | 0 |
| Dead Run P2 | | 4 | 2 | 7 | 1 | 0 | 2 | 0 | 0 | 0 |
| Dead Run P3 | | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 1 |
| Donaldson P1 | | 6 | 3 | 43 | 0 | 0 | 9 | 0 | 20 | 0 |
| Donaldson P2 | | 9 | 8 | 9 | 1 | 0 | 0 | 0 | 76 | 0 |
| Donaldson P3 | | 5 | 1 | 31 | 0 | 0 | 1 | 0 | 88 | 0 |
| Spout Run P1 | | 20 | 8 | 20 | 0 | 1 | 2 | 0 | 97 | 0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Spout Run P2 | | 40 | 10 | 9 | 2 | 1 | 1 | 0 | 26 | 0 |
| Spout Run P3 | | 46 | 45 | 6 | 0 | 0 | 0 | 0 | 71 | 0 |

# Appendix 6: 2010 Data Collection

| Round 3 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Stream | Hellgrammites, Fishflies, and Alderflies | Common Netspinners | Most Caddisflies | Beetles | Midges | Blackflies | Most True Flies | Gilled Snails | Lunged Snails | Clams |
| Mine Run P1 | 1 | 124 | 18 | 20 | 38 | 2 | 21 | 0 | 0 | 1 |
| Mine Run P2 | 2 | 292 | 25 | 21 | 19 | 4 | 13 | 0 | 0 | 2 |
| Mine Run P3 | 1 | 64 | 7 | 23 | 11 | 0 | 8 | 0 | 0 | 0 |
| Pimmit Run P1 | 0 | 69 | 63 | 1 | 31 | 6 | 0 | 0 | 0 | 0 |
| Pimmit Run P2 | 0 | 284 | 176 | 1 | 63 | 11 | 0 | 0 | 0 | 0 |
| Pimmit Run P3 | 0 | 79 | 86 | 0 | 52 | 3 | 1 | 0 | 0 | 0 |
| Gulf Branch P1 | 0 | 75 | 2 | 0 | 55 | 3 | 10 | 0 | 0 | 0 |
| Gulf Branch P2 | 0 | 122 | 0 | 0 | 137 | 12 | 9 | 0 | 2 | 0 |
| Gulf Branch P3 | 0 | 38 | 0 | 1 | 88 | 9 | 14 | 0 | 1 | 0 |
| Turkey Run P1 | 0 | 144 | 54 | 0 | 6 | 0 | 5 | 0 | 0 | 0 |
| Turkey Run P2 | 0 | 142 | 10 | 3 | 18 | 3 | 4 | 0 | 0 | 0 |
| Turkey Run P3 | 0 | 234 | 23 | 2 | 16 | 3 | 3 | 0 | 0 | 0 |
| Dead Run P1 | 0 | 142 | 63 | 2 | 89 | 2 | 6 | 0 | 0 | 0 |
| Dead Run P2 | 0 | 56 | 71 | 1 | 100 | 1 | 1 | 0 | 0 | 0 |
| Dead Run P3 | 0 | 26 | 6 | 1 | 141 | 0 | 4 | 0 | 1 | 0 |
| Donaldson P1 | 0 | 113 | 0 | 1 | 81 | 0 | 4 | 0 | 10 | 0 |
| Donaldson P2 | 0 | 101 | 1 | 0 | 21 | 0 | 1 | 0 | 9 | 0 |
| Donaldson P3 | 0 | 15 | 0 | 3 | 55 | 0 | 1 | 0 | 5 | 0 |
| Spout Run P1 | 0 | 23 | 1 | 0 | 83 | 0 | 0 | 0 | 0 | 0 |
| Spout Run P2 | 0 | 26 | 0 | 0 | 91 | 0 | 1 | 1 | 0 | 0 |
| Spout Run P3 | 0 | 31 | 0 | 0 | 62 | 0 | 2 | 0 | 1 | 0 |

# Appendix 6: 2010 Data Collection

| Round 3 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stream | Total Organisms | Metric 1 - Percent Mayflies, Stoneflies, and Most Caddisflies | Metric 2 - Percent Common Netspinners | Metric 3 - Percent Lunged Snails | Metric 4 - Percent Beetles | Metric 5 - Percent Tolerant | Metric 6 - Percent Non-Insect | Score | Ecological Conditions |
| Mine Run P1 | 317 | 21.1356 | 39.1167 | 0 | 6.3091 | 26.18 | 13.25 | 7 | Acceptable |
| Mine Run P2 | 476 | 19.3277 | 61.6445 | 0 | 4.4118 | 11.13 | 6.72 | 7 | Acceptable |
| Mine Run P3 | 213 | 25.3521 | 30.0469 | 0 | 10.7981 | 28.17 | 16.9 | 9 | Acceptable |
| Pimmit Run P1 | 303 | 28.3828 | 22.7723 | 0 | 0.33 | 48.51 | 36.3 | 5 | Unacceptable |
| Pimmit Run P2 | 619 | 28.9176 | 45.8805 | 0 | 0.1616 | 25.04 | 13.09 | 6 | Unacceptable |
| Pimmit Run P3 | 332 | 31.0241 | 23.7952 | 0 | 0 | 44.88 | 28.01 | 6 | Unacceptable |
| Gulf Branch P1 | 232 | 9.0517 | 32.3276 | 0 | 0 | 54.31 | 29.31 | 4 | Unacceptable |
| Gulf Branch P2 | 419 | 3.75 | 30.5 | 0.5 | 0 | 63.25 | 26.25 | 2 | Unacceptable |
| Gulf Branch P3 | 202 | 0 | 18.8119 | 0.495 | 0.495 | 73.76 | 25.74 | 3 | Unacceptable |
| Turkey Run P1 | 226 | 26.4957 | 61.5385 | 0 | 0 | 9.4 | 7.26 | 6 | Unacceptable |
| Turkey Run P2 | 214 | 7.4766 | 66.3551 | 0 | 1.4019 | 21.03 | 13.08 | 5 | Unacceptable |
| Turkey Run P3 | 323 | 13.7931 | 73.3542 | 0 | 0.627 | 10.03 | 5.33 | 6 | Unacceptable |
| Dead Run P1 | 330 | 21.5152 | 43.0303 | 0 | 0.6061 | 32.42 | 5.45 | 6 | Unacceptable |
| Dead Run P2 | 246 | 28.8618 | 22.7642 | 0 | 0.4065 | 47.15 | 6.5 | 6 | Unacceptable |
| Dead Run P3 | 203 | 11.33 | 12.8079 | 0.4926 | 0.4926 | 73.4 | 3.45 | 5 | Unacceptable |
| Donaldson P1 | 290 | 6.8966 | 38.9655 | 3.4483 | 0.3448 | 52.41 | 24.48 | 1 | Unacceptable |
| Donaldson P2 | 236 | 32.6271 | 42.7966 | 3.8136 | 0 | 23.73 | 15.25 | 5 | Unacceptable |
| Donaldson P3 | 205 | 42.9268 | 7.3171 | 2.439 | 1.4634 | 47.8 | 20.98 | 5 | Unacceptable |
| Spout Run P1 | 255 | 38.4314 | 9.0196 | 0 | 0 | 52.55 | 20.0 | 8 | Acceptable |
| Spout Run P2 | 208 | 12.5 | 12.5 | 0 | 0 | 73.08 | 30.77 | 4 | Unacceptable |
| Spout Run P3 | 264 | 26.8939 | 11.7424 | 0.3788 | 0 | 60.61 | 37.12 | 5 | Unacceptable |

# Appendix 6: 2010 Data Collection

| Round 3 | | | | | |
|---|---|---|---|---|---|
| Stream | Fish Water Quality Indicators | Barriers to Fish Movement | Surface-water appearance | Stream Bed Deposit | Odor |
| Mine Run P1 | Scattered Individuals | No Barriers | Clear | Brown/Tan/SIlty/Muddy | None |
| Mine Run P2 | Scattered Individuals | No Barriers | Clear | Brown/Tan/SIlty/Muddy | None |
| Mine Run P3 | Scattered Individuals | Waterfalls | Clear | Brown/Tan/Silty/Muddy/Sandy | No Odor |
| Pimmit Run P1 | Scattered Individuals | Waterfalls | Clear but tea colored | Brown/Tan/Silty/Muddy/Sandy | None |
| Pimmit Run P2 | Scattered Individuals/ Scattered Schools | No Barriers | Clear but tea colored | Brown/Tan/Silty/Muddy/Sandy | No Odor |
| Pimmit Run P3 | Scattered Schools | No Barriers | Clear but tea colored | Brown/Tan/Silty/Muddy/Sandy | No Odor |
| Gulf Branch P1 | Scattered Individuals | Waterfalls | Oily | Brown/Tan/Silty/Muddy/Sandy | None |
| Gulf Branch P2 | Scattered Individuals | Waterfalls | Clear But Tea Colored | Brown/tan/Silty/Muddy | Musky |
| Gulf Branch P3 | Scattered Individuals | Waterfalls | Clear but tea-colored | Brown/Tan/Silty/Muddy/Sandy | No Odor |
| Turkey Run P1 | Scattered Individuals | No Barriers | Muddy | Brown/Tan/Silty/Muddy/Sandy | No Odor |
| Turkey Run P2 | Scattered Individuals/Scattered Sc hools | Waterfalls | Cloudy/Turbid | Brown/Tan/Silty/Muddy | Other |
| Turkey Run P3 | Scattered Individuals | No Barriers | Muddy | Brown/Tan/Silty/Muddy/Sandy | No Odor |
| Dead Run P1 | Scattered Individuals | Waterfalls | Muddy | Silty/Muddy | No Odor |
| Dead Run P2 | Scattered Individuals | Waterfalls | None | Brown/Tan/Silty/Muddy/Sandy | No Odor |
| Dead Run P3 | Scattered Schools | Waterfalls | Muddy | Brown/Tan/Silty/Muddy | No Odor |
| Donaldson P1 | Scattered Individuals | None | Clear | Brown/Tan/Silty/Sandy/ | No Odor |
| Donaldson P2 | Scattered Individuals | Waterfalls | Clear | Brown/Tan/Silty/Muddy/Sandy | No Odor |
| Donaldson P3 | Scattered Individuals | Waterfalls | Clear | Brown/Tan/Sandy | No Odor |
| Spout Run P1 | No Fish | Waterfalls | Clear | Brown/Tan/Silty/Muddy | Musky |
| Spout Run P2 | No Fish | None | Clear | Brown/Tan/Silty/Muddy/Sandy | Sewage |
| Spout Run P3 | No Fish | None | Clear | Brown/Tan/Silty/MuddySandy | Sewage |
| | | | | | |

## Appendix 6:  2010 Data Collection

| Round 3 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stream | Stability of stream | Algae Color | Algae located | Percent algae | Stream shade | % Silt | % Sand | % Gravel | % Cobbles |
| Mine Run P1 | No Spots | Light Green/Dark Green/Matted | In Spots | 10 | High | 10 | 10 | 30 | 50 |
| Mine Run P2 | A Few Spots | None | N/A | | Full | 10 | 0 | 10 | 80 |
| Mine Run P3 | A Few Spots | Brown Coated/Matted | In Spots | 20 | High | 5 | 10 | 25 | 60 |
| Pimmit Run P1 | A Few Spots | Dark Green/Brown Coated/Matted | In Spots | 40 | Moderate | 0 | 20 | 20 | 60 |
| Pimmit Run P2 | A Few Spots | Dark Green/Brown CoatedMatted | In Spots | 40 | High | 5 | 20 | 40 | 35 |
| Pimmit Run P3 | A Few Spots | Dark green/Brown Coated/Matted/Hairy | Everywhere | 100 | Moderate | 0 | 10 | 40 | 50 |
| Gulf Branch P1 | A Few Spots | Dark Green/Matted | In Spots | 60 | High | 0 | 10 | 20 | 70 |
| Gulf Branch P2 | No Spots | None | N/A | 0 | Full | 10 | 0 | 30 | 60 |
| Gulf Branch P3 | No Spots | None | N/A | 0 | Moderate | 0 | 10 | 50 | 40 |
| Turkey Run P1 | Many Spots | Dark Green/Brown/Matted | In Spots | 40 | Full | 10 | 0 | 20 | 70 |
| Turkey Run P2 | A Few Spots | Dark Green/Matted | In Spots | 10 | Moderate | 10 | 10 | 60 | 20 |
| Turkey Run P3 | A Few Spots | Dark Green/Brown/Matted | In Spots | 25 | Full | 10 | 10 | 30 | 50 |
| Dead Run P1 | A Few Spots | Dark Green/Brown/Matted | Everywhere | 100 | Full | 10 | 10 | 0 | 80 |
| Dead Run P2 | Many Spots | Light Green/Matted | In Spots | 5 | High | 10 | 20 | 20 | 50 |
| Dead Run P3 | Many Spots | Dark Green/Brown/Matted | In Spots | 5 | High | 5 | 10 | 30 | 55 |
| Donaldson P1 | A Few Spots | Dark Green/Matted | In Spots | 10 | Moderate | 0 | 10 | 30 | 60 |
| Donaldson P2 | Many Spots | Dark Green/Matted | In Spots | 20 | Slight | 5 | 5 | 40 | 50 |
| Donaldson P3 | Many Spots | Dark Green/Matted | In Spots | 60 | Slight | 0 | 5 | 20 | 75 |
| Spout Run P1 | A Few Spots | Dark Green | In Spots | 5 | Moderate | 10 | 5 | 30 | 55 |
| Spout Run P2 | Many Spots | Dark Green/Brown/Matted | Everywhere | 100 | Full | 0 | 10 | 20 | 70 |
| Spout Run P3 | Many Spots | Dark Green/Brown/Matted | Everywhere | 100 | Full | 0 | 0 | 20 | 80 |

# Appendix 6: 2010 Data Collection

| Round 3 | | | | | |
|---|---|---|---|---|---|
| Stream | Stream channel erosion potential | Area 1 | Area 2 | Area 3 | Area 4 |
| Mine Run P1 | Moderate | 3x3 | | | |
| Mine Run P2 | Moderate | 3x3 | | | |
| Mine Run P3 | Moderate | 3x3 | | | |
| Pimmit Run P1 | Moderate | 3x3 | | | |
| Pimmit Run P2 | High | 3x3 | | | |
| Pimmit Run P3 | Moderate | 3x3 | | | |
| Gulf Branch P1 | High | 2x3 | 3x3 | | |
| Gulf Branch P2 | Moderate | 3x3 | 3x3 | | |
| Gulf Branch P3 | High | 3x3 | | | |
| Turkey Run P1 | High | 3x3 | | | |
| Turkey Run P2 | Severe | 3x3 | | | |
| Turkey Run P3 | Moderate | 3x3 | | | |
| Dead Run P1 | Moderate | 2x3 | 2x3 | | |
| Dead Run P2 | Slight | 2x3 | | | |
| Dead Run P3 | High | 2x3 | | | |
| Donaldson P1 | Moderate | 2x3 | 2x3 | | |
| Donaldson P2 | Moderate | 2x3 | 1x3 | | |
| Donaldson P3 | Moderate | 3x3 | | | |
| Spout Run P1 | Moderate | 3x3 | | | |
| Spout Run P2 | High | 3x3 | | | |
| Spout Run P3 | High | 3x3 | 2x3 | | |

# Appendix 7: Water Chemistry Data
# Round 1, Summer 2010

| Stream Site | Day | Time | pH | Temp | DO % | DO mg/L | Cond. uS |
|---|---|---|---|---|---|---|---|
| Mine P1 | 6/2/10 | 7:16 AM | 7.47 | 20.1 | 94 | 8.5 | 148.1 |
| Mine P2 | 6/2/10 | 7:30 AM | | | | | |
| Mine P3 | 6/3/10 | 7:34 AM | 7.7 | 24.2 | 96 | 8.1 | 151.2 |
| Pimmit P1 | 6/3/10 | 7:39 AM | 7.85 | 23.7 | 91 | 7.7 | 332.6 |
| Pimmit P2 | 6/3/10 | 7:44 AM | | | | | |
| Pimmit P3 | 6/4/10 | 8:12 AM | 7.59 | 21.6 | 93 | 8.2 | 310.3 |
| Gulf P1 | 6/4/10 | 7:47 AM | 7.34 | 20.5 | 89 | 7.8 | 316.3 |
| Gulf P2 | 6/4/10 | 7:51 AM | | | | | |
| Gulf P3 | 6/8/10 | 4:29 PM | | | | | |
| Turkey P1 | 6/9/10 | 3:57 PM | | | | | |
| Turkey P2 | 6/9/10 | 4:00 PM | | | | | |
| Turkey P3 | 6/8/10 | 4:31 PM | 7.87 | 18.6 | 97 | 9.1 | 345.3 |
| Dead P1 | 6/10/10 | 8:00 AM | | | | | |
| Dead P2 | 6/10/10 | 10:18 AM | 7.81 | 18.2 | 94 | 8.9 | 260.3 |
| Dead P3 | 6/10/10 | 1:01 PM | | | | | |
| Donald.P1 | 6/11/10 | 10:15 AM | 7.50 | 19.2 | 87 | 8.1 | 441.5 |
| Donald.P2 | 6/11/10 | 1:16 PM | 7.60 | 20.0 | 94 | 8.6 | 436.1 |
| Donald.P3 | 6/11/10 | 1:21 PM | 7.65 | 20.4 | 93 | 8.5 | 441.9 |
| Spout P1 | 6/14/10 | 9:27 AM | 7.71 | 21.5 | 86 | 7.6 | 673.0 |
| Spout P2 | 6/14/10 | 11:04 AM | 7.84 | 21.9 | 94 | 8.3 | 675.0 |
| Spout P3 | 6/14/10 | 1:00 PM | 7.81 | 22.5 | 86 | 7.4 | 605.0 |
| Windy P1 | 6/30/10 | 9:15 AM | 7.54 | 19.8 | 88 | 8.1 | 547.7 |
| Windy P2 | 6/30/10 | 11:09 AM | 7.36 | 20.5 | 90 | 8.1 | 553.0 |
| Windy P3 | 6/30/10 | 1:12 PM | 7.36 | 20.6 | 85 | 7.6 | 558.0 |
| Difficult P1 | 7/1/10 | 10:04 AM | 7.72 | 21.9 | 101 | 8.9 | 223.6 |
| Difficult P2 | 7/1/10 | 11:33 AM | 7.73 | 22.7 | 104 | 9.0 | 224.9 |
| Difficult P3 | 7/1/10 | 4:04 PM | 7.40 | 23.2 | 83 | 7.1 | 229.6 |
| CIA P1 | 7/2/10 | 9:46 AM | 7.61 | 17.0 | 91 | 8.9 | 837.0 |
| CIA P2 | 7/2/10 | 12:12 PM | 7.69 | 17.3 | 89 | 8.6 | 839.0 |
| CIA P3 | 7/2/10 | 1:48 PM | 7.59 | 18.1 | 90 | 8.6 | 874.0 |

Appendix 7: Water Chemistry Data
Round 2, Summer 2010

| Stream Site | Day | Time | pH | Temp | DO % | DO mg/L | Cond. uS |
|---|---|---|---|---|---|---|---|
| Mine P1 | 6/17/10 | 8:49 AM | 7.67 | 21.1 | 89 | 7.8 | 149.9 |
| Mine P2 | 6/17/10 | 10:43 AM | 7.55 | 21.6 | 88 | 7.7 | 149.3 |
| Mine P3 | 6/18/10 | 7:21 AM | 7.65 | 22.5 | 90 | 7.8 | 152.2 |
| Pimmit P1 | 6/18/10 | 9:46 AM | 7.68 | 21.0 | 85 | 7.4 | 316.6 |
| Pimmit P2 | 6/18/10 | 11:23 AM | 7.79 | 21.8 | 100 | 8.8 | 317.1 |
| Pimmit P3 | 6/18/10 | 1:14 PM | 7.56 | 24.1 | 91 | 7.8 | 321.6 |
| Gulf P1 | 6/22/10 | 8:01 AM | 7.43 | 21.6 | 86 | 7.6 | 404.9 |
| Gulf P2 | 6/22/10 | 10:00 AM | 7.46 | 21.9 | 93 | 8.1 | 405.9 |
| Gulf P3 | 6/22/10 | 11:34 AM | 7.47 | 22.3 | 90 | 7.8 | 404.7 |
| Turkey P1 | 6/23/10 | 8:01 AM | 7.92 | 21.0 | 93 | 8.4 | 384.7 |
| Turkey P2 | 6/23/10 | 10:04 AM | 7.95 | 21.3 | 94 | 8.3 | 384.9 |
| Turkey P3 | 6/23/10 | 12:23 PM | 7.90 | 22.1 | 97 | 8.5 | 361.4 |
| Dead P1 | 6/24/10 | 1:21 PM | 7.85 | 24.9 | 90 | 7.4 | 270.7 |
| Dead P2 | 6/25/10 | 8:37 AM | 7.84 | 23.1 | 90 | 7.7 | 271.6 |
| Dead P3 | 6/25/10 | 9:45 AM | 7.64 | 23.2 | 91 | 7.8 | 272.5 |
| Donald. P1 | 6/25/10 | 11:17 AM | 7.56 | 23.1 | 88 | 7.5 | 454.8 |
| Donald. P2 | 6/25/10 | 1:46 PM | 7.69 | 24.2 | 85 | 7.1 | 450.8 |
| Donald. P3 | 6/28/10 | 8:17 AM | 7.69 | 23.1 | 88 | 7.5 | 450.2 |
| Spout P1 | 6/29/10 | 9:14 AM | 7.77 | 23.5 | 84 | 7.1 | 585 |
| Spout P2 | 6/29/10 | 11:51 AM | 7.88 | 24.9 | 94 | 7.8 | 628 |
| Spout P3 | 6/29/10 | 1:28 PM | 7.87 | 25 | 91 | 7.5 | 623 |
| Windy P1 | 7/23/10 | 8:14 AM | 7.51 | 22.7 | 83 | 7.1 | 574 |
| Windy P2 | 7/23/10 | 10:15 AM | 7.37 | 23.4 | 80 | 6.8 | 574 |
| Windy P3 | 7/23/10 | 12:00 PM | 7.41 | 24.1 | 87 | 7.3 | 574 |
| DifficultP1 | 7/26/10 | 8:30 AM | 7.68 | 25.9 | 95 | 7.7 | 196.7 |
| DifficultP2 | 7/26/10 | 10:15 AM | 7.66 | 26.1 | 97 | 7.8 | 191.6 |
| DifficultP3 | 7/26/10 | 12:21 PM | 7.38 | 26.3 | 91 | 7.3 | 191.1 |
| CIA P1 | 7/27/10 | 9:53 AM | 7.6 | 20.9 | 86 | 7.7 | 785 |
| CIA P2 | 7/27/10 | 11:20 AM | 7.53 | 21.1 | 82 | 7.3 | 795 |
| CIA P3 | 7/27/10 | 12:51 PM | 7.57 | 21.7 | 69 | 6.1 | 831 |

Appendix 7: Water Chemistry Data
Round 3, Summer 2010

| Stream Site | Day | Time | pH | Temp | DO % | DO mg/L | Cond. uS |
|---|---|---|---|---|---|---|---|
| Mine P1 | 7/7/10 | 8:57 AM | 7.61 | 22.5 | 81 | 7.1 | 150.6 |
| Mine P2 | 7/7/10 | 10:27 AM | 7.57 | 22.9 | 89 | 7.6 | 150.2 |
| Mine P3 | 7/7/10 | 12:43 PM | 7.7 | 24.2 | 96 | 8.1 | 151.2 |
| Pimmit P1 | 7//8/10 | 9:03 AM | 7.85 | 25.2 | 96 | 7.9 | 352.2 |
| Pimmit P2 | 7/8/10 | 10:34 AM | 8.06 | 26 | 101 | 8.2 | 344.9 |
| Pimmit P3 | 7/8/10 | 12:25 PM | 8.3 | 27.3 | 110 | 8.7 | 343 |
| Gulf BranchP1 | 7/12/10 | 9:29 AM | 7.52 | 22.2 | 89 | 7.7 | 386 |
| Gulf BranchP2 | 7/12/10 | 10:36 AM | 7.49 | 22.7 | 91 | 7.8 | 387.7 |
| Gulf BranchP3 | 7/12/10 | 12:34 PM | 7.47 | 22.8 | 89 | 7.6 | 388.3 |
| Turkey P1 | 7/13/10 | 8:41 AM | 7.75 | 21.2 | 93 | 8.3 | 218.2 |
| Turkey P2 | 7/13/10 | 9:53 AM | 7.73 | 21.2 | 94 | 8.3 | 232.4 |
| Turkey P3 | 7/13/10 | 11:23 AM | 7.68 | 21.3 | 93 | 8.2 | 234.8 |
| Dead P1 | 7/15/10 | 9:26 AM | 7.66 | 22.9 | 89 | 7.7 | 181.6 |
| Dead P2 | 7/15/10 | 10:59 AM | 7.71 | 23.2 | 95 | 8.1 | 188.6 |
| Dead P3 | 7/16/10 | 8:59 AM | 7.58 | 23.5 | 90 | 7.6 | 210.2 |
| Donaldson. P1 | 7/16/10 | 11:50 AM | 7.5 | 23.6 | 79 | 6.7 | 417.5 |
| Donaldson. P2 | 7/16/10 | 1:19 PM | 7.66 | 24.2 | 90 | 7.5 | 417.3 |
| Donaldson. P3 | 7/20/10 | 9:04 AM | 7.73 | 23 | 91 | 7.8 | 394.3 |
| Spout P1 | 7/20/10 | 11:56 AM | 7.86 | 24.2 | 93 | 7.8 | 646 |
| Spout P2 | 7/20/10 | 1:13 PM | 7.84 | 24.6 | 79 | 6.6 | 652 |
| Spout P3 | 7/20/10 | 2:24 PM | 7.94 | 25.3 | 94 | 7.7 | 647 |

**Appendix 8**
**Water Chemistry Lab Results Round 1**

| Stream | Acid Neutralizing Capacity (ANC) (mg/L) | Nitrate (mg/L) | Phosphorus (mg/L) | Chlorine (mg/L) |
|---|---|---|---|---|
| Mine | 32.7 | 1.5 | .41 | .02 |
| Pimmit | 52.9 | 2.1 | .49 | .03 |
| Gulf Branch | 63.2 | 1.2 | .40 | .04 |
| Turkey | 76.8 | 1.6 | .28 | .02 |
| Dead | 53.2 | 1.9 | .20 | .13 |
| Donaldson | 48.8 | 2.1 | .53 | .04 |
| Spout | 83.6 | 2.6 | .66 | .03 |
| Windy | 60.8 | 3.6 | .27 | .05 |
| Difficult | 43.6 | 1.3 | .14 | .02 |
| CIA | 54 | 2.1 | .42 | .00 |

**Appendix 8**
**Water Chemistry Lab Results Round 2**

| Stream | ANC (mg/L) | Nitrate (mg/L) | Phosphorus (mg/L) | Chlorine (mg/L) |
|---|---|---|---|---|
| Mine | 45.6 | 1.5 | .24 | .02 |
| Pimmit | 72 | 1.8 | .94 | .03 |
| Gulf Branch | 54.8 | 2.6 | .29 | .03 |
| Turkey | 78.8 | 2.0 | .38 | .02 |
| Dead | 65.6 | 1.5 | .37 | .00 |
| Donaldson | 56 | 3.4 | .30 | .13 |
| Spout | 82 | 2.9 | .71 | .02 |
| Windy | 58.8 | 3.3 | .67 | .01 |
| Difficult | 47.6 | 1.3 | .33 | .00 |
| CIA | 50.8 | 1.9 | .56 | .00 |

**Appendix 8**
**Water Chemistry Lab Results Round 3**

| Stream | ANC | Nitrate (mg/L) | Phosphorus (mg/L) | Chlorine (mg/L) |
|---|---|---|---|---|
| Mine | 44.4 | 1.0 | .00 | .04 |
| Pimmit | 60 | 1.0 | .43 | .02 |
| Gulf Branch | 63.3 | 2.4 | .74 | .00 |
| Turkey | 85.2 | 1.6 | .40 | .00 |
| Dead | 62 | 1.4 | .36 | .00 |
| Donaldson | 53.2 | 2.7 | .62 | .03 |
| Spout | 85.2 | 2.7 | .62 | .01 |

## Appendix 9: 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 10: Location Data

| Monitoring: Summer 2009 | | | | | |
|---|---|---|---|---|---|
| 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 |
| CIA | 1 | Fairfax | VA | N 38 58.14.56 | W 77 08.12.24 |
| CIA | 2 | Fairfax | VA | N 38 58.14.31 | W 77 08.13.61 |
| CIA | 3 | Fairfax | VA | N 38 58.14.84 | W 77 08.15.05 |

| Monitoring: Summer 2009 | | |
|---|---|---|
| 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 won't be there next season) |
| Difficult | 3 | Next to fallen log leading to island |
| Windy | 1 | Upstream near the large drop-off |
| Windy | 2 | Right under GWMP |
| Windy | 3 | Right near the stream crossing |
| CIA | 1 | 20m upstream of Potomac Heritage Trail. |
| CIA | 2 | Next to small tributary (sample upstream of it) |
| CIA | 3 | 75m downstream of Culvert |

| Appendix 11:Net New Development 2002-2010 | | | | | |
|---|---|---|---|---|---|
| *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 |
| 2010 | 374,379 | 75,768 | 0 | 242 | 0 |
| Total | 3,503,544 | 557,923 | 893,985 | 6,185 | 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 12: 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 13: 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 14: 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 15: Statistically Invalid Sampling Data '01-'09

**Table 2: Statistically Invalid Sampling Data (<200 macroinvertebrates): 2001-2009**

| | | | | |
|---|---|---|---|---|
| **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 |
| 2010 | | | | |
| Of 90 Stations | Stream | Round | Station | Total # of macroinvertebrates |
| | Spout | 2 | 3 | 165 |

# Appendix 16: Insect Descriptions

**Distinguishing Characteristics**

**Beetle Larvae**

- **Small Bristles of hair protruding from their back end, Moves in and out to breathe**
- **Can be very small**
- **Dark to light brown**
- **Visually similar to a meal worm**
- **Six legs**
- **Has an exoskeleton that looks harder than a midge**
- **Segments are smooth and straight**
- **Moves sluggishly**
- **Darkened head**

**Midges**

- **Tiny (size of a paint brush hair)**
- **Soft worm like body**
- **Will "dance" when poked, sort of like a spasm**
- **Has two prolegs (caterpillar-like legs, rather than insect-like legs) at the head and tail**
- **Vary in color from white to red to brown to see through**
- **Head is fatter than tail**
- **Will inch along like an inchworm when undisturbed**
- **Head is very defined, is a dark color and has pincers**

**Black Flies**

- **Will cling one end to the side of the ice tray and leave other end dangling free**
- **Normally mottled black and white**
- **Small like a midge**
- **Bowling pin shape with a fat head and tail area**
- **Blackened head**

**Planarian**

- **Has two spots for eyes**
- **Will glide along**

- **Usually white color, but can be dark**
- **Looks like a long blob**

**Sow bug**

- **Looks like a roley poley (also an armadillo)**
- **More than 6 legs**
- **Hard plated exoskeleton**
- **Usually gray with white legs**
- **Short antennae**

**Scud**

- **Swims sideways**
- **Very quick**
- **Looks similar to a shrimp**
- **Darts around**
- **Curved shape**
- **More than 6 legs**
- **Lays on side**
- **Usually clear buy can be dark or greenish**

**Stonefly**

- **Looks like a small cricket**
- **Has two tails (one may be longer than the other)**
- **Crawls instead of swims**
- **No abdominal gills**
- **Long antenna**
- **Short stout wings**
- **Six legs**

**Mayflies**

- **Very similar to a stonefly**
- **Short antennae**
- **Abdominal gills, which can vary from puffy stiff and straight**
- **3 tails**
- **Swims by slithering or undulating**
- **Tail can be webbed sometimes**

**Damselfly**

- **Very larger than many mayflies**
- **3 tails (oar shape)**
- **Large protruding jaw**
- **Large bug eyes**
- **Short antennae**
- **Long thin abdomen**

- **Premature wings folded in close to the body**

**Hellgrammite**
- **6 legs**
- **Large spikes coming out of abdomen behind legs**
- **Looks kind of like a millipede**
- **Large pincers on head**
- **Head looks similar to an overgrown netspinner**

**Caddisfly**
- **Two prologs on tail**
- **Six legs**
- **Bright orange**
- **Usually lighter in color then a net spinner**
- **Usually does not have darkened plates behind the head**
- **One back plate**
- **More defined head than netspinner**
- **No abdominal gills**
- **Practically no antenna**
- **Two small pincers**
- **Abdominal segments are bulgy**
- **Normally has a very hooked tail**

**Net Spinner**
- **Darker in color than a common caddisfly**
- **Fluffy abdominal gills**
- **3 dark plates behind head**
- **Fluff on tail end**

**Dragon Fly**
- **Large hinged protruding jaw**
- **Big bug shaped eyes**
- **Short antenna**
- **Three short triangular tails**
- **Flat, broad and wide abdomen, which is usually what distinguishes it**
- **Usually are quite big (like damselflies), the smaller varieties were rare**

**Snail**
- **Lunged**
    - **Opening opens to the left**
- **Gilled snail**
    - **Opening opens to the right**

**True fly-Crane Fly**
- **Can be very small and midge like to very large and fat**
- **Darkened head**
- **Caterpillar like**

- **Has bristles or branches on one end**
- **Rings with small rounded spikes on then, separate segments of body**
- **Excrete abundantly (useful to keep in separate beaker)**

# Appendix 17: 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

Alternate directions

1. Turn right onto the GWMP
2. Take the first exit (Turkey Run Park)
3. Pass the entrance to the park
4. Turn on hazard lights and start to slow down
5. When you get under the parkway pull onto the side of the road and park.
6. Cross the road and proceed down the hill until you reach the water
7. Site 3 will be on your right

*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. Proceed through first stop sign
8. Follow signs to Military Road (2 left's after exit)
9. Turn left onto 36th Road (not 36 Street)
10. Drive approximately 0.1-0.2 miles and park at trail head (across Nelson Street intersect)
11. Hike to bottom of stairs and turn left onto trail
12. 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. Proceed through stop sign.
8. Follow signs to Military Road (2 left's after exit)
9. Turn left onto Marcey Road
10. Drive back to Donaldson Run Park HQ and park just beyond HQ building, if full then park in lot outside HQ driveway entrance
11. Walk to the end of the paved road and find trail heading downhill
12. At the trailhead at the bottom of the hill, take the trail to the right
13. Proceed to station locations

*Alternate Route*:

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 exit toward Rosslyn
5. Bear right and keep following signs toward Rosslyn
6. At stop sign, turn right
7. As soon as possible, merge into left lane
8. Keep following road and follow signs for GWMP
9. Turn left at second light near key bridge
10. Merge onto GWMP west
11. Follow GWMP and pass Overlook 1 heading toward headquarters
12. Turn on Hazards
13. Before the bridge that has the "Donaldson Run" sign attached to it, pull on to side of road
14. Walk toward bridge and walk down the side and under the overpass until you get to the Potomac Heritage Trail
15. Once on path, turn right and follow path until you find stairs leading down to site locations

NOTE: This is a shorter, but much steeper walk

*To Return to Headquarters:*

1. Hike back to vehicle

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

Spout Run

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

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

*To Return to Headquarters:*

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

Difficult Run

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

*To Return to Headquarters:*

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

11. Turn left into parkway headquarters

Windy Run

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

*To Return to Headquarters:*

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

CIA 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. Take immediate exit left to return back on the parkway west
6. Look for long stone wall on the right hand side.
7. Once you see the large CIA sign before the entrance turn on the emergency lights and start to pull over after the sign
8. Walk back to the wall and proceed down the side of the hill
9. Look out for spiderwebs!

*To Return to Headquarters:*

1. Follow stream back up towards the parkway
2. Turn on the emergency lights and enter back onto the parkway going west
3. Turn right into parkway headquarters

Center for Urban Ecology

1. Take a right onto the GWMP
2. Take the first Exit and to head east on the GWMP
3. Take the 123 north exit
4. Turn left on Glebe road and cross over the Chain Bridge (the actual bridge)
5. Turn right onto Canal Rd
6. Turn left onto Arizona St
7. Turn right onto Macarthur Blvd.
8. Keep right to stay on MacArthur Blvd.
9. Turn right onto Elliot Pl.
10. Take an immediate right to enter CUE

*To return to Headquarters*

1. Turn left onto Elliot Pl.

2. Turn left onto MacArthur Blvd.
3. Turn left onto Arizona St.
4. Turn right onto Canal Rd
5. Turn left onto the Chain Bridge (the actual bridge)
6. Turn right on Chain Bridge Rd (Rt. 123) immediately after crossing the bridge
7. Turn right onto GWMP heading west towards 495
8. Turn right into 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 18: Supplies

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

1. **Cell Phone**
2. **3'x 3' kick-seine net (1/16-inch mesh)**
3. **Waders**
4. **Two backpacks**
5. **Collapsible table**
6. **Uniform**
7. **Two collapsible seats**
8. **Timer**
9. **Field first aid kit**
10. **Meter stick**
11. **Magnifying glass**
12. **Collection vials and Ethyl Alcohol**
13. **Pens/Pencils**
14. **Measuring tape**
15. **Brush**
16. **Forceps**
17. **Two ice cube trays**
18. **Virginia Save Our Streams benthic macroinvertebrate tally sheets (Appendix 1)**
19. **YSI meter, model 85**
20. **YSI meter, model 60**
21. **Squirt bottle with DI water**
22. **Hand sanitizer**
23. **Flagging**
24. **Sunscreen and bug spray**
25. **Virginia Save Our Streams stream quality survey form (Appendix 8)**
26. **Digital Camera**
27. **XPLORE tablet**
28. **Keys to vehicle**
29. **Traffic safety vests**
30. **Water bottle (to drink)**
31. **Hat**

Appendix 19: Calibration Chemicals Ordering Information:

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

# Appendix 20: Sampling Procedure

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

## Appendix 21: 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
5. Obtain uniform
6. Complete online security training
7. Obtain login/password information for use of office computers
8. Complete first-aid/CPR training
9. Navigate to stream stations (same stations as previous years) using GPS unit and flag for future sampling
10. Attend a Bridging the Watershed orientation/seminar
11. Visit the Center for Urban Ecology and meet with the Water Resource Specialists

# Appendix 22: 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)*

Appendix 23: Flag Color By Site

| Stream Name | Site 1 | Site 2 | Site 3 |
|---|---|---|---|
| Mine Run | Blue | Blue | Blue |
| Pimmit Run | Blue | Yellow | Yellow |
| Gulf Branch | Blue | Orange | Orange |
| Turkey Run | Blue | Orange | Orange |
| Dead Run | Blue | Blue | Orange |
| Donaldson Run | Pink | Pink | Pink |
| Spout Run | Pink | Blue | Blue |
| Windy Run | White with yellow polka dots | Blue | Blue |
| Difficult Run | Blue | Blue | Blue |
| CIA Run | Blue | Blue | Blue |

Appendix 24
Field Protocol Checklist

| | |
|---|---|
| | Calibrate field equipment monthly, or before use if using quarterly |
| | Load field equipment into vehicle (see checklist) |
| | Measure stream wetted width |
| | Collect samples (ANC & Nutrients) after rinsing bottles 3x with stream water |
| | Record visual data (color, flow, algae etc) |
| | Record air temperature |
| | Record data from ProPlus (1 reading per 10 ft.of stream width) |
| | Rinse ProPlus probe with DI water |
| | Place samples in cooler, refrigerate until analysis is done |
| | |

Appendix 25

WATER CHEMISTRY FORM vers 3.1 11/2007 Park/Unit 4 letter Code:_____

Print on water resistant paper

| | | |
|---|---|---|
| Site ID | Waterbody Name: | □ photographs |
| Date:______/___/___ | Start Time: ___:___ AM / PM | Data Collected By: |

| | Dist. (ft) | Depth(ft) | Flow (ft/s) | Dist. (ft) | Depth(ft) | Flow (ft/s) |
|---|---|---|---|---|---|---|
| Ambient Temperature (C):<br>Weather Conditions: | | | | | | |
| Algae (% cover): | | | | | | |
| Algae appearance: | | | | | | |
| Stream Conditions: | | | | | | |
| Stream Wetted Width (ft): | | | | | | |
| FIELD EQUIPMENT: | | | | | | |
| Replace battery? □ yes □ no | | | | | | |
| Maintenance: | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | Mean | | |

| Probe Readings | pH | Temp(EC) | DO(%) | DO(mg/L) | Specific Conduct. (µS) | Salinity (ppt) |
|---|---|---|---|---|---|---|
| | | / | | | / | / |
| | | / | | | / | / |
| | | / | | | / | / |
| | | / | | | / | / |
| Mean | | | | | | |

| Samples Collected | Preservation Method | Container | Amount | location @ site: |
|---|---|---|---|---|
| Nutrients | Refrigeration | Acid-washed lmHDPE | 125 mL | |
| ANC | Refrigeration | Clean smHDPE | 500 mL | |
| | | | | |

NOTES:

| |
|---|
| |
| |
| |
| |
| |
| |

------------------------------------------------------------------------------------------------------------------
--------------------

*To Be Completed in Lab:* Location of Lab:________________________________________________________

Date & Time of Analysis:______________________ Analyzed by:_____________________________________

ANC Data

| Expected Range | Sample Volume | Titration Cartridge | Digit Multiplier | # of Digits for Phenol | Bromcresol Endpoint | # of Digits for Bromcresol |
|---|---|---|---|---|---|---|
| 10-40 mg/L | 100 mL | 0.1600 | 0.1 | | 4.9 (light pink) | |
| 40-160 mg/L | 25 mL | 0.1600 | 0.4 | | 4.6 (light pink) | |
| 100-400 mg/L | 100 mL | 1.600 | 1.0 | | 4.6 (light pink) | |
| | | | | | | |

ANC Calculations

| Phenolphthalein Alkalinity | Total Alkalinity (mg/L $CaCO_3$) | Hydroxide Alkalinity | Carbonate Alkalinity | Bicarbonate Alkalinity | Microequivalents/L Alkalinity |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

NUTRIENT ANALYSES

| Analytical Method: | Sample Reading (mg/L): | Blank: |
|---|---|---|
| | | |
| Total Phosphorus, LR TNT | | |
| Nitrate, HR TNT | | |
| Free Ammonia (*ONLY if pH is >7!!) | | |
| Monochloramine (*ONLY if pH is >7 !!) | | |
| DPD Total Chlorine | | |

| | | |
|---|---|---|
| | | |
| | | |
| | | |

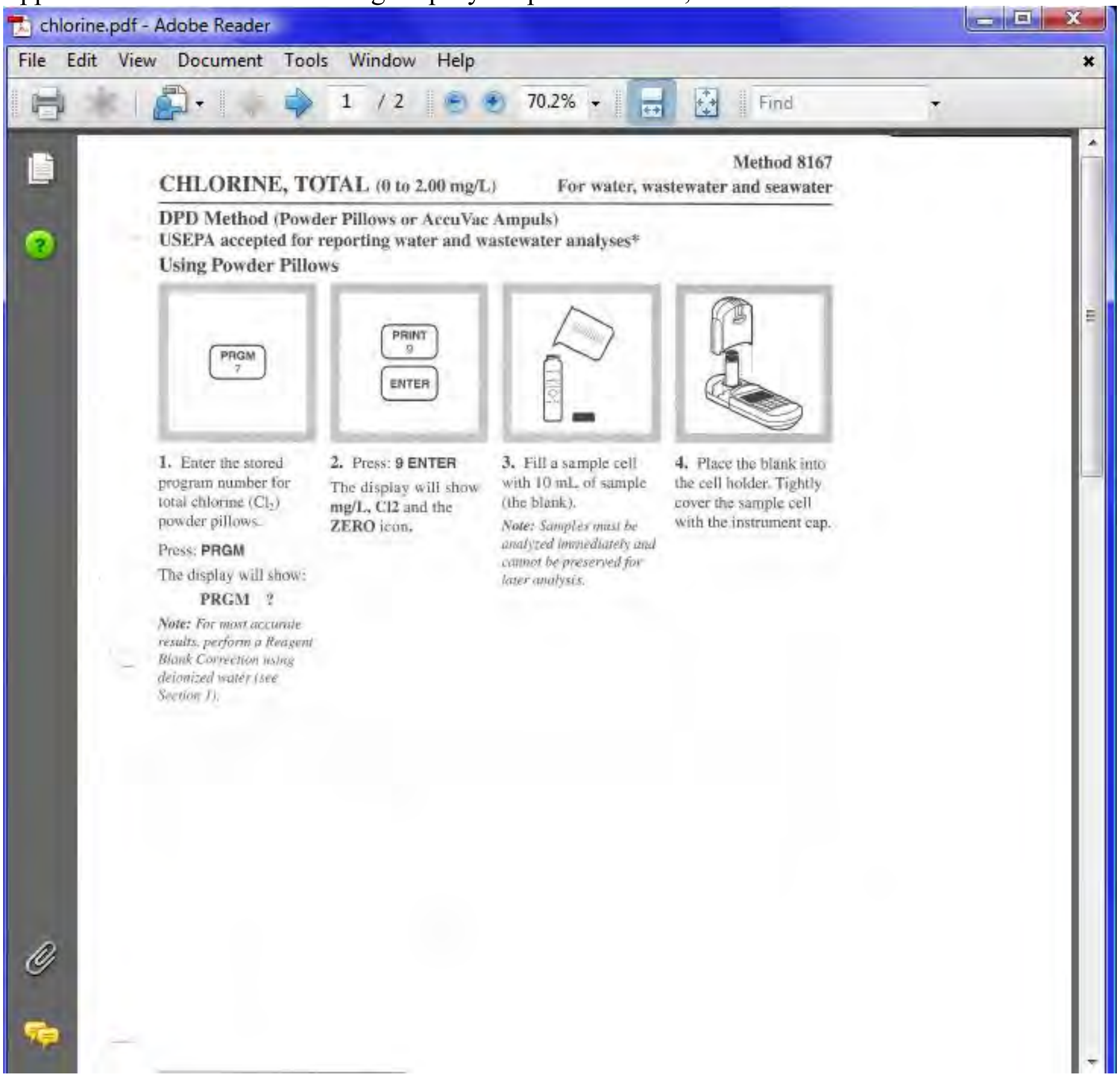
*DO NOT run Free Ammonia and Monochloramine analysis if pH is less than 7.0!!
NOTES:

| |
|---|
| |
| |
| |
| |
| |
| |

------------------------------------------------------------------------------------------------------------------------

Data Entered:_______________ By:__________________________
Into:________________________

Appendix 26a : Chemical Testing Step-by-Step Instructions, Total Chlorine




Method 8167

**CHLORINE, TOTAL** (0 to 2.00 mg/L) **For water, wastewater and seawater**

**DPD Method (Powder Pillows or AccuVac Ampuls)**

**USEPA accepted for reporting water and wastewater analyses***

**Using Powder Pillows**



**1.** Enter the stored program number for total chlorine ($Cl_2$) powder pillows.

Press: **PRGM**

The display will show:

**PRGM ?**

***Note:*** *For most accurate results, perform a Reagent Blank Correction using deionized water (see Section 1).*

**2.** Press: **9 ENTER**

The display will show **mg/L, Cl2** and the **ZERO** icon.

**3.** Fill a sample cell with 10 mL of sample (the blank).

***Note:*** *Samples must be analyzed immediately and cannot be preserved for later analysis.*

**4.** Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.


**5.** Press: **ZERO**

The cursor will move to the right, then the display will show:

**0.00 mg/L Cl2**

***Note:*** *If Reagent Blank Correction is on, the display may flash "limit". See Section 1.*

**6.** Fill a second cell to the 10-mL mark with sample.

**7.** Add the contents of one DPD Total Chlorine Powder Pillow to the sample cell (the prepared sample). Cap and swirl the sample cell vigorously to dissolve the powder.

***Note:*** *It is not necessary that all the powder dissolves.*


**8.** Press:

**TIMER ENTER**

A three-minute reaction period will begin. A pink color will develop if chlorine is present.

***Note:*** *The SwifTest Dispenser for Total Chlorine can be used in place of the powder pillows in step 7.*

**9.** After the timer beeps, place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.


**10.** Press: **READ**

The cursor will move to the right, then the result in mg/L total chlorine will be displayed.

***Note:*** *It the sample temporarily turns yellow after sample addition, or the display flashes "limit", it is due to high chlorine levels. Dilute a fresh sample and repeat the test. A slight loss of chlorine may occur during dilution. Multiply the result by the dilution factor; see Section 1. Or use the High Range Total Chlorine test, program #8.*

***Note:*** *Standard Adjust may be performed using a prepared standard (see Standard Adjust in Section 1).*

152

Appendix 26b: Chemical Testing Step-by-Step Instructions, Nitrate

## NITRATE, High Range, Test 'N Tube (0 to 30.0 mg/L $NO_3^-$-N)

**Chromotropic Acid Method** — **For water and wastewater**

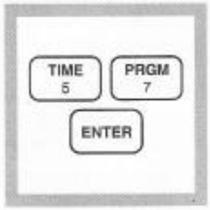

**1.** Enter the stored program number for Test 'N Tube nitrate nitrogen ($NO_3^-$-N).

Press: **PRGM**

The display will show:

**PRGM ?**

***Note:*** *If samples cannot be analyzed immediately, see Sampling and Storage on page 321.*




**2.** Press: **57 ENTER**

The display will show **mg/L, NO3-N** and the **ZERO** icon.

***Note:*** *For alternate forms ($NO_3$) press the* **CONC** *key.*

**3.** Insert the COD/TNT Adapter into the cell holder by rotating the adapter until it drops into place. Then push down to fully insert it.

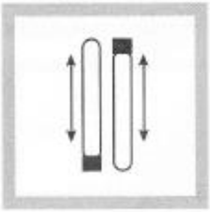
***Note:*** *For proof of accuracy, use a 20 mg/L $NO_3^-$-N standard in place of the sample.*

***Note:*** *For increased performance, a diffuser band covers the light path holes on the adapter. Do not remove the diffuser band.*

**4.** Remove the cap from a Nitrate Pretreatment Solution Vial and add 1 mL of sample (the blank).

***Note:*** *For most accurate results, perform a Reagent Blank Correction using deionized water (see Section 1).*

319



**5.** Cap the tube and invert 10 times to mix.

***Note:*** *This test is technique-sensitive. Low results may occur if these instructions are not followed. Hold the vial vertical with the cap up. Invert the vial so the cap points down. Wait for all of the solution to flow to the cap end. Pause. Return the vial to the upright position. Wait for all the solution to flow to the vial bottom. This process equals 1 inversion. Do this 10 times.*

**6.** Clean the outside of the vial with a towel.

***Note:*** *Wipe with a damp towel and follow with a dry one to remove fingerprints and other marks.*

**7.** Place the blank in the vial adapter with the Hach logo facing the front of the instrument.

Push straight down on the top of the vial until it seats solidly into the adapter.

***Note:*** *Do not move the vial from side to side as this can cause errors.*

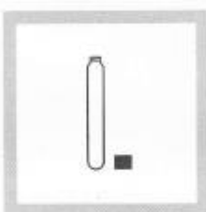
**8.** Cover the vial tightly with the instrument cap.


**9.** Press: **ZERO**

The cursor will move to the right, then the display will show:

**0.0 mg/L NO3-N**

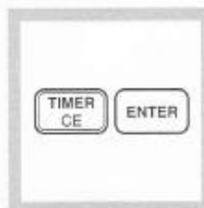
***Note:*** *If Reagent Blank Correction is on, the display may flash "limit". See Section 1.*



**10.** Remove the vial from the instrument. Remove the cap from the vial.

**11.** Using a funnel, add the contents of one NitraVer X Reagent B Powder Pillow to the vial. Cap. Invert 10 times to mix (this will be the prepared sample).

***Note:*** *See Step 5 for inversion instructions*




**12.** Press:

**TIMER ENTER**

A five-minute reaction period will begin. Do not invert the vial again.

***Note:*** *A yellow color will develop if nitrate nitrogen is present.*

***Note:*** *Complete Steps*

**13.** After the timer beeps, clean the outside of the vial with a damp towel and follow with a dry one to remove fingerprints and other marks.

**14.** Place the prepared sample in the adapter with the Hach logo facing the front of the instrument.

Push straight down on the top of the vial until it seats solidly into the adapter.

*Note: Do not move the vial from side to side as this can cause errors.*

**15.** Cover the vial tightly with the instrument cap.


**16.** Press: **READ**

The cursor will move to the right, then the result in mg/L nitrate nitrogen ($NO_3$-N) will be displayed.

*Note: Standard Adjust may be performed using a prepared standard (see Standard Adjust in Section 1).*

## Sampling and Storage

Collect samples in clean plastic or glass bottles. Store at 4 °C (39 °F) or lower if the sample is to be analyzed within 24 to 48 hours. Warm to room temperature before running the test. For longer storage periods (up to 14 days), adjust sample pH to 2 or less with sulfuric acid, ACS (about 2 mL per liter). Sample refrigeration is still required.

Before testing the stored sample, warm to room temperature and neutralize with 5.0 N Sodium Hydroxide Standard Solution.

Do not use mercury compounds as preservatives.

Correct the test result for volume additions; see *Correction for Volume Additions* in *Section 1* for more information.

Appendix 26c : Chemical Testing Step-by-Step Instructions,
Total Phosphorus

75% Find

## PHOSPHORUS, TOTAL (0.00 to 3.50 mg/L $PO_4^{3-}$) For water, wastewater and seawater

**PhosVer 3 with Acid Persulfate Digestion*** USEPA Accepted for reporting wastewater analysis**
**Test 'N Tube Procedure**

**1.** Turn on the DRB200 Reactor. Heat the reactor to 150 °C.

*Note: See DRB200 instrument manual for selecting preprogrammed temperature applications.*


**2.** Enter the stored program number for total phosphorus, ($PO_4^{3-}$). Test 'N Tube.

Press: **PRGM**

The display will show:

**PRGM ?**

*Note: For most accurate results, perform a Reagent Blank Correction using deionized water (see Section 1).*


**3.** Press: **82 ENTER**

The display will show **mg/L, PO4** and the **ZERO** icon.

*Note: For alternate forms (P, $P_2O_5$), press the* **CONC** *key.*

**4.** Insert the COD/TNT Adapter into the cell holder by rotating the adapter until it drops into place. Then push down to fully insert it.

*Note: A diffuser band covers the light path holes on the adapter to give increased performance. The band should NOT be removed.*

**5.** Use a TenSette Pipet to add 5.0 mL of sample to a Total and Acid Hydrolyzable Test Vial.

*Note: Adjust the pH of stored samples to 6-8 before analysis.*

**6.** Using a funnel, add the contents of one Potassium Persulfate Powder Pillow for Phosphonate to the vial.

**7.** Cap tightly and shake to dissolve.

**8.** Place the vial in the DRB200 Reactor. Heat the vial for 30 minutes.

* Adapted from *Standard Methods for the Examination of Water and Wastewater.*
** Procedure is equivalent to USEPA Method 365.2 and Standard Method 4500-P B. 5 and P.E.

507

**9.** Carefully remove the vial from the reactor. Place it in a test tube rack and allow to cool to room temperature.

*Note: Vials will be hot.*

**10.** Use a TenSette Pipet to add 2.0 mL of 1.54 N sodium hydroxide to the vial. Cap and mix.

**11.** Clean the outside of the vial with a towel.

*Note: Wiping with a damp towel, followed by a dry one, will remove fingerprints or other marks.*

**12.** Place the sample vial in the adapter.

Push straight down on the top of the vial until it seats solidly into the adapter.

*Note: Do not move the vial from side to side as this can cause errors.*

**13.** Tightly cover the vial with the instrument cap.


**14.** Press: **ZERO**

The cursor will move to the right, then the display will show:

**0.00 mg/L PO4**

*Note: For multiple samples, zero only on the first sample. Read the remaining samples after adding the PhosVer 3 reagent.*

**15.** Remove the cap from the vial. Using a funnel, add the contents of one PhosVer 3 Phosphate Reagent Powder Pillow to the vial.

**16.** Cap tightly and shake for 10-15 seconds.

*Note: The powder will not completely dissolve.*


**17.** Press:

**TIMER ENTER**

A 2-minute waiting period will begin.

***Note:*** *Read samples between 2 and 8 minutes after the addition of the PhosVer 3 reagent.*

***Note:*** *A blue color will form if phosphate is present.*

**18.** After the timer beeps, clean the outside of the sample vial with a towel.

***Note:*** *Wiping with a damp towel, followed by a dry one, will remove fingerprints or other marks.*

**19.** Place the prepared sample vial in the adapter.

Push straight down on the top of the vial until it seats solidly into the adapter.

***Note:*** *Do not move the vial from side to side as this can cause errors.*

**20.** Tightly cover the vial with the instrument cap.


**21.** Press: **READ**

The cursor will move to the right, then the result in mg/L phosphate ($PO_4^{3-}$) will be displayed.

***Note:*** *Standard Adjust may be performed using a prepared standard (see Section 1).*

**IMPORTANT NOTE:**

The test range for total phosphate is limited to 0 to 3.5 mg/L $PO_4^{3-}$. Values above 3.5 mg/L may be used to estimate dilution ratios, but should NOT be used for reporting purposes. If a value above 3.5 mg/L $PO_4^{3-}$ is obtained, dilute the sample and repeat the digestion and the colorimetric test.

## *Appendix 27 Lab Protocol Checklist*

File

### Lab Protocol Checklist

| | |
|---|---|
| | Let samples, test tubes and reagents stand until room temperature |
| | Turn on digester (Hach DR8200) and set to appropriate temp. & time for PO4 (150°/30min.) |
| | Label test tubes to reflect sample location, including "blank" |
| | Program DR890 for appropriate test you are running |
| | Always wear gloves! |
| | Run analysis in well ventilated area |
| | Run analysis for: |
| | PO4 (Method 8190) |
| | NO3 (10020) |
| | Free Ammonia (Method 10200) except when pH is lower than 7.0!! |
| | Monochloramine (Method 10200) except when pH is lower than 7.0!! |
| | Total Chlorine (DPD method 8167) |
| | Record Data |
| | Discard waste separately in appropriate HAZMAT container (see clean up protocol) |
| | |
| | |
| | |
| | |

Appendix 28: Tolerant Species Chart

| | Round 1 | Round 2 | Round 3 | Average |
|---|---|---|---|---|
| Mine | 27.52667 | 19.66333 | 21.82667 | 23.00556 |
| Pimmit | 39.77667 | 30.52667 | 39.47667 | 36.59333 |
| Gulf Branch | 77.85333 | 54.37333 | 63.77333 | 65.33333 |
| Turkey | 54.81667 | 16.86333 | 13.48667 | 28.38889 |
| Dead | 57.92667 | 51.00667 | 50.99 | 53.30778 |
| Donaldson | 45.37 | 61.91667 | 41.31333 | 49.53333 |
| Spout | 71.18333 | 70.61667 | 62.08 | 67.96 |
| Windy | 42.54 | 62.94 | | 52.74 |
| Difficult | 11.78333 | 15.05667 | | 13.42 |
| CIA | 33.72667 | 49.42333 | | 41.575 |

Appendix 29a: Water Chemistry Charts, ANC (mg/L)

| Stream | Round 1 | Round 2 | Round 3 | Average |
|---|---|---|---|---|
| Mine | 32.7 | 45.6 | 44.4 | 40.9 |
| Pimmit | 52.9 | 72 | 60 | 61.63333 |
| Gulf Branch | 63.2 | 54.8 | 63.3 | 60.43333 |
| Turkey | 76.8 | 78.8 | 85.2 | 80.26667 |
| Dead | 53.2 | 65.6 | 62 | 60.26667 |
| Donaldson | 48.8 | 56 | 53.2 | 52.66667 |
| Spout | 83.6 | 82 | 85.2 | 83.6 |
| Windy | 60.8 | 58.8 | | 59.8 |
| Difficult | 43.6 | 47.6 | | 45.6 |
| CIA | 54 | 50.8 | | 52.4 |

Appendix 29b: Water Chemistry Charts, Nitrate (mg/L)

| Stream | Round1 | Round 2 | Round 3 | Average |
|---|---|---|---|---|
| Mine | 1.5 | 1.5 | 1 | 1.333333 |
| Pimmit | 2.1 | 1.8 | 1 | 1.633333 |
| Gulf Branch | 1.2 | 2.6 | 2.4 | 2.066667 |
| Turkey | 1.6 | 2 | 1.6 | 1.733333 |
| Dead | 1.9 | 1.5 | 1.4 | 1.6 |
| Donaldson | 2.1 | 3.4 | 2.7 | 2.733333 |
| Spout | 2.6 | 2.9 | 2.7 | 2.733333 |
| Windy | 3.6 | 3.3 | | 3.45 |
| Difficult | 1.3 | 1.3 | | 1.3 |
| CIA | 2.1 | 1.9 | | 2 |

Appendix 29c: Water Chemistry Charts, Phosphorus (mg/L)

| Stream | Round 1 | Round 2 | Round 3 | Average |
|---|---|---|---|---|
| Mine | 0.41 | 0.24 | 0 | 0.216667 |
| Pimmit | 0.49 | 0.94 | 0.43 | 0.62 |
| Gulf Branch | 0.4 | 0.29 | 0.74 | 0.476667 |
| Turkey | 0.28 | 0.38 | 0.4 | 0.353333 |
| Dead | 0.2 | 0.37 | 0.36 | 0.31 |
| Donaldson | 0.53 | 0.3 | 0.62 | 0.483333 |
| Spout | 0.66 | 0.71 | 0.62 | 0.663333 |
| Windy | 0.27 | 0.67 | | 0.47 |
| Difficult | 0.14 | 0.33 | | 0.235 |
| CIA | 0.42 | 0.56 | | 0.49 |

Appendix 29d: Water Chemistry Charts, Chlorine (mg/L)

| Stream | Round 1 | Round 2 | Round 3 | Average |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Mine | 0.02 | 0.02 | 0.04 | 0.026667 |
| Pimmit | 0.03 | 0.03 | 0.02 | 0.026667 |
| Gulf Branch | 0.04 | 0.03 | 0 | 0.023333 |
| Turkey | 0.02 | 0.02 | 0 | 0.013333 |
| Dead | 0.13 | 0 | 0 | 0.043333 |
| Donaldson | 0.04 | 0.13 | 0.03 | 0.066667 |
| Spout | 0.03 | 0.02 | 0.01 | 0.02 |
| Windy | 0.05 | 0.01 | | 0.03 |
| Difficult | 0.02 | 0 | | 0.01 |
| CIA | 0 | 0 | | 0 |

Appendix 30: Specific Conductivity Chart (uS)

| Stream | Round 1 | Round 2 | Round 3 | Average |
|---|---|---|---|---|
| Mine | 149.65 | 150.4667 | 150.6667 | 150.2611 |
| Pimmit | 321.45 | 318.4333 | 346.7 | 328.8611 |
| Gulf Branch | 316.3 | 405.1667 | 387.3333 | 369.6 |
| Turkey | 345.3 | 377 | 228.4667 | 316.9222 |
| Dead | 260.3 | 271.6 | 193.4667 | 241.7889 |
| Donaldson | 439.8333 | 451.9333 | 409.7 | 433.8222 |
| Spout | 651 | 612 | 648.3333 | 637.1111 |
| Windy | 552.9 | 574 | | 563.45 |
| Difficult | 226.0333 | 193.1333 | | 209.5833 |
| CIA | 226.0333 | 803.6667 | | 514.85 |

Appendix 31: Temperature Chart (°C)

| | Round 1 | Round 2 | Round 3 | Average |
|---|---|---|---|---|
| **Mine** | 22.15 | 21.73333 | 23.2 | 22.36111 |
| **Pimmit** | 22.65 | 22.3 | 26.16667 | 23.70556 |
| **Gulf Branch** | **20.5** | 21.93333 | 22.56667 | 21.66667 |
| **Turkey** | 18.6 | 21.46667 | 21.23333 | 20.43333 |
| **Dead** | **18.2** | 23.73333 | 23.2 | 21.71111 |
| **Donaldson** | 19.86667 | 23.46667 | 23.6 | 22.31111 |
| **Spout** | 21.96667 | 24.46667 | 24.7 | 23.71111 |
| **Windy** | 20.3 | 23.4 | | 21.85 |
| **Difficult** | 22.6 | 26.1 | | 24.35 |
| **CIA** | 17.46667 | 21.23333 | | 19.35 |

Appendix 32: pH Chart

| | Round | Round | Round 3 | Average |
|---|---|---|---|---|

| | 1 | 2 | | |
|---|---|---|---|---|
| Mine | 7.59 | 7.62 | 7.63 | 7.61333 |
| Pimmit | 7.72 | 7.68 | 8.07 | 7.82333 |
| Gulf Branch | 7.34 | 7.45 | 7.49 | 7.42667 |
| Turkey | 7.87 | 7.92 | 7.72 | 7.83667 |
| Dead | 7.81 | 7.78 | 7.65 | 7.74667 |
| Donaldson | 7.58 | 7.65 | 7.63 | 7.62 |
| Spout | 7.79 | 7.84 | 7.88 | 7.83667 |
| Windy | 7.42 | 7.43 | | 7.425 |
| Difficult | 7.62 | 7.57 | | 7.595 |
| CIA | 7.63 | 7.57 | | 7.6 |

Appendix 33: Dissolved Oxygen Chart (%)

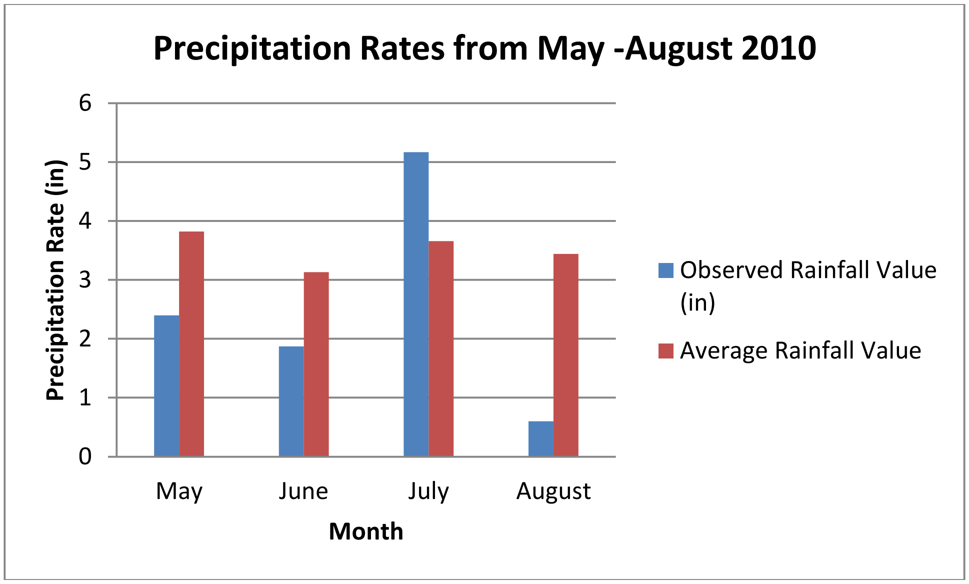
| | Round 1 | Round 2 | Round 3 | Average |
|---|---|---|---|---|
| Mine | 95 | 89 | 88.67 | 90.89 |
| Pimmit | 92 | 92 | 102.33 | 95.44333 |
| Gulf Branch | 89 | 89.67 | 89.67 | 89.44667 |
| Turkey | 97 | 94.67 | 93.33 | 95 |
| Dead | 94 | 90.33 | 91.33 | 91.88667 |
| Donaldson | 91.33 | 87 | 86.67 | 88.33333 |
| Spout | 88.67 | 89.67 | 88.67 | 89.00333 |
| Windy | 87.67 | 83.33 | | 85.5 |
| Difficult | 96 | 94.33 | | 95.165 |
| CIA | 90 | 79 | | 84.5 |

Appendix 34: Sampling Dates and Times

| Round 1 | | | Round 2 | | | Round 3 | | |
|---|---|---|---|---|---|---|---|---|
| Mine P1 | 6/17/2010 | 8:49 AM | Mine P1 | 6/17/2010 | 8:49 AM | Mine P1 | 7/7/2010 | 8:57 AM |
| Mine P2 | 6/17/2010 | 10:43 AM | Mine P2 | 6/17/2010 | 10:43 AM | Mine P2 | 7/7/2010 | 10:27 AM |
| Mine P3 | 6/18/2010 | 7:21 AM | Mine P3 | 6/18/2010 | 7:21 AM | Mine P3 | 7/7/2010 | 12:43 PM |
| Pimmit P1 | 6/18/2010 | 9:46 AM | Pimmit P1 | 6/18/2010 | 9:46 AM | Pimmit P1 | 7//8/10 | 9:03 AM |
| Pimmit P2 | 6/18/2010 | 11:23 AM | Pimmit P2 | 6/18/2010 | 11:23 AM | Pimmit P2 | 7/8/2010 | 10:34 AM |
| Pimmit P3 | 6/18/2010 | 1:14 PM | Pimmit P3 | 6/18/2010 | 1:14 PM | Pimmit P3 | 7/8/2010 | 12:25 PM |
| Gulf P1 | 6/22/2010 | 8:01 AM | Gulf P1 | 6/22/2010 | 8:01 AM | Gulf BranchP1 | 7/12/2010 | 9:29 AM |
| Gulf P2 | 6/22/2010 | 10:00 AM | Gulf P2 | 6/22/2010 | 10:00 AM | Gulf BranchP2 | 7/12/2010 | 10:36 AM |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Gulf P3 | 6/22/2010 | 11:34 AM | Gulf P3 | 6/22/2010 | 11:34 AM | Gulf BranchP3 | 7/12/2010 | 12:34 PM |
| Turkey P1 | 6/23/2010 | 8:01 AM | Turkey P1 | 6/23/2010 | 8:01 AM | Turkey P1 | 7/13/2010 | 8:41 AM |
| Turkey P2 | 6/23/2010 | 10:04 AM | Turkey P2 | 6/23/2010 | 10:04 AM | Turkey P2 | 7/13/2010 | 9:53 AM |
| Turkey P3 | 6/23/2010 | 12:23 PM | Turkey P3 | 6/23/2010 | 12:23 PM | Turkey P3 | 7/13/2010 | 11:23 AM |
| Dead P1 | 6/24/2010 | 1:21 PM | Dead P1 | 6/24/2010 | 1:21 PM | Dead P1 | 7/15/2010 | 9:26 AM |
| Dead P2 | 6/25/2010 | 8:37 AM | Dead P2 | 6/25/2010 | 8:37 AM | Dead P2 | 7/15/2010 | 10:59 AM |
| Dead P3 | 6/25/2010 | 9:45 AM | Dead P3 | 6/25/2010 | 9:45 AM | Dead P3 | 7/16/2010 | 8:59 AM |
| Donald. P1 | 6/25/2010 | 11:17 AM | Donald. P1 | 6/25/2010 | 11:17 AM | Donaldson. P1 | 7/16/2010 | 11:50 AM |
| Donald. P2 | 6/25/2010 | 1:46 PM | Donald. P2 | 6/25/2010 | 1:46 PM | Donaldson. P2 | 7/16/2010 | 1:19 PM |
| Donald. P3 | 6/28/2010 | 8:17 AM | Donald. P3 | 6/28/2010 | 8:17 AM | Donaldson. P3 | 7/20/2010 | 9:04 AM |
| Spout P1 | 6/29/2010 | 9:14 AM | Spout P1 | 6/29/2010 | 9:14 AM | Spout P1 | 7/20/2010 | 11:56 AM |
| Spout P2 | 6/29/2010 | 11:51 AM | Spout P2 | 6/29/2010 | 11:51 AM | Spout P2 | 7/20/2010 | 1:13 PM |
| Spout P3 | 6/29/2010 | 1:28 PM | Spout P3 | 6/29/2010 | 1:28 PM | Spout P3 | 7/20/2010 | 2:24 PM |
| Windy P1 | 7/23/2010 | 8:14 AM | Windy P1 | 7/23/2010 | 8:14 AM | | | |
| Windy P2 | 7/23/2010 | 10:15 AM | Windy P2 | 7/23/2010 | 10:15 AM | | | |
| Windy P3 | 7/23/2010 | 12:00 PM | Windy P3 | 7/23/2010 | 12:00 PM | | | |
| DifficultP1 | 7/26/2010 | 8:30 AM | DifficultP1 | 7/26/2010 | 8:30 AM | | | |
| DifficultP2 | 7/26/2010 | 10:15 AM | DifficultP2 | 7/26/2010 | 10:15 AM | | | |
| DifficultP3 | 7/26/2010 | 12:21 PM | DifficultP3 | 7/26/2010 | 12:21 PM | | | |
| CIA P1 | 7/27/2010 | 9:53 AM | CIA P1 | 7/27/2010 | 9:53 AM | | | |
| CIA P2 | 7/27/2010 | 11:20 AM | CIA P2 | 7/27/2010 | 11:20 AM | | | |
| CIA P3 | 7/27/2010 | 12:51 PM | CIA P3 | 7/27/2010 | 12:51 PM | | | |

## Appendix 35: Rainfall Data 2010




Appendix 36: Developmental Activities

- Visit Clara Barton House
- Visit Mt. Vernon
- Tour USGS office
- Visit Prince William County Forrest Park or other neighboring park
- Tour regional Park Service office
- Go out to do field work with principal investigators around the DC area
- Ride along with park police
- Assist with other surveys going on in the park (like Brent Steury's snail survey)
- Canoe around Dyke Marsh
- Help with clearing invasive plants
- Visit Glen Echo
- Explore Great Falls Park
- Visit Teddy Roosevelt Island