Spring 2022 Water Quality Monitoring in the Hunting Creek Watershed

(Final, January 5, 2023)

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Summary

On April 3, 2022, the Friends of Hunting Creek (FOHC) again participated in the Water Quality Blitz spearheaded by the American Chestnut Land Trust (ACLT). FOHC volunteers collected water samples in 17 non-tidal streams across the almost 20,000-acre Hunting Creek watershed. Ten of these sites were also sampled in 2021, our first Blitz. To expand coverage, we added seven new sites in 2022. Also, at two additional sites (HC18: Chingaware Run and HC19: unnamed tributary to Mill Creek), stream health was evaluated by sampling aquatic macroinvertebrates (macros) and also by scoring ten physical habitat parameters.

Nitrogen levels at the ten sites sampled in 2021 and 2022 were similar. In both years, eight of the ten sites had nitrogen levels considered to be “good” water quality by ACLT (<or=0.7 mg/L). Nitrogen levels are measured as NO23, nitrite + nitrate, the major forms of nitrogen in freshwater streams. The two sites with slightly elevated nitrogen levels in 2021 (Little Lyons Creek, HC3=1.660 mg/L and Fox Point Creek, HC10=1.093 mg/L) also had elevated nitrogen levels in 2022 (HC3=1.880 mg/L and HC10=1.140 mg/L). Only one of the seven new sites added in 2022 had a nitrogen level above the 0.7 mg/L threshold: Quail Ridge Run, HC16=0.938 mg/L. Overall, in 2022, 14 of the 17 stream sites had nitrogen levels in the “good” range; i.e., <or=0.7 mg/L. Based on the method used by ACLT to grade non-tidal stream sites for nitrogen in the Parkers Creek watershed, Hunting Creek watershed earned a score of 95.6% in 2022, an “excellent” grade.

Phosphorus levels at the 17 sites sampled in 2022 ranged from 0.0034 mg/L to 0.0095 mg/L, well within the “good” category threshold of <or=0.037 mg/L used by ACLT.

Macros community scores were similar at HC18 and HC19, both in the “poor” category along a condition scale from “very poor” to “poor” to “fair” to “good”. A comparison of tolerance to pollutants/habitat degradation values suggested that the macros were in somewhat better condition at HC18 than at HC19. This difference was supported by slightly higher physical habitat scores at HC18 and less impervious land cover in its catchment (5.4% imperviousness vs. 13.7% for HC19).

Results of Spring 2022 water quality monitoring by the FOHC in the Hunting Creek watershed did not raise any serious “red flags” that are cause for concern. Nor did we see any large changes in nitrogen levels between 2021 and 2022. Spring nitrogen and phosphorous levels are low in all the non-tidal streams that have been sampled. The macros sampled at two sites for the first time in 2022 reflect the adverse impacts of stressors associated with physical habitat degradation probably caused by past and current land use practices.

Overall, the Hunting Creek watershed is 29.4% developed, with 7.7% imperviousness---not a condition we can call “pristine”. So, the FOHC must do what’s possible to keep impervious land cover below 10% and out of the ‘danger zone’ for macros. We must also insist that well-

designed and effective stormwater management practices be used in the Prince Frederick Town Center and elsewhere in the watershed.

On a more positive note, many FOHC members will tell you that paddling a canoe or kayak on the creek downstream from the Rts. 2/4 bridge looks and feels like a true wilderness experience. Over half of the watershed (56.2%) is still covered with forests and wetlands. Hence there are many reasons to expect that constant vigilance and faithful stewardship will ensure that the Hunting Creek watershed continues to flourish ecologically and also provide many valuable ecosystem services.

Introduction

The Mission of the Friends of Hunting Creek (FOHC) "…….*is to promote the ecological health and resiliency of the watershed's 50 miles of stream and landscape so that landowners, citizens, government agencies, and elected officials together take an active role in protecting and sustaining the natural and cultural resources."* In keeping with this Mission statement, the FOHC works to "*expand the scientific understanding of our land and water resources."* One way to achieve this goal is to conduct water quality monitoring throughout the Hunting Creek watershed.

2021

In April 2021, members of the FOHC conducted the first Water Quality Blitz at 10 non-tidal stream sites in the watershed. Our monitoring activities coincided with similar efforts also conducted the same day in the Parkers Creek and St. Leonard Creek watersheds. Grab water samples collected at the 10 sites were filtered by Dr. Walter Boynton at the American Chestnut Land Trust (ACLT) office and then sent to the Chesapeake Biological Laboratory (CBL) in Solomons, MD, for analysis of NO23, the major forms of nitrogen in target streams. Current velocity, water temperature, conductivity, dissolved oxygen, dissolved oxygen saturation, and pH were measured at a limited number of sites (specifically at HC3, HC6, HC8B, HC11, HC12, and HC13). Detailed discussions of these parameters can be found in the 2021 report (Ref 1). These measurements were not repeated in 2022 however, sites 8b, 11, and 13 were tested for NO23 and PO4 in 2022.

2022

On April 2, 2022, a second Water Quality Blitz was conducted by FOHC members in the Hunting Creek watershed. Grab water samples were collected at the same ten non-tidal stream sites sampled in April 2021. Sites 8b, 11, and 13 from 2021 were also tested for NO23 and PO4 in 2022. To expand the coverage of the watershed, seven additional sites were sampled in 2022. All water samples were filtered at the ACLT office by FOHC members and ACLT staff, under the direction of Dr. Walter Boynton. The filtered samples were sent to CBL where they were analyzed for [NO23] and [PO4]. In 2021, [PO4] was not measured.

Rationale for Blitz Sampling Dates

A major goal of the Water Quality Blitz in 2021 and 2022 is to characterize concentrations of inorganic nitrogen (measured as nitrite NO2 + nitrate NO3) in near-surface groundwater. Scientists at the University of Maryland's Center for Environmental Science, Appalachian Laboratory in Frostburg found after making many measurements of dissolved inorganic nitrogen throughout all months of the year that a good approximation of average annual concentrations in near-surface groundwater can be obtained by collecting a single stream water sample under two conditions. First, the sample should be collected in early spring, before leaf-out occurs. In Calvert County, early to mid-April typically precedes leaf-out. Once trees have fully leafed-out, nitrogen concentrations are depressed. Second, the stream water samples should be collected under dry conditions. The rule of thumb followed by ACLT is no rain and associated surface run-off for three days prior to sample collection. Typically, surface run-off depresses inorganic nitrogen concentrations and would thus hamper our goal to obtain average annual concentrations. Dissolved inorganic nitrogen (I.e., NO2 and NO3) are the two forms of bioavailable nitrogen in near-surface groundwater. Other forms of nitrogen (e.g., ammonium, dissolved organic nitrogen, particulate organic nitrogen) are generally at low concentrations in groundwater and except for ammonium are not directly available to support plant growth.

Macroinvertebrate Sampling

Another activity was added to the FOHC's water quality monitoring program in Spring 2022. At two stream sites (HC19: a tributary to Mill Creek and HC18: Chingaware Run), stream health was evaluated by sampling aquatic benthic macroinvertebrates and also by scoring ten physical habitat parameters. HC19 was sampled on April 9; HC18 on April 16 (Figures 1, 2, 3).

Figure 1 and 2 Macroinvertebrate Test Sites HC19 and HC18

Macroinvertebrates were collected using Maryland Biological Stream Survey (MBSS) methods (Ref 2) and identified by Istvan Turcsanyi (a certified macroinvertebrate taxonomist) to family and genus level.

Figure 3 Macroinvertebrate Sampling Equipment

<u>What are aquatic benthic macroinvertebrates and why should we sample them?</u>

Aquatic benthic macroinvertebrates are small organisms that are visible to the naked eye, live on the bottom of freshwater streams for at least part of their lives, and do not have a backbone. They include aquatic insects (mostly the larval stages), crayfish, mussels, clams, worms, leeches, snails, flatworms, and sponges. Often referred to as “stream bugs”, they are important members of aquatic communities.

Macroinvertebrates are excellent indicators of stream health because they stay only in areas that are suitable for their survival, are easy to collect, are relatively easy to identify in the laboratory by trained individuals, have limited mobility, and often live for more than one year. So, macroinvertebrates are exposed to their habitats every day they are present and thereby integrate many components of stream health. Chemical monitoring typically gives us a snapshot in time of water quality, a slice of the stream health picture. Chemical monitoring can often underestimate degradation in an aquatic system. So, biological monitoring is an important and necessary complement to water quality monitoring.

Perhaps most important from a stream health assessment perspective is that aquatic macroinvertebrates differ in their tolerances/sensitivities to amounts and types of water pollution, hydrologic alterations, and physical habitat degradation.

Based on these characteristics, tolerance values can be assigned to individual macroinvertebrate groups (taxa) along a scale of 0 to 10 (Ref 3). An Excel spreadsheet of the tolerance values being used by MD/DNR for the Maryland Biological Stream Survey (Ref 4) can be obtained from Kyle Hodgson (kyle.hodgson@gmail.com). These tolerance values were used in our report. Those taxa with the greatest sensitivity (least tolerant) to environmental stressors are assigned a tolerance value of 0. Conversely, those taxa that show the least sensitivity (most tolerant) to environmental stressors are assigned a tolerance value of 10, with other taxa arrayed along the tolerance gradient from 0 to 10.

The larval forms of most mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa are examples of aquatic macroinvertebrates with low tolerance values (least or less tolerant). These taxa tend to either disappear or decrease significantly in abundance when water quality and/or physical habitat quality in a freshwater stream degrades. Taxa with moderate and high tolerance values (somewhat, more, and most tolerant) can occur in healthy streams, but tend to be the most common macroinvertebrate groups found in degraded streams.

Collecting samples and identifying which macroinvertebrates are present or absent in those samples allows a determination of the biological integrity of that stream.

Using MBSS methods, family-level and genus-level Indices of Biological Integrity (IBIs) for aquatic macroinvertebrates were calculated for HC19 and HC18. An IBI is a multi-metric measure of biological integrity that assesses the condition (health) of a stream site based on the kinds and numbers of taxa that were collected there. IBI scores can range from 1.0 (worst) to 5.0 (best), depending how far they deviate from minimally-disturbed reference streams (Ref 5). IBI scores fall into four assessment categories (1.0-1.9=very poor, 2.0-2.9=poor, 3.0-3.9=fair, 4,0-5.0=good). IBIs are a useful tool for distinguishing degraded from healthy streams. Identifying the major stressors that are impacting macroinvertebrates in degraded streams is more challenging.

Physical Habitat Parameters

To assess the condition of the physical habitat available to the aquatic macroinvertebrates present at HC19 and HC18 and to help us determine the extent to which human-related activities may be impacting these two stream sites, we evaluated and scored each of ten parameters from 0 points (poor) to 20 points (optimal). The ten habitat parameters for low gradient streams were: epifaunal substrate/available cover, pool substrate characterization, pool variability, sediment deposition, channel flow status, channel alteration, channel sinuosity, bank stability, vegetative protection, and riparian vegetative width (for definitions and scoring criteria, refer to the Habitat Assessment Field Data Sheet included in Appendix 3. In addition, wetted width and thalweg depth (deepest point) were measured at four transects located at the 0m, 25m, 50m, and 75m locations along the 75m-long sampled stream segments. Maximum stream depth within the entire segment at HC19 and HC18 was also measured.

Results

Sample Sites

There are two broad categories of locations for the sample sites. The first category is samples taken at a bridge. The description of the site includes the road and the upstream or downstream side of the bridge. The second category of sample sites are those not taken close to a bridge and usually are taken with permission of a property owner. All sites have detailed site location information for the purpose of repeating site data in future years' test efforts. A further general description of the sites can be found in Appendix 1.

Water Chemistry

The samples were measured for nitrogen (NO23 = Nitrite and nitrate) and phosphorus (PO4). See Appendix 1 for supplemental information on NO23. The tabular data (Table 1) and sample site maps (Figures 4, 5, and 7) are shown below. The detailed discussion follows the global site maps.

Table 1. Spring Nitrogen (as NO23) and Phosphorus (as PO4) Concentrations in Non-tidal Streams, Hunting Creek Watershed, 2021 and 2022

Site Number	2021 NO23 (mg/L)	2022	
		NO23 (mg/L)	PO4 (mg/L) [a]
HC1	0.444	0.161	0.0074
HC2	0.465	0.473	0.0063
HC3	1.660	1.880	0.0092
HC4	0.542	0.609	0.0096
HC5	0.419	0.287	0.0036
HC6	0.335	0.201	0.0064
HC7	0.534	0.441	0.0037
HC8a	0.538	0.264	0.0053
HC8b	NS[b]	0.349	0.0062
HC9	0.712	0.153	0.0066
HC10	1.093	1.140	0.0095
HC11	NS	0.156	0.0034
HC13	NS	0.586	0.0058
HC14	NS	0.175	0.0034
HC15	NS	0.380	0.0058
HC16	NS	0.938	0.0095
HC17	NS	0.311	0.0034
HC18	NS	NS	NS
HC19	NS	NS	NS

a: PO4 was not measured in 2021. **b:** NS = Site was not sampled

Figure 7 Water Chemistry - Nitrogen, 2022

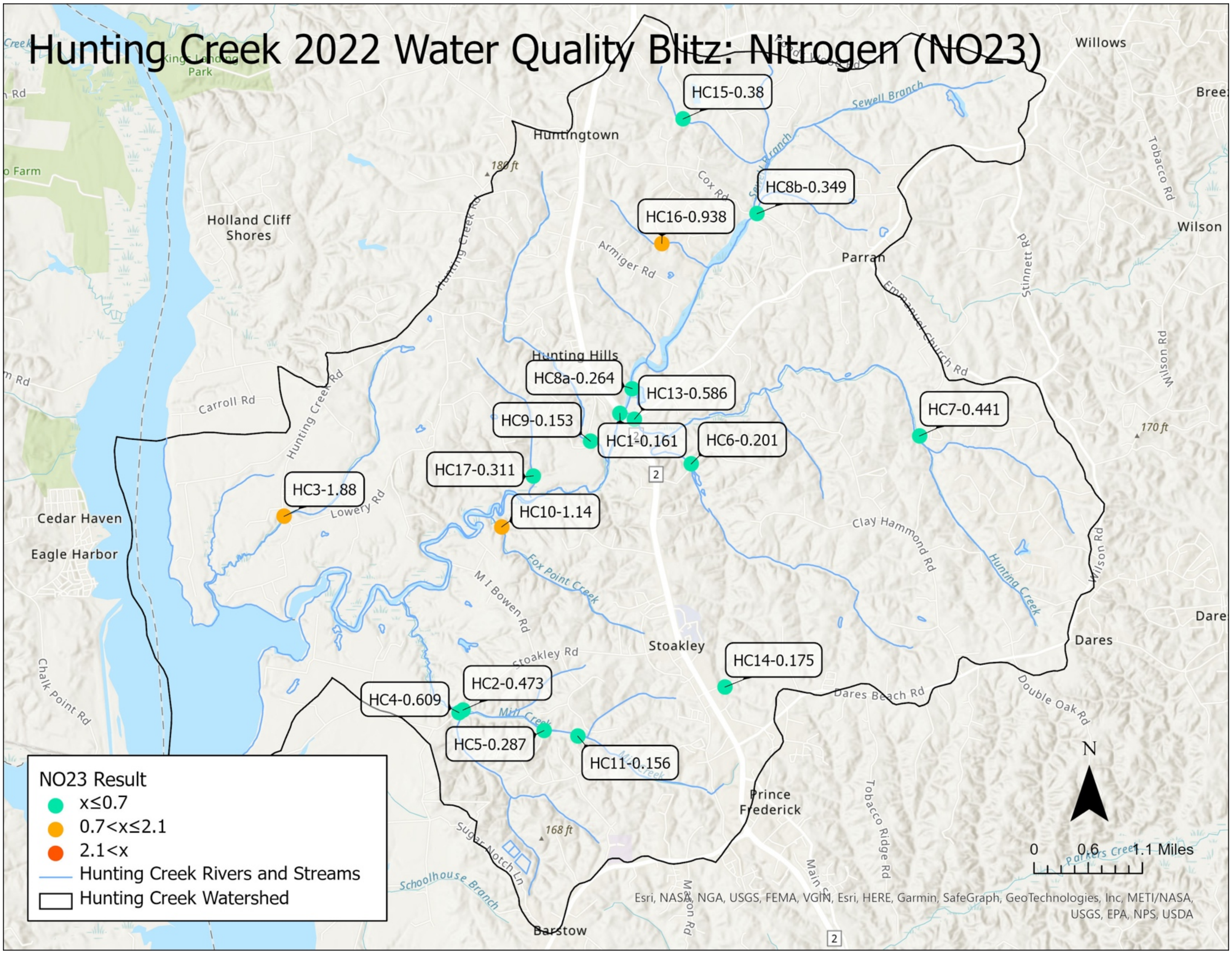


Figure 8 Water Chemistry - Nitrogen, 2021

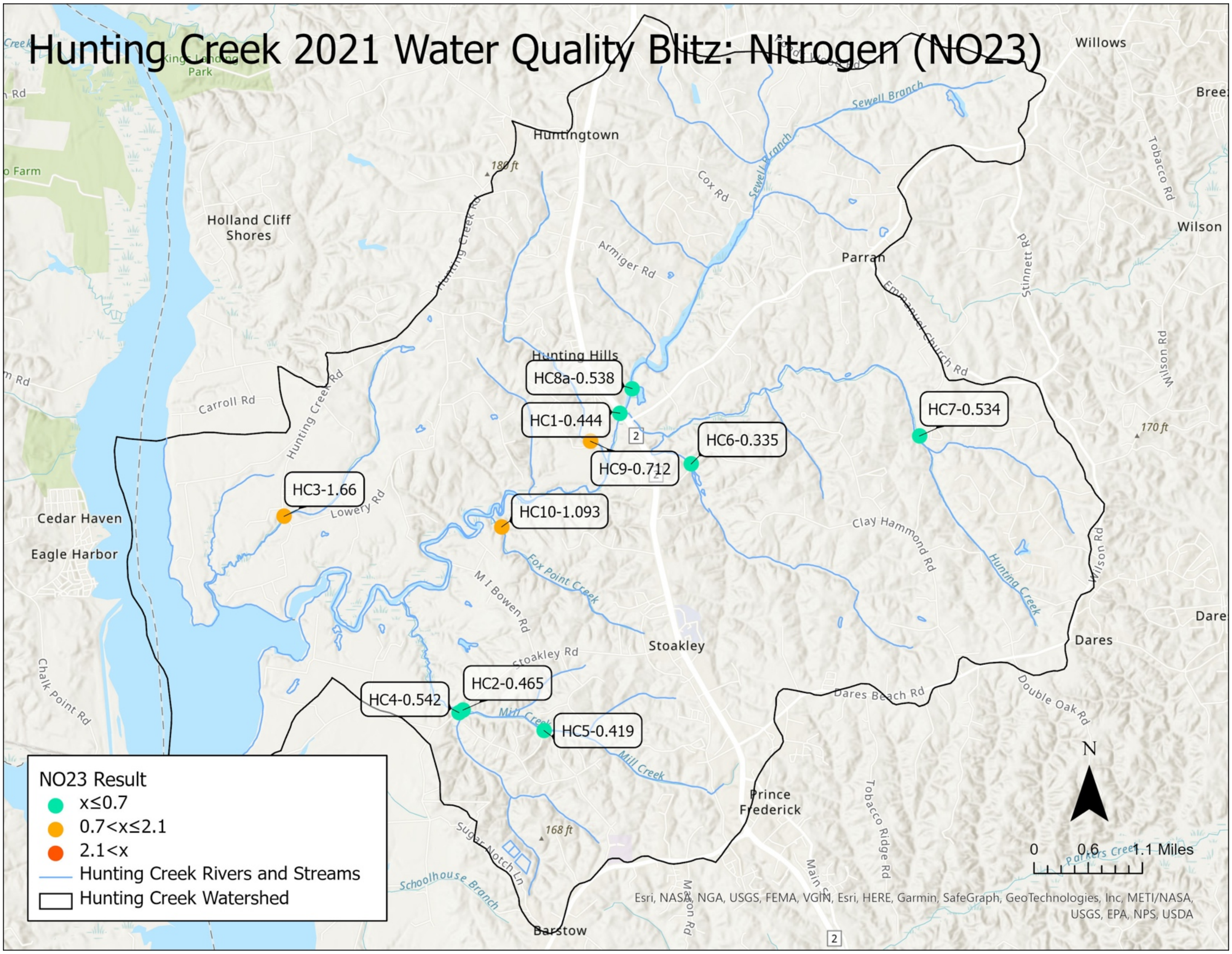
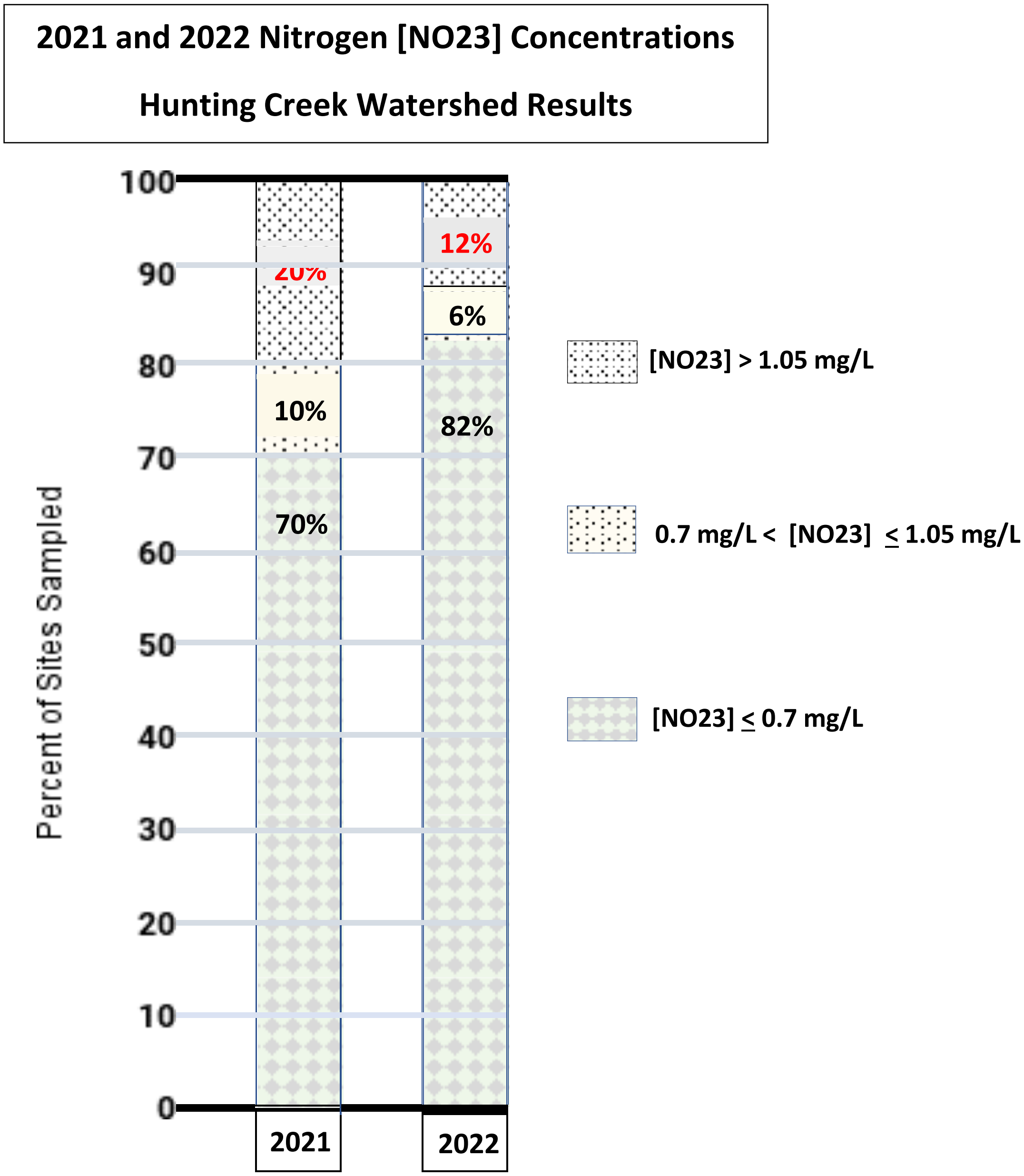


Figure 6 Comparison of NO23 for 2021 and 2022

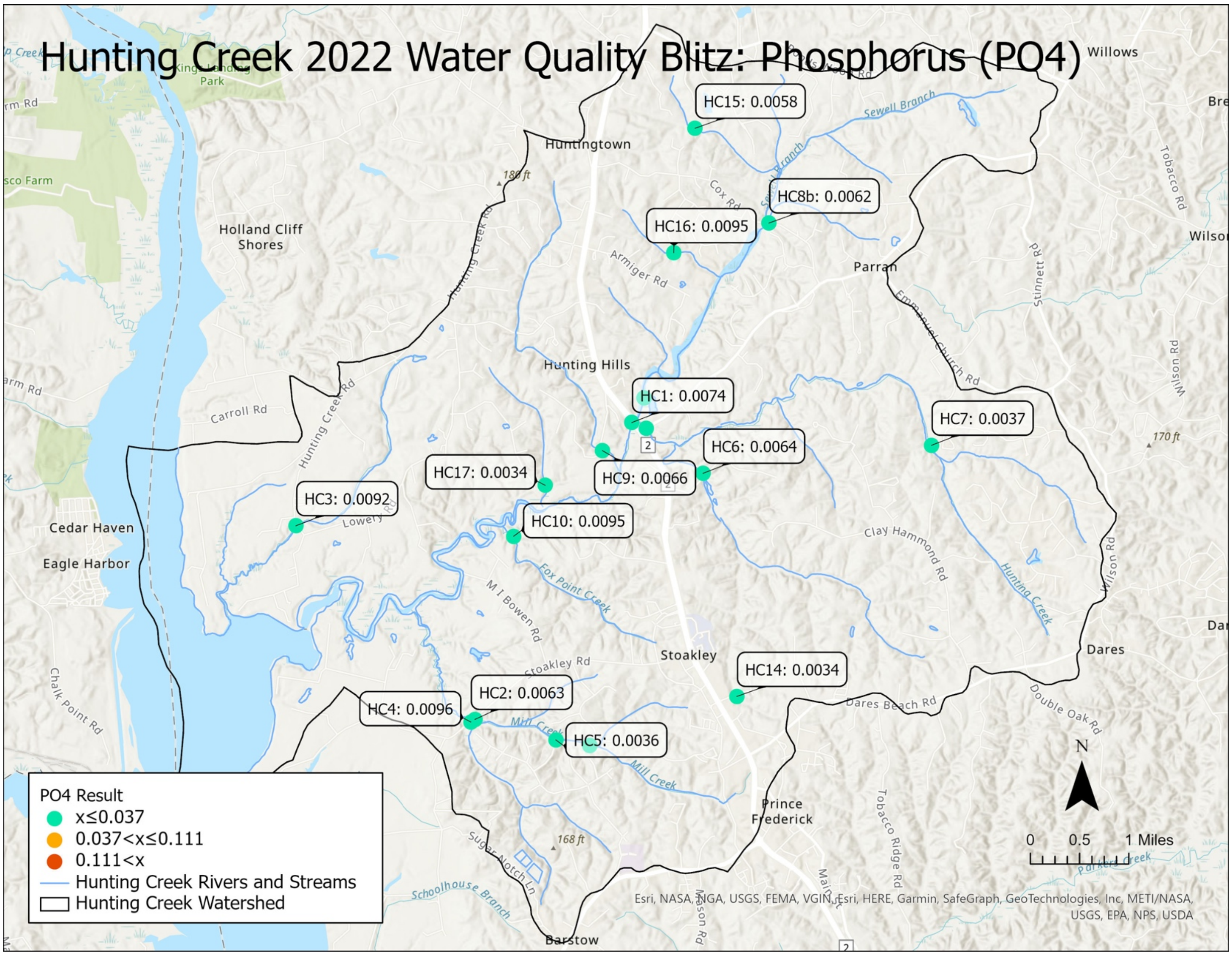


Nitrogen concentrations (as measured by NO23) at the ten stream sites sampled in 2022 showed the same basic results as these sites showed in 2021. In both years, eight of the ten sites had [NO23] below the 0.7 mg/L threshold considered to be "good" by ACLT. Six of the seven new sites added in 2022 also had [NO23] in the "good" range (Figure 6).

The same two of the ten sites sampled in 2021 and 2022 (HC3, Little Lyons Creek and HC10, Fox Point Creek) had [NO23] that were slightly elevated and in the "fair" range: >0.7 but less than 2.1 mg/L. In addition, one of the seven new sites added in 2022 (HC16, Quail Ridge Run) also had a [NO23] in the "fair" range.

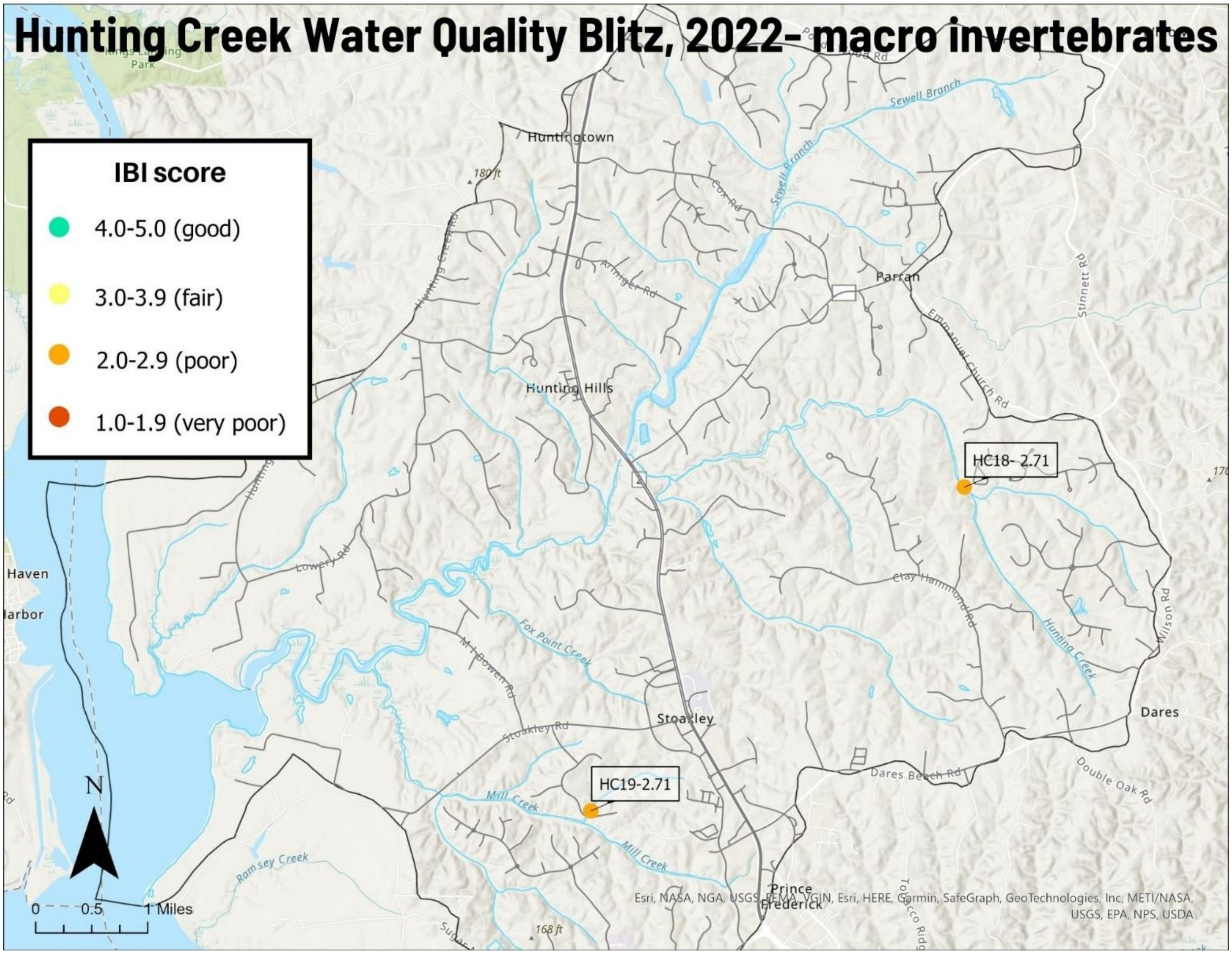
Overall, 14 of the 17 stream sites (82.4%) sampled during the 2022 Water Quality Blitz had [NO23] in the "good" range. ACLT recently prepared a report card for the Parkers Creek watershed (https://www.acltweb.org/wp-content/uploads/2022/03/Parkers-Creek-Preserve-Report-Card-FINAL.pdf). Using the draft method developed by ACLT for scoring [NO23] in non-tidal streams, the Hunting Creek watershed scored 95.6% in 2022 for nitrogen, an "excellent" grade.

Figure 7 Water Chemistry-Phosphorus, 2022



All 17 non-tidal stream sites had [PO4] in the "good" range in 2022: <0.037 mg/L. [PO4] ranged from a low of 0.0034 mg/L to a high of only 0.0095 mg/L, well below the "good" category threshold used by ACLT for Parkers Creek tributaries (≤ 0.037 mg/L). Perhaps not surprising, the three sites that had the highest [NO23] in 2022 also had the highest [PO4]: HC3, Little Lyons Creek; HC10, Fox Point Creek; and HC16, Quail Ridge Run.

Figure 8 Aquatic Macroinvertebrates



The IBI scores calculated for the macroinvertebrates collected at the two non-tidal stream sites in the Hunting Creek watershed in early April 2022 were more similar than different. Family-level and genus-level IBI scores at HC19 (tributary to Mill Creek) were 2.14 and 2.71, respectively. Family-level and genus-level scores at HC18 (Chingaware Run) were 2.43 and 2.71, respectively. These IBI scores all fall into the “Poor” condition range, compared to minimally-disturbed reference streams sampled by the MBSS in Maryland’s Coastal Plain. The genus-level scores for HC19 and HC18 are shown in Figure 8.

Digging deeper into the data, some differences emerge between the macroinvertebrate communities at the two stream sites. These differences are discussed below.

HC18 had more kinds of aquatic organisms (taxa) than HC19: 26 vs. 19. Generally, more taxa (i.e., higher biodiversity) reflect better stream conditions.

Gammarus sp. (Figure 9), a somewhat pollution-tolerant amphipod crustacean (tolerance value = 6.7 on a 0 to 10 scale, from least to most tolerant) were the most common taxa collected at both sites: 41.4% of all macroinvertebrates at HC19 and 30.9% at HC18. *Gammarus sp*.

comprise a diverse group of freshwater shrimps that includes more than 200 species worldwide. They often represent the dominant macroinvertebrate species, by weight, in freshwater streams. *Gammarus sp*. also represent important keystone aquatic species because they play a central role in the detritus cycle (e.g., litter breakdown processes). They also constitute an important component in aquatic food webs by being food items for fish. Four or five species of *Gammarus* inhabit Maryland waters, but they are challenging to distinguish.

Fig. 9
Cheumatopsyche sp.

Diptera (true flies) taxa were also common at both HC19 (42.1% of all taxa collected) and HC18 (61.5% of all taxa collected). Only those insects having one pair of wings belong to the Diptera. This groups includes flies, mosquitos, gnats, midges, and no-see-ums. There are about 120,000 known species of true flies. The immature life stages (larvae) of many Diptera species (e.g., midges, Figure 10 and craneflies, Figure 11) inhabit freshwater and estuarine habitats.

Fig. 10
Midge Larva

In general, Diptera taxa have moderate to high tolerance values, meaning they are somewhat tolerant to most tolerant to environmental stressors. However, one Dipteran genus (*Potthastia sp*.), with a tolerance value of 0 (least tolerant, most sensitive) was found in the macroinvertebrate sample collected at HC18. Tolerance values for the eight Diptera taxa collected at HC19 ranged from 4.6 to 9.2 (on the 0 to 10 scale), with average and median tolerance values of 6.6 and 6.5, respectively. Tolerance values for the 16 Diptera taxa collected at HC18 ranged from 0 to 9.2, with average and median tolerance levels of 5.9 and 6.1, respectively.

Fig. 11
Cranefly
Larva

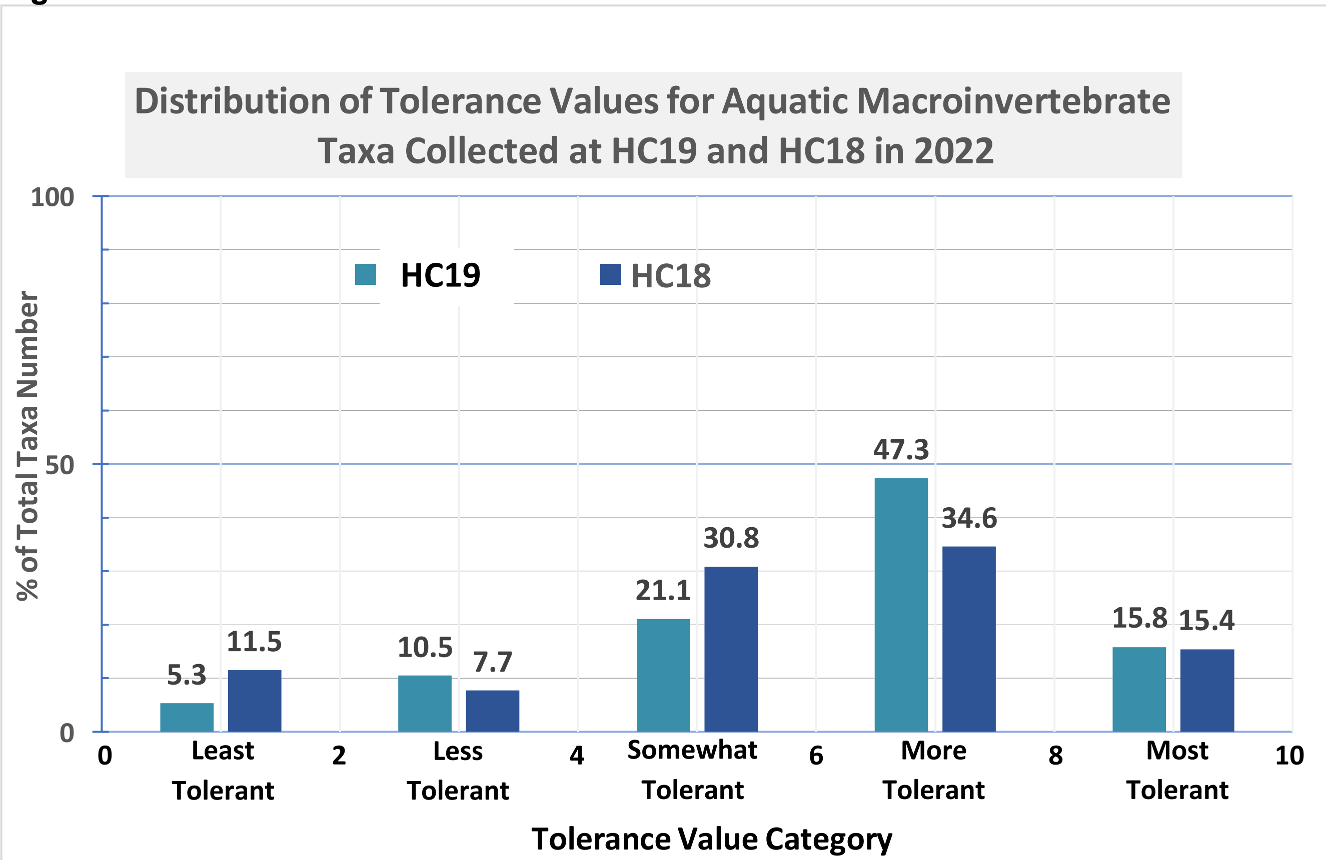
No mayflies, mostly least and less pollution-tolerant taxa, were collected at either stream site. One caddisfly genus (*Cheumatopsyche sp.,* tolerance value = 6.5) was collected at HC18; no caddisfly larvae were collected at HC19. Two stonefly taxa (*Haploperla sp.,* tolerance value = 1.6, and *Amphinemura sp.*, tolerance value = 3) were collected at HC19. One stonefly taxon (*Amphinemura sp.,* tolerance value = 3) was collected at HC18.

Looking at the tolerance values for all taxa collected (19 at HC19 and 26 at HC18), other site differences can be seen.

The average tolerance value at HC19 was 6.2. The average tolerance value at HC18 was slightly less tolerant at 5.7. As a reminder, lower average tolerance values indicate more least and less tolerant taxa that may, in turn, reflect better stream conditions.

One more comparison of tolerance values for macroinvertebrate taxa collected at HC19 and HC18 is shown in Figure 12. As a percentage of the total taxa number, HC18 had slightly more least and less tolerant taxa than HC19 (19.2% vs. 15.8%) and fewer more and most tolerant taxa than HC19 (50.0% vs. 63.1%).

Figure 12



Physical Habitat Parameters

The two stream sites were comparable in size. Average width was 2.1 m for HC19 and 2.5 m for HC18. Maximum depth was 46 cm at both sites.

Scores for the ten physical habitat parameters assessed at HC19 and HC18 were also more similar than different. HC19 scored a total of 162 points out of a maximum score of 200 (81%) for all ten parameters, with an average score of 16.2 points (low optimal). The lowest scoring physical habitat parameters at HC19 were epifaunal substrate/available cover (10 of 20 possible points = marginal) and sediment deposition (10 of 20 possible points = marginal). HC18 scored a total of 156 points (out of 200) for the ten physical habitat parameters (78%), with an average score of 15.6 points (high suboptimal). The lowest scoring parameters at HC18 were pool substrate characterizations (9 of 20 possible points = marginal) and pool variability (10 of 20 possible points = marginal). Both stream sites scored in the optimal range for vegetative protection and riparian vegetative zone width, reflecting the fact that the two sites are well-buffered by large trees and shrubs growing in the adjacent flood plain.

To sum up, aquatic macroinvertebrate sampling and physical habitat evaluation at two non-tidal stream sites in the Hunting Creek watershed in 2022 suggested that neither the tributary to Mill Creek (HC19) nor Chingaware Run (HC18) are in pristine or even “Fair” condition. However, neither stream site is badly degraded. The IBI scores were at the high end of the “Poor” condition range and approaching “Fair”. In addition, the relatively large numbers of taxa at both sites are encouraging. The relative scarcity of pollution-sensitive (least and less tolerant) taxa and the dominance of somewhat, more, and most-tolerant taxa may reflect physical habitat parameters and/or water quality issues that were not captured by the Water Quality Blitz.

The detailed examination of the macroinvertebrate taxa collected at the two sites suggests that, although similar, overall habitat quality at HC18 (Chingaware Run) may be somewhat better than at HC19 (tributary to Mill Creek). We hypothesized this difference prior to sampling after examining the available 2017 data on land use/land cover in the Mill Creek and Chingaware Run catchments (Table 2). Impervious surfaces and developed land use made up 13.7% and 32.8% of the total catchment area, respectively, for upper Mill Creek, in which HC19 is one of the major tributaries. In comparison, the Chingaware Run catchment had 5.4% impervious surface and 24.3% developed land use.

Many studies have shown that habitat quality decreases in freshwater streams when impervious surfaces and development increase (Ref 6, Ref 7, Ref 8). A more comprehensive sampling program focused on aquatic macroinvertebrates, along with the collection of water samples and assessment of the physical habitat, is needed to more robustly explore how land use/land cover influences stream health in the Hunting Creek watershed.

Table 2. 2017 Land Use/Land Cover Data for Selected NHD v.2.1 Catchments in the Hunting Creek Watershed.
(Percentages of Total Catchment Acres Minus Water)

Catchment Name & Area	Natural	Agriculture	Developed	Impervious	Mixed Other
[Acres]					
College Creek	63.4	1.3	25.9	8	9.5
[760.2]					
Upper Mill Creek	56	1.7	32.8	13.7	9.6
[1693.5]					
Lower Mill Creek	63.3	15.3	11.3	1.6	10.2
[489.9]					
Fox Point Creek	55.4	8.7	26	8.6	9.9
[711.9]					
Fox Run	70.1	1.5	23.7	8.9	4.7
[2263.8]					
Chingaware Run	68.7	2.6	24.3	5.4	4.3
[1982.7]					
Barberry Branch	48	1.4	43.8	11.1	6.9
[733.6]					
Quail Ridge Run	51.1	1.2	37.6	8.9	10.1
[411.2]					
Reits Branch	42.1	2.7	49.4	10.4	5.8
[1155.6]					
Winterberry Creek	57.5	7.2	27.6	4.9	7.7
[417.2]					
Little Lyons Creek	47.3	26.8	19.9	4.6	6
[1590.1]					
Total Hunting Creek Watershed	**56.2**	**6.8**	**29.4**	**7.7**	**7.6**
19,878 acres					

- **Natural = Forest + Wetlands, Floodplain + Wetlands, Other + Wetlands, Tidal**
- **Agriculture = Cropland + Pasture**
- **Developed = Impervious Roads + Impervious Non-roads + Tree Canopy Over Impervious + Turf Grass + Tree Canopy Over Turf Grass**
- **Impervious = Impervious Roads + Impervious Non-Roads**
- **Mixed Open = Pervious Developed + Harvested Forest + Natural Succession + Solar Fields + Active Mines + Bare Shore, Water Margins**

Looking Ahead

Conducting annual Water Quality Blitzes across the Hunting Creek watershed is one way the FOHC are documenting catchment differences in average annual concentrations of nitrogen and phosphorus, two key nutrients. This approach is affordable and achievable with limited funding and volunteer samplers. In 2022, we collected a grab water sample at 17 stream sties with five 2-person teams between about 0930 and 1230 on April 2nd. Three FOHC volunteers spent an additional hour or so at ACLT headquarters filtering the 17 samples. Prior to the next sampling campaign, FOHC will review the previous set of sampling sites for inclusion in the next "blitz." We will also evaluate the watershed for new test sites including visiting potential sites and gaining permissions as required.

To add measurements of current velocity and discharge to enable us to calculate nitrogen and phosphorus loads at those 17 sites, although desirable, would have required equipment the FOHC do not have and training for one or more 2-person teams. If the FOHC decides to measure discharge at Blitz sites on the same day grab water samples are collected and we gain access to the necessary equipment, it is unlikely that we could sample more than 5 or 6 streams.

In 2022, two FOHC volunteers spent about 90 minutes at each of two stream sites collecting macros and scoring physical habitat parameters, another way we are documenting watershed health. The cost for sorting and identifying macros to the genus level by a certified taxonomist is about $200 per sample. If funding and volunteer numbers permit, more stream sites should be sampled for macros in 2023 and beyond.

A detailed description of land use and land cover can also help us explain catchment differences in water quality, integrity of macros communities, and physical habitat conditions.

Additionally, the FOHC should also consider mapping the location and describing the sizes and other characteristics of small ponds that are found throughout the Hunting Creek watershed. These ponds are all artificial and are generally related to stormwater management or are old agricultural ponds. Studies have shown that small ponds (e.g., farm ponds, community ponds, stormwater management impoundments, beaver ponds) less than 3 acres (130,680 ft^2) in surface area, located in headwater catchments, trap a substantial amount of nutrients that are exported annually to downstream rivers and estuaries (Ref 9, 10).

These studies also tell us that pond location is important. Small ponds located directly adjacent to streams or in upland locations have distinct and dominant effects on nitrogen, phosphorus, and sediment. Ponds adjacent to headwater streams are significant nitrogen sinks, while upland ponds are significant phosphorus sinks that can reduce runoff of nutrients to downslope streams and infiltration into shallow groundwater. Small upland ponds located in lower-slope (<14%) catchments also retain sediment (Ref 10). In summary, the role of small ponds in nutrient and sediment budgets could be huge because there are so many of them.

How effectively small ponds trap nutrients and sediment will likely depend on many factors, including age, volume, storage capacity, residence time of the water, sediment input quantity and quality, the presence or absence of oxygen at the sediment-water interface, and the frequency/magnitude of storm events that will influence residence time of the pond water.

Documenting the number, sizes, and locations of small ponds that occur across the Hunting Creek watershed is something the FOHC could pursue. If there is agreement, we can begin to plan this challenging task soon and implement our plans in 2023. For the Fox Point Creek catchment, a cursory look at a 1” = 400’ scale map on the Calvert GIS system revealed 6 ponds greater than 1500 ft^2. A 1” = 100” scale was needed to verify ponds less than 1500 ft^2 (2 total). The maximum magnification available (1” = 60’) was used to trace a polygon to calculate pond areas. The details of the pond system upstream of HC10b, Fox Point Creek can be found in Appendix 4.

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References Cited

1. Klauda, Ron and Bob Estes. 2021. Spring Water Quality Blitz in Hunting Creek Watershed on 04/03/21. Friends of Hunting Creek (https://www.acltweb.org/wp-content/uploads/2021/08/Hunting-Creek-Spring-Water-Quality-Blitz-3apr2021-results-final-080421-WO-hdr.pdf).

2. Stranko, S., D. Boward, J. Kilian, A. Becker, M. Ashton, M. Southerland, B. Franks, W. Harbold and J. Cessna. 2019. Maryland Biological Stream Survey: Round Four Field Sampling Manual. Maryland Department of Natural Resources, Annapolis, MD. (https://dnr.maryland.gov/streams/Publications/R4Manual.pdf)

3. Stribling, J.B., B.K.Jessup, J.S. White, D. Boward and M. Hurd. 1998. Development of a Benthic Index of Biotic Integrity for Maryland Streams. Report No. CBWP-EA-99-3. Maryland Department of Natural Resources, Annapolis, MD.

4. Excel tolerance values spreadsheet (used by MD/DNR for the Maryland Biological Stream Survey), contact Kyle Hodgson, Maryland Department of Natural Resources, Annapolis, MD. (kyle.hodgson@gmail.com)

5. Southerland, M.T., G.M. Rogers, M.J. Kline, B.P. Morgan, D.M. Boward, P.J. Kazyak, R.J. Klauda and S.A. Stranko. 2005. New Biological Indicators to Better Assess the Condition of Maryland Streams. Maryland Department of Natural Resources, Annapolis, MD. (https://dnr.maryland.gov/streams/publications/ea-05-13_new_ibi.pdf)

6. Barnum, T.R., D. E. Weller and M. Williams. 2017. Urbanization Reduces and Homogenizes Trait Diversity in Stream Macroinvertebrate Communities. Ecological Applications. Vol 27. doi = 10.1002/eap.1619. (https://www.researchgate.net/publication/319492264_Urbanization_reduces_and_homogenizes_trait_diversity_in_stream_macroinvertebrate_communities)

7. The Impervious Cover Model. Center for Watershed Protection, Ellicott City, MD. (http://www.cwp.org). table only (no author, journal or date) (https://www.stormwatercenter.net/monitoring%20and%20assessment/imp%20cover/impercovr%20model.htm)

8. Maryland Department of Natural Resources. How Impervious Surface Impacts Stream Health (https://dnr.maryland.gov/streams/Pages/streamhealth/How-Impervious-Surface-Impacts-Stream-Health.aspx)

9. Fairchild, G.W. and D.J. Velinsky. 2006. Effects of Small Ponds on Stream Water Quality. Lake and Reservoir Management, 22:4, 321-330, DOI:10.1080/07438140609354366. (PDF) Effects of Small Ponds on Stream Water Chemistry (researchgate.net)

10. Schmadel, N.M., J.W. Harvey, G.E. Schwarz, R.B. Alexander, J.D. Gomez-Velez, D. Scott and S.W. Ator. 2019. Small Ponds in Headwater Catchments Are a Dominant Influence on Regional Nutrient and Sediment Budgets. Geophysical Research Letters. Volume 46, Issue 16, 9669-9677. (Small Ponds in Headwater Catchments Are a Dominant Influence on Regional Nutrient and Sediment Budgets - Schmadel - 2019 - Geophysical Research Letters - Wiley Online Library)

Appendices

Table of Contents

Appendix
Supplemental Information

Nitrite (NO_2) and Nitrate (NO_3)

Nitrite and nitrate are forms of dissolved nitrogen that occur naturally in soil and water. Nitrate is the primary source of nitrogen for phytoplankton and aquatic plants. Most natural concentrations of nitrite and nitrate in water bodies, generally only a few milligrams per liter (mg/L), are not concerning. But concentrations above 4 mg/L can stimulate algal blooms, often with adverse environmental impacts; while even higher concentrations in drinking water supplies can pose a health hazard to humans. The primary sources of these dissolved nitrogen constituents in surface and groundwater are fertilizers, animal wastes, septic systems, wastewater treatment facilities, and atmospheric deposition of nitrogen compounds.

Broad Test Site Descriptions

There are two broad categories of locations for the sample sites. An attempt was made to gather GPS location data for each site either by direct GPS measurement or by locating the site on the Calvert County GIS system which outputs a set of coordinates. This can be crosschecked by inputting the coordinates into Google Earth or a similar mapping program. The first category is samples taken at a bridge. Note that no samples were taken directly from the bridge and when practical the sample was taken upstream of the bridge. An estimated distance from the bridge is included in some descriptions. The second category of sample sites are those not taken close to a bridge and are usually accessed with permission of a property owner. It was found that the GPS coordinates from devices did not agree exactly with the coordinates found on the Calvert County GIS system. The disagreement was usually beyond the circular error cited by the GPS device. Still, the differences were less than 50’ and usually within 30’. If the circle of uncertainty included a significant feature such as a confluence the sample taker provided additional information to guide the positioning of location marks relative to the significant feature. For sites near bridges the sample taker provided relevant location descriptions for the placement of location marks and the coordinates of the marks were taken from the County GIS data. In addition to the global map depicting all sites, detailed maps of the sites are also supplied in the Appendix such that by combining the global map, detailed maps, GPS coordinates, and photographic data, future testing can replicate previous test sites. Note that a set of coordinates was created for positioning the site markers for the global map. These coordinates are only accurate to within a few hundred feet. The global map is only used to give the user a broad reference to the basic location within the watershed.

Appendix
2022 Test Site Descriptions, Coordinates, Map Directory

The following maps are closeups of the locations of the test sites with sufficient resolution to allow future sample volunteers to locate the site and take a repeat sample. Note that in some cases more than one sample may appear on an image. The coordinates are the same as those in the body of the report.

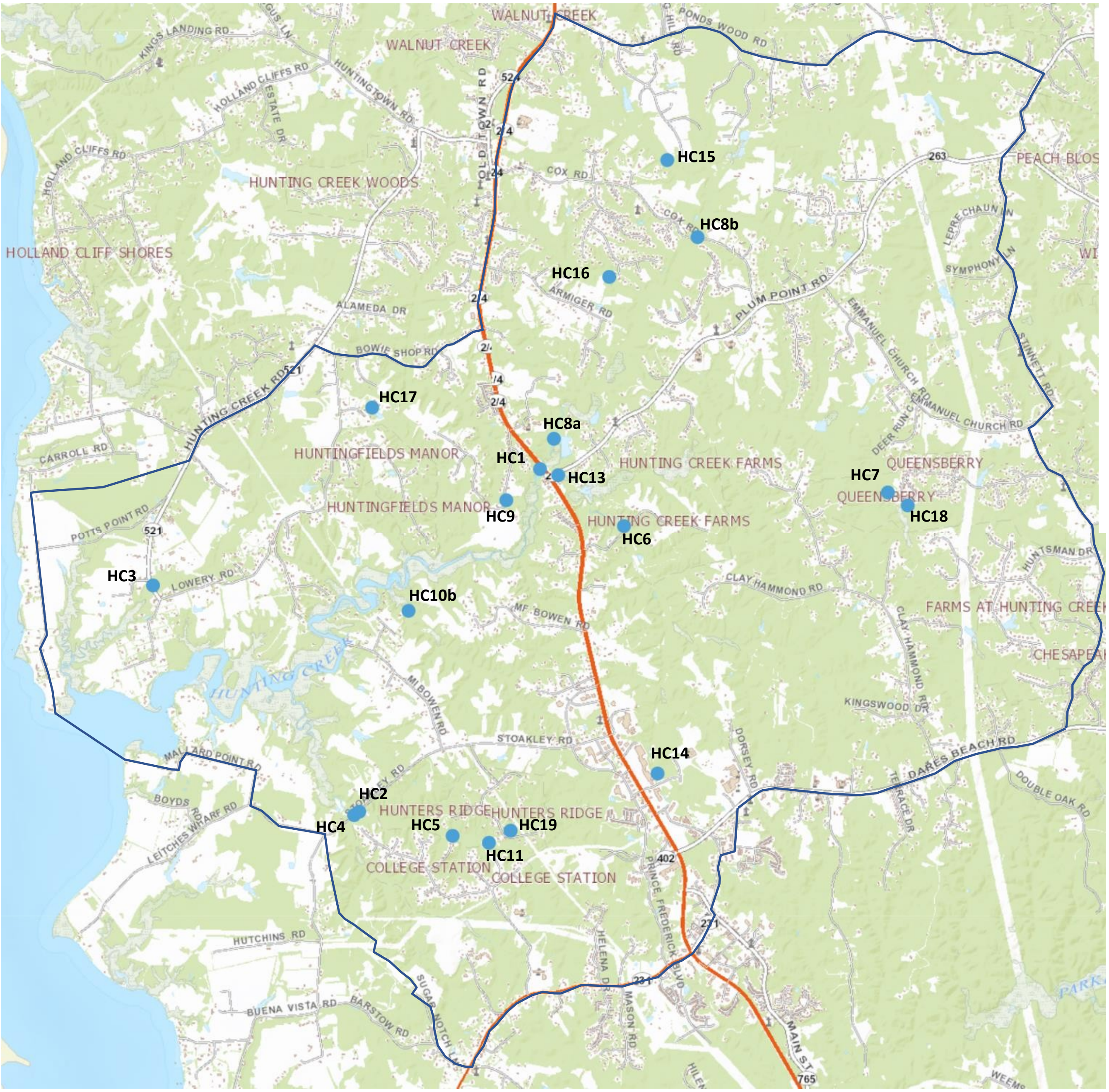
Table A2-1 2022 Test Site Descriptions, Coordinates, Map Directory

Sample ID	Designation and Description	Coordinates*	Detailed Map Appendix 2
HC1	Route 2/4 bridge	38.584843 -76.607017	A1
HC2	Mill Creek at Stoakley Rd	38.550865, -76.630076	A2
HC3	Little Lyons Creek at Hunting Creek Rd	38.573407, -76.656031	A3
HC4	UT** Mill Creek (College Creek, Stoakley Rd)	38.550589, -76.630649	A2
HC5	Mill Creek, 1440 Foxtail Ln, Hunters Ridge	38.548495, -76.618217	A4a
HC6	Fox Run, Hunting Farms Ln	38.579128, -76.596507	A5
HC7	Hunting Creek, Queensberry	38.582335 -76.563076	A6
HC8a	Sewell Branch, upstream of Hunting Crk	38.587877 -76.605287	A7
HC8b	Sewell Branch, Cox Rd.	38.607776, -76.587049	A8
HC9	Reits Branch at Walton Rd	38.581740, -76.611284	A9
HC10b	Fox Point Creek, upstream of Hunting Creek	38.570806 -76.623676	A10
HC11	UT Mill Creek, 650 Willow Way, Hunters Ridge	38.547717, -76.613674	A4b
HC13	Hunting Creek, upstream Plum Point. Rd.	38.584250, -76.604804	A11
HC14	Fox Run near Fox Run Blvd	38.554528 -76.592331	A12
HC15	Ponds Woods, Barberry Dr (Barberry Branch)	38.615396, -76.590811	A13
HC16	Marley Run, Quail Ridge Way (Quail Ridge Run)	38.603900, -76.598206	A14
HC17***	Hunting Lake near 875 Hunting Lake Dr.	35.591009, -76.628232	A15
HC18	Queensberry, Chingaware Run (macroinvertebrates only)	38.581099, -76.560572	A16
HC19	**UT to Mill Creek, Willow Way, Hunters Ridge (macroinvertebrates only)	38.548962, -76.610882	A17

*Coordinates are generally within 50' of sample site, Features such as which side of a bridge or relationship to incoming tributary are reflected in coordinates detail maps
**UT = Unnamed Tributary (Unofficial FOHC may be used)
***Test in stream (original intent) abandoned due to low water, test in upstream pond

Figure A2-1 Locations of Sites Per Table A2-1 Coordinates

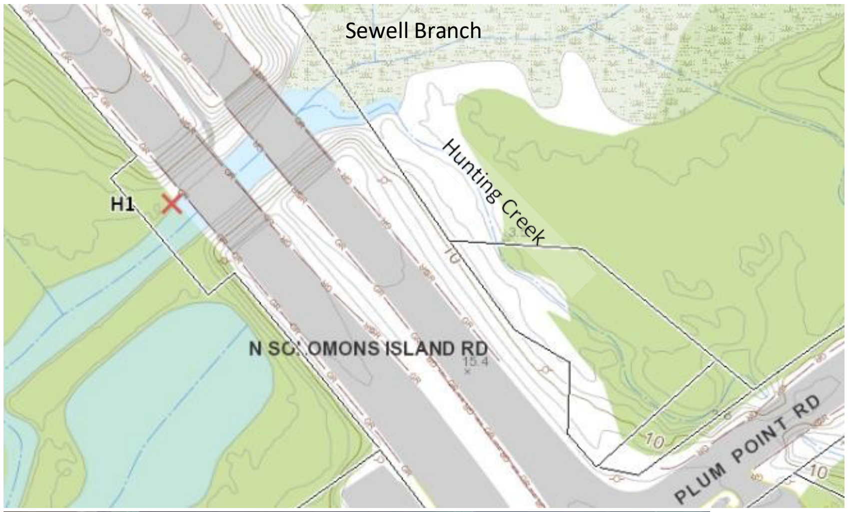
The blue outline is the Hunting Creek watershed



Note that some of sites listed as UT in Table A2-1 are also given an unofficial name by FOHC. The unofficial name will be in brackets - [unofficial name].

A

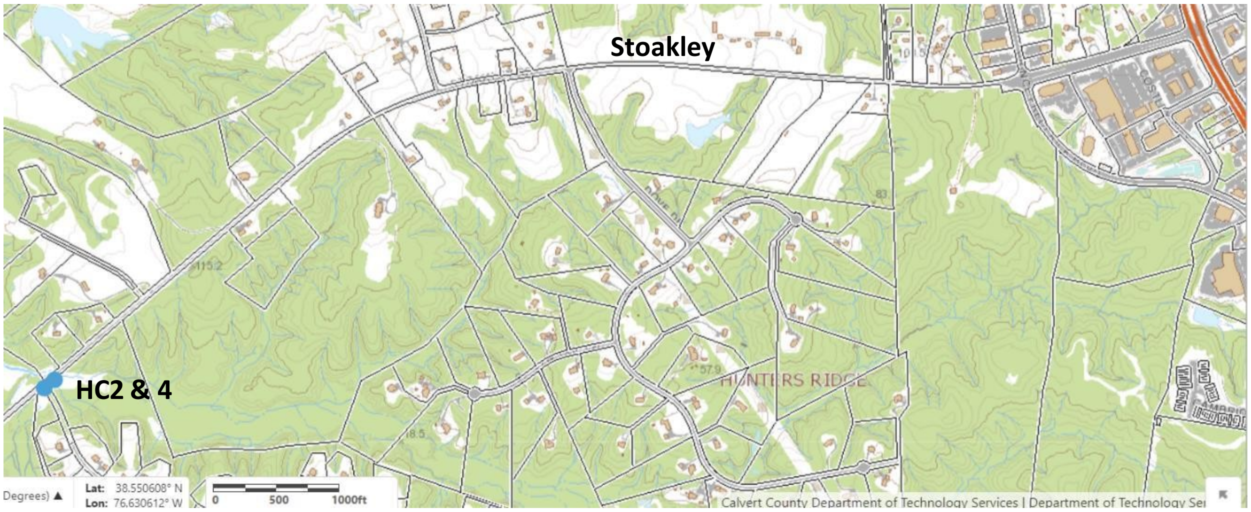
HC1 (Hunting Creek at Route 2/4 bridge, 38.584843 -76.607017)

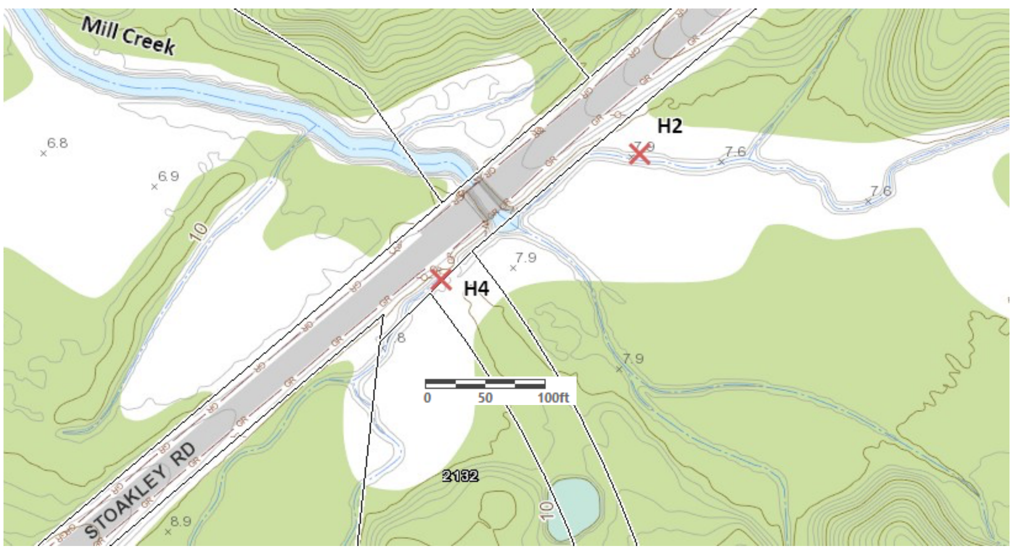


A

HC2 (Mill Creek at Stoakley Rd. bridge, 38.550865, -76.630076)

HC4 (UT Mill Creek just upstream from Stoakley Rd. bridge [College Creek], 38.550589, -76.630649)



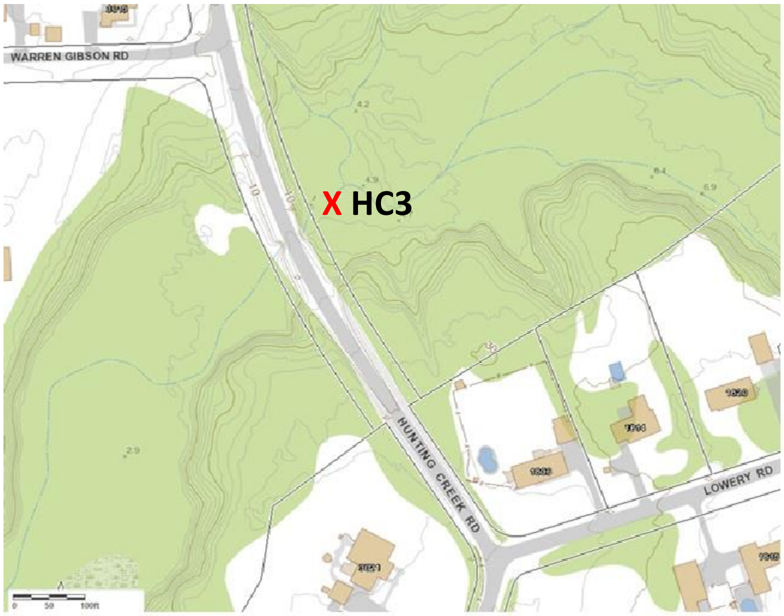


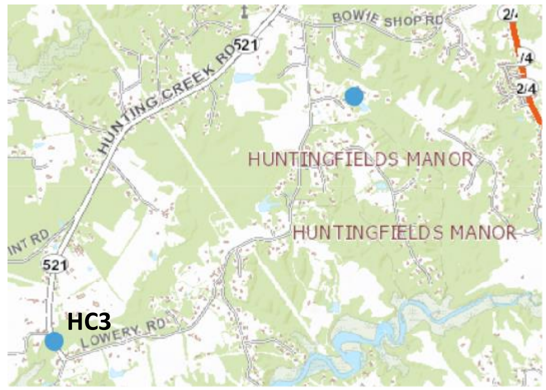

HC4 Upstream 2022

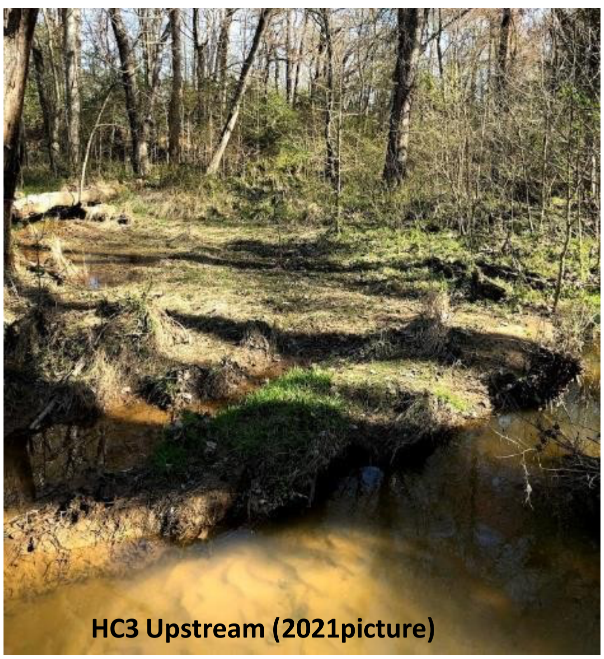

HC4 Downstream 2022

A3

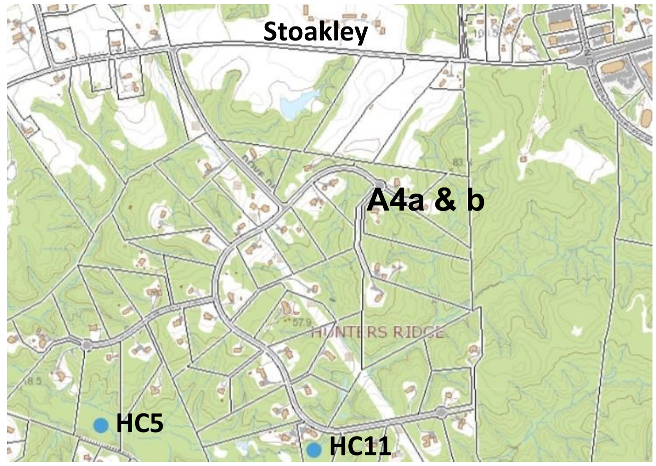
HC3 (Little Lyons Creek at Hunting Creek Rd. bridge, 38.573407, -76.656031)



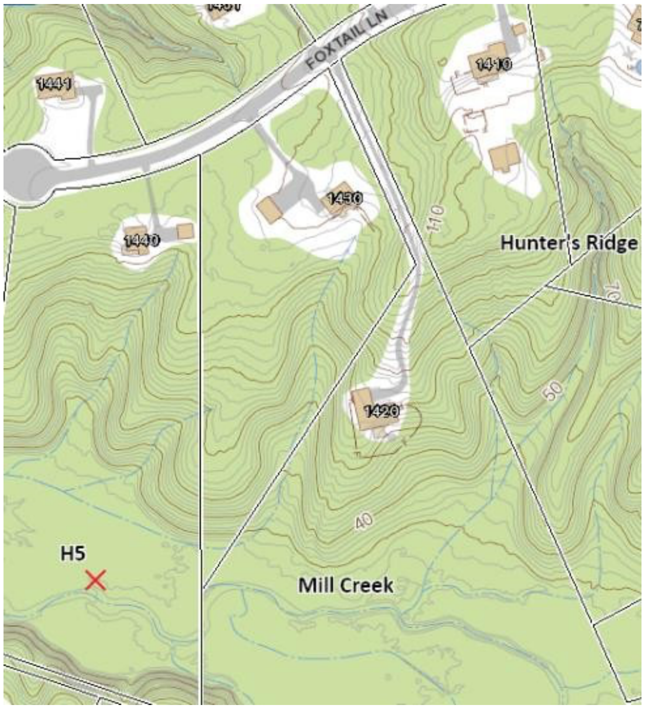




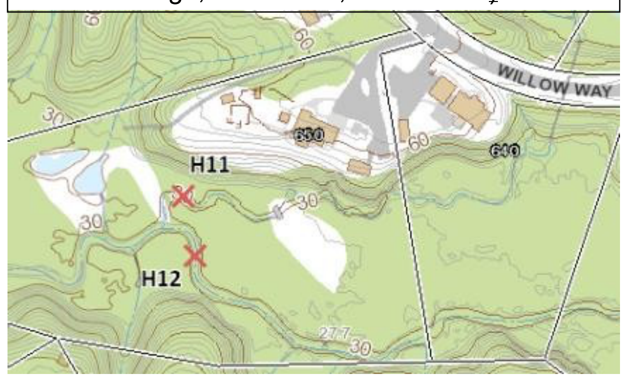
HC5 & 11



A4a
HC5 (Mill Creek behind 1440 Foxtail Lane, Hunters Ridge (38.548495, -76.618217)



A4b
HC11 UT* Mill Creek behind 650 Willow Way, Hunters Ridge, 38.547717, -76.613674)



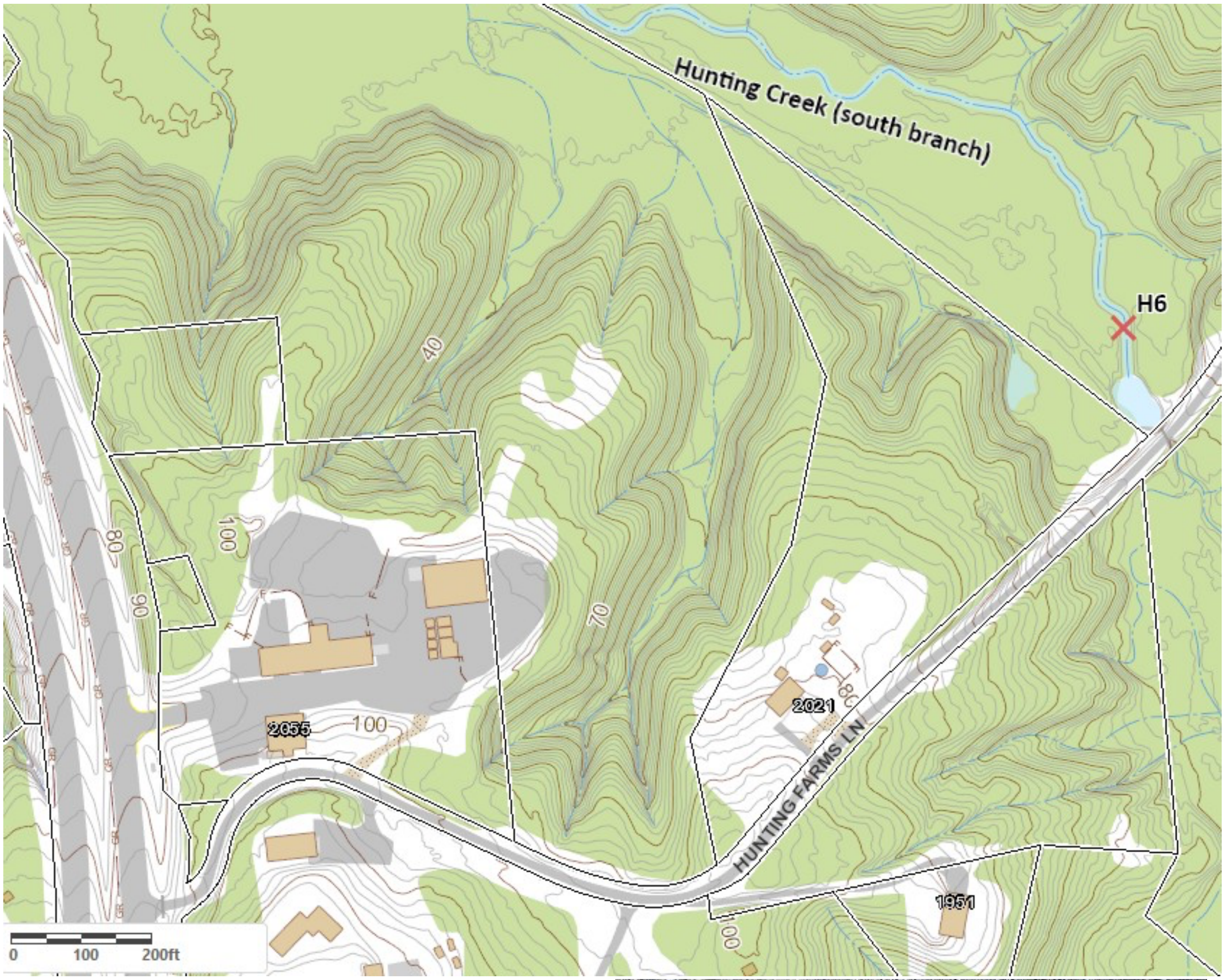
Site HC5 (2021 pictures)

*** UT =Unnamed Tributary**

Site HC 11 2022

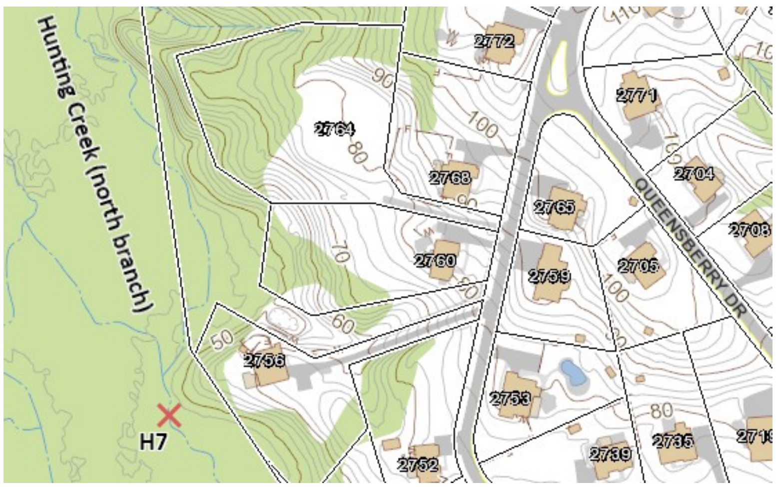
A5

HC6 (Fox Run at Hunting Farms Lane bridge, 38.579128, -76.596507)



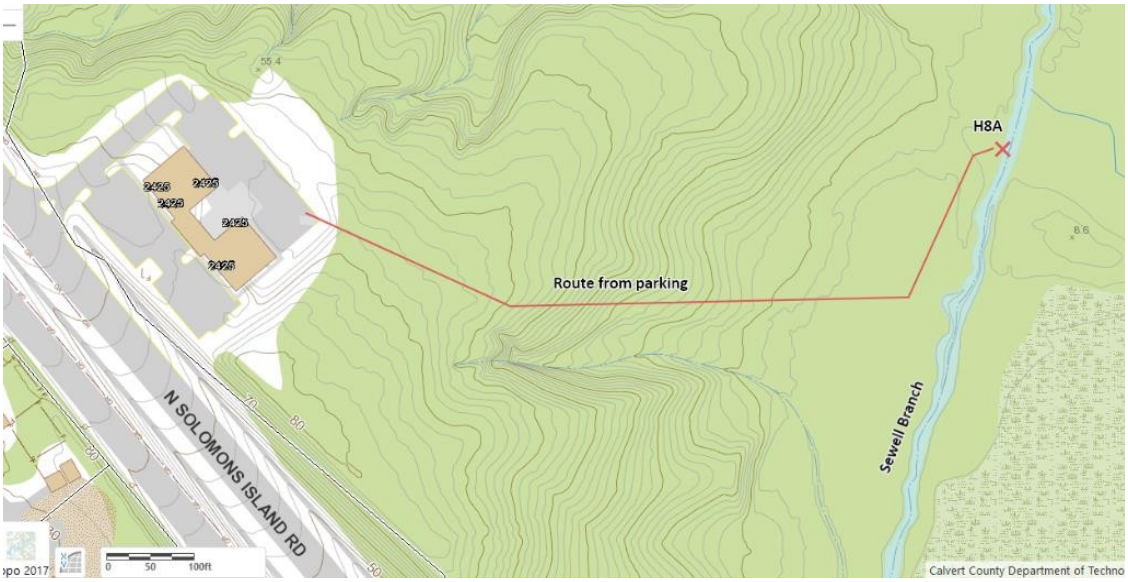
A6

HC7 (upper Hunting Creek west of Queensberry; 38.582335 -76.563076)



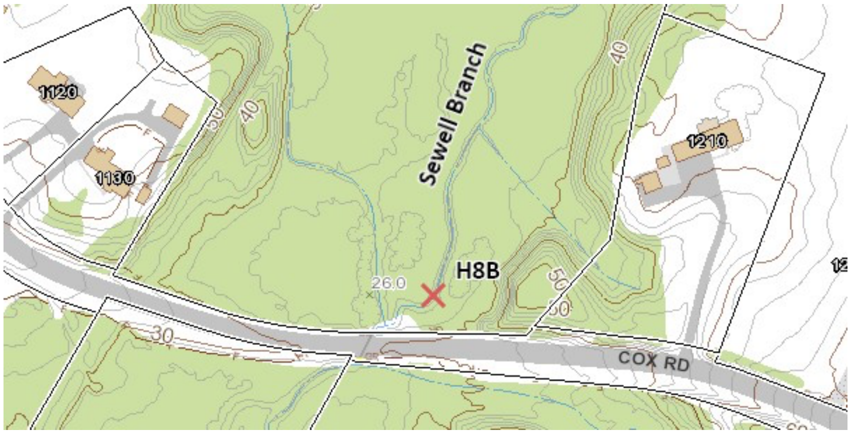
A

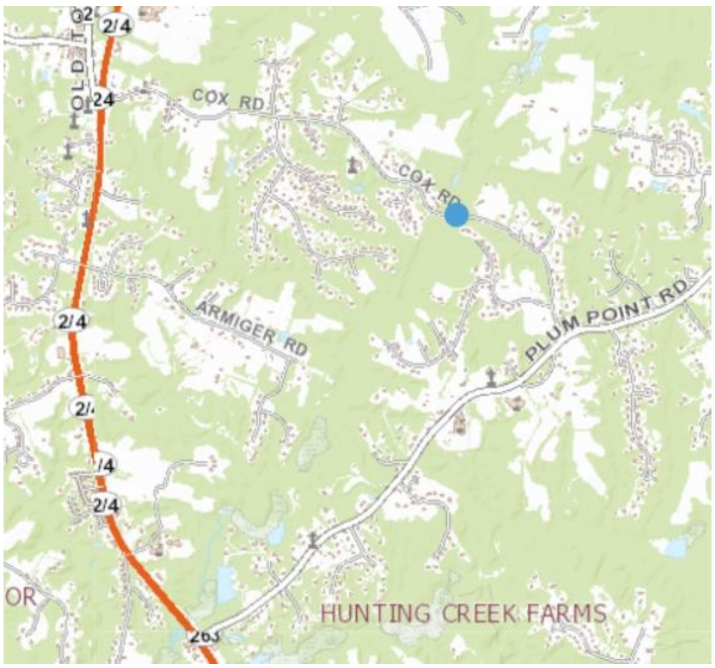
HC8a (Sewell Branch upstream of confluence w/Hunting Creek, 38.587877 -76.605287)



A

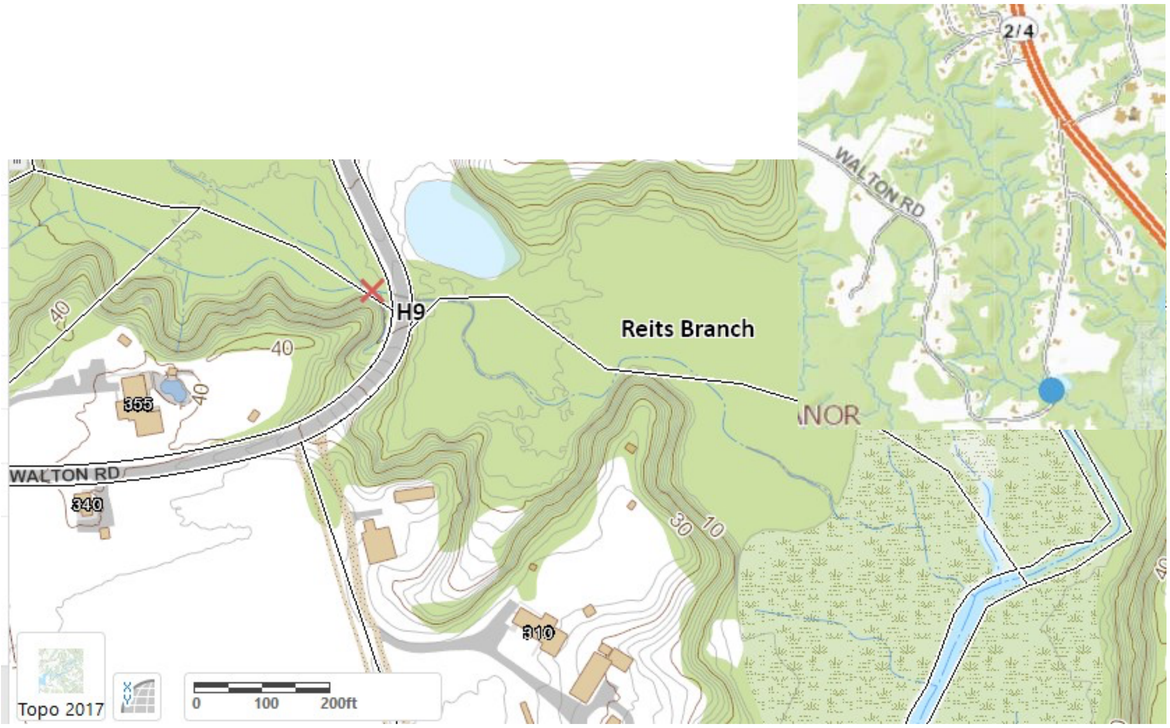
HC8b (Sewell Branch at Cox Rd. bridge, 38.607776, -76.587049)

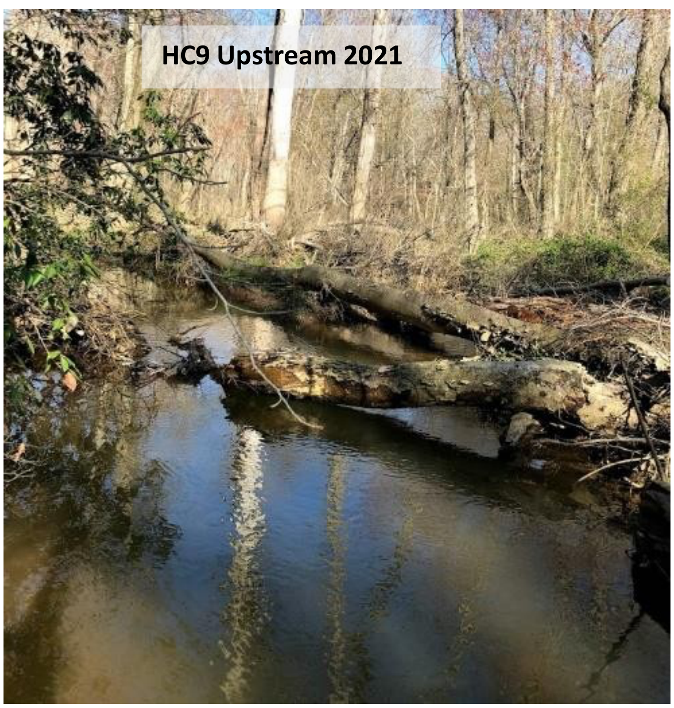




A

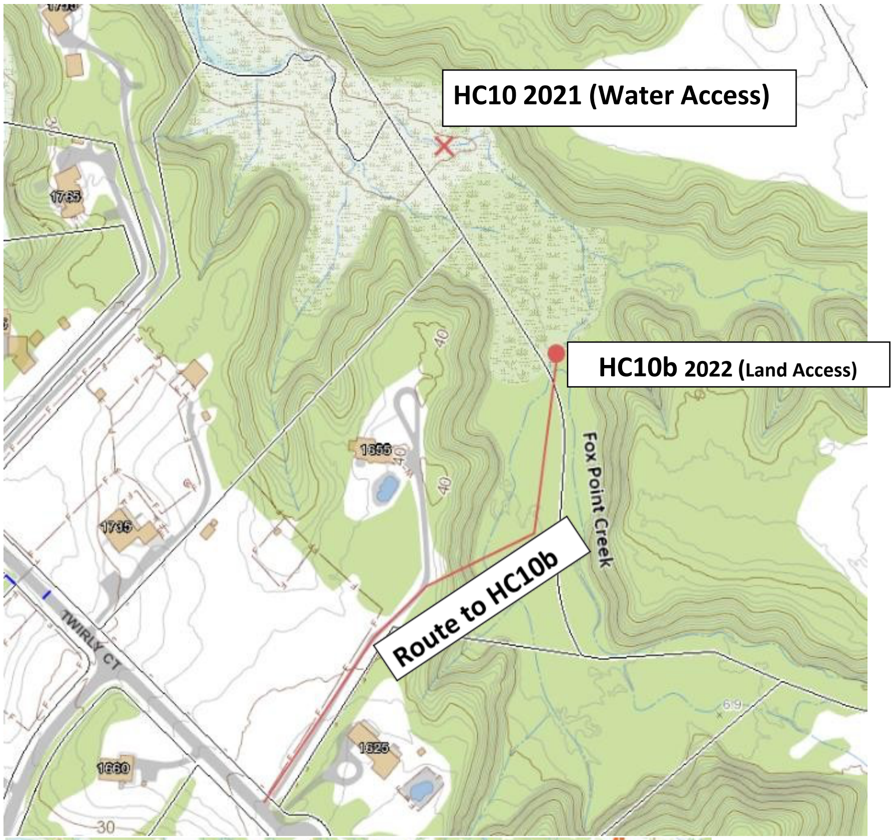
HC9 (Reits Branch at Walton Rd. bridge, 38.581740, -76.611284)

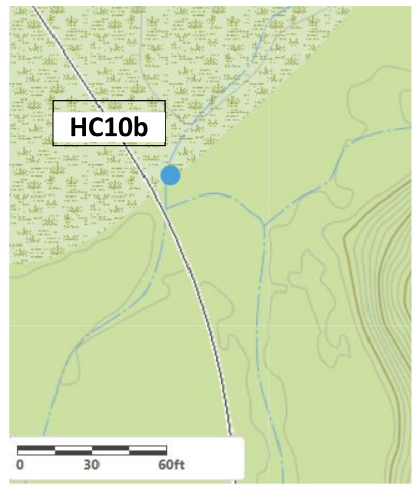


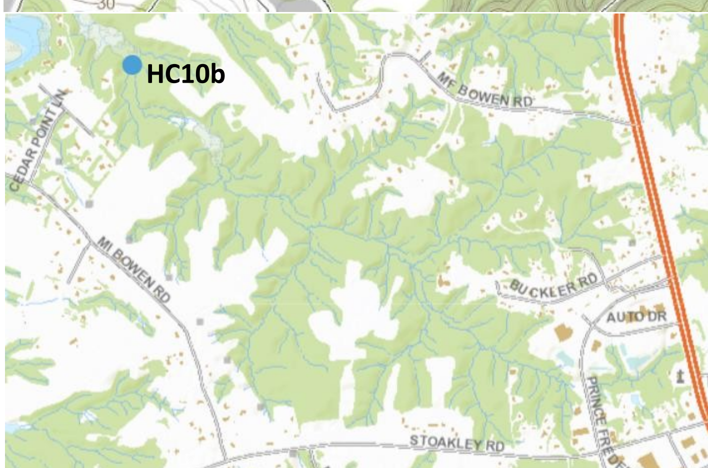


A34

HC10b (Fox Point Creek upstream from confluence w/Hunting Creek, 38.570806 -76.623676)





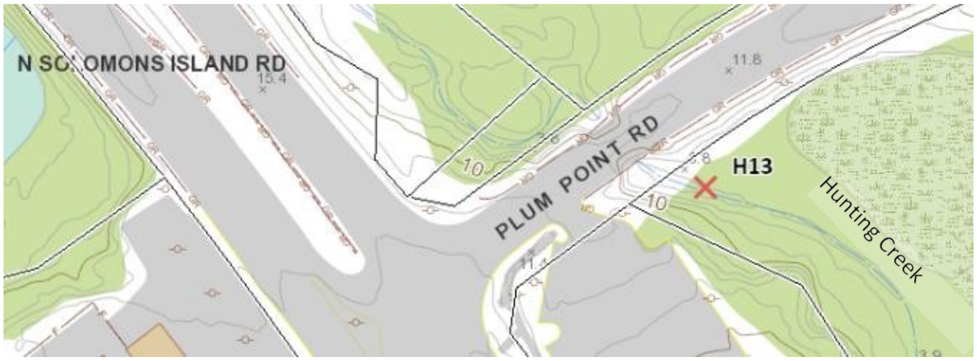


The HC10b site shown for 2022 is upstream of high tide. Permission granted by the Wahl family.


HC10 Upstream 2022

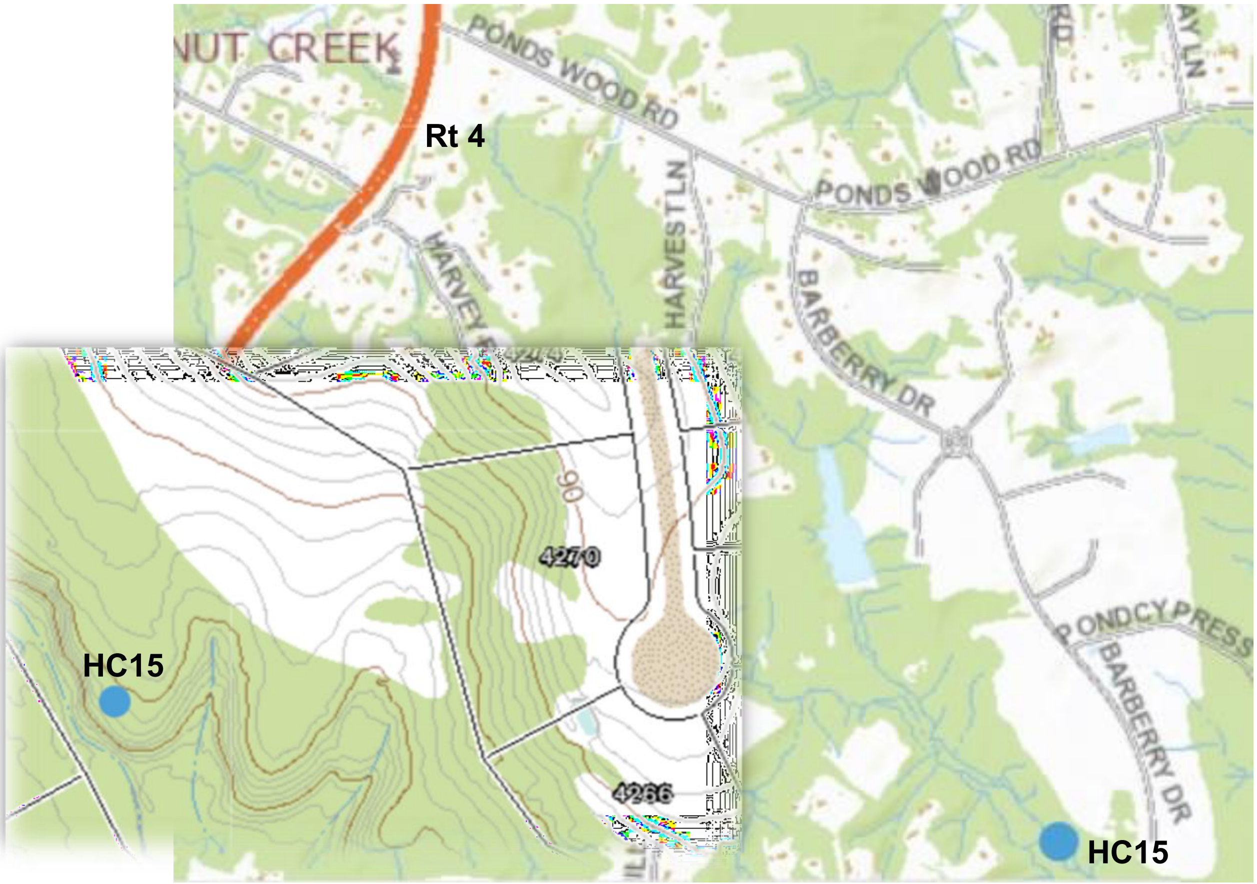

HC10 Downstream 2022

A35
HC13 (Hunting Creek just upstream from Plum Pt. Rd. bridge, 38.584250, -76.604804)

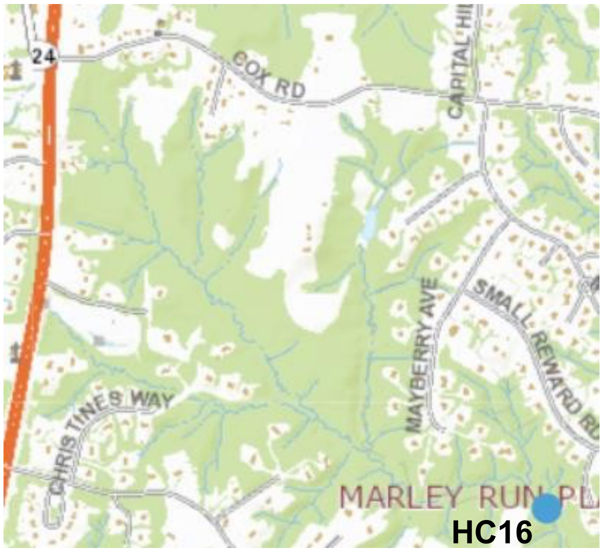


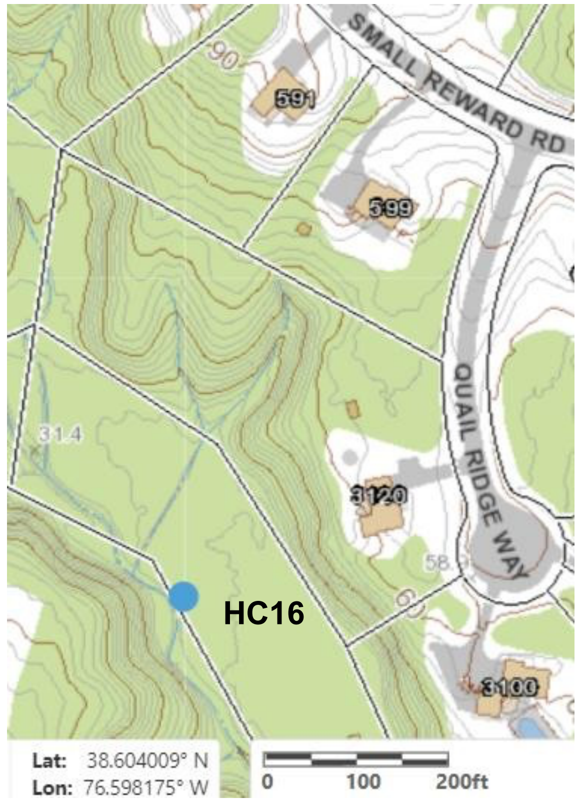
A36
HC14 (Fox Run, access via Fox Run Blvd 38.554528 -76.592331)

A37
HC15 (Ponds Woods [Barberry Branch] 38.615396, -76.590811)



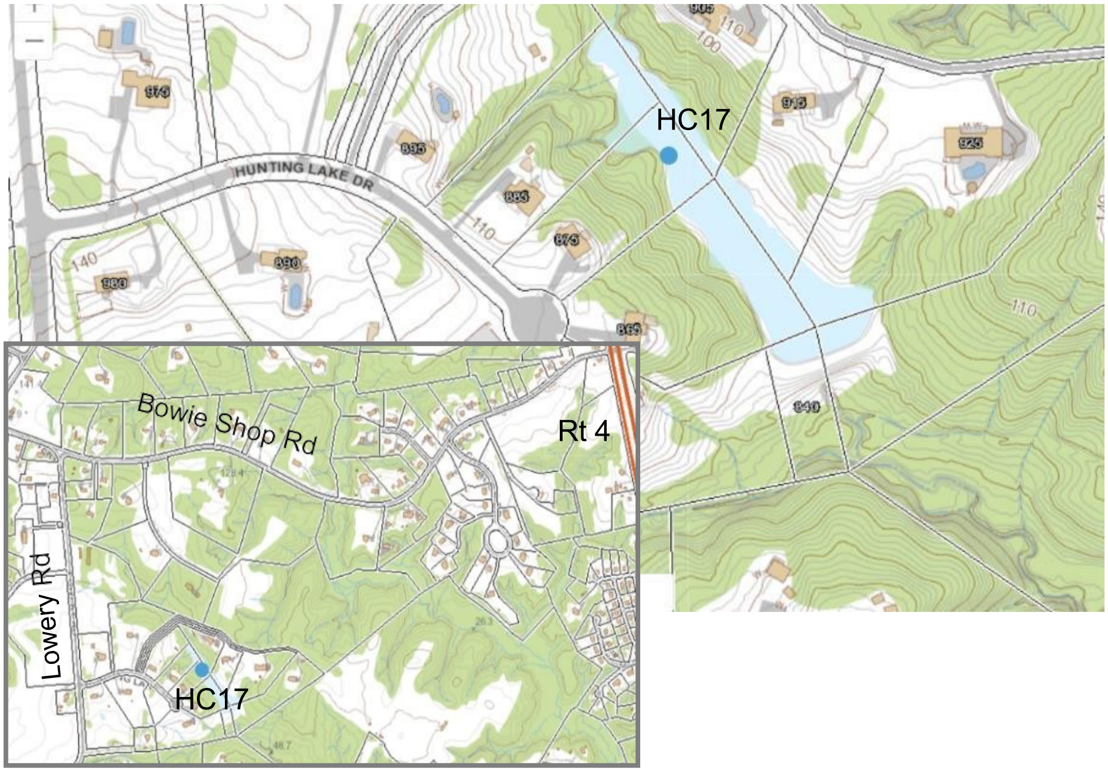
A38
HC16 (Marley Run, Quail Ridge Way [Quail Ridge Run] 38.603900, -76.598206)



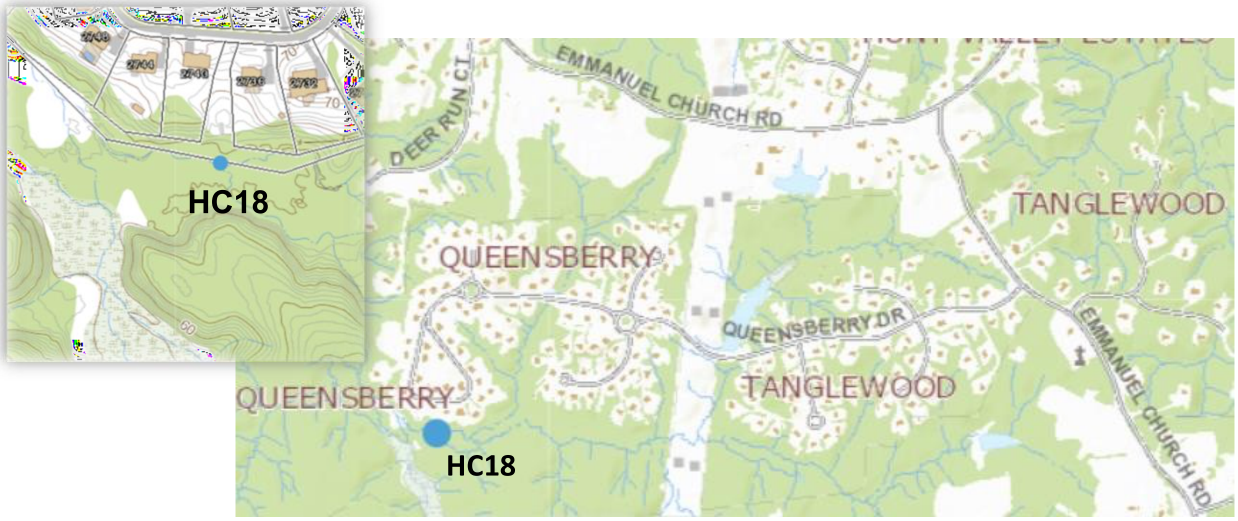


A39

HC17 (Hunting Lake near 875 Hunting Lake Dr. 35.591009, -76.628232)



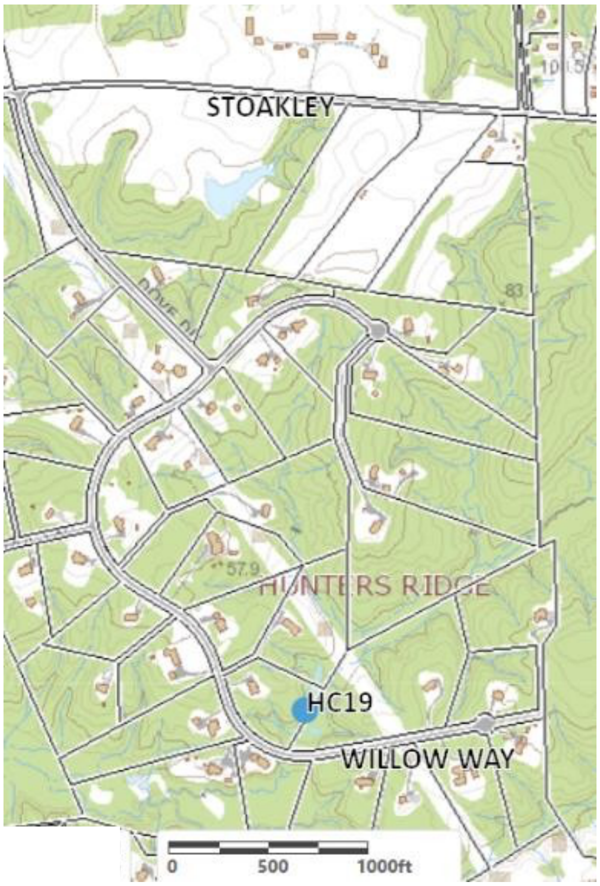
A40
HC18 Microinvertebrates only
(Queensberry, Chingaware Run 38.581099, -76.560572 sample taken over a 75-m long segment of stream, coordinates roughly in middle of span)

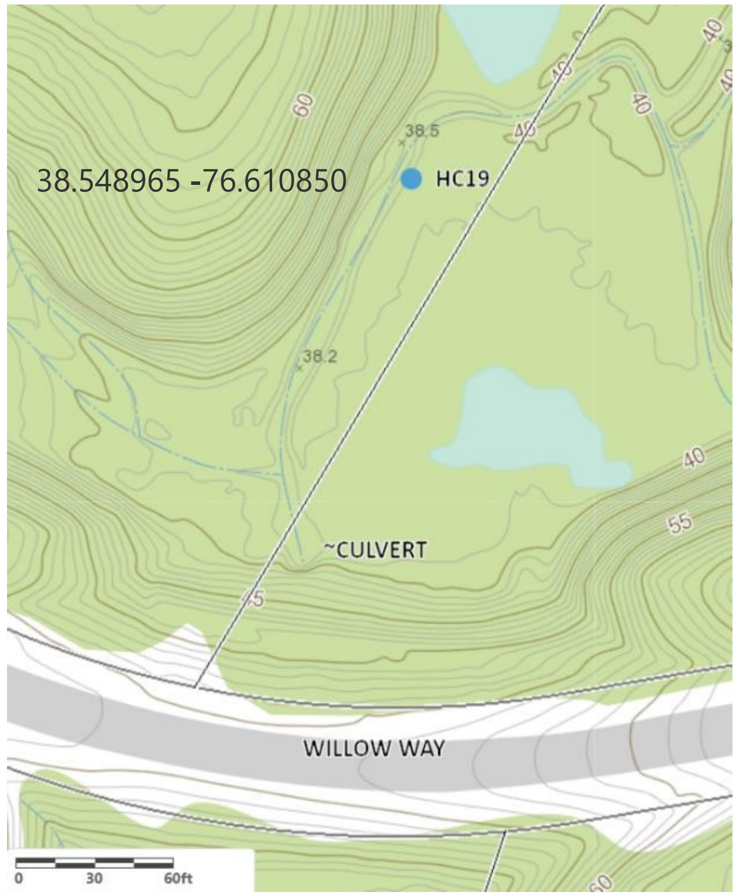


A41

HC19 Microinvertebrates only

(UT to Mill Creek, Willow Way, Hunters Ridge, 38.548962, -76.610882, sample taken over taken over a 75-m long segment of stream, coordinates roughly in middle of span)





Appendix 3

HABITAT ASSESSMENT FIELD DATA SHEET-LOW GRADIENT STREAMS (FRONT)

HABITAT ASSESSMENT FIELD DATA SHEET-LOW GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #__________	STREAM CLASS	
LAT _______________	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _________ TIME	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET-LOW GRADIENT STREAMS (BACK)

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

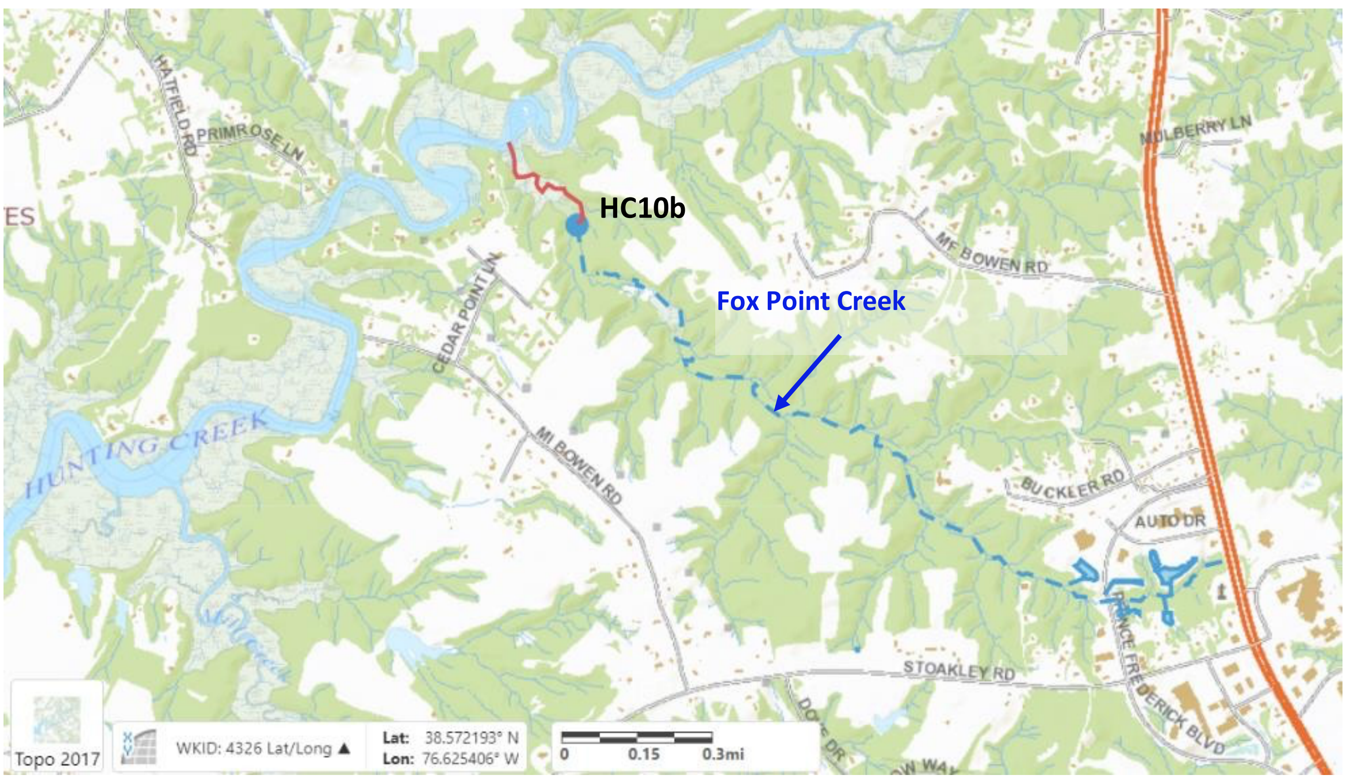
Total Score _______

Appendix 4

Site HC10b, Fox Point Creek Ponds

FOHC is considering mapping the location and describing the sizes and other characteristics of small ponds that are found throughout the Hunting Creek watershed. As stated within the body of the report, studies have shown that small ponds located in headwater catchments trap a substantial amount of nutrients that are exported annually to downstream rivers and estuaries. The maps and table in this appendix document a first attempt at locating and measuring one instance of headwater ponds. The Fox Point Creek ponds were selected because they are clustered at the headwaters and no other ponds flow into test site HC10b. The details of the pond outlets are also well known by one of the authors (Estes). The topographic maps shown below were the result of screen snaps taken of the area using the Calvert County GIS online utility. The GIS is capable of producing outlines of the ponds as well as calculating lengths of multisegmented lines and areas and perimeters of enclosed polygons. For future planning purposes, the effort to produce the images and table shown below required ~6 – 8 hours for this single catchment.

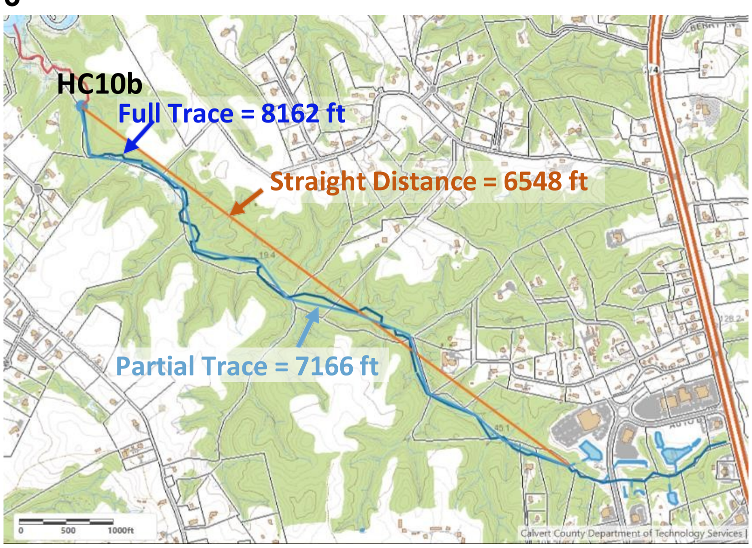
1



2

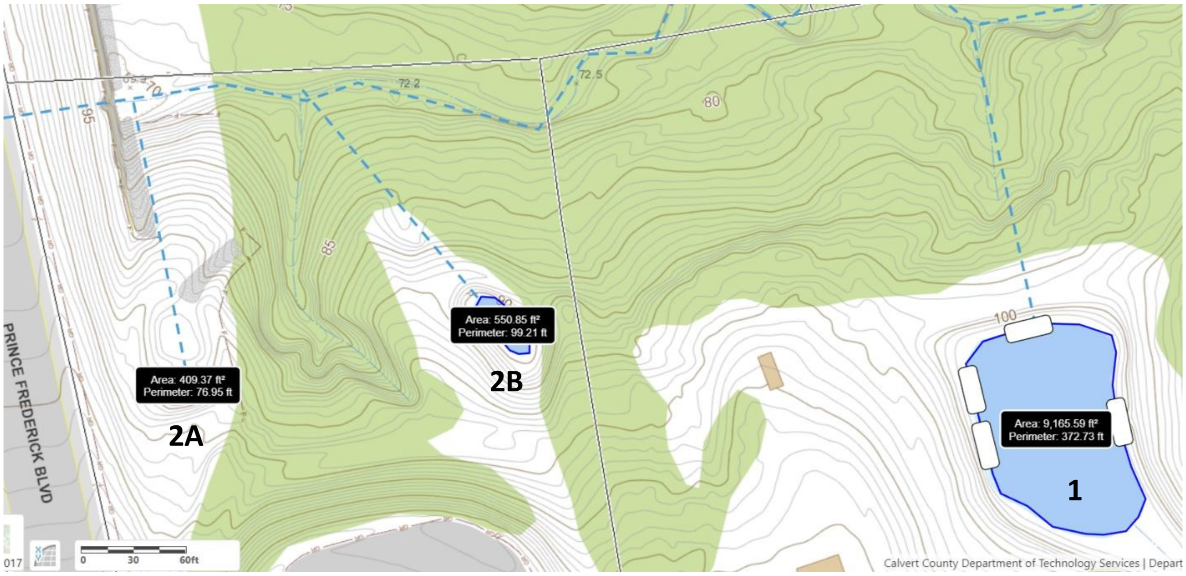
The graphic below is included here to show the sensitivity of using various degrees of complexity in estimating the distances. The partial trace example is about 14% lower than the full trace. The full trace is probably within ± a couple percent of actual. The full tracing of a stream course can be a tedious and time-consuming process. A partial trace which follows the basic course of a stream is a simpler way to measure the length. The partial trace in this example was 14% lower than the full trace. If one were to multiply the partial trace by 1.10 to 1.15 and round off to the nearest 500' or 1000' an adequate estimate of the distance between a pond or pond system can be obtained.

3

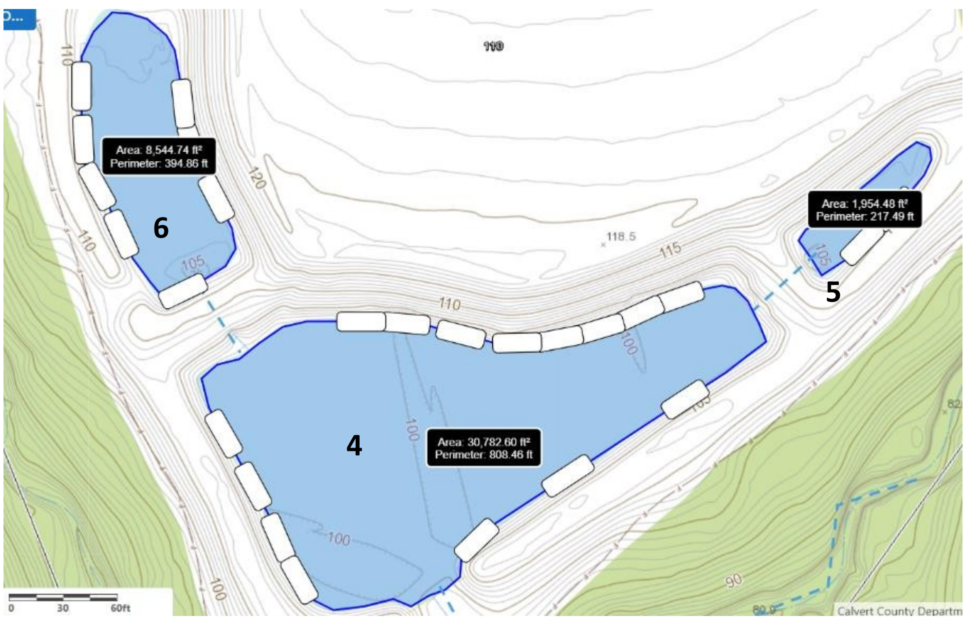


Figures 4 – 6 show pond shapes and surface areas. Note that the GIS application does not allow one to scale the text to a larger size and the white rectangular boxes cannot be removed. Note that ponds 2A and 2B can be seen in Figure 2. Both are very small and “pond” 2A is often observed to be dry. Ponds 4-6 are part of a connected system whose combined flow exits through pond 4.

4



5



6

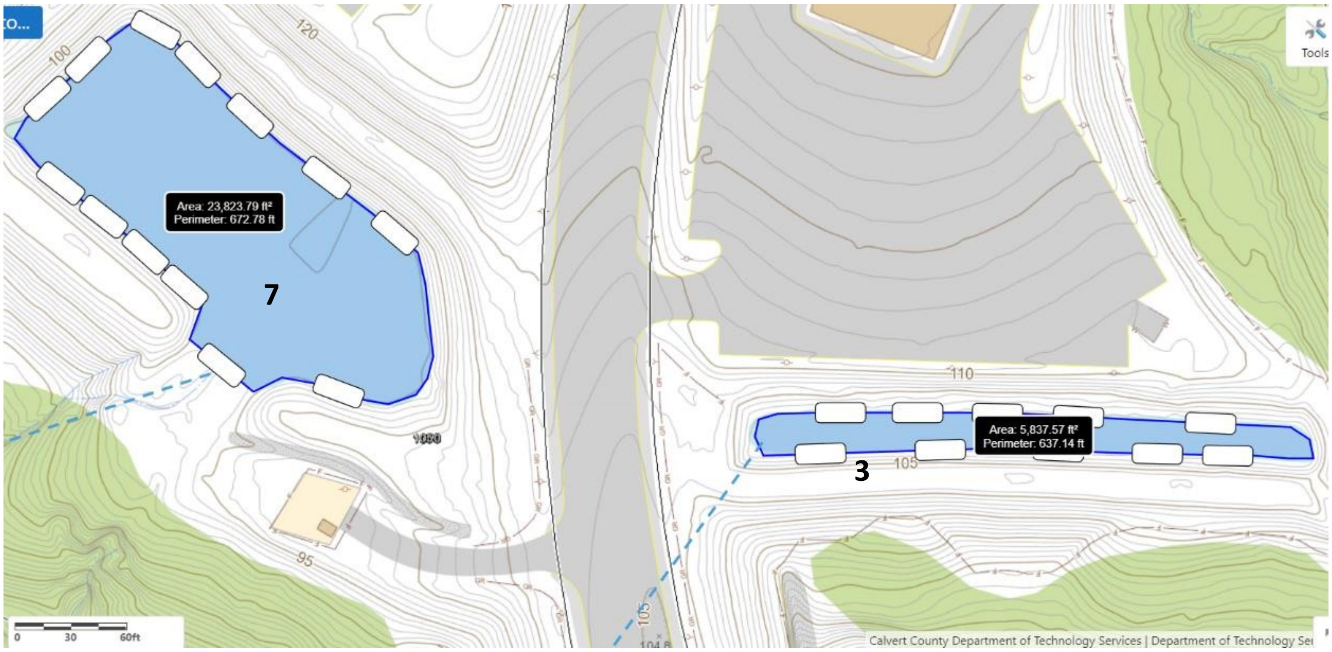


Table 1

Pond #	1	2A	2B	3	4	5	6	7
Area (ft^2) *	9166	409	551	5838	30783	1954	8545	23824
Notes	1. Upstream of site 10b Fox Point Creek. Approximate distance from where pond 7 flow enters the creek to site 10b as measured by a full tracing is 8162 ft (Note that the partial trace is ~14% shorter than the full trace). 2. Pond 1 is an old fam pond. It has a flow maintenance pipe that conveys water directly to the creek. 3. Ponds 2A and 2B are small (recommend ponds smaller than 1500 ft^2 not be measured but be noted) 4. Pond 3 maintenance and primary exit is a riser at its west end which leads to the creek via an underground culvert. A rock overflow exit is at the east end. Overflow discharge flows to a super silt fence barrier (see topo map. 5. 4, 5, 6 are part of a group that flows out of pond 4. Pond 4 uses a 4" pipe for maintenance flow and a sheet flow wall. A super silt fence (SSF) ~ 50 feet downhill of the exit has been destroyed and a deep eroded ravine now exits. 6. Pond 7 drains the aquatic center. The exit uses a 4" pipe for maintenance flow and a sheet flow wall. There is no SSF downhill of the exit. Two deep eroded ravines exist downhill of the exit.							

* 43560 ft^2 = 1 acres