Protecting Ten Mile Creek Based on Watershed Science and Local Experience

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<u>Summary</u>
The Ad-Hoc Water Quality Working Group, established by the October 13, 2009 Resolution of the Montgomery County Council, is charged with making recommendations on the best ways to protect Ten Mile Creek, part of our Little Seneca backup drinking water supply, and a recreational trout stream and designated Special Protection Area. This section summarizes scientific findings on stream protection and its relationship to land cover conditions and changes induced by development, based mainly on information presented to the Working Group by Keith Van Ness and Tom Schueler on December 2, 2009, and Keith Van Ness on January 22, 2010. Appended to this section are notes from the December 2, 2009 presentations and excerpts from other documents.

The Montgomery County Council's October 13, 2009 Resolution that established the Ad-Hoc Water Quality Working Group included Item 7, which states:

> **Since the approval of the 1994 Clarksburg Master Plan, Montgomery County has gained experience in protecting streams using land cover requirements, including limiting impervious surfaces and maintaining riparian and upland forest cover, in the Upper Paint Branch and Upper Rock Creek Special Protection Areas and in the Sandy Spring/Ashton Rural Neighborhood Cluster Zone in Upper Northwest Branch. Key to the establishment of these land-cover-based watershed protection approaches was the County's recognition of the importance of headwater stream systems. These systems provide the foundation for a stable flow of water, including through maintenance of groundwater recharge levels.[1]**

Consideration of watershed and water quality studies related to land cover conditions, and applying the County's prior experience in use of land cover requirements in making recommendations about how to protect Ten Mile Creek, forms a key part of the deliberations of the Ad-Hoc Water Quality Working Group.

<u>Ten Mile Creek is Ecologically Unique</u>
The Clarksburg Master Plan describes Ten Mile Creek as "fragile and sensitive." Ten Mile Creek in the Clarksburg Special Protection Area, (Clarksburg Master Plan, Stage 4) has a high level of diversity of the fish, aquatic insects, and amphibians that live in and around the stream. There are few streams left in Montgomery County that have similar levels of biodiversity, and in fact in several respects Ten Mile Creek is the "Last of the Best" streams in Montgomery County. [2]

[1] Montgomery County Council Resolution # 16-1149, adopted on October 13, 2009.
[2] Wiss, C.J., July 9, 2009 Fact Sheet on Water Quality Monitoring Results at Ten Mile Creek, Monitoring Site 32. Provided to the Montgomery County Planning Board for the hearing on Clarksburg Stage 4 (Fact sheet appended to this paper).

In 2009 the planning staff report to the Montgomery County Planning Board observed, "**There are few watersheds that can compare to the Ten Mile Creek watershed's rich and diverse ecosystem within Montgomery County"** MNCPPC, 2009 quoted in the 2008 SPA Report (op cit.), page 79.

Ten Mile Creek:

- maintains summer base flows
- minimizes the response to storms
- has tributaries that function as a refuge for fish during droughts
- contains consistently cool water
- has shallow soils overlying fragile, folded metamorphic rocks
- supports a high quality biological community including amphibians
- supports some macroinvertebrates rarely if ever found elsewhere in the County
- is a "reference watershed."

Effectively protecting the fragile and unique water quality of Ten Mile Creek involves effective watershed protection approaches based on a combination of local experience in the prior Clarksburg Stages (Stages 1 through 3), along with the body of published scientific reports on the relationship between land uses, land cover conditions and stream quality.

Cut-and-Fill Operations' Effect on Watershed and Stream Quality

Construction operations can permanently alter the "lay of the land" and the hydrology of our streams. Cut-and-fill operations, which were used in prior Clarksburg stages, amount to "hilltop removal." Cut-and-fill is an earth moving operation that re-works the topography. Also termed "terraforming," cut-and-fill operations in the Clarksburg area have resulted in: soil compaction; breakage of metamorphic rocks and disruption of their ability to infiltrate and transmit groundwater; decreases in groundwater recharge and stream dry weather base flows; obliteration or alteration of the smallest seeps, springs, and "zero-order streams;" and increases in sediment discharges.

The Working Group's discussion on December 2, 2009 and in subsequent meetings highlighted the cut-and-fill operations used in the prior Clarksburg stages. Cut-and-fill techniques, which reportedly sometimes cut 60 feet into the soil profile, are required under local road and building codes, and thus would be part of any development projects in the Ten Mile Creek watershed. Figure 1 below shows the difference between "before and after" LIDAR images of a Clarksburg development project indicating the impact of cut-and-fill practices in re-shaping, or "terraforming" the landscape. Erosion, sediment and turbidity (E,S&T) practices used during active construction are aimed at reducing sediment and turbidity discharges; they cannot prevent the topographic, soil structure, geologic, and hydrologic alterations and associated stream biological degradation caused by cut-and-fill operations.

Data show that the development process used in the Clarksburg test areas permanently changes the character of the landscape. These changes are cumulative and influence the receiving streams in many ways. The current cut-and-fill approach to site development permanently alters the overall topography, natural drainage patterns, and natural infiltration conditions. These disturbances to the landscape alter hydrology including base flow, characteristics of the stream channel, and the community of organisms living in the streams and adjoining wetlands. Water quality can be permanently altered as well.[3]

Transportation and Water/Sewer Infrastructure Projects also contribute to degradation.

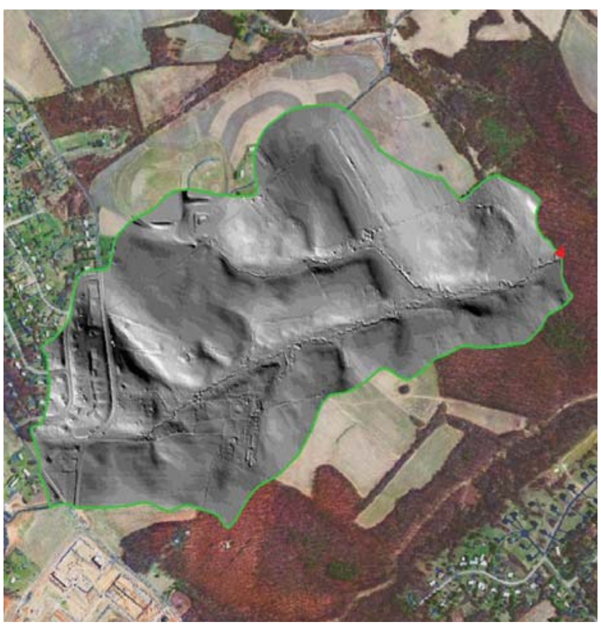
Montgomery County DEP has also documented that the insertion of sewer lines contributed to groundwater problems and stream degradation in Clarksburg Stages 1-3. In addition, road crossings

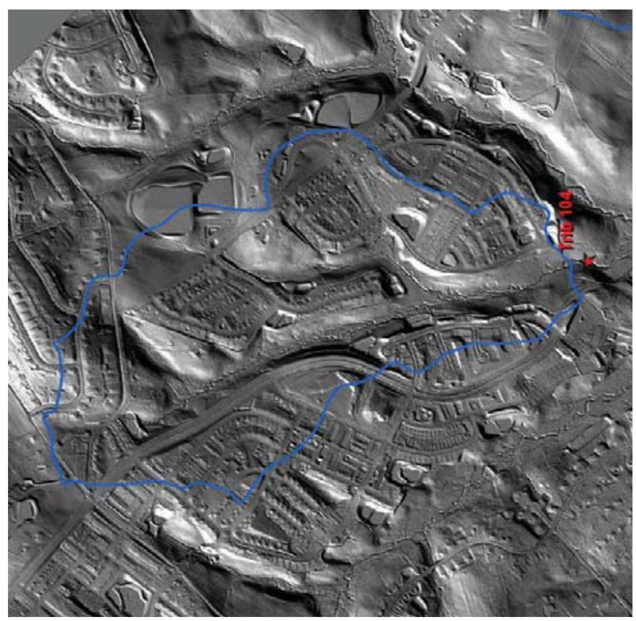
[3] Montgomery County DEP, 2008 Special Protection Area Report, Executive Summary.

over streams with associated culverts and other structures contributes to stream degradation both during and after project construction. These various impacts of development projects – even those incorporating new construction and post-construction stormwater controls – create a host of water quality impairments. The only scientifically-proven way to prevent (not simply lessen) this host of impairments is to avoid construction of damaging infrastructure projects in the Ten Mile Creek watershed, and to apply protective and conservative land cover requirements.

The Scientific Evidence on the Relationship between Land Cover and Stream Quality

The term “land cover” in the context of watershed science means the type of material covering a landscape; it includes impervious surfaces, e.g. roads and roofs, and pervious surfaces, e.g. forests and meadows in good condition. Scientists have documented the relationship between land cover conditions, especially imperviousness, and stream quality for the past 30 years, with some of the most prominent databases generated in Maryland and Montgomery County.[4] In 2008, the National Research Council stormwater committee found that “**There is a direct relationship between land cover and the biological condition of downstream receiving waters.** The possibility for the highest levels of aquatic biological condition exists only with very light urban transformation of the landscape.”[5] (emphasis in the original.) Klein’s 1978 paper was followed by Schueler’s 1994 analysis of the available national data on the imperviousness – stream quality relationship[6]; and in 2009 Schueler published a second, updated meta-analysis of 65 published studies, confirming that as imperviousness increases, stream quality decreases[7]. The Impervious Cover Model indicates that as watershed imperviousness increases from 5% to 10%, stream quality transitions from “sensitive” to “impacted.”





[4] Klein, R. (1979) Urbanization and Stream Quality Impairment. *Journal of the American Water Resources Association* vol.15, No. 4, pp. 948-963

[5] National Research Council (2008), Committee on Reducing Stormwater Discharges to Receiving Waters. *Urban Stormwater Management in the United States* p. 195.

[6] Schueler, T. (1994) The Importance of Imperviousness. *Watershed Protection Techniques*, 1(3); pp. 100-111.

[7] Schueler, T. (2009) Is Imperviousness Still Important? *Journal of Hydrologic Engineering*, vol. 14, no.4, April 2009.

Figure 1 – LIDAR before-and-after images showing impact of cut-and-fill operations on topography in Clarksburg. Presentation of Keith Van Ness, 01/22/10 to the Ad-Hoc Water Quality Working Group, at: www.montgomerycountymd.gov/content/council/mem/knapp_m/pdf/clarkburgadhocwqgroup1.pdf

In 2003, DEP charted 352 monitored stream stations in Montgomery County and depicted the linear relationship between stream quality and watershed imperviousness, (Fig. 2).[8] In a nutshell, Montgomery County's own documented science indicates that as imperviousness increases in a watershed, stream health declines – and there is no threshold below which a stream can reliably remain high quality and without observable degradation, while imperviousness is increased. Similarly, Goetz et al. in 2003 examined Maryland stream data and land cover conditions via remote sensing, and found that a stream quality rating of Excellent required a maximum of 6% impervious cover in the watershed, at least 65% tree cover in the riparian zone and 50% in the overall watershed; a rating of Good required less than 10% imperviousness; 60% riparian and 45% overall watershed tree cover.[9]

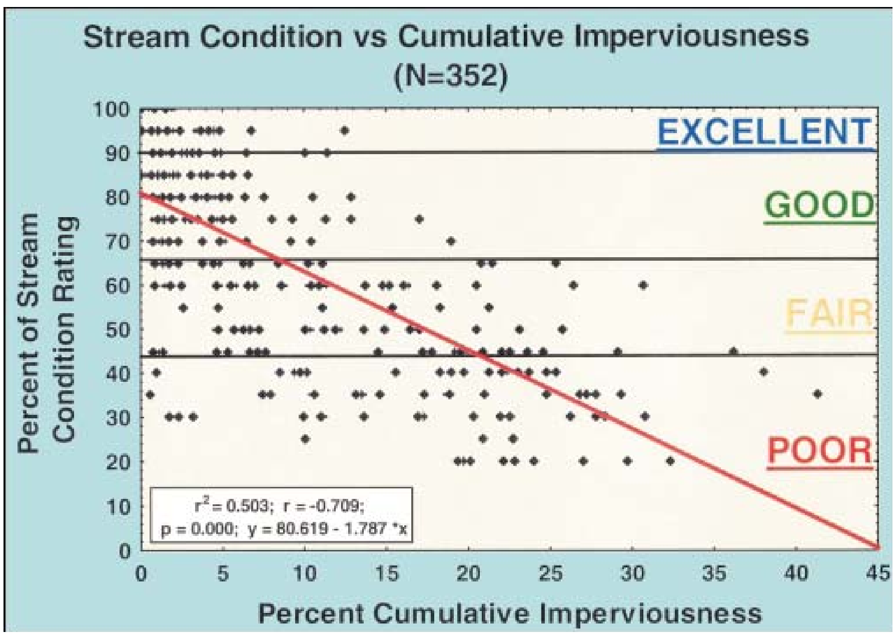


Figure 2. Montgomery County's stream monitoring program data analysis, indicating that as imperviousness increases in a watershed, stream health declines.

In the past, it was believed that below a certain threshold of imperviousness, (usually pegged at 10%), no stream degradation occurred; this theory has been replaced with the finding that any level of watershed imperviousness in high-quality, sensitive streams – even as much as 2% - causes degradation and loss of aquatic species' diversity and abundance. The 2008 National Research Council Stormwater Report noted that there is a "*near-universal, negative association between biological assemblages in streams and increasing urbanization, to the extent that it has been termed "The Urban Stream Syndrome.*"[10] The Urban Stream

[8] Montgomery County DEP, Countywide Stream Protection Strategy, 2003 Update. at: http://www.montgomerycountymd.gov/content/dep/Publications/pdf/CSPS2003.pdf
[9] Goetz., S. (2003) et al., IKONOS Imagery for Resource Management: Tree cover, impervious surfaces, and riparian buffer analyses in the Mid-Atlantic region. Remote Sensing of the Environment, 88 (2003), 195-208. See also: Presentation with Montgomery County data at: http://calval.cr.usgs.gov/JACIE_files/JACIE04/files/3Goetz5.pdf
[10] National Research Council (2008) www.epa.gov/npdes/pubs/nrc_stormwaterreport.pdf p. 176, citing Walsh, (2005), Walsh, C. J., A. H. Roy, J. W. Feminella, P. D. Cottingham, P. M. Groffman, and R. P. Morgan. 2005. The

Syndrome is a complex of changes that occur in a stream and its watershed as development occurs; these include replacement of rural forests and farms with suburban and urban land uses and impervious land covers. In addition to the land cover changes, the Urban Stream Syndrome -- as documented in the declining water quality in streams in the Clarksburg Special Protection Area-- resulted from the infrastructure and other construction projects that have flattened hilltops; inserted sewer lines and stream crossings; removed and compacted native soils; discharged toxic chemicals into the streams; and interfered with the flow of groundwater through easily-broken metamorphic rocks.

Montgomery County's Experience in Applying Land Cover Requirements to Protect Sensitive Streams
Land cover requirements, including impervious cover caps and open space protection requirements, have been used elsewhere in Montgomery County in an attempt to avoid or at least limit the water quality degradation that occurs with the Urban Stream Syndrome. The success of land cover-based watershed protections via Environmental Overlay Zones in Montgomery County (Upper Rock Creek and Upper Paint Branch) has also been documented; these include an 8% impervious cover limit for new developments combined with minimum stream buffer and/or overall upland forest cover levels. The proven relationship between imperviousness, watershed and buffer forest cover, and stream health should inform the Council's decision to protect Ten Mile Creek.

Stormwater BMPs alone (including ESD practices), are not proven to protect high quality, fragile streams from degradation. On the other hand, strict, protective limits on imperviousness and enforcement of a minimum level of forest cover (percentage of acres out of total watershed percentage acres), have been proven to protect sensitive, fragile, high-quality streams from development impacts. The lesson learned is that protection of Ten Mile Creek's sensitive biology and hydrology depends upon application of land cover requirements of imperviousness limits and forest cover minimums.

Stormwater Practices Are Unproven to Protect Fragile Streams, and Can Bring Impacts of Their Own
The hydrology and biological health of streams must be considered in tandem with post-construction impacts for a full and accurate understanding of watershed protection versus degradation. Changes brought by development projects both during and after construction to the landscape, the flow of water, and the biological diversity of a stream, can be partially mitigated, but not prevented, by improved stormwater best management practices (BMPs), including Environmental Site Design (ESD) practices. Depending on the device selected, and its design, installation and maintenance, stormwater BMPs themselves sometimes involve detrimental consequences to stream health. Detrimental stormwater BMP impacts recorded in Montgomery County include: groundwater interception by stormwater detention ponds (noted to have occurred in one or more Clarksburg development projects); oxygen depletion of water held in stormwater ponds during the summer; and fish kills resulting from release of chemical flocculants used to reduce turbidity from construction site runoff discharges.

The Special Protection Area program was established by Montgomery County in 1994. According to the Montgomery County Code, Section 19-61(h), a Special Protection Area is defined as:

"a geographic area where:

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urban stream syndrome: Current knowledge and the search for a cure. *Journal of the North American Benthological Society* 24(3):706–723. The NRC Stormwater report noted, "Although the "problem" of stormwater runoff is manifested most directly as an altered hydrograph or elevated concentrations of pollutants, it is ultimately an expression of land-use change at a landscape scale. Symptomatic solutions, applied only at the end of a stormwater collection pipe, are not likely to prove fully effective because they are not functioning at the scale of the original disturbance…"(NRC stormwater report, p. 25)

(1) existing water resources, or other environmental features directly relating to those water resources are of high quality or unusually sensitive; and
(2) proposed land uses would threaten the quality or preservation of those resources or features in the absence of special water quality protection measures which are closely coordinated with appropriate land use controls."

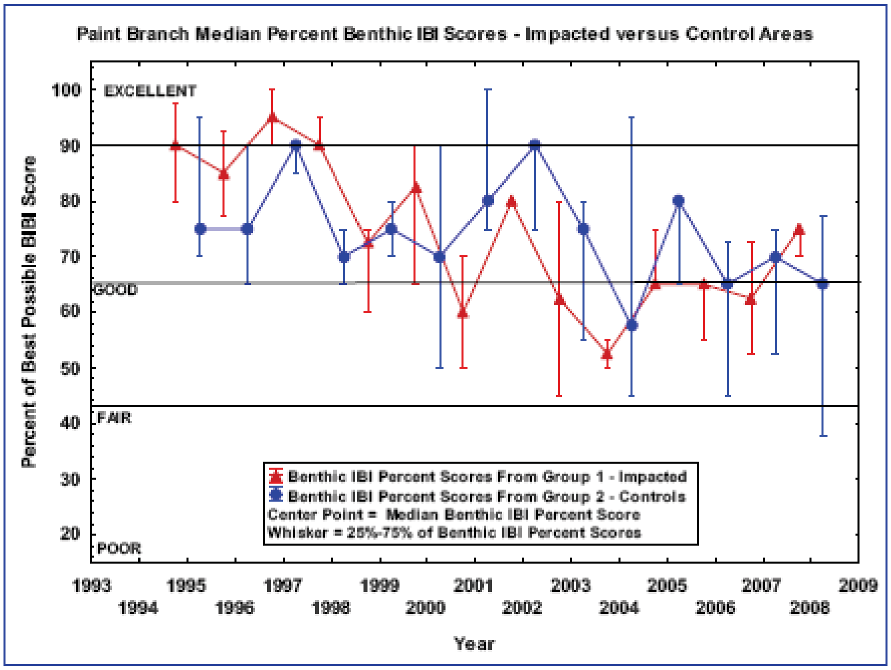
Out of the four SPAs in Montgomery County, the streams that have most consistently maintained their high quality are Upper Paint Branch and Upper Rock Creek (at least prior to construction of the ICC); both of these streams have had Environmental Overlay Zones that have imposed land cover requirements limiting imperviousness to 8% along with open space preservation targets. (Figure 3.)

DEP's 2010 SPA report noted:
"Despite the protection offered by the regulations, there are continuing conflicts between SPA goals for environmentally sensitive developments and other development requirements that sometimes foster increased impervious areas including: Master Plan-designated ***transferable development right (TDR)*** receiving areas, zoning density, construction sequence, and road grade and design requirements that require extensive ***cut and fill***. These increased development pressures compete with the protection of natural stream systems." The report also states:

"The natural hydrology of the Newcut Road Neighborhood in Clarksburg has been altered dramatically by the development process. The ability of BMPs to mimic pre-construction hydrologic conditions will be evaluated once the construction process has been completed and the SWM BMPs are online and functioning as designed."[11]

Thus, end-of-pipe stormwater BMPs, whether under the standard rubric of detention ponds, or the new rubric of Environmental Site Design techniques such as "microbioretention," are at best unproven as a method of maintaining the water quality of sensitive, fragile streams including Ten Mile Creek. Even the extraordinary and redundant BMPs used in previous Clarksburg stages have failed to protect the majority of the streams from degradation (Figure 4.) In addition, such stormwater treatment techniques do not address the many other elements of the Urban Stream Syndrome, including hilltop removal/ cut-and-fill, soil compaction, and stream crossings by infrastructure projects.

[11] Montgomery County DEP, Jan. 2010, Special Protection Area Report for 2008. page 74.



'igure 5.12. Median Benthic IBI Scores for Upper Paint Branch Control and Test Areas. [12]

Figure 3. Upper Paint Branch test and control stream Index of Biotic Integrity scores,1993 – 2008.

Stormwater Measures, including ESD practices, are not sufficient to protect Ten Mile Creek. Environmental Site Design (ESD) practices required under the Stormwater Management Act of 2007 combine new and older stormwater technologies. The SWM Act requires that ESD be used as the new norm for stormwater management for both new development and redevelopment projects. The Ad-Hoc Water Quality Working Group is charged in part with examining the effectiveness of the requirements of the SWM Act, and in particular the use of new-generation ESD practices, in protecting the water quality of Ten Mile Creek. Other chapters of this report describe the various local, state and federal stormwater laws and how they might be applied to Ten Mile Creek, including the recently-published state and federal requirements for construction site discharges and Maryland's post-construction stormwater management regulations.

[12] DEP SPA Report op cit., page 89.

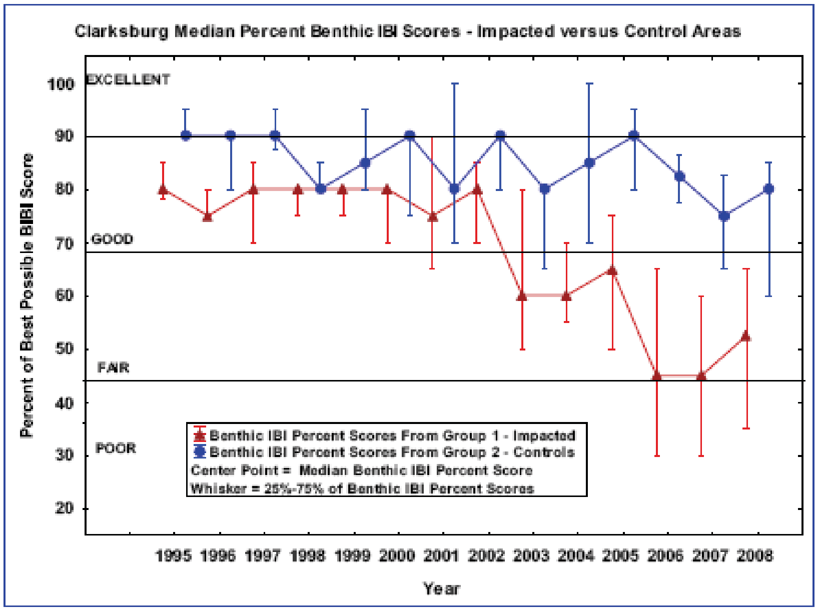


Figure 5.10. Median Benthic IBI Scores for Clarksburg Control and Test Areas.

Figure 4. Decline of Clarksburg streams undergoing development versus control streams.

From the 2008 Special Protection Area Report, p. 5-15.

How Much Will SPA Streams Recover After Development is Completed?

The Upper Paint Branch SPA streams are very likely to recover to near pre-construction conditions. It is uncertain whether a full recovery is possible. It appears that the 8% impervious cap restricting the amount and impacts of development, the sediment and erosion controls, stormwater management, and the relatively short time to complete development (from 2003 to 2006), have limited impacts to these streams.

The frequent, intense, and ongoing disturbances through the development period in the Clarksburg Master Plan SPA Town Center and Newcut Road areas may have impaired the ability of the benthic communities to fully recover to near pre-construction conditions.

The level of recovery and the direct influence of SWM BMPs (described to be "state-of-the-art" designs at the time) are unclear at this time. The ability of SWM BMPs to minimize impacts to streams cannot be considered separately from the development process. SWM is a component of the whole; the entire development process must be considered in its ability to minimize stream impacts.

Excerpt from the 2008 Special Protection Area Report (Page 5-18).

Discussions of the Working Group, including with invited guest speakers, have highlighted several ESD approaches including pervious concrete, clustering, use of conservation buffers and wooded stream buffers, and bioretention. All of these ESD techniques have been applied to development projects in Montgomery County to one degree or another, including in the Special Protection Areas. The key to protecting a sensitive waterbody is the application of an entire suite of whole-watershed protection measures including land cover requirements at the watershed level; examinations of the efficacy of a given BMP in removing a given pollutant are not adequate to address the vulnerability of stream biota and hydrology to the multitude of changes induced by the development cycle on a sensitive and fragile stream and its watershed.

Conclusion: Stormwater treatment practices have not been documented to protect the water quality of sensitive streams. Land use and stormwater practices may work better over time, and in other watersheds, but the published science from Montgomery County, regional, and national studies indicates that stormwater management measures, including ESD measures, will not provide sufficient protection for Ten Mile Creek. In order to protect Ten Mile Creek and its high levels of diverse aquatic life and cold, clear, steady flow of water, Montgomery County needs to apply land cover requirements – impervious cover maximums and forest/meadow cover minimums – based on the available science and prior experience in Upper Paint Branch, Upper Rock Creek and Upper Northwest Branch (Sandy Spring). If land cover requirements sufficient to protect Ten Mile Creek are not applied, the extremely diverse biota and the clean drinking water supply that the biota represent are likely to decline, probably irretrievably. As DEP describes the prognosis in the 2008 Special Protection Area Report,[13]

> **If sensitive organisms are no longer present or if the habitat no longer supports these more sensitive taxa, the stream condition may not be able to fully improve.**

Both the Special Protection Area ordinance, and the Clarksburg Master Plan, direct Montgomery County to apply land use controls as needed to protect Ten Mile Creek. The Planning Department and Board should be directed to revise the Clarksburg Master Plan as necessary to apply our local experience and the available science to protect Ten Mile Creek, including use of land cover requirements and other appropriate planning and zoning tools.

[13] Montgomery County DEP, 2008 Special Protection Area Report, page 5-18.

AUDUBON NATURALIST SOCIETY
WATER QUALITY MONITORING PROGRAM

TEN MILE CREEK, "SITE 32"
Testimony of Cathy J. Wiss
ANS Water Quality Monitoring Program Coordinator
Before the Montgomery County Planning Board
Hearing concerning Ten Mile Creek and the Clarksburg Master Plan, Stage IV
July 9, 2009

Since 1992, the Audubon Naturalist Society (ANS) in Chevy Chase, MD has trained and equipped volunteers to monitor the water quality of county streams by collecting data on habitat parameters including temperature and pH, and macroinvertebrate populations. Teams of volunteers currently visit 18 permanent sites in Montgomery County three to four times a year to conduct their analyses. These sites are located in the Little Seneca, Great Seneca, Watts Branch, Rock Creek, Northwest Branch, Sligo Creek, and Paint Branch watersheds.

ANS has one permanent monitoring site on Ten Mile Creek, which we have monitored since 1997. It consistently shows high taxa richness and abundance of benthic macroinvertebrates:

- ANS consistently finds more aquatic insect families at Ten Mile Creek than at the other sites in the program, often more than 20. At some sites we find 3 or less families. Within some families, we find several different genera at the same time.

- Ten Mile Creek is one of three ANS sites where we average more than 8 families of stoneflies, mayflies, and caddisflies during a single monitoring visit. These are the more sensitive aquatic insects. The other two sites are on Bucklodge Branch and Wildcat Branch. Some sites find 3 or less.

- A large number of stonefly families are found at Ten Mile Creek. These are insects that require cool clean water and are not found in many streams throughout Montgomery County. We also find especially sensitive families of mayflies, true flies and salamanders.

- Unlike other sites in the program, at Ten Mile Creek we find great abundance of macroinvertebrates. ANS monitors are required to collect 100 macroinvertebrates during a monitoring session by taking 9 net samples. If that is not sufficient, they must take 9 more net samples until they reach 100 organisms. During times of drought, we have never had to take more than 9 net samples to find more than 100 macroinvertebrates at Ten Mile Creek. At the same time, the majority of teams at other sites must take 18 net samples, and even then, many of them do not find 100 macroinvertebrates. (On occasion, the sites at Sligo Creek and Paint Branch have found no water and no macroinvertebrates.)

Ad-Hoc Water Quality Working Group
Meeting of December 2, 2009
Notes from the presentations of Keith Van Ness and Tom Schueler
(notes prepared by Diane Cameron)

Keith Van Ness Senior Aquatic Biologist, Montgomery County DEP

Ten Mile Creek was one of the last places where brook trout were found in the 1970s in Montgomery County.

The Clarksburg Master Plan describes Ten Mile Creek as "fragile and sensitive." "Fragile" is defined as "easily damaged; must be handled carefully;" while "sensitive" is defined as: "highly responsive, easily damaged or hurt." This watershed "really is different" than other watersheds that Keith has studied.

Ten Mile Creek:

- maintains summer base flows
- minimizes the response to storms
- has tributaries that function as a refuge for fish
- contains consistently cool water
- supports a high quality biological community
- is a "reference watershed."
- locally-rare amphibians

The Ten Mile Creek watershed has many springs, seeps, intermittent and ephemeral streams. It has many wetlands and vernal pools; DEP staff have mapped each of these. Locally rare amphibians -- longtail salamanders --have been found in Ten Mile Creek and Little Bennett. Examples of sensitive fish species that still exist in Ten Mile Creek include: Rosy-Sided Dace; Stone Rollers and Brown Trout.

Natural Resources Mapping and Buffers

For any development in this watershed, the requirements of the "NRI-FSD" (Natural Resources Inventory – Forest Stand Delineation) would involve wetland and water feature delineation and mapping in the Spring when all of these features are mappable – at other times of year, some of these are less discernible.

Land cover conditions in the Ten Mile Creek watershed as of today include forests and farmlands and rolling hills. An example of a recent development is at the intersection of Shiloh Church and West Old Baltimore Road: 10 houses on large lots.

Highway I-270 sits at the top of these local drainages; other existing developments include the SBA and Gateway Commons at Rte. 121 DEP mapped a 300-foot buffer area on both sides of the streams of Ten Mile Creek as per the Master Plan.

Question -- whether DEP, in its mapping and groundtruthing, found that the “Zero-Order” streams (the smallest ephemeral streams and associated seeps and springs) had been missed by the USGS in its quad sheets (topographic maps)?

Keith answered yes, DEP found that the topo maps missed many of these zero order streams, so DEP itself mapped these on their own.

Another example of the uniqueness of Ten Mile Creek: there are one or more beaver dams in the stream that enable the nutrients and sediment to be settled out. You can go into the mainstem of Ten Mile Creek and find beaverdams that have survived for years. The mainstem about ½ mile upstream from the ford on West Old Baltimore Road has a large 6 foot tall beaverdam built across it.

<u>Local Geology and Hydrology of Ten Mile Creek</u>
The watershed is characterized by fracture-fault geology in folded metamorphic rocks. The fractured quartzite layers along the faults are the ones that bear the water for the seeps and springs and ephemeral streams. Mapping these water features involves knowing, and mapping, the geologic faults and quartz veins.

Notes that the valleys in Ten Mile Creek watershed are steep (shown in red in one of the maps) and that these steep valleys are another indication of the fractures, folds and faulting of the local geology.

Question -- Whether there is evidence of the “Hungry Water” syndrome, whereby some streams that run very clear have been observed to cause erosion? Keith answered that he had not seen head cuts or other evidence of erosion in Ten Mile Creek.

Regarding Summer low flows (a member noted that he has seen the mainstem of TMC go dry sometimes in the summer) – Keith said that “the Ten Mile Creek mainstem sometimes gets very, very low; while the side tributaries maintain their more steady flow year-round. These side tribs serve as the refugia and the breeding ground/ nurseries for these fish.”

Question -- Whether the beaver dams blocked the fish's migration? Keith responded that he wasn't aware of such blockage having happened.

Keith concluded by observing that “Land use and stormwater practices may work better over time, and in other watersheds, but they probably will not provide sufficient protection for Ten Mile Creek.”

Tom Schueler   Director   Chesapeake Stormwater Network

The Impervious Cover Model

It's easy to produce a fair amount of impervious cover in a given development project. The Impervious Cover Model is represented by a graph based on dozens of scientific studies, that relates stream biological health on the "y" axis with different percentages of watershed total impervious cover on the "x" axis. Total impervious cover is measurable at the watershed level, and this graph relates to total watershed statistics, not to individual site statistics. The "new deal in town" on this issue is "EIC", or "Effective Impervious Cover." EIC relates to the impervious surfaces that are piped or otherwise connected directly to a stream discharge point, whereas Total Impervious Cover counts all imperviousness in a watershed whether it is directly piped to a stream or whether it creates sheet flow into a forested or meadow buffer.

The "Zero Order" streams are important – they matter enormously, and merit the greatest possible protection to keep them going; they serve many functions including as groundwater discharge channels.

The loading of pollutants into a stream increases as imperviousness increases in a watershed.

The Impervious Cover Model has some "prerequisites," factors or assumptions that go along with it – including that land management must be good, e.g. there must be no deforestation.

An implication of the Impervious Cover Model is that if you are a fish or a bug in the stream, your lifestyle changes abruptly once imperviousness is added to your watershed. In Maryland, there have been indications of stream degradation at 2% watershed imperviousness.

Comment -- The Planning Staff's Clarksburg Stage IV analysis included a table delineating the current imperviousness levels of the 12 subwatersheds of Ten Mile Creek, and 7 of them are listed as being below 2% imperviousness. (see page 14 of the analysis at: http://www.montgomeryplanning.org/viewer.shtm#http://www.montgomeryplanningboard.org/agenda/2009/documents/20090709_attachment1-analysis_clarksburg_stage4.pdf).

Riparian Buffers and Their Interaction with Levels of Imperviousness

Tom observed that riparian cover helps maintain high water quality levels in watersheds up to 15% impervious cover; Forested buffers are important for biodiversity and geomorphologic indicators (such as stream channel stability).

Question: About differences between different riparian buffer protection strategies, and whether there is a difference in recommended forested buffer width depending on the stream order. Tom responded in the affirmative, and gave the example of Ontario, where there are zero order streams that have been provided buffer protection; with a protocol based upon increased buffer widths for the lower order streams. Tom also cautioned that a buffer strategy alone is not sufficient to protect water quality. For the zero-order small streams, in watersheds that are undergoing development, there are three choices: 1) "Blow it away"; 2) pipe it; or 3) use a Regenerative stormwater conveyance/ in-line bioretention technique (also termed "stepped pool seepage wetlands" and "Coastal Plain Outfalls.")

Tom further noted that there is not much effect or water quality protection actually documented for current Watershed Treatment Practices (e.g. stormwater BMPs) – they are good for Bay nutrient reduction, but not for small stream health or biodiversity protection.

Tom reported that he had scoured the literature, but had not been able to find a single study of development in a watershed of equal to or greater than 25% imperviousness, where BMPs had enabled the maintenance of a high quality stream. These studies have in general been hampered by two factors: 1) lack of whole-watershed treatment examples –the studies have tended to only look at the individual site level; and 2) historically, ponds have not worked.

Construction Phase Issues

Tom observed, "Whatever you do, you must consider the Construction Phase." Turbidity, and clearing and grading practices, are important factors and impacts. Typically, with conventional clearing and grading practices, zero order streams are "wiped off the face of the Earth."

Montgomery County is the "Titan of Turf" – with 44% of its land area covered with turf. The rule of thumb is that there is a 3:1 ratio of turf coverage to impervious cover .

Tom said that "it's important to not fixate on obtaining a low impervious cover - fixate also on high percentage of forest cover, and obtaining the lowest percentage possible of turf cover."

Question: Don't the low-density, 2-acre lots we saw earlier create a lot of turf?
Answer: Yes – this is generally true.

Below 10% imperviousness in a watershed, research shows that metrics such as watershed forest cover, turf cover, and stream buffers are strong indicators for stream health.

There is a higher degree of freedom to incorporate ESD solutions in greenfield situations.

Question: With alternative turf care, such as organic leaf mulch applications, and compost amendments, isn't it possible to increase the runoff absorption of turf?
Answer: yes, but compaction during construction is a major factor in the loss of infiltration capacity of soils, down to 36 to 44" deep. That compaction tends to swamp out the effects of soil amendments.

Comment – Cut and fill (e.g. The road building practices that were used in Clarksburg Stages 1 through 3) will come into play, and will wreck the topsoil and the local geology and hydrology. The local geology, as noted previously by Keith, is fragile and with the road and site grading and "hilltop removal" used in Clarksburg Stages 1 through 3, the tilted metamorphic rocks break, and their associated fracture-fault aquifers are compromised or destroyed.

Tom - "Terraforming" [re-forming the land with conventional grading and cut and fill practices] makes it impossible to maintain groundwater recharge properties. This and the other factors we've listed brings us to the question: "Is Environmental Site Design to the Maximum Extent Practicable (ESD to the MEP) enough to protect the water quality of Ten Mile Creek? The answer is: Probably not." Getting the full reduction of the 2.6" channel protection volume is extremely difficult to do. The Construction stage impacts are serious and hard to mitigate. Stream crossings, roads, bridges, and buffer encroachment all occur during construction, and have significant water quality impacts.

The full ESD is technically hard to achieve at sites, and even if this volume is achieved, it still does not address other stormwater impacts. These include: hotspots, leaks, spills, and road salt. Chlorides from wintertime road salt applications impact the biota. Keith noted that "We have documented fish kills from road salt."

Comment: MDE's requirements only require 1" up to 2.6" of stormwater volume management on-site via ESD, so you might be able to achieve MDE's numbers on a given site.

Tom: Those are MDE's regulations; that is different than whether reduction of the full Channel Protection Volume [2.6"] can be achieved on a given dense site; it's easier and more doable for the 1" to be reduced on site, but tough to achieve much above that on a dense site.

Question: Is there a threshold of stream loss for the zero order streams, in terms of the rest of the watershed being able to maintain high water quality after a certain portion of the smaller streams are destroyed?

Tom: Overall, a significant watershed protection approach is needed, based on land conservation. There is no set answer to that question – no certain threshold, of whether water quality is maintained if you lose 3 out of 12 catchments, or 6 out of 12, or what have you....what are the implications? It's like asking, "How many fingers can you cut off, and still have a working hand?"

Whatever you do, if you develop the land, there will be some loss of biotic integrity in the system.

Sediment and Turbidity Pollution and the Limits of Mitigation

Keith: Sediment is an enormous impact to aquatic species – these critters are highly sensitive to sediment loads.

Comment: Turbidity is a tricky indicator.

Tom: Seattle Sea-Tac airport has a permit with a 5 NTU (Nephelometric Turbidity Units) limit; generally the only way to achieve this kind of low turbidity consistently, is through an Active Treatment System (ATS).

New MDE construction standards, including turbidity controls for the Piedmont region, are mostly passive systems that don't work as well and as consistently as ATS. During a study we did, 250 NTU was the best we got in Montgomery County sedimentation basins.

Keith – Rick Brush and his shop at DPS did everything they could to reduce construction site sediment in Clarksburg Stages 1 through 3, but the best results were only 70 to 75% [pollutant removal] efficiency.

Comment: Where you lose efficiency is with the smaller particles that stay in suspension and that clog silt fences and filter devices.

Comment: removal efficiency using percentages has recently been questioned as a valid measure of stormwater BMP effectiveness. For instance, if an influent to a pond has a turbidity level of 1000 NTU, and discharge outflow level of 200 NTU, that's an 80% pollutant removal efficiency; but cleaner initial water yields a smaller resulting pollutant removal efficiency – even if the water coming out of the sediment trap is the same or cleaner.

Tom – Sediment loadings and turbidity are typically higher at the tail end of the construction phase, when they install the pipes and other infrastructure.

Comment --In that case you have direct delivery where there's bare soil and the sediment needs to be trapped. I agree that construction is the biggest weak spot. On a typical construction site, a violation may be longstanding before and after the inspections are done and citations are issued.

Comment – the Development industry recognizes that stormwater issues are important and of strong current interest.

Comment – There is really no penalty that matters – the enforcement fines and citations that are issued amount to mere slaps on the wrist.

Question – What about the new stormwater regulations, don't they require before and after stormwater monitoring? With the new regulations, there will be a better result.

Tom – Agreed with the last statement to a point, but noted that the lack of an enforceable standard for construction site runoff discharges has meant 40 years of the lack of an incentive to really effect a change and apply the best technologies.

With the new regulations, including EPA's new effluent guideline for the Construction and Development industry, there will be a much higher level of importance given to these issues and to enforcement.

Keith noted that Clarksburg stages 1 – 3 did include ESD practices: swales; permeable pavements; rooftop disconnections.

Comment: But admittedly, these things were not enough.

Rick Brush: when the sewer lines were put in, the streams started to degrade. The underground stormwater drainage pipes diverted and intercepted the groundwater adversely.

Question: Keith has a section called "SPA [Special Protection Area] Observations" in his presentation – that we have yet to see. Could KVN come back and circle back to that section?

Answer: Yes…will do so in January.   (Keith came back on Jan. 22, 2010 to present information on the County's Special Protection Areas.)