MCPB
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MEMORANDUM

TO: Montgomery County Planning Board

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Countywide Planning Division
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SUBJECT: Roundtable Discussion: Definition of Impervious Surface and How it Relates to Regulatory Impervious Surface Limits

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RECOMMENDATON: Information and Discussion

Introduction

Limits of imperviousness have joined more-traditional land use regulations as a tool controlling site development in Montgomery County. There are two overlay zones in the County Zoning Ordinance which require land development projects to meet impervious surface limits: the Environmental Overlay Zones of the Upper Paint Branch Special Protection Area and of the Upper Rock Creek Special Protection Area. Some master plans include imperviousness limits for specific properties in environmentally sensitive areas. The Planning Board has raised questions in the review of projects that are subject to regulatory impervious surface limits or master plan recommendations, about using certain engineered structures, such as porous pavement, grasscrete, or green roofs, to meet the imperviousness limits. This paper provides information for discussion and dialogue on this topic.

Environmental Functions and Benefits Provided by Natural Vegetated Land

To best understand the extent to which impervious surfaces negatively affect water resources in multiple ways, a quick review of the valuable functions of natural vegetated land is important for comparison. Originally, nearly the entire surface of Montgomery County was covered by natural vegetation. The environmental benefits provided by natural vegetated land are many, and go beyond the surface of the land itself to include the structure and processes of natural layers in the soil, as well as the biological processes provided by plants, animals, and micro-organisms.

These environmental functions include:

- Storage of precipitation on vegetation;
- Significant air deposition of pollutants onto vegetation;
- Plant uptake of deposited pollution washed off vegetation;
- Plant uptake of pollutants deposited directly on the ground;
- Return of water to the atmosphere through evapotranspiration;
- Infiltration of the remaining water after treatment by natural pollutant removal processes;
- Carbon sequestration by vegetative growth through the metabolism of carbon dioxide;
- Release of oxygen to the atmosphere;
- Chemical adsorption of pollutants beginning in the organic layer above the soil, and continuing down through the various subsurface soil layers;
- Uptake of pollutants through microbial and other biological activity in the organic layer and topsoil;
- Maintenance of flow regimes and water quality that support aquatic life and human health;
- Prevention of soil erosion;
- Lowering of runoff temperature;
- Oxygenation of runoff;
- Food sources for aquatic life; and
- Habitat for the organisms that contribute to the overall ecosystem processes.

This list describes environmental functions and benefits that go well beyond the benefits provided by infiltration alone, although discussion of imperviousness often seems focused exclusively on that one feature. Each of these functions is important, interdependent with the others in an overall system, and disrupting one will usually involve some disruption of the others.

Collectively, these functions provide a huge economic benefit to society that generally does not get factored into the assessing the cost of development. Indeed, full cost accounting of the costs of land development is not yet a reality in most places. Because the true long-term societal costs of development have not been effectively recognized, the result has been an ever increasing legacy of problems associated with global warming, negative health effects, degradation of air quality, declining water quality, loss of natural land in self-sustaining quantities and connectivity, loss of native plants and animals, increased exotic-invasive species, and the mounting costs of mitigating such effects late in the game.

Increasing environmental problems and crises on both local and regional levels, including degrading streams and a Chesapeake Bay nearing collapse as a viable resource, clearly indicate that we have hardly begun to properly account for the damage or how to fix it.

Impervious surfaces are only one aspect of how we affect the land we live on, although its inverse correlation with water quality is well documented. As a result, the issue of impervious surfaces, and their effect and management, cannot be understood without being seen in the broader context described above.

Impacts on Environmental Functions and Benefits due to the Alteration of Natural Land

Generally speaking, human-mediated changes to natural land result in some degree of environmental degradation and loss of the environmental services listed above. The more natural land cover, structure, and processes are altered, the greater the adverse impacts tend to be. The most environmentally damaging alteration is to convert it to an impervious surface. As a result, imperviousness integrates the impacts of all the aforementioned environmental benefits. Although the degree of environmental impact varies with land use type and specific practices on the land, in general, urbanization has had the most profound adverse environmental effects. This is due in large part to the significant increase in impervious surfaces that are characteristic of the urbanization process. Clearly then, the impacts of urbanization, and their mitigation, cannot be considered simply as a matter of infiltration. Although infiltration of precipitation is an important environmental service, it is but one of many important functions provided by the processes operative on natural land.

Environmental impacts from the alteration of natural land typically involve:

- Significant clearing of natural vegetation (if it is not already cleared);
- Grading of the natural topography and altering the natural drainage, removal of the organic layer, topsoil, and often more;
- Disruption of the natural chemical and biological processes that help uptake and process pollutants;
- Compaction of the remaining soils—further impeding infiltration—even on grassed areas;
- Addition of hard surfaces which themselves prevent or significantly impede the infiltration of precipitation. These artificial hard surfaces are typically termed impervious surfaces;
- Altered flow regimes in streams resulting in habitat degradation and channel erosion;
- Disruption of the above-listed listed environmental functions and benefits; and
- Additional pollutant loadings resulting from human activities on the altered land surfaces.

As indicated above, the impacts of development not only include the loss of valuable environmental functions, but also additional negative impacts due to increased pollutant loadings. Of the various surfaces created by development, impervious surfaces typically result in the greatest impacts to environmental functions. Because impervious surfaces integrate so many of the overall adverse effects of development, including the reduction of most, if not all of the above mentioned environmental functions, it is often used as an index of environmental impact in urban areas.

Definition of Impervious Surface

In recent years an interagency workgroup was convened to draft a Zoning Text Amendment (ZTA) to address the issue of Private Institutional Facilities (PIFs) in the Agricultural Reserve. The workgroup involved staff from M-NCPPC, DEP, DPS, and the County Council. As part of this ZTA, the workgroup developed a working definition of impervious surface to be used in the ZTA. As things turned out, the ZTA never went to the Council for consideration, and the PIF issue was resolved through other means. Although future discussion may refine it further, the following definition is used as a working definition of impervious surface by the various agencies of the County. As a definition, it is very similar to the definitions of impervious surface used by urbanized counties across the country.

<u>Impervious Surface:</u> ***Any surface that prevents or significantly impedes the infiltration of water into the underlying soil, including structures, buildings, patios, decks, sidewalks, compacted gravel, pavement, asphalt, concrete, stone, brick, tile, swimming pools, and artificial turf. Impervious surface also includes all areas used by or for motor vehicles or heavy commercial equipment, regardless of surface type or material, including roads, road shoulders, driveways, and parking areas.***

Because the most characteristic feature of impervious surfaces is the completely or significantly reduced infiltration through them, the effect on infiltration is generally the key in defining what surfaces are impervious. This does not mean that there are no other impacts from impervious surfaces, or that simply increasing the infiltrative capacity of these surfaces can mitigate these impacts. The surfaces captured in the impervious definition are the ones that generally have the highest impact on all the environmental functions listed above.

The information provided to this point provides a baseline for examining the following questions:

Can higher levels of imperviousness than mandated by law or otherwise deemed desirable due to associated adverse environmental impacts, be permitted in exchange for additional and/or enhanced stormwater best management practices (BMPs)?

Limiting total imperviousness on a site is generally considered throughout the country, and especially in urbanized regions, to be a high-priority, non-structural stormwater best management practice (BMP). Limiting overall site grading is another important non-activities, and reduces sediment loading on receiving aquatic systems. In light of strong supporting data correlating long-term environmental benefits with low levels of imperviousness, the position shared by all county agencies responsible for water quality is that minimizing imperviousness is the best method of protecting water quality. As such, the top priority is to explore and implement all feasible options for minimizing imperviousness, before creating a significant reliance on engineered or structural BMPs. Ideally, a site should be designed to achieve the minimum imperviousness practicable, and at the same time integrating the best BMPs into that overall design. In this way, stormwater management is optimized as a part of the site design process from the beginning, and not as an afterthought.

Structural stormwater BMPs have been proven to be useful in helping to mitigate impacts resulting from development. However, what has also been demonstrated is that BMP performance is imperfect and often highly variable, especially over time. BMPs, depending on type, location, soil conditions, geology, and construction, vary in the types of pollutants they remove as well as the efficiency with which they remove them. In addition, BMP performance varies with respect to how well they are maintained, as well as with respect to facility age, even when well maintained. Many BMPs are constructed in ways that make it hard to tell when they are failing. A summary of a literature search by M-NCPPC provides an indication of the current state of the science with respect to BMP performance and has served to highlight these facts (See Attachment A).

It is important to note that almost all data on BMP effectiveness is based on intake/outfall analyses. There is very little data available regarding BMP effectiveness on a watershed scale. According to *Impacts of Impervious Surfaces on Aquatic Systems* (CWP, 2003): "We cannot directly answer the question as to whether or not stormwater treatment practices can significantly reduce water quality impacts at the watershed level, simply because no controlled monitoring studies have yet been conducted on this scale." Some uncontrolled studies suggest that there are some larger-scale benefits, but the results so far are sketchy. There are signs that efforts are underway to begin to address the dearth of BMP performance data on a watershed scale, but results will be some time in coming. In the meantime, we are in the position of knowing that well designed, constructed, and maintained BMPs make a positive difference in watershed water quality, without knowing how much benefit is provided, and how variable the benefit is, especially over time. The existing evidence is clear, however, that the benefits conferred by BMPs are not sufficient to fully mitigate development impacts, in light of the continuing degradation of our receiving ecosystems.

So far, the discussion has centered on imperviousness as it relates to calculating total site imperviousness. Considering imperviousness as it relates to stormwater and water quality management is another matter. For the purpose of stormwater management calculations perviousness is a function of many factors such as land use, soil type, soil compaction, type and condition of vegetation. Natural and altered surfaces run a range of degrees of perviousness that is taken fully into account in stormwater management process.

Montgomery County, through its Stormwater Manual, currently provides incentives in the form of water quality control credits for the use of BMPs that promote infiltration of stormwater. This type of credit is similar to credits given for such BMPs in jurisdictions throughout the country. Montgomery County currently encourages the use of porous and pervious materials in stormwater management design.

Our current knowledge does not support allowing higher imperviousness than mandated by law or otherwise deemed desirable due to associated adverse environmental impacts, in exchange for extra BMPs. Continued use of state of the art best structural BMPs should certainly continue to be encouraged, although the evidence on sustainable watershed-level effectiveness is not complete. If, however, in particular cases, the Planning Board or the County Council were to decide that other factors outweighed the need to guarantee the long-term protection of the environment through limiting imperviousness, it would certainly be advisable to continue to require extra, or even redundant BMPs as a condition, but with no assumption that the additional BMPs will provide permanent mitigation for the excess in imperviousness. In addition, where we want to ensure water quality protection, additional and/or enhanced BMPs could be required to provide an extra level of protection beyond that provided by imperviousness limits and normal BMPs.

Can higher levels of imperviousness than mandated by law or otherwise deemed desirable due to associated environmental impacts, be permitted in exchange for the use of porous pavement techniques and/or green roofs?

Both pervious pavement techniques and green roofs are considered to be engineered or structural BMPs, and subject to the same concerns regarding structural BMPs already discussed. These BMPs involve significant total impacts to the listed environmental functions, including significant impediments to natural infiltration, whether it is a hard rooftop surface or significant compaction for subgrades to support vehicular loadings. For these reasons, porous pavement and green roofs are included in the surfaces that are considered to be impervious. Although all BMPs have certain features that distinguish them from other BMPs, these two BMPs are different from the others in ways that has led to some confusion and misunderstanding, and justify some further discussion.

BMPs are usually not considered to be impervious surfaces (e.g. stormwater management ponds, infiltration trenches, sand filters, etc.) with the exception of pavement structures such as porous pavement and grasscrete, which fall within a special class of BMP that is itself a hard artificial surface. The reason they are considered to be impervious is not because their increased pervious nature is not recognized, but because their long-term ability to treat or simply just to infiltrate stormwater, is like other BMPs, subject to unpredictable degrees of variation in performance, as well as degradation of effectiveness over time, even with maintenance. The inclusion of porous pavement as an impervious surface for the purposes of calculating site imperviousness remains a sound environmental policy that is well supported by the existing data, and usage throughout the country.

As indicated above, Montgomery County encourages the use of BMPs that increase infiltration, including porous pavement, and grants water quality management credits for their use.

Green roofs are another BMP that only partially mitigate the many negative environmental impacts of the impervious surfaces they are installed on. Green roofs are a special type of BMP that attempts to mitigate the impacts of an impervious surface directly underneath it. They are useful, but their shortcomings also preclude classifying them as pervious surfaces for the purpose of calculating total site imperviousness. Green roofs are not a substitute for a natural ecosystem on the ground. None of the water that is absorbed by a green roof infiltrates into the ground; therefore, the function found in natural pervious soil systems of infiltrating surface water to recharge groundwater and stream base flow supplies does not exist with a green roof structure. Moreover, as very shallow systems, they can only handle a limited amount at any time before the stormwater overflow system comes into play. Likewise, they can only process a portion of the pollutants, compared with natural vegetated ground cover. Moreover, green roofs are also subject to variations in pollutant removal and hydrologic performance. Because of these considerations, green roofs are also classed as impervious surfaces.

Montgomery County currently encourages the use of green roof technology to meet a project's water quality control requirements. Green roofs are given both stormwater and water quality management credits.

In summation, the answer to this question is essentially the same as the preceding one. Our current knowledge does not support allowing higher imperviousness than mandated by law or otherwise deemed desirable due to associated adverse environmental impacts, in exchange for the use of porous pavement or green roofs.

Summary

Stormwater management BMPs of various types have been in use for decades, yet the data indicate that even though their use provides some environmental benefits, aquatic habitat and water quality, both locally and regionally, continue to degrade. The state of Maryland, in its stormwater manual (which has been formally adopted by Montgomery County) has reviewed and approved a number of techniques for use in managing stormwater, and grants both stormwater and water quality volume credits for their use.

The average performance of BMPs in general indicates that there will be some overall benefits to using them. But BMPs will inevitably perform better or worse on some sites than on others. As a result, there is no way to predict how well they will ultimately perform in specific applications or on a watershed-scale, especially over time. Experience has shown that engineered stormwater BMPs cannot recreate or fully compensate for all the environmental functions and benefits natural soil and vegetative systems. These facts are the basis for the current practice of granting credits for the use of structural BMPs for stormwater and water quality management, but not for the calculation of total site imperviousness.

Staff Position

We believe that the policy of minimizing imperviousness as much as possible for all types of development should continue as the top priority approach to sustainable long-term protection of water quality, and be rigorously applied to all development projects.

Use of new technologies and techniques should continue to be encouraged and fostered, including incentives such as giving credits toward stormwater and water quality management requirements, but not as credits for extra site imperviousness.

If a project has minimized the amount of impervious surfaces, cannot meet regulatory imperviousness limits, and is determined to be sufficiently in the public interest to override environmental concerns, we believe that innovative BMPs should used to offset impacts of the excess imperviousness.

ATTACHMENT A

SUMMARY OF SOME RECENT ASSESSMENTS OF BMP PERFORMANCE
12/03/07

National Pollutant Removal Performance Database, 2nd edition, 2000, Rebecca Winer, Center for Watershed Protection: The actual performance of a specific Stormwater Treatment Practice (STP) in the field may be influenced by a variety of factors including STP geometry, site characteristics, monitoring methodology, and influent pollutant concentrations. However, it is not possible to quantify the relative influence of each of these factors on reported STP performance with currently available data. Table 2.1 reveals critical gaps in current knowledge about urban STP performance. Perhaps the most critical gaps in STP performance research exist for infiltration and bioretention practices, which have not yet been adequately monitored in the field. More research on the performance of water quality swales appears warranted, not only because so few have been monitored, but because of the wide removal variability among those that have been sampled. Other STPs have been the subject of scant performance research because they are new.

While ponds, wetlands and open channels have been extensively monitored in the field, significant gaps exist with respect to individual stormwater parameter. In particular, bacteria, hydrocarbons, and dissolved metal data are scarce. Despite well-established correlations with human health, recreation, and aquatic toxicity, these three parameters were measured in only 10 to 20% of the STP performance studies included in the Database. A greater focus on these important parameters is warranted in future STP monitoring efforts.

Another remaining research gap is the ability to determine the relative benefits of various design features. For example, while it is assumed that increasing the storage volume will improve treatment capability, it is not possible to develop a statistically significant relationship using the Database in its current form. One reason for this result is that storage in "impervious inches" is rarely reported. This value would most likely provide the best regression. Descriptions of other design features are also rarely reported.

King County Surface Water Management and Washigton State Department of Ecology. *Evaluation of Water Quality Ponds and Swales in the Issaquah/East Lake Sammamish Basins*, (October, 1995): There are few reported studies of the long-term performance and maintenance of public domain BMPs. This document reported that 52% of wet ponds had significant defects. Seventy-five percent of bioretention swales surveyed were in either fair or poor condition due to a combination of design, construction, and inspection shortcomings and inadequate maintenance.

Livingston, Baldwin, and Clevenger (2000), in "Lessons Learned About Successfully Using Infiltration Practices" *National Conference on Tools for Urban Water Resource Management and Protection Proceedings*, Chicago, stated that less than 50% of the infiltration practices, including basins, trenches, dry well, pervious pavement, and vegetated swales studied were functional. The contributing factors included inaccurate estimates of infiltration rates, high water tables, excessive compaction, sediment loadings, and lack of maintenance.

Horner, May, and Livingston, (2003), *Linkages Between Watershed and Stream Ecosystem Conditions in Three Regions of the United States*: Statistical examinations of BMP areal coverage, with overall watershed condition being a controlled variable, exhibited very weak or even negative partial correlations between biological integrity and BMP presence. Even with these shortcomings, though, results indicate that structural BMPs appear to help in sustaining aquatic biological communities at fairly high urbanization levels. They give less evidence of benefit at moderate urbanization and greater natural land cover. If ecological losses are to be stemmed at high urbanization, structural BMPs appear to have a substantial role.

The highest biological indices had no relation to BMPs, because these high scores occurred only in watersheds with no or minimal development, where no BMPs were built. It thus could not be tested if BMPs can replace some loss in natural land cover through light urbanization and still maintain high biological integrity.

Law and Band, (1998), *Performance of Urban Stormwater Best Management Practices*: To date, studies on BMP effectiveness demonstrate a wide range of pollutant removal capabilities that range from net export to more than a 90% reduction. Research indicates that performance is affected by specific design characteristics, processes affecting chemical phase and speciation, and environmental conditions. However, it is difficult to interpret the pollutant removal efficiencies beyond generalities. Studies report only influent and effluent concentration and/or pollutant loading reductions, thus making it difficult to determine what specific factors are affecting BMP performance. Currently there is a lack of within-BMP monitoring of water quality and other media (e.g. sediment, vegetation) to provide a strong understanding of factors and processes responsible for export or detention of urban stormwater pollutants. There is a need to study the fate of contaminants within the BMP and the interactions amongst media. Further, the variability in results is not only due to factors affecting BMP performance, but also the methods used to calculate effectiveness and estimate flow for non-gauged BMPs.

Randall and Fusco, 2003, Santa Clara Valley Urban Runoff Pollution Prevention Program, *Guidance on Prioritization and Frequency of Stormwater Treatment Best Management Practices Inspections*: Stormwater treatment systems that rely on infiltration (e.g. infiltration basins and trenches) have been documented to fail from excessive sediment accumulation resulting in clogged systems. Over sixty percent of the infiltration trenches built in Prince George's County, Maryland had stopped functioning within five years of construction (CASQA, 2003). Lack of pretreatment controls is suggested to be a significant contributor to system failures (WMI, 1997). In addition, all contributing drainage areas must be stabilized to ensure long-term functioning of infiltration practices. Once oil and grease or sediments clog the filter media, the system is no longer effective in removing pollutants from stormwater runoff. Filter systems require inspection by the property owner on a monthly basis and after major storm events to ensure proper functioning. In addition, filter surfaces should be cleaned out twice a year. If infiltration systems become clogged, the entire stone reservoir base layer requires replacement resulting in large costs.

Due to improper installation and maintenance, porous asphalt and pervious concrete also have a high rate of failure due to sediment clogging (EPA, 1999). Clogging may occur due to improper design, batching, pouring and finishing of the pavement system (WMI, 1997). Once clogged, it is very difficult and expensive to rehabilitate porous pavements. Other type of porous pavements (i.e., turf blocks and interlocking pavers) may be more effective over time and are much less expensive to replace.

Preliminary Data Summary of Urban Storm Water Best Management Practices, EPA, 1999: Some BMP types have been analyzed for performance in terms of site-specific pollutant removal, although not extensively enough to allow for generalizations. The pollutant removal performance of some BMP types is essentially undocumented. There is no widely accepted definition of "efficiency" or "pollutant removal" for storm water BMPs. The role of chemical pollutant monitoring in evaluating BMP performance is not well documented. Due to the limited cost data, a lack of clear definitions of performance, and limited "performance" data, it is difficult at this time to develop cost-effective comparisons for various BMP types. The benefits of individual BMPs are site-specific and depend on a number of factors including: the number, intensity and duration of wet weather events; the pollutant removal efficiency of the BMP; the water quality and physical conditions of the receiving waters; the current and potential use of the receiving waters; and the existence of nearby "substitute" sites of unimpaired waters. Because these factors will vary substantially from site to site, data are not available with which to develop estimates of benefits for individual BMP types. A number of researchers are continuing to work on BMP performance monitoring, and there are several attempts underway to develop comparison frameworks through the construction of comprehensive databases on BMP design characteristics and performance.

Frequently, there are too many variables in a watershed and too many other potential sources of degradation to isolate the improvements (or even to indicate potential negative impacts) of a particular BMP or group of BMPs. For example, Maxted and Shaver (1997) did not observe a significant difference in macroinvertebrate communities between 8 sites with stormwater retention ponds and 33 sites with no stormwater controls. In addition, the BMPs did not prevent the almost complete loss of sensitive aquatic species.

Available data seem to indicate that urbanization and traditional urban development at almost any level can cause degradation of streams, and that BMPs may be able to mitigate these impacts to a certain level. Acordingly, stormwater management should start at the point of runoff generation, and incorporate site planning principles that prevent or minimize the generation of runoff, preserve natural drainage systems, and avoid disturbing sensitive areas such as floodplains, wetlands and riparian areas. Where runoff generation cannot be avoided, then properly sited, designed, constructed and maintained BMPs can be implemented to attempt to reduce the impacts associated with this runoff. There are data available on the effectiveness of BMPs in reducing pollutant loads, but these data are not comprehensive enough to either fully characterize the performance of all BMPs in use or to determine the extent to which they are controlling impacts to receiving waters. Additional data gathering is necessary, but the monitoring and data analysis protocols necessary to do so have not been fully developed.