Homeowner Association Resident's Perceptions on Stormwater Retention Ponds and Clean Drinking Water: (Montgomery West Homeowners Association (MWHOA) Gaithersburg, Maryland).

William Hadyn Roberts, Jr.

Oregon State University

Capstone project submitted in partial fulfillment of the Masters of Natural Resources

June 12, 2015

Abstract

This report describes the findings from a 22 question survey of the 104 member Montgomery West Homeowners Association (MWHOA) in Gaithersburg, Maryland. Resident's perceptions of their practices as related to the neighborhood storm ponds, stormwater, and how homeowner practices contribute to non-point source pollutants. An understanding of Green Infrastructure (GI) processes and techniques, and perceived awareness of a list of 14 governmental and nonprofit organization education programs was conducted. The MWHOA contains two stormwater retention ponds which drain into an adjacent watershed and then into the Potomac River. The local water utility company, the Washington Suburban Sanitary Commission (WSSC), has a raw water intake system downstream of MWHOA drainage. A survey of MWHOA residents was employed to inform two project objectives. The primary project objective was "What are the Montgomery West Homeowners Association (MWHOA), Gaithersburg, MD residents' perceptions, understanding of connections and current practices that influence stormwater management ponds and clean water". The secondary project objective was "What additional interconnected relationships can be derived from the MWHOA resident perceptions and awareness levels towards current solutions to clean water (such as Green Infrastructure (GI) techniques and educational awareness programs)? A 49% survey response rate was achieved with homeowners but a zero response rate for renters in the Association. Only one-third of the residents had ever visited their neighborhood pond. Two-thirds of residents indicated some general awareness that the ponds controlled stormwater flows but there was little knowledge of pond function or impact on the environment beyond that. There was some knowledge of residential gasoline and fertilizer products washing into the stormwater ponds. Aside from using rain barrels and landscape mulching there was little knowledge of GI to reduce onsite runoff water volume. The MWHOA residents were aware of only four (out of fourteen) pollution reduction education programs: 1) Adopt-A-Road, 2) Hazardous Household Waste Collection Events, 3) Storm Drain Marking Program, and 4) Marylanders Plant Trees. Examples of County programs identified in the survey that work: "Save the Bay" storm drain marking, Adopt-A-Road anti-littering, and household hazardous waste collection events have high visibility and usage within the MWHOA. However, the Rainscapes program, and the illegal dumping and stream contamination hotline have very low visibility to Association residents. Our survey identified a number of low cost practices that may offer improvements in stormwater quality. The MWHOA board of directors may adopt recommendations to influence positive change in individual actions affecting the quality of the supply of local drinking water. Publicizing good application practices for lawn fertilizer, as well as educating the Association about the County fertilizer law and penalties, is a good example of a low cost action with potential large scale water quality improvement.

Acknowledgements

I wish to acknowledge and thank my dedicated and enthusiastic Oregon State University Graduate Advisory Committee. The Chair, Dr. Samuel Chan, was a true mentor throughout the project and paper. The Committee members of Dr. David Perry and Dr. Christine Olsen provided critical subject matter expertise and help to this author. I thank you all for your time and dedication!

Table of Contents

Chapter 1

Outline of the Study

Background

Two stormwater retention ponds, located in the Montgomery West Homeowner's Association (MWHOA), Gaithersburg, Maryland, serve as the *headwaters* for the local Potomac River tributary stream and surrounding watershed. The Washington Suburban Sanitary Commission (WSSC), the local water distribution company, has a water intake system that is downstream of the MWHOA watershed drainage area. While this water distribution pattern is common in Montgomery County, Mary, it is apparently unusual to examine the interconnected network of factors that affect the quality of the drinking water.

Problem Statement

The MWHOA has two, quarter acre stormwater retention ponds within its boundaries (Appendix 1). These two ponds were originally designed to drain the surrounding 52 acre MWHOA (104 household) as it existed in 1982. In the succeeding 33 years another 200 acres of developed land drains into these two small stormwater retention ponds. Particularly during spring and fall large volumes of water pulse into these ponds and collect an assortment of litter, sedimentation, and non-point source pollutants from residential yards and surrounding roadways.

Apparently perceptions of Homeowner's Association residents, their individual interactions with the stormwater ponds, and the resulting interconnected network of effects on water quality have not been previously examined. The basic step of measuring individual perceived awareness levels of pond functions, values and definitions of

stormwater has not been documented. A perceived awareness profile of the various sources and types of household non-point pollutants has not been done within the MWHOA. However, this lack of data has not prevented Montgomery County, Maryland from a planned (2013) redesign and reconstruction of the ponds to reduce Total Maximum Daily Load (TMDLs) of nonpoint source pollutants as mandated by the federal Environmental Protection Agency (EPA). The lack of data has also not prevented any number of state and county governments, as well as nonprofit organizations, from conducting ongoing education programs to prevent these problems. A post effectiveness survey on clean water education efforts has never been conducted in the MWHOA. Resident perceptions that measure zero or at very low levels of awareness may be consistent with low program effectiveness.

A similar perception awareness survey has never been conducted for Green Infrastructure (GI) processes and techniques after GI implementation within the MWHOA. It was unknown whether residents attempted to keep water volumes in their yards, or realized that runoff carried visible and invisible pollutants into the stormwater retention ponds thus affecting downstream water quality. Although various levels of government and numerous nonprofit organizations have attempted to educate the public on these issues it was not known whether MWHOA had ever heard of any of these programs.

Rationale and Purpose

The overall concern for this case study was to learn HOA resident perceptions and practices that may affect stormwater runoff and pollutants. Another purpose of this case study was to document awareness of current educational efforts. However, just the act of

administering this perception survey (with the Principal Investigator's and Student Researcher's informed consent letter) may have started an important education process. For those have who actually filled out the perception survey they will have taken the first step in becoming aware that their individual perceptions and actions affect the connections between the stormwater ponds as well as the volume and quality of water flowing into the pond. Perceptions of these negative externalities within the MWHOA has not been previously measured.

The Montgomery County, Maryland Department of Environmental Protection (Copiz 2013) indicates that a perception survey of this type has never been done in Montgomery County or the state of Maryland. The literature provides numerous examples of best practices in storm water management, case studies, sources of non-point pollutants and other aspects of storm water management. However, there is only one perception survey conducted for a residential subdivision and its stormwater retention ponds in Scotland (Quek, Heal, Duffy and Apostalki, 2010). This face to face structured interview had some similarity to this study's perception survey.

There is apparently no survey in the literature measuring basic environmental perceptual awareness of a homeowner's association residents and their relationship to an adjoining storm water retention pond. The lack of a perception survey on any number of related topics means awareness of a potential problem issue cannot be documented or measured. For example, if residents lack knowledge of best practices in Green Infrastructure (GI) then they probably lack knowledge that the volume of stormwater runoff from their properties is an issue that can only be resolved by keeping water on their properties via GI devices.

It is important that residents know something about interconnected factors such as storm water retention ponds and their residential lifestyle choices. Perceptions may lead to choices that affect the quality of the water coming out of their household taps. I say *may* lead to choices as Kollmus and Agyeman (2002) summarize the results of hundreds of studies on this question but state that no definitive explanation has yet been found. They also reviewed numerous deliberative and inclusionary processes or procedures (DIPS) theoretical models with the same conclusion. These authors acknowledge that their review did not include economic or psychological models.

The resulting residential storm water runoff eventually drains off into the Potomac River, and back into the Washington Suburban Sanitary Commission (WSSC) raw water intake pipe that supplies the MWHOA with water. The importance of clean water involves other interconnected factors such as downstream communities or the local watershed plant and animal life.

Primary Research Question:

What are the Montgomery West Homeowners Association (MWHOA), Gaithersburg, MD residents' perceptions practices on the interconnections of their neighborhood stormwater management ponds?

Secondary Research Question:

What additional interconnected relationships can be derived from the MWHOA resident perceptions and awareness levels towards improved practices they can adopt?

Hypotheses:

Residents of the MWHOA have little if any awareness of the important interrelated cycle of stormwater retention ponds and local clean drinking water.

Green Infrastructure (GI) governmental or nonprofit organization educational programs, have achieved little individual awareness with MWHOA residents.

Assumptions

There are various assumptions that this case study and perception survey are based on:

- That the lack of awareness and knowledge of an issue will affect human conduct towards that issue. For example, if a resident has no awareness of a problem issue they are not likely to do anything about that issue. While Kollmus and Agyeman (2002) do not offer a solution as to whether an individual will act they due presume that knowledge of a problem is a precursor to potential action.
- Even if the problem is known, it then follows that if there is a lack of awareness and knowledge of a potential solution to that problem in that a solution will not be used.
- That most MWHOA residents can read and write in the English language. The Association is a very diverse neighborhood with a sizeable minority of English speakers as a second language.
- That a large enough survey response will be received to gain data that will answer the primary and secondary research questions, and to confirm or deny the hypotheses.
- That the MWHOA Board of Directors will offer at least passive support in favor of filling out the survey.
- That homeowners are more likely to fill out the perception survey than renters within the MWHOA.

- **Structure of the Following Chapters**

In Chapter 2 a limited Literature Review is conducted. It is limited in the sense that there are very few mentions of surveys on stormwater retention ponds in general and

only one indirect (non-HOA) example of a pond perception survey. The theory offered for perceptions of residents and stormwater retention ponds and related individual actions is an economic theory. The remainder of the Literature Review is devoted to the major areas of stormwater pond management covered by the MWHOA perception survey. Such major survey areas covered include pond functions, the value of a pond as Green Infrastructure (GI), definitions, and non-point source pollution indicators and metrics. The reader is referred to Appendices 2-3 that cover plant and animal species of the site pond. There are a total of thirteen appendices that provide additional information on various aspects of stormwater retention ponds as well as the study methodology.

In Chapter 3 the Methodology of the MWHOA perception survey is covered. The overall Research Design is covered; along with a Population, Sample, and Sampling Framework explanation; and finally a description of Data Collection and Data Analysis. In Chapter 4 a Results and Findings is offered based on the 2014 conducted MWHOA perception survey. Each question is quoted, followed by a pre-survey projection, an actual post-survey results, and finally a discussion of that and related questions. Chapter 5 has the Discussion, Summary, Recommendations and Conclusion, based on the overall relatedness of each clean water factor as covered in the perception survey. Specific recommendations are made to the MWHOA Board of Directors as well as Montgomery County government, Maryland, for implementation of education, communication and implementation actions.

Chapter 2

Literature Review

Introduction

A comprehensive literature review has not revealed any previous studies that are specific to homeowners' association (HOA) residents' perceptions of their awareness or environmental importance of their neighborhood storm water retention pond. It is an assumption that the depth of storm water pond (SWP) knowledge, and range of perceptions as to SWP environmental importance, can affect human conduct. Such conduct could range from recognizing their local storm water retention pond as an important first step in improving water quality, to using the pond as a convenient waste sink for a variety of household, yard and industrial strength non-point source pollutants.

The theme of water pollution is prominent throughout the Oregon State University course textbook, *Environmental Economics for Tree Huggers and Other Skeptics* (Jaeger, 2005). In this branch of economic theory the concept of negative externalities is mentioned over and over again in discussions of the economic costs of water and other types of pollution. Such theory includes the fact that costs can be both tangible and intangible to both the polluters and the non-polluters downstream.

A close reading of this theory of negative externalities does not indicate whether polluters have to be conscious of their actions. My hypothesis in fact states that most of my neighbors' actions may be unconscious and that they don't know what their individual adverse actions are doing to the local and larger environment. Of course, it is another assumption that if residents are aware of their poor choices in affecting their own drinking water they will want to do something about it.

According to Tavris (2015) a new field of behavioral economics is challenging the last fifty years of rational man economic theory. I think it is true that many human beings make extremely poor choices that are against their economic self-interest. However, one part of economic theory appears to stand up well particularly with government involvement. It appears true to me that the old maxim that government subsidizes that which it wishes to support, and taxes that which it wishes to discourage.

Economic theory indicates that individual polluting behavior will change if subjected to an adverse economic cost such as a tax. For example, in Montgomery County there is an overall water utility fee called the "rain tax". This has proved to be an unpopular tax and is under review by the newly elected (2015) Republican governor and a smaller yet still Democratic Party dominated state Senate and Assembly.

Another tax under consideration in Montgomery County is an impermeable surface area tax. In this case the tax is directed at the issue of retaining runoff water onsite by reducing the volume of stormwater runoff. The more impermeable surface one has on their property the greater the tax based on total surface area. This tax is applicable to both business and individual private property owners. That these proposed taxes may work is demonstrated by the Maryland plastic bag tax of five cents per bag. Consumer behavior has been altered over the last two years by this tax. More consumers are using re-useable bags but not all.

This economic theory also states that individuals will respond to a positive force such as an incentive or a subsidy. While no such action was proposed in the perception survey it is mentioned in the Recommendations section. Montgomery West Homeowners

Association resident's perceptions, if changed by educational awareness, can change their actions to be less detrimental to the environment, if they choose to do so.

Although I was unable to find a HOA perception study on stormwater retention ponds I recently found (April 2015) a previously overlooked power point presentation from Scotland (Quek, Heal, Duffy and Apostalki, 2010) on "Public perception and amenity value of stormwater retention ponds". This was a door to door structured interview conducted in November/December 2000 with a follow-up survey in June 2010. Although I was not familiar with this study prior to formulation of my perception survey it appears that a majority of the issues covered are the same.

The questions covered the areas of respondent characteristics; purpose, advantages and disadvantages of pond; respondent interactions with pond; and lastly pond maintenance issues. Unlike my perception survey, these authors (Quek, Heal, Duffy and Apostalki, 2010) gathered standard demographic information such as age and gender. They also gathered number of years in residence which my survey also collected. Although the survey was divided into three pond areas only the overall statistics will be commented on. Roughly one quarter of respondents agreed that "The pond is an important part of the local area." This same study result percentage indicated that "Pond influenced decision to move into neighborhood" and "Main attraction = open space and no other houses directly in front."

This study examined a number of "Perceived pond advantages" such as: Prevents floods, Removes pollution, Creates new habitat, Pet walking, Attracts wildlife, Adds aesthetic value, Adds financial value, Non/Unsure and Other. Interestingly most of these measures showed a *reduced awareness* of the issue in the later survey. There was also a

great increase in respondents in the Unsure/No advantages characteristic. The only characteristic that remained unchanged was "Attracts wildlife" characteristic.

Perceived pond disadvantages from this study were: Safety risks, Attracts pests, Smell, Litter, Not esthetically pleasing, Vandalism, Algal growth, None/Unsure and Other. The later 2010 survey showed an increase in the None/Unsure, and an increase in the pond maintenance characteristics of Attracts pests, Smell and Algal growth. The primary pond site in my study is only a periodic flooded pond so much of this is not directly applicable. However, the other MWHOA pond is a wet pond but most immediate respondents to that Association pond did not respond to the survey. Under the overall characteristic of "Limited visits to ponds by residents" over 85% of residents had never visited their neighborhood pond.

The study concludes that resident perceptions change over time with decreased safety concerns and increased maintenance concerns. Other study conclusions: "Well-maintained ponds increase amenity value"; and "Measures to reduce safety risk reduce amenity value of the pond". The most important conclusion in my opinion is the "Challenge for design is to accommodate differing public perceptions". This is an important conclusion but it is based on the assumption that the pond design authority is even aware of the perceptions of the resident most affected by pond design decisions.

This of course is one of many reasons for the MWHOA pond perception study. The overall comparison with the MWHOA study is in the commonality of pond characteristics examined, but not in methodology, data, findings, conclusions, or recommendations. This was the only study in the literature that came even close to the

MWHOA perception survey study. This is why the remainder of this literature review has been so extensive on the major elements making up the MWHOA perception survey.

Functions of Stormwater Retention Ponds

It is the position of the Montgomery County, Maryland staff (Copiz 2013) that the site pond (Appendix 1) can be redesigned to filter out pollutants to protect the adjoining watershed. However, it was stated during the public meeting that this technical solution is destined to be only partially effective if residents do not acknowledge their generation of the various excess materials and/or possibly problematic non-point source pollutants. As the stormwater retention ponds in the Montgomery West Homeowners Association (MWHOA) slowly silt up their depth decreases and their carrying capacity for flood water is subsequently reduced. The ponds thus require periodic maintenance by the County. I have observed periodic dredging activity at the Mourning Dove Court pond site.

For this case study the vintage (early 1980's) storm water retention pond is located in Montgomery County, Maryland, and is described in Appendix 1. The primary research question is: how do perceptions of the residents of the Montgomery West Homeowners Association (MWHOA) (intentionally and unintentionally) affect their conduct towards their neighborhood pond? Residential homeowner conduct potentially affects the flows of organic and inorganic inputs (including non-point source pollutants) into the site pond and its subsequent effect on water quality. A residential homeowner baseline perception survey can help focus future survey efforts in measuring potential non-point source pollutants. For example, according to Copiz (2013) there are no current pollution monitoring or measurement protocols for the current site storm water retention

pond. Yet Copiz states he thinks there may be a problem with meeting federal TMDL limits with only addressing pond redesign and not considering possible adverse homeowner behavior.

We do not know because these questions have apparently not been asked before in the literature about stormwater retention ponds. Thus there may be a large disconnect between what these public agencies and non-profit organizations think they are doing in educating the public, and the actual conduct of residential homeowners in these areas. If it is true that knowledge and education can change human conduct, then it must be equally true that the lack of knowledge will make no contribution to these efforts.

Storm water retention ponds are quite common in Montgomery County, Maryland. The site pond is one of over 2,000 that were built in the 1970's and continue to be built today (2016). Prior to 1986 one of the main purposes of these ponds was to smooth out the hydrologic flow of water surge from rain storms to prevent surge flooding and erosion of adjacent stream banks. Wet ponds built after 1986 had the primary purpose for the ponds is to act as settling mediums where particulate matter and sediments drop out of the water column before entering adjacent streams.

Excessive sediments can harm many aquatic organisms such as covering over fish eggs. The federal Environmental Protection Agency website provides several reasons why excess sedimentation is bad for fish eggs. For example, sedimentation can also decrease sunlight penetration generating warmth for the eggs as well as generating physical abrasion of the eggs. Subdivisions in Montgomery County have large areas of impervious surfaces that generate fast flowing stormwater. Roads, sidewalks, driveways and paved common areas all contribute to these erosion issues.

During the late 1980's the threat of non-point pollution became better known. Retention ponds built in these later years (after 1986) have been better designed to act as biological buffers between polluted storm water runoff and downstream watersheds. As the threat of non-point pollution was better understood best management practice (BMP) strategies were developed to deal with identified pollution threats, invasive species and fire mitigation issues.

Based on a recent Annual Meeting of the MWHOA (where I live) the site pond will apparently be upgraded in 2016 to a sand berm pond with a bio-filtering capability similar to a septic filter system (Copiz, 2013). This type of re-engineered pond will still maintain the function of smoothing out precipitation surges caused by large areas of impervious surfaces. The new pond design will remove particulates while serving as a bio-filter for non-point source pollutants. A public meeting on this construction was held in January 2014.

In spite of the technological advances which may result in construction of a sand berm pond the issue of the site pond serving as a non-point pollution toxic sink remains. The Montgomery County representative (Copiz, 2013) indicated that water and sediment sampling of the site pond has never been conducted. It was unknown whether sediment testing would be conducted after the top few feet of sediment were removed and replaced with sand berms. It was also unknown whether water and sediment testing would be conducted on the new and improved sand berm filtration pond.

From a zoning and planning perspective, Brabeck, Schulte, and Richards (2002) conducted a literature review that showed most government jurisdictions focus on the zoning and planning issue of total amount of impervious surfaces in a specific geographic

area. However, these authors pointed out that there is a lack of uniform planning standards for watershed planning and modeling. This could affect the design and resulting effectiveness of storm water retention ponds such as the capstone case study pond. The authors also point out that most impervious surface models used in the 1970's and 1980's were concerned with hydraulic flow of water off of these surfaces into surrounding watersheds.

Persson, Somes, and Wong (1999) address the issue of hydraulic efficiency and point out that there are varying standards used in the field. These authors indicate that oftentimes the aesthetic issue took precedence over optimal flow. This does not appear to be an issue for the site pond as it is located at the lowest elevation of the adjacent landscape. The site pond is also the entry site for adjacent Montgomery County parkland and the adjacent watershed. Thus, the site pond serves as a critical ecotone between an area containing large amounts of impervious surfaces and an area of relatively healthy County parkland. Still, the pond was built in the late 1970's before much of the current knowledge was available on hydraulic efficiencies.

Based on the MWHOA Annual Meeting Montgomery County representatives (Copiz, 2013) indicated that their calculations indicated that the site pond is undersized for the area it drains. Apparently the footprint of the pond cannot be increased due to encroachment concerns with the adjacent County parkland. This is why a highly efficient sand berm pond is scheduled to be installed on the existing site in 2016. Sand berm ponds were mentioned during this Annual Meeting as a relatively new type of design for storm water retention ponds. It was selected because this design can most efficiently process the large surges of water draining into the pond.

Booth (1991) reminds us that channelized water flow is not the only water flowing into the storm water retention pond. He indicates that water movement is complex and includes water below, at the surface and above ground level as contained in soils and vegetation (p. 93). Another function of the site pond is to both build up adjacent ground water tables. These tables also serve as filters for pond water entering adjacent streams. This article adds to the function approach of this site pond by accounting for the water inflows from the higher elevation embankments surrounding the pond.

Even after the new sand berm pond is reconstructed the issue of homeowner generated non-point pollution remains. The County representative acknowledged this during the MWHOA Annual Meeting. The pressure on the County from the EPA for the pollution diet made this sand berm design selection the "biggest bang for the buck" (Copiz, 2013). However, other County departments are still interested in reducing the non-point pollution issue.

Hogan and Walbridge (2007) also address the issue of flooding caused by increased impervious surface cover (IPC) construction (2007, p. 386). These authors look to an analysis of soil composition and soil absorption capacity in artificial versus natural wetlands. If a storm water retention pond was designed and constructed with these concerns in mind then the protection of adjacent watersheds is increased. These authors conclude that "Protecting and restoring the physical, chemical, and biological integrity of riparian areas has not always been a priority for storm water management in urban watersheds" (2007, p. 386). In Montgomery County this calculus has been

changed with the EPA pollution diet mandating new minimum TMDLs for area streams for several types of non-point source pollution.

Roy et al (2008) sums up the newer biological functions of storm water retention ponds in several basic premises. For example he mentions the function of sustainability that ponds play in helping to "maintain the natural ecological structure and function of receiving water bodies" (2008, p. 345). A second premise echoes that of other authors in that ponds and current technology can help sustain the natural hydrologic cycle and in "reducing downstream transport of storm water pollutants" (2008, p. 345). This premise may not apply to the site pond due to its age. The last premise is that "Sustainable urban storm water management must be planned and implemented at the watershed scale" (2008, p. 345).

The Value of Stormwater Management Green Infrastructure

Green infrastructure (GI) that results in wet ponds often creates ecosystems with inherent ecosystem values. Both private goods and services (waste disposal, air and water pollution) as well as public goods/ecosystem services (clean water, nutrient balance, biodiversity, and reduced flood risk) are present in pond sites. Wet ponds were created to deal with the negative externalities generated by the surrounding human population and associated impervious surface flooding (Persson, Somes, and Wong 1999).

Positive externalities are present with created wetlands when a wet pond is created for storm water retention and bio-filtration. Many dry ponds also often have marshes that can tolerate long periods of drought outside the annual spring and fall flood pulses. Resultant ecosystem services in such a GI technique includes providing habitat

for local and migratory waterfowl (Sandstrom, Angelstam and Mikusinski, 2006) as well as various local mammals, reptiles, amphibians, insects and plants. Milkweed often grows in storm water pond meadows, which provides food and egg laying habitat for migratory monarchs. Another economic value that is created is the creation of green space in urban and suburban areas. Green space often increases local homeowner property values as well as regional economic well-being (Landscape and Human Health Laboratory webpage).

It is also of importance as GI storm water management often plays a role in retaining as much storm water runoff as possible at the landfall point of origin. A recent newspaper article (Swarts, 2014) indicates that up to 40 states could experience significant water shortfalls due to climate change. Details of this can be found in an International Food Policy Research Institute report (Global Water Outlook to 2024 – Averting an Impending Crisis) by Rosegrant, Cai and Cline (2002). These authors indicate that shortfalls will be made worse by increases in population, increased economic activity and changing land uses that reduces water quality and further limit sources of high quality supply.

Definitions

One author indicates that GI is an ambiguous term as well as a possible corruptible concept due to the wide audience that often uses this term in different contexts (Wright, 2011). These contexts range from interest with planning practitioners in socio-economic policy, to academicians in environmental theory to local government agencies and nonprofit organizations designing and implementing a GI technique. One possible solution to the term corruption issue is to mention a specific example of a GI

technique within the definition of the term so the audience is sure what you are talking about.

While there are many elements of Green Infrastructure (GI) such as energy conservation, microclimate formation, and habitat conservation this paper addresses only the issue of storm water management techniques as listed in Appendix 8. While not an exhaustive list Appendix 8 does mention many of the current techniques in the literature. Green Infrastructure (GI) is defined aby the USEPA as a community based approach that maintains healthy waters and supports sustainable communities. Of course, this assumes there has been a measured community consensus (i.e., measured perceptions) which has apparently not been documented in the literature.

Stormwater Management Techniques (Appendix 8) weave natural process into the human built environment. An important goal of effective storm water management GI is to manage rainwater where it falls. This survey (Appendix 6) addresses many perception issues by residents on their role in managing storm water. By doing so many of the non-point source pollutants (Appendix 7) are retained onsite which greatly diminishes their effects downstream. The EPA also recognizes budgetary constraints in replacing aging infrastructure and that GI techniques provide affordable and resilient solutions to communities.

Graphically this website shows GI as

Figure 1. U.S. Environmental Protection Agency homepage.

Non-point Pollution Indicators and Metrics

As mentioned earlier, storm water retention ponds built in later decades after the 1980's were better designed to deal with non-point pollution sources. Davis, Shokouhian, Sharma, Minami (2001) confirm that suburban and urban storm water runoff have many types of non-point pollutants that end up in adjacent streams (2001, p. 5). They explore different types of bioremediation systems for storm water retention ponds. It is my contention that a bare clay depression does not serve this function.

One of the research questions in this case study is to inventory the different types of non-point pollution sources as well as to assess the risks present in a 1980's vintage pond. Examples of non-point pollution include: heavy metals (bio-accumulation issue for organisms), seasonal application of de-icing materials (sand, dirt, salt and other de-icing

chemicals), leaking and improperly disposed of automotive petroleum products, lead dust from automotive brake pads (lead, copper, asbestos), automotive brake fluids, excess lawn fertilizer runoff (phosphorus, nitrogen, iron), automotive radiator fluids, transmission fluids, possible invasive species issues, possible fire mitigation issues, and neighborhood pet *e-coli* issues. Booth and Jackson (1997) were among the first researchers to call for more study of stormwater retention ponds and their mitigation effect on adjoining watersheds. Montgomery County, Maryland will be directed by the TMDL pollution diet agreement of 2012 in monitoring and reducing these non-point source pollutants in Maryland streams.

For example, Walker (1985) deals with the issue of phosphorus retention in urban runoff ponds. Although this is an old term, the problem is still relevant for a suburban storm water retention pond where the residents of the MWHOA appear to over-fertilize their lawns. This author provides pollution metrics for mitigation efforts that include making ponds deeper in depth, increasing infiltration capacity, advocating for the use of wet ponds, plant buffers at the pond margins to include growing aquatic plants that utilize phosphorus, and when all else fails, chemical treatments of the phosphorus (1985, p. 325).

For the site pond this would require a change in Montgomery County management philosophy to change from a semi-dry to a wet pond. The site soil is a majority clay which makes greater infiltration of the water table problematic. Wet ponds are not always selected due to topographical factors and the area drained. While the site pond will be reconstructed as a sand berm pond in 2016 the other MWHOA pond will be reconstructed from a dry to a larger permanent wet pond.

Roy, et al (2008) address the nation-wide problem of storm water runoff polluting freshwater watersheds. However, in Montgomery County, Maryland, the issue is even more widespread as polluted freshwater runs into the Chesapeake Bay which is the largest estuary in the United States. These authors indicate that storm water retention ponds are effective in mitigating many pollution issues. However, they also indicate there are several constraints in having a sustainable program. Several items were mentioned, including issues of cost and performance, technical standards and market incentives.

These issues are true in the sense that the site storm water retention pond was built at least thirty-five years ago and there has been much technical progress since then. The issues of lack of legislative mandate and resistance to change are not applicable in my area. Maryland in general and Montgomery County in particular, are very progressive with environmental issues. Even if they were not the current Environmental Protection Agency (EPA) has been very aggressive overall in the last four years (2008-2013). Recently the EPA has focused on areas of water flow into watershed, sedimentation issues and even bacterial counts. However, the most specific pollution indicators and metrics are the Total Maximum Daily Loads (TMDLs). These TMDLs are located at Chesapeake Bay TMDL Quick Finder website (Environmental Protection Agency website 2014) which serve as the core of the "pollution diet" for Maryland. In short, there are TMDLs for all the possible non-point pollution types currently listed for the site pond.

Major Plant Types and Major Forest and Other Vegetation (See Appendix 2)

Habitats

The site pond is considered a semi-dry wetland also known as a wet meadow. It is defined as "Open prairie, grassland or savannah with waterlogged soils but without standing water for most of the year" (http://academic.emporia.edu/aberjame/wetland/define/define.htm). At one time it was maintained as a traditional wetland. As described earlier part of the site pond area is woodland.

Mourning Dove Court Pond Vertebrate Assemblages (See Appendix 3)

Mourning Dove Court Pond Invertebrate Assemblages (See Appendix 4)

Chapter 3

Methodology

This study will not be hard to duplicate. A comprehensive twenty-two question survey (Appendix #1) was built on the primary and secondary research questions. The specific HOA perception survey gap in the literature did not provide a baseline of other surveys to review so the survey developed is a first time effort. I consciously made the decision not to incorporate standard demographic data (gender, race, ethnic background, age) as I saw no value added for doing so. The only demographic related information included in the survey was whether a respondent was a homeowner or a renter, and how many years the respondent had lived in the Montgomery West Homeowners Association.

Research Design

A confidential perception survey was chosen as the most economical way to ascertain the perceptions of 104 households in the MWHOA. A survey is inexpensive to administer with the U.S. Postal Service, and relatively easy to analyze the data using the Qualtrics program whose use was strongly suggested by the Oregon State University (OSU) Institutional Review Board (IRB).

The twenty-two question perception survey is a combination of multiple choice, fill in the blank and short open ended essay questions. All questions were designed with one end in mind: to measure resident's perceptions of stormwater management and related issues as covered in the Introduction of this paper.

This confidential survey was designed to take less than 30 minutes to complete. The survey cover letter from the Principal Investigator (PI) (Dr. Samuel Chan) and the Student Researcher (William H. Roberts, Jr.) served as informed consent. A personal

identification code was assigned to each of the 104 surveys and tracked within the Qualtrics program. No personal demographic information was collected and any household member over 18 years of age could fill out the survey.

Only the PI and Student Researcher know the numeric identification key. The key is kept within the confines of the Qualtrics program and website. The only login access was password protected. No compensation was provided to the survey respondents although upon request the aggregate data and this paper can be provided to a survey respondent. The survey was administered by hard copy as the e-mail addresses for the 104 households was not available. The administration of the survey was designed for three different contact attempts to maximize the response rate. A target response rate of 40% was hoped for. As indicated earlier the final response rate achieved was 49%.

The first attempt was a first class mailing utilizing the U.S. Postal Service. Addresses for the 104 households was obtained from the MWHOA Secretary during a Board of Directors meeting. A Self Addressed Stamped Envelope was mailed in each envelope, along with the survey and the informed consent cover letter. The first attempt ran for a duration of two weeks.

The second mailing attempt was originally planned as another First Class mailing but permission was received form the PI to hand deliver the second survey attempt to non-respondents. Part of this change in survey administration was the cost involved in the mailing of the survey. Another reason for hand delivery was the realization from the first attempt results that no renters had filled out the survey. It was surmised that First Class mail was not going to renters but was being forwarded to the landlords that were the actual MWHOA members. Two weeks response time was also allowed for this

second contact attempt. As part of the second attempt process signs were put up around the Association streets to encourage members to fill out their surveys.

At the end of four weeks, and the two contact attempts, a response rate of 49% was achieved. This response rate was more than half of the actual 102 households (two houses were in foreclosure and not available for survey). At the request of the Student Researcher a third attempt involving structured interviews utilizing the survey was eliminated. This change in research design was approved by the PI in writing as it was determined that the remaining non-respondents would not be receptive to someone showing up at their door.

Population, Sample, and Sampling Framework

The population of the MWHOA consists of 104 households. Only 102 households were actually surveyed as two houses were in foreclosure and there was no contact information available on the previous owners. A sample was not considered because the entire population could be easily surveyed. Out of 102 households there were 54 responses for a 49% response rate.

Data Collection and Data Analysis

The perception survey and all associated documents were approved through the Oregon State University (OSU) Institutional Review Board process during the Spring Quarter 2014. The OSU approved Qualtrics program and website was used to draft, administer and analyze the survey data. Since e-mail addresses were not available to send to potential survey respondents, the term administer means the survey was drafted, modified and revised through the Qualtrics program but the U.S. Mail was used to send the survey to the 104 MWHOA households. The term administer also means that all 54

completed and returned surveys had the data manually typed into 54 electronic survey templates by the Student Researcher. These 54 electronic responses then formed the data set that was used to generate the MyReport from the Qualtrics program in Appendix 2.

Chapter 4

Results

In this chapter I report my results from the Qualtrics MyReport and provide my results. Since there is no previous research on perceptions of homeowners association residents of their stormwater management/retention/detention pond, it is difficult to relate or mesh these results with data that does not currently (2015) exist. However in the next chapter I do make several inferences about this data. This survey will serve as a baseline for future research efforts.

The approach I have used is to quote the question from the perception survey, make a pre-survey projection of results, and then indicate the post-survey results. I then conducted an explanation and context not only on that particular question but other related questions. During this section I have attempted to highlight the most notable overall points while pointing out any limitations of the question itself.

Question 1 (Appendix 6): Have you ever visited or walked around the ponds at Mourning Dove Court or Kinglet Place/Swallow Court?

Pre-survey projection: It is expected that only a small minority of residents have visited either pond. It is anticipated that less than 50% have walked around either pond. This may be because the ponds are below line of sight from the main adjoining road. The view from Mourning Dove Court is obstructed by houses, and from the townhouses by a stand of woods.

Qualtrics results (Appendix 10): Roughly one third of the MWHOA residents have walked around one or both storm water retention ponds. Only 30% of respondents have visited either pond even though it is literally in their backyards. While residents may

walk the streets they apparently rarely walk the common area corridors that lead to the ponds. The ponds have always been there and are part of the background landscape.

There is also a fair amount of green space and parkland in the area and the ponds may just be viewed as a smaller and unnoticed feature of the environment. The ponds commonly fill with bulk litter after a rainstorm so this may add to the decision not to walk near or around the ponds. An alternative explanation is that there is a large majority of new residents although Question 19 indicated a fairly even distribution of1-2 years responses per year, with a few spikes, in the range from 1 to 32 years.

Question 2 (Appendix 6): What primary purpose do you think these ponds serve? Control and slowly release rainfall flows; Retains and filters pollutants and sediments; Wildlife habitat; Recreation; Aesthetics; No purpose; I don't know; Other.

Pre-survey projection: It is expected there will be a variety of answers to this question. An unknown number of respondents will select from each of the responses.

Qualtrics results (Appendix 10): Of the eight choices, more than two thirds of respondents (72%) picked control and slowly release rainfall flows. The next highest selected choice was retains and filters sediments (46%). Tied for a distant third was wildlife habitat and unknown (18%). Perhaps this question was too obvious in defining a storm water retention pond as over 66% of respondents identified that named function of these ponds. It is unknown whether the respondents actually know something about storm water management, or just selected the first choice because it was there. A secondary biological function of filtering sediment and pollutants was identified by 46% of respondents. This function is true of newer ponds but for the most part is not present

in the currently configured ponds. This is also a highly specialized function of the ponds probably not well known by the general public.

I make that statement based on the information received from Montgomery County officials at the public hearing. Both ponds will be rebuilt in 2016 by Montgomery County to perform this function (Copiz 2013). The new pond will be built as a sand berm pond with a saw dust reservoir to serve as a bio-filter. Only ponds built after approximately 1996 incorporate new construction standards for bio-filtering capacity. It is unknown whether Montgomery County feels residents should be educated about their storm water management ponds since the County has not conducted any perception surveys on the issue. Please see Question #18 on several Montgomery County storm water management related education programs.

Question 3 (Appendix 6): Who owns and manages the ponds at? Mourning Dove Court; Kinglet Place/Swallow Court

Pre-survey projection: It is expected that residents will assume that the MWHOA owns all the ponds.

Qualtrics results (Appendix 10): Roughly a third of respondents did not know who owned the ponds while another third identified Montgomery County ownership for both ponds. This is a correct answer only for the Swallow Court Pond. The issue of who actually owns the ponds is admittedly confusing as ownership has changed over the years, and the County performs maintenance on ponds that it does not own. The actual ownership is not as important as the local perception of ownership. Environmental stewardship and education can be built on a neighborhood sense of ownership. This is true even if the residents are confused on whether the Association or local government

owns the ponds. The confusion can even be expected as that the Swallow Court pond, while owned by the Association is actually maintained by the County using tax dollars. The Not-In-My-Backyard (NIMBY) scenario is less likely once residents are aware of the degree of ownership they have in the local ponds. The more compelling education argument is the water quality issue as that "ownership" issue literally runs out of the household tap.

Question 4 (Appendix 6): What do you value about these ponds?

Pre-survey projection: I had no specific estimate of what residents will say in this text block. It is hoped that some residents are aware of some basic storm water function at least as to holding capacity which is readily observable after a rain storm. Some residents may also appreciate the wildlife that uses the pond area as a refuge habitat from the nearby streets and traffic.

Qualtrics results (Appendix 10): Although the detailed listing of the thirty comments can be found in Appendix 10, MWHOA resident comments ranged from unknown (seven comments); management of water flows (ten comments); and wildlife issues (eight comments).

Resident responses covered the range of standard water flow issues to issues of wildlife habitat and the general aesthetics of having green space in the neighborhood. At least two thirds of respondents do have an opinion of some type – and that is a good education foundation to build on. Some examples of responses are: #1 Helps with heavy (ready outlet) during wet season's flash floods of rain and snow melt. #12 Tranquility – peacefulness – being in nature and enjoying the beauty formation of geese when they

land; co-existence of people and animal life. #26 It attracts wildlife and they're (Montgomery County) is not building 10 houses on it!

Question 5 (Appendix 6): How would you define storm water? Water runoff from roofs, yards, streets and sidewalks; Water with substances washed off of roofs, yards, streets and sidewalks; Water from storms that can cause flash floods when it runs off too quickly from pavements and does not drain fast enough through the soil; All of the above; Other definition?

Pre-survey projection: It is expected that residents will have an opinion but that different answers will be selected.

Qualtrics results (Appendix 10): More than three quarters of respondents selected all of the above as the definition of storm water. One explanation is that it would appear that this was a badly worded question as 76% of respondents apparently guessed and covered their bets by checking all of the above. However, in the next Question #6 shows some knowledge of stormwater management as the top two choices were evens out stormwater and stores stormwater runoff. Several comments in Question #21 show knowledge that storm water from the streets eventually drains into the Chesapeake Bay. Comments addressed the pollutants that street water runoff often carries.

Question 6 (Appendix 6): What is your perception of the roles of storm ponds in the Montgomery West HOA (Check ALL that apply): Evens out storm water flow, Filters out sediment, Filters out pollutants, Stores storm water runoff, Wildlife habitat, Other?

Pre-survey projection: Of those respondents who are aware of the ponds they may be aware of the storage function of pond water but minimal recognition of the other uses.

Qualtrics results (Appendix 10): Almost two thirds of respondents picked that ponds smoothes out surges in storm water flow. Just over half identified the function of the pond temporarily storing storm water runoff. One third of the choices identified the function of filtering out sediment and wildlife habitat as role perceptions. The highest rated perceptions of the pond role is smoothing of water flows (60%) and stores water (55%). Residents in the MWHOA have had occasional flooded basements in the past due to bad drainage from their individual properties. Both of these functions are easily observed during and after a rainstorm in the Association ponds.

This is particularly dramatic when angry looking brown water (sediment bearing) is swirling around the pond with a layer of litter on top of the pond surface. The issues of filtering out pollutants and sediments or wildlife habitat is half of the top rated responses. The Association ponds are old ponds (1982) that were built to do exactly what these residents have perceived their function to be. The newer functions of bio-retention to filter out sediment and pollutants is present only on ponds built in the 1990's and later. This is still relatively new information and a tipping point in education on this issue has not been reached.

Question 7 (appendix 6): How important of a problem do you regard excessive runoff and pollution of stormwater? To the environment High Low To the neighborhood High Low

Pre-survey projection: It is unknown whether residents regard this as a problem or not.

Qualtrics results (Appendix 10): Approximately two thirds of residents thought this was a high problem to both the environment and to the neighborhood. I was

surprised at these results; I did not think the awareness level was that high. An alternative explanation is poor survey question wording choice. The term excessive could be viewed as a loaded term that biased the results. Of course, any water coming off an individual property is by definition excess water to that property. There is some awareness on the issue of excess wastewater and associated pollution. While 63% think it is a high problem for the overall environment only a bare majority (54%) think it is a high problem for the Association. It could be argued that larger education efforts are responsible for the first perception, while homeowner denial of any involvement in causing the issue is responsible for the second rating.

For example most of the newspaper coverage on the Chesapeake Bay pollution issues is attributed to industry, agriculture and Eastern Shore poultry farmers – rarely is the suburban homeownership issue mentioned. The Not in My Backyard (NIMBY) syndrome, literally in this case, can apply to the self-generation of a problem as well as any other NIMBY issue. To quote Pogo, "We have met the enemy and he is us". A goal of modern Green Infrastructure (GI) storm water management is to retain water onsite where it falls from the sky or melts from the snow. This not only reduced the overall volume of water but tends to keep non-source pollutants onsite where they are generated. I believe that this goal can be achieved with greater education efforts.

Question 8 (Appendix 6): Are you aware of any of the following sources of chemicals and runoff in the MWHOA neighborhood that can enter streams and the Chesapeake Bay? (Check ALL that apply): Radiator fluid on driveway/roads, Oily fluids (gasoline, diesel, engine oil, etc.) on driveways/roads, Degreasers, Solvents, Soapy

water from car washing, Lawn fertilizer pellets, Deicers, Sediments, Garage and wood shop waste materials (oils, stains, turpentine, paint thinner, sawdust), Other?

Pre-survey projection: It is projected that there is some knowledge of automotive leaks on the driveway.

Qualtrics results (Appendix 10): The top five sources identified were: soapy water, lawn fertilizer, oily fluids, radiator fluid, and sediment. This question could have been viewed by respondents as designed to reveal who are polluters in the neighborhood. The least controversial choice proved to be the most popular choice. Soapy water (39 responses) was the top response. The washing of cars is another Association norm and clean cars rate highly with green lawns with no weeds. Also highly recognized was lawn pellets (32 responses), petroleum products (30 responses), radiator fluid (24 responses) and sediments (23 responses). With the exception of the town houses there are many cars in the Association – each house has two to three cars on average. All but the newest cars have some type of leak which is apparently observed on the driveways and streets of the neighborhood.

There was a surprising number of responses (23 out of 46) for sediment. In a heavy rain there is a noticeable and visible amount of mud in the street gutters from lawn and other types of erosion. There are several areas of bare ground in both the common areas and homeowner lawn areas. There are land gradients with small gullies as well as sparsely seeded and covered areas subject to erosion. This mud has apparently been observed in the gutters by many residents after a rain is over. Also, in early spring after the last snowfall the County applied sand is visible in many street gutters. Awareness of the problem is only the start in mitigating the issue.

Residents must be somewhat sensitized to the presence of possible non-point source pollutants (Question #8, #9, #12, #13, #14, #15, #16) before they are made aware of possible solutions (#17, #18). This survey actually starts the education process and that process is furthered by implementation of the recommendations contained at the end of this paper.

Question 9 (Appendix 6): Which type of lawn care products do you typically use? (Check ALL that apply.) Row: Fertilizer only, Weed and feed, Organic lawn care products; Column: Spring, Summer, Fall, Winter.

Pre-survey projection: It is projected that most residents use all types of lawn care products.

Qualtrics results (Appendix 10): Spring proved to be the most popular time to apply lawn products, with one third of respondents applying fertilizer only and another one third applying weed and feed fertilizer. The Association norm for a lawn is dark green (lots of nitrogen, phosphorous and iron) lawns with few weeds (e.g. yellow dandelions). This is not to say that a resident's lawn is a moral judgment of that family. Can this Association norm be changed? Perhaps if residents understand that light green grass (as opposed to dark green grass) will mean saving money as well as contributing to better water quality for themselves and other communities downstream.

A new Maryland Lawn Fertilizer Law took effect October 1, 2013. In short, there is a certification program for lawn care professional and homeowners are required to follow the directions on the fertilizer bag. Fertilizer may not be applied between November 15 and March 1 (due to the snowmelt). Fertilizer may not be applied within 20 feet of any water source. Phosphorous may not be applied unless indicated by a soil

test or a lawn is being patched or renovated. This information is another limitation of this study and survey.

I became aware of this new law only on February 16, 2015 after attending an inter-faith environmental awareness meeting; therefore this law is not covered in the survey. It is doubtful that many MWHOA residents are aware of this new law. Specifically, it is against the law to apply fertilizer to impermeable surfaces. Fertilizer that lands on such surfaces must be swept back up onto the lawn or cleaned up and removed.

Question 10 (Appendix 6): Do you hire someone to take care of your lawn? Yes___ No___

Pre-survey projection: It is predicted that less than ten respondents use a lawn care service.

Qualtrics results (Appendix 10): Approximately one third off residents hire someone to take care of their lawn while the other two thirds take care of their own lawns. The MWHOA is a diverse middle class neighborhood. While there is some money in the Association much of it is tied up in the property owned by residents. This may explain the relatively low rate of employment of professional landscapers. The new Maryland fertilization law is now a point of discussion for all homeowners whether they employ a lawn professional or not.

Question 11 (Appendix 6): Have you observed any lawn care products spilling out onto the street during application of lawn care products? Yes___ No___

Pre-survey projection: Most residents will respond affirmatively to this statement.

Qualtrics results (Appendix 10): A resounding 96% of respondents have not observed fertilizer spillage as an issue. This perceived problem is not an issue according to a super majority of homeowners (47 out of 49 responses). While homeowners may be careful with their applications it is also noted that newer lawn spreaders have guides to restrict a full sweep application which prevents excess fertilizer from being spread into the street. Those homeowners who employ commercial vendors probably do not waste fertilizer on the streets due to its relatively high cost.

However, the state of Maryland must have thought this was an issue somewhere as the law was recently passed although general awareness of this law is probably very low. It has been pointed out that some lawn fertilizer is very small and may not be noticed until after a light rain that shows up as speckles if it has iron in it.

Question 12 (Appendix 6): Do you ever apply any of these products to the exterior of your house or landscaping? (Check all that apply): Pesticides, Herbicides, Fungicides, Weed preventer, Dandelion weed control, Insect and grub control, Crab grass control, Moss control, Algae control, Rodent control, Other?

Pre-survey projection: There will be a mixed percentage used for all these products.

Qualtrics results (Appendix 10): Of the top five choices, two thirds of respondents applied weed preventer followed in about equal proportions by pesticides, crab grass control, insect and grub control, and dandelion weed control. Weed preventer (30 responses) was the top response as this item is as common and popular as lawn fertilizer in the Association. It is often sold together as a common lawn product in the local repair/supply stores. Distant seconds by half were pesticides (16 responses), crab

grass control (16 responses), grub control (15 responses) and dandelion weed control (14 responses). All the other items ranged from 0 to 6 responses. The norm in the Association is green grass with no weeds in it. Many homeowners spare no expense in making sure this standard is maintained. In late 2014/early 2015 a group called the Environment and Health Coalition of Montgomery County launched a petition to help address this problem.

Question 13 (Appendix 6): Do you apply driveway sealants or cleaning products? (Check all that apply): Driveway sealant, Asphalt patch, Tar, Driveway degreaser, Oil spot primer, other?

Pre-survey projection: Many residents will reply affirmatively to this statement.

Qualtrics results (Appendix 10): Over half of respondents have applied driveway sealant while about ten percent have applied an asphalt patch. It is not surprising that driveway sealant is heavily used (18 responses) in the Association. It is yet another association norm to "paint" the driveway dark black (the darker the better) with these products at least every other year. Other norms in the Association include regular mowing of lawns and mulching around trees. Asphalt patching was a distant second. This is probably because regular maintenance of an asphalt drive will prevent erosion and the opportunity for water to freeze and thaw during winter and spring and cause cracks needing repair. As shown by the answers on Question #17 there is no knowledge about GI alternatives such as permeable pavement/pavers, porous concrete or porous asphalt.

Question 14 (Appendix 6): How important do you view an excessive amount of the following landscape debris on the streets, roofs, gutters and drainages as a problem

for your house and the livability of the community? (Check all that apply): Grass clippings, Fallen leaves, Weeds, Foreign, exotic or invasive clippings or seeds, Other?

Pre-survey projection: Many residents will respond affirmatively to this statement.

Qualtrics results (Appendix 10): Two thirds of respondents identified fallen leaves as the major issue in the street gutters while weeds and other clippings were a close secondary problem. Fallen leaves (29 responses) was identified as the excessive organic matter issue. This is probably due to the sheer mass of falling leaves (September thru January) in the MWHOA plus the lack of street gutter leaf pickup. All leaves must be bagged by the homeowner and picked up by the County, or composted on site. Leaves may lay in the street and gutter for months before decaying and flowing down the gutter with water into the storm water retention ponds. In several instances the storm drains have filled with fallen leaves and backed up causing local flooding problems.

There is no law or regulation that leaves must be picked up by the homeowner in the fall and winter and many residents just let them lie until their spring cleanup activities. Weeds (17 responses) and grass clippings (16 responses) are lower visibility issues although the consequences are the same. The Association could increase awareness of these issues through mention of the issue in their various communications. In Question #17 only 5 respondents showed any knowledge of compost bins for organic waste.

Question 15 (Appendix 6): In the wintertime do you apply snow and ice melt treatments? (Check all that apply): Road salt (sodium chloride), Ice melt treatment, Sand, Cat litter, Soil sediment, Other?

Pre-survey projection: It is predicted that most residents will check road salt and ice melt treatment choices.

Qualtrics results (Appendix 10): Two thirds of respondents applied ice melt treatment while one third applied road salt. The application of sand was a distant third choice. Most residents put down either road salt or ice melt treatment. These are the two main items sold in local home repair/supply stores. These are heavily used because they are effective as demonstrated in the winter of 2015. This is a classic tradeoff between human safety and the resultant impact on the local environment and downstream watersheds.

Question 16 (Appendix 6): Are you aware of any of the following items in the MWHOA street gutters? (Check ALL that apply): Paint, Dog droppings, Cleaning supplies, Cooking oil or grease, Cigarette butts or ashes, Pharmaceuticals or other drugs, Other household liquids?

Pre-survey projection: It is estimated there will be a mixed percentage to this question.

Qualtrics results (Appendix 10): Just under two thirds of respondents identified cigarette butts as the items most visible in street gutters. Another one third identified other household liquids placed in gutters with one quarter of respondents identifying dog droppings in the local street gutters. It was interesting that the most observed issue in the MWHOA street gutters was cigarette butts (22 responses) followed by other household liquids (12 responses) and dog droppings (9 responses). Cigarette butts are the most common litter items in coastal and stream cleanups. Dog droppings are also common as many residents curb their dogs as opposed to cleaning up droppings on common areas.

All the other responses ranged from 0 to 4 responses. At a recent (February 16, 2015) inter-faith environmental awareness meeting the author (Roberts 2015) picked up several plastic dog bones with plastic bags in it for distribution to dog owners to pick up their dog droppings. These items were handed out by the Montgomery County Department of Environmental Protection.

Question 17 (Appendix 6): Are you aware of any of the following means used by MWHOA homeowners to reduce stormwater runoff? (Check ALL that apply): Maintain lawn, Rain barrels, Rainwater cistern, Roof downspout diversion, Infiltration trench, Rain garden, Drywell/French drain, Swale, Low Impact Development, Permeable pavement/pavers, Porous concrete, Porous asphalt, Green (vegetated) rooftop, Planting trees, shrubs, and other vegetation, Mulching around shrubs and trees, Compost bins for organic waste, Other?

Pre-survey projection: It is projected that residents will indicate that they maintain their lawns and a few may have installed rain barrels.

Qualtrics results (Appendix 10): Of the top four methods to reduce storm water runoff, over two thirds of respondents maintain lawns, and two thirds mulch around plants trees, shrubs and other vegetation. About half of respondents planted tree, shrubs and other vegetation as well as using roof downspout diversions to control water flows on their property. The results indicate that no tipping point has been reached in the education, awareness and usage of Green Infrastructure (GI) devices in the MWHOA. For the most part residents are doing what they would do anyway: mow their lawns (35 responses), mulch around their trees and shrubs (32 responses), and plant more trees and shrubs (28 responses). Roof downspout diversions were also recognized (23 responses)

as the device is readily available in local home repair and supply stores as a cheap flood control device that has received some marketing as a way to keep water out of basements.

Closely related to landscaping activities is the issue of compost bins. Montgomery County has a very active Master Gardener program and this is a heavily marketed device to homeowners. Outreach efforts from the County and many local jurisdictions include free compost bins and informational literature at multiple outreach community events. However, all of the other GI responses only ranged from 0 to 6 responses. This indicates a very low level of awareness of any of these listed devices.

The Association could raise the awareness level by educating residents on the usefulness of these additional means of controlling excess waste water as well as possible pollutants into the storm water retention ponds and local waterways. It is unknown why awareness and adoption of these tools is so low in the community. The sad fact is that many of the government agencies and nonprofits may think they are doing a good job but they have never performed a perception survey of their efforts so they really don't know. The results of this survey will be widely distributed so awareness of lack of a tipping point in public education efforts can be made known.

Question 18 (Appendix 6): Are you aware of any of the listed Federal, State of Maryland, Montgomery County, or other non-profit programs to reduce the problems listed in this survey? (Check all that apply): Adopt-a-Road (Montgomery County), Backyard Buffers (Montgomery County Department of Natural Resources Forest Service, and Potomac Watershed Partnership), Storm drain Marking Program (Montgomery County), Environmental Site Design (Montgomery County), RainScapes Program (Montgomery County Department of Environmental Protection), Total

Maximum Daily Load (TMDL) (U.S. Environmental Protection Agency), Conservation Landscapes (Casa De Maryland), Marylanders Plant Trees (Maryland Department of Natural Resources), Illegal Dumping and Stream Contamination Hotline (Montgomery County Department of Environmental Protection), Household Hazardous Waste Collection Event ((Montgomery County Department of Environmental Protection), Pharmaceutical Drugs and Drinking Water (Washington Sanitary Suburban Commission), Water Wise Landscaping (Washington Sanitary Suburban Commission), Forestry for the Bay (Montgomery County Department of Natural Resources Forest, Service, Alliance for the Chesapeake Bay, Chesapeake Bay Program), Low Impact Development (LID) (Potomac Conservancy and The Nature Conservancy), Other?

Pre-survey projection: It is unknown what programs will be identified by respondents. However, it is anticipated that a tipping point has not been reached in any program as to resident awareness of a specific program.

Qualtrics results (Appendix 10): Almost all respondents had heard of the Adopt A Road program; and about half of the respondents have participated in a household hazardous waste collection event. About a third of respondents are aware of the storm drain marking program (Chesapeake Bay Drainage) and Marylanders Plant Trees program. The first program is very well known (34 responses) as there are Adopt-a-Road sponsor signs all over Montgomery County. This coverage includes the local access roads to the MWHOA. Various commercial vendors and other well-known non-profits have high visibility over large portions of the County for inexpensive advertising. The second highest program (15 responses) of Hazardous Materials Collection Events is well

advertised through weekly newspaper notices as well as flyers as numerous community events.

The Storm Drain Marking Program (11 responses) and Marylanders Plant Trees (10 responses) were the third and fourth most mentioned programs respectively. It was initially surprising that the storm drain marking was not rated higher but this may be due to the low visibility of the current stencils in the Association. The recognition of the Marylanders Plant Trees program was surprising as the only past observed advertising has been at the Montgomery County Agricultural Fair. All of the other programs' responses ranged from 0 to 6. The measured levels of recognition matched the hypothesis that an educational tipping point has not been reached on most programs.

The three highest rated programs have multiple marketing methods and the advantage of local visibility. With the exception of Marylanders Plant Trees, no other program apparently enjoys either local visibility or the number and type of marketing options as the highest mentioned programs. The MWHOA could help increase visibility of all of these programs by mentioning one or two programs per quarter in the dues notice as well as information in the e-mail distribution and Association website. Some quotes from Question #21 enforce these findings: #3 Storm drain filters replace out dated storm drains, so that there is no direct runoff into the Bay/ocean. #13 Reduction of chemicals; educate residents on environmental impact reduction; promote residential gardening; - improve chemicals (content) – public information on high visibility website.

Question 19 (Appendix 6): How long have you lived within the Montgomery West Homeowners Association (MWHOA)? ____ years

Pre-survey projection: It is expected that the range of years listed will range from a high of 32 years to a low of one year. The MWHOA is aging out as homeowners retire and move to less expensive areas of the County, State and other parts of the County.

Qualtrics results (Appendix 10): From less than one year, to 32 years, there was an almost even distribution of one to two respondents per year over the entire range of years. The only years without representation was year 7, 8 21, 22 and 23**.** For whatever reasons beyond the scope of this survey, there has been a steady and gradual turnover in homeownership over the last 32 years in the MWHOA. Based on the 41 responses to this question there is a wide but shallow dispersal in the age of homeownership. There were only 12 responses from homeowners who have been here for more than 25 years. While this dispersal is neither good nor bad, it is indicative that any education efforts should be ongoing to be effective with newly presented information. Unfortunately this survey question was structured as an open ended question.

Question 20 (Appendix 6): Do you own or rent your home? Homeowner household__ Renter household __

Pre-survey projection: It is anticipated that over 90% of the MWHOA residents are homeowners. Will there be a statistical difference in the answering of the questions based on this status? Do homeowners feel a greater sense of ownership in the larger community and environment because they have more invested in property values? That will be the interesting data to see.

Post-survey results (Appendix 10): Of the 46 respondents to this question *all* identified themselves as homeowners. There are only five renters in the Association.

The first mailing went to all owners of record. The second survey contact was hand delivered to all non-respondents which would have included renters. Since no renters responded to the survey it is unknown whether there are any perception differences between owners and renters. This is another limitation of this study. It is a future area for further investigation whether renter responses are different from homeowner's responses.

Question 21 (Appendix 6): What do you think can or should be done to reduce the runoff of chemicals and other potential pollutants from our community into our waterways?

Pre-survey projection: It is projected that residents may have heard about some TMDLs and the EPA.

Post-survey results (Appendix 10): A detailed list can be found in Appendix 10. Several comments mentioned repainting "Save-The-Bay" stencils over the storm water grates. This had been done once before many years ago and the stencils are badly warn or nonexistent. One comment mentioned that streets and/or gutters need repaving to prevent erosion and sediment issues. Several comments mentioned education needs of the residents as to not over fertilize their lawns and the proper application of pesticides.

Other comments urged publication of hazardous materials and medicines drop off dates and locations. Education of residents on general and specific issues could be made via the quarterly dues notice as well as the opt-in e-mail list or MWHOA website. Some comments urged education for residents on sustainable gardening. This would be an effective technique as I have observed some type of front, side or back garden in each of the 104 MWHOA residences. This could be done via the Maryland Master Gardeners or

the Forest Steward programs. These education efforts would include information about over fertilization of lawns and proper application of lawn chemicals to control pests.

Question 22: What additional questions and comments do you want to know about water quality, stormwater ponds, stormwater and things we can do in our neighborhood?

Pre-survey projection: Unknown.

Post-survey results (Appendix 10): A detailed list of responses is contained in Appendix 10. Of the 20 written comments received for this question 11 of them were None, Nothing or Not Applicable (N/A). Several other comments were along the lines of thanks, you are welcome, and good luck with your degree. Some respondents wondered whether the ponds were natural or manmade. This was an interesting comment as the survey did not make that issue clear during the survey. This same respondent also wondered as to the basic purpose of the ponds if it was something other than a wildlife habitat. One comment expressed concern about a neighboring storm water retention pond and the observation that waste water from a nearby car wash was flowing into the pond. This same comment stated there were other industrial zone activities sending waste water into the pond.

The issues of excess nutrients from soapy water and oily waste water are the same issues as in the MWHOA streets and ponds. The writer wanted to report the issue to authorities so another recommendation will be to list federal, state and county hotline numbers for the dumping of oil and other pollutants over and above street level accumulations. Two comments requested a formal annual report on the state of the ponds. This is an interesting idea as it fulfills educational objectives as well as possibly

strengthening property values of the MWHOA with a shared responsibility for the ponds. Another comment brought up the interesting issue of maintaining the MWHOA common areas as an issue of green infrastructure in maintaining proper water flow to the ponds as well as a neighborhood aesthetic issue.

Examples of quotes from Association top educators, role models and enablers: #6 Maintain ponds so that trees, weeds don't interfere with drainage; landscaping to direct water flow; keep common areas free of lawn debris so mowers can mow. #8 A report on the ponds every year would be nice and include anything residents should do to help with issues if any; provide info on above and where to purchase subsidize part of cost or do rebate or tax break.

Chapter 5

Discussion, Summary, Recommendations and Conclusion

Summary and Conclusion

This study indicates that overall awareness of any interconnectedness between the clean water drinking supply and most stormwater management pond issues in the MWHOA tends to be low. This is important because low perceived awareness means most residents may not be aware of the interrelationships between their individual adverse actions on the ponds and their ultimate drinking supply. The survey tool itself was cited as helping some respondents become aware of the role of their community on practices contributing and water pollution, stormwater and its connections to source drinking water. However, residents in the MWHOA attributed negative practices to others in the community rather than to themselves.

Increase awareness of green infrastructure practices. Only one third of residents have any type of awareness of their neighborhood ponds and few knew of their in providing *downstream clean drinking water*. While this study has shown there is some awareness of one or two common GI techniques it is marginal knowledge at best. The top three GI techniques identified by residents are common landscaping practices such as maintaining the lawn (74%); mulching around trees and shrubs (68%); and planting trees (60%).

For example, there does not appear to be a concerted effort to keep excess volumes of water flows on an individual's property. Homeowners should care about this because it affects their clean water drinking supply. While Montgomery County GI education programs and GI devices have been available for several years this study has

measured little impact of those efforts. For example, on a heavily advertised County program such as RainScapes (which provides rain barrels) only 15% of residents used this GI device. If GI best practices (such as rain gardens, drywells or swales) were adopted then reductions in volume of water flows, spread of sedimentation, as well as reductions in several types of non-point source pollutants may be achieved.

There was 0% knowledge about such GI devices as porous concrete or porous asphalt; there was only 11% knowledge of permeable pavement and pavers. All these GI techniques keep water on the homeowner's property. Some jurisdictions are formulating a tax on total residential surface area of impermeable surfaces. Aside from the collective Association self-interest in contributing to clean water, the possibility of HOA user fees for stormwater retention ponds is another reason to be concerned about the volume and quality of stormwater runoff.

Increase resident's awareness of agency programs and roles and for agencies to fill needs expressed by residents. There is little awareness (only 4 out of 14 programs with significant use) of the roles of governmental and nonprofit organization programs to reduce environmental degradation. The prime area for improvement is an education campaign to reduce household pollutants. If household non-point pollutants can be reduced by residents than the newly redesigned and reconstructed stormwater retention ponds will be much more efficient and effective. Therefore Montgomery County, Maryland will have a much greater chance of reducing their Total Maximum Daily Load (TMDL) mandate from the federal Environmental Protection Agency (EPA).

Increase awareness in HOA's education resources that can mitigate stormwater flows and improve water quality. Although this study has shown that

there is some awareness (in the 27% to 92% range) of four green infrastructure education programs, residents may perceive that agencies and organizations are not catering to opportunities afforded by HOAs. These HOAs outnumber any other jurisdiction in Maryland by a ratio of 3 to 1. Since homeowner associations (HOAs) form a majority of the housing stock in Montgomery County this presents opportunities to target audiences for many of these programs. In the absence of specific government subsidies for good behavior, or taxes for bad behavior, this study has assumed that awareness may lead to positive actions for the environment. This assumption is particularly strong given the self-interest of clean drinking water.

Improve knowledge about stormwater and ways to reduce runoff and pollution. There was some knowledge that the ponds filter out sediment (35%) and pollutants (27%); and an understanding that one of the primary purposes of the pond is to retain and filter these substances (46%). There was a high agreement (76%) that the definition of storm water includes controlling water runoff flooding and the sedimentation and pollutants that flow with the water. However, just over half (54%) of the residents think the MWHOA neighborhood has a problem with excessive runoff and pollution of stormwater. A slightly higher percentage (63%) thought this issue was important to the overall environment. This may show disconnects in understanding that local actions influence the larger environment.

For example, residents showed high awareness of their lifestyles that used non-point source pollutants such as: soapy water with excess nutrients (85%), lawn fertilizer pellets (70%), gasoline and oil spills (65%), radiator fluid (52%) and even excess sediments (50%) in their stormwater runoff. Almost two-thirds (64%) of residents take

care of their own lawns yet a resounding (96%) claim to have never observed spillage of excess lawn products into the street. This apparently includes the 63% who use weed preventer, 33% who use pesticides, 33% who use crab grass control, 31% who use insect and grub control, and 29% who use dandelion weed control.

This may mean that all my neighbors have the latest anti-spill guard technology on their lawn spreaders (like I do). However, it is more likely that they did not observe spillage onto the gutters and roadway. While this is noticeable after a rain it may be more noticeable to the Montgomery County Department of Environmental Services who was responsible for getting the County fertilizer law approved in 2013. While fine particulate lawn care products may have not have been observed, there was high recognition of large organic matter in the streets. Over two-thirds of residents observed fallen leaves (69%), weeds (40%), clippings and seeds (38%), and excess grass (26%) in the street gutters. There was also high recognition of large granular snow/ice treatments placed on driveways to include ice melt treatment (63%), road salt (35%), and even sand (21%). Other large objects were also recognized such as cigarette butts and ashes (59%), and dog droppings (24%).

There is variable and high recognition of a large inventory of household and yard non-point source pollutants, with a possible mixed message in perception versus reality in the visible application of lawn products in the streets. The perception survey also asked an open ended question of what can or should be done to reduce the runoff of chemicals and other potential pollutants. There were 32 responses to this question of which two-thirds (21 responses) indicated either a need to reduce chemicals, educate residents on the runoff issue or a lot of no opinions. Apparently there was not one response that indicated

that the individual respondents would take immediate action to reduce their use of lawn or household chemicals. There was also not one response that indicated a desire to increase their use of Green Infrastructure (GI) devices.

The survey as an education tool. A majority of the local homeowner association residents are not aware of the source of their local drinking water supply. As a long-term resident of 27 years I was not aware of this until learned about it with ten other residents at the MWHOA Special Meeting (Copiz, 2013). This fact was so important the Principal Investigator and I included it in the informed consent cover letter for the survey. I believe that the administered perception survey increased awareness and contributed to the high survey response rate (54%).

The lack of knowledge on GI processes may be understandable as many of the terms have only gained currency in the last ten years. Even the GI philosophy of keeping stormwater runoff onsite as much as possible has been in the popular literature only over the last few years. However, the issue of polluted water has been around since the 1970's. This issue alone might be the most important "hook" to base future education programs on. They are also not aware of the non-point source pollution problems that they themselves generate.

Results revealed GI practices that residents currently practice and opportunities for further adoption. The easiest and lowest cost Green Infrastructure (GI) techniques used by a majority of the residents are landscaping techniques that help retain water onsite. Half the residents reported diverting stormwater via a roof downspout. These downspouts usually direct water into gardens and lawns to retain water onsite. Every one of the 104 houses in the MWHOA have these downspouts.

Retrofitting existing storm water retention ponds as bio-filters will solve only a part of the pollutant problems. Long-term improvements in water quality can only be achieved by residents changing their lifestyles in minimal ways that do not affect their quality of life. The closest analogy to this is recycling efforts and programs. While initially resisted by many homeowners it has gained widespread acceptance with a minimal change of human behavior. The same can be done with implementation of many GI techniques as well as the proper disposal and use of non-point source pollutants commonly used in the home and yard.

Probably the most important education effort should be directed to making residents aware that it is their responsibility to do as much as possible to keep water onsite. For example, the number one source of chemicals and runoff identified by residents was soapy water from car washing (85%). Most residents wash their cars on their driveways or common area parking spaces. The easiest solution to this problem is for residents to park their cars on their front lawns and wash the car so that the lawn soaks up the soapy water and excess water runoff. In economic terms this practice is known as a secondary use.

In other economic terms implementation of GI will cost money. For example a rain barrel can cost up to $100. It is expected that GI implementation will be slow as residents undertake home projects that can incorporate GI processes to increase ground permeability to rainfall while reducing stormwater runoff with other techniques such as drains, swales and rain gardens. Montgomery County can increase usage of these devices with free or reduced prices. A rebate program or tax incentives at the County level may also increase usage.

Montgomery County can take the study survey results and compare them to other information on program evaluation efforts. The County's market penetration for environmental education is extremely low within the MWHOA. Assuming that this Association is not an outlier than the County needs to reevaluate its outreach efforts in marketing its GI and reduction of non-point source pollutant programs. This Association may serve as a test case in the implementation of GI devices as well as reduction of pollutants as the County is investing in two newly designed stormwater retention ponds. This would be the ideal time to increase education and other solutions in concert with the pond reconstruction.

Reductions in all the other sources of non-point solutions involves: reading of lawn care products and their proper application as regulated by law; proper maintenance of vehicles and other equipment to reduce leaks; care in the handling of fluids to prevent spills; continued proper lawn maintenance and planting of ground cover to prevent erosion and resulting sedimentation issues. However, the optimal solution is for residents to recognize that their individual actions, or inaction, has a direct downstream impact on the quality of their drinking water.

However, this lifestyle change cannot be achieved until residents recognize that the interconnections, and resulting actions between themselves and their stormwater runoff, impact the local supply of drinking water. In the larger Montgomery County, Maryland, it is expected that a combination of implemented study recommendations, increased education efforts, taxes, retrofitted storm water retention ponds, and communication of best practice actions, will lead to a residential reduction of non-point pollutants.

The following recommendations are based on synthesizing the literature and HOA perception survey results into collective group and individual actions. There is little or no awareness of many Green Infrastructure (GI), as well as pollution prevention programs from governmental and nonprofit education. My findings suggest that opportunities exist to work with homeowner's associations (HOA) for the collective public good of clean drinking water.

Education and Communication Recommendations

The MWHOA should publish quarterly status reports on the status on the storm water retention ponds in the Association newsletter. This will be an easy recommendation to implement as there will be higher interest from the Association membership when the two ponds are renovated in late 2015 by Montgomery County, Maryland. Other actions the Association can take are to utilize the current MWHOA website and the newly developed opt-in e-mail list to publicize all Green Infrastructure (GI) environmental and education issues.

In 2016 construction equipment for the pond renovations will be moving around the Association neighborhood. This can be leveraged to provide context that highlight the intended outcome of the project, the pond's role and overall environmental visibility. This would be a good time to perform a number of the following actions:

- An Association Special Meeting can function as a neighborhood workshop that be held for HOA residents to explain the reasons why the pond is being converted into a sand berm bio-filter.
- The results of this study can be presented face to face as a means of communicating with MWHOA residents to foster their interconnectedness to their

ponds. This can also engage them on practices they can take to reduce pollutants flowing into stormwater.

- Another possible idea is a listing of wildlife and plant life found in the pond areas as showing that nonhuman factors are also affected by large volumes of polluted stormwater runoff.
- For any "concerned citizens" a listing of government hotline numbers can be published if dumping of yard waste or pollutants is observed.
- At the Annual HOA Meeting held every November the Board of Directors can request that Mr. Copiz (2013) from Montgomery County Department of Environmental Services address the membership, on specific actions that individual homeowners can take to reduce their negative impact on stormwater which they eventually end up drinking.
- Prior to this meeting the board of directors can share the results of this study with Mr. Copiz. It was Mr. Copiz who in the MWHOA Special Meeting (Copiz, 2013) provided the downstream water intake information. This is why residents should be concerned with pollutants from homeowner activities such as landscaping and house/car maintenance. He can also reiterate that the County will have a greater chance of reducing its total TMDLs if residents can control the non-point source pollutants within their yards.
- In the quarterly HOA newsletter, the Association should publish a short paragraph about various Green Infrastructure devices and techniques to increase resident awareness and program participation. Lastly, the Association can publicize the provisions of the recently passed 2013 Maryland Lawn Fertilizer Law.

Action Recommendations

Communication at the Association and individual homeowner level can lead to improved environmental practices. The MWHOA Annual Meeting which is held every November just as the fall rains arrive. This is an ideal time to recap the storm water retention pond progress by providing an annual update on construction as well as maintenance of the ponds. The Board of Directors can highlight the MWHOA common areas as Association owned Green Infrastructure.

The City of Gaithersburg in Montgomery County is considering a water stormwater tax based on percentage of impervious surface on a homeowners property. Risks to water quality from homeowner activities can be mitigated by educating landscaping contractor on lower impact mowing judicious and proper application of fertilizers and weed killers, mulches the trees and shrubs to absorb water flows, and that dog droppings are picked up by residents.

The Association common area woodlands are the largest surface area that can retain water from precipitation and runoff. The MWHOA should request the Montgomery County forester to survey the MWHOA wooded commons to evaluate the overall health of the MWHOA forests help residents protecting the local watershed. The survey will look at how the vegetation in the neighborhood can help reduce erosion and sedimentation into the ponds. Good management practices by the Association may influence individual homeowners to adopt good management practices on their private property.

The Association can partner with the Maryland Master Gardener and Maryland Forest Steward programs to provide general and specific information about sustainable

landscaping practices via the quarterly dues notices, e-mail list, website, and at MWHOA meetings. The use of sustainable landscaping practices is not new in progressive Maryland. For example, residents can now buy fertilizer with microbes added to the mix to create even healthier lawns! However, the interconnectedness of the reduction of volume of stormwater runoff to the ponds, and to the issue of cleaner runoff leading to cleaner downstream water quality, is probably a new perspective for most MWHOA residents.

There are several relatively inexpensive actions that can be taken to reinforce the interconnectedness between neighborhood activities and their environmental impact. One is to repaint "Save the Bay" stencils on all MWHOA storm water grates. This simple action serves as a highly visual reminder to all residents that their stormwater runoff just does not disappear – that it has an ultimate destination – in addition to influencing their local drinking water.

The Association could also recognize individual homeowners as having the "best of breed" lawn demonstrating sustainable gardening and proper use of slow release organic nitrogen fertilizers. Such an award could include recognition of the installation and use of Green Infrastructure (GI) devices to maximum effect to keep water on the landowner's property.

Another inexpensive action to reinforce this same interconnection is the placement of certified habitat and related signs from several different non-profit organizations. One example is to install a Pollinator Habitat sign from The Xerces Society for Invertebrate Conservation. This sign can be used in gardens that certify that they do not use insecticides. Also related to gardens is the installation of a sign for a

Monarch Waystation Program Site from MonarchWatch.org. Finally, an Association resident can install a Butterfly Garden Certification Program sign from the North American Butterfly Association (NABA).

Installation of highly visible signs can help increase general community awareness of the various interconnections between people, nature and the water cycle. For example, Certified Habitat signs are available from organizations such as the National Wildlife Federation, Wildlife Habitat Council, Audubon Society, and Penn State University. Each has a different application process, fee, and criteria for approval. Such signs could be installed by the MWHOA on the common property gardens while individual homeowners can also apply for these signs for their own sustainability efforts.

Another simple action is to publicize drop off dates and locations for hazardous materials, left over paint and pesticides, waste oil, medicines and other substances for proper disposal. This reminds residents not to dump these substances into their yards and what the correct action is to take with these substances. On an ounce for ounce basis this is direct action by the homeowner to divert pollutants from stormwater runoff.

These collective actions can provide the final management solutions to this critically important natural resource challenge. The MWHOA board of directors may conduct a follow-up evaluation of this outreach effort. This study has established the baseline effort as well as the recommendations for improvement and areas for education efforts.

As mentioned earlier there is much work to be done!

References

Aad, A. S., M. & Shuter, W. (2010). Modeling Techniques of Best Management Practices: Rain Barrels and Rain Gardens Using EPA SWMM-5. *Journal of Hydrologic Engineering, 15,* 434-443.

Aber, J. S. Wetland Environments – Definitions and Classification. Retrieved from http://academic.emporia.edu/aberjame/wetland/define/define.htm on October 13, 2013.

Arnold, Jr., C. L. & Gibbons, J. (2007). Impervious Surface Coverage: The Emergence of a Key Environmental Indicator. *Journal of the American Planning Association 62*(2), 243-258.

Benedict, M. A. & McMahon, E. T. (2002). Green infrastructure: smart conservation for the 21st century. *Renewable Resources Journal 20,* 12-17.

Brabeck, E., Schulte, S., & Richards, P. L. (2002). Impervious Surfaces and Water Quality: A Review of Current Literature and Its Implications for Watershed Planning. *Journal of Planning Literature, 16,* 499-514.

Brattebo, B. O. & Booth, D. B. (2003). Long-term Stormwater Quality and Quality Performance of Permeable Pavement Systems. *Water Research 37*(18), 4369-4376.

Booth, D.B. (1991). Urbanization and the Natural Drainage System – Impacts, Solutions and Prognoses. *The Northwest Environmental Journal*, 7, 93-118.

Booth, D. B. & Jackson, C. R. (1997). Urbanization of Aquatic Systems: Degradation Thresholds, Stormwater Detection, and the Limits of Mitigation. *Journal of the American Water Resources Association, 33*(5), 1077-1090.

Chesapeake Bay Foundation, (2014, January). *Saving A National Treasure – Polluted Runoff: How Investing in Runoff Pollution Control Systems Improves the Chesapeake Bay Region's Ecology, Economy, and Health.*

Copiz, D., (2013, November 12). Montgomery County Watershed Planner. Montgomery West Homeowners Annual Meeting.

Davis, A. P., Shokouhian, M., Sharma, H., Minami, C. (2001). Laboratory study of biological retention for urban storm water management. *Water Environment Research* 73, 5-14.

Davis, J. (2014, April 2). "New Stormwater management program in the pipeline." *The*

Gazette. p. A-3.

DeSousa, C. A. (2003). Turning brownfields into green space in the City of Toronto. *Landscape and Urban Planning 62*, 181-198.

Environmental Protection Agency (EPA). (2014). Chesapeake Bay TMDL Quick Finder. Accessed May 28. http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/RestorationUnderway.html?tab2=2&tab1=2 .

Environmental Protection Agency (EPA). (2014). How Can I Overcome the Barriers to Green Infrastructure. Accessed May 28. http://water.epa.gov/infrastructure/greeninfrastructure/gi_barrier.cfm.

Environmental Protection Agency (EPA). (2015). Sediments: Sources, Stressors and Responses. http://www.epa.gov/caddis/ssr_sed4s.html. Accessed February 25.

Farm, C. (2003). Constructed Filters and Detention Ponds for Metal Reduction in Storm Water. Dissertation. Malardalen University Press: Arkitektkopia, Sweden.

Fiskel, J. (2003). Designing Resilient, Sustainable Systems. *Environmental Science and Technology* 37:5330-5339.

Hogan, D. M. & Waldbridge, M. R. (2007). Best management practices for nutrient and sediment retention in urban stormwater runoff. *Journal of Environmental Quality*, *36*(2), 386-395.

Hossain, M. A., Alam, M., Yonge, D. R. & Dutta, P. (2005). Efficiency and Flow Regime of a Highway Stormwater Detention Pond in Washington, USA. Washington State University: Pullamn, WA.

Jones, Jonathan E., Guo, James, Urbonas, Ben, and Pittinger, Rachael. (2006). Essential safety considerations for urban stormwater retention and detention ponds. *Stormwater,* January/February, 1-18.

Jones, R. (2006). For First Time, More Poor Live in Suburbs Than Cities. National Public Radio, http://www.npr.org/templates/story/story.php?storyId=6598999 accessed on April 28, 2014.

Kates, Robert W., Parris, Thomas M. and Leiserowitz, Anthony A. (2005). What is sustainable development? Goals, indicators, values and practice. *Environment: Science and Policy for Sustainable Development 47*, 8-21.

Kaufman, M. M. and Wurtz, M. (2007). Hydraulic and Economic Benefits of Downspout Diversion. *Journal of the American Water Resources Association* 33, *2,* 491-497.

Kollmus, A. and Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research 8*,3, 239-260.

Krishnappan, B. G. & Marsalek, J. (2002). Modelling of flocculation and transport of cohesive sediment from an on-stream stormwater detention pond. National Water Research Institute: Ontario, Canada.

Krugman, P. Building a Green Economy. (2010, April 5) *The New York Times, p. 1*

Landscape and Human Health Laboratory webpage, University of Illinois Urbana – Champaign, http://lhhl.illinois.edu/ retrieved on June 12, 2015.

LeBlanc, D. (2010). Sustainable consumption and production: Policy efforts and challenges. *Natural Resources Forum 34*, 1-3.

Mullich, J. 2014. New water ways - The business imperative to manage resources. *The Wall Street Journal* May 28.

Perez-Pedini, M., Limbrunner, J. F., & Vogel, R. M. 2005. "Optimal Location of Infiltration-Based best Management Practices for Storm Water Management". *Journal of Water Resources Planning and Management, 131*(6), 441-448.

Perry, D.A., Oren, R., and Hart, S. C. (2008). *Forest ecosystems*. 2nd ed. Baltimore, MD: The Johns Hopkins University Press.

Persson, J., Somes, N. L. G., & Wong, T. H. F. (1999). "Hydraulics Efficiency of Constructed Wetlands and Ponds". *Water Science Technology 40,* 291-300.

Policy Options. Ch 7. *Biodiversity: Its Importance to Human Health.* NY, NY: United Nations.

Roberts, Jr., William H. (2015, April 18). *Montgomery West Homeowners Association Perception Survey*. Unpublished paper.

Rosegrant, M. W., Cai, X, & Cline, S. A. (2002). *Global water outlook to 2025 – Averting an impending crisis.* Washington, DC: International Water Management Institute.

Roy, A. H., Wenger, S. J., Fletcher, T. D., Walsh, C. J., Ladson, A. R., Shuster, W. D., Thurston, H. W. & Brown, R. R. (2008). Impediments and solutions to sustainable, watershed scale urban storm water management: Lessons from australia and the united states. *Environmental Management 42,* 344-359, DOI 10.1007/s00267-008-9119-1.

Sandstrom, U. G., Angelstam, P. & Mikusinski, G. (2006). "Ecological diversity of birds in relation to the structure of urban green space." *Landscape and Urban Planning 77*, 39-53.

Stevens, C. (2010). Linking sustainable consumption and production: The government role. *Natural Resources Forum 34,* 16-23.

Swarts, Phillip. (2014, May 28). Nation could face water shortfall in next decade, watchdog warns. *The Washington Times*, p.1.

Tavris, C. (2015). How homo economicus went extinct. *The Wall Street Journal,* May 16-17, A3.

Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kazmierczak, A., Niemela, J., & James, P. (2007). Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. *Landscape and Urban Planning 81,* 167-178.

United States Environmental Protection Agency. 2014. Water: Green Infrastructure. Accessed May 22. http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm.

Walker, Jr., W. W. (1985). Phosphorus removal by urban runoff detention basins. *Lake and Reservoir Management, 3*(1), 314-326.

Walsh, C. J., Fletcher, T. D., & Ladson, A. R. (2005). Stream restoration in urban catchments through redesigning storm water systems: Looking to the catchment to save the stream. *Journal of the North American Benthological Association, 24*(3), 690-705.

Ward, D. (2009). *The Biology of Deserts*. Oxford, UK: Oxford University Press.

Weiss, P. T., Gulliver, J. S., & Erickson, A. J. (2007). Cost and Pollutant Removal of Storm-Water Removal Practices. *Journal of Water Resources Planning and Management*, May/June, 218-229.

Wright, Hannah. (2011). Understanding green infrastructure: the development of a contested concept in England. *The International Journal of Justice and Sustainability 16,* 1003-1019.

Appendix 1

Storm Water Retention Pond Site

My topic of stormwater retention ponds was drawn from my Sustainable Natural Resource (SNR) Graduate Certificate capstone project paper. It was actually Dr. Dave Perry's Forest Ecosystem course at Oregon State University (OSU) that got me thinking about the micro-ecology pond site behind my house. I discovered that many of the course weekly written assignments easily applied to the woodlands found on the stormwater retention pond site behind my house.

Another course that influenced my choice of topic and research design was Dr. Chan's fisheries management risk management course during OSU's Natural Resource Leadership Academy. This course got me thinking about risk, perceptions of risk and the measurement of risk. All of this lead me to approach the Montgomery West Homeowners Association (MWHOA) Board of Directors with my idea. I would develop a stormwater management technical paper that would aid them in decisions affecting the re-design and re-construction of the two ponds adjacent to MWHOA property. Further, I would develop, administer and provide the results of a perception survey concerning current issues with the ponds. Although the OSU Master of Natural Resources is a non-thesis degree program I have incorporated many thesis format elements from Dr. Christine Olsen's course in research methods in the social sciences into this paper.

I have lived adjacent to the pond site since moving to my home in 1988 – over twenty-seven years ago. I have watched a site go from a disturbed patch of earth when the pond was built in 1982 to a heavily wooded site. While I have no background in stormwater management I do like to observe nature. This is easy to do on a daily basis when looking out your sunroom windows. I have observed a variety of plant and animal successional stages on this pond site. I have also observed the effects of occasional human maintenance activities and how they affected the ecosystem. I have seen changes in maintenance status, changes in water levels, and changes in plant and wildlife characteristics. It is quite the mini-ecosystem with the ponds serving as the "headwaters" for the local streams feeding into the Potomac River.

The Montgomery West Homeowners Association (MWHOA) subdivision was built by the Ward Development Corporation from 1980 to 1982. The area was previously gently rolling hills covered by woodlands. When the housing sub-division was built the storm water retention ponds were built and turned over to the MWHOA. The MWHOA did little to maintain the pond and eventually the site was taken over by Montgomery County around 2008. Perry (2008) covers several types of natural disturbances, yet the

site pond was disturbed and created by man for an artificial purpose of controlling floods of off impervious asphalt surfaces (eight MWHOA roads). The site pond has never experienced a brushfire or any of the woodlands in the adjoining landscape in over thirty-five years. Some homeowners trim trees on the site away from their backyards and create an informal fire line. Homeowners also harvest fallen firewood from the site for a fireplace that reduces fuel on the woodland floor. The County does not appear to have any particular fire suppression techniques. Wind disturbance has contributed some potential fuel to the site. The infamous *derechos* of 2012 felled some small trees and large tree limbs although most of the site appeared undisturbed.

As designed in 1982 the pond site floods every time it rains. This characteristic may not change in 2015 when the pond is re-constructed using sand berms. The pond's embankments are maintained by mowing and cutting down any small trees that try to grow on the sides. Apparently their roots would undermine the embankment and cause it to leak. The woodlands on the elevated slopes show no signs of erosion. It is not known whether there are any invasive species in the site area. This is one of several potential threats going into, and coming out of, the site pond. The pond site does have alternate stable states by functional design if not by policy default. The main factor for this is the flood control device (FCD) in the corner of the lowest elevation of the pond which looks like a giant aluminum mushroom. The alternative stable states of the site storm water retention pond could be divided into four possible end states. They are: semi-wet/semi-dry pond; wet pond, dry pond, and abandoned/unrepaired pond.

The semi-wet (semi-dry) pond represents the current (2013) stable state. There is a constant stream of water running through one channel which goes straight out the FCD. The site provides only temporary storage of storm water. The FCD allows only minimal outflow so that downstream banks are not damaged by erosion. At the point of the site pond triangle is a flood control device (FCD) that can be adjusted for water flow. There are two inlet pipes into this pond that drain street water runoff from two different portions of the Montgomery West Homeowners Association. This is composed of six separate streets that represent 104 separate sources of potential pollution. Water flows down the sides of the hill and embankments into the pond, as well as inflows from rainfall and the adjacent water table. There is a main road (Centerway) that border the stormwater retention pond so this represents another major source of pollution with hundreds, if not thousands of cars per day, going past this site. There is no bio-filtering capability within this pond. The pond has no designed on-site storage capability. The site ponds were *not* designed with any type of bio-filtering capability. These types of features are common to ponds built after 1986 when the standards were changed. In 2015 the site pond is scheduled to be rebuilt as a sand berm pond to add bio-filtering capability. After a rainstorm the pond retains water for up to one week depending on how much it rained and how long it rained. This stable state has been maintained since 2008 when the FCD was repaired. This apparently represents the long-term stable state of a well maintained storm water retention pond in the time period 1982 through 2014.

The wet pond was in existence from approximately 2000 to 2008. The pond was wet because the FCD was broken and got clogged up with debris. It was during this time

that the threat of mosquitoes was greatest from diseases such as West Nile virus. It was also during this time that the diversity of wildlife seems to be the greatest. For example in 2007 a pair of Canadian geese built a nest on the embankment and raised a brood of goslings for one year. A pair of beavers was also attracted to the wet pond. They built their mound at the slower drainage inlet channel into the pond which is just a few feet past my backyard fence. It was quite an impressive mound although most of my neighbors were not impressed. It appeared that these beavers chopped down all the expensive ornamental trees in our cul-de-sac. After several complaints the beavers were trapped and removed. It was about this time that Montgomery County, Maryland, started paying more attention to the maintenance of the pond. The FCD was repaired, the clogging debris removed, regular mowing of the embankment was initiated and litter was picked up every two to three months form the pond.

The dry pond was in existence when the case study author (Roberts 2015) moved here in 1988. It stayed a dry pond until approximately 2000 when a gradual buildup of debris appeared to clog the FCD most of the time. The grass was not mowed and small trees grew on the sides of the embankment. It is difficult to know what an abandoned dis-repaired stable state pond might look like. There was probably an overgrown embankment, with short grass giving way to long grass, and then perhaps shrubs and small trees. This was the site condition in 1988. The pond appeared to always be a dry pond with no water retention at all although the FCD was present. With severe budget cutbacks it is certainly possible that this one small pond, out of over 2,000, could be a victim of budgetary cutbacks.

Land Area Description

Google Earth pictures illustrates all of the Montgomery West Homeowners Association area to include the specific streets that provide the runoff water to the retention pond. According to Perry (2008) "…landscape patterns result from interactions among many different factors…" (p. 73). One of the main factors affecting the site pond landscape patterns are the presence of water in both lentic and lotic stages. The original pond was designed as a concave lentic depression and this is the predominant landscape pattern visible from the ground as well as from the air. This lentic pattern is bounded on three sides in the rough form of a right triangle. On one side there is a gradual 35-45 degree slope that is covered by woodlands.

The second and third sides are marked by an artificial embankment that is rounded and grass covered. Within these boundaries are lotic patterns of two artificial streams that are rock constructed drainage channels. These channels are just inside the artificial embankment and run from the two inflow entrances into one outflow. The apex of these two angles is marked by a flood control device (FCD) that looks like a giant steel mushroom.

Biotic factors also influence the retention pond landscape patterns. On the artificial embankment there are several varieties of wild grass and weeds. This area is mowed approximately every two months. In the spring and summer this is a verdant

green; in the fall and winter a golden brown. Within the lentic pond there are hydric soils that limit growth to low profile weeds, shrubs and willows. As the ground elevation increases the water drains to the pond from the woodlands and succession forest that marks the landscape pattern. There are no erosion patterns in the landscape as the woodlands are well established and hold the soil well.

There are three major land types surrounding the site storm water retention pond. The smallest is literally my backyard at 8812 Mourning Dove Court, Gaithersburg, MD 20879-1775, which is the address used to locate the site on Google Earth. This project paper's author's (Roberts 2015) house is representative of the surrounding residential neighborhood. The second land type is a county road known as Centerway Road. This is visible both from the site and the air. It is a heavily traveled road and contributes noise, air and water runoff pollution to the storm water retention pond. The third and last land type is woodlands and forest of the Parks and Planning Commission, Montgomery County, Maryland. Within this area, and three houses down from address 8812 is a small stream. This forms the core of the Cabin Branch Stream Valley Park. There are no apparent However, the issue of invasive species in Montgomery County retention ponds has not been researched. If there are any invasive organisms within the site there is nothing here to make this particular habitat unique to support them.

The site is owned by Montgomery County Parks and Planning Department as part of their network of dry, wet and semi-wet storm water retention ponds. There is a network of over 2,000 such ponds in Montgomery County. Subsidies maintain the mowing of grass on embankments, maintenance of flood control devices, and maintenance of flood channels. This Appendix shows Mourning Dove Court as a street that ends in a cul-de-sac. This is one street of eight streets within the Montgomery West Homeowners Association. Water runs down the impervious asphalt surface, past the Project paper author's house at the end of the cul-de-sac, and enters a storm water drain down one house from the street address of 8812. The earthen berms are visible but it is difficult to make out the one type of trees (willows) within the flooded portion of the retention pond versus the higher elevation woodlands.

The Google Earth view also shows the adjoining Montgomery County Parks and Planning land. This land is known as the Cabin Branch Stream Valley Park. Water from the storm water retention pond runs into the Cabin Branch stream. This is via a small drainage ditch through the adjacent woodlands. There is a lateral dark line that marks this stream although the drainage ditch is hidden by the stream cover. Storm water retention pond site at the back of 8812 Mourning Dove Court, Gaithersburg, MD 20879-1775. Various views available at this link http://www.google.com/earth/explore/products/.

First picture is the Google Earth view of a down sloping Mourning Dove Court and cul-de-sac; 8812 is the first house on the right hand turn and curve.

Second view is a Google Earth view of the storm water retention pond at the back of 8812 Mourning Dove Court. The curved clear path is the site pond embankment that

serves as two thirds of the rough triangle of the pond site. The rest of the pond channels, flood plain and higher elevation is covered by woods that have grown up over the last thirty-five years.

MWHOA aerial map.pdf

Appendix 2

Major Plant Types, Major Forest and Other Vegetation

There are several types of currently unidentified weeds, grasses, and shrubs. There may be invasive plant species present. In 2012 Montgomery County surveyed, tagged, and numbered all trees on the case study site. The appropriate county office will be contacted to see if a biological inventory was conducted. If not available then the author will conduct an inventory using taxonomic guides and Maryland plant species lists.

As mentioned in Ward (2009) the world is green (179) particularly in this small site. Whitetail deer do feed on the understory and smaller trees but not in enough numbers to remove this vegetation. Vegetation types include the following: algae, lichens (fungi and algae), fungi (below and above ground), grasses, weeds, shrubs, and trees. Perry (2008) adds lichens, algae and fungi in reference to the discussion on species composition surrounding individual trees and dead logs. Montgomery County conducted an inventory which included a specific survey of all trees over a circumference of one inch. Each tree received a metal and numbered tag. It is winter time in Maryland which makes almost impossible to identify individual tree species. However, examples of tree species include some type of Willow (*Salix alba*), Black Cherry (*Prunus seritina*) , and Sassafras (*Sassafras albidum).*

Appendix 3

Vertebrate Assemblages

Most of the animals listed below use the site pond as habitat. They rely on the running water in the channels, the embankment meadows, the understory and mature forest for food, shelter and protection from predators. For example, the Eastern white tailed deer (*Odocoileus virgininus*) are mostly transients but some resting activity has been observed along with daily feeding on the site grass and shrubs. Very few animals were observed at this site thirty-five years ago when it was mostly bare soil and then meadow. As benign neglect from the homeowners association and County have predominated the trees and shrubs have grown over the last two decade and many other types of animals have been observed.

My perception is that most local homeowners have a neutral view towards the pond if they are even aware of its existence. Most homeowners do not like the deer munching on their expensive ornamental shrubs and plants. The deer roam throughout the year even though they have ample vegetation sources on the site and adjacent landscape. However, the problem is more pronounced during the winter time and evergreens of various types are a particular deer favorite. Residents also don't like hitting deer with their cars but this is a common occurrence in the fall rutting season.

The species composition of vertebrate abundance appears to be the same as the adjacent landscape that contains a water feature. Ward (2009) mentions "…the species-area curve is one of the few 'laws' in nature, which indicates that as area increases, the number of species increases" (p. 193). Since the site pond is an extremely small area the inverse is also true – there are not too many animal or vegetation species. Reptiles observed over the last twenty-five years include: Eastern Black Kingsnake (*Lampropeltis nigra*), Eastern Garter Snake (*Thamnophis sirtalis sirtalis*), Eastern box turtle (*Terrapenne carolina carolina*), and Eastern snapper turtle (*Chelydra serpentine serpentine*). Amphibians observed over the last twenty-five years include: Northern leopard frog (*Rana pipiens*), American bullfrog (*Rana catesbeiana*), and various species of toads of unknown species. Mammals observed over the last twenty-five years include: white-tailed deer (*Odocoileus virginianus*); raccoons (*Procyon lotor*); groundhogs (*Marmota monax*); red fox (*Vulpes vulpes*); Eastern chipmunk (*Tamias straitus*); Northern short-tailed shrews (*Blarina brevicauda*); cows (unknown species escaped from a local farm), an occasional Eastern coyote (*Canis latrans*), occasional pet dogs of various breeds, and numerous pet and feral cats of various breeds.

Birds observed over the last twenty-five years tend to be suburban backyard species that roost and nest in the site woodlands. During the wet pond stable state there was even a pair of Canadian geese nesting on the embankment. Other species noted include: Northern cardinal (*Cardinalis cardinalis*), blue jay (*Cyanocitta cristata*), House sparrow (*Passer domesticus*), and a pair of Canadian geese (*Branta Canadensis*) one year, Common starling (*Stumus vulgaris*), American crow (*Corvus brachyrhynchos*), Turkey vulture (*Cathartes aura*), mallard duck (*Anas platyrhynchos*), Great Blue Heron

(*Ardea Herodias*), Wood Thrush (*Hylocichla mustelina*), Northern mockingbird (*Mimus polyglottos*) , Red-tailed hawk (*Buteo jamaicensis*) , Mourning Dove (*Zenaida macroura*), and House Wren (*Troglodytes aedon*).

Appendix 4

Invertebrate Assemblages

There are at least five types of insect herbivores at the site. The first example is yearly infestations of the Eastern Tent Caterpillar (*Malacosoma americanum*). The second is the white pine beetle (*Pinus albicaulis*) larvae found at the tops of the white pine trees. The third is an unidentified white grub found in decomposing tree stumps; probably a wasp or bee of some wood eating species. The fourth are monarch butterfly (*Danaus plexippus*) caterpillars attracted to milkweed. The fifth type of insect includes both annual and periodic (13 and 17 year) cicadas (*Tibicen pruinosa*).

At the site pond the ecological roles are diverse. First and foremost the various types of insects provide food for different types of birds. Caterpillars and other leaf munching insects provide food for woodland canopy loving birds. There are also insects that in their larval life cycle state live in standing and fallen trees. They provide food for such birds as woodpeckers and I have seen a number of trees in my site with the characteristics woodpecker holes. With the cicadas as Perry has mentioned (p. 436) these insects take nutrients from the roots of hardwood trees and pulse these nutrients into the topsoil when they die and decompose. Other herbivores such as monarch butterfly caterpillars do not provide as much food for birds as they find them distasteful due to chemicals ingested from the milkweed plant. Insect infestations that kill trees can provide an important source of natural disturbance in the site woodlands by providing a source of standing deadwood habitat for different types of animals and birds.

There are several factors that keep herbivores in check. As mentioned above it appears to be primarily birds that maintain a check and balance on this small site ecosystem. However, in the case of the tent caterpillar, some years have seen major infestations, and other years they hardly make an appearance at all. The site woodlands are a heterogeneous stand so its diversity of tree species may also be keeping the tent caterpillars in check. They appear to like black cherry in particular.

Another factor mentioned by Perry (2008, p. 420) is the role of secondary chemicals in controlling insect infestations. Some of these hardwood trees may be producing a chemical that inhibits the insects by providing a natural pesticide that either inhibits growth, or makes toxins or digestibility reducers that the insects do not like. It is also possible that the local climate is changing, and that extremes of temperature during the winter or summer are keeping the insect populations in check by disrupting their life cycles. Perhaps the flooding or drought has the same effect of insect populations.

Environmental stress of the trees can create opportunities for insect outbreaks. However, the trees on the site appear to be very healthy and not stressed, with positive growth every year. It is also possible that there is nothing within the site that is inhibiting the populations but some effect in the adjacent landscape that is responsible. For example, there may have been some type of pollution from the nearby road that coats trees with a manmade chemical that inhibits insect populations.

Appendix 5

Informed Consent Letter for Montgomery West Homeowners Association

October 10, 2014

Dear Resident of Montgomery West Homeowners Association (MWHOA),

My name is Bill Roberts and I am your neighbor at 8812 Mourning Dove Court. I am currently enrolled in an online Master of Natural Resources (MNR) program at Oregon State University. As part of the MNR degree requirements I am distributing the attached perception survey to you on relevant issues of clean water in our community. While the attached survey has been reviewed by the MWHOA Board, and some feedback incorporated into the final product, this survey is not part of the MWHOA nor endorsed by them. This is your opportunity to learn what is important to MWHOA residents on the critical issue of storm water, runoff and the role of storm water ponds in our neighborhood.

This survey asks about your experiences with storm water management, your opinions about residential storm water runoff, and possible pollutants carried by that runoff into our local storm water retention ponds, streams and watershed. This survey is only being distributed to the 104 households of the MWHOA. Your participation is completely voluntary. However, your responses are very important to our work and they will give managers and researchers a better understanding of the actions people believe are important for improving conditions in our local watershed. We will summarize the views expressed by survey participants and prepare a full report for the MWHOA Board of Directors and other interested Montgomery County agencies land and water quality managers. This information will be useful for local managers who are faced with future storm water events while recovering from the effects of past ones.

We hope you will take a few minutes to fill out this questionnaire and return it in the self-addressed stamped envelope provided. It should take about 15 minutes to complete. We understand how valuable your time is and appreciate your efforts. Any adult over 18 years of age can fill out the survey. Your responses will be kept confidential. Any information you provide will not be associated with you personally. It will be combined with other responses and presented in a summary format. If you do not want to participate and do not wish to be contacted further, please return the uncompleted survey in the envelope enclosed. This will prevent further survey contact efforts by myself.

Participation in this survey is voluntary and you may skip any questions at any time. While there is no foreseeable risks or benefits to you personally, your participation is highly valued. There is an identification number on the back of the survey that helps us know who has responded to the survey and allows us to stop mailing people who have responded. Once your survey is returned, this number will be disassociated with your personal information and we will not contact you again for this project.

We appreciate your interest in the local water supply. If you have any questions about this survey please contact William H. Roberts, Jr, Student Researcher, or Dr. Samuel Chan, Principal Investigator, using the information below. If you have any questions about your rights as a participant, please contact the Oregon State University Institutional Review Board (IRB) Human Protections Administrator at 541-737-8008 or by e-mail at IRB@oregonstate.edu. We look forward to hearing from you!

Sincerely,

Dr. Samuel Chan, Principal Investigator
Watershed Health Specialist
Oregon State University
(503) 679-4828
Samuel.Chan@oregonstate.edu

William H. Roberts, Jr.
Student Researcher
Oregon State University
(301) 977-3025
whadynrob@gmail.com

Appendix 6

MNR 560 Master's Case Study Montgomery West Homeowners Association Perception Survey

Q1 Have you ever visited and walked around the ponds at:

	Yes (1)	No (2)
Mourning Dove Court (1)	-	-
Kinglet Place/Swallow Court Pond (2)	-	-

Q2 What primary purpose do you think these ponds serve (select up to 2)?

- Control and slowly release rainfall flows (1)
- Retains and filters pollutants and sediments (2)
- Wildlife habitat (3)
- Recreation (4)
- Aesthetics (5)
- No purpose (6)
- I don't really know (7)
- Other? (8) _____

Q3 Who owns and manages the pond at:

	Unknown (1)	MWHOA (2)	Montgomery County (3)
Mourning Dove Court cul-de-sac (1)	-	-	-
Kinglet Place and Swallow Court (2)	-	-	-

Q4 What do you value about these ponds?

Q5 How would you define storm water?

- Water runoff from roofs, yards, streets and sidewalks (1)
- Water with substances washed off of roofs, yards, streets and sidewalks (2)
- Water from storms that can cause flash floods when it runs off too quickly from pavements and does not drain fast enough through the soil (3)
- All of the above (4)
- Other definition? (5) _____

Q6 What is your perception of the roles of storm ponds in the Montgomery West HOA. (Check ALL that apply):

- Evens out storm water flow (1)
- Filters out sediment (2)
- Filters out pollutants (3)
- Stores storm water runoff (4)
- Wildlife habitat (5)
- Other? (6) _____

Q7 How important of a problem do you regard excessive runoff and pollution of stormwater:

	High (1)	Low (2)
To the environment (1)	-	-
To the neighborhood (2)	-	-

Q8 Are you aware of any of the following sources of chemicals and runoff in the MWHOA neighborhood that can enter streams and the Chesapeake Bay? (Check ALL that apply):

- Radiator fluid on driveways/roads (1)
- Oily fluids (gasoline, diesel, engine oil, etc.) on driveways/roads (2)
- Degreasers (3)
- Solvents (4)
- Soapy water from car washing (5)
- Lawn fertilizer pellets (6)
- Deicers (7)
- Sediments (8)
- Garage and wood shop waste materials (oils, stains, turpentine, paint thinner, sawdust) (9)
- Other? (10) _____

Q9 Which type of lawn care products do you typically use? (Check ALL that apply.)

	Spring (1)	Summer (2)	Fall (3)	Winter (4)
Fertilizer only (1)	-	-	-	-
Weed and feed (2)	-	-	-	-
Organic lawn care products (3)	-	-	-	-

Q10 Do you currently hire someone to take care of your lawn?

- Yes (1)
- No (2)

Q11 Have you observed any lawn care products spilling out onto the street during application of lawn care products?

- Yes (1)
- No (2)

Q12 Do you ever apply any of these products to the exterior of your house or landscaping? (Check ALL that apply.):

- Pesticides (1)
- Herbicides (2)
- Fungicides (3)
- Weed preventer (4)
- Dandelion weed control (5)
- Insect and grub control (6)
- Crab grass control (7)
- Moss control (8)
- Algae control (9)
- Rodent control (10)
- Other? (11) _____

Q13 Do you apply driveway sealants or cleaning products? (Check ALL that apply.):

- Driveway sealant (1)
- Asphalt patch (2)
- Tar (3)
- Driveway degreaser (4)
- Oil spot primer (5)
- Other? (6) _____

Q14 How important do you view an excessive amount of the following landscape debris on the streets, roofs, gutters and drainages as a problem for your house and the livability of the community? (Check ALL that apply.):

- Grass clippings (1)
- Fallen leaves (2)
- Weeds (3)
- Foreign, exotic or invasive clippings or seeds (4)
- Other? (5) _____

Q15 In the wintertime do you apply snow and ice melt treatments? (Check ALL that apply.):

- Road salt (sodium chloride) (1)
- Ice melt treatment (2)
- Sand (3)
- Cat litter (4)
- Soil sediment (5)
- Other? (6) _____

Q16 Are you aware of any of the following items in the MWHOA street gutters? Check ALL that apply.):

- Paint (1)
- Dog droppings (2)
- Cleaning supplies (3)
- Cooking oil or grease (4)
- Cigarette butts or ashes (5)
- Pharmaceuticals or other drugs (6)
- Other household liquids? (7) _____

Q17 Are you aware of any of the following means used by MWHOA homeowners to reduce storm water runoff? (Checl ALL that apply):

- Maintain lawn (1)
- Rain barrels (2)
- Rainwater cistern (3)
- Roof downspout diversion (4)
- Infiltration trench (5)
- Rain garden (6)
- Drywell/French drain (7)
- Swale (8)
- Low impact development (9)
- Permeable pavement/pavers (10)
- Porous concrete (11)
- Porous asphalt (12)
- Green (vegetated) rooftop (13)
- Planting trees, shrubs, and other vegetation (14)
- Mulching around shrubs and trees (15)
- Compost bins for organic waste (16)
- Other? (17) _____

Q18 Are you aware of any of the listed Federal, State of Maryland, Montgomery County, or other non-profit programs to reduce the issues listed in this survey? (Check ALL that apply.):

- Adopt-a-Road (Montgomery County) (1)
- Backyard Buffers (Montgomery County Department of Natural Resources Forest Service, and Potomac Watershed Partnership) (2)
- Storm Drain Marking Program (Montgomery County) (3)
- Environmental Site Design (Montgomery County) (4)
- RainScapes Program (Montgomery County Department of Environmental Protection) (5)
- Total Maximum Daily Load (TMDL) (U.S. Environmental Protection Agency) (6)
- Conservation Landscapes (Casa De Maryland) (7)
- Marylanders Plant Trees (Maryland Department of Natural Resources) (8)
- Illegal Dumping and Stream Contamination Hotline (Montgomery County Department of Environmental Protection) (9)
- Household Hazardous Waste Collection Event (Montgomery County Department of Environmental Protection) (10)
- Pharmaceutical Drugs and Drinking Water (Washington Sanitary Suburban Commission) (11)
- Forestry for the Bay (Montgomery County Department of Natural Resources Forest Service, Alliance for the Chesapeake Bay, Chesapeake Bay Program) (12)
- Low Impact Development (LID) (Potomac Conservancy and The Nature Conservancy) (13)
- Other? (14) _____

Q19 How long (in years) have you lived within the Montgomery West Homeowners Association (MWHOA)?

Q20 Do you own or rent your home?

- Homeowner household (1)
- Renter household (2)

Q21 What do you think can or should be done to reduce the runoff of chemicals and other potential pollutants from our community into our waterways?

Q22 What additional questions and comments do you want to know about water quality, storm water ponds, storm water and things we can do in our neighborhood?

Appendix 7

List of Non-point Source Pollutants

Radiator fluid on driveway/roads
Brake fluid on driveway/roads
Power steering fluid on driveway/roads
Transmission fluid on driveway/roads
Oil on driveway/roads
Gasoline on driveway/roads
Diesel fuel on driveway/roads
Degreasers
Solvents
Soapy water from car washing
Fertilizer only
Weed and feed
Organic lawn care products
Pesticides
Herbicides
Weed preventer
Dandelion weed control
Grub control
Crab grass control
Moss control
Algae control
Rodent control
Driveway sealant
Asphalt patch
Tar
Driveway degreaser
Oil spot primer
Grass clippings
Fallen leaves
Tree flower petals
Foreign, exotic or invasive clippings or seeds
Road salt (sodium chloride)
Ice melt treatment
Sand
Cat litter
Soil sediment
Paint
Dog droppings
Cleaning supplies
Cooking oil or grease
Cigarette butts or ashes
Pharmaceuticals or other drugs

Appendix 8

List of Stormwater Management Techniques

Maintain lawn
Rain barrels
Cistern
Downspout diversion
Infiltration trench
Rain garden
Drywell/French drain
Swale
Lawn pond
Permeable pavement/pavers
Porous concrete
Porous asphalt
Green (vegetated) rooftop
Planting trees, shrubs, and other vegetation
Mulching around shrubs and trees

Appendix 9

List of Government and Non-profit Environmental Education Programs

Adopt-a-Road (Montgomery County),
Backyard Buffers (Montgomery County Department of Natural Resources Forest Service, and Potomac Watershed Partnership),
Storm drain Marking Program (Montgomery County)
Environmental Site Design (Montgomery County)
RainScapes Program (Montgomery County Department of Environmental Protection)
Total Maximum Daily Load (TMDL) (U.S. Environmental Protection Agency)
Conservation Landscapes (Casa De Maryland)
Marylanders Plant Trees (Maryland Department of Natural Resources)
Illegal Dumping and Stream Contamination Hotline (Montgomery County Department of Environmental Protection)
Household Hazardous Waste Collection Event ((Montgomery County Department of Environmental Protection)
Pharmaceutical Drugs and Drinking Water (Washington Sanitary Suburban Commission)
Water Wise Landscaping (Washington Sanitary Suburban Commission)
Forestry for the Bay (Montgomery County Department of Natural Resources Forest Service
Alliance for the Chesapeake Bay, Chesapeake Bay Program)
Low Impact Development (LID) (Potomac Conservancy and The Nature Conservancy)

Appendix 10

My Report

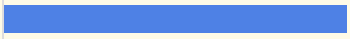
Last Modified: 01/05/2015

1. Have you ever visited and walked around the ponds at:

#	Question	Yes	No	Total Responses	Mean
1	Mourning Dove Court	16	34	50	1.68
2	Kinglet Place/Swallow Court Pond	17	33	50	1.66

Statistic	Mourning Dove Court	Kinglet Place/Swallow Court Pond
Min Value	1	1
Max Value	2	2
Mean	1.68	1.66
Variance	0.22	0.23
Standard Deviation	0.47	0.48
Total Responses	50	50

2. What primary purpose do you think these ponds serve (select up to 2)?

#	Answer		Response	%
1	Control and slowly release rainfall flows		36	72%
2	Retains and filters pollutants and sediments		23	46%
3	Wildlife habitat		9	18%
4	Recreation		1	2%
5	Aesthetics		3	6%
6	No purpose		1	2%
7	I don't really know		8	16%
8	Other?		2	4%

Other?
BOX TURTLES + FROGS
STORM WATER MGMT

Statistic	Value
Min Value	1
Max Value	8
Total Responses	50

3. Who owns and manages the pond at:

#	Question	Unknown	MWHOA	Montgomery County	Total Responses	Mean
1	Mourning Dove Court cul-de-sac	21	10	19	50	1.96
2	Kinglet Place and Swallow Court	20	9	21	50	2.02

Statistic	Mourning Dove Court cul-de-sac	Kinglet Place and Swallow Court
Min Value	1	1
Max Value	3	3
Mean	1.96	2.02
Variance	0.81	0.84
Standard Deviation	0.90	0.91
Total Responses	50	50

4. What do you value about these ponds?

Text Response
HELPS WITH HEAVY (READY OUT LET) DURING WET SEASON'S FLASH FLOODS OF RAIN AND SNOW MELT.
I TRULY KNOW NOTHING ABOUT THEM, NOR THOUGHT OF THEIR PURPOSE BEFORE THIS.
? NOT A FAN OF THE STANDING WATER.
NO VALUE FROM MY POINT OF VIEW
AESTHETICS
WATER - FLOW CONTROL TO SURROUNDING AREAS
THAT THEY ARE BEHIND MY HOUSE CATCH WATER THAT MIGHT GO TO NEIGHBORS HOUSES
WILD LIFE HABITAT AND CONTROL OF RAINFALL FLOWS
RECREATION BEAUTY
AESTHETICALLY PLEASING WHILE PURPOSEFUL AND USEFUL TO WILDLIFE.
NOTHING
HA
HELPS W/ STORM WATER MGMT.
TRANQUILITY - PEACEFULNESS - BEING IN NATURE AND ENJOYING THE BEAUTY FORMATION OF GEESE WHEN THEY LAND CO-EXISTENCE OF PEOPLE AND ANIMAL LIFE
N/A
THE FACT THAT THEY FULFILL THEIR PRIMARY PURPOSE
THEY SERVE THE PURPOSE OF QUENCHING WILDLIFE THIRST IN SUMMER TIME.
THEY CONTROL WHAT EVENTUALLY FLOWS DOWN STREAM/OUR DRINKING WATER
NA
NATURAL AREAS
WILDLIFE HABITAT
NOTHING.
SINCE I DON'T KNOW WHY THEY'RE THERE, I HAVE NO COMMENT ON THEIR VALUE.
STORM WATER MANAGEMENT, WILDLIFE HABITAT
A NECESSARY EVIL
REDUCE FLOODING
WATER FLOW CONTROL
IT ATTRACTS WILDLIFE AND THEY'RE (MONTGOMERY COUNTY) IS NOT BUILDING 10 HOUSES ON IT!!
WATER FOR WILDLIFE
DON'T KNOW
HOPEFULLY IT HELPS WITH FLOODINGS
IMPACT ON RUN-OFF

Statistic	Value
Total Responses	32

5. How would you define storm water?

#	Answer		Response	%
1	Water runoff from roofs, yards, streets and sidewalks		5	10%
2	Water with substances washed off of roofs, yards, streets and sidewalks		1	2%
3	Water from storms that can cause flash floods when it runs off too quickly from pavements and does not drain fast enough through the soil		5	10%
4	All of the above		37	76%
5	Other definition?		2	4%

Other definition?
THEY ALSO BALANCE THE ENVIRONMENT.
WATER FROM A STORM WHETHER OR NOT I HAVE A ROOF, A YARD, OR A STREET.

Statistic	Value
Min Value	1
Max Value	5
Total Responses	49

6. What is your perception of the roles of storm ponds in the Montgomery West HOA. (Check ALL that apply):

#	Answer		Response	%
1	Evens out storm water flow		36	75%
2	Filters out sediment		17	35%
3	Filters out pollutants		13	27%
4	Stores storm water runoff		30	63%
5	Wildlife habitat		19	40%
6	Other?		3	6%

Other?
COLLECTS SOME OF TRASH THAT RINSES ALONG WITH WATER
I DON'T KNOW
(HUMANS) WE SHOULDN'T BE POLLUTING

Statistic	Value
Min Value	1
Max Value	6
Total Responses	48

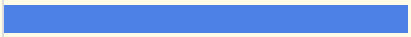
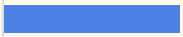
7. How important of a problem do you regard excessive runoff and pollution of stormwater:

#	Question	High	Low	Total Responses	Mean
1	To the environment	34	13	47	1.28
2	To the neighborhood	29	18	47	1.38

Statistic	To the environment	To the neighborhood
Min Value	1	1
Max Value	2	2
Mean	1.28	1.38
Variance	0.20	0.24
Standard Deviation	0.45	0.49
Total Responses	47	47

8. Are you aware of any of the following sources of chemicals and runoff in the MWHOA neighborhood that

can enter streams and the Chesapeake Bay? (Check ALL that apply):

#	Answer		Response	%
1	Radiator fluid on driveways/roads		24	52%
2	Oily fluids (gasoline, diesel, engine oil, etc.) on driveways/roads		30	65%
3	Degreasers		15	33%
4	Solvents		15	33%
5	Soapy water from car washing		39	85%
6	Lawn fertilizer pellets		32	70%
7	Deicers		18	39%
8	Sediments		23	50%
9	Garage and wood shop waste materials (oils, stains, turpentine, paint thinner, sawdust)		17	37%
10	Other?		5	11%

Other?
PAINT WASTE
NONE AWARE
NOT AWARE OF ANY
SOME PEOPLE USE THEM TO LITTERING.
1) APPLES FROM THE NEIGHBOR'S TREE 2) MY KIDS FRISBEE 3) EMPTY WATER BOTTLES

Statistic	Value
Min Value	1
Max Value	10
Total Responses	46

9. Which type of lawn care products do you typically use? (Check ALL that apply.)

#	Question	Spring	Summer	Fall	Winter	Total Responses	Mean
1	Fertilizer only	19	0	0	0	19	1.00
2	Weed and feed	22	4	3	0	29	1.34
3	Organic lawn care products	7	1	0	1	9	1.44

Statistic	Fertilizer only	Weed and feed	Organic lawn care products
Min Value	1	1	1
Max Value	1	3	4
Mean	1.00	1.34	1.44
Variance	0.00	0.45	1.03
Standard Deviation	0.00	0.67	1.01
Total Responses	19	29	9

10. Do you currently hire someone to take care of your lawn?

#	Answer		Response	%
1	Yes		18	36%
2	No		32	64%
	Total		50	100%

Statistic	Value
Min Value	1
Max Value	2
Mean	1.64
Variance	0.24
Standard Deviation	0.48
Total Responses	50

11. Have you observed any lawn care products spilling out onto the street during application of lawn care products?

#	Answer		Response	%
1	Yes		2	4%
2	No		47	96%
	Total		49	100%

Statistic	Value
Min Value	1
Max Value	2
Mean	1.96
Variance	0.04
Standard Deviation	0.20
Total Responses	49

12. Do you ever apply any of these products to the exterior of your house or landscaping? (Check ALL that apply.):

#	Answer		Response	%
1	Pesticides		16	33%
2	Herbicides		7	15%
3	Fungicides		3	6%
4	Weed preventer		30	63%
5	Dandelion weed control		14	29%
6	Insect and grub control		15	31%
7	Crab grass control		16	33%
8	Moss control		1	2%
9	Algae control		0	0%
10	Rodent control		3	6%
11	Other?		6	13%

Other?
NONE IN PAST 5 YRS.
NONE OF THE ABOVE.
INSECT CONTROL
USUALLY ORGANIC PRODUCT
NO
WEED + FEED

Statistic	Value
Min Value	1
Max Value	11
Total Responses	48

13. Do you apply driveway sealants or cleaning products? (Check ALL that apply.):

#	Answer		Response	%
1	Driveway sealant		18	55%
2	Asphalt patch		6	18%
3	Tar		1	3%
4	Driveway degreaser		1	3%
5	Oil spot primer		0	0%
6	Other?		13	39%

Other?
NONE
NONE
NONE, BUT WE HAVE A TAR DRIVE
NONE
NA
NONE OF THE ABOVE.
N/A
NONE
NO BUT I WILL SOON (I'M DUE)
N/A
N/A
NO
NONE

Statistic	Value
Min Value	1
Max Value	6
Total Responses	33

14. How important do you view an excessive amount of the following landscape debris on the streets, roofs, gutters and drainages as a problem for your house and the livability of the community? (Check ALL that apply.):

#	Answer		Response	%
1	Grass clippings		11	26%
2	Fallen leaves		29	69%
3	Weeds		17	40%
4	Foreign, exotic or invasive clippings or seeds		16	38%
5	Other?		5	12%

Other?
NONE
DONT THINK WE HAVE?
?
NONE
FALLEN TREES/LIMBS IN COMMON AREAS

Statistic	Value
Min Value	1
Max Value	5
Total Responses	42

15. In the wintertime do you apply snow and ice melt treatments? (Check ALL that apply.):

#	Answer		Response	%
1	Road salt (sodium chloride)		15	35%
2	Ice melt treatment		27	63%
3	Sand		9	21%
4	Cat litter		5	12%
5	Soil sediment		0	0%
6	Other?		4	9%

Other?
NONE OF THE ABOVE
NO
ICE MELT TREATMENT - RARELY NONE
NONE

Statistic	Value
Min Value	1
Max Value	6
Total Responses	43

16. Are you aware of any of the following items in the MWHOA street gutters? Check ALL that apply.):

#	Answer		Response	%
1	Paint		4	11%
2	Dog droppings		9	24%
3	Cleaning supplies		4	11%
4	Cooking oil or grease		0	0%
5	Cigarette butts or ashes		22	59%
6	Pharmaceuticals or other drugs		0	0%
7	Other household liquids?		12	32%

Other household liquids?
DO NOT KNOW
NONE
NO
TRASH ON CENTERWAY
SODA/BEER CANS/BOTTLES
NONE AWARE
NO
NONE
NOT AWARE OF ANY OF THESE ITEMS PRESENT IN THE MWHOA STREET GUTTERS
NONE.
NOPE
NO

Statistic	Value
Min Value	1
Max Value	7
Total Responses	37

17. Are you aware of any of the following means used by MWHOA homeowners to reduce storm water runoff? (Checl ALL that apply.):

#	Answer		Response	%
1	Maintain lawn		35	74%
2	Rain barrels		7	15%
3	Rainwater cistern		1	2%
4	Roof downspout diversion		23	49%
5	Infiltration trench		2	4%
6	Rain garden		1	2%
7	Drywell/French drain		3	6%
8	Swale		3	6%
9	Low impact development		0	0%
10	Permeable pavement/pavers		5	11%
11	Porous concrete		0	0%
12	Porous asphalt		0	0%
13	Green (vegetated) rooftop		0	0%
14	Planting trees, shrubs, and other vegetation		28	60%
15	Mulching around shrubs and trees		32	68%
16	Compost bins for organic waste		11	23%
17	Other?		2	4%

Other?
NONE
N/A

Statistic	Value
Min Value	1
Max Value	17
Total Responses	47

18. Are you aware of any of the listed Federal, State of Maryland, Montgomery County, or other non-profit programs to reduce the issues listed in this survey? (Check ALL that apply.):

#	Answer		Response	%
1	Adopt-a-Road (Montgomery County)		34	92%
2	Backyard Buffers (Montgomery County Department of Natural Resources Forest Service, and Potomac Watershed Partnership)		0	0%
3	Storm Drain Marking Program (Montgomery County)		11	30%
4	Environmental Site Design (Montgomery County)		6	16%
5	RainScapes Program (Montgomery County Department of Environmental Protection)		4	11%
6	Total Maximum Daily Load (TMDL) (U.S. Environmental Protection Agency)		1	3%
7	Conservation Landscapes (Casa De Maryland)		3	8%
8	Marylanders Plant Trees (Maryland		10	27%

	Department of Natural Resources)			
9	Illegal Dumping and Stream Contamination Hotline (Montgomery County Department of Environmnetal Protection)		5	14%
10	Household Hazardous Waste Collection Event (Montgomery County Department of Environmental Protection)		15	41%
11	Pharmaceutical Drugs and Drinking Water (Washington Sanitary Suburban Commission)		2	5%
12	Forestry for the Bay (Montgomery County Department of Natural Resources Forest Service, Alliance for the Chesapeake Bay, Chesapeake Bay Program)		5	14%
13	Low Impact Development (LID) (Potomac Conservancy and The Nature Conservancy)		6	16%
14	Other?		1	3%

Other?
NO

Statistic	Value
Min Value	1
Max Value	14
Total Responses	37

19. How long (in years) have you lived within the Montgomery West Homeowners Association (MWHOA)?

Text Response
26
15 YEARS
3 YR
10
4
6 YEARS
27
16 OR SO YEARS
12 +
24
31 +
5 YEARS
29 YEARS
30
28
18 YEARS
20 YRS.
15 YEARS
2 MONTHS (0 YEARS)
1 YEAR
19 YEARS, SINCE 1995
14
30 YEARS
2 YEARS
18
4 YEARS
3 YEARS
29 YEARS
26 YEARS, SINCE 1987
15 YEARS
9 YEARS
28 YR.
32 YEARS
20
12
5 YRS
13 YEARS
19 YEARS
25 YEARS
11 1/2 YRS
10

Statistic	Value
Total Responses	41

20. Do you own or rent your home?

#	Answer		Response	%
1	Homeowner household		46	100%
2	Renter household		0	0%
	Total		46	100%

Statistic	Value
Min Value	1
Max Value	1
Mean	1.00
Variance	0.00
Standard Deviation	0.00
Total Responses	46

21. What do you think can or should be done to reduce the runoff of chemicals and other potential pollutants from our community into our waterways?

Text Response
ROAD'S ARE BAD NEED OF RE PAVING WEED'S AND GRASS IS NOW A PROBLEM
WE SHOULD PUT GRATES OVER OUR DRAINS ON THE STREET + MARK "SAVE THE BAY" ON THEM. ALSO EDUCATE NEIGHBORS ON PROPER CHEMICALS TO USE = HOW TO DISPOSE OF THINGS.
? IS IT A PROBLEM HERE?
STORM DRAIN FILTERS REPLACE OUT DATED STORM DRAINS, SO THAT THERE IS NO DIRECT RUNOFF INTO THE BAY/OCEAN.
1) IS THERE A LOCAL PROBLEM? 2) IF SO, BEGIN DISCUSSIONS HOW TO AMELIORATE PROBLEM I DON'T KNOW IF THERE IS SUCH A PROBLEM IN OUR COMMUNITY.
NOT SURE?
NO COMMENTS.
1) LIMIT THE APPLICATION OF LAWN CHEMICALS TO NON-RAINY MONTHS. 2) SET UP DROP OFF CENTER FOR EXPIRED/UNUSED MEDICATIONS AND HOUSEHOLD CHEMICALS.
MORE EDUCATION. SEND INFORMATION VIA HOA OR OFFICIAL COUNTY GOV. MAIL SO RESIDENTS DON'T OVERLOOK THEM AS JUNK MAIL.
KEEP EDUCATING THE PUBLIC
INFORM RESIDENTS ROUTINELY PROVIDE PICKUP (IF FISCALLY POSSIBLE) OF HAZARDOUS WASTE INFORM OF SAFER MEANS TO MAINTAIN LAWN/GARDEN, STOP WEEDS THAT ARE AVAILABLE + AFFORDABLE.
?
NO OPINION
1) REDUCTION OF CHEMICALS. 2) EDUCATE RESIDENTS ON ENVIRONMENTAL IMPACT REDUCTION 3) PROMOTE RESIDENTIAL GARDENING.
- IMPROVE CHEMICALS (CONTENT) - PUBLIC INFORMATION ON HIGH VIS WEBSITE (GAZETTE.NET, MWHOA. ETC)
- EDUCATE MEMBERS OF THE COMMUNITY ABOUT DANGERS CREATED BY THE PRESENCE OF CHEMICALS AND OTHER POLLUTANTS IN OUR WATERWAYS
TIGHTEN CONTROLS ON CHEMICAL USERS LIKE FRANCHISE RESTAURANTS.
NA
CONTROL/REDUCE NUMBER OF COMMERCIAL VEHICLES WHICH CONTRIBUTES TO OIL SLICKS, DEICERS, ETC. AND EACH HOMEOWNER SHOULD BE REMINDED OF PONDS PURPOSE AND CONSCIOUSLY REDUCE POLLUTANTS RUNNING OFF PROPERTY.
DO MORE RECYCLE
HAVE AN EVENT THAT ALLOWS MWHOA OWNERS TO TURN IN POTENTIAL POLLUTANTS
- KEEP THE PONDS WELL MAINTAINED - ADD "DRAINS TO THE BAY" SIGNS ON STORM DRAINS (IF, IN FACT THEY DO DRAIN TO THE BAY!)
UNKNOWN AT THIS TIME.
BE MORE AWARE OF WHAT WE USE ON OUR LAWNS IF THEY'RE DOING HARM.
STOP USING THEM AND CREATE A LOW MAINTENANCE GREEN ENVIRONMENT/SURROUNDING.

REDUCE USE OF LAWN CHEMICALS - MULCHING GRASS CLIPPINGS W/ A MULCHING MOWER IS ALL THAT IS NEEDED FOR FERTILIZER. HEALTHY GRASS WILL CROWD OUT WEEDS + CRABGRASS.
ENFORCE EXISTING LAWS
RAIN BARRELS GRATES ON STORM DRAINS AWARENESS/EDUCATION
BAN NON-ORGANIC FERTILIZERS.
TRANSPORT ANY OLD OR USED CHEMICALS TO APPROPRIATE SECTION OF COUNTY WASTE STATION. TRY TO REDUCE AMOUNT OF DETERGENTS AND OTHER POTENTIAL POLLUTANTS.
DON'T KNOW
TO CONTROL USE. NOT TO OVER USE THE ICE MELTS + FERTILIZERS

Statistic	Value
Total Responses	32

22. What additional questions and comments do you want to know about water quality, storm water ponds, storm water and things we can do in our neighborhood?

Text Response
MAKE SURE EVERY CUTS IT IS/HER YARD NLT 1) EVERY 3 WEEKS 2) TRIM TREES NEAR STREET LIGHTS 3) RE PAVE MWHOA HOME AREA ROAS'
NONE -
PROTECT HOMEOWNERS LAND FROM WEATHER EROSION - I AM CURRENTLY LOSING LAND.
IF WE SHOULD KNOW, PLEASE EDUCATE US. GOOD LUCK WITH YOUR PROJECT + YOUR DEGREE!
NONE
- MAINTAIN PONDS SO THAT TREES, WEEDS DON'T INTERFERE WITH DRAINAGE. - LANDSCAPING TO DIRECT WATER FLOW - KEEP COMMON AREAS FREE OF LAWN DEBRIS SO MOWERS CAN MOW. - 2ND YEAR THE LAWN PEOPLE DON'T MOW COMMON AREA NEXT TO OUR HOUSE.
NO COMMENTS.
A REPORT ON THE PONDS EVERY YEAR WOULD BE NICE AND INCLUDE ANYTHING RESIDENTS SHOULD DO TO HELP WITH ISSUES 9IF ANY).
PROVIDE INFO ON ABOVE + WHERE TO PURCHASE SUBSIDIZE PART OF COST OR DO REBATE OR TAX BREAK.
-
NOTHING
NONE
NIKE PARK NEAR US HAS A S.W.M. POND THIS POND IS SEVERELY POLLUTED BY RUN-OFF FROM THE CAR WASH BUSINESS & OTHER INDUSTRIAL ZONE ACTIVITIES. WE SUGGEST SOMEONE LOOK INTO THIS & REPORT TO AUTHORITIES.
I KNOW NOTHING AT ALL.
NA
NA
LET US KNOW HOW YOUR MASTER'S PROGRAM WORKS OUT.
NONE.
WHAT IS THE PURPOSE OF A POND IF NOT FOR WILDLIFE? ARE THE PONDS MAN MADE OR NATURAL DEPOSITS?
YOUR WELCOME
NONE.

Statistic	Value
Total Responses	21

Appendix 11

Evolving Best Management Practices (BMPs)

Farm (2003) in her dissertation indicates that non-point heavy metal pollution from adjacent traffic areas can be either dissolved in the water column or present as particulates (p. 1). The site pond in not currently managed to help settle out these particulates and may serve only as a pass through for these types of pollutants into the adjacent watershed. Her research covered the different types of filters that can be used to mitigate this issue. However, there is no filter present in the site pond aside from incidental vegetation that has grown up over the last thirty-five years. Also, aside from the two flow channels the storm water retention pond has never been excavated in over thirty-five years.

As of 2013 there was no known testing program for the site pond water, sediment, or in the adjacent downstream wetland and watershed areas. Therefore it is apparently unknown to the County, and certainly unknown to the adjacent home owners, whether this 1980's vintage pond can mitigate any of the non-point pollution sources. There are only two options that can be considered. Either the case study pond serves as a pass-through for these pollutants, or the pond (to some yet to be determined degree) has retained the pollutants as a growing toxic sink for the last thirty-five years. A new technology sand berm pond may in fact make this an even more pressing issue if the filtering efficiency of the pond increases.

Perez-Pedini, Limbrunner, and Vogel (2005) provide one example of a sophisticated model that came after the construction of the site pond. They state that best management practices (BMPs) "…indicate that the optimal location and number of BMPs is a complex function of watershed network connectivity, flow travel time, land use, distance to channel, and contributing area…" (p. 441). The function approach (using a comprehensive set of pond variables to define a unique retention problem and solution) appeals to me since there may be many environmental causes for concern with the site pond. As to scalability, although each pond may be unique the overall BMP approach is scalable.

Hossain, Alam, Yonge, and Dutta (2005) prefer wet detention ponds (p. 79). The site pond has been managed as a dry, then wet, then semi-dry pond, with no apparent consistent management philosophy over the last thirty-five years. The article also makes the point that water inflows via storms and nearby traffic counts are the major contributing factors to pollutant measurement with the storm water retention pond. Therefore, seasonal dry readings in July/August must be compared to spring pulse water conditions in April/May/June, and a reduced water pulse in September/October.

Krishnappan and Marsalek (2002) point out a related issue in wet pond management. They present continuing research in using wet ponds to detain and contain sediment. One county improvement is the two stream flows that are channelized and lined with rocks. The rocks may slow the water to deposit the larger sized sediment

grains but may not do anything for the finer grains of sedimentation. This design does not serve as a biological filter for dissolved pollution such as some heavy metals or excess nutrients.

Davis et. al. (2001) provides one BMP approach and indicates that bio-retention holds pollutants within a pond. It does this through a combination of "porous soil, a topping of hardwood mulch, and a variety of different plant species" (p. 5). The article documents the results of a laboratory bio-retention experiment which showed excellent reduction of all types of metals like zinc, iron, and lead, copper as well as suspended solids. Moderate reductions in ammonium and phosphorus were also noted. However, there was very little reduction in nitrate. All of this is an example of what might be done, (not what is done) at the site pond.

Finally, there may be a cost management issue to many of the BMPs that are present in the current management of the case study storm water retention pond. Weiss, Gulliver, and Erickson (2007) in their survey of BMPs and costs remind us that there may have been a cost concern with the original construction of the site pond. There certainly was a cost concern with the benign neglect MWHOA management philosophy. There may still be cost considerations in the current (2013) Montgomery County management of the site pond. The County may have decided to bury the pollutant issue by letting forest grow on most of the site. If this is the management approach it has not been communicated to adjacent homeowners or the MWHOA.

Appendix 12

Case Studies on Storm Water Retention Ponds

The site pond as well as all other observed ponds in Montgomery County have vegetation. Many solutions to non-point pollution involve primary production as a function of biomass. Davis et. al. (2001) indicates "Some grasses and shrubs are installed in the system to remove water through evapotranspiration and help maintain efficient infiltration. The plant root areas can also promote biological pollutant transformations" (5). Native species that are already adapted to the local climate are chosen for planting. Additional criteria include "the ability to tolerate urban stresses such as air and water pollutants, variable soil moisture, and ponding fluctuations" (p. 5). However, the vegetation at the site pond is present by chance and represents natural seeding with the site pond serving as a seed bank. This article used the example of bio-retention facilities in the Maryland neighboring counties of Prince Charles and Caroline.

Davis et. al. (2001) experiment with a soil-mulch-plant bio-retention facility that simulates a natural forest ecosystem in many ways. The soil, and the content of soil organic matter (SOM), forms the foundation of the primary productivity system. As Perry (2008) has indicated approximately fifty percent of primary productivity may be conducted underground depending on the type of forest. The mulch in the artificial system approximates the natural detritus and leaf litter of the natural forest that interfaces with the soil for the production of soil organic matter. While this article mentioned only grasses and shrubs for bio-retention the pond site has numerous willows and other types of trees in the flood plain that may also play a part in default (as opposed to design) bioremediation.

This article was typical in that it did not describe any positive benefits of pollutants. The pond site probably has large influxes of lawn fertilizers (thus the recently passed Maryland fertilizer law) since neighbors appear to over-fertilize every year. Large inputs of phosphorus, iron, and nitrogen are subject to bio-remediation. At the pond site there appears to be a positive feedback from some of these pollutants in encouraging the growth of grasses, shrubs, and trees. Montgomery County, Maryland may recognize these benefits by limiting mowing to marginal areas of the site and encouraging biomass production throughout the site.

Walsh, Fletcher and Ladson (2005) use the term ecological condition in the same sense that Perry (2008) uses the term ecological health or ecological integrity. The authors use a case study from Melbourne, Australia that compares the riparian ecological condition as a direct result of how much impervious surface drains directly into a stream. They make a recommendation for the use of storm water retention ponds to improve the ecological health of downstream watersheds. The health of the stream is measured by such items as water quality variables, algal biomass, and measures of diatoms and macro-invertebrates.

Walsh, et al (2005) indicate that degradation of stream ecosystems is worldwide problem (p. 690). Problems include low expectations for urban streams and lack of a biological baseline. Monitoring is also an issue. They emphasize that stream health is a direct health issue of the upstream landscape. They also indicate that more research needs to be done on pond size, type of bio-retention pond, as well as the number of ponds required for a sub-division area (p. 691). Their methodology used fourteen ecological indicators and some complex linear regression on four different models. They conclude that the type of management of storm water is the primary factor affecting stream health. Other methods such as planting riparian vegetation and increasing habitat complexity are helpful for stream health but the medium (water volume and water quality) is the message for ecological stream health.

Appendix 13

Societal Issues of Stormwater Management Ponds

Social Context

Montgomery County can have some strong NIMBY (Not in My Back Yard) trends on some social issues. However, environmental issues in general, and storm water retention ponds in particular, are not an issue. Examples of NIMBYs include opposition to affordable housing units in the adjacent landscape that was voiced but overcome by housing proponents. A zoning issue on building a gas station in the adjacent landscape a few hundred feet from the site pond was defeated.

The storm water retention pond is located in a common cul-de-sac Maryland neighborhood. The residents are very diverse (Caucasian, African-American, International (Russia, Pakistan, Senegal, Ghana); the area is relatively free from crime, and very quiet. As mentioned earlier, most residents (two thirds) are not aware of the site ponds. Most of the year they are not visible from the adjoining roads but can be easily accessed as it borders homeowner's common property, County park property and public roads. A few residents walk the embankment when they are doing a short cut from Centerway Road to Mourning Dove Court.

At one time more home owners were aware of the pond as it was a budget item that required occasional maintenance which was discussed at the annual home owners meeting. Since the County took over the pond it has received no visibility. Occasionally children play in the site woods but there is no space for a playground or picnic tables. The woods have never caught on fire and there has been no reported criminal activity. From a distance it is just one more stand of green trees against the larger Montgomery County park landscape. In conclusion, there is little social context. Storm water retention ponds are part of the landscape and thus fade into the background if they are well maintained, don't flood, catch on fire, or become some type of ecological nuisance.

Social aspects may include recreational, aesthetic, and ecological values. Wet and dry storm water retention ponds often provide recreational values for the local and larger community. Play space for children, depending on age and supervision, is possible as are formal playgrounds. On the other end of the play spectrum is the provision of natural and unstructured play areas where kids can explore and build forts. Although DeSousa (2003) uses the example of converting industrial brownfields (instead of storm water retention ponds) into play areas, parks and greenways, the social benefits of such conversions are similar. Aesthetic values include the provision of green space for an appealing vision scape and as a deliberate strategy to land conservation through an interconnected network of green spaces (Benedict and McMahon, 2002). Such areas can provide marked and unmarked nature trails. These areas can also have an educational value as in Maryland with the schoolshed concept for a local school.

Wet ponds are a cultural dimension as far as they are socially accepted as a part of everyday life. These aspects include context (space, place and time), knowledge (technical and personal), aesthetics, process (importance of fairness), and trust (individuals and organizations). Storm water retention ponds have a relatively low cultural profile as to context. The ponds are part of the city or part of the suburban neighborhood. They only gain some profile when they flood adjoining yards or when wildlife from the ponds eat residential plants (eg. beaver or deer). As to space and place they are often overlooked by immediate neighbors and given only a passing glance by motorists speeding by. Only residents adjacent to a storm water retention pond might have a different view.

As to time, wet ponds often predate the current local residents so ponds are often blended into the adjoining landscape. As to knowledge, very few residents have technical knowledge about GI techniques. However, personal knowledge may be greater with some residents who have walked around a storm water pond area. Some residents may trust wet and dry ponds to function as designed, whether for hydrologic flow or for bio-filtration. Other residents may wonder whether the ponds are functioning correctly if there is no government testing program on soil and water samples for non-point source pollutants. These residents may believe that the ponds are creating artificial hot spots for these non-point toxins.

Other negative social aspects of a wet pond could be the very wildlife that are part of this newly created ecosystem. Mammals such as beaver and deer can become a great nuisance to adjoining landowners when they cut down small trees or devour all understory undergrowth. Depending on the location these wet ponds may be in very secluded areas and thus an invitation to criminal activity. Wet ponds and many other types of GI do not lend themselves to Not in My Backyard (NIMBY) syndrome since the design of hydraulics and the drainage dictate where and what type of GI can be developed. Since they are literally low profile they tend to be non-threatening to other agendas and interests

Cultural Context

The cultural context for the site pond is non-existent. The storm water retention pond is the result of thirty-five year old construction practices that were considered modern watershed management practices in the late 1970's. In Maryland storm water retention ponds are part of the sub-division landscape just as much as the presence of homeowners associations.

With the scheduled re-construction of the site pond with bio-filtering sand berms this cultural context could change. An example of how the site pond backyard ecosystem is improved could start an environmental education movement leading to a change in the neighborhood culture. Such a cultural change is an imperative if other non-pond solutions are to succeed in reducing neighborhood non-point pollution sources.

Historical Context

There are no known archeological sites in this area. There are no known historical issues for this area of Montgomery County. This area has always been forested woodland. The Montgomery West Homeowner's Association (MWHOA) and related development was built in the late 1970's and early 1980's. As was customary in Maryland, the development builder owned the homeowners association until it was turned over to the residents. At that time, all common property (sidewalks, parking lots, common land areas) as well as the two storm water retention ponds, was turned over to the MWHOA. In the late 1990's Montgomery County assumed title and maintenance responsibilities for all homeowner storm water retention ponds.

Policy Context

There does not appear to be any disagreement at the County, State, Regional or Federal level to reduce different types of pollutants in the Montgomery County watershed in accordance with the Clean Water Act or the recently agreed to Environmental Protection Agency (EPA) "pollution diet" on Total Maximum Daily Load (TMDL) on a specific list of water pollutants. The lower the threshold for testing TMDLs the greater the economic cost in removing them from the water flow. The proposed 2016 re-construction of the site pond using sand berms is a direct result of this policy decision. While this has often been the case in the eastern Shore of Maryland there is little public opposition to the EPA pollution diet in Montgomery County.

The United Nations (UN) acknowledges that water resources are a critical global issue and that water resources contribute directly to preserving biodiversity. Green infrastructure techniques can provide partial solutions to preserving critical freshwater supplies by retaining and recharging ground water supplies. LeBlanc (2010) also addresses the issue of water by indicating that there are few resource extraction methods or manufacturing processes that do not partially or wholly rely on vast quantities of water.

Green infrastructure techniques can be utilized at manufacturing sites to increase water supplies and improve the water quality of water recycling. Stevens (2010) writes about market failures and water can be used as an example of this. Water is a precious resource and yet water rates are often priced by politicians and not by market supply and demand. In all cases better management of scarce water resources by using GI techniques can help preserve and expand the supplies of fresh water at the site of manufacturing.

Fresh water is a critical global issue. While the critical issue of supply of clean water and GI is a global natural resource issue it is also as local as our own residential or workplace front and back yards. For example, I live in Montgomery County which is one of the most heavily populated counties in Maryland and has about 42% (Copiz 2013) impervious surface. There is literally a wet storm water retention pond at his backyard fence and his property is at the bottom of long hill. Thus he is keenly interested in the

global and local issues of storm water runoff from all his neighbors and their impermeable surfaces. He is also concerned about all the possible non-point source pollutants (Appendix 2) that might be carried in that storm water and collecting in his backyard wet storm water retention pond.

Well, the first and most obvious management solution is to not dump or apply excessive amounts of any of the substances in the Appendix 7 list. A recent Chesapeake Bay Foundation Report (CBF 2014) lists many of the problems in Appendix 7, as well as many of the proposed solutions in Appendix 8. One problem is that water and sediment testing is not conducted in Gaithersburg, Maryland so it is difficult to know precisely what the problems are. However, an educated guess is that excess nitrogen and phosphorous is one issue. This is based on my observation of misapplication of lawn fertilizer. One concern is that all of the substances on the Appendix 1 list will either be carried by water or will dissolve in water. Part of the issue is the volume and rate of fast moving storm water runoff with the resultant flooding of these substances into local storm water retention ponds. However, properly engineered bio-filter storm water retention ponds, coupled with the Appendix 7 list of Green Infrastructure (GI) techniques and devices, can help reduce the water flow issue and the concurrent pollutant issues.

Another management solution is to educate the public on how to reduce potential non-point source pollutants as well as reducing excess water flow from residential yards. Roberts (2014) compiled the list of education programs in Appendix 8. This was done in the preceding year by attending county fairs, libraries and similar public events. There was no central repository that provided information on all these disparate programs. The Appendix 3 list of government and non-profit organization education and environmental remediation programs is from the Roberts (2014) draft perception survey. Many of the programs on the list are local to Maryland but may be recognized as similar programs in other areas of the country.

Kates, Parris, and Leiserowitz (2005) state the most widely accepted and ambiguous definition of sustainable development is “Humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs” (2-3). Since GI techniques mimic natural processes they are likely to be present and functioning as intended for future generations. It is also interesting how the Figure 1 (Definitions of sustainable development) on the preceding page lists Nature, People, Life Support, Economy, Society and Community and how closely they align with the EPA definition of GI.

There is a very strong environmental ethic context in the State of Maryland as well as within Montgomery County. The County is quite concerned about water quality issues as the entire County is a watershed for the Chesapeake Bay. For example, in 2011 this County passed a five cent tax on all plastic and paper bags to reduce litter and pollution of County streams and rivers. The EPA, the State of Maryland and Montgomery County all appear to be in agreement on TMDLs as part of the 2012

pollution diet agreement. The only other ethical context is that of benign neglect. The ethics of non-interest is a type of ethical context.

It is possible that a local homeowner's environmental ethic could be developed and/or strengthened with the communication of this completed Masters in Natural Resources (MNR) Capstone Project to the MWHOA board of directors. This ethic, coupled with a 2015 re-construction of the site pond and a financial concern for property values, could galvanize homeowners to look at potential pollution threats. This would also raise the visibility of the site are as their neighborhood park. The first opportunity to realize this vision will be the public meeting to voice concerns about the non-point pollution threat. Depending on the Montgomery County response then a formal testing program will be requested.

There is a very strong environmental ethic context in the State of Maryland as well as within Montgomery County. The County is quite concerned about water quality issues as the entire County is a watershed for the Chesapeake Bay. The EPA, the State of Maryland and Montgomery County all appear to be in agreement on non-point source Total maximum Daily Loads (TMDLs) as part of a 2012 pollution diet agreement. This Chesapeake Bay TMDL Quick Finder provides guidance on the core of the "pollution diet" for Maryland. These recent developments are a reversal from the past ethical context of benign neglect.

There are many positive ethical aspects of green infrastructure (GI). The various GI techniques (Appendix 8) are all about making dirty water clean while retaining at the point of origin as much storm water runoff as possible. There are few apparent negative ethical aspects of GI. Some might argue that GI is only a mitigation strategy for a growing human population and thus not a solution to larger resource management issues. Others might argue that GI is a poor substitute for the original landscape and natural process before they were bulldozed over. Some jurisdictions have the goal of one hundred percent storm water retention. If achieved such a goal could have a negative ethical aspect on local watersheds and streams that other communities depend on.

Another aspect of indirect negative ethical aspect might be the collateral damage created by one GI technique that creates wet ponds. Wet ponds that are unfenced or improperly constructed for drainage can pose several risks to public health, safety and welfare (Jones, Guo, Urbonas and Pittinger 2006). Wet storm water retention ponds are often unfenced and can attract children. Unfortunately, children sometimes drown in these ponds even when surrounded by a fence on this attractive nuisance. This can also occur in the winter when the ponds ice over but cannot support the weight of a child. Wets ponds with blocked flood control devices (FCD) can lead to stagnant water and thus potential breeding grounds for disease carry mosquitoes. Steep embankments can lead to serious falls and injuries for walkers.

The risks of unclean water are unevenly distributed as a matter of population density, geography and elevation. As the economists like to say (all things being equal) with the same population density and pollution generation patterns, residents downstream

(at lower elevations) will have more risk of using contaminated drinking water than upstream residents. This risk is also a matter of national scale. There is more population pressure in the Maryland coastal plain than in the piedmont region. Globally and nationally there is a long-term movement of population towards the coasts. The Maryland coastal plain and the Chesapeake Bay watershed have more sources non-point pollution (Appendix 7) than the interior of Maryland. All these trends put increasing pressure on the supply of clean water supplies.

The major sources of dissimilarity is not only population pressure that results in non-point pollution sources, but the volume and rate of storm water runoff that carries these pollutants downstream. Upstream population generates more impervious surface area that downstream communities have to deal with. Montgomery County is one of the most heavily populated counties in Maryland and has about 42% (Copiz 2013) impervious surface.

The issue of percentage of impervious surface is a major contributing factor in non-point pollution is barely a visible public issue of concern. For example, the relatively wealthy Montgomery County, Maryland is upstream of relatively poorer and minority Washington, DC. However, in this case being downstream is not one in proving economic or even racial discrimination. While one might think that poor people tend to live in the cities but one article (Jones 2006) points out that this is no longer true. Since 2006 the number of poor suburbanites outnumbered the poor in United States cities by over one million.

For residential yards Aad, Suidan and Shuter (2010) conclude that rain barrels and rain gardens are specialized detention techniques that are very effective in reducing storm water runoff. These authors use new modelling techniques developed from the federal Environmental Protection Agency storm water management model version 5 (SWMM-5) to reach this conclusion. For parking lots, the long-term effectiveness of different permeable pavement systems was evaluated by Brattebo and Booth (2003). The good news is that after six years of evaluation these authors conclude that all provided almost one hundred percent permeability – no surface runoff. The additional good news is that these systems also act as filters for motor oil, zinc, copper and lead. Even the humble downspout diversion has been studied (Kaufman and Wurtz 2007) and in some areas water volume was reduced by as much as twenty-five percent. Not only does this reduction in flow help keep pollutants on the residential property it helps increase the area water table by diverting water onto the neighborhood's lawns. All of these actions help right the wrong of excess storm water.

Political Context

While the State and County are in agreement on policy issues they often disagree on revenue sources to pay for capital improvement and in maintaining services. Tax increases were recently enacted in Maryland and Counties are mandated to pick up the former State bill for education and several other areas, to include pension issues.

Green Infrastructure (GI) is often characterized by the political process of communication. For example, the issue of whether the natural resource communication process was unidirectional or interactive. It is my observation that most of the GI education programs listed in Appendix 3 are unidirectional, consisting of informational brochures or pages on a website. The only interactive GI communication initiatives are the hotlines and the collection points. Very few of the programs can be found at an area science or environmental awareness day or perhaps an agricultural fair where the brochures are used as part of an interactive booth.

The federal Environmental Protection Agency (EPA) webpage at http://water.epa.gov/infrastructure/greeninfrastructure/gi_barrier.cfm "How Can I Overcome the Barriers to Green Infrastructure" address several issues that are basically communication barriers. Under the municipalities section there are knowledge issues (Perception that Performance is Unknown and Perception of Higher Costs). There are also communication issues of resistance to change (Perception of Resistance within the Regulatory Community and Conflicting Codes and Ordinances). Lastly, there are miscommunications of GI issues (Perception of Conflict with Smart Growth and Perception of Conflict with Water Rights Law).

I advance the hypothesis In an unpublished survey I advance the hypothesis that the knowledge level of a typical Maryland homeowners association is very low and that much progress needs to be made in communication and knowledge before a tipping point is reached. This knowledge is in reference to GI techniques in general and wet storm water retention ponds in particular. The reason for this may very well be that government and non-profit management programs as listed in Appendix 3 are mostly unidirectional with a poor audience base for their current communication channels.

Economic Context

The Capstone Project author has used the negative aspects (negative economic driver) of this storm water retention pond to successfully challenge his residential property tax assessment on two different occasions. So, these could be considered negative economic drivers for the property. The homeowner is the only residence out of 104 homes that completely borders this storm water retention pond as well as has the two water utility easements on his property. This residence (8812 Mourning Dove Court) also has a radon gas issue so this could also be a potential issue for the water within the pond. There is occasional flooding of this storm water retention pond that floats a large amount of debris on the water and surrounding woodlands. The debris field is mostly trash and spilled recyclables out of the containers that are placed on the streets every Thursday. When wind and rain occurs, the recyclables are washed down the street gutters, into the inlet pipes, and into the storm water retention pond. There is often a high tide mark of litter after the water has receded.

Mis-management of the pond (by default) is the main negative economic driver. The case study pond has never caused any local street flooding. The design of the pond (for maximum hydrologic flow) appears to work perfectly. This means the design is

efficient for moving water into the pond, holding it, and then slowly releasing the water into the downstream watershed. However, in the early years (1980's) the pond would sometimes overflow its embankments as the FCD was not properly maintained by the homeowners association. Sometimes a corner of my backyard was temporarily flooded. Another reason for the periodic flooding was that the Mourning Dove Pond was designed to drain 54 acres but now drains over 200 acres of developed suburban land.

The more important negative economic driver is whether downstream watersheds are receiving pollutants from the neighborhood impervious surfaces. If the pond only passes these pollutants through then this is a harmful economic impact on downstream ecological services. If the pond is serving as a toxic pollutant sink then the harmful ecological activity is more localized to the adjacent homeowners and possible their property values. This issue may become more problematic with the 2015 scheduled sand berm pond construction.

The greater the amount of impervious surfaces in the adjacent drainage area the greater the amount of negative externalities (Brabeck, Schulte, and Richards, 2002). Thus one could infer that there is a direct relationship between the impervious surface problem and the amount of GI required to resolve the problem. A recent article in *The Wall Street Journal* (Mullich, 2014) shows several related economic aspects of GI. There are now several green bond issues that are part of corporation sustainability plans. These plans promote GI as a way to reduce a company's carbon footprint (through water recycling) while attracting customers as part of a "green-genuity" marketing strategy. Green bonds can be part of their GI financing, branding and imaging communication message to attract environmentally conscious and socially responsible investors. This article states that the current (2014) amount of green bonds ($18.2 billion) could more than double to $40 billion in twelve months.

As to negative externalities litter, the numerous types of non-point source water pollution listed in Appendix 8 (Davis, Shokouhian and Minami, 2001) and even some air pollution particles can precipitate into the pond site. After the wet pond has managed the flood pulse, settled out sediments and solids, and performed bio-filtering on the storm water, the positive externalities of clean water, reduced nutrients, managed flood pulses and often increased biodiversity is the result.

From an economic viewpoint GI is not the only direct solution. In Montgomery County, Maryland where I reside, there is talk of a proposed tax on business and residential owners based on the amount of impervious surface on their property. This idea is similar to the principle of a Pigouvian Tax where economic activities with negative externalities impose costs on neighbors. While impervious surfaces cannot be banned they can be taxed. The tax might discourage overuse of impervious surfaces (Krugman, 2010). He also states that the simplest example of a Pigouvian Tax is an effluent fee where the amount of tax is proportional to the pollutant dumped in a river or spewed into the air. In this example uncontrolled storm water is the effluent. Even excess clean water is an effluent in this context as uncontrolled flooding erodes stream

beds. Therefore a resident can have more asphalt and concrete on their property but will pay for the privilege of generating excess storm water.

Since population pressure is unlikely to decrease, the focus must be on managing and preserving the water supplies that are present. Maryland already has a rain tax and a plastic bag tax with revenues slated to improve storm water retention ponds. In fact, yet another new tax was proposed (Davis, 2014) that would impose a tax on every 500 square feet of impervious surface on a residential and business lot. I think of the pond behind my home as the headwaters of the local watershed. This water eventually runs into the Potomac River in which the local water utility company has an intake pipe to supply clean water to the residents of the homeowners association.

Wet and dry storm water retention ponds, often with wetlands and marshes, form marvelous mini-ecosystems. This is true even within an adjacent landscape overwhelmed with many human influences. These GI sites provide various ecosystem services (hydrologic flow) and human well-being from the healthy presence of green space.

According to Tzoulas, Korpela, Venn, Yli-Pelkonen, Kazmierczak, Niemela and James (2007) these GI sites may very well contribute to biological diversity as well as contributing to various ecosystem services and even health in a more urban environment. The natural capital of these GI sites often echoes natural sites in the adjacent landscape. This is by design as the best GI techniques mimic natural processes. The renewable natural capital is the biotic components of the ecosystem and an example of replenishable natural capital with the GI goal of potable water for downstream communities. These GI sites do not normally have any nonrenewable natural capital (resource extraction) and rarely is there any cultivated natural capital although most sites have woodlands.

Green infrastructure (GI) wet and dry pond sites have well defined ecological footprints as they are artificial creations designed to manage hydrologic flow in a drainage area. As to manmade drivers of ecological change (via bulldozer) these sites were created as bare patches ground subject to natural seeding of various types of plants and eventually animals. The sites are also subject to natural disturbances windstorms, fire, flood (often by design), and insect and plant disease outbreaks can be common. Human activities often disturb GI wet and dry pond sites. Often this can be by design as part of a deliberate management strategy.

Climate change can affect a GI site just as much any natural site. The ponds collect manmade pollution by design. Many wet ponds are constructed as bio-filter ponds (Davis, Shokouhian, Sharma, Minami (2001) to clean dirty water before it enters an adjacent downstream watershed. Wet ponds can be overburdened by excess development and often flood as the amount of impervious surface exceeds original design parameters for the drained subdivision. The pond sites might also harbor invasive species as construction equipment moves from pond to pond construction site without proper wash down procedures.