pennsylvania environmental council

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The Wissahickon Creek
Municipal Sediment Credit System

Final Report

January, 2010

Background & Introduction

Pennsylvania Environmental Council (PEC), Pennsylvania Department of Environmental Protection (PADEP), and the U. S. Environmental Protection Agency (EPA), Region 3, share a common interest in restoring water quality in the Wissahickon Creek. The Creek is impaired by sediment: it does not support its designated uses, which include trout stocking. A sediment Total Maximum Daily Load (TMDL) was established in 2003. Identifying implementation mechanisms for sediment TMDLs have been a challenge nationally, although a clear trend is that controlling stormwater runoff volume is an effective way to reduce sediment in urban watersheds. The highly fragmented local government system in Pennsylvania presents particular challenges.

The Environmental Protection Agency provided the Pennsylvania Environmental Council with a grant to develop options for trading or market mechanisms to support implementation of the Wissahickon sediment TMDL, and to provide a model for other TMDL watersheds. PEC has worked closely with the Pennsylvania Department of Environmental Protection and the municipalities in the Wissahickon to understand the perspectives of the regulators and the regulated community. We have also talked with the environmental community including the Friends of the Wissahickon and the Wissahickon Valley Watershed Association.

While PEC has been developing a market mechanism approach for implementing the TMDL, PADEP issued a revised draft Municipal Separate Storm Sewer System (MS4) general permit that would be applicable to all of the municipalities in the Wissahickon Creek watershed. The draft permit, known as PAG-13, requires municipalities discharging stormwater to a water body with an approved TMDL to prepare and implement a Stormwater TMDL plan containing two TMDL control measures in addition to the basic six minimum control measures (MCMs) required of all MS4 municipalities. The Stormwater TMDL Plan provisions of PAG-13 are included in Appendix VI.

As a group, we have relied upon statutes, regulations and guidance that address stormwater discharges and TMDL requirements in developing a market approach to implementation of the TMDL in the Wissahickon. As to stormwater, Congress has spoken in section 402(p)(3)(B)(iii) of the Clean Water Act: implement controls to reduce the discharge of pollutants to the maximum extent practicable. Congress has also required the establishment of TMDLs for impaired waters, (Section 303(d)), and EPA has required NPDES effluent limitations to be consistent with the assumptions and requirements of the wasteload allocations (WLAs) in the TMDL(40 CFR 122.44(d)(1)(vii)(B)). To reconcile these programs, EPA has spoken through a November 22, 2002 memo signed by Robert Wayland and Jim Hanlon (http://www.epa.gov/npdes/pubs/final-wwtmdl.pdf). The memo recommends that stormwater TMDLs be implemented over time through an iterative, phased, BMP program. PADEP's draft PAG-13 explicitly adopts these principles. However, neither the Congressional and EPA guidance nor the PADEP draft general permit provides practical

instructions on how to select the BMPs that constitute control of stormwater discharges to the maximum extent practicable in the context of a sediment TMDL.

Our conversation with PADEP and EPA has been based on three shared goals. 1) Achieving the WLAs and TMDL as quickly as practicable. 2) Ensuring that the burden on municipalities is one that they can live with, and 3) Establishing a system that promotes and supports choosing the most cost effective stormwater control measures while achieving multiple environmental, economic and social benefits and encouraging multi-municipal cooperation.

Through the research and dialogue supported by this EPA grant, PEC has identified one key element of a solution that supports our shared goals. Maximum extent practicable (MEP) for the Wissahickon sediment TMDL must be defined as a control strategy that will permanently prevent a specified quantity of stormwater from running off into the Creek through installation of new or retrofitted control measures, as part of an iterative program of reduction in each permit cycle. Stormwater volume retention capacity is used as a surrogate for sediment. We also refer to the amount of stormwater volume retention capacity as a sediment credit, as discussed later in the report.

As discussed in the theory section of this report, the quantity of stormwater runoff to be managed in each permit cycle, which establishes MEP, is a policy decision, best made by a state or federal agency. Given the timing of the permit cycle, MEP has not been established by the agencies. In order for TMDL implementation to move forward, PEC is offering a recommendation for MEP for the upcoming permit cycle, as discussed in Appendix II. This report will emphasize the process we are recommending for implementing MEP sediment reduction through a market mechanism that supports both flexibility and accountability. The same process would be useful for any number identified as MEP for a permit cycle.

As discussed in Appendix III, PEC recommends that 267,064 cubic feet of new runoff storage capacity be established in the Wissahickon watershed by the Phase 2 municipalities during the first five-year permit cycle. This quantity, in combination with the other BMPs required by the PAG-13, should be accepted as the level of control that will satisfy MEP for this permit cycle. The recommended 267,064 cubic feet of stormwater volume retention could also be referred to as the municipal stormwater sediment credit commitment.

A second key element of PEC's recommendation is establishing a sediment credit system that will allow for market mechanisms to operate, so that the regulated municipalities can select control measures with the greatest benefits and lowest cost. Using volume as surrogate for sediment and designating a sediment credit commitment allows for immediate practical application of the system and for its further development. In future cycles, PADEP and the municipalities may wish to extend the system to include streambank restoration and other BMPs not directly related to volume, and to incorporate trading ratios and other features to encourage best practices. One example of a best practice would be adoption of municipal ordinances requiring over-control of stormwater

when existing commercial developments are redeveloped or incentives for over-control of stormwater from commercial redevelopment. See Appendix IV for specific examples of these opportunities in the Wissahickon.

A third key element is specifying that design volume, and proper construction and maintenance of control measures are the key factors in measuring compliance, not documented reduction. Empirical measurement of runoff reduction is expensive and varies with rainfall and upstream events. By breaking the link between permit and measured reduction, municipalities can be confident that their implementation activities will comply with their permits, and PADEP can more easily monitor municipal compliance. PADEP will be responsible for evaluating the impact of implementation on the creek itself.

Establishing a specific stormwater volume reduction commitment offers many benefits. PADEP and EPA will have confidence that progress will be achieved in this permit cycle, and that a system is in place for further progress in future permit cycles. The municipalities can budget for and implement control measures identified at the inception of the permit cycle with confidence that they are complying with permit requirements. All citizens are served by ensuring that the Wissahickon will be restored over time.

Summary of Recommendations

PEC recommends that the stormwater management program described in the draft PAG-13 be implemented using the following practices.

1. The municipalities and PADEP adopt PEC's recommended volume of new stormwater retention, expressed as a credit requirement where one credit is equal to one cubic foot of new storage. The total credit number is distributed among the Wissahickon Creek watershed municipalities according to the waste load reduction allocated to each. For example, Lansdale Borough is responsible for 2.03 percent of the total 267,064 cubic feet of volume retention required in this permit cycle. Its retention requirement is 5,436 cubic feet.

2. In order to comply with the TMDL stormwater plan requirements, municipalities must identify locations for control measures, design, construct, and permanently maintain them. The size of the control measure(s) must be designed to meet the allocated volume reduction, according to standard engineering practice. Municipalities can choose from any of the seven TMDL control measures listed in the March 2009 draft PAG-13, except streambank restoration.

3. Control measures can be implemented on either public or private land, as long as the municipality can demonstrate long-term control of the site.

4. Municipalities may purchase credits from other municipalities through individual contractual agreements. Municipalities will monitor and report on implementation and continued maintenance of their control measures in the periodic reports required by the MS4 permit.

5. PADEP will monitor the Wissahickon Creek to identify the impact of the first years of implementation. Either PADEP would establish a new wasteload reduction target for the next permit cycle, or the Wissahickon municipalities would work collaboratively to identify the target.

The proposed program is described in more detail in the following section of this report.

Implementation of Municipal Sediment Credit System

Municipal coordination

In the first cycle of the new MS4 permits, Wissahickon watershed municipalities have an opportunity to take leadership in adopting the municipal sediment credit system. PEC believes that a collaborative approach by the Wissahickon Creek watershed municipalities in adopting the recommended approach would offer two significant advantages. First, if all or most of the Wissahickon watershed municipalities adopt the credit system recommended by PEC, PADEP is highly likely to accept the municipal plans as compliant with the MS4 general permit. The municipalities can then budget for and implement projects with confidence that there will be no unexpected expenses or new requirements.

Second, adopting a system based on a "common denominator" quantity of volume retention will allow flexibility for municipalities to find and implement the most cost-effective projects. The MEP recommendation is based on projects costing up to $4 per cubic foot. Many of the basin retrofit opportunities in the watershed would cost only $2 per cubic foot or less, however these cheaper projects are concentrated in certain municipalities, such as Upper Dublin, Upper Gwynedd, and Whitpain. If municipalities with fewer low-cost retention sites would enter contractual agreements with those having more and cheaper sites, significant cost efficiencies could be realized. PEC is available to work with Wissahickon municipalities to help with negotiating these kinds of agreements and collaborations. PADEP is not expected to have a role in facilitating nor in approving cross-municipal contracts for credits, at least in this first cycle. PEC is not proposing any sort of trading ratios or limitations on locations of cross-municipal contracting for credits, given the goal of keeping it simple in the first cycle.

Application Process

Once the final PAG-13 is released in the spring of 2010, each municipality will need to complete a Notice of Intent (NOI) to apply for coverage under the general permit. Each of the Wissahickon municipalities will also need to submit a Stormwater TMDL Plan. PEC has provided a template for individual municipal stormwater TMDL plans in Appendix I. PEC strongly recommends that the stormwater TMDL plans be consistent among all or most of the Wissahickon municipalities. PEC staff is available to facilitate meetings with the municipalities and their engineers to explain the recommended system and support coordination of the plans. It may also be possible to place much of the plan in a document that each municipality could reference in its own stormwater plan, thereby

reducing the municipalities' administrative costs of preparation and PADEP's cost of review.

PEC's discussions with PADEP have suggested that the major elements of the draft PAG-13 permit are unlikely to change significantly in the final permit. Accordingly, our recommendations are based on the requirements of the draft PAG-13 dated March, 2009, and attached as Appendix VI. Upon final issuance of the PAG-13 permit, each municipality would then prepare the required stormwater TMDL plan, using the template included in this report as Appendix I. If PADEP's final version of the PAG-13 is significantly revised, municipalities might need to apply for an individual permit, and the sediment credit system approach would need to be adapted.

Any municipality that chooses to adopt this approach would prepare their stormwater TMDL plan based on the PEC template, with a specified volume of retention. As discussed in the template, the specific locations and designs of facilities will be provided within one year and sixty days of the date the application is submitted. The size of the control measure(s) must be designed to meet the assigned volume reduction, according to standard engineering practice. Multiple projects could be selected, as long as the aggregate is equal to the municipal credit requirement. Construction of at least half of the design capacity will be completed within three years of permit issuance.

PEC recommends that the Wissahickon Creek watershed municipalities use the credit amounts in the following table to design the volume of control measures specified in their Stormwater TMDL Plans. See Appendix II for a discussion of how these recommendations were developed. Column 2 includes the sediment wasteload allocated to Philadelphia. Because Philadelphia is a MS4 Phase I municipality, we have chosen to look at the portion of the wasteload allocated to the Phase II municipalities separately. In Column 3, the Philadelphia wasteload has been removed, and the figures show how the remaining wasteload is allocated to the Phase II municipalities. The percentages from Column 3 are then applied to the total 267,064 cubic feet of additional permanent retention volume recommended as the municipal commitment for the first five year permit cycle.

Municipality	% of Total TMDL WLA	% of TMDL WLA of Phase 2 municipalities	Design Capacity of Runoff Reduction in ft^3 (credits)
Abington	4.37	5.01%	13,390
Ambler	1.43	1.64%	4,382
Cheltenham	0.20	0.23%	619
Horsham	0.12	0.13%	369
Lansdale	1.77	2.03%	5,436
Lower Gywnedd	14.82	17.01%	45,428
Montgomery	3.76	4.32%	11,543
North Wales	1.43	1.65%	4,397
Philadelphia	12.90	0.00%	0
Springfield	6.44	7.4%	19,752

Upper Dublin	15.74	18.07%	48,259
Upper Gwynedd	18.65	21.41%	57,189
Upper Moreland	0.03	0.03%	89
Whitemarsh	8.11	9.31%	24,880
Whitpain	9.87	11.33%	30,254
Worchester	0.35	0.40%	1,075
			Total: 267,064

Municipalities can choose from any of the seven TMDL control measures listed in the March 2, 2009 draft PAG-13, except streambank restoration. In this first cycle of using the credit system approach, keeping the system as simple as possible is crucial. Streambank restoration does not reduce volume flowing to the stream, therefore it is not comparable to other control measures. The size of the control measure(s) must be designed to meet the assigned volume reduction, according to standard engineering practice. PEC recommends that other control measures be added in each permit cycle.

A key change in PEC's recommendation from the PAG-13 draft is that municipalities should be permitted to implement control measures on either public or private land. The municipality must be able to demonstrate long-term control of the site through an easement or a contractual agreement. Furthermore, municipalities may purchase credits from other municipalities through individual contractual agreements. In these situations, the seller of credits is responsible for maintenance of the sites. Details of the agreements would be included in the annual reports that document actions taken to comply with the permit.

If the municipalities can document permanent volume retention capacity added since the TMDL was established in 2003, they can claim that volume towards their credit commitment. The same requirements for permanent maintenance apply to past projects as to new projects. Municipalities may need to go back to previous work to establish the appropriate legal control for sites. Credits generated beyond the sediment credit commitments proposed in each Stormwater TMDL Plan would be carried forward to the next permit cycle.

Attachment III introduces a compilation of stormwater control sites for which Temple University researchers estimated retention or infiltration capacity and cost of implementation. PEC undertook this study to help the municipalities in identifying suitable projects, and in getting a sense of their cost. We expect it to be particularly useful in looking outside of any single municipality's boundaries to find more cost-effective projects.

Monitoring, reporting and future cycles

Municipalities will monitor and report on implementation of their control measures in the periodic reports required by the MS4 permit. The monitoring will be designed to ensure that the facility or facilities constructed to meet the TMDL commitment will continue to provide the design storage capacity over time. An appropriate technical expert will inspect the facility annually and report on capacity and functioning. When the facility

drops below a target level of capacity, to be identified in the engineering design, the facility will be restored to original capacity and functioning. Monitoring information will be included in periodic MS4 permit reports. Municipalities will estimate the annual amount of retention and sediment removal based on number of storm events and proper construction and management of the facility.

PADEP will be responsible for monitoring the Wissahickon Creek to identify the effect of the first years of implementation. Prior to the next permit cycle, either PADEP would establish a new wasteload reduction target for the next permit cycle, or the Wissahickon municipalities would work collaboratively to identify the target.

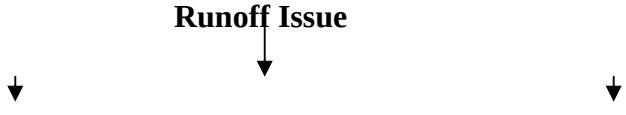
1. THEORY AND OPTIONS CONSIDERED

A. The Stormwater Dilemma

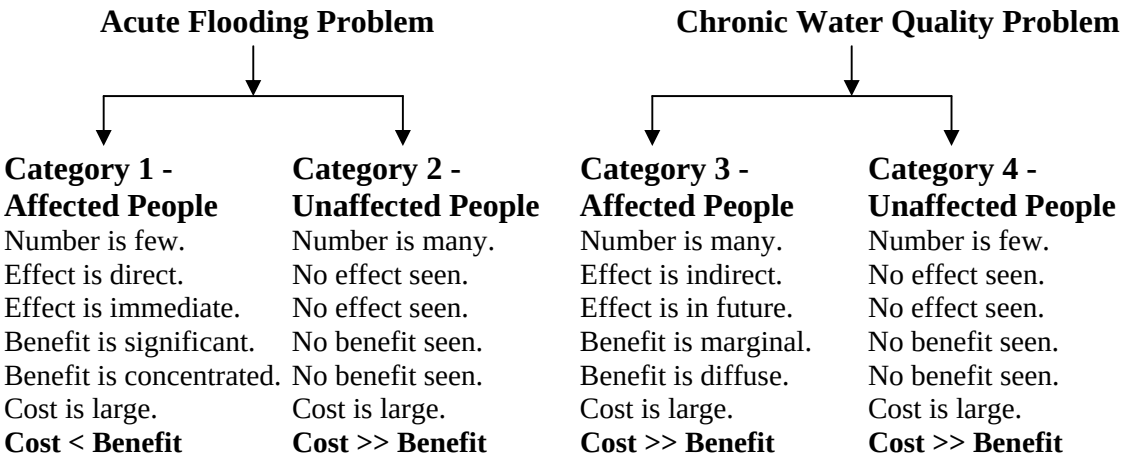
TMDLs from runoff are particularly difficult to implement, as detailed by Figure 1 (below).[1] In this model, runoff issues are divided into acute flooding problems and chronic water quality problems. Each of these subcategories is further divided by groups of people affected by the problem. Each group will value cost and benefit of management actions according to their personal stake in the issue.

Category 1 people, acute flooding victims, advocate for stormwater intervention because the benefits are direct, immediate, significant, and concentrated. Category 2 people, unaffected by acute flooding, do not advocate for intervention because they will not benefit from intervention, regardless of cost. Category 3, those with an ongoing water quality problem, is a large group that will benefit from improvements in water quality. But these benefits are indirect, in the future, marginal, and diffuse, and the cost remains high. Therefore, this group will not advocate for intervention. Finally, Category 4 people are like Category 2 people. They are unaffected by runoff and so are unwilling to pay the cost of intervention. When one views the groups collectively, one sees that the Category 2, Category 3, and Category 4 outnumber Category 1. This model explains the inaction of stormwater intervention. In sum, runoff intervention (including runoff-based TMDL implementation) has languished because the small number of people (for whom the benefits outweigh the cost) have not convinced the large number of people (who perceive that the cost outweigh the benefits) to advocate for intervention. Recognition of this dilemma is important because it means that implementation of runoff control measures (including TMDLs) requires lowering the cost or expanding the benefit.

Figure 1 – Runoff Dilemma



[1] This Runoff Dilemma flow chart was originally developed for a presentation delivered by Donald Curley to a group of citizens in Radnor Township in October 2008. For an explanation of the general concept of concentrated interests vs. diffuse interests see Mancur Olsen, *The Logic of Collective Action; Public Goods and the Theory of Groups*, Harvard University Press, 1965.



Another dilemma is that, in general, the link between runoff-based TMDLs and implementation is weak.[2] Permit requirements typically consist of soft language like "minimum control measures" and "maximum extent practical."[3] The TMDLs seem to emphasize the generalities of what needs to be done not the particulars of how it can or must be done. The National Research Council recognizes that EPA's current approach to regulating runoff is not likely to adequately control stormwater's contribution to waterbody impairment and that radical changes appear necessary.[4] Finally, permits have been ineffective in achieving meaningful retroactive control of sediment, which is essential for achieving the endpoint of the TMDL.

The Wissahickon sediment TMDL, in particular, is affected by this runoff dilemma. Despite the passing of more than five years since approval of the TMDL, the status of implementation is uncertain.[5] Furthermore, our discussions with municipal representatives indicate that municipalities are frustrated by the ambiguity of the draft MS4 permit and are unlikely to implement significant stormwater volume reductions as a result of the PAG-13 requirements.

In sum, the status quo approach is not likely to make meaningful progress toward the endpoint of the TMDL. PEC envisions a new approach, an extension of the existing system that builds on successes but skirts proven barriers.

B. Barriers to The TMDL

Barriers to successful implementation of the TMDL program are fourfold: technical, legal, financial and political. Of these, the political barrier has been the most significant

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[2] United States Environmental Protection Agency Region 5, *Total Maximum Daily Loads and National Pollutant Discharge Elimination System Stormwater Permits for Impaired Waterbodies: A Summary of State Practices (Henceforth Summary of State Practices)*, September 15, 2007. http://www.epa.gov/owow/tmdl/stormwater/ , last visited December 26, 2008.

[3] *Summary of State Practices*, p. 7.

[4] National Research Council, *Urban Stormwater Management in the United States*, Advance Copy, October 15, 2008, National Academies Press, Washington, DC, p. 7

[5] http://www.dep.state.pa.us/watermanagement_apps/TMDL/default.aspx, last visited 01/30/09.

for a number of reasons, mainly stemming from diffuse responsibility and shared authority. These barriers are explored in depth below.

1. Technical Barriers - Critics of the TMDL program state that the science, data, and methods used for assessing and allocating pollution loads are not sufficiently reliable. In March of 2000, The Government Accounting Office (GAO) reported a "pervasive lack of data at the state level available to set water quality standards."[6] Shortly thereafter, Congress requested that the National Research Council (NRC) assess the scientific basis of the TMDL program.[7] The NRC report included numerous recommendations to improve the science of the TMDL program. The NRC reflects many, perhaps most, of the main concerns regarding the TMDL's scientific basis. However, nothing in the report indicates that the technical issues constitute an insurmountable barrier.

Many scholars are critical of the notion that the science is uncertain. Professor Linda Malone states that there is nothing unique about the science of TMDLs, and that every environmental regulation of the past three decades has been forced to address this issue of uncertainty.[8] She states that professor Oliver Hauck "debunks the myth" that nonpoint sources are harder to regulate than point sources, and goes on to argue that there is no legal reason why states cannot regulate nonpoint sources and that the only insurmountable problem of the TMDL program is a lack of political will.[9] Our society has made and currently makes numerous decisions regarding complicated scientific issues. The political process seems especially well-suited to be the final arbiter of what is an appropriate level of certainty. Nothing strikes us as different about the science of TMDLs that would prevent our society from making these decisions. This condition does not mean that scientific issues, methods, and availability of data should be ignored. Instead, implementation should reflect the degree of certainty of the science.

2. Legal Barriers – Legal aspects of the TMDL are somewhat fuzzy. It contains no requirement for implementation, and so functions more as a planning rather than a regulatory document. It is clear that NPDES permits issued must be consistent with the assumptions and requirements of the local TMDL,[10] but the requirement for enforcement

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6 National Research Council, Committee to Assess the Scientific Basis of the Total Maximum Daily Load Approach to Water Pollution Reduction, *Assessing the TMDL Approach to Water Quality Management*, National Academy Press, Washington, DC, 2001, p. 2.

7 See NRC Report.

8 Linda Malone, The Myths and Truths that Ended the 2000 TMDL Program, *20 Pace Entl. L. Rev. 63*, 2002, p. 76.

9 Linda Malone, The Myths and Truths that Ended the 2000 TMDL Program, *20 Pace Entl. L. Rev. 63*, 2002, pp. 63, 78, 79.

10 Jeffrey M. Gabba, Generally Illegal: NPDES General Permits Under the Clean Water Act, 31 Harv. Envtl. Law Rev. 409, 2007, p. 439.

is not clear.[11] Therefore compliance could be viewed as voluntary.[12] Neither Congress nor the courts have shown inclination to force implementation of TMDLs.[13]

The only available recourse against state noncompliance is the withholding of federal funds.[14] These funds are historically so meager that their withholding does not provide sufficient incentive for noncompliant states to begin implementation.[15] Therefore, implementation of the TMDL is effectively voluntary.

PEC's interpretation of the literature tells us that the voluntary nature of implementation does not mean that states do not have the authority to implement the numeric reduction of the TMDL. The logic of Federalism is apparent in that Congress forces the EPA to force states to force municipalities to modify local codes that force land users to control pollutants. Professor Linda Malone states that there has never been any question that states have the legal authority to regulate the environment unless preempted by federal regulation.[16] States, however, have generally not used their power to force action on stormwater because it is not an issue to most citizens.

3. Financial Barriers – TMDLs are expensive to implement. In the case of the Wissahickon, sediment reductions at the scale necessary for implementation require costly construction measures and changes in land use. Our understanding is that no feasibility analysis and or cost estimate was prepared for the Wissahickon TMDL. Our estimate is between $106 million and $230 million, probably towards the higher end. Other financial estimates support our assumption that the cost of implementing a sediment TMDL would be enormous.

- In 1971, Sen. Muskies's staff estimated that nonpoint source control could cost as much as $40 to $50 billion.[17] If one doubles these costs for inflation and considers the population increase since 1971 then one could reasonably expect the national costs on the order of hundreds of billions of dollars.
- The state of MD estimated its nonpoint source control cost to be between $1B and $2B. The federal CWA allocation for MD is just over $5M per year. This more-

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[11] Jeffrey M. Gabba, Generally Illegal: NPDES General Permits Under the Clean Water Act, 31 Harv. Envtl. Law Rev. 409, 2007, p. 440.

[12] Sarah Brull, An Evaluation of Nonpoint Source Pollution Regulation in the Chesapeake Bay, 13 U. Balt. J. Envtl. 221, Spring 2006, p. 227.

[13] Kenneth M. Murchison, Learning from more than five and a half decades of Federal Water Pollution Control Legislation: Twenty Lessons for the future, 32 B.C. Envtl. Aff. L. Rev. 527, 2005, pp. 577, 578.

[14] Oliver A. Houck, The Clean Water Act TMDL Program: Law, Policy, and Implementation, Environmental Law Institute, Washington, D.C., 1999, p. 62. Section 319 is the carrot that funds state programs for non point source abatement.

[15] Sarah Brull, An Evaluation of Nonpoint Source Pollution Regulation in the Chesapeake Bay, 13 U. Balt. J. Envtl. 221, Spring 2006, p. 232.

[16] Linda Malone, The Myths and Truths that Ended the 2000 TMDL Program, *20 Pace Entl. L. Rev. 63*, 2002, p. 81.

[17] Paul Charles Milazzo, *Unlikely Environmentalists, Congress and Clean Water 1945-1972*, University Press of Kansas, 2006, p. 200.

than-two order of magnitude disparity shows the sizable gap between the language of the CWA and the federal funding to support it.[18]

- The Minnesota Pollution Control Authority estimated that the cost to restore waters on its 2002 303(d) list to be between $600M and $3B.[19]

The enormity of cost combined with the cost-benefit distribution provides a clear explanation for why implementation has stalled.

4. Political Barriers – In his 1965 book, *The Logic of Collective Action, Public Goods and the Theory of Groups*,[20] Mancur Olsen defines how the composition of participants in a political battle defines which group will win. Concentrated interests, he tells us, will defeat diffuse interests in the political process. This is especially true for sediment TMDLs, and the case of the Wissahickon is consistent with these predictions. Specifically, the benefits of controlling sediment are:

a. In the future. Restoration of the waterway may take decades.

b. Not local. Many of the benefits will flow downstream. Some downstream communities will receive many of the benefits of TMDL implementation without paying any of its costs.

c. Diffuse and indirect. Most people will receive a small benefit. The net benefit may be large when spread across the community, but few individuals will likely see the direct benefit necessary to spur action.

On the other hand, the costs of sediment control are:

1. Immediate. People will need to pay now for a future benefit.
2. Local. Those who discharge near impaired segments will pay the cost of pollution control, despite the fact that benefits will be shared. Furthermore, people from outside the local area could make trips to the newly restored waterways, thereby receiving benefit without paying any of the cost.
3. Concentrated and direct. Even a modest fee may be perceived as too much for many municipal officials and citizens.

This combination of delayed, regional, diffuse, and indirect benefits with immediate, local, concentrated, and direct costs makes the state implementation of a voluntary TMDL an uphill battle. In legislative battles over spending priorities, support for a program is a function of the perceived benefit vs. cost. The lack of political and popular support for implementation of TMDLs is consistent with Olson's theory. Consequently, many legal scholars paint a dismal picture of the TMDL's potential for effective nonpoint source and runoff control.[21] The history of TMDLs in general and of the Wissahickon

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[18] Sarah Brull, An Evaluation of Nonpoint Source Pollution Regulation in the Chesapeake Bay, *13 U. of Balt. J. Envrtl. L. 221*, Spring 2006, p. 240.

[19] Lames M. McElfish et al, Inventing Nonpoint Controls: Methods, Metrics, and Results, *17 Vill. Envr. L.J. 87*, 2006, p. 134.

[20] Mancur Olson, The *Logic of Collective Action, Public Goods and the Theory of Groups*, Harvard University Press, 1965. See also David Zaring, *Agriculture, Nonpoint Source Pollution, and Regulatory Control: The Clean Water Act's Bleak Present and Future*, 20 Harv. Envtl. L. Rev. 515 (1996).

[21] See generally Wendy Wagner pp. 225-226. William Andreen p. 545, 550. Sarah Brull p. 225-227, Robert Adler p. 230.

TMDL in particular affirms this concept. This is the fundamental disconnect of the TMDL program.

What bearing do these four factors have on the application of market mechanisms to facilitate TMDL implementation? It appears that the legal and technical barriers are not dominant. If political will exists, the state may create a mechanism with legal authority to addresses any technical issues. This does not mean that legal and technical issues may be ignored; rather, they should not be viewed as the fundamental problem.

The fundamental disconnect of the TMDL program for runoff is the combination of high financial cost and low political reward. Unless something is done to overcome this disconnect, the program will be ultimately unsuccessful in meeting target pollution reductions. In the following pages we will propose a market-like mechanism which aims to overcome the political barrier while still providing for the secondary legal, financial, and technical aspects of the program.

C. Current State Policy

TMDL implementation differs somewhat across the country due to varying state controls and phases of the MS4 permit. Pennsylvania lags in its implementation of Phase II of the municipal separate storm sewer system (MS4) permit, which aims to link municipal stormwater management with local TMDLs. Due to Pennsylvania's highly fragmented government and Home Rule provision, tying the permit to the TMDL poses a particular problem here.

1. Draft MS4 Permit - Pennsylvania's Department of Environmental Protection (DEP) has issued its revised draft General Permit for stormwater discharges for small municipalities in March, 2009.[22] The previous general permit, issued in 2003, included no special requirements for TMDL watersheds. The revised 2009 draft MS4 permit includes additional requirements for municipalities including watershed areas of impaired waters for which a TMDL exists. Some of these requirements present obstacles to the use of market mechanisms towards implementation of the Wissahickon's sediment TMDL. If market mechanisms are to be adopted, the permit must be modified. Our opinion is that a permit modified to include market mechanisms such as those recommended in this report would better protect the impaired waters and would be preferable to the municipalities over the existing DEP version. In the following pages are identified key elements of the draft permit, its limitations, and modifications necessary to facilitate market mechanisms, as well as an alternative proposal and advantages.

In general, the alternative proposal seeks to maintain the regulator's role of determining the level of environmental protection while expanding the flexibility of the regulated parties to determine how they can achieve that level. This means that DEP must decide the level of control required, assign it to municipalities, and develop a menu of control measures that achieve that level. Municipalities will then select measures to implement

[22] Pennsylvania Department of Environmental Protection, National Pollutant Discharge Elimination System (NPDES) Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) General Permit (PAG 13), Draft, (Henceforth DEP Draft Permit).

from that menu. If the control measures are realistic and efficient, municipalities may be less resistant to the new regulation. These new efficiencies may also allow PADEP to set a "higher bar" of protection and "ratchet down" protection levels for future permits, potentially satisfying environmental advocates as well. Finally, it is hoped that PADEP will support a system supported by both municipalities and environmental advocates.

In PADEP's proposal, the General Permit (PAG-13) is applied broadly to all small municipalities, with additional requirements for TMDL watersheds. Permit requirements do not reflect the type of pollutant in the TMDL or the degree of contribution of particular municipalities. They take several forms. First, municipalities must "develop, implement, and enforce a Stormwater TMDL Plan."[23] Most of this seems administrative and provides merely a reiteration of the original TMDL document. The Plan must also include information and analysis of how measurable progress shall be made toward substantially reducing the pollutant load consistent with the TMDL.[24] Finally, the Plan must implement two of seven Control Measures (CM).[25] These measures are a combination of physical infrastructure and administrative procedures and are defined as follows:

- Control Measure 1 – Establish and Protect Riparian Forest Buffers
- Control Measure 2 – Disconnect Impervious Area from MS4 System
- Control Measure 3 – Plant Trees
- Control Measure 4 – Construct Recharge/Infiltration Facilities
- Control Measure 5 – Naturalize or Modify Existing Basins for Extended Detention or Infiltration
- Control Measure 6 – Restore Stream Banks
- Control Measure 7 – Construct Green Infrastructure

2. Limitations of PADEP's Draft Permit - Understanding the benefits of our proposal requires understanding the limitations of PA DEP's proposal. These limitations are as follows:

- **Unclear Expectations of Control Measures** – The level of control is not stated. For example, "establishing and maintaining a riparian buffer" does not provide clear guidance to the municipalities. Details about length, width, and composition are missing. Without such information, municipalities cannot know what is expected. The lack of detail is also an issue for CM 2 (disconnects), CM 4 (Recharge), CM 5 (Retrofit Basins), CM 6 (Bank Restoration), and some elements of CM 7 (Green Infrastructure). This failure to specify requirements means that municipalities can't help but push the lower limits of compliance, resulting in decreased effectiveness. Valuable resources will be spent by both the state and municipalities disputing what is in fact a subjective regulation.
- **Inequity of the Allocation of Control Measures** – Control requirements are not distributed according to the Waste Load Allocation (WLA) of the TMDL. For

[23] DEP Draft Permit, Instructions, p. 3.
[24] DEP Draft Permit, Instructions, p. 4.
[25] DEP Draft Permit, Instructions, p. 4.

example, the municipality indicated as Upper (presumed to be Upper Moreland) has an allocation of 862 lbs per year while another indicated as Upper (presumed to be Upper Dublin) has an allocation of 550,584 lbs per year.[26] Despite the nearly three order-of-magnitude difference in sediment contribution, both municipalities must contribute the same degree of control. This disparity is frustrating and encourages municipal resistance.

- **Compliance Uncertainty** – DEP puts the burden on municipalities to identify the monitoring requirements and scope of compliance. When requirements are not made explicit, municipalities cannot be sure of their permit status and will likely resist due to this uncertainty. Furthermore, monitoring will remain in question because the thing that's monitored for is undetermined. With regard to structural controls, this becomes an obvious problem.
- **Unknown Penalty and Liability** - The permit specifies that "Nothing in the General Permit may be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under section 311 of the CWA…"[27] These penalties can be severe, as much as $125,000 per violation for administrative remedies, include attorney's fees for civil remedies, and include confinement and fines of $1,000,000 for criminal remedies.[28] In other words, DEP retains the right to impose harsh penalties for violations but it fails to specify how to ensure compliance. The rational municipality will not support a new way of regulating if that way significantly expands uncertainty of compliance but maintains the significant and open-ended penalties for noncompliance.
- **Unfeasible and Unrealistic Expectations –** Some of the control measures are not politically feasible or realistic. For example, CM 7 requires (among other things) 100,000 square feet of green roof per municipality per permit cycle. Using a low-end budgetary number like $8 per square foot produces a total cost of $800,000. It is not realistic to expect municipalities to spend that amount of money for an uncertain, future, non-local, indirect benefit. Similarly, using a modest cost differential of $1 per square foot between porous and non-porous pavement, the cost of installing porous pavement would exceed $1,000,000 per municipality per permit cycle. This does not include removal, disposal, or engineering, whose combined costs could greatly exceed the cost of the new pavement. In such a scenario, the cost is enormous yet the benefit is unknown. This means that municipalities cannot be sure if they are required to spend millions or tens of thousands of dollars. This, too, will likely lead to resistance.
- **Inappropriate Implementation Requirement –** The permit states that the permittee shall implement control measures on municipal facilities.[29] This requirement means that municipalities are not able to transfer the requirement to other land owners in the municipality, even through a contractual agreement.

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[26] United States Environmental Protection Agency, Nutrient and Siltation TMDL Development for Wissahickon Creek, Pennsylvania, Final Report, October 2003, p. 4-24, (Henceforth TMDL Report).

[27] DEP Draft permit, Part B, Standard Conditions, P. 9.

[28] Olga L. Moya and Andrew L. Fono, Federal Environmental Law, The user's Guide, Second Edition, West Group, St. Paul, MN, 2001, p. 349.

[29] DEP Draft Permit, Standard Conditions, p. 10.

This is problematic because land use management and contracting are familiar municipal roles. Furthermore, this requirement could exclude a considerable amount of land that is available for retrofits. If municipalities must perform retrofits on public land then the number of available sites would decrease considerably.

- **Failure to Define Maximum Extent Practicable (MEP) –** Reducing sediment in the Wissahickon Watershed to the WLA of the TMDL is an enormous task. Unless MEP is defined, sediment reductions can only be measured against the end-point number, which is impractically large. But, in the Draft Proposal DEP does not define MEP. Rather, it assigns the responsibility to "minimize" or "eliminate" the impacts of stormwater runoff according to each municipality's undefined MEP. The determination of MEP is one of the fundamental policy aspects of the permit and ideally should not be deferred to the municipalities. As it stands, "practical" could be interpreted to mean almost nothing. The failure to define what is practical in the regulation of stormwater is one of the major reasons why the regulation of stormwater has lagged behind the regulation of traditional point sources.
- **Insufficient Link Between Sediment and Control Measure –** Some of the control measures identified in the permit are not linked to specific sediment reductions. Consequently, there is no incentive for municipalities to use the likelihood of reductions as the basis for selecting a CM. For example, riparian buffers and recharge facilities will both reduce sediment but not to the same degree. Without linking the specific control measure to sediment reduction in the Wissahickon the municipalities will likely select the least expensive CM, regardless of its capability to reduce sediment.
- **Costs of Control Measures Vary Considerably –** Preliminary estimates of the cost of prospective control measures vary from around $17,000 per cycle (tree planting) to as much as $6.5M per cycle (green infrastructure).[30] This is problematic because it constrains the choices of the municipalities. An alternative that is more than two orders of magnitude more expensive then another alternative is not really an option. No rational municipality will spend $6.5M to comply when they could spend $17,000.

2. APPROACHES

A. Potential Scenarios

Having made an argument that barriers to using market mechanisms to implement the TMDL are real but not insurmountable, and that change needs to be made, three general incentive approaches will be examined for a runoff-based TMDL.

1. No Action – Under the current TMDL system, perceived benefits of implementation are small compared to large political costs. States and municipalities are reluctant to force the issue. The use of market mechanisms for implementation of runoff-

[30] DCPC Memo 8

based and nonpoint source TMDLs has been slow because the CWA fosters uncertainty for participants, and because TMDLs typically do not contain numeric limits or triggers. This status will continue unless a change is introduced to the system. No amount of outreach will change this fundamental disconnect of the TMDL program. Stakeholders across the entire spectrum of interests must recognize that the TMDL program will not be successful without a more explicit interpretation of the draft MS4 permit.

2. Price-Based Approach - One way for regulators to change the incentive for implementing the sediment TMDL and for using market mechanisms to do it is through the direct purchase of sediment reductions. Government could allocate funding for purchasing reductions. An association or regulators could issue and accept bids to achieve these reductions, selecting the bids that provide the largest and most reliable reduction for the price charged. This concept, commonly called a reverse auction, is a part of several trading systems; including the Conestoga Trading system and the California selenium exchange.[31]

The Achilles' heel of this scenario is funding. It is not likely that the Federal Government, the State Government, or municipal governments are willing to provide the amount of funding that implementation of a sediment TMDL for the Wissahickon requires. A funding allocation of the size needed to achieve the endpoint of the TMDL would likely cause great discomfort for government sources. This does not mean that a reverse auction has no role. It is an efficient way to allocate whatever funding government provides toward achieving the endpoint of the TMDL. But, the difficulty of securing a dedicated source of significant funding makes this scenario impractical.

3. Quantity-Based Approach - The quantity-based incentive approach is the flip side of the price-based approach. In it, government establishes the quantity and the market responds by finding the least expensive way to achieve that quantity. The sulfur dioxide trading program and the Long Island Nitrogen Exchange are examples of this type of system.

For the TMDL in the Wissahickon, implementation through the use of market mechanisms will require a firm quantity control requirement under which to establish the mechanism. However, the difficulty here will be determining an appropriate requirement within the framework of the current political, technical, legal, and financial climate.

To trigger the formation of a market mechanism, political benefit of supporting the TMDL must become higher than political cost. Building momentum toward this end would involve raising the benefit or lowering the cost. The former seems impractical, the latter seems possible. One way to do this is to implement the TMDL gradually so that its initial costs are low. In other words, implementation should seek to "pick the low hanging fruit."

Commonly referred to as adaptive implementation (AI), such a process would progress toward achieving water quality goals while using any new data and information to reduce uncertainty and adjust implementation activities.[32] One notable distinction is

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[31] Breetz, Hannah et al, Dartmouth University Survey of Water Quality Trading.

[32] United States Environmental Protection Agency, Benita Best-Wong, Director, Assessment and Watershed Protection Division, Clarification Regarding "Phased Total Maximum Daily Loads", Memorandum to Water Division Directors, August 2, 2006.

that while all parties associated with the Wissahickon's sediment TMDL recognize that it contains considerable uncertainty, the reason for using AI in this case is not to create more certainty but to reduce the initial cost. Again, due to the cost-benefit problem, it is likely that parties subject to the TMDL's new discharge requirements would continue to resist regardless of whether the TMDL level was certain or if the data was plentiful.

It goes without saying that TMDL levels must be set to attain water quality standards.[33] But this does not mean that full implementation must occur all at once. It seems illogical that if no implementation is required at any time, that partial or gradual implementation would be forbidden in the short run. EPA'S guidance memo seems to support this statement.

> Some TMDLs may be based on attaining water quality standards over a period of time, with specific controls on individual sources being implemented in stages (emphasis added). Determining this reasonable period of time in which water quality standards will be met is a case-specific determination...[34]

Furthermore:

> Implementation of TMDLs can take many years and when uncertainty about the effectiveness of implementation activities exists, TMDLs would benefit from containing elements that would facilitate adaptive implementation… EPA believes that in appropriate cases it should be feasible for States to develop TMDLs that facilitate implementation of practicable controls while additional data collection and analysis are conducted to guide implementation actions.[35]

Finally, the National Research Council also supports the concept of adaptive implementation, as stated in its 2001 report on the adequacy of the science of the TMDL program.[36]

B. A Market Approach

The concept of bringing pollution into the economic loop through the use of markets, credits, and payment systems has proven successful in many point-source pollution scenarios. This is evidenced particularly in the air quality sector (sulfur dioxide), and the

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[33] United States Environmental Protection Agency, Benita Best-Wong, Director, Assessment and Watershed Protection Division, Clarification Regarding "Phased Total Maximum Daily Loads", Memorandum to Water Division Directors, August 2, 2006.

[34] United States Environmental Protection Agency, Benita Best-Wong, Director, Assessment and Watershed Protection Division, Clarification Regarding "Phased Total Maximum Daily Loads", Memorandum to Water Division Directors, August 2, 2006. See also Part 132, Appendix F of Title 40 of the Code for Federal Regulations, Chapter I, contains the regulations governing the Total Maximum Daily Load program in the Great Lakes, which were issued in 1995.

[35] United States Environmental Protection Agency, Benita Best-Wong, Director, Assessment and Watershed Protection Division, Clarification Regarding "Phased Total Maximum Daily Loads", Memorandum to Water Division Directors, August 2, 2006.

[36] National Research Council, Assessing the TMDL Approach to Water Quality Management, National Academy Press. Washington, DC, 2001.

water quality sector (nutrients). With nonpoint and stormwater pollution, however, there has not been sufficient regulation in place to set the initial limit against which to trade. However Phase II of the MS4 permit has the potential to change this fact by setting measurable limits on pollutants discharged by a municipality, thereby designating a point source and assigning responsibility. In this case, lessons learned from previous point-source market systems could be applied to a nonpoint-source scenario.

C. Lessons Learned from Air Quality Trading Systems

Scholars have studied air pollution trading, particularly the sulfur dioxide trading program (Title IV). Several themes have been identified that may apply to sediment control in the Wissahickon.

1. Flexibility

Title IV enabled utilities to adapt to unforeseen events (Schmalensee et al, p. 469). It encouraged utilities to investigate new compliance options (Ortolano, p. 235). Prior to the program, utilities believed that blending fuel would adversely affect equipment (Ortolano, p. 235). Using the compliance flexibility of the program, utilities experimented with fuel blends and determined that the adverse effects were less than they had expected (Ortolano, p. 235). The lesson then is that allowing the sort of flexibility typically associated with markets may encourage new efficiencies. The Tar Pamlico program and Nuese River program offer other examples. Dischargers found internal methods to lower reduction and did not need to find offsets (Fisher-Vanden et al, pp. 223, 230).

2. Small Steps

The development of the Title IV market was not fast (Schmalensee, p. 469). The initial volume of permits that were involved in trading was low but increased significantly around 1994 (Schmalensee, p. 465). The key from this lesson is the importance of an incremental approach.

3. Monitoring

Much of the success of Title IV relies upon its provisions for monitoring and enforcement (Schmalensee, p. 469). Monitoring is after-the-fact and administrative; emitters monitor continuously and deliver valid allowances within 30 days of year's end (Schmalensee, p. 457). Compliance is encouraged via a $2,000 per ton penalty for non-compliance (Stavins, p. 474). With the market price of a ton of sulfur dioxide around $100 - $300 dollars and the high likelihood of identifying non-compliers, compliance is superior to noncompliance. In the Wissahickon, an ideal scenario would involve a similar degree of incentive for dischargers.

4. Support

Strong vocal support from the environmental community, particularly the Environmental Defense Fund (EDF), contributed significantly to the creation of Title IV (Stavins, p. 480). Environmental advocacy groups were traditionally hostile to market-based instruments (Stavins, p. 474). But, support from EDF deflected opposition and helped pass Title IV (Stavins, p. 480).

This lesson provides insight into the role of local watershed groups during the development of trading systems. These groups could provide the moral authority that the system needs for creation. One could reasonably expect local advocacy groups to resist the use of trading. But, if developers of the system can convince these groups of the effectiveness of trading programs in other contexts, then these groups may provide support and facilitate the creation of an institution for trading.

5. Reduction not Redistribution

Title IV was in large part successful because it called for reduction rather than simple redistribution of the pollutant (Stavins, p. 480). Congress retained responsibility for goal-setting and established new caps for emissions while allowing emitters the flexibility to change the distribution of the emissions. It should be noted that such a trading system is a tool to achieve a goal, not a tool to set the goal. (Shapiro and Glickman, p. 298, 305). Under this logic, PADEP should place a new requirement upon municipalities in order to affect a trading scenario. This proposed system would efficiently distribute the compliance burden, but the burden itself must first be applied by the State.

6. Marginal Costs

One reason why trading was effective at controlling sulfur dioxide is that the marginal cost of control was high, nearly tripling (between 1972 and 1990) in real dollars from the 1972 price (Stavins, p. 480). It was also varied among emitters, so that those with high marginal costs sought to purchase reductions from those with low marginal costs.

One can expect a sizable difference in the marginal cost of sediment or runoff reduction for the municipalities. Some municipalities are small and fully developed while others are large and not fully developed. Additionally, one can expect that land prices will vary across the municipalities. The difference in marginal cost of sediment (or runoff) reductions and land prices will cause some dischargers to become buyers and some to become sellers.

7. Simplicity

Simplicity and transparency contribute to the success of Title IV (Stavins, p. 483). The trading rules are clearly defined upfront and there is not a requirement for regulator approval of each trade (Stavins, p. 483; Ortolano, p. 238). The requirement to approve each trade hindered EPA's Emissions Trading Program in the 1970s while the lack of this requirement contributed to the success of lead trading (Stavins, p. 483). Additionally, simplicity can contribute to low transaction cost. Low transaction costs contribute to the success of Title IV (Stavins, p. 486; Schmalensee, p. 465). Finally, transparency is an important part of the sulfur dioxide trading program (Ortolano, p. 237). Each participant knows what the allowance entitles them to do (Ortolano, p. 237).

A trading system that mimics Title IV would be simple and transparent. Municipalities must know before the fact that they can do what PADEP requires and that what they are doing will ensure compliance.

D. Lessons Learned from Analysis of Water Quality Trading Systems

An examination of the lessons of using market mechanisms to improve or maintain water resources focuses upon why these mechanisms play little role in policy. Unlike air trading systems, trading (or other market mechanism) plays almost no part in water resources. Consequently, if one wanted to apply lessons from an analysis of lessons learned from trading (or other market mechanisms) for water resource protection then one must consider the failure and not the success of trading.

A review of the spectrum of market mechanism for water resource protections indicates that there are dozens of initiatives, pilots, policies, memos, positions, or other attempts to develop market mechanisms for water resource protection.[37] But only a handful of these creations continue to exist or operate in an ongoing fashion. Many of these initiatives never accomplish their goal. Many of them achieve a one-time outcome but fail to continue.

The following lessons contribute to an explanation as to why the use of market mechanisms for water pollution control is dormant.

1. Technology Requirements

The statutory requirements of the Clean Water Act (CWA) that specify technology-based controls may be a barrier to establishing trades (Stephenson, Shabman, and Geyer, p. 797). First, there is a general unwillingness of regulated dischargers to deviate from the technologies defined in the NPDES permit because they run the risk of being exposed to additional regulatory scrutiny and performance requirements (Stephenson, Shabman, and Geyer, p. 798, 799). Second, the CWA does not explicitly allow trading (Stephenson, Shabman, and Geyer, p. 801). The Government Accounting Office concluded in a 1992 report that there is a "perceived legal risk that the programs will be overturned and disallowed by regulators (Stephenson, Shabman, and Geyer, p. 801). Since the publication of that report, EPA has published a trading policy that, despite few specifics, speaks very favorably of trading (EPA 1996; EPA 2005). Despite the favorable language, trading as a national policy tool remains dormant. Finally, the technology requirement, in and of itself, is a barrier because it represents a sunk cost. If regulators require it then dischargers install it. Once it is in place, there is no reason not to use it and no financial incentive to find alternatives to using it.

2. Permit Renewal

In examples reviewed, the timing of NPDES permit renewal did not facilitate trading (IES, p. 17). Permits in the same watershed cover different time periods. When two permit holders have different cycles to their permits, they have greater uncertainty about the other permit holder as a trading partner. The key is that all permittees must be on the same cycle.

3. Authority for Nonpoint Sources

Lack of authority to force control of non-point sources is a barrier to trading. For nonpoint sources, the CWA used planning instead of direct regulation (Murchison, p. 547). In July 2000, EPA revised its rule for the TMDL but did not require regulatory controls on nonpoint sources (Murchison, p. 576). Instead, states could rely upon "incentives and other voluntary controls" that provided reasonable assurance that the

[37] Dartmouth Report. See Also EPA report.

TMDL would achieve the water quality goal (Murchison, p. 576). Furthermore, Congress revoked the rule in March of 2003 and EPA is unlikely to require states to establish regulatory limits on nonpoint sources, even when water quality standards require these reductions (Murchison, pp. 577, 578). The effect of this condition is that, despite numerous TMDLs involving nonpoint sources, the TMDL has not served as a trigger for measurable reductions and has therefore not been a factor to effect trading.

4. Enforcement

Legal action is the main mechanism of the CWA for ensuring compliance (IES, p. 39). However, this reliance upon legal action for enforcement may be a barrier to the widespread use of trading because legal action is not transparent or easily predictable (IES, p. 39). NPDES permit violations can cost $10,000 or $25,000 per day for civil violations and much more for criminal violations (Moya and Fono, p. 347, 349). Additionally, the Clean Water Act allows the court to award attorney's fees (Moya and Fono, p. 349). But application of penalties is often uncertain, which contributes to the dormancy of trading. Furthermore, legal action often has an "all-or-nothing" character (Gruenspecht and Lave, p. 1523). This characteristic introduces uncertain liability for the participants. This condition may be especially problematic for small dischargers who do not have the financial capability to assume the open ended risk of participation. These participants may choose conventional methods of environmental control instead of market mechanisms because of the relative certainty and well-defined liability of conventional methods. Litigation may also be expensive relative to other mechanisms for regulation (Shortle and Ambler, p. 54). In contrast, Title IV provides transparent penalties. At any time, participants know the cost of compliance (the market price of an allowance) and the cost of non compliance ($2000 per ton per year). For this reason, it is clear from the outset that compliance is the less burdensome option.

5. Uncertainty and Liability

Several studies indicate that the uncertain liability of the participants is a barrier to the widespread use of trading. In most PS-NPS systems, trades transfer the responsibility for reduction but not the liability; this creates an important barrier to the trade (Horan, p. 935, note 3). In Colorado, liability was one of the issues that prevented the use of trading to clean up an abandoned mine (Fisher-Vanden at al, p. 62). The Fox-Wolf program in Wisconsin has not had any trades, in part because point sources are reluctant to trade due of high uncertainty and transaction cost (Fisher-Vanden et al, p. 273).

6. Numeric Limits and Triggers for Runoff – All trading systems need at least two things; a numeric value and a trigger. The CWA, including provisions for runoff-based TMDLs and the MS4 program, provides neither. This condition is problematic.

The numeric value is the quantified unit to be traded. This component is essential because it is the mechanism by which parties in trades identify the element of the exchange. Without it, the exchange is not possible.

Generally speaking, typical MS4 permits contain language that requires best management practices (BMPs), but they do not specify an amount of discharge. Instead, they provide prescriptive procedural requirements about installing BMPs. Furthermore, these requirements are not typically retroactive so they cannot force a reduction of an

historical impairment. Finally, the numeric value of a runoff-based TMDL is usually at the watershed, subwatershed, or municipal level. But, to achieve the reduction specified by a TMDL the reduction must come at the land use level. Individual land users who discharge runoff must decrease their discharge to achieve the objective of the TMDL. States and municipalities have traditionally been resistant to forcing this requirement on the individual land user.

Typically, MS4 permits do not quantify numeric values for runoff or sediment reduction; however, in several regions other values have been used, such as impervious cover and streamflow. Connecticut in particular has made an effort to link impervious cover areas with water quality parameters, thereby assigning a numeric indicator (rather than a numeric quantity). In streams that are generally impaired for support of aquatic life, but where a single pollutant has not yet been determined, regulators have applied a "Stress Index" (SI) which associates general non-supportability of streams with the linked pollution factors associated with stormwater runoff. A TMDL may then be developed using impervious cover in the watershed as a surrogate for a mix of stormwater pollutants, and the TMDL target can be set using the simplified numeric surrogate (impervious cover) rather than the numeric pollutant load. In 2004 such a method was applied to Eagleville Creek in Mansfield, CT. Because the TMDL requirements are more clear, the document provides a more explicit guideline to regional planners and developers.

In cases of TMDL implementation, the trigger is the legal requirement that forces participation. TMDLs that are not accompanied by an implementation requirement cannot serve as a trigger for trading. MS4 permits typically contain language that trigger BMPs for new construction but contain nothing that can trigger new land use practices for restoration of an historical problem. Consequently, neither a TMDL nor an MS4 permit as they are typically applied can serve as a trigger to initiate trading.

It is noteworthy that a typical ordinance adopted as part of an Act 167 Plan contains both a numeric recharge value for runoff and a legal requirement to achieve that value.[38] Most of the stormwater ordinances for municipalities in the Wissahickon watershed do not contain a numeric trigger for runoff or sediment. However, PADEP's draft MS4 permit indicates that municipalities must enact the 2008 Pennsylvania Model Stormwater Management Ordinance or already have enacted an Act 167 Stormwater Management Ordinance.[39] Each of these alternatives contains a numeric trigger for runoff.

E. Guidelines from Theory

Several important studies provide theoretical guidelines for the development of institutions for the protection of natural resources. When considering an institution for the implementation of a sediment TMDL through trading or other scenarios, many of these general guidelines may be applied.

1. Clear Boundaries

The developers of the institution must clearly define the boundaries of the institution (Ostrum 1990, p. 91). This principle applies to the definition of the resource to be

[38] Radnor Township Ordinance.

[39] PA DEP Draft MS4 Permit, Notice of Intent (NOI), F., 4.

managed, the allowable participants, the geographic boundaries that govern the resource, and the rules of the participants. Participants need to know their rights and their responsibilities. The geographic boundaries are important so that participants know which resources and which organizations are within the jurisdiction of the system.

A system built around a TMDL satisfies this guideline. It has a defined pollutant, established dischargers, geographic boundaries, and well defined legal rights (relative to systems without a TMDL). Application of this guideline accepts distribution of the reduction that the TMDL assigns. Additionally, it negatively views inter-pollutant trading, inter-temporal trading, and other complex issues of trading. Our view is that from the perspective of the development of a trading system; it would be wise to accept the output of the TMDL. This means trading only the pollutant specified in the TMDL and among the dischargers who fall under the jurisdiction of the TMDL.

2. Local Conditions

The developers of the institution must recognize the importance of local conditions (Ostrum, p. 92.) Local areas have peculiarities that make them unique. A one-size solution will rarely fit all problems. Additionally, surprises will occur during development and operation of the system (Scott, p. 345). The system should have sufficient flexibility to accommodate these surprises (Scott, p. 345). Finally, individuals or groups that closely work with the system are likely to have the insight to improve the system (Scott, p. 345).

Again, a system built around a TMDL will satisfy this guideline. Most important is the need to allow municipalities to find the efficiencies for reductions. Presumably, these municipalities are better able to identify efficient reductions then a central authority. Furthermore, the five-year permit renewal process provides a natural time to provide feedback to the system. Finally, TMDLs require monitoring, implementation plans, the possibility of removal from the 303 (d) list, and public participation. There may be opportunity for local organizations to provide input during those phases.

3. Rule Change

The developers of the institution should provide a means for which participants can collectively agree to modify the rules to generate optimum equilibrium (Ostrum, p. 93). Successful institutions allow participants to formally modify the rules to improve the system. The idea is that the participants will comply willingly if they know that others are complying. Accordingly, they will develop a good set of rules that ensure compliance if they have the opportunity.

The five year permit cycle for the MS4 permit provides an opportunity for this to occur. The municipalities could be involved during the initial development of the system. Participants could revisit the elements of the system during subsequent permit iterations.

4. Monitoring

The system must have adequate monitoring (Ostrum, p. 94, 186). Again, the compliance of participants increases when each knows that the others are complying and that this collective action will achieve known objectives. Monitoring is needed to ensure that compliance and transparency are shared.

The key here is to monitor the design standard rather than the actual numbers (a.k.a. before the fact). After the fact monitoring involves regulating the actual output that occurred (i.e. lbs of pollutant per day) after it occurs. It requires clear specification and quantification of the unit of concern by comparing actual output to allowable output. Title IV is an example of this form of monitoring.

Before the fact monitoring involves comparison to a design standard. Regulators set design standards and base compliance upon the proper design and operation of a facility. A facility that satisfies design and operation standards is compliant regardless of the conditions it produces in the field. A water quality trading system must have this form of monitoring due to the weather-dependent nature of most structural BMPs (i.e. volume control is dependent on rainfall volume). Otherwise permittees will never achieve certainty as to their compliance status.

5. Graduated Sanctions

Successful longstanding institutions are likely to have graduated sanctions (Ostrum, p. 94). Some theoretical models indicate that large penalties are needed but case studies indicate otherwise (Ostrum, p. 98). Penalties that reflect the circumstances and the severity of the infractions are more likely to continue "quasi-voluntary compliance" than a "relentless process" of penalizing the violator (Ostrum, p. 98).

Again the key is to mimic the penalty structure of Title IV. Here, emitters pay a penalty that transparently reflects the degree to which they are out of compliance. Ideally, a system in the Wissahickon could be established to have a similar penalty structure. Participants should know with as much certainty as possible how to comply and the exact penalty for non-compliance.

6. Conflict Resolution

Successful longstanding institutions have mechanisms to resolve conflicts among participants (Ostrum, p. 100). If participants sense less than full compliance from others, they will gradually come to view the system as unfair and will withdraw their quasi-voluntary compliance. The system will eventually fail. Mechanisms to resolve conflict, formal or informal, increase the likelihood that participants view the system as fair.

7. External Intervention

When an external governmental authority assigns rights to an institution to regulate a system, the government authority should not challenge the authority of the institution to regulate itself (Ostrum, p. 101). Participants who dislike a specific aspect of the system should address the issue within the process established by the participants. If an unhappy participant can use an external governmental organization to change the rules then it will be difficult for local participants to sustain the system.

This guideline favors a system with a very narrow scope. If the scope of the trading system is narrow, the authority will be narrow. If the authority is narrow, their will be less likelihood that external government authorities will try to intervene in the system.

8. Number of Participants

The number of participants is critical. It must be large enough to reap collective benefits of trading, but not so large that administration is difficult (Ostrum, p. 188, 189). A trading system needs a minimum number of participants to exploit the variations of marginal cost that the system requires to create incentive. Too few participants could produce too little marginal variation of cost between participants. Additionally, a system with few participants may not need a market to overcome the information barriers that typically undermine command and control (Wyman, p. 465). Professor Wyman studied Canada's slow development of tradable pollution rights for sulfur dioxide emissions. She argues that Canada does not need a trading system because the small number of major sources can exchange information informally outside of a market more effectively than within a market. Conversely, too many participants can lead to too many agendas and may make organization difficult. In the Wissahickon, one can reasonably expect the number of municipalities subject to the sediment TMDL is large enough to produce variations of marginal cost but small enough to be manageable.

9. Similar Interests

The likelihood of successful organization increases when the participants have similar interests (Ostrum, p. 188). For water pollution control trading systems, this likely means limiting the scope of the trading institution so that participants do not have the opportunity to develop competing interests. Removing sediment (or a surrogate runoff) is sufficiently narrow and the number of participants that the TMDL identifies is manageable.

10. Leadership

The presence of participants with substantial leadership or assets affects the outcome (Ostrum, p. 188). External political regimes had a positive effect on some systems but a negative effect on other systems (Ostrum, p. 188). The idea is that a strong actor with bias and incentive could force the development of the system in a less than efficient direction.

The implication for this proposal is twofold. First, a powerful stakeholder could oppose the new burden of the TMDL and lead a charge to defeat the new rules of any meaningful proposal. Alternatively, another powerful stakeholder could force the adoption of rules that are excessively stringent. Both scenarios would foster municipal resistance and could contribute to the continuation of non action.

There is no reason to believe that this condition will be problematic for the Wissahickon. Both municipalities and advocacy groups are capable of representing their interest. However, it is critical that PADEP use its leadership appropriately; this would mean designing and administering the proposed system at a general level.

11. Small Steps

Developers of institutions should "take small steps" instead of "large steps" (Scott, p. 345). It is not possible to know all the consequences of the proposed interventions. Additionally, institutional knowledge accumulates incrementally. The marginal cost of building upon an institutional base is considerably less than the cost of building the institution from no prior base (Ostrum, p. 189). Small steps allow for feedback and incremental adjustment, which increase the likelihood of success.

A simple, practical, and narrowly-defined system will satisfy this guideline. PADEP must establish requirements that are familiar to municipalities, clear, easily enforceable, easily verifiable, etc. The use of incremental steps increases the likelihood of satisfying these requirements.

12. Property Rights

Pollution markets require the specification of property rights that allow dischargers to exchange pollution credits (Anderson and Leal, p. 132; Richards, p. 234). If property rights cannot be defined then they cannot be traded (Anderson and Leal, p. 128). Specification of the property right for natural resource and environmental amenities is difficult because the cost of measuring and monitoring is high (Anderson and Leal, p. 128).

Simplicity and narrowness of scope are the keys to this recommendation. The system should limit trading to exchanges between municipalities. Also, geographic requirements must be clear and stated before the fact. If a municipality decides to buy or sell a reduction it must know with certainty that it has the authority to make that transaction.

F. Misperceptions

The use of market mechanisms faces at least three common misperceptions that may adversely affect the development of a system. One misperception is that market mechanisms can create a demand for water quality improvement. Some stakeholders hope that water quality can improve with little or no intervention by regulators, which is ultimately an unrealistic assumption. Conventional markets for commodities like shoes, houses, cars, etc. rely on a principle that there exists a direct and immediate demand for these products. Markets can match the supply to demand because the consumer benefits directly and immediately from the purchase. Therefore, the market will allocate a proper supply that matches demand with little intervention from regulators. But, environmental benefits are not like shoes, houses, cars, etc. There is little immediate and direct demand because the benefits are in the future and indirect. Consequently, regulators must create the demand with regulation.

The second misperception is that the use of market mechanisms is a giveaway of environmental protection to the markets (a.k.a. the market establishes the level of protection). This is also not true. Market mechanisms are a way to achieve the endpoint of a regulation. The government must retain the role of establishing and requiring the level of protection, and the market is simply a method to achieve that level. The sulfur dioxide trading program and The Long Island Nitrogen Exchange are examples of this concept. In the former, Congress reduced the allowable level of sulfur dioxide and the market was used to efficiently achieve that new level. In the latter, the State of Connecticut established a new discharge cap for nitrogen and used a market mechanism to achieve efficient reductions. Finally, the conservative economist Milton Friedman specifically identifies the shortcomings of open markets for setting water pollution standards. He indicates that water pollution is one of the classic situations for which markets alone cannot establish the appropriate level of protection.

> A second general class of cases in which strictly voluntary exchange is not possible arises when actions of individuals have effects on other individuals for which it is not feasible to charge to recompense them. This is the problem of "neighborhood effects." An obvious example is the pollution of a stream.[40]

A third misperception involves monitoring and enforcement. Monitoring and enforcement of a runoff-based TMDL is more difficult than monitoring and enforcement of a traditional point source TMDL. The difficulty is analogous to the technical barriers of the TMDL program. For a runoff-based TMDL, many believe that regulators must be able to determine the origin of each particular pollutant contribution in the waterway. This is a bit like "unscrambling an egg."

For conventional point source controls, dischargers control the input to their process (via source control) and the output from their system (via technology controls). So the logical location to measure for compliance is at the discharge. Regulators base compliance upon the results of this measurement because the dischargers have considerable control over the value of the output. But no such conditions exist for runoff. Municipalities have little practical control over the input to the MS4 system. Weather changes and land use changes can considerably change the output from a particular stormwater system. Furthermore, the link (across distance and time) between sediment at a particular location in a stream and runoff at a particular location on a site is weak. A host of factors affect the accumulation of sediment at a particular location and time. Consequently, the outfall of a pipe is not the logical location to evaluate compliance. Similarly, in-stream sediment levels are also poorly suited for determining compliance because proving that a particular excessive measure of sediment is attributed to a particular outfall is all but impossible.

The result of this condition is that the proposed system must "break the link" between the results of sampling and compliance. Regulators should not base municipal compliance upon sampling. Instead, regulators must require numeric design criteria for sediment-specific BMPs. Municipalities that build the BMPs as per the criteria are compliant. Regulators may sample or require sampling but they should not base compliance upon these samples. Instead, they can use the results of sampling to adjust target reductions during future permit cycles.

One should note that the abovementioned procedure is a modification of the conventional method of monitoring point sources. But it is not a change from how municipalities currently regulate runoff or the way that NPDES permits regulate post-construction BMPs. For post-construction BMPs, developers install and operate BMPs. If they design and operate a system in accordance with requirements then they are compliant. No one measures output from the BMPs or bases compliance upon it.

G. THEMES

In general, at least four concepts have emerged per the use of market mechanisms for the implementation of the Wissahickon's TMDL. These themes emerged repeatedly during

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[40] Milton Friedman, *Capitalism & Freedom*, The University of Chicago Press, Chicago, 1962, p. 30.

internal and external consultations. They are consistent with the concepts identified from analysis of theory, lessons from air pollution trading, lessons from water pollution trading, barriers to TMDL, and common misperceptions.

1. Any proposed system should maintain the government's role of establishing the threshold of environmental protection, but must also allow municipalities flexibility of means to achieve this protection. In other words, PADEP would decide the amount of sediment allowed, and municipalities would choose how to achieve that level.
2. The cost to the municipalities must be reasonable. The cost of achieving the endpoint of the TMDL is enormous and impractical. Accordingly, DEP must lower the expectation to a threshold that is practical and that corresponds to a cost that municipalities can be reasonably expected to pay. This will likely mean incremental implementation.
3. DEP or some other third party must perform all upfront analysis in order to eliminate (for all intents and purposes) the uncertainty of municipal liability for compliance.
4. DEP must constrain and specify the control measures that ensure compliance. A host of sediment control measures exist, and it is inefficient for DEP to require each municipality to develop its unique program. Similarly, it is impractical to allow municipalities to choose any combination of measures and expect that DEP would review and approve any combination that might be developed. PEC recommends that the menu of seven control measures in the draft PAG-13 be adopted for the first permit cycle, with the exception of streambank restoration. Additional control measures should be evaluated and added in future cycles. Control measures such as reducing runoff from commercial redevelopment or streambank restoration should be assigned credit values equivalent to the sediment reduction of a single cubic foot of permanent retention.

PEC's proposal offers a valuable alternative to the current draft PAG-13. PEC has developed a solution that emphasized the importance of establishing a level of effort that will achieve progress toward the TMDL goals and will help to establish a stormwater and sediment management system that will promote greater progress in future permit cycles.

Acknowledgements

The Pennsylvania Environmental Council gratefully acknowledges the contributions of the following individuals who contributed significantly to the success of this project:

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Finally, PEC would like to thank the U. S. Environmental Protection Agency, Region 3, which provided the financial support for this project. Particular thanks go to Susan McDowell, the project officer, and Evelyn MacKnight, NPDES Branch Chief.

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Appendix I: Template TMDL Stormwater Plan

Submitted By: [municipality]

Submitted to:
Commonwealth of Pennsylvania
Pennsylvania Department of Environmental Protection
Bureau of Watershed Management

Date: TBD

INTRODUCTION
This Stormwater TMDL Plan is submitted is accordance with the requirements of General Permit PAG 13 for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4).[1]

ADMINISTRATIVE INFORMATION

I. **Title of TMDL:** Wissahickon Siltation TMDL

II. **List of Watershed name(s) and eight digit Hydrologic Unit Code (HUC) Watershed number(s) that the TMDL is located:** Schuylkill Watershed, HUC 02040203

[1] **Commonwealth of Pennsylvania, Department of Environmental Protection, Bureau of Watershed Management, National Pollutant Discharge Elimination System (NPDES) Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) General Permit (PAG-13), Draft, Rev. 03/09, Instructions, Section II.E.1, p. 3, Henceforth "Draft Permit".**

III. **List of Pollutants and Waste Load Allocations (WLAs) assigned to each MS4 covered by the NOI:**[2]

Municipality	Sediment Waste Load Allocation (lbs/year)
Abington	128,913.45
Ambler	42,189.97
Cheltenham	5,961.13
Horsham	3,555.71
Lansdale	52,332.42
Lower Gywnedd	437,360.33
Montgomery	111,128.34
North Wales	42,331.55
Phila	380,861.33
Springfield	190,165.09
Upper Dublin	464,607.68
Upper Gwynedd	550,584.42
Upper Moreland	861.57
Whitemarsh	239,532.46
Whitpain	291,273.25
Worchester	10,350.07

IV. **List of the municipalities subject to the same TMDL within the same eight digit HUC watershed**: See item III.

V. **List of counties subject to the TMDL within the same eight digit HUC watershed:** Montgomery

VI. **Allocated pollutant loadings set forth in the TMDL**: The goal of this TMDL is for the sediment concentrations throughout the Wissahickon watershed to meet water quality standards for the designated uses of the water body that are affected by sediment. These uses include trout stocking.[3] Water may not contain substances attributable to point or non point source discharges in concentrations or amounts sufficient to be harmful to the water uses or to human, animal, plant or aquatic life.[4] To achieve this endpoint, municipalities must reduce sediment according to the following table.

[2] United States Environmental Protection Agency, Region 3, Nutrient and Siltation TMDL Development for Wissahickon Creek, Pennsylvania, Final Report, October 2003, p. 4-23 (Henceforth TMDL Report).
[3] TMDL Report, p. 1-10.
[4] TMDL Report, p. 1-10.

Municipality	Existing Sediment Waste Load (lbs/year)	Sediment Waste Load Allocation (lbs/year)	Sediment Reduction Percentage
Abington	484,142.82	128,913.45	73
Ambler	92,982.99	42,189.97	55
Cheltenham	22,307.75	5,961.13	73
Horsham	8,375.68	3,555.71	58
Lansdale	70,328.33	52,332.42	26
L. Gywnedd	743,756.46	437,360.33	41
Montgomery	160,994.04	111,128.34	31
North Wales	58,485.37	42,331.55	28
Philadelphia	1,547,690.48	380,861.33	75
Springfield	751,758.50	190,165.09	75
Upper Dublin	1,257,002.57	464,607.68	63
U. Gwynedd	768,891.81	550,584.42	28
U. Moreland	2,411.46	861.57	64
Whitemarsh	558,488.91	239,532.46	57
Whitpain	462,914.26	291,273.25	37
Worchester	12,067.90	10,350.07	14

VII. Reduction in pollutant loads to be attained by the stormwater TMDL Plan**:** [name of Municipality] commits to reduce or remove sediment flowing to Wissahickon Creek to the maximum extent practicable (MEP), using a phased and iterative approach. We are adopting the recommendation from Pennsylvania Environmental Council, that by the end of this five-year permit cycle, facilities would be newly constructed or retrofitted that have the design capacity to store _____ cu ft during each design rain event. Our share of this new capacity is ___ cubic feet, as shown in the following table.

Municipality	% of Total TMDL WLA	% of TMDL WLA of Phase 2 municipalities	Design Capacity of Permanent Runoff Reduction in ft^3
Abington	4.37%	5.01%	13,390
Ambler	1.43%	1.64%	4,382
Cheltenham	0.20%	0.23%	619
Horsham	0.12%	0.13%	369
Lansdale	1.77%	2.03%	5,436
Lower Gywnedd	14.82%	17.01%	45,428
Montgomery	3.76%	4.32%	11,543
North Wales	1.43%	1.65%	4,397
Phila	12.90%	0.00%	0
Springfield	6.44%	7.4%	19,752
Upper Dublin	15.74%	18.07%	48,259

Upper Gwynedd	18.65%	21.41%	57,189
Upper Moreland	0.03%	0.03%	89
Whitmarsh	8.11%	9.31%	24,880
Whitpain	9.87%	11.33%	30,254
Worchester	0.35%	0.40%	1,075
	100%	100%	Total: 267,064

VIII. TMDL Control Measures to address the TMDL**:**
(example) We intend to retrofit a stormwater basin identified on the Temple maps included as part of the Pennsylvania Environmental Council recommendation to increase permanent stormwater retention capacity by _____ cubic feet per event. We are reviewing the opportunities to implement this retrofit on both municipal and private land, and expect to have identified the specific site and to have the project designed within one year of permit issuance. We will provide PADEP with the specific location and design information as soon as possible, and in no case later than one year from the date of permit issuance.

IX. **Monitoring information and timeline for achievement in accordance with the TMDL**:

Timeline

- One year from permit issuance: Project selected and designed.
- Three years from permit issuance: At least 50% of new stormwater retention capacity is constructed.
- Five years from permit issuance: 100% of new stormwater retention capacity is constructed and operational.
- Prior to next permit cycle, a new sediment credit commitment is either set by PADEP or developed by a consensus of Wissahickon municipalities.

Monitoring information
Our monitoring effort is designed to ensure that the facility or facilities constructed to meet our TMDL commitment will continue to provide the design storage capacity over time. An appropriate technical expert will inspect the facility annually and report on capacity and functioning. When the facility drops below a target level of capacity, to be identified in the engineering design, we will undertake renovation or restoration to restore capacity and functioning. We will estimate the annual amount of retention and sediment removal based on number of storm events and proper construction and management of the facility. Monitoring information will be included in our periodic MS4 permit reports.

X. **Additional Information**: None

Appendix IIa: An Approach to Setting a Sediment Credit Commitment for Wissahickon Municipalities

The theory section of PEC's report on the Wissahickon Creek Municipal Sediment Credit System describes the "stormwater dilemma." For most citizens, the benefits of stormwater management are in the future, marginal, and diffuse, and the cost is high and in the present. Naturally this situation creates a political challenge when attempting to make progress in reducing sediment in an impaired stream such as the Wissahickon.

One of the key points of the municipal sediment credit system is that a numerical volume reduction amount must be established, as a policy decision. Once there is such a number, it can be allocated and trading or other market mechanisms can operate. Ideally PADEP would set the number, however, it does not appear that the final version of the PAG-13 MS4 permit will specify a volume reduction amount for the Wissahickon. Therefore, PEC identified some key principles and based our recommendation on those principles. We recognize that setting a number is a policy decision, and that there is no one right answer.

Seeking Better Outcomes

PEC started with the draft PAG-13 developed by Pennsylvania Department of Environmental Protection (PADEP). The system to be developed and the recommended "maximum extent practicable" had to provide more benefits than the proposed PAG-13 to both PADEP (on behalf of Pennsylvania citizens) and to the regulated community, the municipalities of the Wissahickon watershed. We believe that our recommendation of setting 267,064 cubic feet of new volume retention (aka sediment credits) provides significantly greater sediment reduction that was likely to occur under the TMDL Stormwater Plans required in the draft PAG-13. Our analysis indicated that a reasonable municipality operating in that system would spend the least possible amount of money, understanding that the likelihood of being challenged by PADEP was relatively low. Many municipalities might select the TMDL control measure that requires planting trees, perhaps the cheapest of the seven options, but one that provides minimal sediment reduction. However, the language of the draft PAG-13 leaves the municipalities unsure that their minimal effort would be compliant. Adopting the 267,064 credit commitment allows the municipalities to take action with confidence of being compliant.

MEP Includes Funding Considerations

A second principle was that "maximum extent practicable" could and should include consideration of financial issues and the practical challenges of implementation. On the financial side, the 267,064 credit commitment will require new funding from the municipalities for capital construction, planning, design, operation and maintenance of stormwater control measures. At a cost of $3.79 per cubic feet, the municipal investment would be approximately 1.3 million dollars per permit cycle.

Is that enough? Achieving the TMDL may require as much as $230 million. Our judgment is that 267,064 cubic feet and approximately $1.3 million will demonstrate effective implementation and engage municipal cooperation. The engineering firm Black & Veatch published a survey in 2007 which includes average annual stormwater payments per household for seventy cities. The

average payment was about $40 per year per household. While details were not given, 87% of the respondents said that their user fees pay for capital projects, planning, administration, and O&M. We decided to allocate just over 15% of a $40 annual fee to capital construction-- $6.60. As shown on the accompanying table, 40,625 households in the MS4 Phase 2 areas of the Wissahickon watershed paying $6.60 each would raise $1,340,625.

PEC advocates the creation of stormwater authorities to plan for better stormwater management, raise needed funds, and implement the plans. However there are only a couple of examples of stormwater authorities in Pennsylvania, none in the Wissahickon. New funding for capital construction will have to come from municipal tax revenues. Given the current economic conditions, PEC's recommendation for 267,064 cubic feet of new storage in the current permit cycle is ambitious.

Another practical challenge is that the basin retrofits that offer the most cost-effective storage face technical and administrative challenges. PEC has funding for three basin retrofit projects in the Wissahickon, two on municipal land and one on private property. All three have faced unexpected challenges and delays. For example, bids for the basin retrofit in Whitpain Township have come in much higher than expected, because of the cost of maintaining plants in the basins over time. Landscape contractors will not guarantee survival of plants unless they are being paid to water plants during dry spells, but assigning them the responsibility raises cost dramatically. Setting the MEP at 267,064 cubic feet of new storage will result in 5-6 major new basin retrofits, an opportunity for the technical communities and municipal staff to learn how to implement these types of projects.

System Supports Collaboration and Cost-Effectiveness

A third principle is that the number selected should encourage collaboration and offer flexibility so that municipalities could find the most cost-effective solutions. PEC is using the national average cost of $3.69 per cubic foot of new storage to estimate spending by each municipality. The Temple survey of BMP opportunities identifies a number of sites where storage would be cheaper, as little as $2 per cubic foot. Identifying these opportunities and allowing municipalities to purchase credits from other municipalities and to locate storage on private land are powerful incentives for collaboration.

The PAG-13 draft permit requires that municipalities invest in developing new storm system mapping and BMP tracking procedures at significant new costs in this permit cycle. Again, the cost of these permit requirements would be less if the municipalities collaborate. These new management systems will also allow for better tracking of expenditures to quantify the real burden on municipalities for consideration in future MS4 permit cycles.

Another way that the recommended approach drives collaboration is that municipalities lower in the watershed, particularly Whitemarsh and Upper Dublin, are stuck with the expense of managing the impact of flooding from runoff higher in the watershed. The system PEC is proposing encourages municipalities to take up their responsibility to manage their own runoff, even if their property is not directly damaged by flooding. Pooling municipal resources to manage runoff further upstream may reduce the cost of flood management and provide a better outcome.

Appendix IIb: Recommended Effort – The Numbers

Donald Curley, P.E., Ph.D., A.I.C.P.

Municipality	Contribution %	LOE (ft^3/event per cycle)	Expected Cost ($/cycle)	Expected cost ($/cycle)	Expected Cost ($/cycle)	Expected Cost ($/cycle)	Expected Cost ($/yr)	Expected Cost ($/yr)	Expected Cost($/yr)
			Capital Construction	Planning, design, admin	O&M	Total	Capital, planning, design, admin	O&M	Total
Abington	5.01%	13,390	$50,748.77	$8,066.03	$8,402.11	$67,216.91	$11,762.96	$1,680.42	$13,443
Ambler	1.64%	4,382	$16,608.73	$2,639.80	$2,749.79	$21,998.32	$3,849.71	$549.96	$4,400
Cheltenham	0.23%	619	$2,346.69	$372.98	$388.52	$3,108.20	$543.93	$77.70	$622
Horsham	0.13%	369	$1,399.76	$222.48	$231.75	$1,853.99	$324.45	$46.35	$371
Lansdale	2.03%	5,436	$20,601.46	$3,274.41	$3,410.84	$27,286.71	$4,775.17	$682.17	$5,457
L. Gywnedd	17.01%	45,428	$172,173.64	$27,365.35	$28,505.57	$228,044.56	$39,907.80	$5,701.11	$45,609
Montgomery	4.32%	11,543	$43,747.39	$6,953.23	$7,242.94	$57,943.56	$10,140.12	$1,448.59	$11,589
North Wales	1.65%	4,397	$16,664.47	$2,648.66	$2,759.02	$22,072.14	$3,862.63	$551.80	$4,414
Philadelphia	0.00%	0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0
Springfield	7.4%	19,752	$74,861.42	$11,898.50	$12,394.28	$99,154.20	$17,351.99	$2,478.86	$19,831
Upper Dublin	18.07%	48,259	$182,899.98	$29,070.20	$30,281.45	$242,251.63	$42,394.04	$6,056.29	$48,450
U. Gwynedd	21.41%	57,189	$216,746.06	$34,449.70	$35,885.11	$287,080.87	$50,239.15	$7,177.02	$57,416
U. Moreland	0.03%	89	$339.17	$53.91	$56.15	$449.23	$78.62	$11.23	$90
Whitemarsh	9.31%	24,880	$94,295.65	$14,987.39	$15,611.86	$124,894.90	$21,856.61	$3,122.37	$24,979
Whitpain	11.33%	30,254	$114,664.21	$18,224.78	$18,984.14	$151,873.13	$26,577.80	$3,796.83	$30,375
Worchester	0.40%	1,075	$4,074.46	$647.60	$674.58	$5,396.64	$944.41	$134.92	$1,079
Sum	100.00%	267,064	$1,012,172	$160,875	$167,578	$1,340,625	$234,609	$33,516	$268,125

Montgomery County Households	40,625	Total $/ year watershed	$268,125
Philadelphia Households	0	total $/ permit cycle watershed	1,340,625
$/ household/ year	$6.60	O&M Cost (% total/ year)	2.50%
Basin Cost ($/$ft^3$)	$3.79	Cubic feet of volume per event per permit cycle (Equals sediment credit commitment)	267,064
Planning, Design, Administration (% of total)	12.00%		

Appendix IIIa: An Assessment of BMP Opportunities in the Wissahickon Watershed August 2009

Jeff Featherstone, Mahbubur Meenar, Richard Nalbandian and Richard Fromuth of Temple University Center for Sustainable Communities, and Derron LaBrake of Wetlands and Ecology, Inc.

This study was commissioned by PEC to identify existing sites within the watershed that would be most appropriate for stormwater detention, retention, and infiltration retrofits, and the cost for construction of each project. The goal was to assist municipalities in choosing and siting BMP controls, and to identify the cheapest and easiest scenarios with greatest potential for volume control. The researchers inspected 75 sites on foot, and many more were analyzed using aerial photography and maps. Information on each site was then digitized using ARC-GIS, and made available as paper and digital maps to municipal managers in October, 2009.

Process

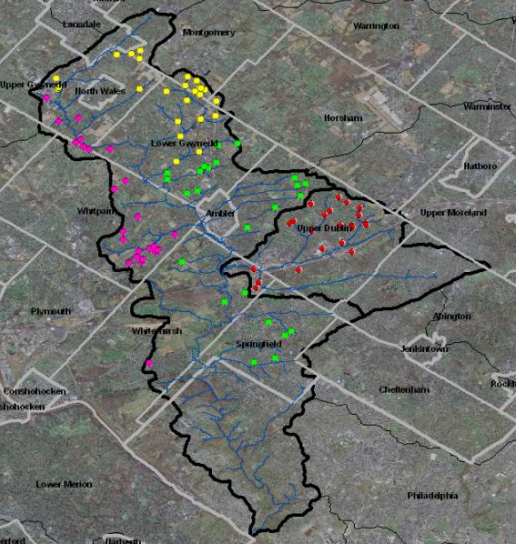
On sites recommended for construction (detention/retention), any existing infrastructure was evaluated for potential volume control, and retrofits for greater control were analyzed and priced. Potential improvements included lowering/vegetating basin floors, modifying outlet structure, and raising berms. Raising berms was not recommended in instances where it would present any risk to adjacent buildings, and floor lowering was not recommended on sites with a high water table.

The study began with a survey of aerial photography, topography maps, and geospatial data generously shared by the Philadelphia Water Department, the Delaware Valley Regional Planning Commission, Temple University, and the Heritage Conservancy. A field inspection was conducted for all sites greater than 0.25 acres to characterize the site and any existing BMP infrastructure (berms, pipes, etc.). This field survey was completed in August, 2009. The attached tables show the results, organized by detention/retention basins and infiltration. Opportunities for riparian forest buffers are indicated on the maps.

Findings

The researchers identified 206 sites for retention, mostly retrofitting detention to retentions basins, and 29 sites for new infiltration. In addition, they quantified the potential benefits and cost of adding riparian buffers. Many of the existing detention sites were 30-40 years old and were no longer being maintained for stormwater management. The cheapest scenario (i.e. the greatest volume control for the cheapest price) was found to be large detention basins where berms could be raised to add extra storage (vs. lowered floors, which necessitate expensive removal of soil). On average, such scenarios would cost the municipality about $2 per cubic foot versus infiltration trenches, which were $3/cu. ft., and infiltration galleries, which were $5.50/ cu. ft. The minimum cost of

expansion was assessed at $30,000 for basins less than 0.25 acres, and the maximum additional capacity was assumed to be 0.2 ac-ft, or 8712 cu. ft.



Assessment of Potential BMP Opportunities
Wissahickon Creek Watershed
August 2009

Information Sources

•Inventory of existing detention basins - Philadelphia Water Department
•Areal photography – Delaware Valley Regional Planninig Commission - 2005
•Topography- 2 Ft. contours - Philadelphia Water Department - 2004
•Watershed boundaries – Philadelphia Water Department
•Streams – Temple CSC - 2005
•Riparian buffers – Heritage Conservancy – 2000
•Municipal boundaries and roads – ESRI Data Set
•Field inspection by project team – August 2009

Procedures

Detention Basins

•Field inspection conducted for all sites greater than 0.25 acres surface area.
•Sites from Sandy Run were previously surveyed in the Ft. Washington Study.
•Capacities estimated from contours or field inspection (Depth x Area x 2/3).
•Inlet and outlet dimensions were determined where possible.
•Potential improvements included: raising berm, lowering floor, vegetating floor, and modifying outlet structure and piping.
•Berm raising was not recommended if higher than nearby homes or businesses or if drainage was impacted.
•Lowering floor was not recommended if floor was wet or at water table.
•Opportunities for constructed wetlands were considered.
•Overall goal to maximize retention of smaller storms.
•All basins less than 0.25 acres were assumed to have the potential for an average of 0.2 acre-ft of additional capacity.

Infiltration Sites

•Used orthophotos and field inspections to identify potential sites.
•For infiltration trenches, one inch of runoff capture from site was assumed.
•For infiltration galleries, four inches of runoff capture from site was assumed.

Riparian Stream Buffers

•GIS was used to determine the miles of stream requiring buffers.
•Buffer width was assumed to be 75 Ft.
•New buffers assigned one inch of runoff volume reduction based on CN change.

Products: Maps and cross referenced tables with costs of potential site improvements - at least three in each municipality. *This was not a design analysis*

Cost Assumptions

Detention/Retention Basins

•Minimum cost for expansion = $30,000 for basins less than 0.25 acres.
•Minimum cost for vegetation and modification of outlet and piping = $12,000.
•Contingency of 20% included in cost estimates.

Infiltration Sites

•Cost for infiltration galleries = $5.50 per cubic ft. of storage
•Cost for infiltration trenches = $3.00 per cubic ft. of storage

Riparian Stream Buffers

•Cost of buffer development= $4,500 per acre.

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Appendix IV: Opportunities to Reduce Stormwater Runoff in the Wissahickon Creek Watershed through the Commercial Redevelopment Process

Nathan Walker, A.I.C.P., with funding from the William Penn Foundation.

PURPOSE

To recommend updates to local land use regulations that will maximize the amount of land in commercial districts available for groundwater infiltration while maintaining sufficient access, parking, and commercial space.

INTRODUCTION

Commercial and industrial zoning districts are the most intensely developed land uses within a community. Not only do these uses create large areas of impervious cover on each lot, zoning maps and historic land use patterns cluster commercial and industrial sites together, increasing their impact to nearby streams. Municipal leaders can reduce runoff volume from these sites as they redevelop by updating codes that improve stormwater management and add to a green infrastructure network. This report targets code updates for commercial districts because of the relatively quick redevelopment cycle commercial property owners follow.

This report focuses on the four townships most active in the Wissahickon Roundtable: Springfield, Upper Dublin, Whitemarsh, and Whitpain. Although retail and mixed-use land use take up less than 3% of the land area in these townships (Table 1), it has significant impact on stormwater runoff volumes. Even dense residential areas often include lawn areas and landscaping that disconnect impervious cover and allow some infiltration. But the impervious buildings, parking, and driveways of commercial areas can cover more than 70% of a tract. Not only is impervious cover high, it is interconnected within each parcel and across parcels, offering no opportunity for infiltration. Further, most commercial developments in this part of the Montgomery County have no stormwater management BMPs in place. Therefore, any new stormwater management in these areas will be a step in the right direction and have a valuable impact on water resource protection.

Figure 1

Township	% Mixed Use/ Retail	Source
Springfield	3.2 (includes office)	Open Space Plan, 2005
Upper Dublin	2.0	Open Space Plan, 2005
Whitemarsh	2.4	Comprehensive Plan, 2003
Whitpain	2.4	Comprehensive Plan, 2006

EXISTING CONDITIONS

Commercial land use in this region can be grouped into 14 clusters (Table 2). These clusters of commercial use fall into four categories that allow some generalizations to be made about some of the common challenges municipalities face.

- **Village**. Oreland is an example of a village commercial area that includes a mix of uses developed within a pattern of interlocking streets. Commercial, industrial, civic, and residential land uses have grown up over time, often with a good deal of landscaping and green space that acts to buffer uses. Of the different types of commercial areas, villages have relatively disconnected impervious cover. However, stormwater that does flow through village commercial areas quickly travels to the storm sewer system, with few opportunities to create new infiltration areas.

- **Crossroads**. Historically sprouting from small villages and hamlets along main roads, crossroads often include historic structures at one or more of the four corners with some automobile-oriented uses farther off the main intersection. Broad Axe is a good example of a crossroad commercial area with intensely developed corners, quickly switching into residential land use as one travels away from the intersection along the arterial roads. Parcels at the core of a crossroads commercial area are often fully built-out with little green area. Parcels with historic structures are usually non-conforming structures that are difficult to redevelop and add stormwater management.

- **Highway**. This form of commercial land use forms a ribbon along major arterial roads to take advantage of the high volume of traffic traveling by. Highway commercial uses require high visibility from the road and often have high turnover of customers. The Bethlehem Pike corridor between Flourtown and Erdenheim is the best example of a highway commercial district in the region. Stormwater issues in a highway commercial district include pavement up to the cartway and single-story structures with high percentages of building cover, all on relatively small parcels all under different ownership.

- **Shopping Center**. This is the most intense form of commercial development found in the region. As this type of district serves a larger community than the others, shopping centers rely on large areas of parking to accommodate cars. As many of these centers developed before stormwater management requirements, they often create the greatest impact on local streams. Center Square is the largest shopping center in the region, located at the intersection of the two largest arterials in this part of Montgomery County, Dekalb and Skippack Pikes. Because of their good location, we often see highway commercial districts often flank shopping centers along the arterial roads leading away from the core.

Figure 2

Commercial Area	Township	General Designation
Bethlehem Pike Corridor	Springfield	Highway
Blue Bell	Whitpain	Crossroad
Broad Axe	Whitpain/Whitemarsh	Crossroad
Center Square	Whitpain	Shopping Center and Highway
Dresher	Upper Dublin	Shopping Center
Fitzwatertown	Upper Dublin	Shopping Center
Flourtown	Springfield/Whitemarsh	Shopping Center
Fort Washington	Upper Dublin/Whitemarsh	Highway
Harmonville	Whitemarsh	Shopping Center and Highway
Lafayette Hill	Whitemarsh	Village
Maple Glen	Upper Dublin	Shopping Center and Highway
Oreland	Springfield	Village
Washington Square	Whitpain	Shopping Center and Highway
Wyndmoor	Springfield	Village

THE REDEVELOPMENT PROCESS

The municipalities that make up the Wissahickon watershed face mandates to tighten stormwater runoff regulations. These regulations will require increased levels of public funding to reduce pollutants entering streams from nonpoint sources. In addition, from a water quantity perspective, municipalities have a duty to find ways to reduce flooding on downstream communities. Municipalities should therefore consider updates to land use regulations that make sure new development has no additional impact on water quality or flooding. Municipalities should also look to find ways to improve stormwater management by updating codes, offering incentives to developers to enhance management, and creating partnerships with landowners to find new solutions.

Owners of commercial properties occasionally upgrade parking areas and facades to stay competitive and attract customers. For instance, owners of shopping centers look to refurbish their properties every ten years or so. Since most of the shopping centers in the region perform well, municipalities may regularly have the opportunity to influence the existing stormwater management on a site. For the other forms of commercial areas, redevelopment cycles differ based on ownership and local conditions, but opportunities do arise to make significant impacts on impervious cover. Building expansion and complete site redevelopment sometimes occur. In these instances, township ordinances can play an even stronger role dealing with stormwater management.

The townships in the Wissahickon watershed are adept at working with developers and property owners on a variety of issues to come up with mutually agreeable terms that benefit all parties. When it comes to stormwater management, the starting point of this discussion is the Zoning Ordinance, Subdivision and Land Development Ordinance, and Stormwater Management Ordinance. Over time, municipal goals, development patterns, and the needs of the community change. Land use regulations should keep up with these changes, especially when appropriate change can save townships money on future stormwater responsibilities. Described below are four actions municipalities can take to use the redevelopment process to reduce excessive stormwater runoff volumes.

- **Ease excessive regulations**. As awareness of proper stormwater management arises, municipalities realize that requiring large parking areas, wide cartways, and curbing everywhere may be excessive. Unfortunately, to minimize delays in the plan approval process, many developers strictly follow the township codes, even when some prescribed improvements are unnecessary. Reducing excessive standards may save developers money and have measurable impact on runoff volumes.

- **Update regulations**. Some regulations from the past are not strict enough and permit excessive amounts of impervious cover. For example, some local codes have impervious cover limits higher than necessary allowing development proposals to sprawl across a lot. Some municipalities do not include limits at all. As another example, developers in this area of the county generally accept higher green infrastructure requirements such as bioretention swales, trees, and landscape islands in parking lots.

- **Offer incentives**. Municipalities can reduce the costs of new stormwater management facilities by offering incentives to property owners. Commercial property owners may be permitted to use a site more intensely, as long as they manage stormwater to a high standard. For instance, municipalities may permit greater building coverage on a site or reduce parking requirements if landowners share parking facilities, create underground detention areas, or provide additional stormwater infiltration capacity. By offering incentives for better site development, stormwater management will improve at a lower cost to the township. Municipalities also have the

perspective to look at a group of parcels within a district to facilitate partnerships between landowners to make parking, stormwater management, and access to commercial areas more efficient.

- **Streamline design approval**. Municipalities can also streamline redevelopment by providing township-supported design standards to developers. These can include standard designs for infiltration trenches or planting schedules for rain gardens. Developers that can quickly access pre-approved designs for portions of their project will save money and help implement the township's stormwater strategy.

CONCEPTUAL ORDINANCE UPDATES

The potential for reducing impervious cover through redevelopment of commercial tracts relies heavily on strong land use regulations that provide high standards and flexibility. This section includes conceptual ordinance changes relating to Parking, Green Infrastructure, and Impervious Cover. If townships decide to adapt their ordinances to include these recommendations, they should remain aware of the future possibility to claim these improvements on their MS4 permit.

Parking. Municipalities manage parking by setting minimum limits for number and size of spaces. By adopting methods to minimize the land area required to park cars, municipalities can maximize the use of land for commercial uses and green infrastructure.

- **Reduce the minimum number of parking spaces required**. Many local zoning ordinances base parking requirements on standards created in other parts of the country or on dissimilar uses. Parking studies are relatively easy to conduct, with many local examples of similar uses available for study. Municipalities should find opportunities to reduce parking requirements while encouraging developers to conduct parking studies to confirm parking needs.
- **Parking in reserve**. When municipalities require a minimum number of parking stalls, the code should also include a parking in reserve provision. This provision requires landowners to fully design parking facilities, but offers flexibility by not requiring full construction. If the full parking lot is needed in the future, the township has the authority to require construction. Figure 3 shows a local example of a pharmacy with parking in reserve. Notice there is sufficient parking, but 25% of the required parking (located in the green space to the right and bottom) was held in reserve.

Figure 3

- **Minimum parking size**. First, an acceptable off-street parking stall size, even for high turnover uses is 9 feet by 18 feet. This is certainly a sufficient standard for office or residential parking. However, instead of a set size for each parking space, developers should have the flexibility to create even smaller stalls to accommodate smaller vehicles or take advantage of overhang space near landscaped areas.
- **Parking caps**. As an alternative to parking minimums, parking caps limit the number of spaces permitted on a site. If this cap is set relatively low, a municipality may permit additional stalls above the cap if certain other conditions are met, such as additional recharge, landscaping, a green roof, or shared parking.
- **Parking caps per district**. Instead of setting a parking cap on each lot, a municipality may prefer to set a limit on parking stalls within a district, block, or subwatershed. New spots on a lot could

only be permitted if removed from another lot. This could lead to more comprehensive parking studies between landowners to determine actual need for parking in a region.

- **Shared parking**. Uses such as dry cleaners and restaurants operate with different peak hours. Business owners who partner with neighbors with different hours can save on costs to construct and maintain parking, while using the additional space for landscaping, commercial areas, or outdoor dining. Municipalities should enable shared parking through specific standards in the zoning ordinance that regulate timing, ratios, and uses.
- **Unbundled parking**. Appropriate in a mixed use district near transit facilities, municipalities can encourage property owners to split uses from parking. For instance, a developer may build condos and rent them out for $1000. The property owner can then give the tenant the option to reduce their monthly rate by only using one parking space instead of two. Developers who can prove a lower demand for parking can apply for a reduction.
- **Transit Oriented Development**. TODs can reduce the demand for impervious cover by limiting the number of vehicle miles traveled (VMT) and cars per household, lowering the demand for parking facilities. By demonstrating that a commercial use serves customers who take advantage of transit and pedestrian routes, a property owner should have the ability to apply for lower parking requirements and therefore allow more space for retail uses and green space.
- **Underground detention**. Where land values are high, this is a good option to allow more intense use of a site while reducing stormwater runoff. Municipalities should encourage property owners that are replacing parking areas or expanding structures to install new detention areas underground by offering incentives and establishing some minimum design standards.
- **Pedestrian and bicycle access**. Many municipalities allow developers to take credit for enhanced pedestrian access, transit access, and bicycle storage racks to reduce the number of parking spaces required.

Green Infrastructure. The term green infrastructure (GI) in a commercial district refers to the street trees, stormwater management facilities, and other green areas that lie within parking lots and around buildings. Not only do components of GI slow, clean, and disconnect runoff, GI adds beauty to commercial areas, shades parking lots, and increases energy efficiency within buildings. Municipalities should consider language that encourages developers to create these areas on the landscape that allow natural processes to provide valuable services for the community.

- **Canopy trees**. Canopy trees in parking lots and along streets provide a wide variety of services: shading parking lots, cleaning air, absorbing water, and adding beauty to a landscape. Township ordinances should provide high standards for placement, quantity, spacing, care, and caliper of trees along the street, surrounding buildings, within parking lots, and along parking lot perimeters.
- **Bioretention and rain gardens**. Underground piping of stormwater quickly concentrates runoff and is expensive to construct and maintain. Municipal ordinances should instead encourage depressed landscape islands and swales within parking areas and along streets to store and convey runoff. This form of stormwater management slows water, cleans it, and provides areas for infiltration.
- **Landscaping network**. GI can have significant benefits to water resources on each site, but when interconnected across sites within a district, benefits can multiply. An interconnected system of swales, parking lot landscaping, and street trees can add a cohesive aesthetic to a district and better manage runoff. Municipalities should consider identifying opportunities within districts, seek landowner input, and prepare master plan concepts of cross-parcel GI networks.
- **Tree replacement**. Some mature canopy trees can detain as much as 50 gallons of rainwater on their surface area alone. Townships should have standards in place to replace the trees destroyed through the land development process to retain this service.

- **Artful stormwater design**. Some municipalities already offer incentives to property owners who offer public space. A growing trend is to use stormwater management facilities as a landscape area, sculpture, or other focal point in gateways and plazas used by pedestrians. These amenities can be artistic, functional, and educational (Figure 4). www.artfulrainwaterdesign.net

Figure 4

- **Stormwater basin landscaping**. Townships should provide minimum standards for stormwater basin landscaping, including seed mixes, shrubs, and canopy trees. The township should list appropriate plants to cover a variety of growing conditions. If well, managed, these naturalized basins will help slow, cool, filter, and infiltrate water before it reaches the stream.
- **Stormwater management banking**. When constructing stormwater management infrastructure, economies of scale play a large role in the cost of construction. Therefore, if a municipality constructs an infiltration BMP to satisfy a TMDL permit requirement or manage flooding, partnerships with commercial property owners seeking land development incentives could allow for cost sharing for construction. Property owners would benefit by being able to apply their share of the stormwater infiltration capacity to incentives offered on their site such as greater building coverage or the option to build a taller structure. Similarly, a developer building an underground detention facility may offer to oversize its capacity in order to offer that capacity to the township or another property owner.
- **Cul-de-sac islands**. Cul-de-sac islands are excellent places to use for stormwater management. Traditionally, cul-de-sac bulbs are fully paved or include a raised interior island with minimal landscaping. Townships should permit, if not require, cul-de-sac islands to be depressed to infiltrate stormwater and appropriately landscaped.
- **Shade Tree Commissions and Environmental Advisory Councils**. Elected officials can appoint a Shade Tree Commission to "plant, remove, maintain, and protect shade trees on the public streets." Elected officials can also appoint an Environmental Advisory Council to help manage natural resources within the township. The volunteers that serve on these organizations provide great services to their municipalities and can help other township officials make wise choices to implement GI strategies. Further, these volunteer boards can play an important role educating members of the community about the ways individuals can improve landscape management and decrease stormwater impacts.

Impervious Cover. Several townships in the region do not have impervious cover limits, but instead rely on building cover, parking requirements, and the stormwater ordinance to manage the intensity of use on a lot. Although this may be an effective method, municipal leaders should consider setting an impervious limit policy as a benchmark when negotiating redevelopment applications.

- **District limits**. Municipalities can set an impervious cover limit for an entire district. This idea is applied by striking a balance between the needs of commercial activity in the district and tolerable stormwater impacts to the stream. Landowners then have the option to maintain their level of impervious cover or reduce it and sell their rights to another landowner. The township could also buy up some of the rights to impervious cover and take it off the market or apply it to a specific proposal.
- **Retention of rights**. Commercial property owners may voluntarily replace impervious cover with green space. However, this reduction may affect their redevelopment potential in the future. If a township discovers that this is a disincentive to landowners who wish to create more green space. Municipalities should provide landowners with reasonable provisions to enable them to recover their impervious footprint in the future. This provision could expire after a period of time.

- **Managing new impervious cover**. As part of the MS4 permit program, most municipalities adopted new stormwater management ordinances. These ordinances include impervious cover square footage thresholds at which the municipality requires construction of stormwater management BMPs. This threshold varies in the region between 200sf and 3,000sf. Townships should consider making this threshold as small as possible in order to minimize negative stormwater impacts accumulated from small, incremental additions of impervious cover.

SPECIFIC RECOMMENDATIONS

At the present time, uncertainty exists about the next draft of DEP's MS4 permit as well as the rate and type of redevelopment that will occur as the economy changes. In the meantime, municipalities should review their codes to ensure they have high standards in place that will not just maintain runoff at its current volume and rate, but will use the redevelopment process to address past issues of poor stormwater management. In addition to the concepts described above, listed here are specific recommendations that all four townships should consider, followed by recommendations for each individual township.

- **Commercial Market Analysis**. Past real estate and development decisions resulted in some areas having more commercial space than necessary, leading to vacant stores and underutilized parking areas. To prevent this, municipalities should require a market analysis when developers propose new commercial buildings in order to inventory existing commercial area and future demand. Information from such a study could encourage property owners to redevelop existing vacant space instead of new construction.
- **Parking Study**. Ownership of parking facilities is fragmented within each commercial district. The townships should consider parking studies to determine where redevelopment will likely occur, which areas are over-parked, and where additional parking and shared access will be needed. As several commercial areas cross municipal boundaries (i.e. Flourtown and Fort Washington), townships should cooperate on such studies. These studies could also support township efforts to create village or TOD overlay districts.
- **Encourage Sketch Plans and Site Visits**. Pennsylvania municipalities cannot require sketch plans. However, most townships list the sketch plan as an optional step in the land development review process. The sketch plan is an invaluable step to any review process that townships should emphasize, not just permit. Further, townships should begin to make it common practice for planning commission members and elected officials to visit sites with the developer. By including the sketch plan and site visit in the plan review process, township officials have a more meaningful opportunity to comment on site development before applicants submit a thorough and engineered plan.

Figure 5 lists many of the recommended ordinance provisions described above. The table specifies the applicable section from each township. Shaded boxes represent ordinance sections where updates would allow townships to take advantage of the redevelopment process, increase the amount of GI on a site, and improve stormwater management.

Figure 5		Springfield	Upper Dublin	Whitemarsh	Whitpain
Plan Review Process	Sketch plan	95-8.B	212-41	105-13	129-66
	Site visit	No	No	105-21.15	No
	Shade Tree Commission	Yes	Yes	Yes	Yes
	Environmental Advisory Council	Yes	Yes	Yes	No
Green Infrastructure	Tree replacement	95-11.I.11	212.32.H	55-4	No
	Street trees	95-11.I.2	212.32.F	105-48	129-43.C.1
	Basin landscaping	No	212.32.F	No	No
	Cul-de-sac islands	No	No	No	129.36
	Curbs	95-10	212-19	105-30	129-33
Parking	Parking lot islands	95-11.I.3	212.32.F	105-38	129-43.C.4
	Parking lot green space	95-11.I.3	212.32.E	105-39	160-214.E
	Parking ratio	114-134	Article XIX	116-184	160-192
	Parking stall size	114-134.C	212.17.I	105-38	160-192
	Parking in reserve	114-134.D	255.135.D	No	160-192
	Shared parking	114-134.E	255-136	No	160-193
Impervious Cover	Cartway width	95-10		105-30	129-35
	Impervious cover limit	No	Yes	Yes	Yes
	New impervious threshold	Chapter 88	206-42	58-3	12.7

Springfield Township

The 2005 Open Space Plan recommends the addition of street trees along most of the roads that pass through the four commercial areas in Springfield. Through redevelopment and other grant programs described in the following section, the township should be able to find ways to install streetscape improvements such as street trees planted within tree lawns.

- **Bethlehem Pike Corridor**. The Flourtown Erdenheim Vision Plan states that although Bethlehem Pike is generally a four lane arterial, it acts as a two lane road with motorists weaving around others turning on and off the road. Therefore, the plan recommends reconfiguration of some areas of Bethlehem Pike to smooth traffic patterns which would allow for roadside swales, landscaped median strips, parking lot buffer areas, and tree lawns for street trees. The gateways recommended in the Open Space Plan are under construction and should act as a starting point for a corridor-wide streetscaping effort. These greener streets provide many opportunities to reduce runoff and encourage infiltration. Shared access and shared parking are also recommendations of the plan that could also enable reduction of impervious cover.
- **Flourtown**. Extending into Whitemarsh, the owners of the Flourtown Shopping Center are considering their redevelopment options for the back half of the site. As redevelopment occurs, the township has considerable opportunities to add GI components such as underground detention, disconnection of impervious cover, and additional infiltration areas.
- **Wyndmoor**. Tree lawns placed between the cartway and parking areas would help disconnect impervious cover in the village. This would provide areas for the street trees recommended in the Open Space Plan. The Open Space Plan also recommends a gateway at Willow Grove Avenue.
- **Oreland**. The mixed use and commercial district in Oreland extends south and west from the train station. The 2005 Open Space Plan recommends more street trees within Oreland and gateways at Bruce Road and Pennsylvania Ave. The addition of canopy trees in and around parking lots and streetscape improvements are applicable throughout the village.
- **Subdivision and Land Development Ordinance**
    - **Cartway width** (95-10). The required cartway width for even the smallest streets in the township is 30 feet. To put this in perspective, the two lanes that make up the northbound side of the Turnpike are only 24 feet wide. Especially in mixed use and residential areas,

the township should consider dropping this to 24 feet or 26 feet to increase safety by reducing travel speeds in pedestrian areas and reduce impervious cover.

- **Street trees** (95-11.I.2). The township has an excellent standard of one street tree for every 35 feet. However, street trees offer more services when placed within the right-of-way between the curb and sidewalk. These services include buffering pedestrians from traffic, reducing the heat island affect of streets, and encouraging good maintenance of a tree lawn that can infiltrate stormwater.
- **Parking area landscaping** (95-11.I.3). The ordinance contains a good provision requiring one landscaped parking island per every ten stalls. Other townships also include the provision that a minimum percentage, say 10% or 15%, of the interior of each parking lot must be green space. The ordinance should also encourage depressed islands by specifically mentioning them or offering sample specifications. Also, the screening buffer required for parking lots is only 15ft wide. This could be expanded to 25 feet.
- **Curbs** (95-10). It is not clear as to the where the township requires curb installation. Therefore, the township should include a description of where curbs are mandatory and where applicants can use roadside swales and bioretention areas to convey and store runoff.
- **Stormwater basin landscaping**. No standards exist for acceptable landscaping and planting with stormwater detention basins. The township should consider creating a list of appropriate species and vegetation management in basins.

- **Zoning Ordinance**
  - **Impervious cover limit**. In most districts, the ordinance does not provide an impervious cover limit. Although the code regulates runoff and land use intensity using other factors, an impervious cover limit is helpful for developers to understand the character and intensity of use envisioned within the district. An impervious cover limit establishes a strong starting point from which the township can guide growth and redevelopment. From this limit, the township can begin to think about offering incentives to property owners to reduce existing impervious cover or add infiltration capability.
  - **B1 District**. The ordinance caps the maximum building cover for a residential use in the B1 District at 70%. First, this is a very high limit that could be reduced. Second, there is no limit to either building or impervious cover for any other use in this district. The township should measure the actual impervious cover in the district and establish a limit to help meet the goal of reducing stormwater runoff. A good option is to set a limit somewhat lower than the existing impervious cover percentage and then offer incentives to reduce paving.
  - **Parking stall size** (114.134.C). For commercial uses, the township sets a parking stall size at 10 feet by 20 feet. To reduce impervious cover by 20% per stall, an acceptable stall size within parking lots is 9 feet by 18 feet.
  - **Shared parking** (114-134). The ordinance mentions shared parking but gives no specific provisions about how property owners can enter into such an agreement. To encourage more shared parking in the township, the ordinance should include provisions describing how many stalls can be shared, which uses can share stalls, and distances between shared stalls and the building it serves.
- **Stormwater Management Ordinance**. It was not clear if a minimum amount of new impervious cover triggers the need for a stormwater management plan. The township should consider specifying a threshold that would reduce additional runoff from even small additions of impervious cover. Other townships set this threshold as low as 200sf of new impervious cover.

Upper Dublin Township

- **Dresher** and **Fitzwatertown**. These two commercial areas include a mix of shopping centers, strip centers, satellite, and pad uses. As redevelopment occurs here, the township should work to

reduce excessive parking, have sites share parking, add canopy trees throughout, and create pocket areas for bioretention. Filling in the gaps between street trees along the roads would add beauty, shading, and stormwater absorption. If redevelopment will not occur in the near term, the township should look to encourage property owners to remove some parking now. The township should also address the office building parking lot in Dresher and encourage additional planting islands for use as bioretention areas.

- **Fort Washington**. Pennsylvania Avenue divides the Fort Washington commercial area between Whitemarsh and Upper Dublin. The location next to the Turnpike exit will help maintain the vitality of the area. The township should expect to work with property owners to add green infrastructure and improve stormwater management as expansion and redevelopment occurs.
- **Maple Glen**. The Maple Glen Action Plan of 2000 makes many recommendations still valid today. The plan recommends making Maple Glen more pedestrian friendly by adding on-street parking and canopy trees between the cartway and sidewalk and within parking lots. Using some of the existing cartway for parking will alleviate the need for some off-street parking. Shared access and parking will also enable better planning for parking facilities that serve the village, not just individual parcels.
- **Subdivision and Land Development Ordinance**
    - **Curbs** (212-19). The township has an excellent standard addressing curbs, specifically describing how an applicant may receive a waiver and not install curbs in order to better treat stormwater.
    - **Parking lot green space** (212-32.E). The township standard requires that if a parking lot is greater than 5,000sf, at least 10% of the interior area must be landscaped. The township may wish to consider reducing this threshold to 2,000sf as in other townships.
    - **Street trees** (212-32.F). The township requires street trees; however they must be separated by at least 50 feet and must be planted outside the ROW. A typical separation distance for street tree placement is every 40 feet. Further, trees planted within the ROW between the sidewalk and cartway help calm traffic, shade streets, and disconnect impervious cover.
    - **Parking islands** (212-32.F). The ordinance permits up to 15 parking spaces in a row before requiring a planting island. Reducing this ratio to one stall to every 12 stalls would add more shading to parking lots and add more opportunities for small bioretention areas.
- **Zoning Ordinance**
    - **CR and SC Districts**. Both of these districts have impervious cover caps of 75%. This is a high limit. The township should consider lowering this limit to 65%, then allow applicants to build to 75% impervious cover conditional upon providing enhanced stormwater management.
    - **Shared parking** (255-136). Shared parking is only permitted by special exception. A hearing in front of the Zoning Hearing Board is an added expense that many landowners would preferably not volunteer for. To encourage shared parking, the township should consider permitting it by right if the applicant meets specific conditions listed in the ordinance.
    - **Overlay districts**. The Emerging Issues Comprehensive Plan developed in 2009 states that the village overlay districts are not resulting in the type of redevelopment the township envisions. If the township updates these overlays to promote redevelopment, they should find a balance between attracting development while addressing poor stormwater management from the past. If the township is intent on permitting high intensity uses in these districts, they may wish to consider increasing height limits or facilitating regional stormwater management in the district instead of permitting high impervious cover.

- **Stormwater Management Ordinance** (206-42). New impervious cover associated with single and two-family construction is exempt from the requirement to submit a full stormwater management plan to the township. Some additions to homes may be of a size that they may warrant a full plan submission. The township should consider adding a square footage threshold to ensure large residential construction, especially near commercial areas already with high impervious cover, does not incrementally increase impacts from excessive runoff.

Whitemarsh Township

- **Broad Axe**. Butler Pike divides Broad Axe between Whitpain and Whitemarsh. Whitemarsh has significant development potential where an abandoned gas station now sits. This station is the subject of an ongoing groundwater clean-up effort in the area. Rehabilitation of this site into a gateway or a use with better stormwater management could help alleviate excessive runoff in the district. Some other relatively small commercial uses with disconnected parking lots that drain to a nearby field lie farther south on Butler Pike
- **Flourtown.** The Flourtown Erdenheim Vision Plan states that parking ratios in the township are excessive and could be reduced to add more flexibility for site design and redevelopment. The gateway proposed by the plan is under construction at Bethlehem Pike starting and Valley Green Road. This gateway should act as a starting point for an overall streetscape plan that adds green infrastructure throughout the district. This would include street trees and a common theme in the streetscape to increase awareness of the entrance to Flourtown. The township also has significant opportunity to guide the redevelopment of the Flourtown Shopping Center, including green infrastructure components such as depressed parking islands.
- **Fort Washington**. The southern side of Pennsylvania Avenue lies in Whitemarsh. The intensity of land use on this side of Pennsylvania Ave. is considerably more intense than across the street in Upper Dublin. The township should consider offering incentives to landowners to reduce existing parking areas. Considerable opportunities exist to share parking facilities and access points in the district. With its history of flooding, the township should consider writing a Green Infrastrucutre plan for the commercial area.
- **Harmonville**. At the intersection of Ridge and Butler Pikes, Harmonville lies in both Whitemarsh and Plymouth Townships. In Whitemarsh, a shopping center with few trees and no parking islands lies on the southern side of Ridge Pike. On the north side of Ridge and east side of Butler are some highway commercial uses that could benefit from shared access and parking, street trees, and incentives for greening.
- **Lafayette Hill**. This fully developed village district with a mix of uses could benefit from filling the gaps in the street tree network. Because of the mingling of residences within the commercial district, quite a few trees and green spaces exist here. The township should work with the Shade Tree Commission to maintain existing trees and promote further greening of the village.
- **Subdivision and Land Development Ordinance**
    - **Cartway width** (105-30). For local streets, the ordinance sets the minimum cartway width at 36 feet. This is unnecessarily wide for streets in residential areas. Reducing the minimum width to 26 feet would increase safety by calming traffic and allow the township to add roadside swales and other GI components within the ROW.
    - **Curbs** (105-30). The ordinance requires parking in all circumstances. The township should eliminate this requirement and describe specific instances where curbing should not be installed, such as to allow for better stormwater management. Model design specifications are available that the township could use to encourage property owners to use bioretention areas in parking lots and alongside streets.
    - **Parking stalls** (105-38). The township recently reduced the minimum parking stall size from 10 feet by 20 feet to 9 feet by 18 feet. The township should also look at lowering the

parking lot interior landscaping standard to construct one parking island for every 12 stalls instead of one per 15 stalls. These islands should be depressed to accept runoff.
    - **Canopy trees** (105-39). The ordinance includes excellent standards for installing new canopy trees in parking lots. However, there are quite a few parking lots in the township that precede these standards. The township should work with property owners when repaving occurs to increase landscaping and promote infiltration.
- **Zoning Ordinance**
    - **Parking ratio**. The Flourtown Erdenheim Vision Plan plan recommends that the number of parking stalls per area of each use should be reduced. The township should conduct a study to determine the actual parking needs of some select uses to see if the ordinance requires too much parking.
    - **CR District** (116-95). Parking standards in this district require 20% more parking than expected during peak hour. This standard seems excessive and should be replaced with provisions that permit greater flexibility for the developer such as parking in reserve.
    - **VC District**. This district encourages shared access by allowing an impervious increase of 10%. If the township continues to update this district, they should consider replacing this incentive with a option to decrease parking requirements.
    - **Development requirements for CR and SC Districts** (116-103.D and 116-117) Both of these commercial districts include provisions to guide the township and the applicant when reviewing a proposal. These include provisions that development should be harmonious with community character and be consistent with the Comprehensive Plan. The township should consider adding language to these sections that encourages stormwater management practices that address unmanaged runoff.
    - **Shared parking**. The township should consider enabling shared parking arrangements between landowners to reduce required parking neighboring uses partner together. In redevelopment projects, parking stalls no longer required could be redeveloped as green space or new commercial space.
    - **Parking in reserve**. Many townships include a reserve parking provision to give property owners more flexibility when developing or redeveloping a site. The township should consider permitting a property owner to keep as much as 50% of required parking stalls graded, but undeveloped as lawn, until the need for that parking area arises.
- **Stormwater Management Ordinance**. Property owners who create less than 1,000sf of new impervious cover are exempt from the requirement to provide infiltration. Other townships in the region set this threshold at 200sf. Especially in the Wissahickon watershed, where excessive stormwater runoff is receiving more attention, the township may wish to reduce this threshold to ensure new impervious does not exacerbate existing issues.

Whitpain Township

- **Blue Bell**. This crossroad consists of two historic restaurants with some highway commercial uses extending west along Skippack Pike. The township may have the opportunity to encourage shared parking in this area as redevelopment occurs.
- **Broad Axe**. Broad Axe in Whitpain is significantly more developed than the Whitemarsh half of this crossroad commercial area. Redevelopment will eventually occur at the northern corner where an abandoned gas station sits. The township will have great opportunity to encourage shared parking and possibly regional stormwater management for the district. The township should also consider coordinated parking and parking reduction in the western corner.
- **Center Square**. This is the largest shopping center in the region. The Comprehensive Plan states that 62 extra spaces exist, or about a half acre of impervious cover that could be transformed into green area and stormwater management. The township should consider partnering with the property owner or offer incentives to reduce this excessive parking now.

The new CVS and Wawa at Center Square, although not pedestrian friendly, are examples of highway commercial uses that manage stormwater well and include significant green area. Improved access from a widened Dekalb Pike will increase the likelihood that other areas of Center Square redevelop. As widening occurs, there may also be opportunities to partner with PennDOT to increase infiltration and manage past stormwater issues. For example, the corner gas station may be removed as the road is widened. This area could become a gateway for the township which includes green infrastructure, infiltration, and underground detention.

- **Washington Square**. The highway commercial uses located within the triangle between Dekalb Pike and Swede Road could benefit from coordinated access and parking. There may also be opportunity to add green space in the area formerly occupied by the Blue Bell Motors. The township should consider offering incentives to the shopping center here to add green infrastructure in unnecessary parking areas.
- **Subdivision and Land Development Ordinance**
    - **Street trees** (129-43.C.1). The ordinance requires street trees at 50-foot spacing. A typical separation distance is 40 feet. The township should also consider permitting street trees to be planted within the ROW to enable greater shading, traffic calming, and installation of tree lawns between sidewalks and cartway for better impervious disconnection.
    - **Parking lot landscaping** (129-43.C.4). The ordinance provides no limit to the number of continuous stalls permitted before requiring a landscaped area. A typical standard requires one landscaped island per 12 stalls. These islands should be depressed and landscaped to allow for bioretention.
    - **Curbs?**
- **Zoning Ordinance**
    - Shared parking only by SE
    - **Impervious cover**. The township should review the recent land developments in the C, C-1, and S-C Districts to determine if the impervious cover limits still apply or if they could be reduced.
- **Stormwater Management Ordinance**. The impervious area permitted before a stormwater management plan is required works on a sliding scale based on tract size. On small parcels, the threshold is 300sf. On parcels greater than 5 acres, the threshold is 3,000sf. This threshold is the highest of the four townships studied. Several townships in the region set a 200sf threshold, applied to all construction, not just those on small parcels. The township could still use the sliding scale, but should consider setting a lower threshold for larger parcels to prevent small increases in impervious cover from accumulating into significant increase in runoff volume.

GREEN INFRASTRUCTURE REDUCES COSTS

Municipalities with sound ordinances in place can take advantage of the redevelopment process to reduce stormwater management costs. This report lists specific ordinance amendments townships should consider to raise standards, increase flexibility, and offer incentives to reduce the harmful impacts of excessive stormwater runoff. In general, these recommendations focus on removing impervious cover on a site in favor of increasing commercial space and green infrastructure.

Townships officials that understand the environmental services they can gain from a functioning GI network will save costs managing runoff while also improving air quality, enhancing aesthetics, and saving energy. GI networks are especially important in commercial districts where land use is intense and the return on a GI investment may be relatively quick. When redevelopment proposals come in, township codes should create a path of least resistance that leads to good commercial development and an expanded GI network.

In regard to the MS4 permitting program, the TMDL control measures printed in the first draft of the permit were all components of GI (i.e. riparian buffers, tree planting, infiltration facilities, basin retrofits, and stream restoration). Townships should understand that the higher standards they adopt and the enhanced GI network property owners create through the redevelopment process may count towards their MS4 permit responsibilities. Implementation of ordinances that promote GI is the most cost effective way to meet permit requirements, improve water quality, and enhance aesthetics in commercial areas.

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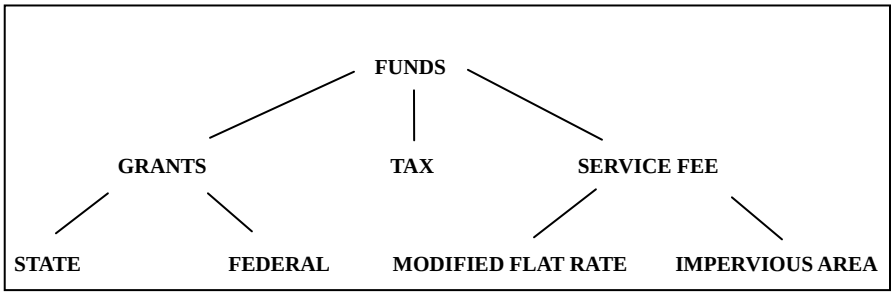
Appendix V: Generating the Funds for Stormwater Management

Lia Mastropolo, University of Pennsylvania

In order for the market mechanism described in this study to progress, some level of funding must be raised initially by municipalities in order to drive capital projects. This may be done through a number of avenues. The three major options for stormwater management are: state and/or federal grants, tax increases, or service fees. Of these, the latter option is best suited to the Wissahickon Watershed for a number of reasons described below.



Grants

The EPA has made it clear that funding for the MS4 program will not come from federal grants. State funding is even less likely in this financial climate. Because the funds needed are great and spread over a long period time, MS4 permits are not consistent with government grant-making priorities. Act 167 has traditionally been a source of assistance for stormwater programs, but it has traditionally provided fairly small sums for planning purposes, and is now limited further by budget cuts.

Taxes

If it is understood that funding is not available from government sources at the scale needed, then it must be assumed that burden will be allocated among land users. While a tax is the simplest option, it is a politically costly and unpopular choice. What is more, competition for general funds is great, and priority is usually placed on urgent, high-visibility capital projects. On a national level, taxes are rarely used for ongoing stormwater management, and when they are, legal challenges often arise.

Stormwater Authorities and Service Fees

Numerous stormwater authorities have been established around the country over the last decades. These all raise funds through some sort of service fee. A service fee assumes that the recipient is receiving some benefit, the cost of which must be defrayed. Legally, a service fee differs from a tax or special assessment because it may be refused; in the case of wastewater or drinking water, the service may be shut off by the recipient, and the utility may refuse service if payment is not met. With the problem of runoff, this theory is complicated by the fact that stormwater travels across property lines, and service in a traditional sense (i.e. drain maintenance, treatment, detention, etc.) cannot be readily

shut off for a single user. However, a user can influence their bill in several ways depending on how the rate is assessed and what is charged for; these methods of assessment fall into two categories, described below.

Modified flat rate
Flat rate fees have been used successfully to raise money by assessing a regular service charge based on property area multiplied by some land use code or density designation. This method is relatively cheap and easy to implement; charges can be assigned using an existing assessor's database and land use or density information. However, this method is general. The only way users may lessen their fee is through a change in land use designation, or by selling off property.

Impervious area
The preferable method for paying for stormwater is to charge by impervious area, and modify the fee as the land cover type changes (i.e. a higher charge per square foot for pavement then for lawn, and a higher charge for lawn than for forest). This provides real incentive for careful land use, and is legally very strong. However billing for cover type requires extensive mapping and continual updates and monitoring as cover types change. It took the City of Philadelphia 8 years of mapping to move from a meter-based to a cover-based fee system (personal conversation, Erin Williams, PWD). Obviously this sort of effort is simply too expensive for small municipalities individually. However aspects of this method may be applicable for multi-municipal groups and or watershed groups.

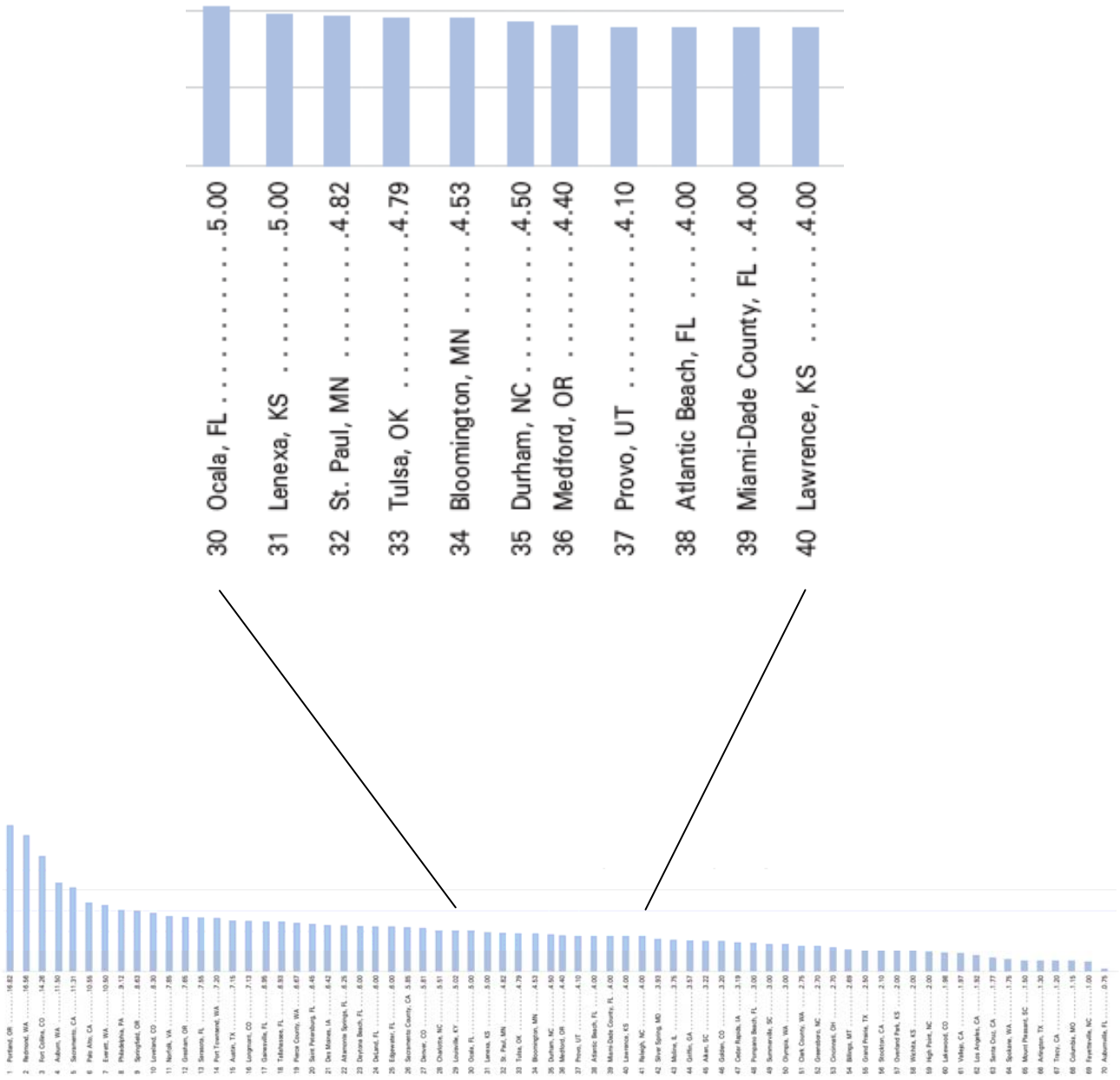
Fee-For-Volume: Pros And Cons
Many challenges face progress toward an impervious area-based fee system. As mentioned above, aggregating and analyzing data to establish the system is a big task.

A major challenge is creating the scale for better watershed management. Single municipalities cannot effectively manage stormwater. The stormwater dilemma described in the body of this report means that those who generate much of the runoff are not harmed by it, and those who are harmed by the effects of unmanaged runoff have few and costly options for managing it. The Pennsylvania Municipal Authorities Act does not specifically state that authorities can be created for the purpose of managing stormwater, which is one of the factors delaying creations of authorities in Pennsylvania. Fortunately, Pennsylvania stormwater management policy is evolving. New enabling legislation for more comprehensive watershed-based stormwater planning was voted out of the Pennsylvania House Local Government Committee in the fall of 2009. The legislation includes a provision for stormwater authorities.

Another challenge is that assigning volume as a surrogate for sediment means that incentives to infiltrate stormwater through better land use and green design strategies are weakened. Because basin control offers the best value, watershed or land managers may take a narrow view so that other options are ignored. From a community planning perspective this may limit attention to other important factors like livability and appearance. Watershed managers may need factor trading ratios or incentives into the stormwater fee system according to community consensus.

Moving Forward
While the move from TMDL to effective incorporation of the TMDL into the MS4 permit and the beginning of implementation is a big one, progress is possible. Using a stormwater authority structure, the costs of beginning implementation can be shared among users without causing disproportionate burden. These funds can be allocated to measurable steps towards the TMDL. As these small steps progress, measured water quality can be expected to improve.

Sample median monthly stormwater payments
(Black & Veatch 2007)



Monthly stormwater utility payments (Black & Veatch 2007)

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The Wissahickon Creek Municipal Sediment Credit System

Appendix VI PADEP Draft PAG-13 MS4 General Permit Notice of Intent instructions for Stormwater TMDL Plan in TMDL watersheds.

E. **Stormwater Management Program**

The MS4 General Permit requires permittees to implement six MCMs to protect water quality standards and to reduce the discharge of pollutants to the Maximum Extent Practicable (MEP). DEP has provided a Stormwater Management Program in the General Permit, which shall be used for permit compliance. In this section, confirm that you will use this SWMP to meet this requirement for all six MCMs. If not, then you must apply for an Individual MS4 permit.

If your NOI is for a group of co-applicants, and one applicant is implementing one or more minimum control measure(s) on the other applicants' behalf, name which applicant is responsible for implementing that measure. The same applies for elements to be implemented by others such as a county, statewide association or watershed group. However, because these non-MS4 entities are not permittees; the MS4s have the ultimate responsibility for implementing each of the elements of this Permit.

1. Additional Requirement of a Stormwater TMDL Plan for Impaired Waters with a TMDL

If your MS4 discharges stormwater into any receiving waters with approved stormwater TMDLs, you shall develop, implement, and enforce a Stormwater TMDL Plan that achieves the pollutant reductions consistent with the applicable TMDL. When a Stormwater TMDL Plan is required to be submitted with the NOI, the municipality shall implement the approved plan.

At a minimum, the Stormwater TMDL Plan shall include information regarding implementation of all of the Best Management Practices (BMPs) from at least two TMDL Control Measures listed below, within the term of coverage of this permit term.

The Stormwater TMDL Plan shall, at a minimum, include:

i. Title of TMDL;

ii. List of the watershed name(s) and eight digit Hydrologic Unit Code (HUC) Watershed number(s) that the TMDL is located;

iii. List of the pollutant(s) and Wasteload Allocations (WLAs) assigned to each MS4 covered by the NOI;

iv. List of the municipalities subject to the same TMDL within the same eight digit HUC watershed;

v. List of the counties subject to the same TMDL within the same eight digit HUC watershed;

vi. Allocated pollutant loadings set forth in the TMDL: (Example language—The goal for this TMDL is for the [insert pollutant] concentrations throughout [insert name of area with TMDL] to meet the water quality standards for the designated uses of the water body that are affected by [pollutant]. These uses include [list uses]. The water quality standard for the uses are [insert water quality standards]. A [insert percent reduction listed for TMDL] percent reduction in the total [pollutant] loading is necessary to meet the TMDL);

vii. Reductions in pollutant loads to be attained by the Stormwater TMDL Plan: (Example language—To reduce or remove all sources of [pollutant] to the stream to the maximum extent practicable. DEP expects that a phased and iterative approach will be utilized. The municipalities will work with partners (adjacent municipalities, counties, watershed associations, conservation districts, etc.) to implement all of the BMPs within the TMDL Control Measures to meet the TMDL);

viii. TMDL Control Measures to address the TMDL: (Example language—List all of the TMDL Control Measures to be implemented and monitored.) Include a brief analysis explaining the rationale for selecting two or more BMPs from the list below for implementation.

ix. Monitoring information and timeline for achievement in accordance with the TMDL: The permittee shall include information and a brief analysis on how implementation of the Plan, including selected TMDL Control Measures, shall make measurable progress in substantially reducing the applicable pollutant loads consistent with the TMDL, including the expected reductions in pollutant load. In addition, the permittee shall propose a timeline, with milestones, that details how implementation of the Plan will attain the pollutant load reductions set forth in the applicable WLA of the TMDL, as soon as practicable. Implementation of the Plan may be phased, in accordance with the timeline, and can be adaptive, iterative, and dynamic. The Plan shall be evaluated and updated by the permittee continuously, as necessary, based on its effectiveness in reducing pollutant discharge loads. Also include a brief description of a process for evaluating the Stormwater TMDL Plan implementation efforts undertaken to date and any changes made to the measures specified in the Plan to obtain greater reductions in pollutant loading;

x. Additional information deemed necessary by DEP for addressing the TMDL.

Information for TMDLs (including HUC numbers) can be found at www.depweb.state.pa.us, keyword: TMDL.

The Stormwater TMDL Plan must be signed and sealed by a professional engineer holding a valid license in good standing from the Pennsylvania Department of State.

You must implement and monitor all of the BMPs, at least two TMDL Control Measures to any of your municipal facilities from the following list. (Note: these are in addition to the six mandatory MCMs). The BMPs are examples of the types of BMPs that could be part of the implementation. Whenever possible, the TMDL Control Measures should be implemented in a manner consistent with the guidance provided by the Pennsylvania Stormwater Best Management Practices Manual (Document No. 363-0300-002). In addition, the Stormwater TMDL Plan should be conducted in a manner consistent with and incorporate appropriate content from Non Point Source Implementation Plans, Watershed Restoration Strategy Plans, County Comprehensive Plans (Act 247 Plans) as well as other applicable resources.

TMDL Control Measure 1. Establish and Protect Riparian Forest Buffers – restore vegetated buffer areas

a. Inventory possible buffer restoration sites
b. Prioritize and select buffer restoration sites
c. Establish and maintain riparian forest buffers utilizing DEP's Riparian Forest Buffer Guidance (Doc. No. 394-5600-001 *(upon publication)*) and the Riparian Forest Buffer Toolkit (www.depweb.state.pa.us, keyword: Stream ReLeaf.)
d. Protect the riparian forest buffers by recording a riparian forest buffer easement or riparian forest buffer agreement
e. Enact and enforce a riparian forest buffer ordinance
f. Quantify and report yearly amount of new riparian forest buffers installed utilizing the Stream ReLeaf data sheets (www.depweb.state.pa.us, keyword: Stream ReLeaf.)

TMDL Control Measure 2. Disconnection Program – Disconnect impervious areas from your MS4 system

a. Survey/inventory system for directly connected roof leaders
b. Survey system for pavement disconnection opportunities
c. Develop and implement a disconnection and retrofit program
d. Enact and enforce an ordinance requiring disconnection and prohibiting direct roof connections
e. Quantify and report yearly volume permanently removed in association with the disconnect program

TMDL Control Measure 3. Tree Planting – Plant trees within the impaired watershed

a. Identify areas for possible tree planting to last a minimum of twenty (20) years
   i. Guidance and grants are available through the TreeVitalize partnership http://www.treevitalize.net/

b, Create a basic planting plan that includes:
   i. A map that delineates each area in which project activities must be performed.
   ii. A sketch or large map identifying the specific location where each tree is to be planted
   iii. The species (and variety, if applicable) of each tree planted
   iv. The location of overhead utilities or other above ground obstructions (lamp posts, fire hydrants, etc..) and any known underground obstructions.
   v. The width of the tree lawn if present, or the size of the sidewalk opening where the tree is to be planted if no tree lawn (5ft x 5ft or 3ft x 10ft is recommended)
   vi. Establish a long-term maintenance program and provide for early care of the trees for the first three years.

c. Plant and maintain trees or tree seedlings;
   i. Municipalities with a resident population density between 1-20,000:
      1. Plant 25 trees with a caliper range between 2 inches to 3 inches measured 6 inches above the root collar of the tree, **OR**
      2. Plant 1,000 tree seedlings with tree shelters (utilize the Conservation Reserve Enhancement Program Guidelines http://www.creppa.org/success.htm. Click on "Landowner Guide to Success.")
   ii. Municipalities with a resident population of 20,001 and over
      1. plant 50 trees with a caliper range between 2 inches to 3 inches measured 6 inches above the root collar of the tree,
      OR
      2. Plant 2,000 tree seedlings with tree shelters.

d. Quantify and report yearly amount of trees planted including but not limited to: tree species, diameter range of trees, and location of planting.

TMDL Control Measure 4. Construct Recharge/Infiltration Facilities

a. Evaluate locations for structural infiltration facilities including vegetative swales
b. Construct recharge/infiltration BMPs (For examples refer to Chapter 6 of the Pennsylvania Stormwater Best Management Practices Manual)
c. Construct BMP with annual volume control equivalent to volume control in 1 & 2 above
d. Quantify and report yearly volume permanently removed in association with the construction of recharge/infiltration facilities

TMDL Control Measure 5. Stormwater Basin Retrofits – Naturalize or modify for extended detention, and/or modify for increased infiltration basin

a. Inventory basins within the urbanized areas
b. Determine feasibility for retrofit naturalization
c. Prioritize and select basins for retrofit
d. Retrofit at least one basin

e. Quantify and report yearly the size and type of stormwater basin retrofits and the volume permanently removed in association with the stormwater basin retrofits

TMDL Control Measure 6. Restore Stream banks – Restore degraded and eroding stream banks

a. Inventory using NRCS assessment tool (http://www.nrcs.usda.gov/technical/ecs/aquatic/svapfnl.pdf)
b. Prioritize segments and select at least one for restoration
c. Restore at least one segment (a minimum of 1000 linear feet and 100 ft wide is suggested)
d. Quantify and report yearly amount of restored stream banks in linear feet volume removed from system

TMDL Control Measure 7. Green Infrastructure

a. Establish a Green roof — minimum of 20,000 square feet per year (suggested)
b. Establish Rain gardens — minimum of two (2) acres per year (suggested)
c. Implement Pervious pavement surfaces — minimum of 5 acres per year on all new pavement (suggested)
d. Quantify and report yearly the size and type of installed green infrastructure BMPs

Guidance on methods to compute the water quality benefits of various interconnected BMPs can be found in Section 8.6 titled "Stormwater Quality Analysis," of the Pennsylvania Stormwater Best Management Practices Manual. , Section 8.6, Stormwater Quality Analysis.

2. *NOI Requirements*

The Stormwater TMDL Plan shall be submitted as an addendum to the NOI, and shall include all of information specified.

3. *Implementation Requirements*

You shall develop and implement a plan that achieves the pollutant reductions established by the TMDL. The plan shall include information concerning implementing at least one of the two TMDL Control Measures as soon as practicable but in no case later than by the beginning of the third year of coverage under the permit. Also, you shall report on the implementation of at least one TMDL Control Measures in the progress report submitted in third year of coverage under the permit. You shall implement the second TMDL Control Measures in your plan MCM as soon as practicable but not later than by the beginning of the fifth year of coverage under the permit. Additionally, all other measures needed to reduce the pollutant load consistent with the TMDL shall be implemented as soon as practicable, in accordance with the Plan timeline, to make measurable progress in substantially reducing the applicable pollutant loads. Implementation of all measures can be adaptive, iterative, and dynamic. The Plan shall be evaluated and updated by the permittee continuously, as necessary, based on its effectiveness in reducing pollutant discharge loads.

You shall report on the implementation in the progress report submitted with the renewal application, including the reductions in pollutant load attained by implementation of the measures, broken down measure by measure. The Stormwater TMDL Plan shall demonstrate that the required pollutant load reductions will be achieved to the Maximum Extent Practicable, consistent with the TMDL. The Plan can demonstrate this by showing how measurable implementation progress will be made in substantially reducing applicable pollutant loads specified in the WLA, in accordance with the implementation timeline, including attainment of applicable milestones, along with the end date for ultimate attainment of the pollutant load reductions set forth in the WLA.

viii. TMDL Control Measures to address the TMDL: (Example language—List all of the TMDL Control Measures to be implemented and monitored.) Include a brief analysis explaining the rationale for selecting two or more BMPs from the list below for implementation.

ix. Monitoring information and timeline for achievement in accordance with the TMDL: The permittee shall include information and a brief analysis on how implementation of the Plan, including selected TMDL Control Measures, shall make measurable progress in substantially reducing the applicable pollutant loads consistent with the TMDL, including the expected reductions in pollutant load. In addition, the permittee shall propose a timeline, with milestones, that details how implementation of the Plan will attain the pollutant load reductions set forth in the applicable WLA of the TMDL, as soon as practicable. Implementation of the Plan may be phased, in accordance with the timeline, and can be adaptive, iterative, and dynamic. The Plan shall be evaluated and updated by the permittee continuously, as necessary, based on its effectiveness in reducing pollutant discharge loads. Also include a brief description of a process for evaluating the Stormwater TMDL Plan implementation efforts undertaken to date and any changes made to the measures specified in the Plan to obtain greater reductions in pollutant loading;

x. Additional information deemed necessary by DEP for addressing the TMDL.

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d. Protect the riparian forest buffers by recording a riparian forest buffer easement or riparian forest buffer agreement
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f. Quantify and report yearly amount of new riparian forest buffers installed utilizing the Stream ReLeaf data sheets (www.depweb.state.pa.us, keyword: Stream ReLeaf.)

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