Guidance For Developing an Off-Site Stormwater Compliance Program in West Virginia

Local Stormwater Program Development in Accordance With The West Virginia General Permit For Stormwater Discharges From Small Municipal Separate Storm Sewer Systems (WV0116025)

Prepared For:
West Virginia Department of Environmental Protection

By:
Center for Watershed Protection, Inc.

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1. Overview of General Permit and Off-Site Compliance Terminology

1.1. The Purpose of This Guidance Document

Through the issuance of the West Virginia MS4 General Permit, the state has established a stormwater performance standard for new development and redevelopment projects within MS4 communities. Part II, Section C.b.5.a.ii of WV MS4 General Permit outlines the Site and Neighborhood Design elements for the Post-Construction minimum measure.

The specific performance standard of this section contains the primary design goal for post-construction stormwater designs and practices:

"Site design standards for all new and redevelopment that require, in combination or alone, management measures that keep and manage on site the first one inch of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation. Runoff volume reduction can be achieved by canopy interception, soil amendments, evaporation, rainfall harvesting, engineered infiltration, extended filtration and/or evapotranspiration and any combination of the aforementioned practices."

The MS4 General Permit also establishes flexibility for meeting the performance standard. Subsection A.4 specifies two alternatives for applicants that can demonstrate that they cannot meet 100% of the 1" runoff reduction performance standard:

1. Off-Site Mitigation: Runoff reduction practices at a redevelopment or retrofit site are implemented at another location within the same watershed or sewershed. The off-site project would likely be initiated by the site developer, and the MS4 can play a coordinating and/or project approval role.

2. Payment in Lieu: The developer pays the MS4 (or its assigned entity) an appropriate fee. Fees from multiple sites are aggregated by the MS4 to construct "public stormwater projects." This requires a much more active role for the MS4 compared to the site developer.

This guidance document provides definitions, details, and resources for MS4s that wish to utilize the one or both of the approaches listed above. Taken together, these approaches are referred to as "off-site compliance" for the purposes of this guidance.

Table 1 lists the actual language concerning off-site compliance from the MS4 General Permit. It should be pointed out that the language, *if these alternatives are chosen* (see bold text in **Table 1**) gives the MS4 discretion to authorize off-site compliance within the jurisdiction or in certain circumstances (or, alternatively, to require full on-site compliance in all cases). Therefore, this is a critical decision point for MS4s as they build the stormwater management program.

There may be multiple objectives for an MS4 to undertake an off-site compliance program:

1. Provide regulatory flexibility for difficult sites and/or sites at which the local government wishes to promote infill or redevelopment.
2. Allow MS4s to collect fees to partially fund stormwater and watershed projects.
3. Seek cost-effective strategies to achieve equivalent or superior runoff reduction compared to what would be accomplished on the site in question.
4. Fulfill other local program goals and objectives.

For more detailed information on the Post-Construction minimum measure, see the MS4 General Permit (WV0116025) and the West Virginia Stormwater Management and Design Guidance Manual. Information is available on the West Virginia Department of Environmental Protection (WVDEP) MS4 website:

http://www.dep.wv.gov/WWE/Programs/stormwater/MS4/Pages/default.aspx

Table 1. MS4 General Permit Language on Off-Site Compliance.
Part II, Section C.b.5.a.ii.*A.4.* *For projects that cannot meet 100% of the runoff reduction requirement on site, two alternatives are available: off-site mitigation and payment in lieu.* ***If these alternatives are chosen****, then the permittee must develop and fairly apply criteria for determining the circumstances under which these alternatives will be available. A determination that standards cannot be met on site may not be based solely on the difficulty or cost of implementing measures, but must include multiple criteria that would rule out an adequate combination of the practices set forth in section 1, above, such as: too small a lot outside of the building footprint to create the necessary infiltrative capacity even with amended soils; soil instability as documented by a thorough geotechnical analysis; a site use that is inconsistent with capture and reuse of stormwater; too much shade or other physical conditions that preclude adequate use of plants. In instances where alternatives to complete on site management of the first inch of rainfall are chosen, technical justification as to the infeasibility of on site management is required to be documented.* *These alternatives are available, in combination or alone, for up to 0.6 inches of the original obligation at a 1:1.5 ratio, i.e., mitigation or payment in lieu must be for 1.5 times the amount of stormwater not managed on site. If, as demonstrated to the permittee, it is technically infeasible to manage on site a portion of all of the remaining 0.4 inches, off site mitigation or payment in lieu will be applied at a 1:2 ratio for that portion. For any of these options to be available, the permittee must create an inventory of appropriate mitigation projects, and develop appropriate institutional standards and management systems to value, evaluate and track transactions.* ***Off-site mitigation****. Runoff reduction practices may be implemented at another location in the same sewershed/watershed as the original project, approved by the permittee. The permittee shall identify priority areas within the sewershed/watershed in which mitigation projects can be completed. Mitigation must be for retrofit or redevelopment projects, and cannot be applied to new development. The permittee shall determine who will be responsible for long term maintenance on mitigation projects.* ***Payment in lieu****. Payment in lieu may be made to the permittee, who will apply the funds to a public stormwater project. MS4s shall maintain a publicly accessible database of approved in lieu projects.*

1.2. Definitions & Terminology

This guidance uses certain terms, some of which are also used in the MS4 General Permit. In the interests of providing clarification and consistency, the following definitions apply in the context of this guidance. Readers should also be aware that Appendix B of the MS4 General Permit also contains definitions, but there is no overlap with those definitions and the ones provided below. The words in *italics* below cross-reference terms that have their own definition.

Allowable Practices: Stormwater and/or watershed practices (*public stormwater projects*) that are authorized by the MS4 to be used as part of an off-site compliance program, and for which runoff reduction volume equivalents can be established.

Credit: The amount of runoff reduction volume assigned to a particular practice based on scientific information, literature review, and/or modeling. This should be distinguished from the term "credit" used as part of a stormwater utility program.

Currency: The unit that is used to compare unmet stormwater control at an *eligible* new development or redevelopment site with the stormwater control provided at the off-site location. The performance standard in the MS4 General Permit, and therefore the baseline currency, is runoff volume.

Eligibility: In the context of this guidance, eligibility refers to the documentation and resulting decision about whether a new development or redevelopment site can use off-site compliance options, as authorized by the MS4. As per the MS4 General Permit, the applicant must document the "technical justification as to the *infeasibility* of on site management," and this must be approved by the MS4 (Part II, Section C.b.5.a.ii.*A*.4).

Infeasibility: To document that a new development or redevelopment site is *eligible* for off-site compliance, the documentation must include "multiple criteria that would rule out an adequate combination of the practices. . ., such as: too small a lot outside of the building footprint to create the necessary infiltrative capacity even with amended soils; soil instability as documented by a thorough geotechnical analysis; a site use that is inconsistent with capture and reuse of stormwater; too much shade or other physical conditions that preclude adequate use of plants." The determination of infeasibility cannot be based solely on the difficulty or cost of implementing measures (Part II, Section C.b.5.a.ii.*A*.4).

Off-site compliance: A general term that covers both *off-site mitigation* and *payment in lieu* options and refers to meeting some or all of a new development or redevelopment's stormwater requirements, as specified in the MS4 General Permit and local stormwater code, at an off-site location.

Off-site mitigation: The off-site compliance approach whereby runoff reduction practices are implemented at redevelopment or retrofit sites at another location in the same sewershed/watershed as the original project, as approved by the MS4 and at the volume ratios specified in the MS4 General Permit.

Payment in Lieu: The off-site compliance approach whereby the developer or applicant pays a fee to the MS4 in lieu of full compliance on the development site, as approved by the MS4 and at the volume ratios specified in the MS4 General Permit. The MS4 can aggregate fees and apply them to *public stormwater projects*.

Public Stormwater Project: Stormwater and/or watershed improvement projects used as part of a *payment in lieu* program. Public stormwater projects are deemed by the MS4 to have a public benefit for water resources protection or enhancement, stormwater treatment, and/or ecological restoration, and which may have other community benefits.

Scale of Trading: The geographic boundary that links the new development or redevelopment site that is *eligible* for off-site compliance and the off-site practice(s) that provides mitigation. The MS4 General Permit specifies that this scale shall be the “same sewershed/watershed” for *off-site mitigation.*

Trading Ratios: The ratio that establishes the runoff reduction volume that an off-site practice must be designed to treat. The MS4 General Permit establishes a trading ratio of 1.5:1 for the volume of runoff associated with the first 0.6 inches to be traded for an off-site practice, and 2:1 for the subsequent 0.4 inches.

Rate: The fee used in a *payment in lieu* program, based on the *currency.* For instance, a payment in lieu fee could be $35 per cubic foot of runoff.

1.3. Appendices

This guidance is a relatively brief overview of the subject of off-site compliance. Much of the detail is contained in program tools in the appendices. The appendices include:

- **Appendix A:** A streamlined statewide application form for off-site compliance, demonstration of infeasibility, and calculation of off-site runoff volume requirements. The intention of this form is that MS4s will adapt it to their particular conditions and needs.
- **Appendix B:** Model ordinance language for off-site compliance. This language is intended to be part of a larger local stormwater ordinance that also addresses on-site stormwater management and other aspects of the local program. The model language should be reviewed and adapted by local program staff, including legal staff.
- **Appendix C:** A procedure for setting a payment in lieu fee that accounts for legitimate programmatic costs. The appendix also includes planning-level costs for a wide variety of BMPs.
- **Appendix D:** A generalized procedure for scoring and prioritizing potential mitigation projects, with reference to other resources to guide this process.

- **Appendix E:** A matrix of example off-site programs from other states and localities.
- **Appendix F:** A procedure for assigning runoff reduction values for reforestation projects so that these types of projects can be used for off-site mitigation.
- **Appendix G:** Similar to Appendix F, a procedure for assigning runoff reduction values for stream restoration projects (this method is considered provisional at this point in time).

2. A General Off-Site Compliance Hierarchy

A hierarchy of off-site compliance options provides a useful framework for MS4s to evaluate the various approaches available through the MS4 General Permit. Four options are described below and include: (1) on-site compliance, (2) developer-driven off-site mitigation, (3) MS4-facilitated off-site mitigation, and (4) payment in lieu. Based on an analysis of these options and the feasibility considerations outlined in **Section 3**, the MS4 may decide to:

- Offer both off-site mitigation AND payment in lieu options,
- Offer JUST the off-site mitigation option, or
- Require all compliance on-site

This hierarchy is not intended to be a mandatory ordering of options that MS4s must provide. Rather, the options are provided in order of the level of effort, level of service, and program sophistication required to implement them. In this regard, it is a way of framing the off-site compliance program as “try the easy things first.” Some MS4s may prefer option #2 because their role in the compliance process is limited to reviewing and verifying activities of the applicant. On the other hand, some utility-based programs that already manage a capital improvement program may prefer option #4 because it can be integrated with existing operations (e.g., collecting fees, designing and building projects) and offers more control of the final product. In this regard, the hierarchy must be understood based on unique characteristics of the MS4.

This section describes each of these options and outlines the roles of the MS4, applicant (developer), and other parties.

2.1. Option #1. On-Site Compliance

Any off-site compliance program must be built on a strong foundation of routine, full on-site compliance for the majority of sites. This foundation is important because the off-site options are not intended to become automatic whenever site compliance becomes somewhat difficult. The MS4 must first develop the standards and protocols for plan review, inspections, and enforcement for on-site compliance in accordance with the MS4 General Permit and WV Stormwater Management & Design Guidance Manual.

In this way, the MS4 will have a better understanding of which sites truly meet the "infeasibility" standard and can be authorized to access off-site options.

As noted in **Section 1,** an MS4 has discretion to authorize off-site compliance options, and some may opt out of this program element. Given this, it should be noted that, without eventual use of off-site compliance options, the MS4 will likely find it challenging to approve difficult or tricky development projects where full on-site compliance is genuinely infeasible. The MS4 General Permit does not include a waiver procedure for the 1" reduction performance standard. Therefore, off-site compliance serves as the "relief valve" for sites where compliance is infeasible.

The specific roles for Option #1 include:

- MS4 – Review and approve the applicant's on-site compliance.
- Applicant – Demonstrate ability to achieve 100% of the runoff reduction requirement on-site.

2.2. Option #2. Developer-Driven Off-Site Mitigation

When the infeasibility of meeting the runoff reduction requirement on-site has been properly documented, runoff reduction practice(s) may be implemented in the same sewershed/watershed as the original project. Depending upon the on-site feasibility, off-site mitigation may be used to fulfill the entire runoff reduction requirement or just the remaining volume after partial on-site management. As described in more detail in **Section 3**, the MS4 General Permit calls for the MS4 to create an inventory of appropriate mitigation practices and to develop appropriate institutional standards and management systems to value, evaluate and track "trades" between on-site and off-site practices.

With this option, the applicant takes the initiative to identify the location for off-site mitigation, with suggestions and approval from the MS4. The MS4 should develop a general prioritization of areas where off-site projects would be most beneficial to receiving waterways; however, the applicant plays the major role in selecting, designing, constructing, and maintaining the project.

Table 2 outlines the specific roles and responsibilities for the MS4 and the applicant for Option #2.

<table>
<tr><th>Table 2. Responsibilities for Off-Site Compliance Option #2</th></tr>
<tr><td>Why MS4s May Be Interested in Option #2
MS4s that are just “dipping their toe” into the off-site compliance realm may want to start with this approach, since the role of the MS4 is to review and verify activities of the applicant.</td></tr>
<tr><td><u>MS4 Responsibilities</u>
Verifies infeasibility of on-site compliance
May identify priority areas and potential projects in sewershed/watershed to help guide applicant in selection of off-site projects
Reviews plans for on-site and off-site compliance
Inspects on-site and off-site practices during installation
Verifies long-term maintenance of on-site and off-site practices
Conducts necessary tracking and reporting for MS4 permit</td></tr>
<tr><td><u>Applicant Responsibilities</u>
Documents infeasibility of full on-site compliance
Identifies location for off-site project (with input from MS4)
Prepares and submits plans for on-site (if any) and off-site practices
Enters into maintenance agreement for on-site and off-site practices
Secures any necessary property rights for off-site practices
Constructs on-site and off-site practices
Maintains on-site and off-site practices, unless this responsibility is assigned to another party (e.g., local stormwater utility that expressly takes the responsibility)</td></tr>
</table>

2.3. Option #3. MS4-Facilitated Off-Site Mitigation

Similar to Option #2 above, when the infeasibility of meeting the runoff reduction requirement on-site has been properly documented, runoff reduction practices may be implemented in the same sewershed/watershed as the original project. However, with this option, the MS4 assumes a more active facilitation role, to possibly include identifying and prioritizing site(s) (see **Appendix D**), assisting with property rights, and guiding the design and construction process. Although the MS4 takes on these additional roles, the applicant is not required to make any payments for those services provided by the MS4. The applicant is still responsible for designing, constructing, and maintaining the project with guidance from the MS4.

Table 3 outlines the specific roles and responsibilities for the MS4 and the applicant for Option #3.

Table 3. Responsibilities for Off-Site Compliance Option #3
Why MS4s May Be Interested in Option #2 As opposed to the more hands-off approach of Option #2, Option #3 suggests that the MS4 may have specific projects that it would like to see constructed (e.g., as part of a watershed or stormwater master plan), so may want to steer or facilitate the process of identifying and selecting off-site mitigation projects without assuming direct responsibility for design and construction.
MS4 Responsibilities ▪ Verifies infeasibility of on-site compliance ▪ Identifies priority areas and potential projects in sewershed/watershed and works with applicant to select a site that helps meet MS4 and community goals ▪ May assist applicant with securing property rights, approvals, permits, etc. ▪ Reviews plans for on-site and off-site compliance ▪ Inspects on-site and off-site practices during installation ▪ Verifies long-term maintenance of on-site and off-site practices ▪ Conducts necessary tracking and reporting for MS4 permit
Applicant Responsibilities ▪ Documents infeasibility of full on-site compliance ▪ Works with MS4 to identify location(s) for off-site project, securing property rights, permits, etc. ▪ Prepares and submits plans for on-site (if any) and off-site practices ▪ Enters into maintenance agreement for on-site and off-site practices ▪ Constructs on-site and off-site practices ▪ Maintains on-site and off-site practices, unless this responsibility assigned to another party (e.g., local stormwater utility that expressly takes the responsibility)

2.4. Option #4. Payment In Lieu

Payment in lieu can be used as an option when full on-site compliance is infeasible and as an alternative to off-site mitigation (Options #2 and #3). With this option, the applicant provides a fee that will help cover the cost of implementing approved runoff reduction projects elsewhere in the sewershed/watershed. The MS4 is responsible for establishing the rate paid for unmet runoff reduction volumes, as described in **Section 3** and **Appendix C**.

This option can be administered through an MS4 program, public/private initiative, or private bank. In some cases, this option is desirable to MS4s because it allows more control of the off-site compliance program in terms of the types of runoff reduction practices, installation, and maintenance. It is most relevant for programs that already have a Capital Improvement Plan and oversee construction activities (e.g. programs managed by a water and sewer utility district).

Table 4 outlines the specific roles and responsibilities for the MS4 and the applicant for Option #4.

Table 4. Responsibilities for Off-Site Compliance Option #4
Why MS4s May Be Interested in Option #4 Some programs, particularly those that operate through utilities with existing mechanisms for collecting fees and capitalizing, constructing, and maintaining projects, may view this option as the most desirable because of the level of control achieved by the MS4. This type of program may rather use its own crews for project management and construction rather than verifying the work of third-party applicants. An important element of this approach is making sure the fee is set at an adequate rate to plan, design, build, maintain, and administer projects.
<u>MS4 Responsibilities</u> ▪ Verifies infeasibility of on-site compliance ▪ Identifies priority areas and potential projects in sewershed/watersheds within MS4 ▪ Sets payment in lieu rate and assesses and collects fee from applicant ▪ Plans, designs, constructs, and maintains projects (with likely use of consultants and contractors in some cases) ▪ Administers program, perhaps in conjunction with private initiative or bank ▪ Conducts necessary tracking and reporting for MS4 permit
<u>Applicant Responsibilities</u> ▪ Documents infeasibility of full on-site compliance ▪ Pays fee

3. Off-Site Compliance Program Considerations

There are many program considerations that should be evaluated when developing an off-site compliance program. This section outlines in more detail the up-front work an MS4 should do to ensure a well-crafted and effective program. Each program consideration is linked to the four Options of the hierarchy described in **Section 2**. **Table 5** identifies the relevance of each program consideration to the four Options in the hierarchy. Taken together, these considerations are a good start towards deciding the type of off-site mitigation program to implement and can be considered a program feasibility analysis.

Table 5. Relevance of Program Considerations to the 4 Options of the Compliance Hierarchy				
Program Consideration	**Option #1 On-Site Compliance**	**Option #2 Developer-Driven Off-Site Mitigation**	**Option #3 MS4-facilitated Off-Site Mitigation**	**Option #4 Payment In Lieu**
Program Motivation & Drivers		X	X	X
Who's Playing		X	X	X
Scale of Trading		X	X	X
Program Administration	X	X	X	X
Eligibility for Off-Site Compliance		X	X	X
Availability of Sites			X	X
Restriction (Kick-Outs)		X	X	X
Allowable Practices	X	X	X	X
Currency of Trade		X	X	X
Rate Setting and a Well-Functioning Market				X
Private Sector Involvement			X	X
Timing and Sequencing		X	X	X

3.1. Program Motivation & Drivers

When developing an off-site compliance program, an MS4 should ask questions that help identify potential issues at an early stage and direct further data-gathering needs.

These questions and considerations include the following examples:

- What local community interests, priorities, and resources should the program reflect? For instance, if the community is building a river corridor park or trail system to enhance water resources and spur economic activity, then at least some of the off-site compliance projects can be focused on river corridor projects. The local government may have a capital improvement program (CIP) with identified stormwater or drainage projects, and an off-site compliance program could provide partial funding (which would lead to Options #3 or 4 in the hierarchy in **Section 2**). Off-site compliance may be an important strategy to meet regulatory objectives, such as a local TMDL or Chesapeake Bay WIP.
- Does the locality have a downtown or intensively developed area where compliance is expected to be difficult and the locality wants to incentivize investment and redevelopment?

- Is the local development community expected to push for the off-site options in order to provide flexibility? What level of participation by the local government is anticipated? If a strong role is expected, Options #3 or 4 should be pursued. On the other hand, if there is motivation to keep things simple and put most of the onus on the developer to justify, find, build, and maintain off-site projects, then Option #2 may be the best fit.

3.2. Who's Playing?

A "basic" off-site compliance program would be administered solely by the MS4 and reside within the MS4 boundaries. However, this is not the only model that is available. Other parties, such as soil and water conservation districts (SWCDs), resource conservation and development councils (RC&Ds), neighboring jurisdictions or MS4s, and/or conservation groups, among other entities, may be able to play a constructive role.

One possible example might be for the local program to establish an environmental improvement fund using payment in lieu fees, and using the fund to award mini-grants to civic or conservation groups to implement reforestation or riparian restoration projects. Another example would be for the MS4 to team with the local soil and water conservation district to help identify and implement mitigation projects. There are many other ways that such partnerships could be applied. The key factor is that the players will influence the geographic scale of the program and can also assist in spreading the administrative burden. However, the MS4 should realize that it is responsible for the ultimate success of the installed practices, even if implemented or administered by other parties. In this regard, clear objectives and guidelines need to be established as well as verification and quality control procedures.

3.3. Scale of Trading

The General Permit establishes that off-site mitigation should be within the same "sewershed/watershed." However, the question remains as to how large these sewersheds or watersheds should or can be. For instance, the entire MS4 can be considered to be within a single watershed in some cases. In others, the MS4 may be divided into subunits of watersheds/sewersheds.

A watershed may rightfully extend beyond the MS4 boundary, but extending an off-site compliance program beyond the MS4 should be considered with care. Depending on program partners, the MS4 must confirm that the program will have authority to verify project design, proper installation, and long-term maintenance. The same goes for potential mitigation projects within the upstream 20 mile area authorized by state legislation for utilities. It may be that these issues can be addressed through cooperative agreements with program partners, and these should be established during program development.

Nevertheless, for payment in lieu programs, scale is a critical issue. If the "scale of the trade" is too small, it may be difficult to find suitable mitigation projects or accumulate adequate funds to undertake the proposed projects. If the scale is too large, mitigation dollars can leave the community or watershed where they are needed most (e.g., MS4 community or TMDL watershed).

3.4. Program Administration

Operating a local off-site mitigation or payment in lieu program requires the MS4 program and its partners to undertake basic tasks, including identifying and prioritizing sites, tracking runoff volume treated across sites, approving designs, inspecting sites, verifying performance through time, and tracking, and reporting. For the payment in lieu option (Option #4), program administration includes systems for collecting money, tracking on-site versus off-site compliance for development sites, and, of utmost importance, spending the available funds on eligible practices. One of the largest criticisms of these types of programs to date is that the program collects the fees but is slow to build the projects.

Several program administration considerations include:

- Ordinances/administrative provisions/program tools – Is there enabling authority to undertake this program; what local ordinances, policies, and administrative provisions must be adopted (see **Appendix B** for model off-site compliance ordinance language)? The MS4 should strongly consider the use of performance bonds, in addition to other compliance tools, as a means to ensure that off-site practices are installed correctly. This can also be a good general stormwater program tool for proper installation of both on-site and off-site practices. In addition, the MS4 General Permit specifically assigns responsibility to the MS4 for determining who will be responsible for long-term maintenance. In this regard, a recorded maintenance agreement for each project would be another important program tool. Maintenance agreements are addressed in the MS4 General Permit.
- Staffing – How many staff will it take to administer the program (e.g., plan reviewers, inspectors, program administrators)? What is the associated administrative cost? These costs would attend to the overall stormwater program and not just the off-site compliance component.
- Fund allocation (Payment in lieu Option #4) – Does the locality have a vehicle for receiving funds, administering the funds, prioritizing projects, allocating funds, and tracking and verifying that the funds are clearly connected to the established goals, objectives, and milestones?
- Program finances – Particularly if the MS4 will be involved with financing mitigation projects, the flow of funds should be considered. In some cases, the mitigation project(s) will need to be funded and constructed prior to volume

credits being offered to development sites (see Timing and Sequencing below). Programmatic and administrative funds must be available during the start-up phase. In addition, the program may consider instituting review or administrative fees to handle off-site mitigation applications; these fees may be in addition to the locality's regular plan review fees (if they exist).

3.5. Eligibility for Off-Site Compliance

As stated in the MS4 General Permit, off-site compliance is not an automatic option for all development and redevelopment sites. The technical justifications for the infeasibility of on-site management of all or a portion of the runoff reduction volume must be documented. This creates a somewhat subjective criterion for the local program. Considerations for eligibility may include geologic and topographic restrictions, whether the site is in an intensively developed area, and other site-specific conditions that make on-site practice installation infeasible (see **Table 1** for actual language in the MS4 General Permit pertaining to infeasibility; see **Appendix A** for a general off-site compliance application form and checklist).

The MS4 General Permit also establishes "trading ratios" for on-site versus off-site treatment. If infeasibility is demonstrated for the partial or full 1-inch runoff reduction volume, then the ratio is either 1.5:1 (for up to 0.6 inches of off-site treatment) or 2:1 (for 0.6 to the full 1-inch treated off-site). That means that treatment for 1-inch on-site can turn into a maximum of 1.7 inches off-site (see the calculation procedure on the application form in **Appendix A**). These ratios represent a margin of safety and also acknowledge that certain mitigation efforts (e.g., planting a riparian buffer) take time to fulfill their anticipated volume and/or pollutant load reduction functions.

Another consideration for eligibility may be the existence of local stormwater detention or flood control requirements. The local program must ensure that sites that utilize partial or full off-site compliance do not create public health or safety issues downstream by not providing any treatment on the site. A local "infeasibility" checklist should include these types of provisions.

3.6. Availability of Sites

To ensure that the "BMP marketplace" will function properly, the demand for off-site mitigation must be balanced with the supply of sites where this demand can be met. This will depend somewhat on the scale of the off-site mitigation or payment in lieu program and the types of practices authorized for off-site mitigation. The MS4 should develop a prioritized list of sites with planning level costs. This can be done through a retrofit inventory, watershed plan, stormwater master plan, or similar effort that includes field verification to determine site feasibility, practice size, and site constraints, among other factors. The identification of available sites can also be tied to ongoing municipal transportation and other capital improvement projects (for instance, parking projects greater than 5,000 square feet, as noted in the MS General Permit).

See **Appendix D** for guidance on prioritizing potential mitigation projects. The Center for Watershed Protection, *Urban Stormwater Retrofit Practices (Manual 3, Urban Subwatershed Restoration Manual Series, 2007)* is a good resource for conducting a stormwater retrofit inventory. The manual can be downloaded at:

http://www.cwp.org/store/free-downloads.html

or at WVDEP's website:

http://www.dep.wv.gov/WWE/Programs/stormwater/MS4/guidance/Pages/default.aspx

3.7. Restrictions (or Kick-Outs)

Certain criteria may constrain the use of an off-site compliance program in a particular location or watershed. These criteria can be regulatory, such as a TMDL watershed where off-site mitigation (outside of the TMDL area) could potentially lead to further water quality impairments. The criteria can also be based on site circumstances, such as degraded conditions downstream that would be worsened if stormwater is not fully managed on-site.

3. 8. Allowable Practices

A major program decision is the types of practices that are authorized as part of an off-site compliance program. Given that runoff volume is the currency of trade, what types of practices can be used for off-site projects? Some are obvious and directly related to the impact (e.g., runoff reduction BMPs in the West Virginia Stormwater Management & Design Guidance Manual). Other types of practices, such as reforestation and riparian and stream restoration, are known to have benefits, but these need to be quantified in order to establish equivalency with the unmet runoff reduction at the development site.

An MS4 may have an interest in keeping the list of allowable practices as broad as possible in order to provide flexibility for off-site project implementation. Desirable practices include those that meet multiple objectives, such as TMDL implementation, community recreational and aesthetic enhancements, revitalization of degraded areas, drinking water supply protection, and other local water resources goals. Examples of such practices may include stream restoration, reforestation, restoration of abandoned or degraded sites in conjunction with conservation easements, streambank erosion control, and rain gardens.

Appendices F and **G** provide methodologies for assigning this volume reduction value for reforestation and stream restoration projects, respectively. An MS4 will have to establish (and vet with WVDEP) a similar methodology for other practices it wishes to include in the off-site compliance program. It is very important that all included practices have a documented equivalency with the runoff reduction control standard.

3.9. Currency of Trade

The MS4 General Permit clearly established runoff volume as the "currency of trade," meaning that runoff volume is the metric used to compare unmet stormwater treatment on-site and stormwater treatment provided in the off-site project. As an alternative, the MS4 may wish to convert runoff volume into a dollar figure, using the data in **Appendix C** as a guide. In other words, the MS4 would calculate the dollar value associated with the unmet runoff reduction on-site based on an average rate to treat a cubic foot of water (see **Appendix C**). This approach would allow for a "dollars to dollars" trade instead of a "cubic foot to cubic foot" trade. Either approach is acceptable, as long as the basis of the calculation is runoff reduction (volume).

3.10. Rate Setting for Payment in Lieu Programs

The rate paid for unmet runoff reduction as part of a payment in lieu program sends an important signal to parties involved in the trade and is related to the allowable practices and the availability of sites. The rate must be a legitimate estimate of the cost to acquire land (if necessary), design, install, and maintain the off-site practice and administer the off-site compliance program. The rate is perhaps the most important element in ensuring the success of the program.

Payment in lieu programs can be unsuccessful for a variety of reasons, including: (1) inadequate fees are collected to implement the mitigation projects (leading to projects not being built in a timely manner, or at all), (2) fees are set so high that developers aren't interested and the program is underutilized, and (3) there are too few sites to satisfy demand, as discussed above. The feasibility study should at a minimum estimate what the rates may be and whether there will be a market for volume credits at that rate. It is also important that the rates be indexed for inflation of construction costs (e.g., as a specific element of rate schedules in the local code). See **Appendix C** for detailed guidance on the rate-setting procedure.

3.11. Private Sector Involvement

It may be advantageous to use public/private partnerships, such as private businesses and watershed or civic groups, to assist with setting up and operating an off-site compliance program. This type of arrangement is perhaps a good future model for West Virginia, if and when WVDEP develops some standards and oversight for such private sector enterprises. Private sector and/or civic group involvement can help leverage private investment, organizational skill, and volunteer energy and labor to create environmental benefits in the community.

As an example, some states authorize the use of wetland, stream, and/or nutrient banks to design, build, and maintain mitigation projects. The District of Columbia is currently envisioning a major private sector role through an open market for stormwater retention credits (SRCs), in which property owners buy and sell certified SRCs, with coordination and guidance from the District Department of the Environment (DDOE) to facilitate transactions. See **Appendix E** for an outline of existing off-site compliance programs, and whether private sector involvement is incorporated into the program.

Of course, the nature of the public/private partnership requires careful forethought and formalization through cooperative and cost-sharing agreements, memoranda of understanding, or similar instruments. The local program (perhaps with State involvement) needs to clearly establish the conditions under which private sector interests should participate in the program, and establish success criteria (ensuring the projects actually provide the required mitigation) and financial assurances (e.g., performance bonds). There may also be a role for watershed and civic groups to implement projects, such as riparian restoration, reforestation of degraded sites, tree planting, and other practices.

With most public/private partnerships, there will be some "basic" roles for the MS4, including:

- Approve the "infeasibility" of full on-site compliance.
- Vet public/private arrangements with WVDEP and appropriate State personnel.
- Review and approve plans for off-site mitigation projects.
- Establish performance standards or checklists for and verifying proper installation and maintenance.
- Track and report runoff volumes controlled on-site and off-site.

Private sector and/or civic and watershed groups may be best suited to:

- Identify potential mitigation sites.
- Coordinate between landowners and obtain property rights.
- Conduct or coordinate project design.
- Construct projects.
- Ensure long-term maintenance.

3.12. Timing and Sequencing

Timing and sequencing are major elements of program accountability. All hierarchy levels (except Option #1) require some consideration of when the off-site project is built compared to the new development or redevelopment site needing the runoff reduction credits. In the past, localities have pooled fees collected from multiple sites and implemented projects once sufficient funds are available (which may be long after the initial sites are developed).

In contrast, some existing programs require the "certification" of mitigation credits before they can be sold to a site needing them (see **Appendix E**). In other words, the off-site project must be constructed first. This may be infeasible or very difficult for local government operated programs due to the flow of capital funds. Other programs specify that the off-site project must be built within a specified timeframe (e.g., within 3 years of the fee payment or plan approval).

Careful consideration should be given to these timing and sequencing issues and whether the projects generating runoff reductions for trades will be implemented prior to, or within a specified period of, being offered to sites needing the credits. This, of course, will bear on program startup costs and financing strategies.

4. Steps to Build the Program

Table 6 provides a relatively brief and conceptual step-by-step process for developing and implementing an off-site compliance program. The sequencing of steps should not be taken too literally, as program development will likely involve some of these steps taking place concurrently or even in a different order than is shown in the table. Much of the information in the table references previous sections of this guidance, as well as the appendices.

Table 6. Outline of Steps Needed to Establish an Off-Site Mitigation/Payment In Lieu Program

Step	Brief Description
Step 1: Program Selection & Feasibility	MS4 should carefully consider which of the 4 program Options outlined in **Section 2** are appropriate for the local program. The MS4 should also consider the factors listed in **Section 3** of this guidance. Factors, such as the demand for and availability of off-site projects and administrative structure, inform the type of program that is feasible. The MS4 may choose to have stakeholder involvement at this point and develop a written plan. The MS4 can also consider when to implement off-site compliance; some may decide to undertake this as a program enhancement after several years of experience with the "basic" stormwater ordinance and program in accordance with the MS4 General Permit (Option #1).
Step 2: Ordinance & Policies	The MS4 must establish the regulatory framework in its stormwater and/or land development ordinances and associated policies. The "rules of the game" have to be established up-front. These would likely include: ▪ Ordinance enabling the specific off-site compliance approaches and the relevant "players" (see **Appendix B** for model language). This should include the means by which infeasibility and eligibility for off-site compliance are established. ▪ Method to verify property rights and maintenance for off-site projects (e.g., maintenance agreements, which are required in the MS4 General Permit). ▪ Authorization for MS4 inspectors to enter the property of off-site projects for the purposes of verification and inspection. ▪ Establishing performance bonds to verify proper installation of off-site practices (also a good tool for on-site practices). ▪ Establishing plan review fees. ▪ Establishing rates for payment in lieu programs. This may be through an ordinance or other rate-setting policy or program. The policy should consider indexing rates for inflation and periodically revisiting the rate based on actual experience with BMP construction and maintenance (see **Appendix C** for guidance on payment in lieu rates). Please note that this step may have to be deferred to later in the program planning process (see Step 5 below in this table).

Table 6. Outline of Steps Needed to Establish an Off-Site Mitigation/Payment In Lieu Program	
Step	**Brief Description**
Step 3: Administrative Structure	For an MS4, operating an off-site compliance program requires tracking and record-keeping. The administrative structure includes systems for collecting fees and allocating funds to eligible mitigation projects (for the payment in lieu option), tracking on-site versus off-site compliance for development sites, and program reporting.
Step 4: Identify Specific Projects & Costs	It is important for MS4-led programs (Options #3 and 4) to identify specific projects (and their planning level costs) that will be implemented through either off-site mitigation or payment in lieu programs. Even for Option #2, the MS4 General Permit states that the MS4 should "identify priority areas" for mitigation projects. Identifying priority areas and/or specific candidate mitigation projects can be done through stormwater retrofit inventories, watershed assessments, stormwater master plans, or other studies that should drill down to the project-site scale. See **Appendix D** for guidance on prioritizing candidate projects.
Step 5: Set the Rate for the Mitigation "Currency" (For Payment In Lieu Programs)	As described in **Section 3, t**he rate paid for unmet volume reduction requirements sends an important signal to parties involved in the trade. Setting the rate may be one of the most complicated elements of the program, especially in the initial stages when local experience with and data on mitigation practices may be in short supply. See **Appendix C** for guidance on setting an appropriate rate.
Step 6: Initiate the Program	Hopefully, Steps 1 through 5 will give the program the adequate regulatory, administrative, and technical structure to begin implementation. Implementation will involve activities associated with the overall stormwater program, such as plan review, inspections, verifying maintenance, enforcement, and tracking and reporting.
Step 7: Education, Training, Stakeholder Involvement	This is called out as a separate step due to its importance and the fact that it is sometimes overlooked once a program is up and running. Education can address the types of off-site mitigation projects and how they benefit the community. Stakeholders may like to be involved in decisions related to project prioritization and selection and even construction and maintenance.

Appendix A
Application for Off-site Compliance

NOTE TO MS4s: This is a sample form to standardize the application process for off-site compliance. The intention is that MS4s will customize the form based on local program needs and characteristics.

Please submit this application in conjunction with the appropriate review fee and a stormwater management concept plan that shows on-site and/or off-site conceptual Best Management Practices (BMPs).

I. Applicant Information		
1. Name:		
2. Primary contact:		3. Title:
4. Mailing address:		
5. City:	6. Zip code:	7. County:
8. Telephone number:		
9. Email:		

II. Site Information		
10. Mailing address:		
11. City:	12. Zip code:	13. County:
14. Driving directions:		
15. Property size (acres):		
16. Watershed/Sewershed (reference MS4 maps):		
17. Plan name/number (attach stormwater management concept plan that shows conceptual on-site and/or off-site BMPs:		

In order to be eligible for off-site compliance, the MS4 General Permit requires that the applicant document the *technical justification as to the infeasibility of on-site management.* Please complete the checklist below and provide additional information in order to provide this documentation.

III. Eligibility for Off-site Compliance: Documentation of Infeasibility of On-site Compliance

18. Check each eligibility criterion that applies to this site:

☐ Too small an area outside of the building footprint or through other site constraints to create large enough BMPs, even with soil amendments, extended filtration, or other measures outlined in the West Virginia Stormwater Management & Design Guidance Manual (attach graphic showing available area and explain below).

☐ Soil instability as documented by a thorough geotechnical analysis (attach geotechnical documentation).

☐ Soil contamination or other subsurface or geologic conditions that create risks or hazards for disturbance, excavation, and/or movement of water into the ground, even with the use of an underdrain (attach appropriate documentation and explain below).

☐ Site use that is inconsistent with capture and reuse of stormwater (explain below).

☐ Physical condition that precludes adequate use of plants and/or other practices outlined in the West Virginia Stormwater Management & Design Guidance Manual.

☐ Other significant site constraints (explain below).

☐ Please explain the condition of downstream receiving waters and whether local stormwater detention and/or flood control standards can be met on the development site.

IV. Water Volume Calculations

STEP 1: FULL 1-INCH TREATMENT VOLUME

1.A. Full 1-Inch Treatment Volume = Tv_{SITE} = (1" x Rv x SA)/12 = ________inches

Where: Rv = Unitless composite site runoff coefficient from Design Compliance Spreadsheet[1] or **Table 1** (for site being developed or redeveloped).

SA = Area of site (square feet)

STEP 2: VOLUME TO BE MANAGED **ON-SITE**

2.A. Rainfall Depth to be Managed **On-Site** = $RD_{ON\text{-}SITE}$ = ________inches

Where: $RD_{ON\text{-}SITE}$ = Rainfall depth to be managed on-site

2.B. Volume to be Managed **On-Site** = ($RD_{ON\text{-}SITE}$ x Rv x SA)/12 = ________cubic feet

NOTE: For 2.B, Rv should be the unitless runoff coefficient for the portion of the site draining to on-site BMP(s), which can be obtained from the individual drainage area tabs in the Design Compliance Spreadsheet or the formula in **Table 1.**

STEP 3: VOLUME TO BE MANAGED **OFF-SITE**

3.A. Rainfall Depth to be Managed **Off-Site** = $RD_{OFF\text{-}SITE}$ = 1.0 - $RD_{ON\text{-}SITE}$ = ________inches

Where: $RD_{OFF\text{-}SITE}$ = Rainfall depth to be managed off-site

3.B. Trading Ratio = TR = ________ (unitless value; see below)

If $RD_{OFF\text{-}SITE} <= 0.6$, TR = 1.5
If $RD_{OFF\text{-}SITE} > 0.6$, TR = $\{0.9 + [(RD_{OFF\text{-}SITE} – 0.6) \times 2]\} / RD_{OFF\text{-}SITE}$

3.C. Volume to be Managed **Off-Site** = (1.A. – 2.B.) x TR = ________cubic feet

Where: 1.A. = Tv_{SITE} from Step 1.A.
2.B. = Volume to be Managed On-Site from Step 2.B.
TR = Trading ratio from Step 3.B.

[1] See Chapter 3 of the West Virginia Stormwater Management & Design Guidance Manual for documentation of the method. The Design Compliance Spreadsheet can be downloaded at: http://www.dep.wv.gov/WWE/Programs/stormwater/MS4/permits/Pages/ToolsandGuidance.aspx

Table 1. Calculation for Composite Site Runoff Coefficient (can also be done in the Design Compliance Spreadsheet)

$Rv_{SITE} = Rv_I \times \%I + Rv_T \times \%T + Rv_F \times \%F$

Where :

Rv_{SITE}	=	Composite Runoff Coefficient for the Site being developed or redeveloped
Rv_I	=	Volumetric Runoff Coefficient for impervious cover (unitless) = 0.95
$\%I$	=	Percent of site in impervious cover (fraction)
Rv_T	=	Volumetric Runoff Coefficient for turf cover or disturbed soils (unitless; see **Table below**)
$\%T$	=	Percent of site in turf cover (fraction)
Rv_F	=	Volumetric Runoff Coefficient for forest cover (unitless; see **Table below**)
$\%F$	=	Percent of site in forest cover (fraction)

For Step 2.B, Rv_{SITE} should be replaced with Rv_{BMP}, which is the same formula, but only for the portion of the site draining to on-site BMPs. This can be obtained from the individual drainage area tabs in the Design Compliance Spreadsheet.

Site Cover Volumetric Runoff Coefficients (Rv)

Land Cover	**Hydrologic Soil Group**			
	A	**B**	**C**	**D**
Forest Cover	.02	.03	.04	.05
Disturbed Soil/ Managed Turf	.15	.20	.22	.25
Impervious Cover	.95	.95	.95	.95

V. Type of Off-site Compliance		
19. Type of off-site compliance:	☐ Off-site mitigation	☐ Payment in lieu

VI. Off-site Mitigation (Only complete if off-site mitigation is chosen in Section V)
20. Please describe the off-site mitigation site and type(s) of practice(s) (the application must also include a stormwater management concept plan showing off-site BMP conceptual designs):
21. Describe property rights obtained (or that will be obtained) in order to use the off-site location:

VII. Payment in lieu (Only complete if payment in lieu is chosen in Section V)
22. Fee amount (See Section IV and multiply off-site volume by appropriate rate or fee established by the MS4):

VIII. Off-site Compliance Determination (to be completed by Stormwater Authority)	
23. Select one of the off-site compliance determinations. ☐ Off-site compliance ***approved*** based on documentation of infeasibility of full on-site compliance and stormwater management concept plan provided in this application. ☐ Off-site compliance ***approved with conditions*** (list conditions to the right). ☐ ***Further documentation needed*** before a decision can be made (list documentation to the right). ☐ Off-site compliance ***NOT approved*** (list reasons to the right).	

IX. Next Steps

24. After approval, the applicant must complete the following steps:

<u>If off-site mitigation has been approved:</u>

☐ Submit final stormwater management plan for on-site and off-site BMPs

☐ Obtain any outstanding property rights

☐ Submit and record maintenance agreement

☐ Calculate and post performance bond for BMPs

<u>If payment in lieu has been approved:</u>

☐ Pay the fee for the payment in lieu option

Appendix B

Model Ordinance for Off-Site Compliance

NOTE to MS4s: This model language is intended to be plugged into a broader stormwater management ordinance that addresses all aspects of stormwater management for new development and redevelopment projects (in other words, not just off-site compliance). Therefore, some sections of the model ordinance below may be duplicative of the broader ordinance (e.g., procedures for plan review, inspections, maintenance, performance bonds, etc.) In these cases, the off-site compliance section can simply reference the appropriate section of the broader ordinance.

Off-site compliance for stormwater management

1. Every Applicant shall install or construct measures that keep and manage on-site the first one inch of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation as described in the GP unless off-site compliance is approved by [Stormwater Authority].

2. [Stormwater Authority] may not waive the minimum requirements for stormwater management of water quality protection.

3. The application for off-site compliance for stormwater management must include:
    a. A review fee in the amount of [$X] for review of the off-site compliance application
    b. Stormwater management concept plan
    c. Applicant information
    d. Site information
    e. Documentation of infeasibility of on-site compliance
    f. Water volume calculations using the Runoff Reduction Method and procedures established in the West Virginia Stormwater Management & Design Guidance Manual, or other equivalent method pre-approved by [Stormwater Authority].
    g. Type of off-site compliance sought

4. In order to be eligible for off-site compliance, the Applicant must demonstrate to the satisfaction of [Stormwater Authority] that off-site compliance will not result in any of the following impacts to downstream waterways:
    a. Deterioration of existing culverts, bridges, dams, or other structures;
    b. Degradation of biological functions or habitat;
    c. Accelerated stream bank or streambed erosion; or
    d. Increased threat to public health or safety, life, property, or the environment.

5. Where off-site compliance is approved, the Applicant shall satisfy stormwater management requirements by accomplishing an approved Off-Site Mitigation project or opting in to the Payment-in-Lieu program.

6. Off-site mitigation projects must meet the following conditions:
    a. The off-site mitigation project must be located in the same [sewershed/watershed] as the original project, as approved by [Stormwater Authority].
    b. [Stormwater Authority] shall, at its discretion, identify priority areas within the [sewershed/watershed] in which off-site mitigation projects can be completed.
    c. Off-site mitigation must be for retrofit or redevelopment projects, and cannot be applied to new development.
    d. In all cases, land rights, access agreements or easements, and a maintenance agreement and plan shall be provided to ensure long-term maintenance of any off-site mitigation project prior to approval of the off-site mitigation proposal.
    e. Installation of the off-site mitigation project shall be completed: (a) within three (3) years from the date that the stormwater management design plan is approved, or (b) prior to full completion of the new development or redevelopment project related to the off-site mitigation project, whichever of (a) or (b) is earlier.

NOTE to MS4s: Section 7 is one model for ensuring that off-site mitigation projects are held to the same requirements as on-site projects. Using this approach, the new off-site ordinance simply references the appropriate sections of the broader ordinance.

7. All requirements in Sections [list sections] for on-site stormwater management shall also apply to off-site mitigation projects. These requirements include but are not limited to a stormwater management design plan, inspections, maintenance, and performance bonds.

NOTE to MS4s: Sections 8 and 9 are alternative models, in which the requirements related to inspections (Section 8) and maintenance (Section 9) of off-site mitigation projects are provided in more detail.

8. [Stormwater Authority] shall inspect all off-site mitigation projects to ensure that they are properly installed to manage the required volume of stormwater.
    a. The applicant shall grant [Stormwater Authority] the right to enter the property of the off-site project for the purposes of making inspections and ensuring compliance with this Section.

b. The applicant must notify [Stormwater Authority] before the commencement of construction. In addition, the applicant must notify [Stormwater Authority] in advance of construction of critical components of the stormwater practices on the approved stormwater management design plan. [Stormwater Authority] may, at its discretion issue verbal or written authorization to proceed with critical construction steps, such as installation of permanent stormwater practices based on stabilization of the drainage area and other factors.
c. [Stormwater Authority] or its representatives shall conduct periodic inspections of the stormwater practices shown on the approved stormwater management design plan, and especially during critical installation and stabilization steps. All inspections shall be documented in writing. The inspection shall document any variations or discrepancies from the approved plan, and the resolution of such issues. Additional information regarding inspections can be found in Section [X]. A final inspection by [Stormwater Authority] is required before any performance bond or guarantee, or portion thereof, shall be released.
d. At its discretion, [Stormwater Authority] may authorize the use of private inspectors to conduct and document inspections during construction. Such private inspectors shall submit all inspection documentation in writing to [Stormwater Authority]. All costs and fees associated with the use of private inspectors shall be the responsibility of the applicant.
    i. If the use of private inspectors in authorized, [Stormwater Authority] shall, at its discretion, maintain a training and certification program, or authorize another entity to maintain such a program. If such a certification program exists, all private inspectors shall be certified prior to conducting any inspections or submitting any inspection documentation to [Stormwater Authority].
    ii. If private inspectors are utilized, then inspections by [Stormwater Authority] or its representatives, as provided in Section [X], may be reduced in frequency. However, [Stormwater Authority] shall remain the responsible entity for ultimate inspection, approval, and acceptance of all stormwater BMPs, and for issuance of the Certificate of Completion in accordance with Section [X].
e. The applicant shall prepare an as-built plan for all off-site projects. The plan must show the final design specifications, materials, and elevations for all stormwater management facilities and clearly show deviations from the approved stormwater management design plan. The as-built shall be sealed by a registered professional engineer or other design professional approved by [Stormwater Authority].
f. Subsequent to final installation and stabilization of all stormwater BMPs shown on the stormwater management design plan, submission of all necessary as-built plans, and final inspection and approval by [Stormwater Authority], [Stormwater Authority] shall issue a Stormwater Certificate of Completion for the project. In issuing such a certificate, [Stormwater Authority] shall determine that all work has been satisfactorily completed in conformance with this Ordinance.

9. The [Stormwater Authority OR Applicant OR Other Responsible Party] shall be responsible for long-term maintenance of off-site mitigation projects. All stormwater BMPs shall be maintained in accordance with the approved and deeded stormwater maintenance agreement and stormwater maintenance plan. The design of stormwater facilities shall incorporate maintenance accommodation and access and long-term maintenance reduction features.

10. Payment-in-Lieu Contribution for Off-Site Projects:
    a. Payment-in-lieu contributions to the public stormwater project fund established by [Stormwater Authority] shall be [at a rate of $X per cubic foot, as amended from time to time by [Stormwater Authority] to account for inflation and actual costs for similar projects OR approximately equal to the cost of stormwater management OR other].
    b. [Stormwater Authority] shall maintain a publicly accessible database of payment-in-lieu contributions and projects funded by payment-in-lieu contributions.

Appendix C

BMP Costs & Setting A Payment-In-Lieu Fee

C.1. Contents and Purpose of This Appendix

For an MS4 wishing to develop an off-site mitigation program, setting proper payment-in-lieu fees may be one of the more complicated and important decisions to be made. In order to do this successfully during the program planning stage, it is necessary for the MS4 to get a good handle on the true costs of the BMPs that will make up the mitigation "portfolio." However, the costs to design, construct, and maintain various stormwater BMP are notoriously variable and dependent on local factors. Cost estimates from the literature are spotty and tend to measure different cost factors for different locations and projects. For instance, some cost estimates address only construction, while others consider design and maintenance, as well as program administrative costs (e.g., plan review and inspection time). Some cost estimates are based on actual projects, while others are modeled figures from literature searches and best professional judgment. Finally, real BMP costs are dependent on temporal market conditions, the costs of materials and labor, and other factors that tend to vary through time.

While there are challenges to establishing "true" BMP costs, it is important for MS4s planning to establish an off-site mitigation program to tackle the cost issue. This is particularly true for programs that want to incorporate a payment-in-lieu component; BMP costs are an important element to setting an equitable fee structure, and also one that can genuinely cover BMP implementation projects.

An addendum at the back of this appendix outlines some of the basic economic principles of establishing real costs (e.g., present value, inflation, discount rates) for BMP projects.

C.2. Methods to Establish a Payment-In-Lieu Fee

There are no widely-accepted means to set a payment-in-lieu fee. However, there are several approaches that an MS4 can consider:

1. <u>Select a "Typical" BMP On Which to Base Payment-in-Lieu Fees:</u>

This approach is fairly straight-forward and has been proposed by some states in the Chesapeake Bay Watershed (CWP, 2011). A typical BMP should be one that is anticipated by the MS4 and/or state to be used widely to comply with the MS4 General Permit standards, and for which cost and implementation data are available. Bioretention is by far the BMP of choice for this exercise, based on its suitability for a wide variety of sites and ability to meet the runoff reduction performance standard. With this approach, establishing typical costs to implement bioretention are used to set the payment-in-lieu fee as a proxy for implementing a variety of off-site mitigation projects (at least those included in the MS4's off-site program). While actual costs to implement other BMPs may be higher or lower, it is assumed that a fee based on bioretention will split the difference and be a fair and equitable method. The bulk of this appendix focuses on this fee-setting method.

2. Set The Fee Based on a Pre-Established Portfolio of Off-Site Mitigation Projects:

In some cases, the MS4 may have conducted an inventory of specific candidate projects to be used for the off-site mitigation program (see **Appendix D** for guidance on prioritizing candidate projects). If this is the case, and project information, such as drainage area and BMP size, are known, then the MS4 can forecast composite costs to implement the priority projects. **It is important that the MS4 consider the full range of implementation costs outlined in this appendix in order to set a fee that will allow for full cost recovery.**

Two tools may be helpful for this second approach:

A. Some studies have established costs for a variety of BMPs. Most recently, King and Hagen (2011) analyzed and compiled costs for BMPs in Maryland that support implementation of the Chesapeake Bay TMDL. **Table C.4** at the very end of this appendix is a compilation of planning-level BMP costs from King and Hagen, as well as additional research from the Center for Watershed Protection. For the purposes of this guidance, all costs have been converted to dollars per cubic foot treated, since volume is the compliance metric in West Virginia. Please note that costs in King and Hagen were originally reported as dollar per impervious acre treated. Also, it is important to note that these represent planning-level costs for typical situations, and a variety of local and/or market conditions would adjust the costs up or down.

B. The Water Environment Research Foundation (WERF) developed *BMP and LID Whole Life Cycle Cost Models* (WERF, 2009). These consist of a series of detailed spreadsheets to calculate costs for a wide range of BMPs. Version 2.0 updates the original 2005 models with several LID-type of practices, including green roofs, commercial cisterns, residential rain gardens, bioretention, and planter vault. The intent of the spreadsheet models is to derive whole life cycle costs, including fifty years of operation and maintenance. There are individual tabs for design and maintenance options, capital costs, whole life cycle costs, present value, and design.

   The spreadsheets include two ways to calculate costs:

   (1) Using design assumptions based on basic inputs (e.g., drainage area, system size) using unit costs from RS Means and literature review ("parametric cost")
   (2) User-defined costs based on multiple unit cost inputs for a site-specific application.

   The WERF tool can be downloaded at:

   http://www.werf.org/i/a/K/Search/ResearchProfile.aspx?ReportId=SW2R08

As stated, the remainder of this appendix addresses method #1, using the "typical" BMP of bioretention. Much of this information comes directly from a senior seminar in environmental economics at Virginia Tech during the spring semester of 2012, directed by Dr. Kurt Stephenson, Professor of Agricultural and Applied Economics.[1]

C.3. Using Bioretention as the "Typical" BMP to Set The Payment-In-Lieu Fee

The objective of this analysis is to provide procedures and estimates for estimating the costs of designing, constructing, and maintaining offsite mitigation projects for local government stormwater payment-in-lieu fee programs in West Virginia. The following assumptions apply to this approach:

- The MS4 is using the information for the payment-in-lieu option, as established in the MS4 General Permit. In this regard, the MS4 is responsible for collecting a fee for unmet stormwater on development sites and applying the funds to "offsetting" projects.
- Bioretention Level 2, as defined in Specification 4.2.3 of the West Virginia Stormwater and Design Guidance Manual (WVDEP, 2012; hereafter referred to as the "WV Manual") is the "typical" BMP for establishing the payment-in-lieu fee.
- The bioretention projects will largely be retrofits on prior developed land.

C.3.1. Representative Bioretention Retrofit Offset Projects

For the purposes of this approach, the "typical" BMP consists of a bioretention retrofit project for an urban site with a one acre contributing drainage area (CDA). The CDA is assumed to be 70% impervious surface and 30% managed turf (Class C Soils). According to the Center for Watershed Protection's MS4 Stormwater Compliance Spreadsheet, a site of these characteristics produces 2,654 cubic feet of runoff in a 1'' storm event.

Assuming a one foot ponding depth, bioretention sizing standards from the WV Manual specify that the above ground storage of a bioretention area capture at least 70% of the total runoff volume. Thus, this representative one acre site requires a roughly 2,000 square foot bioretention area. A bioretention area of this size, which is 4.5% of the one acre CDA, coincides with the rule of thumb that the footprint of a properly designed bioretention area should be 3 to 7% of the size of the CDA. These above ground storage standards are designed to prevent excess stormwater from overflowing the bioretention area before filtering down into the soil

[1] Information derived from the paper: "In-Lieu Fee Proposal for Off-Site Stormwater Management in West Virginia, Prepared for the Center for Watershed Protection," by Jarrad Farris, Mennen Middlebrooks, and Zizi Agabani

media. Consult the Center for Watershed Protection bioretention sizing guide for a full explanation of BMP bioretention sizing criteria (CWP, 2012).

C.3.2. Costs of Implementing Bioretention in Retrofit Situations

Costs must be initially estimated because the municipal programs considering an in lieu fee program have very limited existing cost information on, or experience with, constructing bioretention areas. Given this lack of existing knowledge and since fees will be collected in advance of bioretention construction, considerable uncertainty confounds an in-lieu fee estimate. Municipalities must charge a high enough fee to cover the full cost of mitigating the stormwater impact while remaining fair to the developer. When setting a fee, municipalities must account for cost variability due to specific site characteristics as well as future inflationary pressures. The ideal fee estimate should reflect the typical costs of implementing the on-site accepted Best Management Practices (BMPs) for bioretention retrofits and include such factors as:

- Design and engineering costs
- Land costs (including the opportunity cost of land, or the foregone opportunity to use the land for another purpose)
- Construction costs
- Overhead costs
- Long-term operation and maintenance (O&M) costs (which may include replacement costs)

C.3.3. What's Included in Each Category of Costs?

Design and Engineering

This category includes the costs for all the design and engineering work required in the planning stages of a retrofit. Details of the depth of bioretention drainage area, total ponding area required, land grading to be done, and plant materials to be installed are all included in initial bioretention designs. These serve as project documents used by the installer of the bioretention area, and should be as detailed as possible for proper installation. During the design and engineering of a site, much consideration is given to the attributes of the existing land where the retrofit is to be installed. Design and engineering costs are directly associated with the intensity of the project site. Therefore, designers and engineers who produce more complicated bioretention plans (e.g., tricky grading, utilities, retaining walls, etc.) will most likely require higher design costs than those that develop less complex ones.

Land

Land costs are best defined as the opportunity cost (i.e. the value of the next best alternative foregone) of the land when constructing a retrofit site. Since a bioretention project utilizes land that could be used for additional parking, equipment storage, future building, and other alternative uses, construction of a bioretention project results in a forgone use on that land. In urban retrofit situations where land is scarce, the opportunity cost of land may be high and the installation of bioretention areas should be justified by comparing the project against the next best use of the land.

Construction

Materials, equipment usage, and labor comprise the three main components of construction costs for a bioretention site. Crushed stone (usually "57" stone), hardwood mulch, topsoil, sand, turf, and plant material are all used in varying amounts in a bioretention retrofit. Retrofits can also include additional costs, such as utility relocation, pavement demolition or replacement, and other costs associated with working on prior-developed land. Developers of bioretention sites should seek to establish a source of both materials and skilled labor for the installation of bioretention projects.

Overhead

Construction overhead is commonly overlooked in the development of bioretention sites, but is a crucial cost that must be recognized and accounted for in order for a project to be successful. This category of costs encompasses all the more general costs necessary for the success of the program that are not immediately assigned to a specific project. Thus, overhead costs may include program administration, project management, site inspections, building and administrative overhead, equipment acquisition and maintenance, interest on loans, accounting fees, insurances, and taxes (Rodriguez, 2012).

Long-term operation and maintenance

Periodic maintenance helps prevent issues such as odor, insects, weeds, trash, and plant overgrowth from interfering with bioretention function. In most cases, the lifetime of the site will exceed 25 years, making annual operation and maintenance costs an important factor to consider when developing a fee. Maintenance tasks for most bioretention areas include: Pruning shrubs and trees (0-2 times/year), monthly or seasonal weeding, re-mulching (1-2 times per year), shrub replacement (0-1 times over life of bioretention area), sediment accumulation removal (1-2 times over the initial life of practice), and underdrain inspection (1 time per year) (Wossink and Hunt 2003). Operation and maintenance costs can be expected to increase with the size of the bioretention area.

C.3.4. Bioretention Retrofit Cost Estimation

Construction Costs Estimates

A review of available literature on bioretention retrofit cost estimation shows significant variability. Of the categories of costs, base construction costs are the most widely estimated, with other categories of costs often based on a percentage of construction costs. A 2007 report to the EPA on stormwater retrofit practices derived updated estimates of bioretention retrofit base construction cost by reviewing existing literature (Schueler et. al.). The report relies heavily on three studies (Brown & Schueler 1997, Wossink & Hunt 2003, and Hoyt 2007). Brown & Schueler (1997) and Wossink and Hunt (2003) originally estimated the cost of bioretention in new situations, but converted bioretention retrofit situations by applying a cost escalation factor of 1.5. No indication of the source of this factor is given. Hoyt (2007) analyzed actual costs from 18 bioretention retrofit projects.

Updated to 2011 dollars based on the Producer Price Index for construction (PPI), Schueler et al. (2007) cost estimates range from $8.47 to $45.18 per cubic foot of water treated for retrofits (see Appendix for explanation on converting nominal costs to real costs). Some of the variability in cost stems from economies of scale in bioretention construction in larger sites. The report found the median base construction cost at relatively large sites (updated to 2011 dollars) to be $11.86 while the median at relatively small sites was $33.89.

Small retrofit sites were generally defined as those serving less than half an acre of contributing drainage area (CDA) with connection to a storm drain system (generally, commercial or institutional applications). These sites were distinguished from simple, residential rain gardens, which can be similar to small bioretention sites, but may not include all of the design or engineering features. Large sites were defined as serving more than half an acre of CDA and having an underdrain and bottom liner.

Even when holding size constant, bioretention retrofit construction costs were found to be highly variable due in part to differences in design objectives, complexity, and site conditions (Schueler et al., 2007). Table C.1 summarizes the range of estimated construction costs for various size bioretention retrofits. Even these ranges should not be accepted without scrutiny, as Schueler et. al. emphasizes that “retrofit costs can be extremely variable, and actual costs for individual retrofit projects can significantly exceed the range shown, depending on site conditions" (Schueler et. al. 2007, Appendix E, page #E-4).

	Table C.1. Schueler et. al. Base Construction Cost Estimates (expressed in 2011 dollars per cubic foot treated)		
	Low Bound	High Bound	Median
Relatively Large Bioretention Retrofit	$8.47	$19.48	$11.86
Relatively Small Bioretention Retrofit	$28.24	$45.18	$33.89

A recent, 2011 report by King and Hagen of the University of Maryland Center for Environmental Science also provides updated estimates of bioretention retrofit construction costs by combining a literature review with interviews with municipal stormwater experts. The Maryland-based construction estimate, which was reported in 2011 dollars per impervious acre treated, was converted to 2011 dollars per cubic foot of water treated based on the one acre representative site outlined in the previous section.2 The converted King and Hagen estimate for base construction costs of a bioretention retrofit in Maryland is $34.62 per cubic foot of runoff (2011$).

Other Cost Category Estimates

Even with the large variability in construction cost estimation, even less is known about the other categories of costs. Most studies do not directly estimate the other categories of bioretention costs; instead, these costs are typically expressed as a percentage of construction costs. While this method gives general estimates, it should be emphasized that little is known about the validity of these estimates. Analyses of available cost estimates for each category are expressed in the subsections that follow.

Engineering and Design Costs

King and Hagen, who define pre-construction costs as including, but not limited to, the "cost of site discovery, surveying, design, planning, and permitting," estimate that pre-construction costs amount to roughly 40% of bioretention retrofit construction costs. Their converted pre-construction cost estimate, which is based on the study's estimated base construction cost, is

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[2] Using the WV Design Compliance Spreadsheet, the one acre representative site has a runoff volume of 2,654 cubic feet in a one inch rainfall event. An approximate conversion to 2011 dollars per cubic foot of water treated was derived by multiplying the King Hagen 2011 dollars per impervious acre treated estimate by 70% and dividing by the runoff volume. Unless noted, other cost estimates given in dollars per impervious acre treated were converted using this same method.

$13.85 per cubic foot of water treated (2011). Schueler et al. estimate design and engineering costs for bioretention retrofits as 32% of construction costs (2007).

Land Costs

Given the large variability in the opportunity costs of land due to differences in site design characteristics (e.g. the degree of displacement by the bioretention area), land use (e.g. commercially developable land, non-developable land, etc.), and regional land prices, land costs are often ignored by cost estimation studies. If included, the study is likely to generate multiple estimates based on example scenarios or assume a set cost from a typical situation. King and Hagen incorporate a land cost estimate for Maryland by assuming that the opportunity cost for developable land is $100,000 per acre and that 50% of bioretention projects will take place on non-developable land. Thus, they assume that the opportunity cost of land is $50,000 per acre. Given that bioretention areas generally take up just 5-7% of the contributing drainage area, this brings King and Hagen's estimated land cost to $3,000 per acre. Keeping in mind that these general assumptions were made specifically for Maryland, the converted King and Hagen is $1.13 per cubic foot of water treated[3] (2011). Wossink and Hunt (2003) estimate opportunity costs of land based on undeveloped land for commercial use, undeveloped land for residential use, and undeveloped land required to be kept as open space in North Carolina. The study's converted cost estimates for these three scenarios are $6.96 per cubic foot of water treated, $1.60 per cubic foot of water treated, and $0 per cubic foot of water treated respectively (Wossink and Hunt 2003). These land cost estimates may not be representative of the situation of West Virginia and municipalities should incorporate land costs based on land prices in the project county.

Overhead Costs

A review of available literature on bioretention cost estimation found no estimates on the overhead costs of a bioretention area. Studies may incorporate these costs into other categories or ignore them altogether. In order to accurately set an in-lieu fee, however, municipal government officials should attempt to estimate the annual costs of overseeing a bioretention project.

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[3] Converted by dividing the opportunity cost of land used by the bioretention area by the volume of runoff from the one acre representative site. Other land costs were converted in the same manner.

Operation and Maintenance Costs

The EPA estimates operation and maintenance costs for bioretention areas to be 5%-7% of construction costs per year (1999). More recent reports (such as Weiss and Gulliver 2005) recycle this estimate. The original source of the EPA estimate is based on a 1991 report by the Southeastern Wisconsin Regional Planning Commission (SWRPC) and assumes that operation and maintenance for a bioretention project is the same as a swales project (EPA 1999). King and Hagen (2011) estimate the annual operation and maintenance costs for a bioretention retrofit to be $1,531 per impervious acre treated per year. Converted from dollars per impervious acres treated, this becomes approximately $0.40 per cubic foot per year. Should an annual estimate be incorporated by a municipality in setting an in-lieu fee, refer to the addendum to this appendix for an explanation of how to calculate the present value of a stream of annual costs. Wossink and Hunt's converted estimate for the present value of 20 years of operation and maintenance costs is $4,856.53 per acre of watershed treated or $1.83 per cubic foot of water treated (2001).

It should be noted that, while 20 years is often used to calculate the present value of operation and maintenance costs, it is likely that maintenance will extend beyond this timeframe, and, in some cases, may also include full replacement of the practice.

C.3.5. Setting a Payment-In-Lieu Fee

Given the cost variability and uncertainty of bioretention retrofit projects expressed in the previous sections of this report, the challenges faced by the MS4 in setting a fee should be clear. If the fee is set too low then there will not be enough collected funds for full implementation of stormwater off-site projects without the use of supplemental public funding, thus subsidizing the developer. If the fee is set too high, then undue burden is placed on developers, and this may discourage participation in the program or possibly development of certain sites with limited on-site opportunities.

Table C.2 lists bioretention implementation costs from a variety of the most up-to-date sources as well as sources most relevant to West Virginia, including data from four bioretention projects in Beckley.

Based on the available information in Table C.2 and the preceding sections of this appendix, it seems that a plausible range for a fee would be between $25 and $60 per cubic foot treated with the present value of 20 years of operation and maintenance costs included.4 Beckley site #3 is a possible outlier at over $100 per cubic foot. This project is a highly-urban, small project with concrete retaining walls. If likely off-site mitigation projects are of this nature, a higher fee should be considered.

It should be noted that these are approximate ranges generated for reference and actual costs may be above or below them. It should be noted that some fees do not include annual operation and maintenance costs. This approach is not recommended, and, if used, the local program must develop an alternative plan to pay for these expenses. In some cases, local governments may wish to leave the responsibility for operation and maintenance costs with the landowner. However, this opens up risks that maintenance will not be conducted and the local program would have to expend resources to compel maintenance.

Before setting a fee, West Virginia MS4 officials considering a payment-in-lieu fee program should supplement the general findings outlined in this report with interviews and recommendations with engineers and stormwater experts, along with local examples. Depending on the program characteristics, MS4s may also want to consider:

- Adding overhead costs to the values in **Table C.2** (some organizations use an estimate of 20 to 30% of project costs for overhead; adding overhead of 20% of project costs would result in an approximate range of $30 to $75 per cubic foot treated).
- Extending the operation and maintenance timeframe beyond 20 years.
- Including full replacement costs, depending on the type of practice.

While the bullet points above are valid, there is a balance between having a fee that anticipates every possible contingency and one that is fair and reasonable and that is not out-of-reach for the majority of sites.

[4] In addition to the data in **Table C.2,** the following were used to guide the estimate: the low range of this estimate was approximated using the following ballpark costs (expressed in dollars per cubic foot of water treated): $10 base construction cost, $3.50 pre-construction cost, $1 land cost, $0.50 overhead cost, and the present value of $0.40 annual operation and maintenance costs for 20 years. This results in a fee of $21.50 per cubic foot, rounded up based on the examples in **Table C.2.** The high range was ball-parked using $35 base construction costs, $14 pre-construction costs, $1.50 land costs, $0.50 overhead costs, and 20 years of $0.50 operation and maintenance costs.

Table C.2. Summary of Cost Data for Bioretention from Recent Sources							
Study or Source	**Source of Data, Geographic Location**	**Construction Cost; per cubic foot**	**Design; per cubic foot**	**Land**	**20 Years Operation & Maintenance (O&M); per cubic foot[4]**	**Total 20 Year Cost; per cubic foot[5]**	**Average Annual Cost over 20 Years; per cubic foot**
King & Hagan (2011): new, suburban	MD, literature, WERF model (2009)	$10.87	$2.72	$0.61	$8.88	$23.08	$1.15
King & Hagan (2011): retrofit, urban	MD, literature, WERF model (2009)	$38.05	$15.22	$0.61	$8.88	$62.76	$3.14
CWP (2011)	VA, NC, DE + literature	$ 15.00	No unit cost ; apply per project	Not included	$7.60	$23.00	$1.15
Beckley #1 (2011)	WV	$4.98	$1.59[1]	Not included	WERF[2]	$10.07[3]	$0.50
Beckley #2 (2011)	WV, urban (concrete + grading)	$39.87	$12.76[1]	Not included	WERF[2]	$59.61[3]	$2.98
Beckley #3 (2011)	WV, urban (concrete box)	$53.51	$17.12[1]	Not included	WERF[2]	$101.90[3]	$5.10
Beckley #4 (2011)	WV	$6.05	$1.94[1]	Not included	WERF[2]	$26.68[3]	$1.33

[1] All Beckley sites were designed in-house, so there are no identified design and pre-construction costs. The figures listed are based on an assumed 32% of construction cost (Schueler et al., 2007).

[2] Long-term maintenance costs for Beckley sites were derived using the WERF model for "curb-contained bioretention" (2009) to include routine and corrective/infrequent maintenance costs based on assumed "medium" level of maintenance. Beckley does have some routine annual maintenance cost data, but the WERF model was used to anticipate future costs and corrective actions.

[3] Total life-cycle costs for Beckley sites were derived from the WERF model for "curb-contained bioretention" (2009) using the actual construction costs reported by the City of Beckley.

[4] For the King & Hagan (2011) numbers, the authors of that report assumed that an annual discount rate of 3% (reduced value of the same amount of money spent in the future – see Addendum) would be "washed out" by an annual increase of maintenance costs of 3%. As a result, there is no annual inflation built into these 20 year estimates. This does not match the methodology presented in this Appendix, which recommends a real discount rate of 2.1% based on Office of Management and Budget guidance.

[5] Total 20 year cost estimates may not include all pre-construction (e.g., plan review, inspections, admin.) and ongoing administrative/programmatic costs, so should be considered baseline estimates.

C.3.6. Private Sector Involvement to Ascertain Costs

As with existing wetland and stream mitigation banks, there can be a role for the private sector and use of public/private partnerships for off-site mitigation programs. This may help establish the correct "price points" for various stormwater and watershed practices used as part of the mitigation program. Putting projects out to bid and/or having the private sector conduct some of the design, construction oversight, and maintenance tasks would allow MS4s to know the actual dollar figures of doing these tasks. Costs would likely vary over time as both public and private professionals and materials vendors become accustomed to designing and building the practices. The choice to involve private sector partners rests with the local program and its existing capabilities.

Addendum to Appendix C: Economic Principles of Establishing "Real" BMP Costs

Estimating the Construction Inflation Rate

Addendum C.1. Introduction

In general terms, inflation is the increase in the overall level of prices over time. With inflation, the general purchasing power of the dollar diminishes over time. Thus a dollar (called nominal dollar) in 2003 will purchase fewer goods and services than a dollar in 2012 (dollars expressed as they occur in a particular year are called "nominal" dollars). Removing the influence of inflation requires accounting accurately for costs over time.

Addendum C.2. Measuring Inflation

Inflation rates are measured through the use of a price index. A price index simply expresses the ratio of the price of a fixed bundle of goods over time. A price index is defined as:

$$\text{Price Index}_{(\text{base})} = \frac{\text{Price of the market basket in a given year}}{\text{Price of the same basket in the base year}} \times 100$$

The "market basket" of goods is total dollar value required to purchase a fixed quantity of goods or services. Note that if there were not change in the overall basket of goods from year to year there would be no inflation and the price index would be 100 every year. If the price index goes up over time this is called, by definition, inflation. If the index goes down over time, this is called deflation

There a multitude of different price indices, each distinguished by the type of goods and services included in the fixed market basket. The most widely cited index is the Consumer Price Index (CPI) which includes a diverse bundle of goods and services bought by consumers (housing, food, energy, transportation, medical services, etc). The Producer Price Index (PPI) includes a bundle of goods bought by firms. The Producer Price Index for commodities can be found at the Bureau of Labor and Statistics databases. The PPI includes many sub-indices. A good price index for stormwater projects should correspond with a sub-index that includes the goods and services required for stormwater construction. For this analysis, the PPI materials and components for the construction sub-index is used as a suitable surrogate for stormwater construction costs.

Addendum C.3. Change in the Construction Prices (Construction price inflation)

The inflation rate is simply the percentage change in the price index from one time period to the next, as expressed by the following equation:

Inflation rate = (new index value – old index value)/old index value

The percent change in the price index gives an estimate of the construction inflation rate (how the price of that same bundle of construction goods changes from year to year). Since fees will be collected in advance of constructing the bioretention area (or other applicable stormwater BMP), failing to account for inflation in construction prices may result in the collected fees falling short of the full cost of implementation. By using a construction price index to adjust nominal construction prices, an administrator can ensure that inflation in construction prices is accounted for when calculating the payment-in-lieu fee rate.

Addendum C.4. Historical Rate of Inflation

The PPI Construction materials & components index is shown in Table A1 and includes construction material inflation rates since 1990. The 1990 to 2011 period is a period characterized with relatively stable prices (modest inflation) and provides a good benchmark to examine long term inflation trends (see **Table C.3**).

Table C.3. Construction Materials and Components Inflation Rates		
Year	**Annual PPI, Construction Materials & Components (base year 1982)**	**Construction Material Inflation Rate**
1989	121.3	
1990	122.9	1.32%
1991	124.5	1.30%
1992	126.5	1.61%
1993	132.0	4.35%
1994	136.6	3.48%
1995	142.1	4.03%
1996	143.6	1.06%
1997	146.5	2.02%
1998	146.8	0.20%
1999	148.9	1.43%
2000	150.7	1.21%
2001	150.6	-0.07%
2002	151.3	0.46%
2003	153.6	1.52%
2004	166.4	8.33%
2005	176.6	6.13%
2006	188.4	6.68%
2007	192.5	2.18%
2008	205.4	6.70%
2009	202.9	-1.22%
2010	205.7	1.38%
2011	212.8	3.45%
Average annual construction material inflation rate 1990-2011		2.62%

Table C.3 generally shows an acceleration in construction price inflation during the 2004-6 period, corresponding to the peak of the housing boom. Overall construction prices fell during 2009, reflecting the impact of the recession. Interestingly, overall construction material prices increased an average of 2.62 percent during the 1990-2011 period, almost identical to the overall change in consumer prices (CPI) during the same period (overall consumer prices increased an average annual 2.75% during the same period).

Addendum C.5. Adjusting from Nominal to Real Dollars

Historical costs are reported as the dollars spent in the year they were incurred ("nominal dollars"). To compare costs over time without the influence of inflation, prices must be expressed in a single type of dollar, called "real" dollars (e.g. we can't compare a dollar spent in 2003 to a dollar spent today because they have different purchasing power). Federal benefit cost guidelines require that all costs and benefits be expressed in the current dollars.

To use any price index to express dollars in the current (or nearly current) year, see the calculation below:

$$\frac{\text{Nominal Price in a given year}}{\left(\dfrac{\text{Price Index in a given year}}{\text{Price Index in target (2011) year}}\right)} = \text{Real Price in 2011 dollars}$$

For example, suppose the cost of constructing a bioretention area was $50,000 in 2003. In order to estimate what it would cost to construct the same bioretention area in 2011, the analysis would need to express the 2003 dollars into equivalent 2011 purchasing power. Given that the PPI construction price index in 2003 and 2011 was 153.6 and 212.8 respectively (see Table A1), the cost of construction the bioretention area in 2011 dollars would be calculated by:

$$\frac{\$50{,}000}{(153.6/212.8)} = \$69{,}270.83 \text{ (cost expressed in 2011 dollars)}$$

Thus, the estimated cost of constructing the same bioretention area would require spending $69,270 using 2011 dollars. This should make sense since we need more dollars to buy the same thing 8 years later given the eroding purchasing power of the dollar.

Addendum C.6. Estimating Operation and Maintenance Costs Over Time

To account for operation and maintenance costs of a stormwater off-site mitigation project, it is important to account for inflation. Operation and maintenance costs that might be incurred in the future could be simply estimated by extrapolating the historical rate of inflation into the future. Thus, a $500 annual operation maintenance cost today would require spending approximately $646 ten years in the future assuming a 2.6% increase in inflation.

On the other hand, operation and maintenance costs can also be expressed as a single figure, the sum of the present value of time of all operation and maintenance costs. The present value calculation considers the time value of money. Money not spent today is worth more in the future because money can used for other productive investments, earning a positive rate of return (interest).

Consider a stormwater BMP that requires $500 annual maintenance for 20 years. Assuming no inflation for the moment, the maintenance cost could be paid for annually or these costs could be made by making a single up-front payment. How much money would be required to finance $500 in annual O&M costs over 20 years? Assuming a 5% interest rate (nominal), $6,231 could be invested today to fully pay for all maintenance over 20 years (the present value formula is explained below). Only $6,231 is needed (not $10,000 or $500 x 20 years) because all unused money can earn interest over the 20 years.

While the discount rate represents the time value of money, analysts still need to account for the inflation. While dollars over time can earn a positive rate of interest, the purchasing power of the dollar is also being eroded by inflation. To account for both the time value of money and inflation, a "real" discount rate should be used. A "real discount" rate is defined as the stated or "nominal" rate less the inflation rate. For example, if the current interest rate is 5% and the inflation rate is 2.6%, the real rate of interest would be 2.4%. The White House Office of Management and Budget recommends a real discount rate of 2.1% for discounting 20 years of constant dollar flows in cost effectiveness analyses (Lew 2011).

Assuming a real discount rate of 2.1%, the present value of an annual stream of $500 of operation and maintenance costs over 20 years would be $8,097, based on the following equation:

$$\text{Present value} = \sum FV_t/(1+r)^t$$

Where:
r = the discount rate,
FV = the future value of the operation and maintenance costs in year t
Present value = FV summed over 20 years

In concept, a local stormwater program could take a lump sum payment of $8,097, place it in interest bearing account (and given nominal rates of interest and typical rates of inflation), and generate enough return to cover the full cost of operation and maintenance for 20 years.

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Table C.4. Planning Level Costs for Various BMPs

Stormwater BMPs	Construction Cost (in 2011 dollars); per cubic foot treated [5]	Design Cost; per cubic foot treated [5]	Cost of Land; per cubic foot treated [4, 5]	Total Initial Costs (construction, design, cost of land); per cubic foot treated [5]	Total Mainte-nance Costs (over 20 years); per cubic foot treated [5, 6]	Total Cost (over 20 years); per cubic foot treated [5]	Average Annual Cost (over 20 years); per cubic foot treated [5]
Forest Buffers (WV Specification 4.2.1)[1, 3]	$12.76	$1.28	$0.00	$14.03	$10.46	$24.49	$1.22
Bioretention (new - suburban) (WV Specification 4.2.3) [1]	$10.87	$2.72	$0.61	$14.20	$8.88	$23.08	$1.15
Bioretention (retrofit - highly urban) (WV Specification 4.2.3) 1	$38.05	$15.22	$0.61	$53.89	$8.88	$62.76	$3.14
Water Quality Swale (new) (WV Specification 4.2.3-A) [1]	$8.70	$3.48	$0.41	$12.58	$5.40	$17.98	$0.90
Permeable Pavement w/o Sand, Veg. (new) (WV Specification 4.2.4) [1]	$63.15	$6.31	$0.00	$69.46	$12.69	$82.15	$4.11
Permeable Pavement w/ Sand, Veg. (new) (WV Specification 4.2.4) [1]	$88.41	$8.84	$0.00	$97.25	$17.74	$114.99	$5.75

Table C.4. Planning Level Costs for Various BMPs

Stormwater BMPs	Construction Cost (in 2011 dollars); per cubic foot treated [5]	Design Cost; per cubic foot treated [5]	Cost of Land; per cubic foot treated[4, 5]	Total Initial Costs (construction, design, cost of land); per cubic foot treated [5]	Total Mainte-nance Costs (over 20 years); per cubic foot treated [5, 6]	Total Cost (over 20 years); per cubic foot treated [5]	Average Annual Cost (over 20 years); per cubic foot treated [5]
Grass Swales (WV Specification 4.2.5) [1]	$5.80	$1.16	$0.41	$7.36	$3.54	$10.90	$0.55
Infiltration Practices w/o Sand, Veg. (new) (WV Specification 4.2.6) [1]	$12.10	$4.84	$1.01	$17.96	$5.02	$22.98	$1.15
Infiltration Practices w/ Sand, Veg. (new) (WV Specification 4.2.6) [1]	$12.68	$5.07	$1.01	$18.77	$5.25	$24.03	$1.20
Filtration Practices (sand, above ground) (WV Specification 4.2.10) [1]	$10.15	$4.06	$1.01	$15.22	$8.30	$23.52	$1.18
Filtering Practices (sand, below ground) (WV Specification 4.2.10) [1]	$11.60	$4.64	$0.00	$16.24	$9.46	$25.69	$1.28
Wet Ponds and Stormwater Wetlands (new) (WV Specifications 4.2.11) [1]	$5.38	$1.61	$0.41	$7.40	$4.42	$11.82	$0.59

Table C.4. Planning Level Costs for Various BMPs

Stormwater BMPs	Construction Cost (in 2011 dollars); per cubic foot treated [5]	Design Cost; per cubic foot treated [5]	Cost of Land; per cubic foot treated [4, 5]	Total Initial Costs (construction, design, cost of land); per cubic foot treated [5]	Total Mainte-nance Costs (over 20 years); per cubic foot treated [5, 6]	Total Cost (over 20 years); per cubic foot treated [5]	Average Annual Cost (over 20 years); per cubic foot treated [5]
Wet Ponds and Stormwater Wetlands (retrofit) (WV Specifications 4.2.11) [1]	$12.37	$6.19	$0.41	$18.96	$4.42	$23.38	$1.17
Urban Stream Restoration [1]	$9.56	$4.78	$0.00	$14.33	$17.60	$31.94	$1.60
Impervious Urban Surface Reduction [1]	$25.37	$2.54	$10.15	$38.05	$5.13	$43.19	$2.16
Tree Planting [1, 3]	$14.26	$1.43	$43.75	$59.43	$11.67	$71.10	$3.56
Dry Extended Detention Ponds (new) [1]	$8.70	$2.61	$1.01	$12.32	$7.14	$19.46	$0.97
Dry Extended Detention Ponds (retrofit) [1]	$13.05	$6.52	$1.01	$20.59	$7.14	$27.72	$1.39
Retrofit of Existing Dry Pond (conversion to wet pond or wetland) [2]	$3.59	$1.80	$0.00	$5.39	$4.42	$9.81	$0.49

[1]Source: King and Hagan, 2011. Some BMP names were modified to conform with names in the WV Stormwater Management & Design Guidance Manual

[2]Values derived by CWP from various sources

[3]*Construction costs and land costs for tree planting and forest buffers are from King and Hagan (2011) but are presented in different units than used in their report.*

[4]*Assumptions regarding land values:*

Land cost assumptions in terms of how much land is needed are from King and Hagan (2011)	**Units**	**Cost**
Land Cost per Developable Acre (VA)		$70,000.00
% Project Acres Developable	0.5	

[5]*Assumptions about converting from IC acres treated to cubic feet treated*

For BMPs where the reported unit is IC acres treated (e.g., King and Hagan, 2011), used IC acres cost/3449.

3449 cubic feet is the treatment volume in the WV spreadsheet associated with 1" of rainfall on 1 acre that is 100% impervious

For BMPs where the reported unit is pervious acres planted or treated, used pervious acres cost/800
800 cubic feet is the difference between 1 acre of managed turf and 1 acre of open space in the WV spreadsheet.

For some BMPs (e.g. pet waste, cross-connections, illicit discharge repair), did NOT conver to cubic feet, since the practice does not reduce volume.

[6] *Total Maintenance*

Total Maintenance is comprised of: (1) Annual (routine) maintenance, (2) Annual intermittent maintenance (e.g., repairs, corrective actions), and (3) Annual local government implementation costs (e.g., inspections, enforcement, administration).

Appendix D
Scoring and Prioritizing Potential Mitigation Projects

D.1. Why Score and Rank Your List of Potential Projects?

Once you have completed an inventory of areas in your watershed or jurisdiction that need restoration, it is useful to prioritize that list of potential restoration projects to ensure that off-site mitigation dollars are spent on the most beneficial projects. This appendix suggests a process for how to systematically score and rank projects identified in your watershed assessments, and presents other resources to help you through the process. There are several reasons you should consider scoring and ranking projects in a systematic way rather than just keeping a full list of potential projects. These include:

- Separate the wheat from the chaff – choose to implement those projects that provide the most benefit, first.
- Off-site mitigation funds and other watershed improvement funds are limited, so only a few out of many projects can realistically be implemented.
- A scientific approach to ranking projects can moderate the influence of personal preference and political sway in selecting mitigation projects.

Much of the content of this appendix is derived from the Center for Watershed Protection manual, *Methods to Develop Restoration Plans for Small Urban Watersheds* (Schueler and Kitchell, 2005).

D.2. Steps to Prioritize Projects

The steps involved in prioritizing projects are as follows:

Step 1 – Choose ranking criteria

Step 2 – Develop scoring and weighting structure

Step 3 – Score and rank projects

Step 4 – Finalize list and map projects

Each step is described in more detail below.

Step 1 – Choose ranking criteria. In order to compare the benefit of one mitigation project over another, you will need to select which factors will serve as your points of comparison. For example, you may want to rank your proposed projects based on their pollutant reduction performance, habitat creation capabilities, capital and long-term cost, and community education and outreach potential. **Table D.1** lists a sample of ranking criteria from which you could choose for your prioritization process and presents guidance on how each can be measured.

Table D.1. Example Ranking Criteria for Use in Project Prioritization [Table excerpted from *Methods to Develop Restoration Plans for Small Urban Watersheds* (Schueler and Kitchell, 2005).]
Cubic Foot Runoff Reduced: This criterion ranks the volume of stormwater runoff that can be captured and reduced by the proposed practice. For the purposes of stormwater off-site mitigation in West Virginia, projects should have documented runoff reduction capabilities. See **Appendices F and G** of this guidance and the West Virginia Stormwater Management & Design Guidance Manual for methods to compute runoff reduction values for various practices. The other side of the equation is cost to implement BMPs. **Appendix C** provides guidance on BMP costs.
Total Construction Cost: Cost can be one of the most important ranking criterion and can be derived from preliminary cost estimates from each individual concept design or from construction costs of similar projects implemented in the past (see **Appendix C**).
Cost per Cubic Foot Reduced: For much of West Virginia, volumetric runoff reduction based on the 1-inch performance standard in the MS4 General Permit will be an important scoring metric.
Cost per Pollutant Removed: If water quality is a primary restoration goal (as with the Chesapeake Bay and some local TMDLs), then it is a good idea to rank projects based on the relative cost to remove pollutants. This requires a little more analysis to assess the expected pollutant removal rate for the type of practice and compare it to the cost of the practice. See the West Virginia Stormwater Management & Design Guidance Manual and relevant TMDL websites for guidance.
Compatibility with Watershed Goals: This factor rates how well the proposed project conforms to the overall goals for watershed restoration. Maximum points area awarded for projects that directly support restoration goals (e.g., a fish barrier removal project in a watershed where native trout recovery is the major objective). Fewer points are awarded to projects that only indirectly support watershed goals (e.g., a stream repair project in a watershed where pollution reduction is the primary goal).
Maintenance Burden: The maintenance burden factor should not only estimate future maintenance costs but also whether a responsible party exists to do it. The long-term maintenance needs of each project should be assessed and points deducted if vegetation management, sediment removal and clogging are expected to occur frequently. Points may also be deducted if maintenance is not clearly vested with a responsible party.
Landowner Cooperation: This ranking criterion rates the willingness of private or public landowners to have the restoration project installed on their property. Points are deducted for projects where permission is uncertain, easements must be secured, or landowners are uncooperative.

Table D.1. Example Ranking Criteria for Use in Project Prioritization [Table excerpted from *Methods to Develop Restoration Plans for Small Urban Watersheds* (Schueler and Kitchell, 2005).]
Interaction with Other Restoration Practices: This factor evaluates whether the project can be integrated with other restoration practices at the same site or stream reach to maximize restoration benefits. A classic example would be a stormwater management retrofit located above a comprehensive stream repair project, which is adjacent to a riparian reforestation project. The benefit of the three projects combined together is presumably greater than the benefits of each one alone.
Access: This factor assesses the ability to get to the restoration site with the tools you need (e.g., heavy construction, vehicles). Points are deducted for steep or unstable side-slopes, where construction access disrupts neighbors, when significant tree clearing is required, and other similar factors.
Public Visibility: This ranking criterion examines the visibility of potential demonstration value of a proposed site. Points are awarded for projects that have public access, experience heavy use, are linked to trails, bikeways, or community centers and/or have opportunities for signage and education. Points are deducted for projects out of public view or that have restricted or prohibited access.
Habitat Creation: This factor evaluates whether the project is likely to create new or improve habitat for wildlife, including aquatic life or connect existing habitat features.

There are many combinations of ranking criteria that you can use; it may be most appropriate to select three to eight criteria so that the process is comprehensive but not overly complicated. In order to reduce ambiguities or personal bias, try to select a good proportion of ranking criteria that are numeric in nature and objective (e.g., cost), versus more subjective factors (e.g., public visibility). It is recommended that the objective/numeric criteria should consistitute at least half of the selected criteria. Most importantly, choose ranking criteria that reflect restoration goals and public needs in your watershed or jurisdiction. If your watershed is impaired due to excessive bacteria, for example, bacteria treatment performance should be one of the ranking criteria for your list of restoration projects.

Step 2 – Develop scoring and weighting structure. Once the ranking criteria have been selected, the next step is to assign a relative weight of importance to each ranking criterion that reflects its perceived influence on the success of a restoration project. Ranking criteria that seem most crucial should be assigned a higher maximum score than factors that are of less concern. The weighting usually assigns a variable number of points to each ranking criterion so that the maximum score of all the criteria total 100 points. Within each ranking criterion you must set standards that determine a high or low score within that category and the associated range of scores. See **Table D.2** below for an example.

Weighting and Scoring Example:

For a stormwater retrofit inventory, four ranking criteria were selected that reflect the goals of the local jurisdiction. They are: (1) cubic feet of runoff reduction, (2) cost effectiveness, (3) visibility and outreach potential, and (4) apparent opportunity and interest. **Table D.2** below describes each ranking criteria and scoring scale. The individual scores in each of the categories were summed to produce an overall score for each of the retrofits (100 points maximum), and the retrofits were ranked from highest to lowest score.

Table D.2. Scoring Criteria Used for Ranking

Ranking Criterion	Description	Maximum Score	Scoring[1]
Cubic Feet of Runoff Reduction as indicator of overall stormwater treatment performance	Combines influence of the size and land cover (impervious and turf cover) in the drainage area and the runoff reduction performance of the proposed retrofit.	30	Fourth Quartile = 30
			Third Quartile = 20
			Second Quartile = 10
			First Quartile = 0
Cost Effectiveness (cost per cubic foot reduced)	Construction cost divided by cubic feet of runoff reduction	30	Fourth Quartile (highest cost) = 0
			Third Quartile = 10
			Second Quartile = 20
			First Quartile (lowest cost) = 30
Visibility & Outreach	Extent to which a practice is visible and is useful for educating students and community members about stormwater.	20	High = 20
			Medium = 10
			Low = 0
Opportunity & Interest	Extent to which a practice is likely be implemented due to factors such as local government staff interest, timing with other planned improvements, and opportunity to address several problems at once.	20	High = 20
			Medium = 10
			Low = 0
		Total Max. = 100	

[1] In this example, scoring is determined by "quartile." This is done by listing the scores for all projects, from lowest to highest, and then dividing these data into four groups, or quartiles, each group having the same number of projects. For instance, if there are 100 candidate projects, each quartile would have 25 projects. The projects with the 25 highest scores would be in the "First Quartile," the next 25 in the "Second Quartile," and so on. Quartiles can be computed easily using a spreadsheet or other simple tool.

In this way, all projects within a certain quartile range receive the same score. This is a simple approach that allows for scoring of non-numeric ranking criteria (e.g., visibility and outreach) as well as translation to a 100-point scale. Alternative approaches would be to assign a unique score to each project by dividing the individual project value by the maximum project value for all candidate projects and multiplying by 100. For instance, if the individual project was calculated to achieve a runoff reduction of 250 cubic feet, and the maximum value for all candidate projects was 350 cubic feet, then the individual project score would be: 250/350 x 100 = 71.

To help explain how these four ranking criteria were used to produce an overall score for each retrofit concept, **Table D.3** provides a scoring example for one of the proposed retrofits.

Table D.3. Scoring Example

Ranking Criterion	**Value**	**Quartile**	**Score**
Cubic Feet of Runoff Reduction	150 cubic feet	1st	0 points
Cost per cubic foot treated	$28,571.43 per cubic foot reduced	1st	30 points
Visibility & Outreach	High	--	20 points
Opportunity & Interest	Medium	--	10 points
TOTAL =			**60 points**

The list of restoration projects may include a variety of types of practices such as stream restoration and reforestation, versus only stormwater retrofits for example. If that is the case, it may be easier to score and rank similar type projects together using ranking criteria that are most applicable to each type of practice.

Step 3 – Score and rank projects. The next step is to score each project in your list based on your scoring rules. In order to minimize personal subjectivity and keep the process consistent and fair, it is recommended to have several team members involved in the scoring the projects, especially for the more subjective, non-numeric ranking criteria. Enter the scores for each ranking criterion into a spreadsheet and compute the sum total scores for each project. Identify priority projects based on the highest total scores. If your list of projects is very long, you may want to set a minimum score under which a project does not get recommended for implementation. This is also the time to look for "project killers" that will disallow a project to be implemented. For example, a project may have a high total score but one or more ranking factors receive a very low score.

Step 4 – Finalize list and map projects. Develop your final list of recommended restoration projects and document the assumptions made when scoring and weighting the projects. Proper documentation can be very helpful later on when re-visiting your list. Especially if geographic location of mitigation projects is important, create a map of priority projects with visual indicators of which projects rank highest. Be aware that the resulting prioritized list is a guide or tool. In most cases, professional judgment and stakeholder feedback will be important to select the top projects for funding and implementation. Using this process, there is strong justification to select projects from among the top-ranked candidates.

D.3. Resources

A number of resources may help you assess the performance and benefits of a variety of types of restoration practices. The following is a just a short list of technical resources available to inform and guide the prioritization process. In particular, the first resource listed below provides more detail on the scoring, ranking, and prioritization process. Most of the Center for Watershed Protection resources can be downloaded at: http://www.cwp.org/store/free-downloads.html

Schueler, T. and Kitchell, A. 2005. *Manual 2: Methods to Develop Restoration Plans for Small Urban Watersheds*. Center for Watershed Protection. Ellicott City, MD.

Center for Watershed Protection. 2007. *Manual 3: Urban Stormwater Retrofit Practices. Version 1.0.* Center for Watershed Protection. Ellicott City, MD.

Center for Watershed Protection. 2007. *National Pollutant Removal Performance Database, Version 3.* Center for Watershed Protection. Ellicott City, MD

Center for Watershed Protection and Chesapeake Stormwater Network. 2008. *Technical Memorandum: The Runoff Reduction Method.* Center for Watershed Protection. Ellicott City, MD.

King, D. and Hagan, P. 2011. *Costs of Stormwater Management Practices in Maryland Counties*. University of Maryland Center for Environmental Science. Solomons, MD.

Appendix E

Examples of Off-Site Programs in Other States and Cities

When developing a new off-site program for your MS4 community, it will be helpful to review other similar programs to see how they were structured. While it is unlikely that a West Virginia MS4 will adopt all provisions from any of the off-site programs described in this appendix, certain elements of different programs can be considered. Also, it is worth noting that some of these program elements are already prescribed in West Virginia's MS4 General Permit. Therefore, while a local program in West Virginia has a great deal of administrative and technical discretion in setting up its program, some elements are already set by the General Permit (see **Table E.1** below).

This appendix summarizes six stormwater offset and banking systems: (1) Washington, D.C. (still under development), (2) Saint Paul, Minnesota, (3) Fredericksburg, Virginia (still under development), (4) Neuse River, North Carolina, (5) Maryland Critical Area, and (6) Maine sensitive lakes.[1]

Table E.1 outlines the major building blocks or program elements that these programs include and also what the West Virginia MS4 General Permit prescribes for that element (if anything).

Table E.1. Program Elements for Off-Site Compliance Programs & Relationship to MS4 General Permit

Program Elements	WV MS4 General Permit Provisions
Eligibility to access off-site options	Document infeasibility of on-site management for portion or all of 1-inch volume
Demand versus availability of sites	Not addressed; local program characteristic
Currency of trade	Runoff volume and/or dollars
Trading ratios	1.5:1 for up 0.6 inches of initial obligation; 2:1 for remaining 0.4 inches
Scale of trading	Same "sewershed/watershed" for off-site mitigation, although scale for these can vary
Allowable practices	Not specified, but equivalency with unmet runoff reduction volume must be documented. Also, payment in lieu fees must be used for "public stormwater project"
Private sector involvement	Not addressed; determined by local program

[1] These summaries are based on interviews conducted by Center for Watershed Protection and Downstream Strategies with personnel at each program, and were previously summarized in: Center for Watershed Protection. 2012. Summary of Existing Research to Encourage Smart Growth and Reduce Nutrients in Baltimore City. Prepared for the City of Baltimore. February.

Rates	Not addressed; set by local program
Program administration	MS4 responsible for identifying priority areas for off-site mitigation and determining who is responsible for long-term maintenance; other general administrative items contained in General Permit.

Abbreviations

BMP	best management practice
DDOE	District Department of the Environment
ESD	environmental site design
N	nitrogen
NCEEP	North Carolina Ecosystem Enhancement Program
P	phosphorus
SIF	Stormwater Impact Fund
SRC	stormwater retention credit
SWMP	stormwater management program
WIP	watershed implementation plan

	Washington, DC (under development)	Saint Paul, MN	Fredericksburg, VA (under development)	Neuse River, NC	Critical Area, MD	Sensitive lakes, ME
Eligibility to access off-site options	Retention on-site minimum is “to be determined” (the program is currently under development) Regulated site above the on-site minimum retention can: (1) use stormwater retention credits (SRCs) from the private market or SRCs certified by District Department of the Environment (DDOE) or (2) pay in-lieu fee to DDOE Must have designed and approved stormwater management program (SWMP) Must have current maintenance agreement or contract for off-site practice	Document why standard compliance is not feasible Document what other compliance steps were taken Special cases for “linear” development On-site rate control for 2-, 10-, and 100-year storms Alternative compliance for 1-inch volume reduction when (1) on-site compliance is achieved to extent possible, (2) off-site project or using qualified mitigation bank credit, or (3) pay a fee to fund that will implement elsewhere Most used option is payment into the mitigation bank Private developers have not participated in the alternative compliance program (fee-in-lieu) because it is cheaper to buy banked credits	Volume target is infiltration of the first one-half inch runoff Off-site volume offset if retrofit in same watershed	If nitrogen (N) export exceeds baseline conditions, must use best management practices (BMPs) or regional stormwater strategy to reduce N to baseline conditions Nutrient offset eligibility when a portion of load treated on-site and varies based on watershed strategies Example: Tar-Pamlico strategy requires on-site control for 4 pound/acre/year N and 0.4 pound/acre/year P or less. Offset payment option eligibility if on-site N pollutant load is 6 pound/acre/year (residential) or 10 pound/acre/year (commercial, industrial, and institutional)	Offsets are a last resort Must first reduce pollutant load at least 10% from prior on-site pollutant load (“10% Rule”) On-site BMPs must not be feasible Current minimum on-site requirement is 0.3 pound/acre for new development annual P load, and offsets allowed if designer shows a reasonable effort to install environmental site design (ESD) practices on-site to reduce the load required Spreadsheet available to evaluate ESD compliance and P removal	Limited to eligible lake watersheds On-site project P reduction requirement is 60% P export based on P budget for lake per acre

	Washington, DC (under development)	Saint Paul, MN	Fredericksburg, VA (under development)	Neuse River, NC	Critical Area, MD	Sensitive lakes, ME
Demand versus off-site availability	Changed approach based on market study projections Prioritized list of retrofit sites that can generate SRCs WIPs with potential retrofit sites Looking for more retrofit sites via outreach In public comment stage	No study done to determine demand High demand for banking credits	Based on feedback from the local development and building industry, the City worked collaboratively to allow for an off-site volume offset if retrofits are in the same watershed	North Carolina Ecosystem Enhancement Program (NCEEP) identifies eligible projects from Restoration Priority Plans that are updated at least every five years Analyzed problems and opportunities using geographic information systems, field work, and stakeholder input Developed a Project Atlas for potential projects The market is difficult to judge; payments and mitigation projects occur where development is highest	Offset program should have current watershed restoration inventory identifying priority retrofits for implementation Locality should develop and maintain a retrofit registry for tracking Registry tracks implementation status and P load reduction Developer can find off-site retrofit project that achieves equivalent P removal	Compensation fund for projects in the watershed State will review inactive funds Administrators encouraged to find additional funding, cost share, and in-kind or leveraging sources Low participation due to low development, difficulty in finding acceptable mitigation sites, and refund requests that impacted state implementation ability
Currency of trade	Runoff volume	Runoff volume Total suspended solids	Runoff volume	Pounds of P Pounds of N	Pounds of P	Pounds of P
Trading ratios	1:1 One SRC is defined as one gallon of retention for one year	1:1 for mitigation bank volume reduction 70% credit for off-site volume reduction (i.e., for the 1-inch on-site volume reduction standard, off-site projects must achieve an equivalent reduction of 1.3 inches)	1.5:1 off-site volume offset for new development 1.25:1 off-site volume offset for redevelopment	No trading ratio specified	No trading ratio specified	No trading ratio specified

	Washington, DC (under development)	Saint Paul, MN	Fredericksburg, VA (under development)	Neuse River, NC	Critical Area, MD	Sensitive lakes, ME
Scale of trading	Within the District (62 square miles) Analysis was done in the city's eight wards to prioritize practice implementation	Same drainage/ subwatershed area as project site Funds spent within the local jurisdiction, to extent possible If project site is in a Special Interest subwatershed, then on-site management required but off-site in the same Special Interest subwatershed considered	Same watershed	Same eight-digit hydrologic unit code watershed If in Jordan and Fall nutrient strategy, then as required in that strategy If in area where there will be concentrated loading increases, nutrient offset within ten-digit hydrologic unit code watershed	Same 12-digit hydrologic unit code watershed (about 15 to 65 square miles)	In drainage of eligible impacted lake watershed
Allowable practices	Practices or land cover changes in the District Stormwater Guidebook or approved by DDOE	Money from fund goes to project planning, engineering, and construction of projects Board evaluates projects as funds are available and prioritizes: (1) In same watershed, (2) Identified in watershed or planning documents, (3) Includes multiple funders and collaborators, (4) Quantity of stormwater treated, and (5) Cost per ft^3 volume removed Specific BMPs in the 2005 Minnesota Stormwater Manual The most common practice is street reconstruction projects where the City adds infiltration	Unknown	BMPs and stream and wetland restoration, enhancement, and preservation allowed Prioritize projects using watershed planning Use feasibility and opportunity for watershed improvements Use Project Atlas and link project restoration attributes to local watershed plan goals and objectives Most projects are riparian buffers due to the low comparative cost The least costly options were required (see also Rates)	Appropriate local groups should review and select best offset opportunities that include but are not limited to: (1) BMP construction; (2) Retrofit BMP for improved pollutant removal; (3) Reduce existing property impervious cover; and (4) Additional innovative offset options (e.g., stream restoration, trash interception, wetland restoration, etc.)	Preferred practices include BMPs that: (1) Permanently change from high to low P export in the land use and (2) Treat runoff from high P export land use and preferably have low maintenance costs Projects to-date are small, treat P in runoff (e.g., road repairs with stormwater management), buffers, and small LID practices

	Washington, DC (under development)	Saint Paul, MN	Fredericksburg, VA (under development)	Neuse River, NC	Critical Area, MD	Sensitive lakes, ME
Private sector involvement	DDOE aims for the market to drive the credits, fee in lieu, and ultimately the majority of retrofit design and construction	No private sector involvement District administers the banking credits	Unknown	Regulation promotes private sector to operate mitigation banks (S.L. 2009-337) Regulation guides government entities seeking mitigation credits to purchase from private mitigation banks (North Carolina Session Law 2009-334) Mitigation banking is operable in some of the watershed	Varies based on local jurisdiction	Private sector not involved Seven Stormwater Administrators manage the fee program
Rates	SRC rate not determined yet In-lieu fee based on 80-year obligation for 1.2 inch retention Determined using national building data, capital maintenance costs, rates of interest, etc. Annual in-lieu fee to be based on inflation and can be modified	The Stormwater Impact Fund's (SIF's) current rate of $40,000 per impervious acre is based on cost study for meeting the volume reduction standard To date, no payments were made to the SIF Board sets SIF contribution level annually Cost cap for linear project's design, construction, and other associated costs	Unknown	Use actual costs that are updated by NCEEP at least annually Different rates are set in different watersheds As of 7/1/11, rates range from approximately $12-22/pound N and were set at $134/pound P for one watershed Rates are based on relatively low-cost practices, such as riparian buffers on agricultural land; however, the rates are not adequate to cover costs for stormwater retrofits and BMPs, so few of these have been constructed	$32,500/pound P Offset fee should include construction inflation without re-enacting ordinance	$25,000/pound P export Cost was based on average cost to administer representative BMP that removes 1 pound P

	Washington, DC (under development)	Saint Paul, MN	Fredericksburg, VA (under development)	Neuse River, NC	Critical Area, MD	Sensitive lakes, ME
Program administration	Currently drafting policy Aim to streamline public and agency efforts New policies and procedures will be needed Altered fee in lieu program based on projections that indicated it may be the most popular choice and would have the highest administrative burden	District administers banking credits, provides list of qualified banking credits available, and keeps related records Applicant and seller arrange transaction for volume reduction credits and provide District with form certifying sale District has main permitting role but municipalities can assume more active roles	Unknown	NCEEP uses mitigation procurement programs in the following order of preference: (1) Full Delivery/Bank Credit Purchase Program (private mitigation bank); (2) Existing Local Compensatory Mitigation Bank Credit Purchase Program; (3) Design/Build Program in which NCEEP contracts with a private entity to lead or implement the design, construction, and post-construction monitoring of mitigation at sites; (4) Design-Bid-Build Program Annual reports to the Interagency Review Team	Local jurisdictions administer offset program that includes: (1) Documentation on why on-site compliance is not feasible and (2) Tracking and reporting performance of offset program Offset program should have the following accountability features: (1) Dedicated account; (2) Fiscal accountability; (3) Watershed restoration inventory; (4) Retrofit registry; and (5) Reversion clause (spend offset fees within five years)	Stormwater Compensation Fee Administrators record and track the following criteria: (1) Receipts and procedure for fees and (2) Annual reports to state for work performed, administrate costs/year, and funds expended Funds used in watershed received and spent within three years Local agency has improved local knowledge compared to larger agency, can implement with increased flexibility and efficiency and provide funding more quickly

Appendix F

Assigning Runoff Reduction Values to Reforestation Projects

F.1. Using Reforestation Projects as part of an Off-Site Compliance Program

Off-site mitigation projects can include reforestation projects that reduce the volume of runoff compared to existing site conditions. Reforestation is defined as planting trees on pervious or disturbed areas at a rate that would produce a forest-like condition over time. The intent of the planting is to eventually convert the area to forest. If the trees are planted as part of the landscape, with no intention to covert the area to forest, then this would not count as reforestation. Examples may include:

- Reforestation of disturbed or barren lands (e.g., old logging or mining sites or areas where previous disturbance has not been stabilized).
- Reforestation or riparian corridors that are currently in turf, pasture, overrun with invasive plants, and/or disturbed.
- Reforestation of turf, preferably on public property, such as turf areas at schools, parks, municipal buildings, and other areas that are not actively used (e.g., for sports fields or areas that must remain open).
- Reforestation or revegetation of areas where existing impervious area is removed, such as unused parking lots or abandoned properties.

This appendix documents the runoff reduction benefits of trees and establishes a methodology to calculate the runoff reduction value of reforestation projects to be used as part of a local off-site compliance program.

NOTE: If a reforestation project takes place on a development site in such a way that it is used to help achieve compliance with the site's stormwater requirements (for instance, in accordance with **Specification 4.2.1, Sheetflow to Vegetated Filter Strips and Conservation** Areas), then it cannot then also be used to provide volume offsets as part of a local off-site compliance program.

F.2. How Much Runoff Can Trees Reduce?

There are several methods that have or can been used to estimate the runoff reduction provided by trees. First, monitoring studies can be conducted to measure the proportion of rainfall that is removed through individual processes such as interception, transpiration and infiltration. The sum of these processes equals the total runoff reduction. Alternately, monitoring studies can focus on actually measuring the runoff from a forested watershed. Runoff reduction provided by trees can also be modeled. This is not to suggest that MS4s in West Virginia should conduct their own independent monitoring or modeling. The intent of this section is to help stormwater professionals understand how these methods are used to inform an appropriate runoff reduction performance value that can used as part of an off-site compliance program.

Monitoring and modeling approaches are described briefly below.

Monitoring

Interception. Most interception studies use similar methods where the rainfall beneath the canopy plus the water running down the trunk are measured and subtracted from the measured rainfall outside the dripline. Three studies of canopy interception by deciduous trees report a reduction in rainfall of 13, 8 and 11 percent respectively (Dunne and Leopold, 1978; Reynolds et al., 1988; Xiao et al., 1998). Interception by conifers is greater than interception by deciduous trees and can also be affected by seasonality and rainfall conditions.

Transpiration. Tree transpiration is usually measured using micro-metrological stations positioned above the canopy, sap-flow monitors and soil lysimeters. One study of transpiration by deciduous trees reported a 25 percent reduction in rainfall (Schlesinger, 1997). Transpiration rates are influenced by seasonality, species, and rainfall conditions.

Infiltration. Studies that measure soil infiltration rates in forest conditions compared to other land use conditions generally show significant increased infiltration capacity by forest soils (Lal, 1996; Wondzell and King, 2003; Kays, 1980). Infiltration rates are dependent on land cover, soil type, antecedent soil moisture, seasonality and rainfall conditions.

Runoff. Two primary methods have been used to measure in-stream runoff from forested watersheds. The first is to conduct monitoring of a forested watershed before and after deforestation. The second is to measure rainfall and runoff from a forested basin. Two before/after studies of deciduous forest watersheds reported a 23 and 32 percent increase in runoff after deforestation, and one study measuring rainfall and runoff from a deciduous forest watershed reported that 39 percent of the rainfall was reduced (Martin and Hornbeck, 2000; Hornbeck et al., 1997; Post and Jones, 2001).

Modeling

Most modeling studies of runoff reduction by trees are based on simple land use models that use curve numbers (CNs) and predict runoff based on land use type. One of the most commonly used models of this type is American Forests' CityGreen model, a GIS application that can be used to digitize tree canopy and calculate the stormwater runoff reduction and associated benefits. CityGreen can be calibrated for local condition by adapting the CNs and soil types. CityGreen is based on the NRCS' technical Release 55 (TR-55) which is best applied at the small watershed scale.

The U.S. Forest Service has developed a more sophisticated model called Urban FORests Effects (UFORE). UFORE is based on hydrodynamic canopy models and the Hydro portion of the model estimates streamflow and water quality changes based on tree cover and impervious cover in a watershed. UFORE is calibrated against actual streamflow data and required inputs include rainfall, elevation, land cover, watershed boundary, and gaging station data. The current resolutions available are 10m and 30 but 1 m is available within a <5km^2 area.

A major limitation of the modeling approach is that is does not accurately account for tree interception and canopy storage (Xiao et al., 1998)

Calculating a Runoff Reduction Benefit for Reforestation in West Virginia

To develop an estimate of runoff reduction by reforestation projects in West Virginia, we used the above-described data from monitoring studies of deciduous trees versus studies of conifers. The average proportion of precipitation intercepted by deciduous trees is around 10 percent. Only one study was available for transpiration by deciduous trees and this value was 25 percent of precipitation. Taken together, we can assume that 35 percent of rain falling on a deciduous forest would be intercepted or transpired by the trees. However, this does not account for water losses through infiltration, so this is likely an underestimate. The values derived from infiltration studies are difficult to apply to a reforestation situation because it in unknown how long it takes for soils in a newly planted reforestation site to achieve the infiltration rates associated with undisturbed mature forests, on which these studies were conducted.

For comparison, the average runoff reduction estimated through small watershed-scale studies of forest runoff was around 31 percent. It is probably reasonable to assume that the runoff reduction provided by trees is at least 30 percent given these values and the measured values for interception and transpiration.

One caveat to this approach is that the studies for which the values were derived may have been conducted under varying seasonal and site conditions. Herrera Environmental Consultants (2008) provides more information on the effects of trees on stormwater runoff.

F.3. Method to Derive Runoff Reduction Value for Reforestation Projects Used For Off-Site Mitigation

The method to derive a volumetric runoff reduction value for reforestation projects is based on use of the same Design Compliance Spreadsheet that is used to gage compliance for development projects, as documented in **Chapter 3 of the West Virginia Stormwater Management and Design Guidance Manual**.

Step 1 -- Calculate the Design Treatment Volume Based on Pre-Restoration Conditions. Based on the soil types, land covers, and site area, use the Design Compliance Spreadsheet to calculate the Design Treatment Volume. **Table 1** lists the runoff coefficients for various land covers from the spreadsheet. See **Chapter 3 (Section 3.4, Equation 3.1)** of the Manual for documentation on calculating the Design Treatment Volume.

Step 2 – Calculate the Treatment Volume for Post-Restoration Conditions. The post-restoration Treatment Volume will depend on whether soil amendments are used in the areas that are restored or revegetated. USE THE RUNOFF COEFFICIENTS IN **TABLE F.1** FOR REFORESTATION PROJECTS (HIGHLIGHTED ROW) FOR AREAS THAT ARE RESTORED, REVEGETATED, AND/OR REFORESTED – DO NOT USE THE RUNOFF COEFFICIENTS FOR FOREST/PRESERVED OPEN SPACE (This will involve unlocking the spreadsheet and changing the runoff coefficients based on soil type). The reason for this is that reforestation projects do not automatically and immediately function in a hydrologic sense like undisturbed open space or forest. It may take years for these types of conditions to develop as the vegetation matures and soil structure is restored. The Runoff Coefficients for reforestation projects are in between those for managed turf/disturbed soils and forest/open space, and represent a 30% reduction from managed turf/disturbed conditions, based on the research presented in **Section 2 of this Appendix.** FOR PROJECTS THAT ALSO UTILIZE SOIL AMENDMENTS/SOIL RESTORATION, THE RUNOFF COEFFICIENTS FOR THE NEXT "LOWER" HSG SOIL TYPE CAN BE USED (e.g., C soil goes to B).

Step 3 – Subtract the Volume From Step 2 from the Volume from Step 1. This incremental volume represents the "bounce," or volume reduction that is achieved by the restoration project. This is volume that can be used to offset or trade as part of a local off-site compliance program.

Table F.1. Runoff Coefficients from the West Virginia Design Compliance Spreadsheet, With the Addition of Coefficients for Reforestation Projects

Land Cover Type	HSG A soils	HSG B soils	HSG C soils	HSG D soils
Forest/Preserved Open Space	**0.02**	**0.03**	**0.04**	**0.05**
Managed Turf	**0.15**	**0.20**	**0.22**	**0.25**
Impervious Cover	**0.95**	**0.95**	**0.95**	**0.95**
Reforestation Projects	**0.11**	**0.14**	**0.15**	**0.18**

It is important to note that the runoff reduction value assigned to a particular project is dependent on that project adhering to sound planning, design, and implementation standards, as well as identifying and achieving certain performance standards of success. A project that is not well designed or executed will not successfully "offset" the unmet runoff reduction of the site(s) seeking to utilize off-site compliance. For this reason, it is essential for the MS4 or local program to establish standards, performance measures, and monitoring criteria to ensure project success. The following checklist and list of resources is intended to assist the MS4 with development of these standards, performance measures and criteria for reforestation projects.

- ☐ **Establish specific performance goals for the mitigation project. The performance goals should include survival and health of vegetation, maintenance of the desired vegetative community, preventing erosion in the form of gullies and channels, and other site-specific performance measures (e.g., public access, passive recreation, signage). The average tree spacing at establishment (5 years after planting) should be approximately 20 feet to comply with the performance goal of a minimum of 100 trees per acre.**

- ☐ Follow the Specification 4.2.1, Sheetflow to Vegetated Filter Strips and Conservation Areas, in the West Virginia Stormwater Management and Design Guidance Manual for applications where the restored or reforested mitigation area will receive runoff from adjacent developed areas. The specification provides guidance on using the area to treat adjacent stormwater runoff (e.g., use of level or boundary spreaders, flow paths, etc.). Note, however, that use of this practice on a development site to help achieve compliance with stormwater requirements CANNOT also qualify for volume offsets as part of a local off-site compliance program.

- ☐ Follow the specifications in Appendix D, Soil Amendments, of the Manual for applications where soil restoration or enhancement is necessary in order to establish a healthy vegetative community (e.g., abandoned mine lands or areas where soil is disturbed or compacted). IT IS VERY IMPORTANT TO ESTABLISH FAVORABLE SOIL CONDITIONS IN ORDER TO TAKE MITIGATION CREDIT FOR REFORESTATION OR TREE PLANTING.

- ☐ A qualified professional (landscape architect, ISA certified arborist, or licensed forester) should prepare a detailed plan for the mitigation project. The plan should include common elements, such as: (1) pre-planting considerations, (2) site selection/conditions, (3) site preparation, (4) planting plan, and (5) maintenance. The references in Table 2 provide guidance on planning, design, and implementation of such projects.

- ☐ General planting guidance is as follows, although more detailed guidance should be derived from the resources in Table 2: Native trees and shrubs with a robust root system are recommended for planting to maximize soil infiltration capacity. A minimum of 3 tree/shrub species should be used and no more than 50% of the planting area should be planted with pine. Planting stock, size and spacing should be selected to achieve an overall density of at least 100 trees per acre at establishment (within 5 years). The 100 trees/acre requirement applies across the entire planting area. Note that if larger stock is used, additional maintenance (e.g., watering) will be required. Plant a non-invasive cover crop or herbaceous layer where no desirable one exists to ensure rapid vegetative cover of the surface area.

- ☐ In most cases, the mitigation area should have a minimum contiguous area, such as 1 acre.

- ☐ The mitigation area must be protected by a perpetual easement, or other property restriction that assigns the responsible party to ensure that no future development, disturbance, or clearing may occur within the area.

- ☐ Establish a long-term management plan for the mitigation area, to include vegetation management (including control of invasives and supplementing vegetation over time), site access, maintenance, and enforceable provisions that ensure the long-term success of the area. The latter should identify corrective actions that are necessary to bring the project back in line with established performance measures. The plan should include a schedule and responsible party for inspections, inspection checklists, and follow-up actions in response to inspections.

- **If part of the local program, privately owned and maintained sites may post a performance bond to cover the revegetation establishment period and one or several years or maintenance. Release of performance bond should tie in with the following crucial stages of the planting project: (1) after the initial planting is inspected/approved, (2) after 1 complete growing season has passed, if survival counts indicate that replanting is not needed, and (3) 5 years after planting, once certified by a licensed forester. It is recommended that the amount held in performance bond should be sufficient to fund replacement of the entire project at the 5 year mark if necessary.**

Table F.2 lists some additional resources for the design, construction, and maintenance of reforestation projects.

Table F.2. Design and Implementation Resources for Tree Planting and Reforestation Projects	
Urban Watershed Forestry Manual Part 1: Methods for Increasing Forest Cover in a Watershed. (Cappiella et al., 2005)	This manual introduces the emerging topic of urban watershed forestry and presents new methods for systematically measuring watershed forest cover and techniques for maintaining or increasing this cover. The audience for this manual includes the local watershed planner or forester. http://www.forestsforwatersheds.org/
Urban Watershed Forestry Manual Part 3: Urban Tree Planting Guide (Cappiella et al., 2006)	This manual provides detailed guidance on urban tree planting that is applicable at both the development site and the watershed scale. Topics covered include: species selection, site preparation, tree planting and maintenance techniques, and special considerations for urban tree planting. http://www.forestsforwatersheds.org/
Watershed Forestry Resource Guide	This website serves as a central location for resources on forests and watersheds and provides a range of tools for different audiences, including fact sheets, slideshows, training exercises and other tools, as well as links to research papers, reports and relevant websites. The site includes major sections on 1) forest planning and assessment, 2) reducing stormwater runoff, 3) forest friendly development, and 4) planting and maintaining trees. http://www.forestsforwatersheds.org/
Riparian Forest Buffer Design and Maintenance (Maryland DNR Forest Service, 2005)	This guide was prepared as a resource to the many who wish to establish a forest buffer efficiently, effectively, and with a minimum of maintenance. It is a very thorough guide on planning and implementing riparian buffer projects and includes planting and maintenance techniques and checklists. http://www.dnr.state.md.us/irc/docs/00007844.pdf
A Guide for Foresters and other Natural Resource	A practical guide intended for forestry and natural resources professionals working with landowners to develop a forest resources management plan using the *Managing Your Woodlands: A template for your plans for the*

Professionals on using: Managing Your Woodlands: A template for your plans for the future (NRCS, 2011)	*future* and accessing existing incentive programs. This guide also includes useful information for landowners including description on the type of information that is necessary to include in the template. There is also a glossary with relevant forestry terms, and a list of available resources. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046797.pdf
Stewards of our streams: Buffer strip design, establishment and maintenance (Schultz, et al., 1997)	This publication describes how to design, plant, and maintain a multi-species buffer strip, which is an important part of the riparian, or river, ecosystem. http://www.leopold.iastate.edu/pubs-and-papers/1997-04-stewards-buffer-strip
Minnesota Stormwater Manual (MPCA, 2008)	This manual provides practical guidance on design and maintenance of stormwater management practices in Minnesota. Chapter 11 on Stormwater Credits includes performance measures and standards for reforestation projects as part of the Site Reforestation or Prairie Restoration Credit. http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/stormwater-management/minnesota-s-stormwater-manual.html
Pennsylvania Stormwater Best Management Practices Manual (PA DEP, 2006)	This manual provides practical guidance on design and maintenance of stormwater management practices in Pennsylvania. Chapter 5.6.3, BMP Re-Vegetate and Re-Forest Disturbed Areas Using Native Species, provides guidance on performance measures and standards for reforesting disturbed areas as a stormwater best management practice. http://www.depweb.state.pa.us/portal/server.pt/community/best_management_practices_manual/10631
Silvics of North America (Burns and Honkala, 1990)	This manual describes the silvical characteristics of about 200 conifers and hardwood trees in the conterminous United States, Alaska, Hawaii, and Puerto Rico. It serves as a useful reference and teaching tool for researchers, educators, and practicing foresters both within the United States and abroad. http://www.na.fs.fed.us/pubs/silvics_manual/table_of_contents.shtm

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Appendix G

Assigning Runoff Reduction Values for Stream Restoration Projects

The Stream Restoration Accounting Methods in This Appendix Are Provisional

MS4s that wish to use stream restoration as part of an off-site compliance program should vet the desired approach with WVDEP, and keep careful data on site selection, design, construction, and maintenance in order to inform a more decisive method in the future. Those interested in this approach are also encouraged to keep abreast of methods developed by the Chesapeake Bay Program to define pollutant removal rates for stream restoration projects through an expert panel process:

http://chesapeakestormwater.net/bay-stormwater/baywide-stormwater-policy/urban-stormwater-workgroup/urban-stream-restoration/

G.1. Using Stream Restoration Projects as part of an Off-Site Compliance Program

The use of stream restoration as an “alternative” best management practice for reducing sediment, nutrients, and other pollutants in urban watersheds is becoming more commonplace. States and local jurisdictions that allow/promote this BMP typically provide some guidance to site designers on how to “credit” stream restoration projects. The Chesapeake Bay Program is currently working on protocols for crediting the nutrient and sediment load reductions associated with various stream restoration approaches (Schueler and Stack, 2012).

This type of crediting can be a challenge in states such as West Virginia where the performance standard is based on runoff volume instead of a specific pollutant. This appendix documents a method for calculating the volume reduction credit associated with steam restoration projects installed in West Virginia under the off-site mitigation options in the MS4 General Permit.

In general, there are three ways that stream restoration projects can reduce sediment and nutrient loads:

1. Prevented Sediment Inputs (e.g., natural channel design techniques): Sediment and the associated nitrogen and phosphorus concentration is reduced through methods commonly used in natural channel design that prevent channel and bank erosion that would otherwise be delivered downstream from an actively enlarging or incising urban stream (cross vanes, coir logs, step pools).

2. In stream and Riparian Nutrient Processing (e.g., Denitrification) within the Hyporheic Zone during Baseflow: Some stream restoration approaches include design features (e.g., wetland creation in benches and frequently inundated flood plains) that promote in-stream nutrient processing (e.g., denitrification) during base flow conditions within a stream's hyporheic zones.

3. Floodplain Reconnection during Storm Flow: Additional pollutant removal and volume reduction can be achieved when stream restoration designs include reconnecting the channel to the floodplain (e.g., frequent storm flows access the floodplain versus only very infrequent high flow events). In these cases, the floodplain is able to provide some level of treatment volume, similar to a wetland. For West Virginia, this "floodplain storage" would have to be for rainfall events of 1-inch or less, based on the performance standard in the MS4 General Permit. This means that very frequent storms would have to access the floodplain to take advantage of the storage.

As can be seen, the specific reductions are dependent on the type of stream, existing conditions, and stream restoration approach used. In order to accommodate various approaches, Attachment 1 at the end of this appendix outlines a more generic approach to assigning a volume reduction credit, while Attachment 2 provides an approach that is tailored to specific site conditions.

If stream restoration becomes more widespread as an off-site mitigation practice, it will be necessary to update this guidance and make it more specific to the type of stream restoration approaches employed.

To qualify as "stream restoration" for the purposes of off-site compliance, the design and overall restoration approach should include the following:

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- The restoration design applies to an entire stream reach greater than 100 feet in length that is still actively enlarging or degrading in response to upstream, historic development or adjustment to previous disturbances in the watershed (e.g., road crossing).

- Restoration includes a comprehensive stream restoration design, involving the channel and banks using scientifically and technically appropriate design methods.

- Projects MAY include enhancement through the creation of wetlands and in-stream habitat features within the wetted perimeter of a stream's normal base flow elevation.
- Projects should include reconnection to the floodplain, and this MAY be for storm events generated by the 1-year storm event or more frequent event. This depends on the stream restoration approach, channel design, channel slope, and other factors. Floodplain connection may not be as frequent on step-pool type channels (e.g., Rosgen "B" channel) and/or those with a steep gradient.

Projects, such as the following, do NOT qualify as "stream restoration" to be used for off-site compliance:

- Projects that are primarily designed to protect public infrastructure by bank armoring or rip rap.
- Projects that include hydrologic modification (e.g., straightening or widening of channels) for the purposes of conveyance. For the purposes of this guidance, the regrading and reshaping of stream banks for the purposes of floodplain reconnection as part of a more comprehensive restoration design does not constitute hydrologic modification.
- Small segments of stabilization (e.g., 50 feet or less) in an otherwise unstable reach.
- Projects constructed to provide other types of mitigation, such as for stream and wetland impacts regulated through the Army Corps of Engineers and/or WVDEP. In other words, projects cannot receive "double" mitigation credits.

G.2. Calculating a Runoff Reduction Equivalency for Stream Restoration in West Virginia

There are two basic methods for assigning a runoff reduction equivalent value for stream restoration projects:

1. Equivalent BMP Approach: Use a "typical" stormwater BMP and drainage area for which both runoff reduction and pollutant removal values are known and accepted in West Virginia (e.g., assigned values in the West Virginia Stormwater Design Guidance Manual), and then equate the equivalent linear feet of stream restoration needed to achieve the same pollutant removal. This approach yields a stream restoration equivalent value of 45 cubic feet of volume reduction for each linear foot of stream restoration **that meets the criteria in the checklist below.** The assumptions and computational procedures to derive this value are described in **Attachment 1** of this Appendix. This approach may be considered provisional for West Virginia until such time as state-approved methods are refined.

2. Site Assessment Approach: This approach uses the "Prevented Sediment Inputs" value of stream restoration described in Section 1 of this appendix as a metric for calculating equivalent pollutant and runoff reductions. The approach uses accepted field assessment methods on streambank erodibility, such as the Bank Assessment for Non-point Source Consequences of Sediment (BANCS) (Rosgen, 2001,

EPA, 2012, Doll et al., 2003) to estimate sediment loading from a particular site and from presumed restored conditions. Subsequently, the approach relates the presumed sediment load reduction to equivalent nutrient loading and runoff reduction (again, using bioretention treatment as a benchmark). This method is much more sophisticated than #1 above, and requires site-specific assessment of bank conditions as well as data for stable reference streams. As a result, this approach will probably be phased in as West Virginia communities gain more experience with using stream restoration as part of an off-site mitigation program. The method is outlined in **Attachment 2** of this Appendix. Again, the efficiency provided by the method is conditioned by meeting the criteria in the checklist below.

G.3. Checklist and Resources for Stream Restoration Projects

It is important to note that the runoff reduction value assigned to a particular stream restoration project is dependent on that project adhering to sound planning, design, and implementation standards, as well as identifying and achieving certain performance standards of success. A project that is not well designed or executed will not successfully "offset" the unmet reductions of the site(s) seeking to utilize off-site compliance. For this reason, it is essential for the MS4 or local program to establish standards, performance measures, and monitoring criteria to ensure project success. The following checklists and list of resources are intended to assist the MS4 with development of these standards, performance measures and criteria for stream restoration projects (Beisch, 2012).

Site Selection Guidelines:

Site selection guidelines should be developed to assess and make a determination of what sites are suitable for stream restoration and for use in an off-site mitigation program. Examples of sites which should be avoided include (but are not limited to, based on the discretion of the local stormwater program):

- ☐ **Small segments of restoration within an overall unstable reach or conveyance**
- ☐ **Sites used as mitigation for other regulatory programs (e.g., 404 Permits, 401 Certification, etc.).**
- ☐ **Sites which lack sufficient scale or size to allow for proper funding and capitalization of anticipated maintenance, monitoring, and assurances of meeting success criteria.**
- ☐ **Sites that will not allow for an adequate (e.g., 50 foot minimum) and permanent riparian buffer protection.**
- ☐ **Sites with existing stable streams that are not degraded by upstream watershed development.**

Preferred sites include:

- ☐ **Sites identified as needing restoration in a watershed management plan, stormwater master plan, or similar document.**
- ☐ **Sites where an entire degraded/unstable reach or segment will be restored**

- **Sites which have additional conservation values (community streamside trail system, connectivity to a park, community open space, or other conservation feature (riparian buffers, etc.)**
- **Sites that allow for an adequate (e.g., 50 foot minimum?) and permanent buffer protection**
- **Sites with "entrenched" streams that have lost access to their floodplains during a wide range of storm events, and where restoration can serve to reconnect the stream to its floodplain (this approach will more likely result in runoff reduction benefits)**

Small sites might generally be avoided (due to scale issues) with the exception of:

- **Severe erosional features at the transition between urban drainage inputs and downstream resources (e.g., severe headcuts and erosional issues below historically uncontrolled drainage inputs, especially upstream from important community resources). These projects can be meritorious because of the severity of the erosion problem and impacts on downstream resources.**

Ecological Functions and Values/Permits

- **The restoration of natural stream systems and/or work in jurisdictional waters must receive applicable permits, which may include Section 404 permits from the United States Army Corps of Engineers, State 401 certification from WVDEP, and/or Stream Activity Applications from WVDNR. During their permit review, these agencies may review the restoration methods, the functions and values of the existing resources, and make a determination of whether the project qualifies as ecological restoration.**

Site Assessment

Site assessment should include documentation of the following:

- **Establish existing functional condition to determine the source of functional loss (e.g. instability) in the stream channel?**
- **Determine restoration potential based on an assessment of stream functions (e.g., hydrology, hydraulics, geomorphology) and condition of the watershed**
- **Determine whether the functional "lift" (e.g., improvements in stability, revegetation of eroded areas) from the proposed project can be translated into quantifiable sediment or nutrient reductions? As noted above, reconnecting a stream to its floodplain can also result in some runoff reduction benefits because a higher percentage of storm flows will be spread across a broader and vegetated floodplain area.**
- **Optional: What is the erosion rate in the stream channel, as assessed via physical measurement, historic surveys, and/or erosion assessment methods, such as the Bank Erosion Hazard Index (BEHI).**

Plans

After initial review of site selection and assessment data, and securing permits for work in jurisdictional waters, detailed restoration plans should be developed. Generally speaking, the detailed restoration plans should address:

- **Stream geomorphology**
- **Existing conditions and physical/lateral constraints**
- **Proposed restoration methods and construction methods**
- **Long-term maintenance**
- **Success criteria**
- **Financial and legal assurances for success**

Success Criteria

Appropriate success criteria should be quantifiable and assigned for the site to identify the long-term success of the project and trigger the use of financial assurances in the event of an unsuccessful or partially successful project. Success criteria should be developed for:

- **Riparian buffer restoration**
- **Stream ecological functions and values**
- **Stream erosion and geomorphic evolution**

Monitoring Frequency: The success criteria should define the monitoring frequency and type and nature of reporting. The success criteria should clearly define triggers for additional action and should be used to develop anticipated monitoring and maintenance budgets and long-term financial assurances.

Long-Term Monitoring and Maintenance Plan

- **The applicant should identify the parties responsible for long-term monitoring and maintenance, their ability (financially and technically) to perform the appropriate maintenance and monitoring, the frequency and type of monitoring and the parties responsible for reviewing reports. The long-term monitoring should relate directly to required maintenance or repair actions.**

Financial Assurances, such as Performance Bond (may be applicable for privately-owned or managed sites)

The applicant should provide for appropriate financial assurances and/or a plan for:

- **Initial Maintenance and Monitoring during the establishment period for the stream and buffer (3-5 years)**

- **Long-term monitoring and maintenance (long-term stewardship, monitoring and any necessary permit reporting)**
- **At the local program's discretion, catastrophic damages (set aside for the potential failure of structures or features during events overwhelming initial design criteria (e.g. 100-yr event).**

Typical financial assurances for stream projects (inclusive of all of the above categories) typically range from 5% to 8% of total credit value.

Legal Assurances/Restrictive Covenants

- **The property and associated riparian area or buffer (if any, some projects will be "backyard" restorations in urban areas) should have an appropriate easement which protects the permanency of the project and allows the responsible party to enter onto the property for appropriate monitoring, maintenance and repair.**

Maintenance Agreement/Plan

- **Identifies the responsible party.**
- **Identifies the maintenance responsibilities (success criteria, responsibility for administering financial assurances, responsibility for monitoring and responsibility for long-term maintenance)**
- **"Runs with the land" in a property deed or contains provisions that responsibilities can be transferred to a long-term land steward, such as a land trust, who will then assume responsibility for long-term monitoring and maintenance.**
- **Legally-binding.**

See **Table G.1** for additional design and functional assessment resources for stream restoration.

Table G.1. Design and Implementation Resources for Stream Restoration Projects	
EPA Bank Erosion Prediction Website	Provides documentation and resources for BANCS method (see Attachment 2) http://water.epa.gov/scitech/datait/tools/warsss/pla_box08.cfm
Harman, W., R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller. 2011. *A Function-Based Framework for Developing Stream Assessments, Restoration Goals, Performance Standards and Standard Operating Procedures.* U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds. Washington, D.C.	Outlines a methodology for function-based assessment of impacted and restored streams. This would be a good method to document the "lift" in stream functions based on a restoration project. Download the document at: • www.stream-mechanics.com • http://water.epa.gov/lawsregs/guidance/wetlands/wetlandsmitigation_index.cfm • http://www.fws.gov/chesapeakebay/stream.html
Various web-based resources	Ohio State University STREAMS page that provides spreadsheet tools and educational videos http://streams.osu.edu/ Stream Restoration Assessment and Restoration Examples and Resources http://www.fws.gov/chesapeakebay/stream.html The Natural Channel Design Review Checklist (see also resource papers included here) www.stream-mechanics.com

Attachment 1 (Appendix G): Documentation for "Equivalent BMP Approach"

This addendum documents the method to derive the equivalent BMP value for stream restoration of 45 cubic feet of runoff reduction for each linear foot of stream restoration. There were three basic steps in this approach, as outlined below.

1. Calculate runoff and pollutant loads for a typical drainage area to a BMP

Runoff Reduction spreadsheets developed for the states of West Virginia and Virginia were used to calculate annual runoff volume and pollutant loads (in the case of the Virginia spreadsheet) for a typical drainage area to a BMP. The primary equation used by the spreadsheet to calculate runoff and pollutant loads is the Simple Method (Schueler 1987), and the equation incorporates modified runoff coefficients (Rvs) calculated based on data documented in Hirschman et al. (2008). Default event mean concentrations (EMCs) for total nitrogen (TN) and total phosphorus (TP) provided in the spreadsheet were replaced with default national values from the Watershed Treatment Model (Caraco, 2010) and a load calculation for total suspended solids (TSS) was added into the spreadsheet using default EMCs from Caraco (2010). The assumptions for the drainage area included:

- Drainage area: 1 acre
- Land cover: 100% impervious
- Annual rainfall: 43 inches
- Target rainfall event: 1 inch
- Soil type: HSG C soils

2. Calculate runoff and pollutant load reductions associated with treatment by a typical BMP

Runoff reduction and pollutant removal efficiencies for a typical structural stormwater BMP were applied to the results of Step 1 to calculate the annual runoff and pollutant load reductions associated with the BMP. Level 2 Bioretention was selected to represent the "typical" BMP because of its likely future wide applicability in West Virginia as an effective runoff reduction practice. Runoff reduction and pollutant removal efficiencies for Level 2 Bioretention were taken from the West Virginia Stormwater Manual (CWP, in review). The result of this calculation was an estimate of the annual runoff volume, TN, TP and TSS loads reduced by the "typical" stormwater BMP.

3. Calculate the length of stream that would need to be restored to reduce an equivalent pollutant load

Step 3 involved using a pollutant removal credit for stream restoration to calculate the length of stream that would need to be restored to achieve annual reductions of TN, TP and TSS that are equivalent to what can be achieved with the Level 2 Bioretention. The results were expressed as cubic feet of runoff reduced per linear foot of stream restored and were calculated for each pollutant.

The results varied widely depending on which pollutant was evaluated (range= 45 to 2,455 ft^3/ft), so we chose to use the restored stream length required to achieve an equivalent amount of TN reduction to provide a margin of safety since this credit was the lowest of the three pollutants. The pollutant removal performance values for stream restoration were taken from the City of Baltimore (2006). These numbers are 10-120 times higher than what the Chesapeake Bay Program (CBP) currently allows in their Watershed Model. However, the CBP numbers are currently under internal review and there exists significant evidence that the higher number is justified. The result of this calculation is that every linear foot of stream restored would receive 45 ft^3 of volume reduction credit.

Lastly, we utilized the Maryland Department of the Environment (MDE)'s document *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* guidance for NPDES stormwater permits (MDE, 2011). In this report, MDE documents their method for relating the reduction in pollutant loads from alternative practices into an equivalent impervious acre (the currency of interest in Maryland). The MDE credit is calculated based on the difference in CBP pollutant loading rates for an acre of impervious cover versus an acre of forest. The difference between impervious and forest land is divided into the pounds/foot/year reduced by stream restoration to achieve an equivalent impervious acre factor. Because the Bay TMDL is based on TN, TP and TSS, the equivalent impervious acre analyses for all three pollutants are averaged together to determine a single weighted conversion factor. MDE currently gives credit for treating an acre of impervious cover to every 100 linear feet of restored stream. Assuming a target rainfall event of 1 inch and that 95% of rain falling on an acre of impervious cover becomes runoff, the MDE credit can be converted to a volume reduction credit of 34.5 ft^3 per linear foot of stream restored.

This differential (between 34.5 ft^3 for Maryland and 45 ft^3 for West Virginia seems appropriate since the standards are different (impervious to forest in MD versus 1-inch capture in WV).

Attachment 2 (Appendix G): Documentation for "Site Assessment Approach"

Caveat: It is beyond to scope of this document to provide detailed guidance on the methods (e.g., BANCS) notes below. As such, this document provides a possible framework for the Site Assessment Approach, particularly the translation of sediment erosion rates to an equivalent volume reduction based on pollutant reduction characteristics. Local programs and design consultants are encouraged to explore more detailed guidance on the referenced field assessment methods. The Site Assessment Approach will likely require several test cases and refinement prior to widespread use and adoption for off-site compliance programs in West Virginia. Additionally, this approach is best suited for MS4s that have conducted a comprehensive assessment of their stream networks to target and prioritize candidate stream restoration projects. The stream assessment methods described below (e.g., BANCS, BEHI) are fairly common and used by practitioners to target stream for restoration.

This method is a three step process that involves the following steps:

1. Estimating of stream sediment erosion rates from the "degraded" site proposed to be restored.
2. Converting erosion rates to nutrient loadings.
3. Estimating reduction efficiency attributed to restoration.
4. Equating pollutant reduction efficiency with equivalent runoff reduction for Bioretention Level 2 (using the Runoff Reduction Method and spreadsheet as employed by Virginia DCR).

Step 1. Estimating stream sediment erosion rate

This method is a modification to the "Bank Assessment for Non-point Source Consequences of Sediment" or BANCS method (Rosgen 2001, EPA 2012, Doll et al. 2003) for estimating sediment and nutrient load reductions for this category of stream restoration projects. The BANCS method was developed by David Rosgen and utilizes two commonly used bank erodibility estimation tools to estimate stream bank erosion; the Bank Erosion Hazard Index (BEHI) , and Near Bank Stress (NBS) methods (Rosgen 2001).

An estimate of erosion rate is made for each stream bank, and then multiplied times the bank height times the length of bank of a similar condition, providing an estimate of annual sediment yield in cubic yards and/or tons of sediment/year. Studies have shown that these factors when properly applied can be an excellent predictor of stream bank erosion rate (e.g., Rosgen 2001, USFWS 2012, Doll et al 2003).

The BANCS method has been used by others for the purpose of estimating stream erosion rates. The Montana Department of Environmental Quality (MT DEQ, 2008) used the BANCS method to develop sediment TMDL's and EPA recommends this method for TMDL Guidance (EPA 2012). The Philadelphia Water Department has used the BANCS method to prioritize streams for restoration (Haniman 2012) although cited issues with accuracy most likely attributed to misuse of the BEHI and NBS methods.

Others have used this method to varying degrees of success (Altland, 2012; Beisch 2012) and the BANCS method is similar to the approach that Anne Arundel County, Maryland (Flores 2012) uses to prioritize their stream restoration projects.

The BANCS method has its limitations. A list of concerns is presented below:

- The method is based on the "Rosgen Approach" which uses assumptions regarding bankfull storm frequency which are not universally applicable.
- Frost heaving may be a better predictor of stream bank erosion than NBS.
- Estimates of BEHI and NBS can vary significantly among users.
- Extrapolation of BEHI and NBS data to unmeasured banks can lead to inaccuracies.
- BEHI is not effective in predicting bank erodibility in situations where there are head cuts or storm drain outfalls.
- This method estimates sediment supply and not transport and/or delivery.

Despite these concerns, the studies mentioned above have found good agreement (statistically significant) in using BEHI and NBS to predict stream bank erosion. To improve the consistency of BEHI/NBS scoring, the USFWS is developing a photo glossary to improve standardization in selecting BEHI and NBS. Photo documentation can also address issues regarding extrapolation of BEHI and NBS scores to unmeasured banks. The USFWS is also developing a regional stream bank erosion curve using data from Maryland, D.C. and North Carolina.

The BANCS method uses the following equation:

$S=\sum(c \times A \times R)/2{,}000$

Where: S = sediment load (ton/year) for reach or stream

c = bulk density of soil (lbs/ft3, use local conditions)

R = bank erosion rate (feet/year) (from regional curve)

A = eroding bank area (square feet)

2,000 = conversion from lbs to tons

BEHI and NBS scores are made for each bank and erosion rates are estimated from a graph similar to the one developed by the USFWS with data collected at Hickey Run, Washington D.C.

Output of Step 1: Sediment load in tons/year for reach or stream

Step 2. Converting stream bank erosion to nutrient loading

To estimate nutrient loading rates, the sediment loading rates are multiplied by the median concentrations of total nitrogen and total phosphorus in stream sediments. The default values for TP and TN are from Merritts et al. (2010) and are based on 228 bank samples in Pennsylvania and Maryland. From Merrits et al. (2010), the phosphorus and nitrogen concentrations measured in streambank sediments are:

Total Nitrogen (TN) = *2.6 pounds/ton of sediment*

Total Phosphorus (TP) =*1.2 pounds/ton of sediment*

Output for Step 2: Multiply result for Step 1 by values above to derive tons/year for TN and TP.

Step 3. Estimating reduction efficiency attributed to stream restoration

The BANCS method estimates stream bank erosion but not the efficiency of stream restoration practices (which is why this may be called a *modified* BANCS method). The Spring Branch Study mentioned above is the only documented study where the effectiveness of stream restoration was measured over several years. Sediment and nutrient loading data were collected by automated samplers and instantaneous discharge was measured to determine sediment and nutrient rating curves before and after restoration. Monitoring has continued for 7 years after restoration and sediment and nutrient reductions averaged over this period. Based on the study, the pollutant removal efficiency for stream restoration is assumed to be 50%.[1] This is likely a conservative estimate of efficiency. While this rate can be used in the interim, in the long run, it may not be prudent to use Baltimore County data for West Virginia.

An alternative approach is to use the erosion estimates from banks with low BEHI and NBS scores (e.g., reference sites) to represent “natural” conditions, which is the approach taken by the Montana Department of Environmental Quality (2009). This method uses the difference between the predicted erosion rate from the pre-restoration site and the “natural” reference erosion rate as the stream restoration credit. The Philadelphia Water Department has also suggested using this approach (Haniman, 2012). The alternative approach should be used if the local program commits to collecting data to support higher efficiencies. These data may include representative surveyed stream cross-sections (before and after restoration and measured over several years), bank pins, and other documented monitoring methods.

Output for Step 3: Multiply the TN and TP values from Step 2 by 0.50 to derive post-restoration tons/year for TN and TP.

Output for Step 3 Alternative Approach: Use Steps 1 and 2 for a reference stream or presumed “natural conditions” to calculate the difference between pre and post restoration sediment loads in tons/year:

[1] The 50% pollutant removal efficiency for stream restoration is based on ongoing analysis and discussions between CWP and staff from Baltimore County. The number is subject to change, so users should see updated information if this method is adopted.

Pre-restoration load – Post-restoration load = Load reductions for TN and TP

Step 4. Equating pollutant reduction with equivalent runoff reduction for bioretention

Use the Virginia runoff reduction spreadsheet:

http://www.dcr.virginia.gov/lr2f.shtml

Using an iterative approach using Bioretention Level 2 (in the Drainage Area tab) and a 100% impervious drainage area (in the Site Data tab), model a drainage area size that results in the same load reduction as derived from Step 3 above. This may take separate spreadsheet runs for TN and TP, and pounds should be converted to tons. The following steps should be used:

a. Go to the Drainage Area A tab (D.A. A).

b. Enter a starting impervious cover drainage area size in the "Drainage Area A Land Cover" entry cells at the top of tab, using the soil types characteristic of your area.

c. Enter the same impervious cover drainage area for Bioretention #2 (impervious acres draining to bioretention).

d. Go to the calculation cells immediately below the 9 runoff reduction practices, and see the value for "Phosphorus Removal from Runoff Reduction Practices in D.A. A (lbs/year)." Convert this to tons/year and compare to the value from Step 3 above (load reductions from stream restoration).

e. Use an iterative approach until the values match up: Phosphorus Removal from Runoff Reduction Practices in D.A. A = Load Reductions for Stream Restoration from Step 3.

f. Once the values match, see the value for "Total Runoff Reduction from D.A. A (cf)." This value will be the equivalent runoff reduction value for the stream restoration project.

NOTE: This approach can be used until an equivalent method is developed for West Virginia.

APPENDIX G

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