CSS Long Term Control Plan Update

Green Infrastructure Strategy

City of Alexandria, VA
Department of Transportation and Environmental Services

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GREELEY AND HANSEN

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Executive Summary

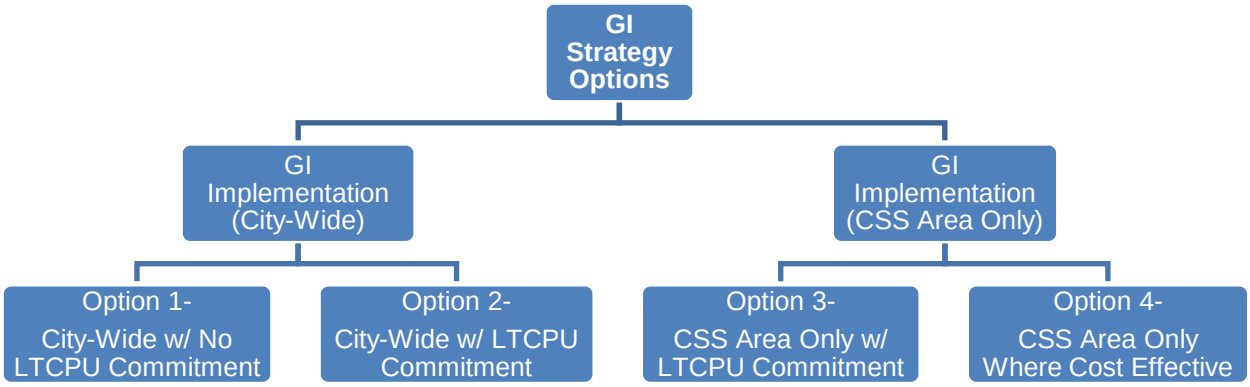
Green Infrastructure (GI) is a source control that reduces stormwater runoff volumes, peak flows, and/or pollutant loads. GI utilizes the processes of infiltration, evapotranspiration, and capture to reduce the amount of stormwater runoff volume. GI can be used as a complementary combined sewer overflow (CSO) control strategy in conjunction with gray infrastructure.

Based on technical evaluation and feedback received from various stakeholders, two main approaches were considered for evaluation as follows:

- GI in the Combined Sewer System Area (CSS) Only
- GI City-Wide

These two approaches were further refined to account for options of implementing GI within the Long Term Control Plan Update (i.e. LTCPU commitment) or outside of the LTCPU (i.e. no LTCPU commitment). Four GI Strategy Options were developed out of these evaluations and are summarized Figure ES-1.

Figure ES-1
GI Strategy Options



A GI Strategy that that provides the City with flexibility to install GI City-Wide while exploring options for implementation within the CSS areas will serve as the best approach to maximizing GI benefits, minimize costs and minimize the potential adverse impacts during construction.

It is recommended that GI Strategy Option 2- City-Wide Implementation w/ LTCPU Commitment be adopted as the City's approach under the LTCPU. The following should be considered as part of developing a GI Implementation Plan for the GI Strategy Option 2:

- Develop suggested criteria for identifying GI projects for implementation;

- Develop project implementation schedules in 5 year increments tied to the CSS Virginia Pollutant Discharge Elimination System (VPDES) Permit cycles;
- Develop GI implementation incentives for private developers and for private property owners;
- Develop GI Maintenance Plans; and
- Monitor ongoing GI projects for construction pricing trends.

It is further recommended that GI be implemented in the City using an adaptive management approach. The City will continue with an implementation and assessment phase for green infrastructure through the next permit cycle (2018-2023). At the end of the assessment, the City would consider adapting the program to include establishing program and target goals for future permit cycles based on the assessment.

Under this approach, the City would continue with the existing green infrastructure pilot included in the current permit cycle (2013-2018). For the next CSS VPDES permit cycle (2018-2023) the City would expand on the existing GI program to include the following:

- Add funding in the City's 10-year Capital Improvement Program and implement a variety of green infrastructure practices for further assessment;
- Evaluate incentives programs for private developers and property owners; and
- Evaluate increasing number of trees including street trees in the CSS area.
- Toward the end of the five year period, assess the cost and effectiveness of the GI program; and
- Based on assessment, consider establishing program and target goals for future permit cycles.
  - Target GI goals either in the CSS or outside it could include acres of Impervious Area (Equivalent Impervious Area) managed by GI, stormwater volume reduction, number of trees/ tree canopies planted, or a cost commitment to GI (specific cost or as a percentage of overall LTCP).

With an adaptive management approach, at the end of each five (5) year cycle, it is recommended to evaluate and modify the program based on actual performance.

Section 1 Introduction

1.1 Purpose

The purpose of this memorandum is to evaluate and develop a high level Green Infrastructure (GI) Strategy for the City of Alexandria as part of the requirements for the City's Combined Sewer System (CSS), Long Term Control Program Update (LTCPU). The steps used in developing the GI Strategy included evaluating the following:

- Evaluation of Regulatory Requirements;
- Green Infrastructure Technology Evaluations;
- Evaluation of GI Strategy in other Cities; and
- Development of GI Strategies specific to the City of Alexandria.

1.1.1 Regulatory Requirements

The City's VPDES Permit (VA0087068) for the Combined Sewer System includes the following requirements related to GI.

- *Green Initiative: The permittee shall study, implement, and promote green infrastructure projects within the CSS sewershed during this permit term. Projects evaluated shall include, but are not limited to: rainfall harvesting, permeable pavements, rain gardens, green roof installation, bioretention cells, urban forestation/reforestation, and public education.*
- *Green Public Facilities: The permittee shall evaluate the practicality of incorporating green infrastructure during major maintenance/enhancement projects at all city facilities (offices, schools, libraries, etc.) located within the CSS sewershed. The permittee shall include with the annual reports, commencing with the report for 2014: (1) a schedule of maintenance/ enhancement projects at city facilities within the CSS sewershed for the forthcoming fiscal year; (2) the City's process for evaluating inclusion of green infrastructure; and (3) green infrastructures planned for selected projects. Technologies to be considered shall, at a minimum, include those listed under the aforementioned Green Initiative Special Condition. Maintenance/enhancement projects for historic designated facilities/structures are exempt from this Special Condition.*
- *Green Maintenance: The permittee shall establish, or alternatively incorporate, a database to manage information on all green infrastructure practices put in place that are owned and/or maintained by the City. The database shall schedule and track maintenance activities to ensure infrastructures are maintained for proper performance. The permittee shall submit to DEQ two updates on the status of the database development. The first update shall be provided on or before 23 August 2014 and the second on or before 23 August 2015. On or before 23 August 2016, the permittee shall submit to DEQ a final report detailing the full database development and implementation.*

It is important to note that these permit requirements are not explicitly required under the LTCPU; however, there are opportunities for synergies with the LTCPU where appropriate.

Additionally, as described in "*Greening CSO Plans: Planning and Modeling Green Infrastructure for Combined Sewer Overflow (CSO) Control*" (USEPA, March 2014), the USEPA requires that any incorporation of GI into a LTCP include analysis in two areas:

- Community and political support for GI; and
- Realistic potential for GI implementation.

The City's CSO Permit and Municipal Separate Storm Sewer System (MS4) permit has load allocations for nutrients and sediment to address the Chesapeake Bay TMDL. The CSS was included in the watershed implementation plan (WIP) submitted to EPA on 29 November 2011. Essentially, waste load allocations assigned to this CSS equates to the City's current Long Term Control Plan consisting of the Nine Minimum Controls. Additional CSO controls resulting from the LTCPU will further reduce these loads below that required by the WIP. The City's MS4 permit mandates nutrient and sediment reduction from separate stormwater areas but not from CSS areas. The CSS area is excluded from the MS4 permit.

1.1.2 Green Infrastructure Technology Evaluation

As part of the LTCPU a CSO technologies screening was conducted to identify and evaluate technology options for use in developing alternatives for CSO Control. A summary of alternatives identified and associated technologies recommended for detailed analysis are described included in the *CSO Control Technologies Screening Technical Memorandum* dated January 2015. Green Infrastructure (GI) was identified as one of the alternatives for further consideration, and based upon a consideration of the benefits and limitations of each of the GI technologies identified, a short-list of GI technologies were identified for further consideration in the alternatives evaluation.

The GI technologies identified in the technologies screening process was further analyzed using the established criteria and included the following technologies:

- Permeable Pavement;
- Planter Boxes;
- Bioswales;
- Bioretention (Rain Gardens); and
- Downspout Disconnects.

Details of the GI alternatives analysis and recommendations are included in the *Alternatives Evaluation: Green Infrastructure Technical Memorandum* dated October 2015. In this technical memorandum, it was recommended GI alternatives be moved forward for scoring and ranking relative to the other alternatives. It was further determined that GI alternatives in the CSO-002, CSO-003, and CSO-004 areas will not achieve the TMDL bacteria reductions for the Hunting Creek on their own; GI is more suited as a complementary technology.

Section 2 GI Strategy In Other Cities

Green Infrastructure (GI) is increasingly being used by major cities across the country for CSO control both to meet regulatory requirements and also as part of city initiatives to create better environments based on economic, social, and environmental benefits associated with GI. A summary of various cities with GI programs and corresponding goals is included in Table 2-1. Details of representative cities is described in the ensuing paragraphs.

Table 2-1
GI Investment in Other Cities

Location	Consent Decree W/ Green Infrastructure?	CSO Annual Overflow Volume, % Reduction Target	Green Investment	
			Proposed Cost ($)	% of Total Investment
Washington, DC (DC Water)	Yes; Amended 2015 (1)	96%	$100-$200 million	4%-8% ($2.6 billion)
Richmond, VA	No	88%	$0(2)	0%(2) ($850 million)
Lynchburg, VA	No	93%	$0(2)	0%(2) ($340 million)
Philadelphia (PWD)	State Approved- 2011 (EPA Admin. Order - 2012)	50%±	$1 billion	63% ($1.6 billion)
New York (DEP)	State Approved; 2012	40%	$1.5 billion	22% ($6.8 billion)
Kansas City (WSD)	Yes; 2010	88%	$3.7 million	1%-2% ($2.3 billion)
Cleveland (NEORSD)	Yes; 2010	89%	$42 million	1%-2% ($3 billion)
Louisville (MSD)	Yes; Amended 2009	88%	$47 million	17% ($377 million)

Note:
(1) On May 20, 2015, the EPA, the Department of Justice, DC Water and the District of Columbia agreed to the Consent Decree Modifications included in the revised agreement.
(2) GI was evaluated but not included as a commitment in the long term control plan to meet the CSO control goals; however, GI may be considered where appropriate and applicable to provide additional benefits.

2.1 Washington, District of Columbia

The 2005 Consent Decree agreement among DC Water, the District, the Department of Justice, and EPA established a schedule for the implementation of a CSO LTCP that included the construction of a series of tunnels and related CSO controls to reduce CSO discharges from the District of Columbia into the Anacostia, Rock Creek, and Potomac Rivers. The LTCP also called for the implementation of $3M of GI

retrofits at DC Water facilities as demonstration projects with pre- and post-construction flow and water quality monitoring to allow for evaluation of the GI implemented. On May 20, 2015, the Environmental Protection Agency (EPA), the Department of Justice (DOJ), DC Water, and the District of Columbia all agreed to modifications included in the revised consent decree agreement to include a Green Infrastructure Program as part of the LTCP. In this modification, GI was proposed for the Rock Creek (Piney Branch) watershed area in place of the Piney Branch tunnel. GI is also proposed for the upstream outfalls of the Potomac watershed with a shorter Potomac tunnel proposed for implementation.

DC Water's approach is Consent-Decree driven and involves a green-gray infrastructure hybrid that allows for the construction of GI where feasible and a reduction in the gray infrastructure. It also involves a phased approach that allows for post construction evaluation of the GI constructed under the first two contracts of the GI program to assess whether the program targets are met and make a determination on whether to revert back to gray infrastructure. The cost of the GI Program is estimated at 4%-8% ($100 - $200 million) of the LTCP.

2.2 Cities of Lynchburg and Richmond, Virginia

The cities of Lynchburg and Richmond, both evaluated GI as an alternative in their LTCP for CSO control, but was not included as a commitment in the LTCP for CSO control goals. However, these two cities have adopted the approach of implementing GI in the city where feasible.

The City of Richmond, for example, has installed GI facilities (bioretention and sidewalk planters) at two city schools (Chimborazo and Norrell Schools) as part of their GI pilot projects. In addition, the City's Stormwater Master Planning Update calls for an integrated approach that includes identifying GI as part water quality improvement projects for implementation.

2.3 City of Philadelphia, Pennsylvania

In 2009 the City of Philadelphia updated their LTCP to include the Green City, Clean Waters Plan that proposes to manage a majority of the City's CSO reductions with GI and will require the retrofit of nearly 10,000 acres within the City. Philadelphia's approach relies mainly on GI for CSO control and is estimated at 63% ($1 billion) of the LTCP.

This program is a public-private partnership and has robust program incentives for private land owners such as the Stormwater Management Incentives Program (SWMIP) established in 2012, which provides stormwater grants directly to non-residential property owners who want to construct stormwater retrofit projects; and the Greened Acre Retrofit Program (GARP), created in 2014, which provides stormwater grants to contractors, companies, or project aggregators to build large-scale stormwater retrofit projects across multiple properties.

2.4 New York City, New York

In 2012, New York State Department of Environmental Conservation (DEC) and New York Department of Environmental Protection (DEP) signed an agreement that modified their LTCP to allow for a hybrid green and gray infrastructure approach for combined sewer overflows reduction. As part of this

agreement, DEP will develop 10 waterbody-specific LTCPs plus 1 citywide LTCP to reduce CSOs and improve water quality in NYC's waterbodies and waterways.

The DEC and DEP have finalized a phased green-gray infrastructure management approach that includes the following GI components:

- City-wide implementation of GI to manage 10% of impervious surfaces by 2030
- Construction of $2 million GI demonstration projects in three neighborhoods

Under this plan, the DEC has agreed to eliminate / defer many of the gray infrastructure projects to allow the DEP time to build and monitor the proposed green infrastructure projects in their place.

New York's GI Program for CSO control is estimated at 22% ($1.5 billion) of their LTCP.

Section 3 Introduction

3.1 GI Strategy Development Process

A number of factors were taken into consideration in order to develop a holistic GI Strategy. This included the following steps:

- GI technologies;
- GI strategy in other cities;
- CSS regulatory requirements;
- Collaboration with Stakeholders;
- Existing City policies and ordinances; and
- Potential impacts of future regulations.

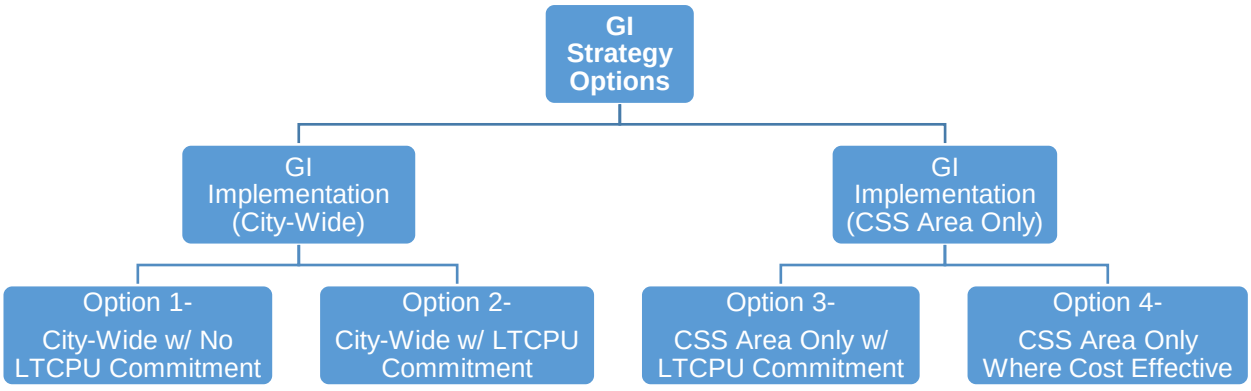
3.2 GI Strategy Options

Based on where GI can be most effective in addressing regulatory requirements of the LTCPU balanced with the other factors listed above the following approaches were developed for consideration:

- GI in the Combined Sewer System Area Only
- GI City-Wide

These two approaches were further refined to account for options of implementing GI within the LTCPU (i.e. LTCPU commitment in the form of an adaptive management approach that allows for a GI implementation and assessment period, and GI target goals setting) or outside of the LTCPU (i.e. no LTCPU commitment). Four GI Strategy Options were developed out of these evaluations and are summarized in Figure 3-1. These options are described in detail in the next paragraphs.

Figure 3-1
GI Strategy Options



3.2.1 GI Strategy Option 1 –City-Wide Implementation w/No LTCP Commitment

Under Option 1, gray infrastructure will be used to achieve the LTCPU goal for CSO mitigation. GI will be implemented as a city-wide strategy as a supplement to the gray infrastructure. This approach will not limit GI to the CSS area and will not include any GI commitment under the City's LTCPU. However, the City will continue with its current GI implementation under existing regulations and policies. This strategy is similar to GI approach used by the cities of Richmond and Lynchburg, VA.

The City will continue with the existing GI implementation under its MS4 Program. GI construction within the CSS under Option 1 will largely be part of re-development projects. This option was evaluated as the baseline for GI implementation.

3.2.2 GI Strategy Option 2 – City-Wide Implementation w/ LTCPU Commitment

The approach for Option 2 calls for use of gray infrastructure to achieve the LTCPU goal for CSO reduction. GI will be implemented as a city-wide strategy as a supplement to the gray infrastructure. This approach will not limit GI to the CSS area but will include GI commitment under the City's LTCPU in addition to the City's current GI implementation under existing regulations and policies.

Under the LTCPU the City will commit to a GI implementation targets tied to the five (5) year CSS permit period and establish goals for GI implementation. As the program progresses, the effectiveness and desirability of GI will be assessed and the program adapted. This option could include the following:

- Establish GI target goals citywide (e.g. cost-based, volumetric reduction);
- Develop a criteria for identifying GI projects for implementation;
- Develop a project implementation schedule;
- GI implementation incentives for private developers and property owners; and
- Develop GI Maintenance Plans.

This allows the City to install GI where it is assessed to be most practical and cost effective City-wide. Under this option, the City could also adopt a targeted GI implementation both within the CSS area and outside of the CSS area.

3.2.3 GI Strategy Option 3 – CSS Implementation with LTCP Commitment

Under the LTCPU the City will commit to a GI implementation targets tied to the five (5) year CSS permit period and establish goals for GI implementation. As the program progresses, the effectiveness and desirability of GI will be assessed and the program adapted. While GI alone will not be able to achieve the LTCPU goals for the City, GI will be implemented as a supplementary strategy on public properties and public right-of-way (ROW) within the CSS area. This option will also include the following:

- Establish GI target goals within the CSS (e.g. cost-based, volumetric reduction);
- Develop a detailed criteria for identifying GI projects for implementation;
- Develop a GI project implementation schedule plan;

- GI implementation incentives for private developers and property owners; and
- Develop GI Maintenance Plan.

This approach provides for the City to adopt a targeted GI implementation within the CSS area:

- Targeted GI within the CSO-002/003/004 areas could be used to offset the potential impacts of future climate change and provide additional capacity in order to supplement the gray infrastructure. Although, it is important to note the water quality benefit of GI is greatly reduced for GI after the gray infrastructure (i.e. storage) is implemented when installed in same sewershed.
- The City's CSO-001 site (located at the intersection of Pendleton Street and Union Street) discharges into Oronoco Bay and out into the Potomac River. Oronoco Bay is not included in the Hunting Creek TMDL and therefore, there are currently no regulatory requirements for the City to address CSO-001 under the current LTCPU. However, implementing GI within this area will complement the City's long-term goal to reduce CSOs into Oronoco Bay. Similar to the City's Area Reduction Plan (ARP), GI could be tied to re-development and be implemented through City-led projects. Over time a reduction in overflow volumes and improvements in water quality can be anticipated. If a regulatory driver, or other driver, eventually emerges to reduce overflows this strategy could potentially reduce the size and cost of a gray infrastructure option. Concurrent with the GI, the City could continue the sewer separation through the ARP with a larger focus on the Pendleton area.

3.2.4 GI Strategy Option 4 – CSS Implementation Where Cost Effective

Under this alternative, GI where practical and cost effective will be used in place of gray infrastructure within the CSS (CSO-002/003/004 areas) to potentially reduce the overall scope and cost of gray infrastructure constructed. A hybrid green-gray infrastructure will be used to achieve the LTCPU goal for CSO mitigation. Under the LTCPU, the City will commit to GI implementation targets tied to the five (5) year CSS permit period and establish goals for GI implementation. This strategy is similar to GI approach used by the City of Wilmington, Delaware.

It must be noted however that as part of the LTCPU process, this option was evaluated and found not to be cost-effective. The CSO volume reductions associated with the GI result in a modest reduction in overflows per year from 50-60 overflows to 40-50 overflows in the typical year. Details of the evaluation are summarized in *Alternatives Evaluation: Green Infrastructure* and *Alternatives Evaluation: Ranking and Recommendation* technical memoranda dated October 2015. The construction of GI within the regulated CSS areas will not result in a significant reduction of the gray infrastructure needed to meet the regulatory requirements.

3.2.5 GI Strategy Recommendation

The use of GI as part of the City's LTCPU addresses nine of the eleven items listed in the vision of the 2008, Eco-City Charter. The Eco-City Charter can be downloaded from the City's website at http://www.alexandriava.gov/uploadedFiles/tes/oeq/EcoCityCharter2008.pdf. It also addresses seven of the nine items in the Environmental Action Plan 2030 (EAP), transportation and solid waste are not directly addressed. The EAP can be downloaded from the City's website at

http://www.alexandriava.gov/uploadedFiles/tes/eco-city/EAP_FINAL_06_18_09.pdf. In addition, the City's citizen education and support services in the *"Build Your Own Rain Barrel Workshops"* promote green infrastructure at the homeowner scale. The City's Green Sidewalks BMP Design Guidelines provides specific instructions for providing stormwater best management practices in the City's public rights-of-way. Adopting GI as part of the City's LTCPU is in line with the City's existing policies.

However, the distribution of land use areas of City-owned parcels within the CSS total 12 acres (2% of the total 540 acres). Fifty-four percent (54%) of the City-owned parcel area is impervious (6.7 acres). The low acreage of City-owned parcels indicates that GI within the CSS will need to serve non-City-owned parcels to have a significant impact on stormwater management.

In addition, a significant portion of the CSS area include the historic downtown areas of the City. This raises concerns about the historic preservation and potential for impacting these areas during construction. Other site constraints such as infrastructure (utilities, pavements, stormwater facilities, etc.) as well as natural conditions (soil types and infiltration rates, water table level, etc.) and, in some cases, pedestrian facilities (ADA curb ramps, sidewalk widths, etc.) could limit the areas within the CSS where GI implementation is feasible. It has also been demonstrated through the technologies screening process and alternatives evaluation that GI as on alternative for CSO control under the LTCPU will not meet the bacteria reduction goals, and can be used instead as complementary tool. The costs of GI within the CSS will not result in a reduction in the cost of gray infrastructure required to achieve the TMDL goals for the CSS.

A GI Strategy that provides the City with flexibility to install GI City-Wide while exploring options for implementation within the CSS areas will serve as the best approach to maximizing GI benefits, minimizing costs and minimizing potential adverse impacts during construction.

It is recommended that GI Strategy Option 2- City-Wide Implementation w/ LTCPU Commitment be adopted as the City's approach under the LTCPU. The following should be considered as part of developing a GI Implementation Plan for the GI Strategy Option 2:

- Establish GI target goals (e.g. Cost based, volumetric reduction) citywide;
- Develop a detailed criteria for identifying GI projects for implementation;
- Develop a project implementation schedule;
- GI implementation incentives for private developers and property owners;
- Develop GI Maintenance Plan; and
- Monitor ongoing GI projects for construction pricing trends

It is further recommended that GI be implemented in the City using an adaptive management approach. The City will continue with an implementation and assessment phase for green infrastructure through the next permit cycle (2018-2023). At the end of the assessment, the City would consider adapting the program to include establishing program and target goals for future permit cycles based on the assessment.

Under this approach, the City would continue with the existing green infrastructure pilot included in the current permit cycle (2013-2018). For the next CSS VPDES permit cycle (2018-2023) the City would expand on the existing GI program to include the following:

- Add funding in the City's 10-year Capital Improvement Program and implement a variety of green infrastructure practices for further assessment;
- Evaluate incentives programs for private developers and property owners; and
- Evaluate increasing number of trees including street trees in the CSS area.
- Toward the end of the five year period, assess the cost and effectiveness of the GI program; and
- Based on assessment, consider establishing program and target goals for future permit cycles.
  - Target GI goals either in the CSS or outside it could include acres of Impervious Area (Equivalent Impervious Area) managed by GI, stormwater volume reduction target, number of trees/ tree canopies planted, or a cost commitment to GI (specific cost or as a percentage of overall LTCP).

With an adaptive management approach, at the end of each five (5) year cycle, it is recommended to evaluate and modify the program based on actual performance.

3.3 Potential GI Project Selection Criteria

A GI project selection criteria should be considered as part of the project implementation plan for the GI Strategy Options discussed. Suggested criteria could include the following:

- Water Quality Improvement
- Volumetric Reduction
- Historic Preservation
- Constructability
- Future Regulations
- Synergy with existing GI Program (MS4 Program)
- Prioritize on Projects Within CSS
- Costs

A weighted criteria approach could be developed to allow prioritizing within the criteria. The criteria and weighted should be determined or updated at the beginning of each 5-year permit period.

Greeley and Hansen LLC
5301 Shawnee Road, Suite 400
Alexandria, VA 22312
571.581.3000
www.greeley-hansen.com

GREELEY AND HANSEN