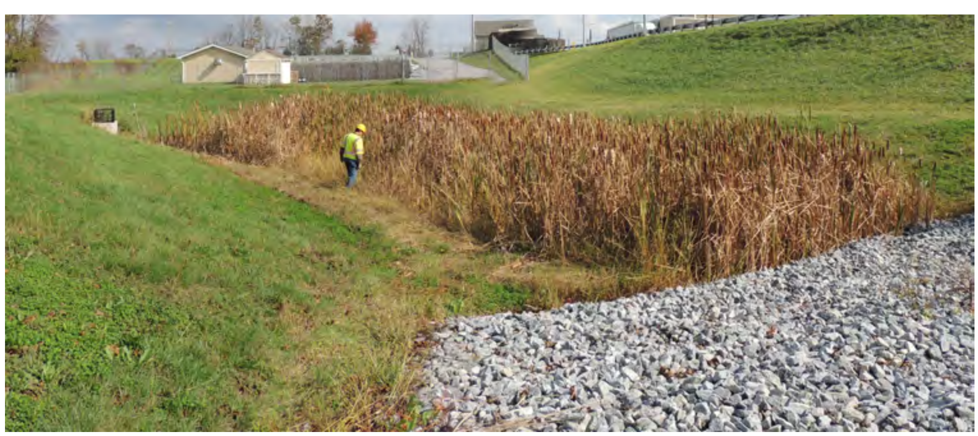
STORMWATER CONTROL MEASURE OPERATIONS AND MAINTENANCE MANUAL

PENNA TURN PIKE



2020

PENNSYLVANIA TURNPIKE COMMISSION
STORMWATER CONTROL MEASURE OPERATIONS AND MAINTENANCE MANUAL

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NOTE: DOCUMENT LINKS (BLUE TEXT) ARE NOT LINKED FOR JUNE 2020 INITIAL SUBMISSION. PDF BOOKMARKS ARE PROVIDED.

ACRONYMS

AIPP- Pennsylvania Department of Labor and Industry, Accident and Illness Prevention Program

BMP – Best Management Practice

COM – Construction Operations Manual

CWA – Clean Water Act

DOM – Design Operations Manual

FVI – Field View Inspection

EPA – U. S. Environmental Protection Agency

ESPC – Erosion and Sediment Pollution Control

LGP – Low Ground Pressure

MS4 – Municipal Separate Storm Sewer Systems

NOT – NPDES Notice of Termination

NPDES – National Pollutant Discharge Elimination System

O&M – Operation and Maintenance

PPE – Personal Protective Clothing and Equipment

PADEP – Pennsylvania Department of Environmental Protection

PAG-02 – PADEP's NPDES General Permit for Stormwater Discharges Associated with Construction Activities

PennDOT – Pennsylvania Department of Transportation

PCSM – Post Construction Stormwater Management

PID – Potential Illicit Discharge

PRP – Pollutant Reduction Plan

PTC – Pennsylvania Turnpike Commission

QA – Quality Assurance

QC – Quality Control

SCM – Stormwater Control Measure

SWAMP – Stormwater Asset Management Program

DEFINITIONS

Best Management Practice (BMP) – a general term used to describe methods that are the most effective and practical means of preventing or minimizing pollution. A BMP can represent both physical features, engineered structures and non-structural methodology approaches to stormwater management.

Field View Inspections (FVI) – a partial SCM inspection focusing only on an identified area of concern within an SCM occurring in between the regularly scheduled Routine Inspections.

Hydrophytic vegetation – plants that have adapted to wet conditions, surviving and growing in the absence of oxygenated soil.

Illicit discharge – any discharge to PTC's right-of-way that is not composed entirely of stormwater and are not permitted pursuant to another type of NPDES permit (e.g. NPDES permit for industrial activities).

Invasive vegetation – plant species that are non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Licensed professional – per Section 102.1 of PA Code Title 25, professional engineers, landscape architects, geologists, and land surveyors licensed to practice in this Commonwealth.

Low Ground Pressure (LGP) Equipment – Equipment that:

1. Weighs less than 5 tons/axial load including all attachments and material loads
2. Ballasted to ensure even axial load distribution
3. Is fitted with turf tread tires, radial ply large diameter tires or tracks
4. Maintains a maximum tire inflation pressure of 7 psi or maximum track pressure of 5 psi.

Municipal Separate Storm Sewer Systems (MS4) – a conveyance or system of conveyances that is:

a) Owned by a state, city, town, village, or other public entity that discharges to waters of the Commonwealth;
b) Designed or used to collect or convey stormwater (including storm drains, pipes, ditches, etc.);
c) Not a combined sewer; and
d) Not part of a Publicly Owned Treatment Works (sewage treatment plant).

National Pollutant Discharge Elimination System (NPDES) – mandated by Section 402 of the CWA for projects that involve the discharge of pollutants into surface waters (including wetlands) for disposal purposes. The EPA has approved a Pennsylvania NPDES Program administered by DEP under the Clean Streams Law.

Quality Assurance (QA) – is the independent verification or measurement of the level of quality of a sample product or service.

Quality Control (QC) – the enforcement of procedures that are intended to maintain the quality of a product or service at or above a specified level.

Routine Inspection – in-depth inspections occurring at standard intervals, looking at all the SCM components, and evaluating all aspects of functionality and performance. It is the SCM inspection used to fulfill PTC's MS4 permit requirements.

Stormwater Control Measure (SCM) – physical features used to effectively control, minimize and treat stormwater runoff.

Stormwater runoff – portion of rainfall (or snowmelt) that does not immediately seep into the ground or evaporate and runs off a surface.

Undesirable vegetation – any vegetation including native, non-native and invasive species which are problematic in a given setting.

Wetlands – areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs and similar areas. Wetlands must be identified in accordance with the 1987 *U.S. Army Corps of Engineers Manual for Identifying and Delineating Wetlands*.

CHAPTER 1

INTRODUCTION

1.1 Background

The Pennsylvania Turnpike Commission (PTC) installs Stormwater Control Measures (SCMs) to control stormwater runoff from the highway system and supporting facilities owned by PTC. These SCMs are engineered structures or devices designed to slow down, hold, infiltrate, and/or treat stormwater runoff before it enters waterbodies and groundwater. These features are a subset of stormwater Best Management Practices (BMPs), which are effective and practical means of preventing or minimizing pollution (Figure 1.1.1). BMPs include physical features as well as design approaches applied to the project prior to construction. The focus of this Publication is maintenance of SCMs.

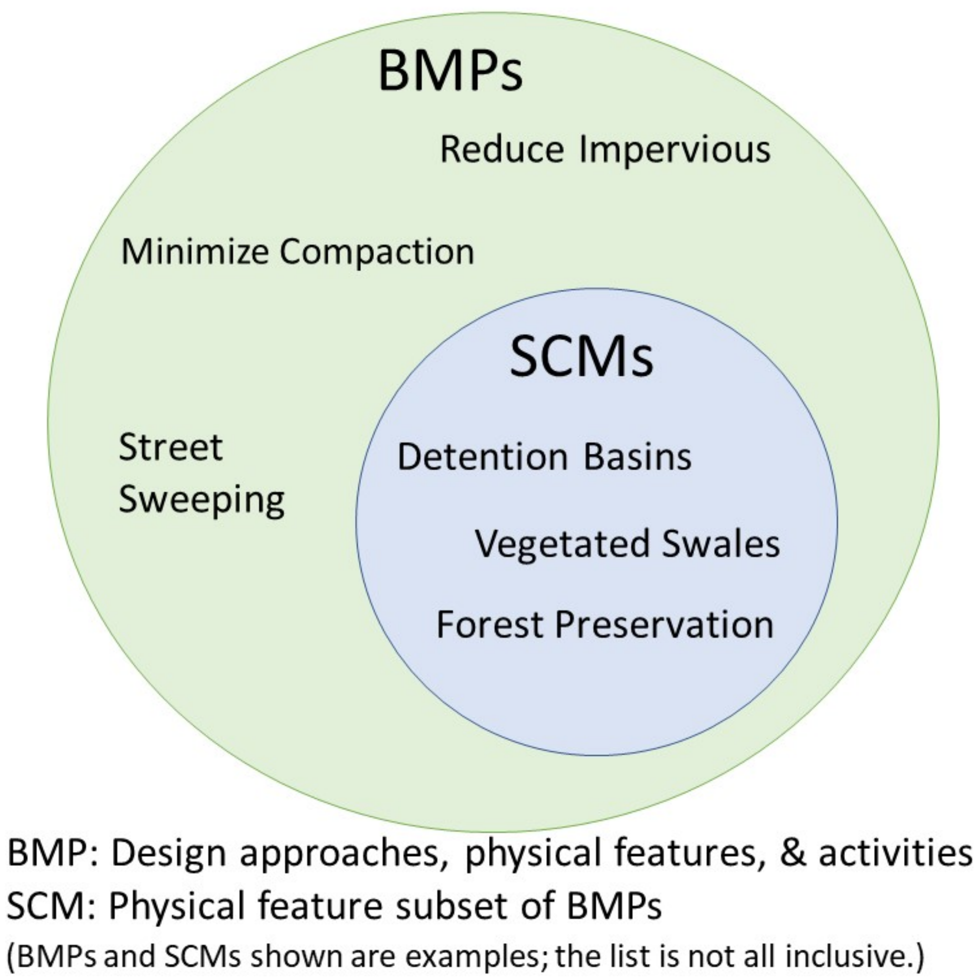


Figure 1.1.1 – SCMs and BMPs

Once constructed, SCMs require routine maintenance, periodic inspections, and as-needed corrective maintenance to ensure they continue to function as designed. A successful SCM maintenance program includes a variety of elements:

- Standardizing processes so the program is applied consistently across all counties and Districts.
- Educating staff on the program and providing training for staff to perform their specific duties.
- Communicating efforts between Design, Construction, and Maintenance.
- Providing an accurate inventory of SCMs to users.
- Performing preventative maintenance on routine schedules.
- Performing corrective maintenance activities as needed in a timely manner.
- Conducting periodic inspections to identify problems and evaluate maintenance practices.
- Documenting program efforts for quality improvement and to maintain regulatory compliance.
- Effective enforcement of the policy.

This Publication serves as the primary reference for all policies and procedures related to inspection and maintenance of SCMs. While similar in nature to certain SCMs, stream and wetland mitigation projects constructed pursuant to 25 Pa. Code 105 are not governed by this publication. Personnel at all levels can find information about required activities, subsequent reporting, and recordkeeping. Cooperation across Department and Maintenance Districts is required for successful implementation of the program. Design, Construction, and Maintenance all play important roles in successful functioning of an SCM (Figure 1.1.2).

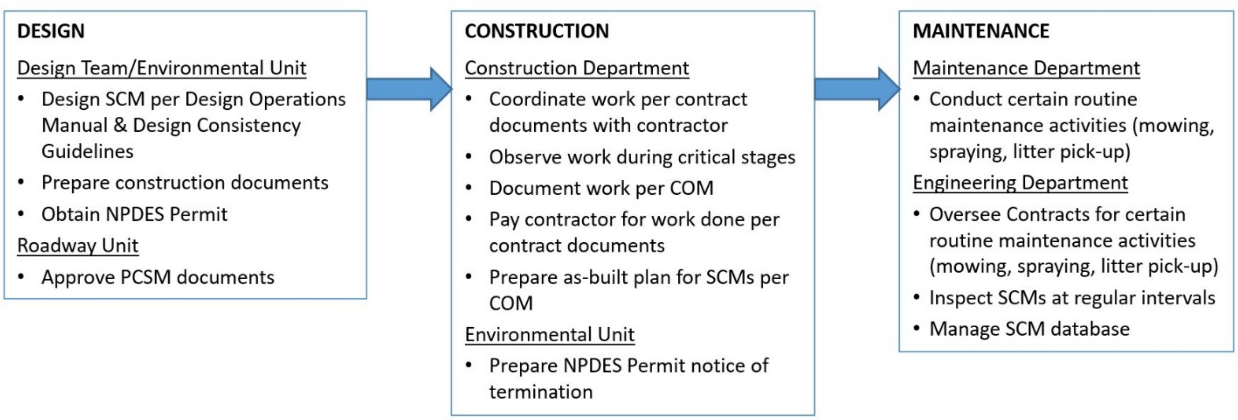


Figure 1.1.2 – Roles of PTC Departments

The following chapters describe common types of SCMs that are constructed by PTC, how these SCMs should be maintained, and what roles and responsibilities the various entities within PTC have in the program.

1.2 Meeting Stormwater Objectives

PTC is responsible for maintaining over 2,400 lane miles of roadways throughout Pennsylvania, most of which either directly or indirectly discharge stormwater runoff to surface waters of this Commonwealth. Adherence to the procedures laid out in this Publication will align PTC's SCM activities with multiple federal and state stormwater and water quality regulations.

Pennsylvania's Post Construction Stormwater Management (PCSM) regulation (25 Pa. Code §102.8) requires a PCSM plan for permits associated with earth disturbance activity. The National Pollutant

Discharge Elimination System (NPDES) Permit for Stormwater Discharges Associated with Construction Activities is required for many PTC projects. Among other things, the PCSM plan must include a program for long-term operation and maintenance of SCMs (see 25 Pa. Code §102.8(f)(10)).

Additionally, PTC is required to maintain an NPDES Municipal Separate Storm Sewer Systems (MS4) Individual Permit for stormwater discharges in urbanized areas of the state (as defined by the U.S. Census Bureau). It does not include combined sewers (sewage and stormwater) or publicly owned treatment works (sewage treatment plant). PTC's MS4 includes conveyance systems owned and/or operated by PTC which are designated or used for collecting or conveying stormwater. This includes SCMs which are legally considered appurtenances to conveyance or drainage systems. SCMs must be maintained in proper working order to achieve the required environmental protection. Adherence to the procedures described in this Publication fulfills the requirements of the permit and any project specific NPDES permits.

An SCM is covered by the PCSM regulation if it was constructed or modified as part of a highway project with an NPDES permit that was issued after the effective date of the regulation. Table 1.2.1 summarizes the applicability of the new regulation to each type of NPDES permit: Individual and General (PAG-02).

Table 1.2.1: NPDES Permit Types

Permit Type	PCSM Regulation Applicability
Individual	Permit issued after November 19, 2010 or Permit renewed after January 1, 2013
General	Notice of Intent approved after December 7, 2012

Consistent with PTC's Strategic Plan, all PTC-owned SCMs will be maintained to provide environmental protection, prevent pollution, and comply with environmental legislation and regulations.

1.3 SCM Types

Chapter 7 of PTC's Design Consistency Guidelines describes the types of SCMs that are recommended for use along the highway system. The most common SCM types that have been constructed by PTC along roadways include dry extended detention basins, wet basins, infiltration basins, vegetated swales, vegetated filter strips, infiltration trenches, infiltration berms, and bioretention (aka, rain gardens). Service plazas, stockpiles, vehicle maintenance facilities, and other non-highway sites offer opportunities for other types of SCMs, such as pervious pavement and manufactured treatment devices. A standard naming convention was created for the various SCM types that have or may be installed by PTC. Table 1.3.1 presents the SCM name and three-letter abbreviation, called Type Code, for each SCM type.

Table 1.3.1: SCM Name and Type Code

SCM Name	Type Code	SCM Name	Type Code
Basin, Dry Detention	BDD	Non-Basin SCM, Other	NBO
Basin, Dry Extended Detention	BED	Pervious Pavement, Asphalt	PPA
Basin, Dry Ultra-Extended Detention	BUD	Pervious Pavement, Concrete	PPC
Basin, Infiltration Detention	BID	Pervious Pavement, Pavers	PPP
Basin, Other	BOT	*Reforestation/Tree Plantings**	*RTP*
Basin, Naturalized Detention	BND	Regenerative Step Pool	RSP
Basin, Wet Detention	BWD	*Riparian Buffer Enhancement**	*RBE*
Bioretention	BRE	*Riparian Buffer Offset**	*RBO*
Bioretention w/Underdrain	BRU	*Soil Amendment Restoration**	*SAR*
Constructed Stormwater Filter	CSF	Stormwater Wetland	SWE
Flow Dispersion, Forest/Buffer	FDF	*Stream Restoration**	*SRE*
Flow Dispersion, Veg. Filter Strip	FDV	*Stream Stabilization**	*SST*
*Forest Preservation**	*FPR*	Subsurface Detention Storage	SDS
Infiltration Berm	IBE	Subsurface Infiltration Trench	SIT
*Landscape Restoration Meadow**	*LRM*	Vegetated Filter Strip	VFS
Level Spreader Outfall	LSO	Vegetated Filter Strip, Steep Slope	VSS
Manufactured Treatment Devices	MTD	Vegetated Swale	VSW
Media Filter Drain	MFD	Vegetated Swale w/ Check Dams	VSC

The SCM types in italics and with an asterisk in Table 1.3.1 have a self-preserving nature, resulting in minimal need for regular maintenance and inspection. Once construction is complete and initial vegetation establishment occurs, these SCMs should not require extraordinary maintenance to properly function. These SCMs should be listed in the inventory for tracking and protection purposes, but in general, they will require less effort to maintain and inspect. A thorough description of each SCM type, including illustrations, relevant inspection information and required maintenance procedures, are included in Chapter 6.

1.4 Stormwater Program Software Platforms

PTC utilizes several software programs to administer the various aspects of the stormwater program including inspections, maintenance, repairs and compliance reporting.

SCM Inventory and Inspections

In order to track the stormwater infrastructure and inspection activities, PTC has compiled an extensive inventory of stormwater facilities data known as the stormwater inventory or database schema (the database schema is the definition of the tables, fields, and data relationships that are contained within the database). PTC manages two primary electronic environments for managing data within their stormwater inventory: ArcGIS Online, and the on-premise environment. The on-premise environment contains a QC Service, and an approved data repository ("SDE").

Each of these environments serves a unique role in the data management and distribution processes of stormwater infrastructure data. The ArcGIS Online environment is hosted by Esri. ArcGIS Online is used to enable field accessibility using the Collector and Survey123 field inspection tools. The QC Service is the primary editing environment for both edits of existing data, and incorporating new stormwater data. Because all field data is stored in ArcGIS Online, then synced automatically to the QC Service, there may be data stored here that is not considered 'accepted' ('accepted' data has been reviewed, verified, and approved as final data). For details on the synchronization of data between the field tool and the on-premise system, see Appendix A Section A2.3.4.

The on-premise environment is the environment used to store, backup, report, and distribute the data to the entire PTC organization. Edits made into the ArcGIS Online database will be regularly synced into the QC Service to be reviewed, approved, and moved into the on-premise environment via a second synchronization procedure. The on-premise environment includes a Structured Query Language (SQL) based database and Portal for ArcGIS, both hosted on-premise by PTC. The on-premise environment is also the source for stormwater data reporting and analyses. The sections below further define and describe these environments and their intent.

The inventory updating, QA/QC and maintenance will be overseen by PTC Engineering. Detailed information about both the ArcGIS Online and the on-premise environment and inventory procedures are contained in Appendix A: SCM Desktop Standard Operating Procedures.

Maintenance and Compliance Reporting

PTC utilizes a GIS based platform tailored to manage the overall stormwater program and MS4 compliance. As part of its multiple permit functions, it will receive the inspection results from the on-premise SCM Inventory information and generate work orders for required SCM repairs and maintenance. Its function includes permit tracking, report generation and numerous other activities beyond the O&M covered in this publication.

1.5 Related PTC References

The Publication is intended to be used in conjunction with other PTC technical references; it is not a standalone reference. The following list includes some, but not all, references that may be applicable and consulted as needed. PTC publications are available on PTC's intranet website.

PTC Publications

1. Design Consistency Guidelines (DCG)
2. Design Operations Manual (DOM)
3. Construction Operations Manual (COM)
4. Maintenance Manual
5. Maintenance and Protection of Traffic Standards - Maintenance
6. Maintenance and Protection of Traffic Standards
7. Maintenance Department Pesticide Applications Guidelines
8. Quality Improvement Website
9. Foreman's Manual

1.6 Disclaimer

This Publication is intended to provide guidance on maintaining typical types of SCMs owned and maintained by PTC. Common SCM configurations and problems likely to be encountered are the focus of the Publication; it is not possible to address every configuration or problem that may be encountered. Therefore, these are guidelines not intended to be a comprehensive reference for all variations of SCMs. Users are expected to apply sound professional judgement. Additional references should be utilized as needed to assess atypical situations encountered to maintain safe and functional SCMs.

This Publication does not address environmental, historic preservation, traffic control, or safety implications. They may be mentioned for reference only as it pertains to a specific discussion. Although developed with safety and minimizing environmental harm in mind, the procedures presented in this publication may not be appropriate in all situations. The practitioners will be responsible for ensuring that procedures considered are consistent with environmental standards and safety codes within the jurisdictions involved, as well as obtaining the required permits before starting work. Always follow all PTC and other applicable requirements.

CHAPTER 2

INVENTORY PROCEDURES

2.1 SCM Identification System

Every SCM PTC is responsible for maintaining is assigned a unique identifier (SCM_ID) comprised of five attributes separated by single dashes. The five identifiers are as follows:

1. Route
2. Milepost
3. Direction
4. Offset
5. SCM Type

Route

There are eight routes that are part of PTCs system, each with its own lettered symbol. Symbols and associated routes as follows:

- T = Mainline / I-76, I-70, I-276
- B = Beaver Valley Expressway / I-376
- G = Amos K Hutchinson (Greensburg) Bypass / PA 66
- M = Mon-Fayette Expressway / PA 43
- S = Southern Beltway / PA 576
- A = Northeast Extension / I-476
- C = Connector / Breezewood Connector to I-70
- H = Interstate 95 (Previously T-356.4 to 359)

Milepost

Milepost delineates the SCM location along the Turnpike route rounded to the nearest hundredth. The location is determined via a line from the centroid of the SCM to a point perpendicular to the centerline of the Turnpike route. A leading zero should be used when the milepost is less than 100. For example, milepost 28 is denoted “028.”

Direction

Describes the side of the route on which the SCM is located. Options as follows:

- EB = Eastbound
- WB = Westbound
- NB = Northbound
- SB = Southbound

Offset

The perpendicular distance, in feet, rounded to the nearest whole number, of the SCM’s centroid from the PTC centerline. Leading zeros should be used when the offset is less than 1000. For example, offset 47 feet is denoted “0047.”

SCM Type

SCMs are classified as one of thirty-six different SCM types, derived primarily from PADEP's *Stormwater Best Management Practices Manual* which are described in Chapter 6 of this manual. The SCM Types are represented by the Type Codes presented in Table 2.1.1:

Table 2.1.1: SCM Type and Type Code

SCM Type	Type Code	SCM Type	Type Code
Basin, Dry Detention	BDD	Non-Basin SCM, Other	NBO
Basin, Dry Extended Detention	BED	Pervious Pavement, Asphalt	PPA
Basin, Dry Ultra-Extended Detention	BUD	Pervious Pavement, Concrete	PPC
Basin, Infiltration Detention	BID	Pervious Pavement, Pavers	PPP
Basin, Naturalized Detention	BND	Reforestation/Tree Plantings	RTP
Basin, Wet Detention	BWD	Regenerative Step Pool	RSP
Basin, Other	BOT	Riparian Buffer Enhancement	RBE
Bioretention	BRE	Riparian Buffer Offset	RBO
Bioretention w/Underdrain	BRU	Soil Amendment Restoration	SAR
Constructed Stormwater Filter	CSF	Stormwater Wetland	SWE
Flow Dispersion, Forest/Buffer	FDF	Stream Restoration	SRE
Flow Dispersion, Veg. Filter Strip	FDV	Stream Stabilization	SST
Forest Preservation	FPR	Subsurface Detention Storage	SDS
Infiltration Berm	IBE	Subsurface Infiltration Trench	SIT
Landscape Restoration Meadow	LRM	Vegetated Filter Strip	VFS
Level Spreader Outfall	LSO	Vegetated Filter Strip, Steep Slope	VSS
Manufactured Treatment Device	MTD	Vegetated Swale	VSW
Media Filter Drain	MFD	Vegetated Swale w/ Check Dams	VSC

Permanent erosion control measures, such as rock aprons and rock energy dissipaters, are not considered SCMs and are not included in the inventory. Rather, as described in Chapter 5, they are inspected and maintained as part of the overall SCM they are associated with.

Example

For example, the SCM pictured in Figure 2.1.1 is a Dry Extended Detention Basin located on the Northeast Extension. The SCM_ID of A-026.57-NB-0132-BED is determined as follows:

- Attribute 1: The SCM is located on the Northeast Extension/I-476 so it gets an **A**.
- Attribute 2: The SCM centroid is perpendicular to the centerline at milepost **26.57**.
- Attribute 3: The SCM is on the Northbound side of the route so it gets a **NB**.
- Attribute 4: The SCM centroid is offset perpendicular from the centerline **132** **(feet)**.
- Attribute 5: The SCM type is a Dry Extended Detention Basin so it gets Type Code **BED**.

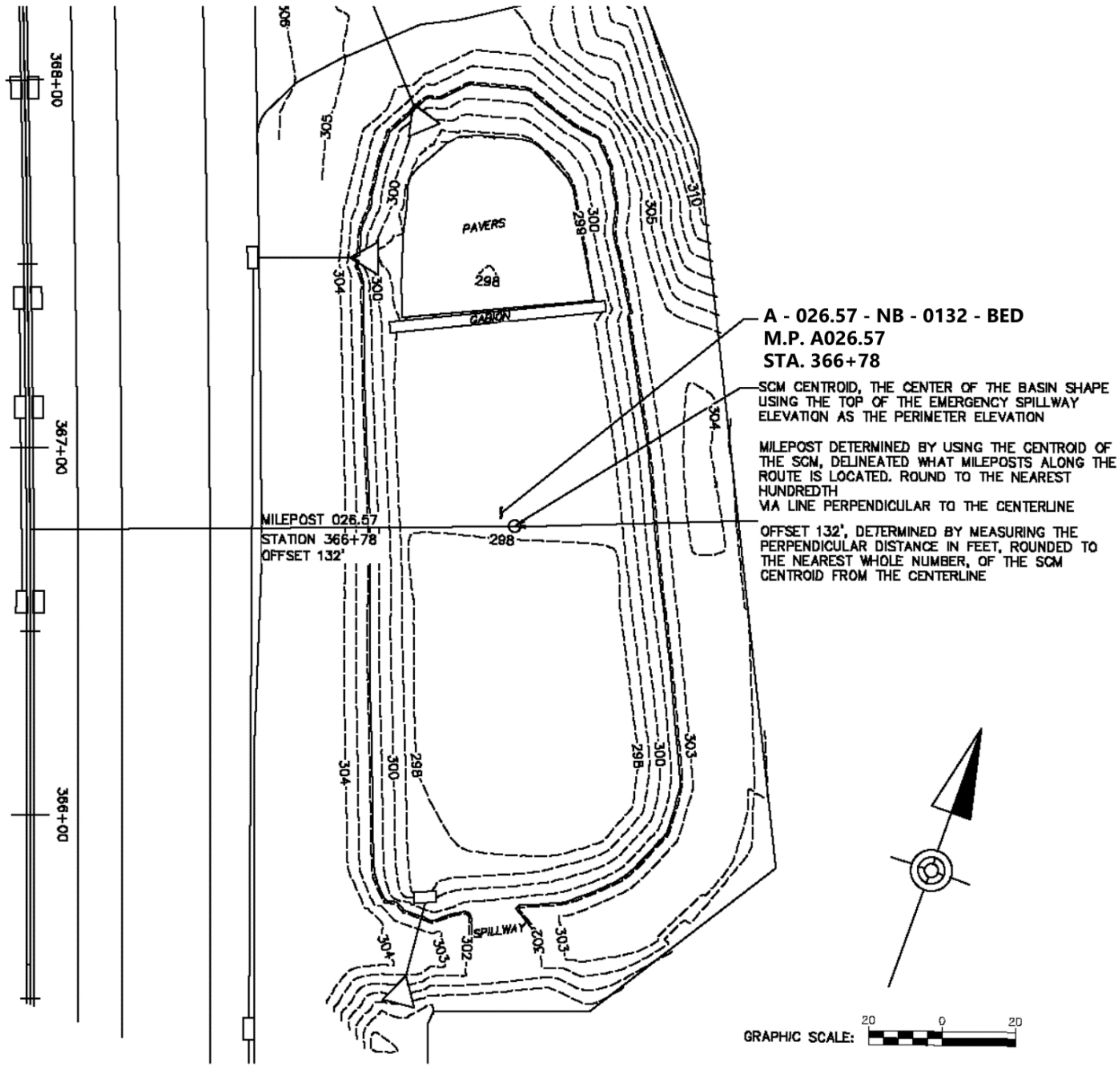


Figure 2.1.1: Example SCM_ID Determination

2.2 Inventory Data

PTC has developed a master stormwater inventory consisting of GIS-based data sets, including SCMs, structures such as inlets and manholes, and conveyances such as pipes and swales. The current master stormwater inventory is a result of digitizing design plan sheets, migration of legacy spreadsheets and tables, and historical inspection information. While the master stormwater inventory should not be considered complete, the SCM specific data sets, known as the SCM inventory, routinely undergoes thorough review and should be considered to be up to date and accurate.

The master stormwater inventory is stored in an enterprise spatial database based upon the Esri ArcGIS platform. Each data set entity is displayed on different layers in the ArcGIS platform.

The SCM inventory consists of over 85 individual data fields for each SCM ranging from SCM type and location to watershed, maintenance access and PCSM plan number. The data fields and their descriptions are included in Appendix B. Within PTCs ArcGIS Platform, this SCM Inventory information is contained in two database entities:

1. **Stormwater Control Measures**: Polygon features, representing the footprint of the SCM. The SCM features carry key inventory attributes such as SCM ID, Access Type, etc., as well as detailed information about the SCM components. The fields associated with the polygon are those required to complete field inspections and are explained more in Section 3.5.
2. **SCM Centroids**: Each Stormwater Control Measure polygon has one related centroid. Centroids are point features, with attributes storing ancillary locational information such as watersheds, PTC maintenance districts, county name, etc. This information is relevant for tracking MS4 permitting information, assigning maintenance activities and similar tasks.

2.3 New Construction Projects

Newly proposed SCMs will be added to the inventory when the project is advertised for construction bids. PTC Engineering will work with the project design consultants to collect the required information. The primary source of SCM data is the Post Construction Stormwater Management (PCSM) Plan. Projects that require an NPDES Permit for Stormwater Discharges Associated with Construction Activities are required to have a PCSM Plan. In accordance with 25 Pa Code 102, PCSM Plans must include SCM locations, design specifications, receiving surface water names and designations, and other information. Most if not all of the data in the SCM inventory database can be found in the PCSM Plan.

The process to added newly proposed SCMs is as follows:

1. A SCM_ID shall be assigned by the design consultants as described in Section 2.1 of this manual.
2. The PTC Design Project Manager collects the SCM attribute and component information from the project designer using the standard data collection instructions outlined in the COM.
3. The PTC Design Project Manager provides the SCM information to PTC Engineering-RSDU.
4. PTC Engineering adds the SCM information to the inventory following the procedures outlined in Appendix A, Section A3.2- Creating Stormwater Features. The SCM Centroid field “Active Flag” is left “Inactive” prior to acceptance.
5. At the conclusion of construction, PTC Engineering changes the SCM Centroid field “Active Flag” field to “Active” initiating the routine cycle PTC inspection and maintenance activities for the SCM.

PTC inspection and maintenance for new SCMs will begin after the final walk through and project acceptance.

2.4 Existing SCMs

Prior to the issuance of this publication in 2020, several hundred SCMs had been constructed by PTC. To the extent possible, these existing SCMs have been added to the inventory. However, several scenarios may require PTC to edit existing features. These include, but are not limited to, SCM redesign, updating attributes for new features, and reviewing updates made by field inspectors. When edits are required, users will utilize the Stormwater Management QC application as described in Appendix A, Section A3.3-Editing Existing Stormwater Features and Inspections.

In some instances, existing previously un-inventoried features may be identified for addition to the inventory. These features should be added as outlined in Appendix A, Section A3.2- Creating Stormwater Features.

For existing SCMs it is important to note that NPDES permits did not require a separate PCSM Plan until 2003. Few projects constructed prior to 2003 have a separate plan detailing SCMs. If a PCSM Plan is unavailable for a project in which SCMs were constructed, other construction plans, such as those listed below, may contain SCM information that can be used.

- Erosion and Sediment Pollution Control (ESPC) Plan
- Contour Grading and Drainage Plan
- Construction (Roadway) Plan
- Landscaping Plan

Procedure to Modify Inspection/Maintenance Requirements

It was not until about 2007 that PCSM Plans consistently included instructions for long-term operation and maintenance (O&M) of the SCMs (aka, stormwater BMPs). Generally, the instructions called for a combination of regularly scheduled (e.g., yearly) and storm-event-based inspections. PTC is required to adhere to the O&M stipulated by the as-built PCSM Plan for all existing SCMs.

As a means to create a more consistent protocol, in coordination with PADEP, PTC developed a process to review existing SCMs and apply the appropriate maintenance protocol to them. The goal is to have consistent inspection and routine maintenance activities and cycles for each SCM type to the extent possible, regardless of when they were constructed. The procedure to migrate an existing SCM onto the routine cycles detailed in this Publication falls into one of two scenarios.

Scenario A:
An existing SCM constructed with no NPDES permit or with no O&M instructions in the PCSM Plan. If the existing SCM was constructed without a PCSM Plan (i.e., not part of an NPDES permit) or prior to the inclusion of O&M instructions in the PCSM Plan, it has no associated regulatory inspection requirement and should follow the standard inspection and maintenance protocols in this Publication. Inspections should begin with a Routine Inspection, and then they should follow a schedule based on the standard cycles.

Scenario B:
An existing SCM constructed with an NPDES permit. The NPDES PCSM Plan O&M requirements must be followed until the steps outlined below are completed. In order to replace the O&M requirements in the PCSM Plan, an evaluation of the SCM must be performed to determine if standard procedures are appropriate. The *Existing Stormwater Control Measure Operation and Maintenance Determination Form* (O&M Determination Form), is used by the licensed professional to guide the evaluation, document findings, and propose changes to the O&M requirements in the PCSM Plan. A copy of the form is included in Appendix C.

The review includes looking at the SCM's design and site limitations, including the following:

Design Limitations

- Excessive loading ratio - Loading ratio exceeding the 2006 PA Stormwater BMP Manual guidelines (e.g., 5:1 max. impervious drainage area to SCM infiltration area).

- Lack of pretreatment - The absence of a forebay, grass filter, gravel diaphragm, or other mechanism for reducing sedimentation within the main SCM area.
- Unique SCMs - SCMs designs that are dissimilar to common SCM types.
- Proprietary SCMs - SCMs that would default to manufacturer's O&M guidelines.

Site Limitations

- High risk of failure - An unlined basin in karst terrain with minimal depth to bedrock.
- History of vandalism or illegal dumping.
- History of intensive O&M to maintain SCM function - Consult with maintenance and engineering personnel (could be corrected over time via a Routine inspection).

The O&M Determination Form provides a systematic approach to verify the applicability of standard inspection and routine maintenance cycles, and to identify SCMs that require special conditions, as noted above. Each question on the form should be answered, and the form is considered complete when the licensed professional has completed the "Certification" section. Each existing SCM must be evaluated separately by a licensed professional (defined in 25 Pa Code 102.1) using the following five-step process. This process is also illustrated in Figure 2.4.1.

1. Obtain the PCSM Plan and review the existing SCM inspection cycle(s). If one is not available, use another plan that provides adequate detail. If no plans are available, either (a) wait until a Routine Inspection is completed and arrange for topographic survey of SCM if needed; or (b) consult with Maintenance and Engineering Department personnel on known issues.
2. Following the decision points shown in Figure 2.4.1, review the plans to identify potential design limitations associated with the SCM and the surrounding site.
3. Complete the O&M Determination Form. Evaluate the SCM for certain limiting conditions, which may indicate the need for more frequent inspections than the standard cycle.
4. Record any special maintenance items on the PCSM Plan that are significantly different than the routine maintenance identified in this Publication for that particular SCM type.
5. Submit the O&M Determination Form to PTC Engineering.

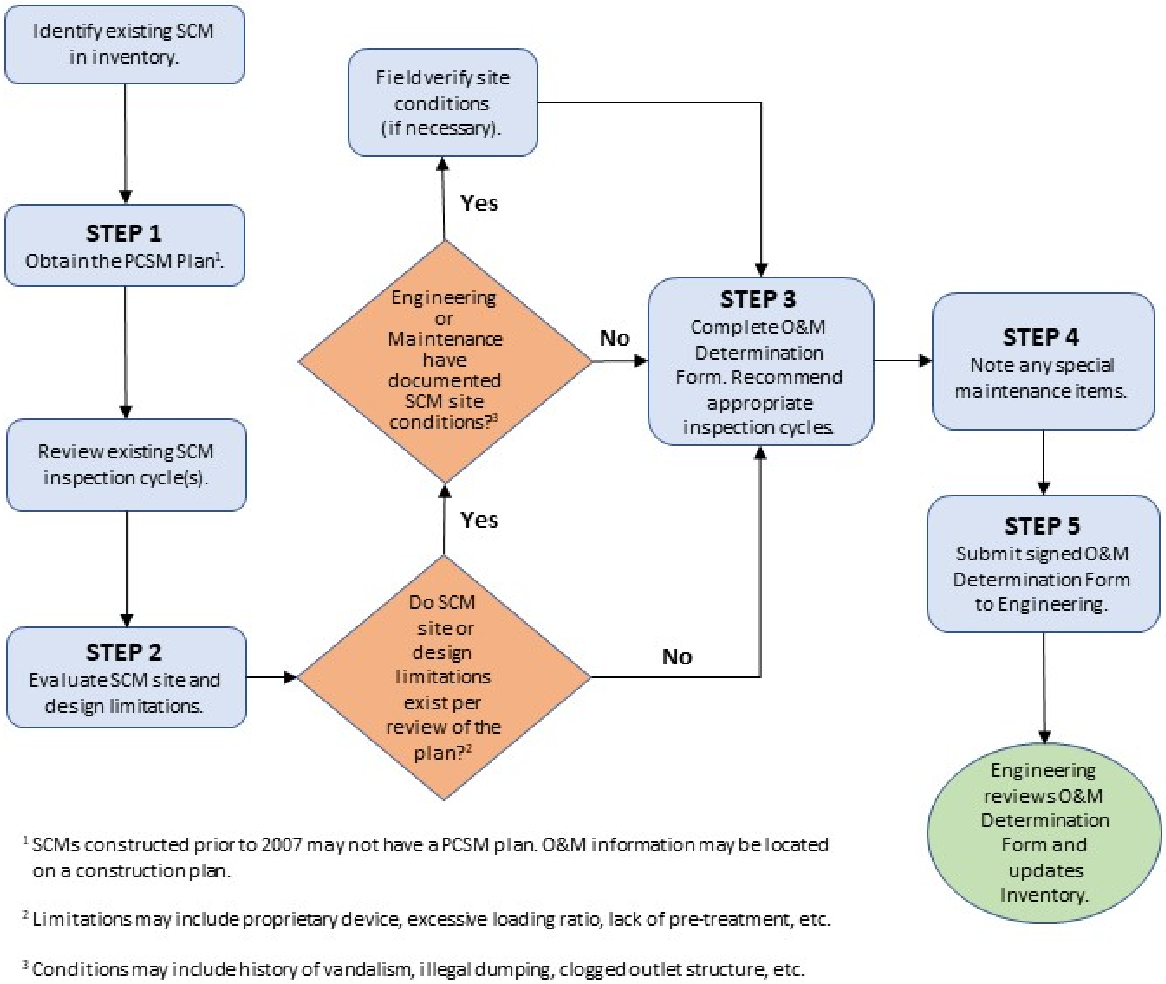


Figure 2.4.1: Process Flow Chart for Evaluating Existing SCM Maintenance Requirements

Examples of recommended modifications to existing SCM inspection and routine maintenance cycles are provided in Table 2.4.1 and Table 2.4.2, respectively. PTC Engineering will review the submitted forms and update the SCM inventory database accordingly. Upon request from PADEP, PTC will provide a list containing SCMs with inspection and maintenance activities and cycles that differ from the original PCSM Plan.

Table 2.4.1: Examples of Inspection Cycle Modifications

SCM ID	Current Cycle (yrs)	Recommended Cycle (yrs)	Justification
T-27.35-EB-113-BID	1 + after >1” rainfall event	Standard	Design is consistent with PA Stormwater BMP Manual; no history of problems.
A-92.05-SB-95-BRE	1 + after >1” rainfall event	1	Excessive impervious area loading ratio; no significant history of problems.
M-19.55-NB-60-SIT	1	No change	Maintenance documented multiple incidents of vandalism.
T-219.71-WB-93-BOT	3	Standard	No PCSM Plan or O&M requirements. Routine Inspection did not reveal major problems.

Table 2.4.2: Examples of Routine Maintenance Modifications

SCM ID	Current Requirement	Recommended Requirement	Justification
B-27.40-WB-79-BDD	Mow 4x/yr	Standard	Update to current policy. No apparent need for more frequent mowing.
A-83.89-SB-95-BWD	Remove sediment 2x/yr	No change	History of sediment accumulation in SCM reported by maintenance.

2.5 SCM Plan Storage

Plans containing information about a PTC-owned SCM are stored electronically on PTCs Engineering drive. A PDF of the plan should be placed in the appropriate location under the Engineering drive folder. If the as-built PCSM Plan is not available, the PCSM Plan that was submitted with the NPDES NOI/application should be copied into the folder. SCMs are placed in a folder by each of the five Maintenance Districts.

Project folders are created by the Engineering Roadway Department and generally use the following naming convention:

T:\Operations\Programs\SCM\District_1\1_Operational\1_PA Turnpike Personnel Inspected

The electronic plan file is named according to the following convention:
T-028.58-WB-0340-BDD

2.6 Adding and Modifying Data

SCM Inventory Data

The SCM inventory is managed solely by PTC Engineering and can be considered to be up to date and accurate. Over time, construction projects may impact the SCM inventory by yielding new SCMs that must be appended to the database or causing SCMs to be taken out of service. A specific workflow process is in place within PTC to identify these impacts and make the appropriate updates to the SCM inventory in a timely fashion.

Because this SCM inventory is carefully curated, maintenance forces and inspectors in the field should not make assumptions to update or otherwise edit an SCM's feature status, ownership information, or location.

Information that is appropriate to update in the field is specifically identified in Appendix D, Section D4.2.

2.7 Signage

Effective signage or delineation of an SCM can prevent unintentional disturbances that affect function. Proper signage also aids in locating the SCM in the field while helping to ensure maintenance tasks are performed. And in public areas, informational signage can promote public awareness and education.

Though PTC does not require formal maintenance directive signs at this time, (e.g., "Do Not Mow" or "No Herbicides"), it is recommended that appropriate directive signage following PTC's standards guidelines be placed at SCMs that require specific maintenance directives.

At a minimum, PTC does require identification delineation signage at all newly constructed SCMs (post 2020) to aid identifying SCMs in the field in the form of a flexible delineator post (SCM Marker). PTC is retroactively installing delineators as feasible at existing locations. The SCM Marker is a white FG500 56-SA PATP Post with a blue water drop decal on the convex face (Figure 2.7.1). Where multiple delineators are used to define the limits of an SCM, the first delineator (as described below) may include a color band or other identifying mark to indicate the start of an SCM. To prevent possible erosion at the base of markers located in grassed areas, the surface around the base should be protected with stone.

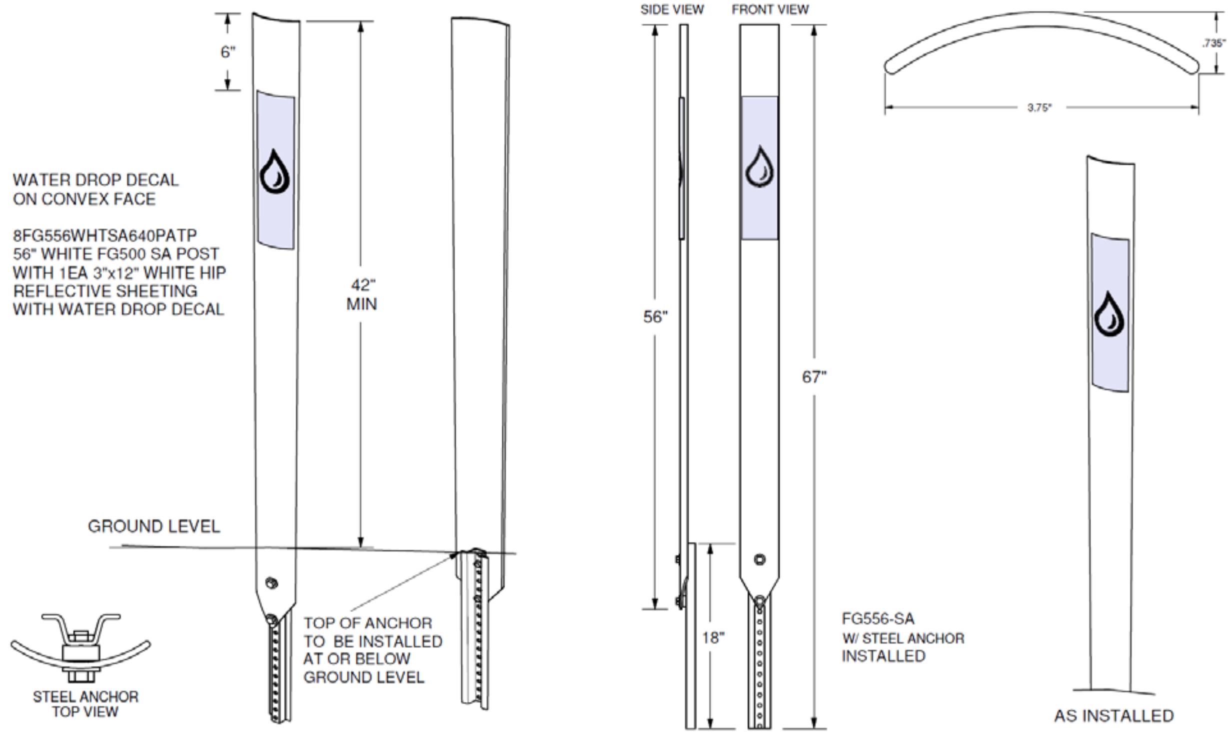


Figure 2.7.1: SCM Marker FG500 56-SA PATP

SCM Marker Placement

Signage placement is dependent on SCM type. Some SCM types are more clearly delineated by using multiple signs. For the purposes of signage, SCMs can be broken down into three categories: linear SCMs, basin SCMs, and underground SCMs (Table 2.7.1). Each category has its own requirements for sign placement (Figure 2.7.2).

The following sections detail the minimum required for SCM identification delineation. Future maintenance coordination efforts may require additional markers at interval spacing along the length or perimeter of the SCMs. As the need is clarified, requirements will be added to this section.

Linear SCMs

SCMs that are generally parallel to the roadway and utilize the shoulder or a pull-off for access should, at a minimum, have SCM Markers placed at the beginning and end of the SCM to mark the extents for visibility as well as maintenance. The first marker is located at the start of the facility with respect to the direction of travel on the adjacent travel lane with the blue water drop decal area facing the oncoming traffic and may include an optional "first delineator" marking. When located in the center median of a divided roadway, the start of the facility and direction of blue water drop decal should be the western terminus for east-west roads and should be the southern terminus for north-south roads (conforming to interstate mileage direction). The SCM Marker at the end of the facility and any intermediate markers used should again have a blue water drop decal facing oncoming traffic but should not receive any additional markings.

Linear SCMs may be placed in succession such that the end of one SCM is the beginning of another. When this is the case, an end marker will only be placed at the end of the series of SCMs. An example of this is as follows: a channel runs along the roadway, midway through the channel is an inlet which will be the end of the first vegetated swale and the beginning of the second. Do not place an end marker for the first SCM at this inlet, simply install the marker for the SCM that starts there with blue water drop decal facing traffic and an optional “first delineator” marking.

The majority of linear SCMs follow the guidance set forth above and are listed in Table 2.7.1. Examples of linear SCMs include but are not limited to vegetated filer strips, vegetated swales, and restoration SCMs.

Signage for the SCMs listed below follow the guidance for linear SCMs even though these SCMs may traditionally fall into other categories or multiple categories.

- Pervious Pavement (PPA, PPC, PPP) – Pervious pavement is currently not recommended for use within the travel way. Should pervious pavement be located in a parking lot, park and ride or other facility, signage should be placed behind the curb line at either extent of the pervious pavement section.
- Subsurface Infiltration Trench (SIT)– Signing should follow the linear SCM placement guidance, not the underground SCM guidance. Signage should be placed at the beginning and end of the trench area relative to the roadway to delineate its extents.

Basin SCMs

Basin SCMs are excavated facilities that create an impoundment for the temporary surface storage of stormwater runoff. Examples of Basin SCMs include but are not limited to detention basins, stormwater wetlands, and infiltration basins. At least one SCM Marker is necessary to locate this type of SCM. The marker should be placed at the SCM access point (e.g., road or pull-off) so that the blue water drop decal is visible from the roadway. If no formal access is provided, the signage should be placed adjacent to the shoulder at the most logical point of access. In certain situations, it may be necessary to place multiple SCM Markers for a basin SCM. Examples include when the SCM is not visible from the roadway or if multiple SCMs utilize the same access point. In these situations, it is necessary to place an SCM Marker at the access point and an additional marker in the vicinity of the SCM itself. Wherever practicable the SCM Marker should be visible from the access point.

Underground SCMs

Underground SCMs include manufactured treatment devices, subsurface detention storage, and other non-basin SCMs such as inlet sumps and water quality inlets. The type of signage employed for underground SCMs depends on the SCMs location relative to the roadway. SCMs located outside of the roadway footprint receive one SCM Marker placed in a similar fashion to basin SCMs with the blue water drop decal and an optional “first delineator” marking. If no access road/pull-off is present, the sign may also be placed next to the access manhole for the SCM if present. For underground SCMs within the roadway footprint, the SCM ID may be stenciled on the access manhole, inlet, or SCM to signify that the facility is an SCM and not a traditional drainage appurtenance.

Table 2.7.1: SCM Categories for Sign Placement

Type	SCM Name/Type	Code(s)
Linear	Flow Dispersion/Level Spreader Outfall	FDF, FDV, LSO
	Forest Preservation	FPR
	Infiltration Berm	IBE
	Landscape Restoration Meadow	LRM
	Media Filter Drain	MFD
	Reforestation/Tree Planting	RTP
	Regenerative Step Pool	RSP
	Riparian Buffer	RBE, RBO
	Soil Amendment Restoration	SAR
	Stream Restoration	SRE
	Stream Stabilization	SST
	Vegetated Filter Strip	VFS, VSS
	Vegetated Swale	VSW, VSC
	Pervious Pavement	PPA, PPC, PPP
	Subsurface Infiltration Trench	SIT
Basins	Detention Basins	BDD, BED, BUD, BND
	Infiltration Basin	BID
	Wet Detention Basin	BWD
	Bioretention	BRE/BRU
	Other Basins	BOT
	Stormwater Wetland	SWE
	Constr. Storm. Filter	CSF
Underground	Manufactured Treat. Device	MTD
	Subsurface Det. Storage	SDS
	Non-Basin Other	NBO

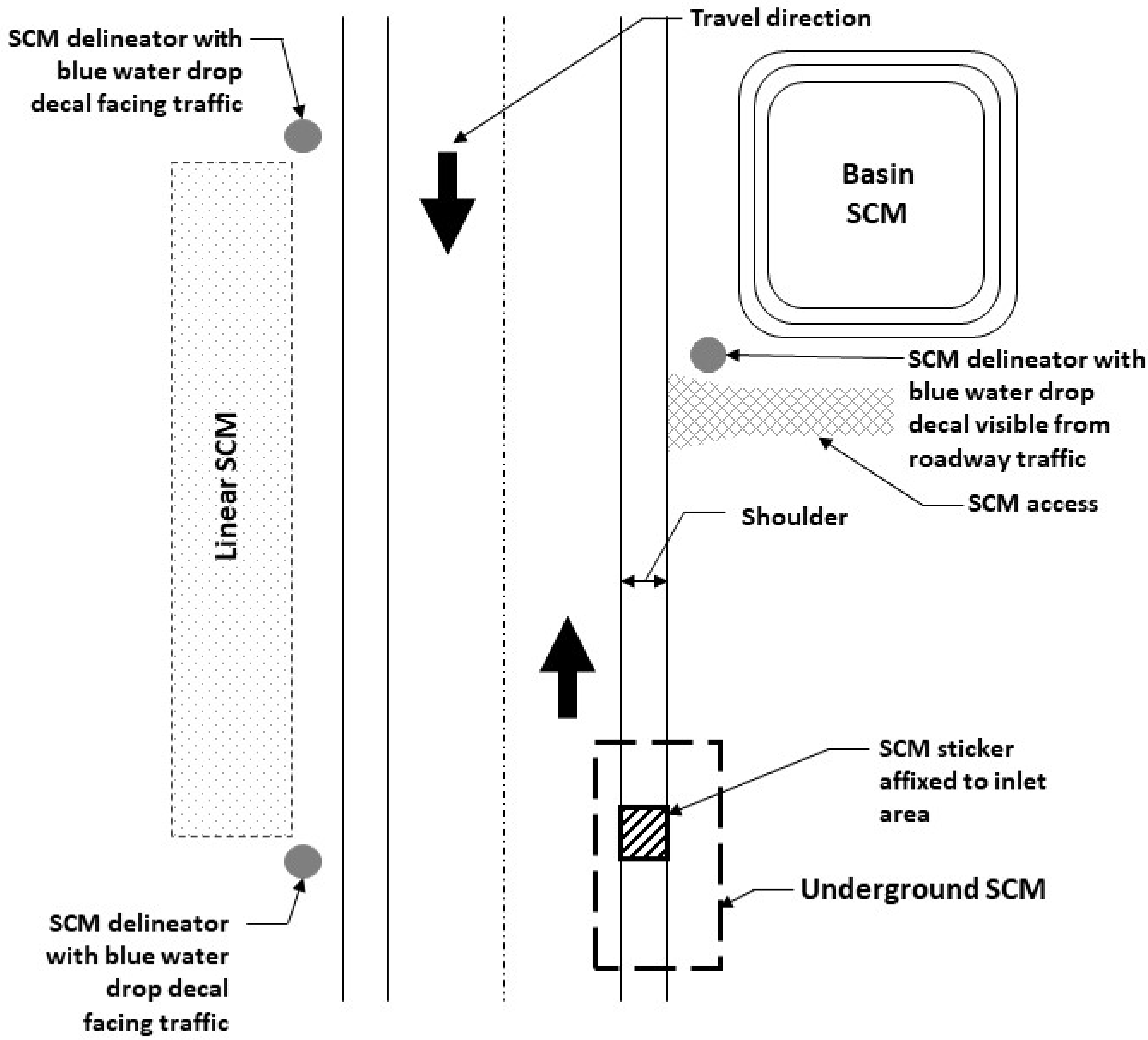


Figure 2.7.2: Example Sign Placement for Each SCM Category

CHAPTER 3

INSPECTION PROCEDURES

3.1 Inspection Types

This chapter describes the inspection procedures required for PTC-owned SCMs under the SCM maintenance program. The inspections are independent of any routine, preventative maintenance cycles, such as mowing and removal of trash/debris required for SCMs. Refer to Chapters 4, 5, and 6 on general maintenance and SCM specific maintenance for additional guidance.

Figure 3.1.1 SCM Inspection in Progress
(photo c/o: PTC)

A key component of the PTC SCM maintenance program is periodic evaluation of the SCM's condition and performance. Two types of evaluations are used with varying levels of effort: Routine Inspection and Field View Inspection (FVI). Each type of evaluation involves an on-site inspection and has standardized methods, and documentation of the inspection process. Note, personnel conducting the inspections must have sufficient knowledge of SCM function through previous experience or via completion of an appropriate training course.

Routine Inspections are in-depth inspections occurring at standard intervals, looking at all the SCM components (described in Section 3.5), and evaluating all aspects of functionality and performance. They are performed using an electronic inspection software application package (Section 3.3), utilizing a predetermined list of the features in the SCM. The inspector must enter information for all features listed in the application; the package will not allow submission if all fields are not complete. A passing grade on a Routine Inspection certifies that the SCM should function properly and provide its intended

PCSM benefits (peak rate control, volume control, and/or water quality) if it is properly maintained. An as-built plan, if it exists, should be reviewed prior to and during the inspection as needed to confirm all components of the SCM are reviewed and functioning. It is recommended that the lead inspector be a licensed professional or have sufficient previous training and experience. Inspectors should anticipate completing the field portion of the inspection for three to four Routine Inspections per day depending on complexity and the proximity of SCMs.

Field View Inspections are inspections focusing only on identified areas of concern within an SCM. Unlike Routine Inspections, they do not occur at standard intervals. Rather they are performed on an as-needed basis when personnel observe a concern outside of a regularly scheduled Routine Inspection. They may also be used as a follow-up inspection after the completion of repairs to a specific component within the SCM or as confirmation of routine maintenance activity completion. They utilize the same inspection software package as Routine Inspections however, for the Field View Inspection the application allows submission without information for all components (described in Section 3.5). This partial submission enables inspectors to highlight a specific concern identified in between scheduled Routine Inspections. The Field View Inspection is not a substitute for the Routine Inspection, and it should not be used as such.

After the field inspection is compete, the results are submitted electronically to PTC Engineering (Section 3.7). PTC will review and approve the information. Refer to Table 3.1.1 for a breakdown of the total effort necessary to complete inspections.

Table 3.1.1: Anticipated Level of Effort by SCM Inspection Type

Task	Routine Inspection (hrs)	Field View Inspection (hrs)
Preparation	1	0.5
Travel	varies	varies
On-Site	2 (4) [1]	0.5 to 1
Results Review[2]	2	0.5
Total 2- person team	5 (7) [1]	1.5 to 2

[1] Number in ( ) is for two people inspection team
[2] Results review performed by PTC Engineering, not inspector

3.2 Inspection Frequency

A schedule of SCM inspection frequencies for newly constructed general SCM types is outlined in Table 3.2.1 (See end of this section for SCMs constructed pre-2020). Similar SCM types are grouped together. Most SCMs that require regular maintenance require routinely scheduled inspections. Routine Inspections will occur every three years beginning after construction acceptance (NPDES NOT). Only certain SCM types can be inspected during winter months, when vegetation dies or goes dormant and the ground freezes. If vegetation or infiltration is a critical component of the SCM, the inspection must occur between the spring and fall seasons as indicated in the table.

Certain SCM types have a "start-up phase", or a period of time following construction in which more frequent check-ups are needed to ensure proper vegetative establishment. These check-ups occur in conjunction with the regular maintenance that occurs during the 2-year start-up phase and/or the PTC "808-Plants, Planting, and Transplanting" Specifications standard installation guarantee reviews. No formal documentation is required for these, however, a Field View Inspection may be completed if desired. The SCM types with a start-up phase are indicated in Table 3.2.1.

Descriptions of these additional start-up requirements are provided in the individual SCM sections in Chapter 6. Inspectors may use a Field View Inspection, completing all relevant sections discussed in the start-up requirements in Chapter 6 for the specific SCM type.

Table 3.2.1: SCM Inspection Requirements

General SCM Type	SCM Type Code(s)	Start-Up Phase[1]	Routine Inspection Required	Spring to Fall Only
Basin	BDD, BED, BUD, BOT, BND, BWD	●[2]	●	●
Bioretention	BRE, BRU	●	●	●
Filter	CSF[3], MFD		●	
Flow Dispersion	FDF, FDV, LSO		●	
Infiltration	BID, IBE, SIT	●[2]	●	●
Manuf. Treat. Device	MTD[3]		●	
Permeable Pavement	PPA, PPC, PPP		●	
Riparian Buffer	RBE, RBO	●	●	●
Stormwater Wetland	SWE	●	●	●
Subsurface Detention	SDS[3]		●	
Vegetated Filter Strip	VFS, VSS		●	●
Vegetated Swale	VSW, VSC		●	●
Restoration	FPR, RTP, LRM, SAR	●	●[4]	●
Other	RSP, NBO[3]		●	

[1]Routine Inspection at year 1; start-up phase check-ups at years 2 and 3 or as indicated in Ch. 6.
[2]BID and BUD only.
[3] Modified inspection frequency, procedures and reporting may be applied.
[4] SAR less than 5,000 SF (contiguous) are exempt from inspection.

Presently, inspections are performed in a single batch. As the number of SCMs increases, additional inspection batches may occur at other times during the year. To matriculate new SCMs into the cycle, the first Routine Inspection should be conducted during the next SCM inspection batch occurring a minimum of six months but not more than eighteen months after construction acceptance of the SCM. This assessment identifies issues that surface after a year of weather conditions and establishes a baseline condition for future inspections. For most SCMs, another Routine Inspection must be performed approximately every three years thereafter. The subsequent assessments are necessary to verify functionality and, if applicable, pollutant reduction credit. Some SCMs may require more frequent inspection due to unique circumstances that merit more regular examination. Where required, this will be noted in the SCM inventory information for the specific SCM.

Figure 3.2.1 presents a timeline of a typical SCM inspection cycle.

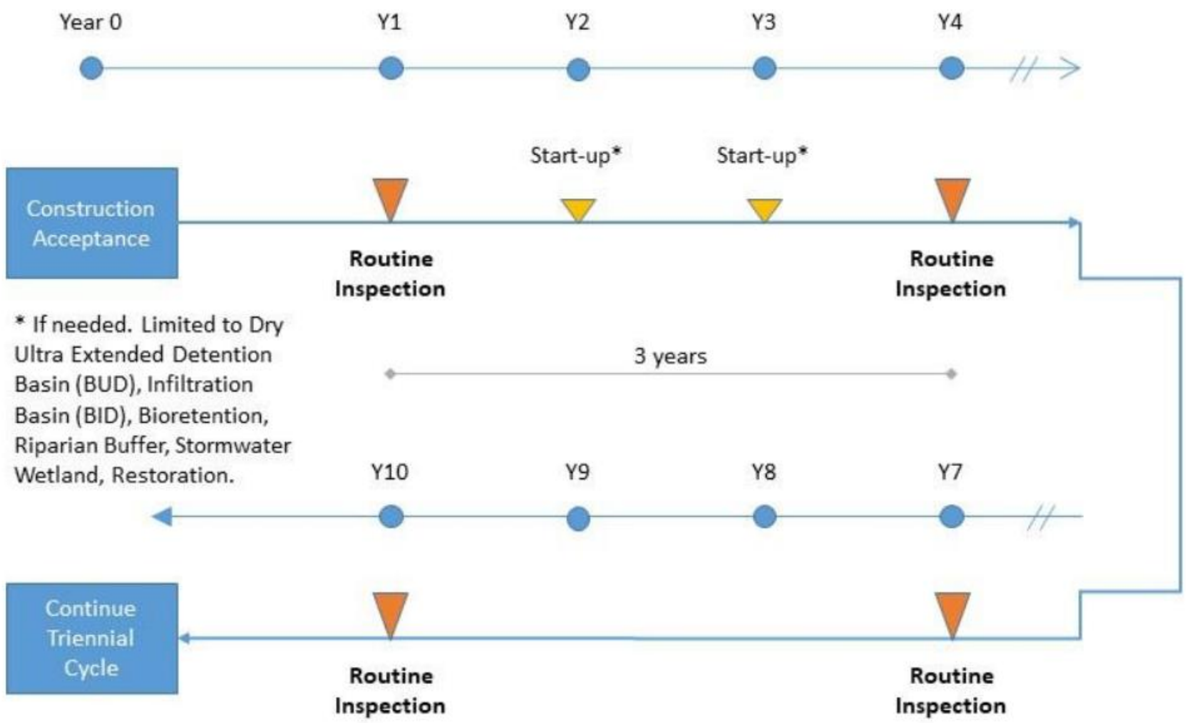


Figure 3.2.1: SCM Inspection Timeline

Existing SCMs (Pre-2020)

Figure 3.2.1 can be applied to existing SCMs after an evaluation using the O&M Determination Form (Section 2.4) is completed. Until the evaluation is completed, the inspection requirements contained in the PCSM Plan must be followed. If the existing SCM was designed and constructed without a PCSM Plan (not part of an NPDES permit or prior to 2007 PCSM inclusion of O&M), it has no associated regulatory inspection requirement, no O&M Determination Form evaluation is required and it should follow the standard cycles.

3.3 Inspection Software Set Up and Navigation

PTC's inspections are performed using a standardized electronic inspection software program. Prior to initiating inspections, the user must obtain a PTC ArcGIS Online Account and install the inspection software onto a mobile device for field use.

The inspections will be performed using two commercial applications that have been configured specifically for PTC's stormwater program: Collector for ArcGIS, and Survey123 for ArcGIS. Both applications are available for Windows, Android, and iOS operating systems.

- Collector for ArcGIS (Collector) is an application that allows users to add, delete, and update spatial data and related attributes directly on a map interface.

- Survey123 is a form-centric, data collection application.

The two applications are used in tandem to allow inspectors to view features on a map, view attributes and data about those features, and then seamlessly launch an inspection form to complete the inspection. Instructions for obtaining a PTC ArcGIS Online Account and software installation are in Appendix D, Sections D3.1 and D3.2 respectively. Details on using the software, including icon definitions and menu layout, are in Appendix D, Section D3.3.

3.4 Inspection Planning

SCM Specific Review

Prior to conducting the field inspection, the available SCM information should be reviewed to prepare for the field effort. The following information is used:

- As-built PCSM plan (or equivalent) of the SCM
- SCM inventory information in PTCs SCM Inventory
- Internet/desktop references such as eMapPA, topographic maps, and aerial images
- Past inspection reports of the SCM

The inspector should review the PCSM plan and SCM Inventory information to gain an understanding of the plan described SCM layout including the contributing drainage area and all SCM Components (Section 3.5). The contributing drainage area land coverage and inflow conveyances (channels, pipes, sheet flow) shown on the PCSM plan should be compared to present day aerial photography and field confirmed to ensure the present runoff patterns (area, rate, volume) match the PCSM design. The type, size and location of the SCMs inflow(s) and outflow(s) should be located on the plans for later field confirmation.

As-Built Plans

A key part of the Routine Inspection is to confirm the SCM matches the as-built plan of record. For newer SCMs, the PCSM Plan filed with the NOT is the as-built plan. The PCSM Plan has been a requirement for projects with an NPDES permit since approximately 2003. PADEP refers to the drawings and a narrative report as the PCSM Plan. In this Publication, the term PCSM Plan refers to only the set of plan drawings.

In order to perform the Routine Inspection for an SCM constructed in 2003 or later, the inspector should review the as-built PCSM Plan for the SCM. PTC has developed an initial collection of available plans for existing SCMs which is stored in PTCs electronic storage system. Newer SCMs should have the as-built PCSM plans filed in the SCM plan database. However, for SCMs that do not have a PCSM Plan available, other plans containing the SCM information must be referenced. The as-built Construction Plans and “Also plans” such as Erosion and Sediment Pollution Control (ESPC) Plans and Landscape plans should contain all information required to construct the SCM. The Construction Plan set may include sheets called Contour Grading and Drainage Plans illustrating the proposed SCM contours, while the details sheets may include inflow and outflow control structures details. The ESPC Plan will likely contain seeding information and may also include grading and flow control structure information.

Prior to performing the initial inspection on SCMs, the available plan material should be carefully reviewed for completeness. When complete as-built information is not found in PTCs electronic system, requests for additional plans and the narrative report should be made to the Engineering Department.

Pre-trip Planning

Inspections may require inspectors to work adjacent to areas of heavy traffic, around impounded water, on steep slopes, or other areas that expose them to the common hazards of field work. For safety reasons, all inspections should be conducted with inspection teams of at least two people.

Prior to going into the field for the inspection, the following preparation is recommended:

- Obtain the location (coordinates) and directions to the SCMs to be inspected. Inspectors should consider getting a quick visual of the site(s) through Google Street View, PennDOT's VideoLog (Off System on State roads), or similar beforehand to minimize potential confusion in the field.
- Have mobile device with Collector for ArcGIS and Survey123 installed (Section 3.2). Ensure device has 4G LTE connection service plan or WiFi access and adequate battery life or power cord/charger available.
- Schedule the daily inspections of SCMs in close proximity to minimize travel time.
- Review ArcGIS to obtain previous inspection data, PCSM Plans and other information about the SCM.
- Assess need for temporary traffic control and make arrangements as needed.

SCM inspectors must adhere to temporary traffic control guidelines in PTC's Maintenance and Protection of Traffic Standards - Maintenance. Most SCM inspections can be considered short term with stationary operations lasting approximately one hour with a work space beyond the shoulder. Confirm the proper Maintenance and Protection of Traffic (MPT) setup is used based on SCM location, access, and staging needs. All inspection vehicles should be equipped with a flashing yellow light.

Schedule inspections during appropriate weather. Avoid performing inspections when the ground and/or standing water is frozen, as it limits inspection of infiltration media and functionality. Winter inspections are not recommended for SCMs which will require vegetative cover identification, as foliage will not be present on deciduous species (see Table 3.2.1). Additionally, densely vegetated SCMs may be challenging to enter during summer and fall months. Early spring, when leaves are present but not in full growth, may be best for these SCMs. Consider scheduling inspections shortly after a rainfall to confirm appropriate drawdown times for detaining, infiltrating and filtrating systems. Typical designs include complete drawdown or infiltration within 72 hours of the rainfall.

Inspectors should be equipped with the proper tools, which will vary from site to site. A list of commonly used equipment is as follows.

- Safety vest, helmet, and other site specific PPE
- Mobile device with Collector for ArcGIS and Survey123 installed (Section 3.2) with WiFi/4-G LTE access and extra batteries or power chord/charger
- Tape measure and measuring wheel
- Camera with extra batteries and memory
- Dry erase board and markers
- Manhole pick - opening grates and manholes
- Wrench - unscrewing caps on PVC observation wells
- Waders - SCMs with permanent pool, inadequate infiltration/drainage, or deep layer of deposited sediment
- Keys for gate locks (where applicable)

- Shovel and rake
- As-built PCSM Plan or other plan
- Hand soil auger and/or soil probe
- Personal field items such as bug/tick spray, sunscreen, etc.

PTC requires all workers (employees and consultants) engaged in field operations to wear a hard hat meeting ANSI Type 1 requirements and a high-visibility vest, t-shirt, or sweatshirt meeting ANSI Class 2 or 3 safety garment requirements. Therefore, SCM inspectors must wear a hard hat and high-visibility vest at all times when completing inspections to remain visible to traffic. PTC recommends footwear be protective shoes with an oil resistant lug sole that are work wise and in serviceable condition. No canvas shoes, tennis shoes, sneakers, sandals or flip-flops are permitted for SCM inspection work. Follow all applicable PTC safety procedures at all times.

A personal flotation device (PFD) or rescue device is recommended when entering standing water. Personnel should not attempt to clear submerged orifice/pipes when in water or a risk of failing in exists.

In accordance with PTC policy, entry into confined spaces is prohibited without proper training certification. Confined space is defined as a space that (1) is large enough and so configured that an employee can bodily enter it; (2) has limited or restricted means for entry and exit; and (3) is not designed for continuous employee occupancy. Inlets, manholes, and most culverts are examples of spaces meeting the confined space definition. Should inspections require entry into confined spaces, personnel with confined space training must conduct the inspections. Trained personnel must follow all applicable PTC entry requirements including use of appropriate safety measures and obtaining an entry permit when applicable.

PTC is governed by Pennsylvania Department of Labor and Industry, Accident and Illness Prevention Program (AIPP) to ensure worker safety. Personnel should follow the Job Safety Analysis contained in Appendix E.

Questions from the Public

When conducting inspections, answer questions from the public honestly and diplomatically to maintain good public relations. Inform the citizen that an inspection is being conducted to better enable PTC to maintain the SCM. Politely direct any specific questions or concerns to the PTC Roadway Site Manager. Keep the appropriate phone numbers on hand for these occasions.

3.5 Stormwater Control Measure Components

The SCM Inventory ArcGIS Stormwater Control Measure polygon database entity carries key inventory attributes about the SCM and detailed information about the SCM components required to complete field inspections. Attributes are data fields which provide supporting information about the SCM, not physically inspected features. They include general overview information about the SCM as described in Table 3.5.1.

Table 3.5.1: Stormwater Control Measure - Attributes

Attribute	Description
SCM_ID	Alpha numeric SCM Identifier.
SCM Legacy Name	The name of the SCM as it appears on plan sheets.
Type of Access Code	Description of how the SCM is accessed for inspection and maintenance purposes.
System Location	Indicates if access to the SCM for maintenance is from on or off the PTC System.
Location Description	On System designates PTC roadway access, while Off Systems designates no PTC roadway access.
Access Easement/Agreement	Indicates if an Easement/Agreement for access for SCM inspection and/or maintenance.
Access Description	Provides additional description to the "Type of Access Code" field.
Dam Category	The dam category of the SCM, if applicable.
Dam Permit Number	DEP Dam Permit Number.
Maintenance and Protection of Traffic (Maintenance)	Indicates if Maintenance and Protection of Traffic (MPT) is required for routine maintenance activities at the SCM.
Maintenance and Protection of Traffic (Inspection)	Indicates if Maintenance and Protection of Traffic (MPT) is required for completion of SCM inspections.

All SCMs are comprised of multiple components which are common to different SCM types. The Stormwater Control Measure polygon utilizes a standardized list of common SCM components to store data about the SCM shown in Table 3.5.2. These are features which must be physically confirmed in the field. Components with similar function are grouped into categories such as the different types of vegetation. Not every component occurs in all SCMs. Refer to Section 5.1 for more detailed definitions of the SCM components including inspection details for each component.

Table 3.5.2: Stormwater Control Measure - Components

Component		Description
Vegetation	Turf: Lawn	A land cover classification dominated by well manicured grassy areas directly surrounding the SCM.
	Turf: Short Meadow	A land cover classification dominated by grasses and sedges vegetation mix approximately 36-inches or less in height.
	Turf: Tall Meadow	A land cover classification dominated by grasses and sedges vegetation mix greater than 36-inches in height.
	Scrub-Shrub	A land cover classification dominated by woody vegetation less than 20 feet tall often stunted by environmental conditions.
	Forest	A land cover classification dominated by tall, mature woody trees.
	Special Plantings: Ornamental	Plantings established for providing aesthetic appeal. Ornamental plantings will often use native and non-native species. Includes individual or groupings of trees, shrubs,

		herbaceous (pots/plugs) outside of the SCM treatment zone typically surrounded by mulch.
	Special Plantings: SCM	Vegetative plantings to support the function of the Stormwater Control Measure such as individual or groupings of trees, shrubs, live stakes, herbaceous (pots/plugs) within the SCM treatment zone typically surrounded by mulch.
Forebay		SCM pretreatment component that slows velocities and captures sediment and debris prior to entrance into the primary SCM storage area.
Inflow(s)	Pipe(s)	SCM inflow pipe
	Curb Cut(s)	Curb cut inflow
	Sheet Flow	Sheet flow inflow to an SCM
	Swale(s)	Inflow that enters an SCM through a swale.
Surface Storage	SCM Floor	Main ponding, conveyance, and treatment area of a surface SCM. May include a layer of engineered (amended) soils or filter media in filtrating or infiltrating SCMs.
	Low Flow Channel	Channel through an SCM basin occupied during smaller runoff events; typically dry between precipitations events.
Subsurface Storage		Areas below ground used to temporarily hold stormwater in a subsurface storage medium for infiltration and/or controlled release. Storage areas may consist of stone, pipes, vaults, tanks or chambers. May include: Underdrains - perforated pipe installed below filter media or stone storage media to effectively dewater the SCM. Observation Well/ Cleanout – An observation well is installed independent of underdrains and is used to observe subsurface water levels. Cleanouts are connected to the underdrains and are used to observer subsurface water level and/or access underdrains for maintenance.
SCM Liner		Liner used to limit water infiltration to adjacent soil. Located (and inspected when applicable) under SCM floor, cut slopes or impounding embankment areas of the SCM.
Cut Slopes		SCM side walls constructed by excavating below grade.
Impounding Embankments		Also known as berms, are “fill” material constructed above the surrounding ground forming a side wall of the SCM.
Sediment Marker		A measuring device that indicates the level of sediment build up within an SCM.
Low Flow Orifice		Small opening within the outflow structure that allows water to escape the SCM during times of low water flow; also controls the rate at which water discharges from the SCM
Primary Outflow		Primary control structure designed to control discharge from the SCM. In SCMs with no structural controlled release feature, this is considered the downstream most point of the treatment area such as the end of a VSW or the lower edge of a VFS.

Primary Outflow Trash Rack		A rack used to prevent trash from entering the primary outflow structure.
Secondary Outflow		Secondary control structure designed to control discharge from the SCM, usually during periods of higher than normal flow.
Secondary Outflow Trash Rack		A rack used to prevent trash from entering the secondary outflow structure.
Emergency Spillway		Provides an alternate path for water to escape the SCM during periods of high flow.
Emergency Spillway Type		Emergency spillways can be constructed using different methods. Armored SCMs use riprap, concrete, or boulders, while vegetated will use low growing plants like grasses to stabilize the spillway.
SCM Discharge		Primary location where water leaves the outflow structure, typically a pipe tied to the outflow structure; includes the pipe immediately downstream of SCM and, where applicable, downstream end section and rip-rap apron.
Fencing	Fencing	Protective barrier around the SCM to limit access from people and animals.
	Gates/Lock	Used to provide secure access to the SCM.
Signage		Sign(s) used to indicate the presence and in some cases the extent of an SCM.

The SCM component information shown by the ArcGIS software is unique to each specific SCM based on its type and individual design. Not every SCM will have all components shown in Table 3.5.2; only those components present for a specific SCM will be displayed by the ArcGIS software.

The majority of the features listed occur only once in an SCM or can be reviewed as a single feature which is called a "single-count component." For example, there can be only one primary outflow per SCM. However, the components such as those in the Inflow category can occur multiple times in a single SCM with each occurrence having different associated information. Therefore, the ArcGIS platform differentiates these features as "multi-count components," allowing multiple separate occurrence per SCM of each multi-count component type of component.

Refer to Chapter 5 for information about common components functionality, inspection and maintenance procedures. Refer to Chapter 6 for SCM specific information regarding SCM specific components functionality, inspection and maintenance procedures. Refer to Appendix F for Plant Identification.

3.6 Field Inspection Procedures

The field inspection process involves a pre-inspection component inventory review followed by a detailed inspection of each of the components present in the SCM. An overview of these steps is presented below. Appendix D, Section D4 contains step-by-step instructions details how they are completed in Collector for ArcGIS, and Survey123 for ArcGIS.

Inspectors should not leave PTCs right-of-way/access easements when performing the inspection.

In-field Pre-Inspection Component Inventory

Prior to launching Survey123 and beginning the formal inspection, the inspector must confirm the Collector for ArcGIS has an accurate list of the components (Table 3.5.2) present in this SCM. During the first-year inspections of existing infrastructure (pre-2020 SCMs) and as new SCMs are constructed, it will be necessary for PTC to populate the component information in the App software for each SCM individually. This should be performed prior to the initial field visit using as-built Plans. The inspector must field confirm all components have been included in the App during this first Routine Inspection. During future inspections, the component inventory data collected in the first year will be saved and only minor updates should be required. Similarly, the inspector should review the SCM Centroid Attribute details for accuracy.

Inspecting SCM Components

After the inspector completes the SCM Component Inventory Verification and SCM Centroid Attribute Detail Viewing, the inspector will launch an inspection survey by selecting the desired inspection type from the Collector for ArcGIS. The Routine Inspection option is the regularly scheduled complete inspection which will be typically used; the Field View Inspection option should only be used when personnel wish to document a condition in between the regularly scheduled Routine Inspections. The Field View Inspection utilizes the component inspection steps described below, however it only reviews the specific components of concern.

Selecting the desired inspection type launches Survey123. The platform automatically populates an electronic inspection form containing only the SCM components present in the SCM as contained in Collector for ArcGIS. After answering a few overview questions such as previous precipitation, the software steps through each component prompting the inspector to enter at least one photograph, list "maintenance" or "repair activity" and select a component rating. While the routine maintenance cycles occur without inspection, the current maintenance and repair needs for each component within the SCM are individually assessed utilizing a rating scale associated with seven varying degrees of Maintenance Types to allow the inspectors to provide direction on required action steps. The seven Maintenance Type assessments are: no maintenance, routine maintenance, corrective maintenance (current year), corrective maintenance (immediate), rehabilitation, redesign and investigation required. Under each Maintenance Type, inspectors select from a component-specific list of possible concerns to clarify the identified issue, such as sediment removal or repair area of erosion, etc. Based on the assessed Maintenance Type, each component receives a Condition Rating grade from A to F defining the condition of the component. Chapter 4 and Appendix D, Section D4.3.4 contain additional details including detailed descriptions of the required maintenance types and step-by-step instructions for completing the inspection app.

When inspecting multi-count components, the inspector must identify each occurrence of the component type assigning it a number. To ensure consistent numbering from inspection to inspection, inspectors must follow the numbering methodology detailed in Appendix D, Section D4.3.5. After assigning the number, the component inspection process is the same as a single-count component, requiring at least one photograph, noting any maintenance or repair items and selecting a component rating.

Visual drainage area confirmation should be conducted to the extent practical in consideration of safety and accessibility limitations such as a divided highway. Where inspection findings suggest actual inflows vary from PCSM plan, recommendations for additional investigation must be indicated in the inspection overall inspection comments.

The software will not consider the inspection complete until the inspector has entered information for every component present.

Overall Ratings, Photographs and Comments

At the end of the inspection form, the inspection app will determine an overall SCM Condition Rating (A through F) and associated descriptive rating based on a calculated score. This overall SCM calculated rating is the average score of all components evaluated during the inspection. To calculate the overall average score, the alphabetic Condition Ratings for each component are converted into numeric values to calculate the overall SCM numeric point score. This numeric point score determines the overall SCM letter grade and associated descriptive text-based rating presented in Table 3.6.1.

Table 3.6.1: Overall SCM Condition Ratings

Alphabetic Rating	Condition Rating
A	Good
B	Good-Fair
C	Fair
D	Fair-Poor
F	Poor

The software displays the calculated rating for inspectors to evaluate. PTC recognizes the variable and dynamic nature of performing SCM inspections. As such, the system provides inspectors with the option to override the system-calculated Overall Rating and provide a user-calculated Overall Rating. User entered scores must be accompanied by an explanation from the inspector documenting the reason for overriding the system calculated score. Refer to Appendix D, Section D4.3.6 for additional details and an example calculation.

The software application includes a required overall SCM photograph as well as space for additional comments.

3.7 Submitting Inspection Results and Post Submission Process

In order to officially save the form from Survey123 back to ArcGIS, the inspector must submit the form. The submission steps are outlined in Appendix D, Section D4.3.7. Submitting a survey synchronizes the inspection data and all the pictures to a hosted feature service on ArcGIS Online. Any submitted data is available for review in real-time. The data can be reviewed by accessing the data directly on ArcGIS Online, or the Survey 123 website. Should system errors occur during the process, inspectors should follow the procedures outlined in Appendix D, Section D4.4.

After submission, PTC Engineering will review the inspection and coordinate with the inspector on required revisions. Following the review, PTC Engineering will approve the data and transfer it to the master stormwater inventory on the Esri ArcGIS platform. The data will then be accessible for PTC wide use as needed. PTC Engineering will also arrange for appropriate licensed professional review of any inspections recommending SCM re-design or requiring additional assessment to determine cause of identified concerns.

Field View Inspections submission procedures follow the same process as Routine Inspections. Field View Inspections will contain completed information for only the components actually reviewed during the visit; omitting areas not related to the concern or intended focus. PTC Engineering will assess the purpose and findings of the Field View Inspection and initiate appropriate follow up processes as required.

3.8 SCM Inspection Photographs

The SCM Inspection Photographs provide evidence that an inspection was performed, and they assist office personal with trouble shooting and remediation planning. The inspection software allows photographs to be inserted directly into the electronic inspection form. For additional details see:

- SCM Component Photographs: Appendix D, Section D4.3.4
- Overall SCM Photographs: Appendix D, Section D4.3.6
- PTC General Photograph Guidelines: Appendix D, Section D5.4

3.9 Accessing Past Inspections Data

Results of the past two inspections are available through the SCMs information available in the Mobile ArcGIS software apps. All previous inspections are assessible via the master stormwater inventory information on the ArcGIS platform.

3.10 QA/QC Procedure for Inspections

The accuracy and consistency of the SCM inspection and its documentation are important to ensure that proper maintenance and operation can occur. The Engineering Roadway Department employs Quality Assurance and Quality Control (QA/QC) procedures for SCM inspections outlined in Table 3.10.1 at the end of this section.

- Quality Control is the enforcement of procedures that are intended to maintain the quality of a product or service at or above a specified level.
- Quality Assurance is the independent verification or measurement of the level of quality of a sample product or service.

QC Recommendations

Quality Control (QC) is the responsibility of the Engineering Roadway Department. The Engineering Roadway Department QC process involves four stages of quality control:

- Completeness of the office SCM records.
- Inspection software system controls and standard operating procedures (SOP).
- QC Service desktop application and standard operating procedures (SOP).
- Execution of identified maintenance and/or rehabilitation needs.

The QC of SCM inspection data, inventory records, and maintenance activities is an ongoing function within the Engineering Roadway Department, administered by the Roadway Site Manger or an appointed designee. The Roadway Site Manager, at a minimum, shall conduct an annual meeting with applicable staff to review all QC comments and observations or on an as-required basis. To ensure uniformity and consistency systemwide, the following QC procedures are recommended.

Completeness of SCM Records

The SCM inventory and SCM files should be reviewed to ensure the information needed for inspections and maintenance is readily available. All documentation of inventory and inspection information should be kept in an orderly and retrievable manner. The Engineering Roadway Department must keep all as-built plans and previous inspection information in the Engineering folders identified in Chapters 2 and 3.

The Roadway Site Manager (or designee) shall semi-annually:

- Review all recently completed projects to ensure that SCMs have been added to the SCM inventory database and as-built plans are filed appropriately when they are received.
- Review the status of inspections that were due within the past 6 months.

Inspection Software System Controls and SOP

The electronic inspection software program outlined in Section 3.3 has system controls that ensure a level of data validation and consistency. This is achieved by standardize drop down selections for maintenance types, maintenance actions and condition ratings. Nearly all entries in the Routine Inspection are mandatory, requiring a complete inspection prior to submission. The inspection software program is accompanied by a standard operating procedure (Appendix D) to guide the user through the system and provide consistent results among inspectors.

QC Service Application and SOP

Through the inspection software program, submitted Routine Inspections are complete based on the system controls. The QC Service application enables the Roadway Site Manager (or designee) to review the incoming inspections for correctness based on a desktop study. If the reviewer concurs with the inspection results, the inspection data quality control procedure is complete, and the reviewer can save the inspection data to the on-premise environment (read-only) GIS database for future reporting and asset management. If the reviewer has comments on the inspection, the inspector can be consulted for further discussion. In the event edits need to be performed to the inspection, they can be made in the QC Service or a new inspection can be performed. The QC Service is accompanied by a standard operating procedure (Appendix A) to guide the user through the system and provide consistent results among reviewers. The following provides recommendations on the number and frequency of inspections for review.

- The Roadway Site Manager (or designee) shall review 10% of the SCM Inspections annually for completeness and accuracy. Review shall be conducted preferably as inspections are completed. The selection shall include a representative sampling of SCM types, and from different inspection teams as applicable, from inspections completed within the last six months. Additional inspections, beyond the 10% minimum, shall be reviewed if deemed appropriate by the Roadway Site Manager.

QC Review of Maintenance Needs

To ensure appropriate maintenance is being performed, the Roadway Site Manager (or designee) shall review the routine and corrective maintenance performed on a representative sample of SCMs inspected within the last year. The review should include 10% of Routine Inspections, 100% of all inspections with a D (Fair-Poor) or F (Poor) grade. The progress and completion of work orders in the StormWater Asset Management Program (SWAMP) should be compared to the recommended corrective activities from inspections and known routine maintenance cycles based on SCM type.

QA Recommendations

Quality Assurance (QA) is an independent, evaluation function performed by the Engineering Roadway Department to ensure that inspections and review is in accordance with QC procedures. The findings from the QA review are used to enhance PTC's SCM inspection standard operating procedures and training to address any SCM inspection anomalies. The program can involve performing independent, re-inspections and desktop review of SCMs to compare the ratings across PTC's system. The QA procedures shall accomplish the following objectives:

- Improve the quality of the SCM data contained in SWAMP, including the inventory and field information recorded from inspections.
- Improve the accuracy of the Routine Inspection ratings.
- Improve the accuracy of maintenance item identification and priority level.
- Identify training needs.
- Identify gaps in quality and provide recommendations to close them.

The procedures shall include the following components:

- Perform an independent QA of a representative sample of inspections in each District.
- Selection process for QA inspections:
  - SCM must have been inspected within the previous 3 months.
  - Generally representative of the PTC's inventory in SCM type and condition.
  - Avoid SCMs reviewed in previous QA cycles to the extent practicable.
- Compile and disseminate a PTC systemwide summary that includes:
  - Summary of the SCMs inspected by Engineering Roadway Department.
  - Different overall performance rating (A through F) for SCMs
  - Component not identified for immediate maintenance action.

Activities in the QA process will be modified or substituted for if it can be determined that the process is not providing the best information to improve quality. PTC anticipates the QA process will undergo continuous assessment and refinement to provide the most accurate and useful information possible.

Table 3.10.1: QA/QC Procedures

Type of Review	Reviewer	Frequency of Review	Level of Review	Number of Inspections to Review/ Work Description
QC	Landscape Specialist r[1]	All reports (required)	Inspection/report completeness and accuracy	All reports
	Roadway Site Manager (or Designee)	Annually	Inspection/report completeness and accuracy	10% of Stormwater Inspections
			Inventory data and as-builts	All projects completed in past 6 months
			Review SCM database, plans, and inspection files for completeness	10% of SCMs with inspection due within next 6 months
			Inspection due dates and progress	All SCMs
	Roadway Site Manager (or Designee)	Annually	Maintenance records in SWAMP	10% of SCMs w/ A, B or C rating
				All SCMs w/ D or F rating
QA	Roadway Site Manager (or Designee)	Annually	SCMs - Independent Field Inspection	Representative sample in each PTC District

[1] When inspection team is a consultant, the PTC PM should provide a completeness and accuracy review prior to submission.

CHAPTER 4

MAINTENANCE PROCEDURES OVERVIEW

4.1 Maintenance and Repair Overview

Under PTC's program, SCM related maintenance can be grouped into two primary categories, Maintenance and Repair Activity, with subcategories defined by degree of predictability and level of effort as listed in Table 4.1.1.

Table 4.1.1: Maintenance and Repair Categories

Maintenance
Routine
Corrective (Current Year)
Corrective (Immediate)

Repair Activity
Rehabilitation
Redesign
Investigation

The activities associated with each subcategory are described in the following sections.

4.2 Maintenance

Maintenance includes "good housekeeping" activities required to keep an SCM operational. Maintenance can be subcategorized into tasks that can be anticipated on a set schedule (routine) and those that must be initiated by field observations and inspections (corrective).

Routine maintenance involves minimally invasive measures associated with general upkeep that prevent common problems and prolong the life of SCMs. These measures (e.g., mowing and trash removal) occur at regular intervals allowing them to be scheduled far in advance of the work.

Corrective maintenance involves work outside of routinely schedule maintenance activities that are initiated because of observed problems with the SCM during an inspection or other field visit. Corrective maintenance activities include a wide range of activities. Anticipated corrective activities are general upkeep items that cannot easily be placed on a set schedule, such as replanting/reseeding denuded areas. Other corrective maintenance work includes more intensive upkeep items such as pipe/headwall repairs. Corrective maintenance will be assigned a response time (immediate or current year) based on the risks associated with the identified condition.

An overview of the general categories of routine maintenance and common corrective activities are presented below. The recommended target months for these activities are summarized in Table 4.2.1. This table does not depict the actual maintenance frequency of each activity, rather it illustrates the optimal time for the various activities to occur. Not all activities occur with each SCM type. Refer to SCM-specific maintenance tables in Chapter 5 and 6 for detailed activity descriptions and actual frequency for specific SCMs. Note that all "as needed" activities should be checked during each routine maintenance visit. Factors such as surrounding land uses, contributing drainage area, and visibility can affect these typical frequencies. The SCM information in the SCM inventory will note when the maintenance needs of an individual SCM deviates from the tables presented in Chapter 5 and 6.

- Turf Mowing/string trimming - Regular mowing/string trimming is specific to site conditions and should be performed as specified herein and in accordance with PTC's mowing policy. The frequency is dependent upon the type of seed mix present:
  - Lawn applies to areas of turf grass and well-manicured grassy areas.
  - Meadow applies to areas of taller grasses, forbs and sedges. It can be further sub divided into Short Meadow (species predominately 36" and under) and Tall Meadow (species predominately over 36").
- Special Planting/Seeding - Through an SCMs lifecycle, the vegetation will need to be refreshed as plants may not survive through all conditions. This category includes:
  - Turf Renewal (seeding) involves applying the appropriate seed mixtures to thinning or bare lawn and meadow areas.
  - Special Planting- Herbaceous (plugs, pots, etc.) includes replacing perennial grasses, grass-like and forb species.*
  - Special Planting- Tree & Shrub includes replacing deceased "woody" plants.*
  - Special Planting- Live Stake Planting replaces those live stakes (dormant, live woody cuttings) that have not established.*

    * These are either SCM or Ornamental special plantings in the SCM Component listing (Table 3.5.2) depending on their location with respect to the SCM floor (treatment zone).
- Vegetation Management – Includes various activities to promote healthy vegetation in the appropriate areas throughout SCMs and prevent problems such as embankment stability, invasive/undesirable (see Appendix F) plant intrusion and uncontrolled growth. Work includes:
  - Watering includes applicable use of hand watering, mobile sprinkler and/or tree watering bags to establish new plantings and prevent established plant loss during periods of draught.
  - Weeding - Hand Pulling involves hand removal of undesirable species from the area.
  - Weeding - Herbicide Treatment involves the use of select herbicide application to control growth of vegetation.
  - Special Plantings: Tree & Shrub Pruning includes trimming woody plants to maintain size, health and form.
  - Special Plantings: Cut Back Perennials & Grasses on a routine cycle encourages vegetation health, increasing plant longevity.
  - Mulching involves placing, spreading and releveling mulch to minimize weeds, promote moisture retention and improve aesthetics of SCMs.
- Litter Control – Debris and trash removal reduces the potential for clogging of outlet structures, trash racks, and other SCM components.
- Sediment Removal – Accumulated sediment should be removed to keep flow pathways open, prevent dispersed flow from concentrating, maintain storage capacity, and keep inlets and outlets unobstructed.

Table 4.2.1: Maintenance Activity Ideal Occurrence Periods

Stormwater Control Measure Maintenance Activity	Spring			Summer			Fall			Winter		
	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Turf: Lawn Mowing*												
Turf: Short Meadow Mowing*												
Turf: Tall Meadow Mowing*												
Turf Renewal (Seeding)												
Special Plantings: Herbaceous (Plugs, Pots, etc.) Planting												
Special Plantings: Tree & Shrub Planting												
Special Plantings: Live Stake Planting												
Watering												
Weeding - Hand Pulling												
Weeding - Herbicide Treatment												
Special Plantings: Tree & Shrub Pruning												
Special Plantings: Cut Back Perennials & Grasses												
Mulching												
Litter Control												
Sediment Removal												

*****Mow heights: Lawn- 2” to 4”; Short Meadow- 6” to 10”; Tall Meadow- 8” to 16”
Mow frequency: Lawn- as needed to maintain max height of 6” (3 times/year min.); Short Meadow- 3 times/year; Tall Meadow- one time per year.

Note:

1. Green squares are recommended target months for activities; variations may occur. This is not a depiction of frequency of activity. Red boxes are suggested tri-annual visit targets referenced in Chapter 5 and 6 SCM specific Maintenance Procedures Tables.
2. Not all listed activates occur in each SCM type. See Chapter 5 and 6 for specific SCM maintenance requirements and frequencies.

4.3 Repair Activities

Maintenance repair activities require more extensive and invasive tasks to correct problems and restore the functionality of the SCM. Repair Activities are initiated based on concerns observed during field inspection or normal maintenance activities. Based on the field observed conditions, the repair activity will be classified into one of three subcategories: rehabilitation, redesign or investigation required. Although completed on an as-needed basis, maintenance repair activities should be factored into the overall SCM maintenance budget.

Rehabilitation involves reconstructing an SCM. Total or partial reconstruction may be required due to significant damage to a component such as a subsurface pipe collapse or require total reconstruction due to an embankment failure. Some SCMs require filter media replacement to maintain sufficient water quality benefits and infiltration rates.

Redesigns of an SCM or an SCM specific component may be required when there is unanticipated failure. For example, a rip-rap apron may erode at in inflow point, requiring reassessment of the inflows and rip-rap apron designs at the point. Occasionally, the functionality of an SCM is compromised requiring full SCM redesign.

Investigation required repair activities are necessary when an SCM or SCM component is malfunctioning but the cause is not evident. Investigations may include soil testing, engineering evaluation or other recommended assessments to determine the correct course of action.

Frequently encountered maintenance repair activities are included in Appendix G in table format with columns linking common issues to the inspection components for cross referencing. Table G.1.1 contains general concerns that are applicable to the majority of SCMs. Table G.1.2 lists issues associated with the common components included in Chapter 5; Tables G.1.3 through G.1.16 are SCM-specific. Note that Table G.1.3 applies to the SCMs in Sections 6.1, 6.2, and 6.3.

PTC Engineering or a designee can use the SCM-specific, general, and component tables provided in Appendix G to assess appropriate corrective maintenance actions based on the results of an inspection. The tables are developed as a guide and are not intended to be all inclusive.

4.4 Post-Construction SCM Modification and PADEP Coordination

PTC must restore, repair, or replace an SCM or provide an alternative method of treatment upon any reduction, loss or failure of an SCM that PTC maintains. In certain cases, PADEP, the local municipality and/or other entity (where SCM specific agreement exists) must be notified prior to commencing modification activities. The two general scenarios that exist for modification after construction and NPDES NOT (where applicable) are described below.

Scenario A

For most “older” SCMs, PTC may modify, rehabilitate or reconstruct the SCM without notifying PADEP. To the extent practical, the changes should maintain the qualitative and quantitative design goals (e.g., peak rate control, volume management, or water quality improvement) of the original SCM. The SCMs that this applies to are either:

- Associated with an NPDES Permit approved on or before November 19, 2010 and not subsequently renewed after January 1, 2013.
- Not associated with an NPDES permit.

Scenario B

PADEP must be notified when PTC wishes to modify “newer” SCMs. Written notification of the proposed SCM modifications shall be provided at least 30 days prior to the start of construction. This applies to SCMs that are covered by the PCSM regulation, as discussed in Section 1.2.

Examples of activities that require PADEP notification and may require municipal/other entity notification (where specific SCM agreement with municipality/entity exists) include:

- Modifications to the dimensions that affect storage area of an SCM.
- Complete reconstruction of an SCM in a new location.
- Changes to the type of SCM (e.g., changing a BID to a BRE or BUD due to inadequate infiltration).
- Modifications to the dimensions (e.g., orifice configuration) of the outflow structure.

Examples of activities that do not require PADEP notification include:

- Replacement of a clogged filter media layer with new filter media to the original dimensions and similar material.
- Replacement of dead vegetation with the same or similar species.
- Repairs or reconstruction of any portion of an SCM in accordance with the original PCSM Plan.
- Removal of sediment buildup in forebay or main SCM storage area.
- Complete reconstruction of an SCM in the same location.
- Installation of a sediment forebay (that does not affect storage) or other type of pretreatment.

A notification package shall be submitted through PTC Engineering, or designee to the appropriate PADEP office and municipal/other entities (where specific SCM agreement with municipality/entity exists) including:

- Transmittal/cover letter with the original NPDES Permit number
- Technical memorandum describing reason for change(s) with supporting calculations attached
- Redline copy of original As-Built PCSM Plan (drawings)
- New supplemental scale drawings, if necessary
- ESPC Plan (if required per Chapter 102 of PA Code Title 25)

The redline PCSM Plan should include a note referring to PTC Stormwater Control Measure Operations and Maintenance Manual for all applicable inspection and maintenance requirements for the modified SCM. If the SCM has special maintenance requirements, they should be added to the plan. The ESPC Plan need only cover the area of earth disturbance for the SCM modification work.

The technical memorandum shall detail the reason for the proposed modification(s) and demonstrate that the modified SCM will provide stormwater controls sufficiently equivalent to the original SCM. Supporting calculations should be attached as an appendix to the memorandum. If new supplemental scale drawings are necessary, they shall include reference to the original NPDES permit number, complete details and plans for construction, and delineation of the SCM’s drainage area. The redline copy of the As-Built PCSM Plan and any new construction plans and details shall be sealed by a licensed professional.

In either of the aforementioned scenarios (A or B), if the proposed modification involves changing the SCM type, PTC Engineering will assign a new SCM ID. An electronic file of the notification package shall be saved with the original electronic As-Built PCSM Plan. Upon completion of construction, PTC Engineering (or designee) shall remove the original SCM data and add the new SCM data to the SCM inventory database.

4.5 Disposal of Sediment Removed from SCMs

Sediment removed from SCMs during maintenance activities is considered fill and may be subject to PADEP's Management of Fill Policy including visual inspection and performance of an Environmental Due Diligence clean fill determination. Adhering to applicable PTC, local, state and federal guidelines, sediment removed from PTC SCMs should be either:

- Utilized immediately as clean fill within the ROW
- Stockpiled for future use at an approved location
- Removed and disposed of off the ROW.

4.6 Vegetation Watering

Some SCMs incorporate seed mixtures and/or rooted plants that require watering to aid in plant establishment and survival. The SCM specific routine maintenance tables in Chapter 6 stipulate which SCMs require establishment watering during the first few years after construction. Typical plant establishment takes one to three growing seasons based on specific site factors. PTC Construction Contracts typically include a two-year vegetation establishment period completed by the Contractor. Where SCM plant installation occurs without Contractor required establishment care or after Construction during SCM maintenance or rehabilitation, PTC shall perform or Contract for watering as follows:

- Use an appropriate water supply via truck or on-site tank storage.
- Minimize use of sprinklers/overhead watering during sunny days (10am-5pm) to prevent leaf scorch.
- When hand watering herbaceous plants, shrubs, trees and seeded areas:
    - Water at base of plant/tree.
    - Use hose sprinkler attachments and avoid directing concentrated flows around planted/seeded areas.
    - Allow water to soak into ground in each area; each 100 SF area of vegetated SCM should be evenly watered for five minutes or until ground is saturated; each tree should be watered for 5 minutes or until ground is saturated.
- When using bag waterers for trees:
    - Install watering bag in April per manufacturer's recommendations.
    - Fill with 15-20 gallons of water, refilling when bag is empty.
    - Remove bag between October 15 and October 31.

4.7 Maintenance and Repair Techniques for SCMs

Maintenance and repair activities performed on SCMs require the use of different equipment and procedures than applied in standard roadside activities to ensure SCM functionality. The requirements are determined from two key aspects of the SCM:

1. **The SCM Floor type:** Many SCMs have a surface of infiltrating/filtrating material. This area is highly sensitive to compaction and sediment laden flows. Any SCM with an infiltrating or filtrating surface must be protected from compaction though the use of minimal disturbance techniques as described below. In addition, activities that expose soil and could cause sediment laden flows must utilize appropriate Erosion and Sediment Pollution Control protective measure to prevent surface clogging.
2. **The SCM Vegetation type:** While many SCMs are planted with standard mowable grass seed mixes, some are planted with specialty no-mow plants. Tree, shrubs, and perennial herbaceous (pots/plugs) material require hand pruning and other alternative maintenance practices.

Requirements for All SCM Types

No equipment may enter any type of SCM when the SCM floor is not dry (approximately 5 days after the SCM storage area has totally emptied). This includes equipment of any type, including small mowers. All SCMs must be protected from surface rutting, even non-infiltrating/filtrating surfaces.

Prior to mowing any SCM, review the operations and maintenance plan for the facility to confirm vegetation is to be mowed and mowing specifications such as mow height and mowing frequency.

Infiltrating/Filtrating SCMs: Minimal Disturbance Techniques

SCM infiltration and filtration ground surface areas (SCM Floor) must be protected from inadvertent compaction and damage to maintain functionality. Table 4.7.1 summarizes which SCMs have infiltrating or filtrating surfaces. Where the table indicates that an infiltrating or filtering surface is “possible,” prior to performing maintenance, the SCM Inventory and SCM plans must be checked to determine the presence of infiltrating/filtration surfaces.

Table 4.7.1: SCMs with Infiltrating and Filtrating Ground Surfaces

SCM Name	Type Code	Infiltrating or Filtrating Surface		
		Yes	Possible	No
Basin, Dry Detention	BDD			X
Basin, Dry Extended Detention	BED		X	
Basin, Dry Ultra-Extended Detention	BUD	X		
Basin, Infiltration Detention	BID	X		
Basin, Other	BOT		X	
Basin, Naturalized Detention	BND		X	
Basin, Wet Detention	BWD			X
Bioretention	BRE	X		
Bioretention w/Underdrain	BRU	X		
Constructed Stormwater Filter	CSF	X		
Flow Dispersion, Forest/Buffer	FDF	X		
Flow Dispersion, Veg. Filter Strip	FDV	X		
Forest Preservation	FPR	X		
Infiltration Berm	IBE	X		
Landscape Restoration Meadow	LRM	X		
Level Spreader Outfall	LSO		X	
Manufactured Treatment Devices	MTD			X
Media Filter Drain	MFD	X		
Non-Basin SCM, Other	NBO		X	
Pervious Pavement, Asphalt[1]	PPA			X
Pervious Pavement, Concrete[1]	PPC			X
Pervious Pavement, Pavers	PPP		X	
Reforestation/Tree Plantings	RTP	X		
Regenerative Step Pool	RSP	X		
Riparian Buffer Enhancement; Offset	RBE	X		
Riparian Buffer Offset	RBO	X		
Soil Amendment Restoration	SAR	X		
Stormwater Wetland	SWE			X
Stream Restoration[2]	SRE	X		
Stream Stabilization[2]	SST	X		
Subsurface Detention Storage	SDS			X
Subsurface Infiltration Trench	SIT	X		
Vegetated Filter Strip	VFS	X		
Vegetated Filter Strip, Steep Slope	VSS	X		
Vegetated Swale	VSW		X	
Vegetated Swale w/ Check Dams	VSC	X		

1-PPA & PPC has a filtering/infiltrating ground surface but is not subject to compaction

2- Areas adjacent to channel

When maintenance or repair activities are required on SCMs with infiltrating or filtrating surfaces, employing minimum disturbance techniques can minimize the risk of damage. The following guidelines should be applied as appropriate for the required activities.

General Equipment Use Around Infiltrating/Filtrating SCMs
No heavy equipment (greater than 5 ton/axle) shall enter the SCM at any time. Rather, it should work from the banks of the SCM, extending operation arms into the SCM to perform tasks.

If possible, all work shall be performed with equipment operation from outside of the SCM footprint. If exterior operation does not provide sufficient reach, construction/repair activities should use a cell construction approach in larger SCMs, whereby the SCM is split into 500 sq. ft. temporary cells with a 15 foot earth bridge in between, so that cells can be excavated or material placed from the side.

When operating equipment in an SCM within 3-feet vertically of the proposed final surface elevation, Low Ground Pressure (LGP) equipment must be utilized. LGP is defined as:

- Maximum weight of 5 ton/axle load (including all attachments and material loads)
- Equipment shall be ballasted to ensure even load distribution.
- Tires:
  - Turf Tread
  - Radial ply tired
  - Tire inflation of 7 psi or less (use tires design to operate within this range)
- Tracks:
  - Manufacturer ground pressure rating for tracked vehicles shall be 5 psi or less

The critical goal is to minimize compaction by using LGP equipment. Additionally, these guidelines shall be followed:

- No equipment should enter the SCM when it is not dry (approximately 5 days after the SCM storage area has totally emptied; a handful of soil should not be able to be formed/shaped into a ball).
- Use the smallest, lightest equipment with lowest axle loads (note, axle load is not evenly distributed, confirm highest axle load) to accomplish work.
- Minimize the number of times the equipment enters the area and limit the amount of surface area traversed within the footprint. Where multiple trips are needed, follow the same wheel tracks to traverse the SCM to minimize the amount of area impacted.
- Place matting (as specified for wetland crossing in the PADEP ESPC Program Manual using configurations resulting in maximum soil pressure below mats of 7 psi per manufacture load reduction documentation) in one area of the SCM to allow work/reach into the entire area, restricting access to the maximum extent practicable.
- After equipment has completed work in SCM footprint, assess SCM surface for compaction. If compaction has occurred, perform infiltration testing and/or aeration and tilling (soil loosening) if required to restore functionality. Aeration should be punch core method; do not use spike aeration equipment.
- Remediate surface rutting caused by LGP vehicles by tilling to restore the surface integrity and soil porosity. Extend tilling to a depth 6-inches below the rutting depth or depth of compaction whichever is greater. The tilling operation shall result in a uniform surface at design elevations. Rutting remediation is to be completed within 1 week of the observed rutting occurrence or as soon as soil moisture conditions permit thereafter.

Lawn Mowing Infiltrating/Filtrating SCMs
No equipment should enter the SCM when it is not dry (approximately 5 days after the SCM storage area has totally emptied; a handful of soil should not be able to be formed/shape into a ball).

Use hand-held equipment (string trimmers) or small push mowers when possible.

Where hand-held equipment cannot be utilized, boom mowers operated from the perimeter of the SCM may be used when the SCM is dry. Mower arms should not apply pressure to the SCM surface.

When mowing equipment must enter the SCM, LGP equipment must be used. LGP lawn mowing equipment should be the lightest available and have no extra attachments installed while operating on the SCM infiltrating/filtrating surface. Turf tread or similar tires should always be operated at the lowest allowable tire pressure (7 psi or less). Tracked equipment meeting the LGP equipment requirements may be used.

Material Placement Activities Around Infiltrating/Filtrating SCMs
Material, including snow, should never be stored on the surface of an infiltrating/filtrating SCM.

Perform all work when SCM is dry (approximately 5 days after the SCM storage area has totally emptied; a handful of soil should not be able to be formed/shape into a ball).

When placing new mulch, soil, or similar materials within the footprint of an infiltrating/filtrating SCM, never dump directly onto the surface. Rather, place material adjacent to SCM and spread materials over the surface, preferably by hand. For larger SCMs, spread by pushing material with equipment in a horizontal motion. Do not use vertical or angled motions as it could compact the infiltrating area. Do not compact materials unless directed by an overseeing licensed professional.

CHAPTER 5

COMMON SCM COMPONENTS – OVERVIEW AND SPECIFIC INSPECTION AND MAINTENANCE PROCEDURES

5.1 SCM Overview and Anatomy

SCMs function by temporarily storing collected stormwater runoff where it may be cleaned, soaked into the ground (infiltrated), used (evapotranspiration), or slowly released (retained) ultimately improving the water quality and decreasing the water quantity. Figure 5.1.1 illustrates this basic process.

Figure 5.1.1: Stormwater Runoff- SCM Process

(Adapted from Philadelphia Water Department, Stormwater Management Practice Operation & Maintenance Manual)

All SCMs in this Publication are comprised of components that require regular maintenance.
Figure 5.1.2 illustrates a typical surface basin type SCM with the various parts labeled. The key features, which are found in other SCM types as well, are described in more detail. Not all features shown appear in all SCMs.

Inflows: The inflow of stormwater runoff for nearly all SCMs include features like swales/channels, pipes, curb cuts and overland sheet flow. The inflow system includes associated end section and outfall protection such as a rip-rap apron when present. An SCM can have multiple inflow points at different locations such as pipes and channels comprising the overall inflow system. An exception is pervious pavement, which may receive inflow only from the actual surface of the SCM (rainfall that falls directly on it).

Pretreatment: As part of the inflow system, many surface and subsurface SCM designs incorporate a pretreatment feature which functions to capture sediment, debris and trash prior to entering the main SCM storage area. In Figure 5.1.2, the type of pretreatment area shown is a forebay. Forebays slow flow velocities while capturing sediment and debris just upstream of the entrance into the primary SCM Floor area, typically separated from the rest of the SCM by an earthen or rip-rap berm, or a concrete or gabion wall. Often another SCM may serve as pretreatment, such as a piped flows passing through an inlet with a sump/trap or manufactured treatment device (MTD), a vegetated swale (VSW/VSC) channelizing flows into a detention type SCM, or a vegetated filter strip (VFS/VSS) directing sheet flow into an infiltration type SCM. Forebays are inspected under the forebay section in PTCs inspection software while upstream SCMs are individually inventoried and inspected as a separate facility.

SCM Floor: The surface storage area is the main ponding, conveyance, and treatment area of a surface SCM. This is where runoff is temporarily held for infiltration, evapotranspiration, and/or controlled release to downstream points. In vegetated filter strips and similar SCMs, the treatment/conveyance area is the surface area of the filter (with no ponding).

Low Flow Channel: Within the main surface storage area, some SCMs have a defined channel that conveys flows during smaller runoff events and is typically dry between precipitations events (not illustrated in Figure 5.1.2). This may be lined with concrete, rock, impermeable geotextile or vegetated. When present, a low flow channel is inspected under the surface storage portion of PTCs Inspection software.

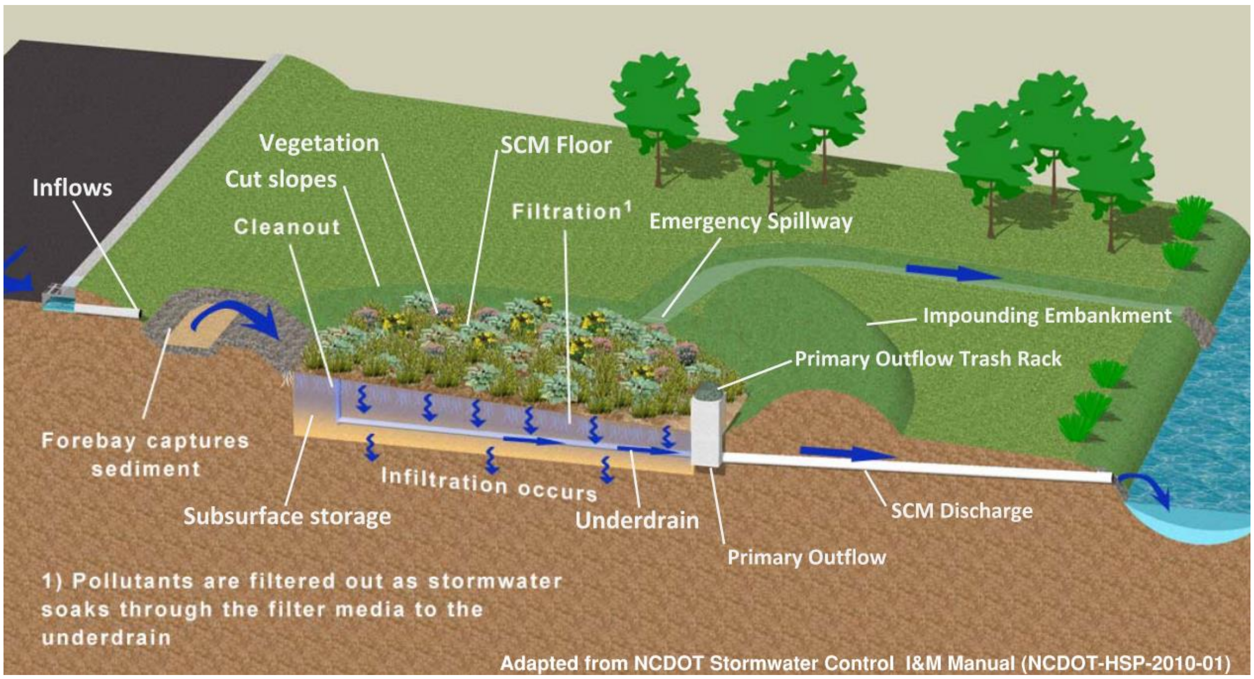


Figure 5.1.2: Anatomy of a Typical Surface SCM

Filtration: At the ground surface, infiltrating and filtrating surface SCMs may have a layer of engineered (amended) soils or filter media placed above native soils. This illustration shows the filter layer with flow arrows through it indicating filtration of pollutants as water drains through the medium. Some SCMs are designed to allow water to infiltrate into the subgrade below the SCM, while others are designed to drain the filtered water through an underdrain and away from the SCM. Filtration layers are inspected under the surface storage portion of PTCs Inspection software.

Vegetation: SCMs such as bioretention areas utilize vegetation in the surface storage area for enhancing filtration, infiltration, and evapotranspiration properties. Vegetation such as herbaceous material, shrubs and trees are used to aid in treatment. Vegetation is divided into subcategories for inspection and maintenance considerations as defined in Table 3.5.2. Other SCMs, like constructed stormwater filters (CSF), will not have vegetation on the surface but may have vegetated cut slopes/embankments and surrounding areas which contribute to SCM functionality.

Subsurface Storage: SCMs such as subsurface detention storage and subsurface infiltration trenches are designed to temporarily hold stormwater in a subsurface storage medium for infiltration, controlled release and/or reuse. The storage medium may consist of clean stone and/or storm pipes, vaults, and chambers. Subsurface storage systems may be incorporated below surface storage/filtration areas in combination surface/subsurface SCMs or, it may be a standalone subsurface SCM.

Underdrain: Underdrains are installed below the filter or stone storage media to effectively dewater the SCM where an SCM contains impermeable lining, the underlying soil does not provide adequate infiltration rates, or a backup drainage feature is needed. Cleanouts can be installed into the underdrains for inspection and maintenance purposes. Underdrains are inspected under the subsurface storage portion of PTCs Inspection software.

Observation Well/Cleanout: Underdrains should have cleanouts, which can also serve as observation wells, visible on the surface of the SCM. These provide an access point for maintenance to clean out piping systems and allow inspectors to check the subsurface storage area for proper dewatering. Some SCMs may have an observation well installed independent from underdrains in the filtration media to allow for subsurface storage inspections. Observation wells are similar in appearance to cleanouts on the surface. Observation wells and cleanouts are inspected under the subsurface storage portion of PTCs Inspection software.

SCM Liner: Some SCMs may have an impermeable liner installed under the SCM floor, cut slopes or impounding embankment areas of the SCM to limit water infiltration into the surrounding ground in sensitive locations such as karst or contaminated areas. Impermeable liners may be constructed from geosynthetics (geosynthetic clay liners/impermeable liners), clay or a combination of materials and are typically not visible from the surface (not illustrated in Figure 5.1.2).

Sediment Marker: A measuring device permanently installed in an SCM forebay or SCM floor that indicates the level of sediment build up within an SCM used to indicate when sediment removal is needed.

Cut Slopes and Impounding Embankments: Surface SCMs can be built by constructing a berm above existing grade, excavating a pit below existing grade, or both. Cut slopes are the SCM side walls constructed by excavating below grade. Impounding embankments, or berms, are “fill” material constructed above the surrounding ground forming a side wall of the SCM. Larger embankments may be considered a regulated dam structure depending on height and storage. Inspections and maintenance of these must also comply with the requirements of the Dam Safety permit and should be noted in the inventory. Embankments and cut slopes, collectively called side slopes, may not be present in all SCMs like subsurface SCMs (SDS, SIT), pervious pavement (PPA, PPC, PPP), and infiltration berms (IBE).

Primary Outflow: Except for very rare cases, all SCMs that detain water have a flow control structure that serves as the primary or principal outflow point. As depicted in Figure 5.1.2, basin type SCMs often utilize a metal or concrete box (riser) with one or multiple orifices and weirs to release stored water in a controlled manner. Subsurface SCMs typically have outflow structures built into a concrete box. SCMs that do not contain water (VFS, VSS, VSW, VSC) do not have outflow structures.

Low Flow Orifice: The lowest above-grade outflow orifice in the SCMs Primary Outflow (not illustrated in Figure 5.1.2). In SCMs designed to have a permanent pool or an infiltration/filtration volume (e.g., BID, BWD, CSF, and SWE), the low flow orifice is located above the surface elevation of the SCM. SCMs designed to draw down completely via the outflow structure (e.g., BDD, BED, and BUD) have the low flow orifice at the surface elevation of the SCM.

Secondary Outflow: A structure designed to control discharge from the SCM during periods of higher than normal flow or in the case of failure of the primary outflow (not illustrated in Figure 5.1.2). Typically, similar in appearance to the primary outflow utilizing a metal or concrete box (riser). The secondary outflow structure's lowest outlet point is situated higher than the primary outflow structure.

Trash Rack: Trash and debris can block openings in outflow structures. To prevent clogging, a metal or plastic grate structure is commonly installed on the top and/or sides of outflow structures. Both the primary outflow and the secondary outflow may have a trash rack. In PTC's inspection software, they are denoted "Primary Outflow Trash Rack" and Secondary Outflow Trash Rack".

SCM Discharge: The location water leaves the SCM from the primary outflow to a stable location. In basin type SCMs, this is the pipe immediately downstream of the outflow structure and where applicable, downstream end section and outfall protection such as a rip-rap apron. In VSW and VSC, this is the downstream discharge point from the channel. In VFS, VSS, MFD, and similar, this is the sheet flow discharging from the downslope edge of the VFS/VSS.

Emergency Spillway: Surface storage SCMs normally incorporate an emergency spillway that provides a stable release of water from the SCM in the event the principal outflow fails. Surface SCMs constructed in fill areas typically have an earthen weir constructed into the berm to function as an emergency overflow point. This area may be vegetated or have surface stabilization such as turf reinforcement matting (TRM), rip-rap or concrete to ensure peak flows do not erode the underlying berm. SCMs located entirely in cut or surrounded by roads may not have an emergency spillway.

Fencing: To protect the SCM from undesired entry by humans or animals, perimeter fencing may be installed (not illustrated in Figure 5.1.2). Fencing provides a protective barrier around the SCM and incorporates gates with locks where appropriate.

Signage: Signs may be placed in or around SCMs for multiple reasons (not illustrated in Figure 5.1.2). They can indicate the presence, delineate the extends/boundaries of the SCM or, in public areas, provide educational information.

5.2 Access, Fencing, and Security

Figure 5.2.1: Fencing Surrounding an SCM
(photo c/o: PennDOT)

5.2.1 Description and Overview

All SCMs and SCM components should be accessible to PTC personnel for maintenance-related activities. For some SCMs, this may include a dedicated access road, while others may simply require nearby parking with walking access. Due to highway safety considerations, some SCMs are constructed behind guide rail or other roadside barriers requiring special equipment for access. See Appendix B for listing of the types of access and associate abbreviations used in the inventory.

While SCMs are normally constructed within PTC's right-of-way, occasionally the SCM and associated access route are located in an easement. It is important that all maintenance and inspection activities remain within PTC's right-of-way or legal easement. The entranceway must be properly maintained to allow for SCM access. Some SCMs also require fencing and security gates to protect from vandalism, damage and unauthorized access.

5.2.2 Common Elements

Other common SCM components described in this chapter may be associated with access fencing and security. Refer to the appropriate section of this chapter for the following components:

- Signage

In addition, other elements associated with access, fencing, and security may include:

- Access road
- Vegetation
- Fencing

- Gates
- Lock
- Guide rail

Typical drawings for PTC right-of-way fencing and gates can be found in PTC Standards PTS-150 and PTS-154 and PennDOT Publication 72M, Sections RC-60M and RC-61M. Guide rail details can be found in PTC Standards PTS-130 and PTS-135 as well as PennDOT Publication 72M, Sections RC-50M, RC-51M, and RC-54M.

5.2.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of access, fencing, and security should focus on its key functional areas. Specifically:

- Inspect all access ways and area near fencing for trash, debris, sediment, or undesired vegetation. Desirable vegetation includes native grasses, shrubs, and trees that are not interfering with the access, fencing, or security. Undesirable vegetation includes excessive invasive species, hazardous trees, poisonous/noxious plants, or any growth that would interfere with maintenance equipment or personnel. Vegetation should be maintained to the heights indicated in the maintenance procedure tables based on the plan depicted vegetation type.
- Inspect access road surface for loss of gravel material, rutting or other conditions that limit access. Inspect access road and entire easement area for bare, eroded soils or signs of rills.
- Inspect for insects, such as wasps and hornets, that would interfere with access for maintenance activities.
- Inspect for holes in fence, around bottom of fence, or near footings that would interfere with security. Check structural integrity of all fence components.
- Inspect for presence and function of gate and/or locking mechanism.
- Inspect all areas for signs of vandalism.

When completing PTC's inspection app for Access, Fencing and Security:

- Access way concerns should be noted in the overall comment section completed on the last page of the inspection app.
- Fencing and Security are inspected under the Fencing/Gates/ Locks/Signage section of the inspection app.

5.2.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 5.2.1: Maintenance Procedures for Access, Fencing, and Security

Frequency	Activity
Annually (minimum*)	• Remove trash, debris, and/or sediment. • Remove or treat undesirable vegetation including weeds, poisonous plants (e.g. poison ivy), or tree growth that interferes with maintenance activity. Remove trees that are dead, diseased, or dying and in danger of falling onto the access way, fencing, or SCM.
As needed	• Maintain other applicable common components as described in other sections of this Chapter at the indicated frequencies.

* Should be completed each time on site for other routine maintenance activities.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SCM specific tables (G.1.3 through G.1.16).

5.3 Signage

Figure 5.3.1: Educational Signage at an SCM
(Photo c/o https://farm9.staticflickr.com/8339/8245031912_452a53aa50_z.jpg)

5.3.1 Description and Overview

SCMs may have signage or markers to indicate the extents of the SCM area, to aid in locating the facility and prevent unintentional disturbances. The number and location of delineation signage varies based on the type of SCM. Section 2.7 of this publication describes the recommended placement and type of delineation signage.

In addition to delineation, some SCMs in pedestrian friendly areas may include educational signage about the SCM. In more remote or inaccessible locations, signage may be used to prohibit entry.

5.3.2 Common Elements

Other common SCM components described in this chapter may be associated with signage. Refer to the appropriate section of this chapter for the following components:

- Access, Fencing, and Security

Additionally, other elements associated with signage vary depending on the type of signage present and may include:

- Flexible delineator post
- Blue water drop decal
- Sign post (PennDOT Type A through F as applicable)
- Concrete foundation

Typical drawings for PTC SCM delineation signage is provided in Section 2.1. Where optional education or other signs are present, typical drawings can be found in PennDOT Publication 111M, Sections TC-8604 and TC8702 through 8702E, respectively.

5.3.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of signage should focus on its key functions. Specifically:

- Where signage is not present, assess and make recommendation for signage installation. At a minimum, PTC requires SCM Marker delineators (Section 2.7) at all SCMs.
- Inspect SCM delineator signage for damage. For linear SCM, confirm start and end marker is in place. Ensure SCM ID is readable and accurate.
- Inspect post mounted signs for leaning and foundation issues. Signage leaning more than 8 inches off vertical should be reset to plumb.
- Inspect surface readability of post mounted signage. Signage should be replaced when more than 20% of the surface is unreadable.
- Inspect all signage for evidence of vandalism.
- Check for adequate signage visibility; note vegetation or other items obstructing view.

When inspecting signage, it should be inspected and photographed under the Fencing/Gates/ Locks/Signage section of PTC's inspection software.

5.3.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCMs information in the SCM inventory for potential variations.

Table 5.3.1: Maintenance Procedures for Signage

Frequency	Activity
Annually (minimum*)	• Remove or treat vegetation including weeds, shrubs, or tree growth that obstructs view of signage.
As needed	• Maintain other applicable common components as described in other sections of this Chapter at the indicated frequencies.

* Should be completed each time on site for other routine maintenance activities.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SCM specific tables (G.1.3 through G.1.16).

5.4 Inflow Systems

Figure 5.4.1: Inflow System- Curb Cut
(photo c/o: PTC)

5.4.1 Description and Overview

The majority of SCMs receive stormwater flows from adjacent and nearby areas via a drainage collection system or simply called, an inflow system or Inflows. Inflows can be comprised of different components including inlets, pipes, conveyance channels, and sheet flow. While not every one of these components will be present in every SCM, the inspection and maintenance procedures for all are discussed in this section.

Inlets, or catch basins, are typically rectangular concrete boxes fitted with pipe connections below grade and a slotted metal or plastic grate on the surface. Stormwater flows are directed into the grate, through the box, and to underground pipes. Note: For inlets with a sump (storage volume) below the pipe outlets and/or a hood or trap over the pipe outlets, refer to Section 6.13 Manufactured Treatment Devices for information on Inlet with Sump/Traps.

Storm sewer pipes (pipes) come in a variety of materials such as concrete, metal, or plastic. They can be used to convey stormwater into, through, and from SCMs. Some pipes found in SCMs may be perforated to allow stormwater to enter and exit the pipe from the surrounding area. Pipes discharging directly to the surface of an SCM may do so via a headwall or end section into an outfall protection feature (refer to Section 5.9 Structures and Appurtenances and Section 5.11 Outfall Protection component sections).

Swales, also known as ditches or channels, provide above-ground conveyance of stormwater to the SCM surface and may be lined with vegetation, turf reinforcement matting, concrete, or riprap. These differ from SCM type swales (VSW/VSC) as they do not incorporate stormwater treatment, such as filtration or infiltration. Note both conveyance channels and VSW/VSC can be used to deliver flow to an SCM; the key difference is a conveyance channel simply carries flow to the SCM while a VSW/VSC provides flow treatment while carrying the flows.

Curb cuts allow passage of concentrated stormwater flow along a curb (gutter) line into a conveyance channel or directly into the SCM. They are formed by a break or depressed section in the curb line that leads to the intended SCM. Riprap aprons are frequently installed on the downslope side of a curb cut to prevent erosion (refer to Section 5.11 Outfall Protection).

Sheet flow is the movement of stormwater runoff in a shallow, unconcentrated manner over plane surfaces. Sheet flow enters surface SCMs directly from the drainage area surrounding the SCM.

An SCM's inflows can be comprised of any combination of the above components. Some inflow systems pass through a pretreatment component, such as a forebay, prior to entering to the SCM. Refer to Sections 5.5, 5.6, 5.7 and 6.13 for pretreatment component information.

5.4.2 Common Elements

Several of the common SCM components described in this chapter may be associated with inflow systems. Refer to the appropriate section of this chapter for the following components:

- Inlet with Sump/Traps (Section 6.13)
- Forebay
- Structures and Appurtenances
- Outfall Protection
- Flow Splitter
- Outflow Structures

Additionally, other associated elements of typical inflow systems may include:

- Grate/cover
- Concrete curb

Typical drawings for inlets and inlet grates can be found in PTC Standards PTS-120, PTS-121, PTS-122, PTS-124 and PTS-125 as well as PennDOT Publication 72M, Sections RC-45M and RC-46M. Curb cuts are illustrated in PennDOT Publication 72M, Section RC-64M (Sheet 1, Depressed Curb for Driveways detail). Typical conveyance channel details are presented in the PADEP Erosion and Sediment Pollution Control Program Manual.

5.4.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of inflows should focus on its key functional areas. Specifically:

- Confirm stormwater runoff flows freely into the inflow system.
- Inspect all inflow system components for trash, debris, sediment, and undesired vegetation. Undesirable vegetation includes any plants that may impede flow into and through the inflow component including invasive, native, or woody plants. Desirable vegetation includes grass cover in a conveyance channel to prevent soil erosion. Vegetation should be maintained to the heights indicated in the routine maintenance tables based on the plan depicted vegetation type.
- Check all inflow areas for evidence of erosion. Inspect pipe inflow and outflow points, channels, and sheet flow areas for signs of erosion. Pipe inflow or outflow points showing signs of

significant sediment buildup suggest possible sediment buildup throughout the subsurface piping system and should be noted.

- Check for excessive sediment buildup at any entrance to or within a component of an inflow system. If present, check the SCM drainage area for bare soil or other possible sources of sediment.
- Inspect inlets, grates, curbs and curb cuts, headwalls, and any other structural components visible on the surface for signs of structural damage or deterioration.
- Inspect the ground surface above buried pipes and structures for depressions and other signs of pipe or structural damage, deterioration, or joint separation. If there is concern of damage or deterioration of a subsurface feature based on age or surface evidence, consider recommending video inspection or a confined space entry inspection to confirm system functionality.
- Inspect end sections and outfall protection as described in Sections 5.9 and 5.11.

Each SCM inflow is inspected under the Inflow section of in PTC's inspection software as described in Section 3.5 and Appendix D, Section D.4.3.

5.4.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 5.4.1: Maintenance Procedures for Inflow Systems

Frequency	Component	Activity
Three times per year	All	• Prior to mowing, remove trash, debris, and sediment impeding or blocking flow of water to inflow component. • Remove or treat undesirable vegetation. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. • Remove animal carcasses from vicinity of inflow system and inside inlet boxes and pipes.
	Inlets; curb cuts; sheet flow	• Remove vegetation obstructing flow into inlets, curb cuts, or sheet flow areas.
	Ditches; sheet flow	• Mow areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow areas to a height of 6 to 10 inches. • Do not mow areas planted with no-mow landscaping such as shrubs. • Remove or treat undesirable and woody species.
Annually	Sheet flow	• Mow tall meadow areas to height of 8 to 16 inches. • Do not mow areas planted with no-mow landscaping such as shrubs.
As needed	All	• Maintain other applicable common components as described in other sections of this Chapter at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SCM specific tables (G.1.3 through G.1.16).

5.5 Flow Splitter

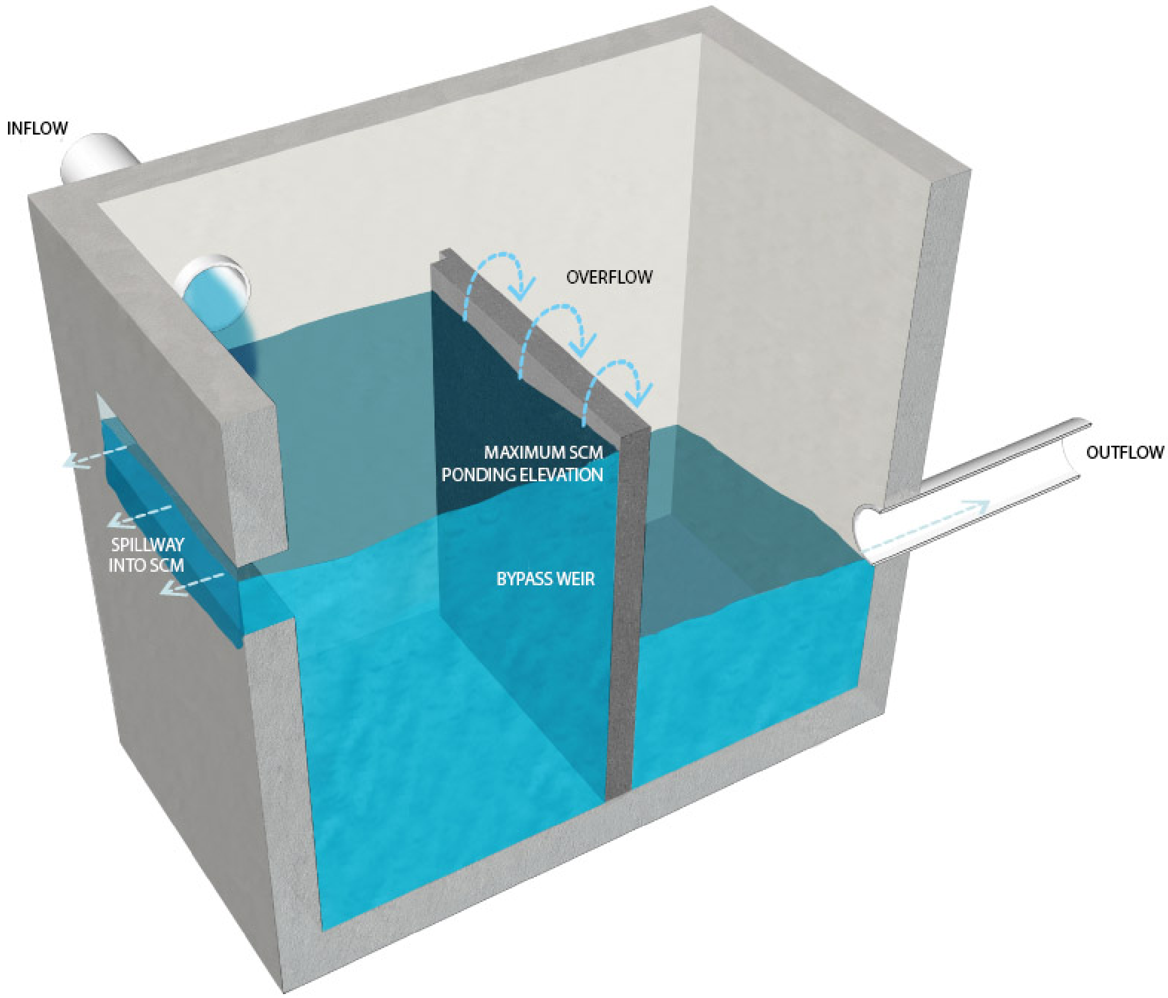


Figure 5.5.1: Flow Splitter
(photo c/o: Philadelphia Water Department, Stormwater Management Guidance Manual)

5.5.1 Description and Overview

Flow splitters, also called flow bypass structures, are SCM components which direct a portion of stormwater runoff into an SCM while bypassing excess flows from larger events around the SCM. Flow splitters are located at the upstream inflow point of the SCM. Generally, a flow splitter will consist of a small storage area (sump) having one inflow point and two outflow points set at different elevations and/or separated by a weir. The elevations and sizes of the outflow points and/or weirs within the flow splitter are important for proper function.

Subsurface flow splitters are generally constructed utilizing components described in Structures and Appurtenances (Section 5.9) by installing weirs in concrete boxes and manholes.

Forebays can also be used as a form of a surface flow splitter by installing a low flow weir into the SCM and a high flow bypass channel that allows for overflow to a channel around the SCM (refer to Section 5.4 Inflow Systems and Section 5.6 Forebay).

5.5.2 Common Elements

Several of the common SCM components described in this chapter are associated with flow splitters. Refer to the appropriate section of this chapter for the following components:

- Inflow Systems
- Inlet with Sump/Traps (Section 6.13)
- Structures and Appurtenances

Additionally, other associated elements of typical flow splitters may include:

- Concrete boxes or manhole
- Grate/cover
- Concrete joints
- Weir
- Steps/ladder
- Pipes

Figures 5.5.2 and 5.5.3 illustrate the common elements of typical flow splitters.

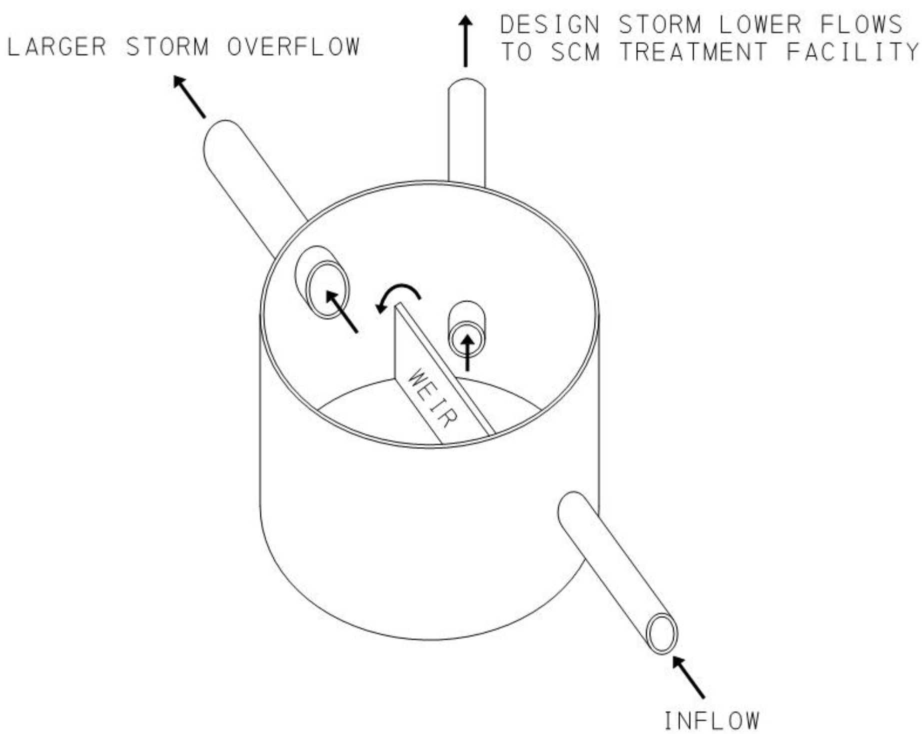
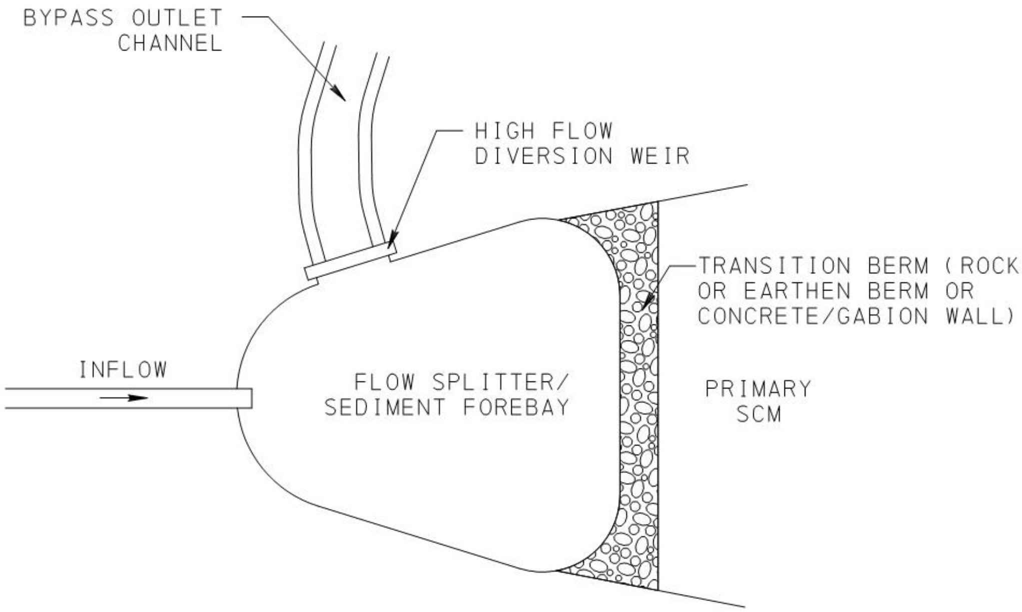
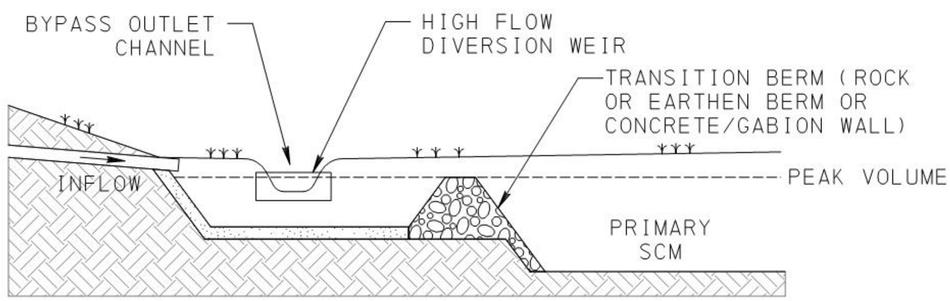


Figure 5.5.2: Subsurface Flow Splitter – Common Elements



Plan View



Section View

Figure 5.5.3: Surface Flow Splitter – Common Elements

5.5.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of a flow splitter should focus on its key functional areas. Specifically:

- Inspect for trash, debris, and/or sediment that is blocking or impeding the flow of water through the flow splitter; flow splitters can be prone to sediment and debris clogging as they are a component found upstream of most pretreatment measures.
- Check for vegetation that impedes flow into, through or out of the flow splitter.
- Check that the top of weir, if present, and pipe connection elevations (with respect to bottom elevation of the splitter) are consistent with design plans using measurements of the relative dimensions between each feature.

- Inspect for visual signs the system is receiving flow, such as water present in sump. Inspect for nearby erosion and sedimentation that would indicate the incoming flow is overwhelming the system.
- Inspect all structures and weirs for signs of structural deterioration. Check for corroded, spalling, or damaged structural components.

When completing inspection, flow splitters are inspected and photographed under the associated inflow system in PTCs inspection software.

5.5.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCMs information in the SCM inventory for potential variations.

Table 5.5.1: Maintenance Procedures for Flow Splitter

Frequency	Activity
Three times per year	• Remove trash, debris, undesirable vegetation, and/or sediment blocking flow of water into, through and out of flow splitter. For subsurface flow splitters, use a vacuum truck or other appropriate method. For surface flow splitters, refer to forebay section for sediment removal and maintenance procedures. • Remove animal carcasses from vicinity of and within flow splitter.
As needed	• Maintain applicable common components as described in other sections of this Chapter at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SCM specific tables (G.1.3 through G.1.16).

5.6 Forebay

Forebay with Paver Surface

Forebay with Rock Surface

Figure 5.6.1: Forebays
(photo c/o: PT)

5.6.1 Description and Overview

Forebays are SCM components which slow flow velocities and capture sediment and debris just upstream of the entrance into the primary SCM storage area. They are most commonly found in Stormwater Wetlands (SWE), Wet Basins (BWD), Infiltration Basins (BID) Dry Basins (BDD, BED, BUD, BOT, BND) and Bioretention (BRE, BRU). A properly functioning forebay will increase the lifecycle of the SCM.

Forebays are physically separated from the rest of the SCM by a transition berm comprised of an earthen or rip-rap berm, or a concrete or gabion wall. This transition berm or wall is located at the downstream end of the forebay and acts as a weir (refer to Section 5.9 Structures and Appurtenances) to release flow to the main body of the SCM. Cut slopes and embankments may incorporate vegetation such as turf grass or larger grasses and shrubs.

Forebays may have a permanent or temporary ponding area, depending on the design of the associated SCM. The bottoms of forebays may be earthen (vegetated) or lined with rock, concrete, or landscaping pavers. The surface storage area of the forebay functions as a sediment settling and storage zone. Solid bottoms (concrete, pavers or similar) in permanently ponded forebays help to facilitate sediment removal. Variations of forebays may include a flow splitting function (refer to Section 5.5 Flow Splitter) or dewatering riser (refer to Section 5.9 Structures and Appurtenances).

5.6.2 Common Elements

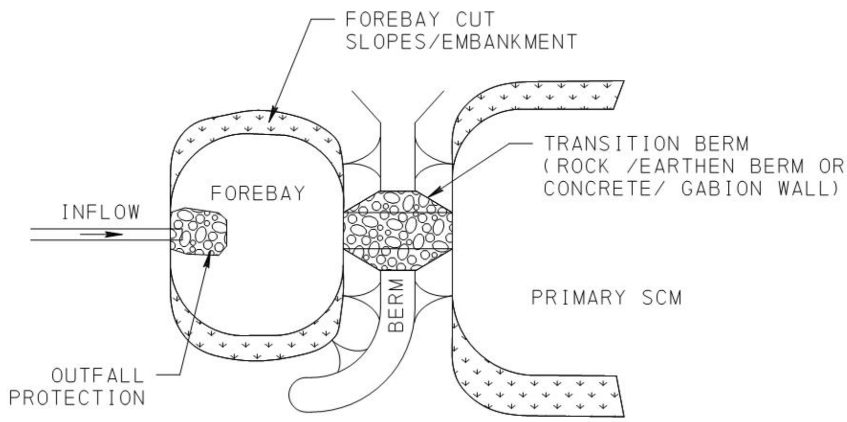
Other common SCM components described in this chapter may be associated with a forebay. Refer to the appropriate section of this chapter for the following components:

- Inflow Systems
- Flow Splitter
- Structures and Appurtenances
- Outfall Protection

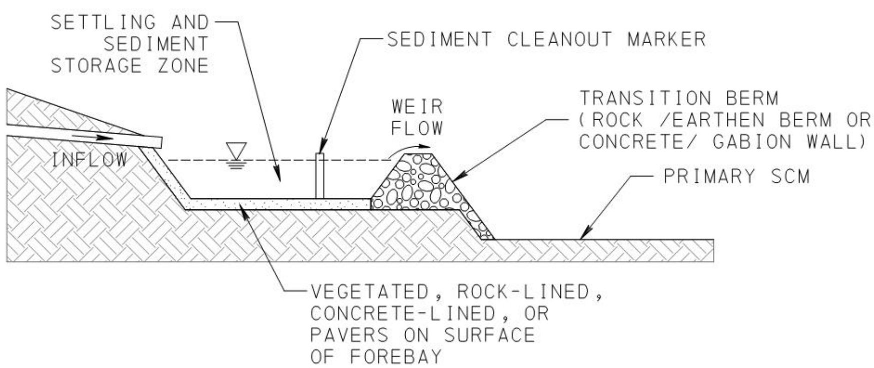
Additionally, other associated elements of typical forebays may include:

- Cut slopes/ impounding embankment
- Transition berm (rock/earthen berm or concrete/gabion wall)
- Sediment cleanout marker
- Vegetation
- Settling and sediment storage zone

Figure 5.6.2 illustrates the common elements of a typical forebay.



Plan View



Section View

Figure 5.6.2: Forebay - Common Elements

5.6.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of a forebay should focus on its key functional areas. Specifically:

- Inspect forebays for trash, debris, and undesirable vegetation. Vegetation may be present on the cut slopes/impounding embankments but is generally not located within the pooling area of solid surface forebays. In earthen surface forebays, turf plant growth within the pooling area is acceptable (up to 25% depth of forebay), but if it becomes excessively thick or tall, removal should be recommended to ensure adequate storage volume and ease of sediment removal. Vegetation should be maintained to the heights indicated in the routine maintenance tables based on the plan depicted vegetation type.
- Check all cut slopes/ impounding embankments and transition berm for evidence of erosion and for structural stability.
- Inspect inflow and outflow areas for signs of erosion.
- Inspect the forebay bottom for signs of erosion, channelization. In solid surface forebays, check the surface for structural integrity. Concrete should not be cracked, broken or spalling. Pavers should be intact with no missing or dislodged units.

- Determine if sediment removal is needed:
  - Most sediment forebays should have a permanent sediment marker. Read the marker and note the sediment level compared to the cleanout mark/elevation.
  - If a sediment marker is not present or damaged, the O&M section of the PCSM plan should have a cleanout level noted for the pretreatment area. If no impermeable liner is present (check PCSM plan), use a soil probe to recover a sample at several locations within the pretreatment area. The sediment depth can be interpreted based on the depth to the base soil from the surface (look for soil type change in texture, grain size, color). Compare the measured depth of sediment to the PCSM plan cleanout depth.
  - In the absence of other information, the sediment should be removed when it is half the depth of the forebay area. Complete a soil probe sample as described above (if no impermeable liner is present) to determine the depth of sediment. The forebay depth should be measured from the invert of the lowest inlet point to the bottom of the forebay (as determined from as-built plans or soil probes).
- If no permanent sediment marker is found in a forebay, make recommendations to add a permanent sediment marker to aid in maintenance.

Forebays are inspected and photographed in the Inflows Section under Forebay sin PTC's inspection app as described in Section 3.5 and Appendix D, Section D.4.3.

5.6.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCMs information in the SCM inventory for potential variations.

Table 5.6.1: Maintenance Procedures for Forebay

Frequency	Activity
Three times per year	• Remove or treat undesirable vegetation growth from forebay surface. Remove or treat undesirable and woody vegetation on embankments/cut slopes or transition berm before they become well-established. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. • Prior to mowing, remove litter, trash, and debris from surface, side slopes, inflow/outflow points, structures and surrounding area. • Mow areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow areas to a height of 6 to 10 inches. • Perform mowing operations when forebay is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • LGP equipment must be used on SCM Floor (see Section 4.7); do not drive heavy equipment on SCM Floor.
Once every five years or sooner if indicated by cleanout marker	• Remove sediment accumulation in forebay. Perform removal operations when forebay and SCM is completely dry, preferably using vacuum truck; do not drive heavy equipment on earthen and gravel surfaced forebay surfaces; only LGP equipment may enter the forebay (see Section 4.7). Do not allow material storage on SCM surface.
As needed	• Maintain other applicable common components as described in other sections of this Chapter at the indicated frequencies.

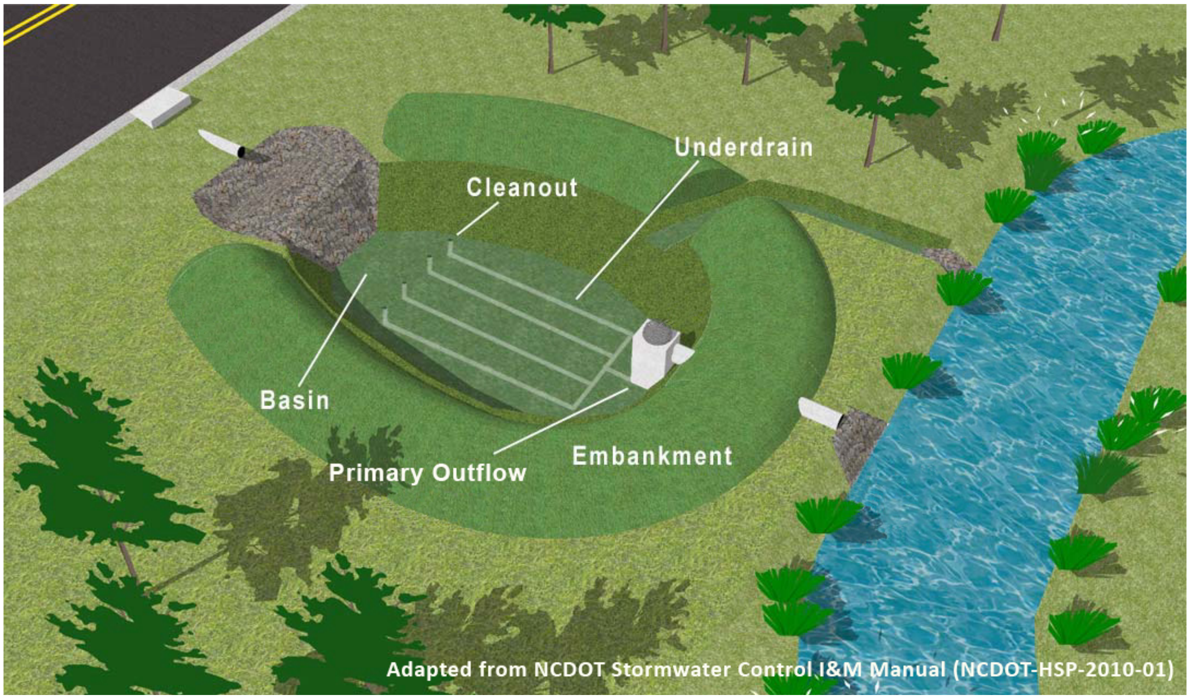
Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SCM specific tables (G.1.3 through G.1.16).

5.7 Underdrain



Underdrain System in Basin Type SCM
(Adapted from NCDOT-HSP-2010-01)

Metal Cleanout/Observation Well Lid

Plastic Cleanout/Observation Well Lid

Figure 5.7.1: Underdrains

5.7.1 Description and Overview

Underdrains are perforated pipes installed in or under the filter media or engineered soil subsurface storage area to convey runoff that has filtrated through the media. It is usually constructed of PVC (polyvinyl chloride) or HDPE (high density polyethylene) pipe materials that are perforated to allow water to enter the pipe. The pipe may be wrapped in a geotextile fabric and/or embedded in coarse aggregate to prevent the filter media or engineered soils from clogging the perforations and washing into the pipe. Underdrains are installed when the SCM contains an impermeable lining, the underlying soil does not provide adequate infiltration rates, or as a secondary backup outflow path in the event of infiltration failure after construction.

The underdrains are frequently directly connected to the Primary Outflow Structure (Section 5.8) where it drains freely into the structure and out of the SCM. In other cases, the underdrain system is directly connected to a piping system leading out of the SCM. In either case, when the underdrain is installed as a secondary backup system, it may have a cap to prevent flow through the system while the SCM infiltration is functioning. The cap is removed only when the infiltration is deemed inadequate.

Underdrain systems should have periodic cleanouts installed which are pipe connections from the ground surface to the underdrains to allow for system cleaning and inspection. From the surface, the cleanout cap is visible typically as a white plastic or metal lid screed into the pipe below as shown in the pictures above (Figure 5.7.1). The cap may be flush with grade or it may be raised above ground.

Observation wells are similar in appearance to a cleanout at the ground surface but they are not connected to underdrains. An observation well is a vertical pipe extending through the SCMs filter media or engineered soils with perforated pipe to allow the level of subsurface water storage to be “observed” from the ground surface.

5.7.2 Common Elements

Other common SCM components described in this chapter may be associated with an underdrain. Refer to the appropriate section of this chapter for the following components:

- Structures and Appurtenances
- Outflow structures

Additionally, other associated elements of typical underdrains may include:

- Perforated pipe
- Observation well/cleanout
- Observation well/cleanout cap
- Geotextile
- Filter media/ engineered soils
- Coarse aggregate

Figure 5.7.2 and 5.7.3 illustrate the common elements of a typical underdrain and cleanout. Figure 5.7.4 illustrates a typical observation well in section view.

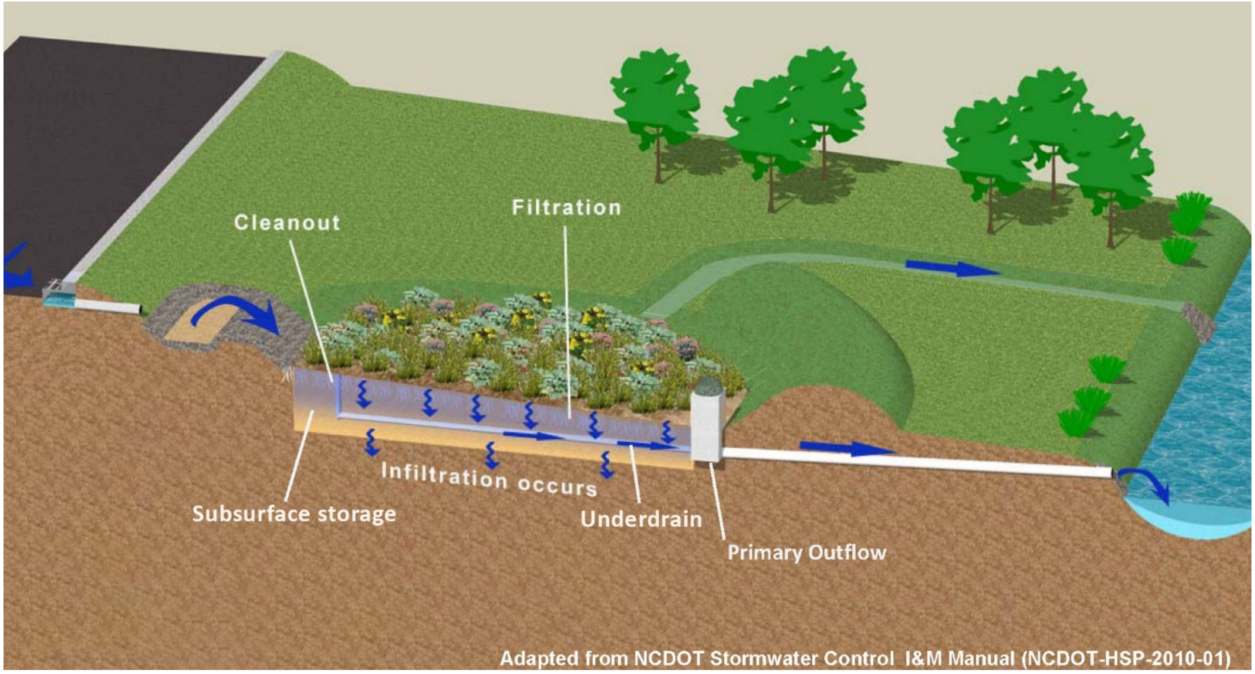


Figure 5.7.2: Underdrain System
(Adapted from NCDOT-HSP-2010-01)

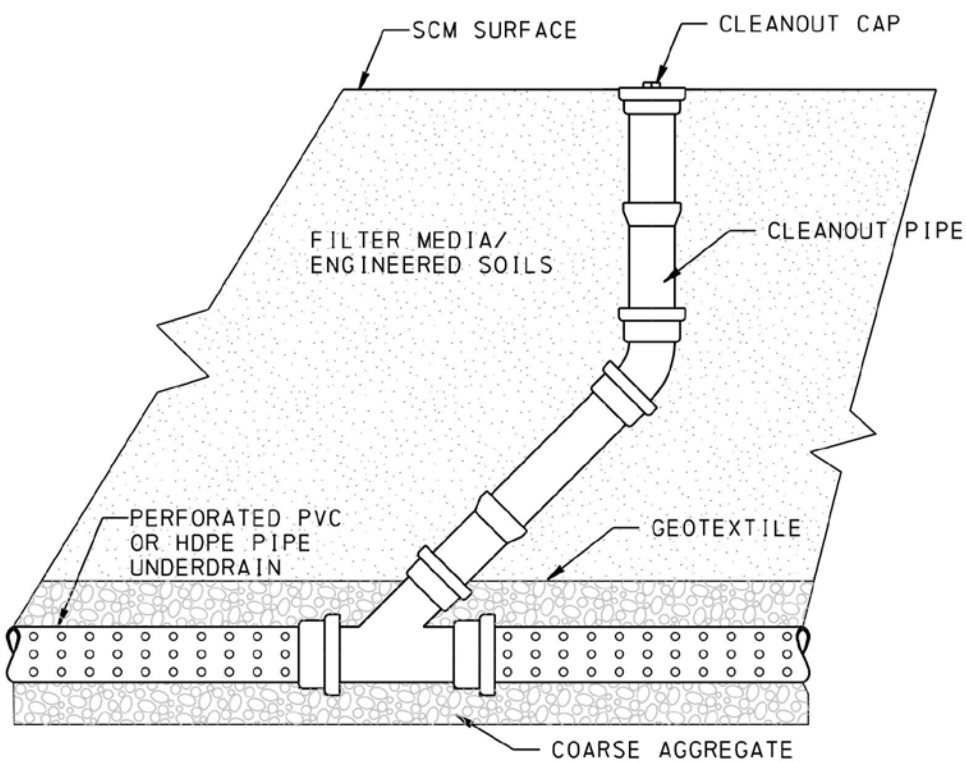


Figure 5.7.3: Underdrain and Cleanout– Section View

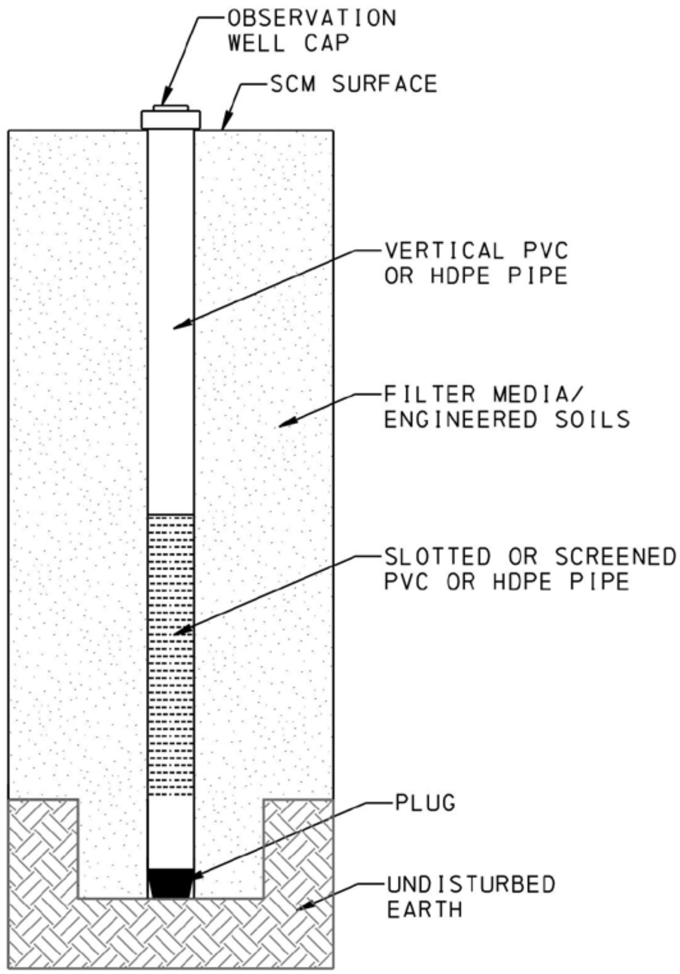


Figure 5.7.4: Observation Well – Section View

5.7.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of an underdrain, cleanouts and observation wells should focus on its key functional areas. Specifically:

- Check all cleanouts and observations well caps are in place and undamaged.
- Open all cleanouts and observations wells present inspecting each for:
    - signs that standing water remains in the system longer than 72 hours after a rain event
    - presence of soil, sediment or debris in the piping system
    - signs of plant root intrusion into the piping system.
- Inspect the underdrain connection to the outflow structure (when present and visible) for:
    - evidence water able to freely drain from the underdrain to into the outflow structure.
    - no flowing water unless it has rained in the last 72 hours. Water continuously draining without rain suggests high ground water.
    - sign of soil or sediment washing through the underdrain system.
- Inspect the SCM surface above the underdrain system for signs of depressions or “sinkhole” like activity which may indicate the underdrain has collapsed or soil is entering the underdrain system.

Underdrains, cleanouts and observation wells are inspected under the subsurface storage portion PTC's inspection software.

5.7.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCMs information in the SCM inventory for potential variations.

Table 5.7.1: Maintenance Procedures for Underdrain

Frequency	Activity
Three times per year	• Remove or treat vegetation growth which may obscure the visibility of the cleanout or observation well caps taking care not to damage the caps with equipment. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
As needed	• Maintain other applicable common components as described in other sections of this Chapter at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SCM specific tables (G.1.3 through G.1.16).

5.8 Outflow Structures

Circular orifices with trash rack on low flow orifice and top

(photos c/o: PTC)

V-notch weir with top mounted trash rack **Rectangular weir & circular orifice with trash rack**

(photos c/o: PennDOT)

Figure 5.8.1: Outflow Structures

5.8.1 Description and Overview

Outflow structures, also known as flow control structures, risers, or outlet structures, are an SCM component which restricts flow out of the SCM to a specific design rate. The outflow structure conveys water from the SCM to the downstream drainage system or receiving water. Most SCMs that store/detain water will have an outflow structure of some form. Proper maintenance practices on outflow structures will prevent the structure from overtopping or releasing water too quickly.

The most common types of outflow structures are comprised of a concrete box, manhole, or upturned metal pipe structure with a combination of orifices, weirs, and grates that allow flow into the structure, and a pipe carrying flow out of the structure to a downstream drainage system or receiving water (refer to Section 5.9 Structures and Appurtenances). Each orifice, weir, or grate opening is designed to release a different amount of flow to achieve the stormwater requirements for the SCM. In SCMs that are designed to completely dewater, the outflow structure will likely have a low flow orifice or opening that is even with the SCM ground surface elevation. Orifices may be incorporated into the structure by constructing small holes through the concrete box or affixing an orifice plate. An orifice plate is a thin metal or plastic plate with a small hole in it placed over a larger diameter outflow point. Sometimes outflow structures have a sump area below the outlet pipe, which provides storage volume for sediment and debris to settle out of the collected runoff (refer to Section 6.13 Manufactured Treatment Devices for information on Inlet with Sump/Traps).

In its simplest form, an outflow structure commonly associated with infiltrating SCMs, such as Infiltration Basins (BID) and Bioretention (BRE, BRU), can be a standard inlet box/grate installed at a set elevation above the basin bottom. The inlet grate functions as the outflow structure releasing excess stormwater during large storm events while retaining a ponded area for infiltration typically 6 to 18 inches deep.

Other times, where there are weirs/orifices located lower on the structure, the top of the outflow structure may function as an emergency outlet, similar to and in lieu of an Earthen Emergency Spillway (refer to Section 5.10 Emergency Spillway). Outflow structures are commonly comprised of variations of the components included in Section 5.9 Structures and Appurtenances, such as concrete boxes, metal pipe risers, weirs and trash racks.

Outflow structures associated with subsurface SCMs are typically constructed within a manhole or concrete box. The outflow structure typically includes a series of orifices and weirs built on an internal baffle wall designed to function similar to a surface SCM outflow structure.

5.8.2 Common Elements

Several of the common SCM components described in this chapter may be associated with outflow structures. Refer to the appropriate section of this chapter for the following components:

- Inflow Systems
- Inlet with Sump/Traps (Section 6.13)
- Structures and Appurtenances
- Outfall Protection

Additionally, other associated elements of typical outflow structures may include:

- Grate/cover
- Sump
- Orifices
- Orifice plate
- Pipe
- Steps/ladder

A typical concrete box outflow structure and orifice plate detail can be found in PennDOT Publication 72M, Section RC-71M (Sheet 4, Concrete Outlet Structure).

5.8.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of an outflow structure should focus on its key functional areas. Specifically:

- Stormwater should be able to flow freely through all parts of the outflow structure. Inspect for trash, debris, and/or sediment that is blocking or impeding the flow of water into the outflow structure, around weirs, orifices, or grates.
- Check for vegetation that might block flow through the outflow structure.
- Confirm the low flow orifice (if present) is clear without obstructions to flow.
- Inspect for trash, debris, and/or sediment buildup within the riser, concrete box or manhole. If the outflow structure has a sump area, cleanout should be required when the sediment depth exceeds 50% of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin.
- Inspect that the top of weir, orifice, pipe, and bottom elevations are consistent with plans using measurements of the relative dimensions between each feature.
- Inspect for erosion and sedimentation that would indicate flow is overwhelming the outflow structure.
- Inspect for signs of structural damage or deterioration including cracks, leaks, corroded, spalling, or damaged structural components. Concrete structures, such as boxes and manholes, shall be checked for holes or cracks greater than 1/2 inch and longer than one foot or other signs of differential settlement. Metal components shall be checked for excessive corrosion. Inspect the ground surface above buried pipes and structures for depressions or other signs pipe or structural damage, deterioration, or joint separation. If there is concern of damage or deterioration of a subsurface feature based on age or surface evidence, consider recommending video inspection or a confined space entry inspection to confirm system functionality.
- Confirm that the outflow points are adequately protected and covered with a trash rack or grate. Inspect for trash and debris buildup on the trash rack/grate.
- Check for evidence of malfunctioning structural components.

Outflow structures are inspected and photographed under the appropriate Primary Outflow or Secondary Outflow in PTC's inspection software.

5.8.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCMs information in the SCM inventory for potential variations.

Table 5.8.1: Maintenance Procedures for Outflow Structures

Frequency	Activity
Three times per year	• Remove trash, debris, undesirable vegetation, and/or sediment blocking or impeding flow of water in, out, and through outflow structure. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. • Remove animal carcasses from vicinity of and within the outflow structure. • Remove obstructions from weirs and orifices.
As needed	• Maintain other applicable common components as described in other sections of this Chapter at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined the in maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SCM specific tables (G.1.3 through G.1.16).

5.9 Structures and Appurtenances

Metal Riser with Trash Rack and Vortex Plate
(photo c/o: PADEP E&S Manual)

Endwall with Trash Rack
(photo c/o: PennDOT)
Figure 5.9.1: Structures and Appurtenances

5.9.1 Description and Overview

The structures and appurtenances described in this section include a combination of different components including endwalls, end sections, concrete boxes, manholes, risers, trash racks, and weirs. While not every one of these components will be present in every SCM, the inspection and maintenance procedures for each are discussed in this section. This information should be applied as applicable to different SCMs.

Endwalls, or Headwalls, are typically concrete walls that surround the entry or exit point of a pipe or culvert that help prevent erosion around pipe or culvert installations. Headwalls can be flat vertical walls or can have angular shapes to direct flow into or out of the pipe. Commonly, headwalls will be attached to pipe ends with a form of outfall protection constructed immediately downstream (refer to Section 5.11 Outfall Protection). Headwalls may be fitted with a trash rack as described in this section.

End sections are flared metal or concrete structures typically located on the exit point of a pipe or culvert that help prevent erosion around pipe installations. End sections function similarly to angled headwalls located at a pipe outfall. End sections are frequently installed on pipe ends with a form of outfall protection constructed immediately downstream (refer to Section 5.11 Outfall Protection).

Concrete boxes are rectangular reinforced concrete structures. In SCMs applications, they are most commonly associated with subgrade structures such as inlets (refer to Section 5.4 Inflow Systems) or an inlet with sump/trap (refer to Section 6.13 Manufactured Treatment Devices for information on Inlet with Sump/Traps) which are fitted with pipe connections below grade and a slotted metal or plastic grate on the surface. Concrete boxes can also be used as junction boxes combining flows from multiple pipes, points for maintenance access, flow splitters (refer to Section 5.5 Flow Splitter) and Outflow Structures (refer to Section 5.8 Outflow Structure). These concrete structures range in size, typically from 2 feet x 4 feet to 10 feet x 10 feet with varying depths from 3 feet to >15 feet. In accordance with standard detail requirements, access steps should be present when the depth between the finished grade elevation and the interior bottom of the box is greater than 5 feet. A concrete box may include a storage volume, or sump beneath pipe connections or traps over pipe connections (refer to Section 6.13 Manufactured Treatment Devices for information on Inlet with Sump/Traps).

Manholes are cylindrical subgrade concrete structures fitted with pipe connections below grade and fitted with a solid (typically) or grated (occasionally) metal plate on the surface. A manhole's main function in SCMs is to serve as junction or maintenance access point for pipe systems. Manhole diameters range from 4 feet to 12 feet and varying depths from 4 feet to 15 or more feet and typically have steps mounted on the side of the structure to allow access. If a manhole includes a sump or trap, refer to Section 6.13 Manufactured Treatment Devices for information on Inlet with Sump/Traps maintenance procedures.

Pipe Risers are upturned pipe sections located on a pipe inlet. They can be made of metal, plastic or other material and are sometimes perforated. Risers are common appurtenances incorporated into the Outflow Structure (Section 5.8) for SCMs such as Dry Basins (BDD, BED, BUD, BOT, BND), Wet Basins (BWD), and Stormwater Wetlands (SWE). Metal risers commonly have an open top fitted with a trash rack and may have a vertical plate at the top for vortex prevention.

Trash racks are debris barriers that prevent large materials from entering a closed pipe system to prevent clogging of a pipe or control structure inflow point. Most commonly, a trash rack is a bar grate, typically made of epoxy coated metal reinforcing bar or plastic molded bars fitted over an opening into a pipe or outflow structure. They can also be used to prevent human or animal entry into the system. Trash racks are a common appurtenance of concrete endwalls, metal end sections, metal risers and Section 5.8 Outflow Structures.

Weirs are a physical barrier that intentionally cause water to pool upstream and release flows over the barrier in a controlled manner. The barrier can be made from metal, concrete, rock, earth, or other material. The crest, or top, of the weir can be flat, or have a rectangular or v-notched shape allowing higher flows to pass more quickly as the pooled elevation increase. Weirs are a common appurtenance of many components of SCMs such as forebays and outflow structures.

The above structures and appurtenances can be standalone components within an SCM or they may be incorporated as parts of other SCM components as listed. Refer to other applicable component sections for more information.

5.9.2 Common Elements

Several of the common SCM components described in this chapter may be associated with structures and appurtenances. Refer to the appropriate section of this chapter for the following components:

- Inflow Systems
- Inlet with Sump/Traps (Section 6.13)
- Outflow Structure
- Outfall Protection

Additionally, other associated elements of typical structures and appurtenances may include:

- Inlet grate
- Manhole cover
- Concrete joints
- Epoxy-coated reinforcing bars
- Steps

Typical drawings for headwalls/endwalls, end sections, concrete boxes, and manholes can be found in PTC Standards PTS-120, PTS-121, PTS-122, PTS-124 and PTS-125 as well as PennDOT Publication 72M Sections RC-31M, RC-33M, RC-46M, and RC-39M, respectively. Metal risers and trash racks are illustrated in PennDOT Publication 72M, Section RC-71N (Sheet 2, Sediment Trap Riser and Trash Rack and Anti-Vortex Device details).

5.9.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of structures and appurtenances should focus on its key functional areas. Specifically:

- Inspect for trash, debris, and/or sediment that is blocking or impeding the flow of water through all structures and appurtenances.
- Inspect for signs of structural damage or deterioration of all structures and appurtenances. Concrete structures such as endwalls, concrete boxes, manholes, and weirs shall be checked for cracks greater than 1/2 inch and longer than one foot or other signs of differential settlement. Metal structures such as end sections, risers, trash racks, and weirs shall be checked for corrosion. If there is concern of damage or deterioration of a subsurface feature based on age

or surface evidence, consider recommending video inspection or a confined space entry inspection to confirm system functionality.
- Inspect pipe connections to inlets, manholes, concrete headwalls, and end sections for areas of settlement or misalignment.
- Inspect the foundation and subgrade below endwalls and end sections for signs of erosion or undermining of the structure.
- Inspect for presence of trash rack. They should be present on any pipe riser greater than 18 inches in diameter and on smaller orifices/weirs constructed into concrete boxes. Inspect for excessive corrosion (50% or more) and bent (out of shape more than 3 inches) or missing bars on trash racks and protective grates.

When completing PTC's inspection software for an SCM, trash racks for primary and secondary outflows are inspected under the respective outflow trash rack portion of the software. All other structures and appurtenances are inspected and photographed under their related SCM component. For example, an endwall at a pipe at the SCM inflow point is inspected under the "Inflows" Section as part of the incoming pipe, while an endwall at the end of the pipe immediately downstream of the SCM outlet structure is inspected as part of the SCM Discharge.

5.9.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCMs information in the SCM inventory for potential variations.

Table 5.9.1: Maintenance Procedures for Structures and Appurtenances

Frequency	Activity
Three times per year	• Remove all trash, debris, and/or sediment blocking or impeding flow of water in, out, and through structures. • Remove animal carcasses from vicinity of and within structures. • Remove or treat vegetation growth which may impede the flow of water. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
As needed	• Maintain other applicable common components as described in other sections of this Chapter at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SCM specific tables (G.1.3 through G.1.16).

5.10 Emergency Spillway

Figure 5.10.1: Emergency Spillway
(photo c/o: PennDOT)

5.10.1 Description and Overview

An emergency spillway (spillway) is a SCM component found in most surface basin type SCMs. It is an open channel through the SCM side slopes, located at an elevation slightly below the top of main embankment but above the elevation of the primary outflow structure. The spillway carries occasional to infrequent flows resulting from large storm events or blockage of the primary outflow structure. Sometimes called earthen emergency spillways, they are most commonly found in Infiltration Basins (BID), Stormwater Wetlands (SWE), Wet Basins (BWD), and Dry Basins (BDD, BED, BUD, BOT, BND).

The surface of a spillway is typically grass, turf reinforced matting (TRM), concrete, or riprap. When possible, they are typically constructed by cutting into existing ground as opposed to being constructed through the fill section of an impounding embankment wall. The spillway is comprised of an inlet channel/weir within the SCM surface storage area and an exit channel or area of sheet flow that conveys flow beyond the SCM. The inlet channel/weir includes the spillway crest, or level section through the SCM wall. The exit channel is the constructed spillway downstream from the crest. Some spillways include a longer exit channel leading to a downstream discharge point some distance away. Others, particularly those constructed through embankment areas, may include the inlet channel with only a short exit channel that ends just beyond the toe of slope. They are typically constructed approximately 2 feet below the top elevation of the SCM and may be 10 to over 40 feet wide.

5.10.2 Common Elements

Other common SCM components described in this chapter may be associated with spillways. Refer to the appropriate section of this chapter for the following components:

- Outfall Protection

Additionally, other associated elements of typical emergency spillways may include:

- Spillway crest
- Cut slopes/impounding embankment
- Channel
- Vegetation
- Geotextile
- Riprap or concrete

Typical emergency spillway details can be found in PennDOT Publication 72M, Section RC-71M (Sheets 1-3).

5.10.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of an emergency spillway should focus on its key functional areas. Specifically:

- Inspect for trash, debris and undesirable vegetation. In spillways with vegetated surfaces, undesirable vegetation includes invasive species or woody shrubs or trees of any size within the spillway area. Intentionally vegetated areas should be maintained to the heights indicated in the routine maintenance tables based on the plan depicted vegetation type. In spillways with riprap or concrete surfaces, undesirable vegetation includes the presence of any growth.
- Inspect concrete, if present, to ensure it is in good structural condition. Inspect riprap, if present, to ensure adequate amount is present. Rip-rap should be uniform thickness, matching nominal placement thickness per PTC CS-850 with no bare spots.
- Inspect slopes/embankments surrounding area for structural damage or deterioration including signs of uneven settlement and cracking.
- Inspect for signs of erosion and sedimentation, especially where inlet channel meets the base of SCM, exit channel meets toe of embankment, and the spillway weir. Verify the elevation difference between emergency spillway and the embankment is the same as plans and that no excessive settlement has occurred.
- Check that channel and side slopes are structurally sound.

5.10.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 5.10.1: Maintenance Procedures for Emergency Spillway

Frequency	Activity
Three times per year	• Prior to mowing, remove litter, trash, and debris from channel surface, side slopes, inflow/outflow points, and surrounding area. • Mow grassed side slopes and channel bottom (if grassed). • Mow areas indicated to be lawn to height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow to a height of 6 to 10 inches. • Perform mowing operations when Emergency Spillway is completely dry. • Remove or treat undesirable vegetation growth. Undesirable growth in grassed spillways includes invasive species, shrubs, or trees. Undesirable growth in rip-rap or concrete spillways is any vegetative growth. Repair disturbed areas with original spillway surface treatment. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
Annually	• Remove sediment, from channel surface, side slopes, inflow/outflow points, and surrounding area.
As needed	• Maintain applicable common components as described in other sections of this Chapter at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outline in the maintenance tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SCM specific tables (G.1.3 through G.1.16).

5.11 Outfall Protection

Riprap Apron
(photo c/o: PennDOT)

Plunge Pool
(photo c/o PADEP Erosion and Sediment Pollution Control Program Manual)
Figure 5.11.1: Outfall Protection

5.11.1 Description and Overview

Many SCMs have a form of outfall protection to dissipate energy to a non-erosive level at the SCMs inflow and SCM discharge. Different types of outfall protection such as riprap aprons, plunge pools, or other energy dissipators are chosen based on the required protection. Outfall protection can be seen at any point of concentrated flow at both inflow and outflow points of an SCM. Properly maintained outfall protection ensures stormwater is conveyed without causing erosive damage.

Riprap aprons are typically located at storm sewer system outfalls on mild to flat slopes. Aprons are constructed of large diameter rocks over geotextile liner and fan out from the end of the channel to a certain distance downstream. The size of rock and apron dimensions are a function of flow and pipe/channel size.

Plunge pools, also known as rock basins or stilling basins, are typically located at the outfall of a closed pipe system on a near horizontal grade. They are pre-shaped pools lined with 4- to 12-inch diameter rocks over geotextile. Varieties of designs can include wire gabion baskets, trenches, grouted rock, and specially designed pools or manhole structures.

Other outfall protection is typically used where anticipated velocities exceed the maximum permissible values for riprap aprons and plunge pool. They are features typically located at pipe outfalls constructed with either concrete, rock, turf reinforcement matting or other material. One type known as a concrete energy dissipator typically incorporates a concrete apron with features such as concrete blocks or rocks projecting from the surface to dissipate the flow energy. Turf reinforcement mats (TRM), or transition mats, are permanent geotextiles that are placed on the surface to provide erosion resistance. They generally incorporate a grid of material with open spaces that allow vegetative growth through the material.

5.11.2 Common Elements

Several of the common SCM components described in this chapter are associated with outfall protection. Refer to the appropriate section of this chapter for the following components:

- Inflow Systems
- Outflow Structures
- Structures & Appurtenances
- Emergency Spillway

Additionally, other associated elements of typical outfall protection may include:

- Pipe outfall
- Riprap, concrete, turf matting
- Vegetation
- Geotextile

Typical drawings for outfall protection can be found in PTS Standards and PennDOT Publication 72M Section RC-72M (RC-72M). Riprap aprons are illustrated in PTC Standard PTS-124 and in RC-72M on Sheets 6 and 7 (Rock Apron-Defined Channel and Rock Apron-Flat Area). Plunge pools are depicted in RC-72M on Sheet 5 (Rock Basin). Energy dissipators are shown in RC-72M on Sheet 5 (Paved Energy Dissipator and Rock Energy Dissipator).

5.11.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of outfall protection should focus on its key functional areas. Specifically:

- Inspect for trash, debris, trees and shrubs or unintended vegetation in the outfall protection.
- Inspect riprap, TRM or other hard armor material, if specified on design plans, to ensure adequate amount is present. Riprap should be uniform thickness, matching nominal placement thickness per PTC CS-850 with no bare spots. Inspect concrete or other structural members, if present, for signs of structural damage or deterioration.
- Inspect for signs of erosion and sedimentation in and around outfall protection, especially where outfall protection meets the adjacent downstream area. If the adjacent downstream area is vegetated, vegetation should be well established at this interface.
- Inspect for sediment accumulation in outfall protection measures as they are not designed to capture sediment. Sediment on top of outfall protection should not exceed 10% of the surface area.
- Inspect for standing water in the plunge pool; water should only be present within 72 hours of the last storm event.

When inspecting outfall protection, it should be inspected and photographed under the associated inflow or SCM Discharge section of PTC's inspection software.

5.11.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 5.11.1: Maintenance Procedures for Outfall Protection

Frequency	Activity
Three times per year	• Reposition rip-rap that has been displaced from apron area; if issue is reoccurring, assess increasing stone size. • Remove litter, trash, and debris from outfall protection and surrounding area. • Remove animal carcasses from vicinity of and within the outfall protection.
Annually	• Remove sediment from outfall protection and surrounding area. • Remove or treat vegetation growth including grasses, shrubs, and trees through riprap areas in plunge pools and riprap aprons. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
As needed	• Maintain applicable common components as described in other sections of this Chapter at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SCM specific tables (G.1.3 through G.1.16).

CHAPTER 6

SCMS – SPECIFIC INSPECTION AND MAINTENANCE PROCEDURES

6.1 Dry Basins: Dry Detention (BDD), Dry Extended Detention (BED), Dry Ultra Extended Detention (BUD), Naturalized Detention (BND), Other (BOT)

Figure 6.1.1: Dry Extended Detention Basin
(photo c/o: PennDOT)

6.1.1 Description and Overview

Many SCMs are a variation of a surface basin designed to retain and or detain stormwater runoff. These SCMs are constructed by excavating below ground (cut slopes) or by constructing above-ground berms (impounding embankments) creating a surface depression to collect stormwater. Some basins incorporate both cut slopes and embankments to create a water collection area. Larger embankments may be considered a regulated dam structure depending on height and storage. Inspections and maintenance of these must also comply with the requirements of the Dam Safety permit and should be noted in the inventory. In all basins, the primary outflow structure is typically a concrete box or metal riser pipe with orifices at different elevations and many have an emergency spillway constructed through one of the earthen embankments or cut slopes of the SCM. Most basins are typically vegetated with turf lawn or meadow however some may have special SCM plantings like herbaceous, shrubs and trees incorporated into the design. As described below, there are several types of basins that fall into the class of SCMs called Dry Basins, which are typically dry between storm events.

Dry Detention Basin (BDD) temporarily stores stormwater runoff during rain events, and slowly releases retained water through an outflow structure over a period of 24 to 72 hours. BDDs are typically dry between storm events. Prior to 2007, dry detention basins were the primary stormwater management measure employed. Their typical purpose focuses on lowering peak stormwater outflow rates with little to no water quality consideration. More recent designs may incorporate some water quality components, such as a pretreatment forebay to increase pollutant removal.

Dry Extended Detention Basin (BED) is a more recent modification of the original BDD which incorporates components to improve water quality while providing rate control. Features such as pretreatment areas, micropools, and elongated flow paths improves the quality of temporarily stored stormwater runoff. Similar to BDDs, BEDs release flows through an outflow structure in approximately 24 to 72 hours.

Dry Ultra Extended Detention Basin (BUD) is a variation of a BED which further improves on water quality treatment and can take many forms depending on the treatment and storage system chosen. Ultra-extended detention basins provide the same peak rate control for larger storm events as traditional dry detention basins; however, they also employ a slow release concept also called managed release concept (MRC) that provides volume control and water quality treatment. BUDs provide the necessary volume storage in either an above ground impoundment and/or underground infrastructure while incorporating filter media, native plantings, infiltration, evapotranspiration, and/or other means to treat runoff before it is discharged. Underdrains, cleanouts and observation wells are installed into filter media to facilitate runoff discharge, inspections and maintenance.

Naturalized Detention Basin (BND) is a modified or retrofitted version of a BDD or BED with improved water quality through the addition of a vegetative mix of native plants, shrubs, and/or trees in place of turf grass.

Other Basin (BOT) is generally a placeholder classification for basin SCMs that could not be definitively categorized during the initial inventory effort. Most BOT entries in the SCM inventory will be re-assigned as more information is gathered on them (e.g., through inspections or locating “as-built” plans). In some watersheds, spill containment facilities are installed to capture containments upstream of sensitive resources in the event of an inadvertent release. Where these are directly in-line and connected to an SCM, they should be included as part of the SCM in the inventory. When these facilities are in the form of standalone surface basin-like features, they should be classified as BOTs for inventory tracking. Where these facilities are standalone vaults, tanks or similar storage vessels, they should be classified as NBOs (Section 6.18). In the future, BOT may also be used to inventory new or modified basin type SCMs that do not fit into any of the other SCM categories.

6.1.2 SCM Components

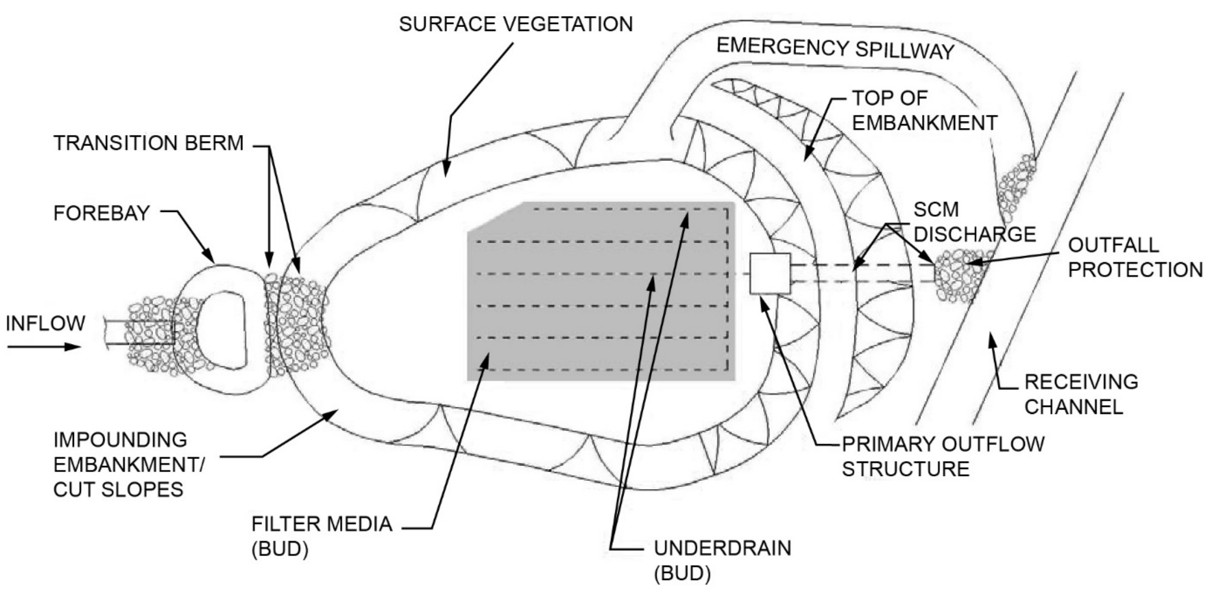
SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 which may be encountered with these SCMs include:

- Access, Fencing, and Security
- Signage
- Inflow System
- Inlet with Sump/Traps (Section 6.13)
- Forebay
- Underdrain, cleanouts, observation wells
- Outflow Structures
- Structures and Appurtenances
- Emergency Spillway
- Outfall Protection

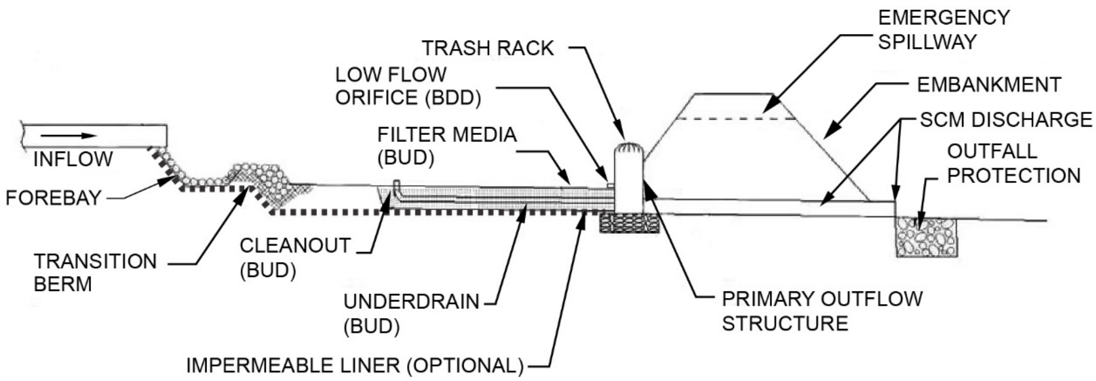
In addition, Dry Basins may include the following other components:

- Filter media/ engineered soils
- Impermeable liner (optional)
- Vegetative shrub, woody, or special plantings
- Turf lawn or meadow
- Impounding embankment/cut slopes
- SCM discharge/receiving channel

Figure 6.1.2 illustrates the common components of typical Dry Basins. Runoff enters Dry Basins via directly connected inlets, pipes, channels and sheet flow. Flows travel through the system to an outflow structure where stormwater release is controlled.



Plan View



Section View

Figure 6.1.2: Dry Basins - Common Elements
(Adapted from NCDOT-HSP-2010-01)

6.1.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of Dry Basins should focus primarily on its key functional areas: inflow, ponding area, vegetation, and outflow structures. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect SCM and surrounding area for trash and debris.
- Sediment accumulation should be removed when it reaches the depth indicated by the cleanout marker. Where a cleanout marker is not present, sediment should be removed when it reaches the lesser of 6 inches in depth, or 10% of the basin storage area, or if it affects inflow or outflow in the SCM. In cases of excessive sedimentation, the drainage area should be inspected for sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- The SCM and vicinity should be checked for signs of erosion, flow channelization, loss of topsoil and sinkhole activity.
- Inspect for appropriate vegetative cover per plan. Surface vegetation should be in good condition with at least 80% coverage and no invasive/undesirable species. Vegetation should not hinder inflow or outflow in the SCM.
- Inspect the basin and observation wells/cleanouts (if present) for signs that standing water remains in the basin longer than 72 hours after a rain event; the presence of hydrophytic vegetation may be an indication. Prolonged ponding suggests the SCM surface/filter media may be clogged with silt or the subsurface infiltration is inadequate.
- When plans indicate an impermeable liner is present look for unintentionally exposed section or signs of puncture, tears or leaks indicated by surface cover erosion, animal burrow activity or similar.

- Impounding embankments should be assessed for erosion, cracking, settlement, sloughing, burrowing animals, instability, and tree growth. Inspect downstream of the toe of embankment for evidence of seepage, piping, or hydrophytic vegetation.
- Baffles may be in place within the SCM to increase the effective flow length in the basin. If present, verify that the baffles are undamaged.
- Some Dry Basins may not have an earthen emergency spillway; instead they may use a secondary outflow in the form of a concrete or metal riser to release excess flows. Inspect these components noting the intended emergency spillway functionality.
- Inspect all applicable common components as described in Chapter 5.

When completing PTC's inspection app for Dry Basins:

- Filtration layers are inspected under the surface storage portion of the app.
- Impermeable liners are inspected under the impermeable liner portion of the app. It should be inspected/commented on when it or possible concerns with it exist.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

Start-up phase check-ups: Dry Ultra Extended Detention Basin (BUD) areas require more frequent startup phase check-ups during plant establishment through the first three years, as stipulated in Chapter 3. The following items should be inspected during these check-ups:

- Vegetation in and around the SCM should be in good condition and per plan including trees, shrubs and herbaceous/grass plant materials. Coverage should reach 70% or more of plan depicted density by one year after construction, 75% by two years, and 80% by three years after construction. No invasive/undesirable species should be present. Dead plants should be removed and replaced. New plants should receive establishment watering for the first two years as stipulated in the routine maintenance table in Section 6.1.4.
- The SCM and vicinity should be checked for signs of erosion of any form including general loss of topsoil and the formation of rills or gullies.
- Confirm mulch cover (if called for) is in good condition. Mulch should be approximately 3 inches in depth and consist of triple shredded or leaf compost mulch. Wood chips shall not be used as mulch.
- Sediment accumulation should be checked and removed when it reaches the depth indicated by the cleanout marker. Where a cleanout marker is not present, sediment should be removed when it reaches 3 inches in depth or affects inflow or outflow in the SCM.

6.1.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.1.1: Maintenance Procedures for BDD, BED, BUD, BND, and BOT

Frequency	Activity
Three times per year	• Prior to mowing, remove litter, trash, and debris from SCM surface, side slopes, inflow/outflow points, structures and surrounding area. • Mow areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow to a height of 6 to 10 inches. • Perform mowing operations within the SCM when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • Where filter media/engineered soils are present (typically BED and BUD), LGP equipment must be used (see Section 4.7); do not drive heavy equipment on SCM surface.
Annually	• Remove or treat weeds and undesirable plants. Where plan specifies shrubs and trees are present, prune to maintain appearance and functionality. Remove woody vegetation on impounding embankments. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. • Mow areas indicated to be tall meadow to a height of 8 to 16 inches. • Perform mowing operations within SCM when SCM is completely dry. • When filter media/engineered soils are present (typically BED and BUD), LGP equipment must be used (see Section 4.7); do not drive heavy equipment on SCM surface. • Do not mow areas planted with no-mow landscaping such as shrubs.
As needed	• Replace diseased or dead plants per plan; if specific species mortality is reoccurring, assess cause and replace with appropriate alternate species. • Remove sediment from SCM floor surface. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

Note:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of for confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the Basin specific table (G.1.3).

6.2 Wet Detention Basin (BWD)

Figure 6.2.1: Newly Constructed Wet Detention Basin
(photo c/o: PennDOT)

6.2.1 Description and Overview

A Wet Detention Basin (BWD), also known as a wet pond, is a SCM similar to a Dry Basin, but is designed to hold a permanent pool of water in the basin. Larger impounding embankments may be considered a regulated dam structure depending on height and storage. Inspections and maintenance of these must also comply with the requirements of the Dam Safety permit and should be noted in the inventory. BWDs provide water quality treatment and provide additional capacity above the permanent pool for temporary runoff storage for peak rate control. BWDs are effective for pollutant removal and peak rate mitigation, but do not achieve significant groundwater recharge or volume reduction. In BWDs, the primary outflow control structure is typically a metal riser pipe or concrete box with orifices and weirs at different elevations and most have an earthen emergency spillway constructed into the top of one of the berms or side walls of the SCM. The lowest outlet point in the BWD's flow control structure is above the permanent water pool level. In some cases, a reverse slope pipe is used in lieu of the lowest orifice in the outlet structure. A reverse slope typically terminates 2 to 3 feet below the permanent water surface, which minimizes the discharge of warm surface water and is less susceptible to clogging from floating debris.

Unlike other basin types, the permanent pool is a key feature and infiltration is discouraged. BWDs typically have low permeability soils underlying the basin and/or are located close to or below the groundwater table to support permanent water ponding. When necessary, BWDs may include an impermeable liner made of clay or impermeable geotextile to maintain a permanent pool. In BWDs with deeper pools of water, the perimeter of the ponded area includes a safety bench and/or aquatic bench graded into the side slopes. Safety benches are designed to remain above the water surface elevation for all major storm events, whereas aquatic benches will be submerged during major storm events. Some BWDs may have a sluice gate or other emergency drawdown opening at the bottom elevation of the basin to empty the system for maintenance or emergencies.

6.2.2 SCM Components

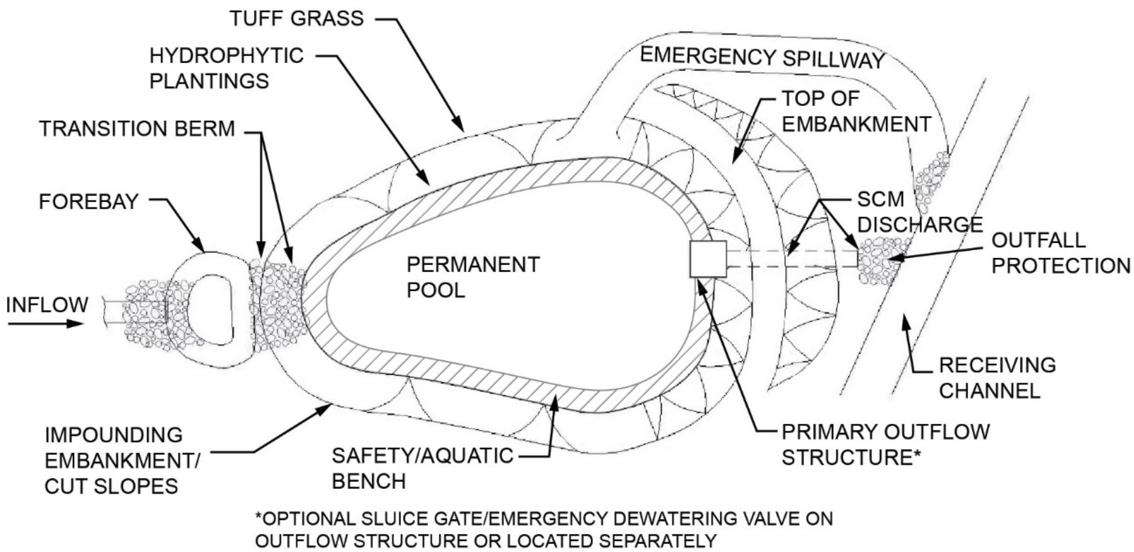
SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 which may be encountered with this SCM include:

- Access, Fencing, and Security
- Signage
- Inflow Systems
- Inlet with Sump/Traps
- Forebay
- Flow Control Structures
- Structures and Appurtenances
- Emergency Spillway
- Outfall Protection

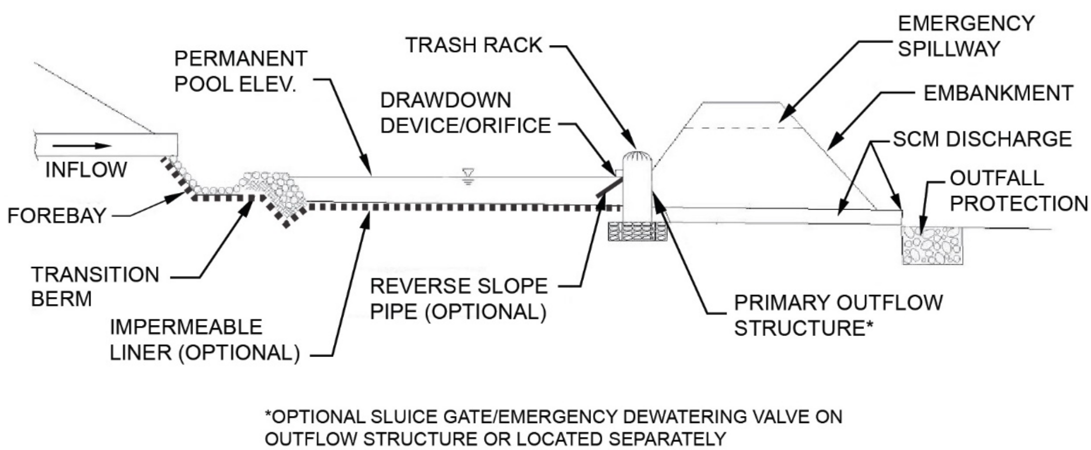
In addition, BWDs may include the following other components:

- Permanent pool
- Impermeable liner
- Hydrophytic (wetland) plantings
- Turf lawn or meadow
- Impounding embankment/cut slopes
- Safety/aquatic benches
- Reverse slope pipe
- Sluice gate/emergency wet pool dewatering valve
- SCM discharge/receiving channel

Figures 6.2.2 to 6.2.4 illustrate the common components of a typical BWD. Runoff enters the BWD via directly connected inlets, pipes, channels, and sheet flow. Flows travel through the system to an outflow structure where the portion above the permanent pool elevation is released at control flow rates.



Plan View



Section View

Figure 6.2.2: Wet Detention Basin - Common Elements
(Adapted from NCDOT-HSP-2010-01)

Figure 6.2.3: Lift-Type Sluice Gate
(c/o NCDot-HSP-2010-01)

Figure 6.2.4: Open Screw-Type Sluice Gate
(c/o NCDot-HSP-2010-01)

6.2.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of a BWD should focus on its key functional areas: inflow, ponding area, vegetation, and outflow structures. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect SCM and surrounding area for trash and debris.
- The basin floor should be covered by a permanent pool of water. The water level should be at or near the invert of the drawdown device/low flow orifice except within 72 hours of storm events and during long dry periods. High water levels indicate an outflow component may be clogged, while low levels indicate the basin may not be receiving the design flows, has a leaking impermeable liner or outlet structure, or is infiltrating more than anticipated.
- When plans indicate an impermeable liner is present look for unintentionally exposed section or signs of puncture, tears or leaks indicated by low water levels, surface cover erosion, animal burrow activity, or similar.
- Look for evidence of excessive algae in the wet pool. Some algae growth is expected and part of the natural system helping with nutrient removal. Algae growth covering more than 50% of the pool area should be considered excessive and requires removal.
- Look for evidence of excessive permanent waterfowl population. Evidence of approximately 20 or more permanent water fowl inhabitants per pond surface acre should be noted.
- Sediment accumulation should be removed when it reaches 50% of ponding storage area or anytime it impacts SCM performance and flow through the system. Pay particular attention to potential blocking of reverse slope pipe where present. Depth from water surface to sediment can be checked using a probe or survey rod. In cases of excessive sedimentation, the drainage area should be inspected for sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- Check for signs of erosion, flow channelization, loss of topsoil and sinkhole activity surrounding the wet pool.
- Surface vegetation around the perimeter of the wet pool should be in good condition with at least 80% coverage with no invasive/undesirable vegetation. The cover type should match original design plans. Hydrophytic vegetation may be present in close proximity to the ponds perimeter with less water tolerant vegetation further up the side slopes. Vegetation should not hinder inflow or outflow in the SCM.
- Impounding embankments should be assessed for erosion, cracking, settlement, sloughing, burrowing animals, instability and tree growth.
- Inspect downstream of the toe of embankment for evidence of seepage, piping, or hydrophytic vegetation. Look for hydrophytic vegetation on the embankment exterior which may indicate water penetration/piping.
- Some BWDs may have a sluice gate or other emergency drawdown opening at the invert of the basin to empty the system for maintenance or emergencies. If present, inspect the sluice gate or other emergency draw down valve. Look for excessive corrosion and signs that the mechanisms have frozen or rusted closed, taking care not to open it. Check for signs of leaking.
- Inspect all applicable common components as described in Chapter 5.

When completing PTC's inspection app for BWDs:

- Impermeable liners are inspected under the impermeable liner portion of the app. It should be inspected/commented on when it or possible concerns with it exist.

- If a sluice gate or emergency drawdown opening is present, when it is attached to/part of the primary outflow structure, it should be inspected as part of the primary outflow. When it is located and functions separately, it should be inspected as the second outflow.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

6.2.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.2.1: Maintenance Procedures for BWD

Frequency	Activity
April-Oct twice weekly for 6 weeks following planting	• Water all seeded/planted areas and fill water bags around trees. Watering may be skipped if ¼" of rainfall has occurred within previous 24 hours of scheduled watering.
April-Oct every two weeks for first two years following planting	• Water all planted (non-grassed/seeded) areas and fill water bags around trees. Watering may be skipped if ¼" of rainfall has occurred within previous 7 days of scheduled watering.
Three times per year	• Prior to mowing, remove litter, trash, and debris from SCM surface, side slopes, inflow/outflow points, structures and surrounding area. • Mow areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow to a height of 6 to 10 inches. • Do not mow areas planted with no-mow landscaping such as shrubs. • Do not allow grass clippings to enter wet pool.
Annually	• Remove or treat weeds and undesirable plants; prune shrubs and trees to maintain appearance and functionality. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Non-invasive, hydrophytic vegetation is acceptable, but should not hinder SCM inflow or outflow. Dispose of vegetative cuttings off-site. • Mow areas indicated to be tall meadow to a height of 8 to 16 inches. • Do not mow areas planted with no-mow landscaping such as shrubs. • Do not allow grass clippings to enter wet pool. • Exercise (move/open) values/sluice gates by briefly opening it enough to ensure that the valve/sluice gate can operate through its full range of motion. If lubrication is necessary, use marine-type grease.
As Needed	• Replace diseased or dead plants per plan; if specific species mortality is reoccurring, assess cause and replace with appropriate alternate species maintaining 80% plant cover. • Remove sediment from SCM floor surface. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the Basin specific table (G.1.3).

6.3 Infiltration Detention Basin (BID)

Figure 6.3.1: Infiltration Detention Basin with Engineered Soil Surface
(photo c/o: PennDOT)

6.3.1 Description and Overview

An Infiltration Detention Basin (BID) is an SCM that looks similar to a dry detention basin (BDD) with a key difference: the lowest outlet point is above the bottom surface of the basin, leaving a volume of collected stormwater to soak into the ground (infiltrate) rather than flow downstream. The infiltration is designed to occur in less than 72 hours after a rain event. The basin bottom may have a layer of engineered soils designed for specific filtration properties, or it may be native soils. Some may have back-up underdrain systems with cleanouts installed that are capped at construction. In the event the SCM begins to function with inadequate infiltration rates during its lifetime, the cap can be removed to allow filtrated runoff to drain out of the SCM. BIDs may also have observation wells installed into the engineered soil to confirm subsurface infiltration is occurring. The surface of the bottom is typically sand or grass. Infiltration basins provide peak rate, volume and water quality management. The surface ponding area of infiltration basins should not be compacted nor should vehicles or equipment be operated within the basin.

6.3.2 SCM Components

SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 which may be encountered with this SCM include:

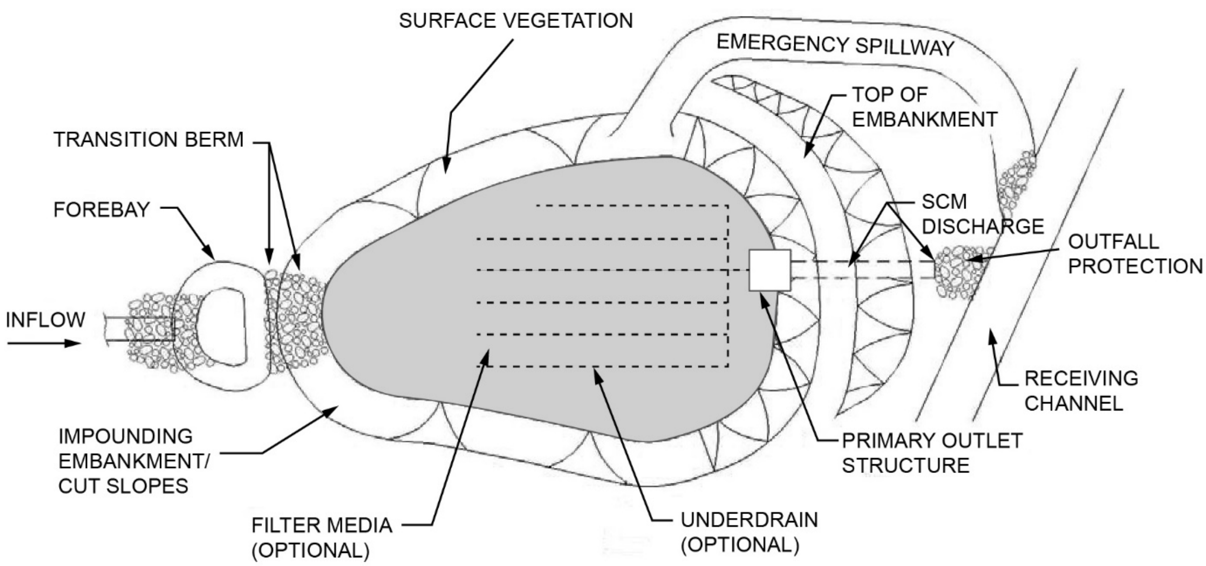
- Access, Fencing, and Security
- Signage
- Inflow Systems
- Inlet with Sump/Traps (Section 6.13)
- Forebay
- Underdrain, cleanouts, observation wells (capped)
- Outflow Structures

- Structures and Appurtenances
- Emergency Spillway
- Outfall Protection

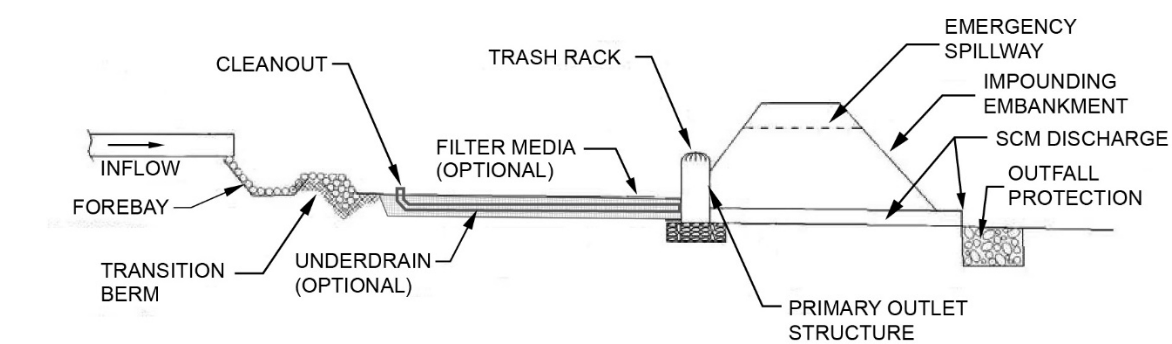
In addition, BIDs may include the following other components:

- Filter media/ engineered soils
- Turf lawn or meadow
- Impounding embankment/cut slopes
- SCM discharge/receiving channel

Figure 6.3.2 illustrates the common components of a typical infiltration basin. Runoff enters infiltration basins via directly connected inlets, pipes, channels and sheet flow where it ponds in the SCM storage area. A portion of the runoff held in the main storage area is allowed to infiltrate while higher flows exit the SCM via the outflow structure where stormwater release is controlled.



Plan View



Section View

Figure 6.3.2: Infiltration Detention Basin - Common Elements

(Adapted from NCDOT-HSP-2010-01)

6.3.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of a BID should focus on its key functional areas: inflow, ponding area, infiltration, and outflow. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect SCM and surrounding area for trash and debris.
- Sediment accumulation should be removed when it reaches the depth indicated by the cleanout marker. Where a cleanout marker is not present, sediment should be removed when it reaches 1 inch depth or anytime it affects infiltration rates, inflow, or outflow in the SCM. In cases of excessive sedimentation, the drainage area should be inspected for sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- Infiltration basins are particularly susceptible to clogging from sediment if the drainage area contributes high sediment loads and/or adequate pretreatment is not present. Assess sediment accumulation existing pretreatment measures and make recommendation as appropriate if additional pretreatment measure may be required.
- The SCM and vicinity should be checked for signs of erosion, flow channelization, loss of topsoil and sinkhole activity.
- Inspect for appropriate vegetative cover per plan. Surface vegetation should be in good condition with at least 80% coverage and no invasive/undesirable species. Vegetation should not hinder inflow or outflow in the SCM.
- Inspect the basin and observation wells/cleanouts (if present) for signs that standing water remains in the basin longer than 72 hours after a rain event; the presence of hydrophytic vegetation may be an indication. Prolonged ponding suggests the SCM surface/filter media may be clogged with silt or the subsurface infiltration is inadequate.
- The embankment should be assessed for erosion, cracking, settlement, sloughing, burrowing animals, instability and tree growth. Inspect downstream of the toe of embankment for evidence of seepage, piping or hydrophytic vegetation.
- Some BIDs may not have an earthen emergency spillway; instead they may use a secondary concrete or metal riser to release excess flows. Inspect these components noting the intended emergency spillway functionality.
- Inspect all applicable common components as described in Chapter 5.

When completing PTC's inspection app for BIDs:

- Filtration layers are inspected under the surface storage portion of the app.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

<u>Start-up phase check-ups</u>: BIDs require more frequent startup phase check-ups during plant establishment through the first three years as stipulated in Chapter 3. The following items should be inspected during these check-ups:

- Vegetation in and around the SCM should be in good condition and per plan including trees, shrubs and herbaceous/grass plant materials. Coverage should reach 70% or more of plan depicted density by one year after construction, 75% by two years and 80% by three years. No invasive/undesirable species should be present. Dead plants should be removed and replaced.

New plants should receive establishment watering as needed after installation. Where plans stipulate a non-vegetated BID surface, vegetation within the SCM footprint should be removed.

- The SCM and vicinity should be checked for signs of erosion of any form, including general loss of topsoil and the formation of rills or gullies.
- Sediment accumulation should be checked and removed when it reaches the depth indicated by the cleanout marker. Where a cleanout marker is not present, sediment should be removed when it reaches 1 inch in depth or affects inflow or outflow in the SCM.

6.3.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes routine activities and the recommended frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

All maintenance activities must be performed in a manner that does not cause compaction of the BID surface area. Vehicles and construction equipment are not permitted to enter into the SCM.

Table 6.3.1: Maintenance Procedures for BID

Frequency	Activity
Three times per year	• Prior to mowing, remove litter, trash, and debris from SCM surface, side slopes, inflow/outflow points, structures and surrounding area. • Mow areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow to a height of 6 to 10 inches. • Perform mowing operations within the SCM when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • LGP equipment must be used on SCM Floor (see Section 4.7); do not drive heavy equipment on SCM Floor.
Annually	• Remove or treat weeds and undesirable plants; prune shrubs and trees (if present) to maintain appearance and functionality. Remove undesirable vegetation, including woody vegetation on embankments. For non-vegetated system, remove all growth using hand methods or herbicide application. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. • Mow areas indicated to be tall meadow to a height of 8 to 16 inches. Perform mowing operations within SCM when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • LGP equipment must be used on SCM Floor (see Section 4.7); do not drive heavy equipment on SCM Floor.
As needed	• Replace diseased or dead plants per plan; if specific species mortality is reoccurring, assess cause and replace with appropriate alternate species. • Remove sediment from SCM floor surface. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

Note:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the Basin specific table (G.1.3).

6.4 Bioretention (BRE); Bioretention with Underdrain (BRU)

Figure 6.4.1: Bioretention

(top photo c/o https://c1.staticflickr.com/9/8343/8183562023_18d937722d_b.jpg; Bottom photo c/o NCDOT HSP-2010-01)

6.4.1 Description and Overview

A Bioretention (BRE), also commonly known as a rain garden, is a shallow ponding area that removes sediment and other pollutants in stormwater runoff by settling coarse particles on the surface and filtering finer particles through soil media planted with native vegetation. The surface depression of a BRE is shallow compared to a stormwater basin and typically allows 6 to 18 inches of ponding depth.

The SCM can look similar to a typical detention basin or it may be a much shallower surface depression. The filter soil can be existing in-situ topsoil, a mix of topsoil and sand/organics, or specifically engineered media. Stormwater is filtered by the planted media and infiltrates into the underlying soils where infiltration is feasible. Some BREs contain subsurface infiltration storage (SDS) below the filter soil (see Section 6.6).

A Bioretention with Underdrain (BRU) is a BRE with perforated underdrain(s) installed at the base of the planted filtration layer. The underdrains typically connect to a storm sewer pipe system to carry flows to a downstream discharge point. In cases where an outflow structure is not present, the underdrain may discharge directly through the embankment to the downstream discharge point. A BRU is installed where the underlying soil conditions do not permit infiltration and may include an impermeable lining to prevent infiltration. In areas where infiltration is questionable, some designs may incorporate an underdrain with a closure valve or cap as a backup feature to open in the event of inadequate infiltration.

The surface of the ponding area in BREs and BRUs is typically covered with mulch and a mix of vegetation of varying density depending on the design. Vegetation can be grasses, perennials, shrubs, trees, or a combination. The grasses and perennials may be planted by seeds (short or tall meadow), or as special SCM plantings (plugs, or potted plants) during construction. Systems with dense vegetation may not require mulch.

Stormwater is directed into the systems in a variety of methods, but most commonly via curb cuts, sheet flow, or pipe discharge. Most BREs and BRUs contain outflow structures in the form of domed grates or standard inlet grates situated above grade at the depth of intended ponding to convey water during large storm events. During smaller storm events, runoff will filter through the media and ultimately infiltrate into the subgrade or drain into underdrains, if present. Both BREs and BRUs may have observations wells installed in the soil media.

6.4.2 SCM Components

SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 which may be encountered with this SCM include:

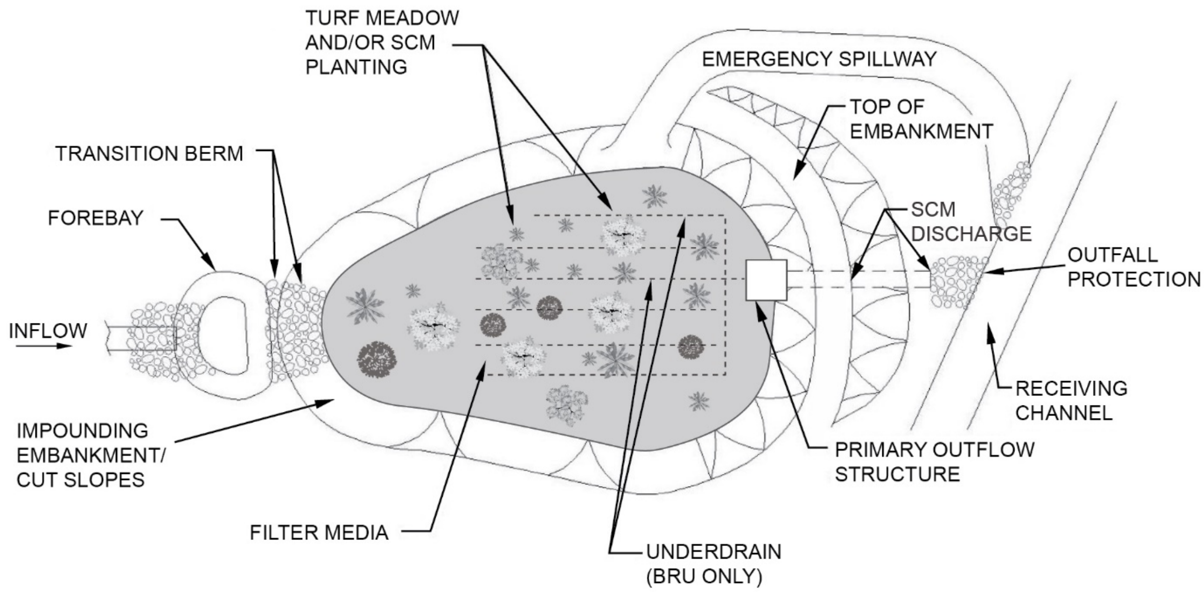
- Access, Fencing, and Security
- Signage
- Inflow System
- Inlet with Sump/Traps (Section 6.13)
- Forebay
- Underdrain (BRU only), cleanout (BRU only), observation wells
- Outflow Structures
- Structures and Appurtenances
- Outfall Protection
- Emergency Spillway

In addition, BREs and BRUs may include the following other components:

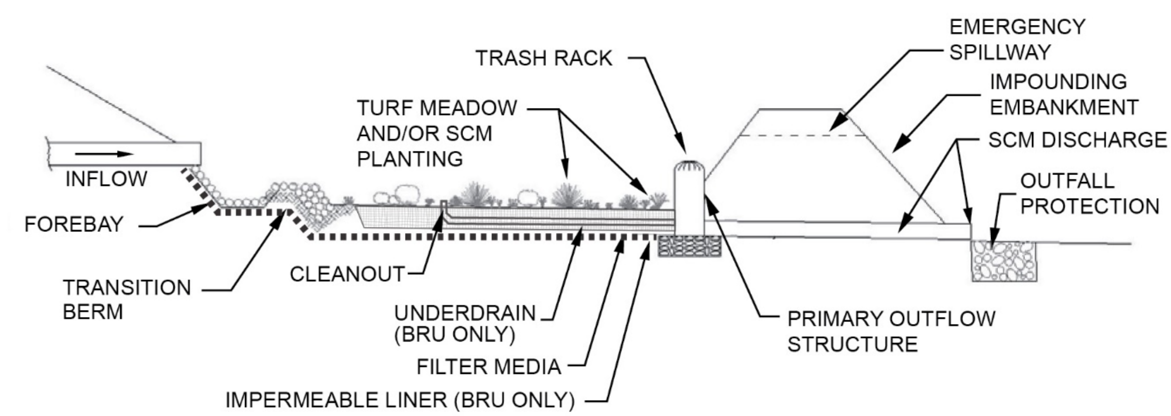
- Impermeable liner (BRU only)
- Filter media/ engineered soils
- Vegetative shrub, woody, or special SCM plantings

- Turf lawn or meadow
- Impounding embankment/cut slopes
- SCM Discharge/receiving channel

Figure 6.4.2 illustrates the components of a typical BRE and BRU. Runoff enters the SCM via directly connected inlets, pipes, channels, and sheet flow. Water ponds in the storage area filtrating into the soil to a designed ponding depth, above which it flows into an outflow structure where stormwater is slowly released.



Plan View



Section View

Figure 6.4.2: Bioretention and Bioretention with Underdrain - Common Elements

(Adapted from NCDOT-HSP-2010-01)

6.4.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of a bioretention system should focus on its key functional areas: inflow, infiltration/filtration, and outflow structures. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect SCM and surrounding area for trash and debris.
- Sediment accumulation should be removed when it reaches the depth indicated by the cleanout marker. Where a cleanout marker is not present, sediment should be removed when it reaches 3 inches in depth or anytime it affects infiltration, inflow, or outflow in the SCM.
- Bioretention systems are particularly susceptible to clogging from sediment if the drainage area contributes high sediment loads and/or adequate pretreatment is not present. Inspect existing pretreatment measures for sediment accumulation and, if excessive sediment is present, make recommendations as appropriate (e.g., additional pretreatment measures, improve efficiency of existing measures). In cases of excessive sedimentation, the drainage area should be inspected for sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- The SCM and vicinity should be checked for signs of erosion, flow channelization, loss of topsoil and sinkhole activity.
- Inspect for appropriate vegetative cover per plan. Vegetation should be in good condition with at least 80% coverage over the plan depicted planting areas and no invasive/undesirable species. Vegetation should not hinder inflow or outflow in the SCM.
- Confirm mulch cover is in good condition. Mulch should be approximately 3 inches in depth and consist of triple shredded or leaf compost mulch. Wood chips shall not be used as mulch.
- Inspect the basin and observation wells/cleanouts (if present) for signs that standing water remains in the basin longer than 72 hours after a rain event; the presence of hydrophytic vegetation may be an indication of this. Prolonged ponding suggests the filter media may be clogged, the underdrains are clogged, or the designed subsurface infiltration is inadequate.
- When plans indicate an impermeable liner is present (BRU only) look for unintentionally exposed section or signs of puncture, tears or leaks indicated by surface cover erosion, animal burrow activity or similar.
- Many BRE/BRUs may not have an earthen emergency spillway; instead they may use a secondary concrete or metal riser to release excess flows. Inspect these components noting the intended emergency spillway functionality.
- In BRE/BRUs, the Primary Outflow structure may be in the form of one or multiple inlet (outlet) domes/grates elevated above the ponding area. In some cases, a primary outflow structure may not be visible on the surface, rather it may be in the form of an underdrain discharging directly to the SCM discharge.
- Inspect all applicable common components as described in Chapter 5.

When completing PTC's inspection app for BRE/BRUs:

- Filtration layers are inspected under the surface storage portion of the app.
- Impermeable liners are inspected under the impermeable liner portion of the app. It should be inspected/commented on when it or possible concerns with it exist.

- When the Primary Outflow is multiple outlet risers/grates at the same elevation, include a photograph of each structure and inspect all under the single Primary Outflow component in the app.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

Start-up phase check-ups: Bioretention areas require more frequent startup phase check-ups during plant establishment through the first three years, as stipulated in Chapter 3. The following items should be inspected during these check-ups:

- Vegetation in and around the SCM should be in good condition and per plan including trees, shrubs and herbaceous/grass plant materials. Coverage should reach 70% or more of plan depicted density by one year after construction, 75% by two years, and 80% by three years after construction. No invasive/undesirable species should be present. Dead plants should be removed and replaced. New plants should receive establishment watering for the first two years as stipulated in the routine maintenance table in Section 6.4.4.
- The SCM and vicinity should be checked for signs of erosion of any form including general loss of topsoil and the formation of rills or gullies.
- Confirm mulch cover is in good condition. Mulch should be approximately 3 inches in depth and consist of triple shredded or leaf compost mulch. Wood chips shall not be used as mulch.
- Sediment accumulation should be checked and removed when it reaches the depth indicated by the cleanout marker. Where a cleanout marker is not present, sediment should be removed when it reaches 3 inches in depth or affects inflow or outflow in the SCM.

6.4.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

All maintenance activities must be performed in a manner that does not cause compaction of the BRE/BRU surface area. Vehicles and construction equipment are not permitted to enter into the SCM.

Table 6.4.1: Maintenance Procedures for BRE and BRU

Frequency	Activity
April-Oct twice weekly for 6 weeks following planting	• Water all seeded/planted areas and fill water bags around trees. Watering may be skipped if ¼" of rainfall has occurred within previous 24 hours of scheduled watering.
April-Oct every two weeks for first two years following planting	• Water all planted (non-grassed/seeded) areas and fill water bags around trees. Watering may be skipped if ¼" of rainfall has occurred within previous 7 days of scheduled watering.
Three times per year	• Prior to mowing, remove litter, trash, and debris from SCM surface, side slopes, inflow/outflow points, structures and surrounding area. • Mow areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow to a height of 6 to 10 inches. • Perform mowing operations within the SCM when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • LGP equipment must be used on SCM Floor (see Section 4.7); do not drive heavy equipment on SCM Floor. • Remove or treat weeds and undesirable plants; prune shrubs and trees to maintain appearance and functionality. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
Annually	• Mow areas indicated to be tall meadow to a height of 8 to 16 inches. • Perform mowing operations within SCM when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • LGP equipment must be used on SCM Floor (see Section 4.7); do not drive heavy equipment on SCM Floor.
Once every other year	• Re-level mulch (if present) to a 2 to 3 inch depth and repair bare spots using triple shredded or leaf compost mulch. Wood chips shall not be used.
Once every five years	• Install fresh mulch (if present) 3 inches deep throughout SCM bottom using triple shredded or leaf compost mulch. Wood chips shall not be used as mulch. If mulch is causing outflow structure clogging or other issues, the area may be seeded.
As needed	• Replace diseased or dead plants per plan; if specific species mortality is reoccurring, assess cause and replace with appropriate alternate species. • Remove sediment from SCM floor surface. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the Bioretention specific table (G.1.4).

6.5 Subsurface Infiltration Trench (SIT)

Figure 6.5.1: Subsurface Infiltration Trench
(photo c/o: PennDOT)

6.5.1 Description and Overview

A Subsurface Infiltration Trench (SIT) is a stormwater control measure that is generally a long, narrow excavated trench with a level bottom, backfilled with a perforated pipe running lengthwise and surrounded by coarse aggregate wrapped in geotextile. A SIT is typically 3 to 6 feet wide and no more than 6 feet deep with cleanout points and/or observation wells connected to the perforated pipe or stone sections. SITs should include an overflow mechanism for larger storm flows to discharge.

The top of the SIT can be exposed or covered. Exposed varieties are designed to receive surface runoff and are normally covered with turf lawn or meadow or with gravel/stone. Pretreatment of runoff occurs at the surface. This type can be located beneath a vegetated swale (VSW/VSC) or infiltration berm (IBE) and are designed to infiltrate flows which percolate from the swale into the trench (see Section 6.11 for VSW/VSC and Section 6.12 for IBE related information).

Covered SITs are located beneath paved areas and receive flows via direct pipe/inlet connection. The inflow point to this type of SIT is often an inlet or manhole structure that includes a trap/sump for pretreatment (see Section 6.13).

6.5.2 SCM Components

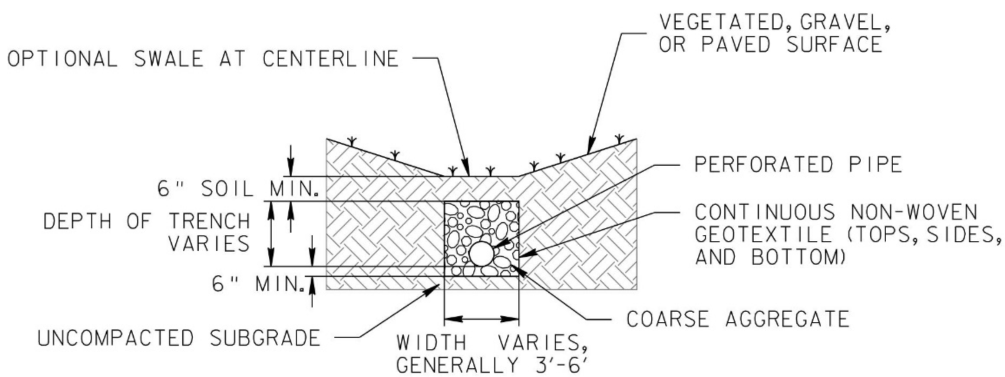
SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 and related SCMs described in Chapter 6 which may be encountered with this SCM include:

- Access, Fencing, and Security
- Signage

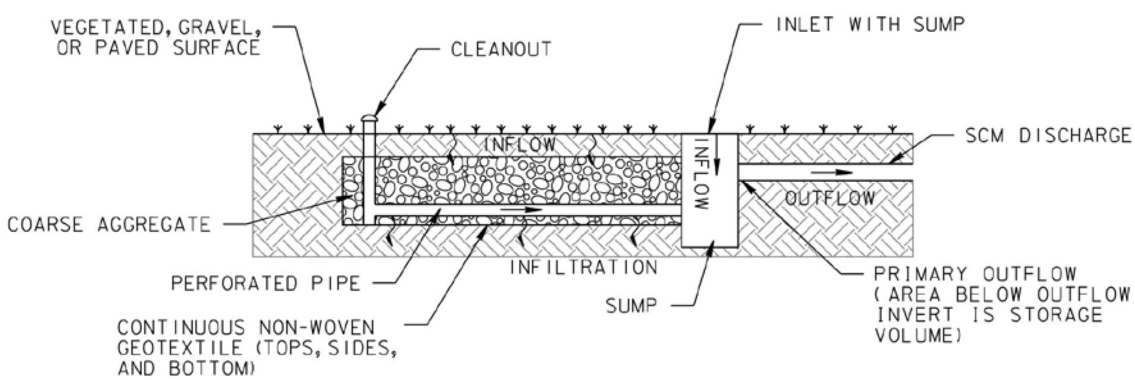
- Inflow System
- Inlet with Sump/Traps (Section 6.13)
- VSW/VSC SCM
- Cleanouts, observation wells (Underdrain Section 5.7)

In addition, SITs may include the following other components:
- Turf lawn or meadow or gravel surface
- Perforated pipe
- Coarse aggregate
- Geotextile
- Overflow pipe/device

Figure 6.5.2 illustrates the common components of a typical SIT. Runoff enters the SIT via infiltration from the surface or from directly connected inlets and pipes. Flows exceeding the infiltration capacity of the trench exit via overflow piping. An observation well or cleanout is typically included for inspections and maintenance.



Section View



Profile View

Figure 6.5.2: Subsurface Infiltration Trench - Common Elements

6.5.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of SIT should focus on its key functional areas: inflow, infiltration, and overflow. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect SCM and surrounding area for trash and debris.
- Where SITs are located beneath vegetated areas, surface vegetation should be in good condition with at least 80% uniform coverage, no invasive/undesirable species, and no signs of erosion. Where SITs are located below another SCM, vegetation coverage should meet surface SCM inspection requirements. SITs designed with a gravel surface should have gravel coverage over the entire SIT area with no vegetation present.
- Examine surface for sediment build-up; sediment should be removed when it reaches 3 inches of build-up, inhibits vegetative growth in 10% of the SCM, or anytime it blocks flow entry into the SCM.
- Check water level measured in observation well/cleanout for signs that standing water remains in the SIT longer than 72 hours after a rain event. Prolonged water storage suggests the SCM may be clogged or the subsurface infiltration is inadequate.
- Inspect overflow spillways for obstructions and structural condition.
- The SIT surface and surrounding area should be checked for signs of erosion and sinkhole activity. Report any surface settlement, erosion or depressions.
- The entrance point of the overflow pipe (or other device) conveying flows out of the SIT during larger storm events is considered the "Principal Outflow". In most cases, the overflow pipe will have a higher invert elevation than the SIT invert, but a lower invert than any directly connected inflow pipes. Inspect this feature as such.
- Make recommendations for pipe video inspection if surface inspection of underdrains or other system piping suggests functionality issues.
- SITs may have an emergency spillway in the form of a surface inlet grate that surcharges in the event the SIT clogs or otherwise fails. Inspect this component noting the intended emergency spillway functionality.
- Inspect all applicable common components as described in Chapter 5.

When completing PTCs inspection app for SITs:

- The Principal Outflow should be considered the concrete structure (if present) or pipe entrance point where the primary outflows leave the SIT.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

6.5.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.5.1: Maintenance Procedures for SIT

Frequency	Activity
Three times per year	• Prior to mowing, remove litter, trash, and debris from SCM surface, side slopes, inflow/outflow points, structures and surrounding area. • Mow areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow to a height of 6 to 10 inches. • Perform mowing operations within the SCM when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • LGP equipment must be used on SCM Floor (surface) (see Section 4.7); do not drive heavy equipment on SCM Floor (surface).
Annually	• Remove sediment from SCM surface. • Mow areas indicated to be tall meadow to a height of 8 to 16 inches. • Perform mowing operations within SCM when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such shrubs. • LGP equipment must be used on SCM Floor (surface) (see Section 4.7); do not drive heavy equipment on SCM Floor (surface).
As needed	• Remove sediment from SCM subsurface storage. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SIT specific table (G.1.5).

6.6 Subsurface Detention Storage (SDS)

Figure 6.6.1: Subsurface Detention Storage Under Construction
(photo c/o The Philadelphia Water Department, Stormwater Management Guidance Manual)

6.6.1 Description and Overview

Subsurface Detention Storage (SDS) is a stormwater control measure which stores collected stormwater below grade in stone aggregate, pipes, vaults, porous crates, baskets, or modular systems. SDSs can be designed to slowly release and/or infiltrate the stored water. SDSs are rarely constructed under roadways; they can be located under shoulders, pull-off areas, grass areas, or under parking lots at visitor centers and maintenance lots. The surface above the SDS can be impervious, gravel or vegetated. SDS systems are accessible via inlet/manhole access points for inspection and maintenance purposes.

Stormwater enters SDSs through inlet grates or via pipes. Pretreatment areas like sumped/trapped inlets or other types of Manufactured Treatment Devices (MTD) are critical components for SDSs because it can be difficult to rehabilitate infiltration clogging and outlet structure clogging issues (see Section 6.13 for MTD related information). Infiltrating SDSs can be designed using solely a stone storage bed or may include a network of pipes, vaults or other permeable modular chambers within a stone bed. Non-infiltrating SDSs typically utilize water tight pipe storage, chamber storage or a stone bed wrapped in an impermeable liner to temporarily store and release collected stormwater.

The outflow from SDSs is via a subsurface outflow structure typically housed in a manhole or concrete box structure. The outflow structure typically includes a series of orifices and weirs built on an internal baffle wall designed to function similar to a surface SCM outflow structure.

Some SDSs may have multiple entry points, however some may just maintain one entry at the flow control structure. Entry into an SDS is considered confined space entry and is prohibited without proper training and safety measures in place. Observation wells and cleanouts may be present in an SDS and can be used for maintenance and inspection from the surface.

6.6.2 SCM Components

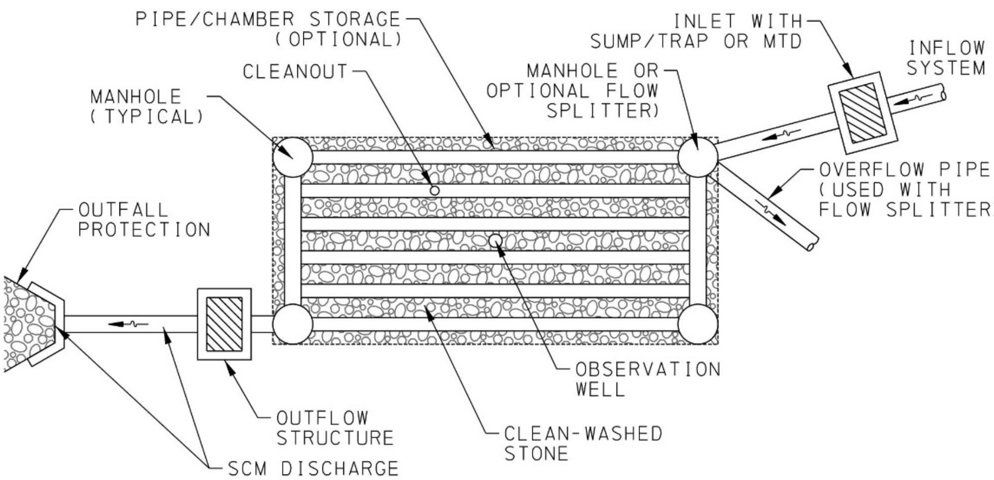
SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 and related SCMs described in Chapter 6 which may be encountered with this SCM include:

- Access, Fencing, Security
- Signage
- Inflow System
- Flow Splitter
- Cleanouts, observation wells (Underdrain Section 5.7)
- Outflow Structure
- Structures & Appurtenances
- Outfall Protection (if system outlets to surface downstream)
- Inlet with Sump/Traps and other Manufactured Treatment Device (MTD SCM)

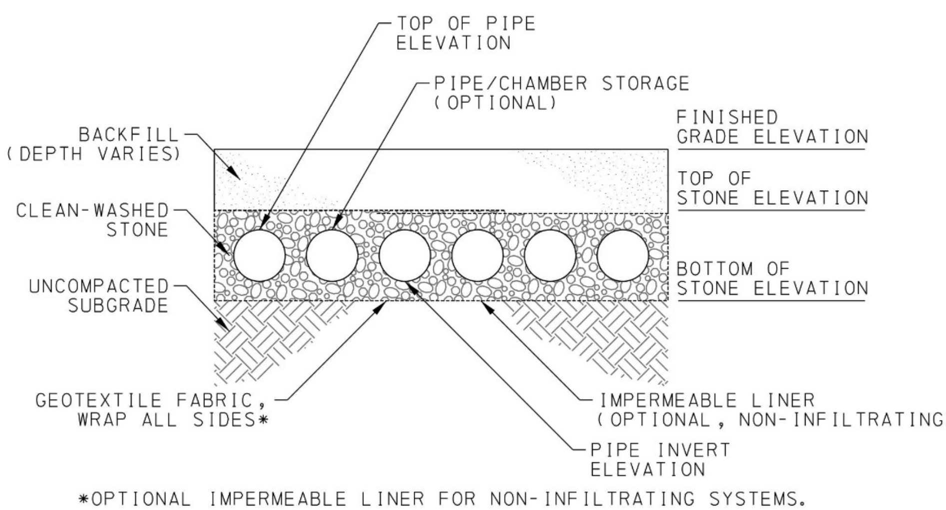
In addition, SDSs may include the following other components:

- Geotextile fabric
- Stone/coarse aggregate
- Overflow pipe/device
- Perforated pipe (infiltrating)
- Impermeable liner (optional; non-infiltrating)
- SCM discharge/ receiving channel

Figure 6.6.2 illustrates the common components of a typical SDS. Runoff enters the SDS through an inflow system that may include a sumped/trapped inlet or other MTD for pretreatment and a flow splitter. Flows are conveyed into a subsurface storage system that may include a stone bed, a series of pipes or a modular storage system. Flows exit the system through an outflow structure before discharging to the SCM discharge. SDSs can be a directly connection to a downstream closed drainage system or a pipe discharging to a surface water or channel.



Plan View



Section View

Figure 6.6.2: Subsurface Detention Storage - Common Elements

6.6.3 Key Inspection Considerations

Under PTC's program, SDS's may utilize alternative inspection forms in lieu of PTC's standardize electronic inspection software program to more thoroughly document the SCM where appropriate. In addition to the general inspection procedures described in Chapter 3, inspections of an SDS should focus on its key areas: inflow, storage system, and outflow structure. Specifically:

- Entry into SDS or any confined space is prohibited without proper training and safety measures in place. Perform initial visual inspections from the surface for underground SCMs. If signs indicate the system may not be functioning properly or if sufficient data cannot be obtained from the surface, recommendations for video inspection, confined space entry, or other means of inspection should be made.

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect area surrounding and above SCM for trash/debris, surface erosion, and sinkhole activity.
- Inspect areas above SDS for signs of ground settlement or subsidence and pavement cracking or fractures which may indicate failure of the subsurface components.
- Inspect the SDS inlets, manholes, and observation wells/cleanouts (if present) for signs that standing water remains in the system longer than 72 hours after a rain event. Prolonged standing water suggests the SCM may be clogged with silt/debris or subsurface infiltration is inadequate.
- Note levels of sediment visible in the inlets, manholes, and observation wells/cleanouts. Sediment and debris build up should be removed when it exceeds the plan specified cleanout depth. In the absence of a plan specified depth, sediment should be cleaned out when it exceeds 10% of the depth of the storage area for 1/2 length of storage area; at any point where the depth exceeds 15% of open storage depth; or at any time when infiltration or flow through the system is impeded. Subsurface inspection may be recommended to confirm sediment accumulation.
- Modular or chamber storage SDS components which are proprietary shall be inspected in accordance with their manufacturer specific requirements. Reference as-built plans for requirements.
- Inspect all applicable common components as described in Chapter 5 including subsurface outflow structures and outfall pipes which outlet to surface locations.

6.6.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.6.1: Maintenance Procedures for SDS

Frequency	Activity
Three times per year	• Prior to mowing, remove sediment, litter, trash, and debris from surface, inflow and outflow points, structures, and area surrounding SDS. • Mow vegetated surface areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow vegetated surface areas indicated to be short meadow to a height of 6 to 10 inches.
Annually	• Mow areas indicated to be tall meadow to a height of 8 to 16 inches. • Do not mow areas planted with no-mow landscaping such as shrubs.
As needed	• Remove sediment from SCM subsurface storage. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SDS specific table (G.1.6).

6.7 Stormwater Wetland (SWE)

Figure 6.7.1: Stormwater Wetland – Extended Detention Shallow Wetland
(photo c/o: PennDOT)

6.7.1 Description and Overview

Stormwater Wetlands (SWEs) are stormwater control measures consisting of a shallow marsh system which has been planted with emergent vegetation. They are similar to constructed wetlands or engineered wetlands with a key difference: they are specifically designed to treat stormwater runoff. SWEs are designed to accommodate larger drainage areas and may be constructed away from major infrastructure and developed areas, receiving only a portion of the stormwater flows.

Typical SWEs consist of approximately 40% open water and contain a variety of plant types based on the relative elevation with respect to the open water. Special SCM plantings comprised of native and beneficial hydrophytic vegetation species are planted within SWEs along the edge of permanent pools of water. These planted areas, referred to as low marsh zones or emergent vegetation zones (water depths up to 18 inches), and high marsh wedges (water depths up to 6 inches), play an integral role in the functionality of these SCMs. SWEs require a larger footprint than most SCMs and require an adequate source of inflow to maintain the permanent water surface elevation necessary to sustain the vegetation.

A pretreatment device such as a forebay is typically located at each point of major inflow into the SWE, and there are frequently multiple inflows due to the larger drainage areas associated with these SCMs. Within the SWE, water flows through open water zones, ranging from 1.5 feet to 6 feet deep, and then ponds in shallower pools of water of varying depths, known as micropools or wet pools. SWEs with deeper pools of water may have safety benches and/or aquatic benches graded into the side slopes. Safety benches are designed to remain above the water surface in between rain events, whereas aquatic benches will be submerged. As with dry basins, larger impounding embankments may be considered a regulated dam structure depending on height and storage. Inspections and maintenance of these must also comply with the requirements of the Dam Safety permit and should be noted in the inventory.

Typically, an outflow structure is used to release outflow from the SWE for larger storm events. Outflow structures can include concrete risers, concrete weir walls, or earthen embankments/spillways. An emergency spillway is also normally present. Some SWEs may have a sluice gate or other emergency drawdown opening at the bottom of the storage area to empty the system for maintenance or emergencies (refer to Wet Detention Basin, Figure 6.2.3 and 6.2.4 for sluice gate photos).

SWEs can be organized into the following four categories:

- Shallow Wetlands – Large surface area, provides water quality treatment through a meandering open water zone in combination with emergent vegetation zones.
- Extended Detention Shallow Wetlands – Similar to the shallow wetland; however, a micropool is utilized along with an outflow structure to provide both water quality and peak rate control.
- Pocket Wetlands – Smaller footprint than shallow wetlands, and typically constructed near the existing water table.
- Pond/Wetland Systems – A combination of a wet pond in series with a shallow wetland.

6.7.2 SCM Components

SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 which may be encountered with this SCM include:

- Access, fencing, and security
- Signage
- Inflow System
- Inlet with Sump/Traps (Section 6.13)
- Flow Splitter(s)
- Forebay
- Outflow Structure
- Outfall Protection

In addition, SWEs may include the following other components:

- Micropool/permanent pool(s)
- Open water zones
- High marsh wedges
- Low marsh zones/Emergent vegetation zones
- Special SCM plantings: Hydrophytic vegetation
- Safety/aquatic benches

- Geotextile
- Riprap/gabion baskets
- Impounding embankment/cut slopes
- Sluice gate/emergency wet pool dewatering valve
- SCM discharge/receiving channel

Figures 6.7.2 to 6.7.4 illustrates the common components of a typical SWE. Runoff enters the SWE through an inflow system that typically discharges to a forebay for pretreatment. Within the SWE, stormwater is conveyed slowly through well-vegetated areas of filtration and shallow storage prior to exiting through an outflow structure. Outfalls for SWEs can be a direct connection to a downstream closed drainage system, to a swale, or directly to a stream.

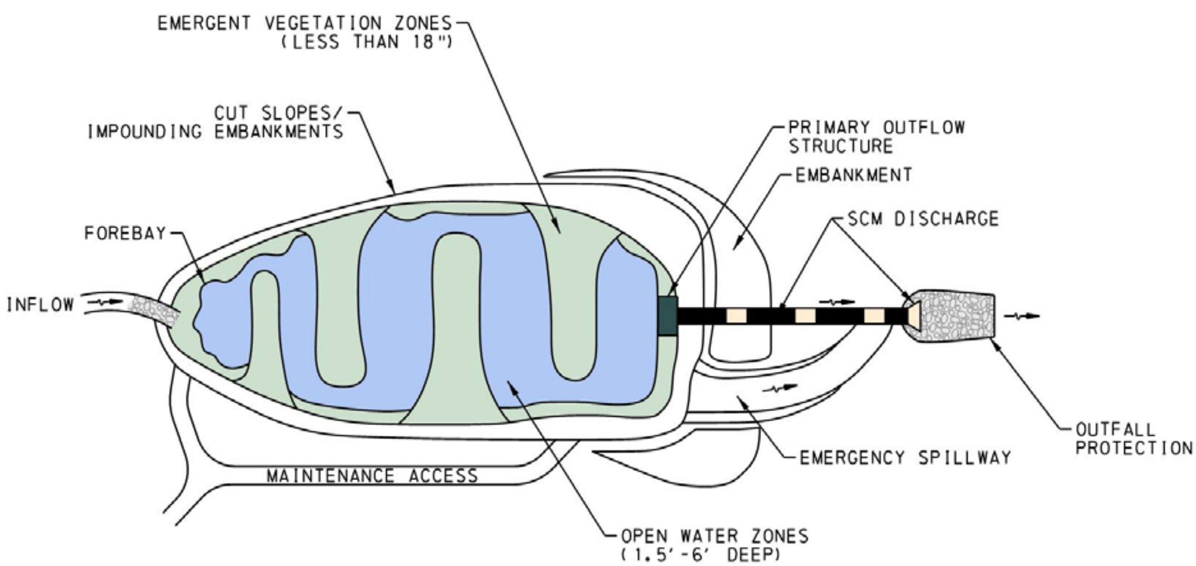


Figure 6.7.2 – Shallow Wetland - Common Elements
(Adapted from PA Stormwater Best Management Practices Manual)

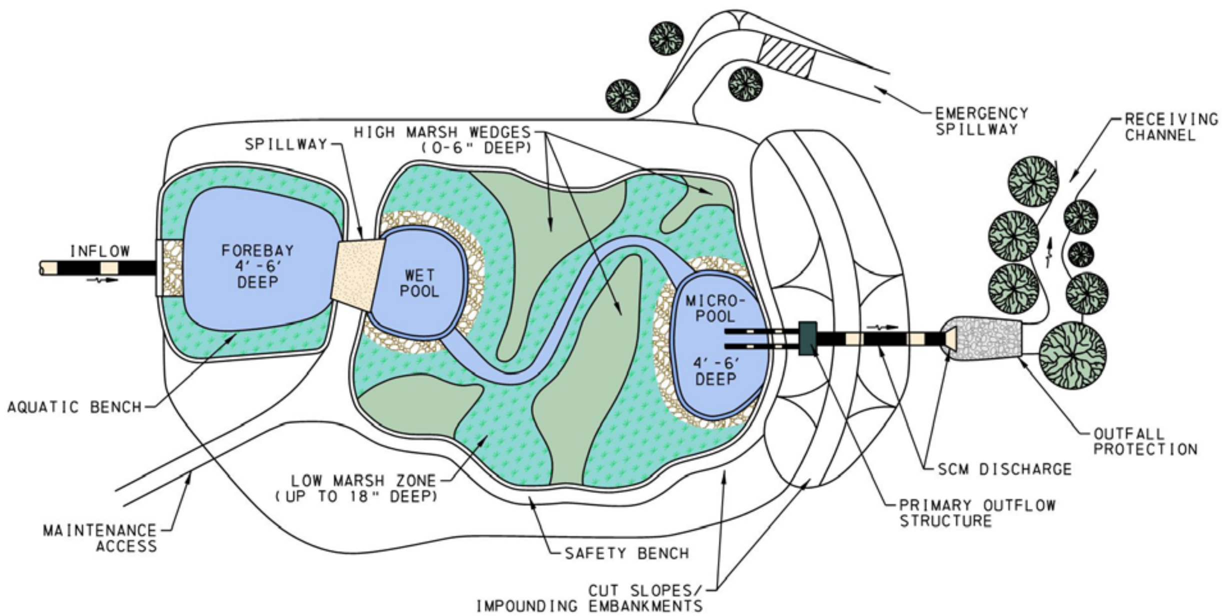


Figure 6.7.3 – Pond/Wetland System - Common Elements
(Adapted from PA Stormwater Best Management Practices Manual)

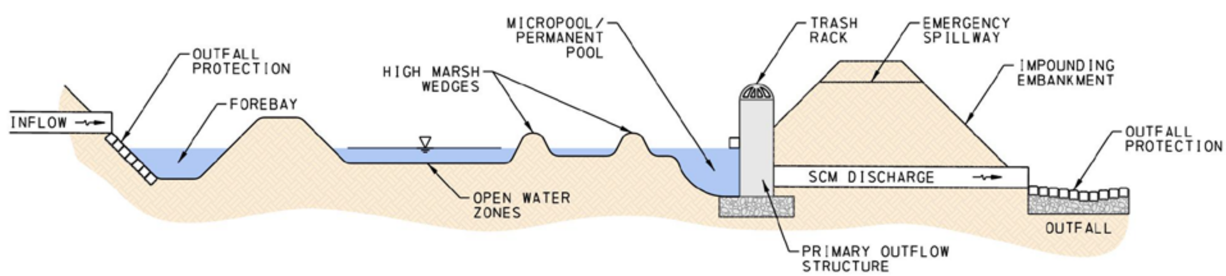


Figure 6.7.4: Typical SWE – Section View
(Adapted from NCDOT-HSP-2010-01)

6.7.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of an SWE should focus primarily on its key functional areas: inflow, storage system, and outflow structures. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect the SWE, cut slopes, embankments, inflow and outflow points for presence and note severity of:
  - Trash/debris
  - Surface erosion
  - Sinkhole activity
  - Signs of contaminants (e.g. gas, oil, fertilizers)
  - Evidence of burrowing animals.

- Inspect the SWE's micropool(s) and/or permanent pool(s) and confirm the pool depths are near the design plans depths. Take note of very low or dry conditions within any of the pools.
- When plans indicate an impermeable liner is present look for unintentionally exposed section or signs of puncture, tears or leaks indicated by low water levels, surface cover erosion, animal burrow activity, or similar.
- Look for evidence of excessive algae in the wet pool. Some algae growth is expected and part of the natural system helping with nutrient removal. Algae growth covering more than 50% of the pool area should be considered excessive and requires removal.
- Look for evidence of excessive permanent waterfowl population. Evidence of approximately 20 or more permanent waterfowl inhabitants per pond surface acre should be noted.
- Check for sediment accumulation. Sediment accumulation should be removed when it reaches 50% of the permanent pool storage volume or anytime it impacts SCM performance and flow through the system. In cases of excessive sedimentation, the drainage area should be inspected for sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- The embankment should be assessed for erosion, cracking, settlement, sloughing, burrowing animals, instability and tree growth.
- Inspect downstream of the toe of embankment for evidence of seepage, piping, or hydrophytic vegetation.
- Inspect wetland and buffer vegetation around the perimeter of the SWE. Vegetation should be in good condition with at least 85% coverage within the emergent vegetation zone. The cover type should match original design plans with no invasive/undesirable species present. Hydrophytic vegetation may be present in and in close proximity to the SWE perimeter with less water tolerant vegetation further up the side slopes. Vegetation should not hinder inflow or outflow in the SCM.
- If present, inspect the sluice gate or other emergency draw down valve. Look for excessive corrosion and signs that the mechanisms have frozen or rusted closed, taking care not to open it. Check for signs of leaking. Some SWEs may have a sluice gate or other emergency drawdown opening at the invert of the facility to empty the system for maintenance or emergencies.
- Inspect all applicable common components as described in Chapter 5.

When completing PTC's inspection app for SWEs:

- Impermeable liners are inspected under the impermeable liner portion of the app. It should be inspected/commented on when it or possible concerns with it exist.
- If a sluice gate or emergency drawdown opening is present, when it is attached to/part of the primary outflow structure, it should be inspected as part of the primary outflow. When it is located and functions separately, it should be inspected as the second outflow.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

Start-up phase check-ups: SWEs require more frequent startup phase check-ups during plant establishment through the first three years as stipulated in Chapter 3. The following items should be inspected during these check-ups:

- Check for sediment, trash, and debris accumulation within the footprint of the SWE.
- Confirm water elevations (depths) within the forebays, micropools, and permanent pools match design plans.

- Inspect wetland and buffer vegetation. Vegetation in and around the SCM should be in good condition and per plan including trees, shrubs and herbaceous/grass plant materials. Coverage should reach 70% or more of plan depicted density by one year after construction, 75% by two years, and 85% by three years after construction. No invasive/undesirable species should be present. Dead plants should be removed and replaced, receiving initial post construction water schedule commencing after reinstallation to establish the intended planting zones.
- The SCM and vicinity should be checked for signs of erosion of any form including general loss of topsoil and the formation of rills or gullies.
- Inspect the SWE for unintended flow channelization through the system.
- Confirm inflow and outflow points are clear and functioning.
- Assess bank stability for embankments, cut slopes, and conveyance channels.
- Inspect forebays, micropools, and permanent pools for excessive sediment accumulation. Sediment and debris accumulation should be checked and removed when it reaches the depth indicated by the cleanout marker.

6.7.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.7.1: Maintenance Procedures for SWE

Frequency	Activity
April-Oct twice weekly for six weeks following planting	• Water all seeded/planted areas and fill water bags around trees. Watering may be skipped if ¼" of rainfall has occurred within previous 24 hours of scheduled watering.
April-Oct every two weeks for first two years following planting	• Water all planted (non-grassed/seeded) areas and fill water bags around trees. Watering may be skipped if ¼" of rainfall has occurred within previous 7 days of scheduled watering.
Three times per year (for the first two years of service)	• Remove or treat weeds and undesirable plants; prune shrubs and trees to maintain appearance and functionality. Remove undesirable vegetation by hand, especially woody vegetation on embankments. Note: Non-invasive, hydrophytic vegetation is acceptable but should not hinder SCM inflow or outflow. Dispose of vegetative cuttings off-site.
Three times per year	• Prior to mowing, remove litter, trash, and debris from SCM surface, side slopes, inflow/outflow points, structures and surrounding area. • Mow areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow to a height of 6 to 10 inches. • Do not mow areas planted with no-mow landscaping such as shrubs. • Do not allow grass clippings to enter wet pool; dispose of off-site.
Annually	• Mow areas indicated to be tall meadow to a height of 8 to 16 inches. • Do not allow grass clippings to enter wet pool; dispose of off-site. • Do not mow areas planted with no-mow landscaping such as shrubs. • Exercise (move/open) valves/sluice gates by briefly opening it enough to ensure that the valve/sluice gate can operate through its full range of motion. If lubrication is necessary, use marine-type grease.
Every other year (minimum*)	• Remove or treat weeds and undesirable plants; prune shrubs and trees to maintain appearance and functionality. Replace diseased or dead plant materials; if specific species mortality is reoccurring, assess cause and replace with appropriate alternate species maintaining 80% plant cover. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Non-invasive, hydrophytic vegetation is acceptable but should not hinder SCM inflow or outflow. Dispose of vegetative cuttings off-site.
As needed	• Replace diseased or dead plant materials per plan; if specific species mortality is reoccurring, assess cause and replace with appropriate alternate species maintaining 80% plant cover. • Remove sediment from SCM floor surface. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

* Should be checked every time on site for maintenance activities and completed more frequently if needed

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.
2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the SWE specific table (G.1.7).

6.8 Constructed Stormwater Filter (CSF)

Figure 6.8.1: Open Constructed Stormwater Filter
(photo c/o PADEP BMP Manual 2006)

6.8.1 Description and Overview

Constructed Stormwater Filters (CSF) are SCMs comprised of a filtering layer (sand, compost, organic material, etc.) which the stormwater flows through. CSFs can be above ground (open CSF) or they can be constructed in a subsurface vault (enclosed CSF). CSFs temporarily detain stormwater runoff allowing it to percolate through the filter layer which removes pollutants from runoff.

Open CSFs may look similar to a surface detention basin with a sand or gravel bottom. Runoff typically enters the filter area as concentrated flow in an inflow pipe or channel. A flow spreading device, such as a level spreader, may be used to evenly disperse the flows over the filter media. Runoff filters through the media into an underdrain collection system for release to a downstream conveyance system, or it infiltrates into the existing soils below the filter area.

Enclosed CSFs are constructed below ground in a manhole or concrete box structure in which the filter media is enclosed. Stormwater enters the vault area where it passes through the filter media into an underdrain where it flows out of the SCM. Some enclosed CSFs have a sediment collection sump area contained within the structure to remove excess sediment prior to entering the media chamber. Excess flows during large storm events overflow via a bypass weir without passing through the filter media. Enclosed CSFs are considered confined spaces and should not be entered without appropriate confined space training and procedures.

6.8.2 SCM Components

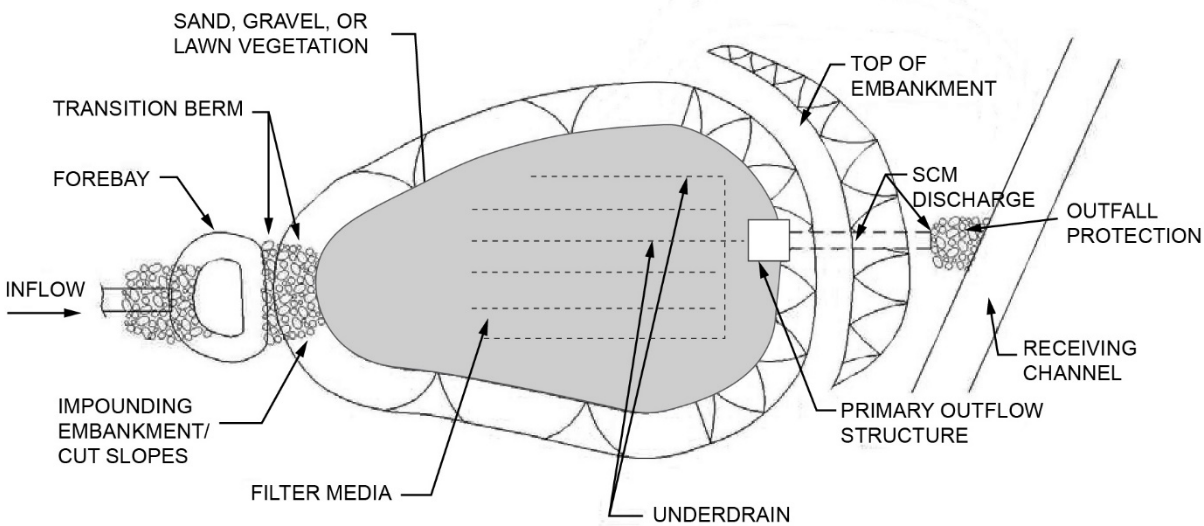
SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 which may be encountered with this SCM include:

- Access, Fencing, and Security
- Signage
- Inflow Systems
- Inlet with Sump/Traps (Section 6.13)
- Forebay
- Flow Splitter
- Underdrain, cleanouts, observation wells
- Outflow Structures
- Structures and Appurtenances
- Emergency Spillway
- Outfall Protection

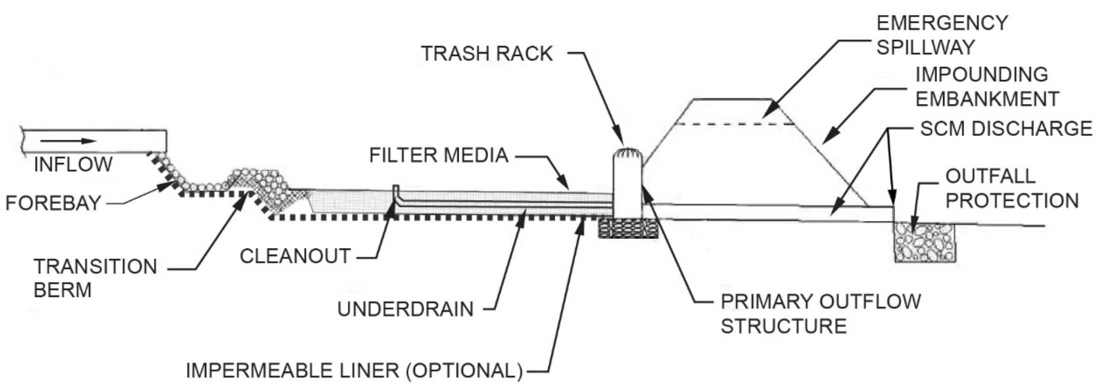
In addition, CSFs may include the following other components:

- Filter media
- Geotextile
- Impermeable membrane (open CSF, optional)
- Vegetation, turf lawn or meadow plantings (open CSF, optional)
- Impounding embankment/cut slopes
- SCM discharge/receiving channel
- Concrete Structure (enclosed CSF)
- Access grate/cover (enclosed CSF)
- Baffles and weirs (enclosed CSF)

Figures 6.8.2 and 6.8.3 illustrate the components of a typical open and enclosed CSF. Runoff enters the SCM via directly connected inlets, pipes, channels, and sheet flow. Water flows through the filter media and out through an underdrain system or infiltration.



Plan View



Section View

Figure 6.8.2: Open Constructed Stormwater Filter - Common Elements

(Adapted from NCDOT-HSP-2010-01)

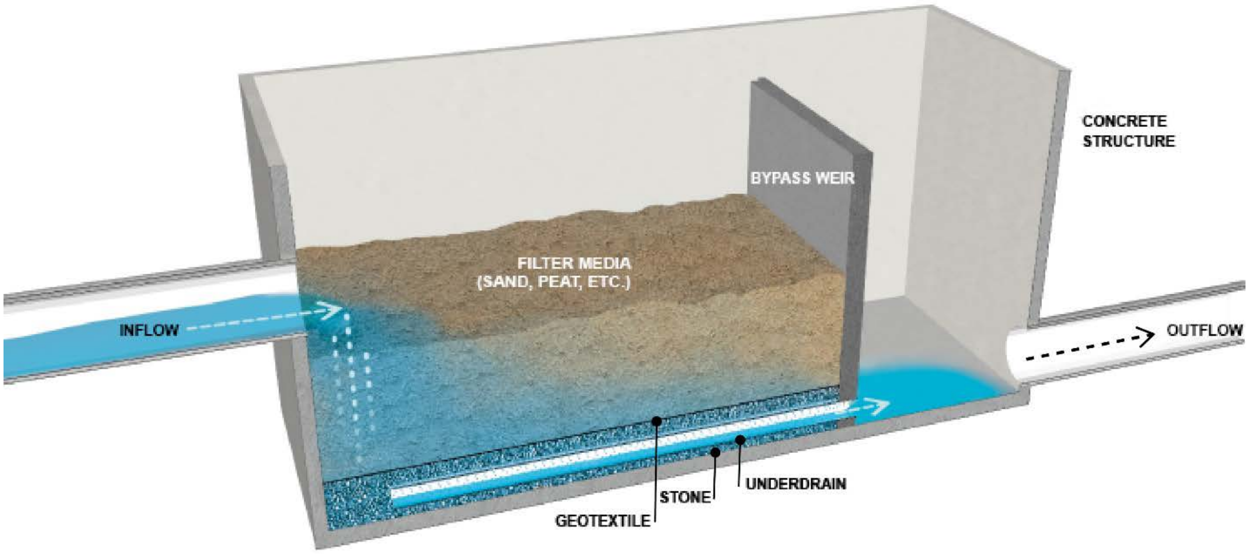


Figure 6.8.3: Enclosed Constructed Stormwater Filter - Common Elements
(Adapted from Philadelphia Water Department, Stormwater Management Guidance Manual)

6.8.3 Key Inspection Considerations

Under PTC's program, Enclosed CSF's may utilize alternative inspection forms in lieu of PTC's standardize electronic inspection software program to more thoroughly document the SCM where appropriate. In addition to the general inspection procedures described in Chapter 3, inspections of a CSF should focus on its key functional areas: inflow, infiltration/filtration, and overflow. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect SCM and surrounding area for trash and debris.
- CSFs are particularly susceptible to clogging from sediment if the drainage area contributes high sediment loads and/or adequate pretreatment is not present. Inspect existing pretreatment measures for sediment accumulation, and if excessive sediment is present, make recommendations as appropriate (e.g., additional pretreatment measures, improve efficiency of existing measures). In cases of excessive sedimentation, the drainage area should be inspected for sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- Sediment accumulation should be removed when it reaches the depth indicated by the cleanout marker. Where a cleanout marker is not present, sediment should be removed when it reaches 1 inch in depth, when there are signs of poor infiltration on the media surface, or it affects inflow or outflow in the SCM.
- Inspect the filter media surface for signs of short circuiting, rills or channelization of flows over the filter media area.
- The SCM slopes and vicinity should be checked for signs of erosion, flow channelization, and loss of topsoil.
- Inspect for signs of sinkhole activity in the SCM floor, slopes and vicinity.

- Check for appropriate vegetative cover per plan. The interior and exterior slopes of the CSF should be stabilized with turf lawn at a minimum. Vegetation should only be present on the media if specified by plans. Vegetation should be in good condition with at least 80% coverage with no invasive/undesirable species. Vegetation should not hinder inflow or outflow in the SCM.
- Inspect for saturated soils, ponding, or other signs of decreased infiltration rates.
- Inspect all applicable common components as described in Chapter 5.

When completing PTC's inspection app for CSFs:

- Filtration layers are inspected under the surface storage portion of the app.
- Impermeable liners are inspected under the impermeable liner portion of the app. It should be inspected/commented on when it or possible concerns with it exist.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

6.8.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.8.1: Maintenance Procedures for CSF

Frequency	Activity
Three times per year	• Prior to mowing around SCM, remove litter, trash, and debris from open and enclosed CSF surface, side slopes (open CSF), inflow/outflow points, structures and surrounding area. • Mow areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow to a height of 6 to 10 inches. • Perform mowing operations within the SCM when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • Where CSF bottom surface (Floor) is intentionally vegetated, LGP equipment must be used on SCM Floor (see Section 4.7); do not drive heavy equipment on SCM Floor. • Do not use herbicides.
Annually	• Remove sediment from CSF surface, side slopes (open CSF), inflow/outflow points, structures and surrounding area. • Open CSF: Remove weeds and undesirable vegetation from side slopes, inflow/outflow points, structures and surrounding area. • Mow areas indicated to be tall meadow to a height of 8 to 16 inches. • Perform mowing operations within the SCM when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • Do not use herbicides. • Open CSF: Remove vegetation from CSFs with sand/gravel Floor (surface). Remove weeds and undesirable vegetation from CSFs with grassed surface. Remove using hand operated equipment and using methods that minimize disturbance. Do not use herbicides. • Enclosed CSF: Remove sediment accumulation in sump area of vault bottom. Remove per guidelines for MTD tables in Section 6.13.
As needed	• Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the CSF specific table (G.1.8).

6.9 Vegetated Filter Strip (VFS); Vegetated Filter Strip on Steep Slope (VSS)

Figure 6.9.1: Vegetated Filter Strip (VFS)
(photo c/o: PennDOT)

6.9.1 Description and Overview

Vegetated filter strips (VFSs) are gently sloping, linear strips of dense turf lawn or meadow vegetation that filter sediment and pollutants from stormwater and encourage infiltration as runoff flows across the surface.

Vegetated Filter Strips, Steep Slope (VSSs) are similar VFSs, but are constructed on steep slopes (exceeding 8 percent) and typically incorporate special design measures such as turf reinforcement matting or other surface stabilization measures. Check dams or pervious berms similar to IBEs may be included on a VSS to slow flow (refer to Section 6.12 for IBE related information).

A VFS/VSS is typically seen along the edge of pavement where runoff flows off the pavement via sheet flow and into a filter strip. These VFS/VSS systems are buffers between runoff from impervious areas and a receiving body of water. Variations of VFS/VSS located at the edge of the roadway can incorporate a flow spreading strip of gravel/rock between the pavement and grass strip to filter larger sediment/debris and avoid creating areas of channelized flow. A VFS/VSS located further from the roadway may incorporate level spreaders (refer to Section 6.14 Level Spreader and Flow Dispersion) to transition channelized flow to sheet flow upslope of VFS/VSS system.

6.9.2 SCM Components

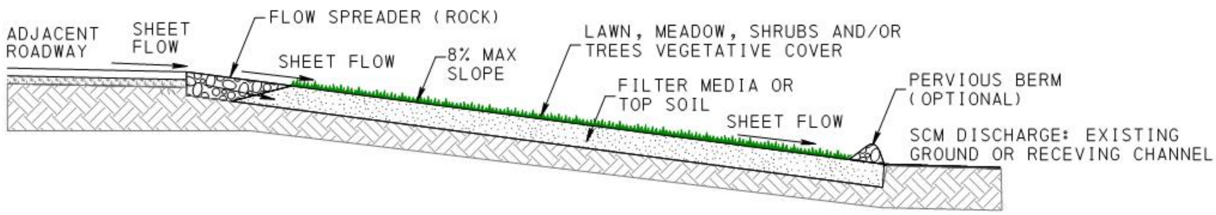
SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 and related SCMs described in Chapter 6 which may be encountered with this SCM include:

- Access, Fencing, and Security
- Signage
- Inflow System
- LSO SCM
- IBE SCM

In addition, a VFS/VSS may include the following other components:

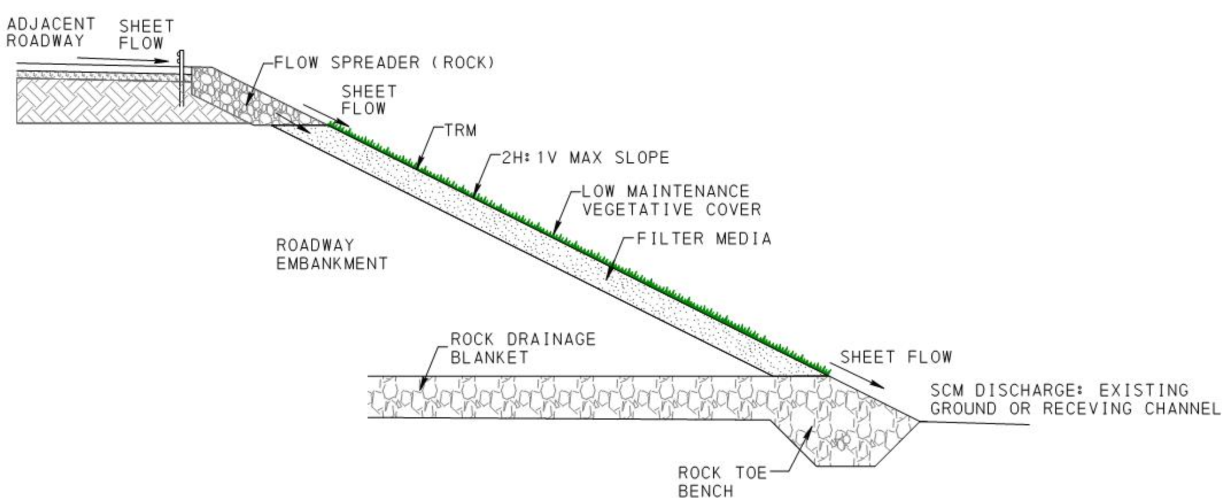
- Flow spreaders
- Filter media
- Vegetative shrub, woody or special SCM plantings
- Turf lawn or meadow
- Pervious berm
- SCM Discharge/receiving channel

Figures 6.9.2 and 6.9.3 illustrate the common components of a typical VFS and VSS.



<u>Section View</u>

Figure 6.9.2: Vegetated Filter Strip (VFS)- Common Elements



<u>Section View</u>

Figure 6.9.3: Vegetated Filter Strip, Steep Slope (VSS) - Common Elements

6.9.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of a VFS/VSS system should focus on its key functional areas: inflow, infiltration, and outflow. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Sediment should be removed from the filter surface when it reaches 2 inches in depth or at any time it affects flow through the SCM. Sediment removal may be required along the upslope edge of the filter and within the rock flow spreader more frequently than the filter surface to prevent channelized flows and vegetation growth in accumulated fine material. In cases of excessive sedimentation, the drainage area should be inspected for sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- Inspect for signs of erosion and channelization at the inflow edge and throughout the filter surface. Note any signs of channelization within the filter surface. Small breaks in the sod and small erosion channels can quickly become large erosion problems. These areas should be repaired and reseeded immediately to ensure proper sheet flow of runoff across the filter.
- Inspect filter surface and surrounding area for trash and debris. Note debris that could cause flow channelization.
- Confirm surface vegetation is in good condition with at least 80% coverage throughout filter area and there are no bare patches exceeding 10% of the area.
- Verify that the vegetation is being mowed at the proper frequency to maintain desired maximum heights and appearance (per Table 3.5.2). Note if more frequent mowing is required. For VSS systems, no-mow plantings may be specified on the plans. If this is the case, mowing is not required.
- If present, inspect rock flow spreader adjacent to roadway.
- If present, inspect IBEs and level spreader as described in Sections 6.12 and 6.14, respectively.
- Inspect all applicable common components as described in Chapter 5.

When completing PTC's inspection app for VFS/VSSs:

- Inspect the entire surface of the VFS/VSS under SCM Surface-SCM Floor.
- Inspect the downslope edge of the VFS/VSS (sheet flow) under Primary Outflow.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

6.9.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.9.1: Maintenance Procedures for VFS and VSS

Frequency	Activity
Three times per year	• Prior to mowing, remove litter, trash, and debris from SCM surface, gravel flow spreader or level spreader (if present), inflow area, and surrounding area. • Mow areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow to a height of 6 to 10 inches. • Perform mowing operations within the SCM when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • Do not use herbicides. • LGP equipment must be used on SCM Floor (see Section 4.7); do not drive heavy equipment on SCM Floor.
Annually	• Mow areas indicated to be tall meadow to a height of 8 to 16 inches. • Perform mowing operations within SCM when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • LGP equipment must be used on SCM Floor (see Section 4.7); do not drive heavy equipment on SCM Floor.
As needed	• Remove sediment from surface of VFS/VSS. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the VFS/VSS specific table (G.1.9).

6.10 Media Filter Drain (MFD)

Figure 6.10.1: Media Filter Drain with Unvegetated Surface
(photo c/o: PennDOT)

6.10.1 Description and Overview

A Media Filter Drain (MFD), also known as an "ecology embankment" or "bioslope," is an embankment that treats runoff by rapid filtering through an engineered soil media commonly known as a media filter drain mix. MFDs use a variety of physical, chemical, and biological processes to improve water quality. They are similar to vegetated filter strips, but instead of filtering runoff via sheet flow through vegetation and surface soils, runoff is rapidly infiltrated into a gravel trench and then filtered via subsurface flow through a media filter drain bed consisting of an unvegetated mixture of crushed rock, dolomite, gypsum, and perlite and a perforated underdrain/infiltration trench at the toe of slope. A MFD's footprint is usually contained within the roadway embankment; however, it can also be located in medians or as an end of pipe treatment when combined with a level spreader (refer to Section 6.14 Level Spreader and Flow Dispersion). The surface of MFDs may be vegetated or, more commonly, an unvegetated exposed engineered filter drain media mix.

6.10.2 SCM Components

SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 and related SCMs described in Chapter 6 which may be encountered with this SCM include:

- Access, Fencing, and Security
- Signage
- Inflow System
- LSO SCM
- Underdrain, cleanouts, observation wells

In addition, MFDs may include the following other components:

- No-vegetation zone
- Gravel
- Turf lawn or meadow
- Filter media
- Geotextile

Figure 6.10.2 illustrates the components of a typical MFD.

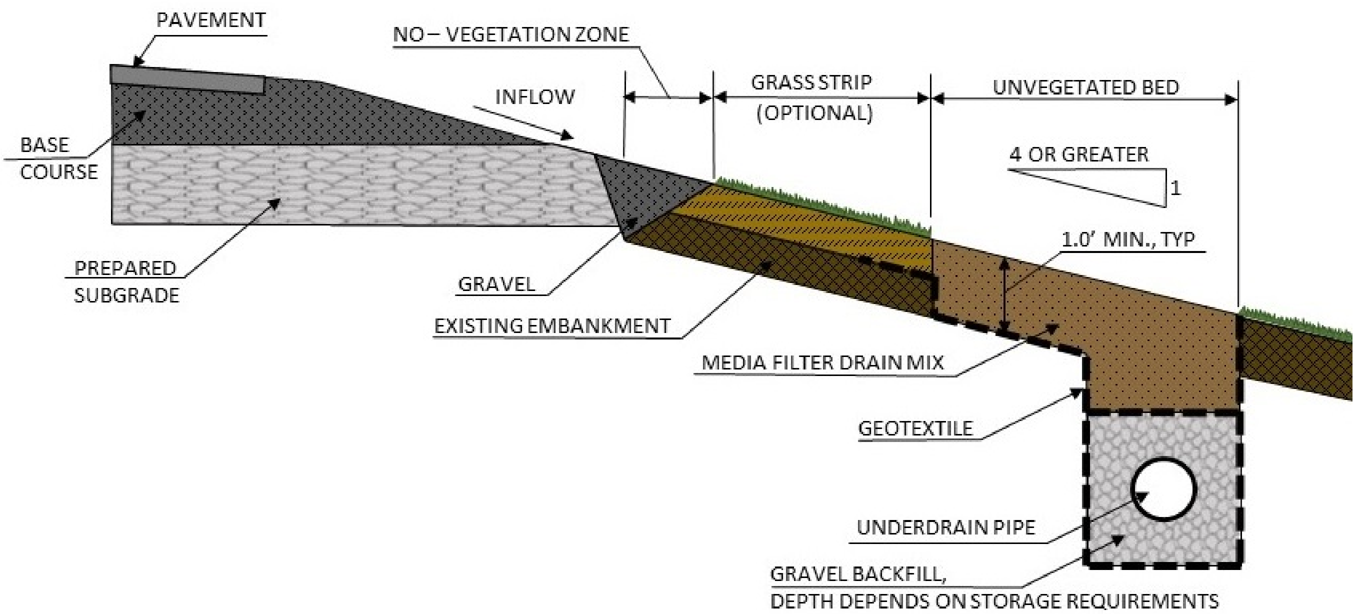


Figure 6.10.2: Media Filter Drain - Common Elements

6.10.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of a media filter drain system should focus on its key functional areas: inflow, infiltration/filtration, and overflow. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Sediment should be removed from the filter surface when it reaches 2 inches in depth or at any time it affects flow through the SCM. Sediment removal may be required along the upslope edge of the filter to prevent channelized flows. In cases of excessive sedimentation, the drainage area should be inspected for sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- Inspect for signs of erosion and channelization at the inflow edge and throughout the filter surface. Note any signs of channelization within the filter surface. Small breaks in the sod and small erosion channels quickly become larger erosion problems. These areas should be repaired and reseeded immediately to ensure proper sheet flow of runoff through the filter.

- Inspect filter surface and surrounding area for trash and debris. Note debris that could cause flow channelization.
- The SCM and vicinity should be checked for appropriate vegetative cover per plan. Vegetation should only be present on the media filter if specified by plans. Where plans called for vegetation, it should be in good condition, free from weeds and invasive/undesirable species, with at least 80% coverage throughout filter area and there are no bare patches exceeding 10% of the area.
- Verify that the vegetation is being mowed at the proper frequency to maintain desired maximum heights and appearance (per Table 3.5.2). Note if more frequent mowing is required.
- Inspect for prolonged saturation of media filter; this suggests the filter media may be silted, the underdrains are clogged, and/or the subsurface infiltration is inadequate.
- Inspect for depressions over underdrain pipes.
- Look for evidence of MFD inundation from flooding of adjacent water bodies. If flooding has occurred, infiltration testing of the media filter should be recommended.
- If present, inspect rock flow spreader adjacent to roadway.
- If present, inspect structural level spreader component as described in Section 6.14.
- Inspect all applicable common components as described in Chapter 5.

When completing PTC's inspection app for MFDs:

- Inspect the entire surface of the MFD under SCM Surface-SCM Floor.
- Inspect the perforated pipe underdrain of the MFD as the Primary Outflow.
- Inspect the sheet flow at the downslope edge of the MFD as the Secondary Outflow.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

6.10.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.10.1: Maintenance Procedures for MFD

Frequency	Activity
Three times per year	• Prior to mowing, remove litter, trash, and debris from SCM surface, gravel flow spreading strip or level spreader (if present), inflow area, and surrounding area. • Mow areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow to a height of 6 to 10 inches. • Perform mowing operations within the MFD area when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • Remove vegetation from portions of MFDs specified on plans as non-vegetated surfaces. Remove weeds and undesirable vegetation from portions with grassed surface. Remove using hand operated equipment and methods that minimize disturbance. • Do not use herbicides. • LGP equipment must be used on SCM Floor (see Section 4.7); do not drive heavy equipment on SCM Floor.
Annually	• Mow vegetated areas of the MFD indicated to be tall meadow to a height of 8 to 16 inches. • Perform mowing operations within SCM when SCM is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • Do not use herbicides. • LGP equipment must be used on SCM Floor (see Section 4.7); do not drive heavy equipment on SCM Floor.
Once every three years	• Remove sediment build-up at the edge of the filter strip and level gravel area to ensure flow is evenly distributed.
Once every ten years	• Excavate and replace all media filter mix within the MFD. Replace with new filter media matching plan materials, restoring slope and geometry to plan dimensions. Restore disturbed areas with vegetation and rolled erosion control product per plans.
As needed	• Remove sediment from surface of MFD. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the MFD specific table (G.1.10).

6.11 Vegetated Swale (VSW); Vegetated Swale with Check Dams (VSC)

Figure 6.11.1: Vegetated Swale (VSW)
(photo c/o Philadelphia Water Department, Stormwater Retrofit Guidance Manual)

Figure 6.11.2: Vegetated Swale with Check Dams (VSC)
(photo c/o: PennDOT)

6.11.1 Description and Overview

Vegetated Swales (VSWs), sometimes called biofiltration swales or bioswales, are linear stormwater control measures consisting of broad, shallow vegetated channels designed to slow runoff, promote infiltration and filter pollutants and sediments while conveying stormwater runoff.

Vegetated Swales with Check Dams (VSCs) are vegetated swales with a series of check dams along the length of the swale. Check dams are small dam-like features designed to capture and infiltrate a small volume of water, or allow retained water to slowly filter through the dam continuing downstream. Check dams vary between 6 to 12 inches in height and are uniformly spaced along the swale. They can be constructed from natural wood, concrete, stone/aggregate, or earth. Check dams are permanent features which should not be confused with temporary erosion and sediment devices. Weep holes, or some other drawdown device, may be present at the base of check dams to allow retained water to slowly pass through the dam following storm events.

VSWs/VSCs (swale) collect surface runoff from roadways, parking areas, and other impervious surfaces directly or indirectly through pipes. Typically located parallel to the roadway at the bottom of the cut slope or toe of fill, runoff is conveyed into the swale via sheet flow leaving the impervious surface. Swales are used as an alternative to curb and gutter storm sewer systems, and can also be used as a form of pretreatment for other SCMs. VSWs/VSCs may appear similar to standard drainage ditches used by PTC, however unlike drainage ditches, VSWs/VSCs provide stormwater benefits such as water quality improvement. VSWs/VSCs are commonly vegetated with a dense short meadow or special SCM planting mix comprised of a diverse selection of native, water-tolerant plants that also have high pollutant removal potential. Some swales include several inches of engineered soil in the bottom of the channel to improve infiltration while others utilize the native soils. VSWs/VSCs may include turf reinforcement or other surface stabilization measures to reduce and/or prevent erosion. Swales typically terminate over an outlet protection (see Chapter 5) into an open grassy/forested area, a stream or another SCM. In these cases, there is no formal outlet structure. Some VSWs/VSCs may outlet into an inlet grate into a piped drainage system. They do not typically have a physical outflow structure at the outflow point.

Variations on VSWs/VSCs include the following:

- Vegetated Swales with Subsurface Infiltration Trench (SIT) – Includes a SIT located beneath the VSW/VSC soil planting layer, providing additional infiltration capacity to the swale system (if a SIT is present also see Section 6.5 for SIT related information).
- Grass Swales – Primarily used as pretreatment for other structural SCMs, a grass swale is similar to a standard drainage ditch with much less dense vegetation than a VSW/VSC. Grass swales are usually sized based on flow rates and are designed to convey very small storm events.
- Wet Swales – Placed in areas with a high-water table or poorly drained soils, wet swales are like a stormwater wetland (SWE) in a linear form, maintaining consistently wet to shallowly pooled areas. Typically, they are densely vegetated with hydrophytic vegetation, and located on mild slopes to sustain the permanent pool elevations.

6.11.2 SCM Components

SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 and related SCMs described in Chapter 6 which may be encountered with this SCM include:

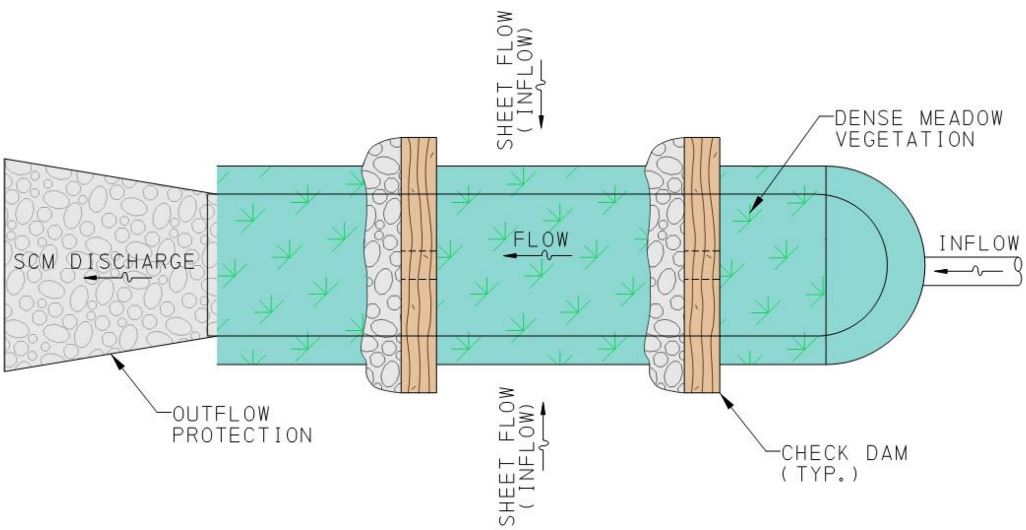
- Access, fencing, and security

- Signage
- Inflow System
- Outfall Protection
- SIT SCM

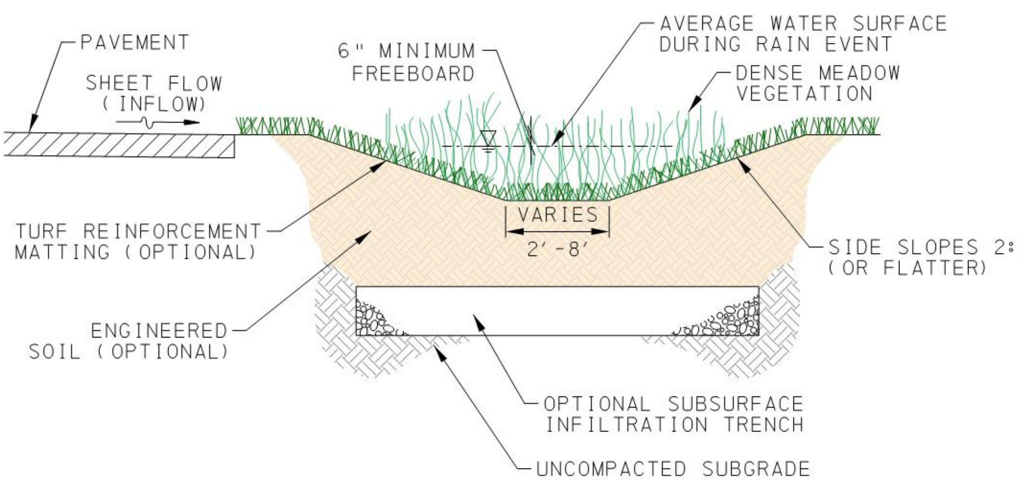
In addition, VSW/VSCs may include the following other components:

- Turf reinforcement matting (optional)
- Engineered soil (optional)
- Turf Meadow Vegetation
- Turf Meadow or special SCM planting-Hydrophytic vegetation (wet swales)
- Check dams (VSC only)
- Check dam dewatering device (VSC only)

Figures 6.11.3 and 6.11.4 illustrate the common components of typical VSWs, VSCs, and check dams.

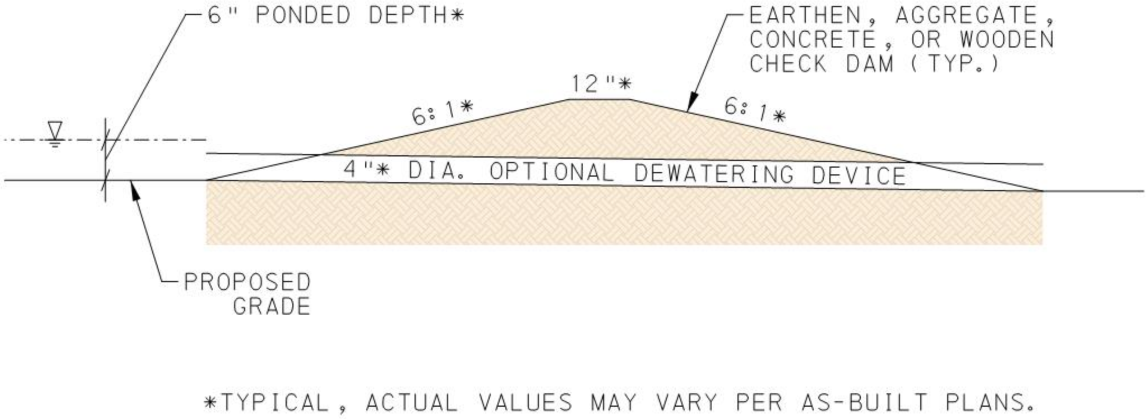


Plan View



Section View

Figure 6.11.3: Vegetated Swale (VSW/VSC) - Common Elements



Section View

Figure 6.11.4: Check Dam - Common Elements

6.11.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of a VSW/VSC should focus primarily on its key functional areas: inflow, vegetation, surface area, and outflow. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect for appropriate vegetative cover per plan. Surface vegetation should be in good condition with at least 90% coverage on the bottom and side slopes. Vegetation should not obstruct flow through the SCM. Inspect for encroachment of woody vegetation and invasive/undesirable species on side slopes and in channel bottom.
- Check for sediment accumulation in the swale, upslope of check dams (where present) and at flow entry points. Sediment accumulation should be removed from swale channel when it reaches the depth indicated by the cleanout marker. Where a cleanout marker is not present, sediment should be removed when it reaches 3 inches in depth or inhibits vegetative growth in 10% of the SCM or anytime it blocks flow entry into or through the swale. In cases of excessive sedimentation, the drainage area should be inspected for sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- Inspect the VSW/VSCs channel bottom, side slopes, inflow and outflow points for the presence and note severity of:
    - Trash/debris
    - Surface erosion, rills, gullies and/or loss of topsoil
    - Sinkhole activity
    - Signs of contaminants (e.g. gas, oil, fertilizers)
    - Evidence of burrowing animals.
- Inspect the VSW/VSCs conveyance channel for standing water. Signs that standing water or soil saturation remain in the swale longer than 72 hours after a rain event should be noted;

the presence of hydrophytic vegetation may be an indication of this (not applicable to wet swales where design calls for hydrophytic plants).

- In VSCs, check dams should be inspected:
    - Confirm the design plan shows permanent check dams as part of the SCM; check dams can look similar to temporary ESPC measures.
    - Confirm check dam material, spacing, and height match the design plans.
    - Note any erosion or deterioration of the check dam material.
    - Note any evidence of flow bypassing around, channelizing over or undermining check dams.
    - Check for sediment accumulation on and upslope of the check dams (removal requirements as described above).
    - Check dams should not retain water for more than 72 hours after a rain event. Note any standing water or signs of inadequate infiltration. Hydrophytic plants, particularly upslope of check dams should be noted. These indicate possible infiltration failure and/or a clogged dewatering device (not applicable to wet swales where design calls for hydrophytic plants).
    - Check that the dewatering device (if present) is free from debris and is sized accordingly to the design plans.
- If present, inspect subsurface infiltration trench as described in Section 6.5.
- Inspect all applicable common components as described in Chapter 5 including subsurface outflow structures and outfall pipes which outlet to surface locations.

When completing PTC's inspection app for VSW/VSCs:

- Impermeable liners are inspected under the impermeable liner portion of the app. It should be inspected/commented on when it or possible concerns with it exist.
- The VSW/VSC channel bottom and check dams are inspected as part of the Surface Storage-SCM Floor.
- The end point of the VSW/VSC is inspected under the Primary Outflow portion of the app.
- When a VSW/VSC discharges to an inlet and/or downstream piping network, it should be inspected under the SCM Discharge portion of the app.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

6.11.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.11.1: Maintenance Procedures for VSW and VSC

Frequency	Activity
Three Times per Year	• Prior to mowing, remove litter, trash and debris from swale bottom, sides, check dams, inflow, outflow and surrounding area. • Mow areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow areas indicated to be short meadow to a height of 6 to 10 inches. • Perform mowing when swale is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • Use hand operated equipment around check dams. • In infiltrating swales or where filter media/engineered soils are present, LGP equipment must be used on SCM Floor (channel bottom) (see Section 4.7); do not drive heavy equipment on SCM Floor (channel bottom).
Annually	• Mow vegetated surface indicated to be tall meadow to a height of 8 to 16 inches. • Perform mowing when swale is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • Use hand operated equipment around check dams. • In infiltrating swales or where filter media/engineered soils are present, LGP equipment must be used on SCM Floor (channel bottom) (see Section 4.7); do not drive heavy equipment on SCM Floor (channel bottom). • Remove or treat woody vegetation and undesirable species from swale bottom, check dams (if present) and side slopes. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
As Needed	• Remove sediment from SCM floor (channel) surface of VSW/VSC. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies. • If present, maintain SIT as described in Section 6.5 at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the VSW/VSC specific table (G.1.11).

6.12 Infiltration Berm (IBE)

Figure 6.12.1: Infiltration Berm
(photo c/o: PennDOT)

6.12.1 Description and Overview

An Infiltration Berm (IBE) is a stormwater control measure consisting of a mound of compacted earth or aggregate, covered with topsoil and seeded. It is typically installed along a continuous elevation (contour) on relatively gently sloping sites. IBEs are used to slow stormwater runoff by providing undulations in the land to retain flow, encourage infiltration, and reduce runoff volume and rate for small storms. They are typically low features, less than 24 inches in height. Design guidance encourages locating the crest of the berm to one side rather than the middle to create an asymmetrical section. The infiltrating area is on the upslope side of the berm where stormwater flows are retained. This area should be carefully protected from compaction. During larger storm events, excess flows pond, gently overtop the berm, and discharge (outflow) downslope into a well vegetated area. Some IBEs have a clay layer to prevent retained flows from seeping through the berm.

IBEs are normally covered in turf lawn or short meadow, but may instead be stabilized with dense and diverse tall meadow, trees, shrubs or special SCM plantings. IBEs may be constructed in series along a sloping area, and may also be used to divert stormwater flows to another SCM. IBEs may include turf reinforcement matting to reduce erosion potential. In some instances, a subsurface infiltration trench (SIT) is constructed on the upslope side of an IBE to provide additional infiltration capacity (if a SIT is present also see Section 6.5 for SIT related information).

IBEs can be designed to provide additional multifunctional benefits:

- Landscaping Berms – IBEs constructed to provide landscape screening for adjacent development. The berm height may be significantly larger than traditional IBE to enhance screening in addition to stormwater retention.
- Slope Protection – IBEs constructed to help protect steeply sloping areas from erosion. IBEs divert concentrated discharge from a developed area away from the sloped area. IBEs may be installed in series down the slope to retain the flow and act as a level spreading device to discourage concentrated flows.
- Flow Pathway Creation – IBEs constructed within existing or proposed SCMs to increase stormwater runoff travel times within the SCM to promote a meandering channelized flow.

6.12.2 SCM Components

SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 and related SCMs described in Chapter 6 which may be encountered with this SCM include:

- Access, fencing, and security
- Signage
- Inflow System
- SIT SCM

In addition, an IBE may include the following other components:

- Compacted earth or aggregate
- Topsoil
- Turf lawn or meadow, trees, shrubs or special SCM plantings
- Clay layer
- Turf reinforcement matting

Figures 6.12.2 and 6.12.3 illustrate the common components of a typical IBE. Runoff sheet flowing down the slope is intercepted by the IBE. Smaller rainfall events are completely retained by the IBE; during larger events, some flow will overtop the berm and continue downslope.

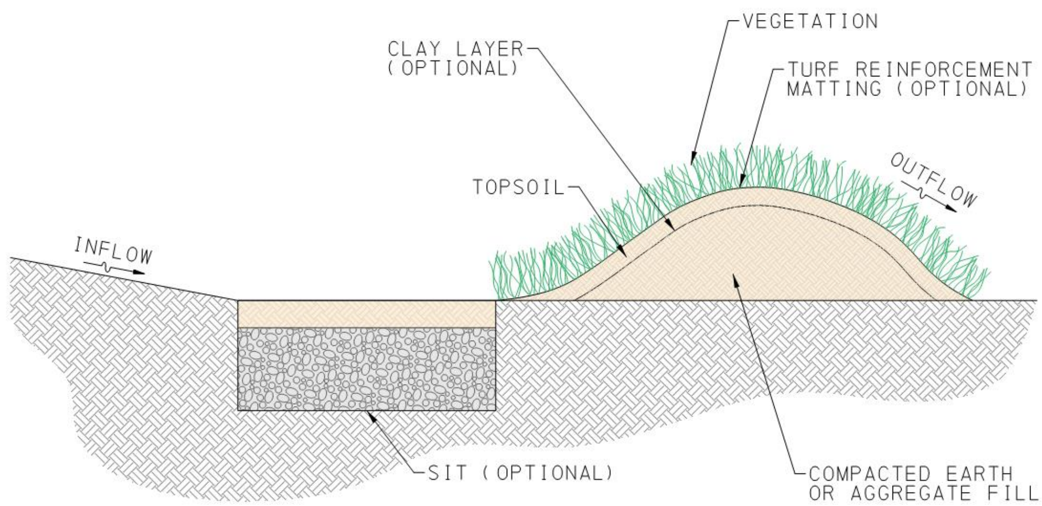


Figure 6.12.2: IBE - Common Components

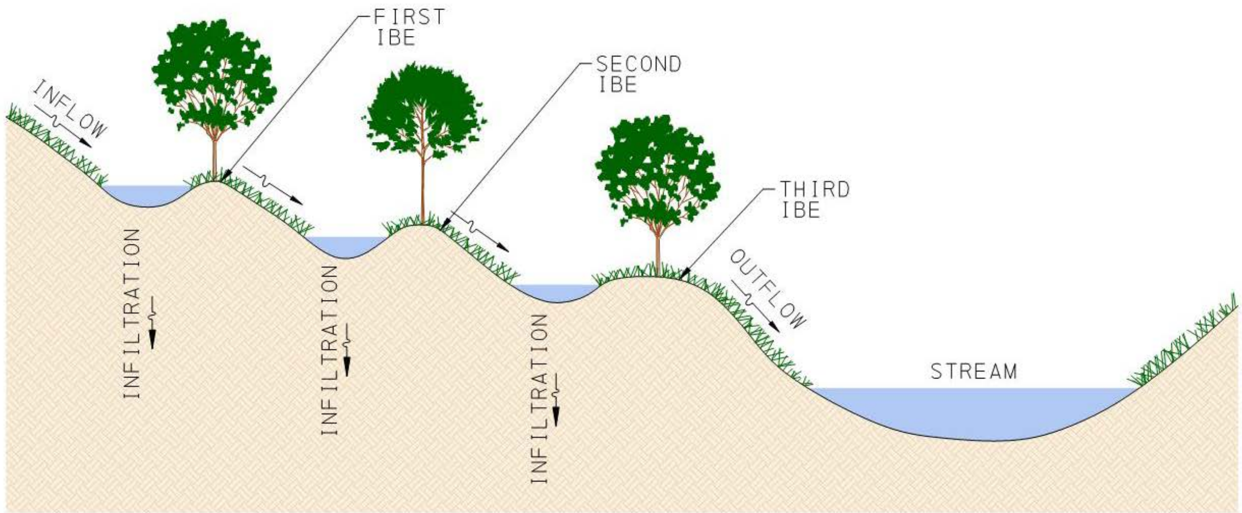


Figure 6.12.3: IBE in Series

6.12.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of an IBE should focus primarily on its functional areas: inflow, vegetation, infiltration and outflow. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Confirm surface vegetation upslope, on and downslope of IBE is in good condition with at least 80% coverage throughout inflow, storage and outflow areas and no bare patches are observed in 10% of a localized area. Note the presence of invasive/undesirable species.
- Verify that the vegetation is being mowed at the proper frequency to maintain desired maximum heights and appearance (per Table 3.5.2). Note if more frequent mowing is required. Shrubs and trees will require pruning and thinning maintenance as needed based on inspection recommendations.
- Sediment accumulation should be removed when it reaches the depth indicated by the cleanout marker. Where a cleanout marker is not present, sediment should be removed when it reaches 2 inches in depth or at any time it affects infiltration or flow through the IBE. In cases of excessive sedimentation, the drainage area should be inspected for sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- Inspect upslope area of IBE for standing water. Signs that standing water or soil saturation remain in the IBE longer than 72 hours after a rain event should be noted; the presence of hydrophytic vegetation may be an indication of this.
- Inspect the inflow areas, IBE's and outflow areas for the presence and note severity of:
  - Trash/debris
  - Surface erosion, rills, gullies and/or loss of top soil
  - Sinkhole activity
  - Signs of contaminants (e.g. gas, oil, fertilizers)
  - Evidence of burrowing animals.

- If present, inspect condition of turf reinforcement matting checking for signs of deterioration, erosion or other concerns.
- If present, inspect for exposure of clay liner. Ensure topsoil and vegetation are present and clay liner is not exposed. Trees and shrubs should not be present on clay lined areas.
- If present, inspect subsurface infiltration trench as described in Section 6.5.
- Inspect all applicable common components as described in Chapter 5.

When completing PTC's inspection app for IBEs:

- Impermeable/clay liners are inspected under the impermeable liner portion of the app. It should be inspected/commented on when it or possible concerns with it exist.
- Inspect the upslope ponding area (to an elevation equivalent to the berm height) and the upslope berm face of the IBE under SCM Surface-SCM Floor.
- Inspect the downslope face of the IBE (sheet flow) as the Primary Outflow.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

6.12.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.12.1: Maintenance Procedures for IBE

Frequency	Activity
Three times per year	• Prior to mowing, remove litter, trash, and debris from IBE surface, inflow/outflow areas and surrounding area. • Mow Grassed IBE areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow Grassed IBE areas indicated to be short meadow to a height of 6 to 10 inches. • Perform mowing when IBE is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • Use LGP equipment in upslope ponding areas and on berm (SCM Floor) (see Section 4.7); do not drive heavy equipment on SCM Floor. • Use appropriately sized mowers and procedures to avoid scalping top of IBE vegetation.
Annually	• Landscaped (non-grassed) IBEs: Remove or treat weeds and undesirable plants; prune shrubs and trees to maintain appearance and functionality. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. • Mow areas of SCM indicated to be tall meadow to a height of 8 to 16 inches. • Perform mowing when IBE is completely dry. • Do not mow areas planted with no-mow landscaping such as shrubs. • Use LGP equipment in upslope ponding areas and on berm (SCM Floor) (see Section 4.7); do not drive heavy equipment on SCM Floor. • Use appropriately sized mowers and procedures to avoid scalping top of IBE vegetation.
As needed	• Replace diseased or dead plants per plan; if specific species mortality is reoccurring, assess cause and replace with appropriate alternate species. • Remove sediment from SCM surface. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies. • If present, maintain SIT as described in Section 6.5 at frequencies indicated.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the IBE specific table (G.1.12).

6.13 Manufactured Treatment Device (MTD)

Inlet with Sump/Hood

Hydrodynamic Separator

Figure 6.13.1: Manufactured Treatment Devices

6.13.1 Description and Overview

A Manufactured Treatment Device (MTD) is a stormwater control measure which consists of prefabricated proprietary products used in-line with a storm sewer system to provide water quality (WQ) treatment. MTDs, also known as water quality "devices," "inlets," or "inserts," are subsurface systems that may be constructed as a self-contained structure or may be inserted into a storm inlet or manhole. These devices can function as a standalone SCM or can be used as pretreatment for other SCMs. MTDs are typically located along shoulders, pull-off areas, parking lots, and maintenance lots. Overflow structures or flow splitters can be constructed upstream of the MTD to divert larger flows away from the MTD. Outflow structures can be incorporated at the outflow of the MTD to regulate release rates. Since MTDs are proprietary products, each device is designed differently based on the targeted pollutants and flow capacity. There are several general categories of MTDs; within each the device will vary from manufacturer to manufacturer. The general categories include the following:

Filter Inserts: An insert in the form of a cartridge, tray, basket, or bag is inserted into a standard inlet box to collect sediment. Typically attached to the inlet grate, the insert functions similarly to silt sacks that are commonly used during construction. Filter inserts treat surface runoff entering the inlet.

Inlets with Sump/hood: Inlets with sumps/hoods are inlets modified to incorporate stormwater pretreatment capabilities in the inlet box. They consist of a standard inlet box and grate as described under Inflow Systems (Section 5.4) with a sump area below the outlet pipe providing storage volume for sediment and debris to settle out of the collected runoff. In conjunction with the sump storage, a hood, also called a trap, is attached over the outflow pipe to prevent floatables or other debris from escaping downstream or clogging the outflow pipe. See the top photo of Figure 6.13.1.

Hydrodynamic Separators: Pictured in the bottom photo of Figure 6.13.1, hydrodynamic separators are flow through devices typically in manholes that use a series of baffle plates, vortex devices, tube settlers or inclined plates to settle solids from flow. They can be inserts or be constructed as a single concrete structure with the separators built into the inlet/manhole box and an outflow structure in the form of a baffle wall with orifice/weirs at the outflow. They frequently contain a cylindrical area where incoming flows travel in a spiral path around the perimeter causing heavy particles to settle out of the water.

Oil/Water Separators: An oil/water separator is a concrete structure that contains a series of baffles and walls to remove sediment, solids, and trap oil. The separator mechanically separates oil from the water by allowing it to rise to the surface in a collection area while sediment settles to the bottom. They are used in areas like vehicle service yards where stormwater is anticipated to have high oil concentrations.

6.13.2 SCM Components

SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 which may be encountered with this SCM include:

- Access, Fencing, Security
- Signage
- Inflow System
- Structures & Appurtenances

In addition, MTDs may include the following other components:

- Grate/cover

- Concrete box
- Hood (trap)
- Overflow pipe
- Baffle walls
- Grit chambers

Figure 6.13.2 illustrates the common components of an inlet with a hood type MTD. Figure 6.13.3 illustrates the common components of a hydrodynamic separator type of MTD. Runoff enters the MTD through an inflow system. Runoff is temporarily stored in the inlet/manhole and is conveyed through the components of the MTD. Each type of MTD is designed uniquely to improve water quality and/or reduce flows. The runoff exits the MTD through an outflow system that typically discharges to a downstream drainage system. Other types of MTDs will involve different components. Refer to the specific manufacture information for each MTD.

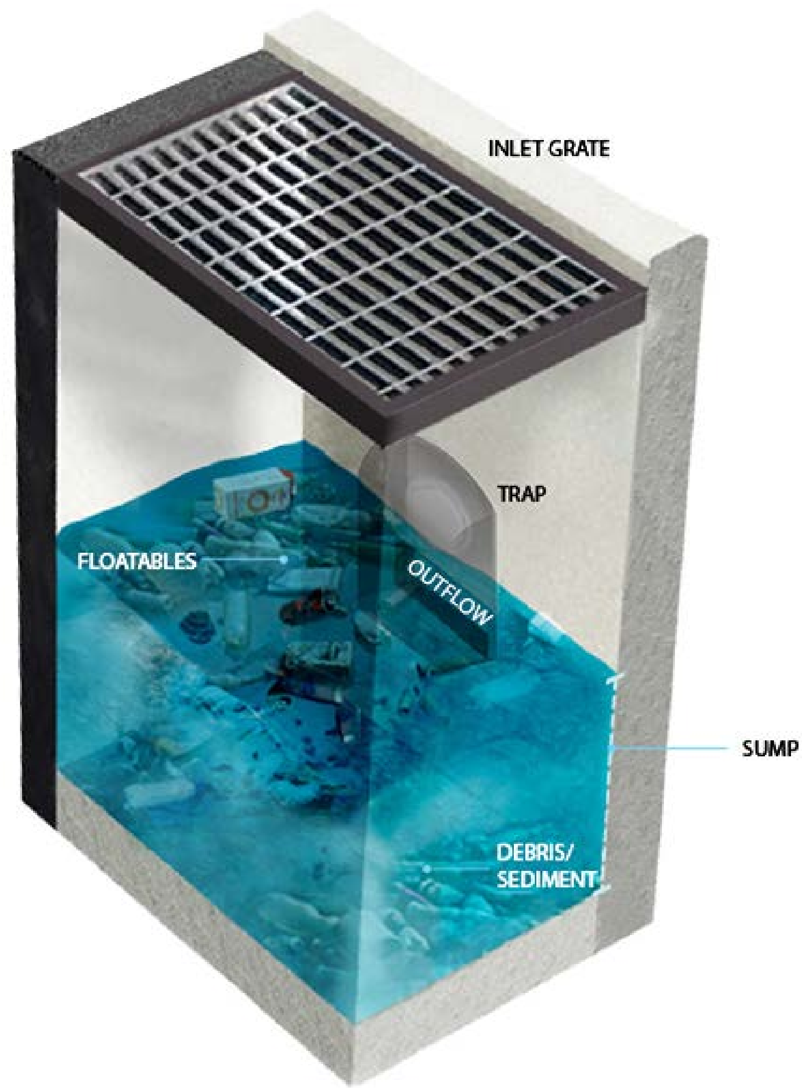
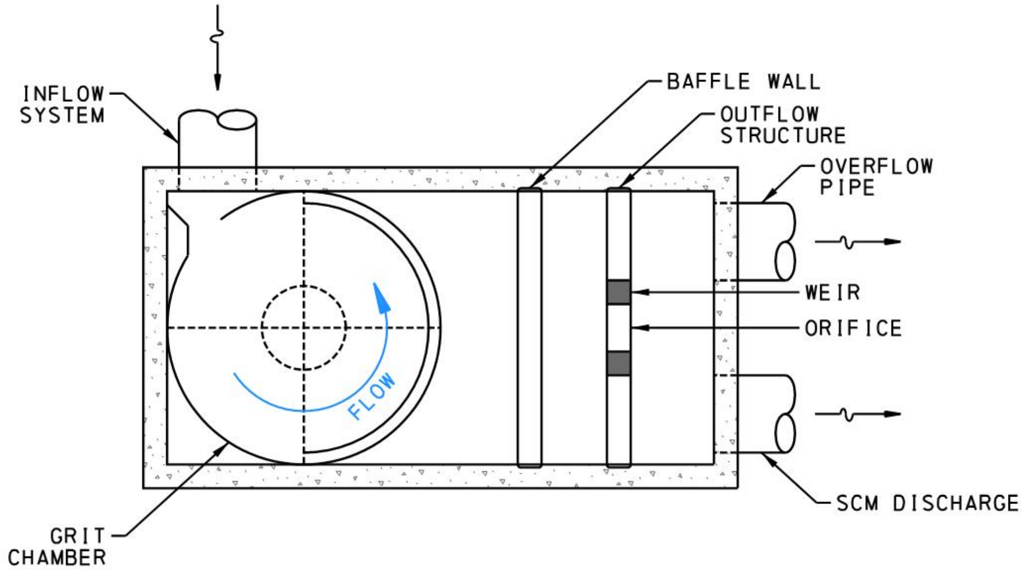
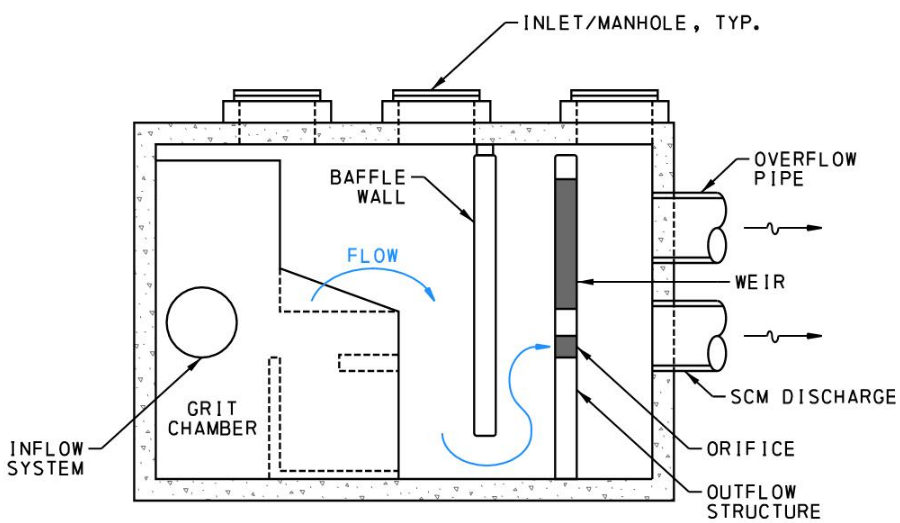


Figure 6.13.2: Manufactured Treatment Device, Inlet with Sump/Hood - Common Elements
(photo c/o: Philadelphia Water Department, Stormwater Management Guidance Manual)



Plan View



Section View

Figure 6.13.3: Manufactured Treatment Device, Hydrodynamic Separator - Common Elements

6.13.3 Key Inspection Considerations

Under PTC's program, MTD's may utilize alternative inspection forms in lieu of PTC's standardize electronic inspection software program to more thoroughly document the SCM where appropriate. In addition to the general inspection procedures described in Chapter 3, inspections of an MTD should focus primarily on its key areas: inflow, treatment area, and outflow structures. Specifically:

- Entry into MTD or any confined space is prohibited without proper training and safety measures in place. Perform visual inspections from the surface for underground SCMs. If signs indicate the system may not be functioning properly or if sufficient data cannot be obtained from the surface, recommendations for video inspection, confined space entry or other means of inspection should be made.

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect area surrounding and above MTD for trash/debris, surface erosion, and sinkhole activity.
- Inspect areas above MTD for signs of ground settlement or subsidence and any pavement cracking or fractures which may indicate structural failure of the underlying MTD.
- Review manufacturer required sediment, oil and other cleanout requirements, indicating when system requires cleanout based on system specific criteria. In the absence of manufacture specified requirements, sediment removal should occur when the debris is half of the depth of the storage area. In inlets with sump/hoods, the storage area should be measured from the bottom of the hood to the bottom of the inlet box.
- Note any signs of obstructed water flow through the system.
- Inspect water level in MTD chambers. High water levels during periods of dry weather can indicate the SCM is malfunctioning.
- Inspect all MTD components including access ladders and concrete vault for structural integrity, signs of damage and deterioration.
- Inflow points, MTD system and outflow points should be visually inspected for any obstructions or structural deformities such as the following:
    - Organic material
    - Sediment
    - Trash/debris
    - Clogged Openings
    - Missing components
    - Holes/fractures

  For MTD's directly collecting surface runoff, stormwater runoff should be allowed to flow freely into the inflow points and through the system. Paving surrounding the inlet structures should be flush with the structure; not impeding inflow. Vegetation growth should not impede stormwater from flowing into the inlet points. If excessive sedimentation is occurring on the surface surrounding the inlet inflow/outflow points or within the MTD, check the drainage area for bare soil or other possible sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- Inspect all applicable common components as described in Chapter 5.

6.13.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.13.1: Maintenance Procedures for MTDs

Frequency	Activity
Monthly*	• Remove trash and debris at all inflow and outflow structures, and from MTD surrounding area that is blocking or impeding flow of water through the system.
Three times per year*	• Remove sediment accumulation from MTD per guidelines of the manufacturer, if applicable. • Remove sediment, trash, and debris buildup from the sump/collection areas of the MTD using a vacuum truck or other appropriate method. • Remove vegetation impeding flow into the inlet grate. • Remove animal carcasses from vicinity of inlet and within inlet boxes.
As needed	• Maintain MTD in accordance with manufacturer's recommendations. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

* Follow manufacturer recommended maintenance requirements. Only in the absence of manufacture provided requirements should the above listed activities be followed.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables are included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the MTD specific table (G.1.13).

6.14 Level Spreader Outfall and Flow Dispersion (LSO, FDF, FDV)


Figure 6.14.1: Level Spreader, Surface Type
(photo on left c/o NCDOT HSP-2010-01; photo of right c/o NCSU)

6.14.1 Description and Overview

Level spreader outfalls (LSOs) are flow discharge measures designed to redistribute concentrated stormwater flow into sheet flow. By doing so, an LSO may also promote infiltration and improved water quality. The top of LSOs must be level to ensure adequate flow distribution and discourage channelization. Concentrated flow enters the LSO where it is slowed and distributed throughout a long shallow trench or behind a low berm. Water fills the storage area and then spills uniformly over the berm or trench edge.

LSOs can be used as a standalone outfall feature or in combination with another SCM. An LSO used as a standalone feature does not provide significant stormwater control benefits. However, when installed upslope of a protected vegetated area, the LSO combined with the sheet flow across the vegetated area functions as an SCM. An LSO installed upslope of an existing forested area is called a flow dispersion, forest/buffer (FDF); upslope of an existing grassed area it is called a flow dispersion, vegetated filter strip (FDV).

To protect and ensure the future functionality of the system, the FDF and FDV must be included in PTC's right-of-way or easements. In the absence of a natural FDV or FDF, a VFS or VSS can be constructed to provide the dispersion area. Follow the inspection and maintenance procedures described in the VFS/VSS Section (6.9) of this manual for care of the FDF and FDV areas. LSOs can also be used at the inflow point into basin type SCMs to spread concentrated flows evenly across the basin floor.

The two main types of LSOs are surface discharging level spreaders and subsurface level spreaders.

Surface discharging LSOs look like a long linear ditch or trough with concrete curb edging or a similar structural edge that creates the downstream weir or lip of the structure that water flows over. Stormwater flows into the trough and fills up to the top, then gently overtops the weir as sheet flow onto the adjacent area, which may contain Turf Reinforcement Mat (TRM, refer to Section 5.11 Outfall Protection). The trough bottom may be gravel, paved or vegetated with low growth lawn grass-type cover.

Subsurface LSOs discharge via a perforated pipe surrounded by gravel bedding material and look like a long, narrow gravel strip on the ground surface. Stormwater enters the LSO and is distributed over the length of the structure in a perforated pipe surrounded in gravel. Similar to a surface LSO, water flows out of the pipe and into the surrounding gravel, filling up the gravel until it reaches the surface and is discharged as sheet flow. Typically, surface cleanouts are connected to the perforated pipe allowing subsurface inspection and maintenance of the perforated piping.

In both types, it is critical that the LSO be constructed along a constant elevation (level) to function effectively and prevent discharging concentrated flow. At times, a flow splitter is installed upstream of the LSO to regulate the maximum flow to the area to prevent erosive flow conditions.

6.14.2 SCM Components

SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 and related SCMs described in Chapter 6 which may be encountered with this SCM include:

- Access, Fencing, and Security
- Signage
- Inflow System
- Flow Splitter
- Cleanouts, observation wells (Underdrain Section 5.7)
- Structures and Appurtenances
- VFS/VSS SCM
- Basin type SCM

In addition, LSOs in combination with a FDF, FDV, VFS or VSS system may include the following other components:

- Bypass swale/pipe
- Concrete curb/lip
- Vegetated/concrete trough
- TRM
- Gravel
- Perforated pipe
- Geotextile
- Vegetative Shrub, woody or special SCM plantings
- Turf lawn or meadow
- Sheet flow
- Receiving water body

Figures 6.14.2 and 6.14.3 illustrate the typical components of a surface and subsurface LSO in combination with a FDF, FDV, VFS or VSS system.

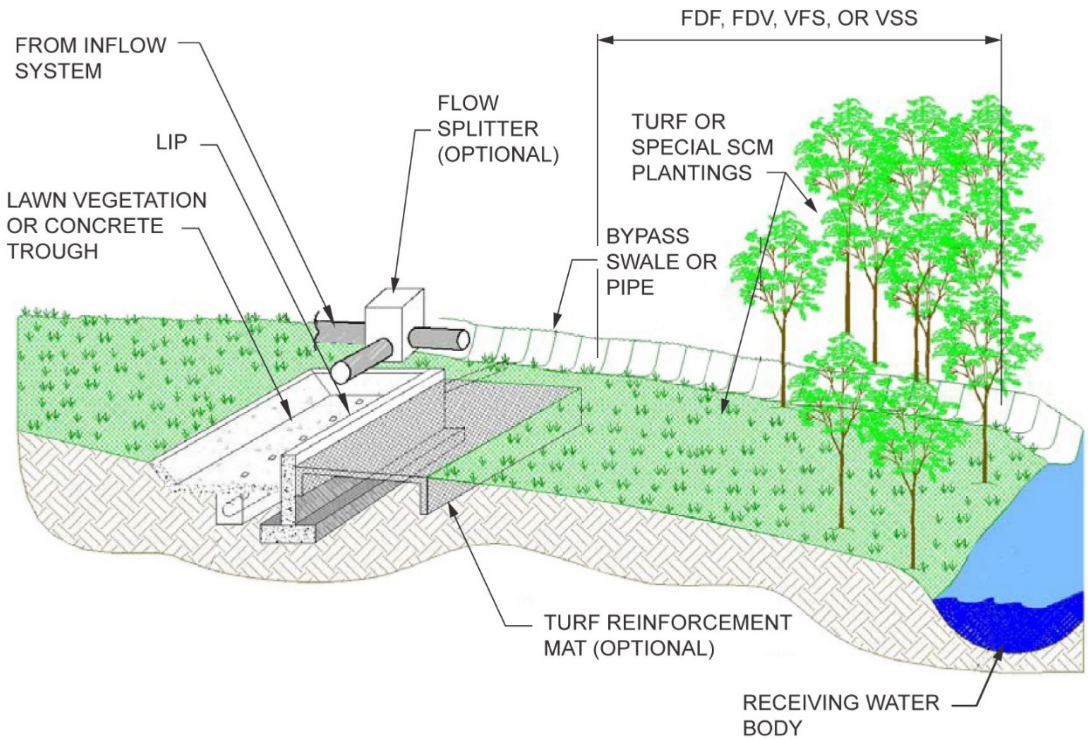


Figure 6.14.2: Surface LSO - Common Elements
(Adapted from NCDOT-HSP-2010-01)

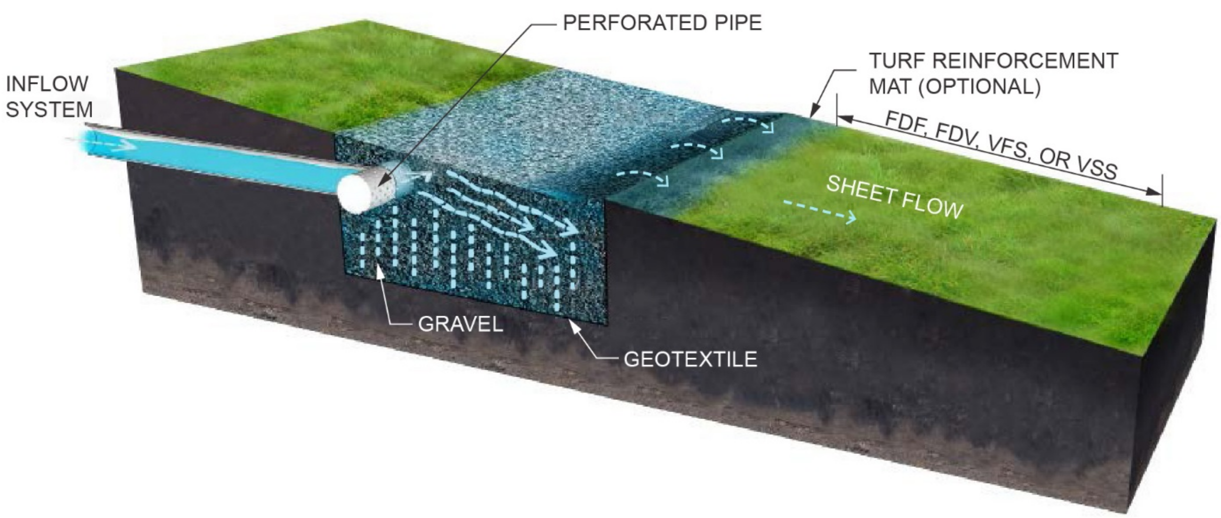


Figure 6.14.3: Subsurface LSO - Common Elements
(Adapted from Philadelphia Water Department, Stormwater Management Guidance Manual)

6.14.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of an LSO should focus primarily on its key functional areas: even distribution of inflow, structural stability, and stability of outflow and downstream surfaces. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect SCM and surrounding area for trash and debris.
- Check for sediment accumulation in LSO. Sediment should be removed before it interferes with the level spreader's ability to distribute flow evenly. Surface LSOs should have sediment removed when buildup is 25% of capacity of the spreading trough. Subsurface LSOs should be checked for sediment by opening cleanouts. Sediment should be removed from the perforated pipe when it reaches 25% capacity. In cases of excessive sedimentation, the drainage area should be inspected for sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- Inspect for signs of uneven flow dispersion, including erosion rills/gullies forming at the lip, around the edges, or near the downslope edge of the LSO, or evidence that the downslope edge of the LSO is not a consistent elevation (level).
- Check the structure for signs of uneven settlement potentially causing an uneven lip. For subsurface LSO, check cleanouts (if present) for signs of standing water and sediment build-up.
- Confirm downslope stabilization are in place and sound. Look for undesirable vegetation, including invasive and hydrophytic species (outside of wetlands) and any root systems that could impact the LSO functionality.
- Confirm the downslope area is free of obstructions and features that may facilitate re-concentration of flow.
- Inspect all applicable common components as described in Chapter 5.

When an LSO is associated with an FDF, FDV, VFS, or VSS or as part of an inflow or outflow system to another SCM type, it should be inventoried and assessed as a standalone SCM receiving its own inspection.

When completing PTC's inspection app for LSOs:

- Inspect the downslope edge (lip) of the LSO (sheet flow) under Primary Outflow. When the LSO is an inflow to another SCM type, inspect the immediate lip under the LSO and the remainder under the other SCM. When there is no downslope SCM, inspect the entire length of reinforced turf at a minimum 10 feet (remaining within the right of way).
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

6.14.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.14.1: Maintenance Procedures for LSO

Frequency	Activity
Three times per year	• Prior to mowing, remove litter, trash, debris, undesirable vegetation from LSO surface, inflow area, outflow area, and surrounding area. • Mow adjacent areas indicated to be lawn to a height of 2 to 4 inches. Increase mow frequency as needed to maintain maximum height of 6 inches. • Mow adjacent areas indicated to be short meadow to a height of 6 to 10 inches. • Perform mowing operations when SCM is completely dry. • LGP equipment must be used on SCM Floor and areas downslope of the LSO (see Section 4.7); do not drive heavy equipment on SCM Floor nor areas downslope of the LSO.
Annually	• Remove or treat undesirable vegetation from LSO surface, inflow area, outflow area, and surrounding area. Undesirable vegetation includes woody or invasive vegetation immediately downslope (approximately 10 feet) of the LSO. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. • Mow adjacent areas indicated to be tall meadow to a height of 8 to 16 inches. • Perform mowing operations when SCM is completely dry. • LGP equipment must be used on SCM Floor and areas downslope of the LSO (see Section 4.7); do not drive heavy equipment on SCM Floor nor areas downslope of the LSO. • Remove sediment accumulation and restore level surface of LSO.
As needed	• Remove sediment from SCM surface. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies. • Maintain FDF and FDV areas as described in Section 6.17 following FPR recommendations for FDF and LRM recommendations for FDV.

Notes:

1. All vegetation, trash, debris, liquids and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the LSO specific table (G.1.14). The Self Preserving SCMs specific table (G.1.9) may be used for general guidance for FDF and FDV areas. Reference FPR recommendations for FDF. Reference LRM recommendations for FDV. Consult a licensed professional for additional guidance.

6.15 Pervious Pavement: Asphalt (PPA), Concrete (PPC), Pavers (PPP)

Figure 6.15.1: Pervious Pavement Pavers (PPP)
(photo c/o The Philadelphia Water Department, Stormwater Management Guidance Manual)

6.15.1 Description and Overview

Pervious pavement consists of a permeable surface course underlain by a uniformly-graded coarse aggregate (stone) bed, which provides temporary storage for stormwater control and promotes infiltration. The surface course may consist of pervious asphalt (PPA), pervious concrete (PPC), or various pervious pavers (PPP). Pervious pavement, unlike conventional pavement surfaces, allows runoff to infiltrate through the SCM where it is temporarily stored and/or infiltrated into and through the void spaces of the underlying stone bed.

PPA and PPC look similar to standard asphalt and concrete surfaces, respectively; however, the material mixes utilize little to no fine-grained materials, creating a finished structure that is more porous than traditional mixes. This allows stormwater to infiltrate quickly through to the underlying aggregate.

There are numerous types of PPPs with varying appearance and functionality. Many are similar in appearance to brick pavers. Some of these brick paver-looking applications utilize pavers constructed from pervious pavement, allowing infiltration through the bricks. Others use interlocking impermeable brick pavers laid in place with a gap in between the bricks filled with coarse grained materials that allows water to infiltrate between the area. Other PPPs utilize open-cell paving grids that look like lattice work with the open grid areas filled with granular material or lawn grass where stormwater infiltrates into the spaces between the lattice material.

In PPA, PPC, and PPP, stormwater enters the system from direct rainfall onto the pavement surface or via curb cuts or sheet flow from adjacent areas. The flows infiltrate through the porous surface material and/or the gaps between the pavers into the underlying aggregate bed. This bed of the pervious pavement systems allows for stormwater storage and/or infiltration into the subgrade soils. It can be constructed with various layers of stone diameter sizes. Where the pavement elevation varies over the surface, the subsurface stone storage area may be terraced or include subsurface compacted earthen berms creating subsurface ponding areas to promote infiltration. Geotextile fabric is used to separate the subgrade soil/stone and the stone/permeable pavement layers. Some systems may include an underdrain throughout the aggregate to carry excess flows from the SCM. Underdrains may convey runoff to an outflow structure that is housed in an inlet/manhole. A stone trench may be included along the border to the pavement to collect any excess surface flows. Outflow from the SCM may be tied directly to storm sewer piping or may discharge to surface channels.

To allow for monitoring of the water levels in the aggregate bed, some designs incorporate observation wells in the storage areas. In systems with underdrains, underdrain cleanouts also function as an observation well.

Pervious pavement is not commonly used on PTC's roadways; however, it can be installed on driveways, parking lots and sidewalks. It is not recommended for areas with heavy vehicle turning movements (i.e., parking lot circulation lanes) as the structure of the pavement can be comprised and lead to accelerated deterioration of the pavement section. Pervious pavement can be found at visitor centers and other PTC-owned buildings and parking lots.

6.15.2 SCM Components

SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 which may be encountered with this SCM include:

- Access, Fencing, Security
- Signage
- Inflow System
- Underdrain (optiona), cleanouts, observation wells
- Outflow Structure
- Structures & Appurtenances
- Outfall Protection

In addition, PPA/PPC/PPP may include the following:

- Pervious surface (wearing/binder course, pavers)
- Geotextile
- Coarse aggregate (stone)
- Subsurface compacted earthen berm (optional)

Figure 6.15.2 illustrates the common elements of a typical PPA, PPC and PPP. Runoff enters the system through sheet flow or direct rainfall. Runoff infiltrates into the porous surface and stores temporarily before discharging to the surrounding soil or to an underdrain and outflow structure.

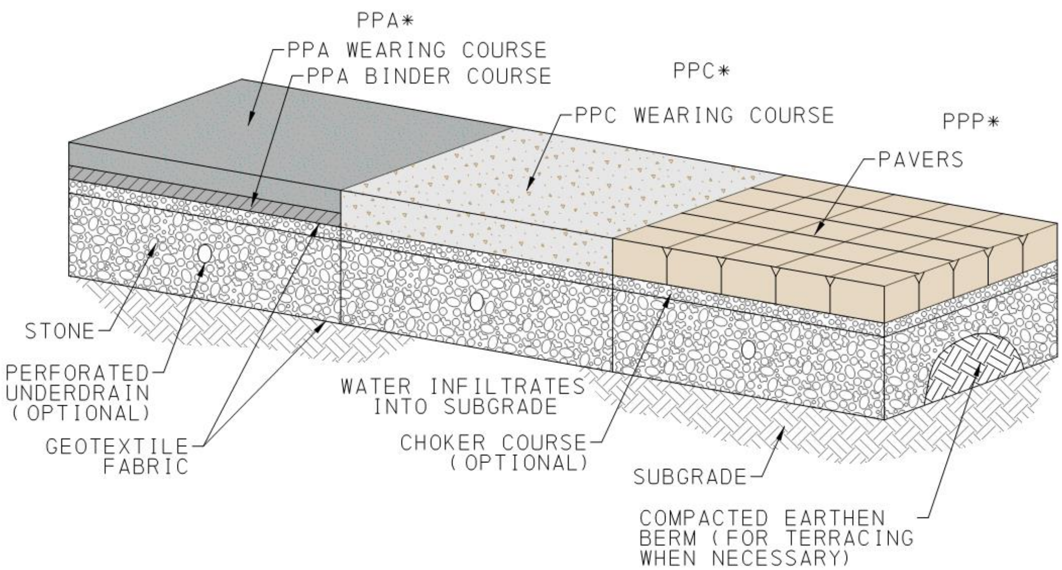


Figure 6.15.2: Pervious Pavement- Asphalt, Concrete and Pavers - Common Elements

6.15.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, inspections of PPA/PPC/PPP should focus primarily on its functional areas: inflow, storage system, and outflow structures. Specifically:

- Entry into any confined space is prohibited without proper training and safety measures in place. Perform visual inspections from the surface for underground SCMs. If signs indicate the system may not be functioning properly or if sufficient data cannot be obtained from the surface, recommendations for video inspection, confined space entry or other means of inspection should be made.
- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect pervious surface and surrounding area for trash/debris, surface erosion, and sinkhole activity.
- Inspect pervious surface for any pavement cracking or fractures, paver damage or missing pavers. Loss of aggregate material from between pavers greater than ½ inch in depth should be noted for repair. Check for surface settlement that inhibits infiltration.
- Inspect pervious pavement surface for signs of sediment build up and clogging. Sediment accumulation covering 10% or more of the surface area requires removal. Moss growth should not inhibit infiltration or cause a slip hazard. In cases of excessive sedimentation, the drainage area should be inspected for sediment sources to the extent feasible. Recommendations for additional investigation should be made if required.
- Pour water onto the surface in several locations to informally assess whether infiltration is adequate; failure to infiltrate should be noted. The formation of an oily sheen when water is applied to the surface indicates surface cleaning is needed.

- Inspect for signs of inappropriate use of sealant treatments (i.e., blacktop sealant), application of sand/cinder winter maintenance material (salt is acceptable), and soil/mulch stockpiling on the surface of the pervious pavement.
- Inspect observation wells and cleanouts for water levels for signs that standing water remains in the system longer than 72 hours after a rain event. Prolonged standing water suggests the stone bed or geotextile may be clogged with silt/debris or the subsurface infiltration is inadequate.
- Note levels of sediment in the observation wells/cleanouts.
- Inspect observation well/cleanout covers for functionality and damage.
- If present, inspect stone trench bordering pervious pavement in accordance with SIT inspections as described in Section 6.5.
- Inspect surface vegetation at surface inflow and outflow locations (where applicable) and within PPP grid systems which are planted with grass. Adjacent vegetation should not exceed 12 inches nor obstruct water flow at inflow areas; PPA surface vegetation should not exceed 5 inches in height. Vegetated areas should be in good condition with at least 70% coverage.
- Pervious pavement systems designed with outflow structures and outfall pipes that daylight should be visually inspected along with all applicable common components as described in Chapter 5.

When completing PTC's inspection app for PPA/PPC/PPP:

- Inspect the entire surface of the PPA/PPC/PPP under SCM Surface-SCM Floor.
- The Principal Outflow should be considered the concrete structure (if present) or pipe entrance point where the primary outflows leave the PPA/PPC/PPP.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

6.15.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.15.1: Maintenance Procedures for PPA, PPC, and PPP

Frequency	Activity
Monthly, April to Oct	• Mow PPPs with surfaces indicated to be lawn to a height of 2 to 4 inches; adjust mowing frequency as needed to maintain a maximum height of 6 inches. Remove surface cuttings.
Three times per year	• Remove sediment, trash, and debris accumulation from the PPA/PPC/PPP surface and surrounding area. • Unless otherwise specified by manufacture recommendations, vacuum surface with regenerative air sweeper or commercial vacuum sweeper. When vacuuming PPP, adjust suction to remove sediment without uptake of aggregate from paver joints. Do not pressure wash surface.
As needed	• Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables are included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the Pervious Pavement specific table (G.1.15).

6.16 Regenerative Step Pool (RSP)

Figure 6.16.1. Regenerative Step Pool (newly constructed; vegetative not fully established)
(photo c/o Center for Watershed Protection pilot regenerative step pool project in Lancaster County)

6.16.1 Description and Overview

Regenerative Step Pools (RSPs) are SCMs comprised of a series of alternating shallow constructed riffles, cascades and pools that mimic a natural stream environment. Similar to VSW/VSCs, RSPs promote infiltration and filter pollutants and sediments while conveying stormwater runoff. The RSPs are typically located between a stormwater system outfall and the receiving stream. These systems are common on steep slopes or are often retrofitted from eroded channels and designed to be blended into the existing landscape, typically under woodland canopies. RSPs may be situated adjacent to or through a riparian buffer or wetlands, with the RSP conveying low flows and the adjacent buffer/wetland carrying high flows.

Riffle sections consist of a reinforced, sloped rock section that discharges to the pool section, which consists of flat shallow ponded areas. The pool sections consist of infiltrating/filtrating sand and woodchip beds that may incorporate hydrophilic types of special SCM planting vegetation and standing water if within a wetland system.

A variation on RSP design includes a cascade section followed by a steep rock cascade section, which then leads into a series of three successive ponds with the same bottom elevation separated by rock/cobble weirs.

6.16.2 SCM Components

SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 which may be encountered with this SCM include:

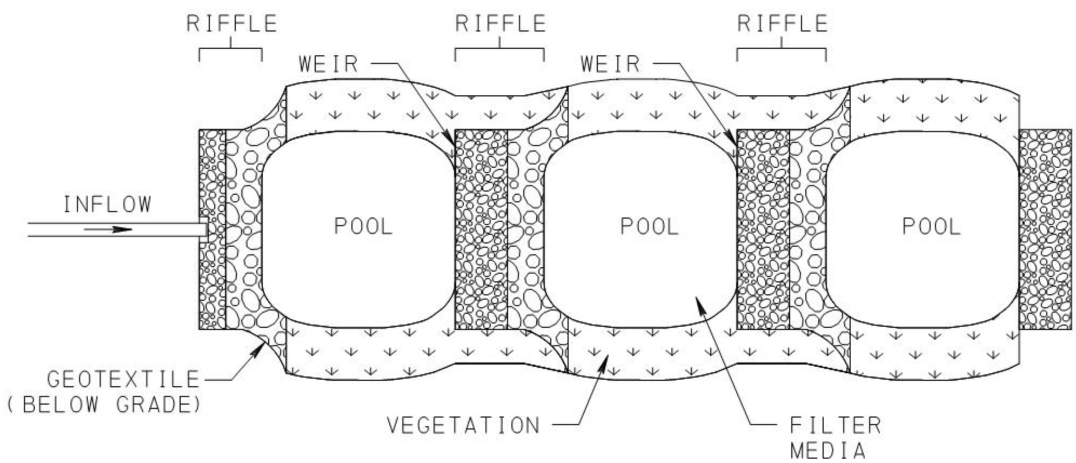
- Access, Fencing, and Security

- Signage
- Inflow System
- Outfall Protection

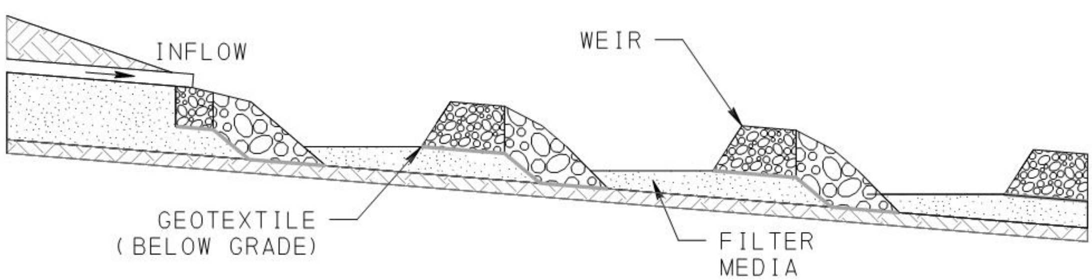
In addition, RSPs may include the following other components:

- Filter media
- Vegetation, special SCM plantings
- Geotextile
- Pools
- Weir and riffle sections

Figure 6.16.2 illustrates the common elements and subcomponents of a typical RSP.



Plan View



Section View

Figure 6.16.2. Regenerative Step Pool - Common Elements

6.16.3 Key Inspection Considerations

In addition to the general inspection procedures described in Chapter 3, the key functional items that need to be confirmed in an RSP inspection are inflow, filtration, infiltration, and overflow. Specifically:

- Confirm the design drainage area is reaching the SCM. Check for indications that the plan depicted upstream piping/channel network is reaching the SCM. Note significant changes in contributing area land use coverages (vegetation versus paved).
- Inspect SCM and surrounding area for trash and debris.
- Vegetation, if present in design plan, should be inspected to be in good condition with no weeds or invasive/undesirable species. If vegetation is present and not in design plans, all vegetation within SCM floor should be removed.
- Presence of hydrophytic vegetation, if not in plans, is an indication of poor drainage and corrective maintenance should be prescribed.
- The filtration/infiltration pool systems can be susceptible to clogging by sediment. If the infiltration capacity is diminished such that the design ponding depth is not reached after 72 hours of a storm event, soil probing within the pools should be performed to assess depth of sediment and need for removal/replacement. Where sediment is causing diminished infiltration capacity, recommendations for sediment removal and replacement of new material should be made.
- Some sediment deposition is expected in the pools. Removal of accumulated sediment should be limited to when it threatens the structural integrity of the system or inhibits filtration/infiltration. Structural integrity is compromised when sediment build-up in upstream pools causes scour to undercut boulder weirs in downstream pools.
- For RSPs with planting in the bottom of the pools, if sediment accumulation in ponds exceed 6 inches in the first year of functioning, place an additional layer of compost and replant the pool bottoms. Assess and note source of sediment.
- All areas within and surrounding the SCM should be checked for evidence of erosion. This may include soil erosion, sediment displacement within the pool, or displaced cobbles or rock within the RSP.
- Weirs should be generally free of obstructions and in good structural condition.
- Inspect all applicable common components as described in Chapter 5.

When completing PTC's inspection app for RSPs:

- The RSP channel, weirs and riffles are inspected as part of the Surface Storage- SCM Floor.
- The end point of the RSP is inspected under the Primary Outflow portion of the app.
- When a RSP discharges to an inlet and/or downstream piping network, it should be inspected under the SCM Discharge portion of the app.
- Drainage area concerns such as land use changes or unanticipated inflow amounts should be noted in the overall comment section completed on the last page of the inspection app.

6.16.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.16.1 Maintenance Procedures for RSP

Frequency	Activity
Annually	• Remove or treat undesirable vegetation; prune shrubs and trees to maintain appearance and functionality. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. • Remove litter, trash, and debris from SCM surface, side slopes, inflow and outflow points, structures, and surrounding area.
As needed	• Replace diseased or dead plants per plan; if specific species mortality is reoccurring, assess cause and replace with appropriate alternate species. • Remove sediment from SCM floor surface. • Maintain applicable common components as described in Chapter 5 at the indicated frequencies.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

2. Do not enter manholes, inlets, or any structure meeting the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the RSP specific table (G.1.16).

6.17 Self Preserving SCMs:

Forest Preservation (FPR);
Landscape Restoration Meadow (LRM);
Reforestation/Tree Plantings (RTP);
Riparian Buffer Enhancement(RBE); Riparian Buffer Offset (RBO);
Soil Amendment Restoration (SAR);
Stream Restoration (SRE); Stream Stabilization (SST)

Riparian Buffer

Stream Restoration- Cross Vane Structures
Figure 6.17.1: Self-Preserving SCMs

6.17.1 Description and Overview

There are some SCM types that have a self-preserving nature, resulting in minimal need for regular maintenance and inspection. As introduced in Section 1.3, once construction is complete and initial vegetation establishment occurs, these SCMs should not require extraordinary maintenance or inspections to properly function. These self-preserving SCMs must be included in the SCM Inventory for tracking and protection purposes. While they are subject to triennial inspections like other SCMs, the lack of structural components results in less in-depth inspections in comparison to structural SCMs. A brief overview of each of these is presented to provide a functional understanding and aid in identification.

Forest Preservation (FPR) is accomplished during the project design phase by minimizing required forest clearing by adjusting project layout and limiting construction operations to only those areas that are essential. Well-planned alignments and construction staging activities can reduce the need to disturb wooded areas outside of the construction footprint. This non-structural SCM can be applied to almost every project by placing a protective easement on the FPR area.

Landscape Restoration Meadow (LRM) and Reforestation/Tree Plantings (RTP) are two types of SCMs that fall under the category of landscape restoration, which is the general term used for actively sustainable landscaping practices that are implemented outside riparian (or other specially protected) buffer areas. LRM includes reestablishing meadow and converting turf to meadow. RTP involves the restoration of forest by implementing reforestation and tree plantings over an area. In both types, designs use vegetation (i.e., native species) that does not require significant chemical maintenance by fertilizers, herbicides, and pesticides.

Riparian Buffer Enhancement (RBE) is a method of revitalizing and improving existing riparian buffers. Riparian buffers are areas adjacent to streams, ponds, etc., that protect those water resources from pollution, prevent bank erosion, provide wildlife food and cover, and shade the adjacent water, moderating temperatures for aquatic species. Buffers are transition areas between aquatic and upland environments. RBE involves complicated natural features requiring a diverse group of expertise to effectively design the enhancement. This SCM is applicable when the development is located adjacent to a body of water with depleted buffers. Riparian Buffers are typically comprised of three distinct zones with different types of vegetation measured from the streambank outward. Zone 1 is the area directly adjacent to the stream which is ideally heavily vegetated undisturbed forest type material approximately 50 feet wide. Zone 2 varies from 15 to 100 feet in width and is vegetated with a mix of managed forest trees and shrubs. Zone 3, located farthest from the stream and sometimes not formally included, is comprised of native meadow grasses and herbaceous type land cover functioning to slow and spread incoming surface runoff.

Riparian Buffer Offset (RBO) is a type of SCM that occurs when a reduction in existing riparian buffer occurs as a result of the land development. The offset is a replacement of the impacted zone through the planting and development of a riparian buffer in the same drainage area as the impacted riparian buffer. The offsetting requirement is dependent on the downstream water body, the amount of disturbance, and the proximity of the disturbance to the water body. This SCM is only applicable when the disturbance impacts an existing riparian buffer.

Soil Amendment Restoration (SAR) may include both mechanical and fertilization techniques, which make the soil more suitable for the growth of plants and increase water retention capabilities. These measures change the physical, chemical, and biological characteristics of the soil allowing it to more effectively reduce runoff volume and filter pollutants. SAR is sometimes done in combination with LRM, which ensures longevity of soil restoration by root growth from dense plantings. Vegetated swales and grass filter strips can be treated with soil amendments to improve performance and increase their permeability. A variety of techniques are included as potential soil amendments including aerating; fertilizing; and adding compost, other organic matter, or lime to the soil.

Stream Stabilization (SST) and Stream Restoration (SRE) are methods for correcting unstable, altered or degraded stream habitat. Existing problems may include stream channel or bank erosion, erosive damage to public utilities or facilities (e.g., parks), or sediment transport adversely affecting downstream resources (e.g., Chesapeake Bay). Stream stabilization typically involves corrections to the streambank and/or channel either at a specific site (e.g., protection of public infrastructure with riprap), or on a watershed level using a combination of grading and rock, log, or various natural stabilizing structures to reduce sediment transport, improve stream habitat, or maintain channel capacity before a complete restoration is necessary. Streambank stabilizing protection includes features such as intentionally placed natural features like tree or root revetments, or in more erosive areas, boulders or rock filled gabion baskets placed into the banks to provide stability. Channel grade and flow control structures include features such as boulders intentionally place in various shapes in the stream channel to control the channel grade (elevation) or direct flow. Common structures include "J-Hooks" which are in the shape of a "J" projecting from one stream bank, or "Cross-Vanes" (e.g. rock vanes) which extend in a generally linear pattern across the stream channel. Stream restoration is best described as a reconnection of the channel to its floodplain for events both large and small. Most construction occurs within the riparian corridor utilizing unique materials to improve ecological habitat while restoring pre-development hydraulic conditions. These SCMs are generally reserved for special projects outside the context of Construction Site NPDES permitted highway projects.

6.17.2 SCM Components

SCMs are comprised of many individual components, some of which are applicable to multiple types of SCMs while others less frequently utilized. Common components that are described in Chapter 5 and related SCMs described in Chapter 6 which may be encountered with these SCMs include:

- Access, fencing, and security
- Signage
- Inflow Systems (sheet flow)
- LSO SCM

In addition, self-preserving SCMs may include the following other components:

- Turf reinforcement matting (optional)
- Engineered soil (optional)
- Turf meadow, Forest, scrub-shrubs or special SCM Plantings: Hydrophytic vegetation, native/indigenous vegetation
- Streambank stabilization structures: tree revetments, root revetments, gabion baskets, boulders, etc. (SST and SRE)
- Channel stabilization structures: J-hooks, cross vanes, weirs, etc. (SST and SRE)
- SCM discharge/receiving channel

Figure 6.17.2 illustrates the zones typically encountered in a Riparian Buffer.

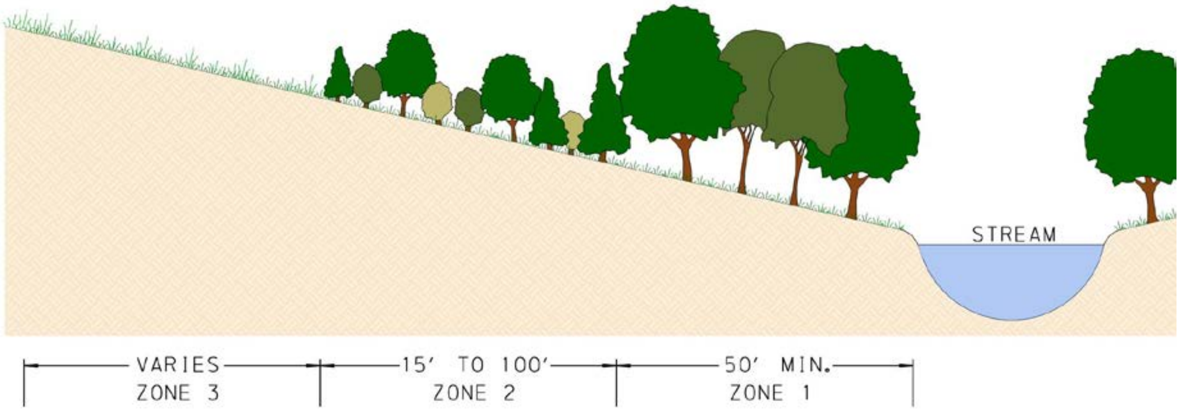


Figure 6.17.3: Riparian Buffer- Typical Zones

6.17.3 Key Inspection Considerations

Only areas of SAR equal to or greater than 5,000 contagious SF are subject to regular inspections; areas under 5,000 contagious SF are exempt from inspection. In addition to the general inspection procedures described in Chapter 3, inspections of a self-preserving SCM should focus primarily on its key functional areas: inflow, vegetation and surface area. Specifically:

- Confirm the foot print surface area of the self-preserving SCM matches the plan depicted area.
- Inspect for appropriate vegetative cover per plan. Surface vegetation should be in good condition with at least 80% coverage throughout SCM area and there are no bare patches exceeding 10% of the area. Inspect for encroachment of invasive/undesirable species.
- Inspect the self-preserving SCM area for the presence and note severity of:
    - Trash/debris
    - Surface erosion, rills, gullies and/or loss of topsoil
    - Signs of compaction by use or settling.
    - Sinkhole activity
    - Signs of contaminants (e.g. gas, oil, fertilizers)
    - Evidence of burrowing animals.
- SST and SRE: Inspect stream channel for signs of erosion, instability or degradation.

When completing PTC's inspection app for self-preserving SCMs:

- The applicable vegetation category is used to assess the entire surface area for SAR, RBE, RBO, FPR, LRM, RTP
- SCM Floor is used to assess the channel bottom of SRE and SST
- Cut Slopes is used to assess the banks of SRE and SST

Start-up phase check-ups: Due to the nature of the installation of self-preserving SCMs, they require more frequent startup phase check-ups during plant establishment through the first three years, as stipulated in Chapter 3. The following items should be inspected during these check-ups:

- SCM vegetation should be in good condition and per plan including trees, shrubs and herbaceous/grass plant materials. Coverage should reach 70% or more of plan depicted density by one year after construction, 75% by two years, and 80% by three years after construction. No invasive/undesirable species should be present. Dead plants should be removed and replaced. New plants should receive establishment watering for the first two years as stipulated in the routine maintenance table in Section 6.17.4.

- The SCM and vicinity should be checked for signs of erosion of any form including general loss of topsoil and the formation of rills or gullies.

6.17.4 Maintenance Procedures and Repair Activities

Certain preventative maintenance activities should be performed on regular cycles to maintain functionality and avoid future issues. The following table summarizes the minimum routine activities and the associated frequencies. Occasionally, SCMs with site specific factors may require more frequent or additional routine maintenance activities than those presented below. Refer to the SCM's information in the SCM inventory for potential variations.

Table 6.17.1: Maintenance Procedures for Self Preserving SCMs

Frequency	Activity
April-Oct twice weekly for six weeks following planting	• Water all seeded/planted areas and fill water bags around trees. Watering may be skipped if ¼" of rainfall has occurred within previous 24 hours of scheduled watering. (Excludes FPR and areas of existing established vegetation)
April-Oct every two weeks for first two years following planting	• Water all planted (non-grassed/seeded) areas and fill water bags around trees. Watering may be skipped if ¼" of rainfall has occurred within previous 7 days of scheduled watering. (Excludes FPR and areas of existing established vegetation)
Three times per year (for the first two years of service)	• Remove or treat weeds and undesirable plants; prune shrubs and trees to maintain appearance and functionality. Remove undesirable vegetation. Do not drive heavy equipment on SCM surface, use LGP equipment (see Section 4.7). If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
Annually	• RTP, RBO, RBE, or any trees with tree shelter: Check tree shelter (protective plastic surround on newly planted trees). Fix any leaning, damaged or downed shelters. Remove top nets when tree reaches net. Remove entire shelter when tree reaches 1.5 to 2" diameter. • SAR and LRM only: Prior to mowing, remove litter, trash, and debris from SCM and surrounding area. Mow areas of SCM indicated to be tall meadow to a height of 8 to 16 inches. Perform mowing operations within SCM when SCM is completely dry. LGP equipment must be used in the SCM (see Section 4.7); do not drive heavy equipment in the SCM. Do not mow areas planted with no-mow landscaping such as shrubs.
Every three years	• Remove or treat undesirable plants; prune shrubs and trees to maintain appearance and functionality. Remove or treat weeds and undesirable plants; prune shrubs and trees to maintain appearance and functionality. Replace diseased or dead plant materials; if specific species mortality is reoccurring, assess cause and replace with appropriate alternate species maintaining 80% plant cover. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. • LGP equipment must be used in the SCM (see Section 4.7); do not drive heavy equipment in the SCM. • SAR only: Dethatch turf to maintain infiltration.
As needed	• Maintain applicable common components as described in Chapter 5 at the indicated frequencies. • Repeat SAR amendment processes.

Notes:

1. All vegetation, trash, debris, liquids, and materials removed from the SCM shall be disposed of in accordance with PTC's waste management policy and all applicable regulations. Sediment shall be disposed of in accordance with PTC's policy on handling of fill and applicable regulations. See Section 4.5 for more details.

In addition to the maintenance efforts outlined above, infrequent corrective maintenance and repair activity tasks are outlined in the maintenance and repair tables included in Appendix G for use when determining the appropriate actions based on the results of an inspection or a report from maintenance crews. Users should reference all of the applicable maintenance information presented on the General and Common Component tables (G.1.1 and G.1.2) in addition to the Self Preserving SCMs specific table G1.).

6.18 Non-Basin SCM, Other (NBO)

Green Roof

Cistern

Figure 6.18.1: Non-Basin, Other

(photos c/o Philadelphia Water Department, Stormwater Management Guidance Manual)

6.18.1 Description and Overview

NBO's are SCMs installed and owned by PTC that do not match the typical highway SCMs in the inventory. Examples such as a vegetated roof, rain water harvesting, or cistern do not receive their own type code in PTCs SCM inventory. Projects that are completed for MS4 PRP credits that do not fall under one of the other SCM types defined in this manual will be inventoried as NBOs for program tracking purposes.

These types of SCMs are mostly commonly installed away from the roadway for stormwater management needs at maintenance facilities, visitor centers, or other PTC buildings.

Generally each occurrence of a NBO will have a unique design and most likely have associated manufacture required protocols. Some that may be more commonly encountered are explained below. For any type, always consult the SCM details and relevant information on the PCSM Plan for inspection and maintenance requirements. Under PTC's program, NBO's may utilize alternative inspection forms in lieu of PTC's standardize electronic inspection software program to more thoroughly document the SCM where appropriate.

Rainwater harvesting involves capturing stormwater typically from roof areas and storing it for later reuse. The collected water may be held in cisterns, tanks or directly on the roof surface (called a blue roof). It may be used for irrigation, toilet flushing and similar uses. Each system will have differing storage capacity and required drawdown requirements based on the permitted and desired uses.

Spill containment facilities are installed to capture containments upstream of sensitive resources in the event of an inadvertent release in appropriate locations. Where these are directly in-line and connected to an SCM, they should be included as part of the SCM in the inventory. Where these facilities are standalone vaults, tanks or similar storage vessels, they should be classified as NBOs. When these facilities are in the form of standalone surface basin-like features, they should be classified as BOTs for inventory tracking (Section 6.1).

REFERENCES

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APPENDIX A
SCM Desktop Standard Operating Procedures

Pennsylvania Turnpike Commission

Stormwater Control Measure (SCM) Desktop

Standard Operating Procedures

DATE... June 27, 2019

DOCUMENT VERSION......................... v3.1

PREPARED BY................................... KCI Technologies

Contents

1 Introduction

The Pennsylvania Turnpike Commission's (PTC's) stormwater program utilizes several technologies to store and manage stormwater inventory and inspection information. These technologies work together to support several key business processes within PTC, including:

- Curation of an up-to-date stormwater inventory
- Field data collection – primarily, SCM inspections
- Review, QC, and acceptance of field inspections by PTC Engineering
- Dissemination of accepted field inspection data to the PTC organization overall
- Reporting and analysis of stormwater inventory and inspection data

This guide documents in detail the processes necessary to maintain proper data flow and function of inventory and field inspection data. While these workflows necessarily identify details that are specific to stormwater, the conceptual data flows are representative of those for any asset type. The workflows are primarily intended for PTC personnel or delegated partners working in-office, within the PTC firewall. This guide does not document management of data sharing with external partners or consultants, as these activities are managed by a broader data governance and data sharing plan.

2 System Architecture

This section will describe the system architecture used to collect, edit, analyze, manage and redistribute PTC stormwater data.

PTC manages two primary environments for managing data within their system: ArcGIS Online, and the on-premise environment. The on-premise environment contains a QC Service, and an approved data repository ("SDE"). Both environments maintain a separate but complete copy of the stormwater database schema (the database *schema* is the definition of the tables, fields, and data relationships that are contained within the database).

Each of these environments serves a unique role in the data management and distribution processes of stormwater infrastructure data. The ArcGIS Online environment is hosted by esri ArcGIS Online is used to enable field accessibility using the Collector and Survey123 field inspection tools. The QC Service is the primary editing environment for both edits of existing data, and incorporating new stormwater data. Because all field data is stored in ArcGIS Online, then synced automatically to the QC Service, there may be data stored here that is not considered 'accepted' ('accepted' data has been reviewed, verified, and approved as final data). Refer to *2.3.4 Synchronization of Data with On-Premise SQL Database* for more details.

The on-premise environment includes a SQL-based database and Portal for ArcGIS, both hosted on-premise by PTC. The primary purpose of the on-premise environment is to store and disseminate accepted data to the entire PTC organization. It is a read-only resource that is regularly synced with the QC Service, and the ArcGIS Online information. The on-premise environment is also the source for stormwater data reporting and analyses. The sections below further define and describe these environments and their intent.

2.1 ArcGIS Online

ArcGIS Online is a cloud-based data storage, mapping, and application development platform managed by esri. PTC has an ArcGIS Online Organizational account available to named users. The PTC account can be accessed using the URL below:

http://paturnpike.maps.arcgis.com

ArcGIS Online named *users* can view and edit data stored on the account. ArcGIS Online named *managers* can publish data to the account, create web maps, and share this content with specific users, groups, or the public. If access is needed to ArcGIS Online, submit a request through PTC's ServiceNow portal.

Note: All SCM data published to ArcGIS Online will only be shared with PTC named users and groups and will not be shared publicly.

ArcGIS Online is leveraged for two primary functions: data accessibility, and integration with esri's configurable mobile applications. Data is made more accessible through ArcGIS Online because as a hosted environment, users are not required to be connected to PTC's network via VPN or other direct connection. Items hosted on ArcGIS Online can be accessed from any location with an internet connection, and this capability better streamlines the work for staff while in the field performing inspections.

Additionally, PTC is leveraging configurable mobile data collection applications, including Collector for ArcGIS and Survey123 for ArcGIS, to perform SCM inspections. These applications are built upon ArcGIS Online, and require ArcGIS Online web maps or hosted feature layers. Data edited or collected in the field is updated into the ArcGIS Online database immediately upon the user submitting the edits from Collector or Survey123.

2.2 On-Premise Environment

The on-premise environment is the environment used to store, backup, report, and distribute the data to the entire PTC organization. Edits made into the ArcGIS Online database will be regularly synced into the QC Service to be reviewed, approved, and moved into the on-premise environment via a second synchronization procedure.

The on-premise environment consists of several networked machines and applications that are used to store and distribute data. The three physical machines used in the production environment are listed in the following table:

Network Machine	Function
CVGISENTDBP1	SQL Database
CVGISAGSVRP	ArcGIS Server
CVGISPRTLP	ArcGIS Portal

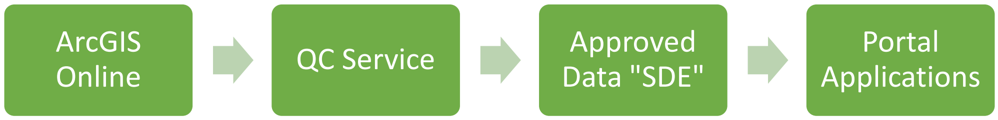
SQL Database
The on-premise SQL database is the primary database used to manage the existing stormwater inventory and inspection data. The SQL database is managed through an ArcSDE database connection that allows the spatial data to be accessed in the ArcGIS desktop environment.

ArcGIS Server
The ArcGIS Server is used to publish and host data from the production database in the form of map and feature services. These services allow visual and tabular access to the database through a URL. The ArcGIS Server manages the online requests to the database and supplies the data back to the user as needed.

ArcGIS Portal
The ArcGIS Portal is an on-premise, web-based platform that provides a place for users to manage, visualize, and interact with the map and feature services. The production portal is used to host mapping applications that consume map and feature services.

2.3 Data Lifecycle

This section describes the flow of data as it moves through the system's various architecture components, from ArcGIS Online, to the on-premise environment and the subsequent Portal applications.



2.3.1 ArcGIS Online

From the ArcGIS Online database, a single set of feature services are published, that support the field data collection tools. Data updates in the ArcGIS Online database or field data collection tools are automatically extended to the other systems.

As data is created new or edited within ArcGIS Online, PTC Engineering will perform QC reviews of the data. If necessary, modifications will be made by either editing the data directly within the Stormwater Management QC application, or coordinating with inspection teams to make the edits within the field data collection tools.

Refer to *Appendix D – System Architecture Diagram* for a visual representation of the architecture, including ArcGIS Online.

Inputs

New data, or data updates, are populated into the ArcGIS Online database through one of the following two input methods:

1. Field data collection
    a. As inspections are performed and submitted using the field data collection tools, those inspections are immediately delivered to the ArcGIS Online database.
2. Data synchronization
    a. As the data sync process occurs, data changes made in the QC Service are populated into the approved data repository (SDE), then also pushed to the ArcGIS Online service. This ensures that any editing that happens within the QC Service can be reflected in the field for field crews.

Outputs

Data updates within ArcGIS Online database are extended to the following two outputs:

1. Field data collection
    a. The field data collection tools, including Collector for ArcGIS and Survey123, directly utilize the feature services sourced from ArcGIS Online. In turn, as data is created and/or updated in the field data collection tools, the ArcGIS Online data is immediately updated to reflect those changes.
    Note that field data collection tools are also an input to ArcGIS Online. This represents a bidirectional relationship between these two entities.

2. Stormwater Management QC application (QC Service)
    a. Through a synchronization effort, data from ArcGIS Online is pushed to the QC Service.

2.3.2 QC Service

As field data from the field data collection tools are collected, it is automatically synced into the QC Service to provide an up-to-date view of field data for review and approval.

Inputs

1. ArcGIS Online
    a. Through a synchronization effort, data from ArcGIS Online is pushed to the QC Service. This process keeps the on-premise SQL database up to date as the "master" source of truth, with only data that has been reviewed and accepted by PTC Engineering.
2. Stormwater Management QC application
    a. QC Service data may be created or updated using the Stormwater Management QC application.

Outputs

1. On-Premise SQL database
    a. Through a synchronization effort, data from the QC Service is pushed to the on-premise environment, and specifically, the SQL database. This process keeps the on-premise SQL database up to date as the "master" source of truth, with only data that has been reviewed and accepted by PTC Engineering.

2.3.3 On-Premise Environment

Inputs

Data is populated into the on-premise SQL database through the following input:

1. QC Service
    a. Through a synchronization effort, data from the QC Service is pushed to the on-premise environment, and specifically, the SQL database. This process keeps the on-premise SQL database up to date as the "master" source of truth, with only data that has been reviewed and accepted by PTC Engineering.

Note that no data editing is occurring within the on-premise SQL database.

Outputs

Data from the on-premise SQL database is extended to the following output:

1. Stormwater Management Viewer
    a. The Stormwater Management Viewer application utilizes the feature services sourced from the on-premise SQL database.
2. Data synchronization
    a. As the data sync process occurs, data changes made in the QC Service are populated into the approved data repository (SDE), then also pushed to the ArcGIS Online service. This ensures that any editing that happens within the QC Service can be reflected in the field for field crews.

2.3.4 Synchronization of Data with On-Premise SQL Database

To synchronize data between the field tools and the on-premise SQL database, there are two steps that need to be taken:

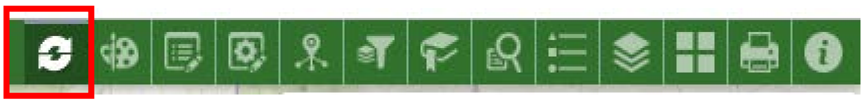
1. Move new and/or edited data from ArcGIS Online into the Stormwater Management QC Viewer (the "QC Service"). Here, the data is reviewed and approved.
2. Move approved data from the QC Service to the on-premise SQL database

Step one takes place automatically through a scheduled Windows task that runs every Sunday at 1:00AM. Step one may optionally be forced by users using the Stormwater Management QC Viewer, as detailed below.

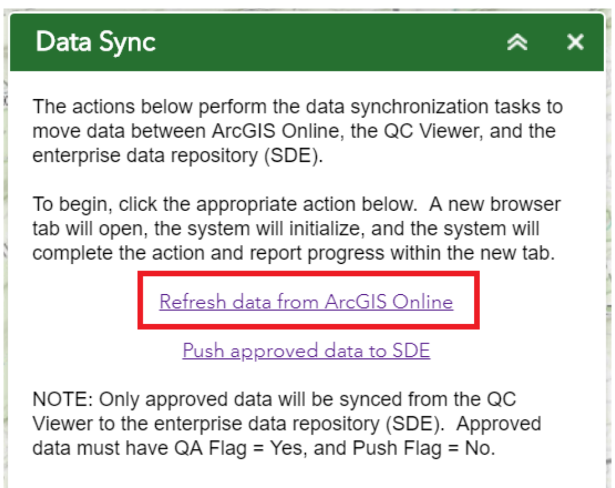
For technical specifications and details about the data transfer routines, including server names and locations and email notification details, please refer to *Appendix E – Data Transfer Routines Specifications.*

Refresh data from ArcGIS Online

1. Within the Stormwater Management QC Viewer, open the Data Sync widget.



2. Click the *Refresh data from ArcGIS Online* button within the widget. This will ensure all field data is displayed within the QC Service.



3. The application will launch a new browser tab and displays the following text: *Process Started – You will be notified via email when the process ends*
4. The system then initiates the data transfer routine on the server. The routine may take between a few seconds and several minutes to execute, depending on the amount of data being transferred (including, primarily, number of photos).
5. When the process has completed, the system will generate and send an email to the PTC Stormwater team, that indicates which process was executed, and if the execution was successful or unsuccessful.

Push approved data to SDE

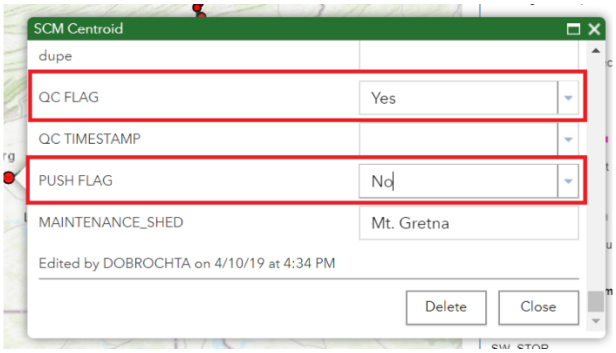
1. Review data, as needed, using the available map tools and functions. Upon approval of a given feature or record (for example, for a modified SCM, or a new inspection), edit the data to

update the QC Flag, and Push Flag fields. Refer to section *3.1.13 - Edit Widget* for details about editing data.

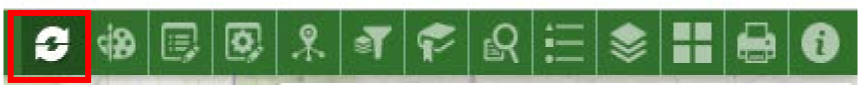
By setting the **QC Flag = Yes**, the user is indicated that the data has been QA Approved.

By setting the **Push Flag = No**, the user is indicating that the data has not been pushed from the QC Service to the on-premise SDE, and therefore, will be pushed during the next sync.

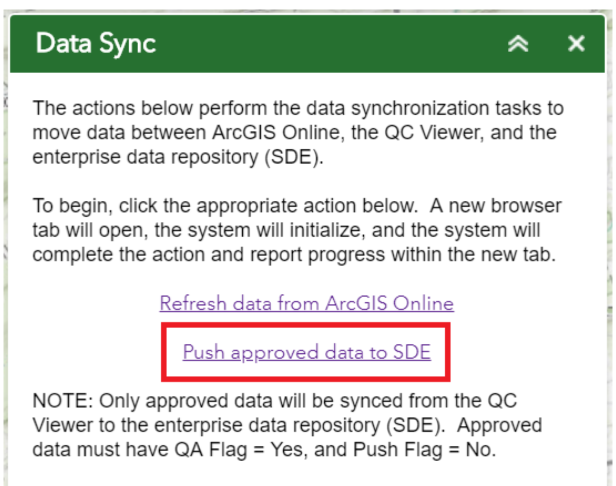
These two flags work in tandem to move data throughout the system.



2. Within the Stormwater Management QC Viewer, open the Data Sync widget.



3. Click the *Push approved data to SDE* button within the widget.



6. The application will launch a new browser tab and displays the following text: *Process Started – You will be notified via email when the process ends*
7. The system then initiates the data transfer routine on the server. The routine may take between a few seconds and several minutes to execute, depending on the amount of data being transferred (including, primarily, number of photos).
8. When the process has completed, the system will generate and send an email to the PTC Stormwater team.

4. If the email notification indicates a successful execution, then the data has been transferred to SDE, and also has been transferred back to ArcGIS Online.

The following diagram provides a high level overview of the data movement during each of the synchronization steps identified above:

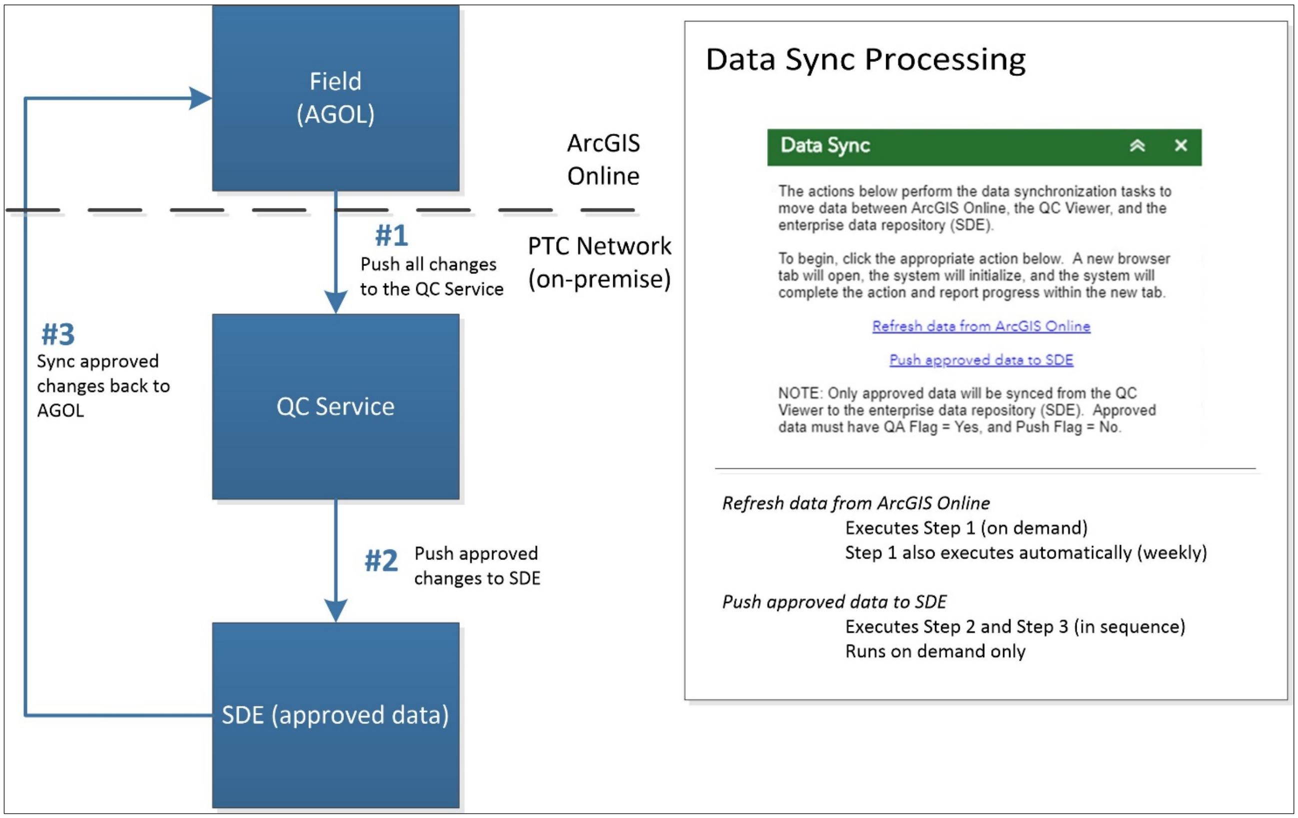


Figure 1

3 Field Data Editing

This section will describe the conditions and processes for editing the Stormwater database in the desktop environment, for data and changes that are not yet approved.

3.1 Stormwater Management QC Viewer

The Stormwater Management QC Viewer is an application found on the ArcGIS Portal that serves as the primary method of editing stormwater data, and reviewing and approving field data. All data contained within the Stormwater Management QC Viewer is sourced from the QC Service, and therefore is the editable data source. This section provides a brief overview of the tools available in the application.

The Stormwater Management QC Viewer is available at the following URL:
https://cvgisprtlp.ptc.local/StormwaterManagementQC/

3.1.1 Map Controls

- Zoom in and out by using the mouse wheel on the map window or the + and – buttons:

3.1.2 Search

- The search has been configured to accept addresses, places, and SCM Number

3.1.3 Click to Identify

- Click on a feature, such as a SCM or an inspection record to view the items information in the popup

3.1.4 Draw

- Select a shape to draw on the map

3.1.5 Infographics

- Displays a list of Inspections that are group by the SCM Number
- Select an SCM number to expand the group
- Select and Inspection Record to zoom to the Inspection Point

3.1.6 Legend

- Click the legend button to show or hide the legend:

3.1.7 Layers

- Click the layers button to show or hide a layer:

3.1.8 Bookmarks

- Click the bookmarks button to view the bookmarks:

3.1.9 Zoom to Route and Milepost

- This is a standard PTC widget for navigation
- Enter a route name
- Enter a milepost number
- Results are displayed in the results pane
    - A selected result will navigate the user to the identified milepost

3.1.10 Basemaps

- Click the Basemap button to view available basemaps
  - The topographic basemap is displayed by default

3.1.11 Attribute Table

The attribute table is at the bottom of the app. It contains a list of all records (governed by any filters in place).

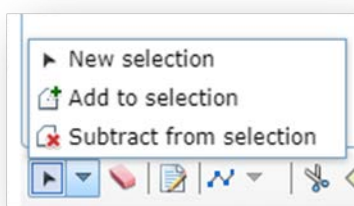
- Select a row in the attribute table by clicking the row button at the left side of the table.
- Zoom to a row by double clicking on the left button.

3.1.12 Home

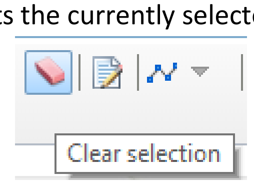
- Click the home button to navigate the map back to the extent of Maryland

3.1.13 Edit Widget

- The Edit Widget allows users to make geometry and attribute updates to:
  - Inspections
  - Stormwater Control Measures
  - SCM Centroids
  - Conveyances
  - Structures
  - SCM Drainage Areas (editing not required)
  - Sewersheds (editing not required)
- This widget also enables attribute edits via pop-up when selecting a feature when it is active in the web app. The **Save** option is available in the pop-up only and must be selected to commit edits to attributes.
- New features can be added to the database using the feature templates
- The Edit Widget toolbar contains various tools:
  - Selection – Selections can be made by selecting this tool and drawing a box around the applicable features on the map. Use the drop down arrow to selection various selection tools.
    - New selection – Selects feature within the box drawn by the user
    - Add to selection – Adds features to a previous selection
    - Subtract from selection – Removes features from a previous selection

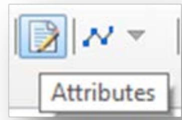


  - Clear Selection - Unselects the currently selected features in the map.



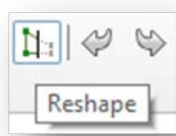
  - Attributes

- Opens the attribute table (in edit mode) for the selected features
- Use the arrows at the top of the attribute pop-up to move through the selected features.

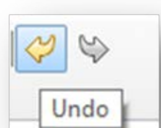


- Geometry
  - When creating a new feature, different drawing options are available:
    - Point
    - Line
      - Polyline
      - Freehand Polyline
    - Polygon
      - Arrow
      - Auto Complete
      - Circle
      - Ellipse
      - Rectangle
      - Triangle
      - Polygon
      - Freehand Polygon

- Reshape
  - Changes the geometry of a selected feature by editing the boundary (polygons) or the vertices (polyline)



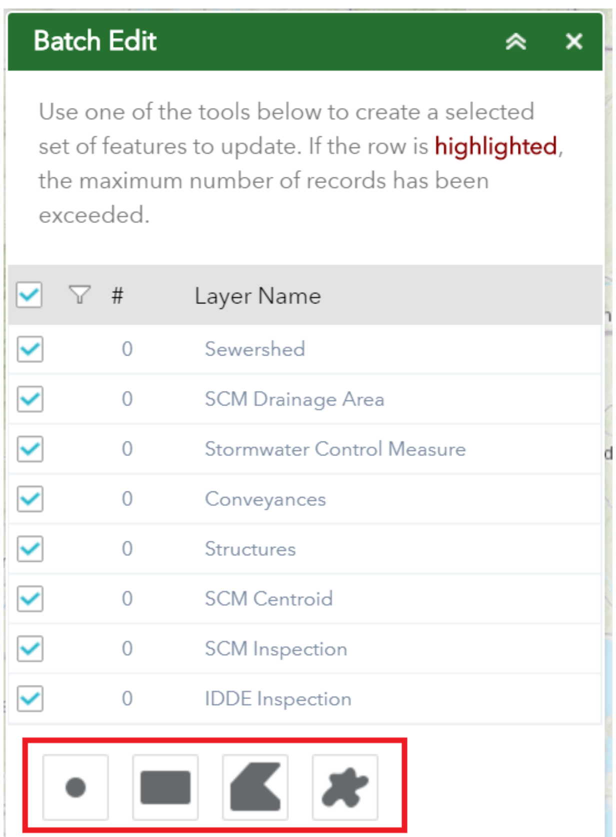
- Undo
  - Reverts changes to a feature in order



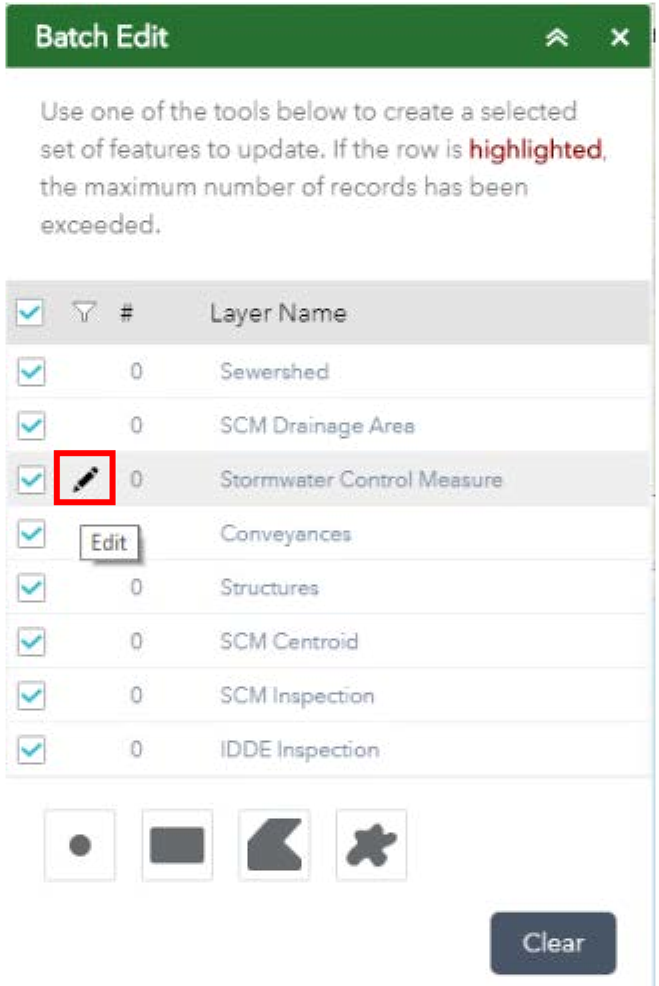
- Redo
  - Reapplies changes to a feature in order

3.1.14 Batch Editor

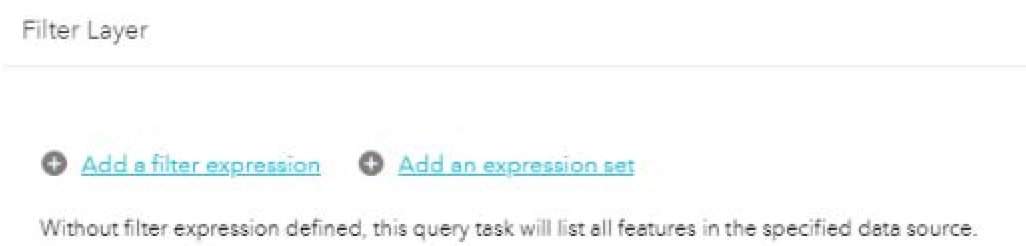
- The Batch Editor widget allows users to modify the QC Flag and Push Flag fields for multiple features simultaneously.
- After opening the widget, users must select a feature to edit. Users choose a feature selection method from the options at the bottom of the widget. The available selection options, from left to right, are:
  - Point
  - Rectangle
  - Polygon
  - Freehand



- Toggle the checkbox for each layer on or off, depending on which layers should be selected.
- Follow the prompts on screen after choosing a selection method to identify the features to update.
- Alternatively: users may select features by apply a filter/query to the data.
  - For the layer to be selected, hover the mouse just to the right of the checkbox for that layer. A pencil (Edit icon) will appear.

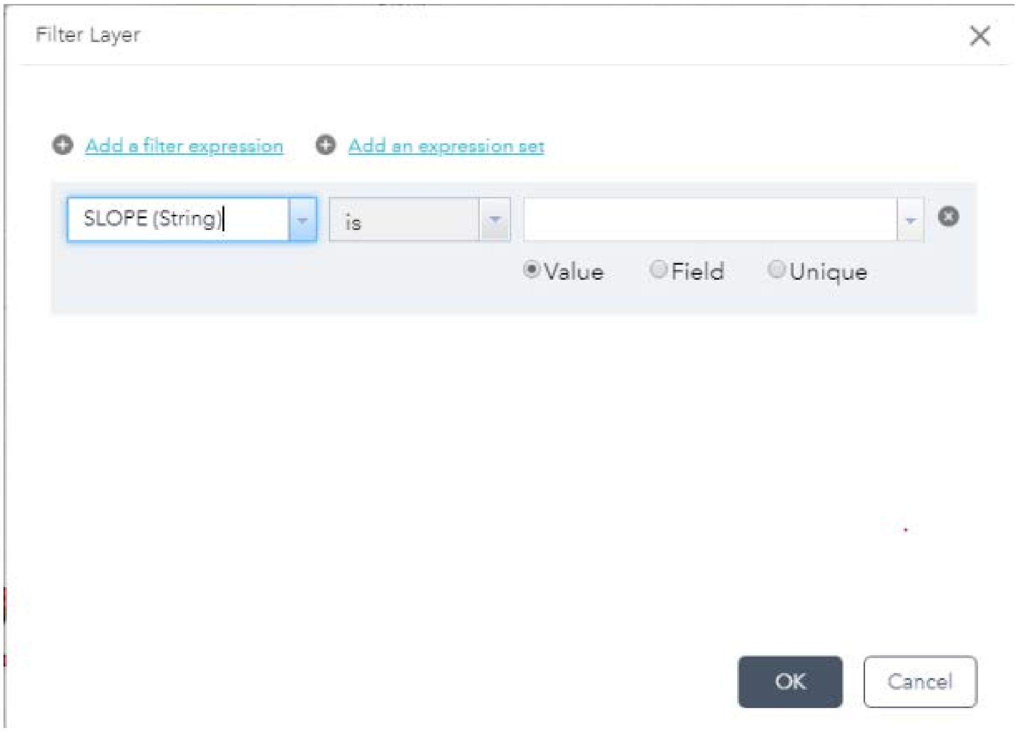


- Click the pencil (Edit icon). The system will display a filter dialogue box.



- Click the *Add a filter expression* button. Select fields, operators, and values to build a query. Note that the system allows users to define values as Value, Field, or Unique.

  Value: *allows user to select from all coded values (if applicable) defined for the field*
  Field: *compare values from one field with the value from another field*
  Unique: *provides a list of all unique values in the given field (note that this option is not available, if the number of unique values exceeds the limit allowed by the layer).*



- After performing a selection, the prompt below will display. To prepare the features to be synced, set QC Flag = “Yes” and Push Flag = “No” then click “Save”.

- All selected features will then be updated, to reflect the values provided.

3.1.15 Query Widget

- The Query Widget selects features in the web map
- The Tasks presented in Query Widget are:
  - Identify Inspections by SCM Name
  - Identify Inspections by SCM Overall Condition
- Select a task from the list shown above to run the query.
- Enter the requested information for the selected task.
- The Results page will display the number of features that are currently selected based on the query along with information about each feature.
- Select the menu button to reveal further options
  - Zoom to
  - Pan to

  - Flash
  - Statistics
  - View in Attribute Table
  - Remove from This Result
  - Show All Related Records

3.1.16 Print Widget

- The Print widget allows the user to generate a pdf of the current map extent
- Select Layout and format
- Update title
  - Default title is Stormwater Management QC
- Advanced settings are available
- Select Print to generate a pdf

3.2 Creating Stormwater Features

New stormwater features may be added to the inventory over time for several reasons, including new design projects coming online, and continued inventory updates to support MS4 permit or operational requirements.

Loading New Stormwater Features from Design Projects

New features (SCMs, stormwater structures, or stormwater conveyances) will be inserted into the database upon the project being advertised for construction bids. At this time, the project design will be complete. PTC Engineering will require the following elements from design consultants, to support the GIS data load:

1. Feature geometry, in either CAD (dgn, dwg, etc.) or GIS (esri file geodatabase) formats
   a. If geometry is received in CAD format, the data will need to be converted to an esri-compatible format using tools available out-of-the-box from esri ArcGIS software.

2. Design plan sheets, to capture key designed engineering parameters stored for each feature

Note: Specific data elements required from the above sources are highlighted in the tables within Appendix B – Data Load Details.

PTC Engineering is responsible for loading the geometry into the QC Service database and populating the attributes for new features. It is recommended to use ArcGIS Pro to perform the loading and data population.

- Create Centroids points using the Feature to Points tool in the Data management toolbox
  - Add the SCM Polygons
  - Identify the output location
    - It is recommended the output be in the same folder as the SCM polygon feature class
  - Run the tool

- The new point feature class will be used as the SCM Centroids Layer in the stormwater Database

Note: An advanced license is required to run the Feature to Point feature class tool.

- Append each source (input) feature class to its associated feature service Layer
  - SCM footprint (polygon geometry) → STORMWATER CONTROL MEASURE
  - Conveyances (polyline geometry) → CONVEYANCES
  - Structures (point geometry) → STRUCTURES
  - Centroids (new geometry created above) (point geometry) → SCM CENTROIDS
- No attributes from the source (input) data will be loaded into the QC Service feature data at this time. The append is only transferring the geometries.
- Create relationships between the STORMWATER CONTROL MEASURE and SCM CENTROID by updating GlobalID information:
  - Start an Editing session
  - Browse to each new SCM and copy the GlobalID field in the STORMWATER CONTROL MEASURE feature layer
  - Populate the SCM_ID field in the SCM CENTROID feature layer using the copied GlobalID from the STORMWATER CONTROL MEASURE feature layer
  - Verify the relationship is working successfully
    - Open the SCM CENTROID attribute table
    - Select the SCM CENTROID with the updated SCM_ID
    - Open related tables
    - The new STORMWATER CONTROL MEASURE feature should be present in the relationship table
  - Repeat this process for each new SCM and SCM CENTROID
  - Save Edits
- Create Relationships between Conveyance and Structures
  - Start an Editing Session
  - Browse to each new conveyance.
  - Identify the Upstream and Downstream structures.
  - Open the attribute table for the upstream structure
    - Copy the GlobalID
  - Open the attribute table for the Conveyance
  - Update the UPSTRM_STR_ID with the copied GlobalID
  - Repeat this process for the downstream Structure and the DWNSTREM_STRU_ID field
- Create additional related tables for Conveyances and Structures
  - Start an Editing Session
  - Open the attribute table for the new Structure
  - Copy the GlobalID of the new structure
  - Open table related to the Structure
    - For example, if the new structure is an inlet open the Inlet table
  - Add a new record to the Inlet table
  - Update the STRUCTURE_ID field with the copied GlobalID

    - Repeat this process for the new Conveyances and each of their related tables.
- Finish updating the attribute tables for all of the new features and related tables using the available source data and reference data layers. See *Appendix B – Data Load Details.*
- Review, approve, and synchronize the data as needed (note, only the *Push approved data to SDE* step must be executed) (see *2.3.4 - Synchronization of Data with On-Premise SQL Database*).

Creating new features individually using the Stormwater Management QC application

There may also be a need to add new stormwater structures or conveyances identified in the field but are not present in the database. The stormwater group can use the Stormwater Management QC application to incorporate these features into the database.

- Zoom to an area on the map
    - There several options available to quickly help the user zoom to an area
        - Infographics widget
        - Zoom to Route and Milepost widget
        - Query widget
        - Search Bar
        - Attribute table
        - Manually zoom to feature
- Select a feature template in the edit widget pane to add new features
    - Only layers toggled on will have feature templates present in the edit widget pane
    - See *3.1.13 Edit Widget.*
- Click on the map to add new point or vertex
    - Double click the map to drop the final vertex when drawing a line feature.
- Review, approve, and synchronize the data as needed (note, only the *Push approved data to SDE* step must be executed) (see *2.3.4 - Synchronization of Data with On-Premise SQL Database*).

Note: Relationships should be maintained when adding new features through the edit widget. If new structures and conveyances are added, ensure related features include the necessary GlobalID.

Any new features and their attributes should be reviewed for accuracy. If updates to the attributes are required, the features should be updated using the edit widget described in section *3.1.13 - Edit Widget*. PTC GeoAnalytics is available to support the insertion of new features if the need may arise.

3.3 Editing Existing Stormwater Features and Inspections

Several scenarios may require the stormwater management group to edit existing features. These include, but are not limited to, SCM redesign, updating attributes for new features, and reviewing updates made by field inspectors. When edits are required, users will utilize the Stormwater Management QC application. The application supports both geometry and attribute edits.

Editing existing stormwater features using the Stormwater Management QC application

- Zoom to a feature to edit
    - There several options available to quickly help the user zoom to a feature

    - Infographics widget
    - Zoom to Route and Milepost widget
    - Query widget
    - Search Bar
    - Attribute table
    - Manually zoom to feature
- Open the Edit widget
    - Reference section *3.1.13- Edit Widget* for more details
- Click on a feature to open the pop-up
    - If multiple features are identified, use the arrows to toggle between the features
- Update the attributes as needed
- Updated related attributes of related tables
    - Scroll to bottom of the current popup
    - Select the related table to update
    - Update attributes as needed
- Review, approve, and synchronize the data as needed (note, only the *Push approved data to SDE* step must be executed) (see section *2.3.4 - Synchronization of Data with On-Premise SQL Database*).

3.4 Archiving Existing Stormwater Features

SCMs and related stormwater inventory may fall out of service for various reasons. These SCM features will remain in the database to provide a historical record of the infrastructure, and will be attributed to denote that the feature is no longer in service. All related records, including inspections and photographs, will also remain in the database.

Stormwater features can be placed into an archived state by updating the FEATURE_STATUS field to read 'Out of Service'. The FEATURE_STATUS field is present in each stormwater feature layer present in the database. The stormwater database can be edited using the procedures documented in section *3.3 - Editing Existing Stormwater Features and Inspections*. Features that have a FEATURE_STATUS value of 'Out of Service' do not have a set symbology in the Stormwater Management QC application, the PTC SCM INSPCTION MAP, or Collector for ArcGIS. A symbol will no longer indicate the location of an archived feature. However, the features will remain present in the attribute table. If for some reason a feature is marked as 'Out of Service' by mistake, or if a feature is reintroduced into service, the FEATURE_STATUS field can be edited and the features symbology will update accordingly.

4 Reporting

As the repository of accepted field data, the on-premise SQL database will be the source of data for stormwater reporting and analyses. PTC is leveraging Geocortex technology to provide users with reporting and analysis functionality, including:

- Export PDF reports, capturing a snapshot of data
- Execute advanced queries to select data across multiple tables within a complex data schema
- Visualize query results on a map, and extract results to Excel or other formats for additional analytical capabilities

The reporting tools developed within the Geocortex application (*Stormwater Management Viewer*) will consume map services published from the on-premise SQL database to the ArcGIS Server. As a function of the nature of map services published this way, any updates or modifications to the on-premise SQL database will be immediately reflected within the Stormwater Management Viewer, with no additional steps needed. The map services, like all services published by the PTC, are continually monitored and maintained through a suite of automated and manual processes as part of the overall PTC GIS system health monitoring efforts.

The Stormwater Management Viewer is available to all users on the PTC network at the following location:

http://cvgisgeocrtxs.ptc.local/Html5Viewer/Index.html?viewer=Stormwater_Management_Viewer_PRD.SWViewer_PRD#

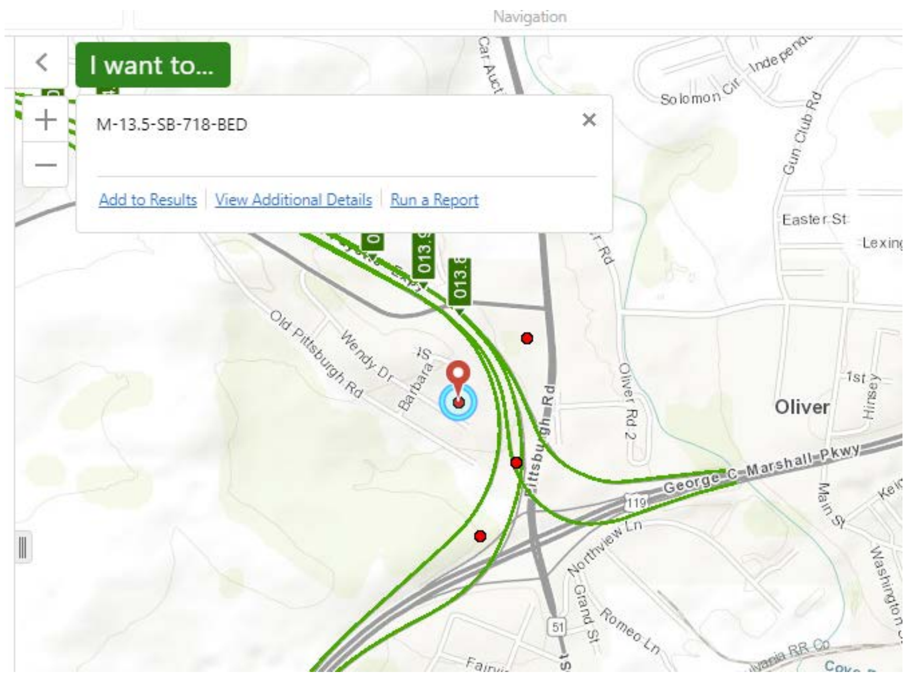
4.1 Generate Reports

There are two types of reports that may be generated from the Stormwater Management Viewer, including *Single SCM Condition Report*, and *Summary Report*.

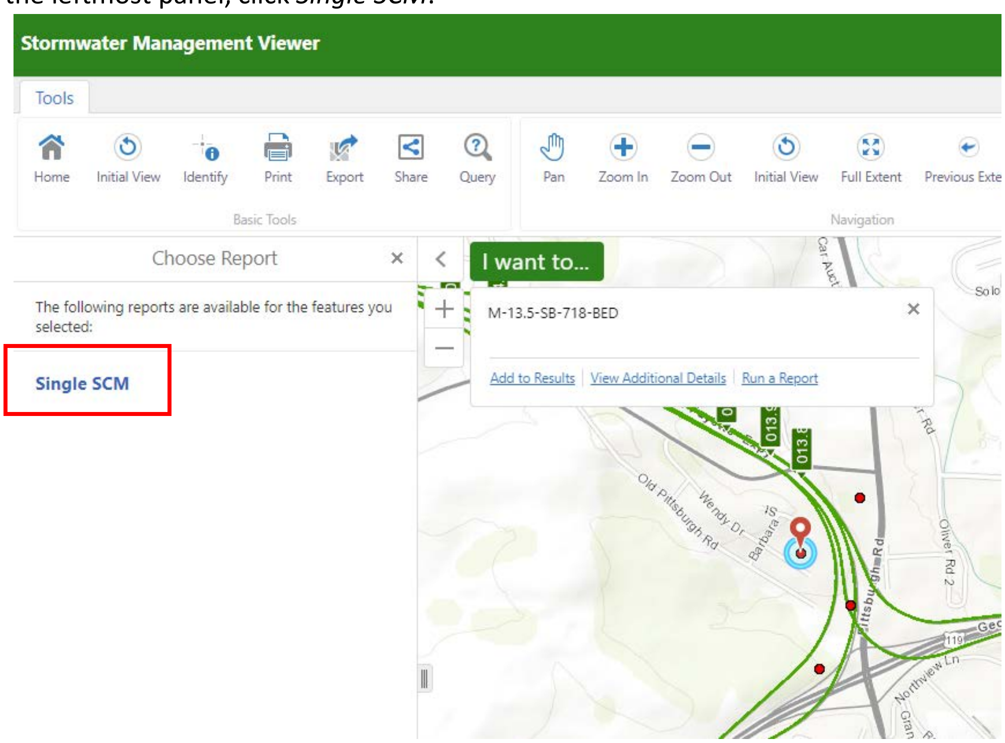
Single SCM Condition Report

This report provides information related to the most recent annual inspection for a single SCM. To generate this report:

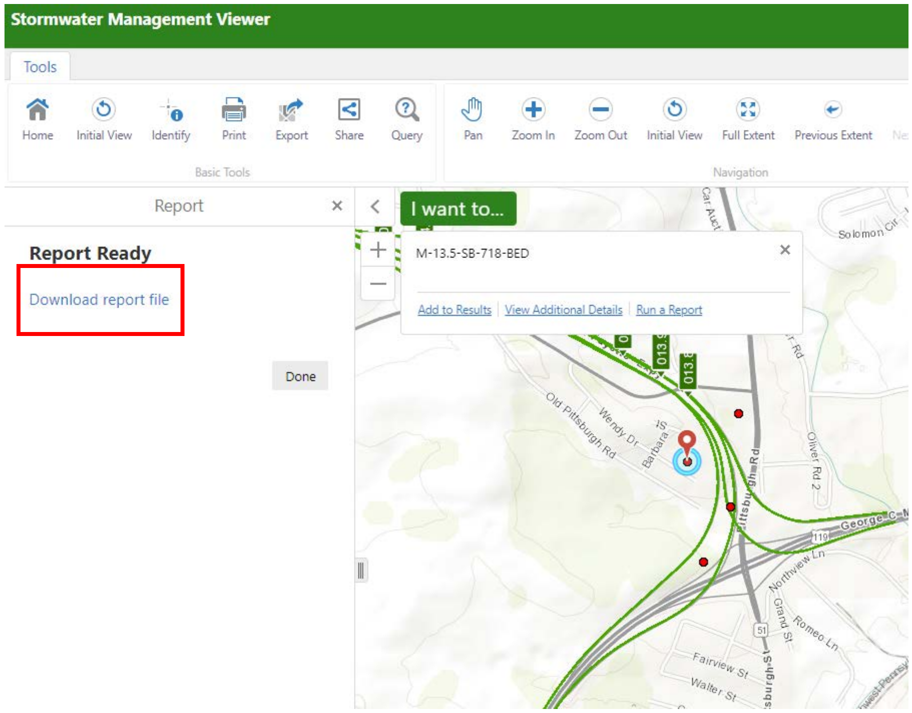
1. On the map, click on the SCM Centroid point for the intended SCM. The system will display a “map tip” (small box in the upper left corner of the map).



2. Within the map tip, click *Run a Report*.
3. Within the leftmost panel, click *Single SCM*.



4. The system will process the request. When complete, the system will display *Report Ready* in the leftmost panel.
5. Click *Download report file* to download the report (the report will be provided as a PDF file, as a web download). **Note: the way in which the browser returns the web download will vary, depending on the browser in use.*



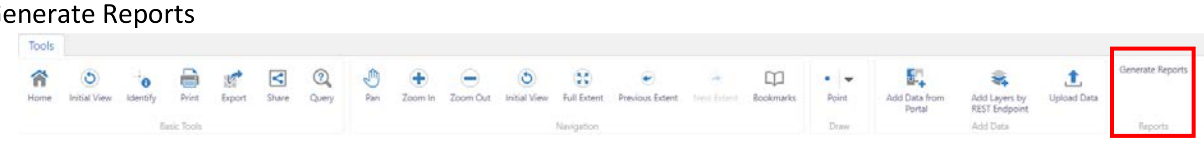
6. To close the Report Ready window, click the Done button.

Summary Reports

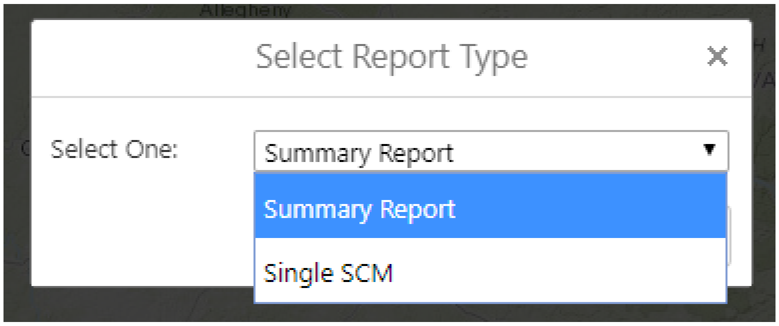
This report provides information related to the most recent annual inspection for a collection of SCM's – grouped by either Maintenance District, Maintenance Section (Shed), Route, or the Entire System. The report aggregates data based upon the selected geography subset.

1. Click the Tools button to display the Tools toolbar.

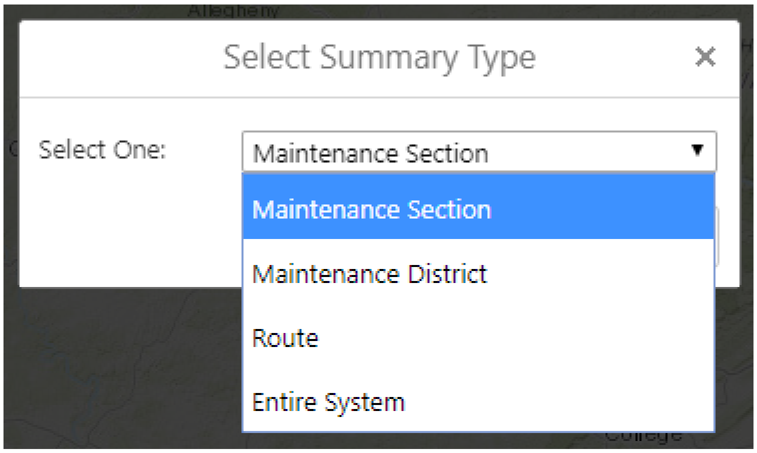
2. Click Generate Reports



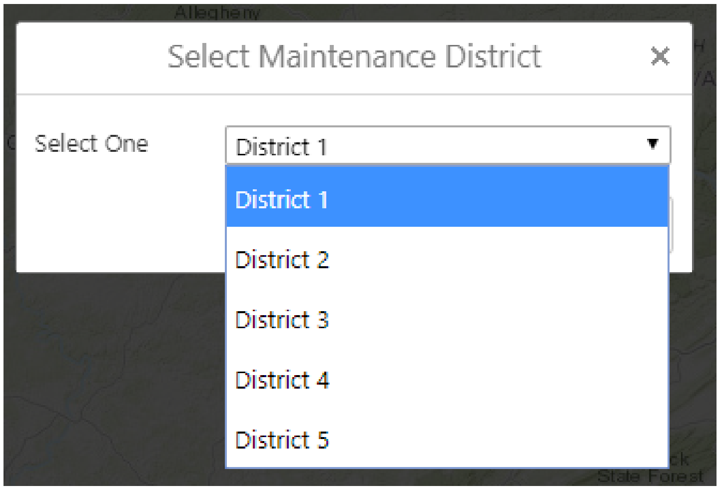
3. From the dropdown menu, select Summary Report and click Next.



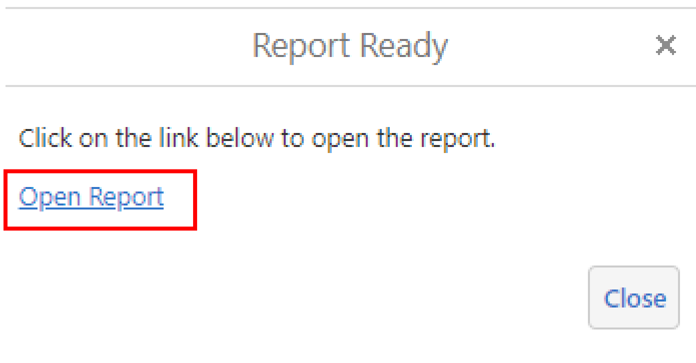
4. From the dropdown menu, select the desired geography. This determines the subset of SCMs that will be included within the report. Click Next.



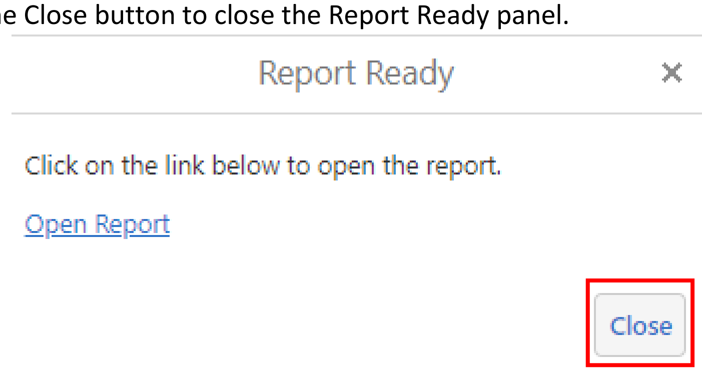
5. Depending upon the geography selected in step four, the application will display a dropdown menu with unique values from the geography selected. Select a unique value, and click Submit.
    a. If the user selects a Summary Report by Maintenance Section, the next dropdown menu will display unique Maintenance Section values.
    b. If the user selects a Summary Report by Maintenance District, the next dropdown menu will display unique Maintenance District values.
    c. If the user selects a Summary Report by Route, the next dropdown menu will display unique Route values.
    d. If the user selects a Summary Report by Entire System, the application will not display another dropdown menu.
    Note: for all geographies except Entire System, the dropdown menu containing unique values will display only those values in which SCMs are located.



6. The system will process the request, and display a new panel on the left side of the application. The panel will display a link to open the report. Upon clicking the link, the report will open in a new tab. **Note: the way in which the browser returns the web download will vary, depending on the browser in use.*



7. Click the Close button to close the Report Ready panel.



4.2 Tools

Home

The Home button will display application specific information and a link to quick start documentation along the left-hand side of the application.

Initial View

The Initial View button will restore the application to the default map extents when clicked.

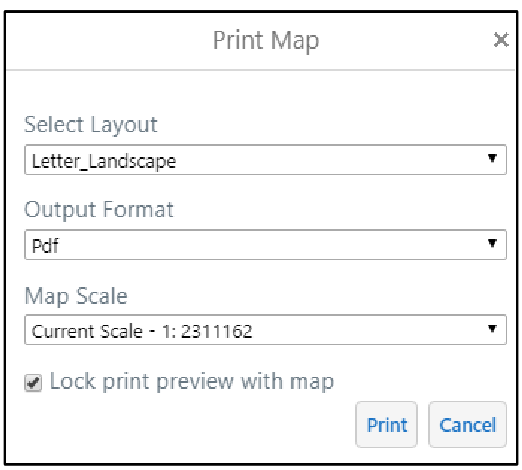
Identify

The Identify button expands to display the tool configuration options displayed below.

- The Disable Buffering option prevents features that are within an additional buffered distance of the selection from being included in the selection.
- The Enable Add Results option allows users to expand their selection by defining an additional selection area after performing an initial selection.
- The Enable Subtract Results option allows users to remove identified features from an initial selection.
- The Identifiable Layers option allows users to make individual layers selectable by toggling check boxes.

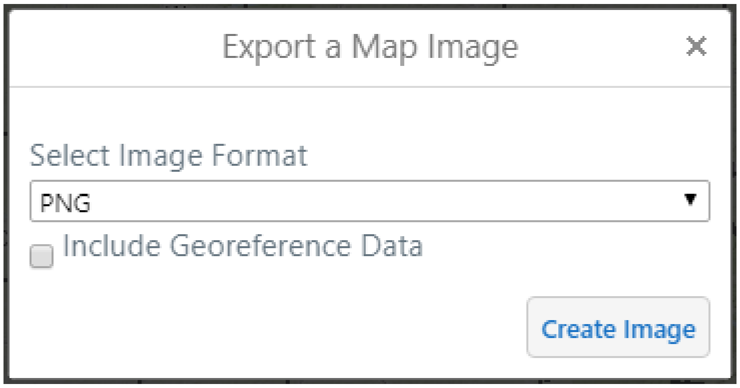
Print

When the Print tool is clicked, the print configuration options, displayed on the left, opens along the left side of the application. After selecting configuration options from the dropdowns and clicking the Print button, the print will be processed and the Print button will be replaced with an Open File button which will open the print in a new browser tab, where it can be saved/printed.



Export

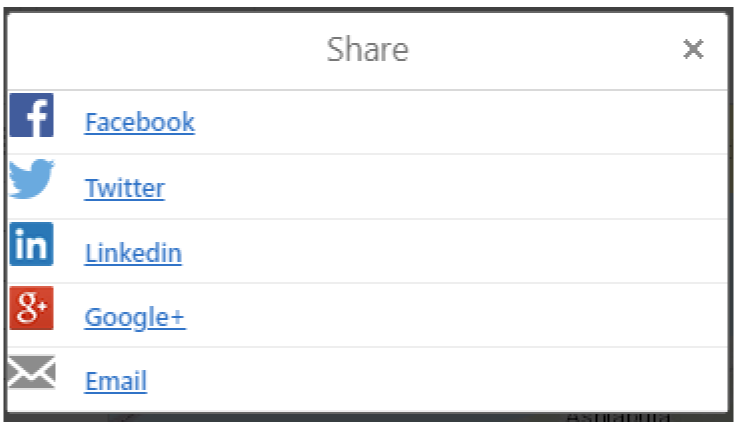
When the export tool is selected the export popup, displayed below, will activate in the map extents section of the application. To use this tool, select the preferred format option from the dropdown list and click the Create Image button. Once the image is processed the popup will update and the export can be opened by clicking the View Image button.



Share

The Share tool allows users to share a link to the site to various social media platforms.

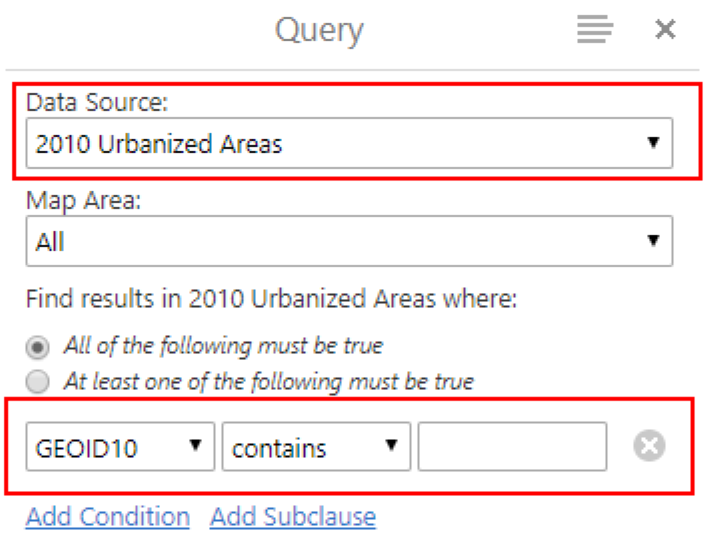
- Upon clicking the tool, the system displays a short list of mediums through which to share the site, including Facebook, Twitter, LinkedIn, Google+, and Email.
- When the user clicks any of the social media sites, the system will launch the site in a browser page (unless the user is already logged in, the site will ask the user to login).
- When the user clicks the Email link, the system will launch a new email in the system's default email client



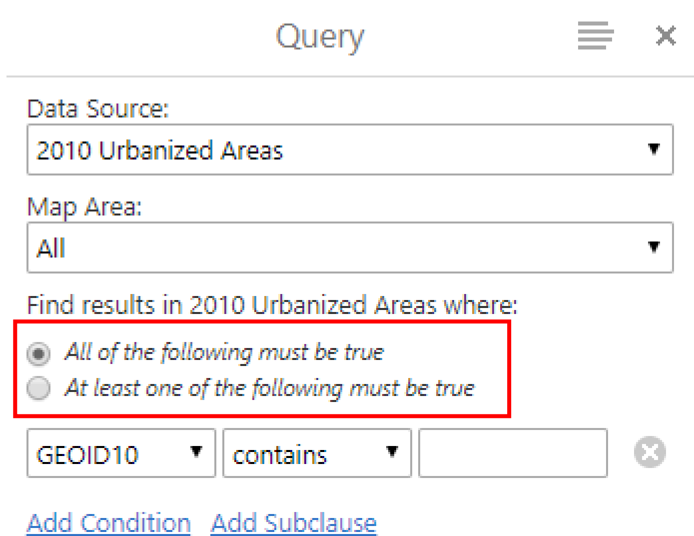
Query

The Query tool allows users to perform advanced ad-hoc queries against fields and tables within the database. To use the tool:

- Select a layer from the Data Source menu
- Build a query by entering and selecting the following values:
    - Select a field name from the field menu
    - Select an operator
    - Enter a value in the text input box



- Optionally, the user may:
  - Add a condition
    - Note that the condition uses either the "And", or "Or" operators. Toggle between operators by switching the operator radio buttons



  - Add a subclause
    - A subclause acts as a nested condition. This allows users to build complex logical queries.

Pan

The Pan tool allows users to adjust the map extents by clicking and dragging within the map extents.

Zoom In

The Zoom In tool allows users to zoom into an area of the map extent by defining a rectangle, into which the extents will zoom, using the mouse.

Zoom Out

The Zoom Out tool allows users to zoom the map extents out, while keeping the extents centered on an area, by defining a rectangle using the mouse.

Initial View

When the Initial View tool is clicked the map extents will zoom in or out to return to the initial extents defined by the application manager.

Full Extent

The Full Extents tool will zoom the map extents in or out to return the map extent to a position that will display all the datasets in use by the application.

Previous Extent

The Previous Extents tool will return the map extents to the previous map extents when clicked.

Next Extent

The Next Extents tool will not function until the map extents have been adjusted. After there are three different extents, the Next Extents and Previous Extents tools can be used to adjust the map extents forward and back in controlled steps.

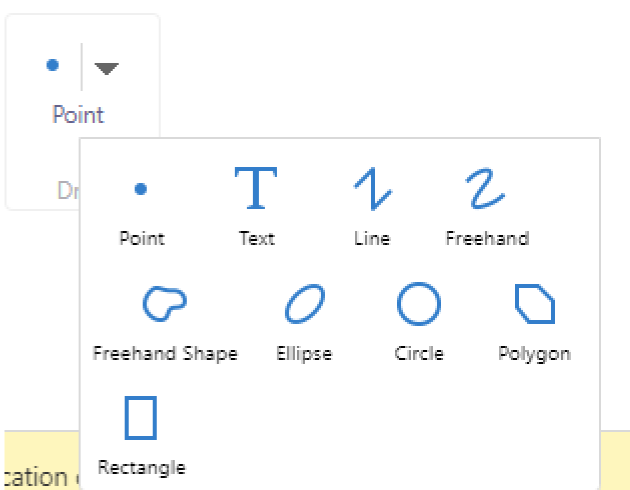
Bookmarks

When clicked, the Bookmarks tool opens a dropdown list of locations that can be zoomed to when clicked and an option to create personal bookmarks. The default bookmarks are:

- CAB – Central Administration Building
- WRO – Western Regional Office
- ERO – Eastern Regional Office

Draw

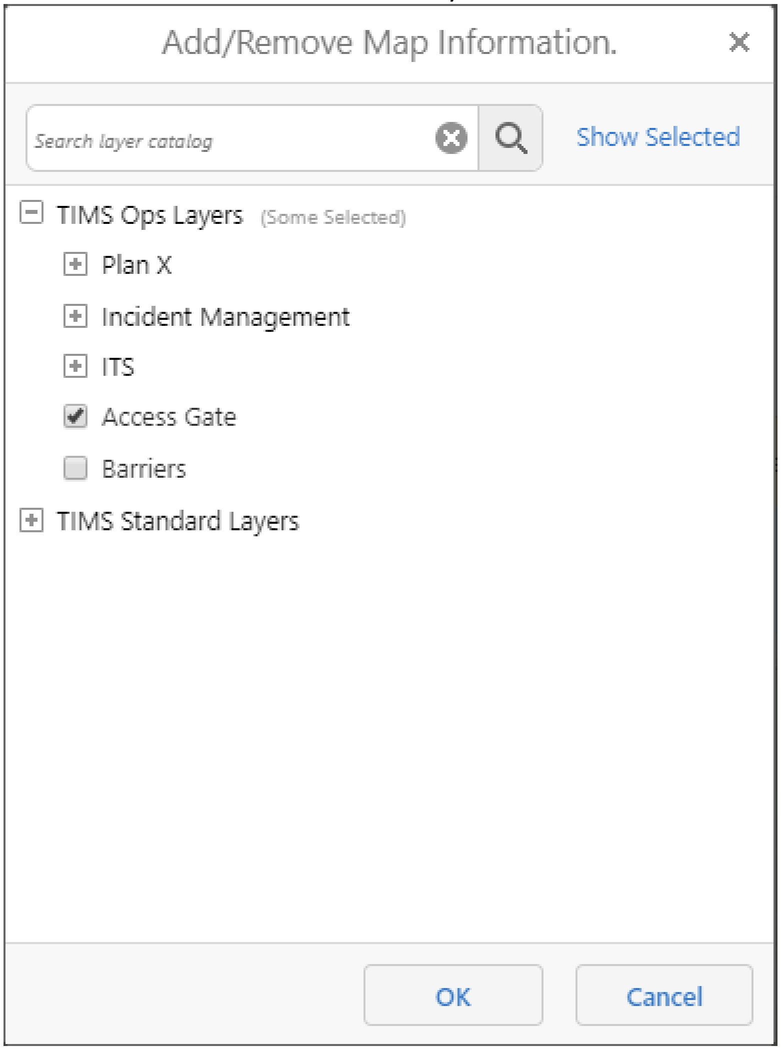
The Draw tool allows users to draw graphics on the map. The graphic options include drawing points, lines, polygons, ellipses, circles, rectangles, freehand shapes, freehand lines and freehand lines.



Add Data from Portal

The Add Data from Portal allows users to search data and add layers to the site. The data provided through this tool has been reviewed and added by GeoAnalytics program's administrators. To use the tool:

- Click the checkbox on an individual layer to select it. Click the OK button to add.



Add Layers by REST Endpoint

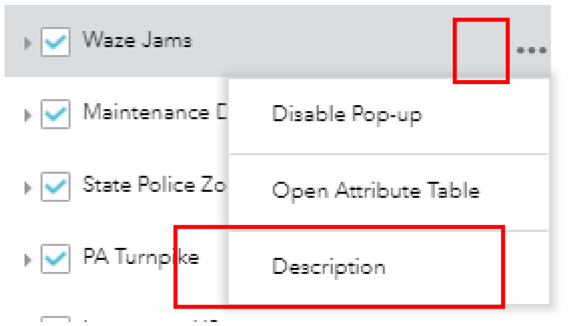
The Add Layer tool allows users to add feature/map services to the application by pasting the REST URL into a text box that activates in the left-hand side of the application when the tool is clicked. To use the tool:

- Copy an existing layer URL*
- Paste the URL into the Search text input box
- Click Search

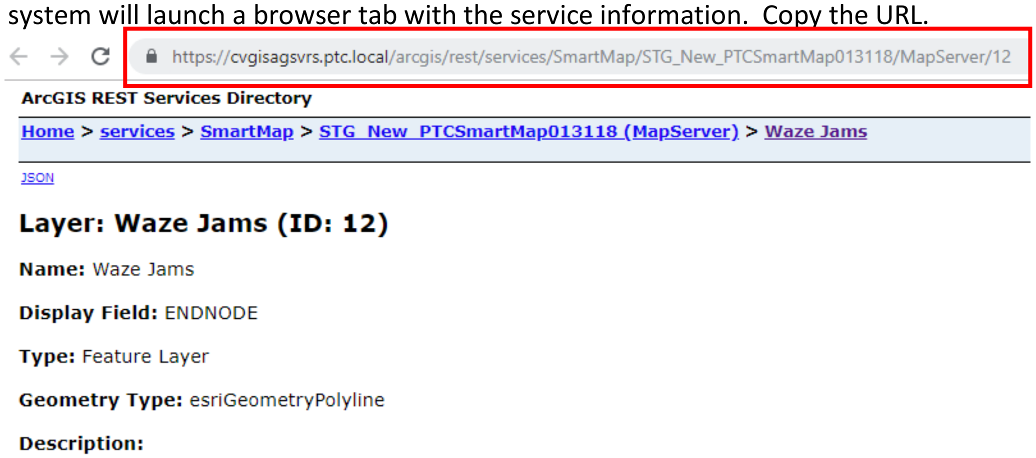
*To identify and copy an existing layer URL:

1. Open any Esri Web App Builder application on the GeoPortal (cannot be a Geocortex application or Operations Dashboard)

2. Open the Layer List widget
3. Click the ellipsis to the right of any given layer
4. Click "Description"

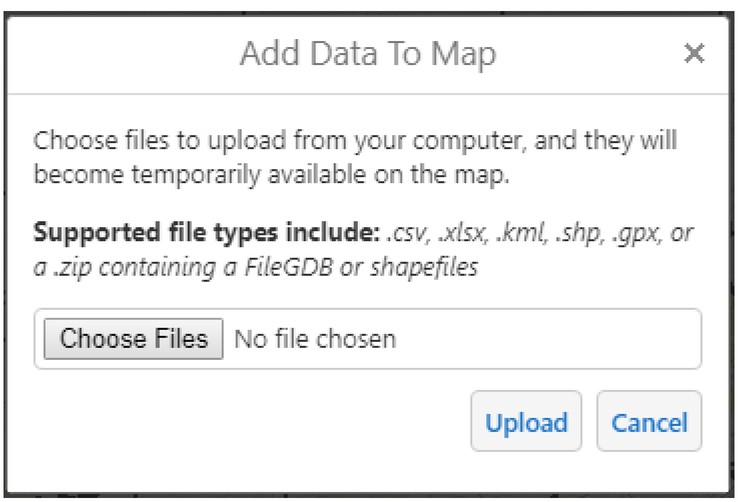


5. The system will launch a browser tab with the service information. Copy the URL.



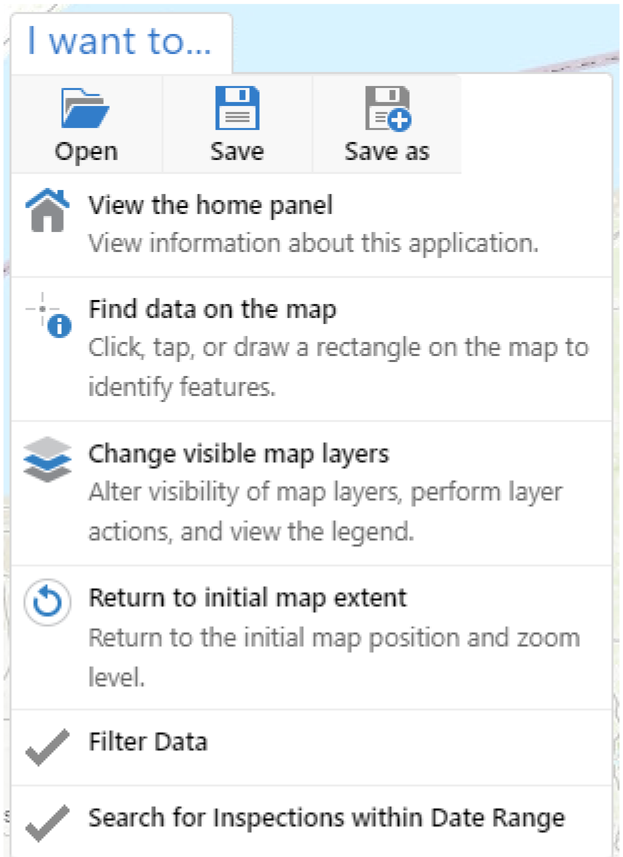
Upload Data

The Upload Data tool opens a popup, displayed below, that allows users to add data to the application by following the prompts in the popup. Note that there are specific requirements for the formatting of data provided for uploading, depending upon the file type.



4.3 Other Workflows

The "I Want To…" button expands to give users access to frequently needed application functions. The options are displayed below:



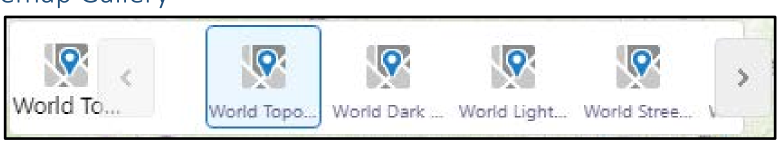
Save Project

The Save, Save As, and Open buttons allow users to save their own modified versions of the app after adding additional layers or adding mark ups. To use the tool:

- Click the Save or Save As button
- The Save Project panel is displayed in the left side of the application
- Enter a project name, and description, then click the Save button.

After the app is saved, click the Open button to open the project.

Basemap Gallery



When clicked, the Basemap Gallery widget expands to the image above. From this position users can select a different basemap to use in the application.

Coordinates and Scale

The Coordinates and Scale widgets, at the bottom of the application, will expand to the layout pictured above when clicked.

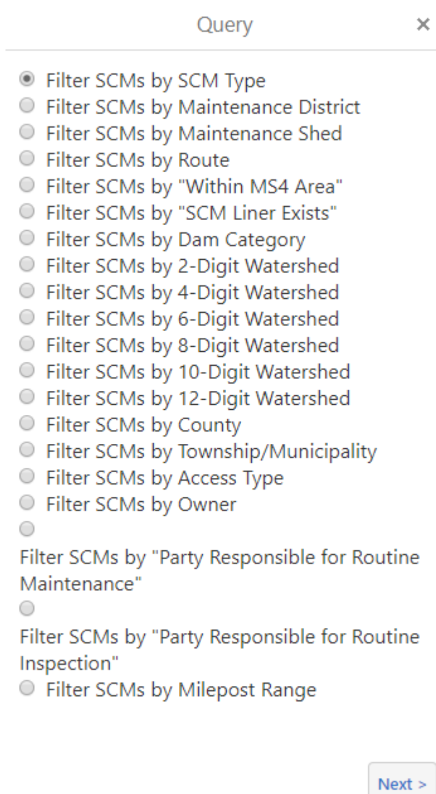
The Coordinates widget allows users to determine the XY Coordinates at the mouse position on the map.

The Scale widget allows users to change the extents of the map to one of the preset options. *Note: the scale options are driven by the basemap, and are not configurable.*

Filter Data

The Filter Data option provides users with a series of predefined filters/queries, to query the Stormwater Control Measure (SCM) layer. To use this tool:

- Select the radio button for one of the available filters, and click Next.

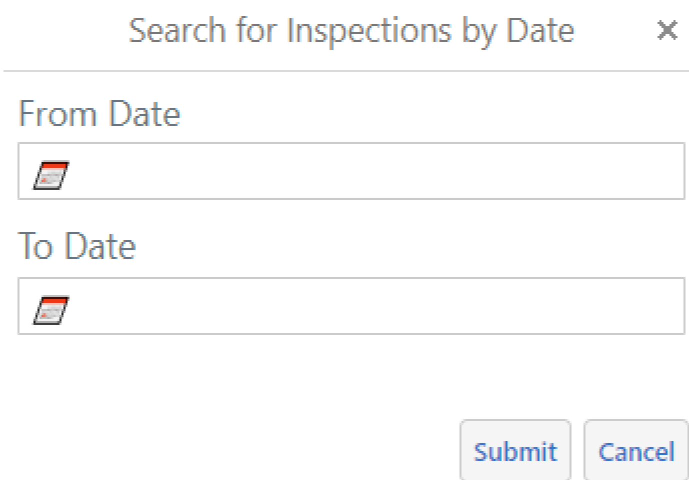


- The system will display a dropdown menu, that displays unique values of possible options. The values provided vary depending upon the filter selected.
- Select a value, and click Submit.
- The system will display a list of SCMs matching the filter.

Search for Inspections within Date Range

The Search for Inspections by Date filter allows users to view a list of SCMs that have an inspection (including both annual / routine inspections, and field view inspections) within a given date range. To use the tool:

- Enter a From Date
- Enter a To Date
- Click Submit. The system displays a list of SCMs that have an inspection within the given date range.



5 Data Loss Prevention

PTC has taken careful consideration to architect and manage the system to reduce the likelihood of loss of data. However, no system is immune from the possibility. This section will identify potential threats to data integrity, and discuss mitigation strategies.

The most likely causes of potential data loss include, but are not limited to, the following:

- Deletion an ArcGIS Online user who owns stormwater content
- An irregular interaction during data movement between one of the system components
- Corruption of the database, including the hosted ArcGIS Online database, or the PTC on-premise SQL database

Collectively, these threats are mitigated by introducing redundancy in the data, and making regular backups to a separate location. Specifically, data to be backed up include:

- ArcGIS Online database
- PTC on-premise SQL database
- Survey123 inspection form

ArcGIS Online Database
The ArcGIS Online database will be backed up weekly to the PTC Server CVGISADMIN. Backups will be performed by PTC Engineering. A total of eight (8) backups will be maintained; as a new backup is created, the oldest backup will be deleted.

For details to backup the database, refer to the first step in *Appendix A – Manual Data Synchronization*. For semi-permanent database backups, the backup should be archived to a static directory.

PTC SDE Database
The SDE database is backed up as part of PTC IT's overall server management. The stormwater data held within SDE will be backed up according to the schedule and logic defined by PTC IT.

Survey Form and Collector Web Map
The Survey form and Collector web maps are a static component of the system, in that upon initial configuration, these components are not expected to change except occasionally. As such, the Survey form and Collector web map will be backed up once, upon initial configuration of the production form and web map. Future back ups will be made only upon enhancement of these components. Those back ups will be performed by PTC Engineering, and will overwrite any existing back up file. Backups will be stored on ArcGIS Online.

6 Appendix A – Manual Data Synchronization

ArcGIS Online is a separate and disconnected from the PTC's on-premise SQL database. When data is published to ArcGIS Online from an on-premise SQL database, there is no longer a relationship between the ArcGIS Online database and the on-premise database, as there is when services are published to an ArcGIS Server. A synchronization effort must be executed, to move edits and updates from ArcGIS Online to the on-premise SQL database. This synchronization effort consists of several tasks that will be performed sequentially. The tasks to be performed are summarized below:

- Append – *Adding records to the target dataset, without deleting any records*
- Delete and Append – *Delete all records within the target dataset, then append all records to the target dataset*
- Delete – *Delete all records within the target dataset*

There are several software applications and tools available to manipulate the ArcGIS Online and on-premise SQL database. ArcGIS Pro is the preferred software for performing these data manipulations and synchronizations, and the following procedures document the steps necessary to execute the synchronization process:

- ☐ Open ArcGIS Pro and create a new project
- ☐ Add a new map to the project.
- ☐ Add the Stormwater Service from ArcGIS Online to the map, using this URL: http://paturnpike.maps.arcgis.com/home/item.html?id=8e22b711da37479bbb041d1fc2b6a450
- ☐ Connect to the production database at CVGISENTDBP1

Create Temporary Backup File

- ☐ Within ArcGIS Pro, execute the Copy geoprocessing tool. Copy the following feature classes:
    - SW_CONVEYANCE
    - SW_SCM_CENTROID
    - SW_SCM_DA
    - SW_SEWERSHED
    - SW_STORMWATER_CONTROL_MEASURE
    - SW_STRUCTURES

      All related tables will also be included in the backup. Specify a location on the local machine to place the export. After the synchronization process has successfully been completed, the local backup can be deleted.

Append Data from ArcGIS Online to On-Premise SQL Database

Each action is performed against a subset of database tables. The actions taken per table are identified in *Appendix C – Synchronization Details*. Reference this table, and for each table identified therein, apply the appropriate steps, below.

- ☐ Execute the *Delete and Append All* process. For each table:
    - Use the Delete Rows geoprocessing tool to delete all records from within the on-premise SQL database. Be sure to preserve the table itself.
    - Use the Append geoprocessing tool to append all data records from the corollary ArcGIS Online table, to the on-premise SQL database table.
- ☐ Execute the *Append* process. For each table:

   - Use the Append geoprocessing tool to append all data records from the corollary ArcGIS Online table, to the on-premise SQL database table.

Delete Records from ArcGIS Online

After the append tasks are executed, additional tasks are executed against the ArcGIS Online database. The purpose of this is to clear the inspection data from ArcGIS Online – this allows the next synchronization process to execute cleanly and simply.

The actions taken per table are identified in *Appendix C – Synchronization Details*.

- Execute the *Delete* process. For each table:
   - Use the Delete Rows geoprocessing tool to delete all records from within the ArcGIS Online database. Be sure to preserve the table itself.

The following image represents a high-level overview of the manual synchronization process:

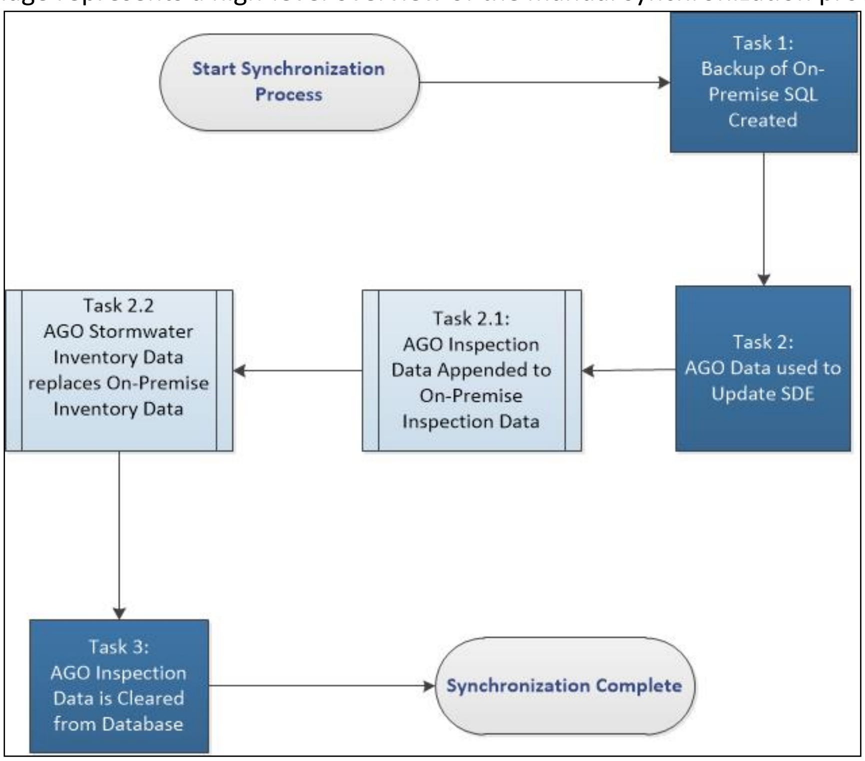


Figure 2

The synchronization process enforces that data only travels in one direction - from ArcGIS Online, down to the on-premise SQL database. There will never be data added or edited directly to the on-premise SQL database. This means that the on-premise SQL database should never have to publish data or services back to ArcGIS Online.

7 Appendix B – Data Load Details

The following table identifies the source from which each data element will be populated. Possible sources include:

- **System** – automatically populated by the system, as needed. No user input is required.
- **Calculated** – edits that are performed by the individual performing the data load, with only GIS layers or information needed as inputs. These edits may be done in batch, and primarily include reference layer overlays such as watersheds and county name.
- **User Input** – populated by the individual performing the data load. These fields are populated on an as-needed basis only, and may be specific to the individual feature.
- **Engineering** – these data elements will be required to be sourced from the designer

Table 1 - SCM Centroids Load Details

Field Name	Data Source
OBJECTID *	System
SCM_ID	Calculated
LATITUDE	Calculated
LONGITUDE	Calculated
Create Date	System
CREATOR	System
Edit Date	System
EDITOR	System
GlobalID *	System
ACTIVE FLAG	User Input
SCM NAME	Calculated
COMMENTS	User Input
CONSTRUCTION CONTRACT	Engineering
COUNTY	Calculated
DESIGN CONTRACT	Engineering
DISCHARGE POINT	Engineering
FILENAME	Engineering
FILENAME LAYER	Engineering
MAINTAINED BY	Engineering
MILEPOST	Calculated
NPDES PERMIT NUMBER	Engineering
OFFSET FROM CENTERLINE ALIGNMENT	Engineering
ORIGINAL DESIGN CONSULTANT	Engineering
OWNER	Engineering
PCSM PLAN NUMBER	Engineering
DISCHARGE DESTINATION	User Input
RETROFIT DESIGN CONSULTANT	Engineering
TOWNSHIP / MUNICIPALITY	Calculated
YEAR OF RETROFIT	Engineering
SCM TYPE	Engineering
IN KARST AREA	Calculated
PLANS EXIST	Calculated

Field Name	Data Source
POST CONSTRUCTION STORMWATER REPORT	User Input
INSPECTED BY	User Input
WESTWARD EXPANSION PROJECT	Calculated
WITHIN MS4 AREA	Calculated
WITHIN URBAN AREA	Calculated
DIRECTION	Calculated
DISTRICT	Calculated
BANK MATERIAL	Engineering
BOTTOM MATERIAL	Engineering
FEATURE STATUS	Engineering
MAINTENANCE NUMBER TYPE	Engineering
NPDES PERMIT TYPE	Calculated
ROUTE	Calculated
12-DIGIT WATERSHED	Calculated
8-DIGIT WATERSHED	Calculated
SCM DEPTH	Engineering
SCM LENGTH	Engineering
SCM SLOPE	Engineering
SCM VOLUME	Engineering
SCM WIDTH	Engineering
SPILLWAY PIPE DOWNSTREAM ELEVATION	Engineering
SPILLWAY PIPE UPSTREAM ELEVATION	Engineering
10-DIGIT WATERSHED	Calculated
6-DIGIT WATERSHED	Calculated
4-DIGIT WATERSHED	Calculated
2-DIGIT WATERSHED	Calculated
SCM LEGACY NAME	Calculated
ST ROUTE NO	Calculated
SECTION	Calculated
SURFACE AREA	Engineering
DATE OF PROJECT COMPLETION	Calculated
DATE NOT RECEIVED	Calculated
DATE OF WARRANTY END	Calculated
DISCHARGE_STRUCTURE	User Input
Shape *	System

Table 2 - SCM Load Details

Field Name	Data Source
OBJECTID *	System
BB	User Input
EMBANK	User Input
SLOPE	User Input

Field Name	Data Source
FENCING	User Input
GATES	User Input
SIGN	User Input
OBS	User Input
SCM_NAME	Calculated
created_user	System
created_date	System
last_edited_user	System
last_edited_date	System
LAWN	User Input
SMEAD	User Input
TMEAD	User Input
SCRUB	User Input
FOREST	User Input
ORNAM	User Input
P_SCM	User Input
PWO_FORE_COUNT	User Input
CC_FORE_COUNT	User Input
CCWO_FORE_COUNT	User Input
SF_FORE_COUNT	User Input
SFWO_FORE_COUNT	User Input
S_FORE_COUNT	User Input
SWO_FORE_COUNT	User Input
PFORE_COUNT	User Input
LOW_FLOW	User Input
ESPILL	User Input
DISCH	User Input
PO_TRASH	User Input
SO_TRASH	User Input
GlobalID *	System
ESPILL_TYPE	User Input
SED_MARKER	User Input
LOW_FLOW_ORF	User Input
SYS_LOC	User Input
LAT	Calculated
LONG	Calculated
ACCESS TYPE	User Input
SCM LINER	User Input
DAM_CAT	User Input
SCM_LEGACY_NAME	User Input
PRIMARY OUTFLOW	User Input
SECONDARY OUTFLOW	User Input
Shape *	System
Shape_Length	System
Shape_Area	System

Table 3 - Structures Load Details

Field Name	Data Source
OBJECTID *	System
ACTIVE FLAG	User Input
COMMENTS	User Input
COUNTY	Calculated
FILENAME	Engineering
FILENAME LAYER	Engineering
LATITUDE	Calculated
LOCATION	Calculated
LONGITUDE	Calculated
MAINTAINED BY	Engineering
MILEPOST	Calculated
OFFSET FROM CENTERLINE ALIGNMENT	Engineering
OWNER	Calculated
STRUCTURE NUM	Calculated
TOWNSHIP / MUNICIPALITY	Calculated
DISCHARGE POINT	Engineering
WITHIN MS4 AREA	Calculated
WITHIN URBAN AREA	Calculated
DIRECTION	Calculated
DISTRICT	Calculated
FEATURE_STATUS	Calculated
ROUTE	Calculated
STRUCTURE TYPE	Engineering
12-DIGIT WATERSHED	Calculated
8-DIGIT WATERSHED	Calculated
INSTALLATION DATE	Engineering
Create Date	System
CREATOR	System
Edit Date	System
EDITOR	System
GlobalID *	System
Shape *	System

Table 4 - Conveyances Load Details

Field Name	Data Source
OBJECTID *	System
ACTIVE FLAG	User Input
COMMENTS	User Input
CONVEYANCE NUM	Engineering
FILENAME	Engineering
FILENAME LAYER	Engineering

Field Name	Data Source
LOCATION	Calculated
LOCATION SOURCE	Calculated
MAINTAINED BY	Engineering
NEW ID	Engineering
OWNER	Engineering
WITHIN MS4 AREA	Calculated
WITHIN URBAN AREA	Calculated
CONVEYANCE TYPE	Engineering
DISTRICT	Calculated
FEATURE_STATUS	Calculated
12-Digit Watershed	Calculated
8-Digit Watershed	Calculated
INSTALLATION DATE	Engineering
UPSTREAM STRUCTURE	Calculated
DOWNSTREAM STRUCTURE	Calculated
Create Date	System
CREATOR	System
Edit Date	System
EDITOR	System
GlobalID *	System
Shape *	System
Shape_Length	System

8 Appendix C – Synchronization Details

The following table identifies the actions needed as part of the synchronization from ArcGIS Online to the on-premise geodatabase. The actions needed to occur are specific to the individual table. The objective in managing the inspection data this way is to reduce the overall ArcGIS Online footprint by moving inspection data (including, namely, inspection photos) to the on-premise geodatabase to reduce ongoing ArcGIS Online credit consumption and associated costs.

Table 5 – SDE Feature Classes and Tables

Name	Update Type in On-Premise SQL	Action in AGO after SDE Update
PTC.GISADMIN.SW_CONVEYANCES	Delete and Append All	No Action
PTC.GISADMIN.SW_SCM_CENTROID	Delete and Append All	No Action
PTC.GISADMIN.SW_SCM_DA	Delete and Append All	No Action
PTC.GISADMIN.SW_SEWERSHED	Delete and Append All	No Action
PTC.GISADMIN.SW_STORMWATER_CONTROL_MEASURE	Delete and Append All	No Action
PTC.GISADMIN.SW_STRUCTURES	Delete and Append All	No Action
PTC.GISADMIN.INSPECTION	Append	Delete
PTC.GISADMIN.BB_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.BB_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.BB_PHOTOS	Append	Delete
PTC.GISADMIN.BB_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.CC_FORE_COMP	Append	Delete
PTC.GISADMIN.CC_FORE_COMP__ATTACH	Append	Delete
PTC.GISADMIN.CC_FORE_COMP_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.CC_FORE_COMP_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.CC_FORE_COMP_PHOTOS	Append	Delete
PTC.GISADMIN.CC_FORE_COMP_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.CCWO_FORE_COMP	Append	Delete
PTC.GISADMIN.CCWO_FORE_COMP__ATTACH	Append	Delete
PTC.GISADMIN.CCWO_FORE_COMP_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.CCWO_FORE_COMP_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.CCWO_FORE_COMP_PHOTOS	Append	Delete
PTC.GISADMIN.CCWO_FORE_COMP_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.DISCH_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.DISCH_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.DISCH_PHOTOS	Append	Delete
PTC.GISADMIN.DISCH_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.EMBANK_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.EMBANK_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.EMBANK_PHOTOS	Append	Delete
PTC.GISADMIN.EMBANK_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.ESPILL_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.ESPILL_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.ESPILL_PHOTOS	Append	Delete
PTC.GISADMIN.ESPILL_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.FENCING_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.FENCING_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.FENCING_PHOTOS	Append	Delete
PTC.GISADMIN.FENCING_PHOTOS__ATTACH	Append	Delete

Name	Update Type in On-Premise SQL	Action in AGO after SDE Update
PTC.GISADMIN.FOREST_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.FOREST_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.FOREST_PHOTOS	Append	Delete
PTC.GISADMIN.FOREST_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.GATES_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.GATES_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.GATES_PHOTOS	Append	Delete
PTC.GISADMIN.GATES_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.INSP_PERSONS_PRESENT	Append	Delete
PTC.GISADMIN.LAWN_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.LAWN_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.LAWN_PHOTOS	Append	Delete
PTC.GISADMIN.LAWN_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.LOW_FLOW_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.LOW_FLOW_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.LOW_FLOW_PHOTOS	Append	Delete
PTC.GISADMIN.LOW_FLOW_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.OBS_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.OBS_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.OBS_PHOTOS	Append	Delete
PTC.GISADMIN.OBS_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.ORNAM_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.ORNAM_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.ORNAM_PHOTOS	Append	Delete
PTC.GISADMIN.ORNAM_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.OV_PHOTOS	Append	Delete
PTC.GISADMIN.OV_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.P_SCM_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.P_SCM_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.P_SCM_PHOTOS	Append	Delete
PTC.GISADMIN.P_SCM_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.PFORE_COMP	Append	Delete
PTC.GISADMIN.PFORE_COMP__ATTACH	Append	Delete
PTC.GISADMIN.PFORE_COMP_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.PFORE_COMP_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.PFORE_COMP_PHOTOS	Append	Delete
PTC.GISADMIN.PFORE_COMP_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.PO_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.PO_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.PO_PHOTOS	Append	Delete
PTC.GISADMIN.PO_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.PO_TRASH_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.PO_TRASH_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.PO_TRASH_PHOTOS	Append	Delete
PTC.GISADMIN.PO_TRASH_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.PWO_FORE_COMP	Append	Delete
PTC.GISADMIN.PWO_FORE_COMP__ATTACH	Append	Delete
PTC.GISADMIN.PWO_FORE_COMP_MAINT_REPAIR	Append	Delete

Name	Update Type in On-Premise SQL	Action in AGO after SDE Update
PTC.GISADMIN.PWO_FORE_COMP_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.PWO_FORE_COMP_PHOTOS	Append	Delete
PTC.GISADMIN.PWO_FORE_COMP_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.S_FORE_COMP	Append	Delete
PTC.GISADMIN.S_FORE_COMP__ATTACH	Append	Delete
PTC.GISADMIN.S_FORE_COMP_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.S_FORE_COMP_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.S_FORE_COMP_PHOTOS	Append	Delete
PTC.GISADMIN.S_FORE_COMP_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.SCRUB_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.SCRUB_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.SCRUB_PHOTOS	Append	Delete
PTC.GISADMIN.SCRUB_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.SF_FORE_COMP	Append	Delete
PTC.GISADMIN.SF_FORE_COMP__ATTACH	Append	Delete
PTC.GISADMIN.SF_FORE_COMP_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.SF_FORE_COMP_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.SF_FORE_COMP_PHOTOS	Append	Delete
PTC.GISADMIN.SF_FORE_COMP_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.SFWO_FORE_COMP	Append	Delete
PTC.GISADMIN.SFWO_FORE_COMP__ATTACH	Append	Delete
PTC.GISADMIN.SFWO_FORE_COMP_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.SFWO_FORE_COMP_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.SFWO_FORE_COMP_PHOTOS	Append	Delete
PTC.GISADMIN.SFWO_FORE_COMP_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.SIGN_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.SIGN_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.SIGN_PHOTOS	Append	Delete
PTC.GISADMIN.SIGN_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.SLOPE_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.SLOPE_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.SLOPE_PHOTOS	Append	Delete
PTC.GISADMIN.SLOPE_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.SMEAD_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.SMEAD_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.SMEAD_PHOTOS	Append	Delete
PTC.GISADMIN.SMEAD_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.SO_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.SO_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.SO_PHOTOS	Append	Delete
PTC.GISADMIN.SO_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.SO_TRASH_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.SO_TRASH_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.SO_TRASH_PHOTOS	Append	Delete
PTC.GISADMIN.SO_TRASH_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.SW_CASING	Delete and Append All	No Action
PTC.GISADMIN.SW_CLEAN_OUT	Delete and Append All	No Action
PTC.GISADMIN.SW_CONTROL_STRUCTURE	Delete and Append All	No Action

Name	Update Type in On-Premise SQL	Action in AGO after SDE Update
PTC.GISADMIN.SW_CONTROL_VALVE	Delete and Append All	No Action
PTC.GISADMIN.SW_DITCH	Delete and Append All	No Action
PTC.GISADMIN.SW_FITTING	Delete and Append All	No Action
PTC.GISADMIN.SW_GRAVITY_MAIN	Delete and Append All	No Action
PTC.GISADMIN.SW_IDDE	Delete and Append All	No Action
PTC.GISADMIN.SW_INLETS	Delete and Append All	No Action
PTC.GISADMIN.SW_MANHOLES	Delete and Append All	No Action
PTC.GISADMIN.SW_OBSERVATION	Delete and Append All	No Action
PTC.GISADMIN.SW_OUTFALLS	Delete and Append All	No Action
PTC.GISADMIN.SW_SYSTEM_VALVE	Delete and Append All	No Action
PTC.GISADMIN.SWO_FORE_COMP	Append	Delete
PTC.GISADMIN.SWO_FORE_COMP__ATTACH	Append	Delete
PTC.GISADMIN.SWO_FORE_COMP_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.SWO_FORE_COMP_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.SWO_FORE_COMP_PHOTOS	Append	Delete
PTC.GISADMIN.SWO_FORE_COMP_PHOTOS__ATTACH	Append	Delete
PTC.GISADMIN.TMEAD_MAINT_REPAIR	Append	Delete
PTC.GISADMIN.TMEAD_MAINT_REPAIR__ATTACH	Append	Delete
PTC.GISADMIN.TMEAD_PHOTOS	Append	Delete
PTC.GISADMIN.TMEAD_PHOTOS__ATTACH	Append	Delete

9 Appendix D – System Architecture Diagram

The following diagram documents the architecture in place to view and edit stormwater data:

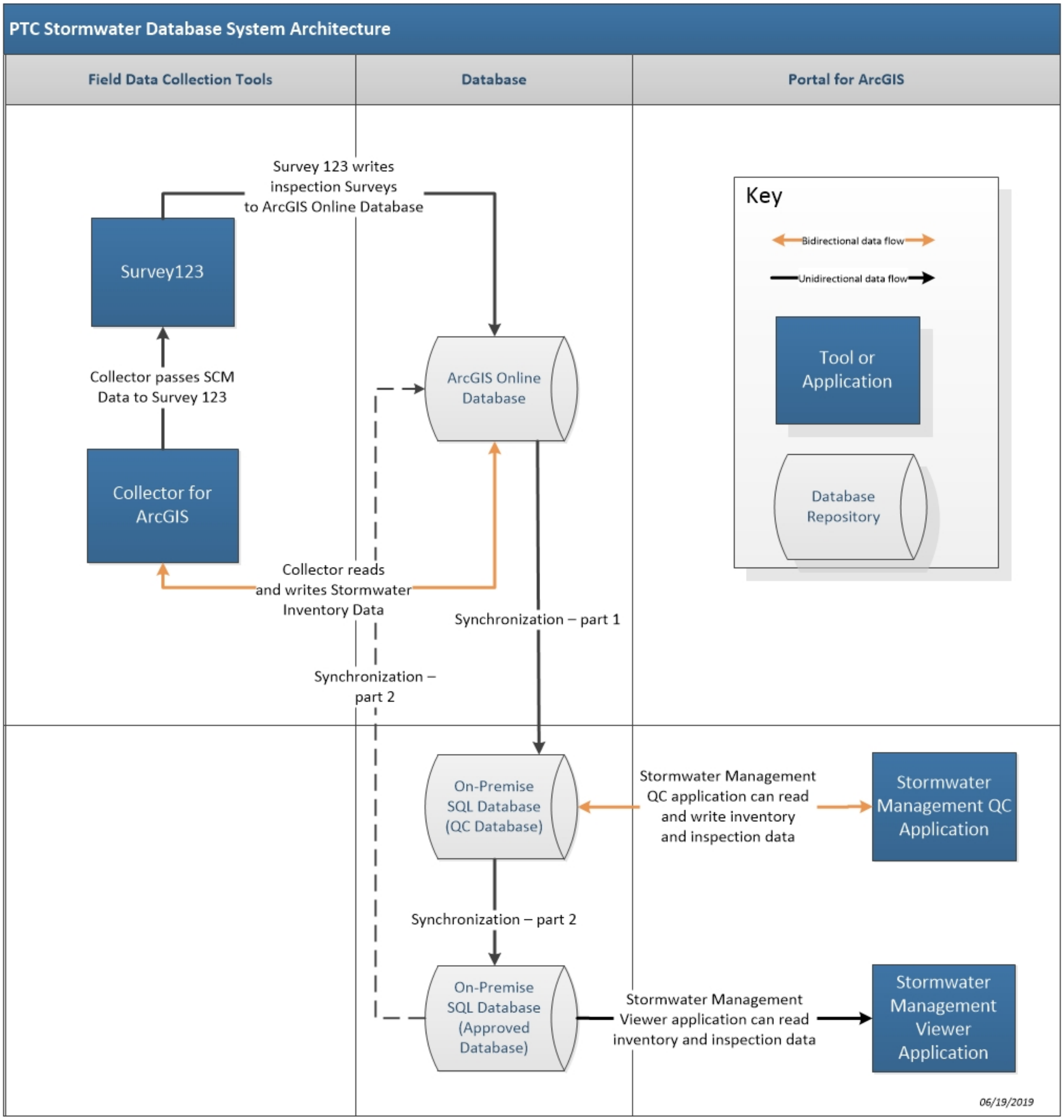


Figure 3

10 Appendix E – Data Transfer Routines Specifications

Server Locations

Both data transfer routines (Stage 1 / ArcGIS Online to QC, and Stage 2 / QC to SDE) run on the PTC server CVGISPRTLP.

The executables and related files are at: C:\inetpub\wwwroot\stormwater.

Windows Scheduled Task (Stage 1 / ArcGIS Online to QC)

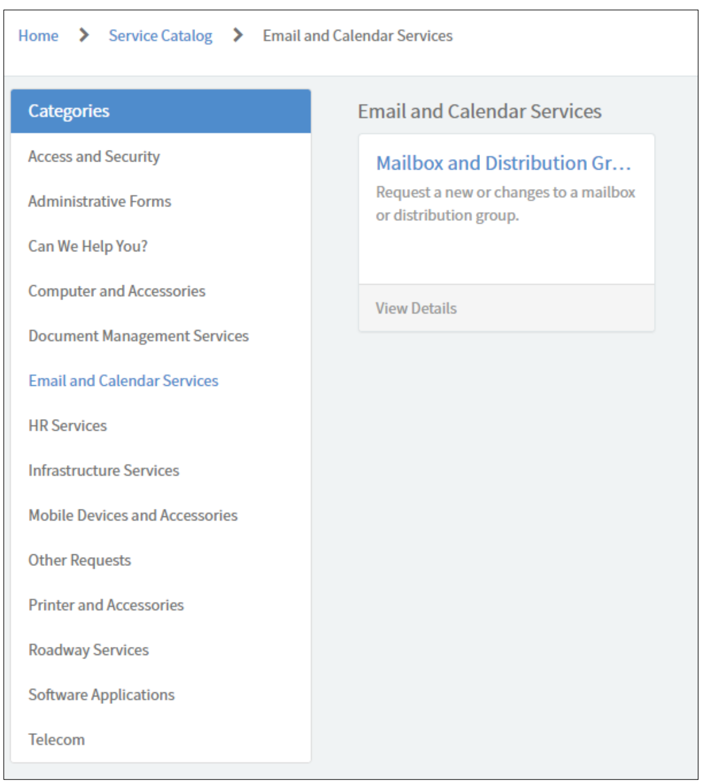
A Windows scheduled task executes Stage 1 / AGO to QC weekly, on Sunday at 1:00AM. The scheduled task is on CVGISADMIN and is named *Stormwater QC - AGO Sync - PRD*.

Email Notifications

Upon successful and unsuccessful execution of the data transfer routines, the system sends an email to the stormwater team to notify them of task completion. The emails are sent to an AD group named *Stormwater Data Sync*, which includes the following individuals:

- James Kaiser, Jr.
- Robert Loncar
- Nicholas Noss
- Erik Johnson
- Lee Ensminger

To modify members of this AD group, submit a ServiceNow ticket under the Mailbox and Distribution Group Services category.



11 Frequently Asked Questions

1. **Q:** How do I get an ArcGIS Online account?

   A: If you have an existing PTC account, including email address, submit a ServiceNow request for ArcGIS Online access. Please be sure to describe the reason for the request. If you do not have an existing PTC account, or do not have an email associated to your account, coordinate with your PTC liaison to request and receive a PTC Active Directory Account.

2. **Q:** I need to be able to perform the synchronization process manually. How do I get ArcGIS Pro installed on my machine?

   A: Submit a ServiceNow request to have the software installed. You must also submit a second ServiceNow request, targeted for GeoAnalytics, to be provided with a license.

3. **Q:** I read the synchronization steps, but I'm still not sure how to execute the process.

   A: Technical help documentation is available on the web, at the links below. If additional assistance is required, contact Ken Juengling for assistance.

   - **Append**: http://pro.arcgis.com/en/pro-app/tool-reference/data-management/append.htm
   - **Delete Rows**: http://pro.arcgis.com/en/pro-app/tool-reference/data-management/delete-rows.htm
   - **Copy**: http://pro.arcgis.com/en/pro-app/tool-reference/data-management/copy.htm

4. **Q:** What browser should I be using?

   A: The functionality described in these SOPs is expected to work in Internet Explorer, as well as Edge and Chrome. Each browser carries nuances in the user experience, especially for more advanced interactions with the system such as generating reports and triggering the data transfer routines. PTC's standard browser is Internet Explorer. However, Edge and Chrome are more advanced browsers that offer better compatibility with more modern web applications, including the applications detailed in these SOPs.

5. **Q:** Something seems off – content is not loading properly in the web application, or I'm not seeing new data or content updates that I'm expecting to see.

   A: Three quick things to try are:
   1. Refresh the browser page
   2. Restart the browser and reload the application
   3. Clear web browser cache. To clear your cache, please visit one of the following web sites, depending on the browser in use:

a. Chrome: https://support.google.com/accounts/answer/32050?co=GENIE.Platform%3DDesktop&hl=en, or, with Dev Tools open (press the F12 key): https://developers.google.com/web/updates/2015/05/hard-reload

b. Edge: https://support.microsoft.com/en-us/help/10607/microsoft-edge-view-delete-browser-history

c. Internet Explorer: https://support.microsoft.com/en-us/help/17438/windows-internet-explorer-view-delete-browsing-history

6. **Q:** There are several places to edit or create data. What tool should I be using to edit or create data?

A: Use the following table for guidance in choosing the best tool:

	Field Tools	Stormwater Management QC	Stormwater Management Viewer
Edit attributes (e.g., SCM components)	X	X	
Modify geometry	X	X	
Create new feature*		X	
Perform SCM inspections	X		
Report on inspection conditions			X

**Creating new features can be performed in batch with GIS technical support*

APPENDIX B
SCM Inventory Data Fields

SCM Inventory Data Fields and Descriptions

Field No.	Field Name	Field Entry Type	Description
A	SCM ID	Text	A concatenation of Route, Milepost, Direction, Offset, and SCM Type. This is the official name of SCM features.
B	SCM LEGACY NAME	Text	The name of the SCM as it was referred to prior to implementation of the SCM ID field. This will generally be the identifier found on design plan documents (e.g., Basin 1).
C	DISTRICT	Domain Values	The PTC Maintenance District in which the SCM is located.
D	PREVIOUS NETWORK FOLDER NAME	Bookkeeping Field - Text	Name of the SCM-specific document folder on the PTC network prior to renaming the folder with the SCM ID.
E	HYPERLINK TO NEW FOLDER	Bookkeeping Field - Text	Hyperlink to the renamed (using SCM ID) SCM-specific document folder on the PTC network.
F	SCM TYPE	Domain Values	Indicates the type of SCM, as derived from the PA DEP Stormwater Best Management Practices manual and indicated in the PTC Design Consistency Guidelines.
G	FEATURE STATUS	Domain Values	The current status of the SCM as it relates to the SCM lifecycle.
H	PCSM PLANS EXIST	Domain Values	Indicates if Post Construction Stormwater Management Plans (PCSM) exist in the SCM-specific document folder on the PTC network.
I	E&S PLANS EXIST	Domain Values	Indicates if Erosion and Sedimentation (E&S) plans exist in the SCM-specific document folder on the PTC network.
J	DRAINAGE PLANS EXIST	Bookkeeping Field - Domain Values	Indicates if Drainage Plans exist in the SCM-specific document folder on the PTC network.
K	LANDSCAPE PLANS EXIST	Bookkeeping Field - Domain Values	Indicates if Landscape Plans exist in the SCM-specific document folder on the PTC network.
L	ROADWAY PLANS EXIST	Bookkeeping Field - Domain Values	Indicates if Roadway Plans exist in the SCM-specific document folder on the PTC network.
M	POST CONSTRUCTION STORMWATER REPORT	Domain Values	Indicates if there is a Post Construction Stormwater Management Report (calculations) in the SCM-specific document folder on the PTC network.
N	SLI BOOKKEEPING NOTES	Bookkeeping Field - Text	Notes to capture assumptions or observations discovered during data inventory and/or data field entry.
O	COMMENTS	Text	General comments related to the SCM. Comments should be focused on inventory-related information. May included additional location information such as service plaza or interchange name.
P	CONSTRUCTION CONTRACT	Text	The contract (WBS element) under which the feature was constructed.

Q	DATE OF PROJECT COMPLETION	Text	The date on which the construction project was complete based on final inspection and acceptance from PTC Construction Engineering.
R	DESIGN CONTRACT	Text	The contract (WBS element) under which the feature was designed.
S	ORIGINAL DESIGN CONSULTANT	Text	The engineering consultant (prime) who designed the SCM for NPDES permit approval.
T	STATE ROUTE NUMBER	Text	Indicates the four digit state route on which the SCM is located for off-system SCMs. If between more than one, use nearest adjacent state route.
U	ECMS PROJECT NUMBER	Text	ECMS Project Number available in ECMS for PennDOT projects.
V	SCM ID	Text	A concatenation of Route, Milepost, Direction, Offset, and SCM Type. This is the official name of SCM features.
W	SCM LEGACY NAME	Text	The name of the SCM as it was referred to prior to implementation of the SCM ID field. This will generally be the identifier found on design plan documents (e.g., Basin 1).
X	SYSTEM LOCATION	Domain Values	Indicates if access to the SCM for maintenance is from on or off the PTC System.
Y	LATITUDE	Number	Latitude of SCM centroid.
Z	LONGITUDE	Number	Longitude of SCM centroid.
AA	TYPE OF ACCESS CODE	Domain Values	Type of vehicle access provided for maintenance of the SCM.
AB	SCM LINER	Domain Values	Liner used to limit water infiltration to adjacent soil. Located (and inspected when applicable) under SCM floor, cut slopes or impounding embankment areas of the SCM.
AC	DAM CATEGORY	Domain Values	The dam category for the SCM, if applicable.
AD	TURF: LAWN	Domain Values	A land cover classification dominated by well manicured grassy areas mowed to 4-inches and under in height, directly surrounding the SCM.
AE	TURF: SHORT MEADOW	Domain Values	A land cover classification dominated by grasses and sedges vegetation mix, mowed to a minimum of 8-inches in height.
AF	TURF: TALL MEADOW	Domain Values	A land cover classification dominated by grasses and sedges vegetation mix, mowed between 8 to 16-inches in height.
AG	SCRUB-SHRUB	Domain Values	A land cover classification dominated by woody vegetation less than 20 feet tall often stunted by environmental conditions.
AH	FOREST	Domain Values	A land cover classification dominated by tall, mature woody trees.
AI	SPECIAL PLANTINGS: ORNAMENTAL	Domain Values	Plantings established for providing aesthetic appeal. Ornamental plantings will often use native and non-native species. Includes individual or groupings of trees, shrubs,

			herbaceous (pots/plugs) outside of the SCM treatment zone typically surrounded by mulch.
AJ	SPECIAL PLANTINGS: SCM - VEGETATIVE	Domain Values	Vegetative plantings to support the function of the Stormwater Control Measure such as individual or groupings of trees, shrubs, live stakes, herbaceous (pots/plugs) within the SCM treatment zone typically surrounded by mulch.
AK	FOREBAY COUNT	Number	Count of SCM Forebays
AL	PIPE(S) COUNT	Number	Count of Pipe inflows to the SCM.
AM	CURB CUT COUNT	Number	Count of Curb Cut components.
AN	SHEET FLOW COUNT	Number	Count of major contributing areas of Sheet Flow.
AO	SWALE COUNT	Number	Count of Swale inflows to the SCM.
AP	SCM FLOOR	Domain Values	Main ponding, conveyance, and treatment area of a surface SCM. May include a layer of engineered (amended) soils or filter media in filtrating or infiltrating SCMs.
AQ	SUBSURFACE STORAGE	Domain Values	SCMs such as subsurface detention storage and subsurface infiltration trenches are designed to temporarily hold stormwater in a subsurface storage medium for infiltration, controlled release and/or reuse. The storage medium may consist of clean stone and/or storm pipes, vaults, and chambers. Subsurface storage systems may be incorporated below surface storage/filtration areas in combination surface/subsurface SCMs or, it may be a standalone subsurface SCM.
AR	LOW FLOW CHANNEL	Domain Values	Channel through an SCM basin occupied during smaller runoff events; typically dry between precipitations events.
AS	OBSERVATION WELL / CLEANOUT	Domain Values	An observation well is installed independent of underdrains and is used to observe subsurface water levels. Cleanouts are connected the underdrains and are used to observer subsurface water level and/or access underdrains.
AT	IMPOUNDING EMBANKMENT	Domain Values	Also known as berms, are “fill” material constructed above the surrounding ground forming a side wall of the SCM.
AU	CUT SLOPES	Domain Values	SCM side walls constructed by excavating below grade.
AV	EMERGENCY SPILLWAY	Domain Values	Provides an alternate path for water to escape the SCM during periods of high flow.
AW	EMERGENCY SPILLWAY TYPE	Domain Values	Emergency spillways can be constructed using different methods. Armored SCMs use riprap, concrete, or boulders, while vegetated will use low growing plants like grasses and trees to stabilize the spillway.

AX	SCM DISCHARGE POINT	Domain Values	Primary location where water leaves the outflow structure, typically a pipe tied to the outflow structure; includes the pipe immediately downstream of SCM and, where applicable, downstream l end section and rip-rap apron.
AY	FENCING	Domain Values	Protective barrier around the SCM to limit access from people and animals.
AZ	GATES/LOCK	Domain Values	Used to provide secure access to the SCM.
BA	PRIMARY OUTFLOW	Domain Values	Primary control structure designed to control discharge from the SCM. In SCMs with no structural controlled release feature, this is considered the downstream most point of the treatment area such as the end of a VSW or the lower edge of a VFS.
BB	PRIMARY OUTFLOW TRASH RACK	Domain Values	A rack used to prevent trash from entering the primary outflow structure.
BC	SECONDARY OUTFLOW	Domain Values	Secondary control structure designed to control discharge from the SCM, usually during periods of higher than normal flow.
BD	SECONDARY OUTFALL TRASH RACK	Domain Values	A rack used to prevent trash from entering the secondary outflow structure.
BE	SIGNAGE	Domain Values	Sign(s) used to indicate the presence and in some cases the extent of an SCM.
BF	SEDIMENT MARKER	Domain Values	A measuring device that indicates the level of sediment build up within an SCM.
BG	LOW FLOW ORIFICE	Domain Values	Small opening within the outflow structure that allows water to escape the SCM during times of low water flow; also controls the rate at which water discharges from the SCM
BH	UNDERDRAIN	Domain Values	Perforated pipe installed below filter media or stone storage media to effectively dewater the SCM.
BI	OFFSET FROM CENTERLINE ALIGNMENT	Number	Distance in feet measured from the SCM centroid to the centerline of the Route. This distance is measured perpendicular to the centerline unless the SCM is beyond the end of a Route (centerline).
BJ	COUNTY NAME	Domain Values	The county name in which the SCM is located, based on the SCM centroid.
Bk	DIRECTION	Domain Values	The direction of travel lane in which the SCM is located along the route.
BL	MAINTENANCE SHED	Text	Indicates the PTC maintenance section that the SCM is located in.
BM	MILEPOST	Number	Identifies the nearest milepost along the Route on which the SCM is located, based on the SCM centroid location. Milepost is determined via the intersection of a line from the SCM centroid to a point perpendicular to the centerline of the Route.

BN	ROUTE	Domain Values	The PTC route on which the SCM is located.
BO	TOWNSHIP / MUNICIPALITY	Text	The township or municipality in which the SCM is located.
BP	MAINTENANCE AND PROTECTION OF TRAFFIC (MAINTENANCE)	Domain Values	Indicates if Maintenance and Protection of Traffic (MPT) is required for routine maintenance activities at the SCM.
BQ	MAINTENANCE AND PROTECTION OF TRAFFIC (INSPECTION)	Domain Values	Indicates if Maintenance and Protection of Traffic (MPT) is required for inspection activities at the SCM.
BR	ACCESS DESCRIPTION	Text	Provides additional description to the ' TYPE OF ACCESS CODE' field.
BS	LOCATION DESCRIPTION	Text	On System designates PTC roadway access, while Off Systems designates no PTC roadway access.
BT	CURRENT INSPECTION FREQUENCY	Text	Indicates the number of regular inspections occurrences per year. For SCMs with non-standard O&M, this should match the 'INSPECTION FREQUENCY PER PCSM PLAN 1' field until a SCM Operation and Maintenance Determination form is completed. For SCMs set to standard Commission O&M policy, enter "Per policy."
BU	INSPECTION FREQUENCY NOTES	Text	Indicates pertinent inspection information not described in other data fields. Include any special requirements listed on the PCSM Plan.
BV	INSPECTION FREQUENCY PER PCSM PLAN 1	Domain Values	Indicates the number or regular occurrences per year, as noted on the PCSM Plan. Note, with the issuance of the PTC Stormwater Control Measure Operation and Maintenance Manual, standard language is being adapted. When the PCSM Plan contains "in accordance with Commission policy" standard language, select "Per policy.
BW	INSPECTION FREQUENCY PER PCSM PLAN 2	Domain Values	Indicates other events that may trigger an inspection, as noted on the PCSM Plan.
BX	NEXT INSPECTION TYPE	Domain Values	
BY	INSPECTION PHASE	Domain Values	
BZ	ROUTINE INSPECTION BY	Domain Values	The organization, agency, or business unit responsible for inspecting the SCM.
CA	CORRECTIVE MAINTENANCE BY	Domain Values	The organization, agency, or business unit that performs corrective maintenance activities on the SCM.
CB	ROUTINE MAINTENANCE BY	Domain Values	The organization, agency, or business unit that performs maintenance activities on the SCM.
CC	LEGAL OWNER CODE	Domain Values	The SCM legal owner type according to plans or agreements. Typically PA Turnpike when within the legal right-of-way.
CD	LEGAL OWNER NAME	Text	The legal owner name according to plans or agreements.

CE	SCM O&M DETERMINATION FORM DATE	Text	Indicates the date on is which the Registered Professional approved the SCM Operation & Maintenance Determination Form.
CF	NPDES PERMIT NUMBER	Text	The NPDES permit number under which the SCM was constructed.
CG	NPDES PERMIT TYPE	Domain Values	The NPDES permit type associated with the SCM.
CH	DATE NOTICE OF TERMINATION RECEIVED	Text	The date on which Notice of Termination (NOT) was received for the project. If null, then not received.

APPENDIX C
Existing SCM Operation and Maintenance Determination Form

EXISTING STORMWATER CONTROL MEASURE OPERATION AND MAINTENANCE DETERMINATION

SCM Type Code: ________ SCM ID: ____________________ Latitude/Longitude: _____________/ _____________

Route/Milepost: _________ /_______ County: _____________ Maint. District: ____________ Yr. Constructed: _______

Determination Made Using (check all that apply): ☐ PCSM Plan ☐ PCSM Report ☐ Maintenance Testimony

☐ Other Plan: ___________________________ ☐ Other: ____

SCM Evaluation

Design Limitations

(1) Drainage area loading ratios exceeds DEP guidance (N/A for non-infiltrating/filtrating SCMs)? ☐ Yes ☐ No ☐ N/A

Impervious drainage area loading ratio:____:1 (5:1 BID max) Overall drainage area loading ratio:____:1 (8:1 BID max)

Comments: ____

____

(2) Pre-treatment present? ☐ Yes ☐ No Type: ____

Comments: ____

(3) Non-standard design is dissimilar to a common SCM type? ☐ Yes ☐ No

If yes, describe:____

____

(4) Proprietary SCM defaults to manufacturer's O&M guidelines? ☐ Yes ☐ No Inspection Freq.: ______________

(5) Do other conditions exist that may limit the applicability of standard O&M procedures? ☐ Yes ☐ No

Comments: ____

____

Site Limitations

(1) Is the SCM located in karst terrain? ☐ Yes ☐ No If yes answer following:

Is the SCM designed to infiltrate? ☐ Yes ☐ No Is the SCM lined? ☐ Yes ☐ No

Design ponding depth: ____ feet Depth to bedrock: ____ feet

Comments: ____

(2) History of vandalism or illegal dumping at SCM site? ☐ Yes ☐ No Contact: _____________________________

Describe: ____

____

(3) SCM has history of intensive O&M needs to maintain function? ☐ Yes ☐ No Contact: ____________________

Describe: ____

____

(4) Are other site conditions present that may limit the applicability of the uniform O&M procedures? ☐ Yes ☐ No

Comments: ____

____

Site Specific Agreements

(1) Are there site-specific agreements associated with the SCM mandating specific O&M requirements? ☐ Yes ☐ No

If yes, is the agreement with a: ☐ Municipality ☐ Private entity ☐ PennDOT ☐ Other

Name of entity agreement is with: ______________________________

List specific O&M requirements included:______________________________

____

____

____

Inspection Frequency Determination

Current Inspection Frequency: ☐ Cycle: ______ per year or every ______ years ☐ None

☐ Event-Based Requirement: ________________ ☐ None

☐ No Inspection Requirements Specified

Recommended Inspection Cycle: ☐ No Change ☐ Cycle: ______ per year or every ______ years

☐ PTC Standard Inspection Cycle

Justification: ______________________________

____

____

Special Maintenance Determination

☐ No special maintenance is necessary to maintain SCM function. PTC's standard routine maintenance procedures for this SCM type are adequate.

☐ Special maintenance items exist on the plan and are documented below.

(1) Maintenance Item: ______________________________

____

Justification: ______________________________

(2) Maintenance Item: ______________________________

____

Justification: ______________________________

(3) Maintenance Item: ______________________________

____

Justification: ______________________________

Certification

☐ I certify that the recommended inspection cycle is appropriate for this SCM. Special maintenance items, if any, have been documented for review by PTC Engineering.

Evaluator: ______________ ______________ ______________ ______________

Print Name Signature Prof. Cert. Date

APPENDIX D
SCM Inspection Standard Operating Procedures

Pennsylvania Turnpike Commission

Stormwater Control Measure (SCM) Inspections

Standard Operating Procedures

DATE... May 12, 2020

DOCUMENT VERSION......................... Draft

PREPARED BY.................................. KCI Technologies

Contents

1 Introduction

The Pennsylvania Turnpike Commission (PTC) leverages a commercial off-the-shelf system to conduct field data collection in support of its stormwater program. This system, including Esri's *Collector for ArcGIS* and *Survey123 for ArcGIS*, have been configured specifically to support the PTC's stormwater program, focusing on inspections of Stormwater Control Measures (SCMs).

This guide details the steps and processes necessary to deploy the SCM inspection system and effectively conduct SCM inspections in the field. It will document practical procedures that will assist inspectors in performing the inspections in alignment with PTC standards and will complement users' existing subject matter expertise to produce consistent and quality SCM inspection results.

2 Inventory

2.1 Current Inventory Status

The master stormwater inventory consists of GIS-based data sets, including SCMs, structures such as inlets and manholes, and conveyances such as pipes and swales. The current stormwater inventory is a result of digitizing design plan sheets, migration of legacy spreadsheets and tables, and historical inspection information. As a whole, the stormwater inventory should not be considered complete but is a work in progress and continually undergoes review and updates. Within the stormwater network overall, however, the SCM specific data set (SCM inventory) routinely undergoes thorough review, and inspectors should consider the SCM inventory to be up to date and accurate.

The master stormwater inventory is stored in an enterprise spatial database based upon the Esri ArcGIS platform. The SCM inventory consists primarily of two database entities:

1. **Stormwater Control Measures** : Polygon features, representing the footprint of the SCM. The SCM features carry key inventory attributes such as SCM ID, SCM Name, Access Type, etc., as well as component information . These attribute fields are described further in section 4.2 and the component information is discussed in section 4.1.
2. **SCM Centroids**: Each SCM polygon has one related centroid. Centroids are point features, with attributes storing ancillary locational information such as watersheds, PTC maintenance districts, county name, etc.

2.2 SCM Inventory Update Process

Over time, construction projects may impact the SCM inventory by yielding new SCMs that must be appended to the database, or may cause SCMs to be taken out of service. A specific workflow process is in place within the PTC to identify these impacts, and make the appropriate updates to the SCM inventory in a timely fashion.

Because this SCM inventory is carefully curated, inspectors in the field should not make assumptions to update or otherwise edit an SCM's feature status, ownership information, or location.

Information that is appropriate to update in the field is specifically identified in section 4.2.

3 Inspection Software and Data Platform

Prior to using the system to conduct inspections in the field, users must:

1. Obtain a PTC ArcGIS Online Account
2. Download and install the inspection software on the field devices

3.1 PTC ArcGIS Online Account

The PTC ArcGIS Online account must be configured by the PTC CADD/GIS Specialist, and provided to the inspector. Each field crew lead should have a unique PTC ArcGIS Online account.

This account information should be provided to the inspectors as part of the task setup and coordination. If users have not received this information, contact the PTC CADD/GIS Specialist (refer to section 5.1.

3.2 Installation

Inspectors will perform inspections using two commercial off-the-shelf applications that have been configured specifically for the PTC's stormwater program: *Collector for ArcGIS*, and *Survey123 for ArcGIS*. Both applications are available for Windows, Android, and iOS operating systems.

- *Collector for ArcGIS* is an application that allows users to add, delete, and update spatial data and related attributes directly on a map interface.
- *Survey123* is a form-centric, data collection application.

The two applications are used in tandem to allow inspectors to view features on a map, view attributes and data about those features, and then seamlessly launch an inspection form to complete the inspection. Install the software using the instructions below for the operating system used on the field device(s):

3.2.1 Windows 10

Collector for ArcGIS

- ☐ Open the Microsoft Store on the device.
- ☐ Search Collector for ArcGIS in the Microsoft Store.
- ☐ Select the application.
- ☐ Select Install, and allow the application to install
- ☐ Launch the application

Survey123 for ArcGIS

- ☐ Browse to the following link https://doc.arcgis.com/en/survey123/download/
- ☐ Under *Get Survey123 => Survey123 field app*, select the *Windows x86* version to download
    - o Please note that *Survey123 Connect* is the *incorrect* application to install
- ☐ After the file downloads, open the .exe file
- ☐ Follow the installation wizard and install the application
- ☐ Select the Survey123 shortcut on the desktop to launch the application

3.2.2 Android

Collector for ArcGIS

- ☐ Open the Google Play application
- ☐ Search Collector for ArcGIS in the Play Store
- ☐ Select the application.
- ☐ Select Install and accept the terms and conditions
- ☐ Select Open to launch the application

Survey123 for ArcGIS

- ☐ Open the Google Play application
- ☐ Search Survey123 for ArcGIS in the Play Store
- ☐ Select the application.
- ☐ Select Install and accept the terms and conditions
- ☐ Select Open to launch the application

3.2.3 IOS

Collector for ArcGIS

- ☐ Open the App Store application
- ☐ Search Collector for ArcGIS in the App Store
- ☐ Select the application.
- ☐ Select Install and accept the terms and conditions
- ☐ Select Open to launch the application

Survey123 for ArcGIS

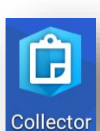
- ☐ Open the App Store application
- ☐ Search Survey123 for ArcGIS in the App Store
- ☐ Select the application.
- ☐ Select Install and accept the terms and conditions
- ☐ Select Open to launch the application

3.3 Launching and Using Collector for ArcGIS

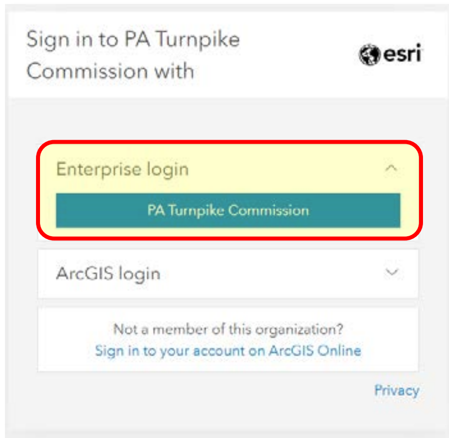
Note: Due to variations across platforms, the application's appearance may vary from the images contained herein.

3.3.1 Signing In

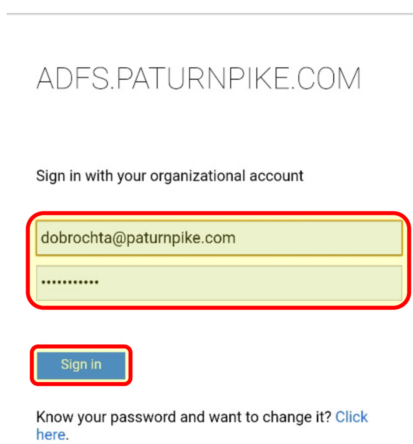
- o Open the Collector for ArcGIS application.



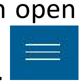
- Select ***PA Turnpike Commission Enterprise login***, or ***ArcGIS Online***, as directed by the PTC CADD/GIS Specialist.



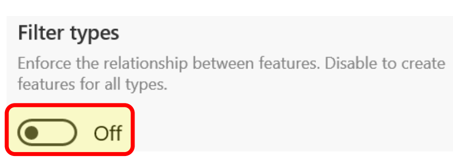
- Enter a valid organizational account (user name and password), and then select **Sign In**.



3.3.2 Edit Settings

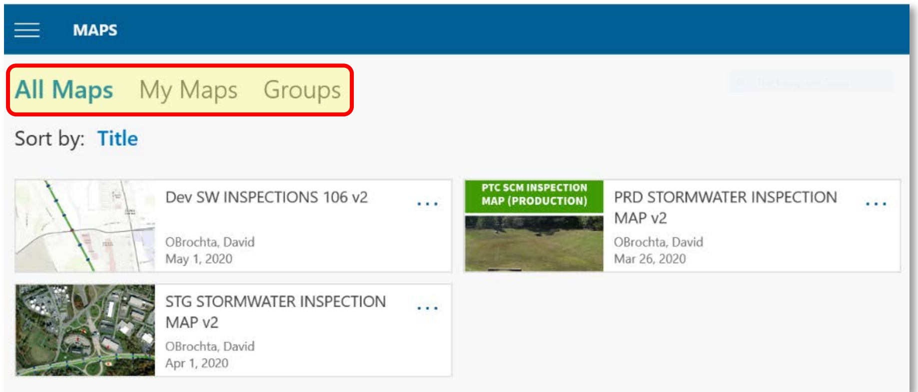
- Prior to opening a map, a user can open and manage the application settings, by selecting the **Menu** button in the top left corner. 
- Select **Settings** in the bottom left corner of the screen 

    - Turn Filter types off, if currently on. This will allow the user to add features without enforcing the relationship requirements between features.



3.3.3 Groups & Maps

- Upon launching Collector for ArcGIS and signing in, the application will default to displaying "All Maps". The user may also click or tap to navigate to see "My Maps", and "Groups".

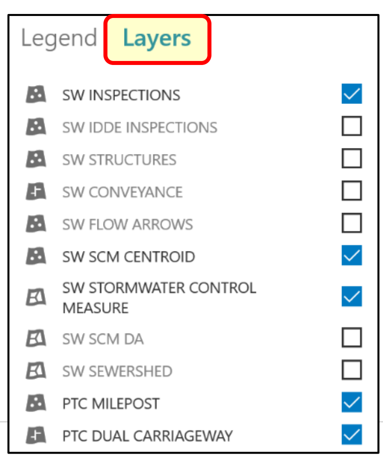


- The *Production* map for the SCM inspections is titled ***PRD STORMWATER INSPECTION MAP v2***. Click or tap this map to open it within Collector.
  - Groups restrict viewing and editing privileges to the map and the inspection survey. The group for the SCM inspection map and survey is *PTC SCM INSPECTION GROUP (Production).* If the user selects the *PTC SCM INSPECTION GROUP (Production*) group, editable maps only within that group are displayed.
- The basemap and feature layers will load, and automatically pan the map to the inspector's current location. If the map does not load at the inspector's current location, the inspector can select the **bullseye** in the top right corner and the map will zoom to their location. 

Note: Location services are enabled only if the device is connected to a Wi-Fi network, a mobile data service plan, an external GPS, or the device has an internal GPS unit. If the device does not meet these requirements, then location services are disabled, and the user will have to locate their position manually.

3.3.4 Map Layers

Clicking or tapping the menu icon  in the upper right, and then clicking ***Map Contents*** and ***Layers*** displays the ***PRD STORMWATER INSPECTION MAP v2*** Layer List. Layers can be toggled on or off by clicking or tapping on the associated check box.



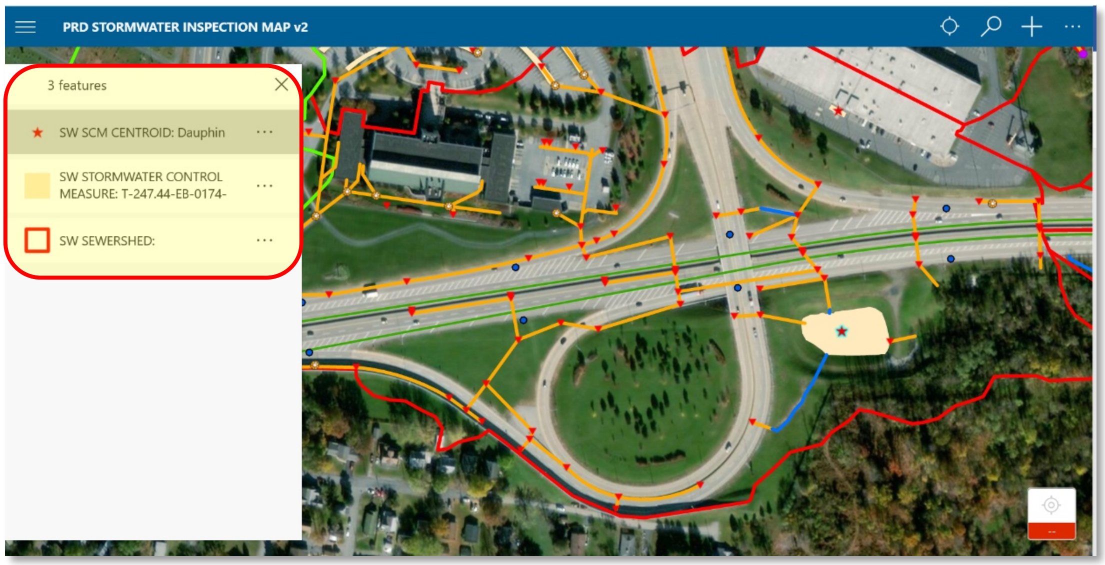
PRD STORMWATER INSPECTION MAP v2 **Layer List**

- Feature Layers (*Editable* Layers Shown in Bold Italic Text)
  - ***SW INSPECTIONS*** (Editable) – Point feature layer that contains Routine and Field View inspection information.
    - Layer is *toggled on* when application initially loads
    - Inspectors should not edit this layer
  - SW IDDE INSPECTIONS – Point feature layer that contains IDDE inspection information.
    - Layer is *toggled off* when application initially loads
    - Inspectors should not edit this layer
  - SW STRUCTURES – Point feature layer that contains features such as inlets, manholes, outfalls, etc.
    - Layer is *toggled off* when application initially loads
    - Inspectors should not edit this layer
  - SW CONVEYANCE – Line feature layer that contains features such as pipes, swales, and other linear stormwater features.
    - Layer is *toggled off* when application initially loads
    - Inspectors should not edit this layer
  - ***SW SCM CENTROID*** (Editable) – Point feature layer that contains all the metadata related to the SCM including its construction contract, design contract, SCM type, feature status, etc.
    - Layer is *toggled on* when application initially loads
    - Inspector should not edit this layer
  - ***SW STORMWATER CONTROL MEASURE*** (Editable) – Polygon feature layer that contains the component information for the SCM.
    - Layer is *toggled on* when application initially loads
    - Inspectors should not add or delete features, or update geometry. Edits should be limited to the component inventory.
  - SW SCM DA – Polygon feature that contains information about the size of the drainage area
    - Layer is *toggled off* when application initially loads
    - Inspector should not edit this layer
  - SW SEWERSHED – Polygon feature layer that contains information about the size, composition, and condition of the area draining to outfalls.
    - Layer is *toggled off* when application initially loads
    - Inspector should not edit this layer

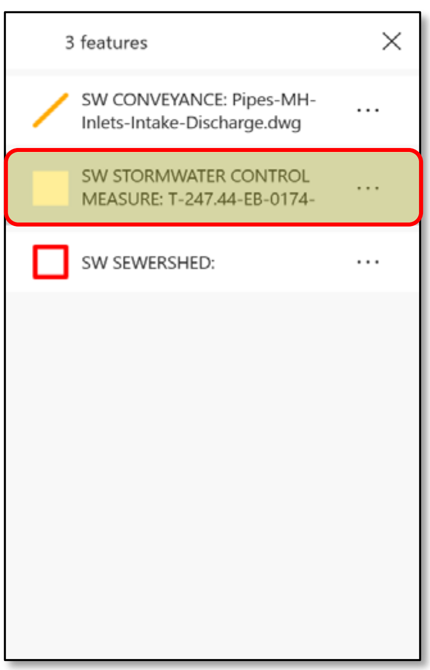
- Additional Non-editable Layers
  - SW FLOW ARROWS
  - PTC MILEPOST
  - PTC DUAL CARRIAGEWAY
  - All available Basemaps

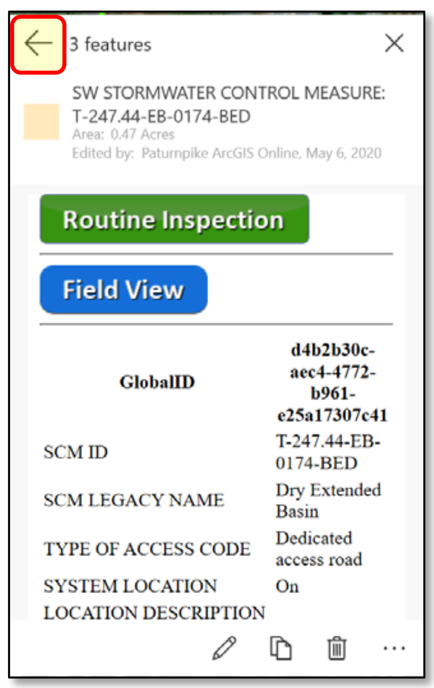
3.3.5 Feature Selection

- Click or tap a feature on the map to select it. When selecting features on a mobile device using touch input, the application typically selects all features within a certain radius (if there are multiple features in that area), depending on the current scale level. If using a mouse or mousepad, the feature selection may be more precise.
- Selected features are then displayed in a selection panel. On Windows, this panel is located on the left side of the screen (the location of the panel on other operating systems may vary).



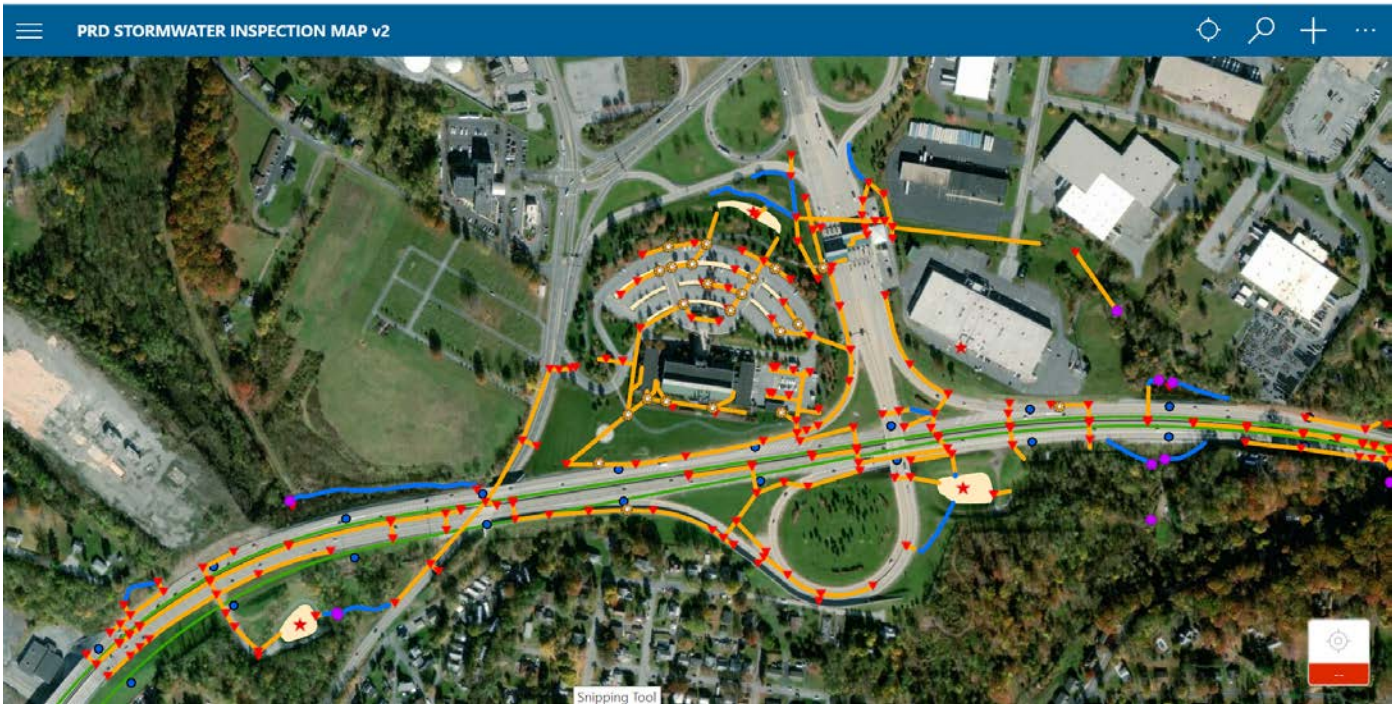
- Within the selection panel, click or tap a feature to open the feature details.
- Click the Back arrow to go back to the feature list.





3.3.6 Application Layout

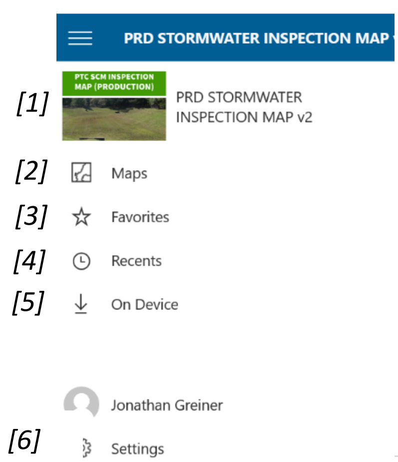
Please reference the screen shot below for an overall reference to specific application tools and locations.



- *<u>Maps Menu</u>* - 

 provides access to the following options (refer to the corresponding numbers in the screen shot below):

  - *<u>Current Map</u> [1]…* Closes the menu and returns the user to the current map
  - *<u>Maps</u> [2]* ………….. Displays all maps available to the user
  - *<u>Favorites</u> [3]……..*. Displays "favorited" maps
  - *<u>Recent</u> [4]………….* Displays recently accessed maps
  - *<u>On Device</u> [5]…….* Displays maps loaded on the device
  - *<u>Settings</u> [6]……….* Opens application settings



- *Location* - Finds your current location on the map (if location services are enabled).

Note: When using a device that does not have GPS capabilities, the location accuracy will be greatly diminished or non-existent. Collector will use the Wi-Fi connection to determine the user's location, if available. If GPS and/or Wi-Fi are not available, the location feature will not function.

- *Search* - Type a place or address of interest to search the map.

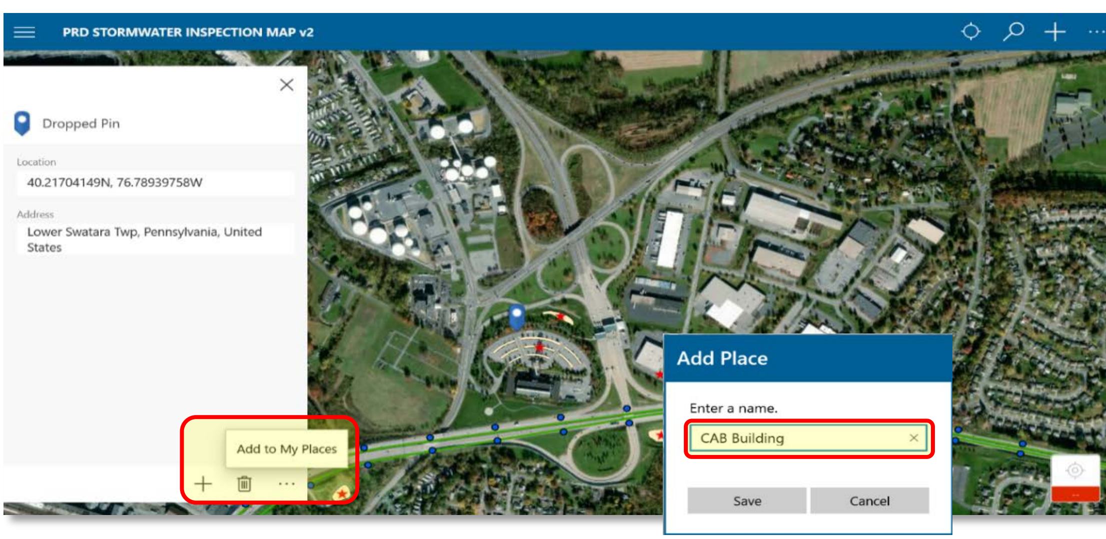
- *Collect new* – Creates new features on the current map within editable layers.
- *Menu* - Access to Map Content, Bookmarks, Basemaps, and Measure tools. Refer to the graphic below for an overall view of the menu items described below.

Map Contents - Provides access to the *Legend* and *Layers*. *Note: additional data layers and associated symbology, pop-ups, and labels must be added to the Web Map to appear in Collector.*

  - *Legend* displays all map symbology
  - *Layers* allows users to toggle map layers on or off

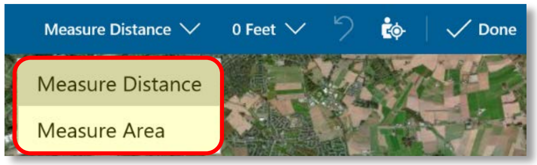
Bookmarks - Provides quick access to pre-defined map locations. *Note: Bookmarks must be added to the Web Map to appear in Collector.*

  - *My Places* can be added by long pressing the map in a location, then selecting the option to drop a pin. The pin information will be displayed in the left pane, with an option to *Add to My Places* in the bottom left menu.
  - *My Places* can also be added by selecting a feature, and selecting *Add to My Places* from the bottom left menu.



Basemaps - Allows users to switch between different types of ESRI created basemaps. Additional basemaps or image services can also be added as required.

Measure - Allows the user to measure *Distance* or *Area* for features or other items on the map.

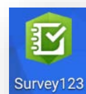


3.4 Launching and Using Survey123 for ArcGIS

It is not necessary to launch Survey123 directly in order to perform inspections. Typically, users will begin in Collector, and launch the Survey123 form from Collector, as described in section 3.3. Information is presented here to help familiarize users with the application interface and navigation.

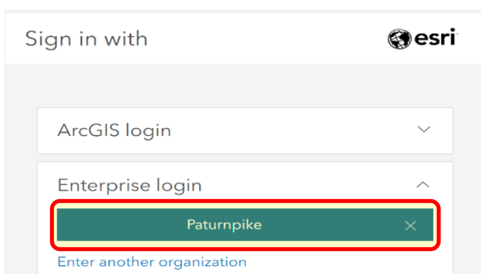
3.4.1 Signing In

- Open the Survey123 for ArcGIS application.



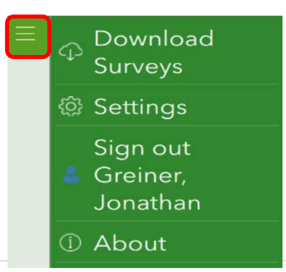
- Select the menu button in the upper-right hand corner, and then select **Sign In**.

- Enter a valid ***PA Turnpike Commission Enterprise login*** username and password to sign in.

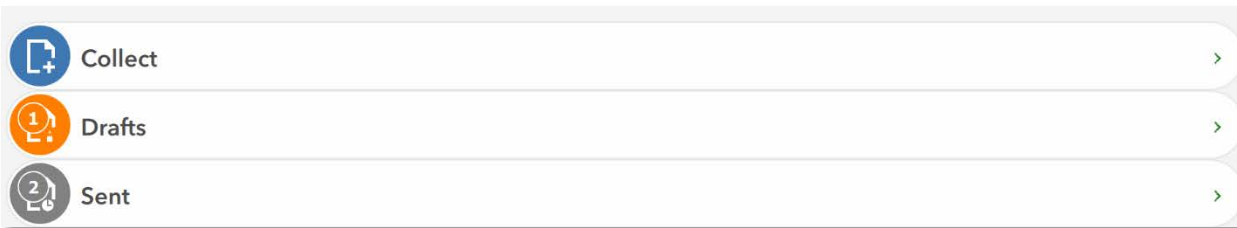


3.4.2 Application Layout

- The Menu button opens the menu tray.



  - **Download Surveys** – Surveys are downloaded to the device and stored. They can be refreshed to apply any changes that may have occurred since the initial download.
  - **Settings** – Allows the user to change the size of the text in the survey forms.
  - **Sign in/Sign out** – Allows the user to sign in, sign out, or switch user accounts.
  - **About** – Provides a description of Survey123, version information and the license agreement.
- Downloaded forms are displayed within the tile grid in the application. Tap a form to open the survey details (note, this will not launch the inspection form).
- There are 2 -3 options at the bottom of the screen to interact with survey forms
  - **Collect** – Launches the currently selected survey.
  - **Drafts** – This option only appears when a survey has been started and exited without being submitted. They can be resumed or deleted through this tab.
  - **Sent** – This option only appears when a survey has been sent. This function allows the user to review, edit, and/or resubmit previously submitted surveys. *Note:* Resubmitting sent surveys will result in survey duplication.

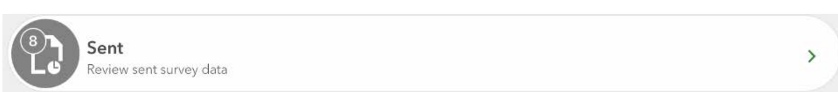


3.4.3 Submitting Forms

- If all required inspection fields have been populated, click the button on the last page of the form. Survey123 will notify the user if any of the required fields have not been completed when attempting to submit the form.
- If all required fields are populated, the application will present three options:
  - **Send Later** – Allows the user to save the survey as a draft, leaving all answers and photos in place until the user is ready to submit the survey. This option is best when completing surveys in an offline/disconnected environment.
  - **Send Now** – Send the completed survey (all answers and photos) now.
  - **Continue this Survey** – Returns to the survey form.

3.4.4 Open & Edit a Submitted Inspection

- Select the **Sent** tab at the bottom of the screen.



- Select a previously submitted survey.
- There are 2 options available to interact with already submitted survey data
    - Edit and resend survey – This option will open the submitted survey and allow the user to perform edits, then the application overwrites the existing information.
    - Copy the sent data to a new survey – This option will copy answers from the sent survey to a new survey form. This option **should not be selected** by users.

4 Inspection Procedures

4.1 Pre-field

Prior to initiating field work, the inspector will receive a list of SCMs to inspect from the PTC. The pre-field investigation should identify potential safety issues such as road access, traffic hazards, and SCM site conditions. Inspectors should follow all general PTC guidelines for fieldwork preparation and safety.

- **Weather** - The date and amount of the most recent precipitation event is automatically populated for each SCM, and will be saved as part of the inspection. This information is obtained from the nearest Accuweather station, for any rainfall event of two-tenths (0.2) of an inch or greater.

- **Equipment** - Inspectors will also need to prepare equipment for field work. A list of minimum recommended field equipment required to support the data collection tools is provided below. This list not all-inclusive, and other safety or operational equipment may also be necessary to complete the inspections.
  - Mobile Device with Collector for ArcGIS and Survey123 installed
  - Wi-Fi hotspot and/or a mobile device with a 4G LTE connection (with service plan)
  - 12v USB car charger (Dual port recommended)
  - Power cords for field device, phones, external GPS units, and external cameras (if applicable)
  - Additional camera or additional camera application installed on Mobile Device
  - External GPS device (if needed)

4.2 In-Field Inventory Review Using Collector for ArcGIS

4.2.1 Stormwater Inventory

For each SCM, the questions that are asked to the inspector within the Survey123 form are tailored to the SCM and the specific components that are present. The inspection questions within the Survey123 form are determined when the user launches the Survey123 inspection form from Collector.

As such, it is critical that the inspector verify the SCM component inventory information <u>prior</u> to launching the inspection form. The component inventory verification process described below should begin upon the inspector arriving at an SCM in the field. The inspector should be cautious when updating the SCM component inventory in the field. If a component is not seen in the field but is shown as present in the component inventory, the inspector needs to be confident that the component never existed.

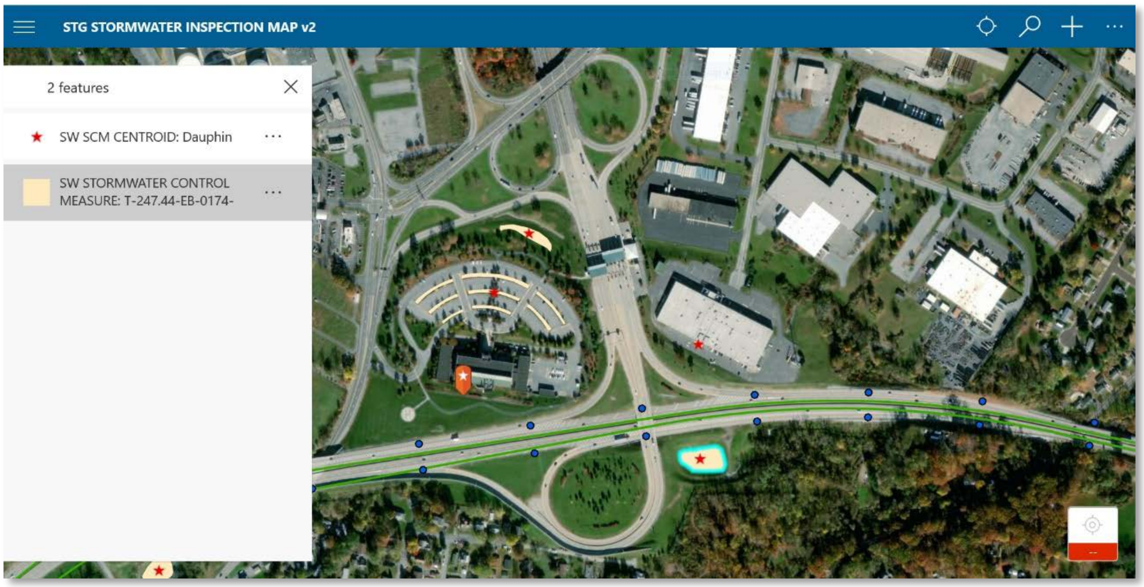
SCM Component Inventory Verification

This section will detail the steps needed to review and, if needed, update the SCM component inventory and subsequently launch the inspection form.

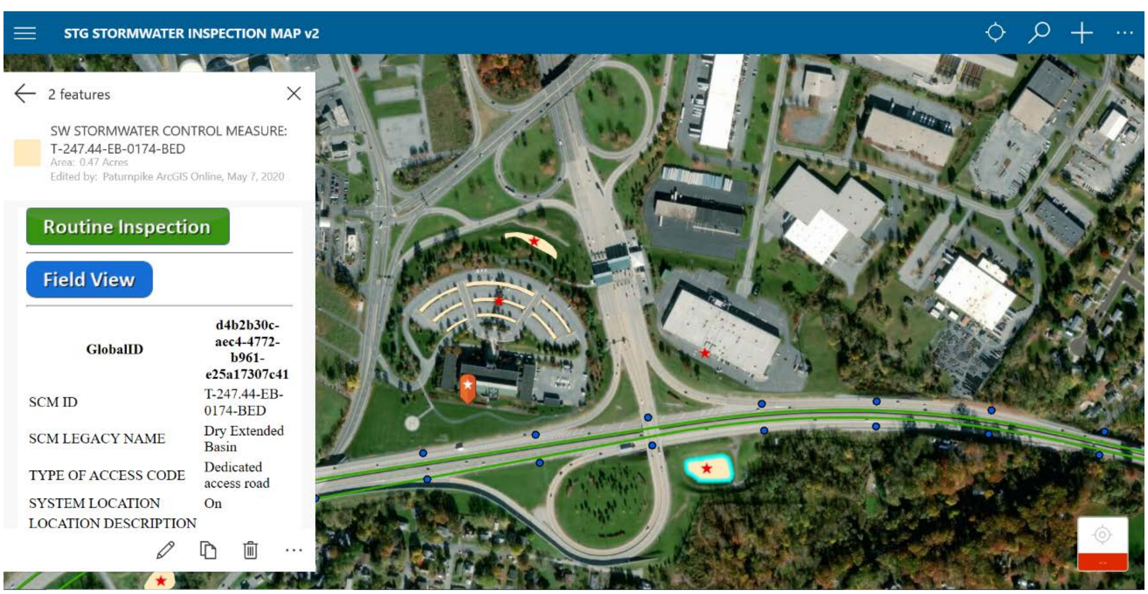
- Open Collector for ArcGIS application, login, and open the ***PRD STORMWATER INSPECTION MAP v2*** map (see section 3.3)
- On the map, select the SCM feature.
  - Tap the SW Stormwater Control Measure on the map

  - Several features may be identified when an inspector tries to select a feature. Collector selects all features within a given radius from screen location identified by the inspector.

- The list of identified features will be displayed on the left pane.



- Select the Stormwater Control Measure feature from the list (example: SCM T-247.44-EB-0174-BED)
  - When the feature is selected, it will be highlighted in light blue and the attribute details will be displayed in the pane on the left pane.



- Review the inventory data displayed on the left pane to make sure it is correct. Each component should be verified to ensure the data in the application matches conditions in the field.
- Update data fields as needed by editing the feature layer.
    - Select the **Pencil** button in the bottom right corner of the details pane to start editing

- Enter the correct response to each attribute field based on the dropdown list values provided.

  Note: Inflow-related components do not have a dropdown menu list. These fields require a nonnegative integer value, which indicates the total number present (count) for each Inflow type.
- Select the Submit button in the top right corner to <u>*save*</u> any edits made to the Stormwater Control Measure layer.
- Select the button in the top left corner to <u>*discard*</u> any edits made to the Stormwater Control Measure layer.

Note: The application requires all Stormwater Control Measure inventory components to be populated prior to completing an inspection. Given that the majority of component inventory data has been pre-populated, only minor updates should be required.

A brief description of the SCM attributes are below:

- ***SCM ID*** – A concatenation of Route, Milepost, Direction, Offset, and SCM Type. This is the official name of SCM.
- ***SCM Legacy Name*** – The name of the SCM as it appears on plan sheets.
- ***Type of Access Code*** – Description of how the SCM is accessed for inspection and maintenance purposes.
- ***System Location*** – Indicates if access to the SCM for maintenance is from on or off the PTC System.
- ***Location Description*** - On System designates PTC roadway access, while Off Systems designates no PTC roadway access.

- ***Access Easement/Agreement*** – Indicates if an Easement/Agreement for access for SCM inspection and/or maintenance.
- ***Access Description*** - Provides additional description to the 'TYPE OF ACCESS CODE' field.
- ***Dam Category*** – The dam category of the SCM, if applicable.
- ***Dam Permit Number*** – DEP Dam Permit Number.
- ***Maintenance and Protection of Traffic (Maintenance)*** – Indicates if Maintenance and Protection of Traffic (MPT) is required for routine maintenance activities at the SCM.
- ***Maintenance and Protection of Traffic (Inspection)*** – Indicates if Maintenance and Protection of Traffic (MPT) is required for completion of SCM inspections.

The inspector will survey the site and verify each potential SCM Component. The components and a brief description are listed below, but inspectors should reference PennDOT Publication 888 and their own subject matter expertise for a more complete understanding.

- ***Turf: Lawn*** – Well manicured grassy areas directly surrounding the SCM.
- ***Turf: Short Meadow*** – dominated by grasses and sedges vegetation mix approximately 36-inches or less in height.
- ***Turf: Tall Meadow*** – dominated by grasses and sedges vegetation mix greater than 36-inches in height.
- ***Scrub-Shrub*** – dominated by woody vegetation less than 20 feet tall often stunted by environmental conditions.
- ***Forest*** – a land cover classification dominated by tall, mature woody trees.
- ***Special plantings: Ornamental*** – Plantings established for providing aesthetic appeal. Ornamental plantings will often use native and non-native species.
- ***Special Plantings: SCM*** - Plantings to support the function of the Stormwater Control Measure.
- ***Forebay Count*** – pretreatment component that slows velocities and captures sediment and debris prior to entrance into the primary SCM storage area..
- ***Pipe(s) Count*** – Number of SCM inflow pipes.
- ***Curb Cut Count*** – Number of SCM inflow curb cuts.
- ***Sheet Flow Count*** – Number of SCM sheet flow inflows.
- ***Swale Count*** – Number of SCM inflow swales.
- ***SCM Floor*** – Main ponding, conveyance, and treatment area of a surface SCM. May include a layer of engineered (amended) soils or filter media in filtrating or infiltrating SCMs..
- ***Low Flow Channel*** – Channel through an SCM basin occupied during smaller runoff events
- ***Low Flow Orifice*** – Small opening within the outflow structure that allows water to escape the SCM during times of low water flow; also controls the rate at which water discharges from the SCM.
- ***Subsurface Storage*** – Areas below ground used to temporarily hold stormwater in a subsurface storage medium for infiltration and/or controlled release. Storage areas may consist of stone, pipes, vaults, tanks or chambers.
- ***Observation Well / Cleanout*** - An observation well is installed independent of underdrains and is used to observe subsurface water levels. Cleanouts are connected to the underdrains and are used to observer subsurface water level and/or access underdrains for maintenance.
- ***Underdrain*** – perforated pipe installed below filter media or stone storage media to effectively dewater the SCM..

- ***Emergency Spillway*** – Provides an alternate path for water to escape the SCM during periods of high flow.
- ***Emergency Spillway Type*** – Emergency spillways can be constructed using different methods. Armored SCMs use riprap, concrete, or boulders, while vegetated will use low growing plants like grasses to stabilize the spillway.
- ***Cut Slopes*** – SCM side walls constructed by excavating below grade.
- ***Impounding Embankment*** – Also known as berms, are "fill" material constructed above the surrounding ground forming a side wall of the SCM ; generally created from fill material.
- ***SCM Liner*** – Liner used to limit water infiltration to adjacent soil.
- ***Sediment Marker*** – a measuring device that indicates the level of sediment build up within an SCM.
- ***Primary Outflow*** – Primary control structure designed to control discharge from the SCM. In SCMs with no structural controlled release feature, this is considered the downstream most point of the treatment area.
- ***Primary Outfall Trash Rack*** – A rack used to prevent trash from entering the primary outflow structure.
- ***Secondary Outflow*** – Secondary control structure designed to control discharge from the SCM, usually during periods of higher than normal flow.
- ***Secondary Outfall Trash Rack*** – A rack used to prevent trash from entering the secondary outflow structure.
- ***SCM Discharge***– Primary location where water leaves the outflow structure, typically a pipe tied to the outflow structure; includes the pipe immediately downstream of SCM and, where applicable, downstream end section and rip-rap apron.
- ***Fencing*** – Protective barrier around the SCM to limit access from people and animals.
- ***Gates/Lock*** – Used to provide secure access to the SCM.
- ***Signage*** – Sign(s) used to indicate the presence and in some cases the extent of an SCM.

Viewing SCM Centroid Attribute Details

During the site inventory, the inspector can access ***SCM Centroid*** attribute data if necessary as follows:

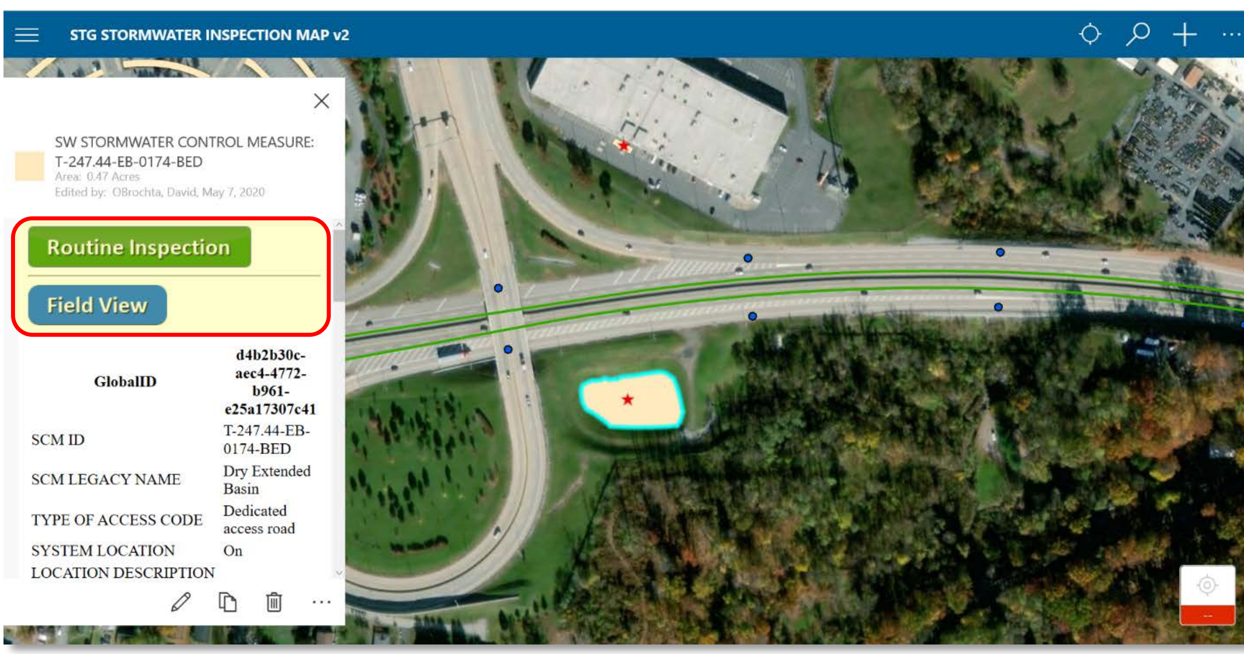
- Select an ***SCM Centroid*** on the map.
  - Tap on the ***SCM Centroid*** of interest.
  - The identified features will be displayed on the left pane. *Note: the application may identify several features near the feature the inspector selected.*
  - Select the ***SW SCM Centroid*** from the list of features on the left pane.
    - When a feature is selected, it will be highlighted in *light blue* and the SCM inventory data will be displayed in the left side pane.
- Review the attribute data displayed on the left panel.

4.2.2 Launch Inspection Survey

After the inspector completes the SCM Component Inventory Verification and SCM Centroid Attribute Detail Viewing, the inspector will launch an inspection survey.

- Select the SCM that will be inspected.
  - Tap the Stormwater Control Measure (SCM Polygon) on the map

    - Several features may be identified when an inspector tries to select an SCM. Collector selects all features within a given radius from the location the inspector selects.
  - The identified features will be displayed on the left pane
  - Select the ***SW Stormwater Control Measure*** Feature
    - When a feature is selected, it will be highlighted in light blue and the Stormwater Control Measure details will be displayed in the left side pane.
- At the top of details pane, both the ***Routine Inspection*** and ***Field View*** *buttons are displayed.*
- *Inspection*.
  - The ***Routine Inspection*** is the primary inspection survey the inspector will use to conduct inspections in fulfillment of the PTC's MS4 permit requirements. The Routine Inspection was designed with a series of conditions and required fields that ensure all necessary data is captured before an inspector can submit a survey. An inspector can launch the Routine Inspection survey by selecting the Routine Inspection button located in the details panel of a selected SCM.
  - The ***Field View*** inspection is a secondary inspection survey an inspector can launch to perform ad hoc data collection related to an SCM. There are no conditions or required fields in the Field View Inspection form. An inspector can submit maintenance concerns and photos for all components, or a single component as needed. None of the requirements discussed in subsequent sections apply to the Field View inspection. An inspector can launch the Field View Inspection by selecting the Field View button located in the details panel of a selected SCM. *The Field View Inspection is not a substitute for the Routine Inspection, and it should not be used as such.*



- Click or tap the Routine Inspection or Field View button to launch the corresponding inspection. The button will automatically open and load an inspection form using Survey123 for ArcGIS.

Note: Depending upon the operating system in use, the user may be asked to confirm to switch applications.

4.3 In-field SCM Inspection using Survey123

4.3.1 Form Framework

Survey123 is a smart form that ingests data from the Collector application to tailor the inspection survey form to the specific components present in each Stormwater Control Measure. Survey123 opens using a dynamic hyperlink button located on the Stormwater Control Measure details panel of the Collector application. The dynamic hyperlink pulls data from the SW Stormwater Control Measure layer and passes the information to the survey.

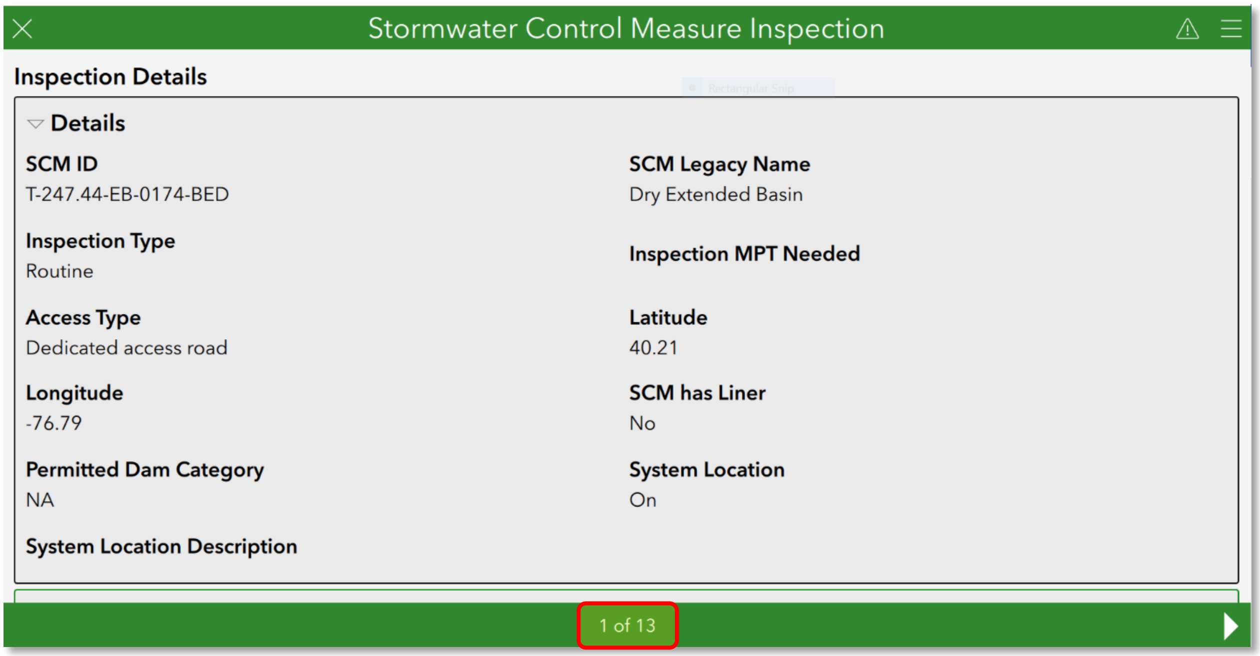
There are two types of data passed to the survey via the dynamic hyperlink:

> The first type of data passed to the survey from ArcGIS Online is general metadata, which includes the SCM ID, Legacy Name, and a GlobalID field, among others. The GlobalID field and the general metadata are used to link the inspection survey to the Stormwater Control Measure within PTC's ArcGIS enterprise database, so the inspection can be effectively recorded and acted upon for future maintenance activities.
>
> The second type of data passed to the survey from ArcGIS Online is component data. The component data is used to tailor the survey questions to the specific SCM being inspected. For example, if the Primary Outfall Trash Rack exists in the inventory (indicated by a value of 'Yes'), the survey will require the inspector to provide associated photos, maintenance, and condition information for this component. Similarly, if the Emergency Spillway is not present in the inventory (indicated by a value of 'No'), the inspector will not be required to inspect this component.

Note: It is important to fully complete the SCM Inventory process in collector prior to launching an inspection. If the component information is incorrect in the inventory, the inspector will not be prompted to answer the proper questions during the inspection.

4.3.2 Overview and Form Layout

The Inspection form is broken up into thirteen pages to help organize the form and simplify navigation. Each page represents a component category that groups together components with similar functions. The exceptions are the ***first page***, which contains <u>*general information*</u> about the SCM and the inspection, and the ***last page***, which includes <u>*summary scores*</u> and an <u>*overall condition assessment*</u>. The inspector can navigate to the next page using the arrow found at the bottom of the survey. The inspector can also use the page indicator buttons at the bottom to help them navigate to a specific page.



The following table details the components presented on each page of the application:

Section	Page Number	Components	Component Type
Inspection Details	1	Inspection Details	N/A
Vegetation	2	Turf: Lawn	Single-Count Components
		Turf: Short Meadow	
		Turf: Tall Meadow	
		Scrub-Shrub	
		Forest	
		Special Plantings: Ornamental	
		Special Plantings: SCM	
Inflows	3	Forebay	Multi-Count Components
		Pipes	
		Swales	
		Sheet Flow	
		Curb Cuts	
Surface Storage	4	Low Flow Channel	Singe-Count Components
		SCM Floor	
Subsurface Storage	5	Subsurface Storage	Singe-Count Components
		Observation Well/Cleanout	
		Underdrain	
Cut Slopes	6	Cut Slopes	Single-Count Component
SCM Liner	7	SCM Liner	Single-Count Component
Impounding Embankments	8	Impounding Embankments	Single-Count Component
Outflow	9	Primary Outflow	Single-Count Components
		Primary Outflow Trash Rack	
		Secondary Outflow	
		Secondary Outflow Trash Rack	
Emergency Spillway	10	Emergency Spillway	Single-Count Component
SCM Discharge Point	11	SCM Discharge Point	Single-Count Component
Fencing/Gates/Lock/Signage	12	Fencing	Single-Count Components
		Gates/Lock	
		Signage	
Component Scores	13	N/A	N/A

4.3.3 Inspection Details Page

The Inspection Details page of the form contains general information related to the current inspection. Most of the information on this page is pulled directly from Collector for ArcGIS. The information is displayed on this page so that the inspector can verify that the data transfer was successful, and the inspection will be associated with the correct SCM.

Instruction Mode appears at the top of each survey page (Note that the default mode is *No*). Toggling Instruction Mode to *Yes* displays notes and instructions for specific survey fields in blue text.

The following data fields are pulled from Collector, or generated by the form upon launch:

- SCM ID
- SCM Legacy Name
- Inspection Type
- Inspection MPT Needed
- Access Type
- Latitude
- Longitude
- SCM has Liner
- Permitted Dam Category
- System Location
- System Location Description
- Inspection Start
- Previous Inspection Date
- Previous Precipitation Date
- Amount of Previous Precipitation

Note: If SCM ID is not displayed within the form, do not continue the inspection. Close and discard the current form, go back to Collector, and relaunch the inspection form.

The inspector is expected to fill in the remaining sections displayed on the first page:

- ***Name all Inspectors*** - Select all inspectors present from the options provided in the drop-down list
  - Select the first inspector from the Name drop-down list and click or tap the + icon in the bottom right corner of the inspector box to add the inspector.
  - If *multiple* inspectors are present, the inspector can add an additional inspector record for each inspector present by selecting the + icon in the bottom right corner of the inspector box.
  - If 'Other' is selected, the inspector will be prompted to enter the name of the inspector.
  - Inspector records can be removed by selecting the icon in the bottom left corner of the inspector box.

- ***Overall Photos*** – The inspector is required to capture at least *<u>one overall photo</u>* of each SCM. The overall photos should try to capture as much of the site as possible and include as many components as possible. This can be difficult for some locations because of vegetation and other limiting factors. At a minimum, each photo must be captured in a standard *<u>landscape</u>* layout. If multiple photos are captured, panoramic pictures are acceptable and encouraged. However, the panoramic photo cannot be the first overall photo captured due to reporting concerns.
  - The user can add photos in two ways:
    - The inspector can select the icon to capture and add a photo using the device's internal camera.
    - The inspector can also add a photo saved on the device by selecting the icon. The inspector can browse to a file and add it as an attachment.

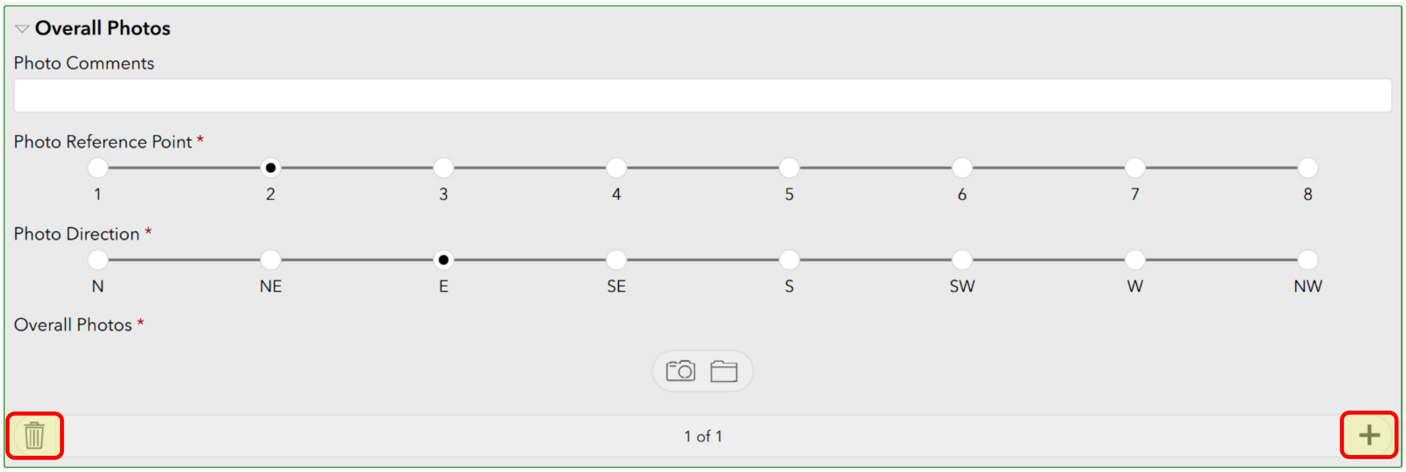
Note: There is no zoom function enabled using the camera function within the <u>Windows</u> version of Survey123. If the inspector needs to zoom to acquire an acceptable picture, the inspector must leave the Survey123 application to acquire the picture and then attach the picture to the inspection. The zoom function is present in the iOS and Android versions of the application.

Note: The inspector is not limited to adding photo files alone. Any file type can be attached using the folder, but there will be no display image for file types that are not standard image file type (.png, .tif, .JPG, etc.).

  - Populate Overall ***Photo Comments***
    - The user should describe the *<u>orientation</u>* in which the photo was taken (for example, "looking northwest").
    - No other comments are required, but the user should record any additional relevant or useful information.
  - Select ***Photo Reference Point***
    - Eight reference point radio buttons are provided for documenting the *<u>relative position</u>* from where the photo was taken. *Note: only <u>one</u> reference point may be selected per photo.*
    - Inspectors are encouraged to be consistent in using these reference points for all photos captured during the SCM inspection for proper reporting documentation.
    - The goal for SCM inspections in subsequent years is to reuse photo reference points to establish consistency in the photo evaluation process.

  - Select Photo ***Direction***
    - Eight photo direction radio buttons are provided for documenting the *<u>direction</u>* from which the photo was taken. *Note: only <u>one</u> direction may be selected per photo.*
    - Inspectors are encouraged to be consistent in using these photo directions for all photos captured during the SCM inspection for proper reporting documentation.

- The inspector can *add* any additional photos by selecting the + icon in the bottom right corner of the ***Overall Photos*** section.
- The inspector can *delete* any attached photos by selecting the icon in the bottom left corner of the ***Overall Photos*** Section.



4.3.4 Inspecting Single-Count SCM Components

This section will review the process for inspecting *Single Count SCM* components as opposed to multiple count SCM components, as referenced in the table below:

Section	Page Number	Components	Component Type
Vegetation	**2**	Turf: Lawn	Single-Count Components
		Turf: Short Meadow	
		Turf: Tall Meadow	
		Scrub-Shrub	
		Forest	
		Special Plantings: Ornamental	
		Special Plantings: SCM	
Surface Storage	**4**	Low Flow Channel	Singe-Count Components
		SCM Floor	
Subsurface Storage	**5**	Subsurface Storage	Singe-Count Components
		Observation Well/Cleanout	
		Underdrain	
Cut Slopes	**6**	Cut Slopes	Single-Count Component
SCM Liner	**7**	SCM Liner	Single-Count Component
Impounding Embankments	**8**	Impounding Embankments	Single-Count Component
Outflow	**9**	Primary Outflow	Single-Count Components
		Primary Outflow Trash Rack	
		Secondary Outflow	
		Secondary Outflow Trash Rack	
Emergency Spillway	**10**	Emergency Spillway	Single-Count Component
SCM Discharge Point	**11**	SCM Discharge Point	Single-Count Component
Fencing/Gates/Lock/Signage	**12**	Fencing	Single-Count Components
		Gates/Lock	
		Signage	

Single count SCM components are components that only have _one distinct feature_ per SCM. For example, there can only be one primary outflow per SCM, so the condition and maintenance needs listed all relate to a singular primary outflow. Components that occur across the SCM will also be evaluated as a single unit or feature. For example, ***Special Plantings: SCM*** may be present across the entire SCM, but are evaluated as a _single unit_.

Multiple count components refer to components that have multiple distinct features. For example, a wet detention basin may have three inflow pipes that discharge into the SCM. These multiple features of the same type will be evaluated individually, using a slightly different workflow than the single-count components. The workflow to inspect these features will be discussed in more depth in section 4.3.5.

- **Component Photos** - This section will describe the photos portion of the inspection form for single count components. The Component Photos section is displayed for all components present at the SCM, and should be used to capture an overall image of the component. A minimum of one photograph is required for each single-count component, but the user may include an unlimited number of photos as necessary.
    - The user can add photos in two ways:
        - The inspector can select the icon to capture and add a photo using the device's internal camera.
        - The inspector can also add a photo saved on the device by selecting the icon. The inspector can browse to a file and add it as an attachment.

Note: There is no zoom function enabled using the camera function within the Windows version of Survey123. If the inspector needs to zoom to acquire an acceptable picture, the inspector must leave the Survey123 application to acquire the picture and then attach the picture to the inspection. The zoom function is present in the iOS and Android versions of the application.

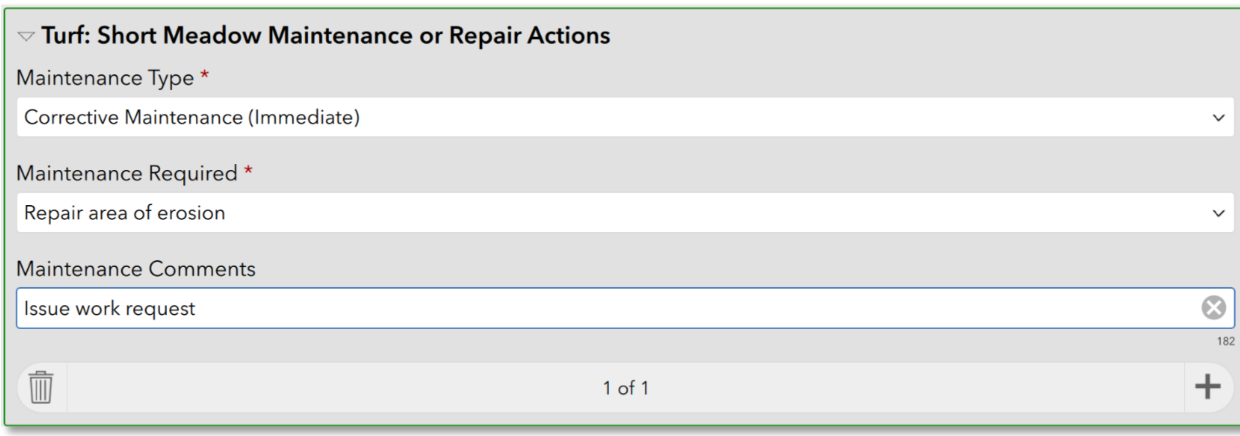
Note: The inspector is not limited to adding photo files alone. Any file type can be attached using the folder, but there will be no display image for file types that are not standard image file type (.png, .tif, .JPG, etc.)

-
    - Populate Component ***Photo Comments***
        - The user should describe the _orientation_ in which the photo was taken (for example, "looking northwest").
        - No other comments are required, but the inspector should record any additional relevant or useful information.
    - The inspector can _add_ any additional photos by selecting the icon in the bottom right corner of the ***Overall Photos*** section.
    - The inspector can _delete_ any attached photos by selecting the icon in the bottom left corner of the ***Overall Photos*** Section.

Refer to section 5.4 for further details describing PTC photo standards and requirements.

- **Maintenance or Repair Actions** - The Maintenance or Repair Actions section allows the inspector to capture one or more maintenance records for an individual component. A maintenance record consists of four pieces of information: a *Maintenance Type*, the *Maintenance Required*, *Maintenance Comments*, and a *Photograph*. In this section, inspectors can add one or multiple maintenance records to document all maintenance needs of a component.

  There are eleven (11) SCM Component pages that support adding maintenance-related information for corresponding SCM components. Additional details are provided in section 4.3.2.

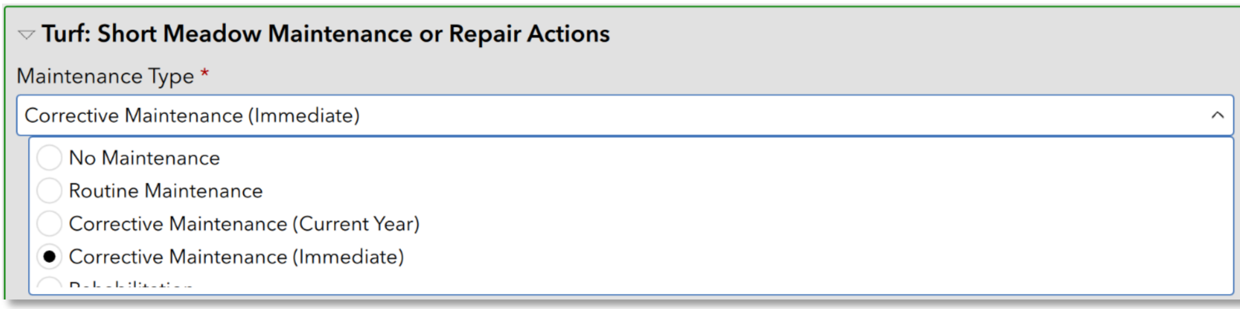


  - Select the ***Maintenance Type*** from the drop-down list. The Maintenance Type field is a *general description* of the level of maintenance required for each SCM component present at the time of inspection. An SCM component can have multiple maintenance records. *Note: the inspector is required to select both a primary Maintenance Type and a Condition Rating for every component present.* *No Maintenance* should be selected for components that do not require routine or corrective maintenance.

    There are seven primary maintenance types available, including:

    1. **No Maintenance** – SCM component has no deficiencies.
    2. **Routine Maintenance** – SCM component exhibits minor deficiencies but can be addressed through regular maintenance.
    3. **Corrective Maintenance (Current Year)** – SCM component function is not at significant risk, but routine maintenance will not address the issue.
    4. **Corrective Maintenance (Immediate)** – SCM component may function with problems that pose significant risk to performance or pose a serious risk of failure. Maintenance is the appropriate action as opposed to Rehabilitation or Redesign.

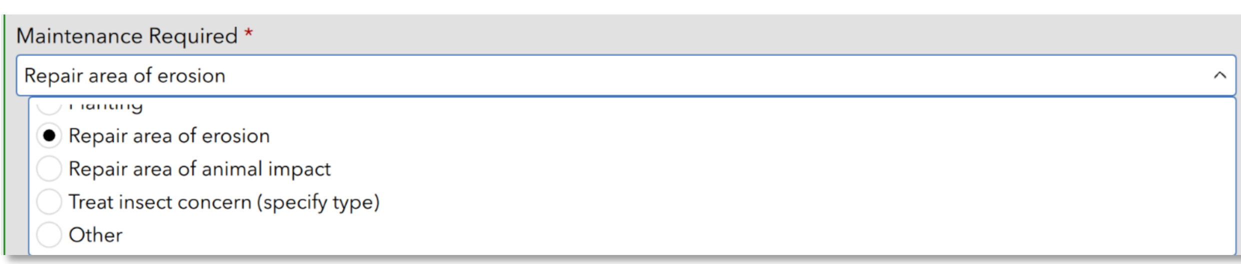
5. **Rehabilitation** – SCM component may not function and may pose serious risk of failure. Addressing the issue would require reconstructing the SCM component to its original as-designed condition.
6. **Redesign** – SCM component does not function and may pose serious risk of failure. Addressing the issue would require redesigning and reconstructing the SCM component.
7. **Investigation Required** – SCM component does not function and may pose serious risk of failure. It is unknown if Rehabilitation or Redesign will address the issue. Additional research, inspection, or design is required.



- Select a ***Maintenance Required*** action from the drop-down list. This field will not be available if No Maintenance is selected. This field further defines the activity required for each SCM component, associated with the defined Maintenance Type.

  There are *eight* primary maintenance types available, including:

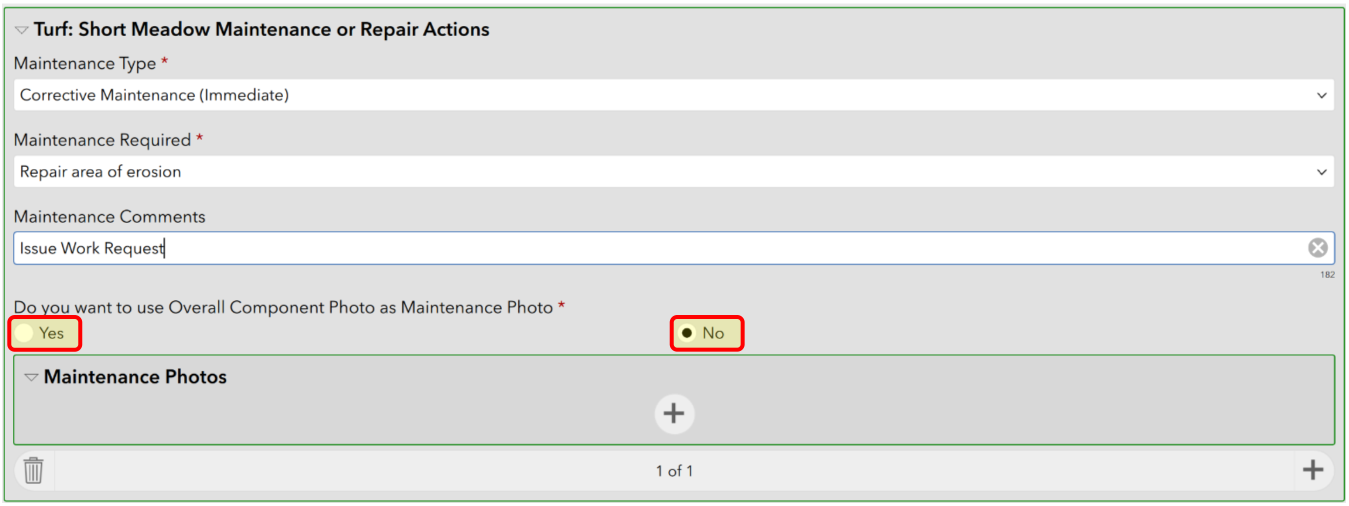
  1. **Litter Control**
  2. **Sediment Removal**
  3. **Seeding**
  4. **Planting**
  5. **Repair area of erosion**
  6. **Repair area of animal impact**
  7. **Treat insect concern (specify type)**
  8. **Other**

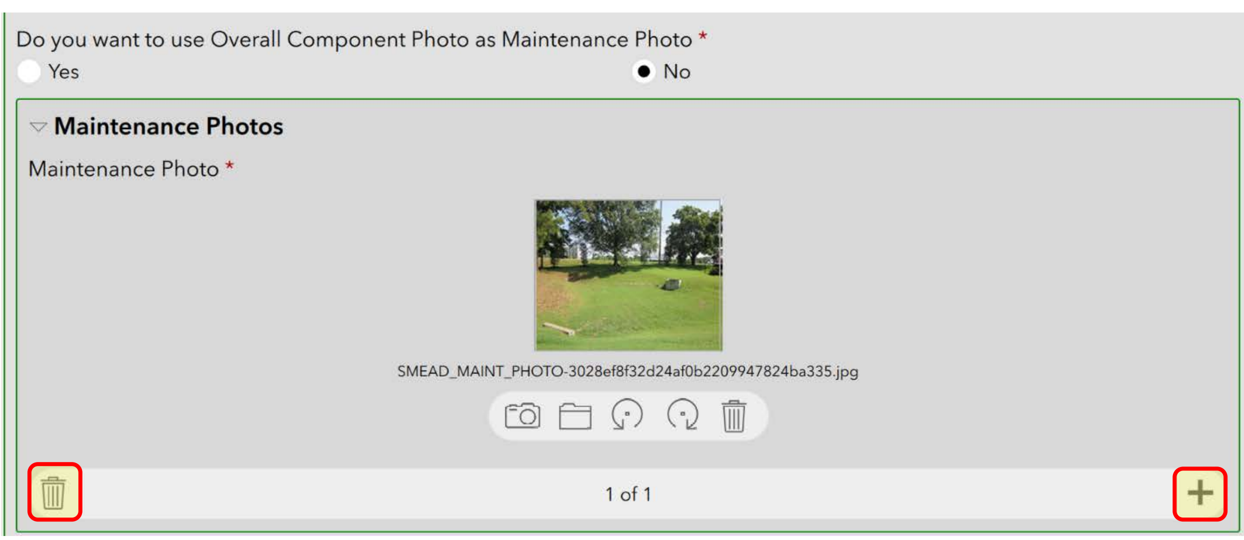


- Add a ***Maintenance Comment*** in the corresponding text field. The inspector should use this field to further define the required maintenance or repair as specified above.

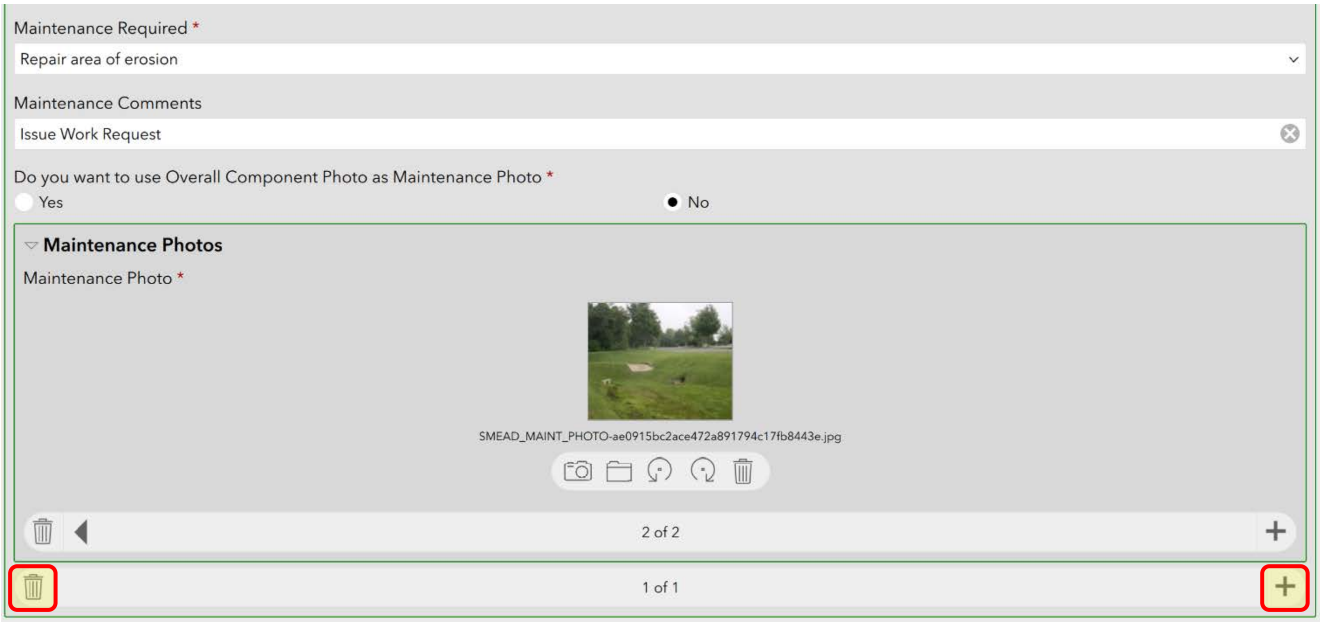
Maintenance comments are optional, unless *__Other__* is selected for Maintenance Required. Selecting Other *__requires__* the inspector to provide comments to clarify the required maintenance.

- Add ***Maintenance Photos*** for the maintenance or repair action. The inspector has the option to use the Overall Component Photo as the Maintenance Photo by Selecting *__Yes__*, or to take / upload one or multiple supplemental Maintenance Photos by selecting *__No__*, and clicking or tapping the + icon. Additional maintenance photos can be taken by clicking or tapping the + icon. Likewise, maintenance photos can be deleted by clicking or tapping the trash can icon.





- *Multiple maintenance records* can be added by the inspector by selecting the icon in the bottom right corner of the ***Maintenance or Repair Actions*** section.
- The inspector can also remove maintenance records by selecting the icon in the bottom left corner of the ***Maintenance or Repair Actions*** section.



Refer to section 5.4 for further details describing PTC photo standards and requirements.

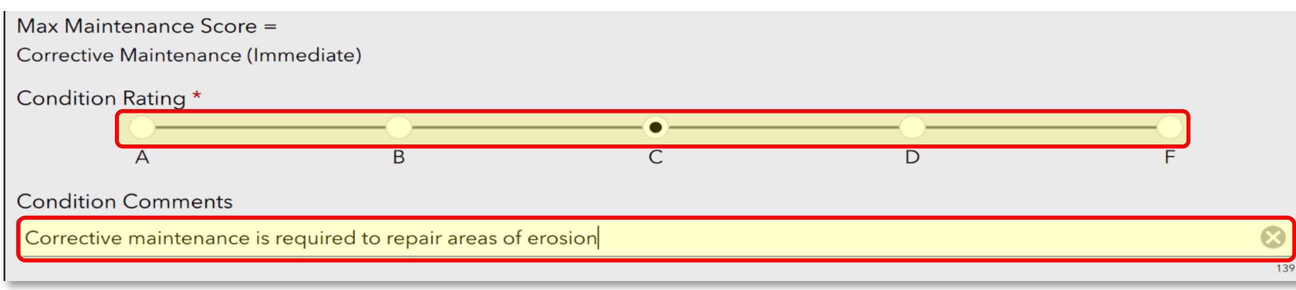
- The ***Condition Rating*** field is a score used to define the overall condition of the SCM Component. Condition Ratings use a letter grade to score the condition, and are defined as follows:

  A – Fully Functional, deficiencies (if any) will be corrected through regular maintenance
  B – Minor deficiency that does not affect function, but should be corrected through maintenance
  C – Major deficiency that will affect function if not corrected
  D – Severe deficiency is that is affecting function
  F – Non-functional, loss of performance

The following table provides recommended Condition Rating scores based on associated Maintenance Types:

Maintenance Type	Condition Rating Options
No Maintenance	A
Routine Maintenance	A, B, C
Corrective Maintenance (Current Year)	A, B, C
Corrective Maintenance (Immediate)	B, C, D
Rehabilitation	C, D, F
Redesign	F
Investigation Required	F

- Select a ***Condition Rating*** of A (best) through F (worst) from the grid.
  - The *Max Maintenance Score* (most *severe* ***Maintenance Type*** for the current component) will be displayed above the ***Condition Rating*** to assist the inspector in rating this SCM component.
  - If the inspector does not agree with the Condition Rating options available, the inspector must return to the maintenance section and review the maintenance records to update as needed.
  - Enter ***Condition Comments*** as needed. Comments are optional, but encouraged to provide additional information regarding their condition assessment.



4.3.5 Inspecting Multiple-Count SCM Components

This section will review the process for inspecting *Multiple Count SCM* components as opposed to single count SCM components, as referenced in the table below:

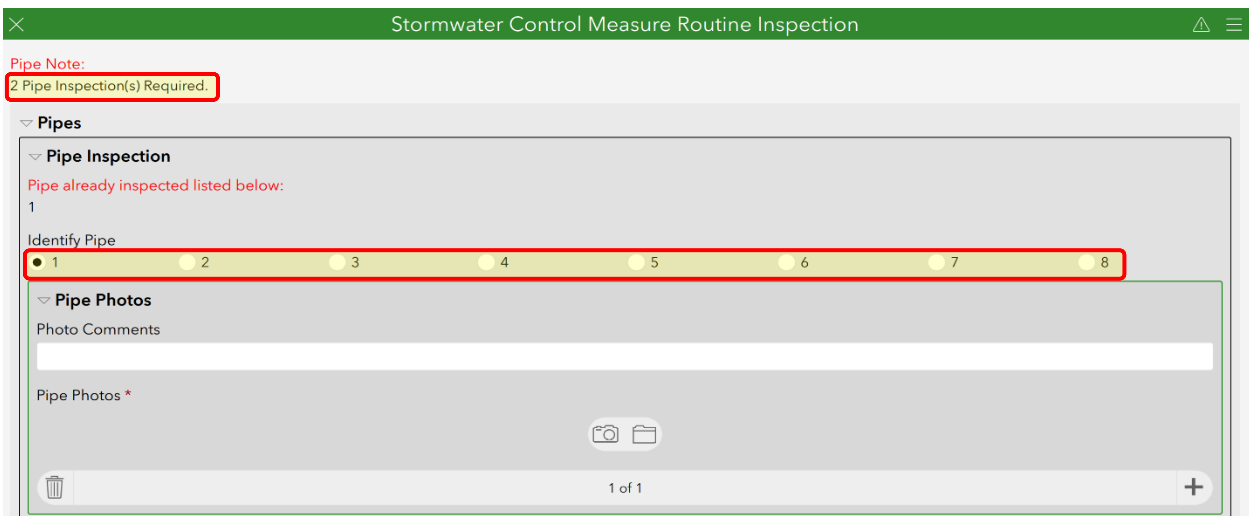
Section	Page Number	Components	Component Type
Inflows	**3**	Forebay Pipes Swales Sheet Flow Curb Cuts	Multi-Count Components

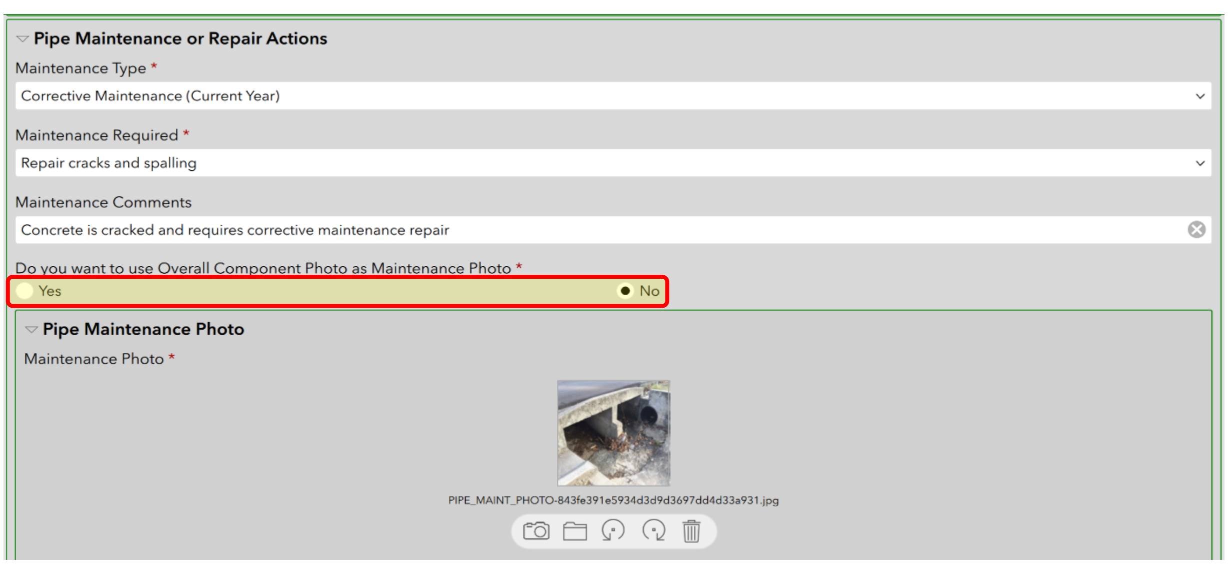
Multiple-Count components are components that could potentially have more than one feature at an SCM that will be inspected independently of each other. At this time, multiple-count components include Inflow components.

Generally, the process to perform an inspection on these components is nearly identical to the single-count components. For multiple-count components, however, users will be required to identify each feature prior to inspecting the component.

- **Identification** - Since there could be more than one feature within the multiple-count component, the inspector must identify each feature individually as they perform the inspection. For each multiple-count component, the survey will display the number of features present for the given component, to help ensure the inspector identifies and inspects all of the inflow features.

  For consistency, it is recommended that inspectors face North from the center of the SCM and identify the first feature for inspection as they look clockwise. After the initial feature has been completed, the inspector should move clockwise to the next multi-count feature for inspection (if more than one feature is present). In the example below, there are two pipe inspections required. The inspector would complete the first pipe inspection following the workflow below before inspecting the second pipe.





- **Example Workflow** – The following methodology will help ensure the identification process is consistent among inspectors and across time.
  - Inspector will move to the center of the SCM. If this is not possible, numbers should be assigned assuming this position.
  - Inspectors will orient themselves facing north.
    Inspectors will assign number one (1) to the first multi-count component feature present in the SCM as they move clockwise from the north.
  - Inspectors will complete the photo, maintenance or repair, and condition rating for the initial feature.
  - For multi-count components with more than one feature, inspectors will assign number two (2) to the next feature as they continue to move clockwise around the SCM.
  - Inspectors will continue completing the photo, maintenance or repair, and condition rating for all subsequent features present in the SCM.

4.3.6 Component Scores and Overall Comments

On the last page of the form (page 13), inspectors will find the Component Scores as well as a place for Overall Comments as described below.

- **Component Scores** – At the end of the inspection form, the survey will calculate an overall SCM Condition Rating based on a calculated score. The SCM calculated score is the average score of all components present that were evaluated during the inspection. The Condition Ratings for each component are converted into numeric values and used to calculate an overall score, as detailed in the following table:

Condition Rating	Component Score	Points Possible
A	5	5
B	4	5
C	3	5
D	2	5
F	1	5
No Component	0	0

For each SCM component present, the total points possible is increased by a value of five, which translates to the maximum possible score for each component. The Overall Score is the average component score for all the components present at the SCM.

Total Points Possible = (Total number of components present) * 5

Total Component Score = sum of individual component scores

(Total Component Score/Total Points Possible) * 5 = Calculated Overall Score

Finally, the calculated score is rounded to the nearest whole number and converted to a text-based condition rating, as detailed in the following table:

Condition Rating	Rating
A	Good
B	Good-Fair
C	Fair
D	Fair-Poor
F	Poor

Component Scores

Calculations

Total Possible Points
60

Total Points Earned
58

Calculated Score
4.83

Rounded Score
5

Condition Rating
Good

Do you agree with the Calculated SCM Condition Rating?

Do You Agree with the Calculated SCM Condition Rating? *

● Yes ○ No

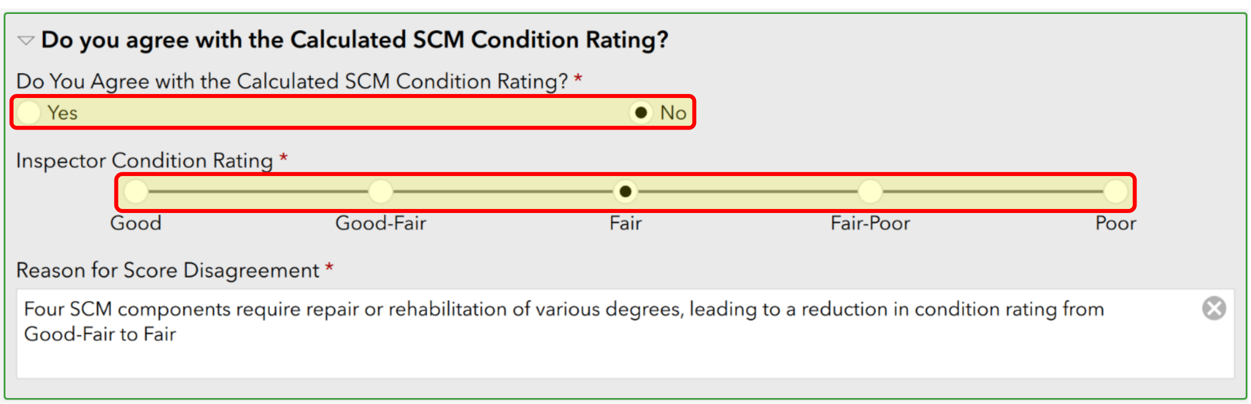
The table below details how the overall score is calculated, based on example component scores:

Component	Component Score	Points Possible
Turf: Lawn	0	0
Turf: Short Meadow	5	5
Turf: Tall Meadow	0	0
Scrub-Shrub	0	0
Forest	5	5
Special Plantings: Ornamental	0	0
Special Plantings: SCM	0	0
Pipes	3	5
Swale	0	0
Sheet Flow	0	0
Curb Cut	0	0
Low Flow Channel	5	5
SCM Floor	5	5
Subsurface Storage	5	5

Observation Well / Cleanout	0	0
Underdrain	0	0
Cut Slopes	5	5
SCM Liner	0	0
Impounding Embankments	2	5
Primary Outflow	2	5
Primary Outflow Trash Rack	5	5
Secondary Outflow	0	0
Secondary Outflow Trash Rack	0	0
Emergency Spillway	3	5
SCM Discharge Point	5	5
Fencing	0	0
Gates/Lock	0	0
Signage	0	0
Summation	**50**	**60**
Calculated Score	**4.17**	
Rounded Score	**4.00**	
Condition Rating	**Good_Fair**	

The calculated Overall SCM score is displayed on the screen for the inspector to evaluate. However, PTC recognizes the variable and dynamic nature of performing SCM inspections. As such, the system provides inspectors with the option to override the system-calculated Overall Rating, and provide a user-calculated Overall Rating.

- Select 'Yes' to agree with the calculated score or 'No' to disagree with the calculated score.
- If the inspector disagrees with the calculated score and Condition Rating, they will be required to complete the following:
  - The inspector must provide the Condition Rating they believe is best representative.
  - The inspector must explain the reason for disagreeing with the system-calculated score.



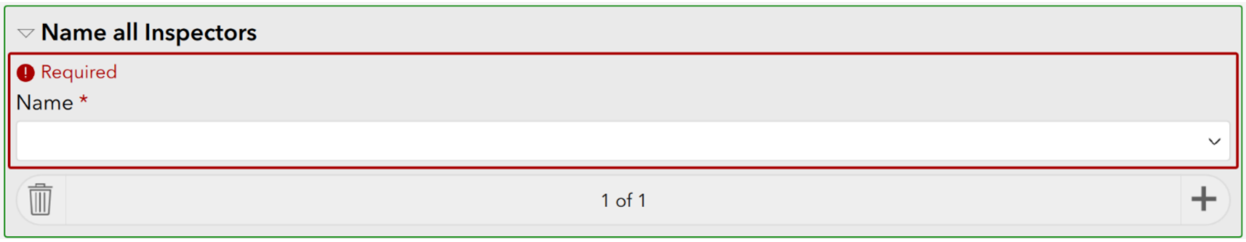
- **Overall Comments** – The Overall Comments field allows the inspector to capture any additional thoughts or insights the inspector wishes to provide about the site. The text box has 1000-character limit, so the inspector can provide extended explanations if needed. Comments can focus on condition ratings, maintenance issues, and access for contractors, etc. The Overall Comments field is not a required field, but additional comments are useful.

4.3.7 Submitting the Form

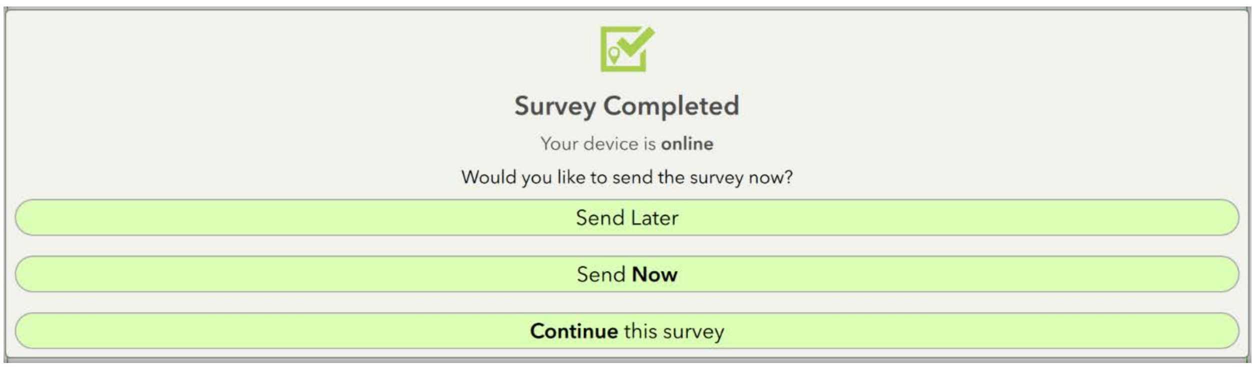
The inspector must submit the form to officially save the inspection and push the data back to PTC's ArcGIS Online. The inspector can submit a survey by completing the steps below.

- To submit the form, tap the  icon in the bottom right hand corner of the screen

- If any required fields are not completed, the survey will automatically flag the required field by jumping to the associated page and outlining the field with a red box. The inspector must complete each mandatory field before being proceeding to the next step.

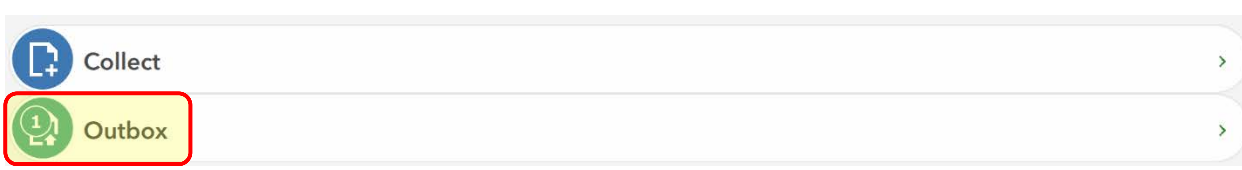


- Select ***Send Now*** if the inspector is working in a connected environment.
- Select ***Continue this survey*** to add additional information to the survey.
- If the inspector is disconnected from the internet, select ***Send Later***.



- Follow the process below to ***Send Later***:
  - Establish a reliable Internet connection using Wi-Fi.
  - Open Survey 123 application, and sign in as needed.
  - Select the correct inspection form
    - Stormwater Control Measure (SCM) Routine Inspection Form
    - Stormwater Control Measure (SCM) Field View Inspection Form

  - Completed surveys that have not be submitted will be presented in the Outbox
  - The number shown represents the number of surveys present in the Outbox



- Select 

in the bottom right corner to finish the submittal process
  - Submitted surveys will appear in the ***Sent*** box within the Survey123 application. An inspector can review submitted forms in the sent box. The sent box will only include forms submitted from the *current device* – it will not reflect inspection forms on other devices.

Note: Surveys should not be edited via the sent box. Surveys edited through the sent box will not carry their original pictures and submission errors will occur.

Note: Pictures will not be visible when reviewing a survey that was already submitted. Do not delete any completed surveys from the sent box unless approved. These survey forms are stored as local backups that can recover information in the event a form does not originally submit successfully.

Submitting a survey synchronizes the inspection data and all the pictures to a hosted feature service on ArcGIS Online. Any submitted data is available for review in real-time. The data can be reviewed by accessing the data directly on ArcGIS Online, or the Survey 123 website (https://survey123.arcgis.com). Inspection data will be reviewed by PTC Engineering as described in section 4.5.

4.4 Error Handling

This section briefly discusses the process for handling system errors in the unlikely event that these errors occur during the data collection and submission process.

- **Internet Connectivity -** The most common issue inspectors will likely encounter in the field will be related to internet connectivity. An internet connection is required to fully leverage the Collector for ArcGIS application, and therefore to launch the inspection forms. To ensure successful data collection, inspectors should only perform inspections while using an internet-connected device as described in section 4.1.

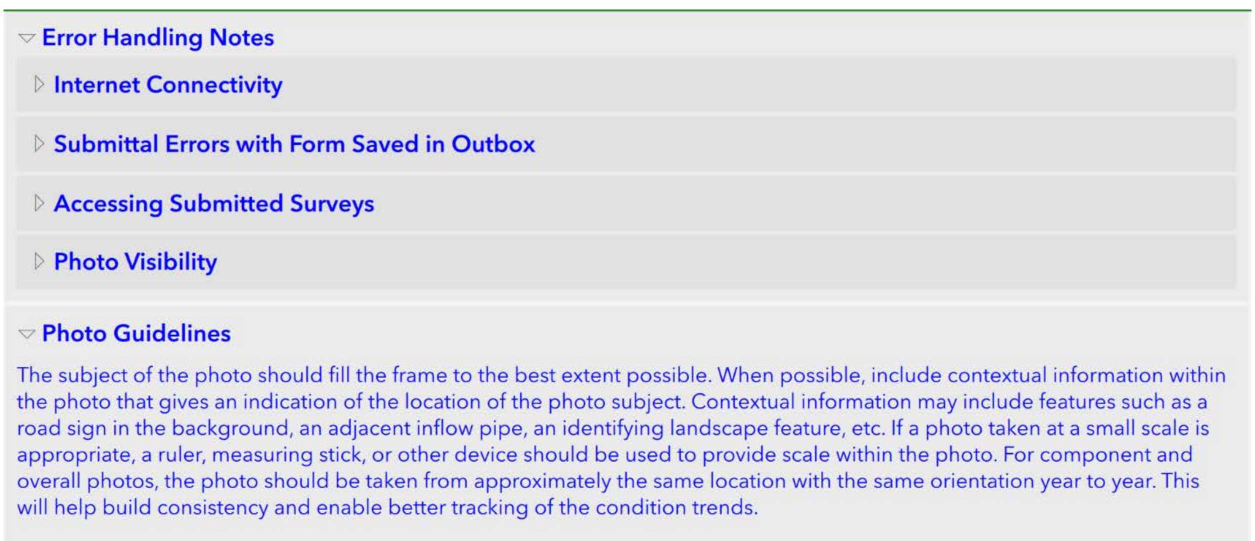
- **Submittal Errors with Form Saved in Outbox** - Other issues may also arise that prevent the successful submission of inspection forms. Inspections that fail to send should be stored in the Survey123 outbox, and inspectors are strongly advised to leave the inspection in the Survey123 outbox. The inspectors may continue to perform field work if the failed inspections are confirmed to be stored in the Survey123 outbox. The inspection forms in the Survey123 outbox can be retrieved and synchronized manually back in the office.
  - The PTC CADD/GIS Specialist should be contacted at the earliest opportunity to alert them of submission issues.

  - If inspections fail to submit and are not stored in the Survey123 outbox after failure, the inspector should stop performing inspections and contact the PTC CADD/GIS Specialist immediately.

- **Accessing Submitted Surveys** – Surveys should not be edited via the sent box. Surveys edited through the sent box will not carry their original pictures and submission errors will occur.

- **Photo Visibility** – Pictures will not be visible when reviewing a survey that was previously submitted. Do not delete any completed surveys from the sent box unless approved. These survey forms are stored as local backups that can recover information in the event a form does not originally submit successfully.

- **Photo Guidelines** – The subject of the photo should fill the frame to the best extent possible. When possible, include contextual information within the photo that gives an indication of the location of the photo subject. Contextual information may include features such as a road sign in the background, an adjacent inflow pipe, an identifying landscape feature, etc. If a photo taken at a small scale is appropriate, a ruler, measuring stick, or other device should be used to provide scale within the photo. For component and overall photos, the photo should be taken from approximately the same location with the same orientation year to year. This will help build consistency and enable better tracking of condition trends.


Error Handling Notes

Internet Connectivity

Submittal Errors with Form Saved in Outbox

Accessing Submitted Surveys

Photo Visibility

Photo Guidelines

The subject of the photo should fill the frame to the best extent possible. When possible, include contextual information within the photo that gives an indication of the location of the photo subject. Contextual information may include features such as a road sign in the background, an adjacent inflow pipe, an identifying landscape feature, etc. If a photo taken at a small scale is appropriate, a ruler, measuring stick, or other device should be used to provide scale within the photo. For component and overall photos, the photo should be taken from approximately the same location with the same orientation year to year. This will help build consistency and enable better tracking of the condition trends.

4.5 Post-field

This section describes the data flow after the SCM inspections are performed in the field, and gives users an awareness of how PTC is viewing and managing data after it is collected in the field.

In-field inventory edits and inspection forms synchronize with a hosted feature layer on ArcGIS Online upon submission. PTC Engineering will review the collected data using a web-based viewer application that leverages the hosted feature layer, and is accessible only on the PTC's local intranet. Following a thorough review of the inspection data and coordinating with inspection teams to make any updates as needed, PTC Engineering will approve the inspections.

Upon approval of the inspection data, PTC will perform a transfer of that inspection data to the enterprise spatial database, where it will become a part of the stormwater inventory. Once in the enterprise spatial database, the data will be accessible to stormwater reporting tools, PTC's asset management system, and also to the PTC organization-wide for viewing purposes.

5 Reference

5.1 PTC CADD/GIS Specialist

At the time of this document's publication, the PTC CADD/GIS Specialist is:

Robert Loncar
rloncar@paturnpike.com
717-831-7342

5.2 Collector for ArcGIS

- https://doc.arcgis.com/en/collector/ios/collect-data/quick-reference.htm
- https://doc.arcgis.com/en/collector/ios/collect-data/collect-tutorial.htm
- https://doc.arcgis.com/en/collector/ios/collect-data/update-a-feature.htm
- https://doc.arcgis.com/en/collector/ios/collect-data/delete-a-feature.htm
- https://doc.arcgis.com/en/collector/ios/collect-data/draw-a-shape.htm

5.3 Survey123 for ArcGIS

- https://doc.arcgis.com/en/survey123/reference/whatsnewsurvey123.htm
- https://doc.arcgis.com/en/survey123/desktop/get-answers/troubleshootgetanswers.htm
- https://survey123.arcgis.com/

5.4 Photos

Photos are a critical part of the submitted inspection, and PTC relies heavily on them to gain an understanding of field conditions. The following are best practices that PTC requires for each photo taken as part of the inspection:

- The subject of the photo should fill the frame to the best extent possible.
- When possible, include contextual information within the photo that gives an indication of the location of the photo subject.
  - Contextual information may include features such as a road sign in the background, an adjacent inflow pipe, an identifying landscape feature, etc.
  - If a photo taken at a small scale is appropriate, a ruler, measuring stick, or other device should be used to provide scale within the photo.
- For component and overall photos, the photo should be taken from approximately the same location with the same orientation year to year. This will help build consistency and enable better tracking of the condition trends.

5.4.1 Maintenance Photos

Below, typical maintenance issues are presented with an example of a high-quality maintenance photo. Note that each photo meets the best practices identified above in section 5.4.

Photo Num	Photo	Description
1		Collect and Remove Sediment
2		Collect and Remove Trash and Debris

5.4.2 Component Photos

Below, typical SCM components are presented with an example of a high-quality component photo. Note that each photo meets the best practices identified above in section 5.4.

Photo Num	Photo	Description
1		Special Plantings 1
2		Special Plantings 2

Photo Num	Photo	Description
3		Special Plantings 3
4		Forebay

Photo Num	Photo	Description
5		Pipe
6		SCM Floor

Photo Num	Photo	Description
7		Low Flow Channel

Photo Num	Photo	Description
8		Observation Well (Inside)
9		Observation Well (Outside)

Photo Num	Photo	Description
10		Cut Slope

Photo Num	Photo	Description
11		Impounding Embankment
12		Primary Outflow (Front)

Photo Num	Photo	Description
13		Primary Outflow (Inside)

Photo Num	Photo	Description
14		Emergency Spillway
15		Discharge Point (Facing Away)

Photo Num	Photo	Description
16		Discharge Point (Facing Towards)
17		Fencing

Photo Num	Photo	Description
18		Gate / Lock
19		SCM Liner

APPENDIX E

SAFETY CONSIDERATIONS FOR SCM INSPECTION & MAINTENANCE

E.1 SCM Safety Overview

While all PTC safety policies should be followed at all times, the following highlights key concerns and risks associated with SCMs.

SECTION UNDER DEVELOPMENT BY PTC SAFETY. TOPICS MAY INCLUDE THE FOLLOWING:

Falls
Confined Space
Drowning (standing water, un-clogging causing rushing water, sediment/muck entrapment)
Traffic safety (for accessing the SCMs)

Other considerations

Snakes (on riprap and in tall grasses)
Cicada Wasps (on side slopes)
Poison Ivy and other plants of concern (See list and discussion at end of App F)
Ticks

APPENDIX F
PLANT IDENTIFICATION

F.1 Common SCM Plantings

Most surface SCMs such as bioretention areas, most types of basins, stormwater wetlands and vegetated swales are planted with vegetation in the form of seed mixes, graminoids, forbs, shrubs and/or trees. Graminoids are grass-like, narrow-leaved, herbaceous plants including sedges, rushes and true grasses. Forbs are flowering, broad-leaved, non-graminoid (grass), herbaceous plants. Typically, native species are preferred. There are numerous varieties, however Table F.1.1 presents some species commonly found in SCMs as listed in PTC's Design Consistency Guidelines.

Table F.1.1: Common SCM Planting Species

Common Name	Scientific Name
Tree	
Swamp White Oak	*Quercus bicolor*
Red Maple	*Acer rubra*
River Birch	*Betula nigra*
American Sycamore	*Platnus occidentalis*
Serviceberry	*Amelanchier Canadensis*
Blackgum	*Nyssa sylvatica*
Willow Oak	*Quercus phellos*
Sun Shrub	
Sweet Pepperbush	*Clethra alnifolia*
Winterberry Holly	*Ilex verticillata*
Common Elderberry	*Samucus nigra*
Steeplebush	*Spiraea tomentosa*
Meadowsweet	*Filipendula ulmaria*
Virginai Rose	*Rosa Virginia*
Black Chokeberry	*Aronia melanocarpa*
Arrowwood Viburnum	*Viburnum dentatum*
Speckled Alder	*Alnus incana*
Shade Shrub	
Red Chokeberry	*Aronia arbutifolia*
Black Chokeberry	*Aronia melanocarpa*
Silky Dogwood	*Cornus amomum*
Sweet Pepperbush	*Clethra alnifolia*
Winterberry Holly	*Ilex veticillata*
Arrowwood Viburnum	*Viburnum dentatum*
Pussy Willow	*Salix discolor*

Common Name	Scientific Name
Sun Herbaceous	
New England Aster	*Symphyotrichum novae-angliae*
Turtle head	*Chelone oblqua*
Blue Lobelia	*Lobelia siphilihica*
Royal Fern	*Osmunda regalis*
Switchgrass	*Panicum virgatum*
Blue Vervain	*Verbena hastate*
New York Ironweed	*Veronia noveboracensis*
Soft Stem Bulrush	*Scirpus validus*
Tussock Sedge	*Carex stricta*
Swamp Milkweed	*Ascelepias incarnate*
Common Three Square	*Scripus amercianus*
Shade Herbaceous	
New York Aster	*Symphyotrichum novi-belgii*
Spotted Joe-Pye-Weed	*Eupatorium maculatum*
Bonset	*Eupatorium perfoliatum*
Blue Flag Iris	*Iris virginica*
Soft Rush	*Juncus effusus*
Cardinal Flower	*Lobelia cardinalis*
Sensitive Fern	*Onoclea sensiblis*
Tussock Sedge	*Carex stricta*

Information about the above and other SCM plants can be obtain from internet and desktop references. When researching plantings for SCMs, it is important to check the local growing habits of the species in question. Some plants will grow in wet areas in some parts of the state while growing only in dry areas elsewhere. Likewise, a plant may be considered native to some areas but invasive in others. The PA Stormwater BMP Manual contains an appendix of plants native to Pennsylvania with information about the plants typical habitat. Philadelphia Water Department's Stormwater Management Guidance Manual V3.1 Appendix I - available via their website - contains thorough landscape guidance that can be used for reference.

F.2 Hydrophytic Vegetation

Prolonged soil saturation causes an oxygen deficiency in the soil. Most plants require oxygen available to their root system for survival. Hydrophytic vegetation are plants that have adapted to wet conditions, thriving and growing in the absence of oxygenated soil. The presence of these plants, particularly combined with the absence of "upland" plants, is an indication of continually wet conditions. Unless the SCM is designed to have a permanent pool of water (such as a wet detention basin or stormwater wetland system), the presence of these plants suggests inadequate SCM drawdown.

Hydrophytic vegetation can be intentional native plantings in an SCM or invasive. When inspecting an SCM with a permeant pool of water, the presence of native hydrophytic vegetation does not indicate an issue, while presence of invasive species indicates a potential problem. Wetland planting guides are a good source to help identify species commonly used in SCMs while invasive species references listed below may be used to identify invasive hydrophytic species.

F.3 Invasive Species

The PA Department of Conservation and Natural Resources (DCNR) defines invasive plants as those that are not native to an area, spread quickly and aggressively, and cause economic or environmental harm or harm to human health (DCNR). These non-native or exotic species are usually introduced to new regions by people accidentally or intentionally. Invasive species displace native species and change the ecological structure of the invaded community, sometimes with dire consequences to native plants and animals (PennDOT Pub. 756).

There are numerous references listing hundreds of plants which are invasive in Pennsylvania. Among these plants, the Pennsylvania Department of Agriculture maintains lists of the highest priority plants denoted Class A, Class B and Class C Noxious Weeds. Class A and C species are the high priority with recommendations to prevent new and eradicate existing infestations. Class B species may require control to contain an injurious infestation. To assist users of this Publication, the Table F.3.1 lists invasive species commonly found along roadway right-of-ways and within SCMs with those on the Class A, B, or C Noxious Weed list noted. However, this is not an exhaustive list.

For additional information, users are encouraged to use available information sources. Reference PTC internal guidance on invasive species management within PTCs right of way. PA Department of Conservation and Natural Resources (DCNR) has developed an overview brochure and individual species fact sheets to aid in education and identification available at their website.

In addition to the DCNR references, for SCMs in and around streams, wetlands and moist areas, PADEP issued "Pennsylvania Field Guide - Common Invasive Plants in Riparian Areas" which can be found at this link.

Table F.3.1: Invasive Species Common in SCMs

Common Name	Scientific Name
Vines	
Porcelain Berry	*Ampelopsis brevipedunculata*
Oriental Bittersweet	*Celastrus orbiculatus*
English Ivy	*Hedera helix L.*
Japanese Hops	*Humulus japonica*
Japanese Honeysuckle	*Lonicera japonica*
Kudzu*	***Pueraria montana var. lobata***
Mile-a-Minute*	***Polygonum perfoliatum***
Chinese & Japanese Wisteria	*Wisteria sinensis, W. floribunda*
Shrubs	
Japanese & European Barberry	*Berberis thunbergii, B. vulgaris*
Russian Olive & Autumn Olive	*Elaeagnus angustifolia L., Elaeagnus umbellata*
Winged Euonymus (aka Burning Bush)	*Euonymus alatus*
Privets Japanese, Boarder, Chinese & Common	*Ligustrum japonicum, L. obtusifolium, L. sinense, L. vulgare*
Glossy Buckthorn	*Rhamnus frangula alnus*
Multiflora Rose*	***Rosa multiflora***
Trees	
Amur Maple	*Acer ginnala*
Norway Maple	*Acer platanoides*
Sycamore Maple	*Acer pseudoplatanus L.*
Tree-of-Heaven*	***Ailanthus altissima***
Empress Tree (aka Princess Tree)	*Paulownia tomentosa*

Common Name	Scientific Name
Aquatic Plants	
Narrow leaved cattail	*Typha angustifolia*
Hybrid cattail	*Typha x glauca*
Curly Pondweed	*Potamogeton crispus*
Herbs and Forbs	
Garlic Mustard	*Alliaria petiolata*
Brown, Black & Spotted Knapweed	*Centaurea jacea, C. nigra, & C. stoebe*
Canada & Bull Thistle*	***Cirsium arvense, C. vulgare***
Poison hemlock*	***Conium maculatum***
Crown-vetch	*Coronilla varia*
Japanese & Giant Knotweed*	***Fallopia japonica, Fallopia sachalinensis***
Lesser Celandine	*Ficaria verna, (formerly Ranunculus ficaria L.)*
Giant Hogweed*	***Heracleum mantegazzianum***
Japanese Stilt Grass	*Microstegium vimineum*
Purple Loosestrife*	***Lythrum salicaria***
Reed Canary Grass	*Phalaris arundinacea*
Common Reed (Phragmites)	*Phragmites australis ssp. australis*
Shattercane*	***Sorghum bicolor***
Johnson Grass*	***Sorghum halepense***

*bold asterisk denotes species on PA Department of Agriculture Class A or Class B Noxious Weed Lists.

F.4 Undesirable Vegetation

Undesirable vegetation is any vegetation including native, non-native and invasive species which are problematic in a given setting. For example, woody trees may be appropriate plantings along a roadside, but they are undesirable on SCM embankment slopes where they may impact the structural integrity of the SCM. In an SCM, undesirable vegetation is anything which may hinder the functionality or structural integrity of the SCM. Vegetation that impacts infiltration/filtration, storage, treatment ability, embankment stability, flow through, or any other function of the SCM is considered undesirable and should be removed.

Undesirable vegetation of particular note are those that pose significant health risks due to contact. Table F.4.1 lists some of the more common species known to present concern.

Table F.4.1: Common SCM Planting Species

Common Name	Scientific Name	Plant Type	Concern
Tree-of-Heaven*	***Ailanthus altissima***	Tree	• Rare reports of myocarditis (inflammation of the heart) with excessive sap exposure to broken areas. • Few cases of skin irritation or dermatitis from contact with any part of the plant.
Giant Hogweed*	***Heracleum mantegazzianum***	Herbaceous	• Contact with the eyes can cause permanent blindness. • Sap makes human skin UV light sensitive leading to severe burns and blisters. • Skin contact may lead to severe itching.
Poison hemlock*	***Conium maculatum***	Herbaceous	• All parts of the plant, especially the seeds are extremely poisonous to humans. • Volatile alkaloids can be toxic when inhaled.
Wood Nettle (Canada nettle)	*Laportea canadensis*	Herbaceous	• Contact with leaves and stems can cause burning sensation followed by rash and blistering lasting several days.
Wild Parsnip*	***Pastinaca sativa***	Herbaceous	• Contact with leaves and sap may cause painful rash in the presence of sunlight.
Poison Ivy, Poison Oak, Poison Sumac	*Toxicodendron Radicans, T. Diversilobum, T. Vernix*	Herbaceous	• Contact with leaves, stems and roots result in skin dermatitis with severe itching. • Inhaling burning poison sumac can cause life-threatening pulmonary edema.

*bold asterisk denotes species on PA Department of Agriculture Class A or Class B Noxious Weed Lists.

APPENDIX G

MAINTENANCE AND REPAIR TABLES

The maintenance and repair tables presented here cover all of the SCMs (Chapter 6) and Common SCM Components (Chapter 5) in this Publication. Note Table G.1.3 applies to the SCMs included in Sections 6.1, 6.2 and 6.3.

TABLE	NAME
G.1.1	General (applicable to all SCMS)
G.1.2	Common Components (all components in Chapter 5)
G.1.3	Basin, Most Types (BDD, BED, BUD, BND, BOT, BWD, BID)
G.1.4	Bioretention (BRE, BRU)
G.1.5	Subsurface Infiltration Trench (SIT)
G.1.6	Subsurface Detention Storage (SDS)
G.1.7	Stormwater Wetland System (SWE)
G.1.8	Constructed Stormwater Filter (CSF)
G.1.9	Vegetated Filter Strip (VFS, VSS)
G.1.10	Media Filter Drain (MFD)
G.1.11	Vegetated Swale (VSW, VSC)
G.1.12	Infiltration Berm (IBE)
G.1.13	Manufactured Treatment Devices (MTD)
G.1.14	Level Spreader Outfall (LSO)
G.1.15	Pervious Pavement (PPA, PPC, PPP)
G.1.16	Regenerative Step Pool (RSP)
G.1.17	Self Preserving SCMs (RBE, RBO, FPR, LRM, RTP, SAR, SRE, SST)

The maintenance and repair activity tables should be used by the assigned PTC representative to determine appropriate corrective maintenance and repair actions based on the results of an inspection or a report from maintenance crews. The tables aid in interpreting inspection reports, scheduling needed repairs, and budgeting required work. They are not intended to dictate routine maintenance activities, which are stipulated in the maintenance procedure tables contained in Chapter 5 and 6, but to guide non-standard, corrective repairs. It is important to reference the applicable corrective maintenance and repair information presented in the general and component tables in addition to the SCM specific table as appropriate.

The tables include scenarios generally encountered in the field, but they cannot cover all potential situations. They are not intended to be a comprehensive guide for major modifications to SCMs that may be required. All repairs should follow applicable PTC standards. Designers, inspectors, supervisors and crews should use good judgment when applying repair recommendations and recommended timing for repairs contained in the tables. When in doubt, potentially unsafe situations should be brought to the attention of a supervisor.

Each table contain six columns, which are described as follows:

- SCM Inspection Section: Component/Feature: The part of the SCM where the defect is identified. It first lists the Section within the Inspection App followed by the specific component or feature. Reference Appendix D, Section D4.3.1 for a table listing of Sections/Components.
- Defect or Problem: Describes the identified concern.
- Maintenance Type Category: Corresponds to the Maintenance Type assigned in the app during an inspection. The ratings are as follows:

  R = Routine
  C = Corrective, Current Year
  I = Corrective, Immediate
  H = Rehabilitation
  D = Redesign
  V = Environmental/engineering Investigation

- Maintenance is needed when…: Describes the circumstances that require action.
- SCM Component Variations or Cause of Defect/Problem: Where needed, clarifies the defect or conditions applicable to alternative resolutions.
- Recommended Maintenance Activity to Correct Problem: Explains the maintenance action(s) most likely to resolve the identified defect.

The following notes apply to all tables:

- All repairs should be done in conformance with all applicable PTC standards.
- Follow all SCM maintenance techniques described in Section 4.7 including no entry into any SCM when wet and use of LGP equipment on all infiltration or filtrating surfaces.
- All vegetation, trash, debris, liquids, and materials removed from the SCM should be disposed of in accordance with applicable PTC and PADEP waste management policies and all applicable regulations. Sediment should be disposed of in accordance with PTC policy on handling of fill and applicable regulations.
- Do not enter manholes, inlets, or any structure meeting for the definition of confined space without current confined space training and appropriate safety measures in place. Do not attempt to perform maintenance activities while water is standing in or flowing through the system without proper training and safety measures in place.
- Cut Slopes are the inside SCM walls formed below surrounding grade where the SCM side wall is constructed by excavating below grade. Impounding embankments, or berms are 'fill' material constructed above the surrounding ground forming a side wall of the SCM. Embankments may not be present in all SCMs. Embankments may be considered a regulated dam structure depending on height and drainage area. The term Side Slopes is used to reference either cut slopes or embankments.
- The use of the word "plan" in the table refers to the as-built plan on record for the SCM.
- Any earth disturbance over 5,000 square feet requires a written ESPC Plan to be prepared and on site. Earth disturbance over one acre may require an NPDES permit.

- Work in wetlands, waterways, and floodplains may require PADEP permitting prior to the commencement of work.
- Call PA One Call prior to digging.
- Maintenance and protection of traffic must conform to PTC policy.
- Invasive plant management should conform with PTC policy. Removal of invasive and non-invasive plants should be as needed when deemed undesirable or as appropriate in accordance with PTC policy.

Table G.1.1: General Maintenance and Repair Table [1]					
SCM Inspection Section: Component/ Feature [2]	**Defect or Problem**	**Maintenance/ Repair Category**	**Maintenance is Needed When…**	**SCM Component Variations or Cause of Defect/Problem**	**Recommended Maintenance Activity to Correct Problem**
All SCM Components: General	Field conditions do not match record plans or inventory information	C, I, H, V	… inspection reveals field conditions of one or more components do not match plans resulting in the potential to impact the SCMs ability to perform appropriately.		Resolution should be determined by a professional engineer. Possible remediation may include modeling actual field conditions in comparison with intended design to assess the impacts on runoff rate, volume and quality controls. If the SCM is performing within the design requirements, the field conditions may be documented as acceptable and the record plans should be updated. If the SCM is not meeting its design requirements, reconstruction of the nonconforming component may be required. Coordination with PADEP may be required.
	Temporary ESPC measures present	C, I	…temporary ESPC measures remain in the SCM drainage area after complete stabilization and Conservation District approval to remove.		Remove temporary ESPC measure, and permanently stabilize areas disturbed by the removal. Note: Riprap outlet protection is typically a permanent measure that should remain.
	Floatable trash observed in SCM, pretreatment, cut slopes/embankment, inflow/outflow channels/ points, or general area	I	…floatable trash can potentially block inflow/outflow structures or escape downstream.		Remove floatable trash and debris.
	Tires, metal, antiskid material, or other non-floatable trash observed in SCM, pretreatment, cut slopes/embankment, inflow/outflow channels/ points, or general area	R,C	…trash and debris inhibit function or is aesthetically unacceptable.		Remove trash and litter.
	Woody debris and leaves (other than intentionally placed mulch material) observed in SCM, pretreatment, cut slopes/embankment, inflow/outflow channels/ points, or general area	C, I	…woody debris and leaves pose a hazard and inhibit function.		Remove debris.
	Hazardous insect nests	C	… insect nests such as wasps and hornets interfere with SCM access or maintenance activities.		Remove insect nests.
	Erosion of soils or bare areas observed	C, I	… general erosion or areas of bare (non-vegetated) soils present causing sediment runoff and continued erosion issues.		Confirm adequate topsoil and sunlight are present for plant establishment. Add topsoil and adjust planting material for appropriate sun exposure. Replant and establish plan specified vegetation cover material. If problem reoccurs, a landscape architect should design the repair.
Vegetation: General	Trees in poor condition near/on/in facility observed	I	…trees found to be weakened, unsound, undermined, leaning, or exposed may fall across roadway or on to SCM/embankment.	Facility designed without trees.	Remove hazard trees.
				Facility designed to have trees.	Remove hazard trees. Determine cause of tree loss. This may require consultation with a landscape architect. Replace trees that were removed with species of sizes indicated on plans, or as specified by a landscape architect.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Inflows: General	Flow from pipe or into SCM noted during time when no rain has recently occurred	I, V	...a substance other than stormwater runoff is suspected to be entering the SCM. …flow into SCM is observed during dry weather.		Do not touch the substance in question. Attempt to find where the substance is originating. Photograph and document the Potential Illicit Discharges (PIDs). Follow procedures for handling PIDs as specified in PTCs Illicit Discharge Detection and Elimination (IDD&E) Program Manual.
Inflows, Surface Storage, Cut Slopes, Impounding Embankments Outflow, Emergency Spillway: General	Sinkhole or depression observed	I, H	…open holes or depressions are observed in the SCM floor, near embankments/cut slopes, or somewhere in the vicinity of the SCM.	No underdrains present and/or large holes/depressions observed.	Surround area with orange construction fence. A geotechnical engineer may be required to evaluate the cause/source of issues. Repair should be designed by a professional engineer. A corrective, local repair may be to place a reverse filter in the hole. A remediation repair may involve installing an impermeable liner on the bottom of the SCM.
				With underdrains, small holes observed in vicinity of underdrain.	If depressions are small and near underdrain or outflow structure, sinkhole may be associated with failure of underdrain system. See "Subsurface Storage: Underdrain- Settlement observed over underdrain" on Table G.1.2.
Inflows, Surface Storage: Water Quality	Strong odor, discoloration of water, oily sheen, foam, or toilet paper observed	I	…non-stormwater discharges are found entering the SCM. …evidence of contaminants discharged from a spill or accident on roadway flowing into SCM.		Do not touch the substance in question. Attempt to find where the substance is entering the SCM. Photograph and document the PIDs. Follow procedures for handling PIDs as specified in PTCs Illicit Discharge Detection and Elimination (IDD&E) Program Manual.
	Stagnant water	C, I	…when algae is present in standing water.		See "Surface Storage: SCM Floor-Water Quality- Algae" on SCM specific maintenance and repair activity tables.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.2: Common SCM Components Maintenance and Repair Table [1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Access, Fencing, Security & Signage					
Overall Comments: Access	Access drive rutting observed Access drive has excessive vegetation growth Stone or soil on adjacent roadway from access drive	C	…stone or mud can be tracked onto adjacent roads, or access is difficult due to condition of access drive.	Stone access drive rutted or loose stone on adjacent roadway.	Sweep stone or soil off of roadway. When ruts occur, the surface should be scarified, graded, add suitable material and roll.
		C		Asphalt access drive rutted or severely cracked.	Repair asphalt by undercutting to a stable subbase and then follow standard procedures for patching and paving.
		R		Vegetation growing in access drive.	Remove or treat vegetation. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
	Access is blocked	I	…access to key components of the facility is inhibited.	Access blocked by illegal dumping.	Remove and dispose of material in accordance with applicable waste disposal regulations.
		I		Access blocked by fallen tree.	Remove fallen trees.
	Stabilized access for vehicles/equipment does not exist	C, D	…lack of access drive to SCM is preventing performance of required inspection and/or maintenance activities.		Construction of temporary or permanent access road may be required to support maintenance activities. Estimate frequency and type of activities and equipment needed to reach SCM to determine if a temporary or permanent access is required. Where access is required over steep slopes, consider hand work alternatives, winching equipment into place, or use of vacuum truck with long hose to reach SCM. Where conditions are too wet to traverse or a wetland/stream crossing is required, follow matting and crossing installation and removal requirements in the PADEP ESPC Manual.
Fencing/ Gates/ Locks/ Signage	Fence damage or open/damaged gate observed	I	…unauthorized access to the facility can occur through a damaged fence or gate.	Lock missing or difficult to open.	Replace lock with one designed for outdoor use and that has a master key.
				Hole in fence.	Temporarily repair with 12-gauge galvanized wire. Schedule replacement of fence fabric.
				Fence posts or gate damaged.	Determine if gate can be temporarily secured and do so if feasible. Schedule fence repair.
				Posts or top rail out of plumb more than 6 inches.	Repair post such that it is within 1-1/2 inches of plumb, and bends in top rails are less than 1 inch.
	Excessive gap between bottom of fence and ground observed	I	…unauthorized access to the facility can occur through an opening beneath fence or gate.		Reestablish proper ground elevation such that opening beneath the fence is less than 6 inches in height. Use of rocks or metal edging may be required. Replace fence fabric if necessary.
	Signs of trespassing	C	…evidence in and around SCM suggests unauthorized access to the facility is occurring and presents safety concerns.	Plans call for fence but none is present.	Install fence per original plans.
				Plans do not call for a fence.	Assess the potential safety hazard for unauthorized access to the SCM. If there is a safety concern associated with authorized access or vandalism is

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Fencing/ Gates/ Locks/ Signage			…vandalism is occurring causing damage to the SCM.		causing damage to the SCM, install fencing with locked gate or other security measures to mitigate safety hazards and/or vandalism.
	SCM marker, delineation or informational signage	C	…plan depicted signage is damaged or missing.		Repair damaged signage. Replace missing signage per plans.
	SCM marker, delineation or informational signage needed	C	…no plan depicted signage indicated and SCM location is difficult to locate.		Install delineation signage as indicated in Chapter 2 of this manual.
	Cleanout marker	C	… cleanout marker is damaged, missing, or not present.		Repair damaged cleanout marker. Replace missing cleanout marker per plans. If not in plan, install cleanout marker per subcomponent instructions.
Inflow Systems, Flow Splitter, Forebay, Underdrains, Outflow Structures, Structures & Appurtenances					
Inflows, Surface Storage, Subsurface Storage, Outflow	Flows are bypassing or short circuiting an inflow, pretreatment SCM treatment or outflow area	C, I, H, D, V	… flow bypasses or short circuits an SCM component allowing untreated or insufficiently treated stormwater flows to be released.	Bypassing/short-circuiting caused by clogging.	Determine the cause of the bypass or short-circuiting of flow. If debris/sediment build-up is the cause, remove build-up and clean area.
				Bypassing caused by structural problem, design related problem, or as a result of poor construction.	If flow bypasses/short circuits a component, determine if topography or misaligned structural features prevent flow from entering area. Review plans to determine the low-flow path through the component. Conduct a topographic survey if needed to assess elevations and define low-flow pathways. Regrade area or repair misaligned structural features to restore flow patterns. If cause cannot be clearly identified, repair should be designed by a professional engineer.
Inflows: Flow Splitter	Sediment accumulation, trash or debris in flow splitter observed	C, I	… accumulation exceeds 50% of storage volume, or at/above cleanout depth specified on plans. …floatable debris is at risk of clogging structure.		Use vacuum truck or other appropriate means to remove all sediment and debris from structure.
	Evidence of oil, gasoline, or contaminants other than stormwater observed	C, I, V	…oil sheen or other contaminants present.		Do not touch the substance in question. Attempt to find where the substance is originating. Check for signs of gas or diesel fuel spill in the form of staining or evidence of an accident in the drainage area. Photograph and document the Potential Illicit Discharges (PIDs). Follow procedures for handling PIDs as specified in PTCs Illicit Discharge Detection and Elimination (IDD&E) Program Manual.
	Flow bypassing flow splitter	C, I, V	…signs of flow splitter being overflowed or bypassed.		Repair areas of erosion. If cause cannot be clearly identified, repair should be designed by a professional engineer.
Inflows: Water Quality	Mosquitoes present in pretreatment area or concrete structure	C, I	…a large mosquito population is present due to standing water in an SCM component causing a significant nuisance or danger to human or animals in the vicinity of the SCM.		Determine the SCM component with standing water causing the mosquito concern. If an enclosed subsurface structure such as a sumped inlet is the source, a licensed applicator in pest management may be needed to treat enclosed/subsurface standing water with mosquito larvicides. A long-term solution may be necessary and should be evaluated by a professional engineer.
Inflows: Forebay	Sediment accumulation in forebay observed	R, C, I	…sediment accumulation affects flow, exceeds depth indicated by cleanout stake, or exceeds ½ the depth of the forebay.		Conduct work when forebay is dry. Remove sediment from forebay and pipe ends as needed to original bottom elevation. Restore bottom cover to match original design for vegetation, rock, concrete or pavers.
	Vegetation in forebay observed	C, I	…vegetation accumulation affects flow or exceeds 50% of forebay area.		Conduct work when forebay is dry. Remove or treat vegetation from forebay.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Inflows: Forebay	Erosion of forebay embankment, cut slopes and/or scouring of bottom	C, I	...gully erosion exceeds 6 inches in depth and/or width.		Repair areas of erosion. Reestablish vegetative or appropriate protective cover as indicated in the plans. If problem persists, repair should be designed by a professional engineer.
	Settlement of forebay embankment, cut slopes and/or bottom	C, I	…settlement exceeds 4 inches.		Repair to height as indicated in the plans. If problem persists, repair should be designed by a professional engineer.
	No permanent pool	C, I	…designed to maintain a permanent pool.		Line forebay with impermeable geotextile liner to maintain depth specified by plans. Repair should be designed by a professional engineer.
Inflows, Outflow	Erosion, scour and/or structural undermining observed at inflow or outflow	C, I, H, D, V	…flows erode vegetation and expose native soil around discharge point, erosion/scour causing sediment transport and/or undermining structures at inflow/outflow points/channels.		If rock armoring (per plan) is missing, see "Inflows, Outflow: Riprap Apron" under the Outlet Protection section of this table. Otherwise, fill and compact the erosion/scour hole with soils and apply original plan specified permanent stabilization treatment. If problem is reoccurring or has undermined the end section, headwall or other nearby structure, repair should be designed by a professional engineer.
	Inflow or outflow is partially or totally submerged by standing water	I, H, D, V	…submerged condition impacts inflow/outflow capacity.		If submerged condition is a result of standing water in SCM, refer to the SCM-specific corrective maintenance table. If submerged outflow point is identified, assess downstream conditions to identify cause of backwater condition. Remove any blockages. If cause is from normal high-water level of discharge location, repair should be designed by a professional engineer.
Inflows, Outflow: Structure	Concrete or metal structure broken	I, H, D	…concrete or metal structure is broken, spalled or otherwise damaged beyond repair and not functioning.		Replace structure with new structure constructed in accordance with plans and manufacture specifications as appropriate. Ensure all orifices, weirs, pipes, etc. are installed per plans. In the absence of plans, repair should be designed by a professional engineer.
	Concrete structure (top, sides or bottom) is damaged, cracked or otherwise compromised	C, I, H, D	…cracks are wider than ½ inch or evidence of soil entering the structure. …the structure is otherwise determined not structurally sound.		Repair or replace structure to restore structural integrity. Repair all cracks wider than ½ inch or any that penetrate through the structure. In the absence of plans, repair should be designed by a professional engineer.
	Cracks or leakage at joints noted in concrete structure or headwall	C	…cracks or open joints are noted.		Repairs of concrete outflow structures may require application of hydraulic cement. Neoprene gaskets or gluable sheets of neoprene may be an option.
		I	…leaks have caused soil to deposit in pipe or structure.		Same as above. Leak can be at construction joints or near pipe openings. Clean soil from pipe and outlet structure.
	Settlement adjacent to an inlet/outflow structure or pipe	I, H, D, V	…any depression near a pipe or structure is larger than 6 inches wide or deep.		Soil settlement adjacent to an inlet/outflow structure suggests either there was incomplete compaction during construction; or there is a crack in the structure, joint or connecting pipe allowing soil to erode. Examine the inlet/outflow structure for evidence of cracks and soil intrusion. Repair structure if damaged. If structure is sound with no evidence of soil intrusion, excavate over the depression to reveal pipe and confirm pipe/joints are sound. If damage is found, replace pipe or repair crack/joint. Clear pipe system of deposited soil. Apply the appropriate permanent vegetative stabilization in accordance with plans.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Inflow, Outflow: Structure	Structure damage or misaligned frame on top slab	C, I	…frame not sitting flush on top slab or frame not securely attached.		Reattach, repair or replace separation of more than 3/4 inch of the frame from the top slab. If slab is out of level or off grade by 2 inches or more, it should be reset or replaced. Slabs with ½ inch wide cracks, cracks that are through the slab, or pitting of slab more than 2 inches deep should be repaired or replaced. Rusted reinforcement bars in top slab is an indication that replacement is warranted.
	Structure has settled or is misaligned	C, I	…it creates a safety concern or impacts function.		Settlement and subsequent misalignment indicates inadequate compaction of foundation material or water seepage around the structure. Investigate the cause of settlement. Excavate 2 feet on all sides and repair backfill materials. Plug sources of water seepage and recompact subgrade in 4 inch lifts by hand. If in good condition, reinstall existing structure; if damaged, replace with new structure. Ensure all elevations and connection sizes and configurations match plans. Elevation confirmation should be based on survey or relative measurements with respect to unmodified features as appropriate.
	Metal components corroded	C, I	…corrosion creates a safety concern or impacts function.		Clean, weld and epoxy coat repairs or replace with corrosion-resistant hardware. Bolts should be stainless steel. Set stainless steel anchors with anchoring epoxy.
	Access ladder is deteriorating or damaged	C	…ladder is corroded, deteriorated, not securely attached to structure, missing or not accessible.		Replace corroded or deteriorated ladder using preformed ladder rungs. Secure ladder in accessible location using anchoring epoxy. Follow PTC standards for materials and installation.
	Inlet, manhole or access cover/grate damaged or missing	I	…lid, cover or grate is damaged, not working or missing.		Secure entry point with fencing or barriers to prevent unauthorized entry or injury until cover has been replaced. Replace missing access covers/grates immediately. When replacing grates, match opening size and configuration of original grate shown on plans. Damaged grated covers: Repair damaged grated covers by welding replacement bars using materials meeting plan. Clean welds, remove loose rust and debris from entire cover, and apply 2 coats of epoxy paint to all metal components except stainless steel.
Inflows, Outflow: Pipe	Obstruction or blockage noted in pipe	C, I	…water does not flow into or out of the outflow structure or piping.		Remove obstructions to restore flow (e.g., remove trash, debris, sediment, or vegetation as necessary). Manual, vacuum, Flusher/vacuum, sewer rooter methods are recommended. Pipe jetting should never be used in SCMs due to highly erosive forces. They may be used in outlet pipe systems flowing downstream from the SCM provided all areas are stabilized and repaired when complete.
	Sediment buildup observed in pipe	C	…sediment or debris is buildup is $^{1}/_{3}$ or more the pipe diameter.		Clean pipe. Utilize vacuum methods that do not cause sediment discharge nor erosive flows into the SCM if possible. If pipe jetting is required, place sediment protection at outlet of pipe utilizing straw bales or sand bags and filter cloth.
	Cracks at the inlet/outlet pipe joints	C	…Evidence of soil entering through the joint of or cracks in a pipe.		Repair cracks wider than ½ inch.
	Obstruction or blockage noted	I	…water does not flow into or out of the SCM.		Remove obstructions to restore flow (e.g., remove trash, debris, sediment, or vegetation as necessary). If no obvious obstruction is visible, pipes may be

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
					clogged or collapsed. Arrange for pipe cleaning. Repairs beyond debris removal and pipe cleaning should be designed by a professional engineer.
Outflow: Structure	Trash rack is broken or badly deteriorated	C	…openings in trash rack are either smaller or larger than when new, or the trash rack has deteriorated to the point where bars are bending.		Replace deteriorated bars with new bars meeting requirements of plan. Weld bars together if separated from frame. Clean welds, remove rust and debris from entire trash rack, and apply 2 coats of epoxy paint. All parts of the trach rack should be coated with epoxy paint, except stainless steel.
		C	…the trash rack is loose.		If frame is separated from structure, drill new hole in concrete, set concrete anchor with anchor epoxy, and use 1/2 inch or 3/8 inch stainless bolts. All parts should be double coated with epoxy paint, except stainless steel.
		I	…the trash rack is missing or destroyed.		If the trash rack is missing or damaged beyond repair, replace with trash rack meeting plan requirements. In the absence of plan information, install trash rack in accordance with PennDOT Pub 72M RC-71M.
Outflow: Structure	Pipe riser, or anti-vortex plate is rusted, bent or leaking	C, H, D	…rust has opened pathways for leakage; or when the riser, trash rack or anti-vortex device is severely bent, loose, or otherwise damaged.		Repair of metal outflow structures may require full replacement. Anti-vortex device can be replaced with new one made of the same type of metal as riser. Openings and elevations must be same as original. In the absence of as-built plans, repair should be designed by a professional engineer.
Subsurface Storage: Underdrain	Prolonged flows	H, D, V	…underdrains carry continuous flow and it has not rained in the previous 72 hours and there is no standing water on SCM surface.		High or perched groundwater may be present. Repair should be designed by a professional engineer. Process may include test pits adjacent to area and ground water monitor to assess typical water table and assess potential limiting layers beneath the SCM.
	Obstruction or blockage noted	C, I	…water does not flow into or out of the outflow structure or piping.		Look for cause of blockage, such as trash in outflow structure. Remove obstructions to restore flow (e.g., remove trash, debris, sediment, or vegetation as necessary). Manual, vacuum, Flusher/vacuum, sewer rooter methods are recommended. Pipe jetting should never be used in SCMs due to highly erosive forces.
	Standing water in cleanout or observation well	C, I, H, D, V	…standing water is observed in cleanout or observation wells and rainfall did not occur in previous 72 hours.		Confirm the standing water is not associated with high ground water flows (See above “Subsurface Storage: Underdrain- Prolonged flows”) or blockage in underdrain (See above “Subsurface Storage: Underdrain- Obstruction or blockage noted”). Prolonged standing water in the cleanouts or observation well can indicate the subsurface infiltration portion of the SCM is malfunctioning with possibly poorly infiltrating underlying soils or clogged geotextile. Repair should be designed by a professional engineer. Possible repair procedure may be as follows: Conduct small (1 foot x 1 foot) test pit explorations through pervious pavement to confirm geotextile functionality. If clogged, replacement of geotextile is required. For poorly infiltrating underlying soils, conduct infiltration testing adjacent to the SCM foot print at the bottom elevation and at successive depths below SCM bottom to assess infiltration capacity and limiting zones of underlying soils. If suitable infiltration rates with no limiting zones are identified below

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
					the original SCM bottom elevation, reconstruct the pervious paving with a thicker aggregate sublayer to lower bottom elevation to the depth of suitable infiltration, reinstall pervious pavement surface to plan surface geometry with plan specified materials and installation methods.
Subsurface Storage: Underdrain	Settlement observed over underdrain	C, I	…soil is entering underdrain or pipe system.		Soil settlement over an underdrain is a sign that a pipe wall or pipe joint has failed. Dig up and replace pipe or repair crack/joint. Clear pipe system of deposited soil. Care must be taken not to compact SCM floor. Hand compact borrow soil material around pipe. Replace media filter/engineered soil around pipe repair, appropriate permanent vegetative stabilization rolled erosion control product per original SCM plans.
	Observation well cover missing or damaged	C	…observation well cover is missing or well is damaged.		Replace missing access cover with cover meeting original plan specifications.
Emergency Spillway					
Emergency Spillway	Emergency spillway not present	I, D	…embankment over 3 feet high and/or there is concern for safety downstream.		SCM modification should be designed by a professional engineer.
	Riprap or hard armor missing/damaged (may not be present in all SCMs)	C, H, D	…areas of riprap/hard armor are missing or damaged.	Rip-rap missing	Repair or replace rock armoring to original design. Replace geotextile fabric. Repair, regrade, and reseed eroded areas adjacent to rock armoring. If problem is reoccurring, repair should be designed by a professional engineer.
	Minor erosion on emergency spillway embankment (fill) area observed	C	… erosion greater than 2 inches but less than 4 inches deep and there is the potential for continued erosion.		Add topsoil and apply the appropriate permanent stabilization or other cover shown on plans to all disturbed areas. Determine cause of erosion and remedy if possible.
	Minor erosion on emergency spillway non-embankment (cut) area observed	C	… erosion greater than 4 inches but less than 12 inches deep and there is the potential for continued erosion.		Add topsoil and apply the appropriate permanent stabilization or other cover shown on plans to all disturbed areas. Determine cause of erosion and remedy if possible.
	Major erosion on emergency spillway embankment (fill) area observed	I, H, D, V	… erosion greater than 4 inches deep on embankment area of spillway.		Take prompt action. A geotechnical engineer may be required to evaluate the cause of erosion. Promptly address erosion that may cause downstream problems (e.g., damage to highway or highway structure, homes, streams wetlands, railroads, etc.). Stabilize slope. Place topsoil and apply the appropriate permanent stabilization or other cover shown on plans to all disturbed areas.
	Major erosion on emergency spillway non-embankment (cut) observed	I, H, D, V	… erosion greater than 12 inches deep on non-embankment (cut) area of spillway.		Take immediate action. A geotechnical engineer may be required to evaluate the cause of erosion. Promptly address erosion that may cause downstream problems (e.g., damage to highway or highway structure, homes, streams wetlands, railroads, etc.). Stabilize slope. Place topsoil and apply the appropriate permanent stabilization or other cover shown on plans to all disturbed areas.
	Severe erosion on emergency spillway observed	I, H, D, V	… evidence of erosion that threatens the integrity of the embankment, slope or adjacent structures.		Take immediate action. A geotechnical engineer may be required to evaluate the cause of issue and direct repairs. Lower water surface by opening pond drain (if one exists). Use of pumps to draw down the pond may be required if standing water is present. Repair should be designed by a professional engineer.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Emergency Spillway	Tree growth on emergency spillway	C, I	…creates blockage problems and may cause failure of the berm.		Remove trees by cutting flush to ground. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Do not excavate into embankment to remove roots.
Outfall Protection					
Inflow, Outflow: Riprap Apron	Insufficient rock armoring observed at inflow or outflow points	C, H, D	…flows expose soil around the rock armored area, or rock is missing from outfalls such as pipe inflow/outflow points, channels, and spillways.		Repair or replace rock armoring to original design. Replace geotextile fabric, if present on plan. Repair, regrade, and reseed eroded areas adjacent to rock armoring. Repair any undermining of pipe or headwall associated with riprap outlet protection. If problem is reoccurring, repair should be designed by a professional engineer.
Inflow, Outflow: Energy Dissipator or plunge pool	Cracks in concrete	C, I	… concrete slab has spalling larger than 2 square inches and 1 inch depth, or cracks are wider than 1/2 inch.		Repair spalling areas and cracks wider than ½ inch or replace structure. When placing concrete patch, use epoxy-bonding compound conforming to ASTM C881, Type II where non-loadbearing or Type V where loadbearing, Grade 2.
Inflow, Outflow: Outfall Protection	Vegetation loss at interface of outfall protection and receiving channel	C, I	… vegetation not well established at interface of outfall protection and receiving channel.		Turf reinforcement mat may be used at this interface to provide additional structure for vegetation. Repair should be designed by a professional engineer.
	Sediment accumulation or anti-skid materials in outfall protection	R, C, I	… sediment deposits on top of rock pad or concrete exceeds 10% of the surface.		Remove material accumulation using vacuum or hand removal methods appropriate for type and size of outfall protection material.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.3: Basin, Most Types: Basin, Dry Detention (BDD); Basin, Dry Extended Detention (BED); Basin, Dry Ultra-Extended Detention (BUD); Basin, Naturalized Detention (BND); Basin, Other (BOT); Basin, Wet Detention (BWD); Basin, Infiltration (BID) Maintenance and Repair Table [1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Vegetation: in SCM and/or SCM Vicinity	Tall or thick vegetation or invasive/undesirable species observed	R, C, I, H, D	…vegetation growth restricts access, obstructs water flow and interferes with maintenance activity. …hydrophytic (wetland) plants are present, which is an indication of poor drainage. (N/A for BWD) …invasive/undesirable species in vicinity of SCM jeopardize SCM plantings.	BDD, BED, BID, BUD, BND: Plans call for meadow, shrubs/plantings or special seed mix.	Review the plans to determine proper care. If landscaping plans are not available, an engineer and/or landscape architect should assess. If non-plan specified hydrophytic plants are present, refer to section "Outflow, Surface Storage: SCM Floor– Standing water is observed in SCM" to assess source of excessive moisture. If invasive/undesirable species are present, remove or treat vegetation. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Mow the basin at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6.
		R		BDD, BED, BID, BUD, BND: Plans call for grass or turf seed mix.	Review the plans to determine proper care. Mow the basin at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6. Follow above procedures for invasive/undesirable species removal. If non-plan specified hydrophytic plants are present, refer to section "Outflow, Surface Storage: SCM Floor– Standing water is observed in SCM" to assess source of excessive moisture.
		R		BID: Plans call for sand or stone.	Remove or treat all vegetation in the sand/stone area. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
		C, H, D		BWD	Review the plans to determine proper care. If plans are not available, an engineer and/or landscape architect should be contacted to assess. If invasive/undesirable species are present, coordinate with a landscape architect or an environmental scientist to remove or treat invasive/undesirable species and re-establish native plantings.
Vegetation: in SCM	Trees/shrubs or woody vegetation observed in ponding area	R, C, I, H	…tree/shrub/woody growth restricts access, obstructs water flow, or interferes with maintenance activity.		If landscaping plans are available and indicate trees/shrubs/woody vegetation are not specified, remove or treat trees/shrubs/woody vegetation. If landscaping plans are not available, an engineer and/or landscape architect should be contacted to assess.
	Vegetation is sparse	C, I, H, D, V	…less than 80% of the planted area is covered by vegetation in the SCM.	Shade is causing poor ground cover. Sun exposure is 6 hours or less per day.	Trim overhanging limbs and remove or treat brushy vegetation that limit sunlight reaching grass and inhibits grass growth. Once sunlight is restored to area apply the appropriate permanent vegetative stabilization.
				Basin bottom is soggy.	Refer to section on "Outflow, Surface Storage: SCM Floor– Standing water is observed in SCM."
				Topsoil not present or is insufficient.	Repair should be designed by a professional engineer. Possible remediation may include: Remove 4 inches of poor soil from affected area. Scarify soil surface. Place 4 inches of sandy loam topsoil (BID ONLY: with infiltration rate equivalent to original SCM design rate infiltration basins; do not compact soil.) Install planting or seed in accordance with plans, stabilizing promptly with rolled erosion control product.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
				Other	Review the plans to determine design plant coverage in basin bottom. If density is less than plan, determine cause of vegetation loss; a professional engineer or landscape architect should design the repair. If plans are not available, a professional engineer and/or landscape architect should be contacted to asses.
Inflows: Swales or Sheet Flow Sediment Management	Sediment accumulation, trash or debris observed in vegetated channel or filter strip pretreatment area observed	C, I	…sediment accumulation affects flow or exceeds allowable VFS, VSS, MFD, VSW, VSC depth or depth indicated on cleanout marker in channel. …accumulation blocks flow entry or distribution of runoff into vegetated filter area.		See applicable maintenance and repair activity table for Vegetated Filter Strip (VFS), Vegetated Filter Strip, Steep Slope (VSS); Media Filter Drain (MFD); Vegetated Swale (VSW), Vegetated Swale w/Check Dams (VSC).
Inflows, Outflow, Surface Storage: Sediment Management	Sediment accumulation on SCM floor observed	C, I, H	…sediment accumulation • affects flow • exceeds depth indicated on cleanout marker, • in the absence of a cleanout marker, exceeds: BDD, BED, BUD: the lesser of 6 inches depth or 10% of design basin volume BWD: 50% ponding storage volume BID: 1 inch.	BDD, BED, BUD, BOT, BND, BID	Remove sediment from basin floor areas using minimal disturbance techniques. Restore SCM bottom slope per plan. Apply the appropriate permanent stabilization.
				BWD	Remove sediment to restore capacity using pond dredging methods. Verify grade dimensions and elevation using plans.
Impounding Embankments/ Cut Slopes	Tall grass observed	R	…tall grasses are observed which may indicate that routine mowing is not occurring.		Mow vegetation at frequencies indicated in the SCM specific Maintenance Procedures tables in Chapter 6.
	Vegetation is sparse	C, I	…less than 80% of the area is covered by vegetation on sloped areas.		Review plans to determine specific vegetative cover. Repair any erosional damage and ensure at least 4 inches of topsoil is present. Reapply the plan specified permanent stabilization.
	Trees/shrubs or woody vegetation observed	R, C, I, H	…trees, shrubs or woody vegetation over four feet in height are present.	Embankments (fill)	Woody vegetation should be removed or treated. Cut stump flush to ground surface. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. If stump removal is required, the removal and embankment repair should be designed by a professional engineer.
				Cut slopes	Review plans to determine if trees/shrubs are part of intended landscaping. If not, assess health and stability of woody vegetation. If the plant is healthy and does not cause a risk to the SCM, it can stay in place. If it could potentially damage the SCM or nearby facilities, it should be removed or treated. Stumps may be left in place.
Impounding Embankments	Minor erosion on embankment, inflow, outfall, and/or emergency spillway observed	C	…embankment slopes show evidence of erosion greater than 2 inches but less than 4 inches deep and there is the potential for continued erosion.		Install and compact topsoil filling eroded area and apply the appropriate permanent vegetative stabilization. If repair is reoccurring, engineer should evaluate the cause of erosion.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Impounding Embankments	Major erosion on embankment, inflow, outfall, and/or emergency spillway observed	I, H, D, V	…embankment slopes show evidence of erosion greater than 4 inches deep.		Take prompt action. A geotechnical engineer may be required to evaluate the cause of erosion. Promptly address erosion that may cause downstream problems (e.g., damage to highway or highway structure, homes, streams wetlands, railroads, etc.) due to either embankment failure or sediment migration. Stabilize slope with topsoil and apply the appropriate permanent vegetative stabilization to all disturbed areas.
	Severe erosion on embankment, inflow, outfall, and/or emergency spillway observed	I, H, D, V	…embankment slopes show evidence of erosion that threatens the integrity of the embankment.		Take immediate action. Notify municipal officials if basin embankment failure could cause downstream flooding problems. Contact the geotechnical engineer and, as directed, lower water surface slowly by opening pond drain (if one exists). Otherwise, obtain pumps and draw down the pond. Care must be exercised to not draw the water down too rapidly as to cause sloughing failure. In the case on BWD or SCM with established pond ecosystem, water draw down can be conducted with consideration to preserving the ecosystem. Repair should be designed by a professional engineer.
	Minor settlement or cracking of embankment not near outflow structure observed	C, I	…part of the berm has settled approximately 4-12 inches.		Repair settled berm to design height with similar materials. Material must be notched into existing pond embankment and properly compacted. Place 4 inches of topsoil and apply the appropriate permanent vegetative stabilization.
	Major settlement or cracking of embankment not near outflow structure observed	I, H, D, V	…part of the berm has settled more than 12 inches.		Take prompt action. A geotechnical engineer may be required to evaluate the cause of the issue. Repair should be designed by a professional engineer. Possible remediation may include repairing settled berm to design height with similar materials. Material must be notched into existing berm and properly compacted. Place 4 inches of topsoil and apply the appropriate permanent vegetative stabilization.
	Settlement or cracking of embankment near outflow structure observed	I, H, D, V	…part of the berm near an outflow structure has settled 4 inches or more, and is not leaking.		Take prompt action. A geotechnical engineer may be required to evaluate the cause of issue and design repair. Determine if soil is entering pipe or outflow structure. Pipes and outflow structure may require repairs and cleaning. Compact borrow soil material around pipe and structure. Place 4 inches of topsoil and apply the appropriate permanent vegetative stabilization.
	Water observed flowing through basin embankment	I, H, D, V	…water is flowing through an embankment, which could cause failure.		Take immediate action. Notify municipal officials if basin embankment failure could cause downstream flooding problems. Contact the geotechnical engineer and, as directed, lower water surface slowly by opening pond drain (if one exists). Otherwise, obtain pumps and draw down the pond. Care must be exercised to not draw the water down too rapidly as to cause sloughing failure. In the case on BWD or SCM with established pond ecosystem, water draw down can be conducted with consideration to preserving the ecosystem. Repair should be designed by a professional engineer.
	Soil saturation or seeps at base of berm/dike observed	C, I, H, D, V	…water is seeping through the berm or soils are saturated on the exterior face of berm.		Decision on timing of repair depends on further evaluation. A geotechnical engineer may be required to evaluate the cause of issue. Monitor seep with decreasing regularity (daily, then weekly, then

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Impounding Embankments					monthly) sufficient to determine if the rate or nature of the leak is changing. Repair should be designed by a professional engineer.
	Burrowing animal holes observed	C, I	…holes that are likely formed by a burrowing animal are located in the basin embankment and present safety, structural or SCM functional risk.		Fill holes with the same or similar material used in the embankment and apply the appropriate permanent vegetative stabilization. If the problem persists, trapping of burrowing animal may be required. Contact PA Game Commission for assistance.
	Sloughing or sliding of berm/dike observed	C, I, H, D, V	…sloughing or sliding of embankment is observed.		Take prompt action as merited by observed size and potential for continued deterioration. A geotechnical engineer should evaluate the cause of issue. Repair should be designed by a professional engineer. A possible repair procedure may be as follows: Excavate effected areas, bench to stepped level 4 feet wide by 4 feet high profile. Compact underlying soil. Place and compact new embankment using suitable soils (typically USCS classified ML to CL), extending 2 feet wider than intended finished profile. All compaction to be to 90% modified proctor density. Trim back to 4 inches less than finished profile. Add topsoil and apply the appropriate permanent vegetative stabilization.
Cut Slopes	Minor erosion on cut slope observed	C	…slopes show evidence of erosion greater than 4 inches but less than 12 inches deep and there is the potential for continued erosion.		Add topsoil and apply the appropriate permanent vegetative stabilization. Determine cause of erosion and correct.
	Major erosion on cut slope observed	I, H, D, V	…slopes show evidence of erosion greater than 12 inches deep.		Address erosion that may lead to damage to highway or structures. Stabilize slope. Place topsoil and apply the appropriate permanent vegetative stabilization. A professional engineer should review to assess cause of problem.
	Severe erosion on cut slope observed	I, H, D, V	…slopes show evidence of erosion that threatens the integrity of the slope, adjacent roadway, or structures.		Take immediate action. A geotechnical engineer should evaluate the cause of issue and direct repairs. Repair should be designed by a professional engineer.
Surface Storage	Flows are bypassing or short circuiting within the pretreatment or SCM treatment area	I, H, D, V	…flow bypasses or short circuits within an SCM component allowing untreated or insufficiently treated stormwater flows to be released.		Determine the cause of the bypassed or short-circuited flow. If debris/sediment build up is cause, resolve by removing material and cleaning area. If flow still bypasses/short circuits the component, determine if topography or misaligned structural features prevent flow from entering area. Review plans to determine if a primary low-flow path through the component has been obstructed/silted. Conduct a topographic survey to assess elevations and define low flow pathways. Regrade area or repair misaligned structural features to restore flow patterns. If cause cannot be clearly identified, repair should be designed by a professional engineer.
Outflow, Surface Storage: SCM Floor	Standing water is observed in SCM (N/A for BWD)	C, I, H, D, V	…standing water is observed on SCM floor and rainfall did not occur in previous 72 hours.	BDD, BED, BOT, BDN, BUD: Clogged outlet orifice/outflow structure failure.	Examine outflow structure, locating low flow orifice. Remove obstruction/debris. If sediment build up in SCM is causing blockage, remove sediment as described in “Inflow, Outflow, Surface Storage: Sediment Management- Sediment accumulation on SCM floor observed.” If outlet orifice/weirs are not clogged and standing water is observed in outflow structure, investigate downstream outlet point for blockage.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Outflow, Surface Storage: SCM Floor					If no flow is observed, the outlet pipe may be clogged or collapsed. Arrange for video inspection or pipe cleaning. Repair beyond debris removal/pipe cleaning should be designed by a professional engineer.
				BID: Sediment or poor soils may be cause of failure.	A geotechnical engineer may be required to evaluate the cause of issue. Repair should be designed by a professional engineer. Possible repair procedure may be as follows: Aeration of soils by mechanically removing plugs, or replacement of soil to a depth as determined by testing. Remove layer of fine sediment and wet soils from bottom of basin, rake bottom, and verify infiltration capacity by performing infiltration test(s). If acceptable infiltration rates are confirmed, apply the appropriate permanent vegetative stabilization/topsoil based on plans or as otherwise directed. If infiltration still is not satisfactory, the geotechnical engineer should perform deep pit soils analysis and infiltration testing. Potential remediation may involve design of a stone filled trench intersecting elevation of acceptable infiltration or installation of an underdrain converting BID into a BED.
				BID: Thick matted grass may be the cause of failure.	Remove standing water and allow soils to dry for several days. Thatch grass area when dry. Rake up dead grass and clippings. Aeration of soils by mechanically removing plugs may be required.
Surface Storage: SCM Floor	Dying/browning or sparse vegetation is observed, suggesting excessive moisture (N/A for BWD)	C, H, D, V	…saturated soils remain long after a storm event; or standing water is observed on SCM floor when no rain in previous 72 hours.	BDD, BED, BUD, BND, BOT: Basin bottom settlement below low flow orifice or inadequate slope across basin floor from inflow points to outflow structure.	Conduct field view to determine if low-flow orifice is above the bottom of the SCM floor. If surrounding basin floor is lower than low-flow orifice, place soil to restore slope and geometry to plan dimensions. Soil used must be similar to the type of soil used in the plans. Reseed/plant as needed to restore permanent vegetated cover as indicated in the plans. If low-flow orifice is located flush with basin floor and/or field conditions match plans, the SCM may need to be regraded to provide sufficient slopes to drain water to the outflow structure. Repair should be designed by a professional engineer. Possible repair procedures may include collecting topographic survey of the SCM floor, cut slopes/embankments, inflow and outflow features, and developing a new grading plan to establish adequate flow.
				BID: Infiltration capacity may be decreasing or areas may have been inadvertently compacted.	Continue to observe condition of vegetation and basin floor moisture. If basin floor soil is saturated or ponding remains for longer than 72 hours refer to "Outflow, Surface Storage: SCM Floor– Standing water is observed in SCM" section.
Surface Storage: SCM Floor Water Level	Permanent pool water level very low or dry (BWD only)	I, H, D, V	…permanent pool elevations are significantly below proposed depth or basin is dry.		A geotechnical engineer may be required to evaluate the cause of issue. Repair should be designed by a professional engineer. Possible repair procedure will vary based on diagnosis. Possible causes include infiltration into surrounding soils, defective/damaged impermeable liner,

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
					piping/seepage through embankment, insufficient inflow/prolonged drought.
Surface Storage: SCM Floor	Beaver dams are observed	C, I	…beaver dam inhibits function of SCM, jeopardizes infrastructure or notably reduces effective storage area of basin.		Contact PA Game Commission to obtain assistance with relocation of beaver inhabitants. After beaver relocation, remove dam debris.
Surface Storage: SCM Floor Water Quality	Algae (for BWD)	C, I, H, V	… algae growth covers more than 50% of pond area or the pond has an odor.		Excessive algae growth is an indicator of excess nutrients from fertilizers in the water or decomposing materials on the SCM surface beneath the water. An engineer and/or landscape architect should assess the problem. The short-term solution is physical removal of the algae. Pump pond dry and clean out the bottom. Long-term resolution/prevention of reoccurrence should include a review of the SCM drainage area for possible sources of nutrient runoff. Review SCM construction and maintenance records to identify if excess is from SCM operation activities. If obvious sources cannot be identified/eliminated, the SCM may require additional pretreatment or buffer areas. Note: Standing water should be present for prolonged periods only in BWDs. See “Outflow, Surface Storage: SCM Floor– Standing water is observed in SCM” for all other SCM types.
	Turbidity	C, I, H, D, V	…sediment laden water present in SCM ponding area.	BDD, BED, BUD, BND, BOT, BWD	Investigate source of sediment laden flows. If a portion of the contributing drainage area has been disturbed, install permanent stabilization such as vegetative cover and monitor for establishment. If no obvious contributing source is identified, the SCM may require additional pretreatment for sediment removal and the repair should be designed by a professional engineer. Resolution may include installation of a forebay, water quality device or other sediment collecting pretreatment means. After turbidity has been resolved, the SCM floor should be clean of accumulated sediment. Note: Water should be present for prolonged periods only in BWDs. For all other SCMs, if recent rainfall has not occurred, also see “Outflow, Surface Storage: SCM Floor– Standing water is observed in SCM.”
				BID	Turbidity/ suspended solids present a significant risk of clogging the SCM, impacting the SCM’s ability to function. After turbidity source issue has been eliminated, the BID should be observed after a storm event to confirm that infiltration still occurs within the design time period. If infiltration appears to be diminished, the repair should be designed by a professional engineer. Resolution may include replacement of a portion or all of infiltration media.
	Large permanent geese or other waterfowl population (for BWD)	C, I	…evidence of over 20 permanent waterfowl inhabitants per acre of pond surface area and noted waste accumulation.		Ensure fecal matter does not cause water quality impacts by monitoring SCM discharge points for elevated fecal coliform. If required, contact PA Game Commission for population relocation assistance. Allowing 3 foot

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Surface Storage: SCM Floor Water Quality					tall grass buffer to surround the SCM for an 5 to 8 foot width will discourage waterfowl from using pond. Note: Water should be present for prolonged periods only in BWDs; other basin SCMs should not attract permanent waterfowl residence.
	Mosquitoes	C, I	…a large mosquito population is present due to standing water in an SCM component causing a nuisance or danger to human or animals in the vicinity of the SCM.		Determine which SCM component has standing water causing the mosquito concern. If an enclosed subsurface structure such as a sumped inlet catch basin is the source, a licensed applicator in pest management should treat enclosed/ subsurface standing water with mosquito larvicides. A long-term solution involving the replacement of the subsurface standing water component can be explored and a professional engineer should design the replacement of the structure with an alternative feature. If the ponding is on the SCM surface, for all basins except BWD, see “Outflow, Surface Storage: SCM Floor– Standing water is observed in SCM” to resolve prolonged standing water issue. In BWD, excess mosquito presence is an indication of a poorly functioning ecosystem. A professional engineer or wetland scientist should assess and develop remediation plan.
Surface Storage, Outflow: SCM Drain/ Mechanical Assemblies	Damaged, non-functioning, or missing components found	C, I	…water continues to flow after shutting the valves/gates or they cannot be opened/closed or are otherwise not functioning properly.		Install cofferdam to dewater work area if possible; pump or drain pond if needed. Repair or replace valves/gates with similar components. Divert flows when valves are out of service.
SCM Liner	Impermeable liner (N/A for BID, may be present in others)	C, I, H, D	…impermeable liner has become exposed and/or damaged. …evidence suggests impermeable liner is leaking below grade.		Impermeable liners can be clay, geotextile, or composite geosynthetic. Repair methods utilized should be based on liner material. If impermeable liner has become exposed, inspect to confirm no punctures, tears or other damage has occurred. If liner is not damaged, restore cover layer using material consistent with original plan. If exposed liner is damaged or evidence suggests a liner is damaged/leaking without being exposed, repair should be designed by a professional engineer. Suspected below grade liner damage requires removal of all planting material to locate damage. Possible repair procedure could involve partial or total liner replacement and consulting with liner manufacture for repair requirements for geosynthetic or bentonite clay liners.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.4: Bioretention (BRE); Bioretention W/Underdrain (BRU) Maintenance and Repair Table [1]					
SCM Inspection Section: Component/ Feature [2]	**Defect or Problem**	**Maintenance/ Repair Category**	**Maintenance is Needed When…**	**SCM Variant or Cause of Problem**	**Recommended Maintenance Activity to Correct Problem**
Vegetation: in SCM	SCM Floor Soils or Media – excessive moisture	C, D, V	…presence of wetland vegetation or death of originally proposed plant material suggests that basin is not draining as designed.		Review plans for original vegetative cover requirements, confirming wetland plants were not specified. Examine the underdrain system, outlet structure, and soil media to determine cause of poor drainage as described in "Outflow, Surface Storage: SCM Floor– Standing water is observed in SCM floor." Consider that a high water table may be the cause of the problem. Replanting of the facility may be required once the poor drainage is corrected. Follow instructions for original design to replant facility or contact a landscape architect to determine if alternative plants should be recommended.
	Tall or thick grass, vines, weeds, or invasive/undesirable species observed	C, I	…vegetation growth crowds out desired plantings, restricts access, obstructs water flow or interferes with maintenance activity.	Plans call for mix of vegetation.	If invasive/undesirable species are present, hand weeding may be required. Weeds must be pulled by roots to prevent regrowth. Be sure to not remove vegetation that is supposed to be present. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Remove dead plants 30 to 60 days after spraying. If facility was designed to have mulch, place a 2 to 3 inch layer of shredded hardwood mulch on all areas of the facility.
		R		Plans call for grass.	Mow the basin at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6. If invasive/undesirable species are present, remove or treat the vegetation. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Remove dead plants 30 to 60 days after spraying.
	Trees and shrubs dying in ponding area but no signs of prolonged inundation observed	C, V	…trees and shrubs are dying.		A landscape architect should be contacted to determine why the trees and shrubs are dying and to recommend replacement plants. Remove dead or dying plants. Cut trees flush with the ground. Do not remove roots of trees. Replace the plants as directed by the landscape architect.
	Vegetation is sparse	C, I, H, D, V	…less than 80% of the proposed vegetation from the original design has survived.	Shade is causing plant mortality. Sun exposure is 6 hours or less per day.	Trim overhanging limbs and remove brushy vegetation that limit sunlight reaching grass and inhibits grass growth. Once sunlight is restored to area apply vegetation in accordance with the plans.
				Basin bottom is soggy.	Refer to section on "Outflow, Surface Storage: SCM– Standing water is observed in SCM".
				Invasive/undesirable species crowding out desired vegetation.	Refer to section on "Vegetation: in SCM– Tall or thick grass, vines, weeds or invasive/undesirable species observed".
Vegetation: Mulch	Mulch layer thin	R	…mulch is not thick enough to prevent weed growth.		Two to three inches of shredded hardwood mulch should be present. Be sure the facility is free of weeds before adding mulch. Weeds must be pulled by roots to prevent regrowth.
	Mulch accumulation near outlet structure	C, I	…mulch being washed out of facility.	Softwood mulch that is too light to remain in place when facility is full of water may be the cause.	Remove all old mulch. Be sure the facility is free of weeds including weed root systems to prevent regrowth before adding mulch. Apply 3 inches of shredded hardwood mulch.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Variant or Cause of Problem	Recommended Maintenance Activity to Correct Problem
Inflows, Outflow, Surface Storage: Sediment Management	Sediment accumulation on SCM floor observed	C, I	…sediment accumulation affects flow through bioretention system, exceeds depth indicated by cleanout marker or, in absence of cleanout marker, exceeds 3 inches in depth.		Conduct work when SCM is dry. Remove sediment and 3 to 4 inches of bioretention soil working around existing plant material taking care not to damage roots. Replace bioretention soil with soil meeting requirements of the plans. Reseed or replant if needed in accordance with the original plans to restore vegetated cover. Apply 3 inches of shredded hardwood mulch, if indicated on the plans.
Impounding Embankments/ Cut Slopes	Tall grass observed	R	…tall grasses are observed which may indicate that routine mowing is not occurring.		Review planting plan to assess if tall grass is intentionally planted ornamental grasses intended to be observed height. If tall grasses are not intended to be present, mow vegetation at frequencies indicated in the Bioretention Maintenance Procedures Table in Chapter 6.
	Vegetation is sparse	C, I	…less than 80% of the area is covered by vegetation or eroded patches occur on the sloped area.		Review plans to determine required vegetative cover. Repair any erosional damage and ensure 4" of topsoil is present. Reinstall appropriate permanent vegetative stabilization in accordance with plans.
	Trees/shrubs or woody vegetation observed	C, I, H, V	…trees, shrubs or woody vegetation over four feet in height could lead to piping through embankment leading to failure.	Embankments (fill)	Woody vegetation should be removed. Cut stump flush to ground surface. Herbicide treatment of trunks may be required to prevent regrowth of trees. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. If stump removal is required, the removal and embankment repair should be designed by a professional engineer.
				Cut slopes	Review plans to determine if trees/shrubs are part of intended landscaping. If not, assess health and stability of woody vegetation. If the plant is healthy and does not cause a risk to the SCM, it can stay in place. If it could potentially damage the SCM or nearby facilities, it should be removed. Stumps may be left in place.
Impounding Embankments	Minor erosion on embankment, outlet/outfall, and/or emergency spillway observed	C	…slopes show evidence of erosion greater than 2 inches but less than 4 inches deep and there is the potential for continued erosion.		Add topsoil and apply the appropriate permanent vegetative stabilization to all disturbed areas. Determine cause of erosion and remedy if possible.
	Major erosion on embankment, outlet/outfall, and/or emergency spillway observed	I, H, D, V	…slopes show evidence of erosion greater than 4 inches deep.		Take prompt action. A geotechnical engineer may be required to evaluate the cause of erosion. Promptly address erosion that may cause downstream problems (e.g., damage to highway or highway structure, homes, streams wetlands, railroads, etc.) due to either embankment failure or sediment migration. Stabilize slope. Place topsoil and apply the appropriate permanent vegetative stabilization to all disturbed areas.
	Severe erosion on embankment, outlet/outfall, and/or emergency spillway observed	I, H, D, V	…slopes show evidence of erosion that threatens the integrity of the embankment.		Take immediate action. A geotechnical engineer may be required to evaluate the cause of issue and direct repairs. Lower water surface by opening pond drain (if one exists). Use of pumps to draw down the pond may be required. Care must be exercised to not draw the water down too rapidly as to cause sloughing failure. Repair should be designed by a professional engineer.
	Settlement or cracking of embankment not near outlet structure observed	C, I	…part of the berm has settled 4 inches or more.		Repair settled berm to design height with similar materials. Material must be notched into existing pond berm and properly compacted. Place 4 inches of topsoil and apply the appropriate permanent vegetative stabilization.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Variant or Cause of Problem	Recommended Maintenance Activity to Correct Problem
Impounding Embankments	Settlement or cracking of embankment near outlet structure observed	I, H, D, V	…part of the berm near an outlet structure has settled 4 inches or more, which may be a sign of leaking.		Take prompt action. A geotechnical engineer may be required to evaluate the cause of issue. Repair should be designed by a professional engineer. Possible remediation may include: Determine if soil is entering pipe or outlet structure. Pipes and outlet structure may require repairs and cleaning. Compact borrow soil material around pipe and structure. Place 4 inches of topsoil and apply the appropriate permanent vegetative stabilization.
	Burrowing animal holes observed	C, I	…holes that are likely formed by a burrowing animal are located in the basin embankment present safety, structural or SCM functional risk.		Fill holes with the same or similar material used in the embankment and apply the appropriate permanent vegetative stabilization. If the problem persists, trapping of burrowing animal may be required. Contact PA Game Commission for assistance.
Cut Slopes	Minor erosion on cut slope observed	C	…slopes show evidence of erosion greater than 4 inches but less than 12 inches deep and there is the potential for continued erosion.		Add topsoil and apply the appropriate permanent vegetative stabilization. Determine cause of erosion and remedy if possible.
	Major erosion on cut slope observed	I, H, D, V	…slopes show evidence of erosion greater than 12 inches deep.		Address erosion that may lead to problems (e.g., damage to highway or structures, etc.). Stabilize slope. Place topsoil and apply the appropriate permanent vegetative stabilization.
	Severe erosion on cut slope observed	I, H, D, V	…slopes show evidence of erosion that threatens the integrity of the slope, adjacent roadway, or structures.		Take immediate action. A geotechnical engineer should evaluate the cause of issue and direct repairs. Repair should be designed by a professional engineer.
Outflow, Surface Storage: SCM Floor	Standing water is observed in SCM floor	C, I	…rainfall did not occur in previous 72 hours and observation well or underdrain cleanout in BRU has little to no water above outlet invert.	Thick matted grass, or other vegetation clogging surface.	Remove standing water. Thatch grass area when dry. Rake up dead grass and clippings.
				Top layer of soil clogged.	Use a soil probe or soil auger to examine the SCM soil. If standing water/saturated soil is limited to top few inches of soil, likely the top layer of soil is clogged by sediment. See "Inflows, Outflow, Surface Storage: Sediment Management -Sediment accumulation on SCM floor observed" for instructions on repair.
		C, H, D, V		Geotextile clogged.	Use a shovel to dig to top of geotextile (if present). Examine the fabric for signs of clogging and water passage. If water not passing through geotextile fabric, the geotextile fabric is likely clogged. Consult with an engineer to design this repair. Possible remediation may include: Remove plants and preserve in shade (water daily). Remove and dispose of mulch. Remove engineered or amended soil and stockpile for reuse. Be sure to not allow soil to fall onto stone under fabric. Remove and dispose of geotextile fabric. Engineer should specify correct geotextile fabric or determine another repair method. Replace and do not compact engineered or amended soil. Replace plants. Apply 3 to 4 inches of shredded hardwood mulch, if indicated on plans.
		C, H, D, V	…rainfall did not occur in previous 72 hours and observation well or underdrain cleanout	Clogged or collapsed underdrain or outlet pipe.	See Table G.1.2 on "Subsurface Storage: Underdrain - Settlement observed over underdrain."

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Variant or Cause of Problem	Recommended Maintenance Activity to Correct Problem
Outflow, Surface Storage: SCM Floor			in BRU indicates underdrain is full of water with no flow at outlet point.	Clogged outlet orifice/outlet structure failure.	Remove obstruction/debris, ensuring to completely unclog the low flow orifice in the outlet structure. If outlet is not clogged and standing water is in outlet structure, investigate downstream outlet point for signs of flow. If no flow is observed, the outlet pipe maybe clogged or collapsed. Arrange for pipe cleaning. Repair beyond debris removal/pipe cleaning should be designed and/or approved by a professional engineer.
		H, D, V	…water flowing from underdrain in BRU when there has been no rain in last 72 hours.	Suspected high ground water.	See Table G.1.2 on "Subsurface Storage: Underdrain - prolonged flows."
		C	…rainfall did not occur in previous 72 hours for BRE.	Thick matted grass, or other vegetation clogging surface.	Remove standing water. Thatch grass area when dry. Rake up dead grass and clippings.
				Top layer of soil cogged.	See "Inflows, Outflow, Surface Storage: Sediment Management -Sediment accumulation on SCM floor observed" for instructions on repair.
		C, H, D, V		Geotextile clogged.	See above BRU Geotextile clogged instructions.
				Poorly infiltrating underlying soils.	If SCM is non-under drained infiltrating system and media soils/geotextile are not clogged, underlying soils may have insufficient or poor infiltration capacity. A geotechnical engineer may be required to evaluate the cause of issue. Repair should be designed by a professional engineer. Possible repair procedure may be as follows: Remove and stock pile filter media. Conduct test pit explorations and infiltration testing at the bottom of SCM and at successive depths below SCM bottom to assess infiltration capacity and limiting zones of underlying soils. If suitable infiltration rates with no limiting zones are identified below the original SCM bottom elevation, reconstruct SCM with a new lower bottom elevation, using additional filter media to bring the top surface of the SCM to plan surface geometry.
Surface Storage: SCM Floor	Erosion observed	C, I, D, V	…rutting, rills, or scour present in basin bottom, especially from inflow structures.	Erosion limited to mulching layer	Restore mulch to even cover of basin bottom. Replace any damaged vegetation per the plan. Attempt to find reason for channelized flow, check for blockage or damage at inlet structure remove or repair as needed. If issue is reoccurring, install energy dissipator at inlet to disperse flow.
				Erosion extends into soil media.	An engineer may be required to evaluate cause of erosion. Possible remediation may include: Attempt to find reason for the channelized flow that is causing the erosion. Evaluate velocities entering basin and consider adding energy dissipator, rock channel, turf reinforcement matting or grade breaks. Restore soil and mulch. Soil should be as specified on the plans. Replace any damaged vegetation per the plan. Add 2 to 3 inches of shredded hardwood mulch if the facility was designed to have mulch.
	Basin bottom below designed proposed grade	C, I, H, V	…evidence of settlement of basin bottom.	Amended soil compaction may be cause of lower grade.	An engineer may be required to evaluate cause of settlement. Possible remediation may include: Verify depth of amended/engineered soils. Remove compacted soils. Replace with the appropriate soil mixtures, permanent mulch and plantings as indicated on the original design plans.
				Erosion of amended soils may be cause of failure.	Refer to Section on "Surface Storage: SCM Floor– Erosion Observed."

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Variant or Cause of Problem	Recommended Maintenance Activity to Correct Problem
Surface Storage: SCM Floor Water Quality	Algae	C, I, V	…excessive algae growth present.		Water should not be present for periods more than 72 hours to allow algae growth. See "Outflow, Surface Storage: SCM Floor: Standing water observed in SCM floor" to address standing water problem.
	Turbidity	C,I, V	…sediment laden water present in SCM ponding area.		Investigate source of sediment laden flows. If a portion of the contributing drainage area has been disturbed, install permanent stabilization such as vegetative cover and monitor for establishment. If no obvious contributing source is identified, the SCM may require additional pretreatment for sediment removal, and the repair should be designed by a professional engineer. Resolution may include installation of a forebay, water quality device or other sediment collecting pretreatment means. After the source has been minimized, the SCM floor should be clean of accumulated sediment. Turbidity/suspended solids present a significant risk of clogging the top layer of the SCM, impacting the SCM's ability to function. After the source of sediment has been minimized, surface infiltration testing should be performed to confirm actual infiltration rates match design rates. If recent rainfall has not occurred, also see "Outflow, Surface Storage: SCM Floor: Standing water observed in SCM floor."
	Mosquitoes	C, I	…a large mosquito population is present due to standing water in an SCM component causing a nuisance or danger to human or animals in the vicinity of the SCM.		Determine the SCM component with standing water causing the mosquito concern. If an enclosed subsurface structure such as a sumped inlet catch basin is the source, a licensed applicator in pest management should treat enclosed/subsurface standing water with mosquito larvicides. A long-term solution involving the replacement of the subsurface standing water component can be explored and a professional engineer should design the replacement of the structure with an alternative surface feature. If the ponding is the SCM surface, see "Outflow, Surface Storage: SCM Floor: Standing water observed in SCM floor" to resolve prolonged standing water issue.
Subsurface Storage	Subsurface infiltration area not draining	C, V	…standing water is observed in SCM observation wells and rainfall did not occur in previous 72 hours.		Review plans to confirm intended function of subsurface storage. If plans indicate the subsurface storage area is designed as an anaerobic nitrogen treatment area with standing water present, standing water is acceptable and no action is required. If subsurface storage area is intended to be infiltration or slow release storage area that is dry between storm events, see maintenance and repair activity tables for "Subsurface Infiltration Trench (SIT)" and "Subsurface Detention Storage (SDS)" as appropriate. Note, most systems are designed to be dry between storm events.
SCM Liner	Impermeable liner visible and/or damaged (note liners are not present in all SCMs)	C, I, H, D	…impermeable liner has become exposed and/or damaged. …evidence suggests impermeable liner is leaking below grade.		Impermeable liners can be clay, geotextile, or composite geosynthetic. Repair methods utilized should be based on liner material.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Variant or Cause of Problem	Recommended Maintenance Activity to Correct Problem
SCM Liner					If impermeable liner has become exposed, inspect to confirm no punctures, tears or other damage has occurred. If liner is not damaged, restore cover layer using material consistent with original plan. If exposed liner is damaged or evidence suggests a liner is damaged/leaking without being exposed, repair should be designed by a professional engineer. Suspected below grade liner damage requires removal of all planting material to locate damage. Possible repair procedure could involve partial or total liner replacement and consulting with liner manufacture for repair requirements for geosynthetic or bentonite clay liners.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.5: Subsurface Infiltration Trench (SIT) Maintenance and Repair Table [1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Vegetation: in/on SCM	Tall or thick vegetation or invasive/undesirable species observed	R, C, I	…vegetation growth restricts access, obstructs water flow and interferes with maintenance activity. …hydrophytic (wetland) plants are present, which is an indication of poor drainage.	Plans call for meadow, turf or seed mix.	If non-plan specified hydrophytic plants are present, refer to section "Outflow, Surface Storage, Subsurface Storage: Above or in SCM- Standing water is observed on SCM surface or in subsurface storage area" to assess excessive moisture. If invasive/undesirable species are present, remove or treat the vegetation. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Remove dead plants 30 to 60 days after spraying. Mow the SIT at frequencies stipulated in the SCM specific Maintenance Procedures Table in Chapter 6.
		R, C, I		Plans call for sand, gravel or stone surface.	Remove all vegetation in the sand/stone area. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Remove dead plants 30 to 60 days after spraying. If non-plan specified hydrophytic plants are present, refer to section "Outflow, Surface Storage, Subsurface Storage : Above or in SCM- Standing water is observed on SCM surface or in subsurface storage area" to assess excessive moisture.
	Trees/shrubs or woody vegetation observed in SCM	R, C, H	…tree/shrub/woody growth within footprint of infiltration trench.		Remove or treat trees/shrubs/woody vegetation. Cut trunk flush to ground. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
	Vegetation is sparse	C, I, H, D, V	…less than 80% of the area is covered by vegetation or bare patches occur in more than 10% of the SCM.	Shade is causing poor ground cover. Sun exposure is 4-6 hours or less per day.	Trim overhanging limbs and remove or treat brushy vegetation that limit sunlight reaching grass and inhibits grass growth. Once sunlight is restored to area apply the appropriate permanent vegetative stabilization.
				Topsoil not present.	Replace topsoil, regrading area to original plan contours. Do not compact soil. Reseed in accordance with original SCM plans, stabilizing immediately with rolled erosion control product. If problem is reoccurring, repair should be designed and/or approved by a professional engineer.
Inflows, Outflow, Surface Storage: Sediment Management	Sediment accumulation on SCM surface observed	C, I	…sediment or debris build up exceeds 3 inches or any depth if infiltration is impeded (in SITs with gravel or vegetated surface where surface flows infiltrate through soil media into the gravel storage area).		Remove sediment from SCM surface areas using minimal disturbance techniques. Restore slope and geometry to plan dimensions. In vegetative SITs, restore permanent vegetated stabilization indicated by plans. In gravel/sand surface SITs, restore surface using materials matching plan requirements.
Outflow, Surface Storage, Subsurface Storage: Above or in SCM	Standing water is observed above or in subsurface storage area	C, I	…rainfall did not occur in previous 72 hours and observation well/underdrain cleanout indicates underdrain has no water above outlet invert.	Clogged SIT surface.	Use a soil probe or soil auger to examine the surface soils. If standing water/saturated soil is limited to top few inches of soil, likely the top layer of soil is clogged by sediment. See "Inflows, Outflow, Surface Storage: Sediment Management - Sediment accumulation on SCM surface observed" section.
		C, I, H, D, V		Geotextile Clogged.	Use a shovel to dig to top of geotextile (if present). Examine the fabric for signs of clogging and water passage. If water not passing through geotextile fabric, the geotextile fabric is likely clogged. Repair should be designed by a professional engineer. Possible remediation may include: excavate and remove existing trench material and dispose of geotextile fabric. Engineer

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
					should specify correct geotextile fabric or determine other repair method. Reconstruct trench.
				Poorly infiltrating underlying soils.	If soils/geotextile are not clogged, underlying soils may have insufficient or poor infiltration capacity. Repair should be designed by a professional engineer. Possible repair procedure may be as follows: Conduct test pit explorations and infiltration testing adjacent to the SIT foot print at the bottom elevation and at successive depths below SIT bottom to assess infiltration capacity and limiting zones of underlying soils. If suitable infiltration rates with no limiting zones are identified below the original SIT bottom elevation, reconstruct SIT with a new lower bottom elevation, using additional materials to bring the top surface to plan surface geometry.
		C, I, H, D, V	…rainfall did not occur in previous 72 hours and observation well/underdrain cleanout indicates underdrain is full of water with no flow at outlet point.	Clogged or collapsed underdrain or outlet pipe.	See Table G.1.2 on "Subsurface Storage: Underdrain - Obstruction or blockage noted."
				Clogged outlet orifice/outflow structure failure.	Remove obstruction/debris from outflow structure. If outlet is not clogged and standing water is in outflow structure, investigate downstream outlet point for signs of flow. If no flow is observed, the outlet pipe maybe clogged or collapsed. Arrange for pipe cleaning. Repair beyond debris removal/pipe cleaning should be designed and/or approved by a professional engineer.
		H, D, V	…water flowing constantly from underdrain and it has not rained in the previous 72 hours.	Suspected high ground water.	See Table G.1.2 on "Subsurface Storage: Underdrain -prolonged flows."
Surface Storage: Above or in SCM	Signs of general settlement or compaction over grass or paved surface above SCM area	C, I, H, D, V	…depression detrimentally effects ability to use paved surfaces for intended purpose. …depression causes excessive ponding or impacts permeable area.		Review geology of area to confirm settlement is not due to karst action. If karst area, see Table G.1.1 "Inflows, Surface Storage, Cut Slopes, Impounding Embankments Outflow, Emergency Spillway: General:-Sinkhole Observed." If no karst geology is present: Note: If problem is reoccurring, a geotechnical engineer should to evaluate the cause of issue. In paved areas, saw cut a rectangular pavement area 1 feet beyond limit of depression in all directions. Remove settled pavement section to saw cut lines, place subbase material in 6 inch lifts, hand tamping each lift to elevation of original top of subbase course. Reinstall paving in accordance with plan pavement type or current equivalent. In pervious area, place soils matching plan specifications over SCM footprint, compacting as specified by plans to bring area to plan specified grade. If no compaction method is specified, place in 6" lifts and hand tamp. Reseed/plant as needed to restore vegetated cover indicated on the plans applying the

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
					appropriate permanent vegetative stabilization and rolled erosion control product. In gravel/sand surface SITs, restore surface using materials matching plan requirements.
Inflows, Subsurface Storage, Outflow: Water Quality	Mosquitoes	C, I	…a large mosquito population is present due to standing water in an SCM component causing a nuisance or danger to human or animals in the vicinity of the SCM.		Determine which SCM component has standing water causing the mosquito concern. If an enclosed subsurface structure such as a sumped inlet catch basin is the source, a licensed applicator in pest management should treat enclosed/subsurface standing water with mosquito larvicides. A long-term solution involving the replacement of the subsurface standing water component can be explored and a professional engineer should design the replacement of the structure with an alternative feature. If the ponding is in the SCM where continued standing water should not occur, see "Outflow, Surface Storage, Subsurface Storage: Above or in SCM - Standing water is observed above or in subsurface storage area" to resolve prolonged standing water issue.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.6: Subsurface Detention Storage (SDS) Maintenance and Repair Table [1]					
SCM Inspection Section: Component/ Feature [2]	**Defect or Problem**	**Maintenance/ Repair Category**	**Maintenance is Needed When…**	**SCM Component Variations or Cause of Defect/Problem**	**Recommended Maintenance Activity to Correct Problem**
Inflows, Outflow, Surface Storage, Subsurface Storage: Sediment Management	Sediment accumulation in SCM storage area observed	C, I	…sediment or debris build up in subsurface vaults, pipes or chamber type storage exceeds: -plan specified cleanout depth, or -10% of open storage space for ½ the length of the open chambers, or -exceeds 15% of open storage depth at any point, or -any amount if infiltration or flow through the system is impeded.		Remove sediment from SCM storage areas using a vacuum truck or other appropriate means to remove sediment and debris from structure. For infiltrating systems, confirm infiltration draw down time is still per plan by observing the system during the next rain event.
Outflow, Subsurface Storage: SCM storage	Standing water is observed in subsurface storage area	C, I, H, D, V	…rainfall did not occur in previous 72 hours and SCM storage area has standing water with no evidence of flow discharging from outlet point.	Clogged outlet orifice/outflow structure failure.	If flow is not flowing from outflow structure, possible cause is outflow structure clog or collapse. Remove obstruction/debris from outlet structure. If outlet is not clogged and standing water is in outflow structure, investigate downstream outlet point for signs of flow. If no flow is observed, the outlet pipe maybe clogged or collapsed. Arrange for pipe cleaning. Repair beyond debris removal/pipe cleaning should be designed and/or approved by a professional engineer.
			…rainfall did not occur in previous 72 hours and SCM storage area has standing water with evidence of flow discharging from outlet point and probe of standing water in accessible storage (pipe, chamber type areas) indicates bottom is covered with sediment or debris.	Sediment build up is blocking infiltration	See section titled "Inflows, Outflow, Surface Storage, Subsurface Storage: Sediment Management - Sediment accumulation in SCM storage area observed."
			…rainfall did not occur in previous 72 hours and SCM storage area has standing water with evidence of flow discharging from outlet point and probe of standing water in accessible storage (pipe, chamber type areas) indicates bottom of open area is free from sediment or debris.	Suspected high ground water	High groundwater may be present. Repair shall be designed by a professional engineer. Process may include test pits and ground water monitor to assess typical water table and assess potential limiting layers beneath the SCM.
				Geotextile Clogged	Consult with an engineer to design this repair. Possible remediation may include: excavate and remove existing trench material and dispose of geotextile fabric. Engineer should specify correct geotextile fabric or determine other repair method. Reconstruct SDS.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Outflow, Subsurface Storage: SCM storage					
				Poorly infiltrating underlying soils or clogged geotextile.	A geotechnical engineer may be required to evaluate the cause of issue. Repair should be designed and/or approved by a professional engineer. Possible repair procedure may be as follows: Conduct test pit explorations to confirm geotextile functionality. If clogged, replacement of geotextile is required. For poorly infiltrating underlying soils, conduct infiltration testing adjacent to the SCM foot print at the bottom elevation and at successive depths below SCM bottom to assess infiltration capacity and limiting zones of underlying soils. If suitable infiltration rates with no limiting zones are identified below the original SCM bottom elevation, reconstruct SCM with a new lower bottom elevation, using additional materials to bring the top surface to plan surface geometry.
Surface Storage, Subsurface Storage: SCM Surface	Signs of general settlement or compaction over grass or paved surface of SCM area	C, I, H, D, V	…depression detrimentally effects ability to use paved surfaces for intended purpose. …depression causes excessive ponding or impacts to permeable area.		Review geology of area to confirm settlement is not due to karst action. If karst area, see "Table G.1.1 "Inflows, Surface Storage, Cut Slopes, Impounding Embankments Outflow, Emergency Spillway: General:-Sinkhole Observed. If no karst geology is present: Note: If problem is reoccurring, a geotechnical engineer should to evaluate the cause of issue. In paved areas, saw cut a rectangular pavement area 2 feet beyond limit of depression in all directions. Remove settled pavement section to saw cut lines, place subbase material in 6" lifts, hand tamping each lift to elevation of original top of subbase course. Reinstall paving in accordance with plan pavement type or current equivalent. In pervious area, check integrity of geotextile fabric and place soils matching plan specifications over SCM footprint, compacting as specified by plans to bring area to plan specified grade. If no compaction method is specified, place in 6" lifts and hand tamp. Reseed/plant as needed to restore vegetated cover indicated on the plans applying the appropriate permanent vegetative stabilization.
Outflow, Subsurface Storage: Storage and Outlet Pipe	Settlement observed over one area of storage pipe/chamber or outlet pipe	C, I, H, D, V	…soil is entering subsurface storage area or outlet pipe system.		Soil settlement over a section of subsurface storage structure (pipe, chamber, etc.) or outlet pipe is a sign that a chamber wall, pipe wall or joint has failed. If settled area is above the outlet pipe and outside of the SCM foot print, dig up and replace pipe or repair crack or joint. Clear pipe system of deposited soil.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
					If settled area is within the SCM footprint, repair shall be designed by a professional engineer. Possible repair procedure may be as follows: Care must be taken not to compact SCM area. Damaged pipe or storage chambers shall be replaced and failing joints shall be repaired. Re-install bedding material and geotextile warp around SCM in accordance with plans. Hand compact soils above SCM. Apply the appropriate permanent vegetative stabilization in accordance with plans.
Subsurface Storage: Observation Wells	Standing water in observation well	C, I, H, D, V	…standing water is observed in observation wells and rainfall did not occur in previous 72 hours.		See section titled "Outflow, Subsurface Storage: SCM storage- Standing water is observed in subsurface storage area ."
Subsurface Storage: Observation Wells	Observation well cover missing or damaged	C	…observation well cover is missing or well is damaged.		Replace missing access cover with cover meeting plan specifications.
Inflows, Subsurface Storage, Outflow: Water Quality	Mosquitoes	C, I	…a large mosquito population is present due to standing water in an SCM component causing a nuisance or danger to human or animals in the vicinity of the SCM.		Determine which SCM component has standing water causing the mosquito concern. If an enclosed subsurface structure such as a sumped inlet catch basin is the source, a licensed applicator in pest management should treat enclosed/subsurface standing water with mosquito larvicides. A long-term solution involving the replacement of the subsurface standing water component can be explored and a professional engineer should design the replacement of the structure with an alternative feature. If the ponding is in the SCM where continued standing water should not occur, see "Outflow, Subsurface Storage: SCM storage- Standing water is observed in subsurface storage area" to resolve prolonged standing water issue.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.7: Stormwater Wetland System (SWE) Maintenance and Repair Table [1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Vegetation: in SCM and/or SCM Vicinity	Tall or thick vegetation or invasive/undesirable species observed	R, C, I, H, D	…vegetation growth restricts access, obstructs water flow and interferes with maintenance activity. …invasive/undesirable species in vicinity of SCM jeopardize SCM plantings.		Review plans to determine what kind of vegetation should be present and proper care. If plans are not available, an engineer and/or landscape architect should be contacted to assess. If invasive/undesirable species are present, remove or treat invasive/undesirable species and re-stablish native plantings. Avoid spraying herbicides in and around the basin. Remove undesirable vegetation by hand if possible or by wiping plants with herbicide. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Dispose of vegetative cuttings off-site, so they do not contribute additional nutrients to the stormwater wetland.
Vegetation: in SCM	Trees/shrubs or woody vegetation observed in ponding area	R, C, I, H	…tree/shrub/woody growth obstructs water flow or interferes with maintenance activity.		Remove or treat only trees/shrubs/woody vegetation that are obstructing flow or hindering maintenance. Avoid spraying herbicides in and around the basin. Remove undesirable vegetation by hand if possible or by wiping plants with herbicide. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Dispose of vegetative cuttings off-site, so they do not contribute additional nutrients to the stormwater wetland.
	Vegetation is sparse	C, I, H, D, V	…less than 85% of the emergent vegetation zone is covered by vegetation.		Review the plans to determine design plant coverage in SWE. If density is less than plan, determine cause of vegetation loss; a professional engineer or landscape architect should design the repair. If plans are not available, a professional engineer or landscape architect should be contacted to assess.
Inflows, Outflow	Inflow or outflow point is partially or totally submerged by standing water	I, H, D, V	…submerged condition impacts inflow/outflow points ability to convey flows effectively.		If submerged inflow point is observed, reference plans to determine if intended water pool and inlet elevations vary from design. If water pool elevation is high, check outflow structure for obstruction or malfunction. If no visible obstruction or cause is identified or inlet point is lower than plans, repair should be designed by a professional engineer. If submerged outflow point is identified, assess downstream conditions to identify cause of backwater condition. Remove any unintended blockages identified. If cause is from high water level in discharge stream/pond, repair should be designed by a professional engineer.
Inflows, Outflow, Surface Storage: Sediment Management	Sediment accumulation on SCM floor observed	C, I, H	…sediment accumulation affects flow through system, exceeds depth indicated by cleanout marker, or, in absence of cleanout marker, exceeds 50% of permanent pool volume.		Remove sediment to restore plan geometry using pond dredging methods.
Impounding Embankments/ Cut Slopes	Tall grass observed	R	…tall grasses are observed which may indicate that routine mowing is not occurring.		Mow at frequencies stipulated in the SCM specific Maintenance Procedures Table in Chapter 6 above ordinary high water elevation and on embankment to low water elevation. Dispose of vegetative cuttings off-site.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Impounding Embankments/ Cut Slopes	Vegetation is sparse	C, I	…less than 85% of the area is covered by vegetation.		Review plans to determine specific vegetative cover. Repair any erosional damage and ensure 4 inches of topsoil is present. Reinstall appropriate permanent vegetative stabilization in accordance plans.
	Trees/shrubs or woody vegetation observed	R, C, I, H	…trees, shrubs or woody vegetation over four feet in height are present.	Embankments (fill)	Woody vegetation should be removed or treated. Cut stump flush to ground surface. Herbicide treatment of trunks may be required to prevent regrowth of trees. Avoid spraying herbicides in and around the basin. Remove undesirable vegetation by hand if possible or by wiping plants with herbicide. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Dispose of vegetative cuttings off-site, so they do not contribute additional nutrients to the stormwater wetland. If stump removal is required, the removal and embankment repair should be designed by a professional engineer.
				Cut slopes	Review plans to determine if trees/shrubs are part of intended landscaping. If not, assess health and stability of woody vegetation. If the plant is healthy and does not cause a risk to the SCM, it can stay in place. If it could potentially damage the SCM or nearby facilities, it should be removed or treated. Avoid spraying herbicides in and around the basin. Remove undesirable vegetation by hand if possible or by wiping plants with herbicide. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Dispose of vegetative cuttings off-site, so they do not contribute additional nutrients to the stormwater wetland. Stumps may be left in place.
Impounding Embankments	Minor erosion on embankment, inflow, outfall, and/or emergency spillway observed	C	…embankment slopes show evidence of erosion greater than 2 inches but less than 4 inches deep and there is the potential for continued erosion.		Add topsoil and apply the appropriate permanent vegetative stabilization to all disturbed areas. Determine cause of erosion and remedy if possible.
	Major erosion on embankment, inflow, outfall, and/or emergency spillway observed	I, H,D, V	…embankment slopes show evidence of erosion greater than 4 inches deep.		Take prompt action. A geotechnical engineer may be required to evaluate the cause of erosion. Promptly address erosion that may cause downstream problems (e.g., damage to highway or highway structure, homes, streams wetlands, railroads, etc.) due to either embankment failure or sediment migration. Stabilize slope. Place topsoil and apply the appropriate permanent vegetative stabilization to all disturbed areas.
	Severe erosion on embankment, inflow, outfall, and/or emergency spillway observed	I, H, D, V	…embankment slopes show evidence of erosion that threatens the integrity of the embankment.		Take immediate action. Notify municipal officials if basin embankment failure could cause downstream flooding problems. Contact a geotechnical engineer and, as directed, lower water surface slowly by opening pond drain (if one exists). Otherwise, obtain pumps and draw down the pond. Care must be exercised to not draw the water down too rapidly as to cause sloughing failure. In the case of BWD or SCM with established pond ecosystem, water draw down can be conducted with consideration to preserving the ecosystem. Repair should be designed by a professional engineer.
	Minor settlement or cracking of embankment not near outflow structure observed	C, I	…part of the berm has settled approximately 4-12 inches.		Repair settled berm to design height with similar materials. Material must be notched into existing pond berm and properly compacted. Place 4 inches of topsoil and apply the appropriate permanent vegetative stabilization.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Impounding Embankments	Major settlement or cracking of embankment not near outflow structure observed	I, H, D, V	…part of the berm has settled more than 12 inches.		Take prompt action. A geotechnical engineer may be required to evaluate the cause of issue. Repair should be designed by a professional engineer. Possible remediation may include: Repair settled berm to design height with similar materials. Material must be notched into existing dam and properly compacted. Place 4 inches of topsoil and apply the appropriate permanent vegetative stabilization.
	Settlement or cracking of embankment near outflow structure observed	I, H, D, V	…part of the berm near an outflow structure has settled 4 inches or more, which may be a sign of leaking.		Take prompt action. A geotechnical engineer may be required to evaluate the cause of issue. Determine if soil is entering pipe or outflow structure. Pipes and outflow structure may require repairs and cleaning. Compact borrow soil material around pipe and structure. Place 4 inches of topsoil and apply the appropriate permanent vegetative stabilization.
	Water observed flowing through basin embankment	I, H, D, V	…water is flowing through an embankment, which may cause failure in a short time (hours).		Take immediate action. Notify municipal officials if basin embankment failure could cause downstream flooding problems. Contact a geotechnical engineer and, as directed, lower water surface slowly by opening pond drain (if one exists). Otherwise, obtain pumps and draw down the pond. Care must be exercised to not draw the water down too rapidly as to cause sloughing failure. In the case of BWD or SCM with established pond ecosystem, water draw down can be conducted with consideration to preserving the ecosystem. Repair should be designed by a professional engineer.
	Soil saturation or seeps at base of berm/dike observed	C, I, H, D, V	…water is seeping through the berm or soils are saturated on the exterior face of berm.		Decision on timing of repair depends on further evaluation. A geotechnical engineer may be required to evaluate the cause of issue. Monitor seep with decreasing regularity (daily, then weekly, then monthly) sufficient to determine if the rate or nature of the leak is changing. Repair should be designed by a professional engineer.
	Burrowing animal holes observed	C, I	…holes that are likely formed by a burrowing animal are located in the basin embankment present safety, structural or SCM functional risk.		Fill holes with the same or similar material used in the embankment and apply the appropriate permanent vegetative stabilization. If the problem persists, trapping of burrowing animal may be required. Contact Pa Game Commission for assistance.
	Sloughing or sliding of berm/dike observed	C, I, H, D, V	…sloughing or sliding of embankment is observed.		Take prompt action. A geotechnical engineer may be required to evaluate the cause of issue. Repair should be designed by a professional engineer. Possible repair procedure may be as follows: Correcting the cause of sloughing and repairing berm with similar materials.
Cut Slopes	Minor erosion on cut slope observed	C	…slopes show evidence of erosion greater than 4 inches but less than 12 inches deep and there is the potential for continued erosion.		Add topsoil and apply the appropriate permanent vegetative stabilization. Determine cause of erosion and remedy if possible.
	Major erosion on cut slope observed	I, H, D, V	…slopes show evidence of erosion greater than 12 inches deep.		Address erosion that may lead to problems (e.g., damage to highway or structures, etc.). Stabilize slope. Place topsoil and apply the appropriate permanent vegetative stabilization.
	Severe erosion on cut slope observed	I, H, D, V	…slopes show evidence of erosion that threatens the integrity of the slope, adjacent roadway, or structures.		Take prompt action. A geotechnical engineer should evaluate the cause of issue and direct repairs. Repair should be designed by a professional engineer.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Surface Storage: SCM Floor Water Level	Permanent pool water level very low or dry	I, H, D, V	…permanent pool elevations are significantly below proposed depth or basin is dry.		A geotechnical engineer may be required to evaluate the cause of issue. Repair should be designed by a professional engineer. Possible repair procedure will vary based on diagnosis. Possible causes include infiltration into surrounding soils, defective/damaged impermeable liner, piping/seepage through embankment, insufficient inflow/prolonged drought.
Surface Storage: SCM Floor	Beaver dams are observed	C, I	…beaver dam inhibits function of SCM, jeopardizes infrastructure or notably reduces effective storage of basin.		Contact PA Game Commission to obtain assistance with relocation of beaver inhabitants. After beaver relocation, remove dam debris.
Outflow, Surface Storage: SCM Drain/ Mechanical Assemblies	Damaged, non-functioning, or missing components found	C, I	…water flows after shutting the valves/gates or they cannot be opened/closed or are otherwise not functioning properly.		Install cofferdam to dewater work area if possible; pump or drain pond if needed. Repair or replace valves/gates with similar components. Divert flows when valves are out of service.
Surface Storage: SCM Floor Water Quality	Algae	C, I, H, V	…algae growth covers more than 50% of pond area or the pond has an odor.		Excessive algae growth is an indicator of excess nutrients from fertilizers in the water or decomposing materials on the SCM surface beneath the water. An engineer and/or landscape architect should be contacted to assess the problem. The short-term solution is physical removal of the algae. Pump pond dry and clean out the bottom. Long term resolution/prevention of reoccurrence should include a review of the SCM drainage area for possible sources of nutrient runoff. Review SCM construction and maintenance records to identify if excess is from SCM operation activities. If obvious sources cannot be identified/eliminated, the SCM may require additional pretreatment or buffer areas.
	Turbidity	C, I, H, D, V	…sediment laden water present in SCM ponding area.		Investigate source of sediment laden flows. If a portion of the contributing drainage area has been disturbed, install permanent stabilization such as vegetative cover and monitor for establishment. If no obvious contributing source is identified, the SCM may require additional pretreatment for sediment removal and the repair should be designed by a professional engineer. Resolution may include installation of a forebay, water quality device or other sediment collecting pretreatment means. After turbidity has been resolved, the SCM floor should be cleaned of accumulated sediment.
	Large permanent geese or other water fowl population	C, I	…evidence of over 20 permanent water fowl inhabitants per acre of pond surface area and noted waste accumulation.		Ensure fecal matter does not cause water quality impacts by monitoring SCM discharge points for elevated fecal coliform. If required, contact Pa Game Commission for population relocation assistance. Allowing 3 foot tall grass buffer to surround the SCM for a 5 to 8 foot width will discourage waterfowl from using pond.
	Mosquitoes	C, I	…a large mosquito population is present due to standing water in an SCM component causing a nuisance or danger to human or animals in the vicinity of the SCM.		Determine which SCM component has standing water causing the mosquito concern. If an enclosed subsurface structure such as a sumped inlet catch basin is the source, a licensed applicator in pest management should treat enclosed/ subsurface standing water with mosquito larvicides. A long-term solution involving the replacement of the subsurface standing water

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
					component can be explored and a professional engineer should design the replacement of the structure with an alternative feature. If the ponding is the SCM surface in a SWE, excess mosquito presence is an indication of a poorly functioning ecosystem A professional engineer or wetland scientist should assess/develop remediation plan.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.8: Constructed Stormwater Filter (CSF) Maintenance and Repair Table [1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Vegetation: on Open CSF Floor	Vegetation or invasive/undesirable species observed	R, C	…vegetation growth restricts access, obstructs water flow and interferes with maintenance activity. …hydrophytic (wetland) plants are present, which is an indication of poor drainage.	Plan calls for sand or stone bottom	Review the plans to determine if SCM is to have vegetative cover. If plan indicates no vegetative cover is called for on CSF floor, remove vegetation. Remove vegetation annually from CSF media area if no instructions are provided on the plan. If non-plan specified hydrophytic plants are present, refer to section "Outflow, Surface Storage: Open CSF -SCM Floor -Standing water observed in open CSF" to assess excessive moisture. Remove invasive/undesirable species. Hand weeding is preferred removal method. Do not use herbicides.
		R		Plans call for grass or meadow seed mix.	Mow at frequencies stipulated in the SCM specific Maintenance Procedures Table in Chapter 6.
	Trees/shrubs or woody vegetation observed	R, C, I	…tree/shrub/woody growth restricts access, obstructs water flow, are growing in CSF, or interferes with maintenance activity.		If landscaping plans are available and indicate trees/shrubs/woody vegetation is not specified, remove trees/shrubs/woody vegetation and root systems. Repair filter area using materials meeting plan specifications. Do not use herbicides. Remove vegetation annually from CSF media area if no instructions are provided on the plan.
Inflows: Open CSF Sediment Management	Sediment accumulation on CSF media observed	C, I	…sediment accumulation affects flow, exceeds depth indicated by cleanout marker or, in absence of cleanout marker, exceeds 1 inch in depth.		Conduct work when area is dry. Remove sediment from CSF floor areas using minimal disturbance techniques such as hand raking. Restore to plan elevation. Reseed/plant if specified on plan to restore vegetated cover if indicated in the plans applying the appropriate permanent vegetative stabilization.
Inflows: Enclosed CSF Sediment Management	Sediment accumulation in pre-treatment area	C, I	…sediment accumulation in pre-treatment area affects flow, exceeds cleanout depth indicated by cleanout marker or, in absence of cleanout marker, is less than 6 inches from invert out of storage area.		Use vacuum truck or other appropriate means to remove all sediment and debris from inlet structure.
	Sediment accumulation on CSF filter material observed	C, I	…sediment accumulation affects flow through system, exceeds cleanout depth indicated by cleanout marker or, in absence of cleanout marker, or exceeds ½" depth.		Remove sediment and 1 inch of filter media from filter media surface. Scarify media surface, replacing any media which has been clogged with sediment with materials meeting plan requirements.
Impounding Embankments/ Cut Slopes: Open CSF	Tall grass observed	R	…tall grasses are observed which may indicate that routine mowing is not occurring.		Mow grass at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Impounding Embankments: Open CSF	Settlement of embankment not near outflow structure observed	C, I	…part of the berm has settled 4 inches or more.		Repair settled berm to design height with similar materials. Material must be notched into existing pond berm and properly compacted. Place 4 inches of topsoil and apply the appropriate permanent vegetative stabilization.
	Settlement or cracking of embankment near outlet structure observed	I, H, D, V	…part of the berm near an outlet structure has settled 4 inches or more, which may be a sign of leaking.		Take prompt action. A geotechnical engineer may be required to evaluate the cause of issue. Repair should be designed by a professional engineer. Possible remediation may include: Determine if soil is entering pipe or outlet structure. Pipes and outlet structure may require repairs and cleaning. Compact borrow soil material around pipe and structure. Place 4 inches of topsoil and apply the appropriate permanent vegetative stabilization.
	Burrowing animal holes observed	C, I	…holes that are likely formed by a burrowing animal are located in the SCM embankment present safety, structural or SCM functional risk.		Fill holes with the same or similar material used in the embankment and apply the appropriate permanent vegetative stabilization. If the problem persists, trapping of burrowing animal may be required. Contact PA Game Commission for assistance.
Impounding Embankments/ Cut Slopes: Open CSF	Minor erosion on side slope observed	C	…slopes show evidence of erosion greater than 4 inches and there is the potential for continued erosion.		Add topsoil and apply the appropriate permanent vegetative stabilization. Determine cause of erosion and remedy if possible.
Inflows: Open CSF Flow Spreader	Flow spreader uneven or clogged	R, C, I, H	…flows are not uniformly distributed across CSF floor.		Remove cause of clogging. If flow spreader is uneven, see LSO maintenance and repair activity table.
Outflow, Surface Storage: Open CSF SCM Floor	Standing water observed in open CSF	C, I, H, D, V	…rainfall did not occur in previous 72 hours and well/underdrain cleanout in open CSF indicates underdrain has little to no water present.	Top layer of media filter may be clogged.	Use a soil probe or soil auger to examine the SCM soil. If standing water/saturated soil is limited to top few inches of soil, likely the top layer of soil is clogged by sediment. Remove layer of fine sediment and top 1 to 2 inches of media soil, rake bottom, and verify infiltration capacity matches original design by inspecting CSF 72 hours after a rain event exceeding 0.1 inches in 24 hours or by performing infiltration test(s). If acceptable infiltration rates are confirmed, install new media filter matching plan materials, restoring geometry to plan elevation. If infiltration still is not satisfactory, a professional engineer may be required to evaluate the cause of issue and design a repair.
				Geotextile clogged.	Use a shovel to dig to top of geotextile (if present). Examine the fabric for signs of clogging and water passage. If water is not passing through geotextile fabric, the geotextile fabric is likely clogged. Consult with a professional engineer to design this repair. Possible remediation may include: Remove filter material and stockpile for reuse. Remove and dispose of geotextile fabric. Professional engineer should specify correct geotextile fabric or determine other repair method. Reinstall and do not compact filter material.
		C, I, H, D, V	…rainfall did not occur in previous 72 hours and well/underdrain cleanout in open CSF	Clogged, or collapsed underdrain.	See Table G.1.2 on "Subsurface Storage: Underdrain- Obstruction or blockage noted."

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Outflow, Surface Storage: Open CSF SCM Floor			indicates underdrain is full of water with no flow from outlet point.	Clogged outlet orifice/outflow structure failure.	Remove obstruction/debris and unclog the low flow outlet in the outflow structure. If sediment build up in CSF is causing blockage, remove sediment as described in "Inflow, Pretreatment: Open CSF Sediment Management - Sediment accumulation on CSF media observed." If outlet orifice/weirs are not clogged and standing water is in outflow structure, investigate downstream outlet point for signs of flow. If no flow is observed, the outlet pipe maybe clogged or collapsed. Arrange for pipe cleaning. Repair beyond debris removal/pipe cleaning should be designed by a professional engineer.
		H, D, V	…water flowing constantly from underdrain in open CSF when it has not rained in the previous 72 hours.	Suspected high ground water.	See Table G.1.2 on "Subsurface Storage: Underdrain- Prolonged flows".
Surface Storage, Subsurface Storage: Open and Enclosed CSF Floor General	Short circuiting	C, I	…flows become concentrated across one area of the media.		Determine and remediate cause of short circuiting: 1) check inlet points and ensure they are directed to a flow spreader if appropriate (see flow section on "Inflows: Open CSF Flow Spreader- Flow spreader uneven or clogged"); 2) check CSF Floor media for grade, ensuring it is not uneven/channelizing flow. After cause of short circuiting is resolved, repair any damage to CSF media, restoring the surface to plan elevations.
Inflows, Outflow, Surface Storage, Subsurface Storage: Enclosed CSF Vault/Structure	Defective internal baffle walls	C, I, H, D, V	…baffles or walls are corroding, cracking, warping or failing.		Repair baffles to plan specifications. In the absence of plans, repair should be designed by a licensed professional engineer.
SCM Liner	Impermeable liner visible and/or damaged (note liners may not be present in all SCMs)	C, I, H, D	…impermeable liner has become exposed and/or damaged …evidence suggests impermeable liner is leaking below grade.		Impermeable liners can be clay, geotextile, or composite geosynthetic. Repairs methods utilized should be based on liner material. If impermeable liner has become exposed, inspect to confirm no punctures, tears or other damage has occurred. If liner is not damaged, restore cover layer using material consistent with original plan. If exposed liner is damaged or evidence suggests a liner is damaged/leaking without being exposed, repair should be designed by a professional engineer. Suspected below grade liner damage requires removal of all bioretention planting material to locate damage. Possible repair procedure could involve partial or total liner replacement, consulting with liner manufacture for repair requirements for geosynthetic or bentonite clay liners.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.9: Vegetated Filter Strip (VFS); Vegetated Filter Strip, Steep Slope (VSS) Maintenance and Repair Table [1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Vegetation: on SCM	Excessively tall vegetation or invasive/undesirable species observed	R, C, I, H, D	…vegetation growth exceeds 12 inches or restricts access, obstructs water flow and interferes with maintenance activity. …invasive/undesirable plants material covers more than 10% of SCM area.		Review the plans to determine proper care. Mow the filter surface at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6. If invasive/undesirable species are present, remove unwanted vegetation. Hand weeding is preferred removal method. Herbicide use in VFS/VSS should be avoided. If herbicide use is considered in areas outside of the SCM, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Replant filter area with native plants and/or seed mix per plans. If replanting is required repeatedly, consult a landscape architect for assessment.
	Trees/shrubs or woody vegetation observed	R, C, I	…tree/shrub/woody growth restricts access, obstructs water flow, are growing in SCM, or interferes with maintenance activity.		If plans are available and indicate trees/shrubs/woody vegetation is not specified, remove trees/shrubs/woody vegetation when the area is dry. Cut stumps flush to ground. Herbicide use in VFS/VSS should be avoided. If herbicide use is considered in areas outside of the SCM, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Repair disturbed area, replanting and stabilizing per plans immediately. Remove trees/shrubs/woody vegetation from filter area when dry if no instructions are provided on the plan.
	Grass not growing well	R, C, I	…excessive dead grass prevents growth or area too compacted to allow growth.		Thatch grass area when dry. Rake up dead grass and clippings. Aeration of soils by mechanically removing plugs may be required.
	Hydrophytic (wetland) plants observed	R, C, I, H, D, V	…hydrophytic (wetland) plants are present, which is an indication of poor drainage.		Surface flows through and out of filter area are insufficient. Confirm slope of area matches plan. Regrade surface of filter using soil mix materials matching plans. Re-establish permanent vegetative stabilization per plans. If topography matches the plans and no solution is evident, consult with an engineer to design this repair. Possible remediation may include: assessing groundwater table in area, ensuring adequate surface drainage downslope of the SCM and testing soils for infiltration rates.
	Vegetation is sparse	C, I, H, D, V	… less than 80% of the area is covered by vegetation or bare patches are observed in more than 10% of filter surface area.		Replant area using seed mix or plant materials as specified on plans utilizing fertilizers/amendments if indicated by plans. If sparse vegetation is a reoccurring problem or no plans are available, request a landscape architect for revised planting approach. If area is excessively shaded (6 hrs. or less of sun/day), trim overhanging limbs and brushy vegetation (if within right of way). Once sunlight is restored, replant as described above.
Inflows, Surface Storage: Sediment Management	Sediment and/or anti-skid material accumulation on filter area	C, I	…accumulation blocks flow entry or distribution of runoff in filter area.		Remove accumulated sediment/materials. Regrade area so slope is even and flows pass through without concentrating, referencing plans for grading.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
			…accumulation exceeds 2 inches in depth. …accumulation inhibits vegetative grown in more than 10% of filter surface area.		Equipment should not enter filter area; minimize compaction. Restore appropriate permanent vegetative stabilization as indicated on the plans.
Inflows: Flow Spreader	Flow spreader area not distributing flow	R, C, I, H	…flow spreading area is uneven, clogged with sediment/material causing uneven distribution of flows over SCM vegetative area.		Remove accumulated sediment/materials. Level area so flows pass through without concentrating, referencing plans for grading.
Surface Storage: SCM Floor	Burrowing animal holes observed	C, I	…holes that are likely formed by a burrowing animal are located in the SCM filter area.		Fill holes with the same or similar material used in the filter and apply the appropriate permanent vegetative stabilization. If the problem persists, trapping of burrowing animal may be required. Contact PA Game Commission for assistance.
	Minor erosion, channelization, or short circuiting on SCM observed	C, I	…VFS/VSS surface shows evidence of erosion greater than 4 inches.		Fill erosion areas with materials matching original SCM design and apply the appropriate permanent vegetative stabilization. Determine cause of erosion and remedy if possible.
	Major erosion, channelization, or short circuiting on SCM observed	I, H, D, V	…VSS surface shows evidence of erosion greater than 12 inches wide/deep.		Regrade/reconstruct SCM in areas with erosional damage. Utilize appropriate permanent vegetative stabilization per plan. If problem is reoccurring or no plans are available, repair should be designed by a professional engineer.
	Standing water or soggy soils are observed in filter area	C, I, H, D, V	…standing water is observed on SCM surface or filter media remains saturated and rainfall did not occur in previous 72 hours.		Use a soil probe or soil auger to determine if standing water/saturated soil is limited to top few inches of soil. If so, the top layer of soil is likely clogged by sediment. Remove layer of fine sediment and top several inches of filter soils from SCM surface. Install new filter materials matching plan materials, restoring slope and geometry to plan dimensions. Restore disturbed areas with appropriate permanent vegetative stabilization per plans.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.10: Media Filter Drain (MFD) Maintenance and Repair Table[1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Vegetation: on SCM	Vegetation or invasive/undesirable species observed	R, C, I, H, D	…vegetation growth on surface or restricts access, obstructs water flow and interferes with maintenance activity. …invasive/undesirable plants material covers more than 10% of SCM area.		Review the plans to confirm filter surface is to be vegetated. If plans do not call for vegetation on the surface, remove growth. Hand weeding is preferred removal method. Do not use herbicides within the MFD. If surface is to be vegetated, mow the filter surface at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6. If invasive/undesirable species are present on an intentionally vegetated MFD surface, hand weeding is preferred removal method. Do not use herbicides within the MFD. Herbicides may be used in areas around/adjacent to the MFD. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Remove dead plants 30 to 60 days after spraying. Replant filter area with native plants and/or seed mix per plans. If replanting is required repeatedly, consult a landscape architect for assessment.
	Trees/shrubs or woody vegetation observed	R, C, I	…tree/shrub/woody growth restricts access, obstructs water flow, are growing in SCM, or interferes with maintenance activity.		If plans indicate trees/shrubs/woody vegetation are not specified, remove trees/shrubs/woody vegetation when the area is dry. Cut stumps flush to ground. Do not use herbicide within the MFD. Herbicides may be used in areas around/adjacent to the MFD. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Repair disturbed area, replanting and stabilizing per plans immediately. If no instructions are provided on the plan, remove trees/shrubs/woody vegetation from filter area when dry.
	Hydrophytic (wetland) plants observed	R, C, I, H, D, V	…hydrophytic (wetland) plants are present, which is an indication of poor drainage.		The engineered soil mix or perforated underdrain may be clogged. Consult with an engineer to design this repair. Possible remediation may include inspection or underdrain observation wells/cleanouts. If standing water is present in underdrain, underdrain maybe clogged. See Table G.1.2 on "Subsurface Storage: Underdrain- Obstruction or blockage noted." If no moisture is present but filter soil is moist, filter soil is most likely clogged. Remove top several inches of filter media to expose dry media material. Install new media material matching plan design material specifications and elevations.
	Vegetation is sparse	C, I, H, D, V	…less than 80% of the area is covered by vegetation or bare patches are observed in more than 10% of filter surface area.		Review plans to confirm surface is to be vegetated. If vegetation is called for, replant area using seed mix or plant materials as originally specified on the plans utilizing fertilizers/amendments only if indicated by plans. If sparse vegetation is a reoccurring problem or no plans are available, consult a landscape architect for revised planting approach.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
					If area is excessively shaded (6 hrs. or less of sun/day), trim overhanging limbs and brushy vegetation if within right of way. Once sunlight is restored, replant as per above.
Inflows, Surface Storage: Sediment Management	Sediment and/or anti-skid material accumulation on filter area	C, I	…accumulation blocks flow entry or distribution of runoff in filter area. …accumulation exceeds 2 inches in depth. …accumulation inhibits vegetative grown in more than 10% of filter surface area.		Remove accumulated sediment/materials. Regrade area so slope is even and flows pass through without concentrating, referencing plans for grading. Restore appropriate permanent stabilization as indicated in the plans.
Inflows	No-vegetation zone not distributing flow	C, I	…no vegetation zone is uneven, clogged with sediment/material causing uneven distribution of flows over SCM area.		Remove accumulated sediment/materials as needed. Level the no-vegetation zone so flows pass through without concentrating, referencing plans for grading.
Surface Storage: SCM Floor	Burrowing animal holes observed	C, I	…holes that are likely formed by a burrowing animal are located in the SCM filter area.		Fill holes with the same or similar material used in the filter and apply the appropriate permanent stabilization. If the problem persists, trapping of burrowing animal may be required. Contact PA Game Commission for assistance.
	Minor erosion, channelization, or short circuiting SCM observed	C, I	…slopes show evidence of erosion greater than 4 inches but less than 12 inches wide/deep.		Fill erosion areas with materials matching original SCM design and apply the appropriate permanent stabilization. Determine cause of erosion and remedy if possible.
	Major erosion, channelization, or short circuiting on SCM observed	I, H, D, V	…slopes show evidence of erosion greater than 12 inches wide/deep.		Regrade/reconstruct SCM in areas with erosional damage. Utilize appropriate permanent vegetative stabilization per plan. If problem is reoccurring or no plans are available, repair should be designed by a professional engineer.
	Severe erosion, channelization, or short circuiting on SCM observed	I, H, D, V	…slopes show evidence of erosion that threatens the integrity of the slope, adjacent roadway, or structures.		Take prompt action. A professional engineer should evaluate the cause of issue and direct repairs.
	Standing water or soggy soils are observed in filter area	C, I, H, D, V	…rainfall did not occur in previous 72 hours and observation well/underdrain cleanout in filter indicates underdrain has little to no water present.	Top layer of filter clogged.	Remove layer of fine sediment and a minimum of the top 1 to 2 inches of filter media from SCM surface; remove sufficient depth of media to expose clean, unclogged media. If entire media is clogged, remove full depth of media. Install new filter media matching plan materials, restoring slope and geometry to plan dimensions. Restore disturbed areas with Appropriate permanent stabilization.
			…rainfall did not occur in previous 72 hours and observation well/underdrain cleanout indicates underdrain is full of water with no flow from outlet point.	Clogged or collapsed underdrain.	See Table G.1.2 on "Subsurface Storage: Underdrain - Obstruction or blockage noted" and "Subsurface Storage: Underdrain - Settlement observed over underdrain observed ."
				Clogged/collapsed outlet pipe.	Examine outlet location. Remove obstruction/debris. If standing water is in underdrains, investigate downstream outlet location for signs of flow. If no flow is observed, the outlet pipe maybe clogged or collapsed. Arrange for pipe cleaning. Repair beyond debris removal/pipe cleaning should be designed by a professional engineer.
		D, V	…water flowing from underdrain and it has not rained in the previous 72 hours or more.	Suspected high ground water.	See Table G.1.2 on "Subsurface Storage: Underdrain -Prolonged flows".

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Surface Storage: SCM Floor	Evidence of flooding of MFD	D, V	…MFD is/was inundated by flood water.		Perform infiltration testing on MFD surface and within media layer to confirm infiltration rates meet design values. If infiltration rates are not sufficient, remove media filter material and replace with new filter media matching plan materials, restoring slope and geometry to plan dimensions. Restore disturbed areas with appropriate permanent stabilization per plans.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.11: Vegetated Swale (VSW); Vegetated Swale W/Check Dams (VSC) Maintenance and Repair Table [1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Vegetation: in SCM and/or SCM vicinity	Excessively tall vegetation or invasive/undesirable species observed	R, C, I	…vegetation growth restricts access, obstructs water flow and interferes with maintenance activity.		Review the plans to determine intended vegetation cover type in channel bottom, side slopes and vicinity. Mow the swale at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6. If invasive/undesirable species are present, remove or treat unwanted vegetation. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
Vegetation: in SCM	Trees/shrubs or woody vegetation observed	R, C, I	…tree/shrub/woody growth restricts access, obstructs water flow, are growing in channel bottom or on side slopes, or interferes with maintenance activity.		If plans indicate trees/shrubs/woody vegetation are not specified, remove or treat trees/shrubs/woody vegetation and root systems from channel bottom and/or side slopes when SCM is dry. Repair disturbed area, replanting and stabilizing per plans. If no instructions are provided on the plan, remove or treat woody vegetation annually from channel bottom and side slopes when area is dry. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
	Hydrophytic (wetland) plants observed	R, C, I, H, D, V	…hydrophytic (wetland) plants are present, which is an indication of poor drainage.	Hydrophytic vegetation immediately upslope of check dams only	See “Surface Storage: SCM Floor (Channel)- Check dams are retaining water”
				Without subsurface infiltration trench (SIT) below	Surface flows through and out of the channel area are likely insufficient. Confirm profile slope of channel matches plan. Regrade surface of filter using soil mix materials matching plans. Re-establish appropriate permanent vegetative stabilization per plans. If topography matches the plans and wet conditions exist, consult with an engineer to design repair. Possible remediation may include: assessing groundwater table in area, ensuring adequate surface drainage downslope of the SCM and testing soils for infiltration rates.
				With SIT below	Reference subsurface infiltration trench (SIT) maintenance and repair activity table.
	Vegetation is sparse	C, I, H, D, V	…less than 90% of the area is covered by vegetation or bare patches occur in more than 10% of the SCM.		Confirm a minimum of 4 inches of topsoil or plan specified modified soils mix is present. If depth is not sufficient, place topsoil or modified soils specified by design plan to a depth of at least 4 inches. Do not mechanically compact. Replant area using appropriate permanent vegetative stabilization per plans. If sparse vegetation is a reoccurring problem or no plans are available, consult a landscape architect for revised planting approach. If area is excessively shaded (6 hrs. or less of sun/day), trim overhanging limbs and brushy vegetation if within right of way. Once sunlight is restored, replant as per above.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
			…less than 20% of area is covered by vegetation and turf reinforcement mat (TRM) is visible.		It is possible that TRM is choking plant roots. Contact a landscape architect to evaluate problem. If TRM is not in contact with soil, work soil under matting in problem areas. Work soil into TRM in problem areas and reseed using vegetation per original design plans.
Inflows, Surface Storage: Sediment Management	Sediment and/or anti-skid material accumulation on SCM surface observed	C, I	…accumulation blocks flow entry or through swale. …accumulation exceeds 3 inches in depth. …accumulation inhibits vegetative grown in more than 10% of SCM surface area.		Remove accumulated sediment/materials. Regrade swale so slope is even and flow passes, referencing plans for grading. Reseed/plant as needed to restore vegetated cover as indicated in the plans applying the appropriate permanent vegetative stabilization.
Surface Storage, Cut Slopes	Tall grass observed	R	…tall grasses are observed which may indicate that routine mowing is not occurring.		Mow SCM and surrounding areas at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6.
	Burrowing animal holes observed	C, I	…holes that are likely formed by a burrowing animal are located in the SCM		Fill holes with the same or similar material used in swale and apply the appropriate permanent vegetative stabilization. If the problem persists, trapping of burrowing animal may be required. Contact PA Game Commission for assistance.
	Minor erosion on side slope observed	C	…slopes show evidence of erosion greater than 4 inches and there is the potential for continued erosion.		Add topsoil and apply the appropriate permanent vegetative stabilization. Determine cause of erosion and remedy if possible. Remove any sediment deposited in swale as described under sedimentation management.
Outflow, Surface Storage: SCM Floor (Channel)	Standing water or soggy area observed in swale underlain by a SIT	C, I, H, D, V	…standing water or saturation is observed in swale or channel bottom and rainfall did not occur in previous 72 hours.		See subsurface infiltration trench (SIT) maintenance and repair activity table.
	Standing water or soggy bottom is observed in swale not underlain by a SIT	C, I, H, D, V	…rainfall did not occur in previous 72 hours and standing water is observed in swale or channel bottom with no flow from outlet point.	Clogged outlet.	Remove obstruction/debris. If sediment build up in SCM is causing blockage, remove sediment as described in “Inflow, Surface Storage: Sediment Management - Sediment and/or anti-skid material accumulation on SCM surface observed.” If standing water extends downstream of SCM, see Table G.1.2 “Inflows, Outflow-Inflow or Outflow point is partially or totally submerged by standing water”.
				Soil Clogged.	A geotechnical engineer may be required to evaluate the cause of issue. Repair should be designed and/or approved by a professional engineer. Possible repair procedure may be as follows: Conduct test pit explorations and infiltration testing at the bottom of SCM and at successive depths below SCM bottom to assess infiltration capacity and limiting zones of underlying soils. If suitable infiltration rates with no limiting zones are identified below the original SCM bottom elevation, reconstruct SCM with engineered soils providing sufficient infiltration rate to a depth reaching the identified acceptable subgrade infiltration depth, reshaping the surface of the SCM and replanting to original plan surface geometry.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Outflow, Surface Storage: SCM Floor (Channel)		C, I, H, D, V	…rainfall did not occur in previous 72 hours and standing water is observed in swale or channel bottom with no obstruction at outlet point.	Top layer of soil clogged.	Use a soil probe or soil auger to examine the soil in the swale. If standing water/saturated soil is limited to top few inches of soil, likely the top layer of soil is clogged by sediment. See "Inflows, Surface Storage: Sediment Management - Sediment accumulation in SCM surface observed" section.
				Geotextile clogged.	Use a shovel to dig to top of geotextile (if present). Examine the fabric for signs of clogging and water passage. If water not passing through geotextile fabric, the geotextile fabric is likely clogged. Consult with an engineer to oversee this repair. Possible remediation may include: Remove top soil material and stockpile for reuse. Remove and dispose of geotextile fabric. Engineer should specify correct geotextile fabric or determine other repair method. Reconstruct swale and replant per original plans.
				Poorly infiltrating underlying soils.	If soils/geotextile are not clogged, underlying soils may have insufficient or poor infiltration capacity. A geotechnical engineer may be required to evaluate the cause of issue. Repair should be designed and/or approved by a professional engineer. Possible repair procedure may be as follows: Conduct test pit explorations and infiltration testing at the bottom of SCM and at successive depths below SCM bottom to assess infiltration capacity and limiting zones of underlying soils. If suitable infiltration rates with no limiting zones are identified below the original SCM bottom elevation, reconstruct SCM with engineered soils providing sufficient infiltration rate to a depth reaching the identified acceptable subgrade infiltration depth, reshaping the surface of the SCM and replanting to original plan surface geometry.
		H, D, V	…water flowing constantly from swale for a week or more.	Suspected high ground water.	Repair should be designed by a professional engineer. Process may include test pits and ground water monitor to assess typical water table and assess potential limiting layers beneath the SCM.
Surface Storage: SCM Floor (Channel)	Check dams are retaining water (VSC only)	C, I, H, D, V	…standing water or channel bottom remains saturated immediately upslope of check dams and rainfall did not occur in previous 72 hours. …hydrophytic (wetland) plants are present immediately upslope of check dams, which is an indication of localized poor drainage.	Infiltrating dams	Poorly infiltrating underlying soils or high ground water are likely the cause of failure, see "Outflow Surface Storage: SCM surface (Channel)-Standing water or soggy bottom is observed in swale".
				Slow flow dams	Check dam is likely clogged, silted or debris covered. Remove obvious trash/debris present. When areas are dry, remove silt accumulation from check dam. Stabilize any disturbed areas using appropriate permanent vegetative stabilization as specified by original plans. If problem persists, repair should be designed and/or approved by a professional engineer.
SCM Liner	Impermeable liner visible and/or damaged (note liners may not be present in all SCMs)	C, I, H, D, V	…impermeable liner has become exposed and/or damaged. …evidence suggests impermeable liner is leaking below grade.		Impermeable liners can be clay, geotextile, or composite geosynthetic. Repairs methods utilized should be based on liner material. If impermeable liner has become exposed, inspect to confirm no punctures, tears or other damage has occurred. If liner is not damaged, restore cover layer using material consistent with original plan. If exposed liner is damaged or evidence suggests a liner is damaged/leaking without being exposed, repair should be designed by a professional engineer.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
					Suspected below grade liner damage requires removal of all bioretention planting material to locate damage. Possible repair procedure could involve partial or total liner replacement, consulting with liner manufacture for repair requirements for geosynthetic or bentonite clay liners.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.12: Infiltration Berm (IBE) Maintenance and Repair Table [1]					
SCM Inspection Section: Component/ Feature [2]	**Defect or Problem**	**Maintenance/ Repair Category**	**Maintenance is Needed When…**	**SCM Component Variations or Cause of Defect/Problem**	**Recommended Maintenance Activity to Correct Problem**
Vegetation: in SCM and/or SCM vicinity	Excessively tall vegetation or invasive/undesirable species observed	R, C, I	…vegetation growth restricts access and interferes with maintenance activity.		Review the plans to determine appropriate vegetation. In areas intended to be mowed, mow berm and adjacent area at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6. All mowing must be performed when the area is dry. Do not remove trees, shrubs or other plants intended to be present based on the plans. If woody growth is present and plans are not available to clarify design plantings consult a professional engineer and/or landscape architect for direction. If invasive/undesirable species are present, remove or treat unwanted vegetation. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
Vegetation: in SCM	Trees/shrubs or woody vegetation observed	R, C, I	…tree/shrub/woody growth restricts access, obstructs water flow, are growing on berm, or interferes with maintenance activity.		If landscaping plans are available and indicate trees/shrubs/woody vegetation should not be permitted to grow on the berm, remove or treat trees/shrubs/woody vegetation. Repair disturbed area, replanting and stabilizing per plans immediately. If plans do not clearly indicate woody vegetation must be removed, consult a professional engineer or landscape architect for guidance.
	Hydrophytic (wetland) plants observed	R, C, I, H, D, V	…hydrophytic (wetland) plants are present, which is an indication of poor drainage.	Hydrophytic vegetation immediately upslope of berm only	See "Surface Storage: SCM Floor - Standing water or soggy area observed upslope of berm" to resolve excessive moisture. After resolution, restore planting to original plan design.
				With subsurface infiltration trench (SIT) below	Reference subsurface infiltration trench (SIT) maintenance and repair activity table.
				Hydrophytic vegetation both upslope and down slope of berm	Refer to plans to confirm wetlands were not originally present in the area. Consult an environmental scientist and professional engineer to assess.
	Vegetation is sparse	C, I, H, D, V	…less than 80% of the area is covered by vegetation or bare patches occur in more than 10% of the berm and surrounding area.		Confirm a minimum of 4 inches of topsoil or plan specified modified soils mix is present. If depth is not sufficient, place topsoil or modified soils specified by plan to a depth of at least 4 inches. Do not mechanically compact soil. Replant area using seed mix or plant materials as specified on plans utilizing fertilizers/amendments if indicated by plans. Install rolled erosion control product meeting plan specifications. If sparse vegetation is a reoccurring problem or no as-built plans are available, consult a landscape architect for revised planting approach. If area is excessively shaded (6 hrs. or less of sun/day), consult a landscape architect to assess restoration of sunlight or revised planting approach.
Inflows, Surface Storage: Sediment Management	Sediment and/or anti-skid material accumulation on or upslope of berm observed	C, I	…accumulation blocks flow entry or distribution of runoff into/through bern area.		Remove accumulated sediment/materials. Regrade area so berm is even and flows enter area without concentrating, referencing plans for grading. Equipment should not enter berm area; do not compact upslope berm area.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
			…accumulation exceeds 2 inches in depth. …accumulation inhibits vegetative grown in more than 10% of berm surface area.		Restore appropriate permanent vegetative stabilization as indicated on the plans.
Surface Storage: SCM Floor Berm Surface	Burrowing animal holes observed	C, I	…holes that are likely formed by a burrowing animal are located in the IBE surface or adjacent roadway embankment present safety, structural or SCM functional risk.		Fill holes with the same or similar material used in the berm and apply the appropriate permanent vegetative stabilization. If the problem persists, trapping of burrowing animal may be required. Contact PA Game Commission for assistance.
	Minor erosion on berm surface observed	C	…berm surface shows evidence of erosion greater than 3 inches but less than 6 inches deep and there is the potential for continued erosion.		Perform work when area is dry. Add topsoil or plan specified modified soils mix and apply the appropriate permanent vegetative stabilization per plan. Determine cause of erosion and remedy if possible. Remove any sediment deposited in area using minimal compaction methods such as hand raking.
	Major erosion on berm surface observed	I, H, D, V	…slopes show evidence of erosion greater than 6 inches deep.		Determine cause of erosion and/or concentrated flows. After erosive flows have been resolved, repair berm as described in "Surface Storage: SCM Floor-Berm Surface- Minor erosion on berm surface observed." If no cause of erosive flow is identified, consult a professional engineer to resolve erosion problem and develop restoration plan. Address erosion that may lead to problems (e.g., damage to highway or structures, etc.). Stabilize slope. Place topsoil and apply the appropriate permanent vegetative stabilization.
IBEs are typically located on the cut slope or embankment of roadways where the IBE surface is actually part of the roadway fill structure. Malfunctioning IBEs could lead to flow channelization causing erosion of areas crucial to the stability of adjacent roadways and structures. Embankment concerns may be within and extending above the SCM. For purposes of this table, the words 'Embankment' and 'Cut slope' refer to roadway structural fill and 'Berm Surface' refers to the cross-sectional area of the berm mound structure. Where erosion or other concerns exist regarding the overall roadway cut slope or embankment, refer to the "Basin, Most Types" Maintenance and Repair Activity tables section on Embankment/Cut Slopes for defect resolution guidance.					
Inflows, Outflow, Surface Storage	Minor erosion on roadway embankment/cut slope in vicinity of SCM observed	C, I, H	…roadway embankment/cut slopes show evidence of erosion which is being deposited at berm.		Add topsoil and apply the appropriate permanent vegetative stabilization. Determine cause of erosion and remedy if possible. Remove sediment build up in vicinity of berm when area is dry using minimum compaction methods such as hand raking.
	Major/severe erosion on roadway embankment/ cut slope in vicinity of SCM observed	I, H, D, V	…roadway embankment/ slopes show evidence of erosion that threatens the integrity of the slope, adjacent roadway, or structures.		Take immediate action. A geotechnical engineer may be required to evaluate the cause of issue and direct repairs. Repair should be designed by a professional engineer.
	Standing water or soggy area observed upslope of berm underlain by a SIT.	C, I, H, D, V	…standing water is observed upslope of berm or upslope area remains saturated and rainfall did not occur in previous 72 hours.		See subsurface infiltration trench (SIT) maintenance and repair activity table.
Surface Storage: SCM Floor Berm Surface	Standing water or soggy area observed upslope of berm	C	…standing water is observed upslope of berm or upslope area remains saturated and rainfall did not occur in previous 72 hours.	Trash and debris preventing infiltration	Remove trash and litter.
				Thick matted grass, or other vegetation clogging surface.	Remove standing water. Thatch grass area when dry. Rake up dead grass and clippings.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Surface Storage: SCM Floor Berm Surface		C, I, H, D, V		Top layer of soil may be clogged.	See "Inflows, Surface Storage: Sediment Management - Sediment and/or anti-skid material accumulation on or upslope of berm observed" section.
				Poorly infiltrating underlying soils may be cause of failure.	Repair should be designed by a professional engineer. Possible repair procedure may include conducting test pit explorations and infiltration testing upslope of berm to assess infiltration capacity and limiting zones of underlying soils. If suitable infiltration rates with no limiting zones are identified below surface elevation, excavate to depth of suitable infiltration and place engineered soils providing sufficient infiltration rate to grade, reshaping the surface of the SCM to original geometry and applying appropriate permanent vegetative stabilization per plan.
				Suspected high ground water.	Repair should be designed by a professional engineer. Process may include test pits and ground water monitor to assess typical water table and assess potential limiting layers beneath the SCM.
SCM Liner	Clay layer visible and/or damaged, eroded/ (note clay layer may not be present in all SCMs)	C, I, H, D, V	…clay layer has become exposed and/or damaged or eroded.		Determine cause of erosion/damage and resolve to prevent future damage. Reconstruct clay layer using material consistent with plan. If issue is reoccurring, repair should be designed by a professional engineer.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.13: Manufactured Treatment Device (MTD) Maintenance and Repair Table [1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Vegetation: Around SCM	Tall or thick vegetation or invasive/undesirable species surrounding the SCM observed	R, C, I	…vegetation growth restricts access, and interferes with maintenance activity.		Mow the area surrounding the SCM in accordance with PTC mowing policy.
	Trees/shrubs or woody vegetation surrounding the SCM observed	R, C, I	…tree/shrub/woody growth restricts access, and interferes with maintenance activity.		Remove or treat trees/shrubs/woody vegetation. Repair disturbed area with top soil and seed meeting original plan specifications. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
	Vegetation is sparse	C, I, H, D, V	…less than 70% of the pervious contributing drainage area to MTD is covered by vegetation and sediment is reaching MTD.	Shade is causing poor ground cover. Sun exposure is 6 hours or less per day.	Trim overhanging limbs and remove or treat brushy vegetation that limit sunlight reaching grass and inhibits grass growth. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Once sunlight is restored to area apply the appropriate permanent vegetative stabilization.
				Topsoil not present.	Replace topsoil, regrading area to plan contours. Do not compact soil. Apply permanent vegetative stabilization in accordance with plans. If problem is reoccurring, repair should be designed by a professional engineer.
Inflows: Sediment Management	Sediment accumulation, trash or debris in SCM vicinity or inflow gutter/channel.	R, C, I	…accumulation obstructs flows from entering the SCM. …floatable debris has or could clog SCM inflow points		Remove trash and debris.
Inflows, Outflow, Subsurface Storage	Flows are bypassing or short circuiting an inflow, SCM treatment or outflow area	C, I, H, D, V	… flow bypasses or short circuits an SCM component allowing untreated or insufficiently treated stormwater flows to be released.	Bypassing/short-circuiting caused by clogging.	Determine the cause of the bypass or short-circuiting of flow. If debris/sediment build-up is the cause, remove build-up and clean area.
				Bypassing caused by structural problem, design related problem, or as a result of poor construction.	If flow bypasses/short circuits a component, determine if topography or misaligned structural features prevent flow from entering area. Review plans to determine the low-flow path through the component. Conduct a topographic survey if needed to assess elevations and define low-flow pathways. Regrade area or repair misaligned structural features to restore flow patterns. If cause cannot be clearly identified, repair should be designed by a professional engineer.
Inflows, Subsurface Storage: Sediment Management Inlet with Sump/Trap	Sediment accumulation, trash or debris observed in sumped/trapped inlet structure	R, C, I	… accumulation is within 6 inches of base of inlet trap hood, or exceeds 50% of storage volume, or at/above cleanout depth specified on plans. …floatable debris is at risk of clogging structure.		Use vacuum truck or other appropriate means to remove all sediment and debris from inlet structure.
Inflows, Subsurface Storage: Sediment Management	Sediment accumulation, trash or debris in WQ filter insert tray/bag structure observed	R, C, I	…accumulation exceeds cleanout depth specified on plans or by manufacture. …accumulation inhibits inlets function.		Filters can be bags or cartridges. Large filters require the use of backhoe and chain to remove filter. Small filters can be removed by hand. Replace filter insert in accordance with manufacture recommendations. Some filters include oil absorbent pretreatment that may require frequent replacement.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
	Sediment accumulation, trash or debris in oil/water separator structure or hydrodynamic separator observed	R, C, I	…accumulation exceeds cleanout depth specified on plans, field marked cleanout depth or by manufacture. …accumulation inhibits SCM function.		Use vacuum truck or other appropriate means described by manufacture recommendations to remove all sediment and debris from structure.
Inflows, Subsurface Storage	Missing or expired chemical/oil absorption cartridge	R, I	…plan specified chemical/oil absorption cartridge is missing or out of date, no longer providing intended WQ treatment.		Replace with chemical/oil absorption cartridge meeting original plan/manufacture requirements. Check for odor of gas or diesel prior to replacement. If detected, consider it a hazardous material and implement appropriate PTC procedures for removal and disposal.
Subsurface Storage	Oil accumulation in MTD treatment chamber or inlet sump observed	C, I, V	…oil accumulation on water surface.		Do not touch the substance in question. Attempt to find where the substance is originating. Check for signs of gas or diesel fuel spill in the form of staining or evidence of an accident in the drainage area. Photograph and document the Potential Illicit Discharges (PIDs). Follow procedures for handling PIDs as specified in PTCs Illicit Discharge Detection and Elimination (IDD&E) Program Manual.
Inflows, Outflow, Subsurface Storage: Structure	Defective internal filter tray/bag, baffle, walls or other members	I, H, D, V	…filter tray/bag, baffles, walls or other members are corroding, cracking, warping or failing.		Repair or replace filter tray/bag, baffles, walls or other members to plan specifications in accordance with manufacture recommendations. In the absence of plans, repair should be designed by a professional engineer.
	Hood broken or missing	I	…plastic or metal hood is broken, leaking, or missing.		Replace hood using plumbers putty or gasket to seal crack between wall and hood.
	No water in sump	C, I	…no standing water in sump allows oils and floatables to pass.		Review plans for intentional weep holes or other means for sump to drain. If plans indicate no drains and sump is intended to maintain water surface, check for and repair cracks or damage to the structure causing lack of water. Consider adding a filter bag and oil absorbing bags.
Subsurface Storage: Water Quality	Mosquitoes	C, I	…a large mosquito population is present due to standing water in an SCM component causing a significant nuisance or danger to human or animals in the vicinity of the SCM.		Determine the SCM component with standing water causing the mosquito concern. Reference manufacture recommended solutions for proprietary devices. If a non-proprietary SCM such as a sumped inlet is the source, a licensed applicator in pest management maybe needed to treat enclosed/subsurface standing water with mosquito larvicides. A long-term solution involving the replacement of the subsurface standing water component can be explored and a professional engineer should design the replacement of the structure with an alternative feature.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.14: Level Spreader Outfall (LSO) Maintenance and Repair Table [1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Vegetation: in SCM Vicinity	Excessively tall vegetation or invasive/undesirable species observed	R, C, I	…vegetation growth restricts access and interferes with maintenance activity.		In areas intended to be mowed, mow adjacent area at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6. All mowing must be performed when the area is dry. Do not remove trees, shrubs or other plants intended to be present based on the plans. If invasive/undesirable species are present, remove or treat unwanted vegetation. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application.
Vegetation: in SCM	Trees/shrubs or other vegetation observed	R, C, I	…tree/shrub/vegetation growing in LSO or in proximity to interfere with SCM function.		Review LSO plans to confirm surface treatment does not call for vegetative cover. Remove or treat trees/shrubs/vegetation in a fashion that does not damage the LSO. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Repair disturbed area, replanting and stabilizing surrounding area per plans.
Vegetation: Downslope of SCM	Vegetation is sparse	C, I, H, D, V	…less than 80% of the area is covered by vegetation or bare patches occur in more than 10% of the area immediately downslope of the LSO.		Confirm a minimum of 4 inches of topsoil or plan specified modified soils mix is present. If depth is not sufficient, place topsoil or modified soils specified by design plan to a depth of at least 4 inches. Do not mechanically compact soil. Replant area using appropriate permanent vegetative stabilization as specified on original design plans utilizing fertilizers/amendments if indicated by original design plans. If sparse vegetation is a reoccurring problem or no plans are available, consult a landscape architect for revised planting approach. If area is excessively shaded (6 hrs. or less of sun/day), consult a landscape architect to assess restoration of sunlight or revised planting approach.
Surface Storage: SCM Floor Sediment Management	Sediment and/or anti-skid material accumulation in surface LSO through or in pipes of subsurface LSO observed	C, I	…accumulation blocks flow entry or even distribution of runoff into downslope area. …sediment accumulation in surface LSO exceeds 25% of the capacity of the trough …sediment accumulation in subsurface LSO exceeds 25% of the capacity of perforated pipe		Conduct work when area is dry. Surface LSO: Remove sediment from LSO trench area using minimal disturbance techniques such as hand raking. Restore bottom geometry to plan dimensions, restoring design cover. Subsurface LSO: remove sediment accumulation from distribution pipes using pipe clean methods such as a vacuum truck that minimize sediment escape into the surrounding gravel trench.
Surface Storage	Burrowing animal holes observed	C, I	…holes that are likely formed by a burrowing animal are located in the LSO surface present safety, structural or SCM functional risk.		Fill holes with soil and apply the appropriate permanent stabilization. If the problem persists, trapping of burrowing animal may be required. Contact PA Game Commission for assistance.
Surface Storage: Surface LSO	Flow is short circuiting around end of LSO surface structure	H, D, V	…flows have short circuited and are flowing around the end of the structure, causing concentrated discharge.	Potential causes include inadequate design or improper construction.	Resolution should be designed by a professional engineer. Possible remediation may include repairing the end by constructing an extended concrete edging, turning upslope (perpendicular to the downslope edge), keying into the upslope ground surface. Repair downslope erosion and install appropriate permanent vegetative stabilization per plan.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Surface Storage: Surface LSO	Flow from the upstream inflow piping is overtopping the LSO downslope weir lip	H, D, V	…flows from the upstream inflow pipe overtop the LSO downslope weir lip allowing a concentrated discharge.	Potential causes include inadequate trough length/depth, poor horizontal and/or vertical alignment, weir too close to inflow pipe.	Resolution should be designed by a professional engineer. Possible remediation may include resolving overtopping by retrofitting the structure with a small raised section directly in front of the inflow pipe to divert flow into trough, blocking over topping. If overtopping is not adequately resolved, complete redesign by an engineer and reconstruction should be considered.
	Flow from the LSO is undercutting the structural weir	H, D, V	…flow from the LSO has undercut and is flowing beneath the downslope weir.	Potential causes include inadequate weir invert, inadequate footer depth, construction on fill, improper construction and vandalism.	Resolution should be determined by a professional engineer. Possible remediation may include repair of the undercut area with flowable fill. Repair downslope erosion and install appropriate permanent vegetative stabilization per plan. If undercutting is not adequately resolved, complete redesign by an engineer and reconstruction should be considered.
	Flow from LSO is discharging through a failed joint in the downslope structural weir	C, I	…flow from the LSO is discharging through a failed joint or break in the downslope structural weir.	Potential causes include inadequate joint filler, improper construction and vandalism.	If flow is from a joint, repair the joint by installing a water tight plate spanning the joint or installing proper joint filler that can withstand freeze/thaw. Repair downslope erosion and install appropriate permanent vegetative stabilization per plans. If flow is from a break in the structural weir, reconstruct a minimum of 4 foot length of the downslope weir in accordance with plans. Repair downslope erosion and install appropriate permanent vegetative stabilization per plans.
Surface Storage, Outflow	Unlevel downslope discharge edge	I, H, D, V	…flows are not spread evenly over the downslope discharge lip of the LSO.	Potential causes include differential settlement, frost heaving or improper construction of the downslope edge.	Resolution should be designed by a professional engineer. Possible remediation may include repairing the downslope edge of the LSO to a uniform elevation by either (1) retrofitting the structural edge with a level plate/weir or, (2) total reconstruction of the LSO. Confirm remedial efforts result in a downslope edge of uniform elevation by conducting topographic survey, comparing the elevation at frequent (<5 foot) intervals.
Outflow	Minor erosion on vegetated surface downslope of the LSO observed	C, I, H, D, V	…area downslope of LSO shows evidence of erosion rills/gullies greater than 3 inches but less than 6 inches deep.		Perform work when area is dry. Add topsoil or plan specified modified soils mix and apply the appropriate permanent vegetative stabilization per plan. Determine cause of erosion and remedy if possible. Remove any sediment deposited in area using minimal compaction methods such as hand raking. If rills/gullies reform, consult a professional engineer to develop a restoration plan.
	Major erosion on vegetated surface downslope of the LSO observed	I, H, D, V	…area downslope of LSO shows evidence of erosion rills/gullies greater than 6 inches deep.		Determine cause of erosion and/or concentrated flows. After erosive flows have been resolved, repair the area by adding topsoil or plan specified modified soils mix and apply the appropriate permanent vegetative stabilization per plan. If no cause of erosive flow is identified, consult a professional engineer to resolve erosion problem and develop a restoration plan. Address erosion that may lead to problems (e.g., damage to highway or structures, etc.). Stabilize

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
					slope. Place topsoil and apply the appropriate permanent vegetative stabilization.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.15: Pervious Pavement, Asphalt (PPA); Concrete (PPC); And Pavers (PPP) Maintenance and Repair Table [1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Fencing/ Gates/ Locks/ Signage: Signage	SCM marker, delineation or informational signage needed	C, I	…no signage is present indicating the limits of the pervious pavement. …no signage is present indicating the special maintenance requirements of pervious paving.		Install signage delineating the extents of the pervious paving area. Signage should notify maintenance crews of special requirements such as special plowing producers, specific de-icing requirements and prohibited use of seal coating products. This signage should be installed even if not indicated on the plans. In addition, the frequency of vacuuming should be indicated.
Vegetation: at SCM Outflow Points	Excessively tall vegetation or invasive/undesirable species observed at SCM outflow (where applicable)	R, C, I	…vegetation growth obstructs water flow and interferes with maintenance activity.		If surface discharge is into another SCM (vegetated swale (VSW, VSC) or filter strip (VFS, VSS)), refer to appropriate maintenance and repair activity tables. Review the plans to determine proper care. Mow the adjacent area at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6 . If invasive/undesirable species are present, remove or treat vegetation. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Remove dead plants 30 to 60 days after spraying. Replant area with native plants and/or seed mix per plans. If replanting is required repeatedly, consult a landscape architect for assessment.
	Vegetation is sparse	R, C, I, H, D, V	…less than 70% of the surface outflow points from the SCM are covered by vegetation or bare patches are observed in more than 10% of area.		If surface discharge is into another SCM (vegetated swale (VSW, VSC) or filter strip (VFS, VSS)), refer to appropriate maintenance and repair activity tables. Replant area using seed mix or plant materials as specified on plans. If sparse vegetation is a reoccurring problem or no plans are available, consult a Landscape architect for revised planting approach. If area is excessively shaded (6 hrs. or less of sun/day), trim overhanging limbs and brushy vegetation if within right of way. Once sunlight is restored, replant as per above.
Vegetation: on SCM (open cell paving grid PPA)	Grass coverage is sparse	R, C, I, H, D, V	…less than 70% of the PPA (open cell paving grid) surface is covered by vegetation or bare patches are observed in more than 10% of area.		Replant area using seed mix as specified on plans utilizing fertilizers/amendments if indicated by plans. In the absence of plans, utilize PTC Formula B seed mix. If sparse vegetation is reoccurring, consult a Landscape architect for revised planting approach. If area is excessively shaded (6 hrs. or less of sun/day), trim overhanging limbs and brushy vegetation if within right of way. Once sunlight is restored, replant as per above.
Surface Storage: SCM Floor	Sediment, trash/debris, and/or anti-skid material accumulation on pavement surface area	R, C, I	…accumulation blocks flow entry or distribution of runoff across paving surface area.		Follow sediment removal methods on plans. In the absence of plans, remove accumulated sediment/materials from paving surface using a pure high-pressure vacuum truck or a regenerative air sweeper. Do not use a standard

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Surface Storage: SCM Floor			…accumulation prevents infiltration into pavement.		brush or sweeper. Sweep while surface is dry. Do not spray surface. Control dust by adding water to hopper. PPP: Conduct a test of method on a small section of pavers and adjust settings to remove all visible sediment without dislodging granular joint material between pavers. High pressure washing is not recommended for sediment removal from PPPs.
	Accumulation of leaves, pine needles or other vegetative debris	R, C, I	…accumulation on top of pervious pavement covering more than 10% of surface area.		Remove debris with leaf blower (PPA, PPC or PPP) or pure high- pressure vacuum or regenerative sweeper (PPA and PPC only).
	Moss growth on pervious pavement observed	C, I	…moss growth inhibits infiltration or pose a slip safety hazard.		Remove moss using hand removal methods such as raking. Clean surface of pervious pavement as described in "Surface Storage: SCM Floor- Sediment, trash/debris, and/or anti-skid material accumulation on pavement surface area." After cleaning, confirm infiltration of surface by performing surface infiltration testing. If infiltration rates do not meet or exceed design rates, consult a professional engineer for additional corrective measures.
	An oily accumulation is observed	C, I	…an oily sheen forms when water is applied to pervious pavement surface. …ponding on surface or water flows off pervious pavement during rain event.		Determine source of oil contamination, remediate and prevent additional occurrences. After source has been removed, clean surface of pervious pavement by hand held pressure washing applied at a low to the ground angle (about 30°) being careful not to force oil and debris into pores. Pure high pressure vacuuming could be done after pressure washing if required to remove loose material. PPP: Adjust pressure and angle of pressure washing and suction of vacuuming equipment to avoid dislodging granular joint material between pavers. After cleaning, confirm infiltration of surface by performing surface infiltration testing. If infiltration rates do not meet or exceed design rates, consult a professional engineer for additional corrective measures.
	Surface of pervious pavement is clogged	I, H, D, V	…ponding on surface or water flows off pervious pavement during rain event.	Evidence of clogging from inappropriate winter de-icing material such as sand.	Refer to sediment removal methods on plans. In the absence of plans: PPA and PPC: Remove accumulated sediment/materials from paving surface using pure high-pressure vacuum truck or a regenerative air sweeper. Do not use a standard brush or sweeper. Sweep while surface is dry. Do not spray surface. Control dust by adding water to hopper. PPP: Wet the surface of the clogged areas using large amounts of water. Vacuum aggregate from between pavers to a depth that removes all visible fine sediment. Replace with clean permeable joint material matching material specified on plans. After cleaning, confirm infiltration of surface by performing surface infiltration testing. If infiltration rates do not meet or exceed design rates,

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Surface Storage: SCM Floor					consult a professional engineer for additional corrective measures. Repairs may require the following steps; 1. Micro-mill 1 inch of material from surface. Core asphalt to determine structural integrity and thickness. Examine condition of geotextile fabric looking for evidence of clogging. 2. If geotextile is clogged, full depth of pavement and geotextile replacement maybe required. Consider eliminating geotextile and replacing with mixture of pea and rice gravel. 3. Overlay of 1" pervious asphalt wearing course (maximum aggregate size 5/8 inch) can be considered.
				Sediment laden flows caused siltation.	Address cause of sediment laden flows, installing appropriate E&S measures until permanent stabilization is achieved. Clean surface in accordance with above section "Evidence of clogging from inappropriate winter de-icing material such as sand."
				Sealant inadvertently applied.	Repair should be designed by a professional engineer. Repairs may require total reconstruction of pervious pavement, or micro-milling between 0.2 and 1 inch off the surface and pressure washing milling debris away. Pure high-pressure vacuuming should be done after pressure if milling debris remains.
	Pervious pavement (PPA or PPC) damaged is observed	C, I, H, V	…asphalt or concrete surface has cracking, spalling, raveling, rutting, or other trip hazards.		Small areas of damage (approximately 2 feet x 2 feet) may be repaired using conventional asphalt (for PPA) or concrete (for PPC). Larger deformities should be reconstructed using pavement that meets the plan specifications. Prior to large scale repairs, an engineering evaluation should be performed to assess the reason for failure if the SCM has not reach expected service length at the time of failure.
	Pervious pavement paver (PPP) damage or missing pavers are observed	C, I, H	…individual paver blocks are missing or damaged.		Replace damaged and missing pavers with new pavers. Utilize plan specified pavers, bedding and installation procedures, restoring surface to finished grades per plan.
	Loss of aggregate surrounding pervious pavement pavers (PPP) is observed	C, I, H, V	…loss of permeable granular joint material from in between pavers greater than ½ inch in depth.		Investigate cause of permeable granular joint material loss and remediate, preventing future occurrence. Utilize plan specified materials. Hand sweep material into crack and follow plan specified installation procedures to fill the void space. In the absence of plans, use double washed coarse masonry sand.
	Settlement of pavement surface is observed	C, I, H, D, V	…settlement of pavement surface inhibits infiltration, creates a safety hazard or compromises SCM functionality.		Confirm settlement is not related to possible sinkhole activity; see "Ponding/conveyance: SCM Surface- sinkhole observed" if sinkhole is suspected. <u>PPA and PPC</u>: Small areas (approximately 2 feet x 2 feet) may initially be repaired using conventional asphalt (for PPA) or concrete (for PPC) to fill the settled area. <u>PPP</u>: For small areas (approximately 4 feet x 4 feet), remove pavers and install additional base aggregate to subbase level and reinstall pavers using plan

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Surface Storage: SCM Floor					materials and installation methods restoring surface to finished grades per plan. <u>PPA, PPC and PPP</u>: For larger areas and reoccurring small areas of settlement, consult a geotechnical engineer to assess settlement cause and develop remediation plan.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.16: Regenerative Step Pool (RSP) Maintenance and Repair Table [1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Vegetation: in SCM and/or SCM Vicinity	Excessively tall vegetation or invasive/undesirable species observed	R, C, I	…vegetation growth restricts access, obstructs water flow and interferes with maintenance activity.		Review the plans to determine intended vegetation cover type in RSP, side slopes and vicinity. Mow at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6. If invasive/undesirable species are present, remove or treat unwanted vegetation. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Remove dead plants 30 to 60 days after spraying.
Vegetation: in SCM	Trees/shrubs or woody vegetation observed	R, C, I	…tree/shrub/woody growth restricts access, obstructs water flow, are growing in pool bottom or interferes with maintenance activity.		If landscaping plans are available and indicate trees/shrubs/woody vegetation are not specified, remove or treat trees/shrubs/woody vegetation and root systems from channel bottom and/or side slopes when SCM is dry. Repair disturbed area, replanting and stabilizing per plans. Remove or treat woody vegetation occasionally from channel bottom and side slopes when area is dry if no other instructions are provided on the plan.
	Hydrophytic (wetland) plants observed	R, C, I, H, D, V	…hydrophytic (wetland) plants are present, but not included on plans, is an indication of poor drainage.	Hydrophytic vegetation in pools.	See "Outflow, Surface Storage: SCM Floor: Pool surface"
	Vegetation is sparse	C, I, H, D, V	…less than 80% of plant species originally planted on plans are surviving.	Originally planted with Hydrophytic vegetation.	Confirm that pools are retaining water at correct depth. If they are, replant area using seed mix or plant materials as specified on plans. If sparse vegetation is a reoccurring problem or no plans are available, consult a landscape architect for revised planting approach. If water is not retained in pools or sparse vegetation is a reoccurring problem or no plans are available, consult landscape architect for revised planting approach.
Inflows, Surface Storage: Sediment Management	Sediment and/or anti-skid material accumulation in SCM observed	C, I	…sediment accumulation in pools exceeds 6" depth in first year of functioning.		Conduct work when area is dry. Install/spray an additional layer of compost on sediment build up and replant pool bottoms per plans.
			…sediment accumulation threatens structural integrity or the system.		Conduct work when area is dry. Remove sediment from pool areas using backhoe if slope allows or a vacuum hose if on steep slope or access is restricted. Replace sand/woodchip mixture. Winching equipment into place may be required on steep slopes. Do not drive equipment onto riffle, cascade, or pool areas. Restore geometry to plan dimensions. Restore appropriate permanent vegetative stabilization as indicated in the plans.
	Sand/woodchip mixture has washed out of pools Geotextile has clogged	C, I	…sediment and/or sand/woodchip mixture has washed out due to high flows. …geotextile clogging inhibits SCM performance.		Remove sand/woodchip mixture from pool areas using backhoe if slope allows or a vacuum hose if steep slope or access is restricted. Remove rocks/boulders overlying geotextile fabric. Replace geotextile fabric, rock/boulders, and sand/woodchip mixture. Restore geometry to plan dimensions. Restore appropriate permanent vegetative stabilization as indicated in the plans. If condition persists, add clean #3 stone to surface of sand/woodchip areas.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Surface Storage, Cut Slopes	Erosion on side slope observed	C	…slopes show evidence of erosion greater than 4 inches deep and there is the potential for continued erosion.		Add topsoil and apply the appropriate permanent vegetative stabilization. Determine cause of erosion and remedy if possible. Remove any sediment deposited in SCM as described under sedimentation management. Evidence of large by-pass flows or reoccurring erosion repair needs require consultation with a professional engineer.
Outflow, Surface Storage: SCM Floor Pool surface	Standing water or soggy bottom is observed in pool in non-wetland seepage system.	R, C, I, H, D, V	…standing water is observed in pool bottom remains saturated and rainfall did not occur in previous 72 hours.	Standing water/saturation is limited to top few inches of the media.	Top layer of sand/woodchip may be clogged. See "Inflow, Surface Storage: Sediment Management" section.
				Standing water/saturation extends through media.	Suspected high ground water. Repair should be designed by a professional engineer or landscape architect. Process may include redesign to allow wetland plants to exist.
Inflows, Outflow: Principle Spillway	Movement of rock/boulders from riffle, cascade or weir sections.	C	…movement of rock/boulders from riffle, cascade or weir sections but has not impeded function of SCM.	Displaced rock can be moved back into place by hand.	Replace rock to its original configuration. If problem is reoccurring, repair should be designed by a professional engineer. Possible solution may include reinforcing rock with concrete.
		D, V	…movement of rock/boulders from riffle, cascade or weir sections has impeded function of SCM.	Displaced rock must be moved back by equipment.	Repair should be designed by a professional engineer.

[1] See Appendix G introduction for notes applicable to all work contained on this table.

[2] SCM Component corresponds to the SCM component in the PTC Inspection app.

Table G.1.17: Self Preserving SCMs: Forest Preservation (FPR); Landscape Restoration Meadow (LRM); Reforestation/Tree Plantings (RTP); Riparian Buffer Enhancement (RBE); Riparian Buffer Offset (RBO); Soil Amendment Restoration (SAR); Stream Restoration (SRE); Stream Stabilization (SST) Maintenance and Repair Table [1]

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Vegetation: in SCM	Excessively tall vegetation observed	R, C, I, H, D	…vegetation growth restricts access, obstructs water flow and interferes with maintenance activity.		Review the plans to determine proper care. Mow areas indicated to be mowed at frequencies stipulated in the SCM specific Maintenance Procedures Tables in Chapter 6. If mowing results in excessive clumping of clippings, remove clippings to prevent damage to underlying vegetation. If mowing is not indicated for the SCM, consult with landscape architect for approach to resolve vegetation concern while minimizing impact to SCM vegetation.
	Dead plant material or invasive/undesirable species	R, C, H, D	…accumulation of dead plant material on the ground significant enough to impact over 20% plant coverage over entire area or 10% in a localize area or causes weakened vigor of the plant community. …invasive/undesirable plants material covers more than 10% of SCM area.		Remove materials using hand or mechanical methods. Replant area using seed mix or plant materials as specified on plans. If invasive/undesirable species are present, remove or treat unwanted vegetation. If herbicide use is considered, consult PTC Landscape Specialist for approval of location and herbicide type prior to application. Replant area with native plants and/or seed mix per plans. If replanting is required repeatedly, consult a landscape architect for assessment. RBE, RBO or LRM: If area of dead plant material or invasive/undesirable species is excessively large, a controlled burn may be used where desirable trees/woody plants are not present or can be adequately protected. Schedule burn to minimize impact on nesting birds and animals. A landscape architect should be contacted to assess, and an experienced burn team should be used to develop and implement burn.
	Vegetation is sparse	R, C, H, V	… less than 80% of the area is covered by vegetation or bare patches are observed in more than 10% of SCM surface area.	<u>LRM, RBE/RBO zone 3 and other intentionally non-forested areas</u>	Replant area using seed mix or plant materials as specified on plans utilizing fertilizers/amendments if indicated by plans. If sparse vegetation is a reoccurring problem or no plans are available, a landscape architect should be contacted for revised planting approach. If area is excessively shaded (6 hrs. or less of sun/day), trim overhanging limbs and brushy vegetation (if within right of way). Once sunlight is restored, replant as described above.
				<u>FPR, RTP, and other intentionally forested areas</u>	Replant area with trees and woody plants as specified on plans utilizing fertilizers/amendments if indicated by plans. If sparse vegetation is a reoccurring problem, area is FPR, or no plans are available, a landscape architect should be contacted for revised planting approach.
	Grass/herbaceous area not growing well	R, C	…excessive dead plant material prevents growth or area too compacted to allow growth.		Dethatch area when dry by raking the area vigorously. Collect and remove dead plant material and clippings. When plant growth and health is not restored by dethatching alone, aeration of soils by mechanically removing plugs should be performed.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
Vegetation: Trees/shrubs or Woody Vegetation	Trees/shrubs or woody vegetation observed (LRM and RBE/RBO zone 3 areas only)	R, C	…tree/shrub/woody growth restricts access, obstructs water flow, are growing in SCM, or interferes with maintenance activity.		If plans are available and indicate trees/shrubs/woody vegetation is not specified, remove or treat trees/shrubs/woody vegetation when the area is dry. Cut stumps flush to ground. Repair disturbed area, replanting and stabilizing per plans immediately. Remove or treat trees/shrubs/woody vegetation from SCM when dry if no instructions are provided on the plan.
Vegetation: Wetland Vegetation	Hydrophytic (wetland) plants observed (Excluding RBE/RBO zone 1 and 2 areas, SRE, and SST and any SCM constructed in moist/wet areas)	R, C, H, D, V	…hydrophytic (wetland) plants are present, an indication of poor drainage, and it is restricting access, interfering with maintenance/use activity or causing a safety concern.		Surface flows through and out of the SCM area are insufficient. Confirm slope of area matches plan. Regrade surface of SCM using soil mix materials matching plans. Re-establish permanent vegetative stabilization per plans. If topography matches the plans and no solution is evident, consult with an engineer to design this repair. Possible remediation may include: assessing groundwater table in area, ensuring adequate surface drainage downslope of the SCM and testing soils for infiltration rates.
Vegetation, SCM Surface	Burrowing animal holes observed	C, I	…SCM functionality or public safety is jeopardized by holes that are likely formed by a burrowing animal located in the SCM.		Fill holes with the same or similar material used in the SCM construction or present in adjacent area. Apply the appropriate permanent vegetative stabilization per original plans. If the problem persists, trapping of burrowing animal may be required. Contact PA Game Commission for assistance.
	Minor erosion, channelization, or short circuiting on surface observed	C, I	…SCM surface shows evidence of erosion greater than 4 inches and is jeopardizing SCM functionality.		Fill erosion areas with materials matching original SCM design (or native soils for SCMs constructed from native soils) and apply the appropriate permanent vegetative stabilization. Determine cause of erosion and remedy if possible.
	Standing water or soggy soils are observed in area of SCM (Excluding RBE/RBO Zone 1 and 2 areas, SRE, and SST and any SCM constructed in moist/wet areas)	C, H, D, V	…SCM functionality or public safety is jeopardized by standing water is observed on SCM surface or SCM soils remains saturated and rainfall did not occur in previous 72 hours over 20% of SCM surface.		Use a soil probe or soil auger to determine if standing water/saturated soil is limited to top few inches of soil. If so, the top layer of soil is likely clogged by sediment. Remove layer of fine sediment and top several inches of filter soils from SCM surface. Install new filter materials matching plan materials, restoring slope and geometry to plan dimensions. Restore disturbed areas with appropriate permanent vegetative stabilization per plans.
	Compaction or surface damage found in area of SCM (SAR)	C, I, H, D, V	…tire tracks or other signs of compaction evident in the area of soil restoration		Restore impacted area by tiling, subsoiling and/or amending area using the original plan SAR procedures. If original plans are not available or cause of compaction is not clear, repair should be designed by a professional engineer.
Cut Slopes: Streambank Stabilization Structures	Loose, damaged, or missing bank stabilizing structures (SRE or SST only)	C, I, H, D, V	…components of the bank stabilizing structure (tree revetments, boulders, etc.) have shifted from plan position, have visible signs of damage, or are missing.		Repair and/or reconstruct the damaged or missing structure in accordance with plans. If damage is reoccurring or plans are not available, repair should be designed by a professional engineer.
Cut Slopes: Streambank Erosion	Major erosion, rills, or gullies on streambank observed (SRE or SST only)	I, H, D, V	…SRE or SST streambank slopes shows evidence of erosion greater than 12 inches wide/deep.		Regrade/reconstruct SCM in areas with erosional damage. Utilize appropriate permanent stabilization per plan. Determine cause of erosion and remedy if possible. If problem is reoccurring or no plans are available, repair should be designed by a professional engineer.
SCM Surface: Channel Stability	Vertical instability observed		…headcut or incision in stream channel observed and has potential for continued enlargement.		Assess cause and monitor for worsening instability. Consult a professional engineer for repair design when instability does not self stabilize.

SCM Inspection Section: Component/ Feature [2]	Defect or Problem	Maintenance/ Repair Category	Maintenance is Needed When…	SCM Component Variations or Cause of Defect/Problem	Recommended Maintenance Activity to Correct Problem
SCM Surface: Channel Structures	Channel flow structures loose, damaged, or missing (Applicable for SRE and SST)	I, H, D, V	…components of channel flow structures (weirs, rock vanes, barbs, j-hooks) have shifted from plan position, have visible signs of damage, or are missing.		Repair as needed to ensure proper flow. Review the plans to determine proper configuration. If plans are not available, an engineer should assess the need for redesign.
	Debris in channel flow structures (Applicable for SRE and SST)	I	…major debris accumulation is found in the channel flow structures, blocking or altering flow from the proposed design		Remove debris from the structures without altering the structures or the streambed.

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[2] SCM Component corresponds to the SCM component in the PTC Inspection app.