THE Water Research FOUNDATION

PROJECT NO.

SIWM22T17/4851

Recommended Operation and Maintenance Activity and Cost Reporting Parameters for Stormwater Best Management Practices Database

Recommended Operation and Maintenance Activity and Cost Reporting Parameters for Stormwater Best Management Practices Database

Prepared by:

Jane Clary, M.S.
Andrew Earles, Ph.D., P.E., D.WRE
Wright Water Engineers, Inc.

Marc Leisenring, P.E.
Dan Pankani, P.E.
Geosyntec Consultants, Inc.

Municipal Water Infrastructure Council and
Urban Water Resources Research Council
American Society of Civil Engineers

2018

THE Water Research FOUNDATION

The Water Research Foundation (WRF) is a nonprofit (501c3) organization which provides a unified source for One Water research and a strong presence in relationships with partner organizations, government and regulatory agencies, and Congress. The foundation conducts research in all areas of drinking water, wastewater, stormwater, and water reuse. The Water Research Foundation's research portfolio is valued at over $700 million.

The Foundation plays an important role in the translation and dissemination of applied research, technology demonstration, and education, through creation of research-based educational tools and technology exchange opportunities. WRF serves as a leader and model for collaboration across the water industry and its materials are used to inform policymakers and the public on the science, economic value, and environmental benefits of using and recovering resources found in water, as well as the feasibility of implementing new technologies.

For more information, contact:
The Water Research Foundation

Alexandria, VA Office
1199 North Fairfax Street, Suite 900
Alexandria, VA 22314-1445
Tel: 571.384.2100
www.werf.org
werf@werf.org

Denver, CO Office
6666 West Quincy Avenue
Denver, Colorado 80235-3098
Tel: 303.347.6100
www.waterrf.org
Info@WaterRF.org

©Copyright 2018 by The Water Research Foundation. All rights reserved. Permission to copy must be obtained from The Water Research Foundation.
WRF ISBN: 978-1-60573-345-6
WRF Project Number: SIWM22T17/4851

This report was prepared by the organization(s) named below as an account of work sponsored by The Water Research Foundation. Neither The Water Research Foundation, members of The Water Research Foundation, the organization(s) named below, nor any person acting on their behalf: (a) makes any warranty, express or implied, with respect to the use of any information, apparatus, method, or process disclosed in this report or that such use may not infringe on privately owned rights; or (b) assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method, or process disclosed in this report.

The Environmental and Water Resources Institute (EWRI) of the American Society of Civil Engineers (ASCE) provided funding for this project. Wright Water Engineers, Inc., and Geosyntec Consultants completed this report with support from members of the Municipal Water Infrastructure Council of EWRI.

ED_002551_00001562-00003

Acknowledgments

The protocols presented in this report were developed with financial support from the Environmental and Water Resources Institute (EWRI) of the American Society of Civil Engineers (ASCE). These protocols are a companion product to the Municipal Water Infrastructure Council's book, *Cost of Maintaining Green Infrastructure*, published by ASCE in November 2017. The database associated with these protocols will be a companion database to the International Stormwater BMP Database and publicly accessible at www.bmpdatabase.org. The following individuals and organizations provided input, peer review, and project management support for this effort.

Research Team

Principal Investigators:
Jane Clary, M.S.
Wright Water Engineers, Inc.

Marc Leisenring, P.E.
Geosyntec Consultants

Project Team:
Andrew Earles, Ph.D., P.E., D.WRE
Jonathan Jones, P.E., D.WRE
Wright Water Engineers, Inc.

Dan Pankani, P.E.
Eric Strecker, P.E.
Geosyntec Consultants

EWRI Municipal Water Infrastructure Council Reviewers

Holly Piza, P.E.
Urban Drainage and Flood Control District

Ruth Hocker, P.E., D.WRE
City of Lancaster, *PA*

Elie Araj, P.E., CFM, D.WRE
Applied Sciences Consulting

James Lenhart, P.E., D.WRE,
Contech Engineered Solutions, LLC

WRF Project Subcommittee Reviewers

Henry Barbaro
Massachusetts Highway Department

Michael E. Barrett, Ph.D., P.E., D. WRE
University of Texas

Gregory E. Granato
U.S. Geological Survey

Lisa Biddle and Jason T. Bernagros (Berner)
U.S. Environmental Protection Agency

ED_002551_00001562-00004

Tracy Tackett, P.E.
Seattle Public Utilities

Water Research Foundation Staff

John Albert, MPA
Chief Research Officer

Harry Zhang, Ph.D., P.E.
Program Director

ED_002551_00001562-00005

Abstract and Benefits

Abstract:

This guidance tool describes recommended operation and maintenance (O&M) parameters to track for stormwater best management practices (BMPs), including both activities and cost data. These parameters form the basis of data entry spreadsheets and a companion database that can be used to store collected data. This guidance provides a simple overview of the database structure including tables and fields for storing maintenance records and a narrative description of the reporting parameters. The long-term objective of this effort is to improve the basis for recommended BMP maintenance activities and frequencies, as well as whole lifecycle cost estimation. Through development of a standardized set of parameters forming a reporting protocol, practitioners will have a common basis for cost estimation and maintenance activity planning.

Benefits:

- Provides recommendations for standardized O&M activity and cost tracking protocols for use by local governments.
- Provides a framework to develop a national cost database to improve lifecycle cost estimation for BMP maintenance.
- Provides protocols that can be adapted for use within local government asset management systems.
- Creates a tool to enable better understanding of types of maintenance activities and frequencies necessary for various BMP types.

Keywords: Green Infrastructure, best management practice, stormwater control measure, stormwater, operations and maintenance, cost.

ED_002551_00001562-00006

Contents

Acknowledgments iii
Abstract and Benefits v
Tables vii
Figures vii
Acronyms and Abbreviations viii
Executive Summary ix

Chapter 1: Introduction 1
1.1 Background 1
1.2 Data Submittal and Retrieval Process for National O&M Database 2
1.3 Local Uses of Maintenance Cost Reporting Protocols 2

Chapter 2: Recommendations for Standardized Maintenance Activity and Cost Reporting 4
2.1 Database Structure 4
2.2 Database Tables 6

Chapter 3: Description of Reporting Parameters 11
3.1 Overview 11
3.2 BMP Facility Description (Table 2-1) 12
3.3 Maintenance Event Description (Table 2-2) 15
3.3.1 Maintenance Events: Field Data (Table 2-2a) 16
3.3.2 Maintenance Events: Office Data (Table 2-2b) 18
3.4 Materials and Quantities Supporting Detail (Table 2-3) 19
3.5 Relationship to Other Databases and Asset Management Systems (Table 2-4) 20
3.6 Data Provider Profile (Table 2-5) 21

Chapter 4: Next Steps: Using the Reporting Protocols and Developing a National Database 23

Appendix A 25

References 27

ED_002551_00001562-00007

Tables

2-1 BMP Information 6
2-2a Maintenance Event Records: Field Activities 7
2-2b Maintenance Event Records: Costs and Supplemental Information 8
2-3 Material and Quantities 8
2-4 Additional Asset Management System Fields 9
2-5 Data Provider Information (for data submittal to BMP Database) 9
3-1 BMP Type Picklist 13

Figures

2-1 Overview of BMP O&M Module and Relationship to Other Databases 5
3-1 EPA Rain Zones 21

ED_002551_00001562-00008

Acronyms and Abbreviations

ASCE	American Society of Civil Engineers
BMP	Best management practice
BMPDB	BMP Database (International Stormwater BMP Database)
CLASIC	Community-enabled Lifecycle Analysis of Stormwater Infrastructure Costs
DCIA	Directly connected impervious area
EWRI	Environmental and Water Research Institute
GI	Green infrastructure
GPS	Global positioning system
GSI	Green stormwater infrastructure
LID	Low impact development
MWIC	Municipal Water Infrastructure Council
NSQD	National Stormwater Quality Database
O&M	Operation and maintenance
SCM	Stormwater control measure
SMP	Stormwater management practice
U.S. EPA	U.S. Environmental Protection Agency
UWRRC	Urban Water Resources Research Council
WRF	Water Research Foundation
WQCV	Water quality capture volume

ED_002551_00001562-00009

Executive Summary

The Municipal Water Infrastructure Council (MWIC) Green Infrastructure (GI) task committee of the Environmental and Water Resources Institute of the American Society of Civil Engineers (EWRI-ASCE) identified a need for improved tracking of best management practice (BMP) operation and maintenance (O&M) activities and costs, particularly GI practices. To help meet this need, the MWIC GI task committee developed an initial recommended list of O&M reporting parameters in 2016, which were further refined during 2017-2018. This report describes the recommended O&M parameters to track for stormwater BMPs, including both activities and cost data. These parameters form the basis of data entry spreadsheets and a companion database that can be used to store collected data.

This document provides an overview of the database structure, including tables and fields for storing maintenance records and a narrative description of the reporting parameters. The long-term objective of this effort is to improve the basis for recommended BMP maintenance activities and frequencies as well as whole lifecycle cost estimation. Through development of a standardized set of parameters forming a reporting protocol, practitioners will have a common basis for cost estimation and maintenance activity planning.

The reporting protocols in this guidance have been converted into an Excel-based data entry structure for use in collecting data for upload to a national O&M database and for use by local governments as a template for internal use. Two versions of data entry spreadsheets have been created: a basic, simplified version and a detailed version for data providers with more detailed information available. These spreadsheets can be downloaded from www.bmpdatabase.org.

A simple Microsoft Access database has also been developed to store collected cost data. This database can be used internally by local governments. Additionally, a national database is initially being populated and posted on www.bmpdatabase.org. Users of the data spreadsheets and/or database are encouraged to submit their data to the national database to advance the national state of the practice regarding costs of maintaining stormwater BMPs.

ED_002551_00001562-00010

ED_002551_00001562-00011

CHAPTER 1

Introduction

1.1 Background

The MWIC GI task committee of EWRI-ASCE identified a need for improved tracking of BMP O&M activities and costs, particularly GI practices. To help meet this need, the MWIC GI task committee developed an initial recommended list of O&M reporting parameters in 2016, which were published by ASCE 2017 in *Cost of Maintaining Green Infrastructure* (Clary and Piza, eds., 2017). These recommendations have been further refined through input from a joint MWIC-Urban Water Resources Research Council (UWRRC) BMP Database advisory committee and information gleaned from the national EWRI Operations and Maintenance Conference in Denver, CO in November 2017. Although the recommendations in the MWIC publication were in the context of GI, the reporting protocols described in this document are suitable for a wide range of BMPs in addition to GI practices. The long-term objective of this effort is to improve the basis for recommended BMP maintenance activities and frequencies as well as whole lifecycle cost estimation. Through development of a standardized set of parameters forming a reporting protocol, practitioners will have a common basis for cost estimation and maintenance activity planning.

The purpose of this guidance tool is to describe recommended O&M parameters to track for stormwater BMPs, including both activities and cost data. These parameters form the basis of data entry spreadsheets and a companion database that can be used to store collected data. This document provides a simple overview of the database structure, including tables and fields for storing maintenance records and a narrative description of the reporting parameters. Tables in this document are also available in Microsoft (MS) Excel and MS Access database formats to support the following users:

- Local governments and others seeking guidance on minimum reporting parameters (metadata) needed to internally track O&M activities and costs. Ultimately, a well-populated data set of monitoring events over time should enable local governments to track changes in costs of maintenance at various stages during the life of the BMP. This set of parameters (reporting protocol) can be adapted by users into customized asset management systems or used as a stand-alone database internally.
- Local governments and others seeking national O&M cost data to support budget planning. (This is a future intended use after the database is initially populated.)

Terminology

Many terms are being used nationally to describe practices used to manage and treat stormwater. Examples include BMP, Stormwater Control Measure (SCM), Stormwater Management Practice (SMP), Low Impact Development (LID), GI, and Green Stormwater Infrastructure (GSI), among others. This report uses BMP for consistency with the long-term BMP Database project.

ED_002551_00001562-00012

- Researchers, practitioners, stormwater managers, watershed organizations, and others who both monitor BMP performance and track maintenance activities and costs. The O&M Database is designed to be linked to the International Stormwater BMP Database, enabling comparison of BMP performance at various levels of maintenance in various parts of the country, ideally over the long-term. The BMP Database can be accessed at www.bmpdatabase.org.
- The Water Research Foundation's (WRF's) Community-enabled Lifecycle Analysis of Stormwater Infrastructure Costs (CLASIC) project. The initially populated O&M database will be used to support CLASIC by providing supporting information related to stormwater BMP O&M costs. In particular, the CLASIC scope of work includes the development of standardized data fields for recording maintenance activities and costs for stormwater BMPs.

Like the International Stormwater BMP Database, which is focused on BMP performance, the long-term usefulness of the O&M database will depend on willingness of organizations with maintenance activities and cost data to share their data with the broader technical community to advance a more robust national understanding of BMP maintenance costs and requirements. Based on results of a national survey conducted by EWRI and interest expressed by WRF subscribers, sufficient interest in this database has been documented to justify development of Version 1.0 of the O&M database. Examples of tangible benefits to individual data providers include the ability to compare their maintenance costs and practices to other communities, to utilize the data set to support and refine lifecycle cost estimates, and benefit from national tools (e.g., CLASIC) that are developed based on the populated dataset.

1.2 Data Submittal and Retrieval Process for National O&M Database

The O&M Database is modeled after the process utilized for the International Stormwater BMP Database, accessible at www.bmpdatabase.org. Through the project website, a maintenance data provider will download a data entry spreadsheet and user's guide, enter their data and email the completed file to the O&M Database manager (email contact listed on website). The O&M Database manager will then conduct a basic review of the submitted data and append the dataset into the master cost database, which will be publicly available at www.bmpdatabase.org. The initial version of the database will be available as an MS Access database and also as an MS Excel Workbook.

Two different types of data providers are envisioned for the initial population of the database:

1. Data providers with summary-level cost data on an event or annual basis with a lumped (not itemized) narrative summary of associated activities.
2. Data providers with the ability to export more detailed records related to maintenance costs and activities from an asset management system or in-house database.

To avoid data provider fatigue, two different versions of the data entry spreadsheet are available for providers: "Basic" and "Detailed." The master database will accept and store either type of data. Although detailed data entry is ultimately most useful to future users of the database, detailed information is not expected to be available from all data providers.

1.3 Local Uses of Maintenance Reporting Protocols

These maintenance cost reporting protocols can not only be used for purposes of a national data repository but also for local purposes of documenting BMP maintenance, improving understanding of maintenance needs and frequencies and improving cost projections supporting maintenance budgets. For example, many local governments utilize proprietary asset management systems and/or GIS databases (geodatabases) to store and track information related to stormwater infrastructure. The set of reporting parameters included in this document can be used to customize local databases to support local objectives. Organizations utilizing this information as a starting point for their own systems may

ED_002551_00001562-00013

choose to add additional reporting parameters or may be able to link to other internal databases that already provide some of the information identified in this document.

Additionally, information provided in this document can be used to support mobile field data applications for a subset of the reporting parameters. The recommended reporting data in this report include both desktop and field data parameters, so only a subset of these parameters would likely be used in mobile field data collection applications.

The International Stormwater BMP Database

Over 20 years ago, the U.S. Environmental Protection Agency (EPA) provided funding to support development of a national stormwater BMP performance database through the UWRRC of EWRI-ASCE. The project is now managed by the Water Research Foundation (WRF) and supported by a coalition of project sponsors including EWRI and the Federal Highway Administration. Researchers, governmental organizations and others continue to voluntarily share BMP performance studies to advance the practice. The database contains records for over 650 BMPs, along with various performance summaries. The project's long-term goal is to gather sufficient technical design and performance information to improve BMP selection and design so that local stormwater problems can be cost-effectively addressed. The initial effort has evolved into not only a publicly accessible database, but a website providing a variety of stormwater-related technical resources for use by local governments, researchers, regulators, watershed organizations and others. The cost database described in this report is a companion project to the International Stormwater BMP Database and will be accessible at www.bmpdatabase.org.

INTERNATIONAL STORMWATER BMP DATABASE
www.bmpdatabase.org

ED_002551_00001562-00014

CHAPTER 2

Recommendations for Standardized Maintenance Activity and Cost Reporting

2.1 Database Structure

The O&M database described in this document utilizes a simple relational database structure for tracking BMP O&M activities and costs, as illustrated in Figure 2-1. The database structure includes three primary tables for recording/storing 1) basic BMP characteristics (Table 2-1), 2) maintenance events and activities conducted for the BMP (Table 2-2), and 3) a supporting materials and quantities table to allow more detailed tracking of materials needed for maintenance (Table 2-3). The maintenance event table is partitioned into field data (2a) and desktop data (2b) for purposes of data entry. To maximize flexibility for the type of cost data that local governments are able to provide, the database provides the option to characterize a maintenance event as an individual site visit or as a group of maintenance events (e.g., annual summary). The result is a datastore that can be related (linked) to other databases such as an agency's local asset management system or the performance monitoring data in the International Stormwater BMP Database, provided that facility IDs and other unique attributes (keys) are properly aligned. Table 2-4 describes helpful linkages to other local databases that can be considered. Lastly, Table 2-5 provides a user profile for those submitting data to the national data repository.

The tables in the relational database include recommended reporting parameters to enable normalization of maintenance cost data nationally so that more robust maintenance cost estimates can be developed to support whole-lifecycle cost analysis and O&M planning by local governments. Based on experience developing the International Stormwater BMP Database, it is important to find a balance between asking for the minimum amount of information needed to properly use the data and asking for too much information so that the effort becomes administratively cumbersome and time-consuming, thereby deterring participants from sharing data.

Important: Reporting parameters shaded in gray in Tables 2-1 through 2-5 must be provided; otherwise, there is no basis for normalizing cost data nationally.

ED_002551_00001562-00015

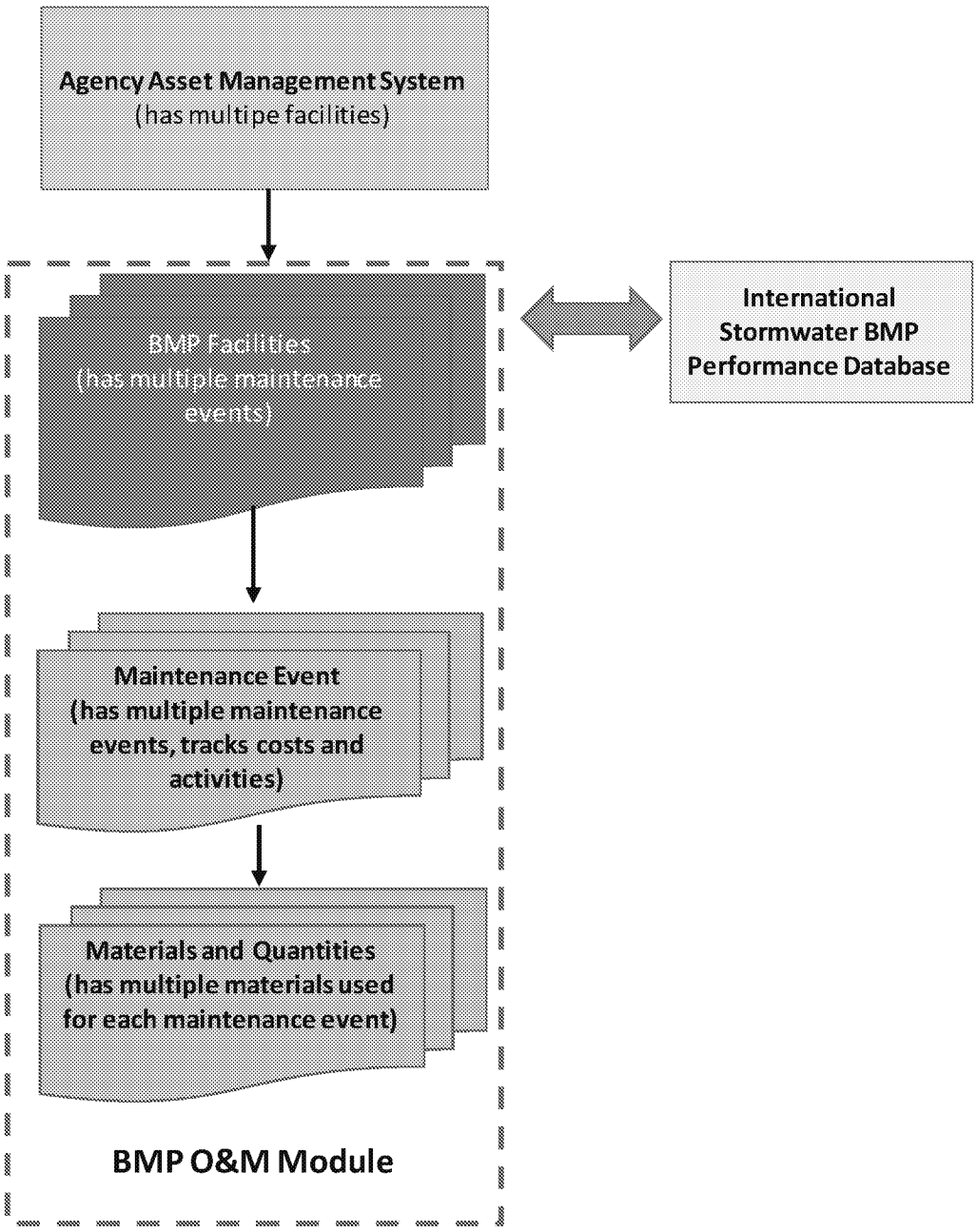

Figure 2-1. Overview of BMP O&M Module and Relationship to Other Databases.

ED_002551_00001562-00016

2.2 Database Tables

Tables 2-1 through 2-5 are provided below, followed by a narrative description of these parameters in Chapter 3.

Table 2-1. BMP Information.

Parameter	Brief Description/Picklist
BMP Information *(single record relates to multiple maintenance records in Table 2-2)*	
Data Provider ID	Assigned at time of upload to national database from Table 2-5.
BMPDB ID	Numeric BMP ID used in the BMP Database assigned at time of upload.
Asset ID	Unique identifier used in local asset management system, if applicable.
BMP Configuration	Configuration of BMP, from picklist: Individual, Cluster, Treatment Train, Other.
Decimal Latitude	Global positioning system (GPS) centroid/geolocated address. Enables mapping of facilities and integration with GIS/asset management systems.
Decimal Longitude	
BMP Name	General BMP name.
BMP Type	Select BMP type from Table 5 picklist: bioretention, grass swale, retention pond, etc.
Installation Date	Date installed to enable tracking of maintenance cost over time.
BMP Description	Narrative description of key BMP features.
Tributary Land Area (ac)	Size of drainage area to facility in acres.
Road Type	For BMPs along roadways, select the road type from picklist: Local, Collector, Arterial, Highway, Not Applicable, Unknown.
Imperviousness (%)	Percent impervious area.
Principal Land Use	Dominant land use from National Stormwater Quality Database (NSQD) picklist.
Secondary Land Use	For Mixed principal land uses, select dominant land use from NSQD picklist.
Snow/Ice Management	Snow/ice management method from picklist.
Qualitative Site Loading Intensity	Describe from picklist: High, Moderate, Low [i.e., *Is the site heavily use/dirty, or is it lightly used/clean*].
Tributary Land Area Description/Conditions	Describe other pertinent characteristics affecting maintenance (e.g., active development in watershed, steep slopes, wildfire impacts, drought).
Treatment Volume or Flow Rate	Provides design basis of the BMP as a treatment volume (e.g., WQCV for bioretention) or rate (e.g., for swales, manufactured devices).
Treatment Volume or Rate Units	Provide treatment volume or rate units (e.g., cfs, gal/min).
Surface Area	Provides information on the footprint of the facility that is maintained.
Surface Area Units	Provides surface area units (e.g., sq. ft.).
Facility Sizing	Qualitative description of facility sizing from picklist: Standard, Over-Sized, Undersized (e.g., not to design standards), Unknown.
Media Type	Select media type from picklist: In situ Soils, Standard Specified Media, Advanced Media, Filter Membrane, Not Applicable, Unknown.
Vegetation Type	Select from picklist: Native Grasses, Manicured Turf, Wetland Vegetation, Rain Garden Plant Palette, Sedum/Green Roof Palette, Other, None.
Street Sweeping Frequency	Street sweeping frequency picklist: None, Annual, Semi-annual, Quarterly, Monthly, Biweekly, Other, Unknown.
Inlet/Pretreatment Features	Describe pretreatment and inlet features that facilitate ease of maintenance, e.g., sediment forebay, pretreatment BMP, catch basin insert.
Underdrain?	Yes/No.
Outlet Features	Describe outlet features (if applicable) that affect maintenance cost/frequency (e.g., orifice size, micropool, trash rack, well screen).
Access Constraints	Describe access conditions affecting ease of maintenance.
Permanent Irrigation System	Permanent irrigation system status from picklist: Yes/No/Unknown.
Facility Ownership	Picklist: Public, Public Right of Way, Private, Private-HOA, Private-CDD, Other, Unknown.
Public Visibility	Picklist: High, Medium, Low, None, Unknown
Monitoring Data?	Yes/No/Unknown (flag to trigger tie-in to BMP Database).
Comments	Additional description of facility that influences maintenance costs, if needed.

ED_002551_00001562-00017

Table 2-2a. Maintenance Event Records: Field Activities.

Maintenance Event Records *(Multiple event records over time, linked to the Facility Information in Table 2-1)*	
Data Provider ID	Assigned at time of upload to national database from Table 2-5.
BMPDB ID	BMP ID used in the BMP Database
Asset ID	*Use number in asset management system, if applicable*
Maintenance ID	Maintenance Record ID
Event Record Type	Individual Event, Annual Summary, Annual Average, Other.
Maintenance Start Date	Enables normalization of cost data over time and documents frequency.
Maintenance End Date	Identifies maintenance end date for multi-day events.
Start Time	Start time (military)
End Time	End time (military)
Maintenance Entity	Picklist: Contractor, Municipal, Volunteer, Combination.
Number of Workers	Enter number of workers present/conducting maintenance
Maintenance Type	Picklist: Inspection Only, Routine, Restoration/Reactive, Rehabilitation, Not Specified, Other.
Facility Condition	Normal, Failing, Failed, Unknown.
Vegetation Stage at Time of Maintenance	Picklist: Establishment, Mature, Post-mature (overgrown), Not Applicable, Unknown.
Maintenance Narrative	Describe activities conducted.
Sediment removal	See Appendix A for a matrix of BMP types and maintenance activities. (Check boxes for each activity performed)
Weeding/Thinning/Vegetation Removal	
Plant Replacement/Seeding/Sodding	
Supplemental Irrigation	
Irrigation System Maintenance	
Mowing	
Fertilization	
Pruning	
Trash/Debris/Leaf Removal	
Erosion Repair	
Mulch Replacement	
Inlet Cleaning	
Outlet Cleaning	
Vacuum/Sweep Surface	
Jet-Vac/Subsurface Vacuum	
Power Washing/Steam Cleaning	
Rechip Permeable Pavement	
Replace Media	
Scarify Media	
Structural Repair	
Clear Pipes	
Mosquito Control	
Algae Control	
Rodent Management/Repair Animal Damage	
Materials Description	Plants, mulch, media, hardscape, chipping materials, etc.
Equipment Description	Equipment used, e.g., vacuum sweeper, shovel, backhoe.
Sediment Disposal Description	Describe type of disposal (e.g., solid waste landfill-direct transport, temporary bulk storage to land fill, etc.).
Other Activity/Comment	Describe other activities/provide comments

ED_002551_00001562-00018

Table 2-2b. Maintenance Event Records: Costs and Supplemental Information.

Maintenance Event Records *(Multiple event records over time, linked to the Facility Information in Table 2-1)*	
Data Provider ID	Assigned at time of upload to national database from Table 2-5.
BMPDB ID	BMP ID used in the BMP Database (autofilled).
Asset ID	*Use number in asset management system, if applicable* (autofilled).
Maintenance ID	Maintenance record number (auto-populated), displayed from Table 2a.
Maintenance Date	Enables normalization of cost data over time and documents frequency, displayed from Table 2a.
Contract ID	Contract ID used in Asset Management System (if applicable).
Work Order ID	Work order ID used in Asset Management System (if applicable).
Work Order Type	Picklist: Individual Facility Visit, Multiple Facility Visits, Individual Facility-Multiple Visits, Multiple Facility-Multiple Visits, Unknown.
Mobilization Type	Picklist: Multiple Facilities, Single Facility, Unknown.
Maintenance History	Picklist: As Recommended, Less than Recommended, Never Maintained, Unknown.
Climatological/Weather Conditions	Picklist of condition affecting maintenance event: Normal, Wet Year, Drought, Minor Flood Event, Major Flood Event, Dry Season, Rainy Season, Other.
Total Cost ($)	Total overall cost for the maintenance event.
Total Cost Basis	Describe basis of total cost provided.
Labor Cost ($)	Total labor cost.
Labor Time (min)	Cumulative time required to complete maintenance/site visit.
Labor Rate ($/hr)	Hourly labor rate. Use average of personnel present.
Labor Rate Cost Basis	Allows narrative to describe the basis of the labor cost rate, if known.
Materials Cost ($)	Cost of materials.
Equipment Cost ($)	Rental cost or owner cost.
Equipment Ownership	Own, Rent, Contractor, Not Specified.
Equipment Cost Basis	Describe basis for allocating cost of owned equipment.
Disposal Cost ($)	Cost of sediment/materials disposal, if applicable.
Traffic Control Cost ($)	Cost of traffic control (including police, if needed) for roadway BMPs.
Mobilization Cost ($)	Cost of mobilization/travel associated with maintenance event.
Admin./Overhead Cost ($)	Administrative cost of scheduling/tracking maintenance not reflected in labor $.
Other Cost ($)	Additional costs not included above.
Comments	Additional comments identifying unusual aspects of maintenance event that affect cost.

Table 2-3. Material and Quantities.

Parameter	**Description/Picklist**
Record ID	Autonumber
Data Provider ID	Assigned at time of upload to national database from Table 2-5.
Maintenance ID	Maintenance Event ID (from Table 2-2)
BMPDB ID	BMP ID used in the BMP Database
Asset ID	Use number in asset management system, if applicable
Material	List each material used during the maintenance event
Quantity	List the material quantity
Unit	Identify the unit of measurement for the quantity (e.g., cubic yards, feet)
Cost ($)	Cost of materials used in maintenance event.

Note: picklists for materials could be developed as part of a local field application that includes auto-populated costs associated with the material.

ED_002551_00001562-00019

Table 2-4. Additional Asset Management System Fields (for customizing internal asset management systems; integrate with Table 2-1).

Parameter	Description/Picklist
Asset ID	Use number in asset management system, if applicable
O&M Requirements	Link to O&M manual/guidance for facility type.
Photographs	Link to photographs in photo library.
As-Built Design Drawings	Link to drawings in drawing library.
Design Standard	Link to standard design details.
Other	Other fields as needed, based on local objectives/needs.

Table 2-5. Data Provider Information (for data submittal to BMP Database).

Parameter	Description/Picklist
Data Provider ID	Assigned at time of upload.
Organization	Name of organization sharing data.
Organization Type	Type of organization submitting data from Picklist: Municipality, Public Agency, Stormwater Utility, University, Private, Other
Contact Name	Contact name for organization.
Contact Email	Email for contact.
City	City name for organization sharing data.
State	State name for organization sharing data.
EPA Rain Zone	EPA Rain Zone, from picklist based on EPA's map.
Maintenance Program Description	Provide brief narrative description of local maintenance program to orient users to the program.
Web Link	Provide website link for more information about the maintenance program, if applicable.

ED_002551_00001562-00020

ED_002551_00001562-00021

CHAPTER 3

Description of Reporting Parameters

3.1 Overview

The data elements introduced in Tables 2-1 through 2-5 are further described in this section. Descriptions in light gray represent "key" fields (alphanumeric codes) used to link the information among the tables, the BMP Database (for performance data), internal asset management systems GIS databases, etc.

Important: This database is structured to track O&M activities and costs for individual BMPs to support cost estimates based on BMP type, basic design features, and tributary area parameters. To use this database, it is necessary for costs to be allocated on an individual BMP basis, even if the BMP is part of a treatment train or the maintenance work order includes multiple BMPs.

The following example scenarios and others like these require additional "pre-processing" to extract or transform data for entry into the database:

- **Single work order for multiple BMPs for a single event.** An example of this scenario would involve a maintenance work order to maintain multiple BMPs. The work order costs would need to be allocated to each BMP in order to use this tool.
- **Single work order for multiple BMPs for multiple events.** An example of this scenario would involve a maintenance work order to a contractor to maintain multiple BMPs for multiple events or for an entire year. The work order costs would need to be allocated to each BMP in order to use this tool. If the contract is an annual contract and the data provider chooses to only provide total annual cost, then the event type would be identified as "annual." If multiple events are included that don't reflect the annual cost, then costs would also need to be allocated among the maintenance events.
- **Shared costs among multiple BMPs.** An example of this scenario would be related to sediment disposal costs. Some local governments remove sediment and store it with sediment from multiple BMPs for one or more maintenance events at a central location (e.g., roll-off dumpster) and then dispose of the sediment in a combined disposal event. In this case, sediment disposal cost would be divided and allocated pro rata to multiple BMPs (and/or multiple events). Other examples would be use of vacuum truck to jet-vac multiple underground BMPs. Shared costs are a challenging parameter to allocate among BMPs but are an important component of understanding actual maintenance costs.

Geospatial Attributes

For purposes of a national cost database, the only geospatial data being stored is "point" data to enable plotting of a general facility location on a national map.
For local governments adopting these protocols, it is recommended that a variety of geospatial data types be utilized such as polygons and polylines.

Where the maintenance database is linked to a geospatial database, local governments may be able to auto-populate some of the fields requested for Table 2-1.

ED_002551_00001562-00022

3.2 BMP Facility Description (Table 2-1)

The purpose of the Table 2-1 reporting parameters (data elements) is to provide important data pertinent to the facility location and design. Such characteristics can affect the frequency and cost of maintenance.

Data Provider ID: For entities submitting data to the national database, a 5-digit numeric data provider ID will be assigned at the time of data upload and auto-populated from Table 2-5.

BMPDB ID: For entities submitting data to the national database, BMP ID is the unique 11-digit numeric code used in the BMP Database and assigned after data submittal. This is the primary key used to link the facility to maintenance activities and costs. For entities providing only cost data, the O&M database will use this format: 4-digit year, 3-digit data provider, 4-digit BMP ID. For example, 20170010001 would correspond to data first submitted in 2017 for a data provider assigned code 001 for the first BMP (0001) with O&M cost data allowing 1000 BMPs to be entered for a data provider. No duplicate BMPDB IDs are allowed.

Asset ID: Use unique alphanumeric codes in local asset management system or database, if applicable. This is the code used to link the facility to a local asset management system. If the facility owner does not utilize an asset management system, this field should be -999999 to indicate no ID is available.

BMP Configuration: BMP configurations can be individual sites, a cluster of sites in close proximity (e.g., bioretention at several corners of an intersection) or a treatment train cluster (e.g., grass swale draining to an extended detention basin). Select the type from a picklist: Individual, Cluster, Treatment Train, Other. For BMP configurations involving multiple BMPs, O&M activities and cost data must be disaggregated and allocated to each individual BMP; however, the BMP configuration is a factor that may affect maintenance efficiencies associated with economies of scale realized when multiple BMPs are maintained in one maintenance activity.

Decimal Latitude: Latitude for GPS centroid/geolocated address. Enables mapping of facilities and integration with GIS/asset management systems.

Decimal Longitude: Longitude for GPS centroid/geolocated address. Enables mapping of facilities and integration with GIS/asset management systems.

BMP Name: General facility name (e.g., Orchard Pond, L-2) or other applicable identifier used in asset management system.

BMP Type: Select BMP type from the picklist in Table 3-1.

Installation Date: Enables tracking of maintenance cost over time. This date is useful for understanding maintenance costs over time for a facility and timing of major rehabilitation. The installation completion date is intended to represent a fully constructed, functioning facility. If the exact day is unknown, use January 1 as the default. (e.g., 01/01/2017).

BMP Description: Narrative description of key BMP features.

Tributary Land Area (acres): Total size of the drainage area to the BMP in acres. Can be used to calculate tributary land area to facility surface area ratio, which is important for some BMP types.

Road Type: For BMPs along roadways, select the road type from picklist: Local, Collector, Arterial, Highway, Not Applicable, Unknown.

Imperviousness (%): Percent of total drainage area to the BMP that is impervious. The parameter serves as a general indicator of urban development intensity. The actual impacts of imperviousness can be moderated by disconnecting directly connected impervious area (DCIA), but DCIA is a less commonly tracked metric.

ED_002551_00001562-00023

Table 3-1. BMP Type Picklist.

BMP Type
Bioretention: Rain Garden
Bioretention: Stormwater Planter
Detention Basin: Concrete Vault
Detention Basin: Grass Lined (Extended Dry)
Grass Strip
Grass Swale
Green Roof
Infiltration: Dry Well
Infiltration: Percolation Trench
Infiltration: Basin
Manufactured Device: Filtration Device
Manufactured Device: Micro-bioretention
Manufactured Device: Inlet Insert
Manufactured Device: Treatment Train
Manufactured Device: Oil and Water Separator
Manufactured Device: Hydrodynamic Separator
Manufactured Device: Subsurface Detention/Retention/Infiltration
Manufactured Device: Wet Vault
Media Filter: Advanced Media
Media Filter: Sand Filter
Permeable Friction Course
Permeable Pavement: Aggregate
Permeable Pavement: Modular Blocks
Permeable Pavement: Pervious Asphalt
Permeable Pavement: Porous Concrete
Permeable Pavement: Turf Grid
Rainwater Harvesting System
Retention Pond (Wet Pond)
Wetland Basin
Wetland Channel
Other

Note: above list does not include Composite (treatment train) or LID sites since each BMP must be entered separately.

ED_002551_00001562-00024

Principal Land Use: Select principal land use in the catchment from the following options - ID: Industrial; RE: Residential; CO: Commercial; IS: Institutional; FW: Highways and/or Freeways; OP: Open Space; UNK: Unknown; MIX: Mixed. If there is more than one principal use, it is considered a mixed land use. The secondary land use is described in the next entry. Picklist convention is based on NSQD. This parameter may be useful in indicating the type and level of pollutant loads in stormwater.

Secondary Land Use: Select secondary land use in the catchment if primary is mixed. Valid selections include the following: ID: Industrial; RE: Residential; CO: Commercial; IS: Institutional; FW: Highways and/or Freeways; OP: Open Space; UNK: Unknown, NA: Not Applicable. Picklist convention is based on NSQD. This parameter may be useful in indicating the type and level of pollutant loads in stormwater.

Snow/Ice Management: The type of snow and ice management can affect maintenance frequencies. For example, more frequent sediment removal may be required if sand is used for traction, and deicing chemicals may affect vegetation and cause soil containing clay to seal up. Choose from this picklist: Sand, Sand/Salt, Magnesium Chloride, Potassium Acetate, Calcium Chloride, Calcium Magnesium Acetate, Potassium Chloride, Other Chemical, Mechanical Only (plow), None, Unknown.

Qualitative Site Loading Intensity: Sites with high loading intensity typically require more frequent maintenance. Select High, Moderate, or Low to characterize whether the site is heavily used/dirty, moderately used, or lightly used/clean.

Tributary Land Area Description/Conditions: Describe other pertinent characteristics of tributary land use affecting maintenance activities and frequencies. The average slope of the drainage area, disturbed land condition, extent of urbanization and other comments can be entered here, along with other pertinent characteristics.

Treatment Volume or Flow Rate and Units: Provides design treatment parameter as a design volume (e.g., water quality capture volume [WQCV]) or flow rate, along with measurement units. If both parameters are used for design, then additional information can be reported in the Comments field. If unknown or not applicable, enter -99.

Surface Area and Units: Provides information on the surface footprint of the BMP that is being maintained. Surface area is a common metric used for maintenance estimates for GI practices. If unknown or not applicable, enter -99.

Facility Sizing: Facility sizing relative to proper design size can affect maintenance frequencies and costs. For example, undersized facilities may require more frequent maintenance and oversized facilities may require less frequent maintenance. From the picklist, select facility sizing as: Standard, Over-Sized, Undersized (e.g., not to design standards), Unknown. "Standard" would represent a properly-sized or typical facility, even if detailed design information is not available by the entity submitting the maintenance/cost data.

Media Type: Select media type from picklist: In situ Soils, Standard Specified Media, Advanced Media, Filter Membrane, Not Applicable, Unknown

Vegetation Type: Type of vegetation can affect time required to maintain the BMP and the frequency of required maintenance. Select vegetation type from picklist: Native Grasses, Manicured Turf, Wetland Vegetation, Rain Garden Plant Palette, Sedum/Green Roof Palette, Other, None, Unknown.

Street Sweeping Frequency: Street sweeping is a source control practice that can reduce sediment and debris loading to BMPs, thereby reducing the facility maintenance and rehabilitation burden. Select from this Picklist: Annual, Biannual, Quarterly, Monthly, Biweekly, Never, Other, Unknown.

ED_002551_00001562-00025

Inlet/Pretreatment Features: Describe pretreatment features or inlet features that affect ease of maintenance. Examples include:

- Sediment forebay
- Level spreader
- Manufactured device providing pretreatment (e.g., hydrodynamic separator)
- Trash net
- Sump inlet
- Inlet inserts
- Number of inlets to facility

Underdrain?: Enter Yes or No to identify whether the BMP is equipped with an underdrain system.

Outlet Features: Describe outlet features (if applicable) that affect maintenance cost/frequency (e.g., orifice size, micropool, trash rack, well screen).

Access Constraints: Allows a narrative to identify access constraints. This may be particularly relevant for subsurface BMPs and sites adjacent to roadways. Access conditions can affect the ease of maintenance, labor time and cost.

Permanent Irrigation System: In semi-arid and arid climates and climates with prolonged dry seasons, permanent irrigations systems may be necessary to maintain plant health for certain BMP types. Sites requiring irrigation will have higher maintenance costs than comparable sites that do not require irrigation. This field provides an initial flag to indicate whether a permanent irrigation system is present at the facility. From picklist: yes, no, unknown.

Facility Ownership: Facility ownership can affect maintenance budget and frequency. Select ownership type from Picklist: Public, Public Right of Way, Private, Private-HOA (Homeowners Association), Private-CDD (Community Development District), Other, Unknown.

Public Visibility: Public visibility is a factor than can affect the frequency of maintenance, with higher visibility facilities generally being more likely to be frequently maintained. Select the general public visibility from this picklist: High, Medium, Low, None, Unknown. Select None for underground facilities accessed by manholes.

Monitoring Data? Select Yes, No, or Unknown. This field is a flag useful for indicating that maintenance and performance may potentially be linked through monitoring data stored in the BMP Database or a local database.

Comments: Additional description of facility that influences maintenance costs, if needed. For picklists where "Other" is selected, provide additional explanation in the comments section.

3.3 Maintenance Event Description (Table 2-2)

The purpose of the Table 2-2 reporting parameters (data elements) is to provide important metadata pertinent to the maintenance event, particularly characteristics that affect economies of scale related to maintenance, the BMP condition, the entities conducting the maintenance, as well as cost data related to labor time, materials, equipment and other information.

This table is divided into two portions, corresponding to field-based data entry (Table 2-2a) and office-based data entry (Table 2-2b). Table 2-2a essentially provides "who did what" and Table 2-2b provides additional information affecting cost and cost data.

ED_002551_00001562-00026

3.3.1 Maintenance Events: Field Data (Table 2-2a)

Data Provider ID: Data Provider ID (auto-filled)

BMPDB ID: BMP ID used in the BMP Database (auto-filled)

Asset ID: Asset ID used in asset management system, if applicable (auto-filled)

Maintenance ID: Maintenance record number (auto-populated)

Event Record Type: To enable storage of a wide range of maintenance and cost data from local governments, the event record type enables the user to select the event record type from this picklist: Individual Event, Annual Summary, Annual Average, Other. Individual monitoring events enable more detailed information about O&M practices; however, some communities may only have annual summaries available for sharing in the national database.

Maintenance Start Date: Enables normalization of cost data over time and documents frequency of maintenance for a series of maintenance events at a facility. If an annual summary is being entered, use 01/01/YYYY as the date associated with the record, with YYYY being a 4-digit year.

Maintenance End Date: Enables normalization of cost data over time and documents frequency of maintenance for a series of maintenance events at a facility. If an annual summary is being entered, use 01/01/YYYY as the date associated with the record, with YYYY being a 4-digit year.

Start Time: Start time (military). Record in the field to calculate total maintenance time.

End Time: End time (military). Record in the field to calculate total maintenance time.

Maintenance Entity: The entity or combination of entities conducting the maintenance affect the recorded cost of maintenance. For example, of community volunteers or property owners maintain the BMP, then the cost tracked by the local government is likely to underestimate the actual cost of maintenance. Picklist: Contractor, Municipal, Volunteer, Combination, Unknown.

Number of Workers: Enter number of workers present/conducting maintenance.

Maintenance Type: The maintenance event type provides a general category for maintenance cost comparisons. Maintenance events are generally categorized according to this picklist:

- Inspection Only: An inspection event that does not result in maintenance activities during the same site visit.
- Routine: Regular, planned maintenance necessary for proper function and aesthetic appearance of the BMP (e.g., mowing, litter removal, vacuuming permeable pavement, sediment removal).
- Restoration/Reactive: Unplanned maintenance/rehabilitation in response to events impacting the facility (e.g., flood damage, vandalism of outlet structure, unanticipated plant replacement due to drought).
- Rehabilitation: Rehabilitation represents major foreseen maintenance activities required due to the expected lifespan of the facility. Examples include media replacement in a bioretention facility after a period of years, dredging a retention pond, or major work on permeable pavement sites.
- Other: Another type of maintenance not characterized by the other maintenance categories in the picklist.

Facility Performance Status: Select the facility performance status at the time of maintenance from this picklist: Normal, Failing, Failed, Unknown. An example of a failing facility would be a bioretention facility with ponded water beyond the intended drain time.

ED_002551_00001562-00027

Vegetation Stage at Time of Maintenance: Maintenance costs and activities are affected by the maturity of the BMP. During establishment, practices such as supplemental irrigation and plant replacement may be required, during the mature stage, routine maintenance activities would typically be required. A post-mature facility would represent a facility that has not be adequately maintained and is overgrown with weeds or has excessive sediment accumulation requiring more costly maintenance. Select the facility stage at time of maintenance from this picklist: Establishment, Mature, Post-mature (overgrown), Unknown, None. Enter None for facilities that do not incorporate vegetation.

Maintenance Narrative and Checklist: Provide a brief narrative summary of the maintenance activities conducted. Additionally, field personnel may also utilize the checklist of the following common maintenance activities with a yes/no ("check box") entered for each maintenance event activity. Multiple maintenance activities are typically conducted during maintenance site visit. Appendix A provides a matrix of common maintenance activities for common BMP types.

- Sediment removal
- Vacuum/sweep surface
- Jet-Vac/subsurface vacuum
- Rechip permeable pavement
- Weeding/thinning/vegetation removal
- Plant replacement/seeding/sodding
- Supplemental Irrigation
- Irrigation system repairs
- Mowing
- Fertilization
- Pruning
- Trash/debris/leaf removal
- Erosion repair
- Mulch replacement
- Inlet cleaning
- Outlet cleaning
- Power washing/steam cleaning
- Replace media
- Scarify media
- Structural repair
- Clear pipes
- Mosquito control
- Algae control
- Rodent management/address animal damage

Materials Description: Describe materials necessary to complete the maintenance activity such as plants, mulch, media, hardscape, chipping materials, etc. Itemized materials and units can be provided in Table 2-3, where such detail is available.

Equipment Description: Describe equipment used to conduct the maintenance event (e.g., vacuum sweeper, shovel, backhoe).

Sediment Disposal Description: Describe disposal method. Examples could include on-site drying with direct transport to a solid waste landfill or transport to a centralized drying location for bulk dry waste disposal and liquid discharge to sanitary sewer.

ED_002551_00001562-00028

Other Activity/Comment: A narrative field is provided to allow description of other maintenance activities conducted during a maintenance event. Additionally, if structural repairs are caused by events such as vandalism, describe these types of conditions in the comments.

3.3.2 Maintenance Events: Office Data (Table 2-2b)

Data Provider ID: Auto-filled from Table 2-2a.

BMPDB ID: Auto-filled from Table 2-2a.

Asset ID: Auto-filled from Table 2-2a.

Maintenance ID: Auto-filled from Table 2-2a.

Date: Auto-filled from Table 2-2a.

Contract ID: Contract ID used in Asset Management System (if applicable) for the maintenance contractor. This information may be useful in populating unit costs associated with the maintenance event.

Work Order ID: Work order ID used in Asset Management System (if applicable).

Work Order Type: Work orders can be issued for a single visit for a single BMP or for a combination of BMPs and/or a combination of visits. From the Picklist, select the work order description type: Individual Facility Visit, Multiple Facility Visits, Individual Facility-Multiple Visits, Multiple Facility-Multiple Visits, Unknown. This information affects economies of scale for maintenance activities.

Mobilization Type: Mobilization type affects economies of scale for maintenance activities. Maintenance mobilization for multiple BMPs will typically be less costly than mobilizations to maintain single BMPs in multiple outings. Select the maintenance mobilization type from this Picklist: Multiple Facilities, Single Facility, Unknown.

Maintenance History: Cost of maintenance for a particular maintenance event can be significantly impacted by prior maintenance history. Select maintenance history from picklist: As Recommended, Less than Recommended, Never Maintained, Unknown.

Climatological/Weather Conditions: Climatological and/or seasonal weather conditions can affect maintenance requirements such as irrigation, plant replacement, erosion, outlet clogging and other issues. The purpose of this field is to provide a general flag on conditions that may impact the cost and activities associated with the maintenance event. From the picklist, select: Normal, Wet Year, Drought, Minor Flood Event, Major Flood Event, Dry Season, Rainy Season, Other.

Total Cost ($): Provide the total overall cost of maintenance for the reported event.

Total Cost Basis: Provide information on how the total cost was determined, describing the information used to develop the cost. For example, does the cost include labor, materials, equipment, disposal, mobilization, traffic control, administration or does it exclude any of these items? Also include whether the cost is based on a flat fee for maintenance or actual time and materials.

Labor Cost ($): Total labor cost.

Labor Time (min): Time required to complete maintenance/site visit. If multiple staff are present, sum the time of each staff person present.

Labor Rate ($/hr): Average hourly labor rate for staff present.

ED_002551_00001562-00029

Labor Rate Cost Basis: Describe how the labor cost is reported. For example, identify whether the labor cost is fully burdened hourly rate. For contractors, the labor rate corresponds to the price of labor. Notes regarding number of volunteer hours can also be described here.

Materials Cost ($): Total cost of materials. (Note: if itemized materials quantities and costs are available, also utilize Table 2-3. Examples of materials used in maintenance include seed, concrete, fertilizer, plants, seeds, asphalt, pavers, filter media, mulch, and others.

Equipment Cost ($): Allocated rental cost or owner cost for the equipment used.

Equipment Ownership: Select equipment ownership type from this picklist: Own, Rent, Contractor, Other, Unknown. This entry is most relevant to facilities requiring special maintenance equipment such as vacuum trucks or backhoes.

Equipment Cost Basis: Describe basis for allocating cost of owned equipment.

Disposal Cost ($): Cost of sediment/materials disposal and/or liquid discharged to sanitary sewer, if applicable.

Traffic Control Cost ($): Sites that require traffic control often incur additional maintenance costs relative to those located in parks or a safe distance from traffic. This may include in-house traffic control utilizing cones, safety vehicles and staff, and it may also include police for some roadway BMPs.

Mobilization Cost ($): Cost of mobilization not included in other cost items.

Administrative/Overhead Cost ($): Administrative cost of scheduling/tracking maintenance not reflected in labor cost. If administration/overhead is assumed to be a percentage of the maintenance cost, note this in the Comments field.

Other Cost ($): Other costs of maintenance not included above. Examples could include impacts to nearby utility infrastructure during the maintenance activity. Describe in comments.

Comments: Additional comments that identify unusual aspects of maintenance event.

3.4 Materials and Quantities Supporting Detail (Table 2-3)

To enable the data to be used for maintenance cost build-ups, materials, quantities, units and costs can be entered. Unit cost build-up is generally the most reliable way to estimate costs, so where such data are available, entry of these supporting details is encouraged.

Record ID: Auto-numbered

Data Provider ID: Auto-filled from Table 2-2a.

BMPDB ID: Auto-filled from Table 2-2a.

Asset ID: Auto-filled from Table 2-2a.

Maintenance ID: Auto-filled from Table 2-2a.

Date: Auto-filled from Table 2-2a.

Material: List the material used during the maintenance event (e.g., plants, concrete, pavers, filter media, fertilizer).

Quantity: List the material quantity used in the maintenance event.

Unit: Identify the unit of measurement for the quantity (e.g., cubic yards, feet).

ED_002551_00001562-00030

Cost ($): Cost of each material used in maintenance event. A look-up table to auto-calculate cost may be utilized if such lookup tables are available. If not, entry of cost data would be an office task rather than a field task.

Note: for data providers who want to collect detailed costs associated with specific activities conducted during a maintenance event, it would also be possible to enter an activity such as mowing under the Material attribute, time under the Quantity attribute, and provide associated cost. For purposes of the national database, this level of detail has not been provided.

3.5 Relationship to Other Databases and Asset Management Systems (Table 2-4)

One of the goals of the O&M cost database design is allow it to interface with other local asset management system and/or work order databases and the International Stormwater BMP Database performance monitoring database for entities tracking both performance and O&M activities.[1] Table 2-4 includes examples of additional data elements that local governments may want to integrate into their own asset management systems; however, these attributes would not be stored in a national O&M database implementation. These fields should be combined with Table 2-1 information about the facility itself when these protocols are utilized in an internal asset management system.

Asset ID: Use unique alphanumeric codes in local asset management system, if applicable. This is the code used to link the facility to a local asset management system.

O&M Requirements: Link to O&M manual/guidance for BMP type. Many local governments have a checklist or manual describing the O&M activities that should be conducted for various BMP types. This link would enable those responsible for maintenance to compare actual maintenance to expected (ideal) maintenance.

Photographs: Link to photographs in a photo library so that the facility characteristics over time can be documented. Photographs could include "what the facility should look like" and photos of common O&M problems for reference by those maintaining the facility, as two examples. Additionally, photos during overtopping or flood conditions may also be helpful.

As-Built Design Drawings: Link to as-built design drawings if stored as part of a local asset management system. The purpose of this linkage would be to enable those conducting O&M to have a reference for what the facility should look like in the field. For example, if facility components are buried with sediment or damaged by flood events, the design drawings provide a reference for the facility features following maintenance. This is particularly important for sediment removal (e.g., to identify the bottom of an extended detention basin that has not been maintained, to repair outlet structures that may have been modified by a private party, or when repaving activities are being conducted in a parking lot or roadway draining to a bioretention facility, as a few examples).

Design Standard: Link to standard design details and/or design standards. This information would provide information to those maintaining the BMP regarding what the BMP attribute should include and/or how the BMP should be functioning. For example, if a bioretention facility is routinely ponding water for multiple days, then the design standard can be referenced to verify the design drain time for the BMP type. Additionally, if as-built drawings are not available and an outlet structure has been damaged, standard details could be used to guide repair of the structure. Other examples would include plant types and media types appropriate for rehabilitation of a bioretention facility.

---

[1] For Version 1.0 of the cost database, linkages between internal asset management systems and the national database are not included, but development of an API could be explored in the future.

ED_002551_00001562-00031

3.6 Data Provider Profile (Table 2-5)

Table 2-5 is essentially the user profile or cover sheet to identify the data provider if maintenance cost data and activities are being shared with the national database. The table provides basic contact information, location information for normalizing data sets once combined in a national database, and basic information about the maintenance program.

Data Provider ID: For entities submitting data to the national database, a 5-digit numeric data provider ID will be assigned at the time of data upload.

Organization: Name of organization sharing data.

Organization Type: Type of organization submitting data from Picklist: Municipality, Public Agency, Stormwater Utility, University, Private, Other.

Contact Name: Contact name for organization.

Contact Email: Email for contact.

City: City name for organization sharing data.

State: State name for organization sharing data.

EPA Rain Zone: EPA Rain Zones are shown on Figure 3-1. Enter the one-digit code between 1 and 9 corresponding to the Rain Zone where the facility is located. For international sites, use -9.

Maintenance Program Description: Provide a brief narrative description of local maintenance program to orient third party users of the maintenance data to the program.

Web Link: Provide website link for more information about the maintenance program, if applicable.

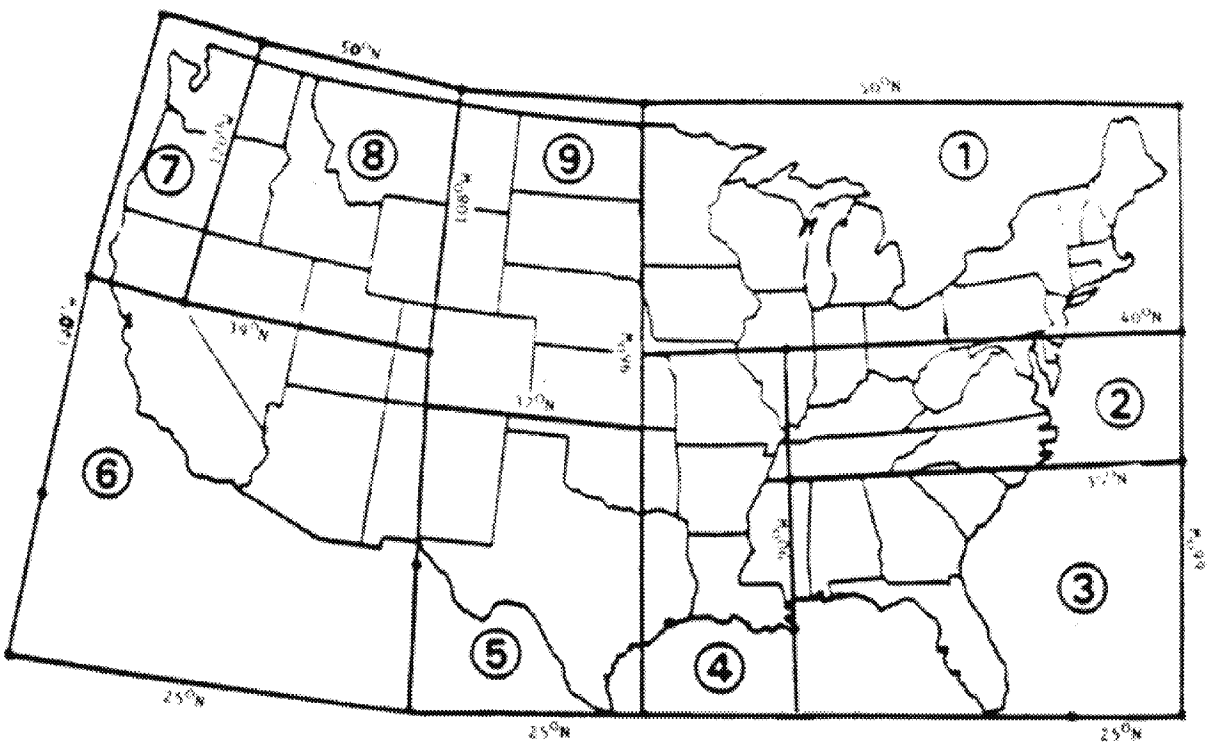

Figure 3-1. EPA Rain Zones.
Source: NPDES Phase I regulations, 40 CFR Part 122, Appendix E (U.S. EPA 1990).

ED_002551_00001562-00032

ED_002551_00001562-00033

CHAPTER 4

Next Steps: Using the Reporting Protocols and Developing a National Database

The reporting protocols in this guidance tool have been converted into an Excel-based data entry structure for use in the O&M Database and CLASIC projects and for use by local governments as a template for internal use. Two versions of data entry spreadsheets have been created: A basic, simplified version and a detailed version for data providers with more detailed information available. These spreadsheets can be downloaded from www.bmpdatabase.org.

A simple Microsoft Access database has also been developed to store collected cost data. This database can be used internally by local governments. Additionally, a national database is initially being populated by WRF's project team on the CLASIC project. This database is being used to validate cost equations used in the CLASIC tool and will also be made available on www.bmpdatabase.org. The initial population of the database will also include data already collected to support EWRI's 2017 publication *Cost of Maintaining Green Infrastructure*. Users of the data spreadsheets and/or database are encouraged to submit their data to the national database to advance the national state of the practice regarding costs of maintaining stormwater BMPs.

ED_002551_00001562-00034

ED_002551_00001562-00035

APPENDIX A

BMP Maintenance Activities by BMP Type

BMP Categories		Maintenance Activity for Typical BMP Installations																							
Code	New Name	Trash/ Debris/ Leaf removal	Sediment removal (shovel or backhoe)	Jet-Vac/ subsurface vacuum	Vacuum/ sweep surface	Pressure Washing/ steam cleaning	Rechip permeable pavement	Weeding/ Thinning/ Vegetation Removal	Plant replacement/ Seeding/ Sodding	Mulch replacement	Mowing	Fertilization	Pruning	Supplemental Irrigation	Irrigation system repairs	Replace media	Scarification of media	Inlet cleaning	Outlet cleaning (Above Ground Structure)	Clear pipes/ underdrains (Below Ground)	Erosion repair	Structural repair	Mosquito control	Algae control	Rodent management/ address animal damage
Typical Frequency if Activity Implemented		Routine	Routine	Routine	Routine	As-needed	Routine	Routine	Routine	Routine	Routine	As-needed (infrequent)	As-needed (infrequent)	As-needed	As-needed	Infrequent	Routine	Routine	Routine	As-needed	As-needed	Infrequent	As-needed	As-needed	As-needed
BI	Grass Strip	✓	✓					✓	✓		✓	✓		✓	✓						✓				
BR	Bioretention	✓	✓					✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
MBR	Microbioretention	✓	✓					✓	✓	✓			✓	✓	✓	✓	✓	✓		✓		✓	✓		✓
BS	Grass Swale	✓	✓					✓	✓		✓	✓		✓	✓						✓				
DB	Detention Basin-Grass Lined	✓	✓						✓		✓			✓	✓			✓	✓		✓	✓	✓		✓
DB	Detention Basin-Concrete Vault	✓	✓	✓														✓		✓		✓	✓		✓
GR	Green Roof	✓						✓	✓		✓	✓	✓	✓	✓	✓			✓			✓			✓
IB	Infiltration Basin	✓						✓								✓	✓	✓			✓	✓			
MD	Manufactured Device-Hydrodynamic Separator	✓	✓	✓														✓		✓		✓	✓		
MD	Manufactured Device-Oil and Water Separator	✓	✓	✓		✓												✓		✓		✓	✓		
MF	Media Filter-Advanced Media	✓						✓								✓	✓	✓	✓	✓	✓	✓			✓
MF	Media Filter-Sand Filter	✓						✓								✓	✓	✓	✓	✓	✓	✓			✓
PP	Permeable Pavement - Pervious Asphalt	✓			✓															✓		✓			
PP	Permeable Pavement - Porous Concrete	✓			✓															✓		✓			
PP	Permeable Pavement - Aggregate	✓			✓															✓		✓			
PP	Permeable Pavement - Modular Blocks	✓			✓		✓													✓		✓			
PP	Permeable Pavement - Turf Grid	✓						✓	✓		✓	✓								✓		✓			
PT	Infiltration (Percolation) Trench	✓																✓		✓		✓			
PT	Infiltration (Dry) Well	✓	✓																	✓		✓			
RP	Retention Pond	✓	✓						✓		✓							✓			✓	✓	✓	✓	✓
RW	Rainwater Harvesting System	✓																		✓		✓	✓	✓	
WB	Wetland Basin	✓	✓					✓	✓		✓							✓			✓	✓	✓	✓	✓
WC	Wetland Channel	✓	✓					✓	✓		✓							✓			✓		✓	✓	✓

BMP Database Practices not included: Composite (Overall Site), Low Impact Development (Site Scale) and Other. Permeable Friction Course is not included in the table because maintenance is typically not required, but full replacement is generally planned at a 10-year interval.

ED_002551_00001562-00036

ED_002551_00001562-00037

References

Clary, J. and Piza, H. (eds.). 2017. *Cost of Maintaining Green Infrastructure*. Prepared by Municipal Water Infrastructure of the Environmental and Water Resources Institute (EWRI) of the American Society of Civil Engineers (ASCE). ASCE: Reston, VA.

Community-enabled Lifecycle Analysis of Stormwater Infrastructure Costs (CLASIC), accessible at http://www.werf.org/c/Lifecycle_Costs/Community-enabled_Lifecycle_Analysis_of_Stormwater_Infrastructure_Costs.aspx.

International Stormwater BMP Database, accessible at http://www.bmpdatabase.org.

National Stormwater Quality Database, accessible at http://www.bmpdatabase.org/nsqd.html.

U.S. Environmental Protection Agency. 1990. NPDES Phase I regulations, 40 CFR Part 122, Appendix E.

ED_002551_00001562-00038

ED_002551_00001562-00039

THE
Water
Research
FOUNDATION

1199 North Fairfax Street, Suite 900
Alexandria, VA 22314-1445
www.werf.org | werf@werf.org

6666 West Quincy Avenue
Denver, CO 80235-3098
www.waterrf.org | info@waterrf.org