Stormwater System Operation and Maintenance Handbook

Prepared for:

Nevada Division of Environmental Protection

and

Nevada Division of State Lands

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Preface

This report has been prepared to assist leaders and managers of Douglas County jurisdictions in the Lake Tahoe Basin and/or agencies that manage stormwater systems in Lake Tahoe (referred to hereafter as the "jurisdictions" or "stormwater system managers") prepare and implement effective inspection and maintenance programs.

The technical draft of this handbook is being circulated to the Tahoe Basin stormwater system managers and others with a stake in maintaining stormwater systems for input and advice on best practices in maintaining stormwater systems in Lake Tahoe. Comments will be incorporated into the final handbook. The final handbook will provided to Douglas County Tahoe jurisdictions for use in developing stormwater inspection and maintenance programs and will be made available for downloading by any interested party.

This O&M Handbook is one of the deliverables included in the scope of work identified in grants provided by Nevada Division of Environmental Protection (Contract Control # DEP-08-029) and funding agreement (LTLP 08-09) with the Nevada Division of State Lands. Other deliverables provided separately include the Douglas Tahoe Stormwater Program Asset Inventory Report and a Stakeholders Presentation.

The sections of the O&M Handbook are derived from the scope of work in the grants. Additional supporting or ancillary material is included in 4 appendices.

It is our hope that the readers of this report find it a useful tool in developing their stormwater inspection and maintenance programs and that perhaps this might become a useful tool for all our Basin partners to use and improve on over time.

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EXECUTIVE SUMMARY

The Operations and Maintenance Handbook is a guidance document for local jurisdictions in Douglas Tahoe to assist them in building an effective stormwater inspection and maintenance program for their stormwater systems. This document is also expected to be useful to other jurisdictions in the Lake Tahoe Basin.

Introduction

A stormwater system feasibility study in the Douglas Tahoe region in 2007 identified the need to develop an Operations and Maintenance (O&M) Handbook to ensure the consistency and completeness of local maintenance practices. Such a handbook would provide clarity to local grant project owners in meeting their grant obligations to maintain the project assets.

During the development of the O&M Handbook, the Total Maximum Daily Load (TMDL) requirements began to evolve with the delivery of tools like the Best Management Practice Rapid Assessment Methodology (BMP RAM) to inspect treatment BMPs and the Regional Stormwater Monitoring Program (RSWMP). The O&M Handbook is thus compatible and complementary to the TMDL developments.

The O&M Handbook is intended to provide inspection and maintenance guidance to local jurisdictions and is expected to be supplemented with their local information and practices. A local inspection and maintenance program should be developed by each jurisdiction. Guidance is provided on how to build this local program with a how to use this handbook discussion.

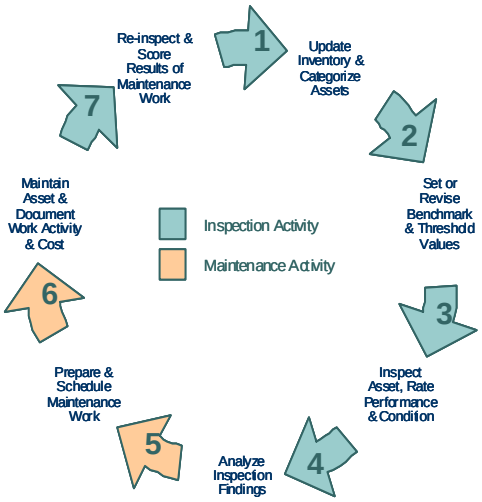
The handbook is organized into four major sections and supplemented with appendices that contain forms and diagrams that can be directly used by each jurisdiction. The major sections include the following:

- Introduction – presenting the purpose, audience, and how to use the handbook
- Inspection of Stormwater Systems – presenting a detailed description of how and when to inspect each BMP type including explanation of how to perform a field inspection and fill out the inspection forms.
- Maintenance of Stormwater Systems – presenting the maintenance processes and schedules and how the inspection process sets up the requirements for an effective maintenance program
- Stormwater System BMPs – presenting the categorization process used to identify how maintenance influenced the selection of the BMP types, discussion of BMP life expectancy, database options for recording and viewing inspection and maintenance data, and fact sheets on each BMP type to provide a simple and quick reference on BMPs, their concerns, considerations, procedures, and schedules for inspection and maintenance.

Inspection and Maintenance of BMPs

There are 16 BMP types that have been selected for inspection and maintenance in the Douglas Tahoe region. This number of BMP types could increase in other regions of Lake Tahoe where BMPs like cartridge filters, porous pavement, and other improvements have been used to provide source control, hydraulic control or pollutant treatment. These other BMP types have not been used in Douglas Tahoe.

The handbook uses an integrated approach of inspection and maintenance to measure and restore both performance capabilities and condition for each asset. The concept of this inspection-maintenance approach is shown below with a seven step process. These seven steps show a complete cycle when maintenance is required. A scoring process is used in the inspection to identify the asset condition or performance with a 1 (worst) to 5 (best) scale. Any score of 2 or less is recommended for maintenance.

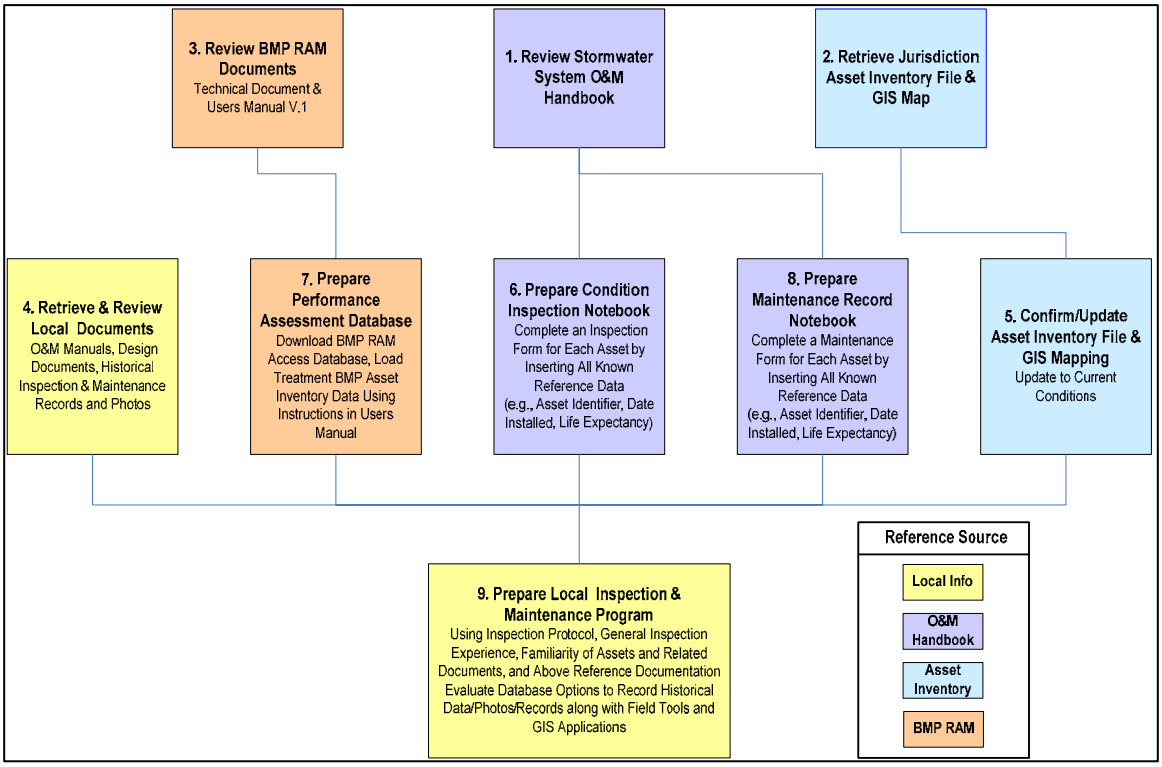


Seven Step Process, ***BMP RAM User's Manual V.1***

All BMPs (assets) are recommended to be inspected annually in the spring. Over time, this inspection frequency is expected to be modified based on tracking trends in the results and observations from local conditions or events (e.g., significant runoff). The result of this annual inspection should include analysis of the results/findings followed by scoping and scheduling of the maintenance work. Next the maintenance work is performed and results recorded followed by another inspection to determine the condition and performance restored from the maintenance work. After several cycles of this inspection-maintenance process the results may establish some recommendations on how best to maintain and or expected life of each asset. This data can then be used to plan improvements and or schedule replacements.

The inspection and maintenance process presented in this handbook will require considerable data collection and analysis. Appendix D shows an example of the data to be collected during inspection and maintenance. This handbook does not include a database system for each jurisdiction to load their data into and thus an approach to storing the data must be developed.

Finally, the development of a stormwater inspection and maintenance program for each jurisdiction is a key recommendation. An approach to developing this program is presented below and outlined in the handbook. Nine components for developing a stormwater program are presented in priority order to organize all of the needs for each jurisdiction and provide recommendations for using the O&M Handbook with other references.



Development of a Stormwater Inspection and Maintenance Program

Recommendations

The O&M Handbook has been prepared as an initial effort for stormwater jurisdictions to formalize their maintenance programs, meet their grant obligations, and measure the condition and performance of their system assets. This handbook recommends and provides guidance to each jurisdiction in preparing a stormwater inspection and maintenance program specific to their local needs.

Preparation of this handbook included literature reviews, field visits, and discussions with local/regional/other staff familiar with stormwater system inspection and maintenance practices. The information received during preparation of this handbook provided a good starting place on when/how/where to inspect and maintain assets it was difficult to be as specific as may be needed for a thorough program. The approach selected for this handbook is to document findings and review them frequently so that over time new details can be added (e.g., inspection protocols and forms, measurement techniques, improved maintenance practices that are effective and efficient) and frequency of work is based on need and not arbitrary. Thus, the materials in this handbook are recommended to be reviewed every few years and shared as new information is discovered through a forum such as the Stormwater Quality Improvement Committee.

Managing the data from a stormwater inspection and maintenance program as described in this handbook will require a careful and structured approach. The options identified range from a manual paper system to incorporating all data in a GIS file with field devices that prompt data entry and simplifies photo entry while geo-referencing the camera and asset. The manual system requires printing forms in the handbook and

manually recording all inspection and maintenance data for each asset on a separate form for each date of collection. The manual system will require setting up a photo library and coding photos with adequate data to support future review.

GIS files have been developed for most EIP project assets in Douglas Tahoe. This effort provides a starting point for developing the GIS data management system. It is recommended that an improved GIS data management system be investigated and developed that is useful to many jurisdictions across the Tahoe Basin. Such a system would have benefits by providing a common/standardized system useful to many and also simplify and reduce the effort of field staff in conducting and recording inspection and maintenance data.

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1 INTRODUCTION

The Nevada Division of Environmental Protection and Nevada Division of State Lands funded this project to develop a formal inspection and maintenance program to clarify what should be performed to assure the stormwater projects were effective and sustainable and support future TMDL requirements. Grant funding for this project was authorized in 2008 and this project work was initiated originally to form a stormwater utility for the region. During the project work the scope was refined to limit the scope to preparation of this Operations & Maintenance (O&M) Handbook as well as an asset inventory and GIS mapping of all project assets. This handbook was prepared in accordance with the grantors requirements.

This handbook provides the inspection and maintenance guidance for each BMP asset type with a general description of the asset type, maintenance concerns/objectives/goals, inspection and maintenance considerations, inspection and maintenance frequency and information, and a listing of references used in developing this handbook. This inspection and maintenance guidance is intended to assist each jurisdiction in developing their specific maintenance plan and should be complemented with an asset inventory prepared and organized by each jurisdiction. Each jurisdiction should also use this guide to identify their resource (e.g., staff, equipment, contractor, budget) needs to sustain a long-term stormwater program that efficiently, effectively, and safely controls stormwater and pollutants in their region.

This handbook supplements specific operation and maintenance information currently being used by local jurisdictions. This handbook should be used in conjunction with operation and maintenance information provided by contractors/engineers/manufacturers, BMP asset manufacturers, and local/state/federal codes and regulations. Requirements for safety including confined spaces, underground excavations, electrical or mechanical devices, and emergency conditions should be adhered to but are not included in this handbook.

1.1 Purpose & Audience

The purpose of this handbook is to provide jurisdictions in the Douglas County region of Lake Tahoe with a guide on how to maintain their stormwater systems. Previous study of the maintenance practices[1] in this region found the jurisdictions focused primarily on routine cleaning and minor repair of the BMP assets vs. inspecting, assessing condition and performance, and performing maintenance to restore performance and extend the life of the asset.

It was recognized in the previous study and development of this O&M Handbook that formal maintenance programs were not previously developed in adequate detail to guide project owners on when and how to inspect and maintain their assets. Further, the jurisdictions are now preparing for new requirements to reduce pollutant loading (Total Maximum Daily Load, TMDL) into Lake Tahoe. With these additional requirements, tools have begun to be developed including BMP asset performance measurement[2] and regional monitoring (Regional Stormwater Monitoring Program, RSWMP) to provide owners, regulators and others the effectiveness of ongoing maintenance programs. This handbook addresses both the immediate need to

[1] Nevada Tahoe Conservation District. April 2008. Stormwater Utility District Feasibility Study, Final Phase 1 Report.
[2] 2ndNature LLC et al. September 2009. BMP RAM Technical Document, Lake Tahoe Basin. Prepared for the U.S. Army Corps of Engineers, Sacramento District.

effectively and efficiently manage the existing BMP assets as well as the future needs to meet new requirements.

This handbook is an initial guidance and is expected to be reviewed and updated over time to improve and refine inspection and maintenance practices. It is expected the tools for measuring asset performance and condition will evolve as experience provides a better understanding of how and when to inspect and better methods to maintain to achieve desired results. This handbook was prepared at a time when little data was available, especially for the Tahoe Basin, and during a period when TMDL requirements were being established. Inspection and maintenance practices should be documented and shared over the next several years to improve them and provide valuable information to incorporate into this handbook.

While this handbook has been prepared for the Douglas County region of Lake Tahoe, much of what is included could be useful in other regions. Thus, other regions may wish to use this handbook for the BMP types presented and adapt the handbook guidance for other BMP types not presented.

1.2 Handbook Organization

The handbook is organized to provide stormwater managers with guidance in preparing their stormwater inspection and maintenance programs.

The handbook begins with a summary to provide quick reading on what to expect in the handbook. The second section of the handbook explains the thought process behind creating the inspection and maintenance handbook and how to use it. The how to use the handbook is important introductory reading to guide the reader on how this handbook fits with related information local stormwater managers will need to prepare them in building their own programs.

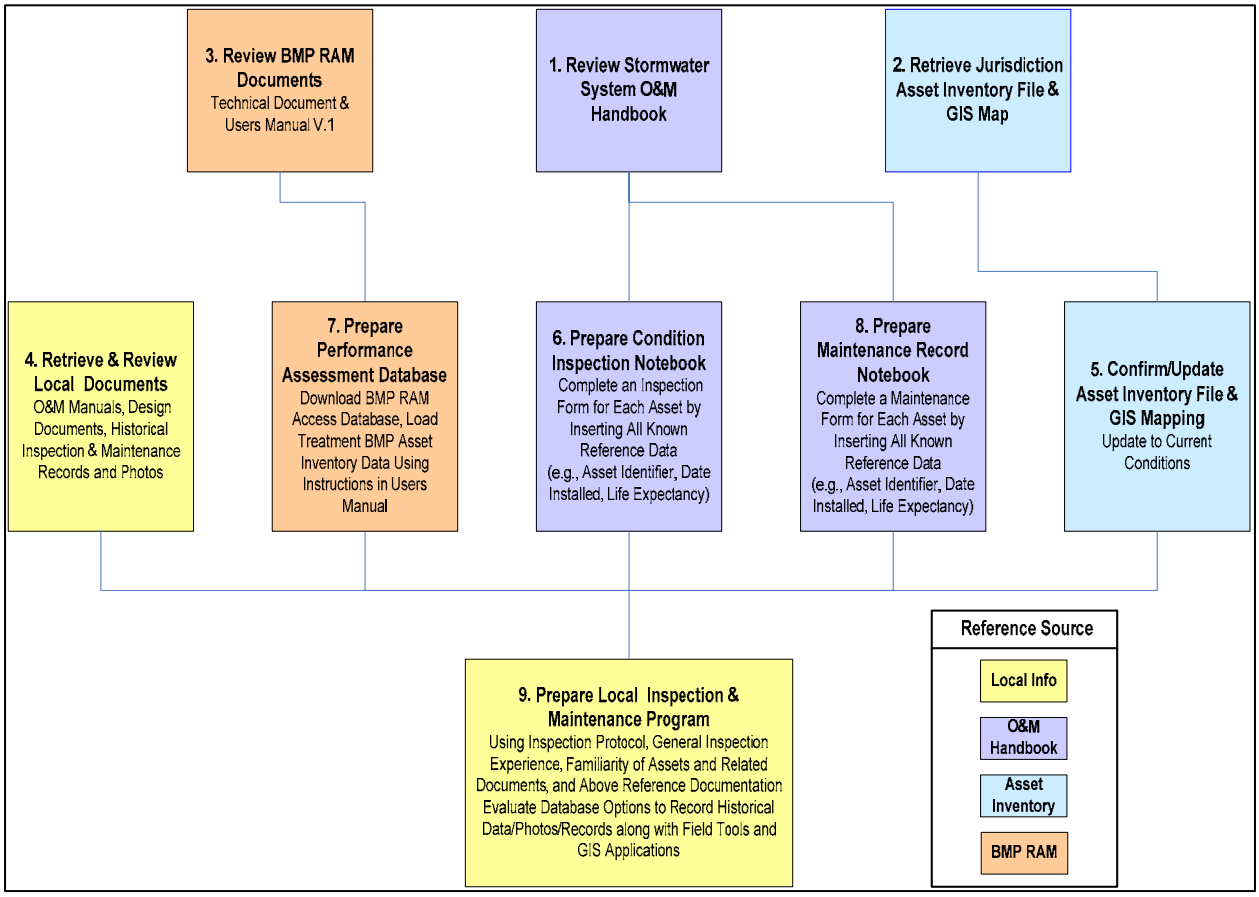
The next three sections provide details on inspection, maintenance, and finally specific information on each BMP type. The inspection section lays out the process and protocols for conducting inspections and discusses the forms used to gather the inspection data. The inspection forms are located in Appendix A. The maintenance section describes the maintenance process and discusses the importance of inspection in determining what and when to perform maintenance. Maintenance forms are also discussed along with reference of the forms to Appendix B. The stormwater system BMP section then discusses the process of categorizing the BMPs (assets) to adapt to maintenance practices and the design life expected for each asset. This section also discusses optional approaches to placing inspection and maintenance data in a database. Finally, this section presents detailed Fact Sheets on each BMP type to provide the reader with summarized information describing the BMP along with concerns, considerations, procedures and schedules for inspection and maintenance.

1.3 How to Use this Handbook

This Operation and Maintenance Handbook is one of several references to be used in developing a stormwater system inspection and maintenance program. Users of this handbook should also retrieve and review related operational and maintenance documents (e.g., device O&M manuals, manufacturer recommendations, design reports) in order to prepare and guide the person responsible for stormwater assets in their jurisdiction to effectively manage their system. Thus the use of the handbook includes discussion of these related documents.

Figure 1 presents a recommended approach for stormwater system managers to develop an inspection and maintenance program using this handbook. This recommended approach is focused on stormwater systems only and may need to be modified when integrated with inspection and maintenance of other assets in the jurisdiction's responsibility. Further, this approach assumes the stormwater system manager understands local/state/federal regulatory and safety requirements and will incorporate these requirements into their specific program.

Figure 1: Building a Stormwater Inspection and Maintenance Program



The nine components of building a local stormwater program are discussed below, providing a typical approach for jurisdictions to organize and prepare their own specific program. This approach is useful in showing how to use this handbook and how to incorporate the asset inventory data and GIS work, prepared as a part of the project, into the local stormwater program. Also shown is the relationship of the BMP RAM inspection process to capture performance data for each treatment BMP. Finally, the relationship of local knowledge, data, and references is presented to complete the sources of information needed. The nine components are presented in a priority order to provide an efficient approach for stormwater managers in developing their program.

1. Review Stormwater System O&M Handbook – This review includes all of the material in this handbook and may require supplemental training or discussion with the authors in order to prepare the local stormwater manager with necessary understanding to apply the procedures/protocols and adapt unique conditions related to their system. Assistance may be needed to understand and conduct inspections as well as provide consistency in scoring results.

2. Retrieve Jurisdiction Asset Inventory File & GIS Map – The asset inventory prepared as a part of this project work is separately reported and includes documentation in both worksheet format (Excel 2003) and GIS format (ArcGIS Desktop 9.2). The inventory database is organized by jurisdiction and includes primarily EIP project assets as shown on Record Drawings. In some cases assets that were not included in EIP projects (e.g., prior project work) are included if these assets were identified on the Record Drawings or identified as a part of field activities verifying assets. Thus, it is possible not all stormwater assets are included in this inventory work and may need to be updated (see step 8). The asset maps can be viewed in GIS format although paper drawings are recommended for field use.

3. Review BMP RAM Documents –The BMP RAM Technical Document and Users Manual V.1 are referenced in this handbook. These documents provide a description of how to develop and conduct an inspection for BMPs that provide stormwater treatment. The field observation datasheets (by Treatment BMP type) identified in the BMP RAM Users Manual are included in the O&M Handbook as Treatment Performance forms, however, the procedure for conducting inspections and developing a treatment performance database (BMP RAM database) is not repeated in the O&M Handbook. Assistance may be needed to understand and conduct inspections as well as provide consistency in scoring results.

4. Retrieve & Review Local Documents – Local documentation on stormwater assets may include record drawings (paper and electronic files), design reports, construction reports/photos, manufacturers recommendations/cut sheets on devices (e.g., vaults), historical records of maintenance/complaints/revisions, cost reports on labor/materials/contractor expenditures, and related operation & maintenance program procedures/protocols (e.g., safety, regulatory, emergency response) considering topics such as hazardous materials/confined space/flooding events. These documents (or understanding if not documented) may need to be revised to comply with current regulatory requirements or field conditions and thus updating these may be needed.

5. Confirm/Update Asset Inventory File & GIS Mapping – Using the data/information from component 2 & 4, the accuracy/completeness of the asset inventory should be determined. It is possible a field inspection may be needed to confirm the asset exists (spreadsheet vs. actual) as well as the location (GIS map). The asset inventory spreadsheet should be updated from this effort although changes/additions should be tracked in order to update the GIS file. Asset identifiers should be added as well as other attributes as shown in the spreadsheet. The location of asset additions/changes should be marked on the GIS map in such a way as to show a change was made. It is recommended the changes be made on GIS file as well.

6. Prepare Condition Assessment Inspection Notebook – This notebook is prepared by compiling condition assessment forms for each BMP asset and placing them in a notebook for field inspection. The forms are included in this handbook and can be printed using the table in Appendix A with hyperlinks to each form. Use the asset inventory to identify how many assets are included in each BMP type and the reference data (e.g., asset identifier, date installed, life expectancy) to place into each inspection form. Note, this notebook should be helpful for each inspection, although managing the data from the inspection may require development of a database and or placing the data into the GIS files for quick reference in the future. Photos to be taken during inspections may also need to be included in a database and or the GIS file. Development of a field tool to take the place of a notebook and record all data including photos is an option that is currently possible and thus may be considered for future assistance where there are large amounts of data and numbers of assets. The field data collection can be incorporated with the GIS database for downloading and thus keeping all historical records in one file. This notebook (or database if developed) will provide inspection results (scoring of the

asset condition from 1-5) that will be needed for analysis by the local stormwater manager to determine need for maintenance.

7. Prepare Treatment Performance Database – The treatment performance database is part of the BMP RAM process and thus performing this task should be based on protocols recommended in the Users Manual V.1. This task involves two steps: 1) load the updated asset inventory from component 5 above for treatment BMPs (assets) into the BMP RAM access database and 2) set the benchmark and threshold values for each BMP (asset) to show where maintenance is triggered. This database is in a separate file and will provide inspection results (scoring of the asset performance from 1-5) that will be needed for analysis by the local stormwater manager to determine need for maintenance.

8. Prepare Maintenance Record Notebook – This notebook is handled in the same way as the condition assessment notebook, except it uses the maintenance record forms and the data collection occurs when maintenance is performed. The forms will only be needed for assets scheduled for maintenance and thus not all assets will need to have forms. The stormwater manager will typically be the person to initiate these forms using the results of inspection analysis (both treatment performance and asset condition inspections). The opportunity for using the same field tool to electronically collect the data and take the place of a notebook can be included in the development of the maintenance application.

9. Prepare Local Inspection & Maintenance Program – Using the information from all above components, along with the knowledge and experience of the stormwater manager, an inspection and maintenance program is created. Options to consider include: who performs what tasks (staff/contractors/local agreements for other resources), when tasks are performed, who analyzes results, training, technology applications, and relationship to and prioritization of related work (e.g. street maintenance, water/sewer maintenance). It is expected that this O&M Handbook and its related Asset Inventory Report will provide a reference to developing a local program such that specific pages can be referred to, forms can be extracted and used, and database and GIS files can be used directly.

2 INSPECTION OF STORMWATER SYSTEMS

Local jurisdictions in charge of maintaining stormwater system assets have been performing asset maintenance since the assets were installed. However, maintenance typically did not include documentation of what was found at each site and such maintenance may not have been required if inspection found the asset was performing as designed or the condition was acceptable. Further, inspection provides needed data to assess if there are concerns that must be addressed as well as the urgency to fix them. Thus, a stormwater system inspection process has been added to provide the needed documentation of actual field conditions and to allow the owners to plan their maintenance activities.

Planning for stormwater system maintenance requires inspection to capture specific conditions of the assets as well as their performance in treating stormwater. This inspection will improve maintenance efficiency and effectiveness and help prepare jurisdictions to meet new Total Maximum Daily Load (TMDL) goals.

2.1 Inspection Process Description

The inspection process generally includes identification of critical information about each asset (condition and performance), providing comparable results for similar assets/conditions and providing a basis for justifying and specifying maintenance. In this handbook, the inspection process is broken out into treatment performance and asset condition. The measurements are

summarized into a score from 1 (worst) to 5 (best) using a process presented for each type of inspection. An inspection score of 2 or less requires maintenance, with 1 or less as urgent.

The inspection process for each BMP type is included in Appendix C: Process Diagrams, with a unique seven step process for each BMP type. The process includes inventory of assets, setting benchmark/threshold values, inspecting and scoring, analyzing and reporting, and re-inspecting. This inspection process includes presentation of specific forms as well as identification of how to perform the inspection for each BMP type (protocol).

This inspection process is used to determine the need for and type of scheduled maintenance and to report on asset performance and condition for basinwide analysis and local planning and budgeting.

2.2 Inspection Forms

Inspection forms were prepared to document important information that can be analyzed to determine need for maintenance and to compare current condition to expected condition for longer term planning. These forms can be found in Appendix A: Inspection Forms and are discussed below.

2.2.1 Treatment Performance Inspection Form

The Treatment Performance inspection form was designed for BMP assets that treat stormwater pollutants, which some assets provide source control but no pollutant treatment. The treatment performance process is documented in the BMP RAM Users Manual V.1 dated September 2009, each BMP RAM Field Observation Datasheet is modified slightly and referred to as Treatment Performance forms for this handbook.

This process was developed by 2NDNATURE, LLC and is copyrighted with license to use it including users of this handbook in accordance with the provisions of the copyright. The treatment performance process is fully documented in the Users Manual with explanations, worksheets, and an access database to record data and identifies performance scores. The information in the BMP RAM Users Manual V.1 is not repeated in this handbook and thus the user of this handbook should refer to that Users Manual. See Section 2.4 Inspection Protocol and the BMP RAM Users Manual V.1 for further information on how to use the Treatment Performance inspection forms and develop the Access database.

2.2.2 Asset Condition Assessment Inspection Form

The Asset Condition Assessment inspection form was designed specifically for this handbook to assess the condition of each BMP asset, which was a major step missing in most maintenance programs. Conducting field observations on individual BMPs allows the jurisdiction to assess the asset condition, which in turn helps evaluate the maintenance needed, create a maintenance schedule, and estimate the remaining life of the asset.

2.3 Inspection Frequency

BMP asset routine inspections should be performed annually in the spring with additional inspections where warranted by the jurisdictions based on complaints or a significant rainfall event. The routine inspection should provide time for scheduling and completing urgent maintenance prior to the following season runoff events.

After the initial inspection, when jurisdictions have a better understanding of the condition of their assets, the inspection optimal time of year and the frequency of inspections should be evaluated for change.

2.4 Inspection Protocol

The following protocol provides general guidance in conducting a field inspection of all BMP assets. There are two major types of protocols presented here: 1) treatment performance and 2) asset condition. These are separated since the treatment performance protocols are developed and presented in the BMP RAM Users Manual and the asset condition protocols are developed in this handbook.

2.4.1 Treatment Performance Inspection Protocol

The treatment performance inspection process is documented in the BMP RAM Users Manual V.1 dated September 2009. This process was developed by 2NDNATURE, LLC and is copyrighted with license to use it, including users of this handbook, in accordance with the provisions of the copyright. The treatment performance inspection process is fully documented in the Users Manual with explanations, worksheets, and an access database to record data and identifies performance scores. The information in the BMP RAM Users Manual V.1 is not repeated in this handbook and thus the user of this handbook should refer to the Users Manual. Jurisdictions can download the BMP RAM Users Manual, Technical Document and database at the following website: TBD

However, a brief description of the Treatment Performance process is as follows: The user of this handbook can use the Treatment Performance form provided in Appendix B or the user can use the BMP RAM Field Observation Datasheets directly from the BMP RAM Users Manual. But, note the BMP asset type names will not match up directly. Refer to the Terminology section for BMP asset name deciphering.

First, the inspection crew uses the asset inventory database to fill in the background information. The crew heads into the field where treatment performance tests are performed. The tests performed include: measuring the amount of accumulated material, measuring the drainage inlet (sediment trap) and treatment vault sump capacity, quantifying the vegetation cover, testing the infiltration capacity with a Constant Head Permeameter, quantifying the amount of runoff that is not infiltrating, and determining if conveyance is obstructed. Each testing category is referred to as a 'factor.' Please refer to the BMP RAM Users Manual for manhours, equipment, and specific observations required to complete the performance factors, see Table 1 for user manual page numbers. Based on the results of each factor, the crew fills out the form in the field.

Table 1: Performance Test Page Numbers, BMP RAM Users Manual V.1

Factor (Performance test)	BMP RAM Users Manual Page Number
Constant Head Permeameter (CHP)	49-52
Infiltrometer	53-54
Material Accumulation	55-57
Runoff	58-59
Sediment Trap Capacity (Drainage Inlet)	60
Treatment Vault Capacity	61-62
Vegetation Cover	63-64

With the form complete, the results are entered into the BMP RAM Access database provided with BMP RAM Users Manual. The database will compute a score for each asset based on the treatment performance test results. Jurisdictions must use the BMP RAM Access database and scoring procedures provided by the BMP RAM Users Manual V.1 to complete the Treatment Performance inspection form. The BMP RAM Score Scale is presented in Table 2. If the score is 2 or below, planned maintenance must be scheduled and performed in a timely manner.

Table 2: Treatment Performance Inspection Form Scoring Scale, *BMP RAM Users Manual V.1*

Table ES.2 BMP RAM Scores relative to Treatment BMP condition and relative maintenance urgency.			
BMP RAM Score	**Condition**	**Maintenance Urgency**	**Description**
0 - 1.0	Failure	**Required**	Little to no downgradient water quality benefit and downgradient water quality may be adversely affected due to failure of Treatment BMP function. Maintenance required immediately.
> 1.0 - < 2.0	Below Acceptable		Treatment BMP load reduction potential is below acceptable condition. Maintenance is required prior to next runoff event.
2.0	Threshold		Threshold condition set by user that corresponds to condition where maintenance is required.
> 2.0 - < 3.0	Acceptable	**Moderate**	Acceptable downgradient water quality benefit, but Treatment BMP condition is closer to threshold than benchmark. Maintenance should be performed if time and resources permit.
> 3.0 - < 5.0		**Low**	Acceptable downgradient water quality benefits. No immediate maintenance needed.
5.0	Benchmark	**None**	Maximum achievable downgradient water quality benefit for the specific Treatment BMP. No maintenance actions needed.

2.4.2 Asset Condition Assessment Inspection Protocol

Asset condition is broken out into 6 factors, based on the features of each BMP type. Below is a presentation of the general approach to inspecting each BMP type with more specific suggestions for each factor.

2.4.2.1 *General*

Conducting field observations on individual BMPs allows the jurisdiction to assess the asset condition, which in turn helps evaluate the maintenance needed, create a maintenance

schedule, and estimate the life of the asset. By evaluating all of Lake Tahoe's assets' condition, jurisdictions are helping protect and reduce the pollutant issues threatening Lake Tahoe. To make the field observations useful and worthwhile, please read the following Asset Condition Assessment protocols prior to entering the field.

Preparation:

- Inspections should be conducted in the spring.
- Avoid making observations within 24 hours of most recent significant runoff event.

Personnel Required:

- One or two (ideal) field workers will require 3-10 minutes to access BMP and make an observation at each field site.

Equipment:

- Inspection forms
- Field notebook
- Camera (batteries)
- Flashlight
- Sharpie/pens
- Manhole cover remover, as needed
- Steel rod, screwdriver, etc (something to probe conveyance pipes for deterioration), as needed
- Appropriate equipment/supplies for your person (water, hat, sunscreen, etc)
- Construction or installation photos- with a lack of recorded asset condition information, initial construction/installation photos are a great help to determine existing asset condition.

Good Field Practices:

- Follow protocols and do not rush when filling out data sheets. Inspection crew must ensure all critical information is recorded in the datasheets during observations and data entry errors are avoided.
- A field notebook is an essential piece of equipment in each field protocol, and crew members should use it to document any additional information, observations, problems encountered, equipment needs, maintenance needs, etc.
- Photos are very useful records and should be categorized by catchment and date. Make it a standard practice before leaving a site to take the time to write down and detail any useful notes.

Confined Space:

- Due to the inability of uncertified personnel to enter a confined space, only qualitative observations of confined assets can be made by the jurisdiction.
- Any BMP asset contained within confined space will require subsequent detailed evaluation (likely defined by the manufacturer and maintenance specifications) of the BMP condition beyond what the field observations can provide.

Complete the field observations required for each asset of interest. Score each factor based on a 1-5 scoring system. The Asset Condition Assessment scoring scale is based on the same 1-5 scale as the BMP RAM Treatment Performance scoring scale. Each asset could have up to five different factors (listed below) per Asset Condition Assessment form. If the

inspection crew scores even one factor with a 2 or below, planned maintenance must be scheduled and completed.

Scoring System:

- The Asset Condition Assessment score system is based on 1-5, with 1 being poor and 5 being excellent condition.
- Use professional judgment when determining a score.
- The scoring system is subjective, but will become more objective as inspectors are trained and complete multiple inspections.
- A Very Poor, score = 1, score means the asset:
  - poses a safety risk
  - violates a compliance discharge limit
  - potential to harm downstream habitat, structures, surface water, etc.
  - immediate action required
- A Poor, score = 2, score means the asset:
  - needs maintenance before the next significant storm.
- An Average, score = 3, score means the asset:
  - keep a close eye on the asset
  - re-inspected in approximately 12 months
  - no immediate maintenance required
- A Good, score = 4, score means the asset:
  - normal wear and tear for asset
  - no immediate maintenance required
- An Excellent, score = 5, score means the asset:
  - like new with no damage
  - maintenance not required.

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

Listed below are the six different factors the inspection crew must observe while in the field. No tests need be performed for the Asset Condition Assessment form, only observations.

2.4.2.2 ***Conveyance Obstruction***

Objective: Visually determine if the BMP's functioning capability is compromised by obstructions in the conveyance system.

Observations:

- Has a runoff event occurred in the past 24 hours (yes/no)?
  - If yes, return at time when answer is NO.
- If no, then continue looking for evidence of conveyance obstruction.
- Circle all evidence (obstructed flow, connection failure, etc) of conveyance obstruction witnessed at field site.
- Briefly describe the extent of the conveyance obstruction and score the overall condition.
- Be aware that not all evidence listed will apply to this asset.

Conveyance Obstruction	
Evidence of: (circle)	obstructed flow sediment/debris accumulation sediment in traps plugged dewatering holes joint/connection failure other
Describe extent of issues:	
Score Conveyance Obstruction Overall Condition 1 – 5 based on observations and scale below	

2.4.2.3 *Erosion Damage*

Objective: Visually determine if the BMP's functioning capability is compromised by erosion damage.

Observations:

- Has a runoff event occurred in the past 24 hours (yes/no)?
  - If yes, return at time when answer is NO.
- If no, then continue looking for evidence of erosion damage.
- Circle all BMP parts (foundation, spillway, flared ends, etc) that are damaged.
- Circle all evidence (dislodging armoring, sediment accumulation, etc) of erosion damage witnessed at field site.
- Briefly describe the extent of the erosion damage and score the overall condition.
- Be aware that not all evidence listed will apply to this asset.

Erosion Damage	
Evidence of erosion **to**: (circle)	foundation check dams flared ends conveyance system inlets outlets spillway embankments other
Describe extent of issues:	
Evidence of: (circle)	exposed fabric edges breach in check dam lack of armoring (veg or rock) unstable contributing areas dislodged rock armoring sediment accumulation bed liner failure other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	

2.4.2.4 *Hazardous Materials*

Objective: Visually determine if the BMP's functioning capability is hindered by hazardous materials.
Observations:

- Has a runoff event occurred in the past 24 hours (yes/no)?
  - If yes, return at time when answer is NO.
- If no, then continue looking for evidence of hazardous material. Circle all that apply.
- Briefly describe the extent of the hazardous material and score the hazardous materials overall condition.
- Be aware that not all evidence listed will apply to this asset.

Hazardous Materials		
Evidence of: (circle)	oil/grease gas/fuel other chemicals poor water color/clarity odors algae/weeds foam stains/deposits trash/debris dumping other	
Describe extent of issues:		
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below		

2.4.2.5 ***Structural Damage***

Objective: Visually determine if the BMP's functioning capability is compromised by structural damage.

Observations:

- Has a runoff event occurred in the past 24 hours (yes/no)?
  - If yes, return at time when answer is NO.
- If no, then continue looking for evidence of structural damage.
- Circle all processes that caused the structural damage
- Circle all structure parts (fence, inlet, dam, etc) that are damaged.
- Briefly describe the extent of the structural damage and score the overall condition.
- Be aware that not all evidence listed will apply to this asset.

Structural Damage	
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water corrosion freeze/thaw settling cracking bulging/bowing misalignment u.v. deterioration design flaws parging/spalling connection/collar failure collapsing/failing leaks other
Describe extent of issues:	
Evidence of damage **to**: (circle)	access roads fences gates locks safety features spillway inlet outlet manholes steps frames covers signs dam other
Describe extent of issues:	
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below	

2.4.2.6 *Vector Damage*

Objective: Visually determine if the BMP's functioning capability is compromised by vector damage.

Observations:

- Has a runoff event occurred in the past 24 hours (yes/no)?
  - If yes, return at time when answer is NO.
- If no, then continue looking for evidence of vector damage. Circle all that apply.
- Briefly describe the extent of the vector damage and score the vector damage overall condition.
- Be aware that not all evidence listed will apply to this asset.

Vector Damage				
Evidence of: (circle)	waterfowl degrading water quality	animal burrows other	beaver dams	ponded water breeding ground (mosquitoes, etc.)
Describe extent of issues:				
Score Vector Damage Overall Condition 1 – 5 based on observations above and scale below				

2.4.2.7 *Vegetation Cover*

Objective: Qualitatively estimate the relative density of each type of vegetation and visually determine if the Bare Soil Cover's functioning capability is compromised by certain disturbances.

Preparation:

- Qualitative estimates of % cover can be difficult and subject to user discretion. To improve the consistency of the observation results across users, upon arrival to the site the user should walk the entire boundaries of the BMP and visually determine the BMP boundaries.
- Visually identify areas within the boundary that may possess different elevations, different vegetative species, different ground water access, different soil type, etc.
- These differences help users estimate % cover and pin point vegetation cover problems.

Observations:

- Has a runoff event occurred in the past 24 hours (yes/no)?
  - If yes, return at time when answer is NO.
- If no, then continue looking for evidence of vegetation cover disturbances.
- Circle all evidence (obstructed flow, connection failure, etc) of vegetation cover disturbances witnessed at the field site.
- Briefly describe the extent of the vegetation cover disturbances and score the overall condition.
- Be aware that not all evidence listed will apply to this asset.

Vegetation Cover					
Groundcover %	Mulch %	Impervious %	Other %	Bare Soil %	Total = 100%
Evidence of: (circle)	exposed soil steep slopes rills/gullies thin litter/mulch recent wildfire irrigation failure parking/compaction lack of vegetation other				
Describe extent of issues:					
Score Vegetation Cover Overall Condition 1 – 5 based on observations above and scale below					

2.4.2.8 ***Inspection Summary***

Objective: Summarize or expand upon the condition of the asset in question. Please add evidence of damage not afore mentioned, or expand upon the extent of the asset conditions.

If the inspection crew is unsure of the maintenance problem or does not fully understand the asset condition, note the need to research the design and maintenance specifications and/or consult an expert.

Inspection Summary
Summary/Additional Comments:

Analyze Results:

Following each Asset Condition Assessment field inspection, the jurisdiction can analyze the results to prioritize immediate maintenance needs. If any one factor within an asset condition assessment inspection form receives a score or 2 or below, planned maintenance must be scheduled and completed.

2.4.3 Inspection Scoring Factor Summary

A summary of the inspection scoring factors is presented in Table 3 below. The summary is intended to provide a quick view of all BMP types and show when a score is expected from the inspection process. Note the treatment performance forms are only required for treatment assets and it is based on a process developed by 2NDNATURE, LLC.

Table 3: Inspection Scoring Factor Summary

Douglas Stormwater Program		Treatment Performance Score (see BMP RAM for Score Factors)	Asset Condition Scoring by Factor					
BMP Type	GIS code		Conveyance Obstruction	Erosion Damage	Hazardous material	Structural Damage/ Asset Condition	Vector Damage or Hazard	Vegetation Cover
Bare Soil Cover	BS	None	None	Score	None	Score	None	Score
Bed Filter	BF	Score	None	Score	Score	Score	Score	None
Conveyance Piping	CP	None	Score	Score	Score	Score	None	None
Curb & Gutter	CG	None	Score	Score	Score	Score	None	None
Drainage Inlet	DI	Score	None	Score	Score	Score	Score	None
Drainage Outlet	DO	None	Score	Score	None	Score	Score	None
Dry Basin	DB	Score	None	Score	Score	Score	Score	None
Infiltration Basin	IB	Score	None	Score	Score	Score	Score	None
Infiltration Feature	IF	Score	None	None	Score	None	Score	None
Manhole	MH	None	Score	Score	Score	Score	None	None
Retaining Walls	RW	None	None	Score	None	Score	Score	None
Riprap Slope Stabilization	RS	None	None	Score	None	Score	None	None
Rock Lined Channel	RC	Score	None	Score	Score	Score	Score	None
Treatment Vault	TV	Score	None	Score	Score	Score	Score	None
Vegetated Swale	VS	Score	None	Score	Score	Score	Score	None
Wet Basin	WB	Score	None	Score	Score	Score	Score	None

3 MAINTENANCE OF STORMWATER SYSTEMS

The goal of maintenance management is defined by Grigg[3] as caring for assets to ensure maximum performance and longevity, obtaining the highest yield from investment in the asset. The investment in stormwater assets in Lake Tahoe over the last 20 or more years has been 10's to 100's of millions of dollars depending on the region selected. Getting the most from this investment requires an effective maintenance program. Effective maintenance programs include routine inspection to establish when/where/what maintenance to perform.

Typically the components of stormwater systems in Douglas Tahoe region do not have routine failure frequencies or other measures that would establish a known frequency for routine repair or action, such as in removal/replacement of filters. There is reason to schedule routine cleaning based on vegetative conditions or snow melt such as spring and fall. All other maintenance is reasonably scheduled based on inspection results. Thus, maintenance of stormwater systems will depend on the results of inspection which can range from targeted cleaning, contaminated soil removal, sediment removal, structure repair, and vegetation replacement.

[3] Neil S. Grigg, CRC Press LLC, 2003. Water, Wastewater, and Stormwater Infrastructure Management

The process for maintenance is presented to show how inspection and maintenance are integrated for a majority of the maintenance program needs and a recommended approach to tracking maintenance work using a maintenance form for all field work (staff/contractor).

3.1 Maintenance Process Description

The maintenance process includes routine maintenance and inspection driven maintenance based on results of each inspection. Routine maintenance is performed on a scheduled basis and is limited to cleaning tasks.

The inspection driven maintenance process is as follows: analyze inspection results, determine maintenance tasks, schedule maintenance work, perform maintenance work, record maintenance actions and cost, and measure the results. The general inspection driven maintenance process is typically a seven step process as shown in Figure 2 below. The seven steps provide a continuous process to inventory, inspect, and maintain each asset to assure it is meeting the requirements expected and to achieve the design life. The steps are discussed below:

1. An inventory of each asset (Asset Inventory Database) was developed with a listing of important attributes (e.g., installation date, location, size, material, design details, and unique identifier number). During field inspection this may be updated if changes are observed in the field. Finally, each asset category is verified confirming its function as a BMP.

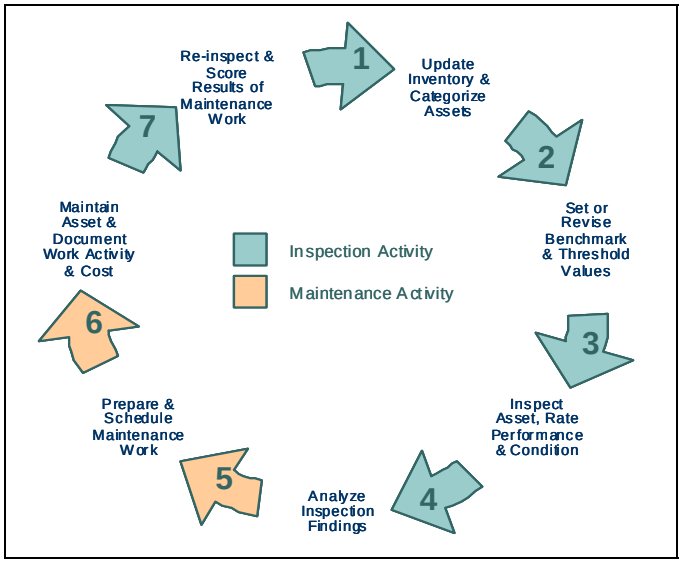


Figure 2: Seven Step Process, BMP RAM Users Manual V.1

2. The best (benchmark) and minimum (threshold) levels of asset performance and condition is determined to set scales on when to perform maintenance. A process to identify these levels for treatment assets (i.e., dry basin, wet basin, infiltration basin, bed filter, treatment vault, vegetated swale, rock lined channel, infiltration gallery, and drainage inlet) is presented in the BMP RAM Users Manual. The best (benchmark) level of asset conditions is based on new conditions with accommodation for actual age allowing for normal wear and tear. The minimum (threshold) level of asset condition is

based on experienced judgment of the inspector using the scoring guide on the inspection form.

3. Inspection of each asset is performed according to a recommended frequency to score the treatment performance and asset condition. This step requires an inspection protocol (included in this handbook), inspection forms (included in this handbook), and equipment and trained personnel. Each asset inspection will conclude with a score for condition and a score for treatment performance (Inspection Protocol section, BMP RAM Users Manual). If any of these scores are at or below 2, then maintenance should be planned and scheduled.
4. Inspection findings are analyzed to prioritize the maintenance work and to report on overall performance and condition of BMPs in the jurisdictions.
5. Maintenance prioritization should take into consideration the inspection form score, public health, safety hazards, location in the watershed, and the proximity to stream systems. Each jurisdiction must prioritize based on each individual watershed.
6. Maintenance plans are prepared to specify the work to be performed, desired schedule, and assign personnel or contractors to do the work.
7. Maintenance work is performed to correct the problems identified in the inspection report using recommended maintenance plans from step 6. The maintenance work is documented using forms in this handbook.
8. Asset re-inspection is performed and documented following maintenance to record the improved asset performance and condition. This inspection step may be performed as a final task during the maintenance work.

This general seven step process is developed in more detail for each BMP type in Appendix C (see steps 4-7). The inspection driven maintenance can result from either routine inspection (e.g., annual) or inspection due to a complaint or noticeable problem or significant runoff event.

3.2 Maintenance Frequency

The maintenance procedures are broken out into routine and those in response to inspection. Routine maintenance should be performed in the spring and fall on BMPs that accumulated debris as suggested in Table 4. Routine maintenance is maintenance on assets that typically jurisdictions have been performing.

Table 4 lists the recommended maintenance frequency for all 16 BMP assets. Inspection driven maintenance is the direct result of a poor inspection score (≤2) and a frequency can not be recommended until the inspection process is complete and the asset receives a score of 2 or lower.

Table 4: Maintenance Frequency Schedule

Stormwater Program BMP Type		Maintenance Frequency	
Description	GIS Code	Routine	Response to Inspection
Bare Soil Cover	BS	None	As Needed
Bed Filter	BF	Twice Per Year	As Needed
Conveyance Piping	CP	None	As Needed
Curb & Gutter	CG	Twice Per Year	As Needed
Drainage Inlet	DI	Twice Per Year	As Needed
Drainage Outlet	DO	None	As Needed
Dry Basin	DB	Twice Per Year	As Needed
Infiltration Basin	IB	Twice Per Year	As Needed
Infiltration Feature	IF	None	As Needed
Manhole	MH	None	As Needed
Retaining Wall	RW	None	As Needed
Riprap Slope Stabilization	RS	None	As Needed
Rock Lined Channel	RC	None	As Needed
Treatment Vault	TV	Twice Per Year	As Needed
Vegetated Swale	VS	Twice Per Year	As Needed
Wet Basin	WB	Twice Per Year	As Needed

Maintenance scheduled in response to inspection is variable and depends on the observed problem. The jurisdiction will need to determine what maintenance tasks need to be preformed and resources to correct problems found in the inspection. The jurisdiction may consider organizing and scheduling maintenance tasks by grouping similar work to fit staff or contractor capabilities and availability. Consideration of the best method to plan and schedule maintenance work will benefit from the inspection work and over time the inspection process and forms may be modified to best fit efficient planning for the maintenance tasks.

3.3 Maintenance Forms

Maintenance forms are provided to document all scheduled work. A form for recording the maintenance work on individual BMP assets is included in Appendix B: Maintenance Forms. The form includes identification of all maintenance resources (staff/contractor, equipment, and materials), time to perform and comments from the maintenance staff for future consideration or if further work is needed. The purpose of documenting the time, resources and tasks performed include tracking the level of effort and cost to maintain the assets as well are reviewing efficiency of the work where new procedures/equipment are used.

4 STORMWATER SYSTEM BEST MANAGEMENT PRACTICES (BMPS)

Stormwater BMPs in the Lake Tahoe Basin included in this O&M Handbook are the permanent structural improvements that achieve source control, hydraulic control, or pollutant treatment to reduce the impacts of erosion and or stormwater runoff. These BMPs have been defined in various national/state/local references. The Tahoe Regional Planning Agency (TRPA) BMP Handbook reference most focused on what is used in the basin[4]. The TRPA BMP Handbook is currently under revision and was not available for reference in this handbook.

The stormwater BMP types referenced in this handbook have a common designation to their assets since they are structural and thus the term BMP type and asset type are synonymous for this handbook. This is discussed further in asset categorizing in this section.

In this section of the handbook, a brief discussion of each BMP (asset) type is provided to prepare the reader for inspection and maintenance work. This briefing includes how the terminology was selected for each type, expected asset life for each BMP type, reference to asset inventory for the Douglas Tahoe EIP project database, and a fact sheet for each BMP (asset) type. The fact sheets are intended to be a quick reference for the reader to review and clarify important information about each BMP type related to objectives/schedules/considerations/description and include photos for examples and other quick reference data to consider in building an inspection and maintenance program.

4.1 Asset Categorizing

In the Tahoe Basin, there were over 20 permanent structural BMP types that had been identified with stormwater projects. When these BMPs were reviewed and inventoried for each jurisdiction in the Douglas Tahoe region, 16 BMP types were selected as unique types based on their maintenance requirements. These 16 BMP types were selected for this handbook by first listing all BMP types and determining if any were physically connected such that the maintenance practice would typically involve the combined assets rather than a separate and individual maintenance on each. The drop inlet and sediment trap was found to meet this combined category typically. The combined BMP was re-titled drainage inlet and the maintenance practice included cleaning the inlet grating and sediment trap. This drainage inlet was also found to include horizontal inlet structures with or without gratings as entrance structures to conveyance piping, yet the maintenance practice remained similar so the categorizing met the test of reviewing for common maintenance practices.

A second categorizing test was to determine if there were assets associated with the BMP that were not considered a BMP type but needed maintenance. In this case, the manhole asset was selected as an asset category since it was determined to have a unique maintenance practice and it is an important asset to maintain hydraulic control of stormwater flows.

Finally, the BMP types were compared with those selected by the BMP RAM project to see if common terminology was used. In this case, several BMP types were re-titled to be consistent with the terminology in the BMP RAM. In three cases the BMP RAM terminology was not selected—drainage inlet, rock lined channel and vegetated swale. The reason drainage inlet was selected is described above (combined with sediment trap). The term rock lined channel

[4] Tahoe Regional Planning Agency. November 2008. Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Best Management Practices.

was selected for this handbook over infiltration feature since the maintenance practice for a channel is different from other BMP types listed as similar in the BMP RAM. Finally, the term vegetated swale was selected for this handbook over the BMP RAM term Biofilter, again based on unique maintenance practices.

Table 5 presents a brief description of each BMP (asset) type with distinguishing features, BMP RAM terminology, and alias terminology commonly used. The table also identifies each BMP (asset) type's expectation to include infiltration or pollutant reduction as a characteristic of the asset, and identification of the structural BMP to perform as a source control, hydraulic control, and or pollutant treatment BMP. This table attempts to provide a listing with common terminology to be used in the basin for description of structural assets to receive inspection and maintenance. Establishing common terminology for BMP (asset) types is expected to evolve over time as owners, regulators, monitoring entities and others begin to collect and share data. This handbook provides an initial step in establishing common terms and since these are not expected to be final, alias terms have been added where needed to provide the reader with optional names for assets.

Table 5: BMP Asset Types for Maintenance

No.	GIS Code	BMP Type (Asset) Terminology			Structural BMP Category			Expected Infiltration	Expected Pollutant Reduction	Description & Distinguishing Features
		O&M Handbook	BMP RAM	Alias	Source Control	Hydraulic Control	Pollutant Treatment			
1	BS	Bare Soil Cover	Not Included	Vegetated Cover, Reveg Area	✓			Yes	None	Land cover with vegetation to reduce erosion of surface flows and stablilize sloped surfaces.
2	BF	Bed Filter	Bed Filter	Basin			✓	None	Yes	Basin or filter control structure and underdrain to collect treated water for transport out of the basin. Minimal vegetation.
3	CP	Conveyance Piping	Not Included	CMP		✓		None	None	Metal/plastic material pipes (underground) to provide hydraulic control of surface flows between source controls and treatment systems.
4	CG	Curb & Gutter	Not Included			✓		None	None	Concrete/asphalt structure to provide hydraulic control of surface flows between source controls and treatment systems.
5	DI	Drainage Inlet	Sediment Trap	DI, Drop Inlet, Catchment Basin		✓		None	None	Structure that include a drainage Inlet (or edge drain) and usually a sediment trap/catch basin to store surface flows allowing sediment to accumulate.
6	DO	Drainage Outlet	Not Included			✓		None	None	Structure at oulets of conveyance piping or basin that discharge to open surface water system and may include energy dissapator.
7	DB	Dry Basin	Dry Basin	Basin			✓	Yes	Yes	Basin with outlet overflow to provide for storage and controlled sedimentation. Minimal vegetation.
8	IB	Infiltration Basin	Infiltration Basin	Basin			✓	Yes	Yes	Basin has no storage for sedimentation only used for infiltration. Minimal vegetation.
9	IF	Infiltration Feature	Infiltration Feature	Infiltration Gallery			✓	Yes	Yes	Infiltration system to temporarily store surface flows and divert underground by infiltration.
10	MH	Manholes	Not Included			✓		None	None	Structure at grade break locations in conveyance piping to provide for inspection and connection of piping structures.
11	RW	Retaining Walls	Not Included		✓			None	None	Structure to retain slopes adjacent to roadways.
12	RS	Riprap Slope Stabilization	Not Included		✓			None	None	Land cover to reduce erosion of surface flows and stablize sloped surfaces.
13	RC	Rock Lined Channel	Infiltration Feature			✓	✓	Yes	Yes	Land cover to increase infiltration and reduce erosion of surface flows
14	TV	Treatment Vault	Treatment Vault				✓	None	Yes	Vault structure with various configurations to separate sediments from stormwater flows. No infiltration.
15	VS	Vegetated Swale	Biofilter			✓	✓	Yes	Yes	Pervious substrate with dense vegetation coverage to achieve infiltration and nutrient reduction in surface flows
16	WB	Wet Basin	Wet Basin	Basin, Wetland			✓	None	Yes	Basin, typically wet with effective vegetation species providing for nutrient and sediment removal

4.2 Asset Design Life Expectancy

Environmental Improvement Program (EIP) projects have been installed in the Tahoe Basin since the early 1990s. Other projects prior to the EIP were installed as far back as the 1950's and 60's. Although the stormwater system assets installed with these projects were designed to last a long time, they will not last forever. Depending upon the asset type and material, life expectancy is anywhere from five to fifty years as shown in Table 6. The design life in Table 6 was developed from a survey of the designers of the Douglas Tahoe consultants and several Tahoe Basin implementers each with over 20 years of experience in Lake Tahoe BMP design and or maintenance. The design life has been identified as a range since many local conditions can affect design life including the level of maintenance provided and potential for damage from snow plows, temperature, road salt, vandalism, construction techniques and quality, exposure to erosion and high stormwater flows, and materials used. This range provides a further need to perform inspection on each asset to determine the asset condition and potential for failure or need for major maintenance/replacement as the asset enters the design life range.

Table 6: BMP Design LIfe

BMP Type	Type/Material	Asset Design Life in Years (Time when replacement needed to achieve desired performance)	Comments
Bare Soil Cover	Various	**indefinite**	Assumes native vegetation
Bed Filter, Wet Basin, Dry Basin, Infiltration Basin	Various	**30-50**	Reduce life if fines not removed prior to infiltraton or suffocation of root zone occurs. Dry detention basins may last 50 yrs or more. Assumes yearly maintenance
Conveyance Piping	HDPE	**20-50**	
	PVC	**20-40**	
	Concrete	**30-50**	
	Metal/Steel	**10-30**	
Curb & Gutter	Various	**5-20**	Shorter life in high snow removal zone. AC damaged by snow plows.
Drainage Inlet	Various	**20-30**	
Drainage Outlet	Various	**20-30**	
Infiltration Feature	Various	**5-15**	Depending on soils and fines present
Manholes	Various	**30-50**	
Retaining Walls	Timber	**10-30**	
	Block/Rock	**25-50**	
Riprap Slope Stabilization	Various	**30**	
Rock Lined Channel	Various	**5-30**	
Treatment Vault	Various	**20-50**	
Vegetated Swale	Various	**5-25**	

With 2010 approaching, some assets in the Douglas Tahoe region have been installed for close to twenty years and are expected to be nearing their design life. The EIP projects in Douglas Tahoe have totaled over $35 million since 1990. Typically the grant funding for these projects has required recipients to provide maintenance for 20 years or more. In order for the project assets to perform to meet design expectations, maintenance should be provided forever. This means at some point major maintenance and or replacement should be anticipated as the asset nears its design life.

Examples of Douglas Tahoe asset age vs. design life are shown in Figure 3, representing life cycles and actual age of assets for curb & gutter and rock lined channel. Note in these examples, the asset age has in all cases begun to enter the design life range and thus some of these assets may be found to require major maintenance or need to be scheduled for replacement in the next few years.

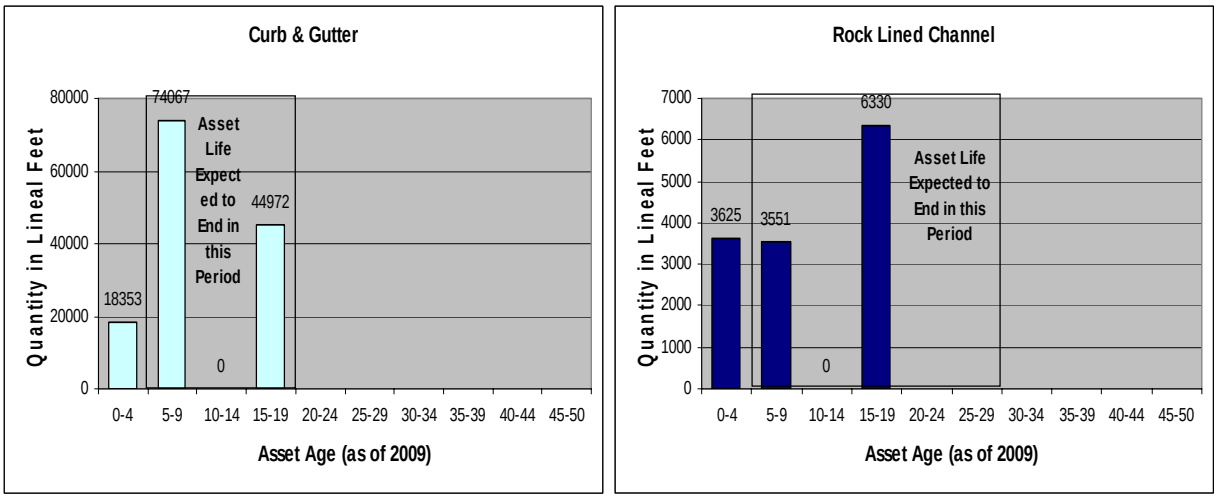


Figure 3: Douglas Tahoe Asset Age vs. Design Life – Curb & Gutter and Rock Lined Channel

The identification of asset age with expected design life as shown in the examples provides a quick reference to asset owners of the need to verify asset conditions and performance as well as planning for major maintenance work.

4.3 Asset Inventory Database

A prior task for this entire project was to create an asset inventory database. The asset inventory database organizes all Douglas Tahoe Environmental Improvement Program (EIP) projects: project cost, funders, installation date, engineer and contractor, and number and amount of each BMP asset within each project. The asset inventory database also gives each BMP a specific asset identifier, which is needed during the inspection process (discussed below). The inventory database also lists the installation date, which tells the inspector the asset age and gives the inspector a better perspective on the wear and tear of the asset which is helpful when determining an inspection score. The asset inventory database is included with the asset inventory report for this project and is also available through the Nevada Tahoe Conservation District.

4.4 Stormwater System Fact Sheets

The 16 BMP types used in Douglas Tahoe are described in the following pages to provide guidance to users of the handbook in understanding each BMP type and describing what should be done to inspect and maintain the assets. The owners of the stormwater assets should review these pages and become familiar with each of the assets they have in their jurisdiction.

The description, concerns, objectives, goals, considerations, procedures and schedules presented here provide important guidance in planning and performing maintenance. This information is supplemented with materials in the appendices that provide inspection and

maintenance forms to document observations and actions taken, process diagrams to show the sequential steps and tasks to be performed for each asset type, and references to review for additional information. Reviewing and applying the information contained in this portion of the handbook is intended to support an efficient and effective maintenance program that extends the productive life of the stormwater assets and ensures treatment performance to meet current and future requirements.

BARE SOIL COVER

General Description

Bare soil cover, for the purposes of this handbook, is land cover to reduce erosion of surface flows and stabilize sloped surfaces. The land cover is often vegetation, but can be mulch, erosion blankets, or jute matting. By establishing perennial vegetative cover, stormwater runoff and erosion can be minimized on disturbed areas. Bare soil cover reduces erosion and sediment loss and provides permanent stabilization. This practice is economical, adaptable to different site conditions, and allows selection of a variety of plant materials.

Bare Soil Cover Example of Need to Prevent Vehicle Use

Bare Soil Cover Example: L to R 1) 2001 Cleared 2) 2003 Vegetation 3) 2009 Vegetation

Vegetation controls erosion by protecting bare soil surfaces from displacement by raindrop impacts and by reducing the velocity and quantity of overland flow.

The effectiveness of vegetation can be limited by high erosion during establishment, the need to reseed areas that fail to establish, limited seeding times, or unstable soil temperature and soil moisture content during germination and early growth. Vegetation does not immediately stabilize soils; therefore, use temporary erosion and sediment control measures to prevent pollutants from disturbed areas from being transported off the site.

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
X		

Asset Effectiveness

- Source Control

Targeted Constituents

- Suspended Sediment
- Fine Sediment Particles

Maintenance Concerns, Objectives, and Goals

- Slope Stability
- Erosion Control
- Vectors (rodents)
- Aesthetics

Inspection/Maintenance Considerations

Maintenance for vegetated areas will vary depending on the level of use expected. Plants must be able to persist with minimal maintenance over long periods of time. Sites suitable for low-maintenance vegetation include steep slopes, stream or channel banks, some commercial properties, and "utility" turf areas such as road banks.

Successful vegetation has the following characteristics:

- Vigorous dark green or bluish green (not yellow) seedlings
- Uniform density, with nurse plants, legumes, and grasses well intermixed
- Green leaves that remain green throughout the summer--at least at the plant bases

Perennial vegetative cover from seeding has been shown to remove between 50 and 100 percent of total suspended solids from stormwater runoff, with an average removal of 90 percent (USEPA, 1993).

Where vegetation is not able to be maintained following installation, expertise may be needed to assess conditions and make recommendations. In the Tahoe Basin, concerns with maintaining vegetation range from growth cannot be maintained after watering is stopped, hillside slope is south/west facing making it difficult to handle summer conditions, and wildlife feeds on the vegetation and optional vegetation has been tried with no success. More work on providing options and support to areas where growth has been found to be difficult.

Inspection Schedule and Preparation

Inspect: minimum every year in spring

Forms: Asset Condition Assessment

Equipment (Bare Soil Cover specific):

- Staff plate (to measure soil erosion at toe of slope)
- Erosion pins (to measure soil erosion on hillslope)

The inspection crew may want to install a staff plate or erosion pins to help monitor soil creep, woody vegetation encroachment, or extensive erosion.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Bare Soil Cover specific):

- Seed, shrubs, trees if revegetation needed
- Erosion blanket, waddles, coir logs, jute matting if slope stability needed
- Irrigation supplies if needed
- Rake, shovel
- Fertilizer, top soil, soil amendments
- Revegetation specialist for expert advice

Bare Soil Cover for most EIP projects in Douglas County refer to revegetation areas, so depending on the state of the revegetation area, the maintenance crew may need a rake to clean up litter and pine needles or a revegetation specialist may need to be called in to assess the problem.

BED FILTER

General Description

A bed filter is a shallow basin that is designed to treat stormwater. Bed filters use the natural filtering ability of the soil to remove pollutants in stormwater runoff. A bed filter is hydraulically similar to infiltration basins except the runoff is filtered through the bed (soil), collected into an underdrain, and discharged to an outlet rather than being infiltrated to the local unsaturated zone. Little to no stormwater volume is lost, yet sediment and pollutants are captured via filtration through the bed material. Bed filters function as long as infiltration capacity is upheld and vegetation is kept at a minimum (not usually a problem in the Tahoe Basin, since getting vegetation to grow can be a challenge).

Bed Filter: This basin looks like a dry basin but has an underdrain to carry flows back to the surface

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
		X

Asset Effectiveness

- Pollutant Removal- high
- Volume Reduction- low
- Peak Flow Reduction- moderate

Targeted Constituents

- Sediment- high
- Trash- high

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Infiltration capacity
- Sediment accumulation
- Vegetation maintenance
- Safety hazards
- Aesthetics
- Contaminant spills

Inspection/Maintenance Considerations

Bed filters perform better in well-drained permeable soils. Bed filters in areas of low permeability can clog within a couple years, and require more frequent inspections and maintenance. The use and regular maintenance of pretreatment BMPs will significantly minimize maintenance requirements for the bed filter. Spill response procedures and controls should be implemented to prevent spills from reaching the infiltration system.

Scarification or other disturbance should only be performed when there are actual signs of clogging or significant loss of infiltrative capacity, rather than on a routine basis. Always remove deposited sediments before scarification.

Clogging bed filters with surface standing water can become a breeding area for mosquitoes and midges. Maintenance efforts associated with bed filters should include frequent inspections to ensure that water infiltrates into the subsurface completely (recommended infiltration rate of 72 hours or less) to prevent creating mosquito and other vector habitats.

Inspection Schedule and Preparation

Inspect: minimum once per year in spring

Forms:
- Treatment Performance
- Asset Condition Assessment

Equipment (Bed Filter specific):
- Constant Head Permeameter (CHP) (Infiltration)
- Staff plate (to measure sediment accumulation)

The inspection crew may want to install a staff plate to help monitor sediment accumulation if not already installed.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Bed Filter specific):
- Shovel or a backhoe, depending on the amount of sediment accumulation
- Aerator to improve infiltration capacity
- Engineered design maintenance plans
- Design specialist if bed filter failing

As of 2009, Douglas County has one bed filter. The bed filter has many different components: an inlet, concrete ditch, pervious pavement, vegetation, infiltration capacity, an underdrain, and an outlet. The maintenance crew needs the knowledge of how the bed filter is designed and the appropriate tools to repair any damage.

CONVEYANCE PIPING

General Description

Conveyance Piping: Example of need for cleaning such

Stormwater pipe systems, also called storm drains, are conveyance pipes designed to collect and transport surface stormwater received through drainage inlets, and convey that water through closed conduits to outfalls at structural stormwater BMPs, or treatment systems. The conduit system is comprised of different lengths, material types, shapes, and sizes of storm drain conveyance pipes which are connected by appurtenant structures as manholes, junction boxes, or other miscellaneous structures.

Conveyance pipes do not remove stormwater pollutants, but rather they transport pollutants to stormwater treatment structures.

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
	X	

- Provides conveyance

Asset Effectiveness

- Pollutant Removal- none
- Volume Reduction- none
- Peak Flow Reduction- none

Targeted Constituents

- None

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Sediment accumulation
- Safety hazards
- Contaminant spills

Inspection/Maintenance Considerations

Conveyance pipes do one thing- they collect and transport stormwater to structural stormwater treatment systems. Thus, routine maintenance to ensure conveyance pipes provide unobstructed flow is key to a properly functioning stormdrain system.

As mentioned, conveyance pipes are comprised of different materials: corrugate metal pipe (CMP), reinforced concrete pipe (RCP), and poly vinyl chloride (PVC). The different materials deteriorate at different rates and by different processes. Corrugated metal pipe is subject to

corrosion whereas PVC is subject to freeze/thaw and u.v. deterioration. The inspection crew should be sure to differentiate between the different pipes, log what type of pipe is present, and tailor the inspection toward that type of pipe.

Typical maintenance of conveyance pipes includes removal of sediment, debris and trash by hand or using a vactor truck. Maintenance should include keeping a log of the amount of sediment collected and the date of removal.

Inspection Schedule and Preparation

Inspect: minimum every year in spring

Forms: Asset Condition Assessment

Equipment (Conveyance Piping specific):
- Manhole cover remover
- Pipe probe (screwdriver) to test pipe for corrosion, deterioration, durability

Important for the inspection crew to test the durability of the pipe because once the pipe cracks or deteriorates, water will undermine the system and erode the stormwater system foundation.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Conveyance Piping specific):
- Manhole cover remover
- Wrench/socket set to remove grate protecting pipe
- Shovel or vactor truck, depending on the amount of sediment/debris accumulation
- Crowbar to reform a crushed pipe

Conveyance piping is everywhere and can sustain all sorts of damage. Maintenance crews most often should be prepared to remove sediment/debris accumulation and/or reform a pipe that was crushed during winter snow removal. Extensive repair issues would include providing riprap to stabilize a surrounding slope or new piping to replace a malfunctioning a pipe.

CURB & GUTTER

General Description

The prime function of curb and gutter in the design of paved roads is to facilitate the channeling of stormwater between source controls and treatment systems. Thus preventing the erosion of shoulders and slopes, and confining water quality contaminants (oil, gasoline, fine sediment, etc) to a designated treatment system prior to entering Lake Tahoe. Curb and gutter does provide some toe protection for slope stabilization.

Curb and gutter in Douglas Tahoe refers to AC swales, valley gutters, and AC dykes also.

Curb & Gutter: Good example

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
	X	

- Provides conveyance

Asset Effectiveness

- Pollutant Removal- none
- Volume Reduction- none
- Peak Flow Reduction- none

Targeted Constituents

- None

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Sediment accumulation
- Contaminant spills

Inspection/Maintenance Considerations

Though curb and gutter is a main component of drainage systems, it does not offer any treatment. Curb and gutter acts as a conveyance system only; transporting stormwater to a treatment system.

Curb and gutter is generally easy to maintain, however, curb and gutter can concentrate flows, which is not a good situation if the amount of stormwater exceeds the capacity of the conveyance system or the conveyance system is obstructed with debris. Routine maintenance includes trash, pine needle, pine cone, and sediment removal using a sweeper truck. Maintenance should include keeping a log of the amount of sediment collected, the date of removal, and the sweeper used to remove the debris.

In the Tahoe Basin, curb and gutter can be damaged by winter snow removal, freeze/thaw, tree roots, and vehicle misuse leading to additional maintenance tasks.

Inspection Schedule and Preparation

Inspect: minimum every year in spring

Forms: Asset Condition Assessment

Equipment (Curb & Gutter specific):
- Rake and/or broom
- Staff plate or erosion pins (to measure soil erosion on steep hillslope)

The inspection crew may want to install a staff plate or erosion pins to help monitor soil creep, woody vegetation encroachment, or extensive erosion upslope of the curb and gutter.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Curb & Gutter specific):
- Street Sweeper
- Rake and/or broom to clean gutter
- Asphalt sealant to seal cracks

Depending on the state of problem, the maintenance crew may need a broom to rake up pine needles, a saw to remove encroaching woody vegetation, asphalt sealant or cement mixture to fix a cracked or crushed section.

DRAINAGE INLET

General Description

Drainage inlets, also known as stormdrain inlets, curb inlets, culvert inlets, catch basins, and sediment traps, are inlets to the stormdrain system. They typically include a grate or curb inlet and a sump to capture sediment, debris, and pollutants. The effectiveness of drainage inlets, their ability to remove sediments and other pollutants, depends on its design (e.g., the size of the sump) and on maintenance procedures to regularly remove accumulated sediments from its sump.

Drainage Inlet: typical with rock bottom

Drainage inlets do not remove pollutants as well as structural stormwater treatment assets (wet basins, sand filter, wetlands), thus they are considered pretreatment structures. Unless frequently maintained, drainage inlets can become a source of pollutants through re-suspension. Drainage inlets do not effectively remove soluble pollutants or fine particles.

Drainage Inlet: includes slotted drains

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
	X	X

Asset Effectiveness

- Pollutant Removal- low
- Volume Reduction- moderate
- Peak Flow Reduction- moderate

Targeted Constituents

- Nutrients- low
- Sediment- moderate
- Trash- high

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Sediment accumulation
- Safety hazards
- Contaminant spills

Inspection/Maintenance Considerations

Though they are used in stormdrain systems everywhere, many drainage inlets are not ideally designed for sediment and pollutant capture. Drainage inlets are ideally used as pretreatment to another stormwater treatment asset.

Drainage Inlet: Needs improvements

Typical maintenance of drainage inlets includes trash removal if a grate or other debris capturing device is used, and removal of sediment using a vactor truck. Operators need to be properly trained in drainage inlet maintenance. Maintenance should include keeping a log of the amount of sediment collected and the date of removal. Drainage inlets can capture sediments up to approximately 60 percent of the sump volume (Pitt, 1985). When sediment fills greater than 60 percent of their volume, drainage inlets reach steady state. Storm flows can then re-suspend sediments trapped in the sump, and the stormwater runoff will bypass treatment.

Inspection Schedule and Preparation

Inspect: minimum every year in spring

Forms:

- Treatment Performance
- Asset Condition Assessment

Equipment (Drainage Inlet specific):

- Staff plate (to measure sediment/debris accumulation)
- Erosion pins (to measure soil erosion on hillslope)
- Tape measure (if no staff plate installed)

The inspection crew may want to install a staff plate to monitor sediment accumulation in the sump or erosion pins to help monitor soil creep, woody vegetation encroachment, or extensive erosion around the drainage inlet.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Drainage Inlet specific):

- Shovel or vactor truck
- Wrench (to remove grate)
- Vector tablets or mats

Douglas Tahoe drainage inlets may or may not have a sump, but maintenance crews need to be prepared to clean the sump, with a vactor truck, and dispose of the accumulated material appropriately.

DRAINAGE OUTLET

General Description

Storm system drainage outlets, whether open channels or pipe systems, are critical locations of conveyance obstruction, structural damage, and erosion potential. Drainage Outlets in Douglas Tahoe refer to basin outlets, conveyance piping outlets, and culvert outlets.

Drainage Outlet: This one is outlet from a basin

The Lake Tahoe basin receives a large amount of precipitation, in the form of snow, during the winter months. Snow plows often obstruct conveyance by piling large amounts of snow on top of drainage outlets. Structural damage occurs when the snow pile crushes the drainage outlet or the snow plow itself crushes or mangles the drainage outlet.

Erosion, in the form of scour, channel degradation, and conduit failure, occur when stormwater exits the drainage outlet at high velocities and the flow expansion creates turbulence. Often, the stormwater transported by man-made conveyances reaches velocities that exceed the capacity of the receiving channel or area to resist erosion. In order to prevent scour at stormwater outlets, protect the outlet structure and minimize the potential for downstream erosion, a flow transition structure (energy dissipater, such as rip rap) is needed to absorb the initial impact of flow and reduce the speed of the flow to a non-erosive velocity.

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
	X	

- Provides conveyance

Asset Effectiveness

- Pollutant Removal- none
- Volume Reduction- none
- Peak Flow Reduction- none

Targeted Constituents

- None

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Safety hazards
- Contaminant spills

Inspection/Maintenance Considerations

Although drainage outlets provide no pollutant removal, volume reduction, or peak flow reduction, drainage outlets do have the potential to compromise a stormwater system by obstructing conveyance, structurally failing, or enhancing erosion. Routine maintenance targeted at preventing the above mentioned issues helps keep the stormwater system functioning properly.

Inspection Schedule and Preparation

Inspect: minimum every year in spring

Forms: Asset Condition Assessment

Equipment (Drainage Outlet specific):
- Staff plate (to measure sediment accumulation)
- Erosion pins (to measure erosion damage)

The inspection crew may want to install a staff plate or erosion pins to monitor extensive erosion or sediment accumulation.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Drainage Outlet specific):
- Shovel or vactor truck
- Wrench (to remove grate)
- Riprap (energy dissipator)

Maintenance crews should be prepared to fight erosion, remove accumulated sediment, and repair damaged outlets.

DRY BASIN

General Description

A dry basin is a shallow impoundment that is designed to provide storage and particle settling as well as infiltration of the stormwater. A dry basin is different from other storage basins, such as wet or infiltration basins, since it has an outlet to control overflow and provide for settling of particles. It is also dry between inflow periods.

Dry Basin: This basin has an outlet to control sedimentation and a gauge to measure depth of sediment accumulation

Dry basins play an important role in reducing stormwater flow rates or surges allowing sediments and pollutants to settle and/or infiltrate. Over time these sediments and pollutants must be physically removed and transported from the site outside the Tahoe Basin in order to prevent them from entering the lake.

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
	X	X

Asset Effectiveness

- Pollutant Removal- moderate
- Volume Reduction- moderate
- Peak Flow Reduction- high

Targeted Constituents

- Nutrients- moderate
- Oil/Grease- high
- Sediment- high
- Trash- high

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Infiltration capacity
- Sediment accumulation
- Vegetation maintenance
- Safety hazards
- Aesthetics
- Contaminant spills

Inspection/Maintenance Considerations

Dry basins are typically constructed based on specific design criteria yet may be limited in size and shape based on available space and local conditions. Some basins may not have specific design criteria due to do local conditions and thus maintenance criteria must be established

based on actual conditions. Inspection and maintenance must first consider the potential of each site to reduce flow rates and pollutants and then develop a strategy to achieve this over the life of the asset most economically.

Inspection of each basin should include setting targeted infiltration capacity, expected annual sediment capture, and identify rainfall/runoff conditions when the storage capacity will be exceeded and overflow expected.

Inspection should also consider the age of the basin and past maintenance practices to provide a general idea of when major rehabilitation or replacement should be planned. A thorough inspection of all structural assets will be needed to determine condition and expected remaining life or need for major repair of the asset.

Inspection Schedule and Preparation

Inspect: minimum every year in spring

Forms:
- Treatment Performance
- Asset Condition Assessment

Equipment (Dry Basin specific):
- Constant Head Permeameter (infiltration)
- Staff plate (to measure sediment accumulation)
- Erosion pins (to measure soil erosion on hillslope)

The inspection crew may want to install a staff plate or erosion pins to monitor soil creep, woody vegetation encroachment, extensive erosion or sediment accumulation.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Dry Basin specific):
- Shovel or vactor truck
- Vector spray
- Riprap, erosion blanket, waddles, coir logs, jute matting if slope stability needed

Most basins in Douglas Tahoe are dry basins; vector hazards and excess vegetation would be a rare maintenance requirement, but sediment accumulation and slope instability would be most likely.

INFILTRATION BASIN

General Description

An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater. Infiltration basins use the natural filtering ability of the soil to remove pollutants in stormwater runoff. Infiltration facilities store runoff until it gradually infiltrates into the soil and eventually into the water table; infiltration basins have no outlet. This practice has high pollutant removal efficiency and can also help recharge groundwater, thus helping to increase baseflow to stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
	X	X

Asset Effectiveness

- Pollutant Removal- high
- Volume Reduction- high
- Peak Flow Reduction- high

Targeted Constituents

- Nutrients- high
- Oil/grease- high
- Sediment- low, requires pre-treatment
- Trash- low, requires pre-treatment

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Infiltration capacity
- Sediment accumulation
- Vegetation maintenance
- Safety hazards
- Aesthetics
- Contaminant spills

Inspection/Maintenance Considerations

The use and regular maintenance of pretreatment BMPs will significantly minimize maintenance requirements for the basin. Spill response procedures and controls should be implemented to prevent spills from reaching the infiltration system.

Scarification or other disturbance should only be performed when there are actual signs of clogging or significant loss of infiltrative capacity, rather than on a routine basis. Always remove deposited sediments before scarification. This BMP may require groundwater monitoring.

Maintenance efforts associated with infiltration basins should include inspections to ensure that water infiltrates into the subsurface completely (recommended infiltration rate of 72 hours or less) to prevent creating mosquito and other vector habitats.

Inspection Schedule and Preparation

Inspect: minimum once per year in spring

Forms:
- Treatment Performance
- Asset Condition Assessment

Equipment (Infiltration Basin specific):
- Constant Head Permeameter (CHP) (Infiltration)
- Staff plate (to measure sediment accumulation)
- Piezometers (measure groundwater)

The inspection crew may want to install a staff plate to help monitor sediment accumulation or piezometers to measure groundwater if not already installed.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Infiltration Basin specific):
- Shovel, backhoe or vactor truck, depending on the amount of sediment accumulation
- Piezometer
- Aerator to improve infiltration capacity
- Engineered design maintenance plans

Infiltration basins have no outlet, so the groundwater should be monitored to avoid contamination. If the basin infiltration capacity fails, the basin will have to be re-designed or a design specialist will need to be consulted.

INFILTRATION FEATURE

General Description

An infiltration feature (a.k.a. infiltration gallery, infiltration trench) is a stormwater asset that slows down runoff and allows the water to infiltrate into the ground. Infiltration features are designed to contain runoff, treat pollutants, and prevent stormwater from continuing down the system. However, some infiltration features in Douglas Tahoe are not designed to contain and infiltrate high flows, thus, some features have outlets.

An infiltration trench is a long, narrow, rock-filled trench that receives stormwater runoff. Stormwater runoff passes through some combination of pretreatment measures, such as a swale and detention basin, and into the trench. There, runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. Infiltration trenches perform well for removal of fine sediment and associated pollutants; pretreatment BMP assets help remove coarse sediment.

An infiltration gallery is similar in build to a treatment vault (concrete structure), but functions like the infiltration trench above. Stormwater runoff is stored in the void space between gravel and infiltrates through the bottom and into the soil matrix. Pretreatment assets are critical for removing coarse sediment prior to the stormwater entering the infiltration gallery.

However, at high flows, it is best to assume that the infiltration features in Douglas Tahoe become inundated with runoff and not all water infiltrates. This assumption is based on initial inspection, feature location, and specific design issues.

It is absolutely critical that settleable particles (coarse sediment) and floatable organic materials be removed from runoff water with pretreatment measures before it enters the infiltration feature. The feature will clog and become nonfunctional if excessive particulate matter is allowed to enter the feature.

While infiltration features can be applied in most regions of the country, their use is sharply restricted by concerns due to common site factors, such as potential groundwater contamination, space restrictions, soils, bedrock, and clogging.

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
	X	X

Asset Effectiveness

- Pollutant Removal- high
- Volume Reduction- high
- Peak Flow Reduction- high

Targeted Constituents

- Nutrients- high
- Oil/Grease- high
- Sediment- low (fine sediment), requires pre-treatment for coarse sediment
- Trash- low, requires pre-treatment

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Infiltration capacity
- Sediment accumulation
- Vegetation maintenance
- Aesthetics
- Contaminant spills

Inspection/Maintenance Considerations

As with all management practices, infiltration features should have an access path for maintenance activities. Piezometers can enable inspectors to monitor the groundwater drawdown rate and the water quality.

While infiltration trenches are visible from the surface and clogging or sediment accumulation can be easily identified, infiltration galleries are below ground with no physical access. Inspection crews must rely on the condition of the infiltration gallery inlet and outlet to determine the treatment performance. Inspection crews may want to inspect the asset during a runoff event to ensure the gallery is not clogged and water is entering the system.

Inspection Schedule and Preparation

Inspect: minimum every year in spring

Forms:

- Treatment Performance
- Asset Condition Assessment

Equipment (Infiltration Feature specific):

- Constant Head Permeameter (CHP) (Infiltration)
- Staff plate (to measure sediment accumulation)
- Piezometers (to measure groundwater)

The inspection crew may want to install a staff plate to monitor sediment accumulation and a piezometer to measure groundwater contamination if not already installed.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Infiltration Feature specific):

- Shovel, backhoe or vactor truck, depending on the amount of sediment accumulation
- Aerator to improve infiltration capacity
- Engineered design maintenance plans

Douglas Tahoe has more than one type of infiltration feature. Based on the asset location, design features, and initial inspection, maintenance for each asset is going to be different. Infiltration features will probably be the most variable BMP asset type to maintain.

MANHOLE

General Description

Manholes are structures installed where conveyance pipes join or intersect. Depending on the location and other utility lines, conveyance pipes often must change flow direction, pipe diameter, and/or elevation. Manholes provide an access point for inspecting conveyance pipe changes. Although not directly related to transporting stormwater, manholes play an indirect role in maintaining stormwater flow through. Although generally not designed to provide a sump area, debris often accumulates at manholes.

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
	X	

- Provides access to conveyance piping

Asset Effectiveness

- Pollutant Removal- none
- Volume Reduction- none
- Peak Flow Reduction- none

Targeted Constituents

- None

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Sediment accumulation
- Safety hazards
- Contaminant spills

Inspection/Maintenance Considerations

Manholes, although they do not have a direct role in transporting stormwater, must be inspected and maintained just as any basin or drain inlet must be inspected and maintained. Inspect manholes for location (often paved over), corrosion, or cracks; these situations often make manholes difficult to enter.

Maintenance should include keeping a log of the manhole components and the condition the components are in: manhole lid, manhole steps/boards, debris/sediment accumulation, conveyance pipe leaks, corrosion or misalignment, and hazardous conditions.

Inspection Schedule and Preparation

Inspect: minimum every year in spring

Forms: Asset Condition Assessment

Equipment (Manhole specific):

- Manhole cover remover
- Staff plate (to measure sediment accumulation)

The inspection crew may want to install a staff plate to monitor sediment accumulation. Erosion pins would help monitor slope instability around the manhole foundation, if needed.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Manhole specific):

- Shovel or vactor truck
- Vector spray or pad

Manholes are everywhere in Douglas Tahoe. Most maintenance issues will probably involve keeping the conveyance unobstructed.

RETAINING WALL

General Description

Retaining Wall: Block structure in good condition.

Retaining walls are structures that hold soil in place or keep it contained within a site boundary, thus preventing erosion. They include grading or reshaping the ground to lessen steep slopes or shoring excavated areas with wood, concrete, or steel structures. Retaining walls replace the toe of the slope that was removed during construction, often of a road, and provide stability against soil creep or slope failure.

Retaining walls are most often made of wood, concrete, steel, or rocks. Retaining walls are built with a drainage swale, designed to intercept upslope drainage, collect it, and discharge the runoff to an approved location, usually the street or storm drain system. Retaining walls also have freeboard, which is the portion of the wall which extends above the drainage swale. The purpose of freeboard is to prevent upslope drainage and debris from overtopping the wall.

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
X		

Asset Effectiveness

- Source Control

Targeted Constituents

- Suspended Sediment
- Fine Sediment Particles

Maintenance Concerns, Objectives, and Goals

- Sediment accumulation
- Vegetation maintenance
- Safety hazards
- Aesthetics

Inspection/Maintenance Considerations

Retaining walls, if properly designed and installed, can effectively prevent erosion in areas with steep slopes and erodible soils. Inspect retaining walls, especially after rainstorms, for erosion, structural damage, vectors, water pressure build up behind wall, and freeboard height. Record drawings should list the freeboard design height.

Inspection Schedule and Preparation

Inspect: minimum every year in spring

Forms: Asset Condition Assessment

Equipment (Retaining Walls specific):
- Staff plate (to measure soil erosion at toe of slope)
- Erosion pins (to measure soil erosion on hillslope)

The inspection crew may want to install a staff plate or erosion pins to monitor soil creep, woody vegetation encroachment, or extensive erosion.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Retaining Walls specific):
- Wall repair (wood, concrete, blocks, rocks, etc)
- Erosion blanket, waddles, coir logs, jute matting if slope stability needed
- Vector traps
- Shovel or backhoe to maintain freeboard design height

Retaining Walls in Douglas Tahoe are used frequently because of the places people want to live and the roads they need to get there. Maintenance crews need to be aware of the retaining wall material. Maintenance could involve replacing a rock or rebuilding the failing wall. Retaining walls often receive damage from snow plows or rodents may compromise the wall stability. Because fine sediment is considering a contributing factor to Lake clarity loss, freeboard must be maintained to prevent sediment from overtopping the retaining wall.

RIPRAP SLOPE STABILIZATION

General Description

Riprap slope stabilization is a layer of large stones used to protect soil from erosion in areas of concentrated runoff. Riprap slope stabilization can also be used on slopes that are unstable because of seepage problems.

Riprap Slope Stabilization: Good example

Use riprap to stabilize cut-and-fill slopes, channel side slopes and bottoms, streambanks and grades. Energy dissipators, installed at inlets and outlets of culverts, bridges, slope drains, grade stabilization structures, and storm drains, are referred to as riprap slope stabilization for the purposes of this handbook.

Vegetation is often incorporated with riprap slope stabilization as an additional source control BMP.

Riprap slope stabilization can be unstable on very steep slopes, consider using other materials for erosion protection.

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
X		

Asset Effectiveness

- Source Control

Targeted Constituents

- Suspended Sediment
- Fine Sediment Particles

Maintenance Concerns, Objectives, and Goals

- Sediment accumulation
- Vegetation maintenance
- Vector hazards (rodents)
- Safety hazards
- Aesthetics

Inspection/Maintenance Considerations

If riprap has been damaged, repair it promptly to prevent a progressive failure. If repairs are needed repeatedly at a location, evaluate the site to determine if the original design conditions have changed. Also, weed and brush growth may need to be controlled in cases where the plants and/or their roots are dislodging the riprap. Vegetation also invites animal habitat, too many rodent holes can compromise the slope stability and cause erosion damage.

Inspection Schedule and Preparation

Inspect: minimum every year in spring

Forms: Asset Condition Assessment

Equipment (Riprap Slope Stabilization specific):
- Erosion pins (to measure soil erosion on hillslope)

The inspection crew may want to install erosion pins to monitor rock/soil creep, woody vegetation encroachment, or extensive erosion.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Riprap Slope Stabilization specific):
- Riprap material to stabilize slopes or outlets
- Backhoe to move/replace riprap
- Vector traps

Maintenance crews should be prepared to move or replace twenty to a hundred and fifty pound rocks and replace filter fabric that was installed beneath the rocks. Maintenance crews may be able to do this work by hand or heavy equipment may be needed. Vegetation may need to be removed if it is dislodging the riprap, and rodents may need to be removed if evidence of slope instability can be linked to their dens.

ROCK LINED CHANNEL

General Description

Rock lined channels are designed to transport runoff down a slope in a manner that minimizes the potential for erosion. Rock lined channels are constructed to intercept the down-slope flow of runoff from a hillslope or adjacent to a stormwater conveyance system. The channels collect stormwater runoff and deflect the runoff to outlets that convey it without causing erosion.

Rock lined channels do allow infiltration and some are built with step-pool combinations or check dams, thus allowing stormwater to infiltrate and particles to settle.

Vegetation is often incorporated with rock lined channels as an additional source control BMP.

Rock Lined Channel

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
X	X	X

Asset Effectiveness

- Pollutant Removal- low
- Volume Reduction- low
- Peak Flow Reduction- low

Targeted Constituents

- Nutrients- low
- Sediment- low
- Trash- low

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Infiltration capacity
- Sediment accumulation
- Vegetation maintenance
- Aesthetics
- Contaminant spills

Inspection/Maintenance Considerations

Inspection crews need to document sediment accumulation, unstable channel banks producing sediment runoff, excessive vegetation blocking stormwater flow, lack of vegetated slope protection, and vector damage. As mentioned, with a step-pool or check dam channel design, when the pools and basins are full of sediment, the channel is no longer functioning properly.

Often, the rocks and the original channel design are buried under sediment, so original design photos and/or record drawings would help inspection crews.

The accumulated sediment may be coming from the conveyance source, hillslope erosion, channel bank erosion, or drainage outlet erosion because of the lack of riprap. The inspection crew needs to identify the sediment source and determine the problem area. Once the sediment source is pinpointed, the maintenance crew can fix the sediment source and repair damage to the rock lined channel. If repairs are needed repeatedly at a location, evaluate the site to determine if the original design conditions have changed.

Inspection Schedule and Preparation

Inspect: minimum every year in spring

Forms:
- Treatment Performance
- Asset Condition Assessment

Equipment (Rock Lined Channel specific):
- 5 gallons water
- Staff plate (to measure sediment accumulation)

The inspection crew may want to install a staff plate to monitor sediment accumulation if not already installed.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Rock Lined Channel specific):
- Shovel or a backhoe, depending on the amount of sediment accumulation
- Additional stability rocks
- Engineered design maintenance plans
- Design specialist if channel failing

Some channels are rock lined from top to bottom, some have minimal rocks, and some have step-pool configuration. Maintenance crews need to be aware of the channel design, best learned from design plans and pictures. Equipment needed depends on the extent of damage to the channel.

TREATMENT VAULT

General Description

Treatment vaults, constructed of concrete to bear the weight of vehicles, are underground structures used to attenuate peak stormwater flows. Treatment vaults do not provide significant water quality control or primary stormwater treatment. Most treatment vaults installed in Douglas Tahoe are Vortechnics, Jensons, BaySavers, CDS vaults, and Stormceptors.

Treatment Vault: Vortechnics

Pretreatment structures, such as drainage inlets (sediment traps, catchbasins, etc), can be installed upstream to treat stormwater runoff and remove trash and debris prior to stormwater entering treatment vaults.

Because treatment vaults are designed to attenuate flow, some particles and nutrients do settle out. There is much concern that resuspension will occur during the next runoff event and the settled particles and nutrients will be transported downstream into Lake Tahoe.

However, depending upon the design, many treatment vaults have high flow stormwater runoff bypasses, which help prevent resuspension of settled particles.

Treatment vaults are primarily used when space is limited and there are no other practical alternatives.

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
	X	X

Asset Effectiveness

- Pollutant Removal- low
- Volume Reduction- low
- Peak Flow Reduction- high

Targeted Constituents

- Nutrients- none
- Sediment- moderate
- Trash- moderate-none

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Sediment accumulation
- Safety hazards
- Contaminant spills
- Vector hazard (mosquito control)

Inspection/Maintenance Considerations

With the facilities located underground, inspection and maintenance are important issues because of the relatively high costs. Maintenance is required to remove sediment and debris and to ensure that the vault outlet is functioning properly. Inspection crews should be sure to check for standing water in the vaults that could result in a vector hazard.

Inspection crews need to understand the stormwater system design, specifically where high flow stormwater is routed. If high flow stormwater does not bypass a treatment vault, the inspection crew may find it necessary to increase maintenance frequency.

Underground systems will be considered confined spaces that require additional safety requirements for inspection and maintenance.

Inspection Schedule and Preparation

Inspect: minimum once per year in spring

Forms:

- Treatment Performance
- Asset Condition Assessment

Equipment (Treatment Vault specific):

- Staff plate (to measure standing water depth and sediment accumulation)

The inspection crew may want to install a staff plate to monitor sediment accumulation if not already installed.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Treatment Vault specific):

- Shovel or vactor truck, depending on the amount of sediment accumulation
- Engineered design maintenance plans

Each vault design is different, and each vault is installed different. Different vault installation designs include: pretreatment vs. no pretreatment, attached to an infiltration feature, high flow vs. no high flow diversion, etc. Inspection and maintenance crews should have the design drawings to properly understand the flow process, and to better inspect and maintain the treatment vaults.

VEGETATED SWALE

General Description

Vegetated swales are open, shallow channels with dense vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat stormwater runoff by vegetation slowing the water to allow sedimentation, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curb and gutter.

Treatment effectiveness in vegetated swales is limited by the residence time of water in the swale: for this reason their applicability depends on the slope and the size of the contributing drainage area. Swales can be paired with many other treatment measures, such as wet basins, infiltration basins, and wetlands.

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
X	X	X

Asset Effectiveness

- Pollutant Removal- high
- Volume Reduction- moderate
- Peak Flow Reduction- high

Targeted Constituents

- Nutrients- low
- Metal- moderate
- Organics- moderate
- Bacteria- low
- Oil/Grease- moderate
- Sediment- moderate
- Trash- low

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Infiltration capacity
- Sediment accumulation
- Vegetation maintenance
- Aesthetics
- Contaminant spills

Inspection/Maintenance Considerations

If properly designed and regularly maintained, vegetated swales can last indefinitely. A pretreatment BMP designed to remove trash and allow coarse sediment to settle out may ease the maintenance burden for the swale itself. The primary maintenance objective for vegetated swales is to maintain the hydraulic and removal efficiency of the channel with a dense, healthy vegetative cover.

Inspection Schedule and Preparation

Inspect: minimum once per year in spring

Forms:
- Treatment Performance
- Asset Condition Assessment

Equipment (Vegetated Swale specific):
- 5 gallons water (measure runoff)
- Staff plate (to measure sediment accumulation)

The inspection crew may want to install a staff plate to monitor sediment accumulation if not already installed.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event
Forms: Maintenance

Equipment (Vegetated Swale specific):
- Shovel or a backhoe, depending on the amount of sediment accumulation
- Aerator to improve infiltration capacity
- Vector control
- Engineered design maintenance plans

Vegetated swales in Douglas Tahoe are located alongside roads, acting as a curb and gutter, in meadows, and within community forested areas. Maintenance crews should use the design plans to know whether the swale's main purpose is infiltration or conveyance and perform appropriate maintenance.

WET BASIN

General Description

Wet basins (a.k.a. stormwater ponds, retention ponds, wet extended detention ponds) are constructed basins that have a permanent pool of water throughout the year (or at least throughout the wet season) and differ from constructed wetlands primarily in having a greater average depth. These basins treat incoming stormwater runoff by settling and biological uptake. The primary removal mechanism is settling as stormwater runoff resides in this pool, but pollutant uptake, particularly of nutrients, also occurs through biological activity in the basin.

Wet Basin: Good condition. Note vegetative growth

Type of BMP Asset

Source Control	Hydraulic Control	Pollutant Treatment
	X	X

Asset Effectiveness

- Pollutant Removal- moderate
- Volume Reduction- moderate
- Peak Flow Reduction- high

Targeted Constituents

- Nutrients- moderate
- Oil/grease
- Sediment- high (67%)
- Trash-high

Maintenance Concerns, Objectives, and Goals

- Obstruction of flow
- Sediment accumulation
- Vegetation maintenance
- Safety hazards
- Aesthetics
- Contaminant spills

Inspection/Maintenance Considerations

Wet basins are widely applicable stormwater management practices, although rare in the Tahoe Basin due to the arid climate. Basin inspection should include monitoring sediment accumulation, vegetation growth, stormwater storage capacity, and vector hazards. With accurate monitoring and adhering to the basin design plans, inspection crews can recommend corrective action to be taken by the maintenance crews, often sediment removal or vegetation

cutback. Wet basins need vegetation for nutrient removal, but too much vegetation can prevent water from flowing or cause an unbalanced system.

Standing water is an ideal breeding ground for vectors (mosquitoes), and wet basins should be closely monitored for any signs of vectors.

Inspection should also consider the age of the basin and past maintenance practices to provide a general idea of when major rehabilitation or replacement should be planned. A thorough inspection of all structural assets will be needed to determine condition and expected remaining life or need for major repair of the asset.

Inspection Schedule and Preparation

Inspect: minimum once per year in spring

Forms:
- Treatment Performance
- Asset Condition Assessment

Equipment (Wet Basin specific):
- 5 gallons water (measure runoff if basin dry)
- Staff plate (to measure sediment accumulation)

The inspection crew may want to install a staff plate to monitor sediment accumulation if not already installed.

Maintenance Schedule and Preparation

Routine: perform the routine work annually

Inspection Driven: perform assigned work from inspection results when inspection score deems necessary (a score of 2 or below) based on either routine inspection or when a complaint is received or after a significant runoff event

Forms: Maintenance

Equipment (Wet Basin specific):
- Shovel or a backhoe, depending on the amount of sediment accumulation
- Vegetation control
- Vector control (tablets)
- Engineered design maintenance plans

Wet basins in Douglas Tahoe are minimal due to the climate. However, maintenance crews should be prepared to remove accumulated sediment, control vector hazards, and constrain vegetation. Vegetation control may be needed on a minimal basis considering vegetation does not grow out of control in this climate.

5 TERMINOLOGY

Asset Inventory Database	A mapped inventory of all BMP assets within the Douglas Tahoe management area. Record drawings, CAD files, GIS layers, and field verification efforts were used to create the database. The inventory includes unique asset identifiers, installation date, spatial location and specific asset information.
Bare Soil Cover	Land cover with vegetation to reduce erosion of surface flows and stabilize slope surfaces. No pollutant removal- source control only.
Bed Filter	Basin or filter control structure and underdrain to collect treated water for transport out of the basin to store surface flows allowing sediment to accumulate.
Benchmark	The desired and achievable asset condition. The benchmark equate to an inspection score of 5. In most instances, benchmark condition may be observed shortly following construction or immediately following appropriate maintenance actions. The exceptions are desired benchmark characteristics that may take some time after construction and/or maintenance to achieve (e.g., benchmark vegetation cover).
BMP RAM	The BMP RAM is a simple and repeatable filed observation and data management toll to assist Lake Tahoe natural resource managers in determining the relative condition of an urban stormwater Treatment BMP. The tool consists of six distinct BMP RAM STEPs implemented by the user and supporting database.
BMP RAM Database	The database is a customized Microsoft Access 2007 file that stores and manages all catchment information necessary to implement, track and maintain BMP RAM inventory and results over time. The BMP RAM user generates data and /or information and enters it into the database.
Constant Head Permeameter (CHP)	Treatment Performance test to measure the infiltration rate in inches per hour (in/hr) of a surface soil substrate in dry basins, infiltration basins, and bed filters. This simple instrument has been developed by the NRCS and is well-accepted in the Lake Tahoe Basin to measure the infiltration capability of Tahoe soils.
Conveyance	Conveyance is the physical process that transports stormwater downgradient in a manner that mitigates, and does not induce, localized flooding. All treatment performance BMPs must be able to convey stormwater both in and out, but conveyance alone provides no water quality benefit. Clear evidence of operating inflow and outflow must be present for treatment performance BMPs to function as designed.
Conveyance Piping	Metal/plastic material pipes (underground) to provide hydraulic control of surface flows between source controls and treatment systems. No pollutant removal- source control only.
Curb & Gutter	Concrete/asphalt structure to provide hydraulic control of surface flows between source controls and treatment systems. No pollutant removal- source control only.
Drainage Inlet (alias sediment trap, catchbasin)	Structure that include a drainage inlet (or edge drain) and usually a sediment trap/catchbasin to store surface flows allowing sediment to accumulate.
Drainage Outlet	Structure at outlets of conveyance piping or basin that discharge to open surface water system and may include an energy dissipator. No pollutant removal- source control only.
Dry Basin (alias (detention pond, detention basin)	basin with an outlet overflow to provide for storage and controlled sedimentation. Minimal vegetation.

Energy Dissipator	A device constructed in a waterway to reduce the kinetic energy of fast flowing water. An example would be riprap at a pipe outlet.
Factor	Both the Treatment Performance and Asset Condition Assessment inspection forms include distinct tests for different BMP assets. These tests are referred to as factors. Each asset has a different combination of factors.
Infiltration	Reduction of stormwater volume by infiltration through soil. Pervious soils capture stormwater runoff, reducing pollutant loads primarily due to volume reductions of stormwater that continues downgradient of the BMP. However, some pollutants contained within the infiltrated volumes, such as dissolved nutrients and fine sediment particles, are captured and trapped within the pore spaces of the unsaturated zone.
Infiltration Basin	Basin has no sedimentation storage, only used for infiltration. Minimal vegetation.
Infiltration Feature (alias infiltration trench, infiltration gallery)	Infiltration system to temporarily store surface flows and divert underground by infiltration.
Inspection	A formal evaluation process involving measurements, tests, and observations on different factors. A poor inspection results in required maintenance.
Jurisdiction	The practical authority granted to a formally constituted legal body, often the general improvement district, homeowners association or public utility district.
Manholes	Structure at grade break locations in conveyance piping to provide for inspection and connection of piping structures. No pollutant removal- source control only.
Material Accumulation	Treatment Performance (BMP RAM) observation to quantitatively track the relative loss of the BMP storage capacity. A permanent staff plate is installed near the outlet of the BMP and the lowest visible value is recorded during the inspection process.
Parging	The process of surface failure in which the thin coat of mortar applied to cement surfaces starts peeling/flaking off. The thin coat of mortar is used to refine the surface and provide a protective coating by filling surface air voids and bugholes.
Piezometer	A small diameter observation well, usually a one half inch PVC pipe, used to measure the groundwater level.
Record Drawing	Drawings prepared during or after construction showing the final measurement of construction, including any deviations from the design drawing and certain other field observations such as tie-in locations.
Retaining Walls	Structure to retain slopes adjacent to roadways. No pollutant removal- source control only.
Riprap Slope Stabilization	Land cover to reduce erosion of surface flows and stabilize sloped surfaces. No pollutant removal- source control only.
Rock Lined Channel (alias, infiltration feature)	Land cover to increase infiltration and reduce erosion of surface flows.
Runoff	Runoff is the water flow which occurs over the ground surface when soil is infiltrated to full capacity and excess water, from rain, snowmelt, or other sources flows over the land.
Score	The score is determined by the inspection process. Each inspection test is converted to an inspection score based on the pre-determined benchmark and threshold values set by the jurisdiction.

Spalling	The process of surface failure in which flakes of a material that are broken off a larger solid body and can be produced by a variety of mechanisms, including corrosion, weathering, impact, etc.
Staff Plate	A long ruler placed semi-permanently in a basin or near an asset and used to read accumulated sediment depth.
Sump	A low space that collects any often-undesirable liquids such as water or chemicals, allowing particles to settle and be removed from the stormwater system.
Threshold	The condition the jurisdiction has determined a BMP asset to no longer be acceptable. The threshold equate to a score of 2. Typically, threshold values for each factor are determined by the user relative to benchmark values.
Treatment Vault	Vault structure with various configurations to separate sediments from stormwater flows. No infiltration.
Vegetated Swale (alias, biofilter)	Pervious substrate with dense vegetation coverage to achieve infiltration and nutrient reduction in surface flows.
Wet Basin (alias, retention pond, constructed wetlands)	basin, typically wet with effective vegetation species providing for nutrient and sediment removal.

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Appendix A: Inspection Forms

There are two types of inspection forms needed for some of the BMP types. For those BMP types that require treatment performance assessment, there are inspection forms identified in the BMP RAM Users Manual that must be used. For all BMP types there are asset condition assessment inspection forms that must be used. The following required inspection forms are presented by BMP type and should be used by the inspector to conduct field observations at each BMP:

BMP Assets	Inspection Forms	
	Treatment Performance	Asset Condition Assessment
Bare Soil Cover		x
Bed Filter	x	x
Conveyance Piping		x
Curb & Gutter		x
Drainage Inlet	x	x
Drainage Outlet		x
Dry Basin	x	x
Infiltration Basin	x	x
Infiltration Feature	x	x
Manhole		x
Retaining Wall		x
Riprap Slope Stabilization		x
Rock Lined Channel		x
Treatment Vault	x	x
Vegetated Swale	x	x
Wet Basin	x	x

Note: These forms are available in electronic format for users of the handbook to print and use for field work and can be selected by hyperlink from this table for printing.

Asset Condition Assessment BARE SOIL COVER			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		

Vegetation Cover					
Groundcover **%**	Mulch **%**	Impervious **%**	Other **%**	Bare Soil **%**	Total = 100%

Evidence of: (circle)	exposed soil steep slopes rills/gullies thin litter/mulch recent wildfire irrigation failure parking/compaction lack of vegetation other
Describe extent of issues:	
Score Vegetation Cover Overall Condition 1 – 5 based on observations above and scale below	

Erosion Damage	
Evidence of erosion **to**: (circle)	foundation embankments steep slopes parent material vegetation other
Describe extent of issues:	
Evidence of: (circle)	lack of armoring (veg or rock) sediment accumulation unstable contributing areas dislodged rock armoring other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	

Inspection Summary
Summary/Additional Comments:

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

X Back to Reference Table

Asset Condition Assessment BED FILTER			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		
Hazardous Materials			
Evidence of: (circle)	oil/grease gas/fuel other chemicals poor water color/clarity odors algae/weeds foam stains/deposits trash/debris dumping other		
Describe extent of issues:			
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below			
Vector Damage			
Evidence of: (circle)	animal burrows ponded water, breeding ground (mosquitoes, etc.) other		
Describe extent of issues:			
Score Vector Damage Overall Condition 1 – 5 based on observations above and scale below			
Structural Damage			
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water corrosion design flaws u.v. deterioration liner exposed bed liner failure parging/spalling leaks collapsing/failing dam seepage other		
Describe extent of issues:			
Evidence of damage **to**: (circle)	access roads fences gates locks safety features spillway frames covers signs dam other		
Describe extent of issues:			
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

X Back to Reference Table

Asset Condition Assessment BED FILTER (cont'd)	
Erosion Damage	
Evidence of erosion **to**: (circle)	foundation check dams flared ends conveyance system inlets outlets spillway embankments other
Describe extent of issues:	
Evidence of: (circle)	exposed liner edges breach in check dam lack of armoring (veg or rock) unstable contributing areas dislodged rock armoring sediment accumulation bed liner failure other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	
Inspection Summary	
Summary/Additional Comments:	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

X Back to Reference Table

Asset Condition Assessment CONVEYANCE PIPING			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		

Conveyance Obstruction		
Evidence of: (circle)	obstructed flow sediment/debris accumulation joint/connection failure other	
Describe extent of issues:		
Score Conveyance Obstruction Overall Condition 1 – 5 based on observations and scale below		

Hazardous Materials		
Evidence of: (circle)	oil/grease gas/fuel other chemicals odors trash/debris algae/weeds foam stains/deposits dumping other	
Describe extent of issues:		
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below		

Structural Damage		
Evidence of damage **from**: (circle)	vandalism snow plow tree roots water corrosion cracking bulging/bowing misalignment design flaws u.v. deterioration parging/spalling connection/collar failure leaks collapsing/failing other	
Describe extent of issues:		
Evidence of damage **to**: (circle)	access roads gates locks safety features signs grates other	
Describe extent of issues:		
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below		

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment CONVEYANCE PIPING (cont'd)	
Erosion Damage	
Evidence of erosion **to**: (circle)	foundation other
Describe extent of issues:	
Evidence of: (circle)	lack of armoring (veg or rock) unstable contributing areas dislodged rock armoring sediment accumulation other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	
Inspection Summary	
Summary/Additional Comments:	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment CURB & GUTTER			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		
Conveyance Obstruction			
Evidence of: (circle)	obstructed flow sediment/debris accumulation woody vegetation joint/connection failure other		
Describe extent of issues:			
Score Conveyance Obstruction Overall Condition 1 – 5 based on observations and scale below			
Hazardous Materials			
Evidence of: (circle)	oil/grease gas/fuel other chemicals odors trash/debris algae/weeds foam stains/deposits dumping other		
Describe extent of issues:			
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below			
Structural Damage			
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water parging/spalling design flaws freeze/thaw cracking collapsing/failing other		
Describe extent of issues:			
Evidence of damage **to**: (circle)	access roads fences gates locks safety features signs other		
Describe extent of issues:			
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment CURB & GUTTER (cont'd)			
Erosion Damage			
Evidence of erosion **to**: (circle)	foundation	embankments	other
Describe extent of issues:			
Evidence of: (circle)	sediment accumulation	unstable contributing areas	other
Describe extent of issues:			
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below			
Inspection Summary			
Summary/Additional Comments:			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment DRAINAGE INLET			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		
Conveyance Obstruction			
Evidence of: (circle)	obstructed flow sediment/debris accumulation joint/connection failure woody veg encroachment other		
Describe extent of issues:			
Score Conveyance Obstruction Overall Condition 1 – 5 based on observations and scale below			
Hazardous Materials			
Evidence of: (circle)	oil/grease gas/fuel other chemicals odors algae/weeds foam stains/deposits trash/debris dumping other		
Describe extent of issues:			
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below			
Vector Damage			
Evidence of: (circle)	animal burrows ponded water, breeding ground (mosquitoes, etc) other		
Describe extent of issues:			
Score Vector Damage Overall Condition 1 – 5 based on observations above and scale below			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment DRAINAGE INLET (cont'd)	
Structural Damage	
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water corrosion settling cracking misalignment design flaws parging/spalling connection/collar failure collapsing/failing other
Describe extent of issues:	
Evidence of damage **to**: (circle)	access roads fences gates locks safety features steps frames covers signs grates other
Describe extent of issues:	
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below	
Erosion Damage	
Evidence of erosion **to**: (circle)	foundation embankments other
Describe extent of issues:	
Evidence of: (circle)	lack of armoring (veg or rock) unstable contributing areas dislodged rock armoring sediment accumulation other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	
Inspection Summary	
Summary/Additional Comments:	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment DRAINAGE OUTLET			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		
Conveyance Obstruction			
Evidence of: (circle)	obstructed flow sediment/debris accumulation joint/connection failure woody veg encroachment other		
Describe extent of issues:			
Score Conveyance Obstruction Overall Condition 1 – 5 based on observations and scale below			
Hazardous Materials			
Evidence of: (circle)	oil/grease gas/fuel other chemicals odors algae/weeds foam stains/deposits trash/debris dumping other		
Describe extent of issues:			
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below			
Vector Damage			
Evidence of: (circle)	animal burrows ponded water, breeding ground (mosquitoes, etc.) other		
Describe extent of issues:			
Score Vector Damage Overall Condition 1 – 5 based on observations above and scale below			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment DRAINAGE OUTLET (cont'd)	
Structural Damage	
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water corrosion settling cracking misalignment design flaws parging/spalling connection/collar failure collapsing/failing other
Describe extent of issues:	
Evidence of damage **to**: (circle)	access roads fences gates locks safety features frames covers signs grates other
Describe extent of issues:	
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below	
Erosion Damage	
Evidence of erosion **to**: (circle)	foundation embankments energy dissipater other
Describe extent of issues:	
Evidence of: (circle)	lack of armoring (veg or rock) unstable contributing areas dislodged rock armoring sediment accumulation other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	
Inspection Summary	
Summary/Additional Comments:	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment DRY BASIN			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		
Hazardous Materials			
Evidence of: (circle)	oil/grease gas/fuel other chemicals poor water color/clarity odors algae/weeds foam stains/deposits trash/debris dumping other		
Describe extent of issues:			
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below			
Vector Damage			
Evidence of: (circle)	animal burrows ponded water breeding ground (mosquitoes, etc.) other		
Describe extent of issues:			
Score Vector Damage Overall Condition 1 – 5 based on observations above and scale below			
Structural Damage			
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water design flaws other		
Describe extent of issues:			
Evidence of damage **to**: (circle)	access roads fences gates locks safety features signs spillway dam other		
Describe extent of issues:			
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment DRY BASIN (cont'd)	
Erosion Damage	
Evidence of erosion **to**: (circle)	foundation check dams spillway embankments other
Describe extent of issues:	
Evidence of: (circle)	exposed fabric edges breach in check dam lack of armoring (veg or rock) unstable contributing areas dislodged rock armoring sediment accumulation other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	
Inspection Summary	
Summary/Additional Comments:	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment INFILTRATION BASIN			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		

Hazardous Materials	
Evidence of: (circle)	oil/grease gas/fuel other chemicals trash/debris odors algae/weeds foam stains/deposits dumping other
Describe extent of issues:	
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below	

Vector Damage	
Evidence of: (circle)	animal burrows ponded water, breeding ground (mosquitoes, etc.) other
Describe extent of issues:	
Score Vector Damage Overall Condition 1 – 5 based on observations above and scale below	

Structural Damage	
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water corrosion settling cracking design flaws u.v. deterioration leaks parging/spalling connection/collar failure collapsing/failing other
Describe extent of issues:	
Evidence of damage **to**: (circle)	access roads fences gates locks safety features spillway signs dam other
Describe extent of issues:	
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment INFILTRATION BASIN (cont'd)	
Erosion Damage	
Evidence of erosion **to**: (circle)	foundation check dams conveyance system spillway embankments other
Describe extent of issues:	
Evidence of: (circle)	breach in check dam lack of armoring (veg or rock) sediment accumulation unstable contributing areas dislodged rock armoring other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	
Inspection Summary	
Summary/Additional Comments:	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment INFILTRATION FEATURE			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		
Conveyance Obstruction			
Evidence of: (circle)	obstructed flow sediment/debris accumulation joint/connection failure woody vegetation other		
Describe extent of issues:			
Score Conveyance Obstruction Overall Condition 1 – 5 based on observations and scale below			
Structural Damage			
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water corrosion design flaws u.v. deterioration parging/spalling connection/collar failure cracking leaks collapsing/failing other		
Describe extent of issues:			
Evidence of damage **to**: (circle)	access roads gates locks safety features signs grates other		
Describe extent of issues:			
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment INFILTRATION FEATURE (cont'd)		
Hazardous Materials		
Evidence of: (circle)	oil/grease gas/fuel other chemicals trash/debris odors algae/weeds foam stains/deposits dumping other	
Describe extent of issues:		
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below		
Vector Damage		
Evidence of: (circle)	animal burrows ponded water, breeding ground (mosquitoes, etc.) other	
Describe extent of issues:		
Score Vector Damage Overall Condition 1 – 5 based on observations above and scale below		
Inspection Summary		
Summary/Additional Comments:		

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment MANHOLE			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		

Conveyance Obstruction	
Evidence of: (circle)	obstructed flow sediment/debris accumulation joint/connection failure other
Describe extent of issues:	
Score Conveyance Obstruction Overall Condition 1 – 5 based on observations and scale below	

Hazardous Materials	
Evidence of: (circle)	oil/grease gas/fuel other chemicals poor water color/clarity odors algae/weeds foam stains/deposits trash/debris dumping other
Describe extent of issues:	
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below	

Structural Damage	
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water corrosion cracking misalignment design flaws parging/spalling connection/collar failure collapsing/failing other
Describe extent of issues:	
Evidence of damage **to**: (circle)	access roads fences gates locks safety features steps frames covers other
Describe extent of issues:	
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment MANHOLE (cont'd)	
Erosion Damage	
Evidence of erosion **to**: (circle)	foundation embankments other
Describe extent of issues:	
Evidence of: (circle)	lack of armoring (veg or rock) sediment accumulation unstable contributing areas dislodged rock armoring other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	
Inspection Summary	
Summary/Additional Comments:	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment RETAINING WALL			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		
Vector Damage			
Evidence of: (circle)	animal burrows other		
Describe extent of issues:			
Score Vector Damage Overall Condition 1 – 5 based on observations above and scale below			
Structural Damage			
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water settling cracking bulging/bowing misalignment design flaws parging/spalling leaks collapsing/failing other		
Describe extent of issues:			
Evidence of damage **to**: (circle)	access roads fences gates locks safety features other		
Describe extent of issues:			
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment RETAINING WALL (cont'd)	
Erosion Damage	
Evidence of erosion **to**: (circle)	foundation embankments other
Describe extent of issues:	
Evidence of: (circle)	exposed fabric edges breach in wall lack of armoring (veg or rock) unstable contributing areas dislodged rock armoring sediment accumulation other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	
Inspection Summary	
Summary/Additional Comments:	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment RIPRAP SLOPE STABILIZATION			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		
Structural Damage			
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water settling design flaws collapsing/failing other		
Describe extent of issues:			
Evidence of damage **to**: (circle)	access roads fences gates locks safety features signs other		
Describe extent of issues:			
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below			
Erosion Damage			
Evidence of erosion **to**: (circle)	foundation embankments other		
Describe extent of issues:			
Evidence of: (circle)	exposed fabric edges lack of armoring (veg or rock) sediment accumulation unstable contributing areas dislodged rock armoring other		
Describe extent of issues:			
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below			
Inspection Summary			
Summary/Additional Comments:			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment ROCK LINED CHANNEL			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		
Conveyance Obstruction			
Evidence of: (circle)	obstructed flow sediment/debris accumulation woody veg encroachment other		
Describe extent of issues:			
Score Conveyance Obstruction Overall Condition 1 – 5 based on observations and scale below			
Hazardous Materials			
Evidence of: (circle)	oil/grease gas/fuel other chemicals odors trash/debris algae/weeds foam stains/deposits dumping other		
Describe extent of issues:			
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below			
Vector Damage			
Evidence of: (circle)	animal burrows ponded water, breeding ground (mosquitoes, etc.) other		
Describe extent of issues:			
Score Vector Damage Overall Condition 1 – 5 based on observations above and scale below			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment ROCK LINED CHANNEL (cont'd)	
Structural Damage	
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water settling cracking design flaws collapsing/failing other
Describe extent of issues:	
Evidence of damage **to**: (circle)	access roads fences gates locks safety features signs other
Describe extent of issues:	
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below	
Erosion Damage	
Evidence of erosion **to**: (circle)	foundation check dams energy dissipator embankments other
Describe extent of issues:	
Evidence of: (circle)	exposed fabric edges breach in check dam lack of armoring (veg or rock) unstable contributing areas dislodged rock armoring sediment accumulation other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	
Inspection Summary	
Summary/Additional Comments:	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment TREATMENT VAULT			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		
Hazardous Materials			
Evidence of: (circle)	oil/grease gas/fuel other chemicals odors trash/debris algae/weeds foam stains/deposits dumping other		
Describe extent of issues:			
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below			
Vector Damage			
Evidence of: (circle)	animal burrows ponded water, breeding ground (mosquitoes, etc.) other		
Describe extent of issues:			
Score Vector Damage Overall Condition 1 – 5 based on observations above and scale below			
Structural Damage			
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water corrosion settling cracking misalignment design flaws parging/spalling connection/collar failure collapsing/failing other		
Describe extent of issues:			
Evidence of damage **to**: (circle)	access roads fences gates locks safety features steps frames covers signs other		
Describe extent of issues:			
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment TREATMENT VAULT (cont'd)	
Erosion Damage	
Evidence of erosion **to**: (circle)	foundation embankments other
Describe extent of issues:	
Evidence of: (circle)	lack of armoring (veg or rock) unstable contributing areas dislodged rock armoring sediment accumulation other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	
Inspection Summary	
Summary/Additional Comments:	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment VEGETATED SWALE			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		
Hazardous Materials			
Evidence of: (circle)	oil/grease gas/fuel other chemicals odors trash/debris algae/weeds foam stains/deposits dumping other		
Describe extent of issues:			
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below			
Vector Damage			
Evidence of: (circle)	animal burrows ponded water, breeding ground (mosquitoes, etc.) other		
Describe extent of issues:			
Score Vector Damage Overall Condition 1 – 5 based on observations above and scale below			
Structural Damage			
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment water design flaws collapsing/failing other		
Describe extent of issues:			
Evidence of damage **to**: (circle)	access roads fences gates locks safety features signs other		
Describe extent of issues:			
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment VEGETATED SWALE (cont'd)	
Erosion Damage	
Evidence of erosion **to**: (circle)	foundation check dams embankments other
Describe extent of issues:	
Evidence of: (circle)	exposed fabric edges breach in check dam lack of armoring (veg or rock) unstable contributing areas dislodged rock armoring sediment accumulation other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	
Inspection Summary	
Summary/Additional Comments:	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment WET BASIN			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Observation Date & Time			
Observer Name			
Date of Last Rainfall:		Amount:	Inches
Reason for Inspection:	Initial Routine Complaint After Significant Rainfall Event		
Hazardous Materials			
Evidence of: (circle)	oil/grease gas/fuel other chemicals poor water color/clarity odors algae/weeds foam stains/deposits trash/debris dumping other		
Describe extent of issues:			
Score Hazardous Materials Overall Condition 1 – 5 based on observations above and scale below			
Vector Damage			
Evidence of: (circle)	waterfowl degrading water quality animal burrows beaver dams ponded water breeding ground (mosquitoes, etc.) other		
Describe extent of issues:			
Score Vector Damage Overall Condition 1 – 5 based on observations above and scale below			
Structural Damage			
Evidence of damage **from**: (circle)	vandalism snow plow woody veg encroachment design flaws liner failure other		
Describe extent of issues:			
Evidence of damage **to**: (circle)	access roads fences gates locks safety features spillway signs dam other		
Describe extent of issues:			
Score Structural Damage Overall Condition 1 – 5 based on observations above and scale below			

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Asset Condition Assessment WET BASIN (cont'd)	
Erosion Damage	
Evidence of erosion **to**: (circle)	foundation check dams spillway embankments other
Describe extent of issues:	
Evidence of: (circle)	exposed fabric edges breach in check dam lack of armoring (veg or rock) unstable contributing areas dislodged rock armoring sediment accumulation other
Describe extent of issues:	
Score Erosion Damage Overall Condition 1 – 5 based on observations above and scale below	
Inspection Summary	
Summary/Additional Comments:	

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Excellent
Poses safety risk. **Immediate** action required	Needs maintenance before next storm	Watch- Re-inspect in 12 months – Maintenance NOT required	Normal wear and tear for asset – Maintenance NOT required	Asset Like New with **NO** damage. Maintenance NOT required

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Treatment Performance BED FILTER			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Inspection Date & Time			
Inspector Name			

Constant Head Permeameter (Infiltration)					
Asset Area (ft2)		# of measurements necessary		Benchmark Reading?	Yes No

Measurement Location ID														
	t*	r*	t*	r*	t*	r*	t*	r*	t*	r*	t*	r*	t*	r*
1														
2														
3														
4														
5														

*Where t is **Time** in minutes and r is **Reading** in inches

Conveyance			
Conveyance Feature ID	Functioning as intended? (Y/N)	If **NOT** functioning as intended	
		Debris removal required? (Y/N)	Advanced maintenance required? (Y/N)

Summary/Additional Comments:

X Back to Reference Table

Treatment Performance DRAINAGE INLET			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Inspection Date & Time			
Inspector Name			

Sediment Trap Capacity (Depth)	
Depth ID (same as Asset Identifier)	
Depth (ft)	
Benchmark Reading? (Y/N)	

Conveyance			
Conveyance Feature ID	Functioning as intended? (Y/N)	If **NOT** functioning as intended	
		Debris removal required? (Y/N)	Advanced maintenance required? (Y/N)

Summary/Additional Comments:

X Back to Reference Table

Treatment Performance DRY BASIN			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Inspection Date & Time			
Inspector Name			

Vegetation Cover					
Wetland Species **Wet %**	Riparian Species **Riparian %**	Terrestrial Trees **Tree %**	Grass Species **Grass %**	NO Vegetation **No Veg %**	Total = 100%

Constant Head Permeameter (Infiltration)					
Asset Area (ft2)		# of measurements necessary		Benchmark Reading?	Yes No

Measurement Location ID														
	t*	r*	t*	r*	t*	r*	t*	r*	t*	r*	t*	r*	t*	r*
1														
2														
3														
4														
5														

*Where t is **Time** in minutes and r is **Reading** in inches

Material Accumulation (Depth)		
Staff Plate ID	Lowest reading visible (0.0 ft)	Benchmark Reading (Y/N)

Conveyance			
Conveyance Feature ID	Functioning as intended? (Y/N)	If **NOT** functioning as intended	
		Debris removal required? (Y/N)	Advanced maintenance required? (Y/N)

Summary/Additional Comments:

X Back to Reference Table

Treatment Performance INFILTRATION BASIN			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Inspection Date & Time			
Inspector Name			

Vegetation Cover					
Wetland Species **Wet %**	Riparian Species **Riparian %**	Terrestrial Trees **Tree %**	Grass Species **Grass %**	NO Vegetation **No Veg %**	Total = 100%

Constant Head Permeameter (Infiltration)					
Asset Area (ft2)		# of measurements necessary		Benchmark Reading?	Yes No

Measurement Location ID														
	t*	r*	t*	r*	t*	r*	t*	r*	t*	r*	t*	r*	t*	r*
1														
2														
3														
4														
5														

*Where t is **Time** in minutes and r is **Reading** in inches

Conveyance			
Conveyance Feature ID	Functioning as intended? (Y/N)	If **NOT** functioning as intended Debris removal required? (Y/N)	Advanced maintenance required? (Y/N)

Summary/Additional Comments:

X Back to Reference Table

Treatment Performance INFILTRATION FEATURE			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Inspection Date & Time			
Inspector Name			

Vegetation Cover					
Wetland Species **Wet %**	Riparian Species **Riparian %**	Terrestrial Trees **Tree %**	Grass Species **Grass %**	NO Vegetation **No Veg %**	Total = 100%

Runoff	
Measurement ID	Is pool of water present after 20 seconds? (Y/N)
IF any measurements above = yes THEN result = yes ELSE no	

Runoff	
Measurement ID	Is pool of water present after 20 seconds? (Y/N)

Conveyance			
Conveyance Feature ID	Functioning as intended? (Y/N)	If **NOT** functioning as intended	
		Debris removal required? (Y/N)	Advanced maintenance required? (Y/N)

Summary/Additional Comments:

X Back to Reference Table

Treatment Performance ROCK LINED CHANNEL			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Inspection Date & Time			
Inspector Name			

Vegetation Cover					
Wetland Species **Wet %**	Riparian Species **Riparian %**	Terrestrial Trees **Tree %**	Grass Species **Grass %**	NO Vegetation **No Veg %**	Total = 100%

Runoff	
Measurement ID	Is pool of water present after 20 seconds? (Y/N)
IF any measurements above = yes THEN result = yes ELSE no	

Runoff	
Measurement ID	Is pool of water present after 20 seconds? (Y/N)

Conveyance			
Conveyance Feature ID	Functioning as intended? (Y/N)	If **NOT** functioning as intended	
		Debris removal required? (Y/N)	Advanced maintenance required? (Y/N)

Summary/Additional Comments:

X Back to Reference Table

Treatment Performance TREATMENT VAULT			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Inspection Date & Time			
Inspector Name			

Treatment Vault Capacity (Depth)		
# of measurements		
Measurement ID	Depth (ft)	Benchmark Reading? (Y/N)

Conveyance			
Conveyance Feature ID	Functioning as intended? (Y/N)	If **NOT** functioning as intended	
		Debris removal required? (Y/N)	Advanced maintenance required? (Y/N)

Summary/Additional Comments:

X Back to Reference Table

Treatment Performance VEGETATED SWALE			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Inspection Date & Time			
Inspector Name			

Vegetation Cover					
Wetland Species **Wet %**	Riparian Species **Riparian %**	Terrestrial Trees **Tree %**	Grass Species **Grass %**	NO Vegetation **No Veg %**	Total = 100%

Runoff	
Measurement ID	Is pool of water present after 20 seconds? (Y/N)
IF any measurements above = yes THEN result = yes ELSE no	

Conveyance			
Conveyance Feature ID	Functioning as intended? (Y/N)	If **NOT** functioning as intended	
		Debris removal required? (Y/N)	Advanced maintenance required? (Y/N)

Summary/Additional Comments:

X Back to Reference Table

Treatment Performance WET BASIN			
Asset Identifier			
Date Asset Installed		Asset Life Expectancy	
Inspection Date & Time			
Inspector Name			

Vegetation Cover					
Wetland Species **Wet %**	Riparian Species **Riparian %**	Terrestrial Trees **Tree %**	Grass Species **Grass %**	NO Vegetation **No Veg %**	Total = 100%

Material Accumulation (Depth)		
Staff Plate ID	Lowest reading visible (0.0 ft)	Benchmark Reading (Y/N)

Conveyance			
Conveyance Feature ID	Functioning as intended? (Y/N)	If **NOT** functioning as intended	
		Debris removal required? (Y/N)	Advanced maintenance required? (Y/N)

Summary/Additional Comments:

X Back to Reference Table

Appendix B: Maintenance Record Forms

These maintenance forms provide for documentation of the work performed by field crews and contractors for routine scheduled work (e.g., cleaning and maintaining vegetation in the spring and fall), reactive work responding to a complaint or rainfall event, or planned work developed from the inspection program that observed problems that should be corrected immediately or before the next storm event. Documenting this work should provide a basis for determining cost and tracking the work effort for each asset to maintain it (e.g., life cycle costs). These cost records should be useful for budgeting and planning for future improvements.

BMP Assets	Maintenance Record Form
Bare Soil Cover	X
Bed Filter	X
Conveyance Piping	X
Curb & Gutter	X
Drainage Inlet	X
Drainage Outlet	X
Dry Basin	X
Infiltration Basin	X
Infiltration Feature	X
Manhole	X
Retaining Wall	X
Riprap Slope Stabilization	X
Rock Lined Channel	X
Treatment Vault	X
Vegetated Swale	X
Wet Basin	X

Note: These forms are available in electronic format for users of the handbook to print and use for field work and can be selected by hyperlink from this table for printing.

Maintenance Record BARE SOIL COVER	
Asset Identifier	
Maintenance Date & Time	
Jurisdiction/Contractor	
Maintenance Worker(s)	
Date of Last Rainfall:	Amount: Inches:
Reason for Maintenance: Routine	Inspection Driven

Routine Work

___ Trash/Debris Removal
___ Irrigation
___ Weeding

Inspection Driven Work

___ Revegetation
___ Erosion Repair
    ___ erosion control blanket
    ___ mulch
    ___ coir logs

___ Soil Improvements
    ___ tilling/scarify
    ___ soil amendments

Other: _____
_____
_____

Estimated total manhours:	
Equipment/Material used:	
Vegetation Area (ft^2) Maintained:	

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record BED FILTER			
Asset Identifier			
Maintenance Date & Time			
Jurisdiction/Contractor			
Maintenance Worker(s)			
Date of Last Rainfall:		Amount:	Inches:
Reason for Maintenance:	Routine	Inspection Driven	

Routine Work

___ Mowing
___ Outlet works cleaning (trash rack/well screen)
___ Weed control (herbicide application)

Inspection Driven Work

___ Sediment Removal
- ___ forebay
- ___ filter media
- ___ inflow

___ Vegetation Removal/Tree Thinning
- ___ inflow
- ___ channel
- ___ upper boundary
- ___ lower boundary

___ Revegetation
___ Vactor/Clearing Drains
- ___ forebay
- ___ outlet
- ___ inflow

___ Tilling/Scarify

___ Erosion Repair
- ___ inflow
- ___ outflow
- ___ spillway
- ___ upper boundary
- ___ lower boundary

___ Structural Repair
- ___ channel
- ___ outlet
- ___ inflow
- ___ forebay
- ___ under drain

Other: _____
_____
_____

Estimated total manhours:			
Equipment/Material used:			
Volume (ft^3) Material Removed from basin:		Material Disposal Location:	
Infiltration Capacity Maintenance performed:			

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record CONVEYANCE PIPING	
Asset Identifier	
Maintenance Date & Time	
Jurisdiction/Contractor	
Maintenance Worker(s)	
Date of Last Rainfall:	Amount: Inches:
Reason for Maintenance: Routine	Inspection Driven

Routine Work

___ Vector Treatment (mosquito)
___ Trash/Debris Removal
___ Clear Asset Access (manhole cover, roadway/path)

Inspection Driven Work

___ Conveyance Improvements
- ___ joints/connections
- ___ parging/spalling
- ___ corrosion

___ Erosion Repair
- ___ inlets
- ___ outlets/outfalls
- ___

___ Sediment Removal
- ___ forebay
- ___ sedimentation chamber
- ___

___ Structural Repair
- ___ cracking/settling
- ___ misalignment
- ___ tree roots
- ___damage

Other: _____
_____
_____

Estimated total manhours:	
Equipment/Material used:	

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record CURB & GUTTER			
Asset Identifier			
Maintenance Date & Time			
Jurisdiction/Contractor			
Maintenance Worker(s)			
Date of Last Rainfall:		Amount:	Inches:
Reason for Maintenance:	Routine	Inspection Driven	

Routine Work

___ Trash/Debris Removal
___ Sweeping
___

Inspection Driven Work

___ Sediment Removal
___ Conveyance Improvements
- ___ crack sealing
- ___ parging/spalling
- ___ freeze/thaw

___ Erosion Repair
- ___
- ___
- ___

___ Structural Repair
- ___ cracking
- ___ vehicle damage
- ___ tree roots

Other: _____
_____
_____

Estimated total manhours:	
Equipment/Material used:	

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record DRAINAGE INLET	
Asset Identifier	
Maintenance Date & Time	
Jurisdiction/Contractor	
Maintenance Worker(s)	
Date of Last Rainfall:	Amount: Inches:
Reason for Maintenance: Routine	Inspection Driven

Routine Work

___ Mowing
___ Vector treatment (mosquitoes, burrowing animals)
___ Algae treatment
___ Inlet cleaning (trash rack/well screen)
___ Weed control (herbicide application)

Inspection Driven Work

___ Erosion Repair
- ___ inflow point
- ___ channel

___ Vegetation Removal/Tree Thinning
- ___ inflow
- ___ channel
- ___ upper boundary

___ Revegetation
___ Vactor/Clearing Drains
- ___ forebay
- ___ inflow

___ Sediment Removal
- ___ forebay
- ___ channel
- ___ inflow

___ Erosion Repair
- ___ inflow
- ___

___ Structural Repair
- ___ channel
- ___ inflow
- ___ forebay

Other: _____
_____
_____

Estimated total manhours:	
Equipment/Material used:	

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record DRAINAGE OUTLET	
Asset Identifier	
Maintenance Date & Time	
Jurisdiction/Contractor	
Maintenance Worker(s)	
Date of Last Rainfall:	Amount: Inches:
Reason for Maintenance: Routine	Inspection Driven

Routine Work

___ Mowing
___ Vector treatment (burrowing animals, mosquitoes)
___ Algae treatment
___ Inlet cleaning (trash rack/well screen)
___ Weed control (herbicide application)

Inspection Driven Work

___ Erosion Repair
- ___ outflow point
- ___ channel

___ Vegetation Removal/Tree Thinning
- ___ outflow
- ___ channel
- ___ upper boundary

___ Revegetation
___ Vactor/Clearing Drains
- ___ forebay
- ___ outflow

___ Sediment Removal (Dredging)
- ___ outlet
- ___ channel
- ___ outflow

___ Structural Repair
- ___ channel
- ___ outflow
- ___

Other: _____
_____
_____

Estimated total manhours:	
Equipment/Material used:	

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record DRY BASIN			
Asset Identifier			
Maintenance Date & Time			
Jurisdiction/Contractor			
Maintenance Worker(s)			
Date of Last Rainfall:		Amount:	Inches:
Reason for Maintenance:	Routine	Inspection Driven	

Routine Work

___ Mowing
___ Mosquito treatment
___ Algae treatment
___ Outlet works cleaning (trash rack/well screen)
___ Weed control (herbicide application)

Inspection Driven Work

___ Erosion Repair
- ___ inflow
- ___ outflow
- ___ spillway
- ___ upper boundary
- ___ lower boundary

___ Vegetation Removal/Tree Thinning
- ___ inflow
- ___ channel
- ___ upper boundary
- ___ lower boundary

___ Vactor/Clearing Drains
- ___ forebay
- ___ outlet
- ___ inflow

___ Revegetation
___ Sediment Removal
- ___ bottom area
- ___ upper are
- ___ outflow

___ Structural Repair
- ___ channel
- ___ outlet
- ___ inflow
- ___ forebay

Other: _____
_____

Estimated total manhours:			
Equipment/Material used:			
Volume (ft^3) Material Removed from basin:		Material Disposal Location:	
Infiltration Capacity Maintenance performed:			

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record INFILTRATION BASIN			
Asset Identifier			
Maintenance Date & Time			
Jurisdiction/Contractor			
Maintenance Worker(s)			
Date of Last Rainfall:		Amount:	Inches:
Reason for Maintenance:	Routine	Inspection Driven	

Routine Work

___ Mowing
___ Mosquito treatment
___ Algae treatment
___ Outlet works cleaning (trash rack/well screen)
___ Weed control (herbicide application)

Inspection Driven Work

___ Vegetation Removal/Tree Thinning
- ___ inflow
- ___ channel
- ___ upper boundary
- ___ lower boundary

___ Revegetation
___ Vactor/Clearing Drains
- ___ forebay
- ___ outlet
- ___ inflow

___ Tilling/Scarify

___ Sediment Removal
- ___ bottom area
- ___ upper are
- ___ inflow

___ Erosion Repair
- ___ inflow
- ___ outflow
- ___ spillway
- ___ upper boundary
- ___ lower boundary

___ Structural Repair
- ___ channel
- ___ outlet
- ___ inflow
- ___ forebay

Other: _____
_____
_____

Estimated total manhours:			
Equipment/Material used:			
Volume (ft^3) Material Removed from basin:		Material Disposal Location:	
Infiltration Capacity Maintenance performed:			

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record INFILTRATION FEATURE	
Asset Identifier	
Maintenance Date & Time	
Jurisdiction/Contractor	
Maintenance Worker(s)	
Date of Last Rainfall:	Amount: Inches:
Reason for Maintenance: Routine	Inspection Driven

Routine Work

___ Mowing
___ Vector treatment (mosquitoes, burrowing animals)
___ Algae treatment
___ Outlet works cleaning (trash rack/well screen)
___ Weed control (herbicide application)

Inspection Driven Work

___ Sediment Removal
- ___ forebay
- ___ channel
- ___ inflow

___ Vegetation Removal/Tree Thinning
- ___ inflow
- ___ channel
- ___ upper boundary
- ___ lower boundary

___ Revegetation
___ Vactor/Clearing Drains
- ___ forebay
- ___ outlet
- ___ inflow

___ Tilling/Scarify

___ Erosion Repair
- ___ inflow
- ___ outflow
- ___ spillway
- ___ upper boundary
- ___ lower boundary

___ Structural Repair
- ___ channel
- ___ outlet
- ___ inflow
- ___ forebay
- ___ under drain
- ___ media filter

Other: _____
_____
_____

Estimated total manhours:	
Equipment/Material used:	
Infiltration Capacity Maintenance performed:	

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record MANHOLE	
Asset Identifier	
Maintenance Date & Time	
Jurisdiction/Contractor	
Maintenance Worker(s)	
Date of Last Rainfall:	Amount: Inches:
Reason for Maintenance: Routine	Inspection Driven

Routine Work

___ Vector Treatment (mosquito)
___ Trash/Debris Removal
___ Asset Access (manhole cover, roadway/path)

Inspection Driven Work

___ Sediment Removal
- ___ sedimentation chamber
- ___ forebay
- ___
- ___

___ Conveyance Improvements
- ___ joints/connections
- ___ parging/spalling
- ___ corrosion

___ Safety hazards
- ___ cover
- ___ steps/boards

___ Structural Repair
- ___ cracking/settling
- ___ misalignment

___ Erosion Repair
- ___
- ___
- ___
- ___

Other: _____
_____
_____

Estimated total manhours:	
Equipment/Material used:	

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record RETAINING WALL	
Asset Identifier	
Maintenance Date & Time	
Jurisdiction/Contractor	
Maintenance Worker(s)	
Date of Last Rainfall:	Amount: Inches:
Reason for Maintenance: Routine	Inspection Driven

Routine Work

___ Vector Treatment (burrowing animals)
___ Trash/Debris Removal
___ Asset Access (roadway/path)
___ Weed control (herbicide application)

Inspection Driven Work

___ Sediment Removal
- ___ behind wall
- ___ base of wall
- ___
- ___

___ Erosion Repair
- ___vegetation/armoring
- ___ erosion control blanket
- ___ irrigation

___ Structural Repair
- ___ cracking/settling
- ___ misalignment
- ___ vehicle damage

Other: _____
_____
_____

Estimated total manhours:	
Equipment/Material used:	

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record RIPRAP SLOPE STABILIZATION	
Asset Identifier	
Maintenance Date & Time	
Jurisdiction/Contractor	
Maintenance Worker(s)	
Date of Last Rainfall:	Amount: Inches:
Reason for Maintenance: Routine	Inspection Driven

Routine Work

___ Vector Treatment (burrowing animals)
___ Trash/Debris Removal
___ Asset Access (roadway/path)
___ Weed control (herbicide application)

Inspection Driven Work

___ Erosion Repair
- ___ replace/add armoring
- ___ additional retaining structures
- ___ vegetation
- ___ sediment accumulation

___ Safety Hazards
- ___ vandalism/damage
- ___
- ___

___ Sediment Removal
___ Structural Repair
- ___ cracking/settling
- ___ misalignment
- ___ tree roots
- ___ vandalism/damage
- ___ parging/spalling
- ___ corrosion/deterioration

Other: _____
_____
_____

Estimated total manhours:	
Equipment/Material used:	

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record ROCK LINED CHANNEL			
Asset Identifier			
Maintenance Date & Time			
Jurisdiction/Contractor			
Maintenance Worker(s)			
Date of Last Rainfall:		Amount:	Inches:
Reason for Maintenance:	Routine	Inspection Driven	

Routine Work

___ Vector Treatment (mosquito, burrowing animals)
___ Trash/Debris Removal
___ Asset Access (roadway/path)
___ Weed Removal (herbicide application)

Inspection Driven Work

___ Sediment Removal
- ___ forebay
- ___ channel
- ___ outlet

___ Erosion Repair
- ___ replace/add armoring
- ___ vegetation
- ___ rills/gullies
- ___

___ Structural Repair
- ___ grade control
- ___ vandalism/damage
- ___ undermined channel
- ___ displaced rock

Other: _____
_____
_____

Estimated total manhours:			
Equipment/Material used:			
Volume (ft^3) Material Removed from basin:		Material Disposal Location:	
Infiltration Capacity Maintenance performed:			

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record TREATMENT VAULT	
Asset Identifier	
Maintenance Date & Time	
Jurisdiction/Contractor	
Maintenance Worker(s)	
Date of Last Rainfall:	Amount: Inches:
Reason for Maintenance: Routine	Inspection Driven

Routine Work

___ Vector Treatment (mosquito)
___ Trash/Debris Removal
___ Asset Access (manhole cover, roadway/path)
___

Inspection Driven Work

___ Sediment Removal
- ___ sedimentation chamber
- ___ forebay
- ___
- ___

___ Conveyance Improvements
- ___ joints/connections
- ___ parging/spalling
- ___ corrosion

___ Erosion Repair
- ___
- ___

___ Structural Repair
- ___ cracking/settling
- ___ misalignment
- ___ tree roots

Other: _____
_____
_____

Estimated total manhours:	
Equipment/Material used:	

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record VEGETATED SWALE	
Asset Identifier	
Maintenance Date & Time	
Jurisdiction/Contractor	
Maintenance Worker(s)	
Date of Last Rainfall:	Amount: Inches:
Reason for Maintenance: Routine	Inspection Driven

Routine Work

___ Mowing
___ Mosquito Treatment
___ Trash/Debris Removal
___ Outlet Cleaning (trash rack/well screen)
___ Weed Control (herbicide application)

Inspection Driven Work

___ Sediment Removal
- ___ inflow point
- ___ swale bottom
- ___ side slope
- ___ buffer strip

___ Revegetation
- ___ swale bottom
- ___ side slope
- ___ buffer strip

___ Erosion Repair
- ___ inflow point
- ___ swale bottom
- ___ side slope
- ___ buffer strip
- ___ grade control/level spreader

___ Structural Repair
- ___ inflow
- ___ outlet
- ___ level spreader

Other: _____
_____
_____

Estimated total manhours:	
Equipment/Material used:	
Vegetation Area (ft^2) maintained:	

Recommendations

Recommendations/Additional Comments:

X Back to Reference Table

Maintenance Record WET BASIN			
Asset Identifier			
Maintenance Date & Time			
Jurisdiction/Contractor			
Maintenance Worker(s)			
Date of Last Rainfall:		Amount:	Inches:
Reason for Maintenance:	Routine	Inspection Driven	

Routine Work

___ Mowing
___ Mosquito treatment
___ Algae treatment
___ Outlet cleaning (trash rack/well screen)
___ Weed control (herbicide application)

Inspection Driven Work

___ Sediment Removal
- ___ forebay
- ___ channel
- ___ inflow

___ Vegetation Removal/Tree Thinning
- ___ inflow
- ___ channel
- ___ upper boundary
- ___ lower boundary

___ Revegetation
___ Vactor/Clearing Drains
- ___ forebay
- ___ outlet
- ___ inflow

___ Erosion Repair
- ___ inflow
- ___ outflow
- ___ spillway
- ___ upper boundary
- ___ lower boundary

___ Structural Repair
- ___ channel
- ___ outlet
- ___ inflow
- ___ forebay

Other: _____
_____

Estimated total manhours:			
Equipment/Material used:			
Vegetation Area (ft^2) maintained:			
Volume (ft^3) Material Removed from basin:		Material Disposal Location:	

Recommendations

Recommendations/Additional Comments:

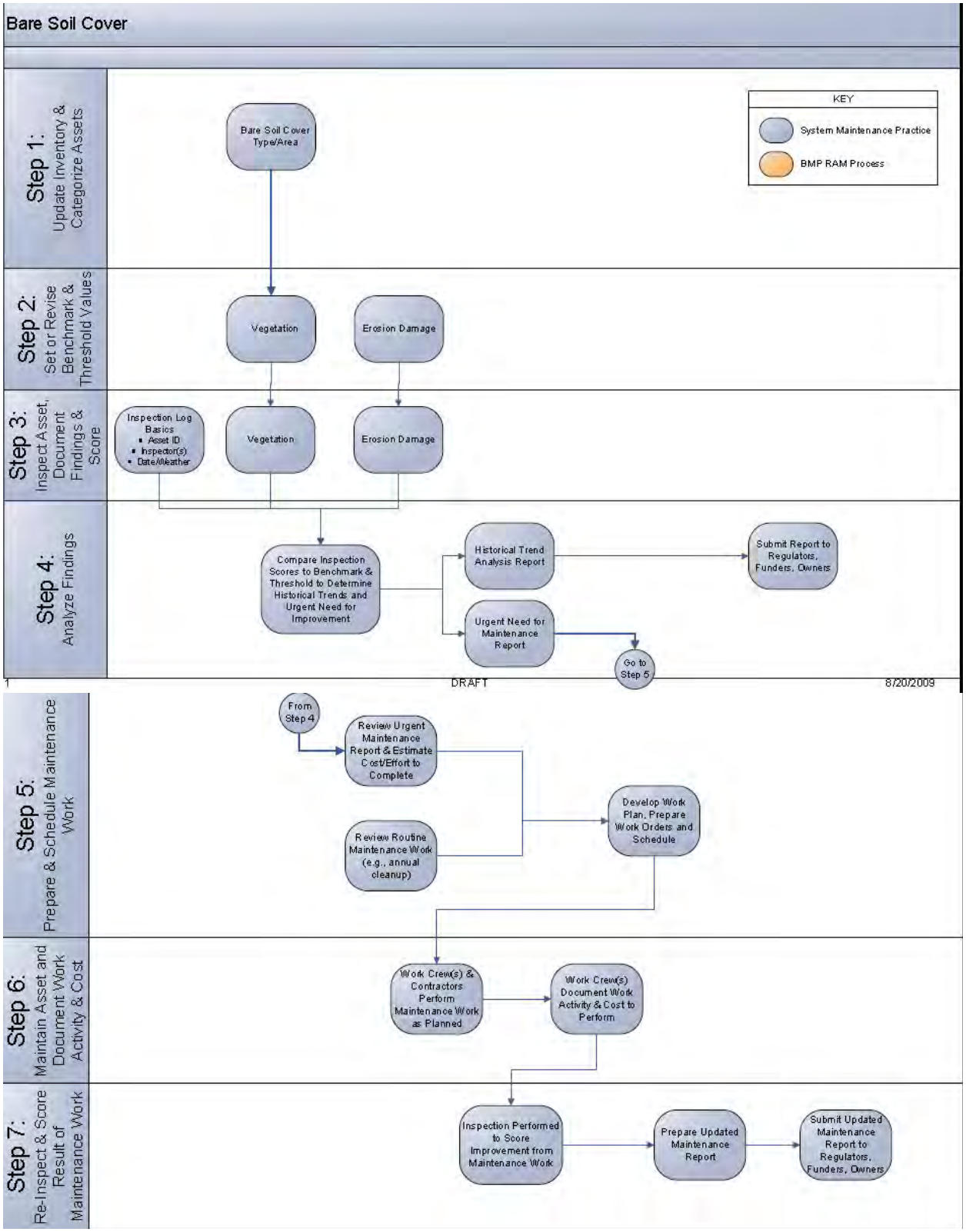
X Back to Reference Table

Appendix C: Process Diagrams

These process diagrams show the specific work processes to be performed in each of the seven steps of the inspection and maintenance process by BMP types. The following is a listing of these process diagrams:

- Bare Soil Cover
- Bed Filter
- Conveyance Piping
- Curb & Gutter
- Drainage Inlet
- Drainage Outlet
- Dry Basin
- Infiltration Basin
- Infiltration Feature
- Manhole
- Retaining Wall
- Riprap Slope Stabilization
- Rock Lined Channel
- Treatment Vault
- Vegetated Swale
- Wet Basin

Noted on these process diagrams are the processes that relate to the treatment performance that is determined by the BMP RAM process. The treatment performance benchmarks and threshold values, inspection scoring, and analysis of findings are to be performed by a proprietary method found in the BMP RAM Users Manual developed and copyrighted by 2NDNATURE and licensed for uses including this O&M Handbook. Refer to the BMP RAM Users Manual for detailed procedures to perform this inspection work. The remaining processes are developed by and for users of this O&M Handbook and are presented herein.


Bare Soil Cover
Step 1: Update Inventory & Categorize Assets
Step 2: Set or Revise Benchmark & Threshold Values
Step 3: Inspect Asset, Document Findings & Score
Step 4: Analyze Findings
Step 5: Prepare & Schedule Maintenance Work
Step 6: Maintain Asset and Document Work Activity & Cost
Step 7: Re-Inspect & Score Result of Maintenance Work
KEY
System Maintenance Practice
BMP RAM Process
Bare Soil Cover Type/Area
Vegetation
Erosion Damage
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Vegetation
Erosion Damage
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Submit Report to Regulators, Funders, Owners
Urgent Need for Maintenance Report
Go to Step 5
1
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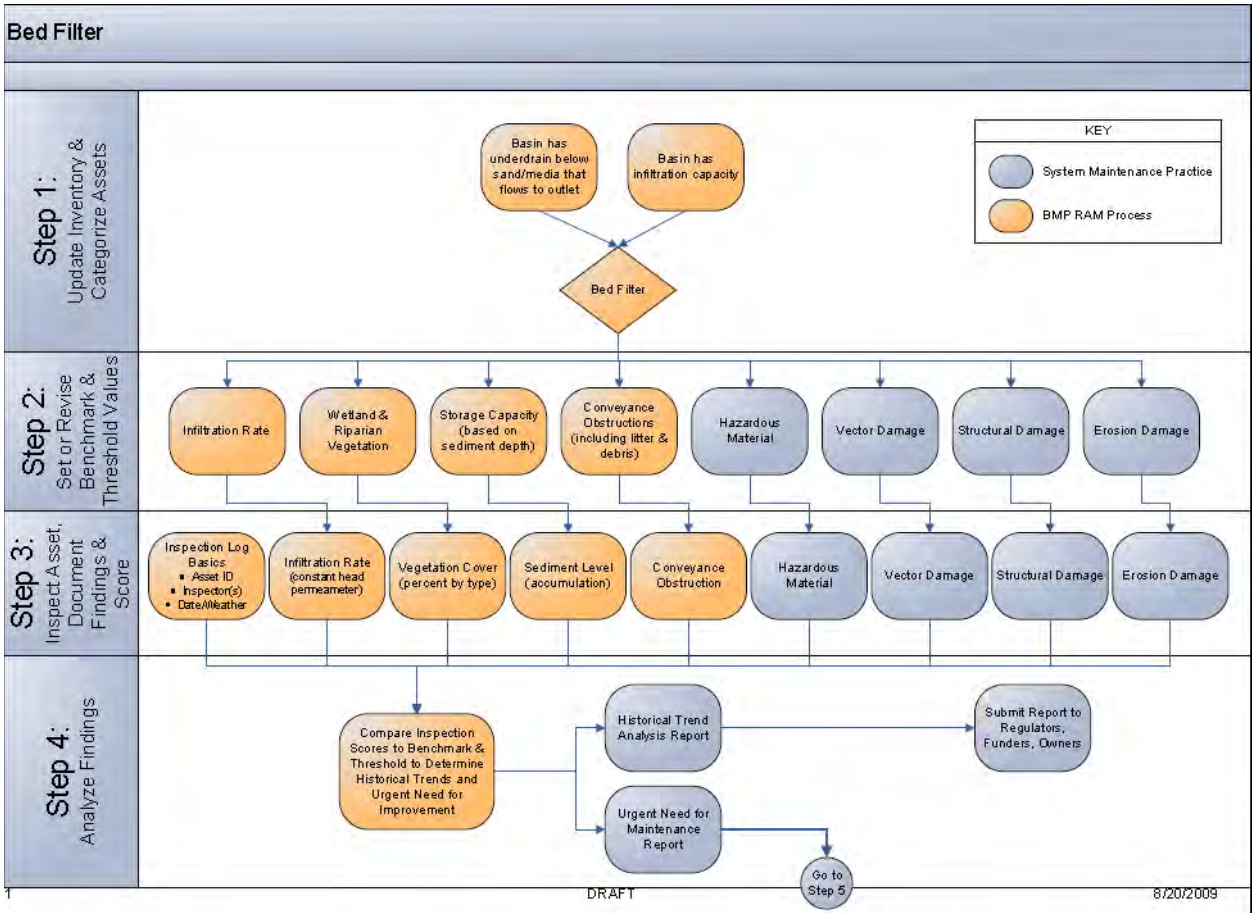
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
Submit Updated Maintenance Report to Regulators, Funders, Owners


Bed Filter
Step 1: Update Inventory & Categorize Assets
Step 2: Set or Revise Benchmark & Threshold Values
Step 3: Inspect Asset, Document Findings & Score
Step 4: Analyze Findings
Basin has underdrain below sand/media that flows to outlet
Basin has infiltration capacity
Bed Filter
KEY
System Maintenance Practice
BMP RAM Process
Infiltration Rate
Wetland & Riparian Vegetation
Storage Capacity (based on sediment depth)
Conveyance Obstructions (including litter & debris)
Hazardous Material
Vector Damage
Structural Damage
Erosion Damage
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Infiltration Rate (constant head permeameter)
Vegetation Cover (percent by type)
Sediment Level (accumulation)
Conveyance Obstruction
Hazardous Material
Vector Damage
Structural Damage
Erosion Damage
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Submit Report to Regulators, Funders, Owners
Urgent Need for Maintenance Report
Go to Step 5
1
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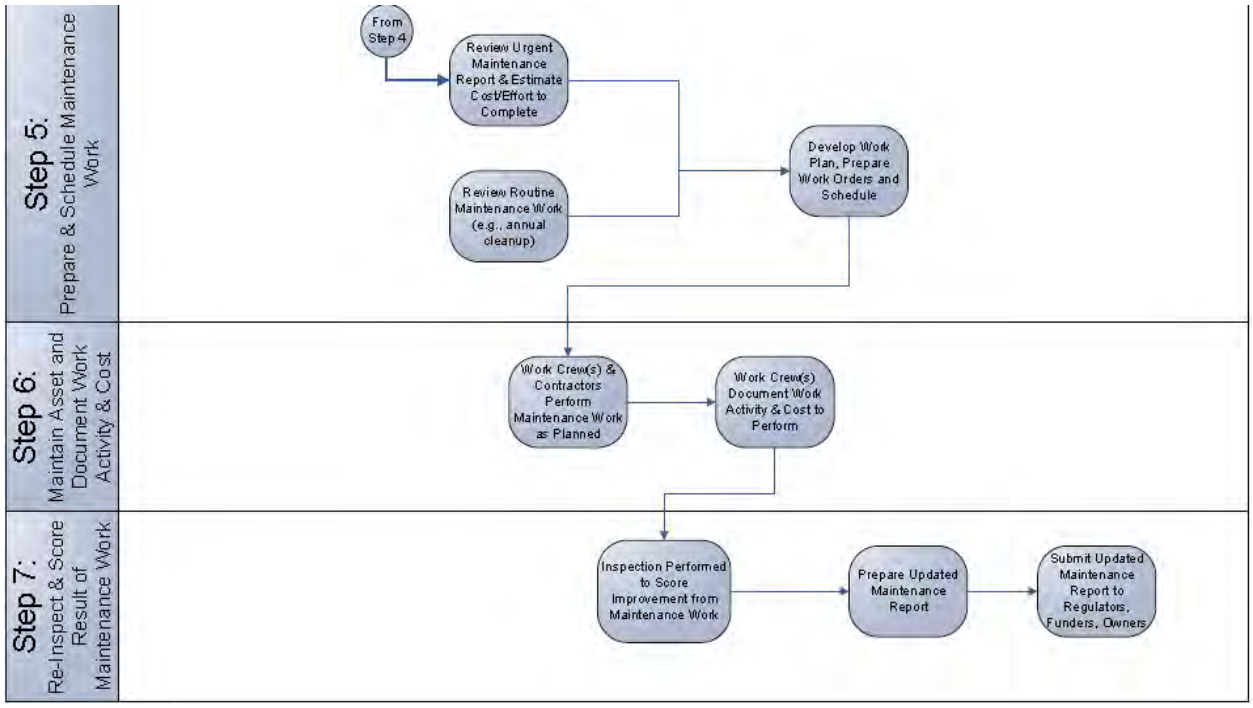
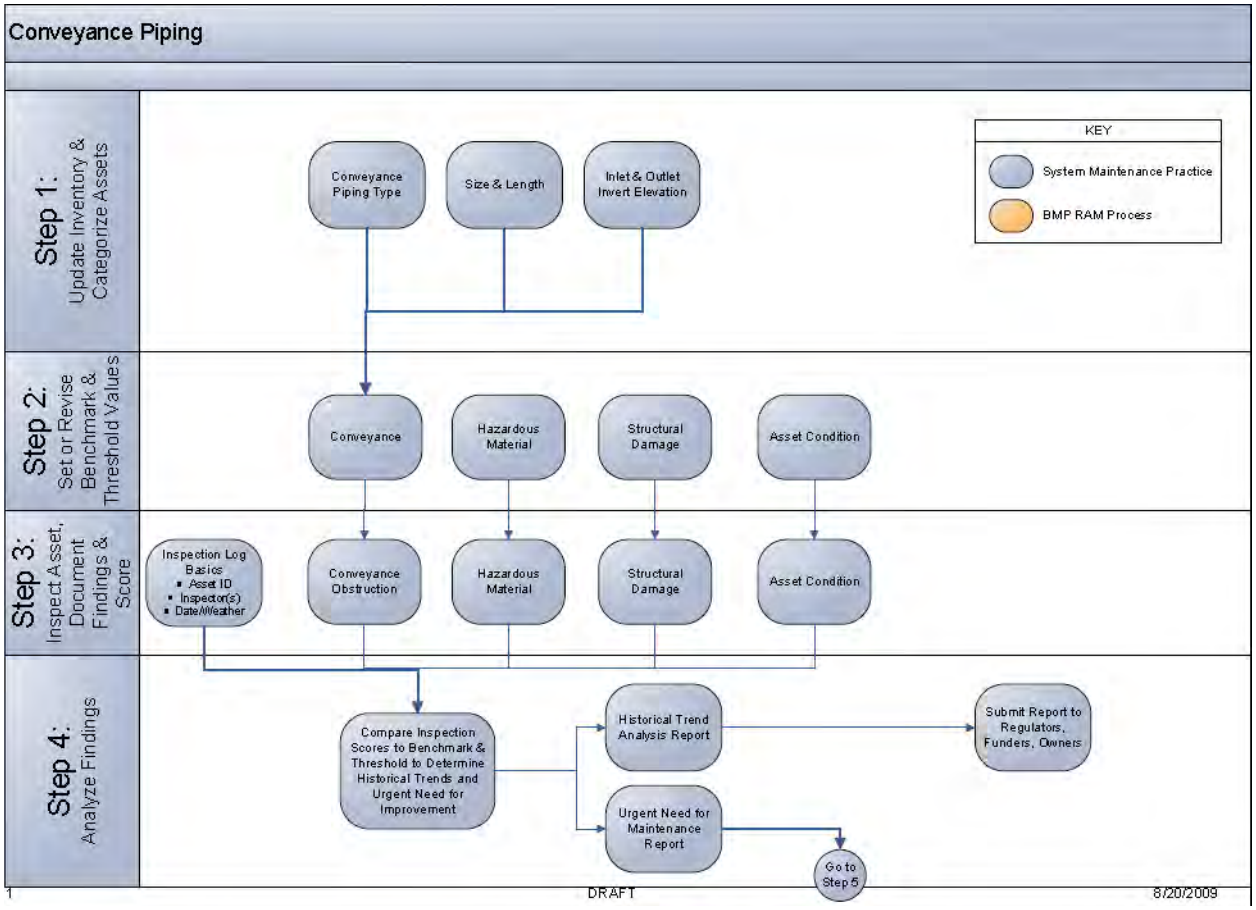

Step 5: Prepare & Schedule Maintenance Work
Step 6: Maintain Asset and Document Work Activity & Cost
Step 7: Re-Inspect & Score Result of Maintenance Work
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
Submit Updated Maintenance Report to Regulators, Funders, Owners


Conveyance Piping
Step 1: Update Inventory & Categorize Assets
Step 2: Set or Revise Benchmark & Threshold Values
Step 3: Inspect Asset, Document Findings & Score
Step 4: Analyze Findings
KEY
System Maintenance Practice
BMP RAM Process
Conveyance Piping Type
Size & Length
Inlet & Outlet Invert Elevation
Conveyance
Hazardous Material
Structural Damage
Asset Condition
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Conveyance Obstruction
Hazardous Material
Structural Damage
Asset Condition
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Urgent Need for Maintenance Report
Submit Report to Regulators, Funders, Owners
Go to Step 5
1
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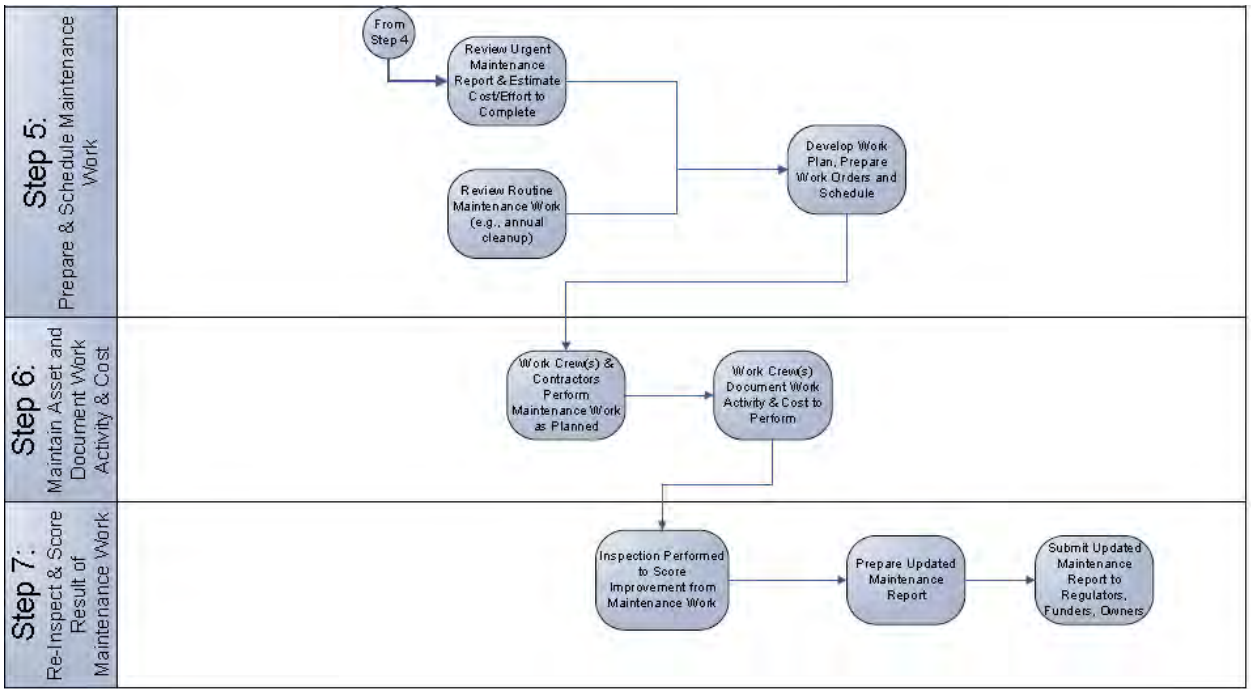
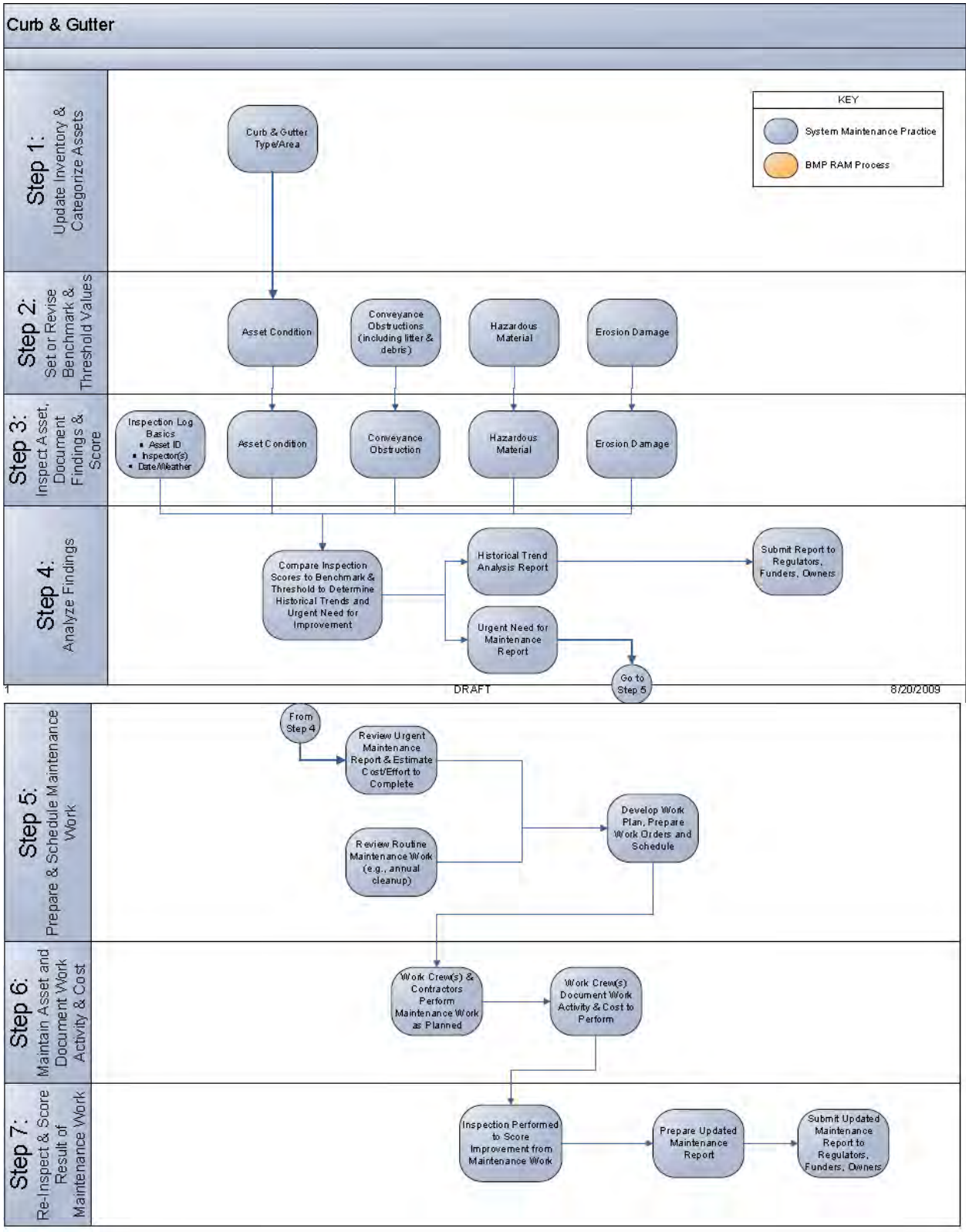

Step 5: Prepare & Schedule Maintenance Work
Step 6: Maintain Asset and Document Work Activity & Cost
Step 7: Re-Inspect & Score Result of Maintenance Work
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
Submit Updated Maintenance Report to Regulators, Funders, Owners


Curb & Gutter
Step 1: Update Inventory & Categorize Assets
Step 2: Set or Revise Benchmark & Threshold Values
Step 3: Inspect Asset, Document Findings & Score
Step 4: Analyze Findings
Curb & Gutter Type/Area
KEY
System Maintenance Practice
BMP RAM Process
Asset Condition
Conveyance Obstructions (including litter & debris)
Hazardous Material
Erosion Damage
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Asset Condition
Conveyance Obstruction
Hazardous Material
Erosion Damage
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Urgent Need for Maintenance Report
Submit Report to Regulators, Funders, Owners
Go to Step 5
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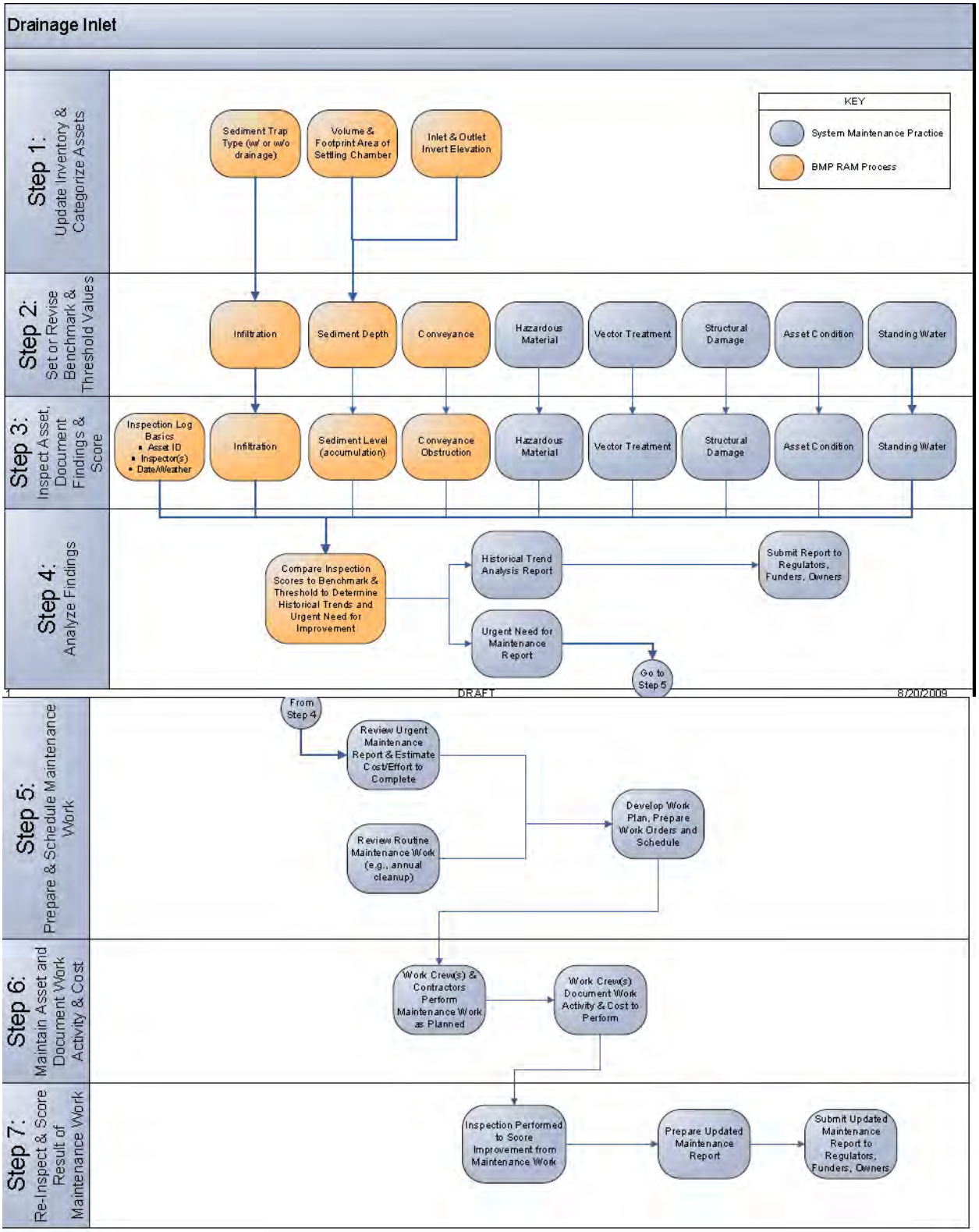
Step 5: Prepare & Schedule Maintenance Work
Step 6: Maintain Asset and Document Work Activity & Cost
Step 7: Re-Inspect & Score Result of Maintenance Work
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
Submit Updated Maintenance Report to Regulators, Funders, Owners


Drainage Inlet
Step 1: Update Inventory & Categorize Assets
Sediment Trap Type (w/ or w/o drainage)
Volume & Footprint Area of Settling Chamber
Inlet & Outlet Invert Elevation
KEY
System Maintenance Practice
BMP RAM Process
Step 2: Set or Revise Benchmark & Threshold Values
Infiltration
Sediment Depth
Conveyance
Hazardous Material
Vector Treatment
Structural Damage
Asset Condition
Standing Water
Step 3: Inspect Asset, Document Findings & Score
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Infiltration
Sediment Level (accumulation)
Conveyance Obstruction
Hazardous Material
Vector Treatment
Structural Damage
Asset Condition
Standing Water
Step 4: Analyze Findings
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Submit Report to Regulators, Funders, Owners
Urgent Need for Maintenance Report
Go to Step 5
1
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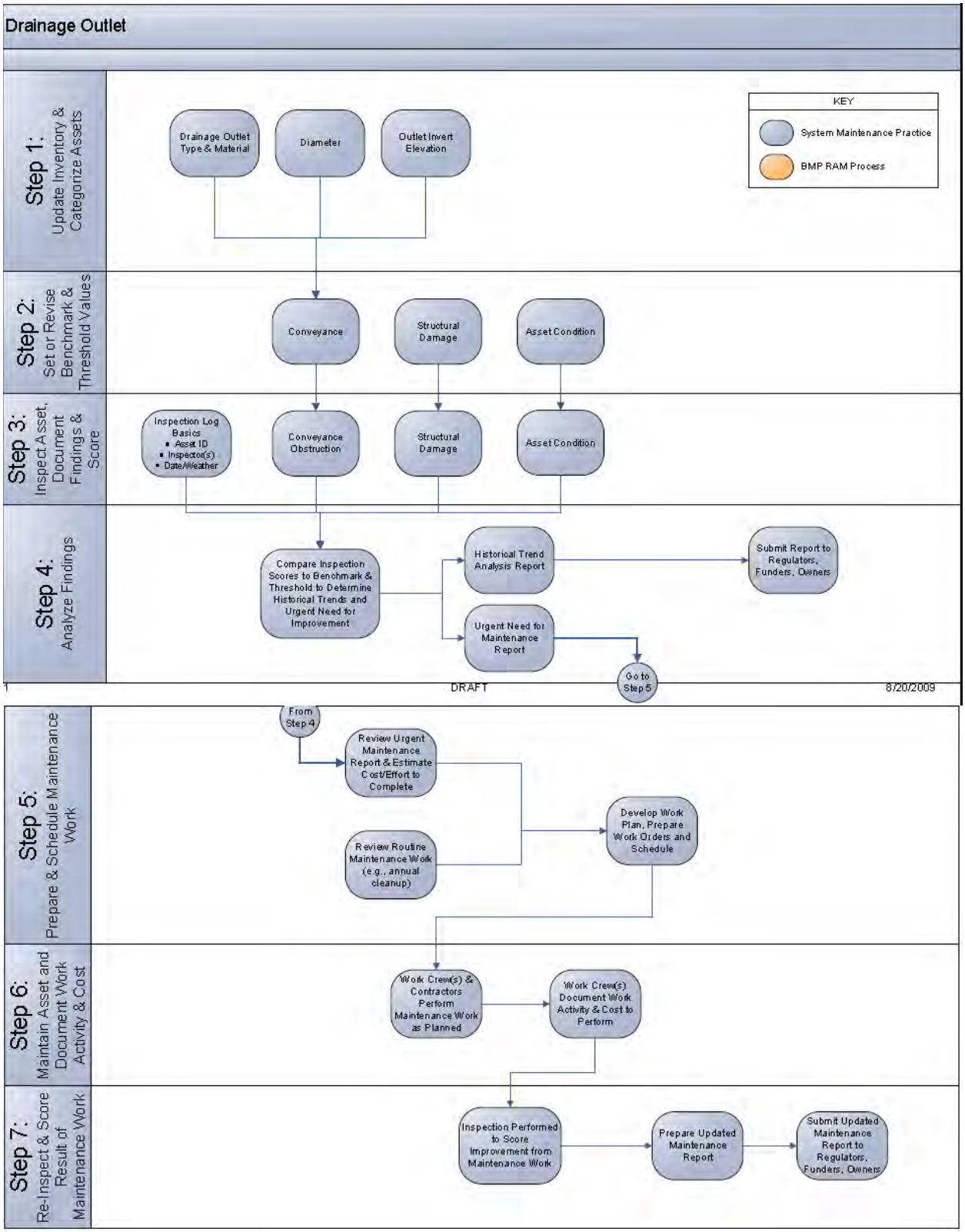
Step 5: Prepare & Schedule Maintenance Work
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Step 6: Maintain Asset and Document Work Activity & Cost
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Step 7: Re-Inspect & Score Result of Maintenance Work
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
Submit Updated Maintenance Report to Regulators, Funders, Owners


Drainage Outlet
Step 1: Update Inventory & Categorize Assets
Drainage Outlet Type & Material
Diameter
Outlet Invert Elevation
KEY
System Maintenance Practice
BMP RAM Process
Step 2: Set or Revise Benchmark & Threshold Values
Conveyance
Structural Damage
Asset Condition
Step 3: Inspect Asset, Document Findings & Score
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Conveyance Obstruction
Structural Damage
Asset Condition
Step 4: Analyze Findings
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Submit Report to Regulators, Funders, Owners
Urgent Need for Maintenance Report
Go to Step 5
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Step 5: Prepare & Schedule Maintenance Work
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Step 6: Maintain Asset and Document Work Activity & Cost
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Step 7: Re-Inspect & Score Result of Maintenance Work
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
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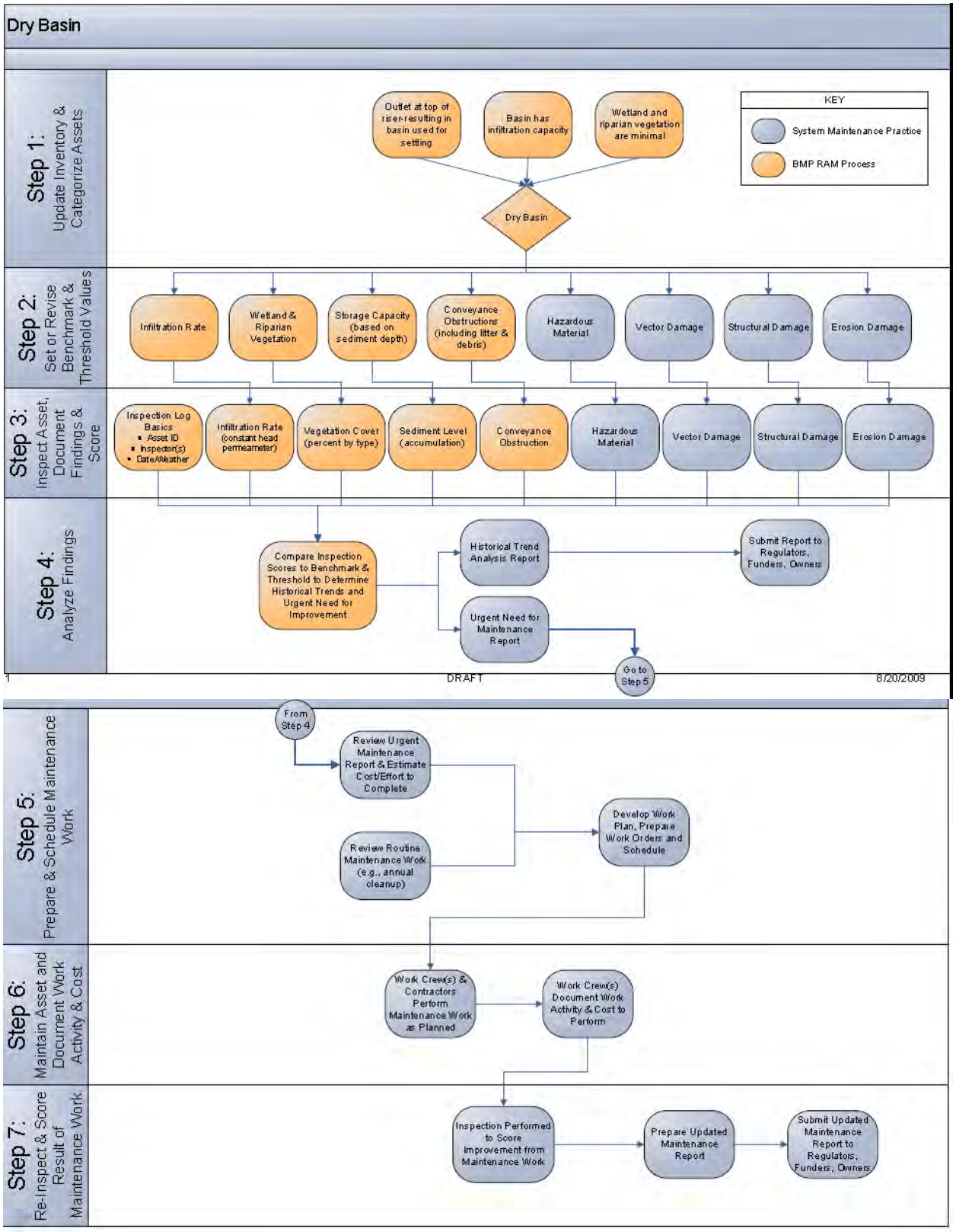
Dry Basin
Step 1: Update Inventory & Categorize Assets
Outlet at top of riser-resulting in basin used for settling
Basin has infiltration capacity
Wetland and riparian vegetation are minimal
KEY
System Maintenance Practice
BMP RAM Process
Dry Basin
Step 2: Set or Revise Benchmark & Threshold Values
Infiltration Rate
Wetland & Riparian Vegetation
Storage Capacity (based on sediment depth)
Conveyance Obstructions (including litter & debris)
Hazardous Material
Vector Damage
Structural Damage
Erosion Damage
Step 3: Inspect Asset, Document Findings & Score
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Infiltration Rate (constant head permeameter)
Vegetation Cover (percent by type)
Sediment Level (accumulation)
Conveyance Obstruction
Hazardous Material
Vector Damage
Structural Damage
Erosion Damage
Step 4: Analyze Findings
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Submit Report to Regulators, Funders, Owners
Urgent Need for Maintenance Report
Go to Step 5
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Step 5: Prepare & Schedule Maintenance Work
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Step 6: Maintain Asset and Document Work Activity & Cost
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Step 7: Re-Inspect & Score Result of Maintenance Work
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
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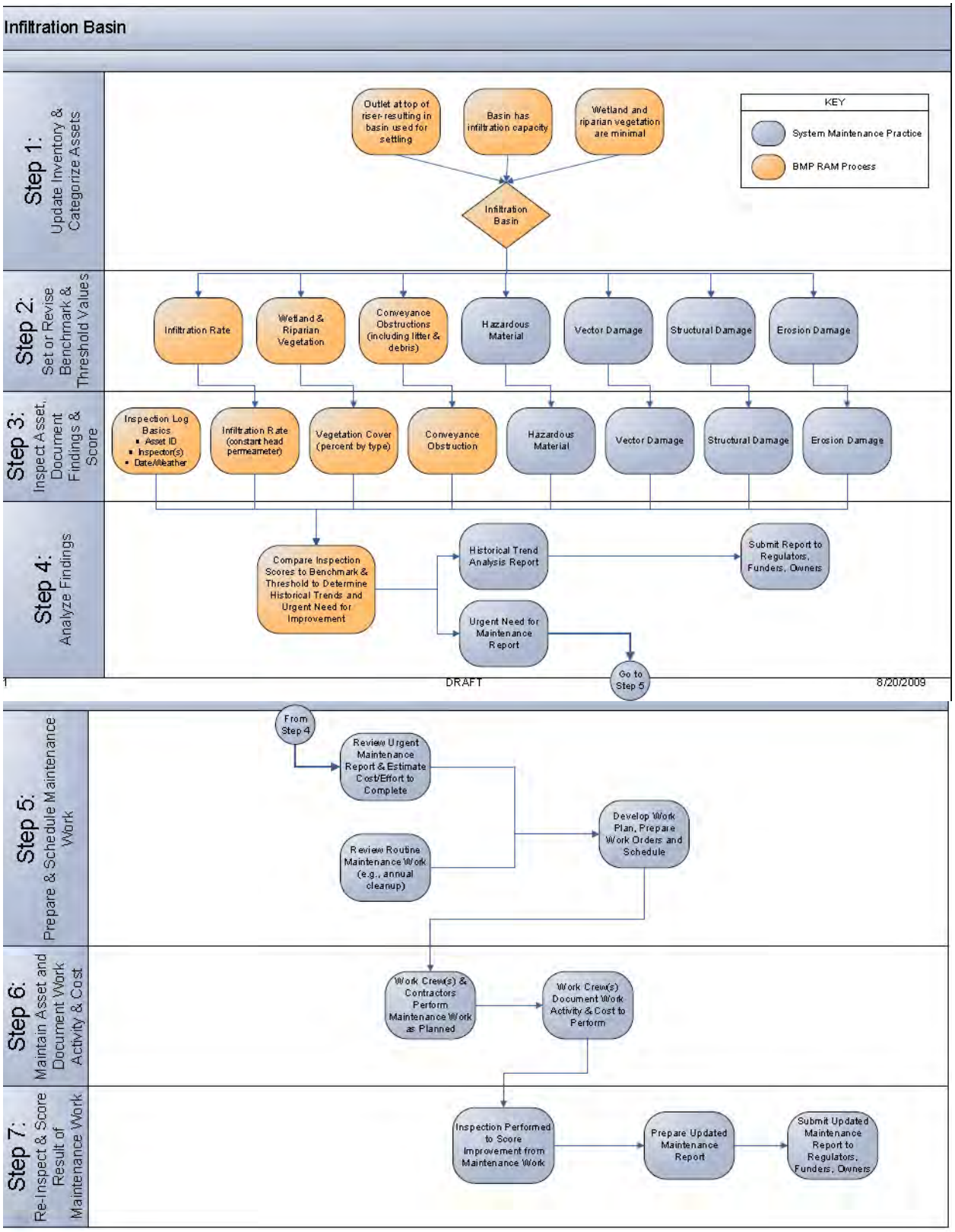
Infiltration Basin
Step 1: Update Inventory & Categorize Assets
Outlet at top of riser- resulting in basin used for settling
Basin has infiltration capacity
Wetland and riparian vegetation are minimal
KEY
System Maintenance Practice
BMP RAM Process
Infiltration Basin
Step 2: Set or Revise Benchmark & Threshold Values
Infiltration Rate
Wetland & Riparian Vegetation
Conveyance Obstructions (including litter & debris)
Hazardous Material
Vector Damage
Structural Damage
Erosion Damage
Step 3: Inspect Asset, Document Findings & Score
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Infiltration Rate (constant head permeameter)
Vegetation Cover (percent by type)
Conveyance Obstruction
Hazardous Material
Vector Damage
Structural Damage
Erosion Damage
Step 4: Analyze Findings
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Submit Report to Regulators, Funders, Owners
Urgent Need for Maintenance Report
Go to Step 5
1
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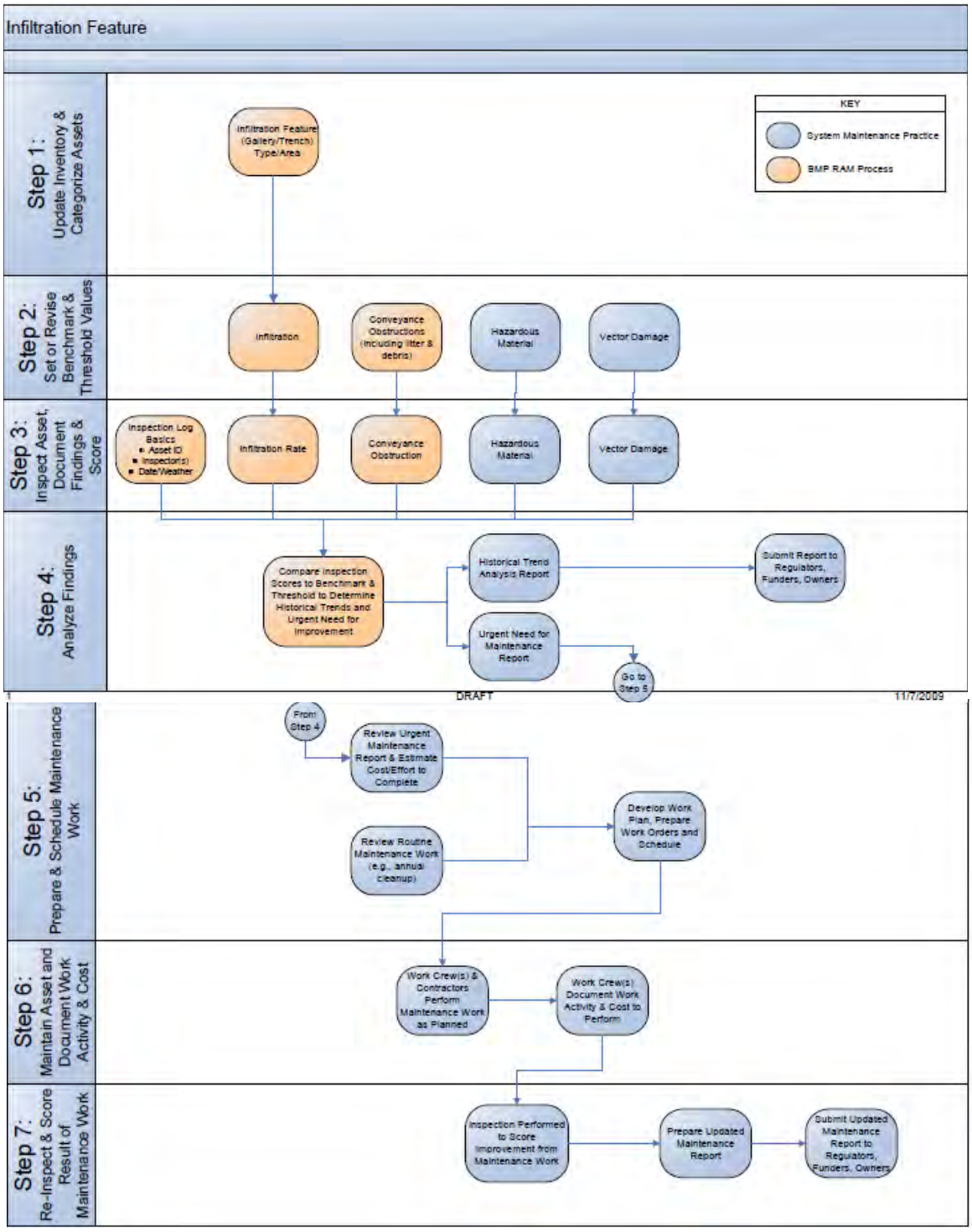
Step 5: Prepare & Schedule Maintenance Work
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Step 6: Maintain Asset and Document Work Activity & Cost
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Step 7: Re-Inspect & Score Result of Maintenance Work
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
Submit Updated Maintenance Report to Regulators, Funders, Owners


Infiltration Feature
Step 1: Update Inventory & Categorize Assets
Infiltration Feature (Gallery/Trench) Type/Area
KEY
System Maintenance Practice
BMP RAM Process
Step 2: Set or Revise Benchmark & Threshold Values
Infiltration
Conveyance Obstructions (including litter & debris)
Hazardous Material
Vector Damage
Step 3: Inspect Asset, Document Findings & Score
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Infiltration Rate
Conveyance Obstruction
Hazardous Material
Vector Damage
Step 4: Analyze Findings
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Urgent Need for Maintenance Report
Submit Report to Regulators, Funders, Owners
Go to Step 5
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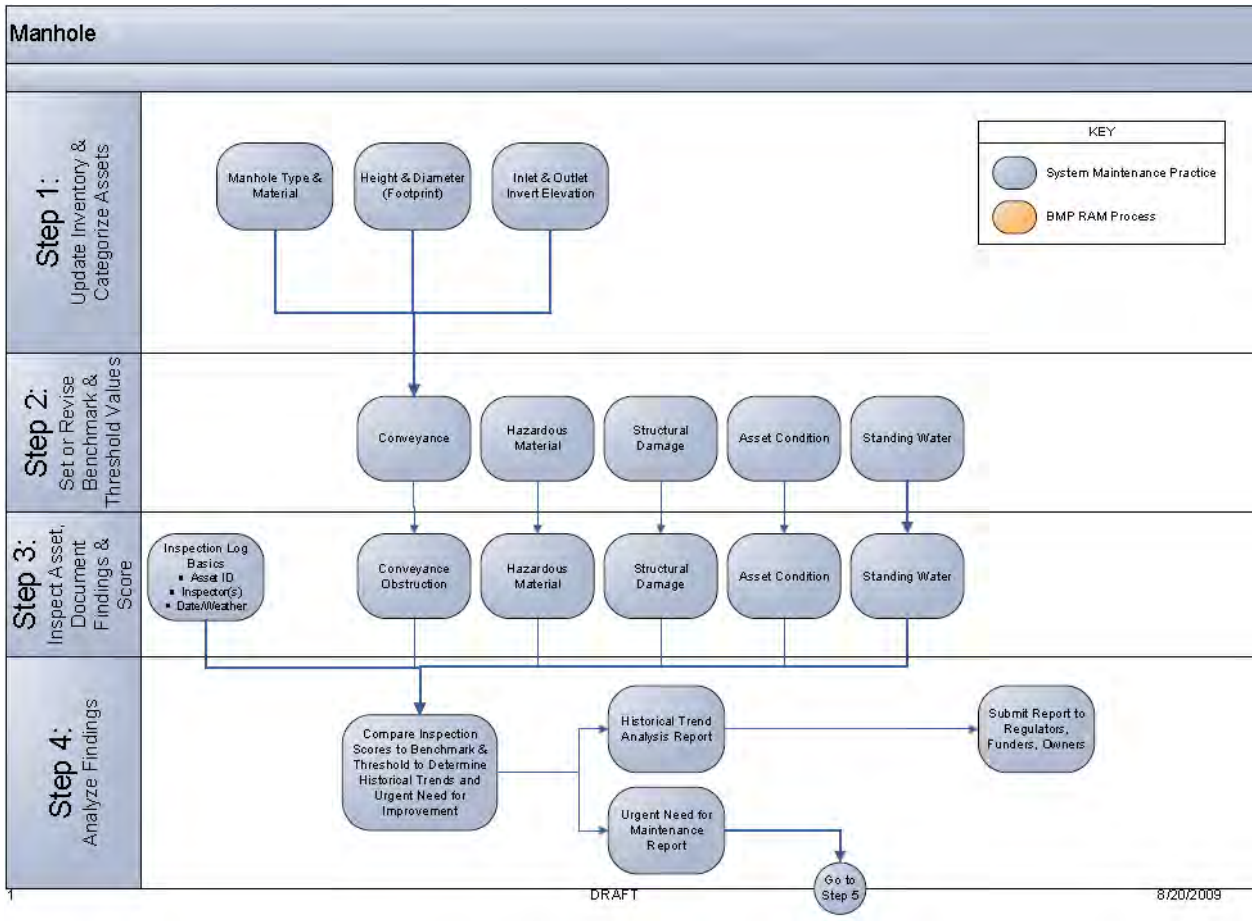
Step 5: Prepare & Schedule Maintenance Work
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Step 6: Maintain Asset and Document Work Activity & Cost
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Step 7: Re-Inspect & Score Result of Maintenance Work
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
Submit Updated Maintenance Report to Regulators, Funders, Owners


Manhole
Step 1: Update Inventory & Categorize Assets
Manhole Type & Material
Height & Diameter (Footprint)
Inlet & Outlet Invert Elevation
KEY
System Maintenance Practice
BMP RAM Process
Step 2: Set or Revise Benchmark & Threshold Values
Conveyance
Hazardous Material
Structural Damage
Asset Condition
Standing Water
Step 3: Inspect Asset, Document Findings & Score
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Conveyance Obstruction
Hazardous Material
Structural Damage
Asset Condition
Standing Water
Step 4: Analyze Findings
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Submit Report to Regulators, Funders, Owners
Urgent Need for Maintenance Report
Go to Step 5
1
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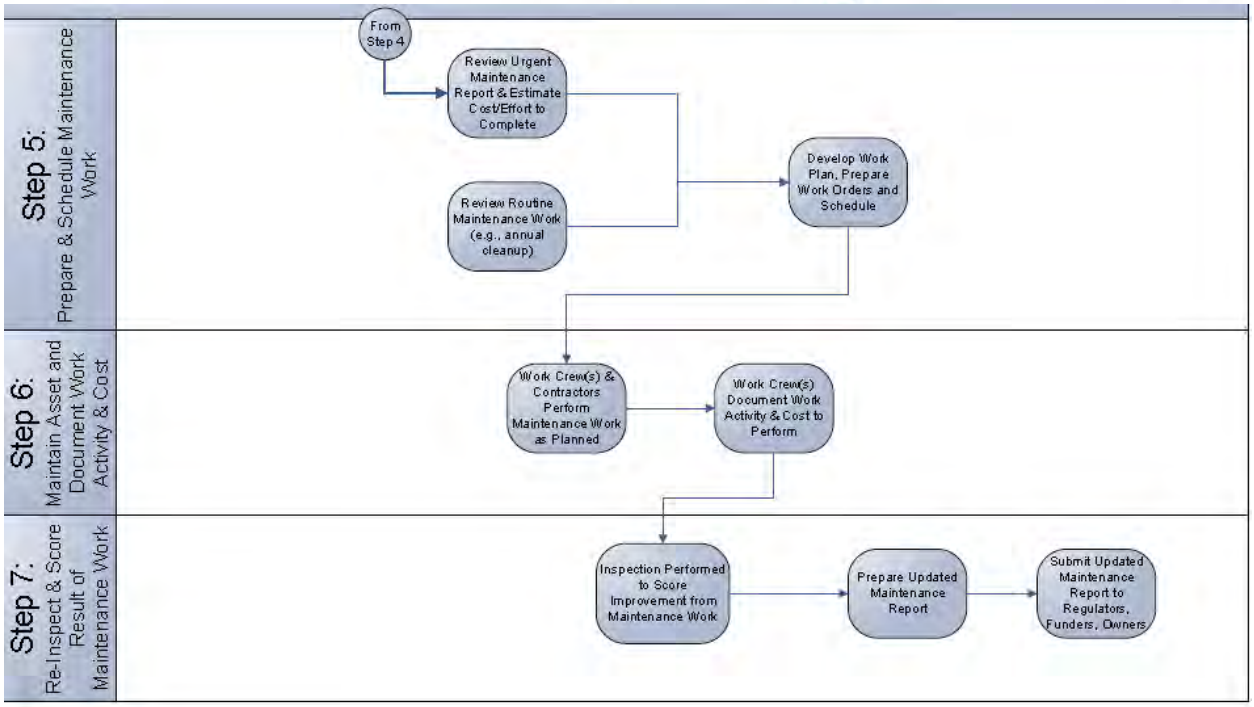
Step 5: Prepare & Schedule Maintenance Work
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Step 6: Maintain Asset and Document Work Activity & Cost
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
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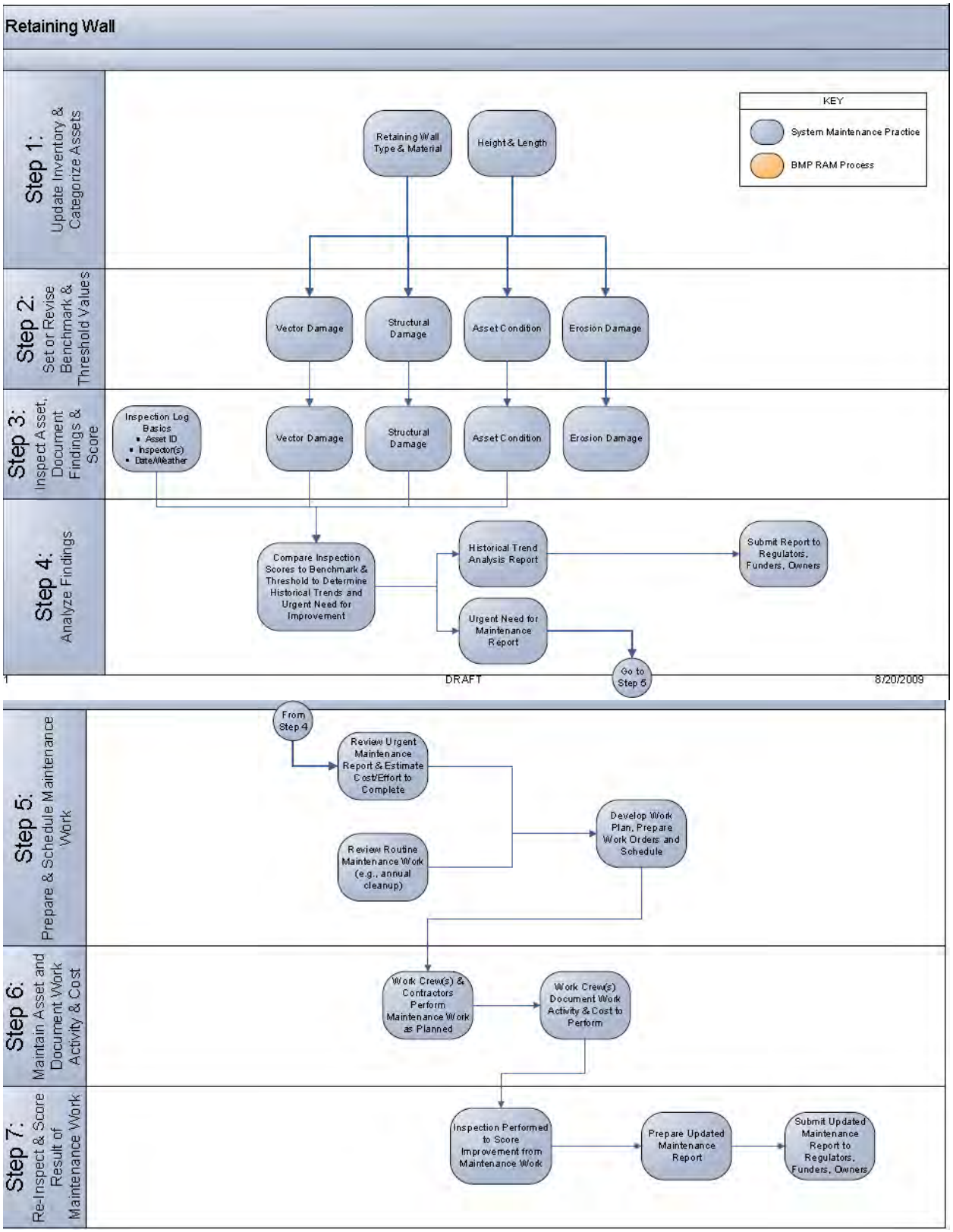
Prepare Updated Maintenance Report
Submit Updated Maintenance Report to Regulators, Funders, Owners


Retaining Wall
Step 1: Update Inventory & Categorize Assets
Step 2: Set or Revise Benchmark & Threshold Values
Step 3: Inspect Asset, Document Findings & Score
Step 4: Analyze Findings
KEY
System Maintenance Practice
BMP RAM Process
Retaining Wall Type & Material
Height & Length
Vector Damage
Structural Damage
Asset Condition
Erosion Damage
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Vector Damage
Structural Damage
Asset Condition
Erosion Damage
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Urgent Need for Maintenance Report
Submit Report to Regulators, Funders, Owners
Go to Step 5
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Step 5: Prepare & Schedule Maintenance Work
Step 6: Maintain Asset and Document Work Activity & Cost
Step 7: Re-Inspect & Score Result of Maintenance Work
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
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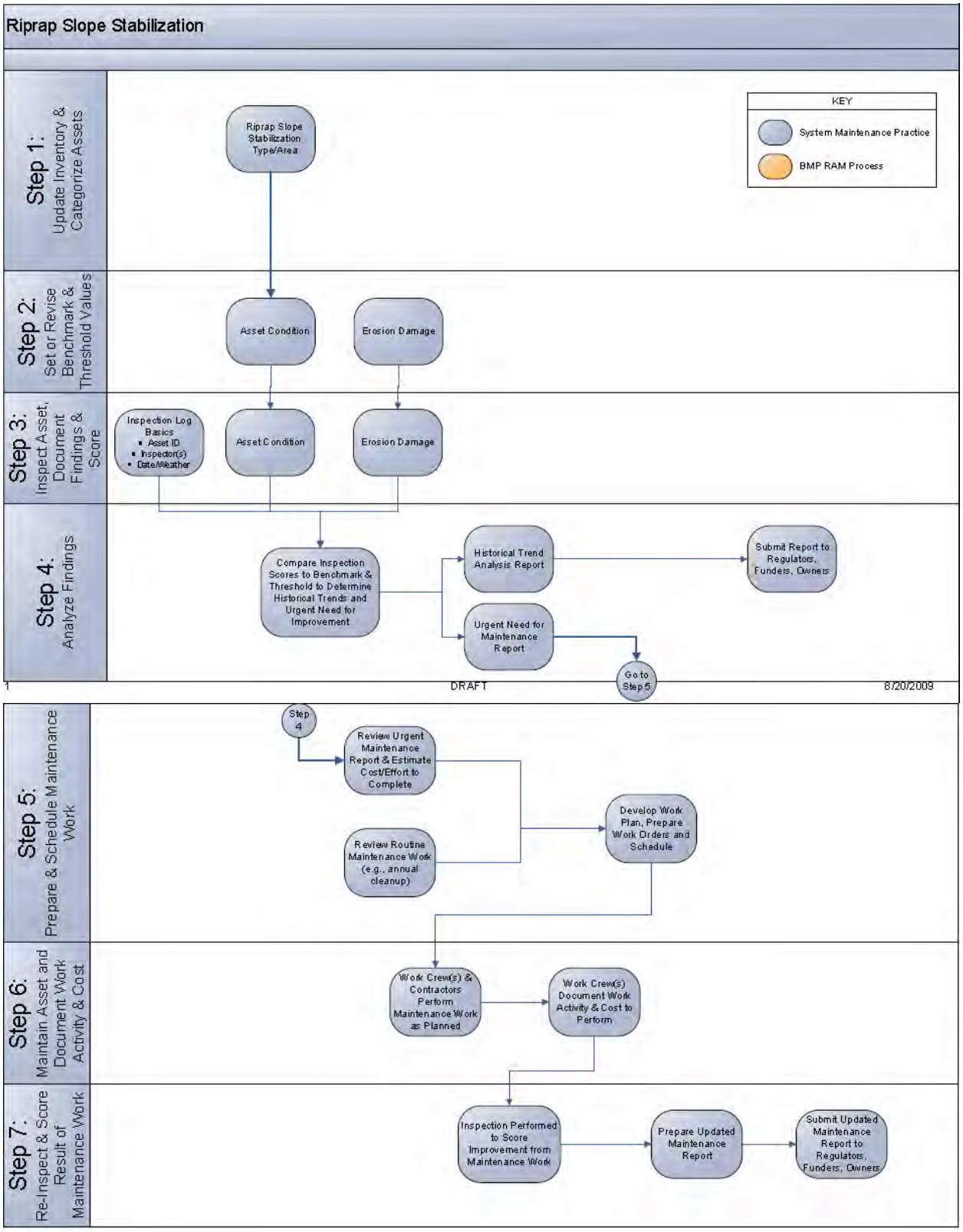
Riprap Slope Stabilization
Step 1: Update Inventory & Categorize Assets
Step 2: Set or Revise Benchmark & Threshold Values
Step 3: Inspect Asset, Document Findings & Score
Step 4: Analyze Findings
Step 5: Prepare & Schedule Maintenance Work
Step 6: Maintain Asset and Document Work Activity & Cost
Step 7: Re-Inspect & Score Result of Maintenance Work
KEY
System Maintenance Practice
BMP RAM Process
Riprap Slope Stabilization Type/Area
Asset Condition
Erosion Damage
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Asset Condition
Erosion Damage
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Submit Report to Regulators, Funders, Owners
Urgent Need for Maintenance Report
Go to Step 5
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Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
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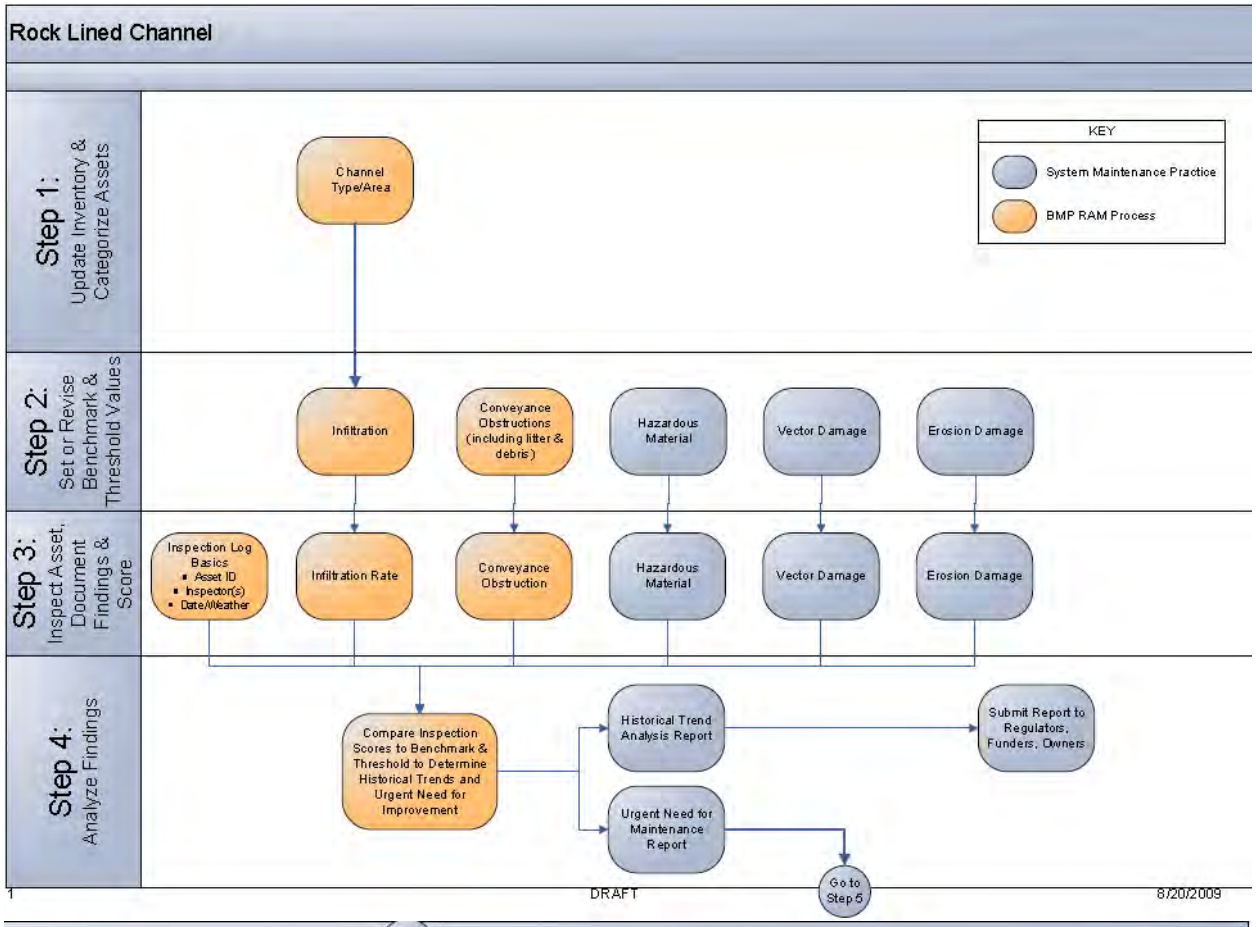
Rock Lined Channel
Step 1: Update Inventory & Categorize Assets
Step 2: Set or Revise Benchmark & Threshold Values
Step 3: Inspect Asset, Document Findings & Score
Step 4: Analyze Findings
KEY
System Maintenance Practice
BMP RAM Process
Channel Type/Area
Infiltration
Conveyance Obstructions (including litter & debris)
Hazardous Material
Vector Damage
Erosion Damage
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Infiltration Rate
Conveyance Obstruction
Hazardous Material
Vector Damage
Erosion Damage
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Submit Report to Regulators, Funders, Owners
Urgent Need for Maintenance Report
Go to Step 5
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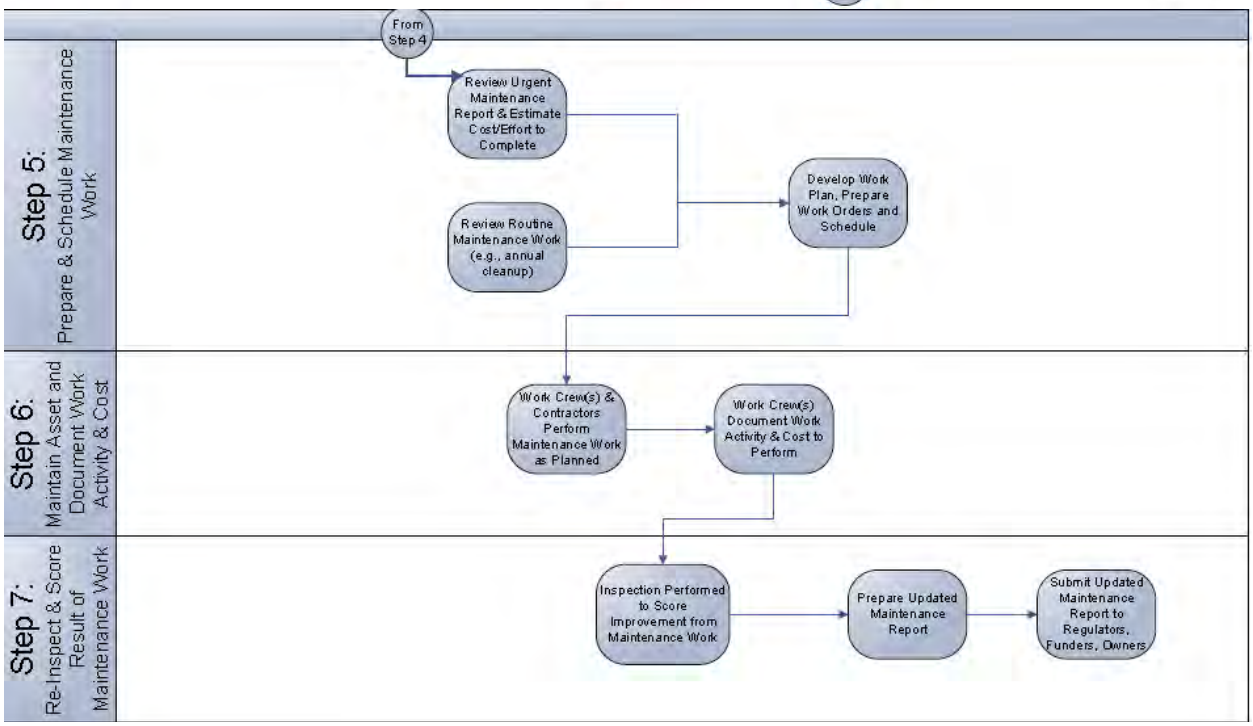
Step 5: Prepare & Schedule Maintenance Work
Step 6: Maintain Asset and Document Work Activity & Cost
Step 7: Re-Inspect & Score Result of Maintenance Work
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Work Crew(s) & Contractors Perform Maintenance Work as Planned
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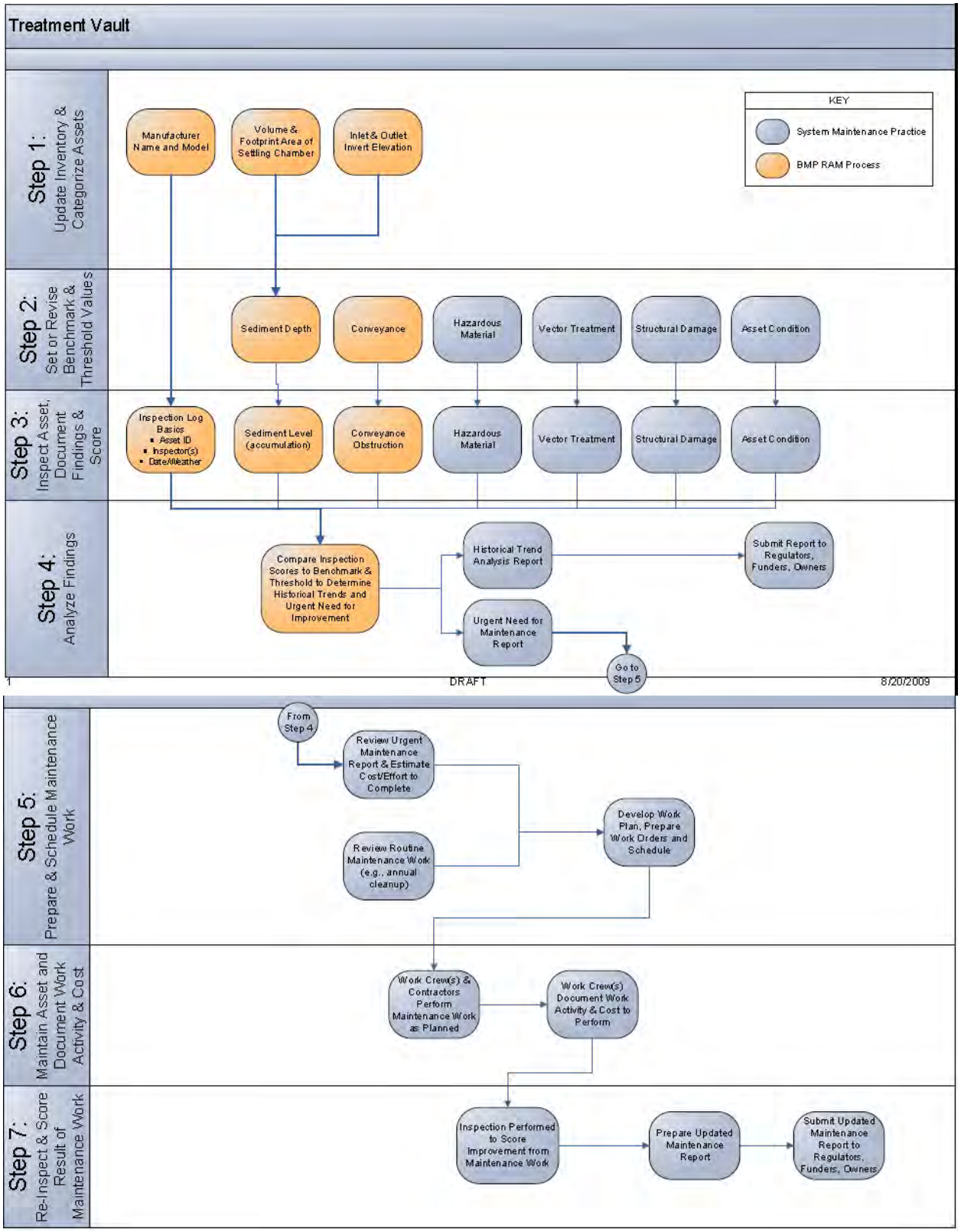
Treatment Vault
Step 1: Update Inventory & Categorize Assets
Step 2: Set or Revise Benchmark & Threshold Values
Step 3: Inspect Asset, Document Findings & Score
Step 4: Analyze Findings
Manufacturer Name and Model
Volume & Footprint Area of Settling Chamber
Inlet & Outlet Invert Elevation
KEY
System Maintenance Practice
BMP RAM Process
Sediment Depth
Conveyance
Hazardous Material
Vector Treatment
Structural Damage
Asset Condition
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Sediment Level (accumulation)
Conveyance Obstruction
Hazardous Material
Vector Treatment
Structural Damage
Asset Condition
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Submit Report to Regulators, Funders, Owners
Urgent Need for Maintenance Report
Go to Step 5
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Step 5: Prepare & Schedule Maintenance Work
Step 6: Maintain Asset and Document Work Activity & Cost
Step 7: Re-Inspect & Score Result of Maintenance Work
From Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
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Work Crew(s) & Contractors Perform Maintenance Work as Planned
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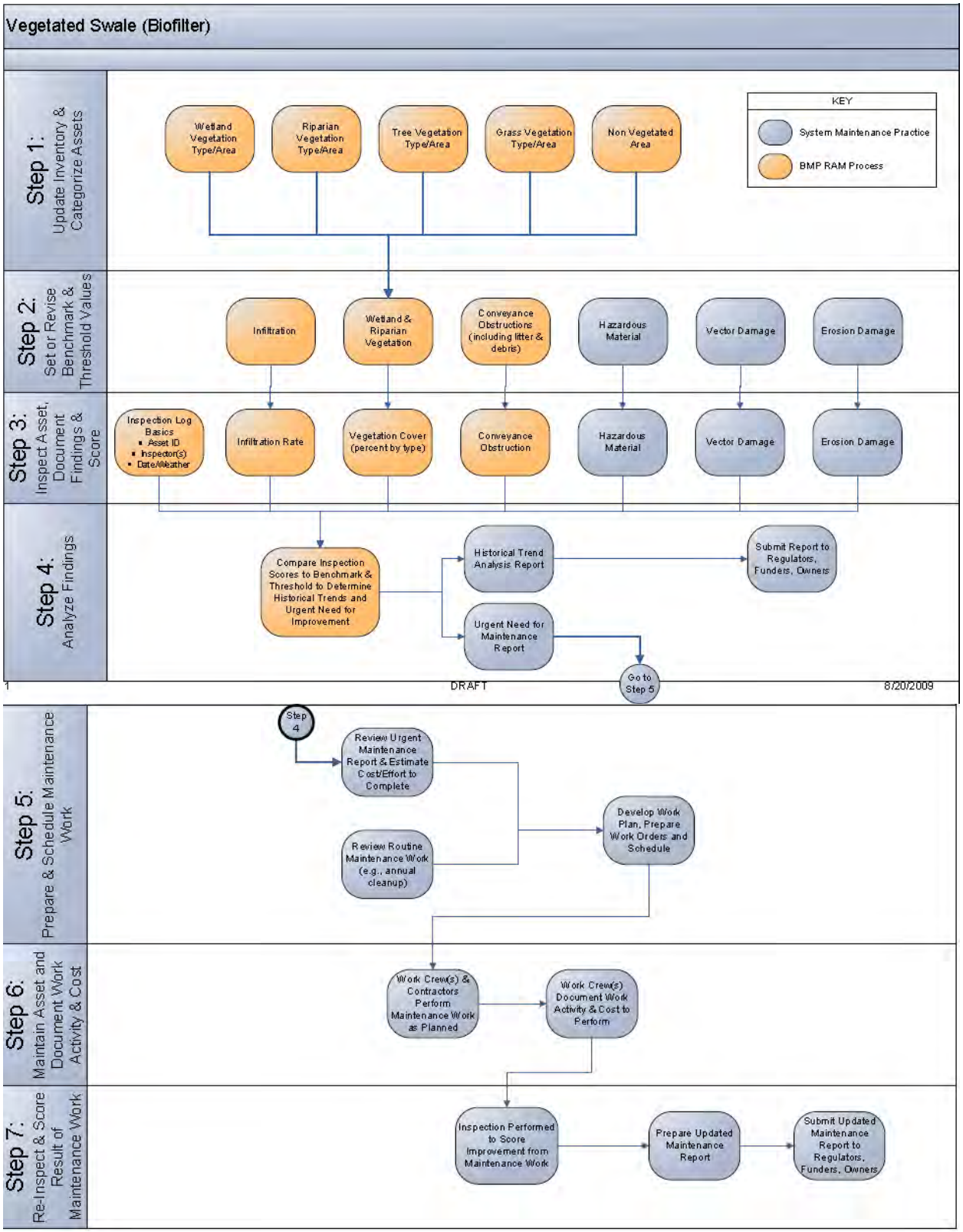
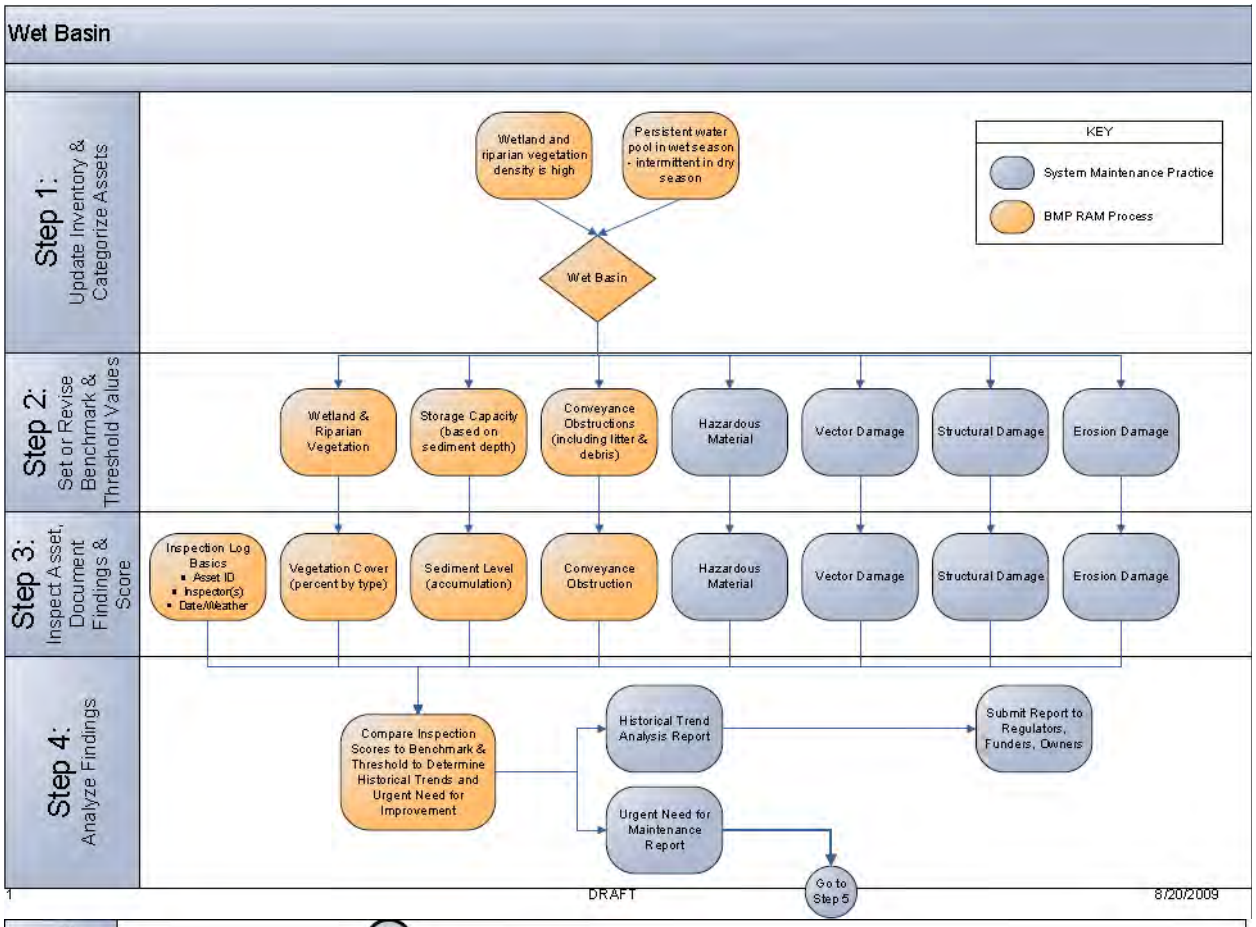
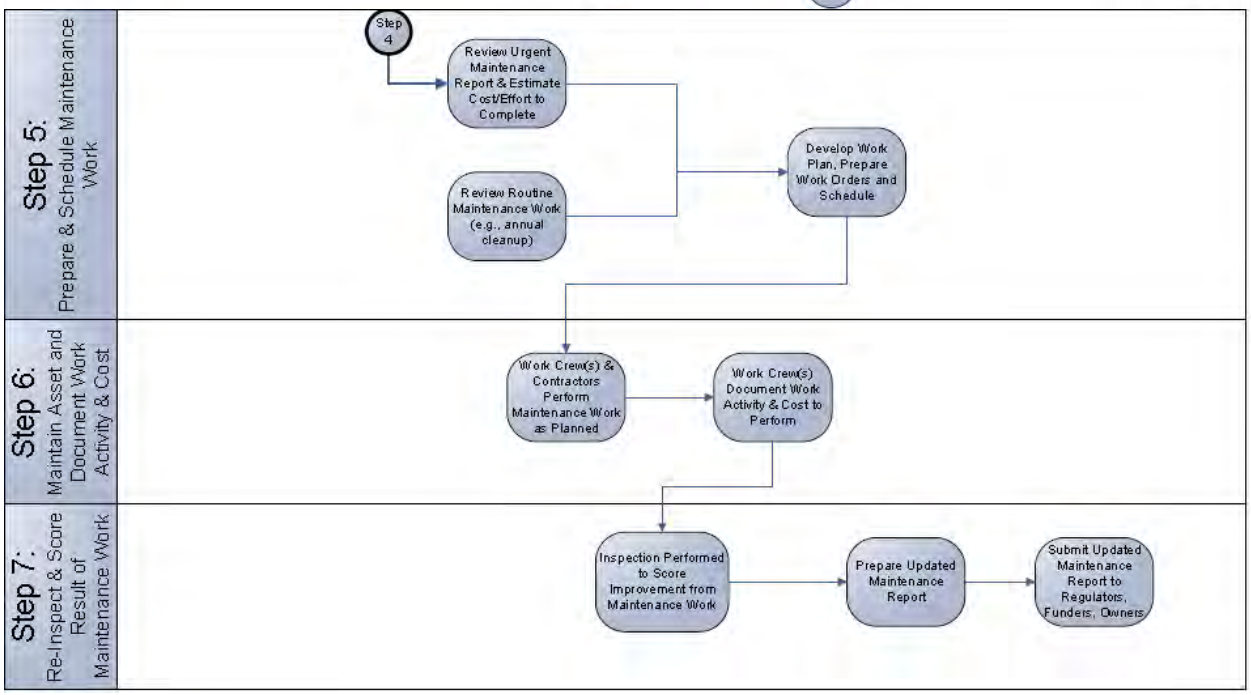

Vegetated Swale (Biofilter)
Step 1: Update Inventory & Categorize Assets
Step 2: Set or Revise Benchmark & Threshold Values
Step 3: Inspect Asset, Document Findings & Score
Step 4: Analyze Findings
Step 5: Prepare & Schedule Maintenance Work
Step 6: Maintain Asset and Document Work Activity & Cost
Step 7: Re-Inspect & Score Result of Maintenance Work
Wetland Vegetation Type/Area
Riparian Vegetation Type/Area
Tree Vegetation Type/Area
Grass Vegetation Type/Area
Non Vegetated Area
KEY
System Maintenance Practice
BMP RAM Process
Infiltration
Wetland & Riparian Vegetation
Conveyance Obstructions (including litter & debris)
Hazardous Material
Vector Damage
Erosion Damage
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Infiltration Rate
Vegetation Cover (percent by type)
Conveyance Obstruction
Hazardous Material
Vector Damage
Erosion Damage
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Urgent Need for Maintenance Report
Submit Report to Regulators, Funders, Owners
Go to Step 5
1
DRAFT
8/20/2009
Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
Submit Updated Maintenance Report to Regulators, Funders, Owners


Wet Basin
Step 1: Update Inventory & Categorize Assets
Step 2: Set or Revise Benchmark & Threshold Values
Step 3: Inspect Asset, Document Findings & Score
Step 4: Analyze Findings
Wetland and riparian vegetation density is high
Persistent water pool in wet season - intermittent in dry season
KEY
System Maintenance Practice
BMP RAM Process
Wet Basin
Wetland & Riparian Vegetation
Storage Capacity (based on sediment depth)
Conveyance Obstructions (including litter & debris)
Hazardous Material
Vector Damage
Structural Damage
Erosion Damage
Inspection Log Basics
Asset ID
Inspector(s)
Date/Weather
Vegetation Cover (percent by type)
Sediment Level (accumulation)
Conveyance Obstruction
Hazardous Material
Vector Damage
Structural Damage
Erosion Damage
Compare Inspection Scores to Benchmark & Threshold to Determine Historical Trends and Urgent Need for Improvement
Historical Trend Analysis Report
Submit Report to Regulators, Funders, Owners
Urgent Need for Maintenance Report
Go to Step 5
1
DRAFT
8/20/2009


Step 5: Prepare & Schedule Maintenance Work
Step 6: Maintain Asset and Document Work Activity & Cost
Step 7: Re-Inspect & Score Result of Maintenance Work
Step 4
Review Urgent Maintenance Report & Estimate Cost/Effort to Complete
Review Routine Maintenance Work (e.g., annual cleanup)
Develop Work Plan, Prepare Work Orders and Schedule
Work Crew(s) & Contractors Perform Maintenance Work as Planned
Work Crew(s) Document Work Activity & Cost to Perform
Inspection Performed to Score Improvement from Maintenance Work
Prepare Updated Maintenance Report
Submit Updated Maintenance Report to Regulators, Funders, Owners

Appendix D: Inspection and Maintenance Database

The inspection and maintenance database is a listing of the historical data from the inspection and maintenance forms and is presented by BMP types. The following is a listing of the database in spreadsheet format:

- Bare Soil Cover
- Bed Filter
- Conveyance Piping
- Curb & Gutter
- Drainage Inlet
- Drainage Outlet
- Dry Basin
- Infiltration Basin
- Infiltration Feature
- Manhole
- Retaining Wall
- Riprap Slope Stabilization
- Rock Lined Channel
- Treatment Vault
- Vegetated Swale
- Wet Basin

Collecting this data should not be limited to using a spreadsheet format as presented herein. The purpose of this presentation of data is to provide in one place the content of the database for each jurisdiction to use in building their database. It is understood each spreadsheet is representative of one asset for the specific BMP type and thus applying this database to the asset inventory will results in thousands of spreadsheets to store all of the data in Douglas County Tahoe.

Inspection Database

Table D-1 presents a listing of the data fields that data will be collected for inspection of each BMP asset.

BMP Type	BMP ID	Observer(s)	Date	Time	Weather Condition	Last Rainfall		Reason for Inspection (initial, Routine, Complaint, Rainfall Event	Routine Inspection						
						Date	Amount (inches)		Treatment Performance (from BMP RAM)	Vegetation Cover Rating	Conveyance Obstruction	Hazardous Material Rating	Vector Damage or Hazard Rating	Structural Damage Asset Condition Rating	Erosion Damage Rating
Bare Soil Cover	✓	✓	✓	✓	✓	✓	✓	✓		✓				✓	✓
Bed Filter	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Conveyance Piping	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓
Curb & Gutter	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓
Drainage Inlet	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Drainage Outlet	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓
Dry Basin	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Infiltration Basin	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Infiltration Feature	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		
Manhole	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓
Retaining Wall	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓
Riprap Slope Stabilization	✓	✓	✓	✓	✓	✓	✓	✓						✓	✓
Rock Lined Channel	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Treatment Vault	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Vegetated Swale	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Wet Basin	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓

Table D-1: Inspection Report Database for All BMP Types

Maintenance Effort Database

Table D-2 presents a listing of data fields that data will be collected for maintenance of each BMP asset.

BMP Type	Asset ID	Maintenace Lead	Date	Time	Personnel or Crew Type	Personnel or Crew Number	Equipment	Materials Used	Time to Complete	Vegetation Area Maintained	Material Removed Volume cu ft	Material Removed Disposal Location	Infiltration Capacity Maintenance Performed	Comments or Recommendations
Bare Soil Cover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓
Bed Filter	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Conveyance Piping	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓
Curb & Gutter	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓
Drainage Inlet	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓
Drainage Outlet	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓
Dry Basin	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Infiltration Basin	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Infiltration Feature	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓
Manhole	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓
Retaining Wall	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓
Riprap Slope Stabilization	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓
Rock Lined Channel	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Treatment Vault	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓
Vegetated Swale	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓
Wet Basin	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓

Table D-2: Maintenance Report Database for All BMP Types