

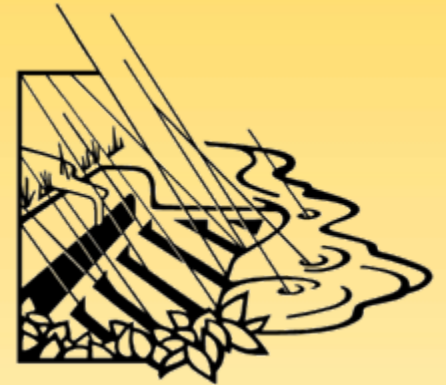
Inspection and Maintenance

Andy Erickson

Green Infrastructure Maintenance Conference

April 13, 2011

Urbana, IL



UNIVERSITY OF MINNESOTA

Driven to DiscoverSM



Acknowledgements



John Gulliver, Ph.D., P.E.
St. Anthony Falls Laboratory



Peter Weiss, Ph.D., P.E.
Valparaiso University



Overview

- Maintenance:
 - Activities that ensure proper function and extend useable life
- Inspection:
 - Quick, simple, visual assessment to schedule maintenance

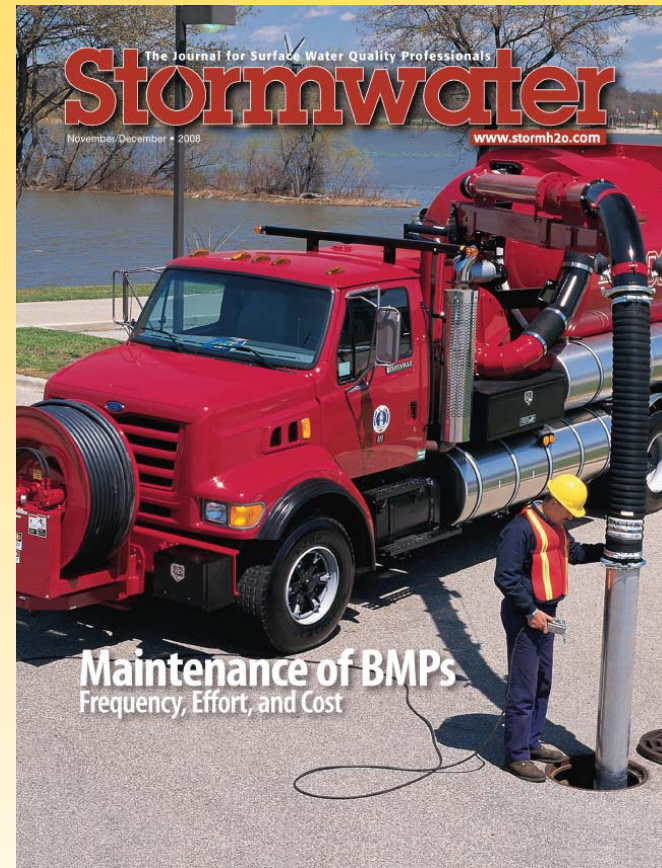


Photo Courtesy: A. Erickson



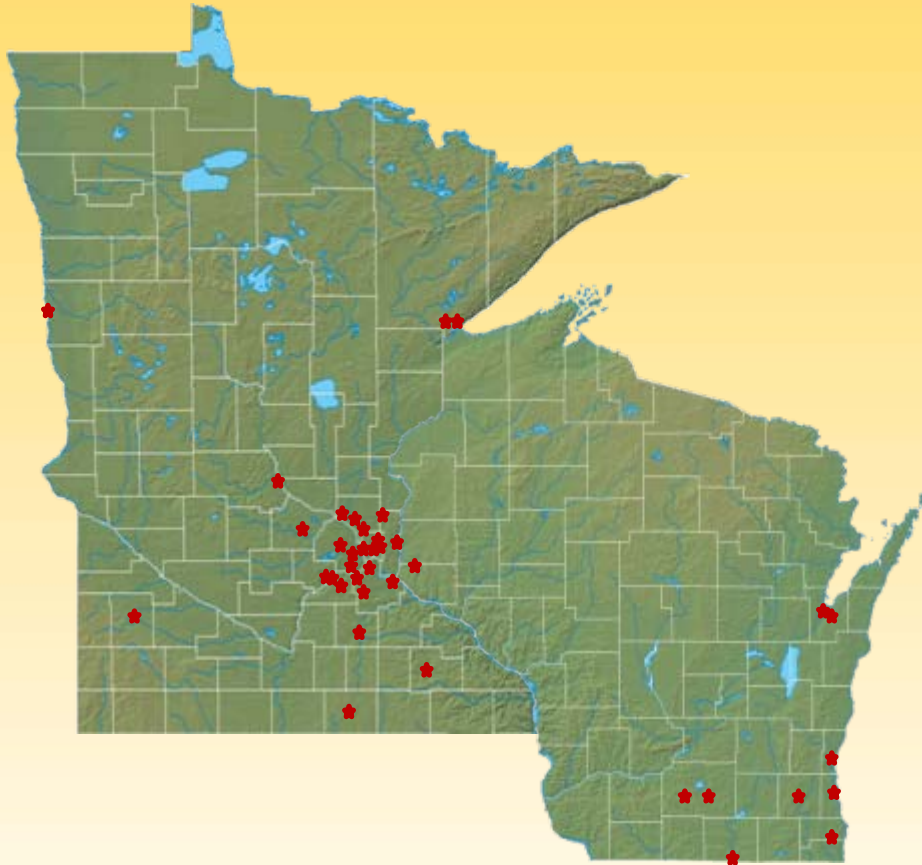
The Realities of Maintenance (Survey)

- Objectives
 - Investigate current status of BMPs and associated maintenance in Minnesota (MN) and Wisconsin (WI)
 - Identify most common maintenance practices and corresponding costs
 - Obtain information to establish guidance for scheduling and budgeting maintenance of BMPs
- 28 Minnesota cities
- 8 Wisconsin cities
- 2 Wisconsin counties





Spatial Distribution of Responses



Maps: <http://geology.com/state-map/minnesota.shtml>,
<http://geology.com/state-map/wisconsin.shtml>

Acknowledgements

Minnesota

Albert Lea
Andover
Blaine
Bloomington
Buffalo
Burnsville
Chaska
Duluth
Faribault
Forest Lake
Hastings
Hermantown
Lakeville
Lauderdale
Little Canada
Marshall
Mendota Heights
Moorhead
North St. Paul

Plymouth
Prior Lake
Ramsey
Richfield
Rochester
Shakopee
St. Cloud
Stillwater
White Bear Lake

Wisconsin

Beloit
Dunn
Grafton
Green Bay
Milwaukee
River Falls
Sturtevant
Verona
Brown County
Waukesha County



Inspection and maintenance

| Stormwater BMP Type | Number of Responses (n) | Less than once per year | Once per year | More than once per year |
|-----------------------------------|--------------------------------|--------------------------------|----------------------|--------------------------------|
| Wet Ponds | 32 | 53% | 44% | 3% |
| Dry Ponds | 27 | 52% | 48% | 0% |
| Rain Gardens | 22 | 23% | 41% | 36% |
| Infiltration Basins or Trenches | 19 | 21% | 68% | 11% |
| Underground Sedimentation Devices | 17 | 12% | 59% | 29% |
| Constructed Wetlands | 16 | 38% | 56% | 6% |
| Porous Pavements | 14 | 29% | 43% | 29% |
| Filter Strips or Swales | 13 | 54% | 31% | 15% |
| Surface Sand or Soil Filter | 9 | 67% | 33% | 0% |
| Underground Filtration Devices | 9 | 44% | 56% | 0% |
| Average | | 39% | 48% | 13% |



Factors affecting performance of BMPs (multiple answers allowed)

| | Surface Sand or Soil Filter | Infiltration Basins or Trenches | Wet Ponds |
|----------------------------|------------------------------------|--|------------------|
| Sediment buildup | 50% | 36% | 26%* |
| Litter & debris | 30% | 21% | 19% |
| Pipe clogging | 10% | 10% | 21% |
| Invasive vegetation | 0% | 5% | 10% |

*** PAH's becoming a significant concern for Wet Pond Sediments**



Factors affecting performance of BMPs (multiple answers allowed)

| | Underground Sedimentation Devices | Permeable Pavements | Rain Gardens | Filter Strips or Swales |
|----------------------------|--|----------------------------|---------------------|--------------------------------|
| Sediment buildup | 58% | 67% | 33% | 21% |
| Litter & debris | 21% | 11% | 22% | 26% |
| Pipe clogging | 11% | 11% | 7% | 5% |
| Invasive vegetation | 0% | 0% | 26% | 26% |



Sediment Buildup



Photos courtesy of B. Asleson and J. Chapman

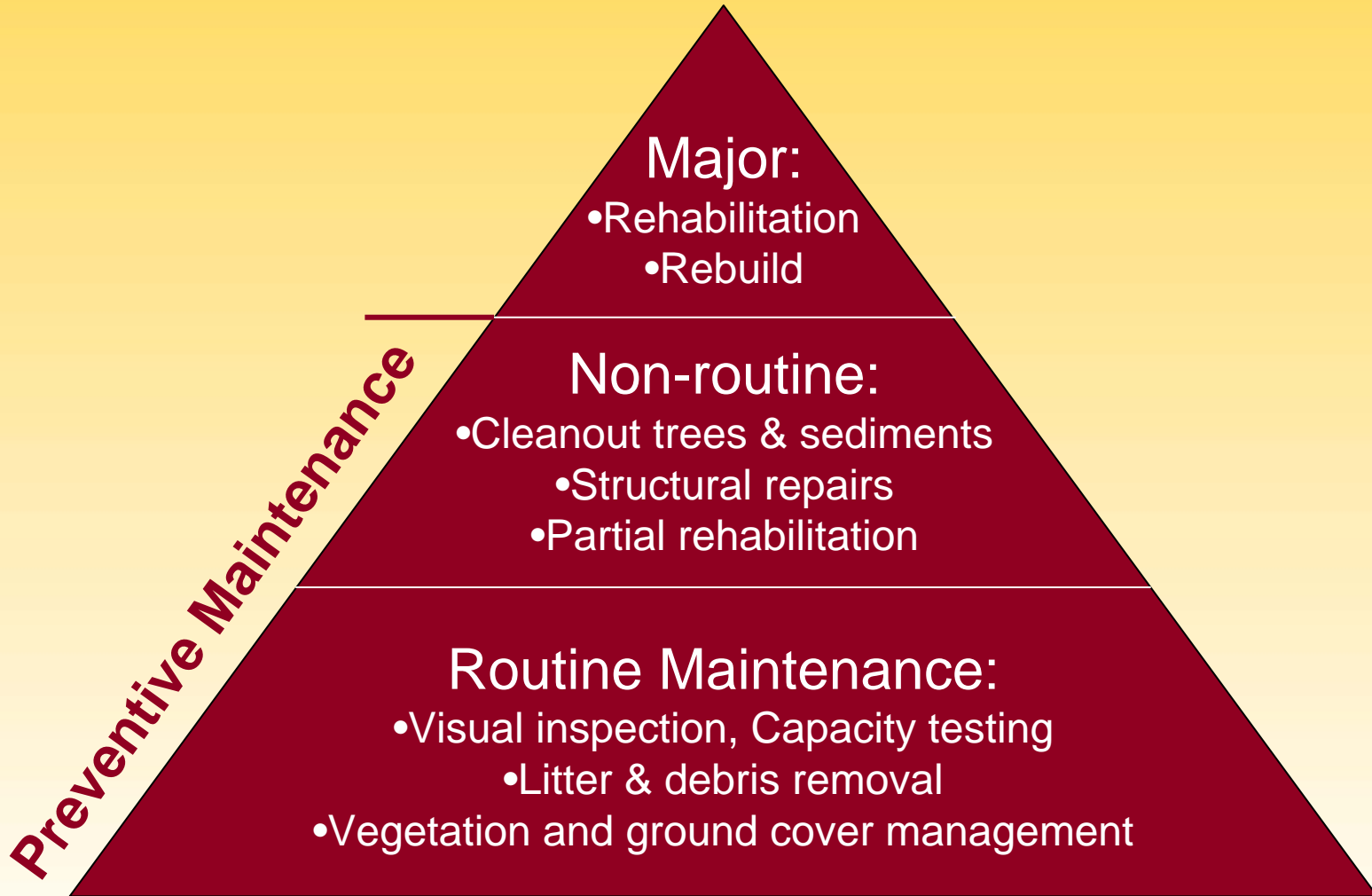


Rule of Thumb

- Maintenance costs are significant!
- Maintenance cost = construction cost after
 - 5 yrs for a \$1,000 installation
 - 10 years for a \$10,000 installation
 - 25 years for a \$100,000 installation



How to Schedule Maintenance?

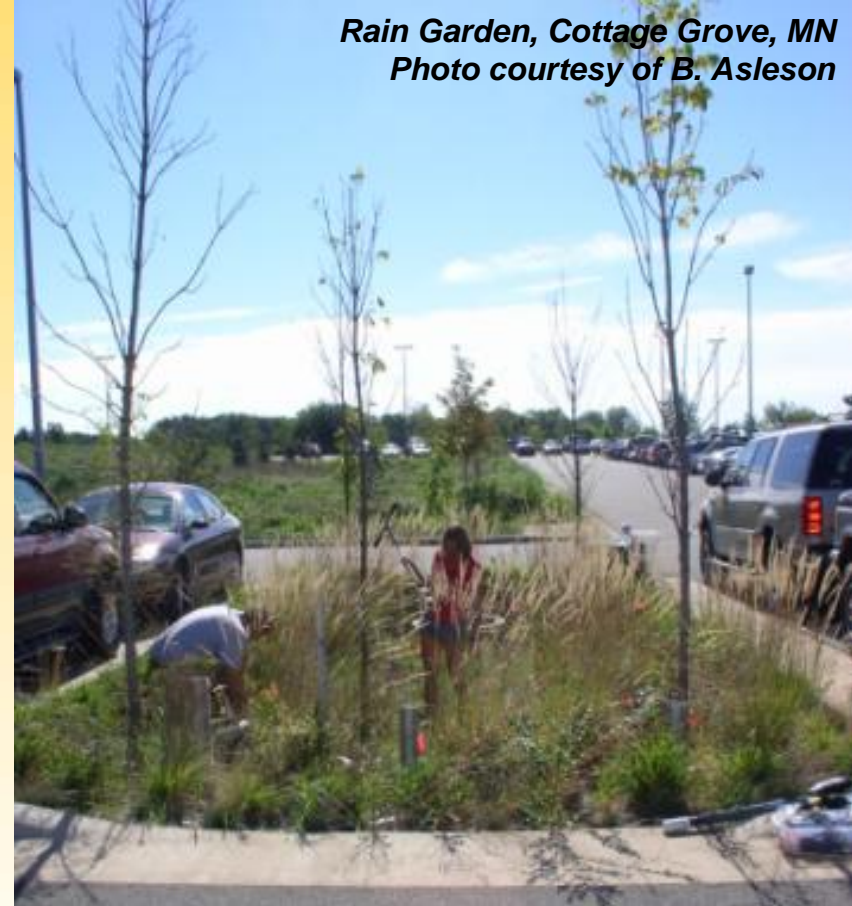




Routine Maintenance



Photo courtesy of J. Hafner



*Rain Garden, Cottage Grove, MN
Photo courtesy of B. Asleson*



How to schedule appropriate maintenance

- Conduct Visual Inspection
- Review “Scheduling Maintenance” at the end of each visual inspection checklist
- If needed, conduct Capacity Testing
 - Focus maintenance as necessary
- Select and Schedule Maintenance



Visual Inspection

- Purpose: Quickly determine if any of the following are required:
 - Changes to routine maintenance
 - Non-routine maintenance
 - Repair or replacement
 - More advanced assessment (e.g., capacity testing to determine effective infiltration rate)



Level 1: Visual Inspection



Visual Inspection of rain gardens in Maplewood, MN

Non-functional Rain garden.

Rain garden that may be functional.



Photos courtesy of B. Asleson & R. Nestingen



EXAMPLE: Visual Inspection of Bioretention Practices

- Review Biologically Enhanced Practices for background information (<http://stormwaterbook.safl.umn.edu/>)

UNIVERSITY OF MINNESOTA
Driven to Discover™

St. Anthony Falls Laboratory

Stormwater Treatment: Assessment and Maintenance

Introduction

Table of Contents

- Introduction
- Stormwater Treatment Processes
- Developing an Assessment Program
- Filtration Practices
- Infiltration Practices
- Sedimentation Practices
- Biologically Enhanced Practices
- Case Studies
- Other Resources

Introduction

This website is an online manual that has been developed to help you **assess and schedule maintenance for**, stormwater treatment practices. This website is based on the Minnesota Stormwater Manual, which provides guidance for the design, installation, and maintenance of stormwater treatment practices.

This online manual provides a standardized methodology for the assessment and scheduling of stormwater treatment practices. It creates guidelines for assessing and scheduling maintenance which allows for comparison across different practice types, seasons, and watersheds.

UNIVERSITY OF MINNESOTA
Driven to Discover™

St. Anthony Falls Laboratory

Stormwater Treatment: Assessment and Maintenance

Home > Biologically Enhanced Practices > Visual Inspection

Visual Inspection for Biologically Enhanced Practices

A.J. Erickson, B.C. Asleson, J.S. Gulliver, R.M. Hozalski

Visual inspection (level 1) of biologically enhanced practices focuses on the condition, abundance, etc.) and the condition of the soil. The species found in a practice and their condition and abundance can provide visual clues as to functionality. For example, the presence of vegetation in a rain garden indicates adequate soil moisture and quick drainage. Conversely, standing water and wetland vegetation (cattails, water lilies, etc.) in a bioretention practice shows that stormwater runoff does not infiltrate adequately. Visual inspections should be performed at least once per year.

Table of Contents

- Introduction
- Stormwater Treatment Processes
- Developing an Assessment Program
- Filtration Practices
- Infiltration Practices
- Sedimentation Practices
- Biologically Enhanced Practices
 - Visual Inspection
 - Capacity Testing
 - Synthetic Runoff Testing
 - Monitoring
 - Maintenance
- Case Studies
- Other Resources

Search this site:



EXAMPLE: Visual Inspection of Bioretention Practices


- Primary functions of bioretention practices are:
 - Runoff volume and rate reduction (infiltration)
 - Sediment collection (settling, filtration)
- Visual inspections should be focused on:
 - Sediment accumulation → reduced infiltration and storage capacity
 - Vegetation management → reduced infiltration and evapotranspiration
- Checklists have been developed!!



Visual Inspection Checklists

- Inspector's Name (s)
- Date of Inspection
- Site Information
- Rainfall Information
- Pretreatment
- Access
- Inlet structures
- Vegetation
- Bank erosion
- Sediment accumulation
- Outlet structures
- Recommendations
- Schedule Maintenance!

Biologically Enhanced Practices



UNIVERSITY OF MINNESOTA
**Stormwater Treatment:
 Assessment and Maintenance**

**Field Data Sheet for Level 1 Assessment: Visual Inspection
 Bioretention Practices (including Rain Gardens)**

Inspector's Name(s): _____
 Date of Inspection: _____
 Location of the bioretention practice: _____
 Address or Intersection: _____
 Latitude, Longitude: _____
 Date the bioretention practice began operation: _____
 Bioretention practice area (ft. x ft.): _____
 Time since last rainfall (hr): _____
 Quantity of last rainfall (in): _____
 Rainfall Measurement Location: _____

Site Sketch (include inlets, outlets, north arrow)

Based on visual assessment of the site, answer the following questions and make photographic or video-graphic documents of the site.

- Has visual inspection been conducted at this location before? Yes No I don't know
 - If yes, enter date: _____
 - Based on previous visual inspections, have any corrective actions been taken? Yes No I don't know (If yes, describe actions in comments box)
- Has it rained within the last 48 hours at this location? Yes No I don't know
- Does this bioretention practice utilize pretreatment practices upstream? Yes No I don't know (If yes, describe pretreatment practices in comment box)

Bioretention practice is: Unobstructed Mostly obstructed Inaccessible
 Action needed (choose and provide comments): _____
 temporary **and** no action needed **or** action needed
 permanent **and** before or during installation **or** new since installation

To download FREE checklists, visit:
<http://stormwaterbook.safl.umn.edu/>



What to Look for



Photos courtesy of B. Asleson

Scheduling Maintenance



Stormwater Treatment: Assessment and Maintenance

Home > Infiltration Practices > Visual Inspection > Scheduling Maintenance

Table of Contents

| | |
|----------------------------------|---|
| Introduction | ▶ |
| Stormwater Treatment Processes | ▶ |
| Developing an Assessment Program | ▶ |
| Filtration Practices | ▶ |
| Infiltration Practices | ▶ |
| Sedimentation Practices | ▶ |
| Biologically Enhanced Practices | ▶ |
| Case Studies | |
| Other Resources | ▶ |

| | |
|--------------------------|---|
| Visual Inspection | ▶ |
| Capacity Testing | |
| Synthetic Runoff Testing | |
| Monitoring | |
| Maintenance | |
| Recommendations | |
| References | |

[Scheduling Maintenance](#)

Scheduling Maintenance for Infiltration Practices

J.L. Nieber, A.J. Erickson, P.T. Weiss, J.S. Gulliver, R.M. Hozalski

Visual inspection is a rapid assessment procedure for qualitatively evaluating the functionality of a stormwater treatment practice. Visual inspections use a set of criteria that can be used to determine if the stormwater treatment practice is malfunctioning. Following visual inspection, the appropriate maintenance practices are selected and scheduled using the following discussion corresponding to the practice. This discussion lists questions. Alternatively, this discussion can be [downloaded in PDF format](#).

Scheduling Maintenance for Infiltration Basins and Trenches

(See [Scheduling Maintenance for permeable pavements](#))

Has a visual inspection been conducted on this location before?

It is important to determine whether this location has been previously assessed so that assessment

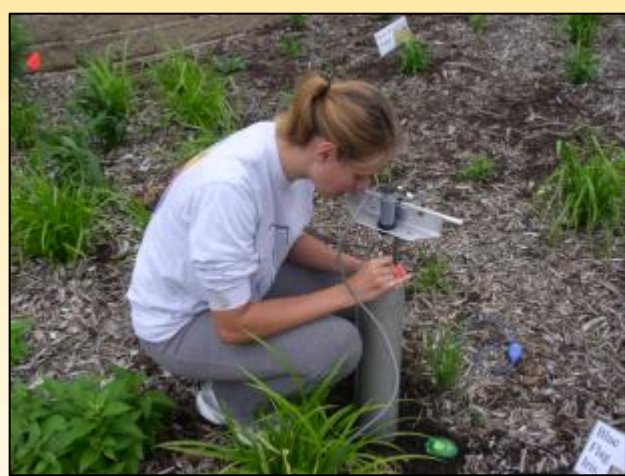


When is Maintenance Needed? (Bioretention)

- Criteria for scheduling maintenance are provided:
 - Before the next rainfall
 - Potential for flooding, structural instability
 - Before the next rainy season
 - Vegetation, litter & debris, future causes of flooding or structural instability
 - Within a year or two
 - Items that may soon reduce performance



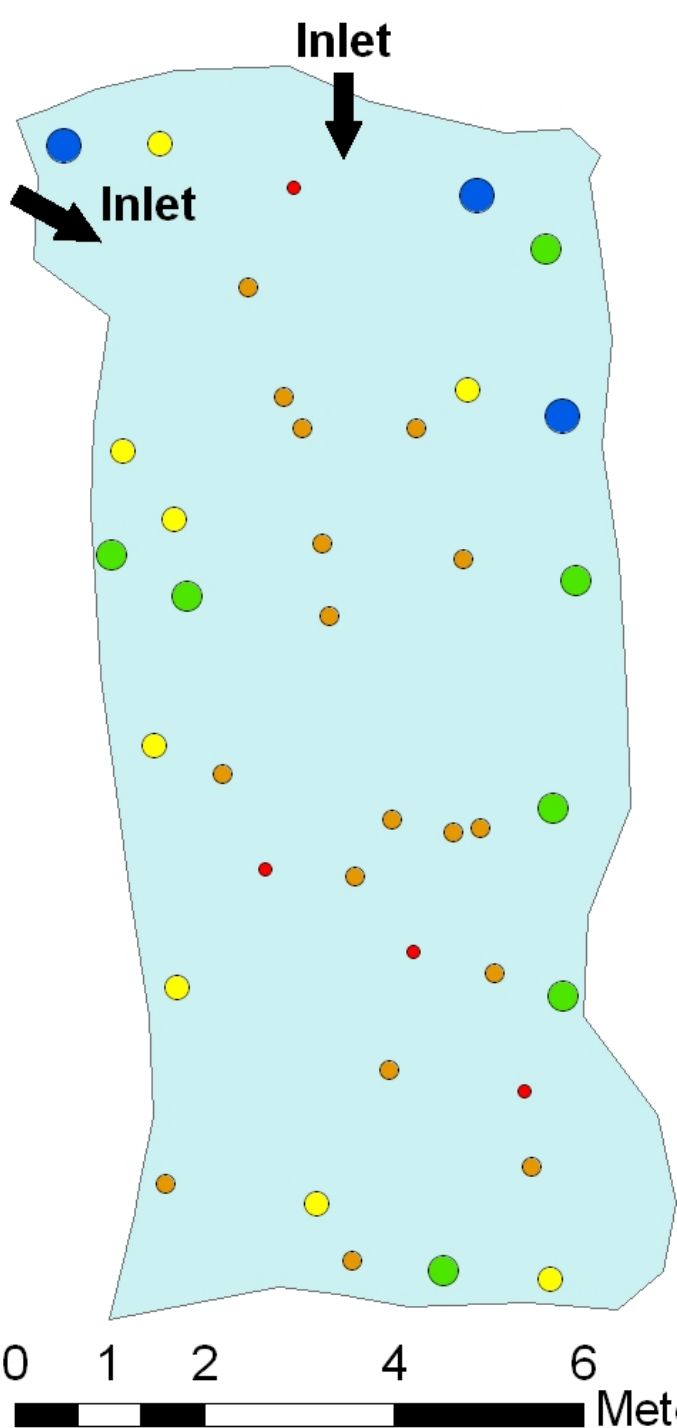
Infiltration Measurements to Focus Maintenance



Synthetic Runoff Testing of a rain garden in Little Canada, MN (Photo courtesy B. Asleson & R. Nestingen)

Capacity Testing

- Estimate overall infiltration rate
- Identify areas of low infiltration
- Select and Schedule appropriate maintenance





Take Home Messages

- Visual Inspection
 - At least once per year
- The Realities of Maintenance
 - Maintenance Costs are Significant!



Photos courtesy Shane Missaghi



Take Home Messages, cont'd

- Preventive Maintenance
 - Minimize life-cycle costs
 - Schedule maintenance effectively
 - Funds can be allocated
 - Fewer surprises

Photos courtesy Shane Missaghi

Stormwater Treatment: Assessment and Maintenance



UNIVERSITY OF MINNESOTA
Driven to Discover™

St. Anthony Falls Laboratory | Stormwater Research at SAFL

Stormwater Treatment: Assessment and Maintenance

Table of Contents


- Introduction
- Stormwater Treatment Processes
- Developing an Assessment Program
- Filtration Practices
- Infiltration Practices
- Sedimentation Practices
- Biologically Enhanced Practices
- Case Studies
- Other Resources

Search this site:

Introduction

This website is an online manual that has been developed to help users assess the performance of and schedule maintenance for stormwater treatment practices. It is intended as a supplement to the Minnesota Stormwater Manual, which provides guidance for the design and installation of stormwater treatment practices.

This online manual provides a standardized methodology for the assessment and maintenance of stormwater treatment practices. It creates guidelines for assessing performance, reporting results, and scheduling maintenance which allows for comparison across geography, stormwater treatment practice type, season, and watershed.



Existing and developing communities are installing a wide variety of urban stormwater treatment practices in order to protect or rehabilitate receiving waters. These efforts incur costs while their environmental effectiveness is still in question, and the many variables involved (e.g., seasons, geology, topography, storm events, etc.) have made it historically difficult to compare results (Wissel et al. 2007). After assessment results are compared with stormwater management goals, users are able to proceed more effectively with their maintenance actions. To meet the needs of existing and developing communities, "Stormwater Treatment: Assessment and Maintenance" provides guidance on:

- The steps necessary to develop an assessment program including methods to consider before establishing a monitoring program
- Four levels of assessment ranging from visual inspection to monitoring
- More accurate methods for flow measurement in stormwater conveyance systems
- Advanced sampling methodologies that will help monitor typical sources of flow

UNIVERSITY OF MINNESOTA

Stormwater Assessment and Maintenance Project



UF

Volume 5 - Issue 2

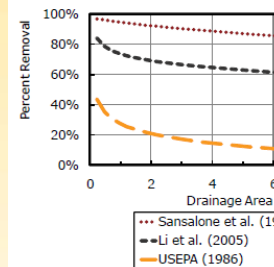
inside:

SPOTLIGHT ARTICLES

- Importance of Particle Settling Velocity in BMP Design 1
- Measuring and Estimating Infiltration Rate with the MPD Infiltrometer 2
- Soil Remediation as a Stormwater Best Management Practice 3

EVENTS CALENDAR

- PUBLICATIONS Maintenance of Stormwater Treatment Practices 4



Having trouble viewing this email? [Click here.](#)

You're receiving this email because of your interest in stormwater management, assessment (including monitoring), and maintenance research at St. Anthony Falls Laboratory and the University of Minnesota.

You may [unsubscribe](#) if you no longer wish to receive our emails.

UNIVERSITY OF MINNESOTA
Driven to Discover™

Stormwater Assessment and Maintenance UPDATES

August 2010 (Volume 5 - Issue 3)

Welcome!

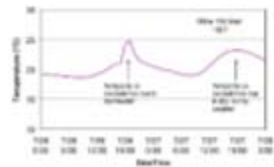
Thank you for reading our newsletter! Our purpose is to create opportunities for partnerships which are crucial to our quest for improving the methods for assessment and maintenance of stormwater treatment practices.

For past newsletters, publications, presentations and more information, please visit our website.

If you have any questions, please contact Jack Erickson.

Towards a Temperature TMDL for Miller Creek

Contributed by [William \(Bill\) Timothy Erickson](#), and Heinz Stefan University of Minnesota, St. Anthony Falls Lab





Thank you for your attention!

Questions?



For more information, contact:
Andy Erickson (eric0706@umn.edu)

*Rain garden, Burnsville, MN
(Photo Courtesy B. Asleson)*