Inspection and Maintenance

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Green Infrastructure Maintenance Conference

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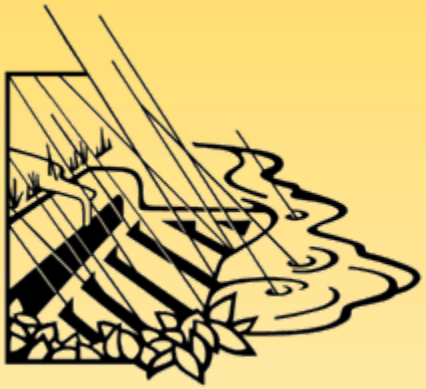
Urbana, IL



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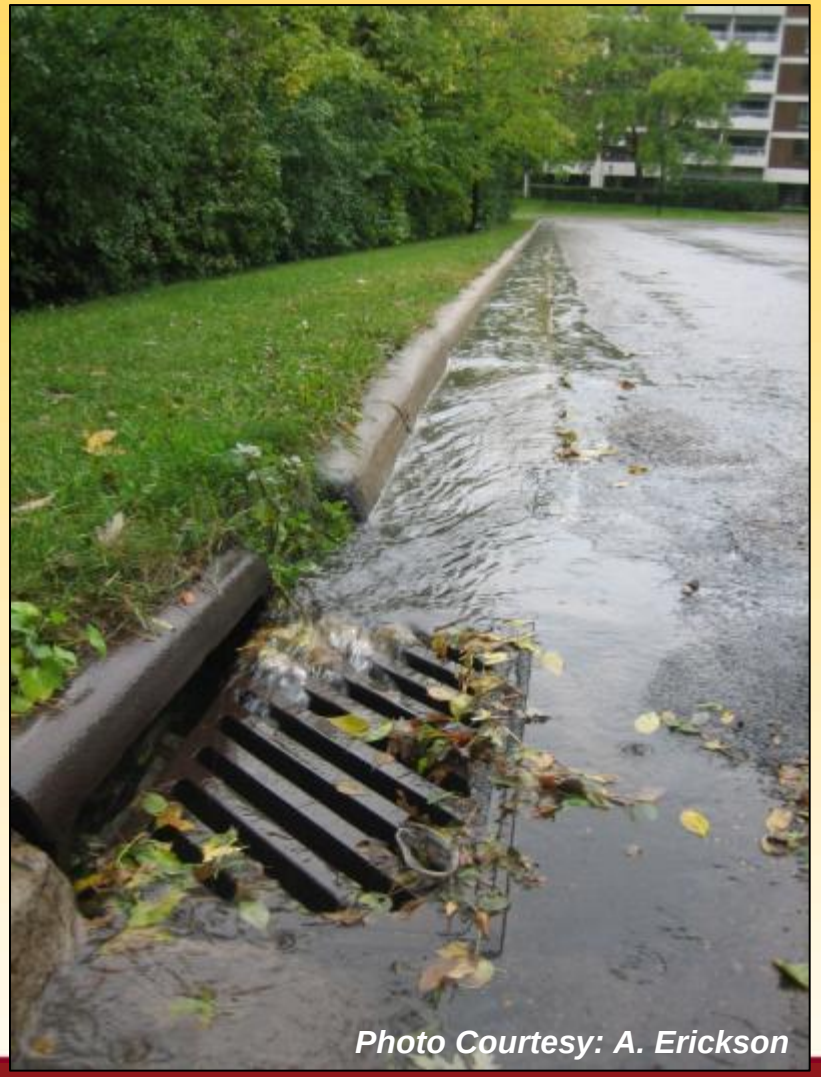
Acknowledgements

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

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

Overview

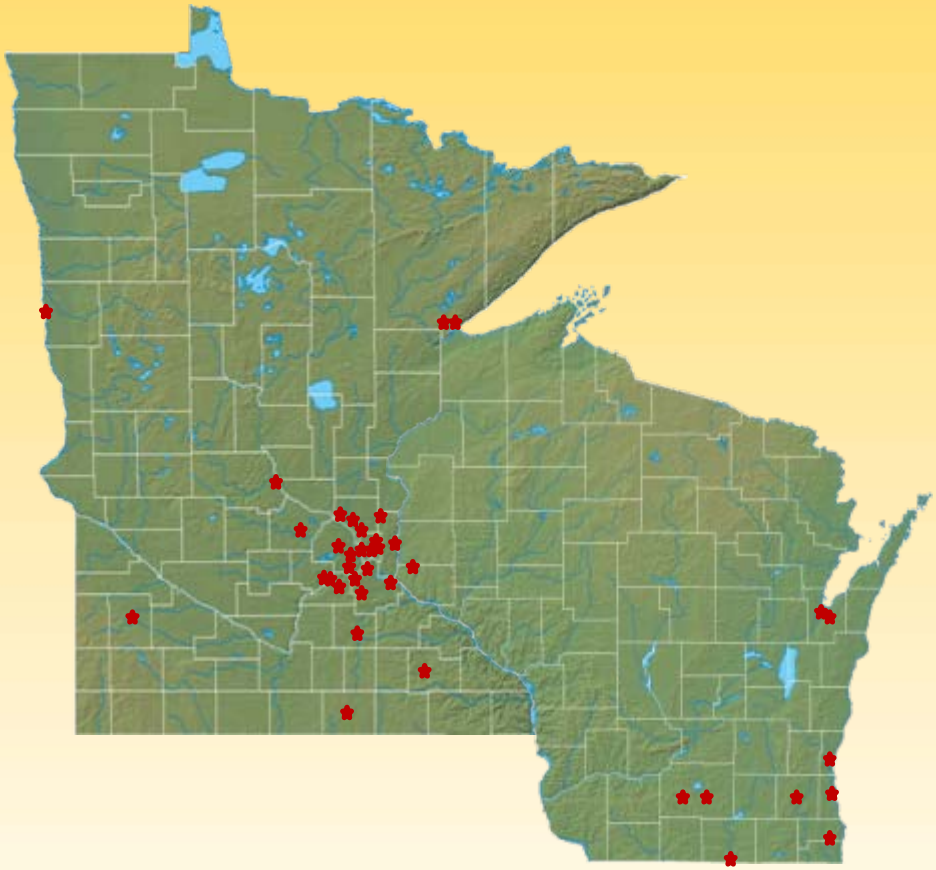
- Maintenance:
  - Activities that ensure proper function and extend useable life
- Inspection:
  - Quick, simple, visual assessment to schedule maintenance



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)

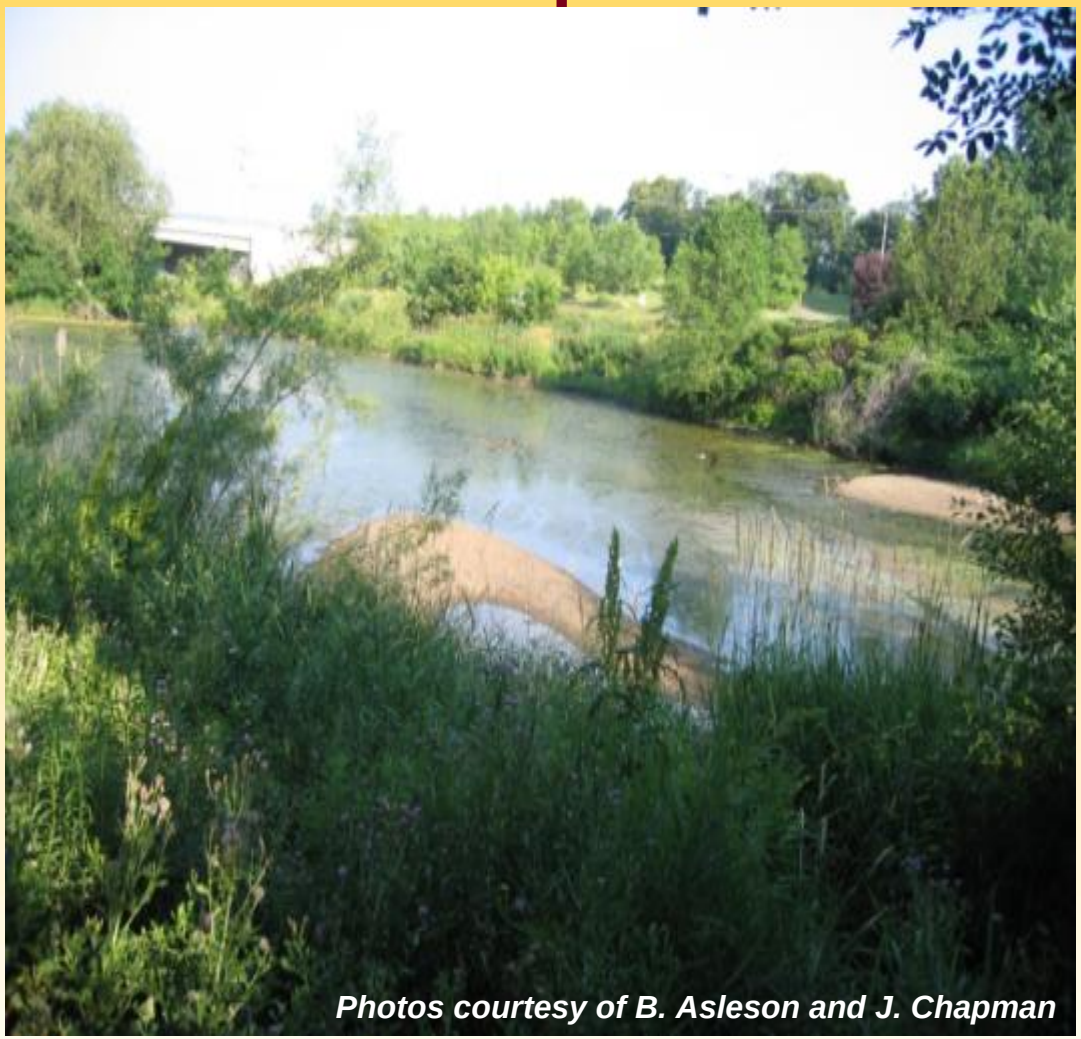
	Surface Sand or Soil Filter	Infiltration Basins or Trenches	Wet Ponds
Sediment buildup	50%	36%	26%*
Litter & debris	30%	21%	19%
Pipe clogging	10%	10%	21%
Invasive vegetation	0%	5%	10%

*** 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

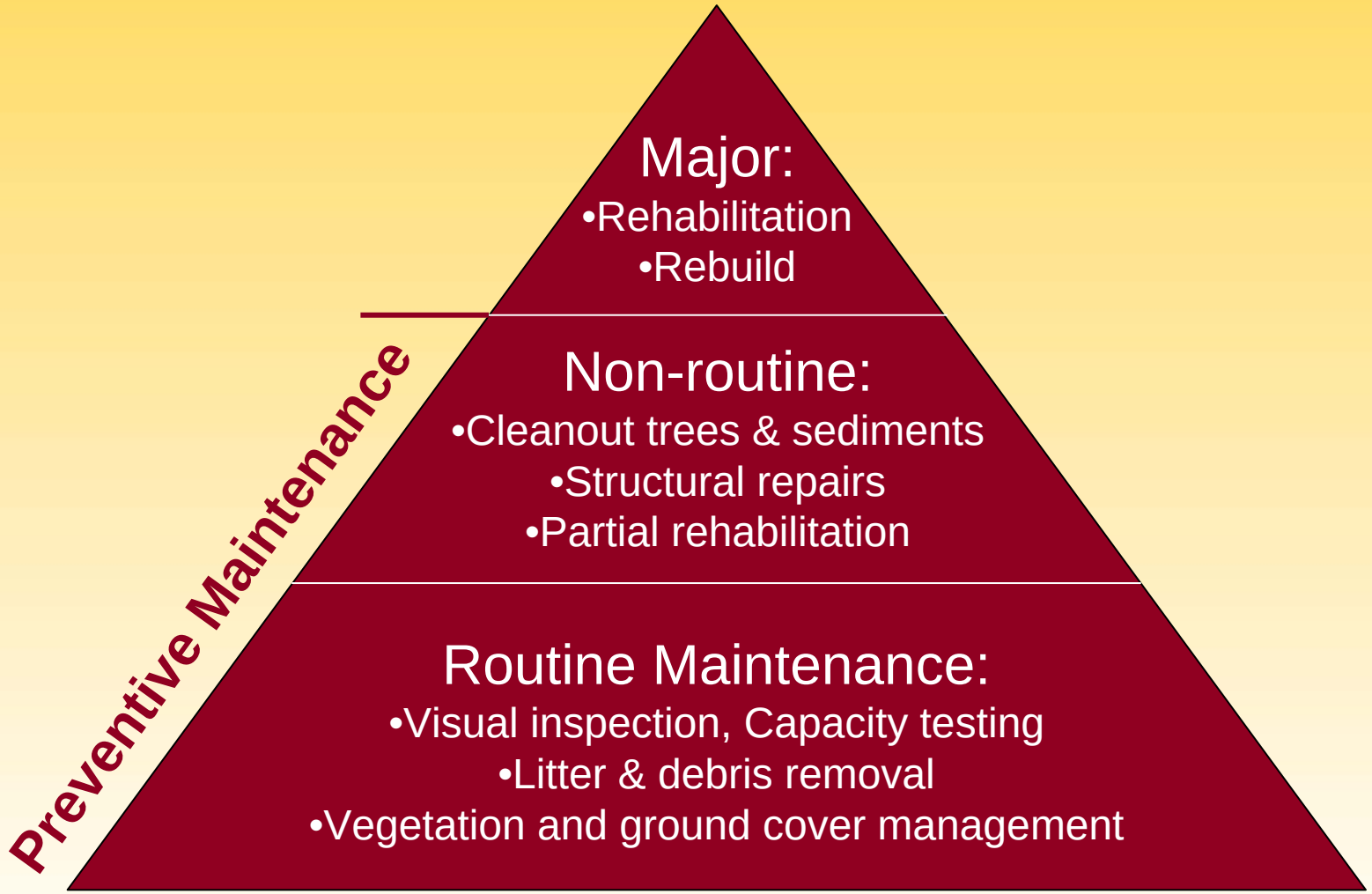


Photos courtesy of B. Asleson and J. Chapman

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

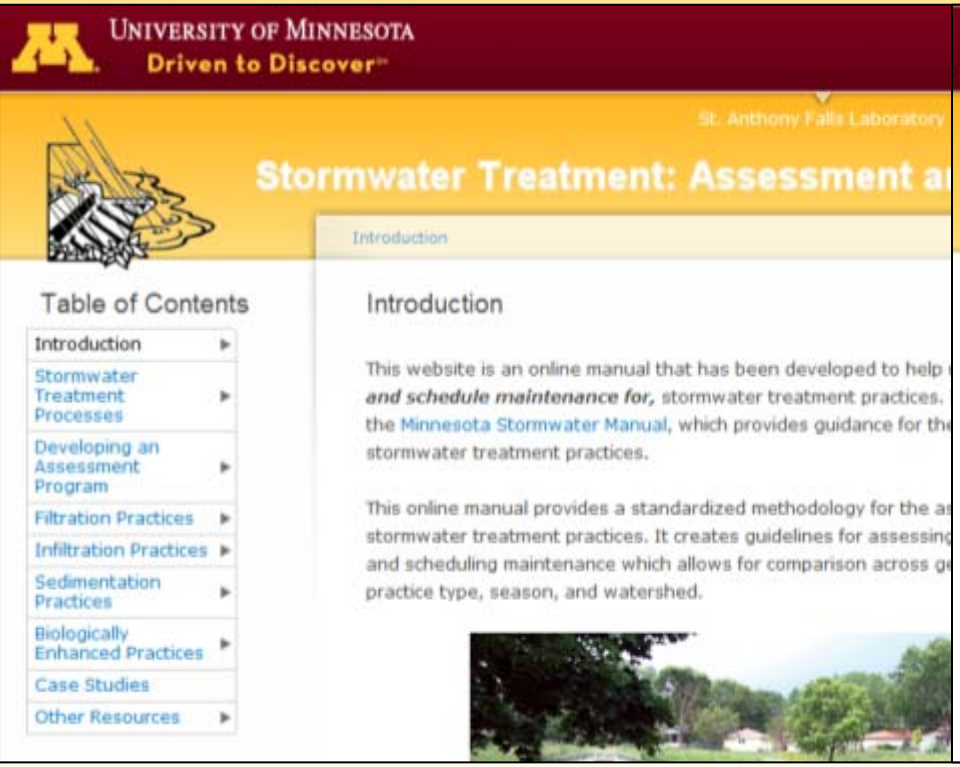
Non-functional Rain garden.

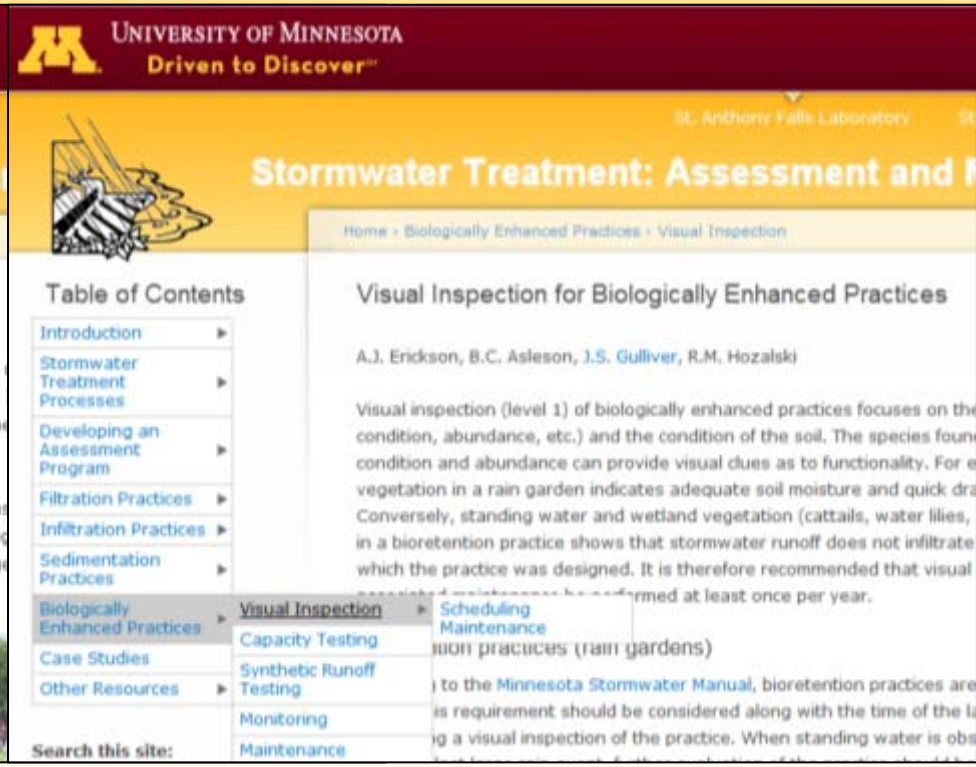
Rain garden that may be functional.

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/)



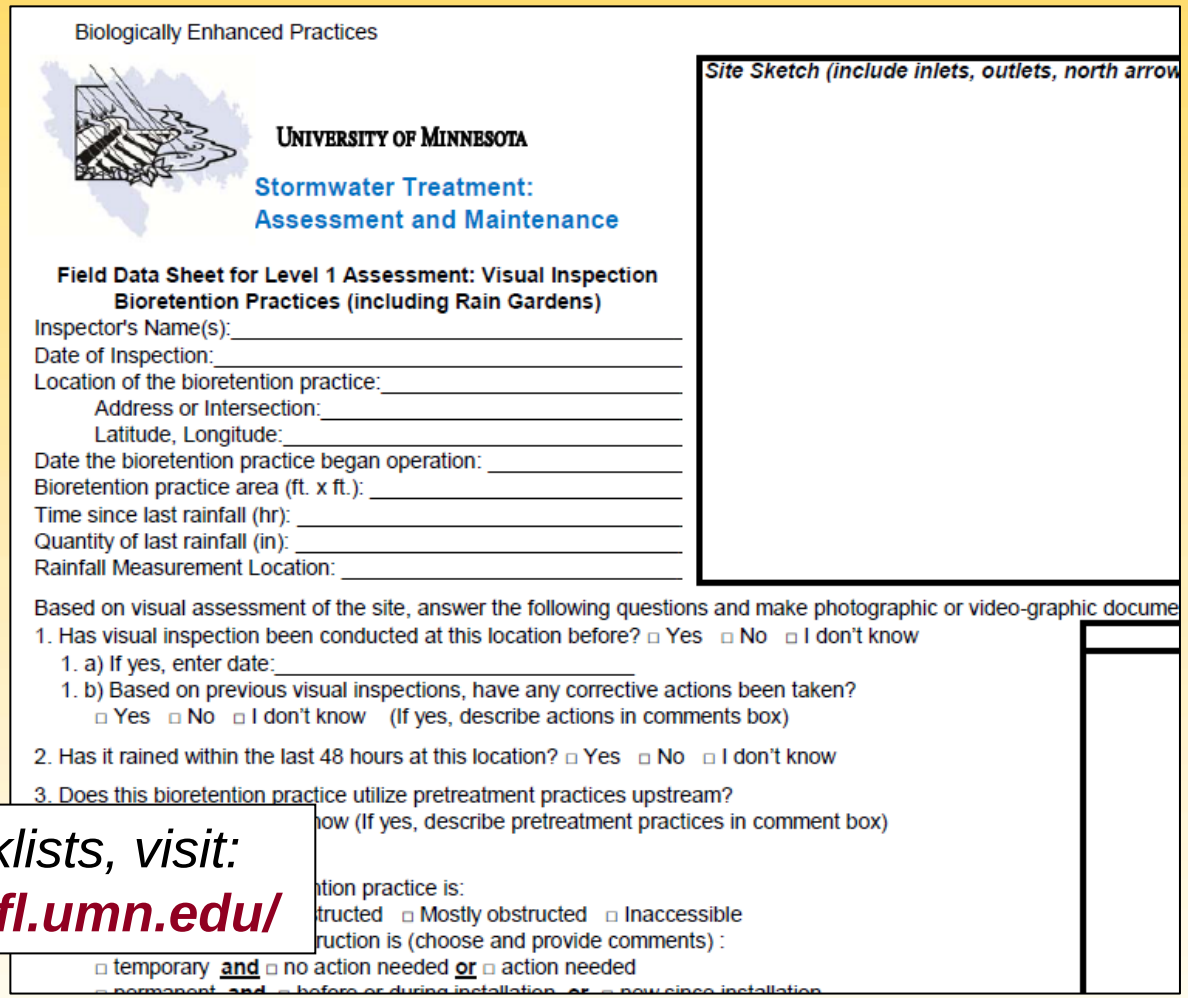


EXAMPLE: Visual Inspection of Bioretention Practices

- 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

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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 docume

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

tion practice is:
tructed □ Mostly obstructed □ Inaccessible
ruction is (choose and provide comments) :
□ temporary **and** □ no action needed **or** □ action needed

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

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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 can be selected and scheduled using the following discussion corresponding to the checklists questions. Alternatively, this discussion can be downloaded in pdf format.

uling Maintenance for Infiltration Basins and Trenches

cheduling Maintenance for permeable pavements)

isual inspection been conducted on this location before?

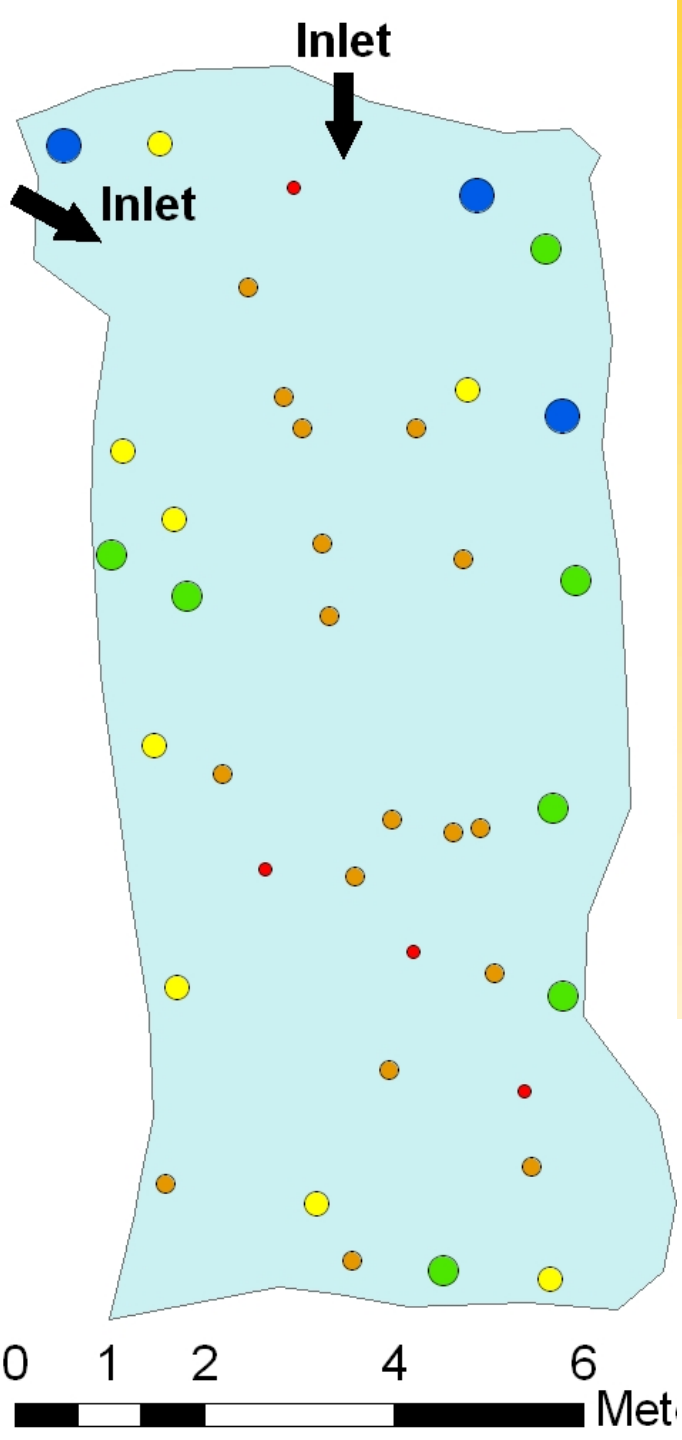
It is important to determine whether this location has been previously assessed so that assessment

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

Hydraulic Conductivity [cm/s]

- 0.000000 - 0.000640
- 0.000641 - 0.002988
- 0.002989 - 0.005672
- 0.005673 - 0.010485
- 0.010486 - 0.015153

Take Home Messages

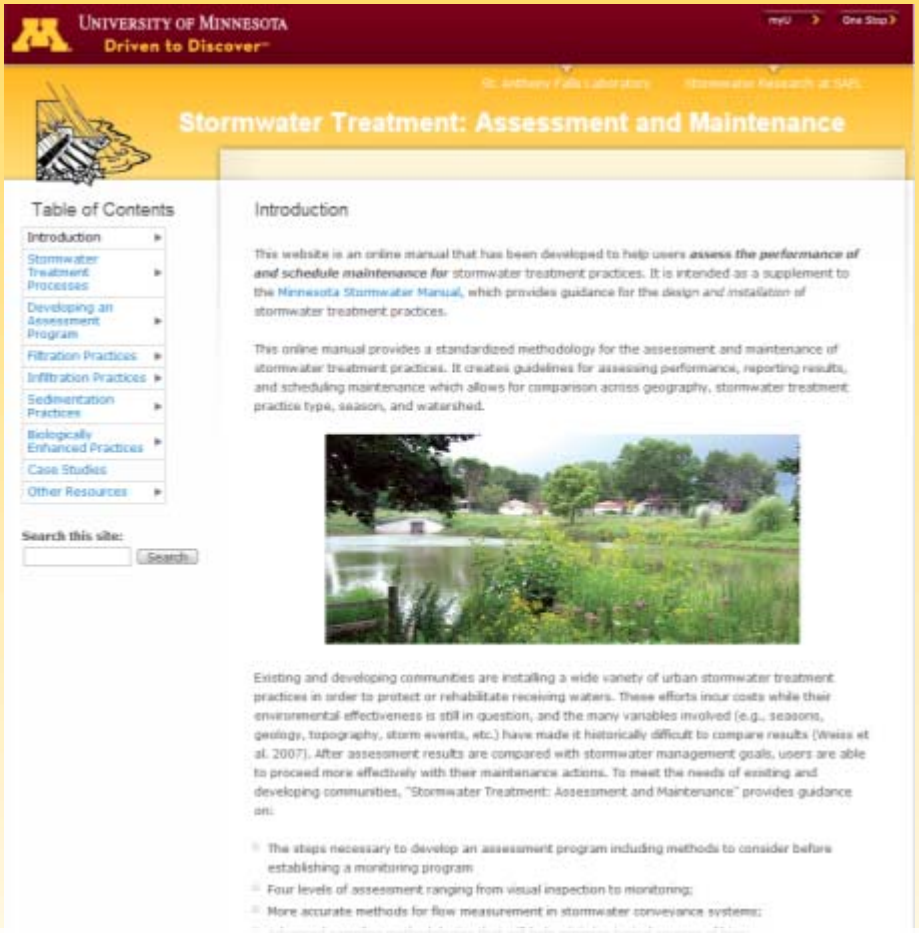
- Visual Inspection
  - At least once per year
- The Realities of Maintenance
  - Maintenance Costs are Significant!

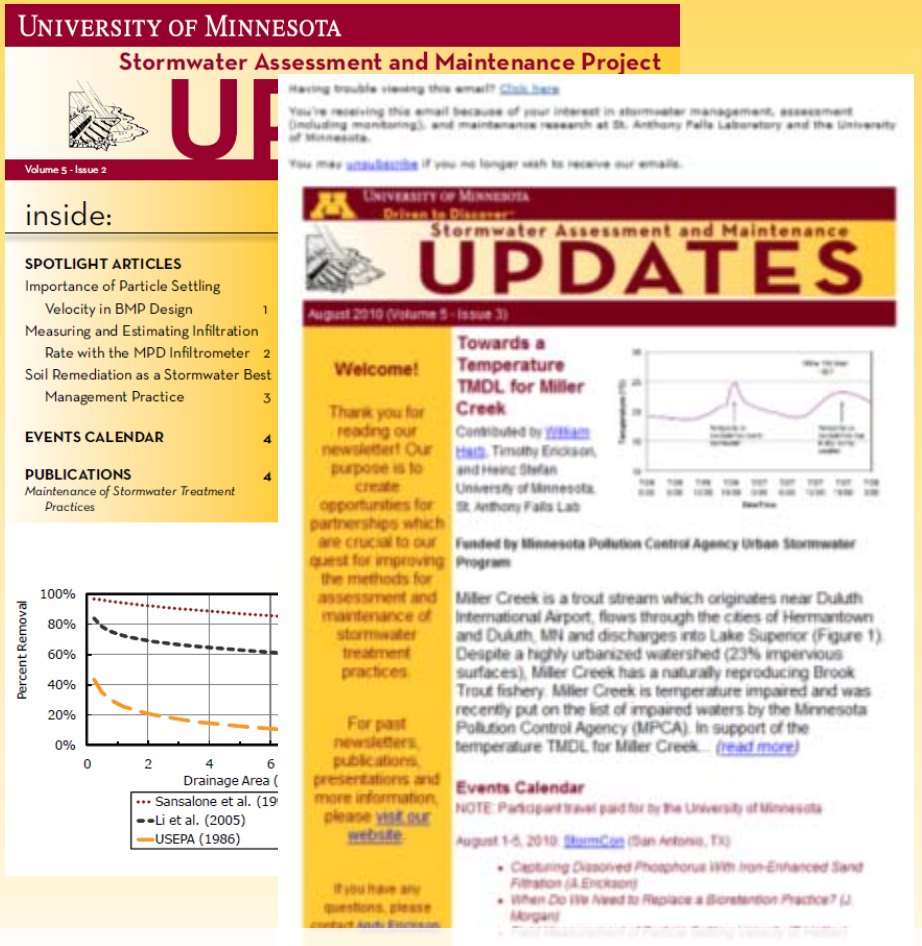
Take Home Messages, cont'd

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

Photos courtesy Shane Missaghi

Stormwater Treatment: Assessment and Maintenance





http://stormwaterbook.safl.umn.edu/

Thank you for your attention!
Questions?

For more information, contact:

Andy Erickson (eric0706@umn.edu)

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