Appendix 9-A

RESULTS OF A FIELD SURVEY OF BMPs

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9-A.1.0. INTRODUCTION

In the late summer and fall of 2008, staff of the Center for Watershed Management and partner organizations involved in an *Extreme BMP Makeover* project conducted a targeted field survey of nearly 200 stormwater control facilities in Virginia's James River Basin (CWP, 2009). This study came out of a desire for empirical data on the relationship between BMP design specifications and BMP performance. The survey was comprised of a visual screening for performance indicators, such as signs of by-passing runoff, proper functioning of inlets and outlets, adequate sizing, integrity of filter media and vegetation, and key maintenance and longevity items.

Gaps in data exist, especially for newer BMPs and those for which design standards have been constantly evolving and lack consistency through time and across regions. This is particularly true for bioretention, infiltration, and low-impact development techniques. In an effort to fill such research gaps regarding BMP performance and help improve BMP design specifications, the following types of stormwater facilities were targeted for this study:

- Newer classes of BMPs that are not well represented in published research.
- BMPs for which design specifications have been developing through time and are inconsistent.
- BMPs that have been difficult to monitor (e.g., infiltration)
- BMPs that are becoming increasingly popular and are likely to have more widespread application in the next decade (e.g., bioretention, some underground BMPs).
- Special categories of more conventional BMPs for which the research has raised questions or been incomplete (e.g., multi-cell pond and wetland designs).

Specifically for this field survey, the CWP staff developed a comprehensive BMP evaluation form that that applies to a wide variety of stormwater facility types, from dry swales to wet ponds. The CWP staff and project partners visited a total of 187 BMPs in eight cites and counties in the James River watershed, starting in the Hampton Roads area (coastal plain) and progressing upriver to the Charlottesville area in central Virginia (Piedmont region). Stormwater management and public works staff from each of these municipalities also participated in the surveys, providing insight into the past history of many of the BMPs.

Table 9-A.1 shows the specific categories and numbers of BMPs that are used in the areas where this study was conducted. **Figure 9-A.1** is a set of box and whisker plots that show the range of overall performance scores for each type of BMP, including the following metrics:

- Entire range of scores (thin line)
- 25th and 75th percentile scores (bottom and top of box)
- Median score (line across box)
- Mean (∗)

For some types of BMPs ("Other" and Wet Swales), the data set was too small to generate a box.

Table 9-A.1. Types of BMPs Used in Eleven Communities in James River Watershed

BMP Type	Number	Percent of Total
Wet Pond (WP)	1785	34%
Dry Pond, no water quality treatment (PU)	933	18%
Dry Pond, water quality treatment (PW)	499	10%
Other (OT)	497	9%
Grass Channel (GC)	439	8%
Infiltration (IN)	428	8%
Bioretention (BR)	237	5%
Proprietary Device (PD)	152	3%
Filtering Practice (FP)	106	2%
Underground Structure (UG)	77	1%
Constructed Wetland (CW)	55	1%
Dry (water quality) Swale (DS)	25	less than 1%
Level Spreader (LS)	10	less than 1%
Permeable Pavement (PP)	6	less than 1%
Wet Swale (WS)	2	less than 1%

Source: CWP, 2009

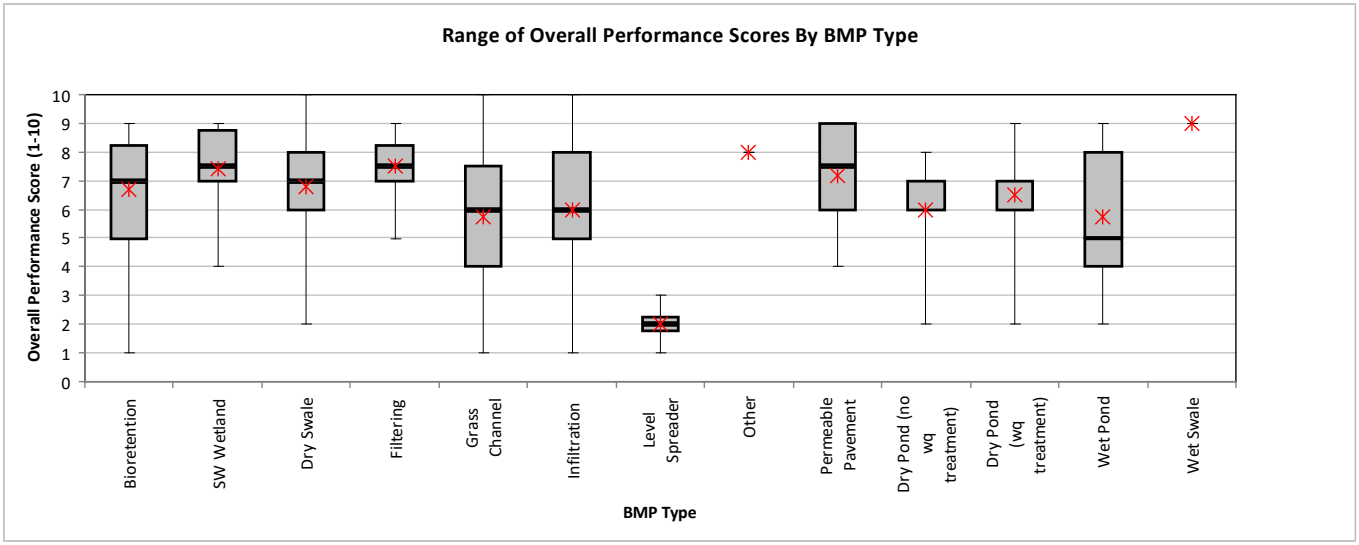

Figure 9-A.1. Box and Whisker Plot for the Range of Overall Performance Scores by BMP Type
(Source: CWP, 2009)

As can be seen in **Figure 9-A.1**, most types of BMPs had mean scores in a range indicating the BMP design is adequate, but the plots for several BMPs indicate performance problems. Wet ponds, dry ponds, infiltration devices, and grass channels had somewhat lower mean scores, and level spreaders generally had significant performance issues.

As might be expected, the ranges of scores are quite large, indicating that each type of practice has some representatives that are failing and others that are performing very well. Some of the practices with the widest ranges of performance scores include bioretention, grass channels, infiltration, permeable pavement, and wet ponds. This may indicate that design, installation, and maintenance guidelines for these practices are not yet well articulated or applied consistently. As one result of this survey, the DEQ is providing much improved BMP specifications on the Virginia Stormwater BMP Clearinghouse web site (http://www.vwrrc.vt.edu/swc/). The following is a summary of some specific BMP performance issues identified by the field survey (examples in **Figure 9-A.2** below):

- ***Ineffective Treatment.*** In many BMPs, the treatment mechanism is not effective due to short-circuiting (e.g., a flow path from inlet to outlet that is too short), no pre-treatment, ineffective treatment mechanisms, incorrect flow paths, and/or water by-passing inlets.
- ***Vegetation.*** Vegetation management is often an issue with BMPs, because the target vegetative community is not known or understood. This can result in excessive vegetation and invasive species, trees on dam embankments, or inadequate vegetation.
- ***Erosion and Deposition.*** Some BMPs were not stable due to erosion of embankments, erosion within the facility itself, or deposition of sediment within the facility.
- ***Awareness of BMP Owners.*** As may be expected, some BMPs had performance problems because the owners are unaware of the BMP or its purpose and functions. Overall, 46% of BMPs were in need of some type of maintenance, and 14% had no access to the BMP to conduct maintenance activities.

The survey determined that problems with BMPs were due to several issues, including incorrect or ineffective design, less than optimum location, improper construction and, of course, lack of proper maintenance.

Accumulation of trash and debris

Clogged pavers and non-infiltrating infiltration bed

Property owners filled in rain garden and replaced it with a sculpture

Sediment forebay filled in and became vegetated

Figure 9-A.2. Examples of Typical BMP Maintenance Problems (Source: CWP, 2009)

Figure 9-A.3 shows the incidence of the most common performance problems.

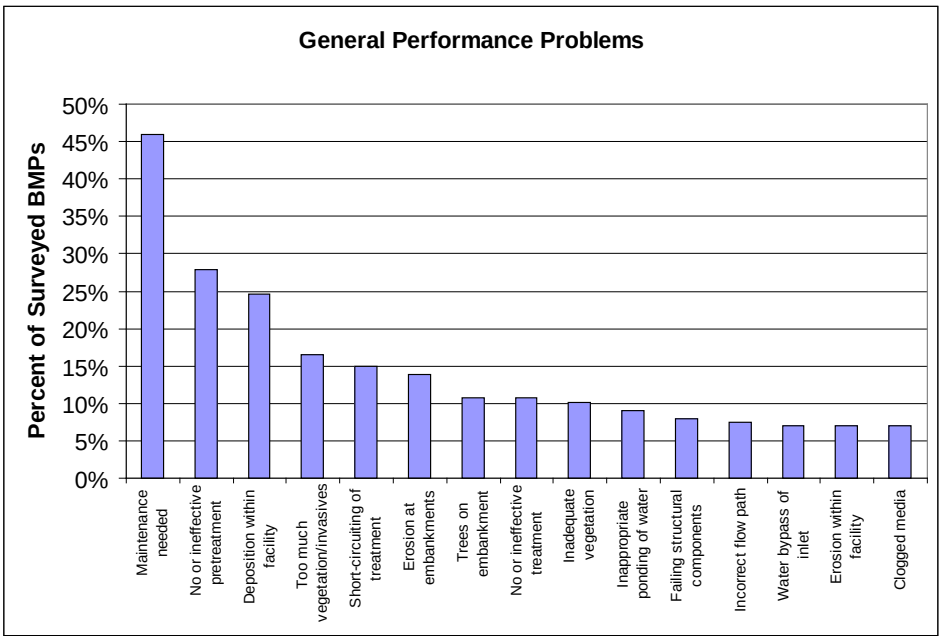

Figure 9-A.3. Incidence of the most common performance problems
(Source: CWP, 2009)

9-A.2.0. REFERENCES

Atlanta Regional Commission (ARC). 2001. *Georgia Stormwater Management Manual*. Prepared by AMEC, the Center for Watershed Protection, Debo and Associates, Jordan Jones and Goulding, and the Atlanta Regional Commission. Atlanta, Georgia.

Center for Watershed protection (CWP). *Technical Report on Stormwater BMPs in Virginia's James River Basin: An Assessment of Field Conditions & Programs*. Ellicott City, MD.