The International Stormwater BMP Database
Part 1: Summary of Database

PHRC Land Development Brief

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INTRODUCTION

This brief, part of a two-part series, provides an introduction to the International Stormwater BMP Database for professionals working in residential land development and stormwater management. The brief contains a description of the data housed in the Database, a summary of Pennsylvania BMPs reported in the Database, and general recommendations on BMP selection to address specific stormwater design problems in residential applications. The second brief in the series (*The International Stormwater BMP Database Part 2: Data Summary for the Design of Residential BMPs*) is more technical and provides stormwater design professionals with additional information on the BMPs located in Pennsylvania, as well as recent research findings on pollutant removal efficiencies of BMPs that address various stormwater management challenges.

WHAT IS THE BMP DATABASE?

The International Stormwater Best Management Practices Database (hereafter referred to as the Database) is a repository of data collected from over 500 Best Management Practices (BMPs) designed to allow researchers and designers access to continually updated data on the performance of stormwater BMPs. The project was started in 1996 and is sponsored and supported by the Water Environment Research Foundation, the U.S. Environmental Protection Agency, the American Society of Civil Engineer's Environmental and Water Resources Institute, the Federal Highway Administration and the American Public Works Association.

The BMP Database is saved in Microsoft Access format and the entire BMP Database is downloadable from the project website at http://www.bmpdatabase.org/. To add data, researchers complete an Excel spreadsheet form that documents study details such as the location of the BMP, watershed characteristics, details of monitored precipitation events, BMP design parameters, instrumentation details, defining characteristics of runoff events, water quality data, and sediment particle distribution. Some data such as project location and BMP type are collected for all studies, but different studies have different goals, so the inclusion of other design parameters or water quality data varies from entry to entry.

The BMPs are grouped according to 17 different categories and each of these categories has additional BMP-specific criteria documented by researchers. Table 1 lists the BMP categories and the number of each type of BMP documented within the Database. The 512 BMPs in the Database are located at 358 different study locations.

In addition to the master BMP Database, the project website also includes a search tool to find data on specific water quality parameters or BMP types, an interactive mapping tool to locate BMPs within the Database, and statistical summary reports developed by the project team.

Figure 1 shows the locations of the BMPs that have been studied and entered in the BMP Database. Note that when the map is zoomed out to the national scale (Figure 1) it appears that that there are ten BMP study locations in Pennsylvania. Zooming in to the state level reveals that there are really only three project locations in Pennsylvania. Data are available for four of the six reported BMPs in Pennsylvania.

BMP DATABASE PROJECTS IN PA

While there are over 500 projects in the BMP database, there are only three project locations in Pennsylvania. These projects are located at the Harrisburg Public Works Yard, Penn State University (University Park) and Villanova University.

The BMP located at the Harrisburg Public Works Yard is a manufactured device: a two-chamber sediment trap with a baffle and screen to remove debris and large sediment and then finer particles.

Table 1. Summary of BMP categories and number of BMPs studied in the BMP Database as of July 2012.

BMP Category	# of BMPs Studied
Bioretention	30
Detention basin	39
Green roof	13
Biofilter – Grass strip	45
Biofilter – Grass swale	41
Infiltration basin	2
LID (site scale)	2
Manufactured device	79
Media filter	37
Percolation trench/well	12
Porous pavement	35
Retention pond	68
Wetland basin	31
Wetland channel	19
Composite (treatment train)	25
Maintenance practice	28
Other	6
Total	**512**

The Villanova Urban Stormwater Partnership (VUSP) is conducting research on multiple BMPs on the Villanova University campus, but has only reported data to the BMP Database for an infiltration trench and a porous concrete infiltration basin. Data on additional BMPs are available through the VUSP website at http://www3.villanova.edu/vusp/.

The project located on the Penn State University Park Campus is a green roof and only has flow data reported for five storm events occurring in 2005 and 2006.

More detailed data for the BMP projects located in Pennsylvania can be found in Part 2 of this series.

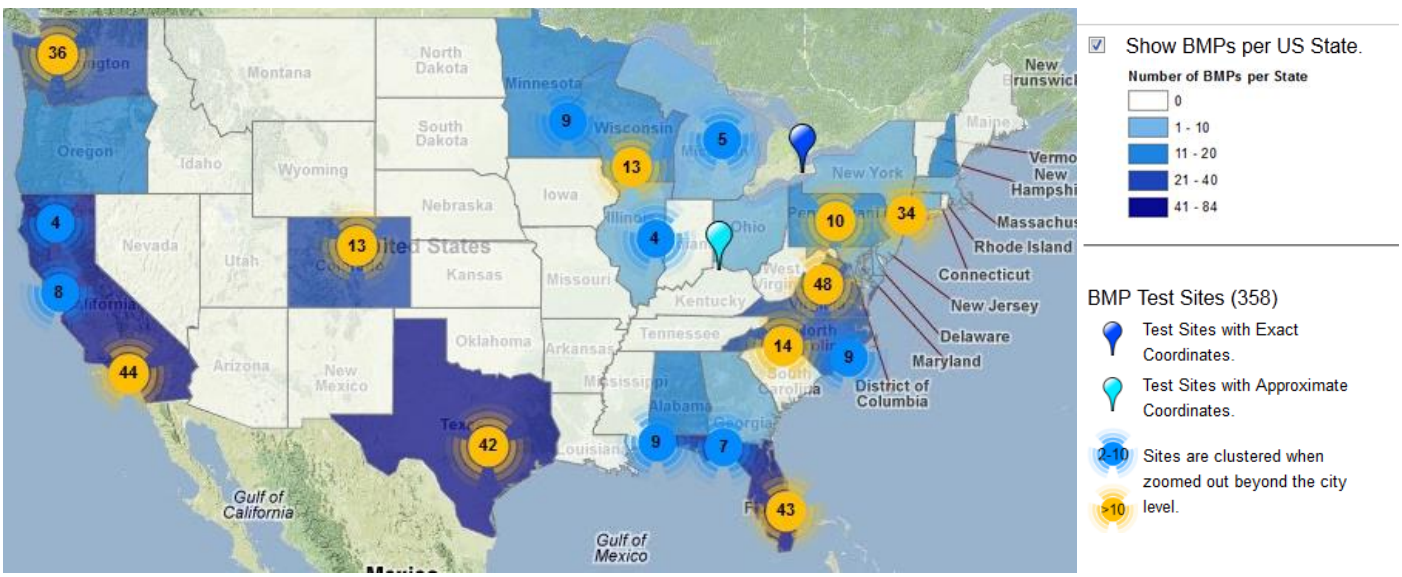

Figure 1. Location of BMPs Database studies in the US

GENERAL CONCLUSIONS FROM THE BMP DATABASE

Because of the limited number of documented projects in Pennsylvania, it is difficult to make statistically valid conclusions regarding BMP effectiveness in Pennsylvania; however, using data from across the country can provide some design information for stormwater professionals.

Because of the many different types of data collected for the different categories of BMPs, the original database is very difficult to use and data are difficult to summarize. Data for a particular constituent from a category of BMPs at a specific study location are easy to access; however, this type of very site-specific data is not useful in determining removal efficiencies for each BMP category across a variety of site conditions. The Database project team developed a series of technical papers (References 6, 7, 8, and 9) that reports summary statistics for influent and effluent data by water quality constituent and by BMP category. The statements in this brief and Part 2 that refer to a particular category of BMP being more or less efficient at pollutant removal than other BMPs are based on the median influent and effluent values reported in the technical papers. The calculation of these median values includes the use of regression-on-order statistics (ROS, Reference 9) to determine estimates of non-detects (samples that may have concentrations below the analysis method detection limit). The design recommendations here are based on the data and findings reported in the series of technical papers and other reports by the project team (References 4, 11, 14).

Water Quality

There are over 3,000 different water quality constituents that have been reported in the Database. Sediment (usually regulated and reported as total suspended solids, TSS), nitrogen (N) and phosphorus (P) have been selected for further examination in this series of briefs because these constituents are the targets of the Chesapeake Bay TMDL Plan and the PA DEP NPDES Permit for Stormwater Discharges Associated with Construction Activities. This brief provides a summary of the BMPs most suited for removal of these pollutants. Refer to Part 2 of this series for additional analysis, including influent to effluent percent removal, which can be used to document BMP efficiency.

Sediment

Based on the results of the Database the highest percent reduction of TSS tends to be achieved through the use of retention ponds, composite BMPs, porous pavement, bioretention, and detention basins

Designers and developers can increase the efficiency of sediment removal by BMPs through increasing the amount of time that runoff is detained by a BMP along with conducting regular maintenance. The amount of time that stormwater is held in a BMP is called the hydraulic residence time. The hydraulic residence time can be increased by eliminating low flow channels through basins, increasing the density of vegetation, using plants other than grass, decreasing the amount and frequency of mowing, or creating a sinuous path of flow through a basin. To ensure effectiveness, BMPs need to be maintained so that vegetation is in good condition and filter structures do not get clogged with sediment, garbage, or leaf debris.

Nitrogen (N)

Bioretention and retention ponds tend to significantly reduce effluent concentrations of total nitrogen (TN), while detention basins show an average *increase* in total nitrogen.

It is important to know what form or forms of nitrogen may be present in stormwater runoff from a particular site to select the best BMPs for that specific location. In addition to TN, other forms of nitrogen are included in the Database, including total Kjeldahl nitrogen (TKN), and NO_x. Refer to Part 2 of this series for more information about the other forms of nitrogen.

Phosphorus (P)

Retention basins, composite BMPs (treatment trains), manufactured devices, media filters, retention ponds, wetland basins, porous pavement, and detention basins tended to reduce total phosphorus. Phosphorus is more likely to be found adhered to sediment particles than dissolved in water; thus, control of sediment pollution can also assist in the control of phosphorus.

Some BMPs were actually found to increase the concentration of phosphorus in the effluent. This is likely the result of phosphorus concentrations in the soil or media used in the BMP. Determining phosphorus concentrations in the soil or media before use in BMPs will help avoid an increase in phosphorus.

Like nitrogen, phosphorus is present in the environment in different forms. Because different BMPs can be more effective at removing some types of phosphorus and not others, knowing the form or forms of phosphorus present on a site will allow a designer to select the best BMPs for that specific location. Additional information about orthophosphate (OP) and dissolved phosphorus (DP) can be found in Part 2.

Volume Reduction

There are fewer data on volume control than water quality in the Database. Based on the available data, BMPs with normally dry conditions such as filter strips, vegetated swales, bioretention, and grass-lined detention basins tend to be the best BMPs to achieve volume reduction.

GENERAL RECOMMENDATION FOR BMP DESIGN BASED ON THE BMP DATABASE

Based on the reported data, there are no clear, easy-to-follow guidelines that can be applied to design for all BMPs. Designing BMPs with longer residence times, such as bioretention and retention ponds, or permanent pools, such as wetland basins, will increase sediment removal, which will also increase the removal of phosphorus adsorbed to the sediment. Bioretention and retention ponds are also effective for removal of total nitrogen

The collection and analysis of runoff samples may be needed to determine what form or forms of nitrogen and phosphorus are present on the site to allow for the selection of the most appropriate BMPs.

Summaries of all BMP categories show that different types of BMPs can be more efficient at removing different types of pollutants; therefore, a treatment train approach using different types of BMPs may be the most effective way to achieve the goals of reducing sediment, nitrogen and phosphorus concentrations, and the rate and volume of stormwater runoff.

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