National Pollutant Removal Performance Database for STPs: 2nd Edition

The Center recently completed the second edition of the *Stormwater Treatment Practice (STP) Pollutant Removal Performance Database* (the "Database") which modifies, clarifies, and expands upon the original *National Database of BMP Pollutant Removal Performance* (the First Edition) by Brown and Schueler (1997).

The First Edition included 129 studies and spanned a 19-year period; the minimum storm sampling criteria was four sampling events, and little effluent concentration data was included. Major changes to the First Edition include the following:

- Addition of 24 studies
- Elimination of studies that did not meet the new minimum storm sample criteria of five
- Update of existing entries to include effluent concentration and other data where available
- Addition of new fields

Eight of the studies included in the First Edition were deleted because of insufficient storm sample size. In addition, concentration data were added to existing studies to make the database a more powerful analysis tool. More than half of the original studies included both influent and effluent concentration data, and these data were not consistently included in the First Edition. Finally, several fields were added since the First Edition, including *Age of the Facility*, *Drainage Class* (based on drainage area), *Land Use Quantification* (e.g., percent commercial, residential, etc.), and storage in *Watershed* and *Impervious Inches*. Unfortunately, many studies did not report these data explicitly. Consequently, the database does not currently have sufficient data to develop relationships between specific site or design characteristics and performance. One exception is the *Drainage Class* field, which classifies ponds and wetlands as Pocket, Regular, or Regional. Although the results are not conclusive, sufficient data are available to characterize each data class.

Table 1. Median Pollutant Removal (%) of Stormwater Treatment Practices							
	TSS	**TP**	**Sol P**	**TN**	**NOx**	**Cu**	**Zn**
Stormwater Dry Ponds	47	19	-6.0	25	4.0	26[1]	26
Stormwater Wet Ponds	80 (67)	51 (48)	66 (52)	33 (31)	43 (24)	57 (57)	66 (51)
Stormwater Wetlands	76 (78)	49 (51)	35 (39)	30 (21)	67 (67)	40 (39)	44 (54)
Filtering Practices[2]	86 (87)	59 (51)	3 (-31)	38 (44)	-14 (-13)	49 (39)	88 (80)
Infiltration Practices	951	70	85[1]	51	82[1]	N/A	99[1]
Water Quality Swales[3]	81 (81)	34 (29)	38 (34)	841	31	51 (51)	71 (71)

1. Data based on fewer than five data points
2. Excludes vertical sand filters and filter strips
3. Refers to open channel practices designed for water quality

NOTES:

- Data in parentheses represent values from the First Edition (Schueler, 1997; Appendix D).
- Shaded regions indicate a difference of at least ± 5% from the First Edition.
- N/A indicates that the data are not available.
- TSS = Total Suspended Solids; TP = Total Phosphorus; Sol P= Soluble Phosphorus; TN = Total Nitrogen; NOx = Nitrate and Nitrite Nitrogen; Cu = Copper; Zn = Zinc

The statistical reanalysis of the First Edition revealed some changes in the pollutant removal efficiencies of STPs (Table 1). These changes can be attributed to the addition of new studies and revisions to the older studies. Most of the shaded regions represent a pollutant removal increase of at least 5%. Three exceptions are nitrogen removal for filtering practices, which decreased by 16%; and zinc and soluble phosphorus removal of stormwater wetlands, which decreased by 18% and 10% respectively. The STP group with the greatest change over original data is filtering practices. This result is not surprising, since a significant number of changes were made to this group (five studies were added to the original 14). In particular, the negative soluble phosphorus in the original was caused by a few values from organic filters, and from one perimeter filter that had become submerged, releasing soluble phosphorus.

Table 2. Median Effluent Concentration (mg/L)[1] of Stormwater Treatment Practice Groups

	TSS	TP	OP	TN	NOx	Cu	Zn
Stormwater Dry Ponds	28[2]	0.18[2]	0.13[2]	0.86[2]	N/A[3]	9.0[2]	98[2]
Stormwater Wet Ponds	17	0.11	0.03	1.3	0.26	5.0	30
Stormwater Wetlands	22	0.20	0.09	1.7	0.36	7.0	31
Filtering Practices[3]	11	0.10	0.08	1.12	0.55[2]	10	21
Infiltration Practices	17[2]	0.05[2]	0.003[2]	3.8[2]	0.09[2]	4.8[2]	39[2]
Water Quality Swales[4]	14	0.19	0.08	1.12	0.35	10	53

1. Units for Zn and Cu are micrograms per liter
2. Data based on fewer than five data points
3. Excludes vertical sand filters and filter strips
4. Refers to open channel practices designed for water quality

NOTES:

- N/A indicates that the data is not available.
- TSS = Total Suspended Solids; TP = Total Phosphorus; OP = Ortho-Phosphorus; TN = Total Nitrogen; NOx = Nitrate and Nitrite Nitrogen; Cu = Copper; Zn = Zinc

Median effluent concentrations by STP groups are summarized in Table 2. Effluent concentration data were added to the Database as a supplement to the pollutant removal capability of STPs. In some instances, pollutant removal percentage may not be a good indicator of the overall removal capability of a STP. Pollutant removal percentages can be strongly influenced by the variability of the pollutant concentrations in incoming stormwater. If the concentration is near the "irreducible level" (Schueler, T. 2000. "Irreducible Pollutant Concentrations Discharged from Urban BMPs," Article 65 in The Practice of Watershed Protection. Center for Watershed Protection. Ellicott City, MD.), a low or negative removal percentage can be recorded even though outflow concentrations discharged from the STP were relatively low. Although these data represent a median, unlike the group mean reported in Schueler (1996), the data suggest that the typical concentration data reported in this initial study and are high compared with the results from the Database.

The data presented in this study support the contention that most STP designs can remove significant amounts of sediment and total phosphorus in urban runoff. Most STP groups, on the other hand, showed a lower ability to remove nitrogen. This result suggests that non-structural nutrient reduction methods, in addition to stormwater STPs, may be needed to meet nutrient reduction targets.

Significant gaps do exist in our knowledge of the removal capability of certain STP designs and stormwater parameters. Filling these gaps should be the major focus of future STP monitoring research. The more well-studied STP groups (ponds, wetlands, and filters) should be re-directed to investigate internal factors (i.e., geometry and sediment/water column interactions) that may create the wide variability in pollutant removal that is characteristic of STP monitoring. Finally, more research is needed with respect to bacteria, dissolved metals, and hydrocarbons; all of these are pollutants associated with human health impacts. Such research could be of great value in developing better designs and reducing pollutant removal variability, allowing for more reliable pollutant reduction at the watershed scale.

The full report, "National Pollutant Removal Performance Database for Stormwater Treatment Practices: 2nd Edition," is available from the Center for $25. Please access our web site at www.cwp.org for ordering information.