Supplementary Materials

A. Design procedure for different BMP group

Detailed procedures for design of different BMPs are provided. For the purpose of design, BMPs are classified in two different groups; infiltration-based BMPs and storage-based BMPs. Also, the method of design varies depends on the pollutant types.

A.1. Design procedure for infiltration-based BMPs

The first group of BMPs are infiltration-based BMPs. This group includes infiltration basin, dry well, infiltration trench, sand filter, porous pavement, grassed swale, vegetated filter strip, bioretention, rain garden, tree box, and wetland. In the following, design of infiltration-based BMPs based on percent pollutant removal are presented.

A.1.2. BMP efficiency based on percent pollutants removal

Design approaches vary by pollutant type. Pollutant types are classified in two different groups; colloids and dissolved and design procedure for each group is presented below.

A.2.2.1 Procedures for calculating BMP efficiency for colloidal pollutants

A simplified form of colloid filtration theory has been applied for removal of colloids.

$$\ln\frac{C}{C_0} = \frac{-3}{2}(1-f)\alpha n\frac{z}{d_c} \tag{A1}$$

$$\frac{C}{C_0} = e^{\frac{-3}{2}(1-f)\alpha n\frac{z}{d_c}} \tag{A2}$$

$$\frac{\mathrm{C_0-C}}{\mathrm{C_0}} = 1 - e^{\frac{-3}{2}(1-f)\alpha n\frac{z}{d_c}} \tag{A3}$$

$$\text{Percent colloid pollutant removal (\%)} = 1 - e^{\frac{-3}{2}(1-f)\alpha n\frac{z}{d_c}} \tag{A4}$$

$$n = \frac{3}{2}\left(\frac{d_p}{d_c}\right)^2 + \frac{v_s A_{BMP}}{Q_{IN}-Q_{OF}}, v_s = 2.81 d_p^2 \tag{A5}$$

Where *f* is filter bed porosity, α is collision efficiency factor, *n* is single collector efficiency, *z* is filter bed depth in m, d_p is median particle diameter in m, d_c is collector diameter in m, A_{BMP} is surface area of BMP in m^2, Q_{IN} is runoff into a BMP in $\frac{m^3}{s}$, Q_{OF} is overflow runoff out of a BMP in $\frac{m^3}{s}$, v_s is settling velocity in $\frac{m}{s}$, C_0 is initial concentration in $\frac{mg}{L}$, and C is final concentration in $\frac{mg}{L}$.

A.2.2.2 Procedures for calculating BMP efficiency for dissolved pollutants

A first-order reaction method has been applied for removal of dissolved pollutant types.

$$\frac{\mathrm{dC}}{\mathrm{dt}} = -\mathrm{kc} \xrightarrow{\text{integration}} \ln\frac{\mathrm{C}}{\mathrm{C_0}} = -\mathrm{kt} \tag{A6}$$

$$\mathrm{C} = \mathrm{C_0 e^{-kt}} \tag{A7}$$

$$\frac{\mathrm{C_0-C}}{\mathrm{C_0}} = 1 - \mathrm{e^{-kt}} \tag{A8}$$

$$\text{Percent pollutant removal (\%)} = 1 - \mathrm{e^{-kt}} \tag{A9}$$

Where, C_0 is initial concentration in $\frac{mg}{L}$, C is final concentration in $\frac{mg}{L}$, t is time in s, and k is first-order reaction decay in $\frac{1}{s}$

$$\text{Percent pollutant removal } (\%) = 1 - e^{-k\frac{d_{media}}{v_z}} \quad \text{(A10)}$$

$$\text{Percent pollutant removal } (\%) = 1 - e^{-k\frac{d_{media}\,(A_{BMP}*\theta)}{Q_{IN}-Q_{OF}}} \quad \text{(A11)}$$

Where v_z is vertical velocity of flow into media in $\frac{m}{s}$, d_{media} is depth of soil media in m, k is decay rate values in $\frac{1}{s}$, Q_{IN} is runoff into a BMP in $\frac{m^3}{s}$, and Q_{OF} is overflow runoff out of a BMP in $\frac{m^3}{s}$.

A.2. Design procedure for storage-based BMPs

The second group of BMPs are storage-based BMPs such as dry pond and wet pond. In the following, design of storage-based BMPs based on percent pollutant removal are presented.

A.2.2. BMP efficiency based on percent pollutants removal

In this section design method varies based on pollutant types. Pollutant types are classified in two different groups including colloid and dissolved which design procedure for each type are presented below.

A.2.2.1 Procedures for calculating BMP efficiency for colloidal pollutants

$$\text{Percent pollutant removal } (\%) = 1 - e^{-\frac{v_s}{v_c}} \quad \text{(A12)}$$

$$v_c = \frac{Q_{IN}}{A_{BMP}} \quad \text{(A13)}$$

$$\log_{10} v_s = 0.34246\,(\log_{10} d_{50})^2 + 0.98912\,(\log_{10} d_{50}) + 1.14613 \quad \text{(A14)}$$

$$v_s = 10^{0.34246\,(\log_{10} d_{50})^2 + 0.98912\,(\log_{10} d_{50}) + 1.14613} \quad \text{(A15)}$$

$$\text{Percent pollutant removal } (\%) = 1 - e^{\frac{-\left(10^{0.34246\,(\log_{10} d_{50})^2 + 0.98912\,(\log_{10} d_{50}) + 1.14613}\right) A_{BMP}}{Q_{IN}}} \quad \text{(A16)}$$

Where v_s is settling velocity in $\frac{m}{s}$, v_c is critical velocity in $\frac{m}{s}$, D is mean sieve diameter of grains in *m*, and Q_{IN} is runoff into a BMP in $\frac{m^3}{s}$.

A.2.2.2 Procedures for calculating BMP efficiency for dissolved pollutants

Similar to infiltration-based BMPs, to design the storage-based BMPs for dissolved pollutant type, first-order reaction method has been implemented.

$$\text{Percent pollutant removal } (\%) = 1 - e^{-k\frac{d_{BMP}\,A_{BMP}}{Q_{IN}}} \quad \text{(A17)}$$