6 Example Calculations

6.1 Introduction

The following example indicates the types and sizes of BMPs that would comply with the proposed Edwards rule requiring 80% reduction in the increase in TSS stormwater loading. Assumptions of this example are:

- The site is currently undeveloped (0% impervious cover)
- Soils are hydrological group D with an infiltration rate of 0.1 inch/hour.
- The proposed site area is 10 ac.
- The site is located in Bexar County
- No runoff enters the site from upgradient (or is directed around the development and does not enter the proposed BMPs)
- The impervious cover after development is 40%
- All runoff leaves the site at a single point

6.2 Required TSS Reduction

The required TSS reduction is calculated from:

$$L = 27.2(A_N \times P)$$

Where:

P = Annual precipitation for Bexar County, 30 inches (Table 3-3)
A_N = 4 acres (40% of 10 acre site)

Consequently:

$$L = 27.2 \text{ x } 4 \text{ x } 30 = 3{,}264 \text{ lbs}$$

6.3 Example Capture Volume Calculations

6.3.1 Retention/Irrigation

Assume that retention/irrigation is the BMP selected for treatment of the stormwater runoff. The maximum load reduction for this type of BMP is calculated from:

$$L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$$

Where:

BMP efficiency = 1.0
P = 30 inches (Table 3-3, Bexar County)
A_I = 4 acres (40% of 10 acre site)
A_P = 6 acres (60% of the site)

Consequently:

$$L_R = (1.0) \times 30 \times (4 \times 34.6 + 6 \times 0.54) = 4249 \text{ lbs}$$

Note that this calculation assumes that runoff from the entire 10 acres is directed into the BMP. The drainage system can be configured so that only the impervious portion of the site is conveyed to the BMP. In this case, A_I and A_P would refer specifically only to those areas draining to the BMP.

The next step is to calculate the fraction of the annual rainfall that must be treated to achieve the required 80% reduction from:

$$F = L/L_R$$

Where:

F = Fraction of the annual rainfall treated by the BMP
L_R = Load removed from Step 3 calculation (4249 lbs)
L = Required load reduction from Step 1 (3264 lbs)

Consequently:

$$F = 3264/4249 = .77$$

From Table 3-5, one can see that 0.77 corresponds to a rainfall depth of 0.97 inches. Next, the runoff coefficient for the site must be calculated using the relationship shown in Figure 3-12 and presented in Equation 3.11.

$$Rv = 1.72(0.4)^3 - 1.97(0.4)^2 + 1.23(0.4) + 0.02 = 0.31$$

These values are used to calculate the water quality volume (WQV) by:

$$\text{WQV} = \text{Rainfall depth x Runoff Coefficient x Area} = (0.97/12) \times 0.31 \times (10 \times 43560)$$

$$= 10{,}915 \text{ ft}^3$$

The area required to irrigate this volume is calculated as:

$$A = \frac{12 \times V}{T \times r} = \frac{12 \times 10{,}915}{30 \times 0.1} = 43{,}661\, ft^2$$

In this example, 60% of the 10-acre site is pervious area (landscaping, etc.), which is equivalent to 261,360 ft^2. Therefore, there is sufficient area on the site for the irrigation system. Ideally, the irrigated area should include as much of the pervious area as possible to provide more effective use of the retained runoff.

6.3.2 Sand Filter System

Assume that a sand filter is the BMP selected for treatment of the stormwater runoff. The potential load reduction is:

$$L_R = \text{(BMP efficiency) x P x } (A_I \times 34.6 + A_P \times 0.54)$$

Where:

BMP efficiency = 0.89
P = 30 inches (Table 3-3, Bexar County)
A_I = 4 acres (40% of 10 acre site)
A_P = 6 acres (60% of the site)

Consequently:

$$L_R = (0.89) \times 30 \times (4 \times 34.6 + 6 \times 0.54) = 3782 \text{ lbs}$$

The next step is to calculate the fraction of the annual rainfall that must be treated to achieve the required 80% reduction from:

$$F = L/L_R$$

Where:

> F = Fraction of the annual rainfall treated by the BMP
> L_R = Load removed from Step 3 calculation (3782 lbs)
> L = Required load reduction from Step 1 (3264 lbs)

Consequently:

$$F = 3264/3782 = .86$$

From Table 3-5, one can see that 0.86 corresponds to a rainfall depth of 1.46 inches. Next, the runoff coefficient for the site must be calculated using the information presented in Figure 3-12 and Equation 3.11.

$$Rv = 1.72(0.4)^3 - 1.97(0.4)^2 + 1.23(0.4) + 0.02 = 0.31$$

These values are used to calculate the water quality volume (WQV) by:

$$WQV = \text{Rainfall depth x Runoff Coefficient x Area} = (1.46/12) \text{ x } 0.31 \text{ x } (10 \text{ x } 43560)$$

$$= 16{,}429 \text{ ft}^3$$

Therefore, the sand filter system must be sized to capture 16,429 ft^3 of runoff.

6.3.3 Combination Grassy Swale/Extended Detention

Assume that grassy swales are used for conveyance of stormwater to an extended detention basin. In this case, there are two BMPs in series and the sizing is dependent on the total efficiency of the system using:

$$E_{Tot} = [1 - ((1 - E_1) \times (1 - 0.5E_2) \times (1 - 0.25E_3))] \times 100$$

$$E_{Tot} = [1 - ((1 - 0.7) \times (1 - 0.5(0.75)))] \times 100 = 0.81$$

The potential solids removal of this combination is:

$$L_R = (\text{BMP efficiency}) \text{ x P x } (A_I \text{ x } 34.6 + A_P \text{ x } 0.54)$$

Where:

> BMP efficiency = 0.81

P = 30 inches (Table 3-3, Bexar County)
A_I = 4 acres (40% of 10 acre site)
A_P = 6 acres (60% of the site)

Consequently:

$$L_R = (0.81) \times 30 \times (4 \times 34.6 + 6 \times 0.54) = 3442 \text{ lbs}$$

The next step is to calculate the fraction of the annual rainfall that must be treated to achieve the required 80% reduction from:

$$F = L/L_R$$

Where:

F = Fraction of the annual rainfall treated by the BMP
L_R = Load removed from Step 3 calculation (3442 lbs)
L = Required load reduction from Step 1 (3264 lbs)

Consequently:

$$F = 3264/3442 = 0.95$$

From Table 3-5, one can see that 0.95 corresponds to a rainfall depth of 2.60 inches. Next, the runoff coefficient for the site must be calculated using the information presented in Figure 3-12 and Equation 3.11.

$$Rv = 1.72(0.4)^3 - 1.97(0.4)^2 + 1.23(0.4) + 0.02 = 0.31$$

These values are used to calculate the water quality volume (WQV) by:

$$\text{WQV} = \text{Rainfall depth} \times \text{Runoff Coefficient} \times \text{Area} = (2.60/12) \times 0.31 \times (10 \times 43560)$$

$$= 29{,}257 \text{ ft}^3$$

Therefore, the extended detention basin must be sized to capture 29,257 ft^3 of runoff, while the swale is sized based on treating a rainfall intensity of 1.1 inches/hour.

6.3.4 Wet Basins and Constructed Wetlands

Assume that a pond is the BMP selected for treatment of the stormwater runoff. The potential load reduction is:

$$L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$$

Where:

BMP efficiency = 0.93
P = 30 inches (Table 3-3, Bexar County)
A_I = 4 acres (40% of 10 acre site)
A_P = 6 acres (60% of the site)

Consequently:

$$L_R = (0.93) \times 30 \times (4 \times 34.6 + 6 \times 0.54) = 3950 \text{ lbs}$$

The next step is to calculate the fraction of the annual rainfall that must be treated to achieve the required 80% reduction from:

$$F = L/L_R$$

Where:

F = Fraction of the annual rainfall treated by the BMP
L_R = Load removed from Step 3 calculation (3950 lbs)
L = Required load reduction from Step 1 (3264 lbs)

Consequently:

$$F = 3264/3950 = .83$$

From Table 3-5, one can see that 0.83 corresponds to a rainfall depth of 1.20 inches. Next, the runoff coefficient for the site must be calculated using the information presented in Figure 3-12 and Equation 3.11.

$$Rv = 1.72(0.4)^3 - 1.97(0.4)^2 + 1.23(0.4) + 0.02 = 0.31$$

These values are used to calculate the water quality volume (WQV) by:

$$WQV = \text{Rainfall depth} \times \text{Runoff Coefficient} \times \text{Area} = (1.20/12) \times 0.31 \times (10 \times 43560)$$

$$= 13{,}504 \text{ ft}^3$$

Therefore, the pond must be sized to capture 13,504 ft^3 of runoff.