Runoff Loadings

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BMPFast

ERD
Water Quality Engineering

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

University of Central Florida

Methodology is Based on the Concentration-Based Method

Annual Loading =
Runoff Concentration x Annual Runoff Volume for Each Land Use

Land Use	Total P Conc. (mg/L)		Runoff Volume (ac-ft/yr)		Total P Mass (kg/yr)
Single Family	0.30	x	120	=	44.4
Low Intensity Commercial	0.15	x	160	=	29.6
Industrial	0.31	x	64	=	24.5
Totals			344		98.5

Calculation of Pollutant Loadings

Annual Loading = emc conc. x annual runoff volume

Load (kg/yr) =

$$\frac{\sum_{i=1}^{n}}{} \left[(A_i) \times \frac{43{,}560 \ ft^2}{acre} \times R \times CV_i \times \frac{1 \ ft}{12 \ inches} \times \frac{7.48 \ gal}{ft^3} \times \frac{3.785 \ liter}{gal} \times C_i \times \frac{1 \ kg}{10^6 \ mg} \right]$$

where:

- A_i = area of land use category, $_i$ (acres)
- n = number of different land use categories
- C_i = concentration of runoff constituent in land use category, $_i$ (mg/l)
- R = annual rainfall at site (inches/yr)
- CV_i = ROC value for land use category, $_i$ (dimensionless)

Example Calculation

1. Land Use: 90 acres of single-family residential
   5 acres of stormwater management systems
   5 acres of preserved wetlands

2. Ground Cover/Soil Types

   A. Residential areas will be covered with lawns in good condition
   B. Soil types in HSG D

3. Impervious/DCIA Areas

   A. Residential areas will be 25% impervious, 75% of which is DCIA

      Impervious Area = 25% of developed site = 90 ac x 0.25 = 22.50 acres

      DCIA Area = 22.50 acres x 0.75 = 16.88 acres

      % DCIA = (16.88 ac/90.0 ac) x 100 = 18.7% of developed area

Example Calculations – cont.

4. Post Development Annual Runoff Generation

- The post development loading reflects the loading discharging to the stormwater management system from the watershed
- Does not include the area of the treatment system
- The wetland area is not included since it is the same under pre and post conditions

Project Location	Area (acres)	Impervious Areas		DCIA		Non-DCIA CN Value	Annual Rainfall (in)	Annual ROC Value	Runoff (ac-ft/yr)
		%	acres	acres	%				
Pensacola	90	25	22.5	16.68	18.75	81.4	65.5	0.304	149.3
Orlando	90	25	22.5	16.68	18.75	81.4	50.0	0.253	94.8
Key West	90	25	22.5	16.68	18.75	81.4	40.0	0.266	79.8

Example Calculations – cont.

5. Generated Loading to Stormwater Pond:

Assume mean emc values for total nitrogen and total phosphorus in single-family residential runoff of:

TN = 1.87 mg/l TP = 0.301 mg/l

Example Calculations – cont.

5. Generated Loading to Stormwater Pond:

a. Pensacola (Zone 1) Project

TN load from single-family area:

$$\frac{149.3 \text{ ac-ft}}{\text{yr}} \times \frac{43{,}560 \text{ ft}^2}{\text{ac}} \times \frac{7.48 \text{ gal}}{\text{ft}^3} \times \frac{3.785 \text{ liter}}{\text{gal}} \times \frac{1.87 \text{ mg}}{\text{Liter}} \times \frac{1 \text{ kg}}{10^6 \text{ mg}} = \frac{344 \text{ kg}}{\text{TN/yr}}$$

TP load from single-family area:

$$\frac{149.3 \text{ ac-ft}}{\text{yr}} \times \frac{43{,}560 \text{ ft}^2}{\text{ac}} \times \frac{7.48 \text{ gal}}{\text{ft}^3} \times \frac{3.785 \text{ liter}}{\text{gal}} \times \frac{0.301 \text{ mg}}{\text{liter}} \times \frac{1 \text{ kg}}{10^6 \text{ mg}} = 55.4 \text{ kg TP/yr}$$

Location	TN Loading (kg/yr)	TP Loading (kg/yr)
Pensacola	344	55.4
Orlando	219	35.2
Key West	184	29.6

Example Calculations – cont.

6. Pre-Development Runoff and Mass Loadings:

- The pre-development area for calculating loadings is 95 acres (100 acres – 5 acres of preserved wetlands)

- The natural vegetation on the area to be developed (95 acres) consists of 60% mesic flatwoods and 40% wet flatwoods in fair condition on HSG D soils.

- From TR-55, the CN value for wooded areas in fair condition on HSG D soils = 79

Project Location	Area (acres)	Impervious Areas		DCIA		Non-DCIA CN Value	Annual Rainfall (in)	Annual C Value	Runoff (ac-ft/yr)
		acres	%	acres	%				
Pensacola	95	0	0	0	0	79	65.5	0.154	79.9
Orlando	95	0	0	0	0	79	50.0	0.105	41.6
Key West	95	0	0	0	0	79	40.0	0.125	39.6

Example Calculations – cont.

6. Pre-Development Runoff and Mass Loadings – cont.

- Composite runoff concentrations should be calculated on a weighted basis based on annual runoff volumes

- Since the CN values for the 2 land covers are the same, the annual runoff volumes are also the same

- Mean emc values for total nitrogen and total phosphorus under pre-development conditions:

Land Cover	Percent Cover (%)	Runoff emc Values (mg/L)		Weighted emc Values (mg/L)	
		Total N	Total P	Total N	Total P
Mesic flatwoods	60	1.000	0.034	1.070	0.026
Wet flatwoods	40	1.175	0.015		

Example Calculations – cont.

6. Pre-Development Runoff and Mass Loadings – cont.

a. Pensacola (Zone 1) Project

TN load from pre-developed areas:

$$\frac{79.9\ \text{ac-ft}}{\text{yr}} \times \frac{43{,}560\ \text{ft}^2}{\text{ac}} \times \frac{7.48\ \text{gal}}{\text{ft}^3} \times \frac{3.785\ \text{liter}}{\text{gal}} \times \frac{1.07\ \text{mg}}{\text{liter}} \times \frac{1\ \text{kg}}{10^6\ \text{mg}} = 105.4\ \text{kg TN/yr}$$

TP load from pre-developed areas:

$$\frac{79.9\ \text{ac-ft}}{\text{yr}} \times \frac{43{,}560\ \text{ft}^2}{\text{ac}} \times \frac{7.48\ \text{gal}}{\text{ft}^3} \times \frac{3.785\ \text{liter}}{\text{gal}} \times \frac{0.026\ \text{mg}}{\text{liter}} \times \frac{1\ \text{kg}}{10^6\ \text{mg}} = 2.56\ \text{kg TP/yr}$$

Location	TN Loading (kg/yr)	TP Loading (kg/yr)
Pensacola	105.4	2.56
Orlando	54.9	1.33
Key West	52.3	1.27

Example Calculations – cont.

7. Calculate required removal efficiencies to achieve post ≤ pre-loadings:

Summary of pre- and post-loadings and required removal efficiencies

Project Location	Total Nitrogen			Total Phosphorus		
	Pre-Load (kg/yr)	Post-Load (kg/yr)	Required Removal (%)	Pre-Load (kg/yr)	Post-Load (kg/yr)	Required Removal (%)
Pensacola (Zone 1)	105.4	344	69.3	2.56	55.4	95.4
Orlando (Zone 2)	54.9	219	74.9	1.33	35.2	96.2
Key West (Zone 3)	52.3	184	71.6	1.27	29.6	95.7

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