NUTRIENT CALCULATIONS

Aaron Ray

SECTION 8

PERFORMANCE CRITERIA

Two-pronged approach.

Evaluation of the greater nutrient load reduction criteria.

Percent reduction.

- Percent reduction would be used for most sites that are non-natural land.
- Percent reduction will usually result in a nutrient loading much less than the average loading on the site at the time of the application.

OR

Post ≤ pre.

- Post ≤ pre would not result in the greater load reduction in most cases relating to land that has been previously developed.
- Post ≤ pre is most often used when the predevelopment condition is that of natural land.

The two-prong system is based choosing the prong that causes the greater load reduction. You cannot choose post ≤ pre on a site that is already developed if a percent reduction would be more protective.

SECTION 8

PERFORMANCE CRITERIA

Two-pronged approach when percent reduction would be used.

Predevelopment condition: residential nutrient loading =

25 total phosphorus (TP).

Post development condition: highway nutrient loading = 20 TP.

Percent reduction.

- Final nutrient loading would be required to use the 80% reduction = 4 TP.

Two-pronged approach when post ≤ pre would be used.

Predevelopment condition: natural land, nutrient loading =

3 TP.

Post development condition: highway nutrient loading = 20 TP.

Percent reduction.

- Final nutrient loading would be required to use the pre ≤ post criteria ≤ 3 TP.

TREATMENT STANDARDS

SUMMARY OF SECTION 8.3, APPLICANT'S HANDBOOK VOLUME I

Project Scenario	TP	TN	Additional Criteria
All sites	80	55	Or post ≤ pre
OFW	90	80	Or post ≤ pre
Impaired water	80	80	And post ≤ pre plus net improvement
Impaired + OFW	95	95	And post ≤ pre plus net improvement
Redevelopment	80	45	N/A
Redevelopment + OFW	90	60	N/A
Redevelopment + impaired	80	45	And net improvement for the pollutant of concern

TP = Total Phosphorus TN = Total nitrogen
OFW = Outstanding Florida Waters

EXAMPLE PROBLEM

IMPAIRED SITES: POST ≤ PRE FOR TN

Method:

- Calculate post-development TN load.
- Calculate pre-development TN load.
- Calculate required treatment efficiency to meet post=pre.

Load = area x annual rainfall x (annual runoff “ROC”) x (EMC*).

NEED TO FIND THIS **AND THIS**

*EMC = event mean concentration (mg/L).

EXAMPLE PROBLEM

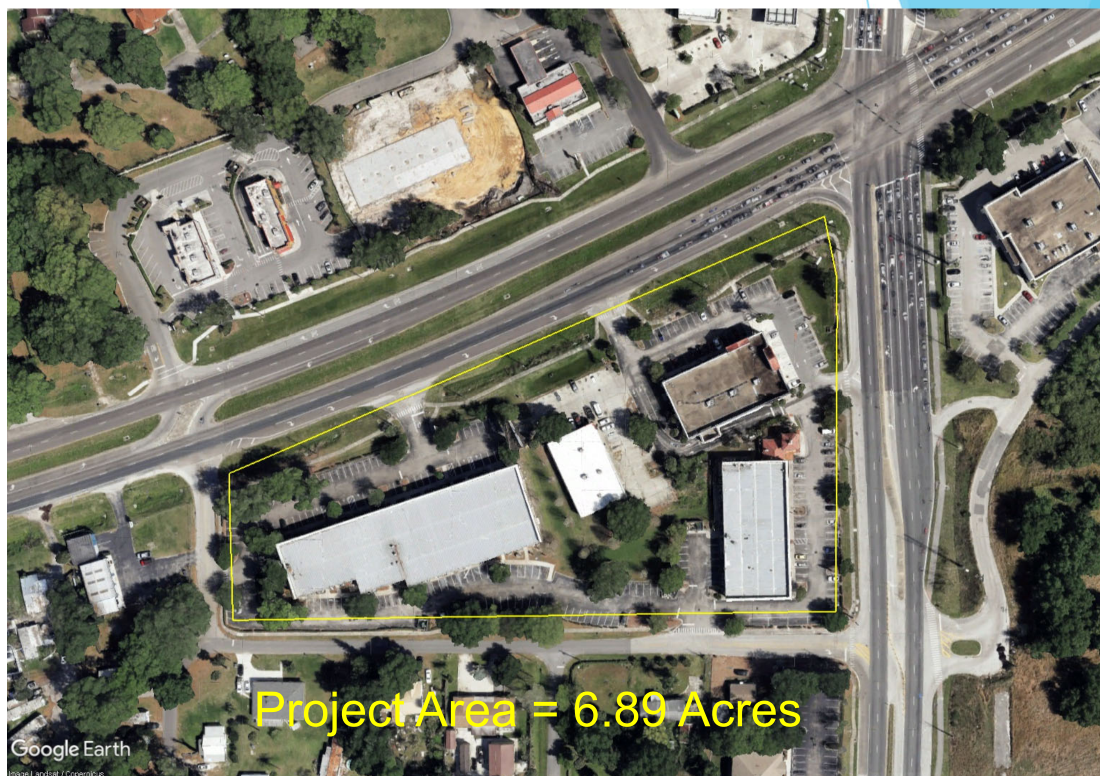
PROJECT INFO

Pre-Development CN

Low/Med Intensity Comm. — Existing Landuse:

Post-Development CN

High Intensity Comm. — Proposed Landuse



DETERMINING RUNOFF COEFFICIENT

C AND CN

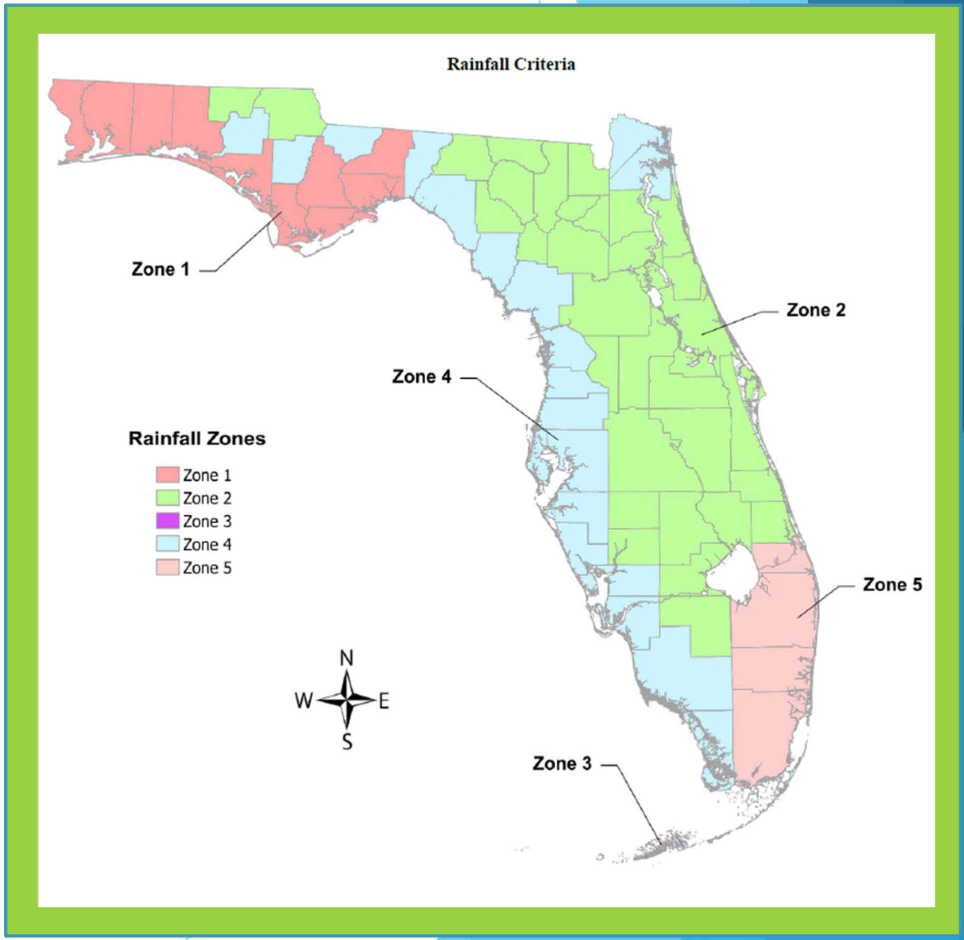
- **Runoff coefficient for small watersheds (C) (C factor x total rainfall = runoff).**
  - C values from various published papers.
  - This method is prone to errors but can be used for quick analyses.

- **Natural Resources Conservation Services (NRCS) runoff curve number (CN) method (see NRCS Technical Release 55).**
  - Developed by Victor Mockus; based on soil type and empirical data.
  - Curve number method predicts total runoff.
  - Curve number or CN is used for flood routing and is inherently different then the Runoff C or ROC.
  - Curve number represents soil and surface storage, strictly a function of the following.
    - Soil type and associated hydrologic soil group (HSG) from soil survey data, ranging from “A” to “D” reflecting infiltration rates (highest to lowest).
    - Cover crop and land use/treatment.
    - Hydrologic condition (poor, fair and good).
    - Antecedent moisture conditions (AMC) I, II and III.

DETERMINING RUNOFF COEFFICIENT

ROC VALUE

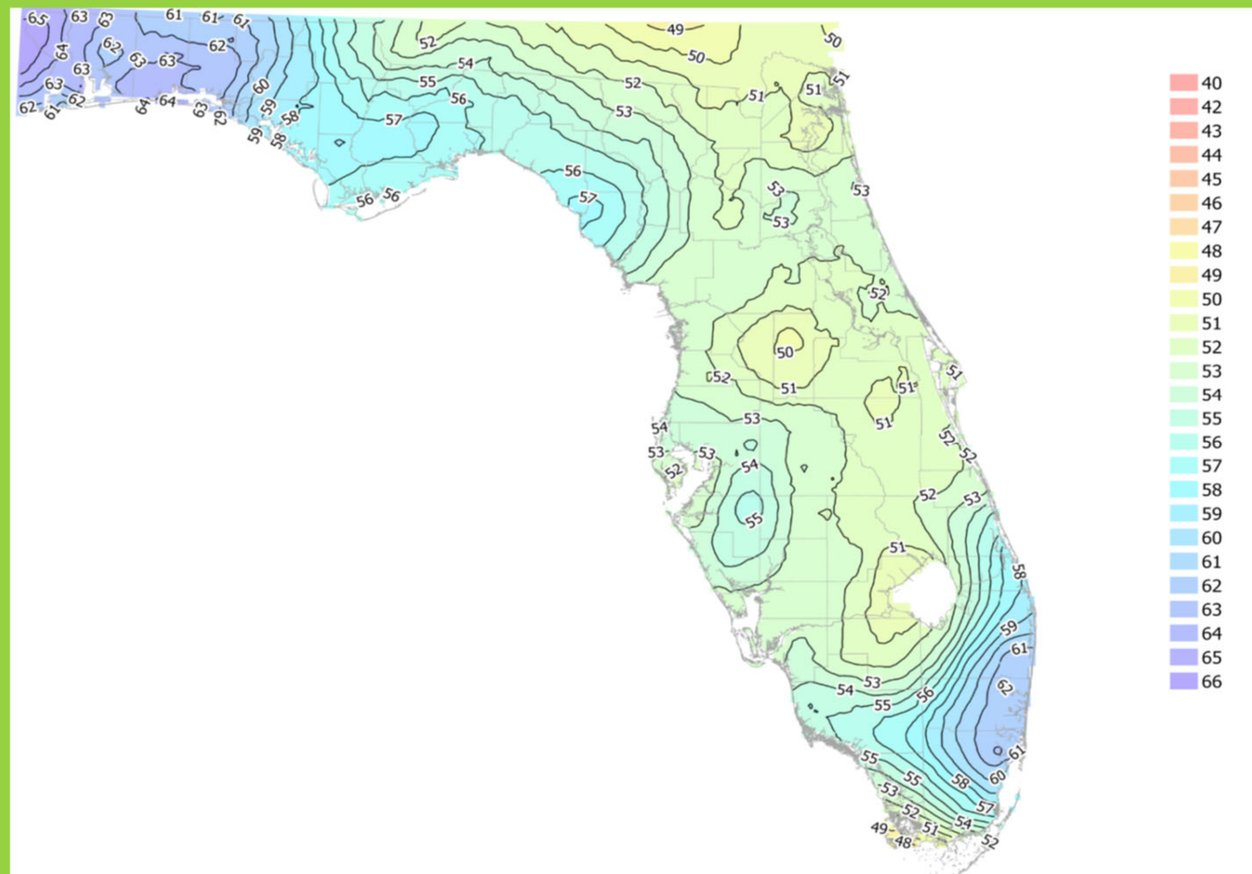
- New rule uses Harper's mean annual runoff coefficient (ROC) (Harper, 2007).
  - Incorporates both CN and directly connected impervious area (DCIA) to generate a more accurate runoff coefficient.
  - Used primarily for determining annual volumes for water quality calculations.
  - Tables available in Appendix N.
- These are separated by meteorological zone.
  - There are five meteorological zones in Florida.
  - Based on the intensity and frequency of rainfall events in different locations.
  - This map is available in Appendix M.



DETERMINING RUNOFF VOLUME

RAINFALL

- To determine the total annual runoff volume, multiply the runoff coefficient with the total annual rainfall.
- Rainfall data from National Centers for Environmental Information.
- Isopleth map available in Appendix M.



EVENT MEAN CONCENTRATION

- To find the annual pollutant loading, multiply the runoff volume with the concentration of the pollutant.
- Concentration is determined by the EMC and is based on the land use type.
- Table 9.2 in Applicant's Handbook Volume I includes the most up-to-date accepted EMC values.
- Other EMCs can be used if properly derived from regional studies.
  - Must demonstrate alternatives are appropriate.

Land Use Category	Total N (mg/l)	Total P (mg/l)
Low Density Residential	1.65	0.270
Single Family	1.77	0.327
Multi-Family	1.84	0.520
Low Intensity Commercial	0.93	0.19
High Intensity Commercial	2.40	0.345
Light Industrial	1.20	0.260
Highway	1.25	0.173
Dry Prairie	2.025	0.184
Marl Prairie	0.684	0.012
Mesic Flatwoods	1.087	0.043
Ruderal/Upland Pine	1.694	0.162
Scrubby Flatwoods	1.155	0.027
Upland Hardwood	1.042	0.346
Upland Mixed Forest	0.606	1.166
Wet Flatwoods	1.213	0.21
Wet Prairie	1.095	0.015
Xeric Scrub	1.596	0.156
Rangeland/parkland	1.150	0.055
General Agricultural	2.29	0.381
Pasture	3.03	0.593
Citrus	2.11	0.180
Row Crops	2.50	0.577

EXAMPLE PROCESS

PROJECT SITE CHARACTERISTICS & HYDROLOGY

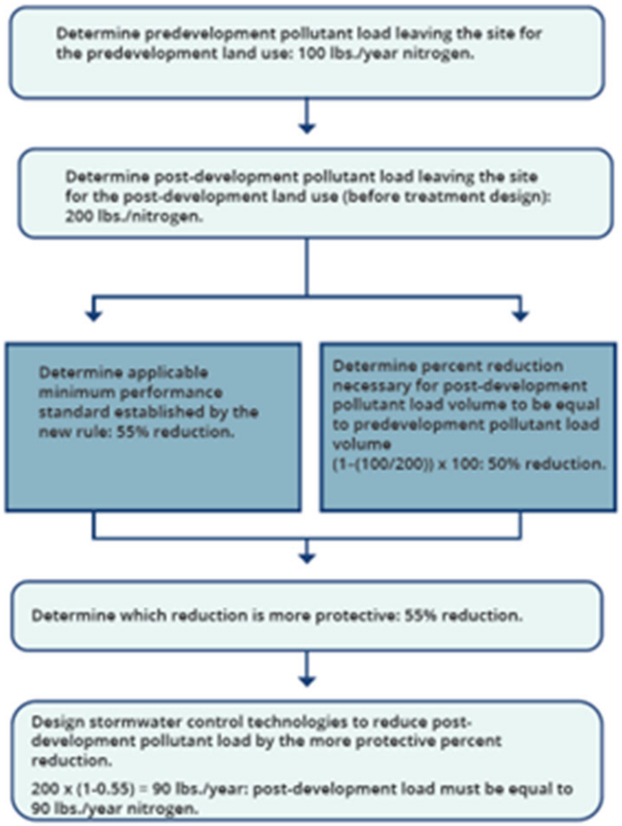


Image Source: FDEP ERP Stormwater Resource Center

- Desktop Review
  - Survey/Property Appraisers Info
  - NRCS Web Soil Survey
  - GIS Map – FDEP's ERP Stormwater Resource Center "HUC12 Boundaries with Impaired Waters and OFWs"
  - GIS Map – FDEPMapDirect "National Hydrography Dataset Map"
  - Land Cover Land Use (WMD data confirmed by onsite investigations)
  - Previously permitted under Chapter 373, F.S.

TREATMENT STANDARDS EXAMPLE

- In a Hydrologic Unit Code (HUC) 12 with an impaired water.
  - Shingle Creek, (030901010302), Impaired Parameter: Nutrients.
  - 8.3.4 - Minimum Performance Standards for Impaired Waters.
- Rule requires greater of the following two options:
  - 80% TP removal and 80% TN removal.
    AND
  - Post-development load ≤ pre-development load for TN and TP.
    AND
  - Post-development impaired parameter ≤ pre-development impaired parameter.

CALCULATE PRE-DEVELOPMENT

SITE CONDITIONS

- 6.89-acre parcel.
- Predeveloped condition = Low Intensity Commercial
- Assumed 65% DCIA.
- Assumed Soils CN of 80.
- Location is Kissimmee.
  - Meteorological Zone 2.
  - Annual rainfall is 52 inches.
  - Source: Appendix M, Applicant's Handbook I.

MEAN ANNUAL ROC VALUE

PRE-DEVELOPMENT

ZONE 2

Mean Annual Runoff Coefficients (ROC Value) as a Function of DCIA Percentage and Non-DCIA Curve Number

NDCIA CN	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
	0.002	0.043	0.083	0.123	0.164	0.204	0.244	0.285	0.325	0.366	0.406	0.446	0.487	0.527	0.567	0.608	0.648	0.688	0.729	0.769	0.809
35	0.004	0.044	0.085	0.125	0.165	0.205	0.246	0.286	0.326	0.366	0.407	0.447	0.487	0.528	0.568	0.608	0.648	0.689	0.729	0.769	0.809
40	0.007	0.047	0.087	0.127	0.167	0.207	0.248	0.288	0.328	0.368	0.408	0.448	0.488	0.528	0.569	0.609	0.649	0.689	0.729	0.769	0.809
45	0.010	0.050	0.090	0.130	0.170	0.210	0.250	0.290	0.330	0.370	0.410	0.450	0.490	0.530	0.570	0.610	0.650	0.690	0.729	0.769	0.809
50	0.015	0.055	0.095	0.134	0.174	0.214	0.254	0.293	0.333	0.373	0.412	0.452	0.492	0.531	0.571	0.611	0.651	0.690	0.730	0.770	0.809
55	0.022	0.061	0.101	0.140	0.179	0.219	0.258	0.298	0.337	0.376	0.416	0.455	0.494	0.534	0.573	0.613	0.652	0.691	0.731	0.770	0.809
60	0.030	0.069	0.108	0.147	0.186	0.225	0.264	0.303	0.342	0.381	0.420	0.459	0.498	0.537	0.576	0.615	0.654	0.693	0.731	0.770	0.809
65	0.042	0.080	0.119	0.157	0.195	0.234	0.272	0.311	0.349	0.387	0.426	0.464	0.502	0.541	0.579	0.618	0.656	0.694	0.733	0.771	0.809
70	0.057	0.095	0.133	0.170	0.208	0.245	0.283	0.321	0.358	0.396	0.433	0.471	0.509	0.546	0.584	0.621	0.659	0.697	0.734	0.772	0.809
75	0.079	0.116	0.152	0.189	0.225	0.262	0.298	0.335	0.371	0.408	0.444	0.481	0.517	0.554	0.590	0.627	0.663	0.700	0.736	0.773	0.809
80	0.111	0.146	0.181	0.216	0.251	0.285	0.320	0.355	0.390	0.425	0.460	0.495	0.530	0.565	0.600	0.635	0.670	0.705	0.740	0.774	0.809
85	0.160	0.192	0.225	0.257	0.290	0.322	0.355	0.387	0.420	0.452	0.485	0.517	0.550	0.582	0.614	0.647	0.679	0.712	0.744	0.777	0.809
90	0.242	0.270	0.299	0.327	0.355	0.384	0.412	0.440	0.469	0.497	0.526	0.554	0.582	0.611	0.639	0.667	0.696	0.724	0.753	0.781	0.809
95	0.404	0.424	0.444	0.464	0.485	0.505	0.525	0.546	0.566	0.586	0.606	0.627	0.647	0.667	0.688	0.708	0.728	0.749	0.769	0.789	0.809
98	0.595	0.605	0.616	0.627	0.638	0.648	0.659	0.670	0.680	0.691	0.702	0.713	0.723	0.734	0.745	0.756	0.766	0.777	0.788	0.799	0.809

Source: Appendix N, Applicant's Handbook I.

Percent DCIA = 65%   Non-DCIA CN = 80

Annual runoff C value = 0.565

EXAMPLE PROBLEM: SELECT EMC

PRE-DEVELOPMENT

Table 9.2 Standardized Statewide Stormwater Nutrient EMC Values

Land Use Category	Total N (mg/l)	Total P (mg/l)
Low Density Residential	1.65	0.270
Single Family	1.77	0.327
Multi-Family	1.84	0.520
Low Intensity Commercial	0.93	0.19
High Intensity Commercial	2.40	0.345
Light Industrial	1.20	0.260
Highway	1.25	0.173
Dry Prairie	2.025	0.184
Marl Prairie	0.684	0.012

Source: Table 9.2, Applicant's Handbook I.

Units for EMCs: (mg/L)

EMC for TN = 0.93 mg/L

CALCULATE PRE-DEVELOPMENT

EQUATION

Pre-development TN load = 6.89 acres x **annual runoff C** x 52 x **EMC**

Load (kg/yr) = 6.89 acres x 0.565 x 52 inches/year x 0.93 mg/L x 1.23 =

ROC ***EMC*** ***Conversion Factor***

Pre-development TN load = 231.6 kg per year.

CALCULATE POST DEVELOPMENT LOAD

SITE CONDITIONS

- 6.89-acre parcel.
- Predeveloped condition = Low Intensity Commercial
- Designed 70% DCIA.
- Assumed Soils CN of 80.
- Location is Kissimmee.
  - Meteorological Zone 2.
  - Annual rainfall is 52 inches.
  - Source: Appendix M, Applicant's Handbook I.

MEAN ANNUAL RUNOFF C

POST-DEVELOPMENT

ZONE 2

Mean Annual Runoff Coefficients (ROC Value) as a Function of DCIA Percentage and Non-DCIA Curve Number

NDCIA CN	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
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85	0.160	0.192	0.225	0.257	0.290	0.322	0.355	0.387	0.420	0.452	0.485	0.517	0.550	0.582	0.614	0.647	0.679	0.712	0.744	0.777	0.809
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Source: Appendix N, Applicant's Handbook I.

Percent DCIA = 70%   Non-DCIA CN = 80

Annual runoff C value = 0.600

EXAMPLE PROBLEM: SELECT EMC

POST-DEVELOPMENT

Table 9.2 Standardized Statewide Stormwater Nutrient EMC Values

Land Use Category	Total N (mg/l)	Total P (mg/l)
Low Density Residential	1.65	0.270
Single Family	1.77	0.327
Multi-Family	1.84	0.520
Low Intensity Commercial	0.93	0.19
High Intensity Commercial	2.40	0.345
Light Industrial	1.20	0.260
Highway	1.25	0.173
Dry Prairie	2.025	0.184
Marl Prairie	0.684	0.012

Source: Table 9.2, Applicant's Handbook I.

Units for EMCs: (mg/L)

EMC for TN = 2.40 mg/L

CALCULATE POST-DEVELOPMENT LOAD

EQUATION

Post-development TN load = 6.89 acres x **annual runoff C** x 52 x **EMC**

Load (kg/yr) = 6.89 acres x 0.600 x 52 inches/year x 2.40 mg/L x 1.23 =

Runoff C **EMC**

Conversion Factor

Post-development TN load = 634.6 kg per year.

EXAMPLE

REQUIRED TN TREATMENT EFFICIENCY

- Pre-development TN loading = 231.6 kg/yr.
- Establish target removal efficiency if post TN = 705.4 kg/yr.

$$\left(1-\left(\frac{Predevelopment\ Loading\ [kg/yr]}{Postdevelopment\ Loading\ [kg/yr]}\right)\right)\times 100$$

Target TN removal efficiency = (1- (231.6/634.6)) x 100 = 63.5%.

CONTROLLING OPTION PER RULE

- TN standard for “Impaired Waters” is 80%, post ≤ pre, **and** post pollutant ≤ pre pollutant.
- In this case, post ≤ pre yields 63.5% removal efficiency for TN. 80% TN governs.
- Shingle Creek Impaired parameter = Nutrients. TN & TP post ≤ pre acceptable.

EXAMPLE

MEETING 69% REMOVAL WITH DRY RETENTION

Mean Annual Mass Removal Efficiencies for 1.50-inches of Retention for Zone 1

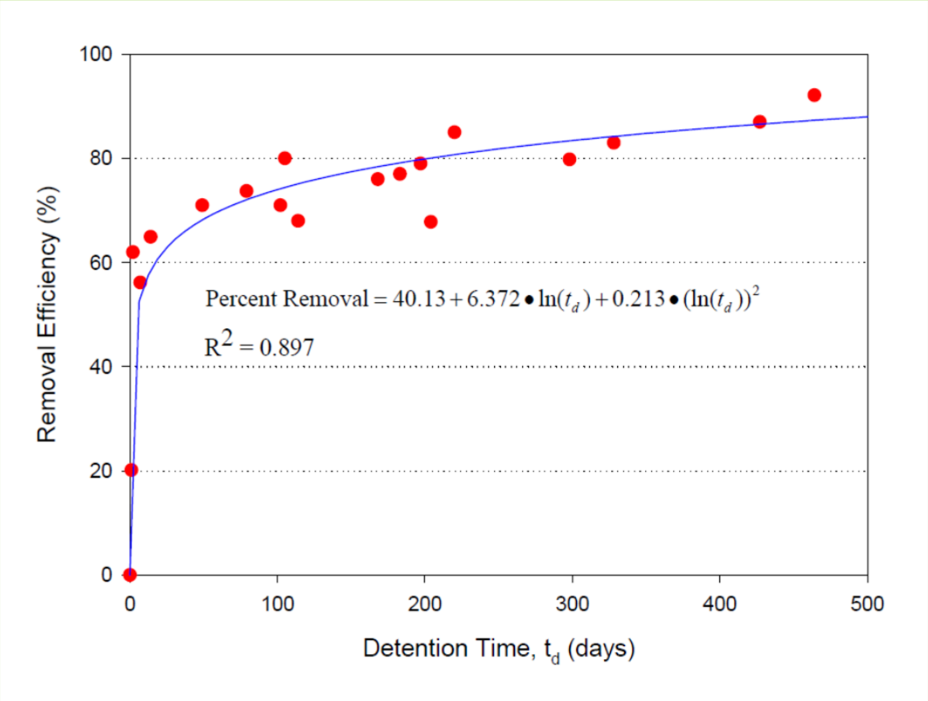
Non DCIA CN	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
30	96.8	97.8	98.0	97.5	96.5	95.3	94.0	92.5	90.9	89.3	87.7	86.0	84.3	82.7	81.0	79.3	77.7	76.1	74.6	73.1
35	95.5	96.9	97.1	96.7	95.8	94.7	93.5	92.1	90.6	89.0	87.4	85.8	84.1	82.5	80.9	79.3	77.7	76.1	74.6	73.1
40	93.9	95.6	96.0	95.7	95.0	94.0	92.8	91.5	90.1	88.6	87.1	85.5	83.9	82.3	80.7	79.2	77.6	76.1	74.6	73.1
45	92.1	94.2	94.7	94.5	93.9	93.1	92.0	90.8	89.5	88.1	86.6	85.1	83.6	82.1	80.6	79.0	77.5	76.0	74.5	73.1
50	90.3	92.5	93.1	93.1	92.7	92.0	91.1	90.0	88.8	87.5	86.1	84.7	83.3	81.8	80.3	78.9	77.4	75.9	74.5	73.1
55	88.2	90.5	91.3	91.4	91.2	90.7	89.9	89.0	87.9	86.8	85.5	84.2	82.8	81.5	80.1	78.6	77.2	75.8	74.4	73.1
60	85.9	88.3	89.3	89.6	89.6	89.2	88.6	87.8	86.9	85.9	84.7	83.5	82.3	81.0	79.7	78.4	77.0	75.7	74.4	73.1
65	83.5	86.0	87.2	87.7	87.7	87.5	87.0	86.4	85.7	84.8	83.8	82.8	81.7	80.5	79.3	78.1	76.8	75.6	74.3	73.1
70	81.4	83.7	85.0	85.5	85.7	85.6	85.3	84.8	84.2	83.5	82.7	81.8	80.9	79.9	78.8	77.7	76.5	75.4	74.2	73.1
75	79.4	81.4	82.5	83.2	83.5	83.5	83.3	83.0	82.6	82.1	81.4	80.7	79.9	79.1	78.1	77.2	76.2	75.2	74.1	73.1
80	77.4	79.1	80.1	80.8	81.1	81.2	81.2	81.0	80.8	80.4	79.9	79.4	78.8	78.1	77.3	76.5	75.7	74.9	74.0	73.1
85	75.7	76.9	77.7	78.3	78.6	78.8	78.9	78.9	78.7	78.5	78.2	77.8	77.4	76.9	76.3	75.8	75.1	74.5	73.8	73.1
90	74.2	74.9	75.4	75.9	76.2	76.4	76.5	76.5	76.5	76.4	76.3	76.1	75.8	75.5	75.2	74.8	74.4	74.0	73.6	73.1
95	73.1	73.3	73.6	73.8	73.9	74.0	74.1	74.2	74.2	74.2	74.2	74.2	74.1	74.0	73.9	73.8	73.6	73.5	73.3	73.1
98	73.1	73.1	73.2	73.2	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.2	73.2	73.2	73.1	73.1

Source: Appendix O, Applicant's Handbook I.

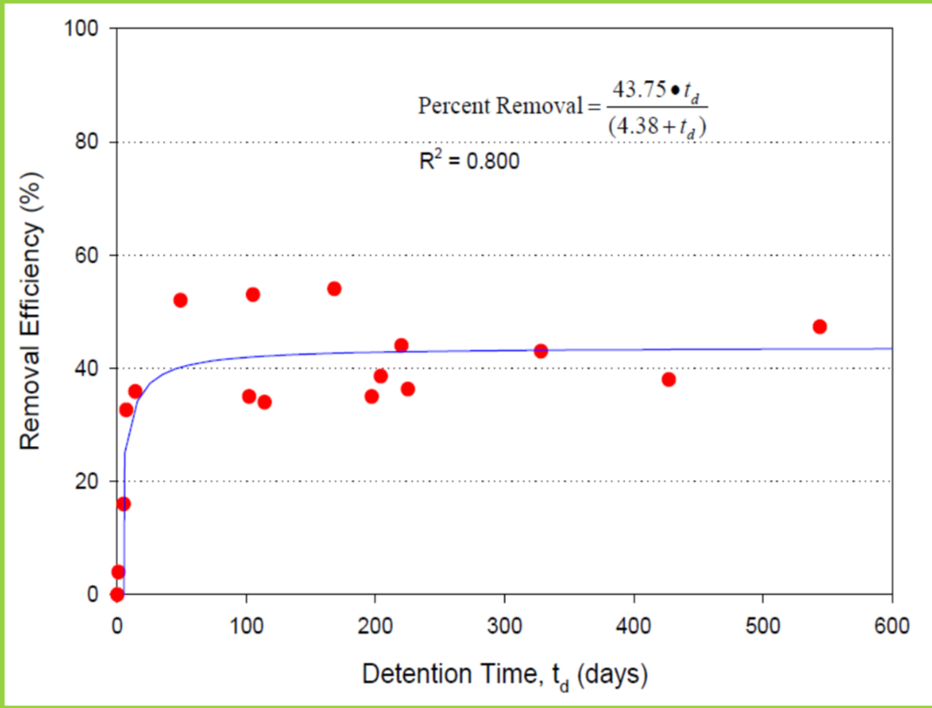
Dry retention not limited to "ponds" or single basins.

DETENTION

METHODS FOR ENHANCING REMOVAL EFFICIENCIES



Total Phosphorus



Total Nitrogen

WET POND ENHANCEMENT

WAYS TO INCREASE EFFICIENCY

- Several best management practices (BMPs) can be used in conjunction with wet ponds to increase treatment efficiencies.
  - Littoral zones (10% TN and TP for minimum coverage per Volume IIs).
  - Floating treatment wetlands (FTWs) provide 12% TN and TP for 5% coverage.
  - Stormwater harvesting based on annual volume removed (credit based on site specific water balance).
- Focus on TN as limiting factor for most wet detention systems.
- Some specific BMPs act independently on the permanent pool and not in series.

These wet pond enhancements do not require any changes to final grading or pond geometry.

LITTORAL ZONES AND FTWS

Source: Solitude Lake Management.

Littoral Zone

10% TN removal credit

Source: Google Earth Pro.

FTW

12% TN removal credit

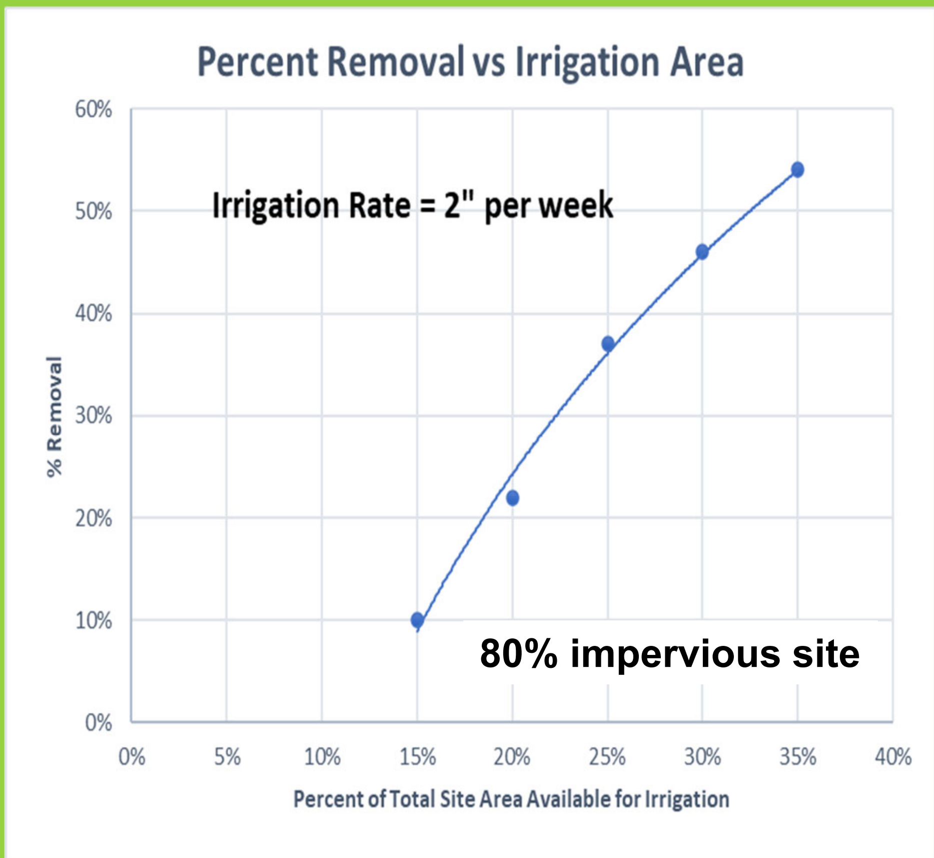
STORMWATER

REMOVAL EFFICIENCY

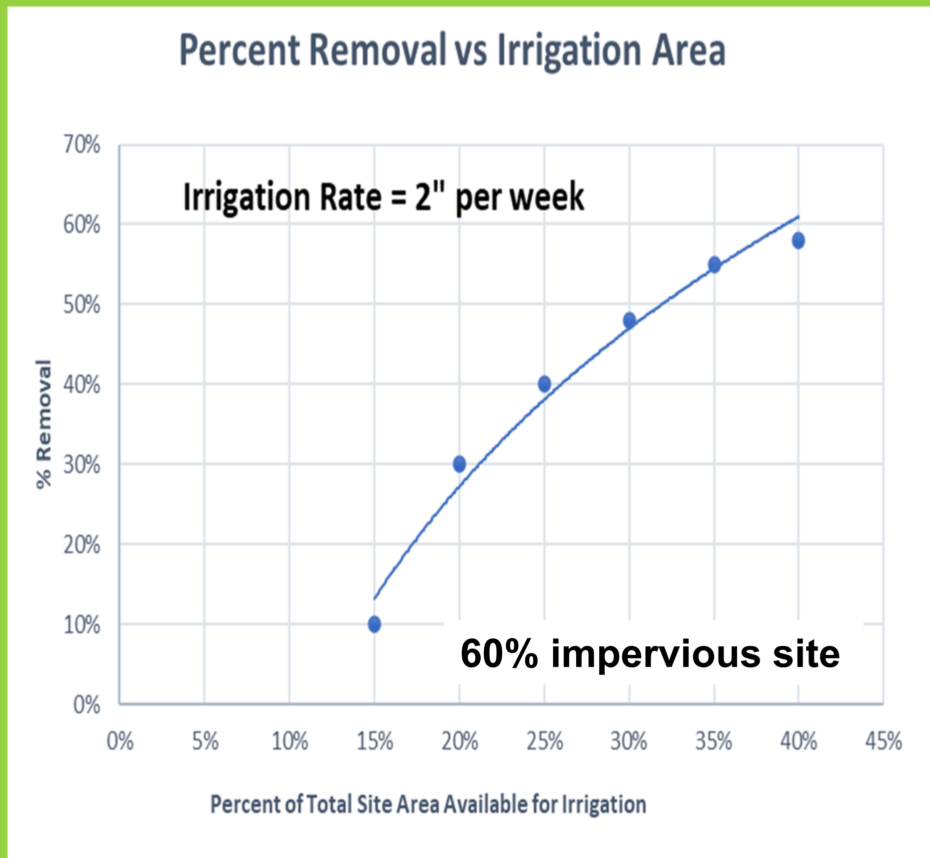
- Reduces annual discharge to surface waters and increases groundwater recharge.
- Efficiency (mass removal of water) is based on annual site runoff, storage, irrigable area and allowable irrigation rate.
- University of Central Florida performed a series of mass balance calculations resulting in plotted-curve solutions (R-E-V curves) relating to the following:
  - Irrigation rate (R).
  - Efficiency (percentage of runoff pumped for other uses) (E).
  - Harvestable volume (V).
- R-E-V curves allow use for any site since data based on **percentages** and is **scalable**.

Section 5.5, Northwest Florida Water Management District (NWFWMD) Applicant's Handbook Volume II, Design Aids, for detailed design methodology.

STORMWATER



Percent Removal vs Irrigation Area
Irrigation Rate = 2" per week
80% impervious site
% Removal
60%
50%
40%
30%
20%
10%
0%
0%
5%
10%
15%
20%
25%
30%
35%
40%
Percent of Total Site Area Available for Irrigation



Percent Removal vs Irrigation Area
Irrigation Rate = 2" per week
60% impervious site
% Removal
70%
60%
50%
40%
30%
20%
10%
0%
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
Percent of Total Site Area Available for Irrigation

GREEN

OVERVIEW

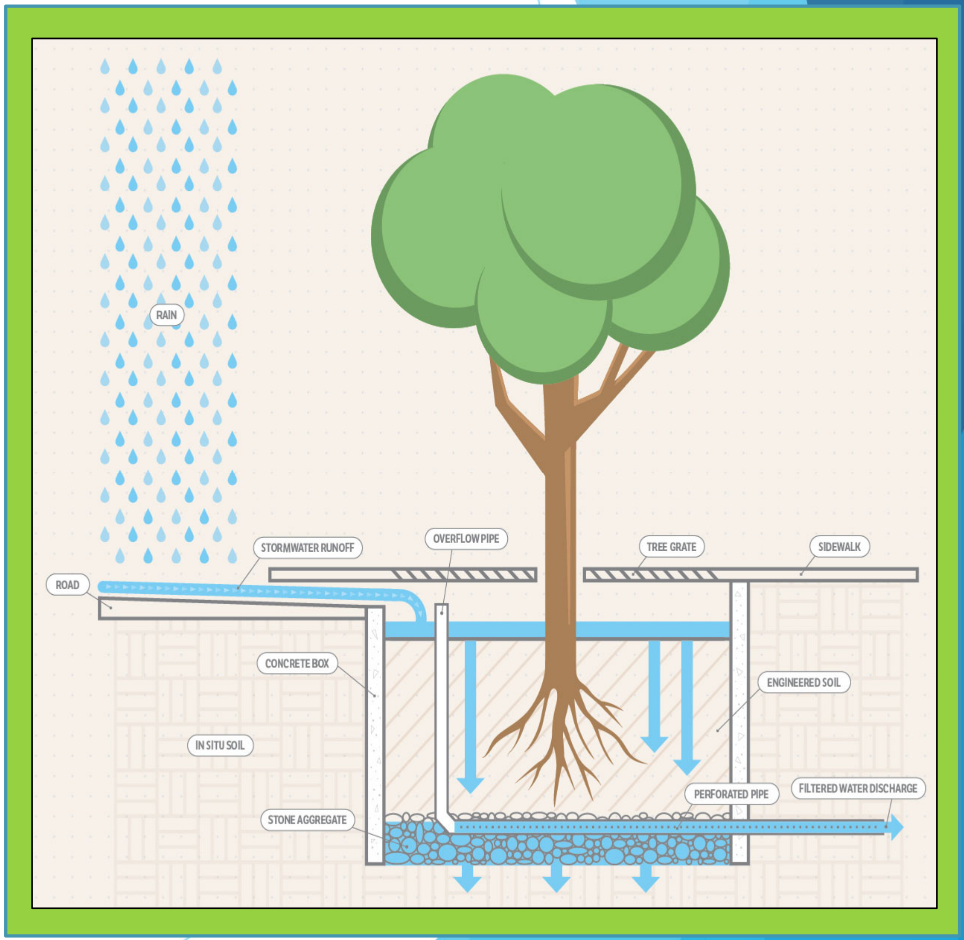
- Green stormwater infrastructure (GSI) = BMPs such as tree wells, raingardens, bio swales, green roofs, etc.
- As retention.
  - Nearly always calculated as a retention system.
  - Must be able to recover their volume within 72 hours.
  - Borings should not be required for every location of a GSI; a representative sample is sufficient.
  - These systems can add to the total volume of retention available on site providing more capacity and efficiency.
- To lower DCIA.
  - Treating GSI as a way to disconnect your impervious area, your DCIA will lower.
  - When calculating the volume of runoff generated and the efficiency of your final retention pond, the lower DCIA could create greater treatment efficiencies.

STRUCTURAL

INNOVATIVE RETENTION SYSTEMS

- Primarily for small catchments (micro-scale).
- Landscape-oriented retention basins and swales.
- Rain gardens.
- Curb cuts.
- Biofiltration systems.
- Rain barrels.
- Tree canopies.
- Pervious walkways.
- Pervious pavement.

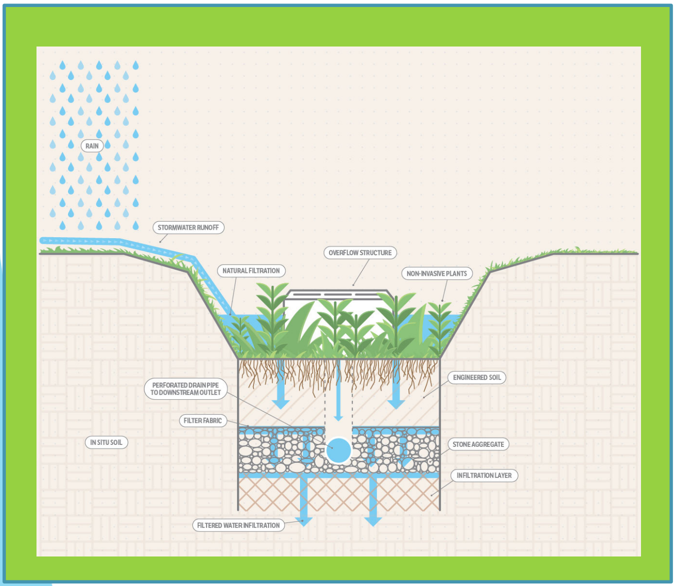
Cumulative storage may be credited to overall retention volume.

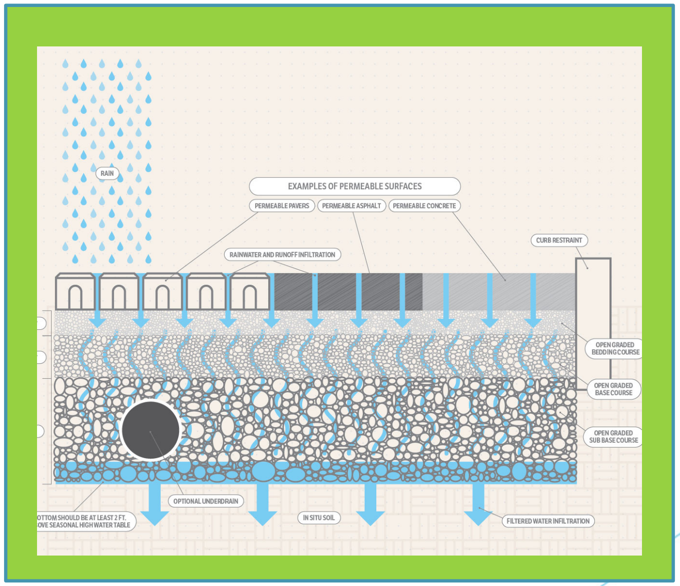


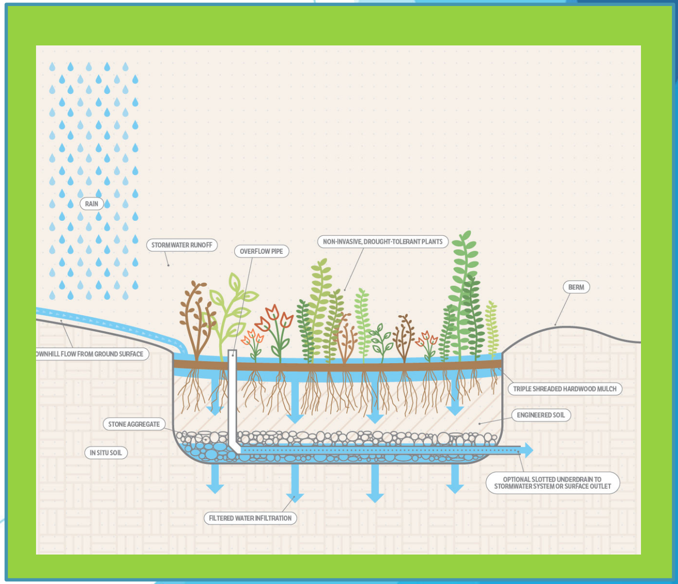
MICROSCALE

TREE BOXES, RAINGARDENS, CURB CUTS, PERVIOUS PAVERS, ETC

- Microscale depressions in the landscape provide retention volume.
- Can be used without trees and/or provide “open bottom” inlets; act as small retention basins.
- Cumulative volume may be significant (100 to 200 cubic feet per box, etc.).







BMP IN SERIES OR USED FOR NET IMPROVEMENT

AND OTHER SPECIFIC REDUCTION TARGETS

- Whenever one BMP does not provide sufficient treatment for a specific discharge goal, BMPs can be routed from one to another forming a “train”.
- BMPs within a “train” should function independently, each treatment system discharging to the BMP downstream and not adversely affecting the downstream BMP.

Swale

→

Dry retention pond

→

Wet detention pond

BMPS

BMP TREATMENT TRAIN

- It is expected that multiple BMPs will be needed on a site in order to reach the percent reductions required.
- Treatment train = BMPs implemented in combination or in conjunction with one another in a series.
- Where BMPs are used in series, the calculated overall efficiency of the treatment train must account for the reduced loading or concentrations that are available for removal by the subsequent downstream treatment device.
- Overall treatment train efficiency = 1-[(1 – Eff1) ×(1-Eff2)×(1-Eff3)× ... ×(1-Effn)].
  - Eff1 = efficiency (as a decimal) of initial treatment system.
  - Eff2 = efficiency (as a decimal) of second treatment system.
  - Eff3 = efficiency (as a decimal) of third treatment system.
  - Effn = efficiency (as a decimal) of the nth treatment system.

TREATMENT

ONLY USEFUL FOR CALCULATED BMP EFFICIENCIES

- Assume a dry retention system as pretreatment, that discharges to a wet detention pond; TP is pollutant of concern.
- Assume dry pond efficiency at 60%; wet pond efficiency at 45%.
  - Overall efficiency = 1 − [(1 – Eff1) × (1 − Eff)].
  - Overall efficiency = 1 − [(1 – 0.6) × (1 − 0.45)].
  - Overall efficiency = 78%.

MEETING NUTRIENT REMOVAL TARGETS

WET DETENTION EXAMPLES

- The following examples include meeting minimum nutrient targets for all sites, impaired waters, OFWs and impaired and OFW.
- The example site is a generic development.
  - 60% impervious.
  - Non-DCIA CN of 60.
  - Wet detention primary driver with a complementary suite of practices.
  - Uses current rule for permanent pool detention time (14 days/21 days).
  - Irrigable area 25% of site; maximum irrigation rate = 2.0 inches per week.

EXAMPLE FOR “ALL SITES”

Rule Target for "All Sites"					
TN=55 TP=80					
Wet Detention Detention = 14 days	**Wet Pond Removal Efficiency**	**Littoral Zone**	**FTWs**	**Stormwater Harvesting**	**Total Reduction**
Percent TN Removal	0.33	0	0	0	**0.33**
Percent TP Removal	0.58	0	0	0	**0.58**

EXAMPLE FOR "ALL SITES" (2)

Rule Target for "All Sites"					
TN=55 TP=80					
Wet Detention Detention = 14 days	**Wet Pond Removal Efficiency**	**Littoral Zone**	**FTWs**	**Stormwater Harvesting**	**Total Reduction**
Percent TN Removal	0.33	0.1	0	0	**0.40**
Percent TP Removal	0.58	0.1	0	0	**0.62**

Overall treatment efficiency =

E1 + (1-((1-E1)*(1-E2)*(1-E3))) + harvesting value.

EXAMPLE FOR "ALL SITES" (3)

Rule Target for "All Sites"					
TN=55 TP=80					
Wet Detention Detention = 14 days	Wet Pond Removal Efficiency	Littoral Zone	FTWs	Stormwater Harvesting	Total Reduction
Percent TN Removal	0.33	0.1	0.12	0	**0.47**
Percent TP Removal	0.58	0.1	0.12	0	**0.67**

Overall treatment efficiency =

E1 + (1-((1-E1)*(1-E2)*(1-E3))) + harvesting value.

EXAMPLE

Rule Target for "All Sites"					
TN=55 TP=80					
	Wet Pond			0.75" per week	
Wet Detention	Removal	Littoral		Stormwater	Total
Detention = 14 days	Efficiency	Zone	FTWs	Harvesting	Reduction
Percent TN Removal	0.33	0.1	0.12	0.15	**0.62**
Percent TP Removal	0.58	0.1	0.12	0.15	**0.82**

Overall treatment efficiency =

E1 + (1-((1-E1)*(1-E2)*(1-E3))) + harvesting value.

EXAMPLE FOR IMPAIRED WATERS

MINIMUM CRITERIA

Rule Target for Impaired Waters					
TN=80 TP=80					
	Wet Pond			**2" per week**	
Wet Detention	**Removal**	**Littoral**		**Stormwater**	**Total**
Detention = 14 days	**Efficiency**	**Zone**	**FTWs**	**Harvesting**	**Reduction**
Percent TN Removal	0.33	0.1	0	0.4	**0.80**
Percent TP Removal	0.58	0.1	0	0.4	**0.95+**

Overall treatment efficiency =

E1 + (1-((1-E1)*(1-E2)*(1-E3))) + harvesting value.

EXAMPLE

Rule Target for OFWs					
TN=80 TP=90					
	Wet Pond			1.7" per week	
Wet Detention	Removal	Littoral		Stormwater	Total
Detention = 21 days	Efficiency	Zone	FTWs	Harvesting	Reduction
Percent TN Removal	0.36	0.1	0.12	0.32	**0.81**
Percent TP Removal	0.62	0.1	0.12	0.32	**0.95+**

Overall treatment efficiency =

E1 + (1-((1-E1)*(1-E2)*(1-E3))) + harvesting value.

EXAMPLE

MINIMUM CRITERIA

Rule Target for Impaired & OFW					
TN=95 TP=95					
	Wet Pond			**2" per week**	
Wet Detention	**Removal**	**Littoral**		**Stormwater**	**Total**
Detention = 21 days	**Efficiency**	**Zone**	**FTWs**	**Harvesting**	**Reduction**
Percent TN Removal	0.36	0.1	0.12	0.4	**0.89**
Percent TP Removal	0.62	0.1	0.12	0.4	**0.95+**

Overall treatment efficiency =

E1 + (1-((1-E1)*(1-E2)*(1-E3))) + harvesting value.

EXAMPLE IMPAIRED AND OFWS (2)

MINIMUM CRITERIA

Rule Target for Impaired & OFW					
TN=95 TP=95					
Wet Detention Detention = 60 days	**Wet Pond Removal Efficiency**	**Littoral Zone**	**FTWs**	**2" per week Stormwater Harvesting**	**Total Reduction**
Percent TN Removal	0.41	0.1	0.12	0.4	**0.93**
Percent TP Removal	0.7	0.1	0.12	0.4	**0.95+**

Overall treatment efficiency =

E1 + (1-((1-E1)*(1-E2)*(1-E3))) + harvesting value.

NOTES ON PREVIOUS CALCULATIONS

- Note that the bulk of removals result from pond detention time and mass removals by harvesting.
- Littoral zone and FTW removals act as final polishing.
- Harvesting rate is somewhat adjustable to meet need.
- Did not account for potential retention opportunities for LID-type microscale storage or pervious pavement/pavers.
- These practices do not require any change to the overall site plan footprint.