Revised March 12, 2021 *Via: Electronic Mail*

City of Stuart Planning Department
121 SW Flagler Avenue
Stuart, FL 34994

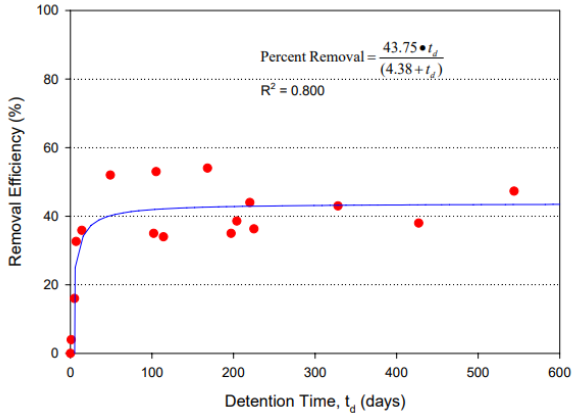
**Re: Costco – Kanner PUD**
**City of Stuart LDC 5.05.02(i) Tree Replacement – Innovative Stormwater Treatment**

To Whom it May Concern:

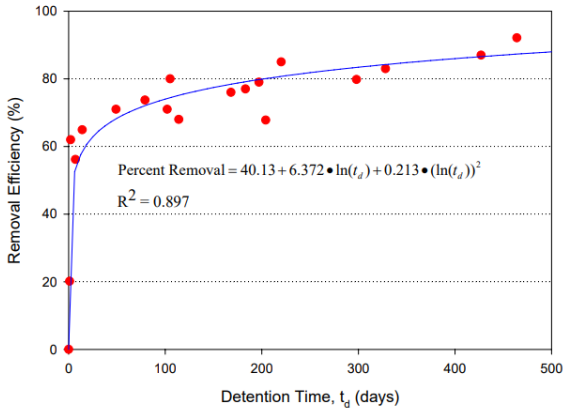
Please find below and enclosed an analysis for the above referenced PUD in accordance with City of Stuart Land Development Code (LDC). The applicant seeks approval of the proposed tree replacement fund credit based on the PUD's stormwater management system removal efficiency of nitrogen and phosphorus per Section 5.05.02(i).

The proposed PUD will convert the existing property from a ruderal upland pine and wet flatwood land coverage to a mixed-use development. The most practical type of stormwater system to serve a development of this size is a wet detention lake system. Lakes provide the required treatment and attenuation per regulations set forth by the City of Stuart, SFWMD, and FDOT while also providing the developer a cost-efficient means of generating fill for their project.

Per the LDC, the City's minimum removal efficiency to qualify for tree replacement credit is 81% for both nitrogen and phosphorus. While wet detention lakes can achieve upwards of 90% removal of phosphorus, the maximum removal efficiency of nitrogen is approximately 45% (Evaluation of Current Stormwater Design Criteria within the State of Florida, Harper, 2007).




Nitrogen Removal Efficiency




Phosphorus Removal Efficiency

As such, the developer is proposing to integrate additional dry retention ponds, a bio-detention shelf, and littoral zone plantings into the stormwater management system serving the PUD. These measures will allow for a higher removal efficiency of both nitrogen and phosphorus.

Please see the enclosed BMP Trains calculations for proposed nutrient removal efficiency. Calculations are based on preliminary engineering of the stormwater management system. The final removal efficiencies will be determined at time of final construction level plan design. The wet detention permanent pool volumes are based on an anoxic depth of 12' below control (not to the maximum depth of 25').

Provided Nitrogen Removal = 81%
Provided Phosphorus Removal = 90%

Tree Replacement Credit:
As a result of constructing additional dry retention ponds the developer is foregoing the opportunity to serve the entire development with wet detention lakes. This will result in additional fill costs to the project that would otherwise be offset by excavating lakes of a total equivalent footprint. Below is a cost breakdown of the result fill costs.

Potential Wet Detention Lake Excavation Volume to be Offset*:
Total Loss of Excavation Volume = 31,606 cuyds
**Potential excavation depth and volume has been calculated assuming a typical wet detention lake section that is consistent with the lakes to be constructed for the project. Loss of potential excavation is assumed to bottom of the proposed dry retention ponds and bio-detention shelf as compared to a lake of equivalent net size. Maximum potential lake depth is assumed to be the same as the proposed lakes at 25' deep. Dry pond bottoms are assumed to start 1' above the lake control elevation. See enclosed Lake Excavation Exhibit included in this submittal.*

Cost of Fill =$10.00/cuyd
= $10.00/cuyd x 31,606 cuyds = **$316,060.00**

Per the City of Stuart LDC:

*Table 2: Credit for Providing Additional Nitrate and Phosphate Removal*

| Percentage of Nitrate and Phosphate Loading Reduction from Stormwater | Maximum Pollutant Removal Factor for Construction Value of Additional Stormwater Treatment [a] |
|---|---|
| 81% to 85% | 1.25 |
| 86% to 89% | 1.5 |
| 90%+ | 2.0 |

To account for varying treatment efficiencies in the proposed system the tree replacement credit calculations will assume a proportionate cost share for nitrogen and phosphorus removal that is equal; $197,537.50 multiplied by the allowable credit. As such:

81% Nitrogen Removal Credit = $197,537.50 x 1.25 = $197,537.50
90% Phosphorus Removal Credit = $197,537.50 x 2.0 = $316,060.00
**Total Credit for Providing Nutrient Removal = $513,597.50**

We feel this analysis and the enclosed calculations provide sufficient support for the above tree removal credit to offset a portion of the overall required tree replacement fund. Should you have any questions or comments do not hesitate to contact our office.

Respectfully,
**ENGINEERING DESIGN & CONSTRUCTION, INC.**

David C. Baggett, P.E.
Professional Engineer

Cc: Doug Fitzwater – Lucido and Associates

Z:\EDC-2020\20-313 - Costco Stuart - Kanner Highway\ENGINEERING\Documents\Submittal Documents\Applications\2021-03-12)CoS_PUD_Site_Plan_1st_Response\2021-03-12_Revised_Tree_Mitigation_Stormwater_Letter.docx

**GENERAL SITE INFORMATION:** V 8.6

GO TO INTRODUCTION PAGE

3/12/2021

| Blue Numbers = | Input data |
|---|---|
| Red Numbers = | Calculated or Carryover |

HELP Rainfall

**Select the appropriate Meteorological Zone, input the appropriate Mean Annual Rainfall amount and select the type of analysis**

NAME OF PROJECT

Cost Co / Kanner Hwy PUD

VIEW ZONE MAP

Meteorological Zone (Please use zone map): CLICK ON CELL BELOW TO SELECT — Zone 5

Mean Annual Rainfall (Please use rainfall map): 57.00 Inches

VIEW MEAN ANNUAL RAINFALL MAP

Type of analysis: CLICK ON CELL BELOW TO SELECT — Specified removal efficiency

Treatment efficiency (N, P) (ex 80 70 (no decimal points) **use only for specified removal efficiency**): 81 81 %

GO TO WATERSHED CHARACTERISTICS

**Select the STORMWATER TREATMENT ANALYSIS Button below to begin analyzing the effectiveness of Best Management Practices.**

**Model documentation and example problems.**

STORMWATER TREATMENT ANALYSIS

**Systems available for analysis:**

Retention Basin with option for calculating effluent concentration
Wet Detention
Exfiltration Trench
Pervious Pavement
Stormwater Harvesting
Biofiltration
Greenroof
Rainwater Harvesting
Managed Aquatic Plants Detention
Vegetated Natural Buffer
Vegetated Filter Strip
Swale
Rain Garden
Tree Well
Lined reuse pond
User Defined BMP

**There is a user's manual for the BMPTRAINS model. It can be downloaded from www.stormwater.ucf.edu. The results from the example problems shown in the manual however may not reflect current model results due to ongoing updates of the model.**

RESET INPUT FOR STORMWATER TREATMENT ANALYSIS

METHODOLOGY FOR CALCULATING REQUIRED TREATMENT EFFICIENCY

METHODOLOGY FOR RETENTION SYSTEMS

METHODOLOGY FOR WET DETENTION SYSTEMS

METHODOLOGY FOR GREENROOF SYSTEMS

METHODOLOGY FOR WATER HARVESTING SYSTEMS

# WATERSHED CHARACTERISTICS V 8.6

GO TO STORMWATER TREATMENT ANALYSIS

Blue Numbers = Input data | Red Numbers = Calculated | LAND USES/EMC

SELECT CATCHMENT CONFIGURATION 3/12/2021

CLICK ON CELL BELOW TO SELECT CONFIGURATION

J - Mixed-4 Catchment-3 Series-Parallel

VIEW CATCHMENT CONFIGURATION

GO TO GENERAL SITE INFORMATION PAGE

For comingling, the off-site catchment must be upstream. The delay is only for retention BMPs and must be used in hours as measured by the time of concentration at a one inch/hour rain

COMINGLING | MULTI-LAND USE

VIEW AVERAGE ANNUAL RUNOFF "C" Factor

VIEW EMC & FLUCCS

GO TO GIS LANDUSE DATA

OVERWRITE DEFAULT CONCENTRATIONS USING:

| | PRE: | POST: |
|---|---|---|
| EMC(N): | mg/L | mg/L |
| EMC(P): | mg/L | mg/L |

USE DEFAULT CONCENTRATIONS

Delay [hrs] | CATCHMENT NO.1 NAME: POST DA A-2

max delay = 15 hrs.

CLICK ON CELL BELOW TO SELECT

Pre-development land use: Undeveloped - Ruderal/Upland Pine: TN=1.694 TP=0.162

with default EMCs

CLICK ON CELL BELOW TO SELECT

Post-development land use: Multi-Family: TN=2.320 TP=0.520

with default EMCs

| | | | |
|---|---|---|---|
| Total pre-development catchment area: | 11.910 | AC | |
| Total post-development catchment or for BMP analysis: | 11.910 | AC | |
| Pre-development Non DCIA CN: | 77.00 | | |
| Pre-development DCIA percentage: | 0.00 | % | |
| Post-development Non DCIA CN: | 88.00 | | |
| Post-development DCIA percentage: | 74.50 | % | |
| Estimated BMP Area (No loading from this area) | 2.730 | AC | |

| | | |
|---|---|---|
| Average annual pre runoff volume: | 7.626 | ac-ft/year |
| Average annual post runoff volume (note no BMP area): | 29.121 | ac-ft/year |
| Pre-development Annual Mass Loading - **Nitrogen:** | 15.932 | kg/year |
| Pre-development Annual Mass Loading - **Phosphorus:** | 1.524 | kg/year |
| Post-development Annual Mass Loading - **Nitrogen:** | 83.321 | kg/year |
| Post-development Annual Mass Loading - **Phosphorus:** | 18.675 | kg/year |

OVERWRITE DEFAULT CONCENTRATIONS:

| | PRE: | POST: |
|---|---|---|
| EMC(N): | mg/L | mg/L |
| EMC(P): | mg/L | mg/L |

USE DEFAULT CONCENTRATIONS

CATCHMENT NO.2 NAME: POST DA A-3

CLICK ON CELL BELOW TO SELECT

Pre-development land use: Undeveloped - Wet Flatwoods: TN=1.213 TP=0.021

with default EMCs

CLICK ON CELL BELOW TO SELECT

Post-development land use: High-Intensity Commercial: TN=2.40 TP=0.345

with default EMCs

| | | | |
|---|---|---|---|
| Total pre-development catchment area: | 27.130 | AC | |
| Total post-development catchment or BMP analysis area: | 27.130 | AC | |
| Pre-development Non DCIA CN: | 77.00 | | |
| Pre-development DCIA percentage: | 0.00 | % | |
| Post-development Non DCIA CN: | 88.00 | | |
| Post-development DCIA percentage: | 74.50 | % | |
| Estimated BMP Area (No loading from this area) | 2.630 | AC | |

| | | |
|---|---|---|
| Average annual pre runoff volume: | 17.371 | ac-ft/year |
| Average annual post runoff volume (note no BMP area): | 77.720 | ac-ft/year |
| Pre-development Annual Mass Loading - **Nitrogen:** | 25.987 | kg/year |
| Pre-development Annual Mass Loading - **Phosphorus:** | 0.450 | kg/year |
| Post-development Annual Mass Loading - **Nitrogen:** | 230.038 | kg/year |
| Post-development Annual Mass Loading - **Phosphorus:** | 33.068 | kg/year |

OVERWRITE DEFAULT CONCENTRATIONS:

| | PRE: | POST: |
|---|---|---|
| EMC(N): | mg/L | mg/L |
| EMC(P): | mg/L | mg/L |

USE DEFAULT CONCENTRATIONS

CATCHMENT NO.3 NAME: Post DA B-NWW-4A

CLICK ON CELL BELOW TO SELECT

Pre-development land use: Highway: TN=1.520 TP=0.200

with default EMCs

CLICK ON CELL BELOW TO SELECT

Post-development land use: Highway: TN=1.520 TP=0.200

with default EMCs

| | | | |
|---|---|---|---|
| Total pre-development catchment area: | 9.386 | AC | |
| Total post-development catchment or BMP analysis area: | 9.386 | AC | |
| Pre-development Non DCIA CN: | 80.00 | | |
| Pre-development DCIA percentage: | 68.08 | % | |
| Post-development Non DCIA CN: | 80.00 | | |
| Post-development DCIA percentage: | 68.08 | % | |
| Estimated BMP Area (no loading from this area) | 0.000 | AC | |

| | | |
|---|---|---|
| Average annual pre runoff volume: | 26.765 | ac-ft/year |
| Average annual post runoff volume (note no BMP area): | 26.765 | ac-ft/year |
| Pre-development Annual Mass Loading - **Nitrogen:** | 50.172 | kg/year |
| Pre-development Annual Mass Loading - **Phosphorus:** | 6.602 | kg/year |
| Post-development Annual Mass Loading - **Nitrogen:** | 50.172 | kg/year |
| Post-development Annual Mass Loading - **Phosphorus:** | 6.602 | kg/year |

OVERWRITE DEFAULT CONCENTRATIONS:

| | PRE: | POST: |
|---|---|---|
| EMC(N): | mg/L | mg/L |
| EMC(P): | mg/L | mg/L |

USE DEFAULT CONCENTRATIONS

CATCHMENT NO.4 NAME: POST DA A-1

CLICK ON CELL BELOW TO SELECT

Pre-development land use: Undeveloped - Ruderal/Upland Pine: TN=1.694 TP=0.162

with default EMCs

CLICK ON CELL BELOW TO SELECT

Post-development land use: Multi-Family: TN=2.320 TP=0.520

with default EMCs

| | | | |
|---|---|---|---|
| Total pre-development catchment area: | 9.950 | AC | |
| Total post-development catchment or BMP analysis area: | 9.950 | AC | |
| Pre-development Non DCIA CN: | 77.00 | | |
| Pre-development DCIA percentage: | 0.00 | % | |
| Post-development Non DCIA CN: | 83.00 | | |
| Post-development DCIA percentage: | 61.40 | % | |
| Estimated BMP Area (no loading from this area) | 2.270 | AC | |

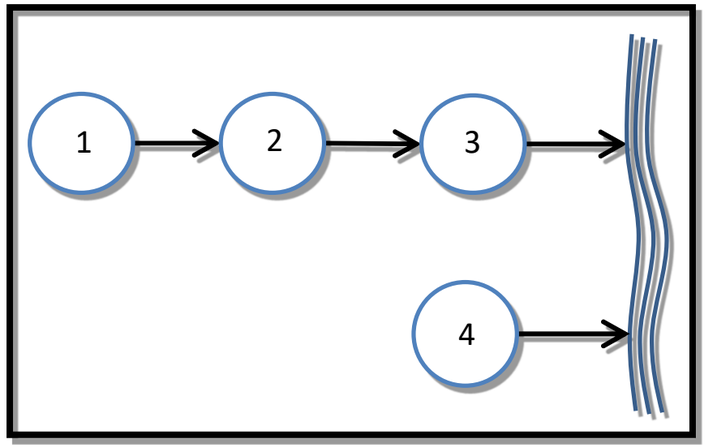
| | | |
|---|---|---|
| Average annual pre runoff volume: | 6.371 | ac-ft/year |
| Average annual post runoff volume (note no BMP area): | 20.733 | ac-ft/year |
| Pre-development Annual Mass Loading - **Nitrogen:** | 13.310 | kg/year |
| Pre-development Annual Mass Loading - **Phosphorus:** | 1.273 | kg/year |
| Post-development Annual Mass Loading - **Nitrogen:** | 59.320 | kg/year |
| Post-development Annual Mass Loading - **Phosphorus:** | 13.296 | kg/year |

| STORMWATER TREATMENT ANALYSIS: | V 8.6 | GO TO GENERAL SITE INFORMATION PAGE | Blue Numbers = | Input data |
|---|---|---|---|---|
| | | | Red Numbers = | Calculated |

If not done, specify pre- and post-development watershed characteristics.

3/12/2021

GO TO WATERSHED CHARACTERISTICS




## Total Required Treatment Efficiency:

| | | |
|---|---|---|
| Required Treatment Eff (**Nitrogen**): | 81 | % |
| Required Treatment Eff (**Phosphorus**): | 81 | % |

Select one of the BMPs below to analyze efficiency or review the summary data.

| | | | | | |
|---|---|---|---|---|---|
| RETENTION BASIN | WET DETENTION / MAP | EXFILTRATION TRENCH | RAIN GARDEN / depression storage | SWALE | USER DEFINED BMP |
| PERVIOUS PAVEMENT | STORMWATER HARVESTING | FILTRATION | View Media Mixes | NOTE !!!: All individual system must be sized prior to being analyzed in conjunction with other systems. Please read instructions in the CATCHMENT AND TREATMENT SUMMARY RESULTS tab for more information. | |
| GREENROOF | RAINWATER HARVESTING | LINED REUSE POND & UNDERDRAIN INPUT | GO TO COST ANALYSIS WORKSHEET | | |
| VEGETATED NATURAL BUFFER | VEGETATED FILTER STRIP | TREE WELL | CATCHMENT AND TREATMENT SURFACE | | |

# WET DETENTION / MANAGED AQUATIC PLANTS: 3/12/2021 V 8.6

| Blue Numbers = | Input data |
|---|---|
| Red Numbers = | Calculated or Carryover |

**Also called: FLOATING ISLANDS and includes a wet detention pond:**

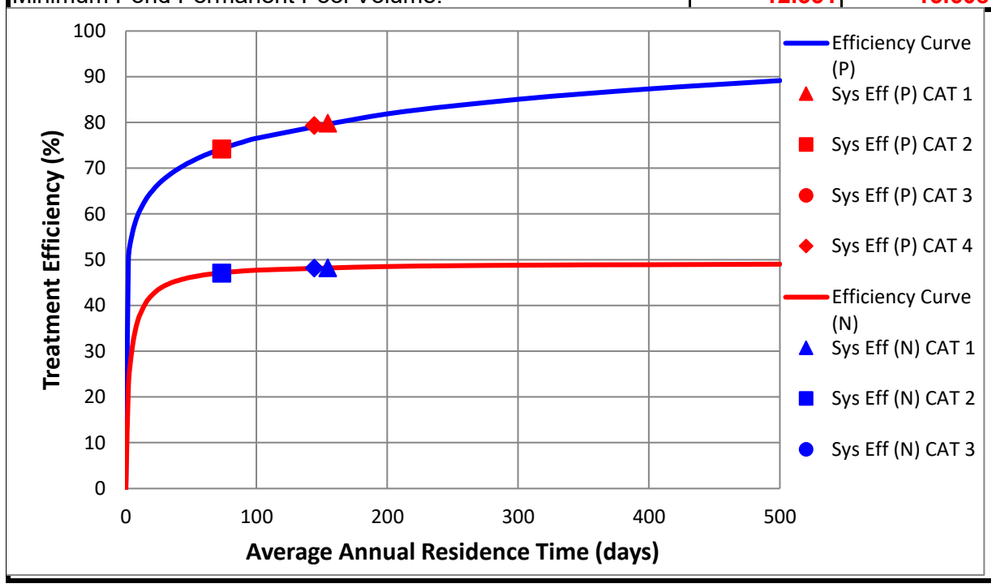
**Cost Co / Kanner Hwy PUD**

**GO TO STORMWATER TREATMENT ANALYSIS**

| | POST DA A-2 | POST DA A-3 | st DA B-NWW | POST DA A-1 | |
|---|---|---|---|---|---|
| Total pre-development catchment area: | 11.910 | 27.130 | 9.386 | 9.950 | ac |
| Total post-development catchment area: | 9.180 | 24.500 | 9.386 | 7.680 | ac |
| Average annual residence time (between 1 and 500 days) | 154.55 | 73.30 | | 144.20 | days |
| Littoral Zone or other improvements used?* | YES | YES | | YES | |
| Littoral Zone or other improvement efficiency credit: | 10.00 | 10.00 | | 10.00 | % |
| Floating Wetland or Mats used in the design: | NO | NO | | NO | |
| Floating Wetland or Mats credit: | 0.00 | 0.00 | | 0.00 | % |
| Total **Nitrogen** removal required: | 81.000 | 81.000 | 81.000 | 81.000 | % |
| Total **Phosphorus** removal required: | 81.000 | 81.000 | 81.000 | 81.000 | % |
| Total **Nitrogen** removal efficiency: | 48.290 | 47.155 | 0.000 | 48.214 | % |
| Total **Phosphorous** removal efficiency: | 79.894 | 74.281 | 0.000 | 79.363 | % |
| Is the wet detention sufficient: | NO | NO | | NO | |
| Average annual runoff volume: | 29.121 | 77.720 | 26.765 | 20.733 | ac-ft/yr |
| Minimum Pond Permanent Pool Volume: | 12.331 | 15.608 | | 8.191 | ac-ft |

* pond coverage must follow Regulatory Requirements

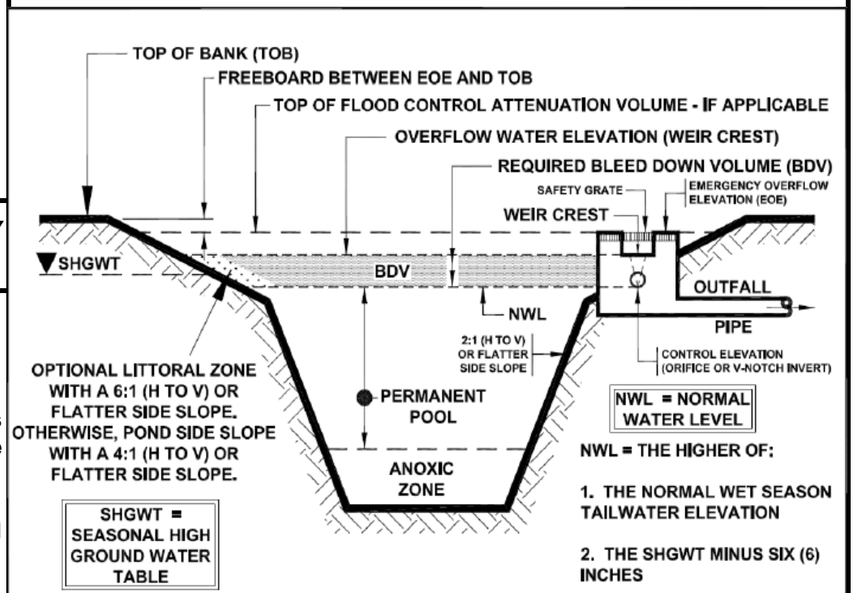
**Wet Detention Pond Characteristic:**




**NOTE FOR TREATMENT EFFICIENCY GRAPH:**

**The purpose of the treatment efficiency graphs is to help illustrate the treatment efficiency of the wet detention system as the function of average annual residence time (and permanent pool volume). The graph illustrates that there is a point of diminished return as the permanent pool volume is substantially increased. Therefore, to provide the most economical BMP treatment system, other alternatives such as "treatment trains" and compensatory treatment should be considered.**

**REQUIRED REMAINING TREATMENT EFFICIENCIES OF TREATMENT SYSTEM IN SERIES WITH FLOATING ISLANDS WITH WET DETENTION. USE FOR SIZING OF TREATMENT SYSTEM IN SERIES WITH FLOATING ISLANDS WITH WET DETENTION.**




**TYPICAL X-SECTION OF A WET DETENTION SYSTEM**

Source of Graphic: draft **STORMWATER QUALITY APPLICANT'S HANDBOOK** dated March 2010, by the Department of Environmental Protection, available at: http://www.dep.state.fl.us/water/wetlands/erp/rules/stormwater, March 2010

## RETENTION BASIN: 3/12/2021 V 8.6

| Blue Numbers = | Input data |
|---|---|
| Red Numbers = | Calculated or Carryover |

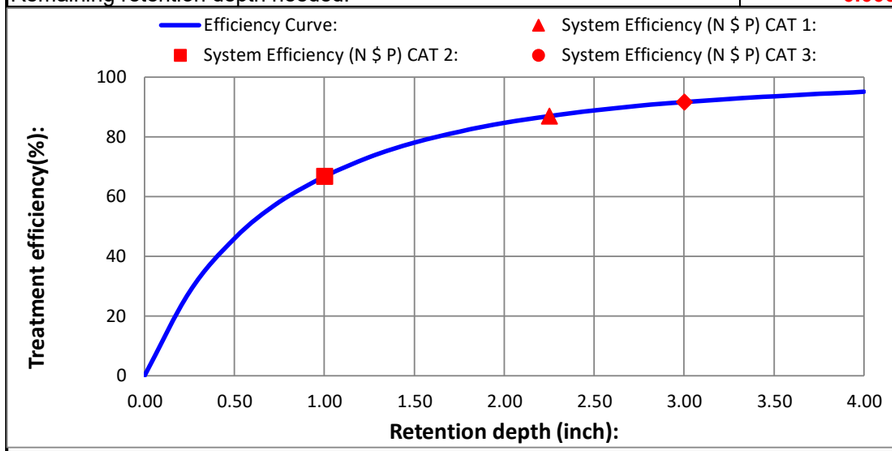
**RETENTION BASIN SERVING:** Cost Co / Kanner Hwy PUD

**GO TO STORMWATER TREATMENT ANALYSIS**

| Loadings from BMP area are contained by the BMP, thus no BMP area load. | POST DA A-2 | POST DA A-3 | ost DA B-NWW-4 | POST DA A-1 | |
|---|---|---|---|---|---|
| Watershed area cotributing to basin: | 9.180 | 24.500 | 9.386 | 7.680 | ac |
| Required Treatment Eff (**Nitrogen**): | 81.000 | 81.000 | 81.000 | 81.000 | % |
| Required Treatment Eff (**Phosphorus**): | 81.000 | 81.000 | 81.000 | 81.000 | % |
| Required retention depth over the watershed to meet required efficiency: | 1.694 | 1.694 | 1.694 | 1.694 | in |
| Required water quality retention volume: | 1.296 | 3.458 | 1.325 | 1.084 | ac-ft |

**RETENTION BASIN FOR MULTIPLE TREATMENT SYSTEMS (if there is a need for additional removal efficiencies in a series of BMPs):**

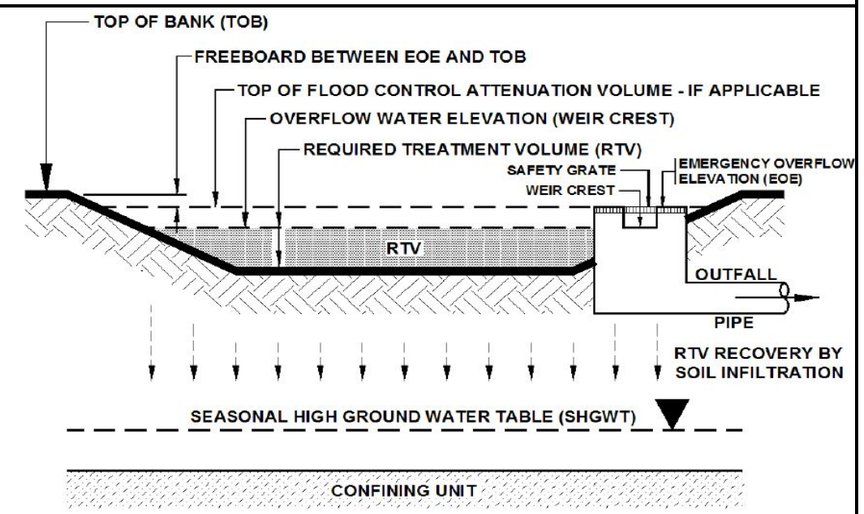
| | | | | | |
|---|---|---|---|---|---|
| Retention volume based on retention depth and Total area - BMP area | 1.721 | 2.042 | 0.000 | 1.920 | ac-ft |
| Provided retention depth (0.1-3.99 inches over the watershed) | 2.250 | 1.000 | | 3.000 | in |
| Provided treatment efficiency (**Nitrogen**): | 87.044 | 66.793 | 0.000 | 91.712 | % |
| Provided treatment efficiency (**Phosphorus**): | 87.044 | 66.793 | 0.000 | 91.712 | % |
| Remaining treatment efficiency (**Nitrogen**): | 0.000 | 42.783 | 81.000 | 0.000 | % |
| Remaining treatment efficiency (**Phosphorus**): | 0.000 | 42.783 | 81.000 | 0.000 | % |
| Remaining retention depth needed: | 0.000 | 0.694 | 1.694 | 0.000 | in |




**NOTE FOR TREATMENT EFFICIENCY GRAPH:**

The purpose of this graph is to help illustrate the treatment efficiency of the retention system as the function of retention depth **for a single BMP and in a single catchment**. The graph illustrates that there is a diminished return as the retention depth is increased. Thus evaluations of other alternatives in "treatment trains" and compensatory treatment should be considered. **NOTE:** the retention volume can not exceed 3.99 inches to be within the range of data used to determine effectiveness.

**HELP - EXAMPLE PROBLEM 3**




**TYPICAL CROSS SECTION OF A "DRY" RETENTION SYSTEM**

View Media Mixes

| Estimate of groundwater impacts | Catchment 1 | Catchment 2 | Catchment 3 | Catchment 4 |
|---|---|---|---|---|
| Use only down flow media mix before water enters the ground, specify type | | | | |
| Nitrogen mass reduction in groundwater discharge (%) | | | | |
| Phosphorus mass reduction in groundwater discharge (%) | | | | |

Source of Graphic: draft **STORMWATER QUALITY APPLICANT'S HANDBOOK** dated March 2010, by the Department of Environmental Protection, available at: http://www.dep.state.fl.us/water/wetlands/erp/rules/stormwater, March 2010.

# CATCHMENTS AND TREATMENT SURFACE DISCHARGE SUMMARY V 8.6

## CALCULATION METHODS:

1. The effectiveness of each BMP in a single catchment is converted to an equivalent capture volume.
2. Certain BMP treatment train combinations have not been evaluated and in practice they are at this time not used, an example is a greenroof following a tree well.
3. Wet detention is last when used in a single catchment with other BMPs, except when followed by filtration

| PROJECT TITLE | Cost Co / Kanner Hwy PUD | Optional Identification | Cost Co / Kanner Hwy PUD | |
|---|---|---|---|---|
| | POST DA A-2 | POST DA A-3 | Post DA B-NWW-4A | POST DA A-1 |
| BMP Name | Retention Basin | Retention Basin | | Retention Basin |
| BMP Name | Wet Detention/ MAPs | Wet Detention/ MAPs | | Wet Detention/ MAPs |
| BMP Name | | | | |

**REVIEW, ONE OR MORE CATCHMENT HAS BEEN SPECIFIED WITHOUT A BMP**

## Surface Water Discharge Summary Performance of Entire Watershed

| Catchment Configuration | J - Mixed-4 Catchment-3 Series-Parallel | | 3/12/2021 |
|---|---|---|---|
| | | | BMPTRAINS MODEL |
| Nitrogen Pre Load (kg/yr) | 105.40 | | |
| Phosphorus Pre Load (kg/yr) | 9.85 | | |
| Nitrogen Post Load (kg/yr) | 422.85 | | |
| Phosphorus Post Load (kg/yr) | 71.64 | | |
| Target Load Reduction (N) % | 81 | | |
| Target Load Reduction (P) % | 81 | | |
| Target Discharge Load, N (kg/yr) | 80.34 | | |
| Target Discharge Load, P (kg/yr) | 13.61 | | |
| Provided Overall Efficiency, N (%): | 81 | | |
| Provided Overall Efficiency, P (%): | 90 | | |
| Discharged Load, N (kg/yr & lb/yr): | 81.57 | 179.67 | |
| Discharged Load, P (kg/yr & lb/yr): | 7.25 | 15.97 | |
| Load Removed, N (kg/yr & lb/yr): | 341.28 | 751.70 | |
| Load Removed, P (kg/yr & lb/yr): | 64.39 | 141.83 | |

**Treatment Objectives or Target for**

**TN MET**

**TP MET**