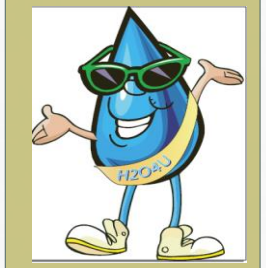
LID CASE STUDY DESIGN WORKSHOP
EXAMPLE 2
MIXED USE DEVELOPMENT PROJECT

BY: MARTY WANIELISTA AND ERIC LIVINGSTON



August, 2016

ACKNOWLEDGEMENTS

- The Low Impact Design BMP workshops were presented on August 24 and 25, 2016 at the Escambia County Central Office Complex in Pensacola.
- The Escambia County LID BMP Manual and the LID BMP Workshops were funded in part by a Section 319 Nonpoint Source Management Program Implementation grant from the U.S. Environmental Protection Agency through an agreement/contract with the Nonpoint Source Management Section of the Florida Department of Environmental Protection.

MIXED USE REDEVELOPMENT

Existing Site

- 4.8 acre high intensity commercial shopping center
- 2 buildings, one fast food restaurant, auto sales office and lot

Redevelopment Proposal 1 – Conventional LU/stormwater management

- Commercial and restaurant with surface parking
- Onsite stormwater retention basin

Redevelopment Proposal 2 – Mixed use with LID stormwater

- Mix of commercial, office and townhouse dwellings
- Mix of LID BMPs

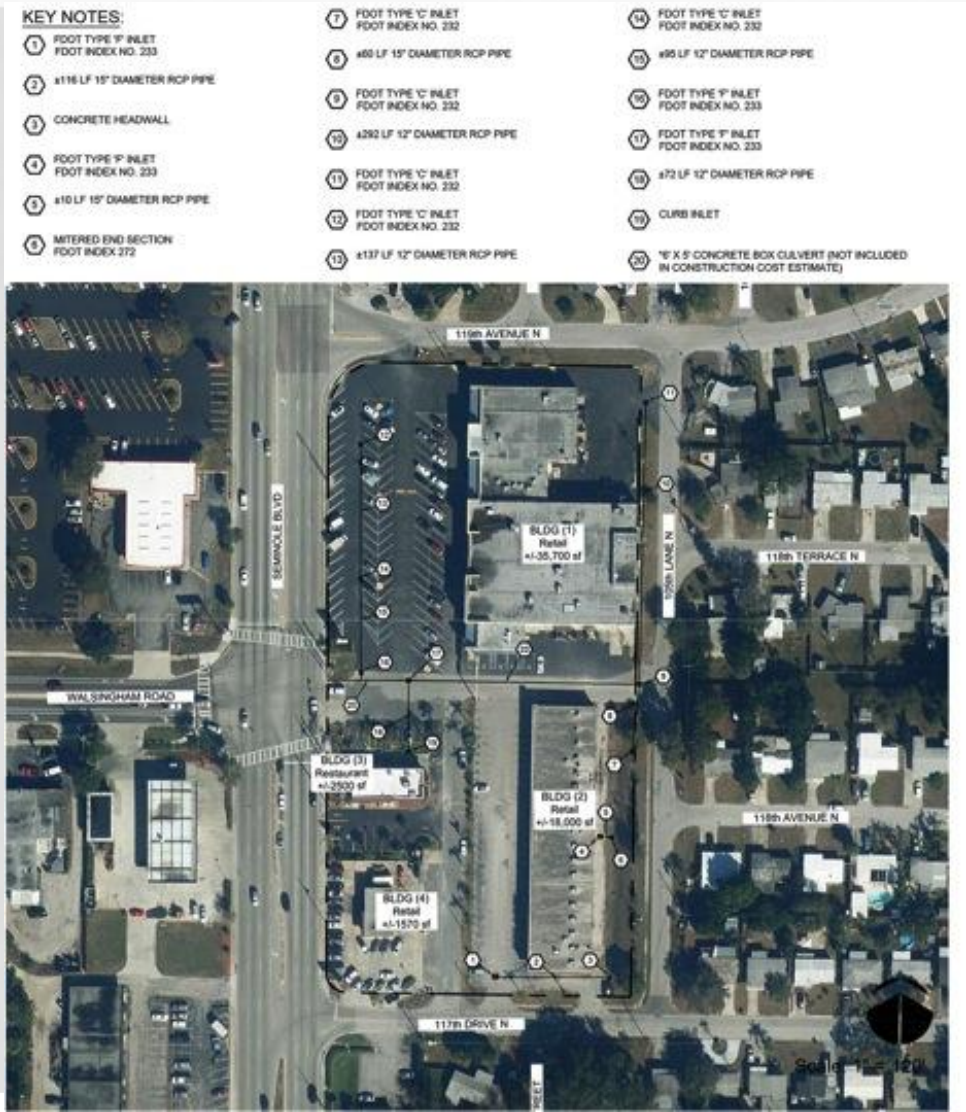
Level of Treatment – Impaired water body with TMDL

- Net improvement = post-development < pre-development – 10%

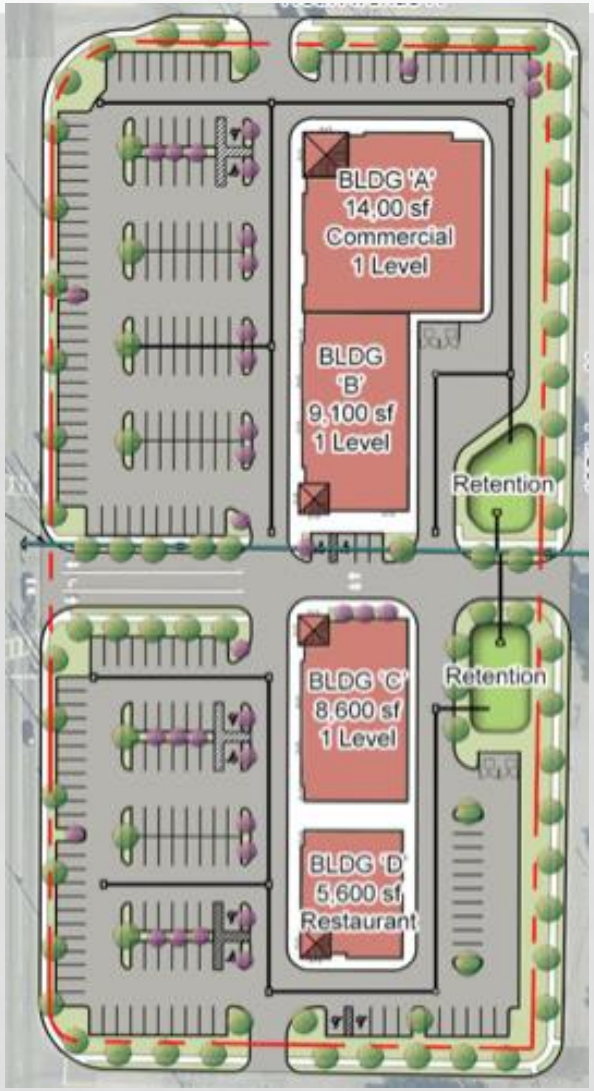
MIXED USE REDEVELOPMENT

Large Commercial to Mixed Land Use Area Information with BMP Options							
Land Use	**Site Area (acres)**	**Impervious Area (acres)**	**Directly Connected Impervious Area**	**Non-DCIA Pervious Area (acres)**	**Soil Types**	**SHGWT**	**Stormwater BMPs**
Existing High Intensity Commercial	4.80	4.32	4.32 90%	0.55 CN=60	HSG A	5 feet below grade	Two parcels with retention basins
Redevelopment Scenario 'A' Proposed High Intensity Commercial	4.80	3.70	3.70 77%	1.09 CN=55	HSG A	5 feet below grade	Retention basin
Redevelopment Scenario 'B' Proposed Mixed High Intensity Commercial and Single-Family Attached (townhouses)	4.80	3.95	3.95 82.4%	0.85 CN=50	HSG A	5 feet below grade	LID BMP Options on site

MIXED USE REDEVELOPMENT
ORIGINAL SITE AND STORMWATER



MIXED USE CONVENTIONAL REDEVELOPMENT AND STORMWATER MANAGEMENT



Building	Size	Req'd Parking Ratio	Req'd Parking Quantity	Proposed Parking Quantity	Difference
Retail/Shopping Center					
BLDG 'A'	14,000-sf	1 / 250-sf	56		
BLDG 'B'	9,100-sf	1 / 250-sf	36		
BLDG 'C'	8,600-sf	1 / 250-sf	35		
BLDG 'D'	5,600-sf	1 / 60-sf	94		
Subtotal	37,300-sf		221	233	12

Note:
(1) Site plan is intended to be conceptual in nature. Designed for land use planning purposes only.
(2) Property data including boundaries and topography based on GIS and aerial photography data. No land survey was used in preparation of this site design.
(3) Project design assumes a shared parking arrangement as allowed in the proposed Pinellas Code Updates.
(4) Stormwater management is conceptually planned with underground exfiltration systems and vaults. Green streets and other Low Impact Development (LID) techniques should be explored.

MIXED USE ALTERNATIVE REDEVELOPMENT AND LID STORMWATER MANAGEMENT

Redevelopment Scenario 'B' Proposed Mixed High Intensity Commercial and Single-Family Attached (townhouses)	4.80	3.95	3.95 82.4%	0.85 CN=50	HSG A	5 feet below grade	LID BMP Options on site

What combination of LID BMPs do you want to use for stormwater treatment?

- **Disconnect impervious area**
- **Florida-friendly landscaping**
- **Rainfall Interception trees**
- **Retention basin**
- **Rain garden (bioretention)**
- **Swales**
- **Pervious pavement**
- **Greenroof with cistern**
- **Rainwater harvesting**
- **Biofiltration systems**
- **Tree wells**

MIXED USE ALTERNATIVE REDEVELOPMENT AND LID STORMWATER MANAGEMENT

Rain Garden

Pervious Concrete

Pervious Pavers

Building	Size	Req'd Parking Ratio	Req'd Parking Quantity	Proposed Parking Quantity	Difference
Retail/Shopping Center					
BLDG 'A'	8,700-sf	4 / 1,000-sf	35		
BLDG 'B'	12,700-sf	4 / 1,000-sf	51		
BLDG 'C'	8,150-sf	4 / 1,000-sf	33		
BLDG 'D'	0	4 / 1,000-sf	0		
Subtotal	29,550-sf		118	95	-23
Office Uses					
BLDG 'C'	8,150-sf	2.5 / 1,000-sf	20		
BLDG 'D'	20,000-sf	2.5 / 1,000-sf	50		
Subtotal	29,550-sf		70	92	22
TOTAL	**57,700-SF**		**189**	**187**	**-2**
Townhouses	**24**	**1.5 / Unit**	**36**	**48**	**12**

Note:
(1) Site plan is intended to be conceptual in nature. Designed for land use planning purposes only.
(2) Property data including boundaries and topography based on GIS and aerial photography data. No land survey was used in preparation of this site design.
(3) Project design assumes a shared parking arrangement as allowed in the proposed Pinellas Code Updates.
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MIXED USE REDEVELOPMENT STORMWATER COMPARISONS

Redevelopment Scenario 'A' Assumptions					
	Total Area (acres)	Impervious Area (%)	Impervious Area (acres)	Pervious Area (%)	Pervious Area (acres)
Pre-Development (Previous Development)	4.8	91%	4.38	8.7%	0.42
Post-Development (Scenario 'A')	4.8	80%	3.84	20%	0.96
North Basin	2.4	80%	1.92	20%	0.48
South Basin	2.4	80%	1.92	20%	0.48

Redevelopment Scenario 'A' Required Water Quality Treatment Volume				
	Drainage Basin (acres)	Runoff (inches)	Required Water Quality Treatment Volume (cubic feet)	
North Basin	2.4	0.5	4,400-ft³	0.5-inch over project area
South Basin	2.4	0.5	4,400-ft³	

Redevelopment Scenario 'A' Retention Pond Design					
	Pond Bottom (elevation / FT)	Top of Bank (elevation / FT)	Area (SF)	Slope (V:H)	Volume (Cubic Ft)
Existing Retention	31.00	35.00	7,000	1:3	8,820
Post-Development (Scenario 'A')					
North Retention	32.00	35.00	2,800	1:4	5,350-ft³
South Retention	32.00	35.00	2,800	1:4	5,350-ft³

Redevelopment Scenario 'A' Water Treatment Volume - Conventional Stormwater Management Methods				
Elevation (ft)	Area (sq ft)	Volume per Foot (cu ft)	Total Volume per Elevation (cu ft)	
32	850	0	0	Bottom of pond
33	1,400	1,125	1,125	
34	2,100	1,750	2,875	
34.62	-	-	4,400	Water Quality Treatment Volume
35	2,850	2,475	5,350	Top of bank

Current Pre-Development Calculation (original development)				
	Cover Description	CN*	Area	Product of CN X Area
Impervious	Buildings, Asphalt, Concrete	98	4.38	429.24
Pervious	Open	39	0.42	16.35
		Totals	4.80	445.59

* *CN: Curve Number. Use only one CN source per line*

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{445.59}{4.80\text{-ac.}} = 92.85$ Use CN **93**

Post Development Calculation – Redevelopment Scenario 'B'				
	Cover Description	CN*	Area	Product of CN X Area
Impervious	Buildings, Paving, Curb & Concrete**	98	4.19	410.34
Pervious	Open and Landscaped	39	0.61	23.88
		Totals	4.80	434.21

* *CN: Curve Number. Use only one CN source per line*

** *This assumes asphalt parking lot paving, pervious pavement and pavers options will result in a different CN value*

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{434.21}{4.80\text{-ac.}} = 90.47$ Use CN **90**

MIXED USE REDEVELOPMENT STORMWATER TREATMENT COMPARISONS

Mixed Land Use Consisting of Large Commercial Shopping (high-intensity commercial) and Town Houses (Single-family attached) Areas Annual Stormwater Loadings and % Reduction

Row #		TN Loadings (kg/year)	TP Loadings (kg/year)	TN % Reduction	TP % Reduction
(1)	Existing Pre-Condition (all high-intensity commercial) Scenario A with % DCIA = 76	37.92	5.45		
(2)	For mixed use using both high-intensity commercial and town houses (without stormwater treatment) Scenario B with a higher density or % DCIA = 82	41.01	5.90		
(3)	Post-Development Condition –Scenario B (assuming 10% reduction in Mixed Use loadings without stormwater treatment)	36.91	5.31		
(4)	Scenario A - Existing rules – meet using 0.5" Retention Basin with all high-intensity commercial area and % DCIA = 76..	17.65	2.54	51	51
(5)	Scenario B - Load after treatment by Manual BMPs – rain gardens, pervious pavement, tree wells used for the Mixed Land Use	7.31	1.24	80	80

Notes: higher development density with Scenario B. Section 3 lists the assumptions and results in the worksheets from the BMPTRAINS model.

TN loadings = Total Nitrogen stormwater pollutant loadings

TP loadings = Total Phosphorus stormwater pollutant loadings

Loadings above DO NOT include load reductions associated with Interceptor Trees adjacent to impervious areas or the 3% load reduction associated with using Florida-friendly landscaping design and fertilizers.

MIXED USE REDEVELOPMENT COST COMPARISONS

Large Commercial Site: Cost Comparison of meeting current ERP stormwater standards and 10% Net Improvement Performance Standard

Item No.	Description	Quantity	Unit	Unit Cost	Extended Cost
Redevelopment Scenario 'A'					
Conventional Stormwater Management System – meeting current ERP stormwater standards					
CON-1	18" RCP	1,711	LF	$60	$102,660
CON-2	6" PVC Roof Drains	200	LF	$25	$5,000
CON-3	FDOT Type F Ditch Bottom Inlet, < 10'	14	EA	$3,800	$53,200
CON-4	FDOT Type C Ditch Bottom Inlet, < 10', Control Structure	2	EA	$3,700	$7,400
CON-5	Regular Excavation (Retention Area)	396	CY	$5	$1,980
CON-6	Grade/Compact	396	CY	$9	$3,564
CON-7	SOD, Retention Area	700	SY	$2	$1,400
CON-8	Mitered End Section, 18"	2	EA	$900	$1,800
CON-9	Manhole, P-7, <10'	1	EA	$3,400	$3,400
				Total Cost:	**$180,404**
				Development Intensity	**37,300-sf**
				Cost Per Unit (SF)	**$4.84**

Cost Comparison of meeting current ERP stormwater standards and 10% Net Improvement Performance Standard

Redevelopment Scenario 'B'

LID Stormwater Management Systems – meeting 10% Net Improvement Performance Standard

LID-1	12" Yard Drain	12	EA	$300	$3,600
LID-2	12" ADS Pipe	241	LF	$53	$12,773
LID-3	FDOT Type C Ditch Bottom Inlet, < 10', Control Structure	2	EA	$3,700	$7,400
LID-4	18" RCP	30	LF	$60	$1,800
LID-5	Pervious Concrete (8") *	42,814	SF	$1	$42,814
LID-6	Pervious Pavers System (Pavers, Stone, Fabric) *	4,067	SY	$38	$152,525
LID-7	Aggregate Base (9") *	4,757	SY	$9	$42,814
LID-8	Filter Fabric	4,757	SY	$5	$23,786
LID-9	Rain Garden	14,819	SF	$20	$296,370
				Total Cost:	**$582,436**
				Development Intensity	**57,700-sf PLUS 24 du (104,700 total)**
				Cost Per Unit (SF)	**$5.56**
Estimated premium cost differential for LID (Scenario 'B') verses Conventional Stormwater Management (Scenario 'A'):					223%

Notes: =

1. Quantities for existing south shopping building and restaurant based on Pinellas County plan submittal. Existing site does not fully comply with present-day stormwater requirements.
2. Quantities for north shopping building based on aerial imagery and site investigation.
3. Unit cost based on current local costs and readily available published data.
4. Existing conditions runoff for north shopping building and restaurant are assumed to be conveyed off-site to regional system. The south shopping building runoff is treated within retention pond to east of shopping building. The vehicle sales building runoff sheet flows onto adjacent roadway.
5. Rain gardens for commercial, industrial and institutional site costs can range between $10 to $40 per square foot based on the need for control structures, curbing, storm drains and underdrains (source http://www.lid-stormwater.net)
6. Items denoted with * include only the cost premium for the LID material versus the standard material (prices reflect the delta between pervious paving systems and typical asphalt paving)

MIXED USE REDEVELOPMENT ADDITIONAL BENEFITS

- Required load reductions were met with LID BMPs
- LID BMP Treatment Train included 0.42 acre rain garden integrated into landscaping with 0.40 acre pervious pavement and pavers, over 15 tree wells with 8 serving as interceptor trees.
- Florida-friendly landscaping provides additional 3% TN load reduction.
- Development density increased with LID BMP option, partly from using Mixed Zoning and partly from the LID BMPs.

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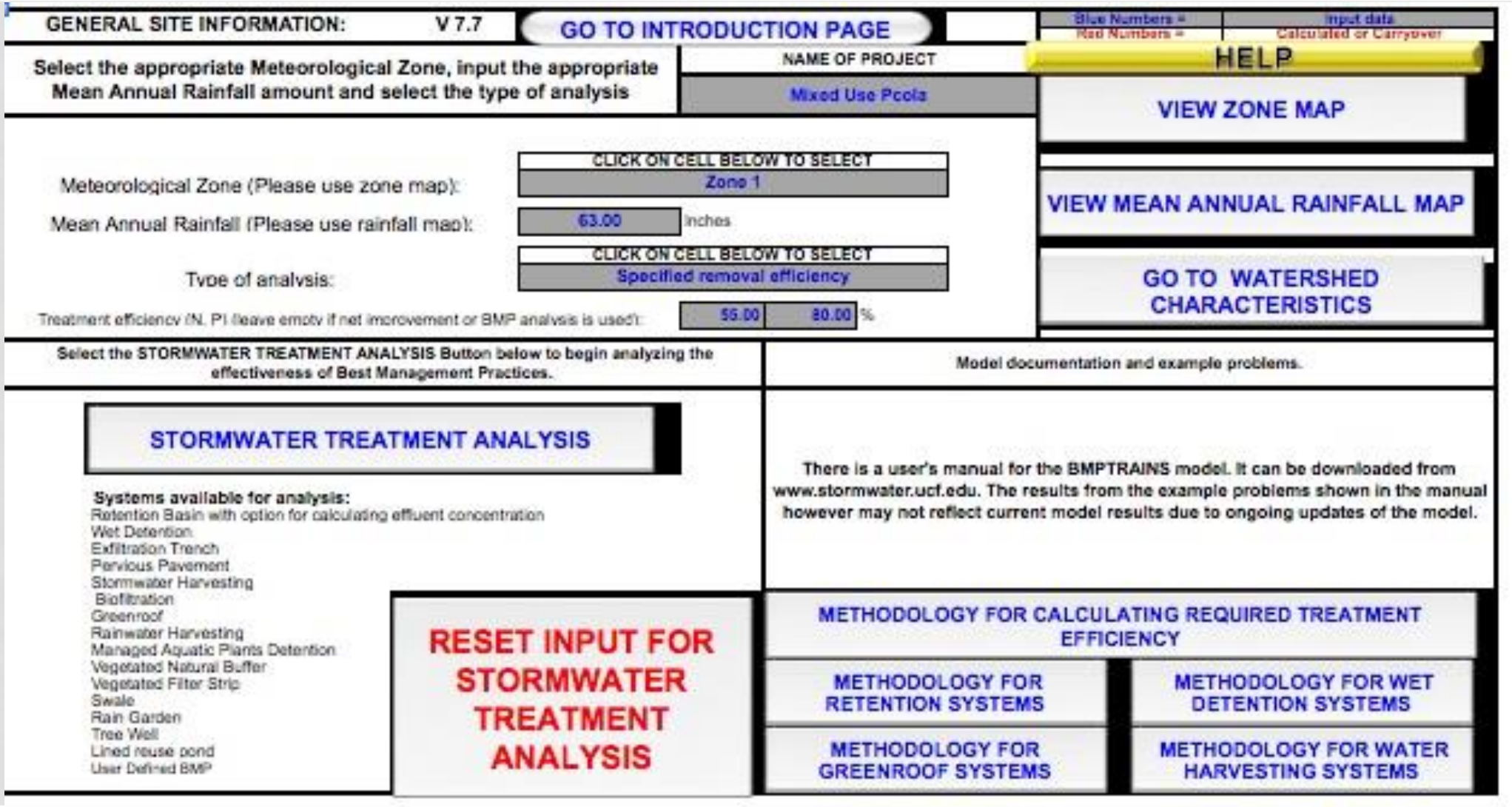
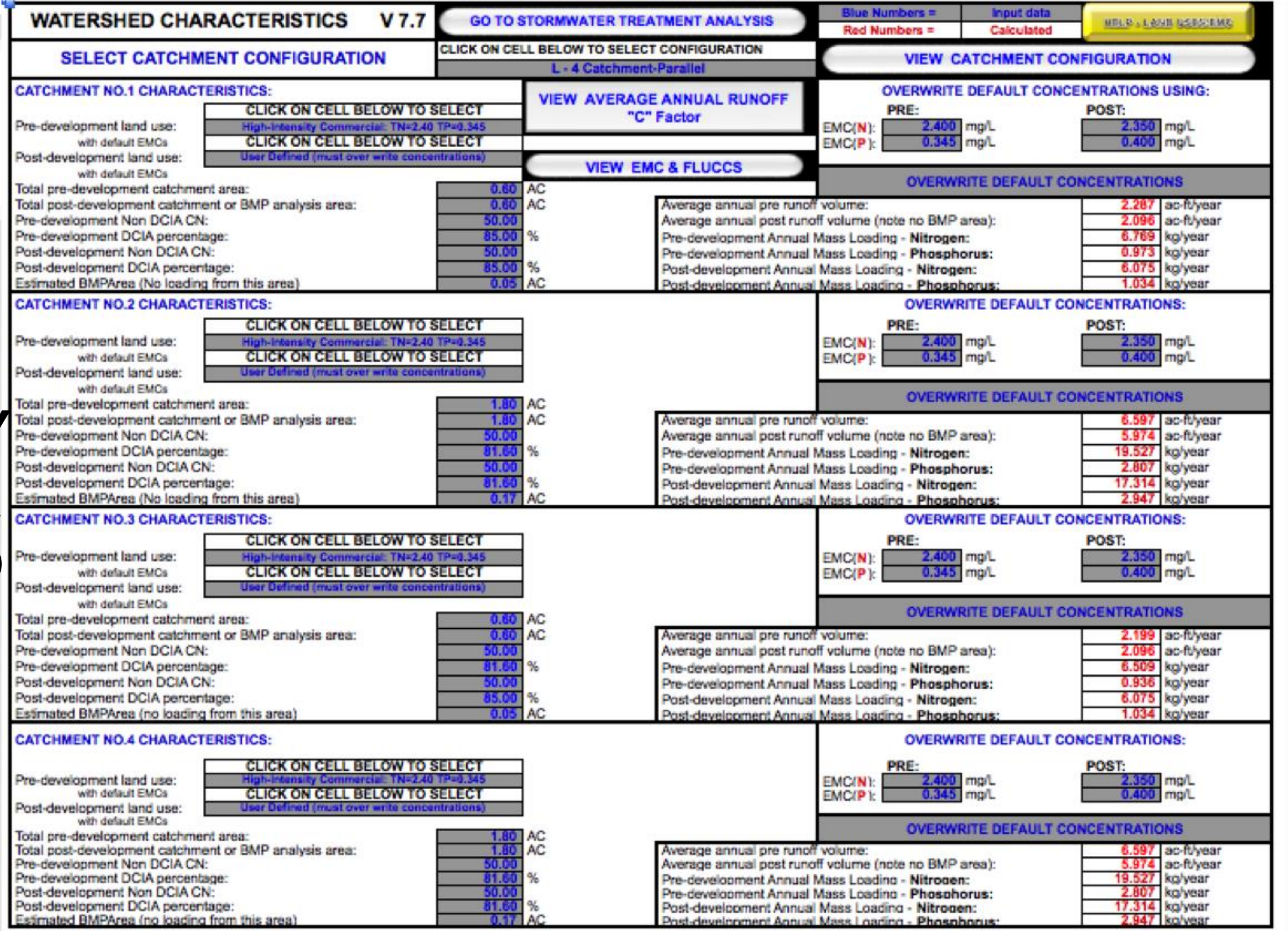
MIXED USE CASE STUDY - PENSACOLA RESULTS



MIXED USE CASE STUDY PENSACOLA WATERSHED DATA



WATERSHED CHARACTERISTICS V 7.7

GO TO STORMWATER TREATMENT ANALYSIS

Blue Numbers = Input data

Red Numbers = Calculated

HELP / LAND USE/EMC

SELECT CATCHMENT CONFIGURATION

CLICK ON CELL BELOW TO SELECT CONFIGURATION

L - 4 Catchment-Parallel

VIEW CATCHMENT CONFIGURATION

CATCHMENT NO.1 CHARACTERISTICS:

CLICK ON CELL BELOW TO SELECT

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

with default EMCs

CLICK ON CELL BELOW TO SELECT

Post-development land use: User Defined (must over write concentrations)

with default EMCs

VIEW AVERAGE ANNUAL RUNOFF "C" Factor

VIEW EMC & FLUCCS

OVERWRITE DEFAULT CONCENTRATIONS USING:

	PRE:		POST:	
EMC(N):	2.400	mg/L	2.350	mg/L
EMC(P):	0.345	mg/L	0.400	mg/L

OVERWRITE DEFAULT CONCENTRATIONS

Total pre-development catchment area:	0.60	AC	Average annual pre runoff volume:	2.287 ac-ft/year
Total post-development catchment or BMP analysis area:	0.60	AC	Average annual post runoff volume (note no BMP area):	2.096 ac-ft/year
Pre-development Non DCIA CN:	50.00		Pre-development Annual Mass Loading - **Nitrogen:**	6.769 kg/year
Pre-development DCIA percentage:	85.00	%	Pre-development Annual Mass Loading - **Phosphorus:**	0.973 kg/year
Post-development Non DCIA CN:	50.00		Post-development Annual Mass Loading - **Nitrogen:**	6.075 kg/year
Post-development DCIA percentage:	85.00	%	Post-development Annual Mass Loading - **Phosphorus:**	1.034 kg/year
Estimated BMPArea (No loading from this area)	0.05	AC		

CATCHMENT NO.2 CHARACTERISTICS:

CLICK ON CELL BELOW TO SELECT

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

with default EMCs

CLICK ON CELL BELOW TO SELECT

Post-development land use: User Defined (must over write concentrations)

with default EMCs

OVERWRITE DEFAULT CONCENTRATIONS:

	PRE:		POST:	
EMC(N):	2.400	mg/L	2.350	mg/L
EMC(P):	0.345	mg/L	0.400	mg/L

OVERWRITE DEFAULT CONCENTRATIONS

Total pre-development catchment area:	1.80	AC	Average annual pre runoff volume:	6.597 ac-ft/year
Total post-development catchment or BMP analysis area:	1.80	AC	Average annual post runoff volume (note no BMP area):	5.974 ac-ft/year
Pre-development Non DCIA CN:	50.00		Pre-development Annual Mass Loading - **Nitrogen:**	19.527 kg/year
Pre-development DCIA percentage:	81.60	%	Pre-development Annual Mass Loading - **Phosphorus:**	2.807 kg/year
Post-development Non DCIA CN:	50.00		Post-development Annual Mass Loading - **Nitrogen:**	17.314 kg/year
Post-development DCIA percentage:	81.60	%	Post-development Annual Mass Loading - **Phosphorus:**	2.947 kg/year
Estimated BMPArea (No loading from this area)	0.17	AC		

CATCHMENT NO.3 CHARACTERISTICS:

CLICK ON CELL BELOW TO SELECT

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

with default EMCs

CLICK ON CELL BELOW TO SELECT

Post-development land use: User Defined (must over write concentrations)

with default EMCs

OVERWRITE DEFAULT CONCENTRATIONS:

	PRE:		POST:	
EMC(N):	2.400	mg/L	2.350	mg/L
EMC(P):	0.345	mg/L	0.400	mg/L

OVERWRITE DEFAULT CONCENTRATIONS

Total pre-development catchment area:	0.60	AC	Average annual pre runoff volume:	2.199 ac-ft/year
Total post-development catchment or BMP analysis area:	0.60	AC	Average annual post runoff volume (note no BMP area):	2.096 ac-ft/year
Pre-development Non DCIA CN:	50.00		Pre-development Annual Mass Loading - **Nitrogen:**	6.509 kg/year
Pre-development DCIA percentage:	81.60	%	Pre-development Annual Mass Loading - **Phosphorus:**	0.936 kg/year
Post-development Non DCIA CN:	50.00		Post-development Annual Mass Loading - **Nitrogen:**	6.075 kg/year
Post-development DCIA percentage:	85.00	%	Post-development Annual Mass Loading - **Phosphorus:**	1.034 kg/year
Estimated BMPArea (no loading from this area)	0.05	AC		

CATCHMENT NO.4 CHARACTERISTICS:

CLICK ON CELL BELOW TO SELECT

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

with default EMCs

CLICK ON CELL BELOW TO SELECT

Post-development land use: User Defined (must over write concentrations)

with default EMCs

OVERWRITE DEFAULT CONCENTRATIONS:

	PRE:		POST:	
EMC(N):	2.400	mg/L	2.350	mg/L
EMC(P):	0.345	mg/L	0.400	mg/L

OVERWRITE DEFAULT CONCENTRATIONS

Total pre-development catchment area:	1.80	AC	Average annual pre runoff volume:	6.597 ac-ft/year
Total post-development catchment or BMP analysis area:	1.80	AC	Average annual post runoff volume (note no BMP area):	5.974 ac-ft/year
Pre-development Non DCIA CN:	50.00		Pre-development Annual Mass Loading - **Nitrogen:**	19.527 kg/year
Pre-development DCIA percentage:	81.60	%	Pre-development Annual Mass Loading - **Phosphorus:**	2.807 kg/year
Post-development Non DCIA CN:	50.00		Post-development Annual Mass Loading - **Nitrogen:**	17.314 kg/year
Post-development DCIA percentage:	81.60	%	Post-development Annual Mass Loading - **Phosphorus:**	2.947 kg/year
Estimated BMPArea (no loading from this area)	0.17	AC		

MIXED USE CASE STUDY - PENSACOLA RESULTS
PERVIOUS PAVEMENT

PERVIOUS PAVEMENT: V 7.7

Mixed Use Pcola

Blue Numbers = Input data
Red Numbers = Calculated or Carryover

CONTRIBUTING WATERSHED AND PERVIOUS PAVEMENT CHARACTERISTICS:

GO TO STORMWATER TREATMENT ANALYSIS

VIEW TYPICAL PERVIOUS PAVEMENT SYSTEM SCHEMATIC

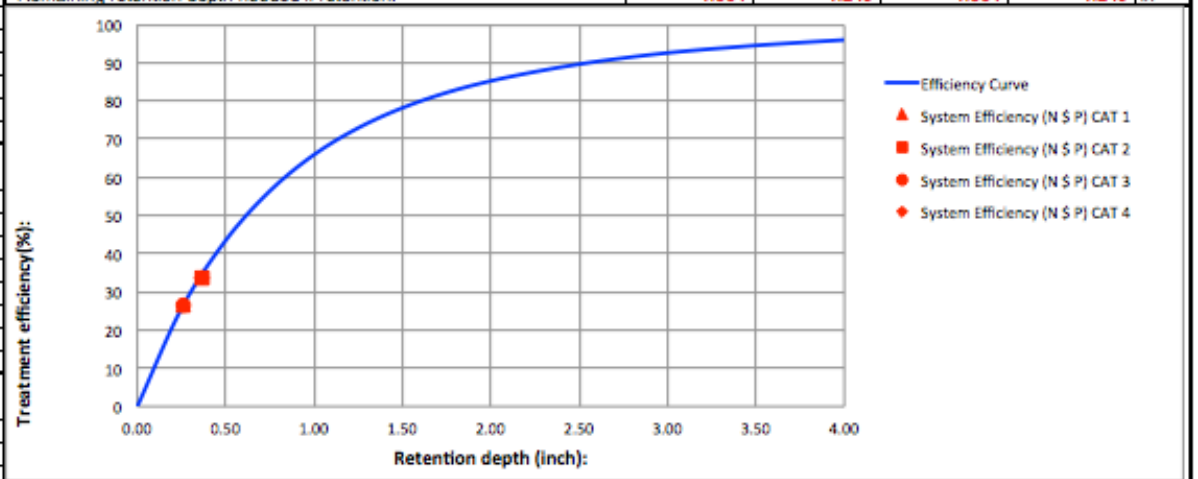
Pervious Pavement Section Storage Calculator (S')

	Layer	Thickness (in):	Void Space (%):	Storage (in):
Catchment 1	Permeable Pavers	4.50	10.00	0.450
	Other Perv. Pvmt. (see note below)			
	#57 rock	8.00	21.00	1.680
	#89 pea rock	4.00	25.00	1.000
	#4 rock		24.00	
	Recycled (crushed) concrete		21.00	
	BOLD & GOLD™		9.00	
	Other Sub Base (see note below)			
Catchment 2	Concrete Pervious Pavement	5.00	25.00	1.250
	Other Perv. Pvmt. (see note below)			
	#57 rock	9.00	21.00	1.890
	#89 pea rock	5.00	25.00	1.250
	#4 rock		24.00	
	Recycled (crushed) concrete		21.00	
	BOLD & GOLD™		9.00	
	Other Sub Base (see note below)			
Catchment 3	Permeable Pavers	4.50	10.00	0.450
	Other Perv. Pvmt. (see note below)			
	#57 rock	8.00	21.00	1.680
	#89 pea rock	4.00	25.00	1.000
	#4 rock		24.00	
	Recycled (crushed) concrete		21.00	
	BOLD & GOLD™		9.00	
	Other Sub Base (see note below)			
Catchment 4	Concrete Pervious Pavement	5.00	25.00	1.250
	Other Perv. Pvmt. (see note below)			
	#57 rock	9.00	21.00	1.890
	#89 pea rock	5.00	25.00	1.250
	#4 rock		24.00	
	Recycled (crushed) concrete		21.00	
	BOLD & GOLD™		9.00	
	Other Sub Base (see note below)			

Note: For other pervious pavement sections and / or other sub-base sections, the user must have the appropriate certified "operational void space percentages" from a licensed geotechnical laboratory.

Note: There are loadings from this BMP area needing treatment.

	Catchment 1	Catchment 2	Catchment3	Catchment 4	
Contributing catchment area:	0.600	1.800	0.600	1.800	ac
Required treatment efficiency (**Nitrogen**):	55.000	55.000	55.000	55.000	%
Required treatment efficiency (**Phosphorus**):	80.000	80.000	80.000	80.000	%
Storage provided in specified pervious pavement system:	3.130	4.390	3.130	4.390	in
Area of the pervious pavement system:	0.050	0.150	0.050	0.150	ac
Provided retention over the contributing catchment area:	0.261	0.366	0.261	0.366	in
Provided treatment efficiency (**Nitrogen**):	26.384	33.883	26.384	33.883	%
Provided treatment efficiency (**Phosphorus**):	26.384	33.883	26.384	33.883	%
Remaining treatment efficiency needed (**Nitrogen**):	38.872	31.939	38.872	31.939	%
Remaining treatment efficiency needed (**Phosphorus**):	72.832	69.751	72.832	69.751	%
Remaining retention depth needed if retention:	1.354	1.249	1.354	1.249	in



MIXED USE CASE STUDY - PENSACOLA RESULTS
TREE WELLS

Tree Well V 7.7

Blue Numbers =	Input data
Red Numbers =	Calculated or Carryover

Tree wells that can include interceptor storage: Mixed Use Pcola

GO TO STORMWATER TREATMENT ANALYSIS

Loadings from BMP area are contained, thus no BMP area load.	Catchment 1	Catchment 2	Catchment3	Catchment 4	
Contributing catchment area:	0.550	1.630	0.550	1.630	ac
Required treatment efficiency (**Nitrogen**):	55.000	55.000	55.000	55.000	%
Required treatment efficiency (**Phosphorus**):	80.000	80.000	80.000	80.000	%
Vegetated Area (Tree Well) depth	3.00	3.00	3.00	3.00	ft
Tree Well Storage (intentional + canopy capture)	0.50	0.50	0.50	0.50	ft
Vegetated Area (Tree Well) length:	6.00	6.00	6.00	6.00	ft
Vegetated Area (Tree Well) width:	6.00	6.00	6.00	6.00	ft
Sustainable water storage capacity of the soil:	0.20	0.20	0.20	0.20	
Number of similar Areas within watershed:	20.00	30.00	20.00	30.00	
Retention depth for provided hydraulic capture efficiency:	0.397	0.201	0.397	0.201	in
Is this a retention or detention system?	Retention	Retention	Retention	Retention	
View Media Mixes#					
Provided treatment efficiency (**Nitrogen**):	36.087	20.568	36.087	20.568	%
Provided treatment efficiency (**Phosphorus**):	36.087	20.568	36.087	20.568	%
Is/are the vegetated areas sufficient?	NO	NO	NO	NO	
# see media mixes for recommended TP and TN removals	0.000	0.000	0.000	1.414	

REQUIRED REMAINING TREATMENT EFFICIENCIES OF TREATMENT SYSTEM IN SERIES WITH VEGETATED AREAS. USE FOR SIZING OF TREATMENT SYSTEM IN SERIES WITH VEGETATED AREAS.

	Catchment 1	Catchment 2	Catchment3	Catchment 4	
Remaining treatment efficiency needed (**Nitrogen**):	29.592	43.348	29.592	43.348	%
Remaining treatment efficiency needed (**Phosphorus**):	68.708	74.821	68.708	74.821	%

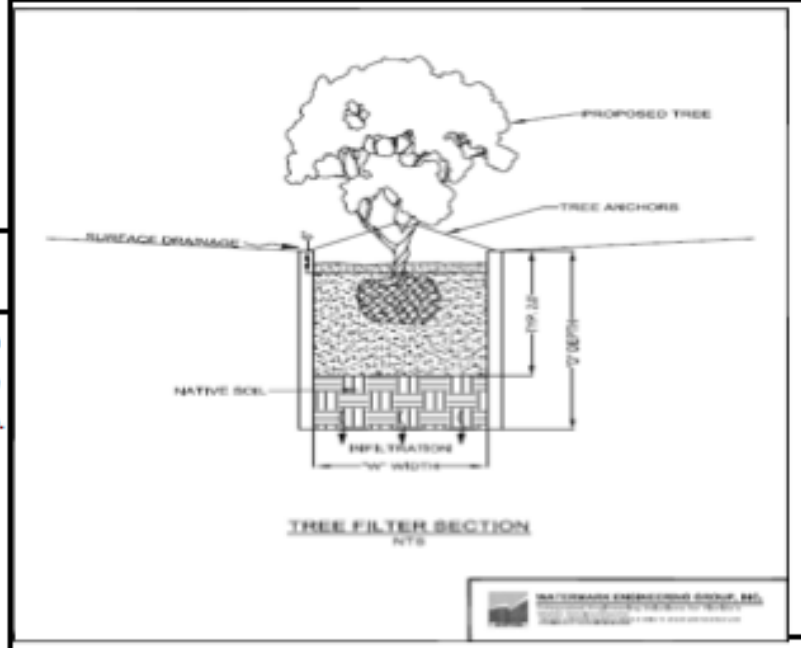
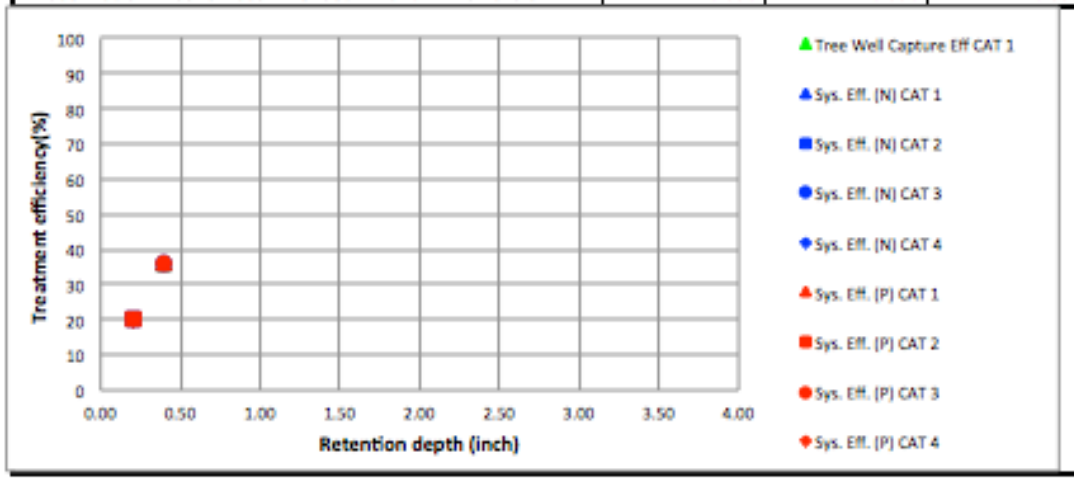


Image Courtesy of Watermark Engineering Group, Inc.



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. The graph illustrates that there is a point of diminished return as the retention depth is substantially increased. Therefore, to provide the most economical BMP treatment system, other alternatives such as "treatment trains" and compensatory treatment should be considered.

MIXED USE CASE STUDY - PENSACOLA RESULTS
RAIN GARDENS

RAIN GARDEN — 8/22/16 — V 8.0

These are depressed areas in a landscape for the storage of runoff water.

Blue Numbers = Input data
Red Numbers = Calculated or Carryover

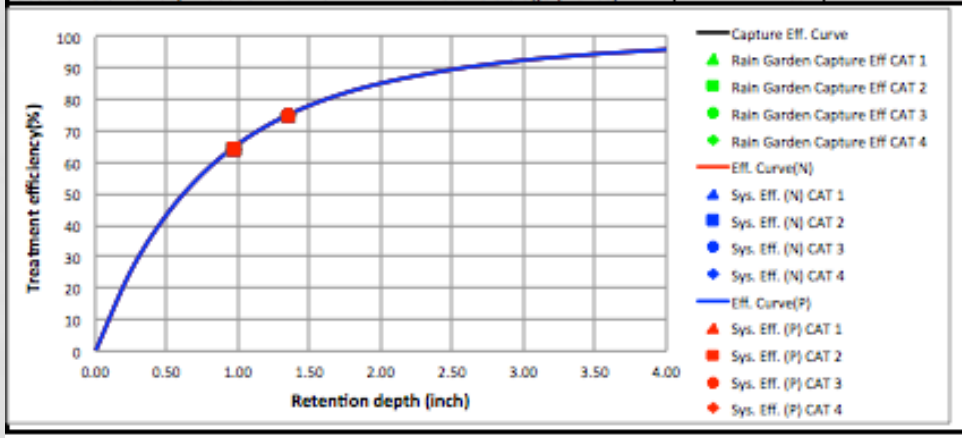
GO TO STORMWATER TREATMENT ANALYSIS

Loadings from BMP area are contained by the BMP, thus no BMP area load.

	Catchment 1	Catchment 2	Catchment 3	Catchment 4	
Contributing catchment area:	0.550	1.630	0.550	1.630	ac
Required treatment efficiency (**Nitrogen**):	55.000	55.000	55.000	55.000	%
Required treatment efficiency (**Phosphorus**):	80.000	80.000	80.000	80.000	%
Provided retention depth for hydraulic capture efficiency (see below):	1.352	0.963	1.352	0.963	in
Provided retention volume for hydraulic capture efficiency:	0.062	0.131	0.062	0.131	ac-ft
Is this a retention or detention system?	Retention	Retention	Retention	Retention	
Select media mix (View Media Mixes)	B&G CTS12	B&G CTS12	B&G CTS12	B&G CTS12	
Provided treatment efficiency (**Nitrogen**):	75.063	64.522	75.063	64.522	
Provided treatment efficiency (**Phosphorus**):	75.063	64.522	75.063	64.522	

Volume Storage Input data

Sustainable void space fraction	0.30	0.30	0.30	0.30	
Media volume CF =	4000	4000	4000	4000	
Water above media in CF =	1500	4500	1500	4500	
Thus volume storage CF=	2700	5700	2700	5700	
Used for retention depth above in row 10 & volume storage (inches) =	1.352	0.963	1.352	0.963	



NOTE FOR TREATMENT EFFICIENCY GRAPH:

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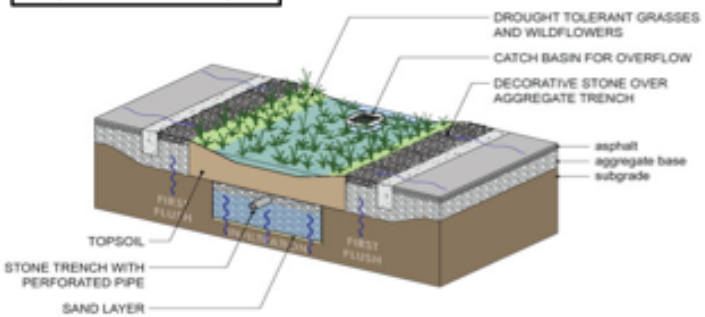
REQUIRED REMAINING TREATMENT EFFICIENCIES OF TREATMENT SYSTEM IN SERIES WITH RAIN GARDEN. USE FOR SIZING OF TREATMENT SYSTEM IN SERIES WITH RAIN GARDEN.

	Catchment 1	Catchment 2	Catchment 3	Catchment 4	
Remaining treatment efficiency needed (**Nitrogen**):	0.000	0.000	0.000	0.000	%
Required pre-treatment efficiency (**Phosphorus**):	19.798	43.627	19.798	43.627	%

Example of a media detention system



Source of Graphic: http://www.stormh2o.com

MIXED USE CASE STUDY - PENSACOLA RESULTS

CATCHMENTS AND TREATMENT SUMMARY RESULTS V 8.0

Blue Numbers = Input data
Red Numbers = Calculated or Carryover

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

GO TO STORMWATER TREATMENT ANALYSIS

GO TO WATERSHED CHARACTERISTICS

PROJECT TITLE	Mixed Use Pensacola	Optional Identification		
	Catchment 1	Catchment 2	Catchment 3	Catchment 4
BMP Name	Pervious Pavement	Pervious Pavement	Pervious Pavement	Pervious Pavement
BMP Name	Tree Well	Tree Well	Tree Well	Tree Well
BMP Name	Rain Garden	Rain Garden	Rain Garden	Rain Garden

Thank you for using this BMPTRAINS model.

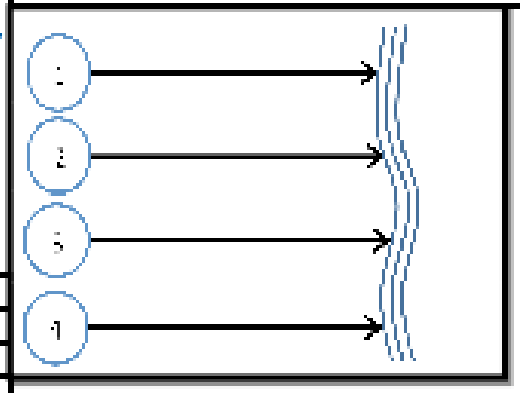
NOTE: Multiple BMPs in a single catchment are treated as in series for calculation purposes. If the BMPs are not in series use multiple catchments. There can be a maximum of 3 BMPs in a single catchment.

Summary Performance of Entire Watershed

Catchment Configuration	L - 4 Catchment-Parallel	Treatment Objectives or Target MET	
Nitrogen Pre Load (kg/yr)	52.59		
Phosphorus Pre Load (kg/yr)	7.56		
Nitrogen Post Load (kg/yr)	46.78		
Phosphorus Post Load (kg/yr)	7.96		
Target Load Reduction (N) %	55		
Target Load Reduction (P) %	80		
Target Discharge Load, N (kg/yr)	21.05		
Target Discharge Load, P (kg/yr)	1.59		
Provided Overall Efficiency, N (%):	80		
Provided Overall Efficiency, P (%):	80		
Discharged Load, N (kg/yr & lb/yr):	9.18	20.22	
Discharged Load, P (kg/yr & lb/yr):	1.56	3.44	
Load Removed, N (kg/yr & lb/yr):	37.60	82.81	
Load Removed, P (kg/yr & lb/yr):	6.40	14.10	

8/22/16

BMPTRAINS MODEL



GO TO GENERAL SITE INFORMATION PAGE

HELP - SERIES

HELP - 3 CATCHMENTS

GO TO COST ANALYSIS WORKSHEET