FSA 2020 Annual Conference
Pre-Conference Session

Getting Maximum Use of Your Stormwater BMPs

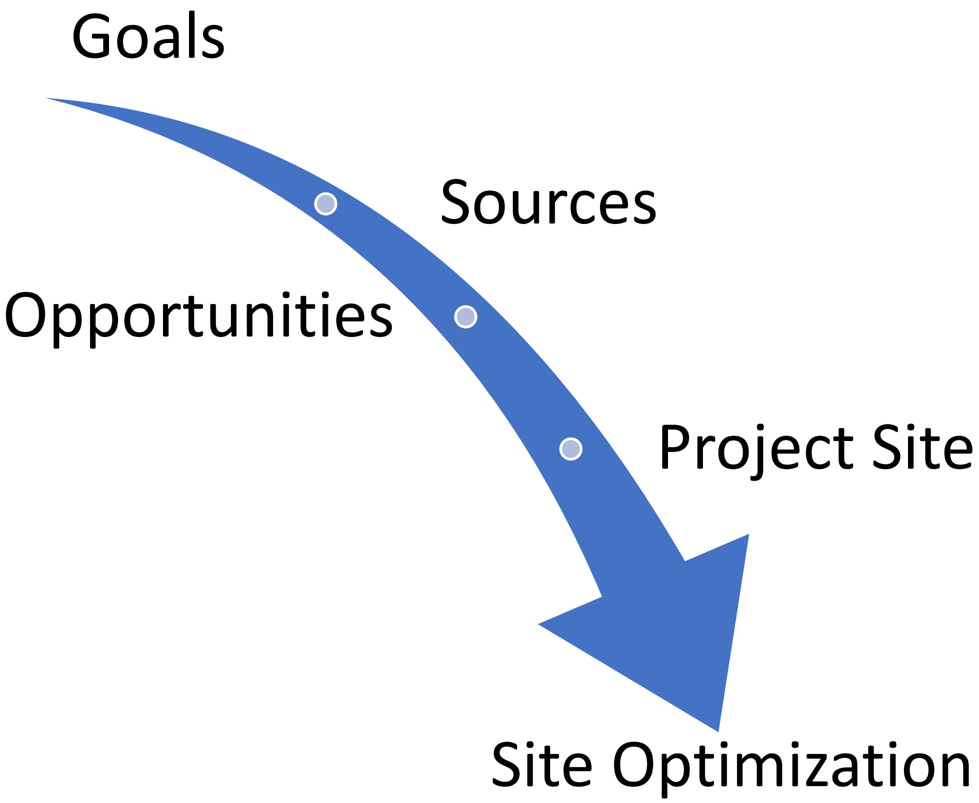
Alachua County, Florida

Brown AND Caldwell

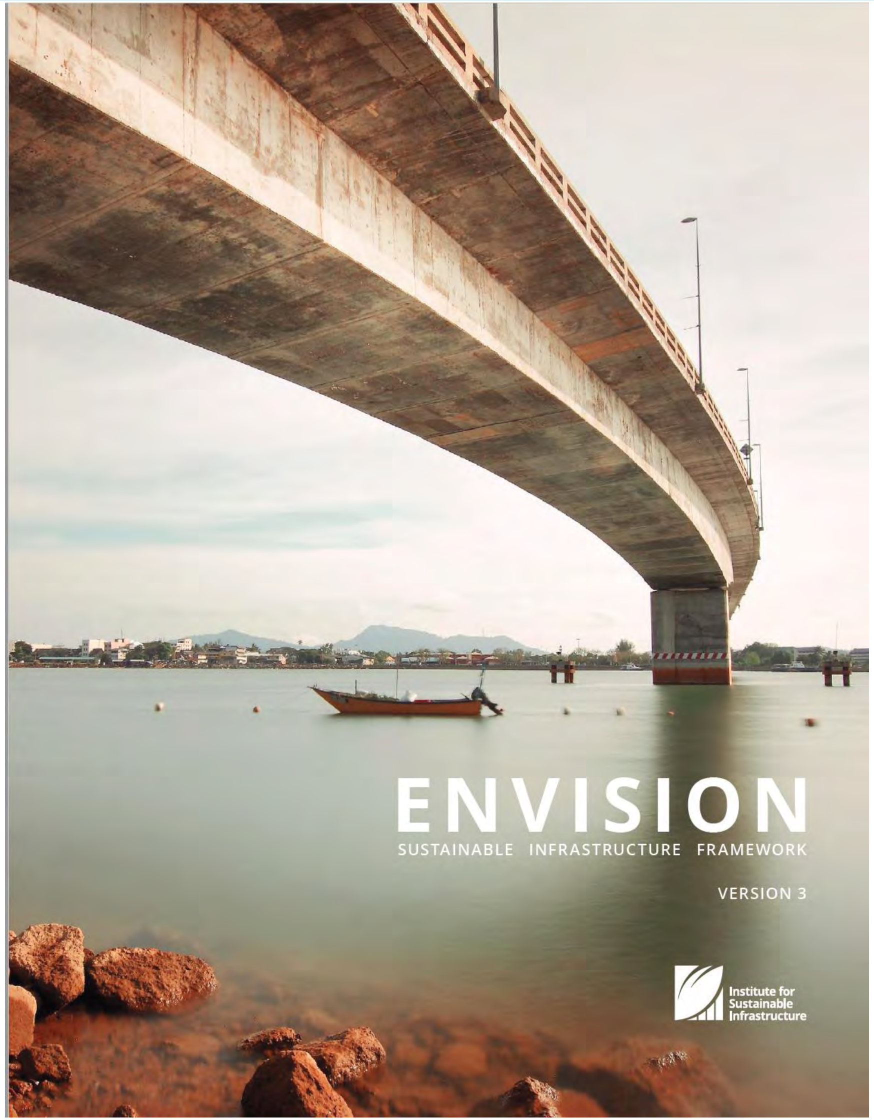
JonesEdmunds

BMP Strategies and Selection

- Retrofit vs. new development
- Watershed scale



Existing Frameworks



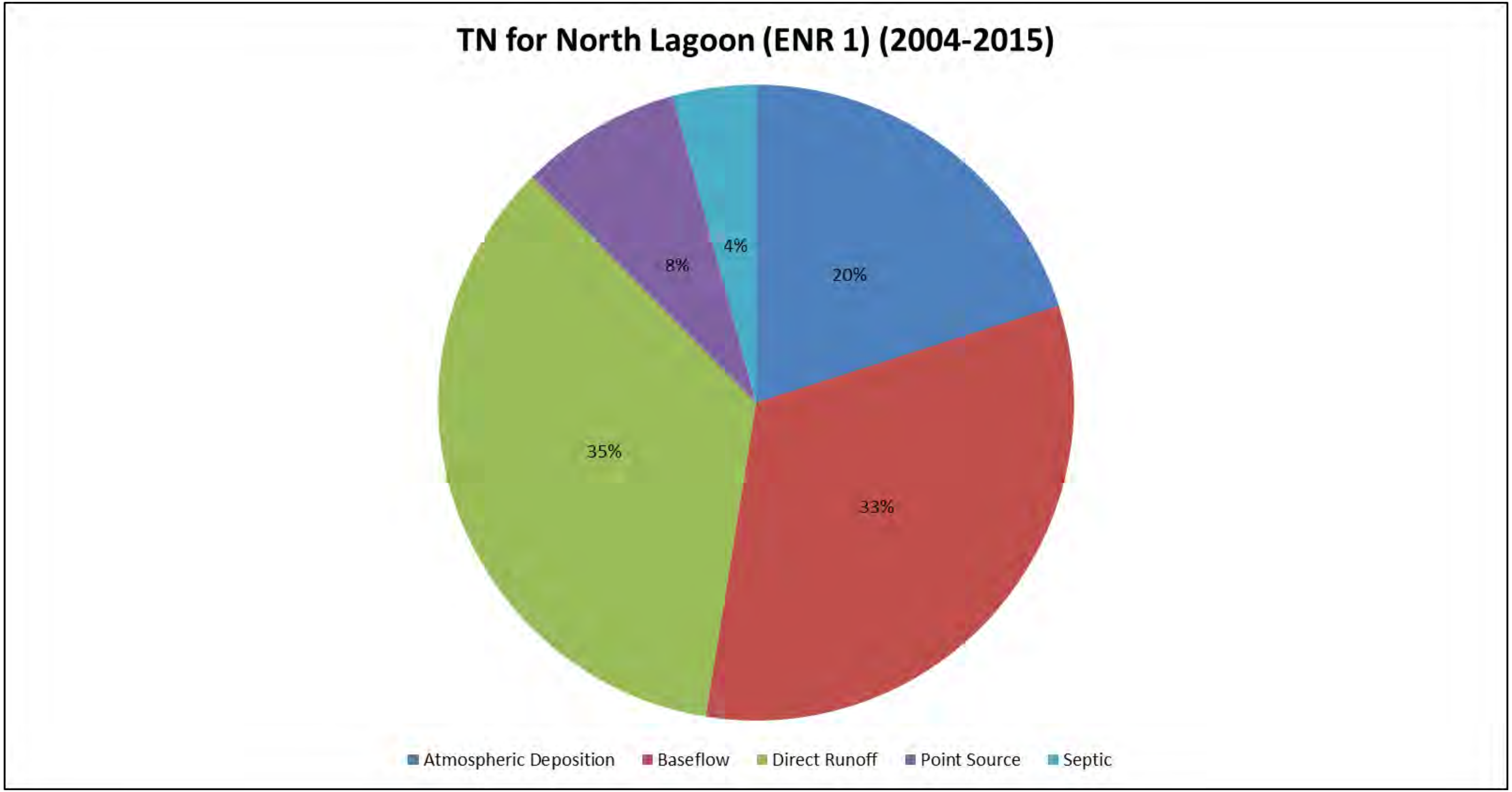
ENVISION POINTS TABLE

Category	Subcategory	Credit	Improved	Enhanced	Superior	Conserving	Restorative	Maximum Points
Quality of Life	Wellbeing	QL1.1 Improve Community Quality of Life	2	5	10	20	26	200
		QL1.2 Enhance Public Health & Safety	2	7	12	16	20	
		QL1.3 Improve Construction Safety	2	5	10	14	—	
		QL1.4 Minimize Noise & Vibration	1	3	6	10	12	
		QL1.5 Minimize Light Pollution	1	3	6	10	12	
		QL1.6 Minimize Construction Impacts	1	2	4	8	—	
	Mobility	QL2.1 Improve Community Mobility	1	3	7	11	14	
		QL2.2 Encourage Sustainable Transportation	—	5	8	12	16	
		QL2.3 Improve Access & Wayfinding	1	5	9	14	—	
	Community	QL3.1 Advance Equity & Social Justice	3	6	10	14	18	
		QL3.2 Preserve Historic & Cultural Resources	—	2	7	12	18	
		QL3.3 Enhance Views & Local Character	1	3	7	11	14	
		QL3.4 Enhance Public Space & Amenities	1	3	7	11	14	
Leadership	Collaboration	LD1.1 Provide Effective Leadership & Commitment	2	5	12	18	—	182
		LD1.2 Foster Collaboration & Teamwork	2	5	12	18	—	
		LD1.3 Provide for Stakeholder Involvement	3	6	9	14	18	
		LD1.4 Pursue Byproduct Synergies	3	6	12	14	18	
	Planning	LD2.1 Establish a Sustainability Management Plan	4	7	12	18	—	
		LD2.2 Plan for Sustainable Communities	4	6	9	12	16	
		LD2.3 Plan for Long-Term Monitoring & Maintenance	2	5	8	12	—	
		LD2.4 Plan for End-of-Life	2	5	8	14	—	
	Economy	LD3.1 Stimulate Economic Prosperity & Development	3	6	12	20	—	
		LD3.2 Develop Local Skills & Capabilities	2	4	8	12	16	
		LD3.3 Conduct a Life-Cycle Economic Evaluation	5	7	10	12	14	
Resource Allocation	Materials	RA1.1 Support Sustainable Procurement Practices	3	6	9	12	—	196
		RA1.2 Use Recycled Materials	4	6	9	16	—	
		RA1.3 Reduce Operational Waste	4	7	10	14	—	
		RA1.4 Reduce Construction Waste	4	7	10	16	—	
		RA1.5 Balance Earthwork On Site	2	4	6	8	—	
	Energy	RA2.1 Reduce Operational Energy Consumption	6	12	18	26	—	
		RA2.2 Reduce Construction Energy Consumption	1	4	8	12	—	
		RA2.3 Use Renewable Energy	5	10	15	20	24	
		RA2.4 Commission & Monitor Energy Systems	3	6	12	14	—	
	Water	RA3.1 Preserve Water Resources	3	5	7	9	12	
		RA3.2 Reduce Operational Water Consumption	4	9	13	17	22	
		RA3.3 Reduce Construction Water Consumption	1	3	5	8	—	
		RA3.4 Monitor Water Systems	1	3	6	12	—	
Natural World	Siting	NW1.1 Preserve Sites of High Ecological Value	2	6	12	16	22	232
		NW1.2 Provide Wetland & Surface Water Buffers	2	5	10	16	20	
		NW1.3 Preserve Prime Farmland	—	2	8	12	16	
		NW1.4 Preserve Undeveloped Land	3	8	12	18	24	
	Conservation	NW2.1 Reclaim Brownfields	11	13	16	19	22	
		NW2.2 Manage Stormwater	2	4	9	17	24	
		NW2.3 Reduce Pesticide & Fertilizer Impacts	1	2	5	9	12	
		NW2.4 Protect Surface & Groundwater Quality	2	5	9	14	20	
	Ecology	NW3.1 Enhance Functional Habitats	2	5	9	15	18	
		NW3.2 Enhance Wetland & Surface Water Functions	3	7	12	18	20	
		NW3.3 Maintain Floodplain Functions	1	3	7	11	14	
		NW3.4 Control Invasive Species	1	2	6	9	12	
		NW3.5 Protect Soil Health	—	3	4	6	8	
Climate and Resilience	Emissions	CR1.1 Reduce Net Embodied Carbon	5	10	15	20	—	190
		CR1.2 Reduce Greenhouse Gas Emissions	8	13	18	22	26	
		CR1.3 Reduce Air Pollutant Emissions	2	4	9	14	18	
	Resilience	CR2.1 Avoid Unsuitable Development	3	6	8	12	16	
		CR2.2 Assess Climate Change Vulnerability	8	14	18	20	—	
		CR2.3 Evaluate Risk and Resilience	11	18	24	26	—	
		CR2.4 Establish Resilience Goals and Strategies	—	8	14	20	—	
		CR2.5 Maximize Resilience	11	15	20	26	—	
		CR2.6 Improve Infrastructure Integration	2	5	9	13	18	
							Maximum TOTAL Points	1,000

Goal-based Strategy

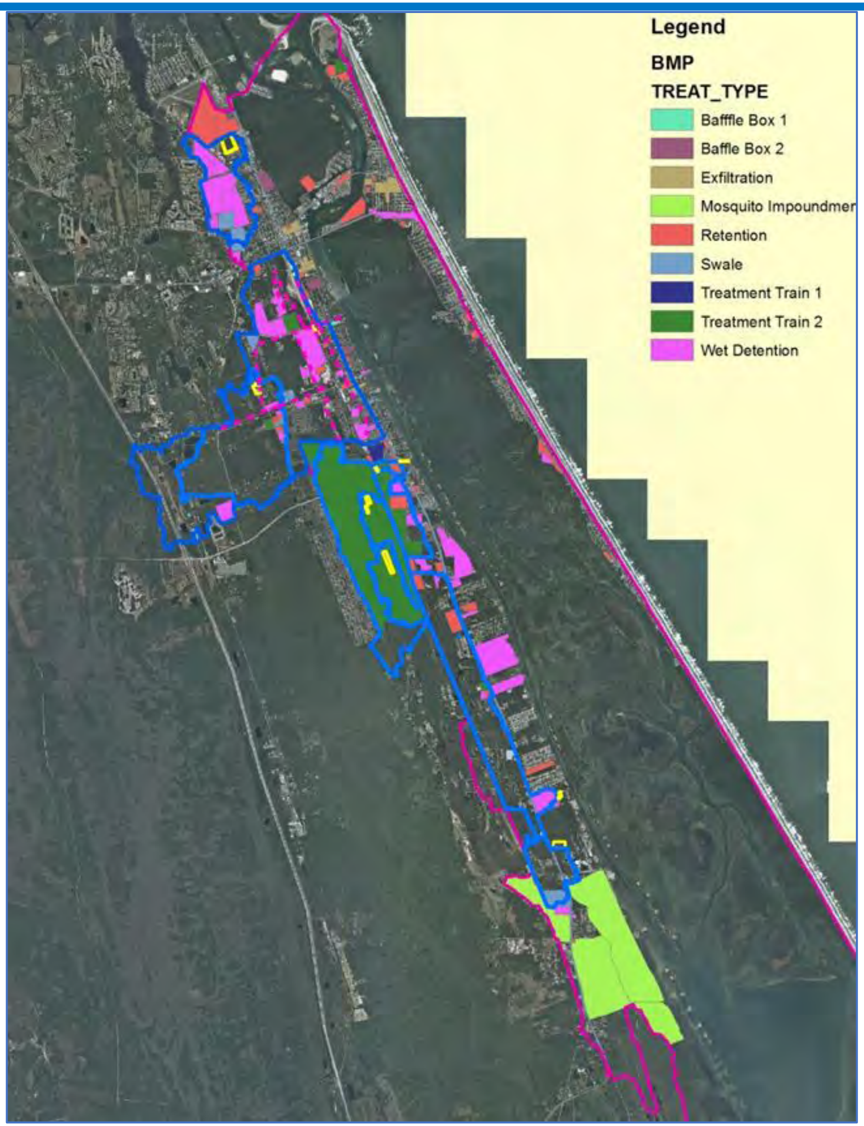
WBID	Parameter	WLA		LA (lbs/yr)[2]	MOS	TMDL (lbs/yr)[2]	Percent Reduction[2]
		Wastewater (lbs/yr)[1]	NPDES Stormwater[2]				
2720A	TN	41,003	45% reduction	215,319	Implicit	256,322	45%

Strategy - Understanding Pollutant Sources



Strategy - Identifying Existing Treatment and Opportunities

- What is currently being treated?
- What land could be available?
- Where are the regional opportunities?
- Retrofit existing projects?



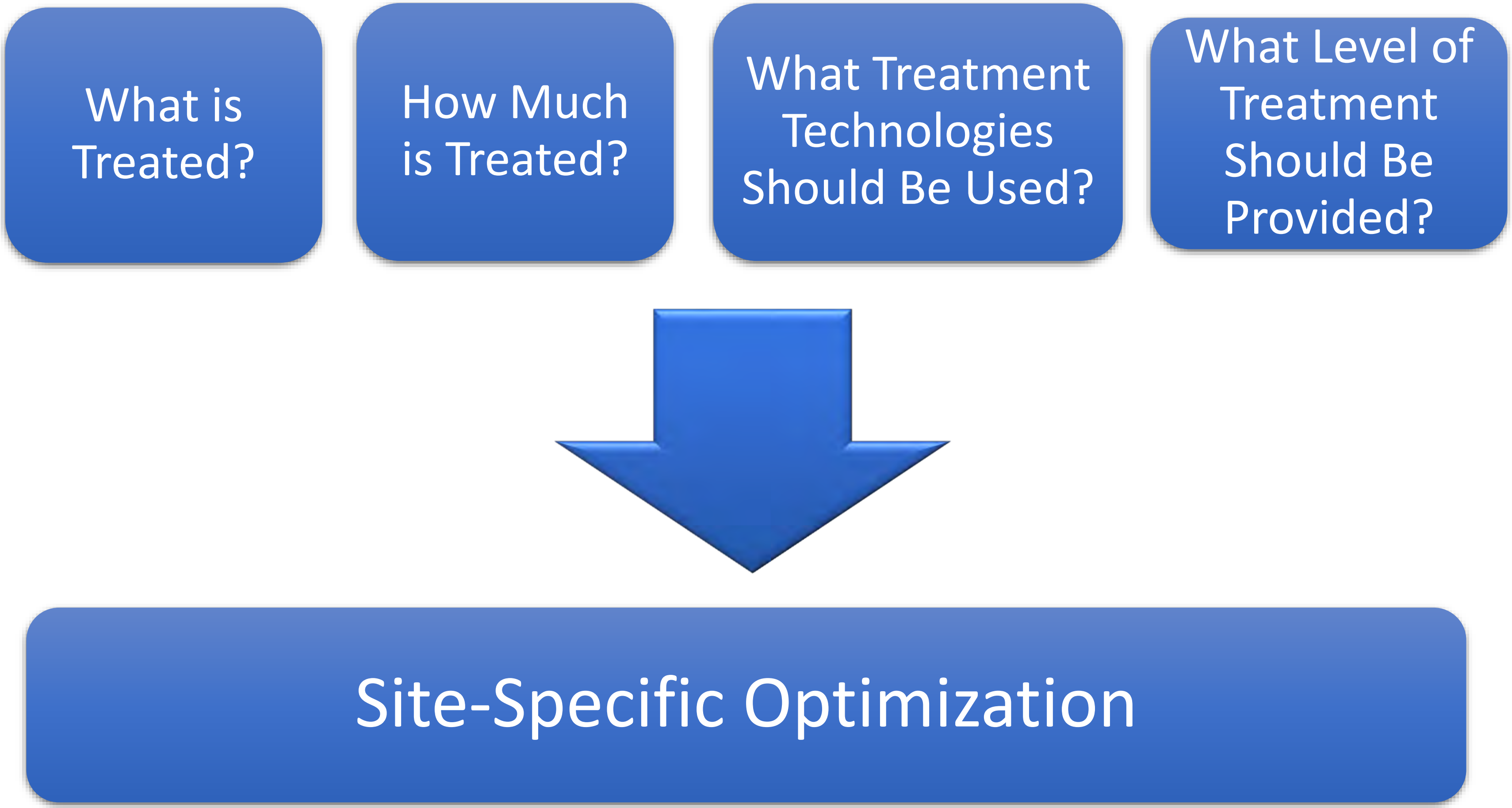
Strategy - Exhaust Least-Cost Options First

Source Controls, Pollutant Trading, Some LID Measures → Regional or Large-Scale BMPs → Smaller-Scale BMPs

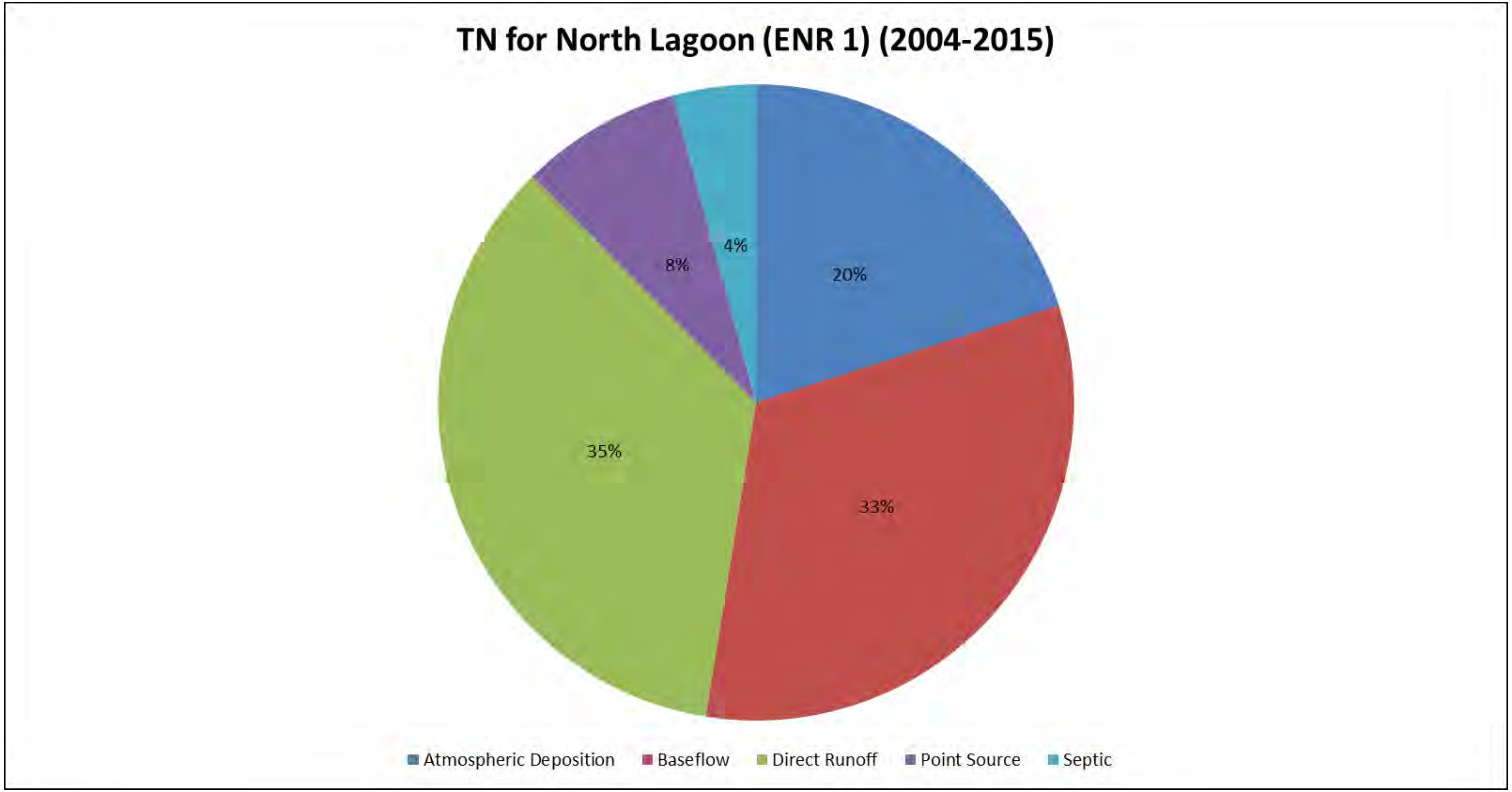
Planning of Individual BMPs

- Lowest $/lb-removed life cycle costs
- O&M and sustainability considered
- Permitting and water quality reasonable assurance
- Consideration of grant funding
- Awareness of multiple purposes

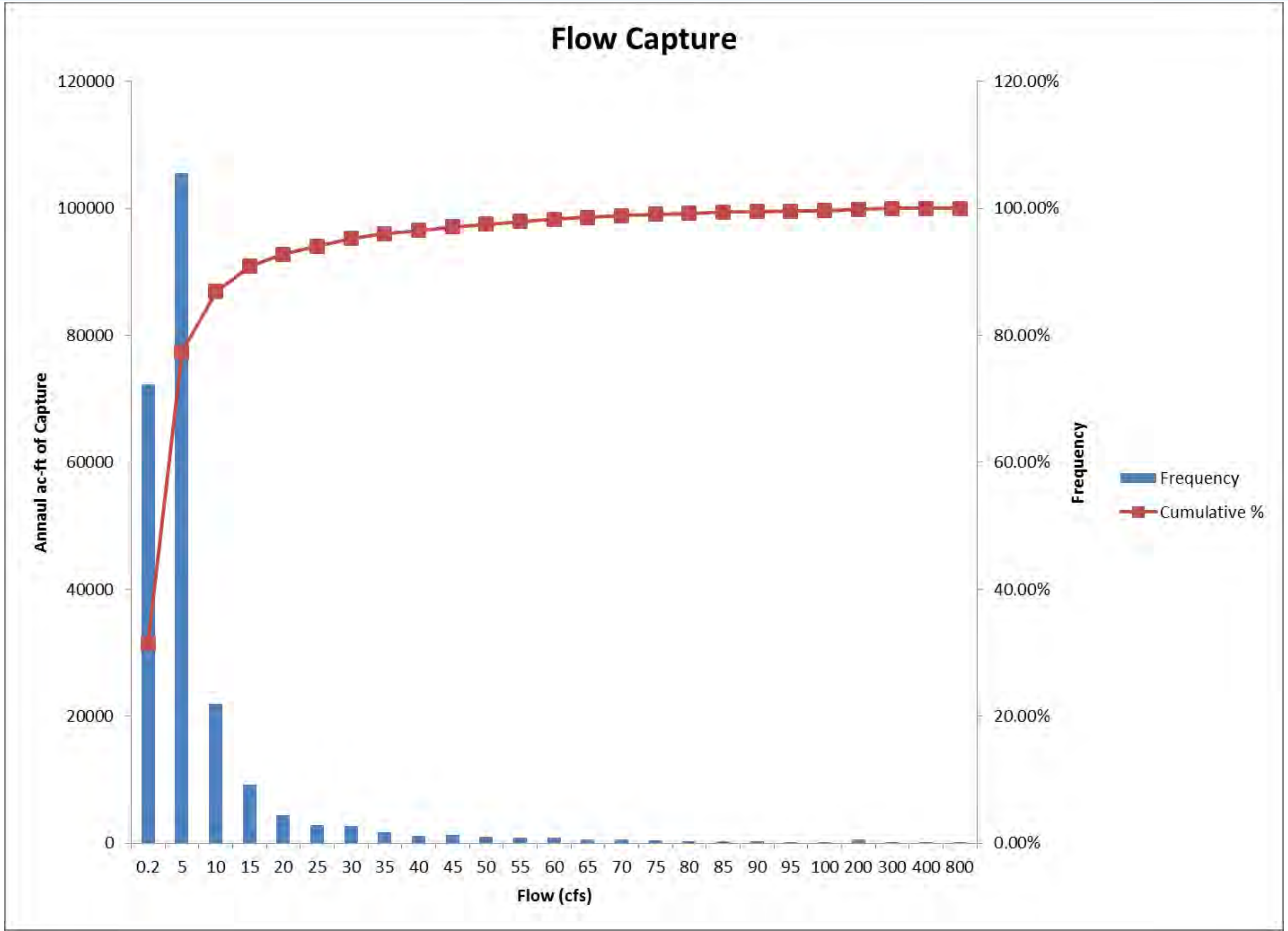
Optimizing BMP Design



What is Treated?

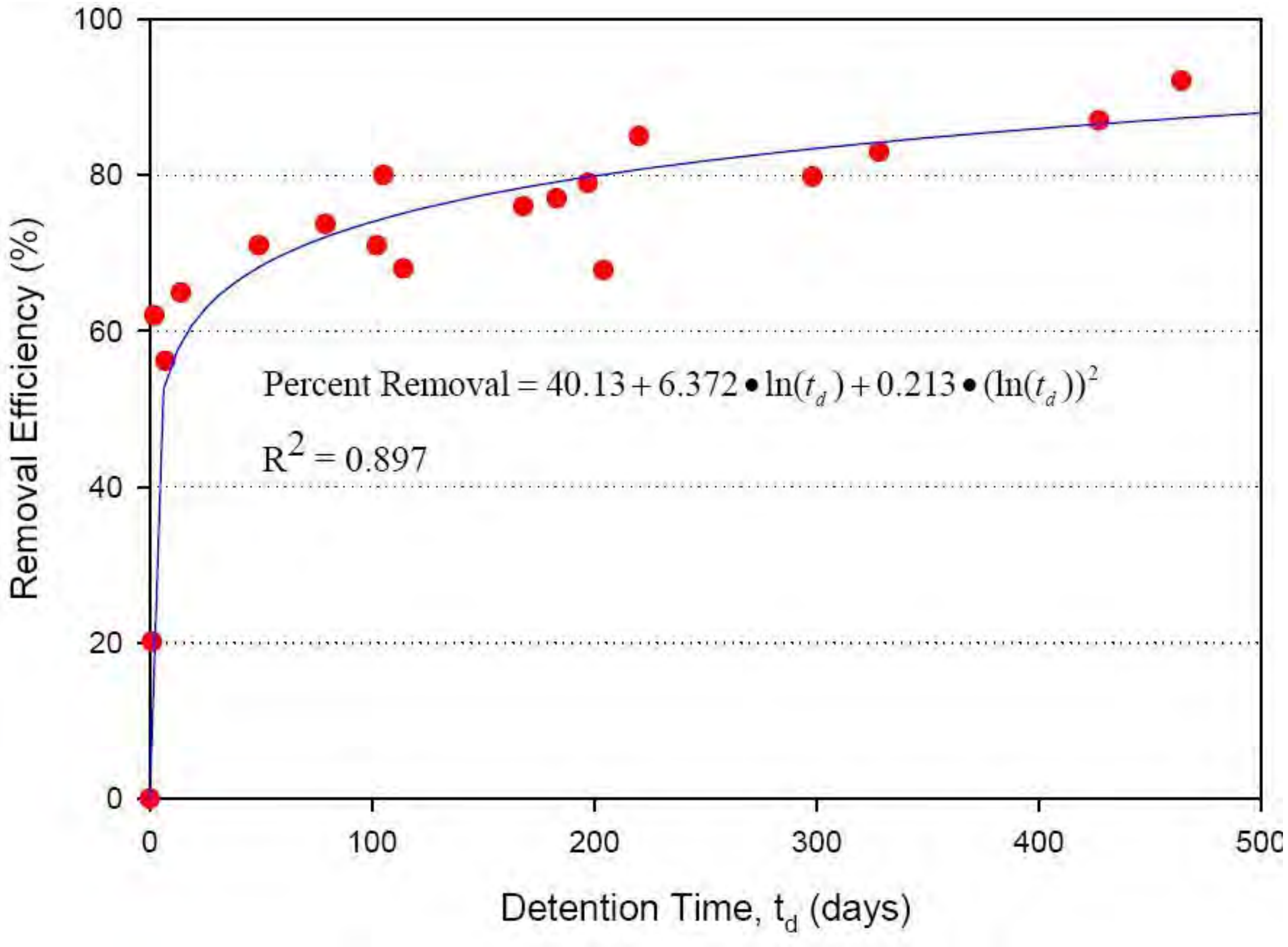


How Much is Treated?



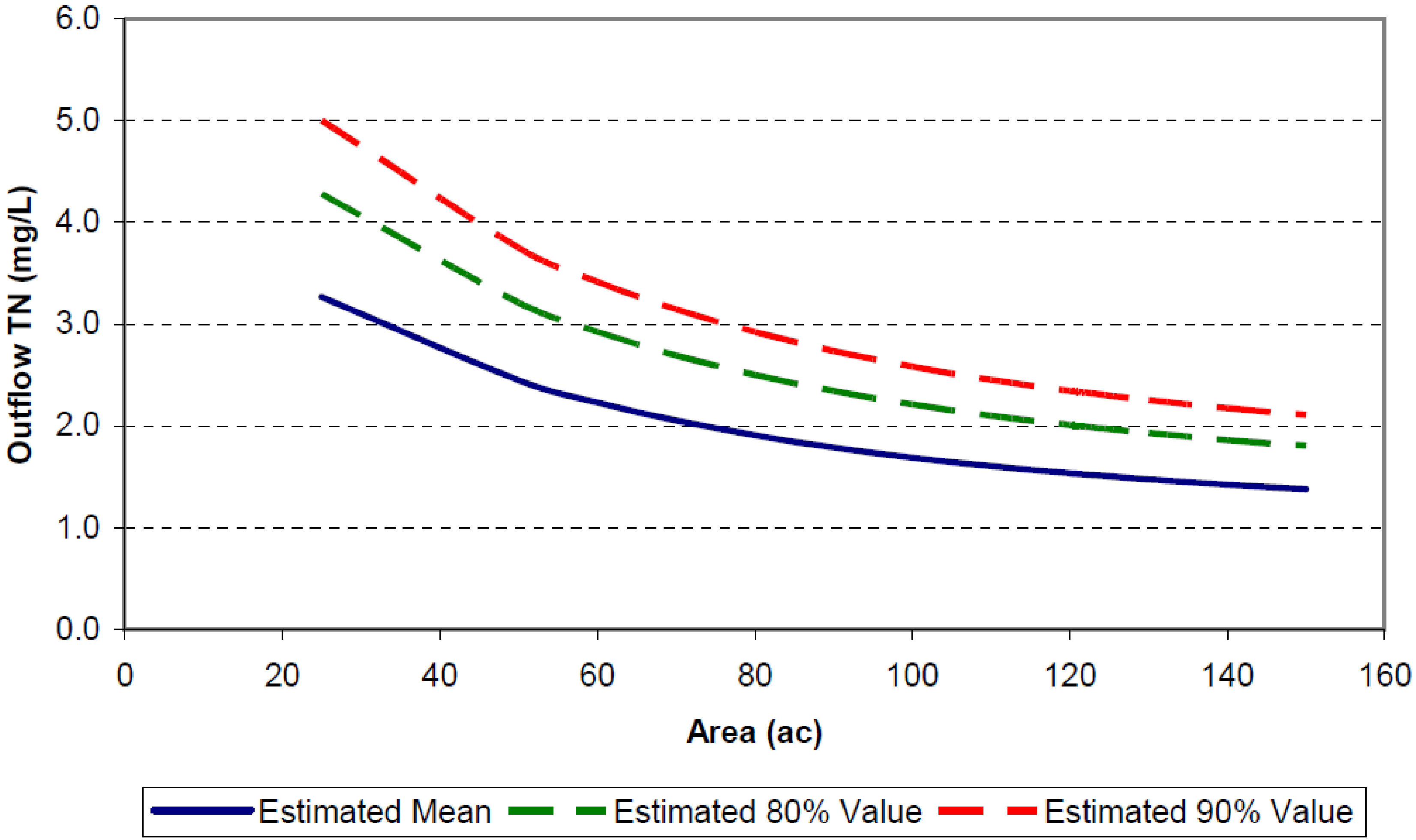
What Treatment Technologies Should Be Used?

What Level of Treatment Should Be Provided?

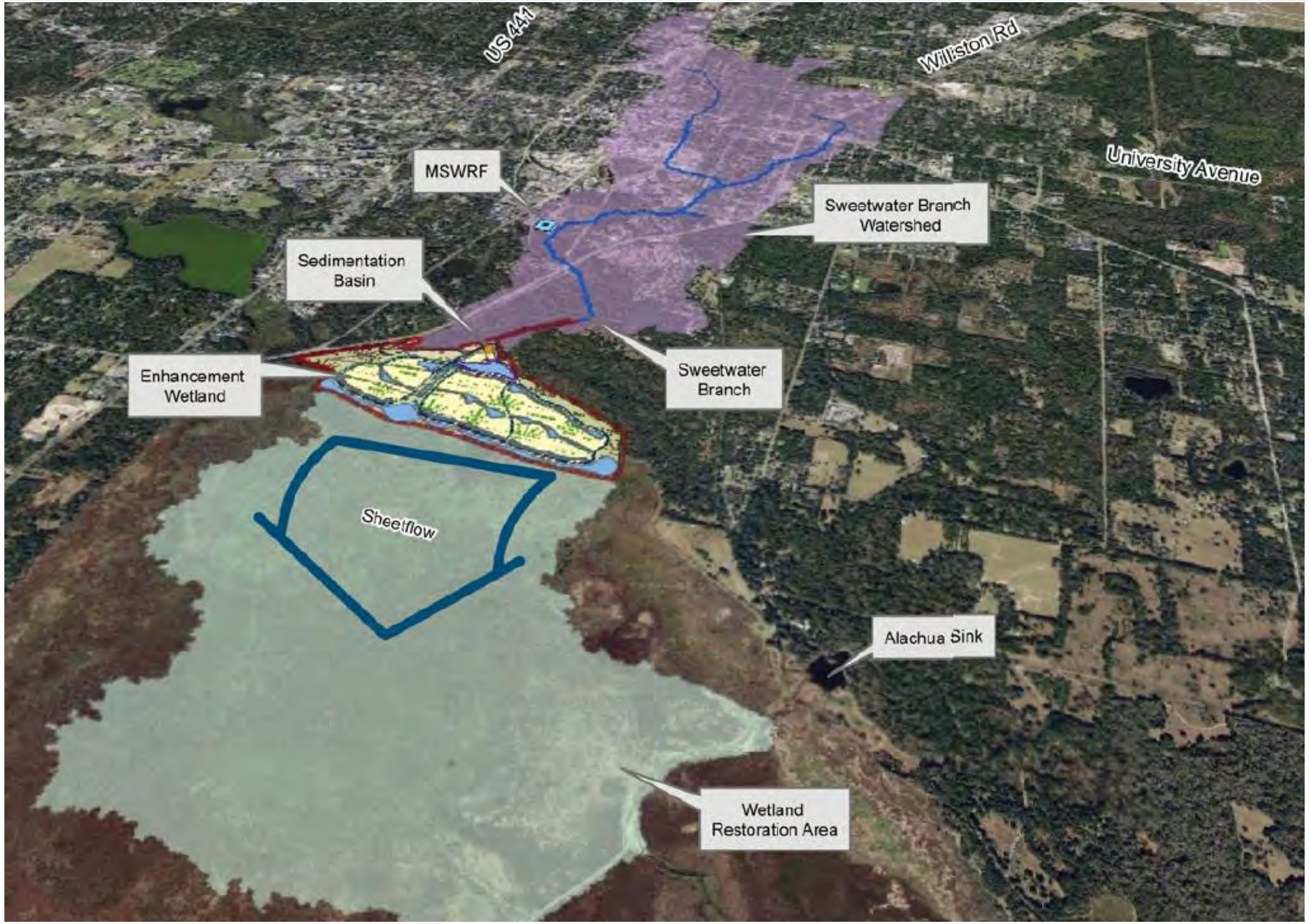


Harper and Baker, 2007

What Level of Treatment Should Be Provided?



Site-Specific Optimization



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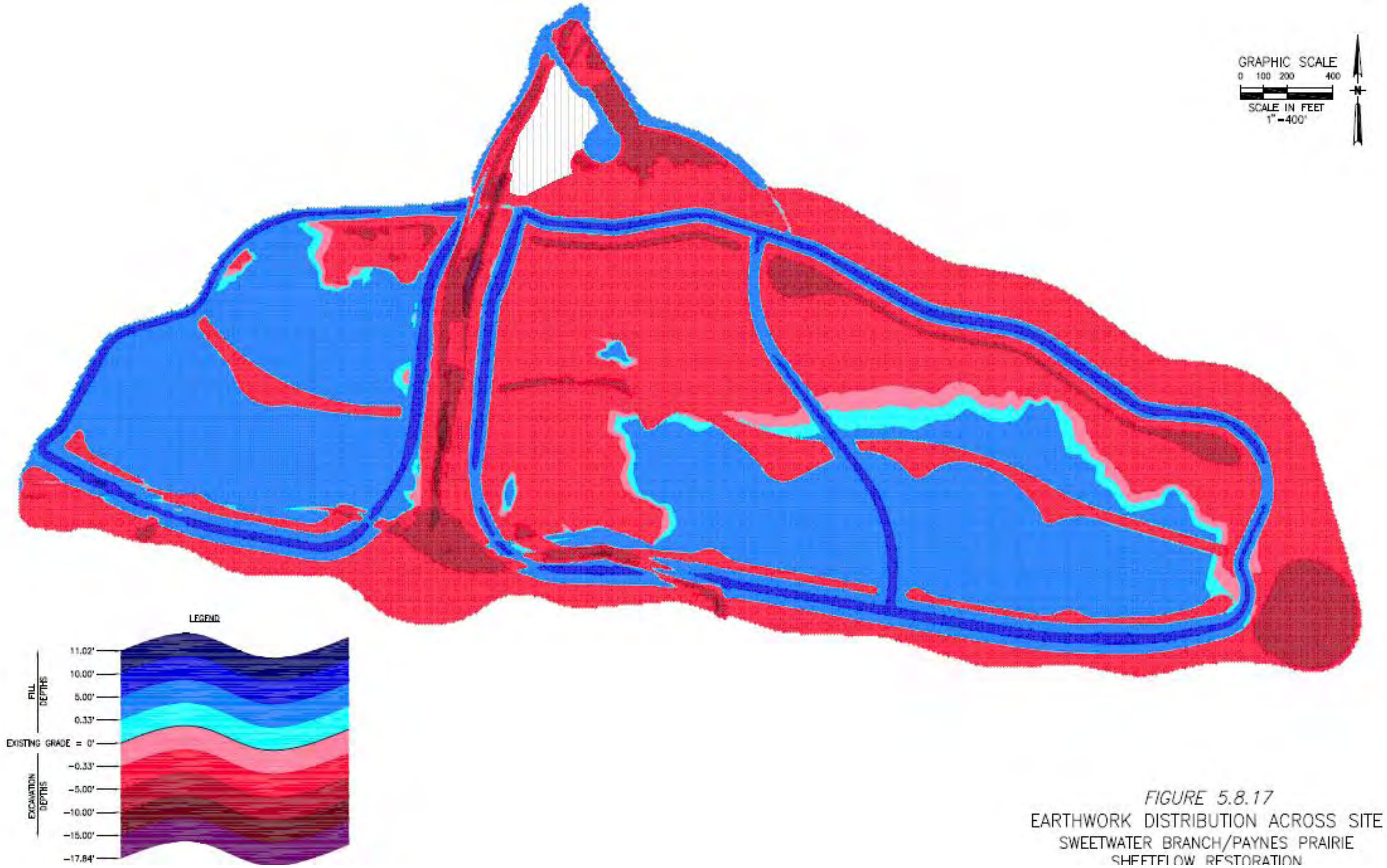


Hydrology: Most rainfall events are 1-inch or less Manage common rain events for WQ improvement

Rainfall Event Range (inches)	Mean Rainfall Depth (inches)	Mean Rainfall Duration (hours)	Fraction of Annual Rain Events	Number of Annual Events in Range
0.00-0.10	0.041	1.203	0.427	56.683
0.11-0.20	0.152	2.393	0.142	18.866
0.21-0.30	0.252	3.073	0.080	10.590
0.31-0.40	0.353	3.371	0.055	7.312
0.41-0.50	0.456	3.702	0.048	6.325
0.51-1.00	**0.713**	**4.379**	**0.129**	**17.102 (117)**
1.01-1.50	1.221	5.758	0.051	6.733
1.51-2.0	1.726	7.852	0.024	3.145
2.01-2.50	2.271	8.090	0.011	1.470
2.51-3.00	**2.704**	**10.675**	**0.006**	**0.726**
3.01-3.50	3.246	9.978	0.003	0.391
3.51-4.00	3.667	13.362	0.002	0.260
4.01-4.50	4.216	15.638	0.001	0.149
4.51-5.00	4.796	17.482	0.000	0.056
5.01-6.00	5.454	23.303	0.001	0.167
6.01-7.00	6.470	40.500	0.000	0.019
7.01-8.00	7.900	31.500	0.000	0.019
8.01-9.00	8.190	3.500	0.000	0.019
>9.00	10.675	46.250	0.001	0.075

Minimal runoff from pervious areas and N-DCIA

Even in HSG 'D' soils – DCIA is the driver

Rainfall	Runoff depth for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77

Which Pollutants? Which Forms?

- Sediment
- Biochemical oxygen demand
- Pathogens
- Phosphorus: SRP, OP, TP
- Nitrogen: TKN = Org N + NH_3; NOX = NO_2 + NO_3

  TN = TKN + NOX

  (Only some forms of nutrients are bioavailable)
- Metals
- Toxic compounds

Organic or inorganic, dissolved or particulate

BMP Selection Criteria

- Land area availability/ownership/access
- Site characteristics
- Regulatory requirements and constraints
- Mass pollutant load reduction/environmental benefits
- Construction/Annual O&M/Life cycle cost
- Maintenance staff availability/sophistication
- Decreased maintenance of problem areas
- Public acceptance
- Non-engineering/cost factors
- Funding partners/Grant potential
- Piggyback on other planned capital improvements
- Regional vs. many smaller systems

Evaluation and Selection of Projects

- Identify primary and secondary pollutants
- Determine min and max influent pollutant concentrations and stormwater flow rates
- Determine desired removal efficiencies
- Identify available land area
- Identify effective treatment train components
- Evaluate potential treatment trains based on BMP Selection Criteria Factors
- Implement best solution – keep pushing forward, you will have obstacles!

Table 5-9. Evaluation Criteria and Option Scoring for the Lake Eva Project							
Selection Criteria	Priority*	Description	Weight	Option 1 Score	Option 2 Score	Option 1 Points	Option 2 Points
Improve Lake Eva Water Quality	1	Achieve Lake Water Quality Improvement for Key Parameters including Total Phosphorus and Chlorophyll-a	15	6	9	90	135
Address Lake Eva Low Water Level Concerns	2	Address Regulatory Requirements for Maintaining MFL in Lake Eva	12	6	9	72	108
Meet Regional Integrated Water Resources Needs	3	Follow Central Florida Water Initiative (CFWI) guidelines, use regional approach to solving multi- jurisdictional "One Water" needs	10	7	9	70	90
Provide Groundwater Recharge and Water Supply Credits	3	Infiltrate "Excess" Water into project area groundwater system with the goal of generating water supply credits	10	6	6	60	60
Minimize Need for Land Acquisition and Easements	4	Maximize the use of existing public lands and easements for project improvements and minimize the need to acquire additional private land or easements	9	8	7	72	63
Utilize Existing Infrastructure and Natural Conveyances	4	Maximize natural conveyance and maintain existing drainage system infrastructure is such a way that it's compatible with maximizing natural conveyance.	9	8	8	72	72
Public / Stakeholder Acceptance	5	Consensus of acceptance by Stakeholders, Residences, and Businesses	7	7	8	49	56
Life-Cycle Cost	6	Lowest combined Capital and O&M Costs for 20- year life per unit of benefit	6	5	8	30	48
Provide Natural Systems Enhancement	7	Improve ecosystem form and function within the project area	5	5	9	25	45
Recreational Benefits	7	Maintain or improve Lake Recreational Benefits (Swimming, boating, fishing, etc.)	5	7	9	35	45
Social Benefits	7	Provide public benefits such as increased property value, economic development, educational opportunities, aesthetics, etc.	5	7	9	35	45
Reduce Lake Henry Flooding During Wet Weather Periods	8	Reduce extent/depth of flooding for residents adjacent to Lake Henry for the 100-year, 24-hour event based on existing flood maps	4	7	7	28	28
Minimize Impacts (temporary/permanent) to residences and businesses	9	Construction and Operation of Proposed Improvements has minimal impact on residences and businesses	3	7	7	21	21
Likelihood or Ease of Permitting	10	Regulatory Acceptability and Less Time/Lower Cost for Project Permitting	2	7	5	14	10
Proven Treatment/Recharge Approach	11	Use project elements which are effective and meet regulatory requirements	1	8	8	8	8
** = Rank from 1 to 15, "1" is most preferred*		*Each criterion scored from 1 to 10, 10 is best Max. Option points = 1030*	TOTALS			681	834

Treatment Train - Implementing Cost Effective BMPs For Non-Point Source Management

MAXIMIZE
Runoff & Load Generation

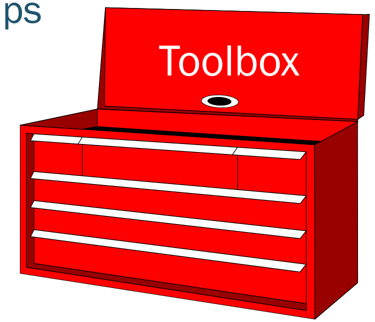
→ Conveyance and Pretreatment

→ Additional Treatment & Attenuation

→ **MINIMIZE**
Final Treatment and Attenuation

Runoff & Load Generation	Conveyance and Pretreatment	Additional Treatment & Attenuation	Final Treatment and Attenuation
Regulations	Swales	Detention	Retention
Public education	Catch Basins	Wetland	Detention
Erosion control	Inlets filters	Storage	Wetland
Roof runoff	Oil/water separators	Sediment sump	Chemical
Disconnect IA	Trash/sediment traps		Ozone
Landscaping			UV
Pervious paving			Reuse
Pavement cleaning			End of pipe

GI



Relative Comparison of Structural BMP Pollutant Removal Effectiveness

POLLUTANT	INFILTRATION/ VOLUME REDUCTION	DETENTION	WETLAND[1]	CHEMICAL COAGULATION	FILTRATION/ UV	FILTRATION/ OZONE	LIQUID/SOLIDS SEPARATION STUCTURE
Nitrogen	H - VH	L - M	L – H	L - M	L - M	L - M	L
Phosphorus	H - VH	L - M	L – H	H - VH	L - M	L - M	L
TSS	H - VH	H	H	H - VH	H - VH	H -VH	L – M
BOD	H - VH	L - M	M	M	M – H	M – H	L – M
Heavy Metals	H - VH	L - M	M - H	M - H	L - M	L – M	L – M
Pathogens	H - VH	L	L	H - VH	VH	VH	L
Gross Solids	H - VH	H	H	L - H	VH	VH	H-VH

1. Highly dependent on influent pollutant concentration and hydraulic loading rate

VH – Very High H – High M – Medium L- Low

Comparison of BMP Treatment Efficiencies for Primary Pollutants

Type of BMP	Estimated Removal Efficiencies (% Load Reduction)			
	TN	TP	TSS	BOD
INFILTRATION/REUSE Volume Reduction 1.00" VOLUME 1.50" VOLUME	 80 90	 80 90	 80 90	 80 90
WET DET (14-21 day WSRT)	25-35	60-70	90	50-70
WET DET/FILTER	0-10	50	85	70
DRY DETENTION	10-20	20-40	20-60	20-50
DRY DET/FILTER	(-)-20	(-)-20	40-60	0-50
CHEMICAL TREATMENT	20-40	80-90	>90	30-60
WETLAND TREATMENT	(-)-90	(-)-90	50-90	(-)-50

BMP Life Cycle Cost Comparisons are highly variable

Retrofit BMP	Life Cycle Cost per kg TP removed ($)	Life Cycle Cost per kg TN removed ($)
Pet Waste Education	**150 - 300**	**20 - 40**
Second Generation Baffle Box	**400 – 1,600**	**250 - 500**
Wet Detention Pond	200 - 2,400	100 - 1,000
Dry Detention Basin	1,500 - 7,000	1,250 - 2,500
LID - Bioretention	1,000- 40,000	500 - 5,000
Stream Restoration	1,000 - 4,000	300 - 600
Chemical Treatment	**90 - 180**	**50 - 100**
Enhanced Wetland Treatment	**100 - 200**	**100 - 200**

Larger - regional systems tend to have significantly lower life cycle costs per mass of TP and TN removed than many smaller systems. LID for new construction is more cost effective.

Recreational and Educational Elements

Include recreational elements to allow a stormwater treatment system to be useful to the public and a benefit to community

Lessons Learned on BMP Design – LID and Innovative BMPs

- Conventional stormwater BMPs designs are standardized
  - They can have problems but standardization helps implementation

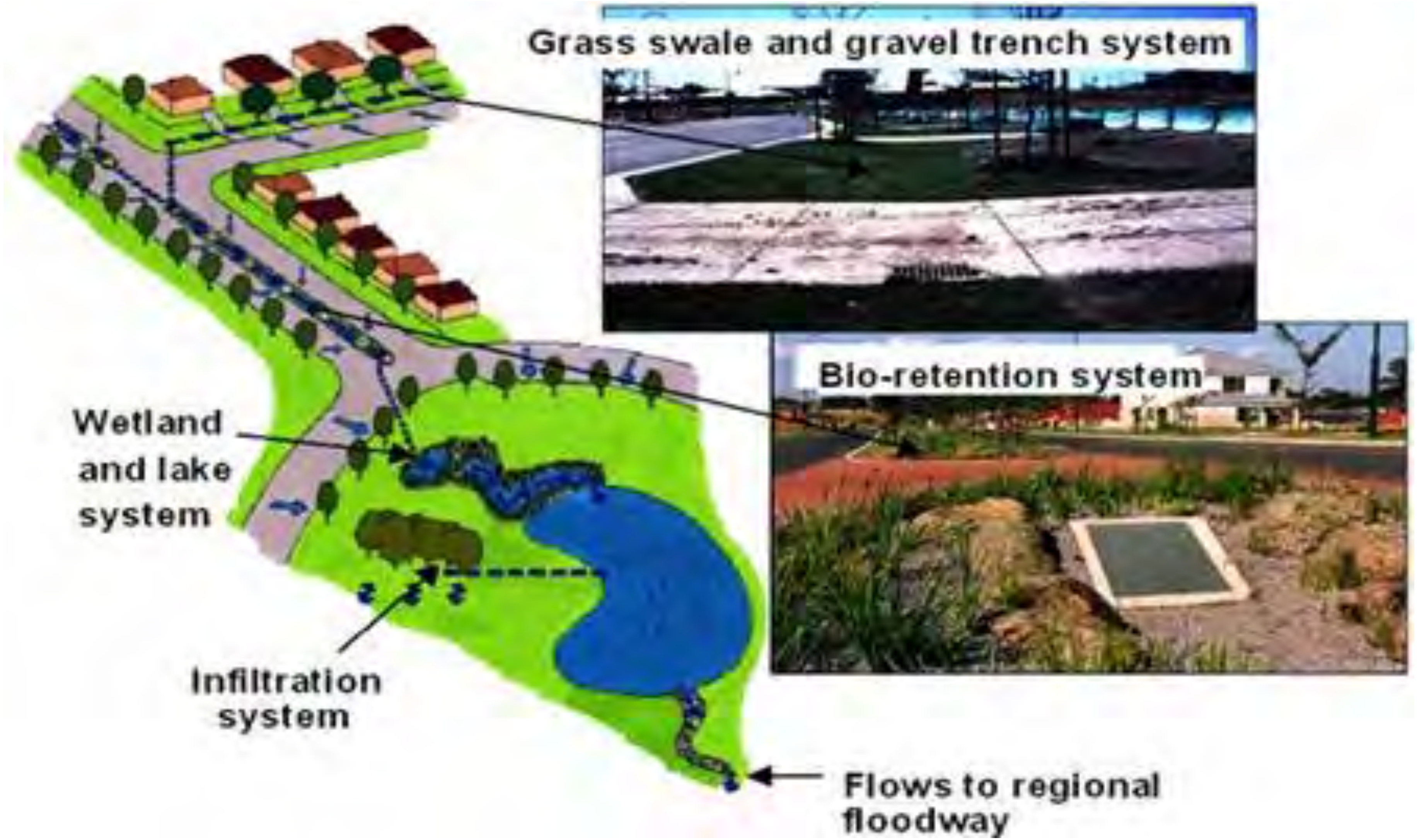
- Innovative and Low Impact Design (development) BMPs are not.
  - The lack of design standards and examples hinders implementation

Lessons Learned on BMP Design – LID and Innovative BMPs

- Lessons learned from:
  - Design and construction of local government projects
  - Designs to met local regulatory requirements
    - In 2018 Alachua County enacted code that requires LID BMPs in certain areas

- Some lessons:
  - There is no consistent method for incorporating LID in design calculations which dis-incentivizes some BMPs
  - Conflicts with other codes and comp plans are possible
  - Designs for nitrogen removal remain a challenge
  - Lack of experience or design standards can lead to poor implementation or construction problems
  - Maintenance issues exist

Lessons Learned on BMP Design – LID and Innovative BMPs



Lack of Consistent Design Calculation Methods

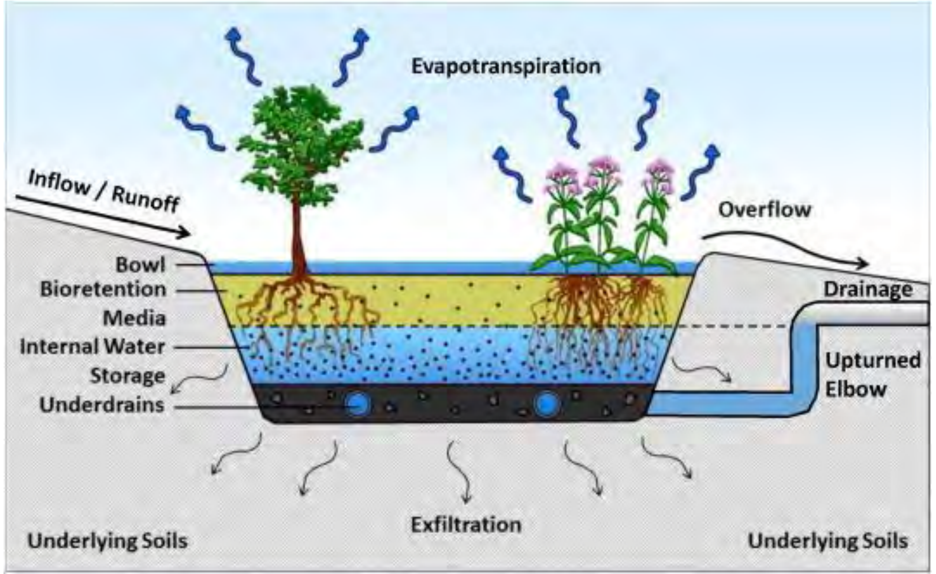
- If this parking lot was pervious asphalt a curve number credit would be given
- But no runoff quantity credit for bioretention islands unless each is modeled
- The end result is that bioretention is designed as an end-of-pipe pre-treatment area adjacent to retention pond

Conflicts With Other Codes

- If the land development regulations require curb and gutter then this isn't possible

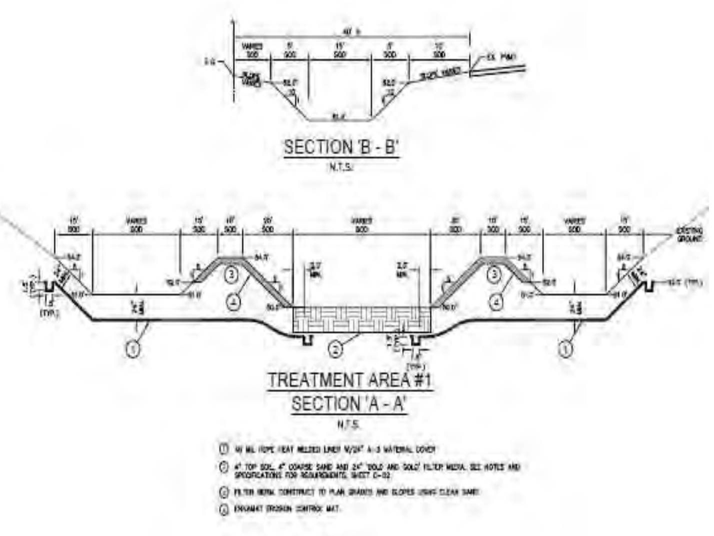
- LID BMPs can take up more space…so do other things like conservation areas, open space, common areas, rights-of-way, etc.
  - LID BMPs are stormwater BMPs…where are stormwater BMPs allowed?

The Challenge of Nitrogen Removal



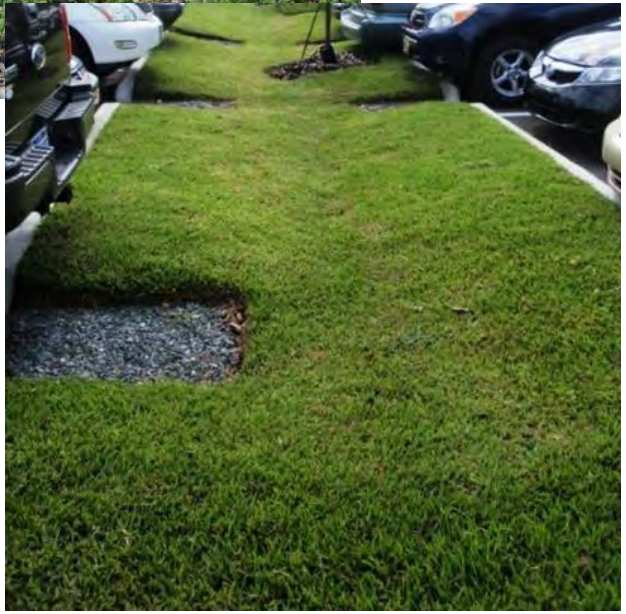
- BMP designs that provide improved nitrogen removal:
  - Biosorption Activated Media (BAM)
  - Internal Water Storage (IWS)
- BAM has the advantage of:
  - More installations and monitoring
  - It can be used in LID and conventional BMPs
  - No liner so retention (infiltration) still possible
- But cost is a concern
- IWS designs haven't been adapted to Florida…yet

We All Make Bad Decisions…



- All BMPs have potential for problems (e.g. retention pond + karst = sinkhole)
- LID BMPs have some unique concerns:
  - Aesthetics – the wrong plants or poor plant location
  - Poor site location – sedimentation or debris buildup
  - Construction errors – improper placement of BAM

Maintenance



- LID BMPs do sometimes have unique maintenance concerns
  - Plantings to maintain
  - Media needing replacement
  - Sweeping of pervious pavements

- Not taking into account the maintenance required can lead to problems later on

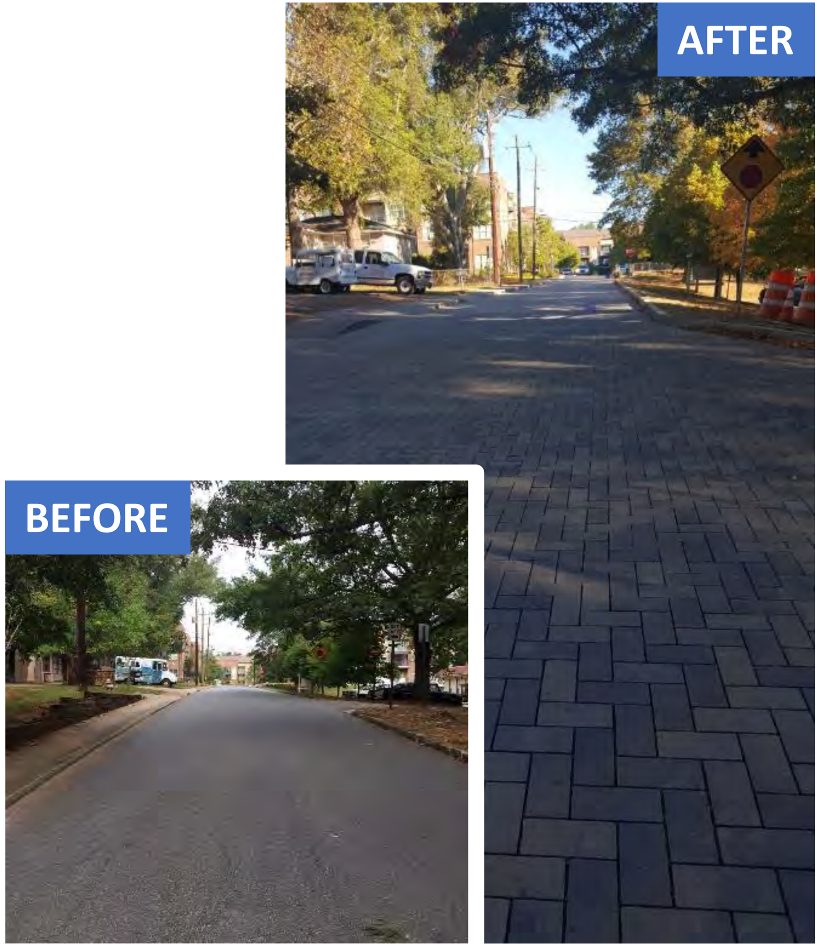
- Another long term issue is making sure these sometimes small scale practices remain in place.

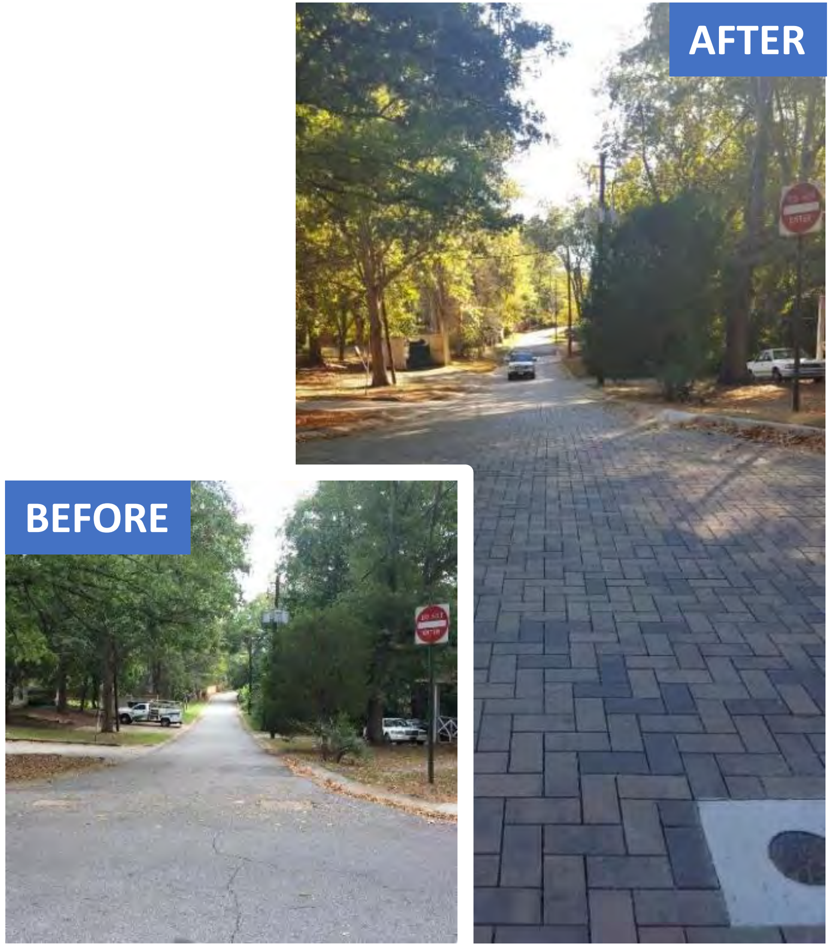
Permeable Paver Projects
Lessons Learned

Myrtle Street and Zion Circle - 1st permeable paver project

- Goal – demonstration project,
- Financing – City Stormwater funds, 319(h) grant, and new BMP credit policy
- Public Outreach – brochure, sign
- Unique – Established Shared Stormwater Policy
- Area 12,400 sf
- Cost $325,984 ($26/sf)

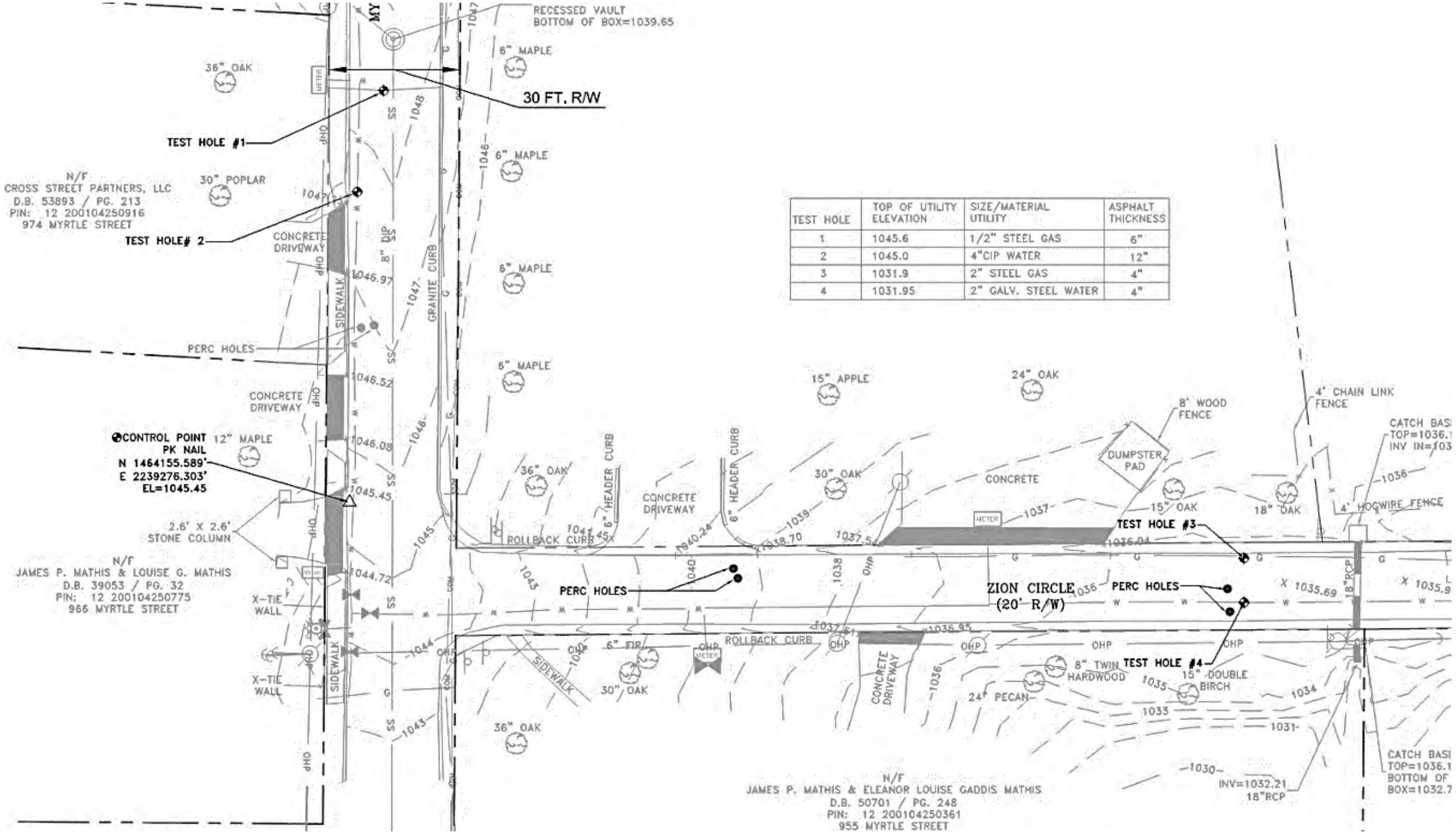
Myrtle Street/Zion Circle





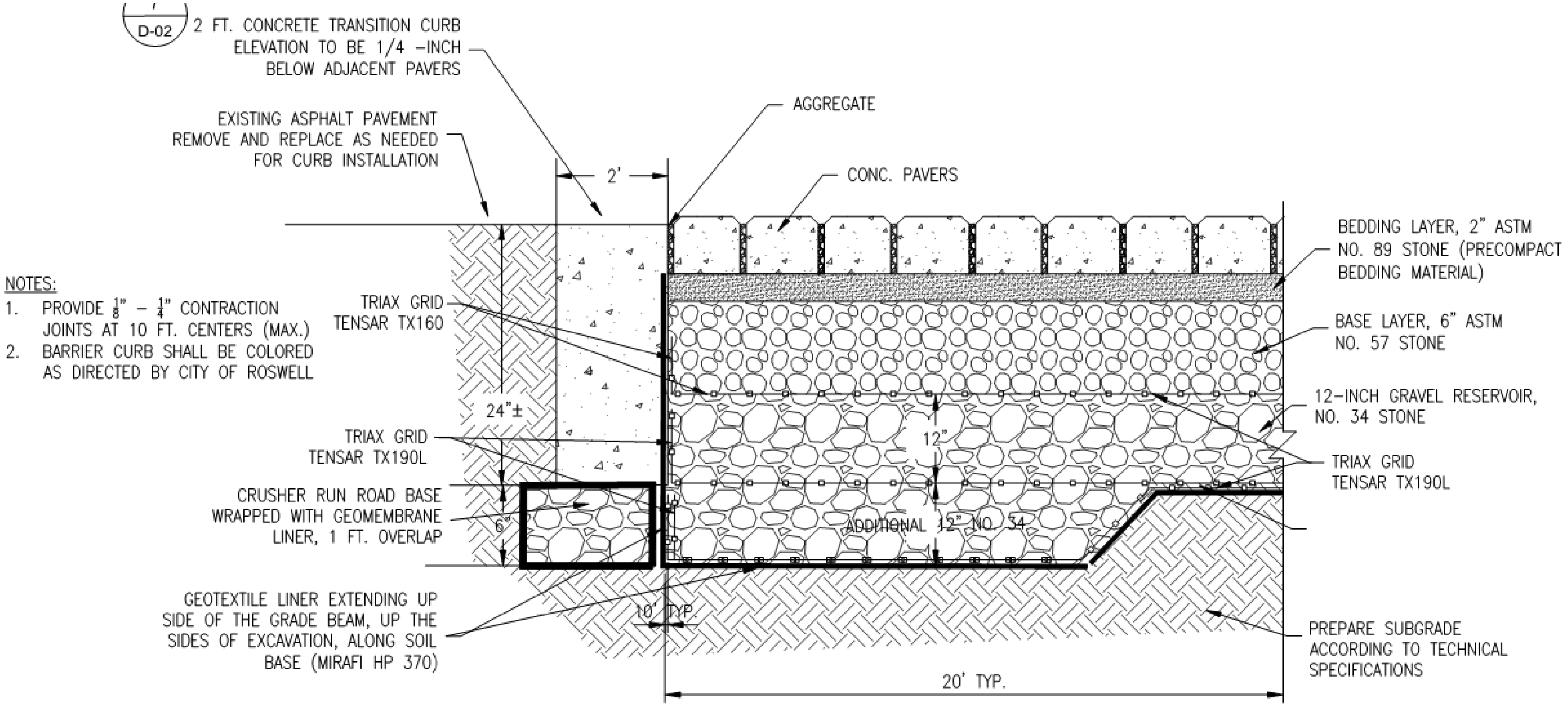
Construction Lessons and Photos

Survey, Geotech and SUE



TEST HOLE	TOP OF UTILITY ELEVATION	SIZE/MATERIAL UTILITY	ASPHALT THICKNESS
1	1045.6	1/2" STEEL GAS	6"
2	1045.0	4"CIP WATER	12"
3	1031.9	2" STEEL GAS	4"
4	1031.95	2" GALV. STEEL WATER	4"

Permeable Paver Detail



PAVER TRANSITION DETAIL 5 C-123

NO SCALE

Excavation

Underdrain Installation

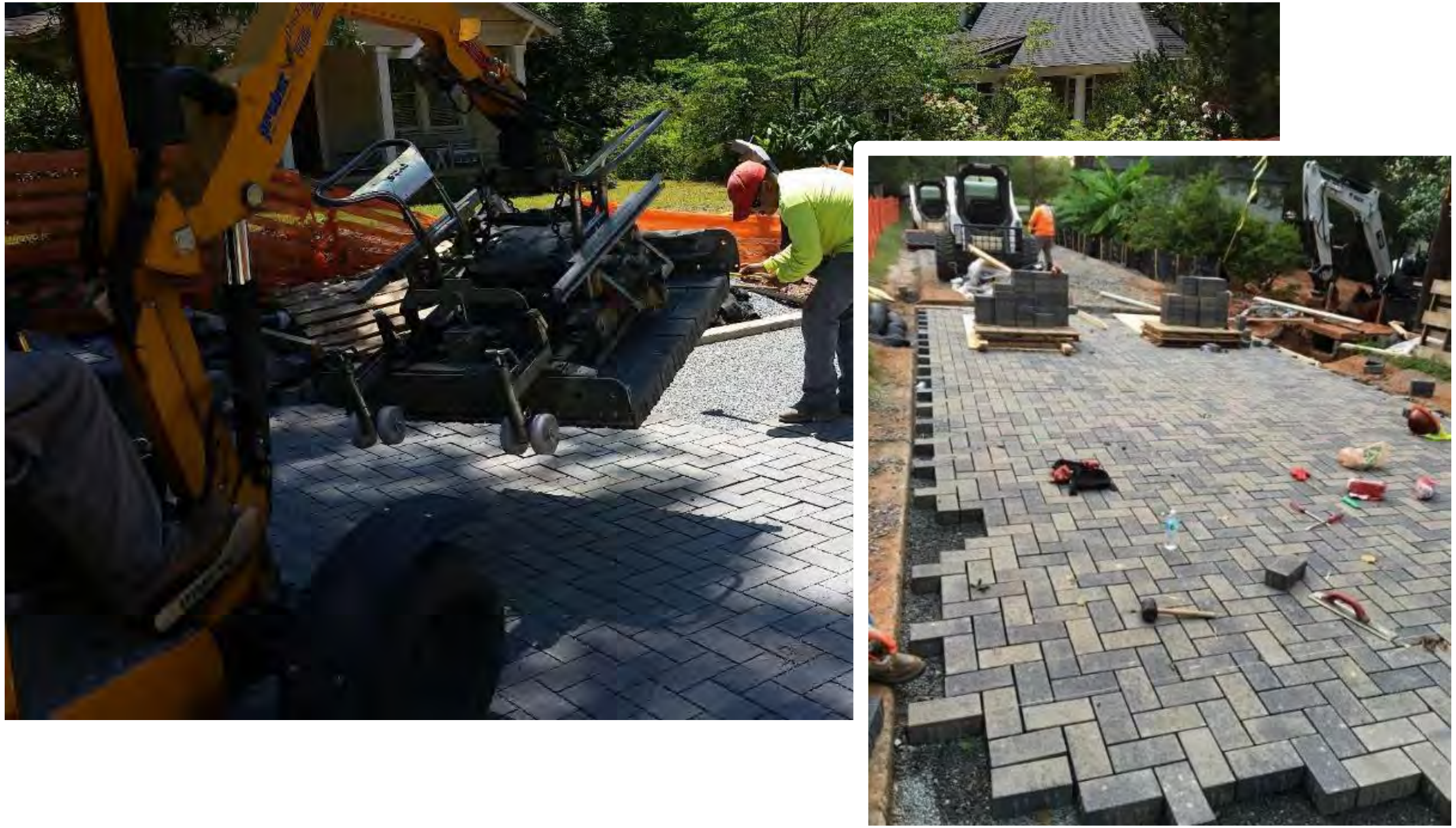
Storage Stone Layer

Base Stone Layer and Compaction

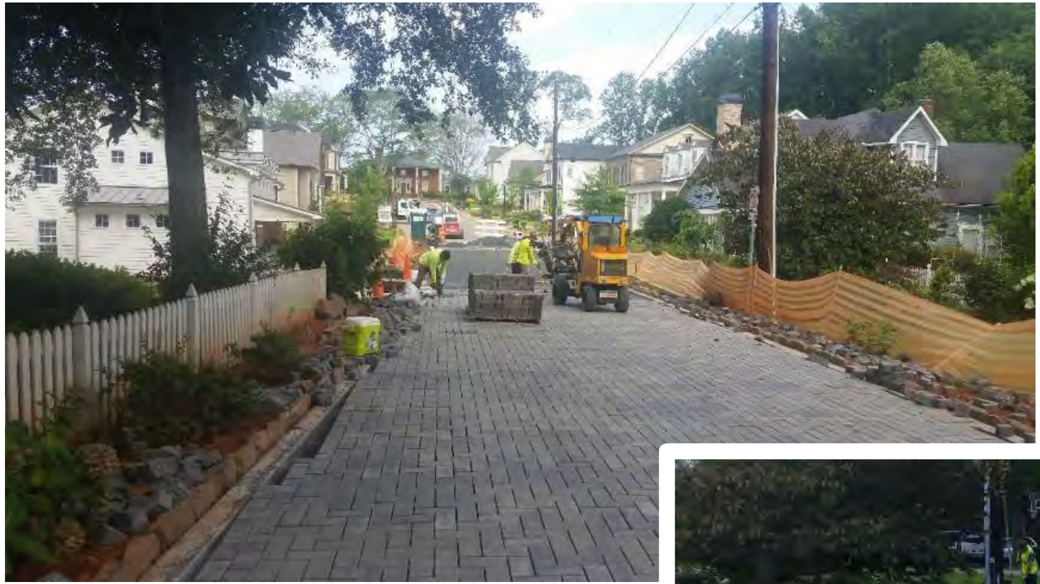
Concrete Cut Off Wall

Homeowner Access?

Paver Installation



Set Curb and Final Aggregate Stone



Lessons Learned

- Contractor needs utility experience
- Compaction of stone layers
- Shallow reservoir less expensive, avoids utilities, easier constructability
- Access to homes during construction may be blocked
- Check stone specs during installation
- Vertical restraining curb
- Transitions – one material to another
- Contingency plan for unsuitable soils

Lessons Learned

- City provides maintenance
- Good education opportunity
- More expensive than some options
- Public and elected officials Love It
- Stormwater treatment that fits in Historic Area

Wetland Treatment Systems

- Wetland treatment systems are scalable
  - 31st St: 30 Ac of drainage area
  - Depot Park: 80 Acres of drainage area
  - Sweetwater: 3.3 Sq. Miles of drainage area
- Do require space:
  - 31st St.: ~3 Ac
  - Sweetwater: 125 Ac
- Typically target nutrients from urban sources

Wetland Treatment Systems

- But can also treat agricultural nutrient sources
- Most are gravity flow systems
- Some like Deep Creek pump from the waterbody being treated

JonesEdmunds

Wetland Solutions Inc

CITY OF GAINESVILLE every path starts with passion FLORIDA

GRU More than Energy

Wharton-Smith, Inc. CONSTRUCTION GROUP

Treatment Wetlands

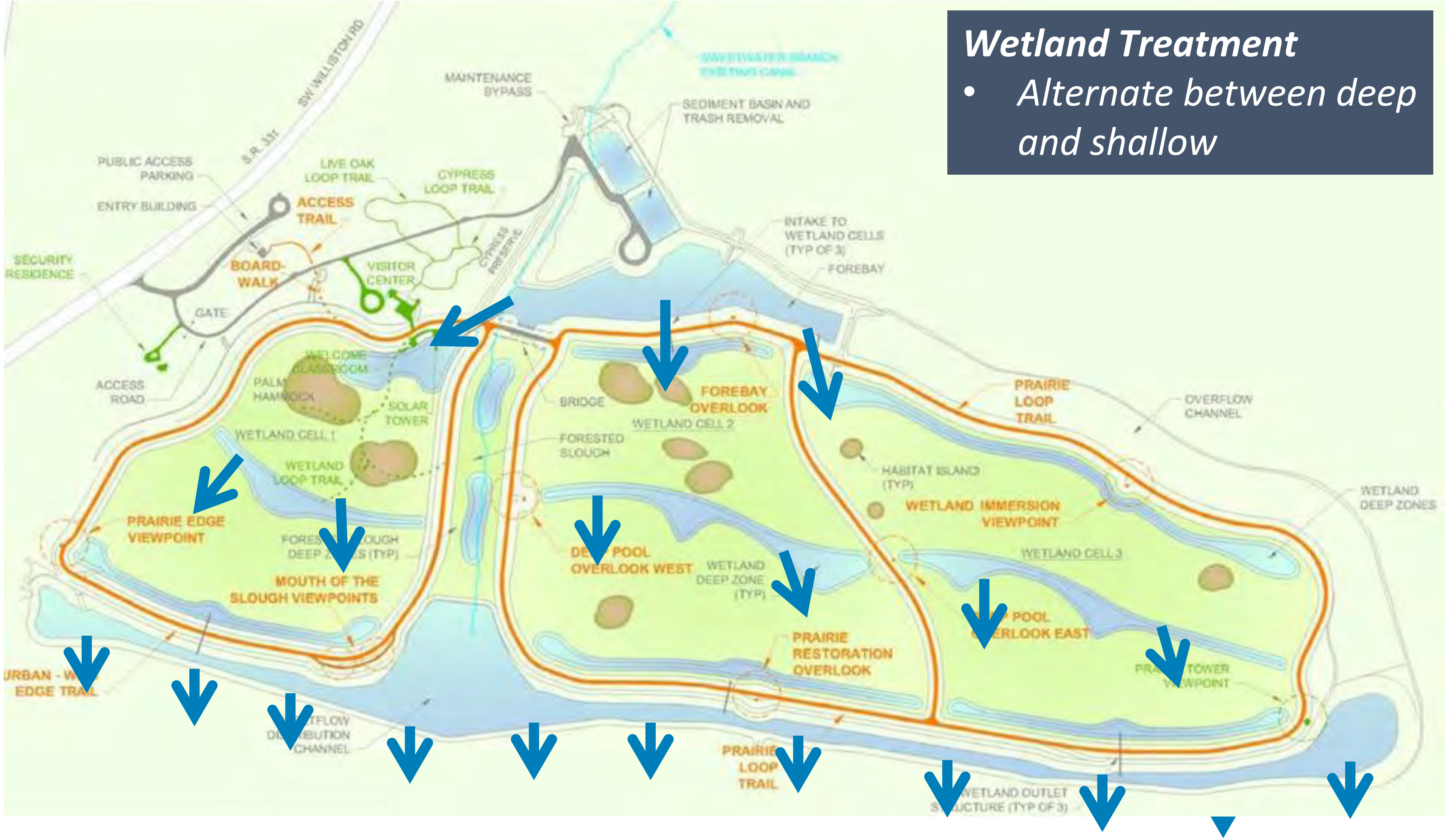
Sediment Basin
And
Trash Removal Area

- *1.3 Acres*

Treatment Wetlands

Overflow Channels – Storm Events

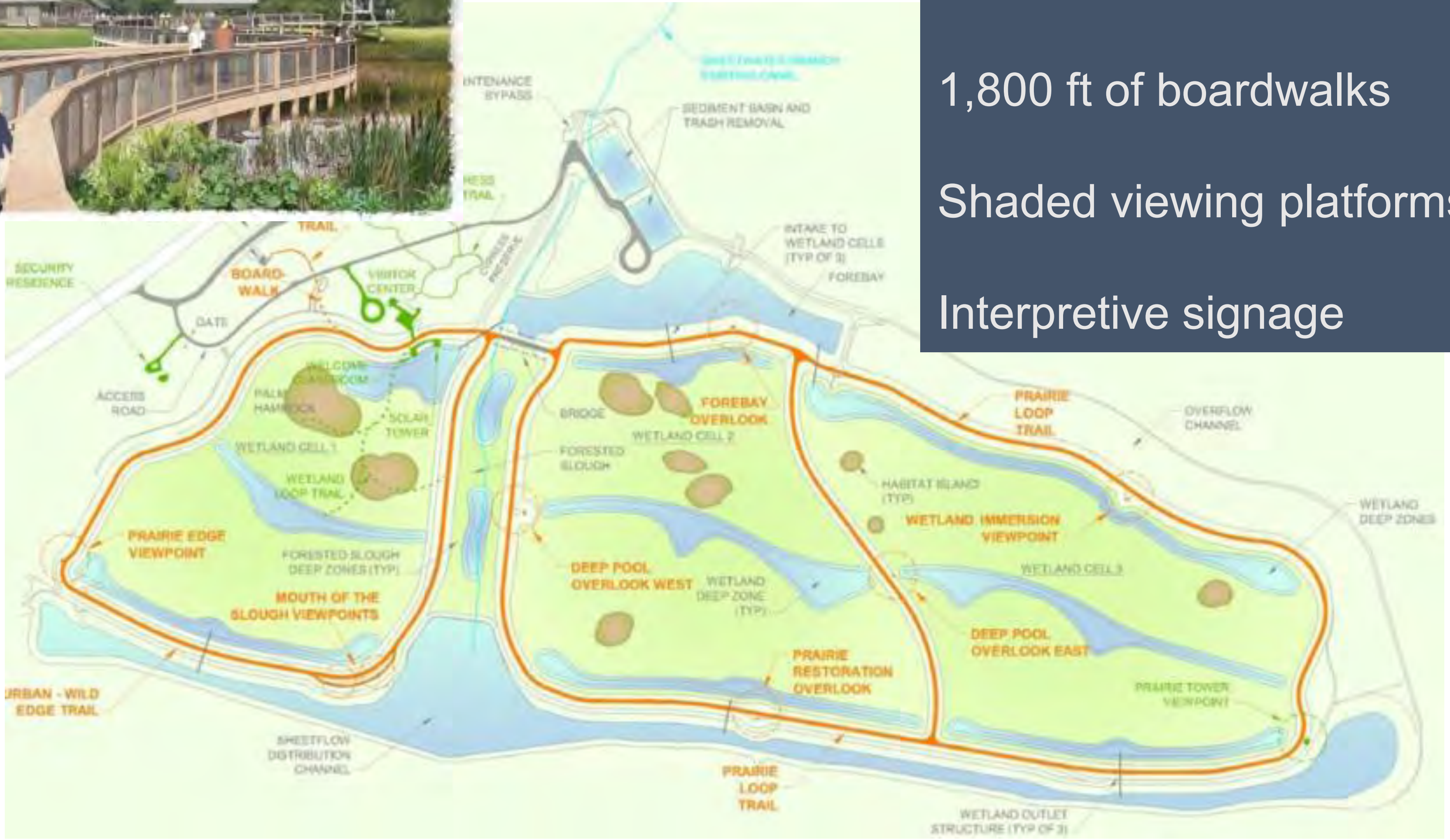
Treatment Wetlands



Wetland Treatment

- *Alternate between deep and shallow*

Treatment Wetlands



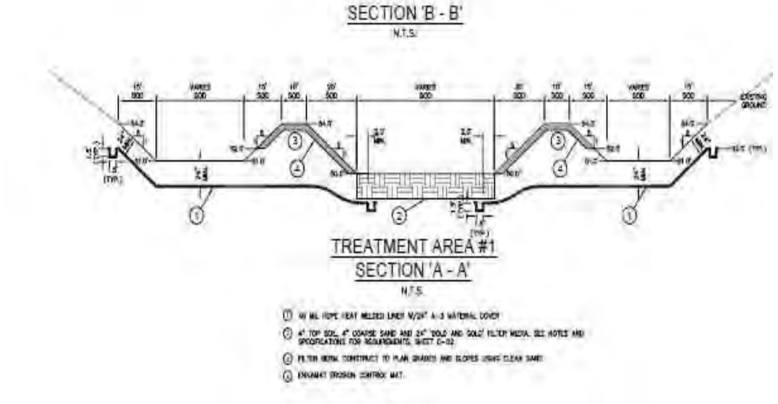
Public Access
3.6 mile berm

1,800 ft of boardwalks

Shaded viewing platforms

Interpretive signage

Biosorption Activated Media (BAM)

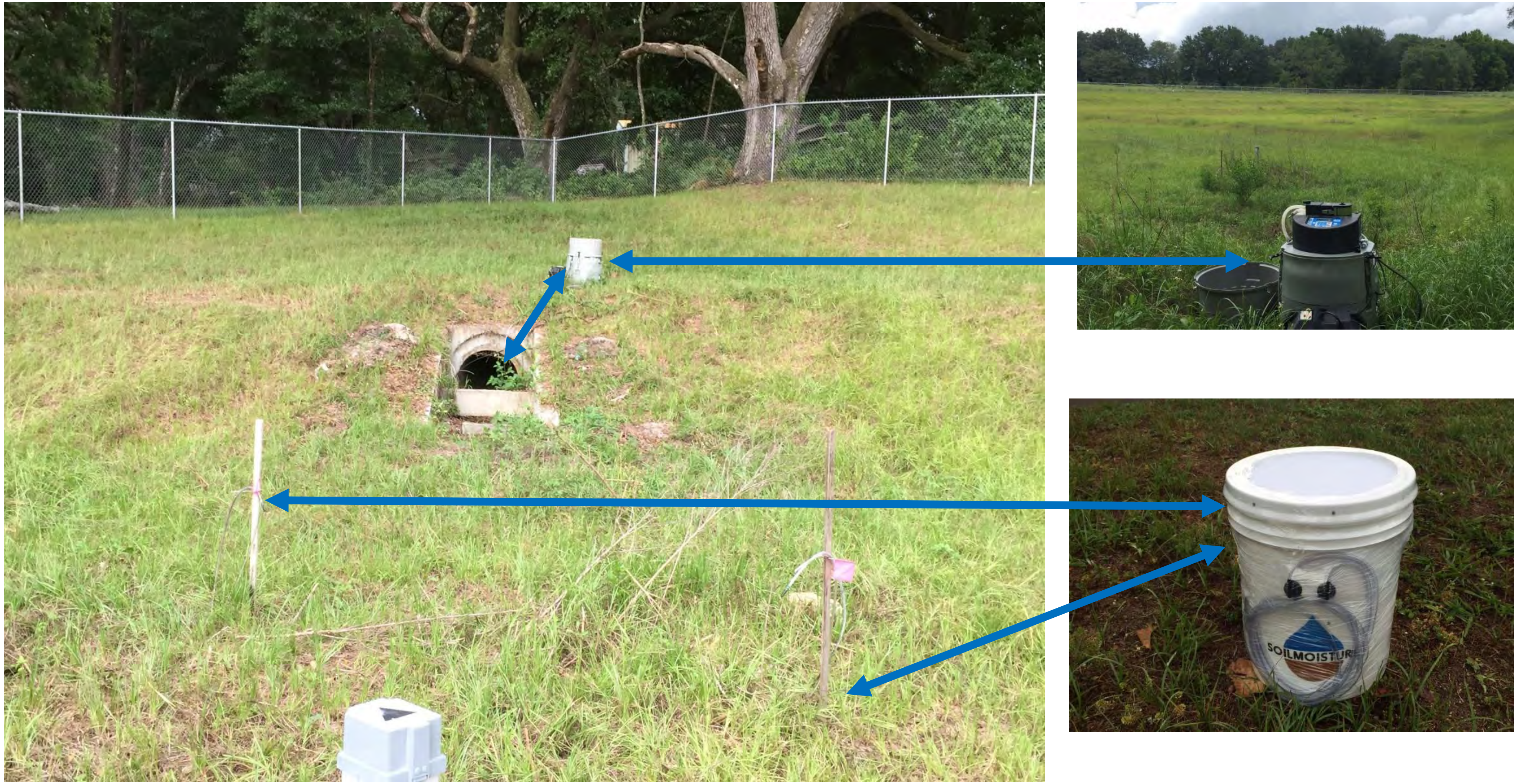


- Typically involves replacing on-site soils with a pre-mixed media that increases nutrient removal
  - Example: Village of Rainbow Springs
- Converting organic nitrogen to nitrate improves removal
  - VRS used lined forebays acting as sand filters
- When used in retention BMPs BAM allows recharge to continue

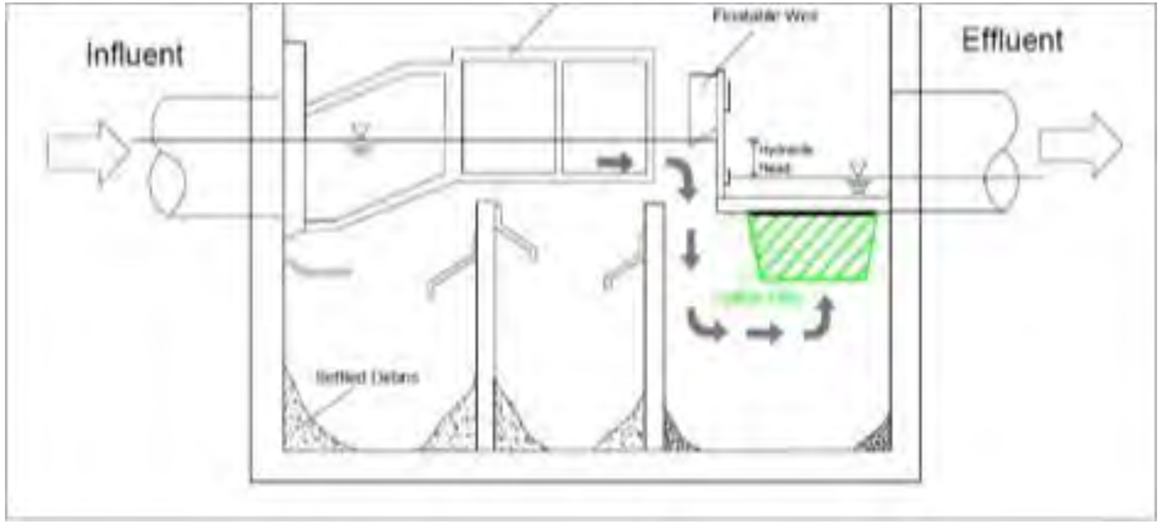
Biosorption Activated Media (BAM)

- The entire retention pond bottom does not need to be lined with BAM
- Studies show relatively high removal rates
- Some limitations:
  - Flood storage
  - Soil hydraulic conductivity
  - High water table

Biosorption Activated Media (BAM)



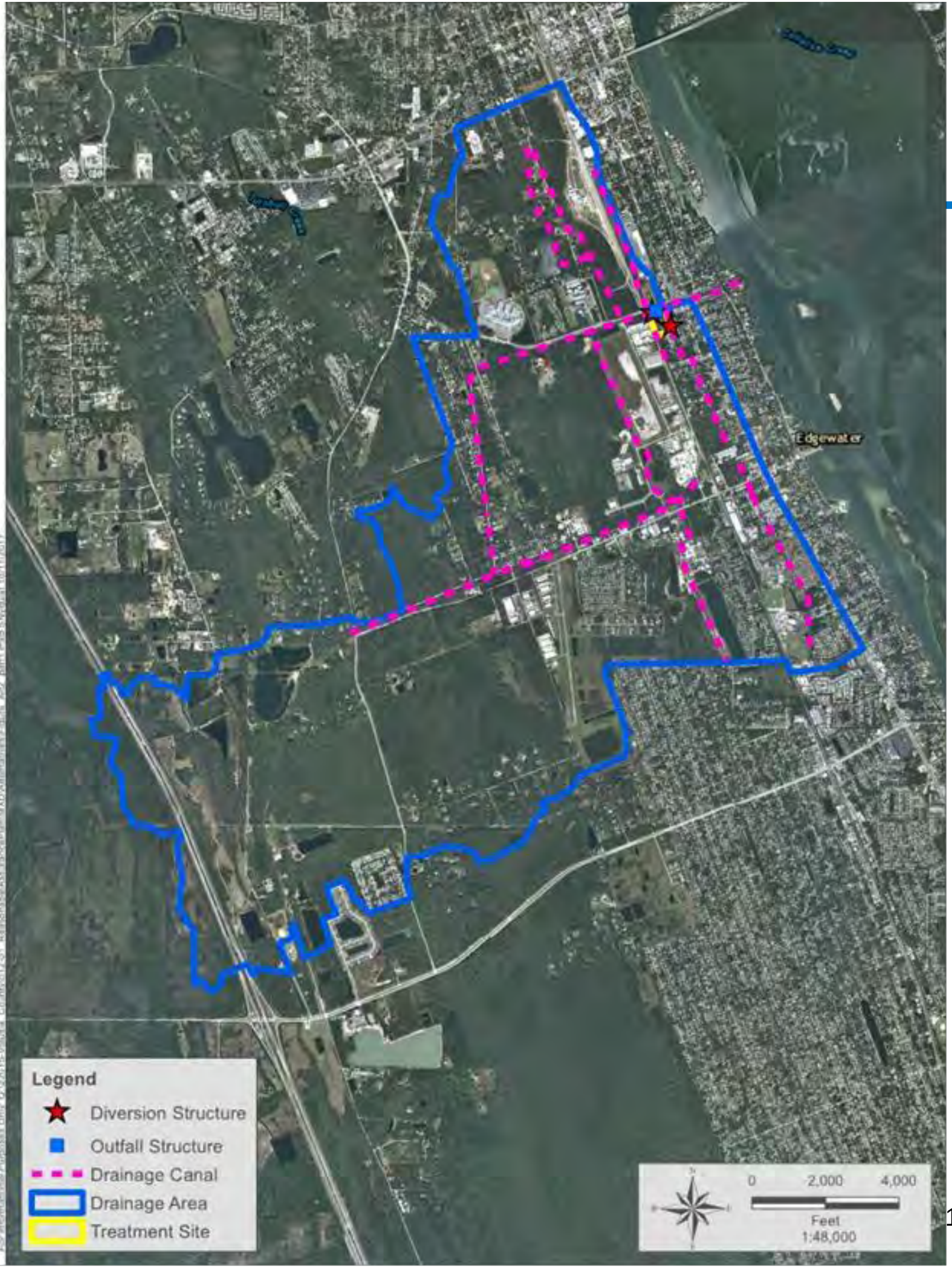
Biosorption Activated Media



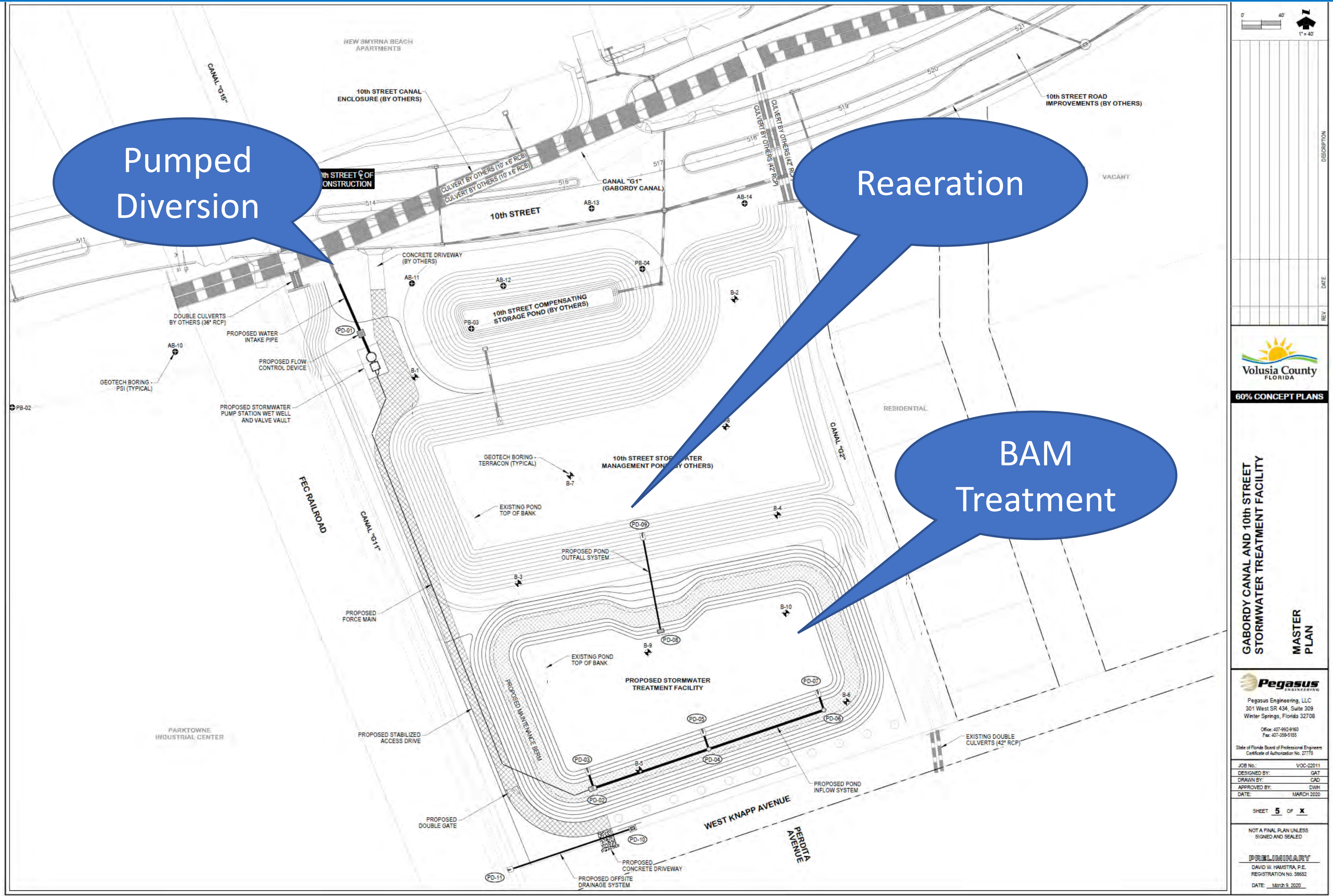
- BAM is also used in upflow filters
- Upflow filters can be used to polish detention pond effluent and in baffle boxes
- Consult with the manufacturer to size

Biosorption Activated Media

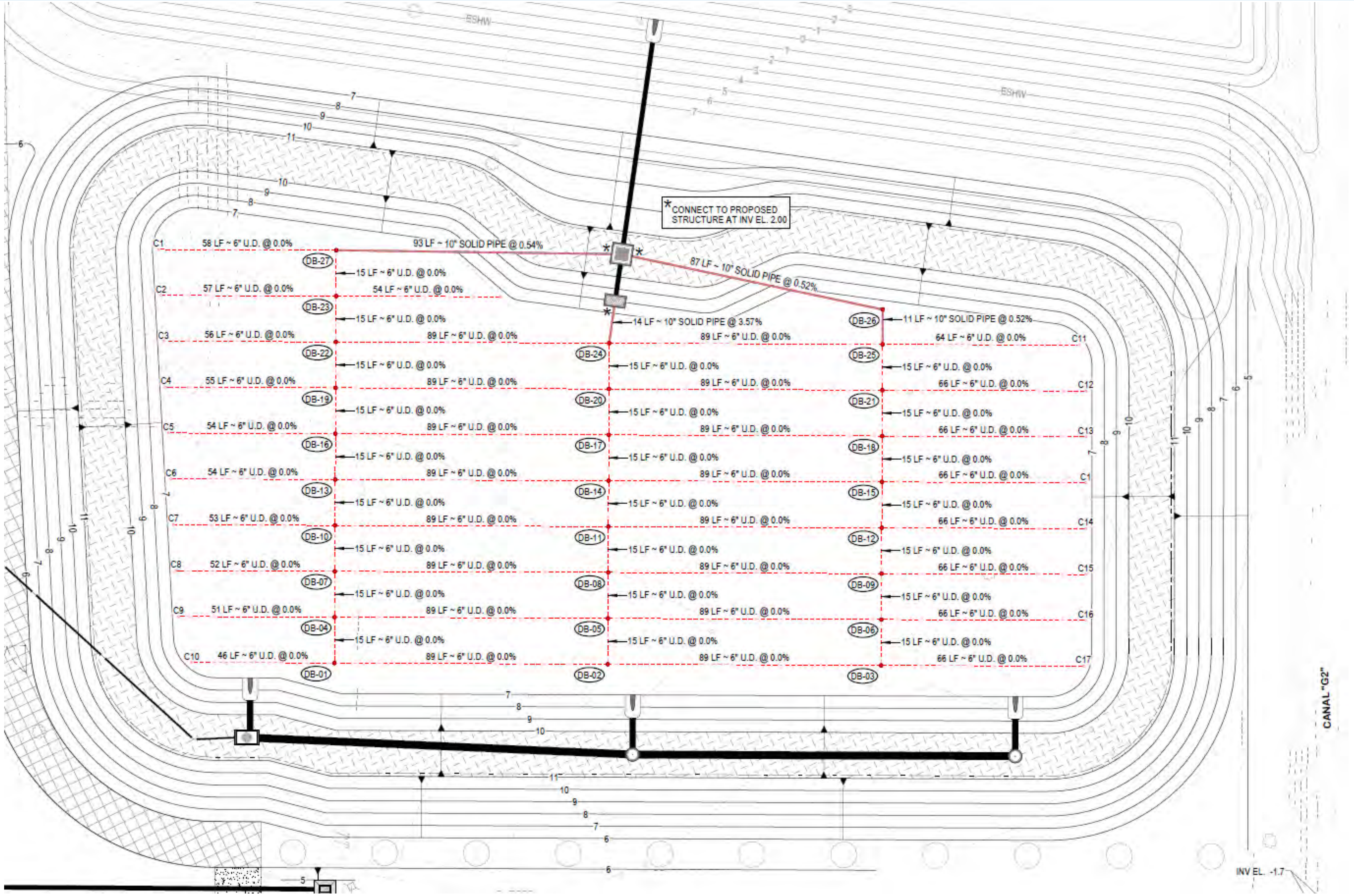
- 4,600-acre area
- 6-acre parcel for treatment → 2.5 acres
- 5,600 lb/yr TN



Biosorption Activated Media



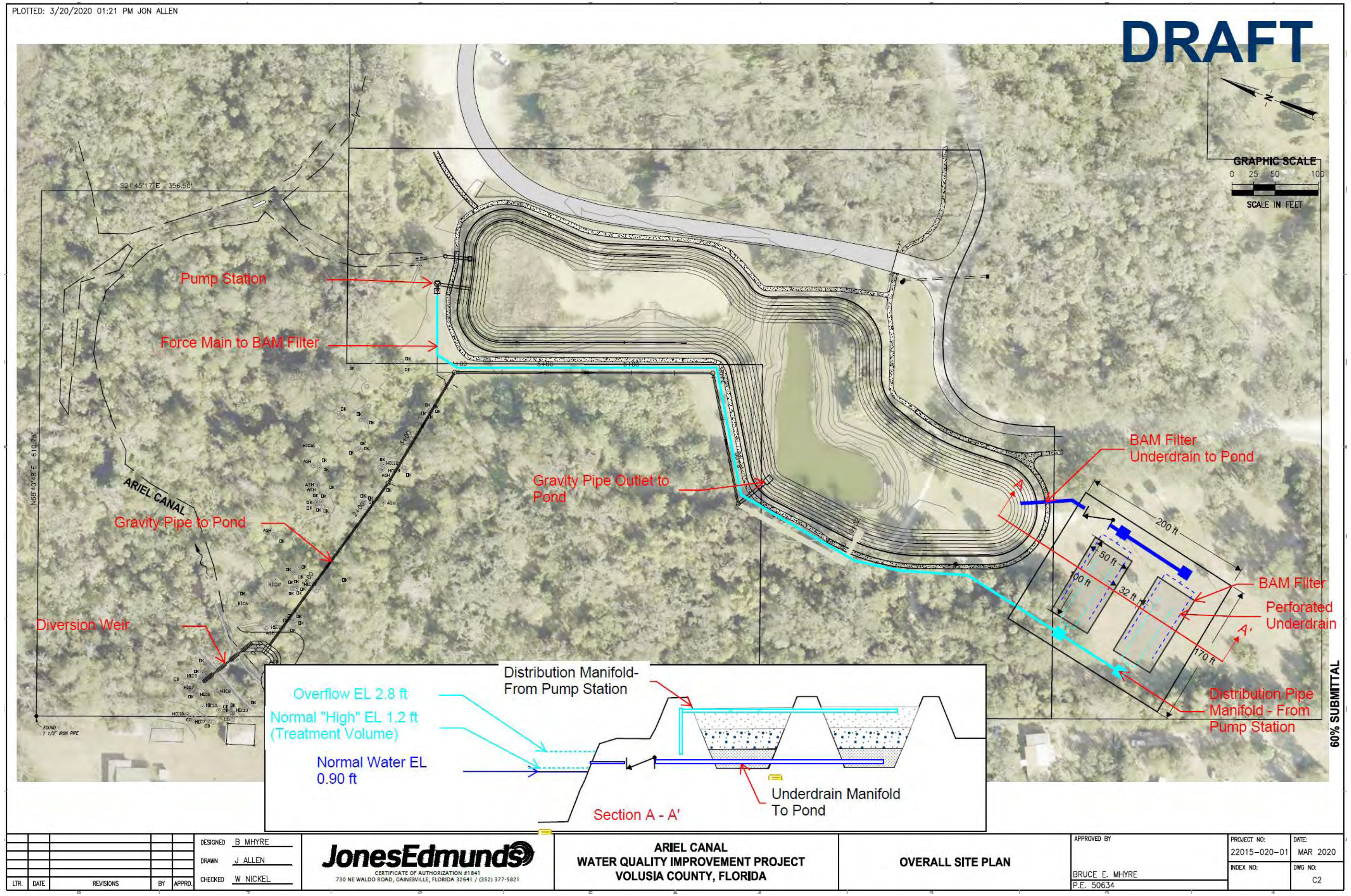
Biosorption Activated Media



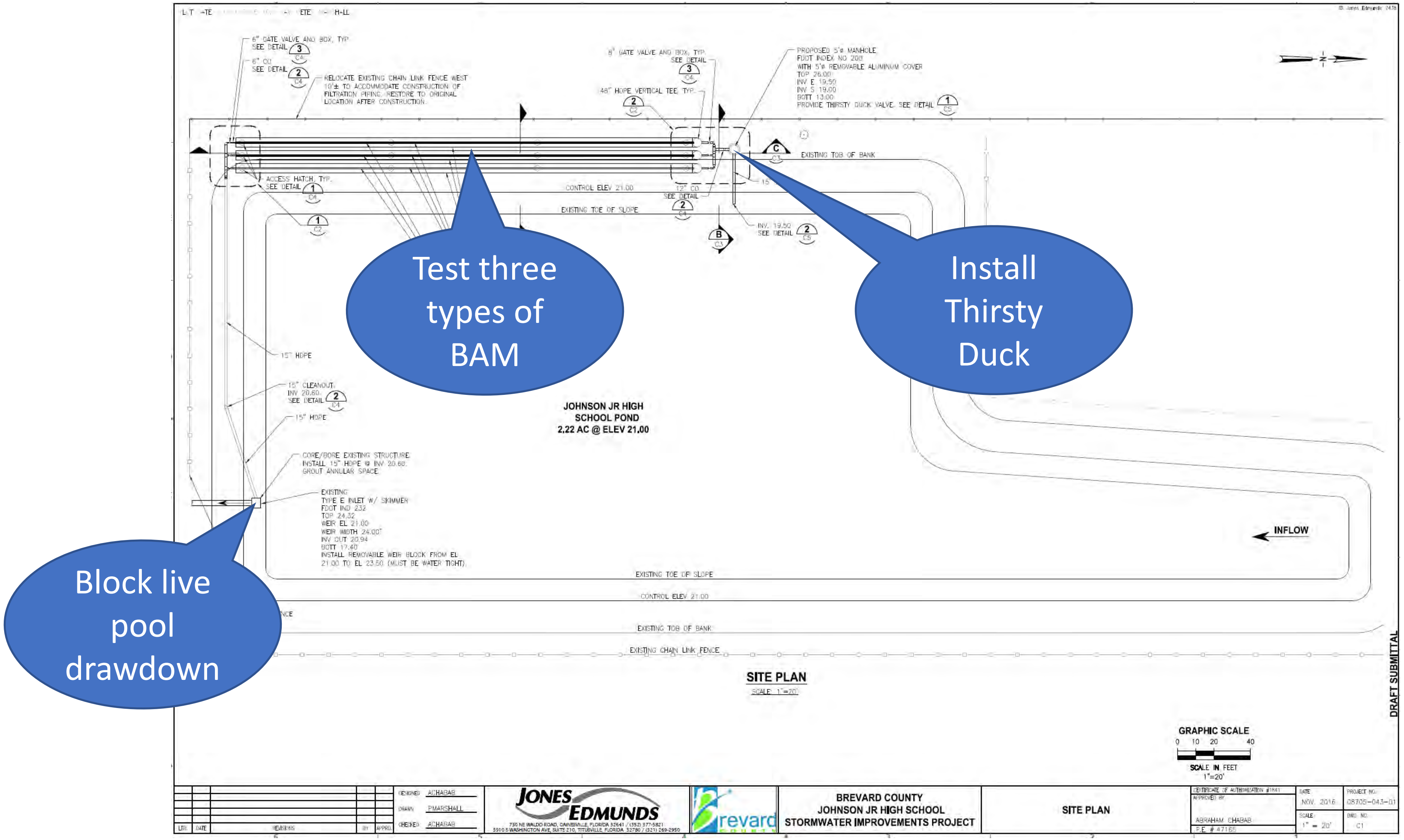
Biosorption Activated Media

- 1,500-acre area
- Existing wet pond and wetland treatment
- 1,300 lb/yr TN

Biosorption Activated Media



Biosorption Activated Media

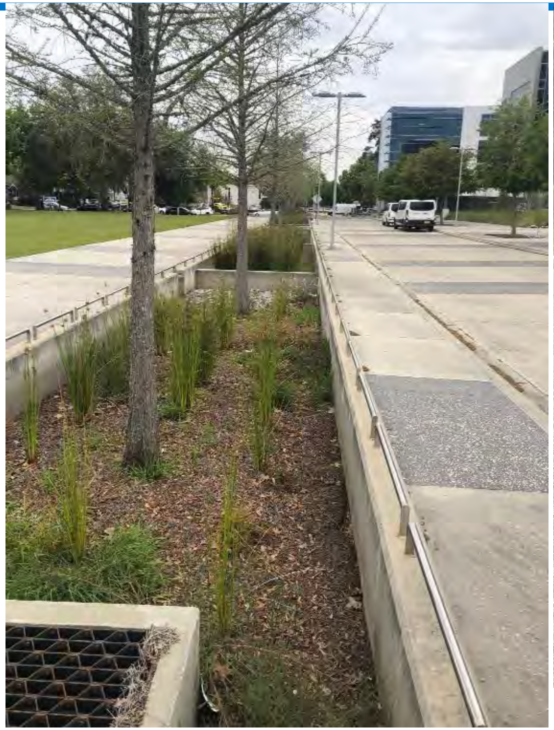


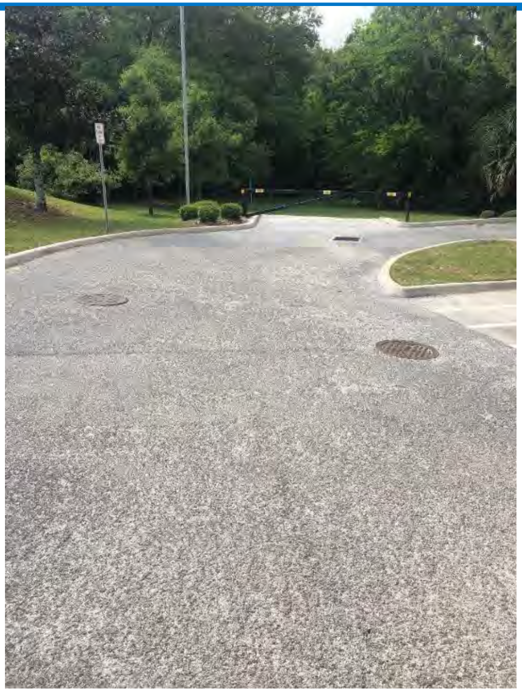
Low Impact Design

Rural				Urban
Natural Area	Rural Agriculture	Suburban/ Large Lot	Urban/ Small Lot	Urban/ Activity Center
Leave unimpacted Preserve and protect	Cluster design Vegetated swales Bioretention Rain barrel/ cistern	Vegetated swales Vegetated natural buffers Bioretention Rain barrel/cisterns Curb elimination/ cuts Native plantings Enhanced stormwater ponds	Vegetated swales Bioretention Rain barrel/cisterns Permeable surfaces Soil amendments Exfiltration Curb cuts Green roofs w/ cisterns Native plantings Enhanced stormwater ponds	Green roofs w/cisterns Cisterns Permeable surfaces Soil amendments Exfiltration Curb cuts Tree filter boxes Native plantings Recessed parking Islands

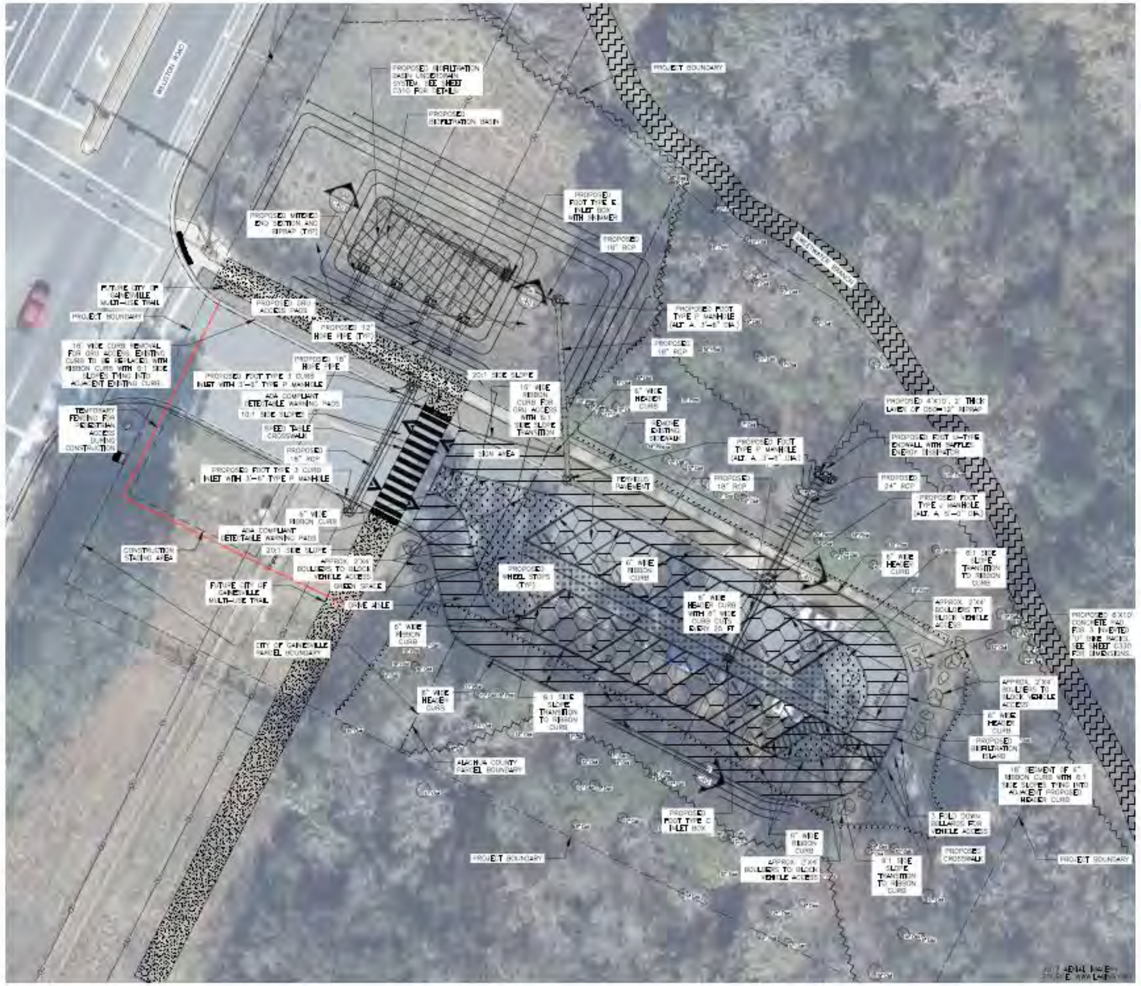
This is not an all inclusive list!

Low Impact Design





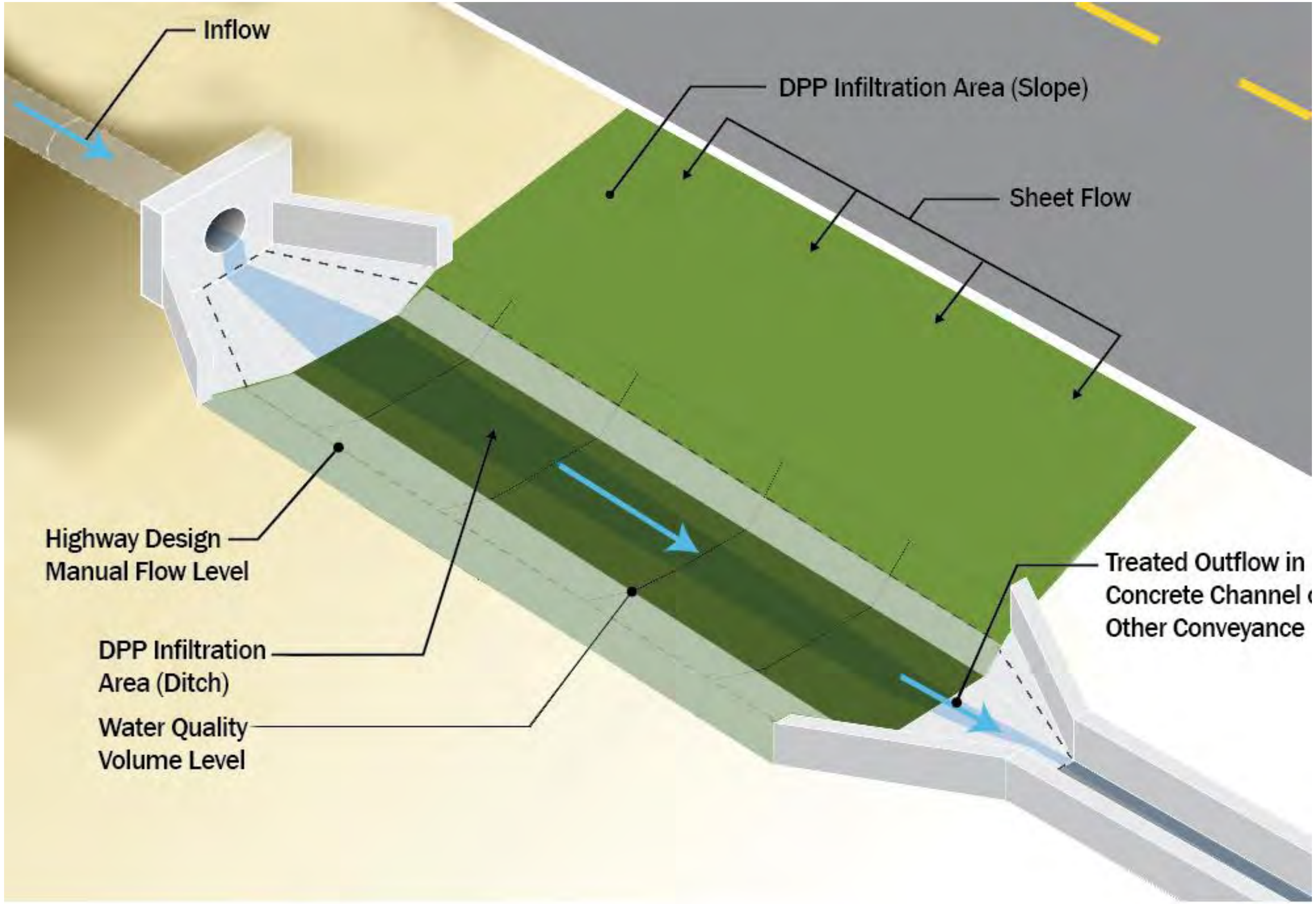
Low Impact Design



- Sweetwater Preserve Trailhead Parking Area
- Parking spaces: interlocking concrete pavers on a reservoir course
- Access drive and road runoff treated in bioretention (filtration)
- Bioretention area will have four subsurface sections to test combinations of IWS and media

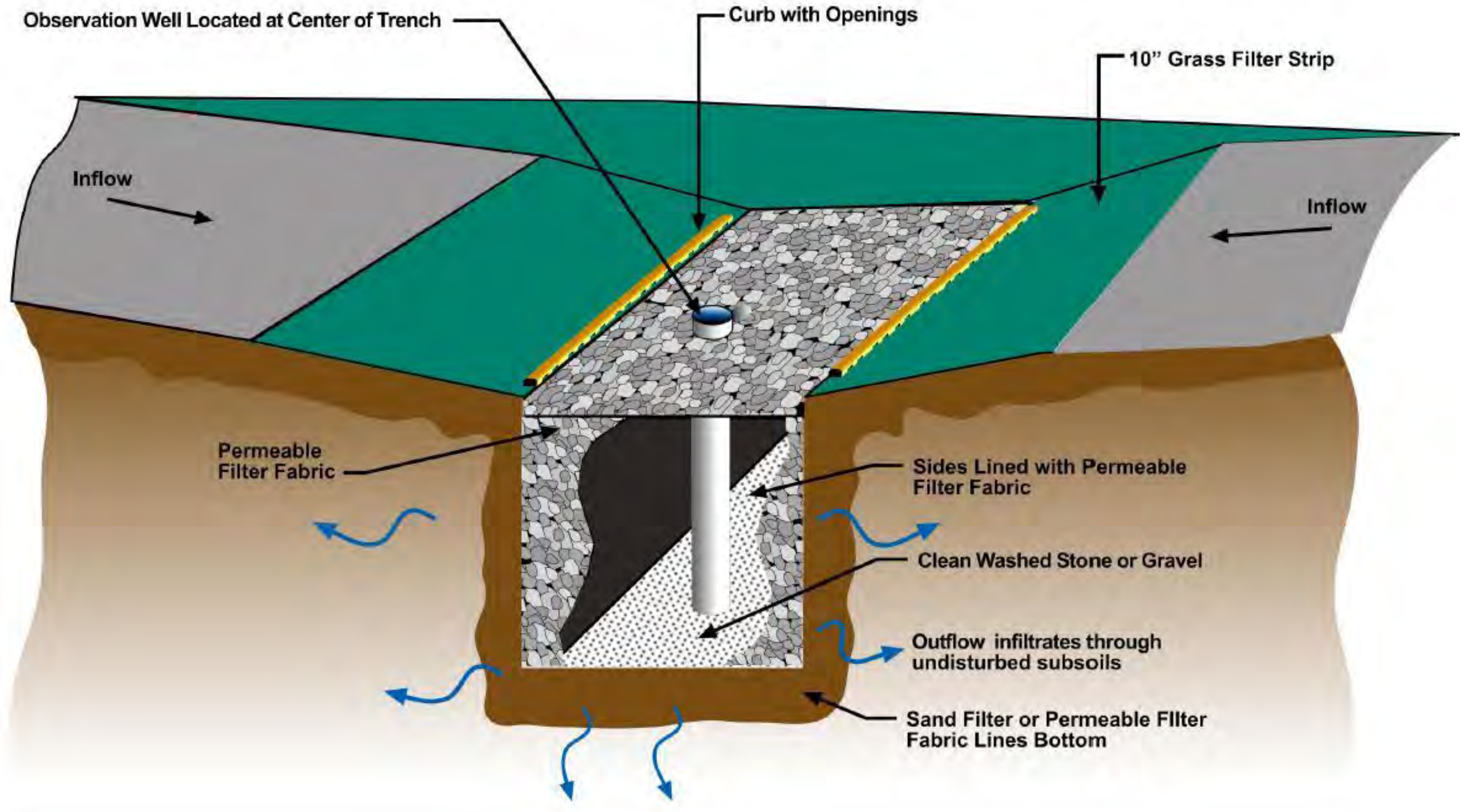
In conclusion

Biofiltration Strips and Swales



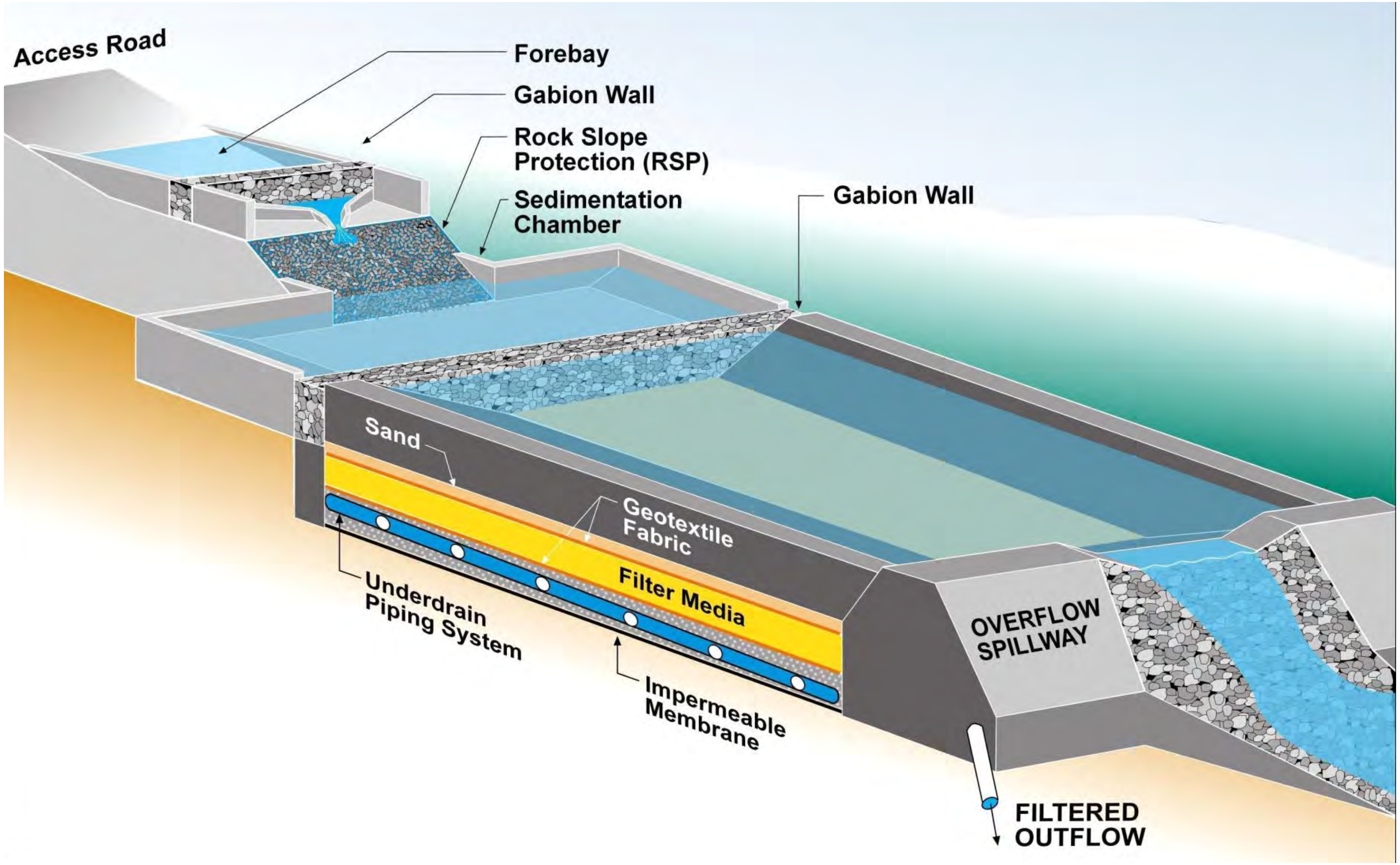
Biofiltration Strips and Swales

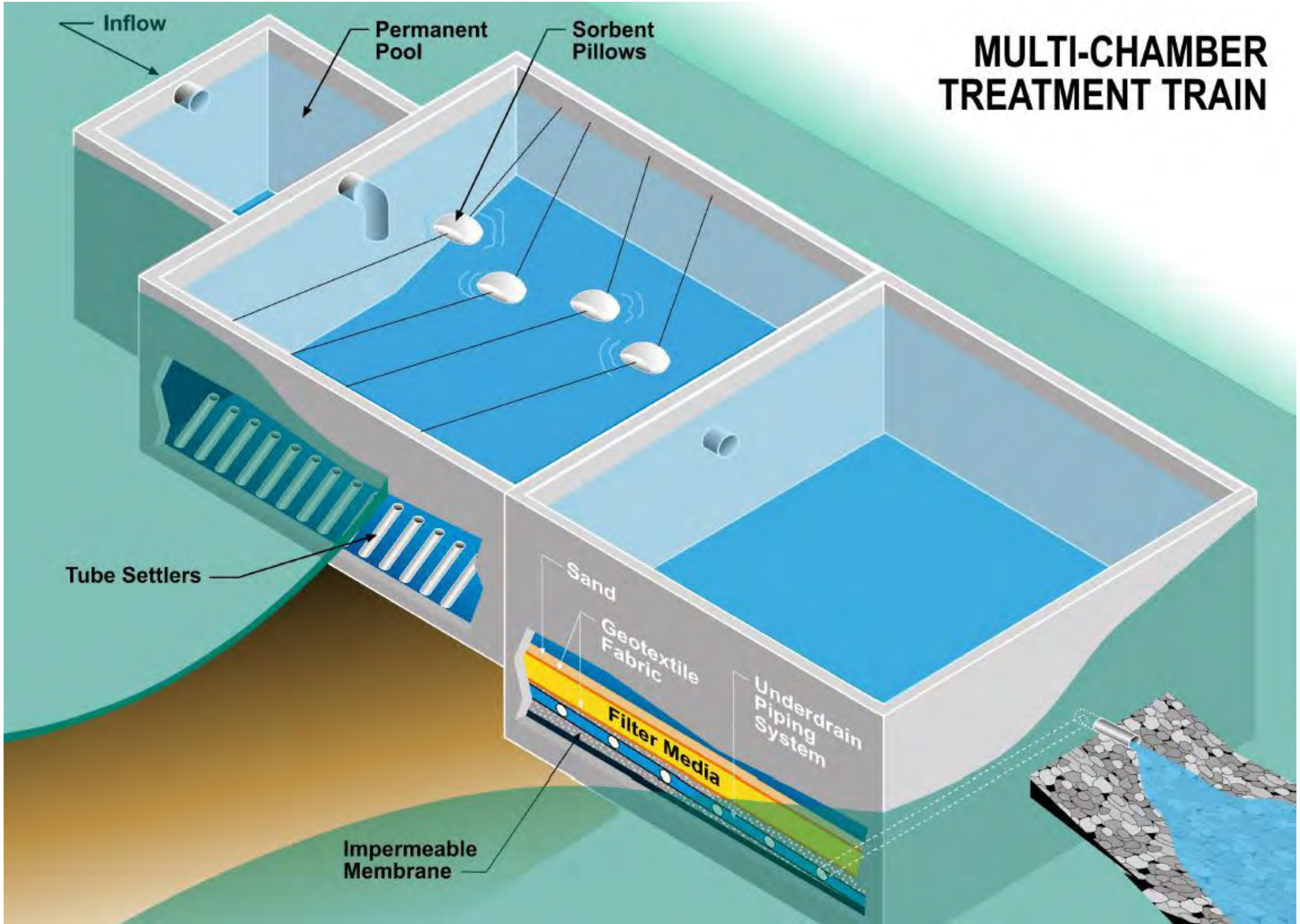
Infiltration Basins and Trenches



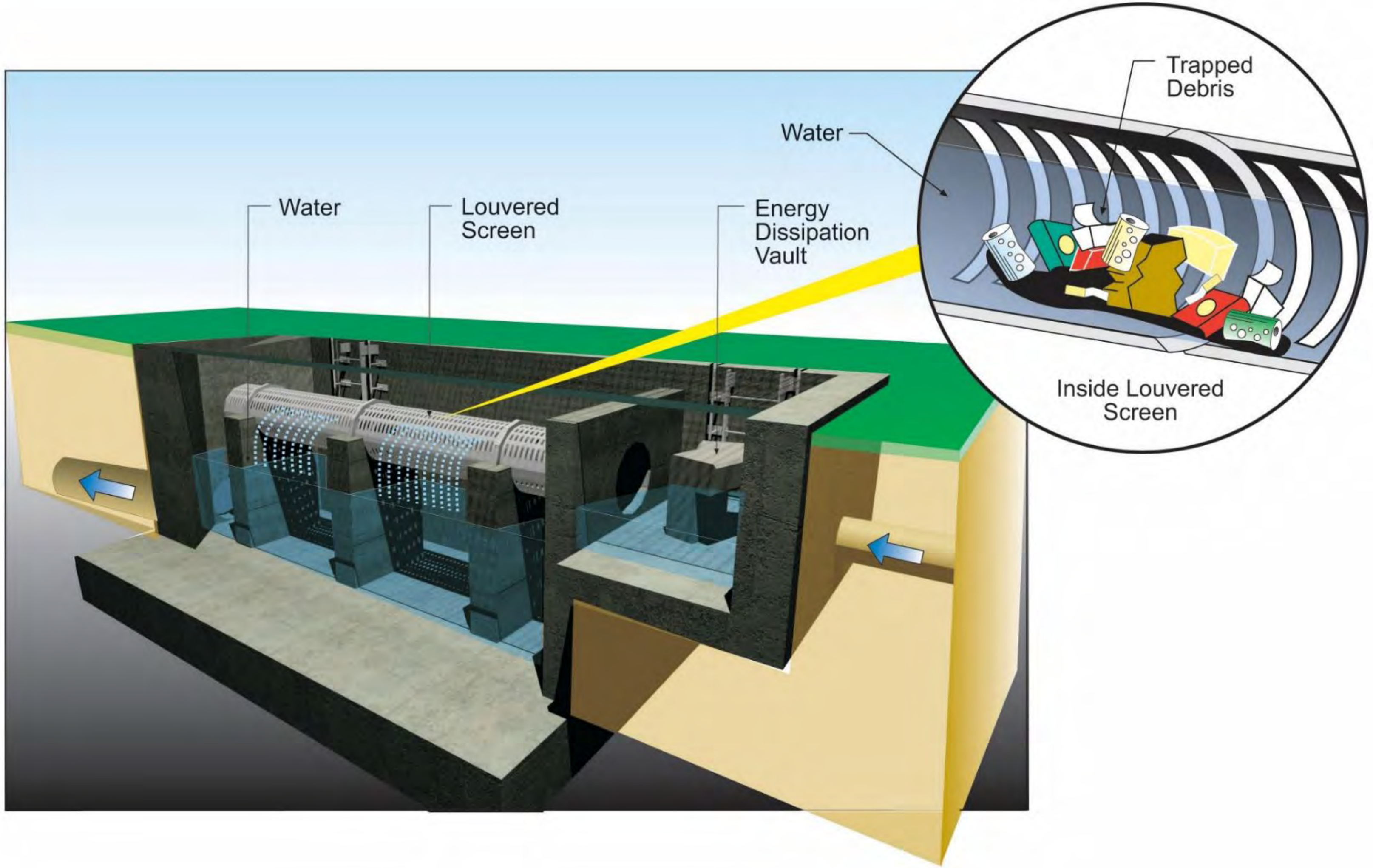
INFILTRATION TRENCH

Infiltration Basins and Trenches


Access Road
Forebay
Gabion Wall
Rock Slope
Protection (RSP)
Sedimentation
Chamber
Gabion Wall
Sand
Geotextile
Fabric
Filter Media
Underdrain
Piping System
Impermeable
Membrane
OVERFLOW
SPILLWAY
FILTERED
OUTFLOW


Inflow
Permanent Pool
Sorbent Pillows
MULTI-CHAMBER TREATMENT TRAIN
Tube Settlers
Sand
Geotextile Fabric
Underdrain Piping System
Filter Media
Impermeable Membrane

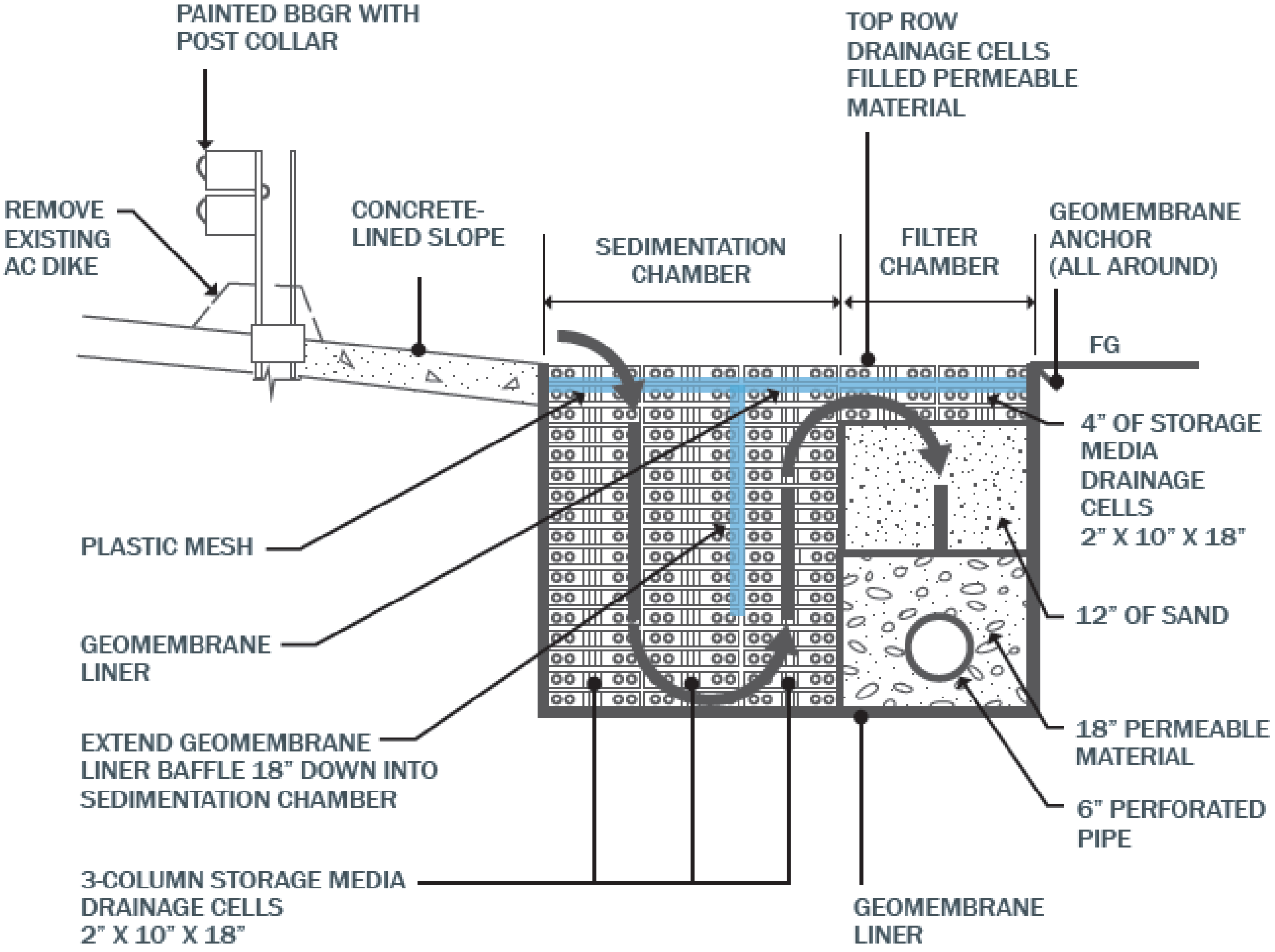
Gross Solids Removal Devices (GSRDs)



Gross Solids Removal Devices (GSRDs)

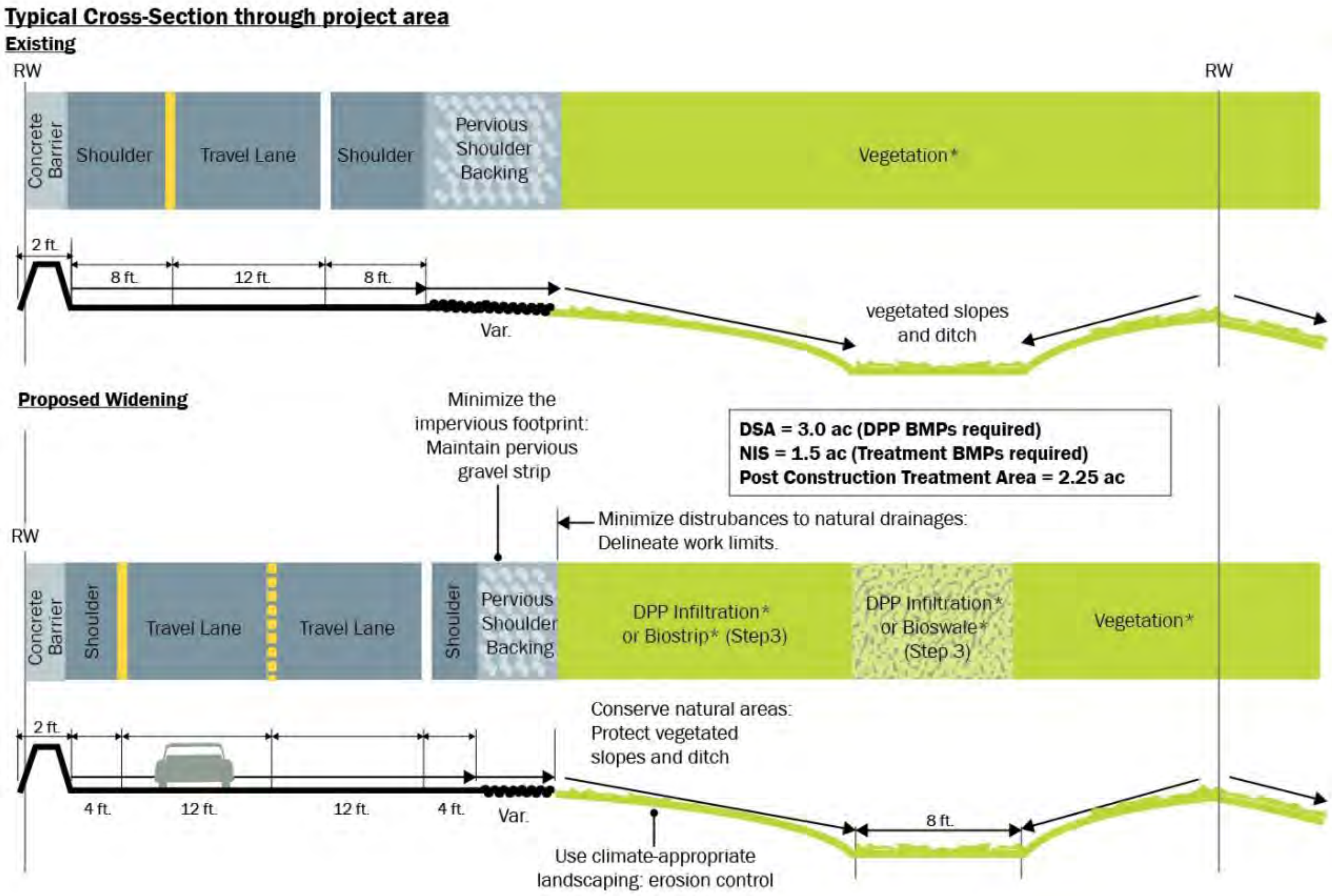
Brown and Caldwell

Pilot Studies




OXYGEN
MAXON

BMP Consideration – in ROW



Completed Project


15 Acre SAV/Wet Detention System treats 600 acres
Construction cost $1M
Annual O&M cost $20,000
Property owned by FDOT

Life Cycle Costing

Table 1: Efficiencies for Nonpoint Source Management BMPs

N/A = Not applicable

[1] This is a change from a previous method. The benefits of a baffle box—including BMP maintenance—are included in the baffle box credits when they are installed.

Standard BMPs	TP % Reduction	TN % Reduction	Data Source
Off-line retention BMPs	40 % - 84 % (see Table 5 for formulas)	40 % - 84 % (see Table 5 for formulas)	Harper, H. & D. Baker. 2007. *Evaluation of Current Stormwater Design Criteria within the State of Florida.*
On-line retention BMPs	30 % - 74 % (see Table 5 for formulas)	30 % - 74 % (see Table 5 for formulas)	DEP Evaluation/Regression of Harper, H., and D. Baker 2007
Grass swales with swale blocks or raised culverts	Use on-line retention BMPs above	Use on-line retention BMPs above	DEP Evaluation/Regression of Harper, H., and D. Baker 2007
Grass swales without swale blocks or raised culverts	50 % of value for grass swales with swale blocks or raised culverts	50 % of value for grass swales with swale blocks or raised culverts	DEP Evaluation/Regression of Harper, H., and D. Baker 2007
Wet detention ponds	Formula shown on Figure 13.2 of the Draft Stormwater Treatment Applicant's Handbook- (see Figure 1 below for formula)	Formula shown on Figure 13.3 of the Draft Stormwater Treatment Applicant's Handbook (see Figure 2 below for formula)	Draft Stormwater Treatment Applicant's Handbook, March 2010
Dry detention ponds	10 %	10 %	DEP Evaluation/Regression of Harper, H., and D. Baker 2007
BMP treatment trains using a combination of BMPs	BMP Treatment Train equation: Efficiency = Eff1 +((1-Eff1) *Eff2) or BMPTRAINS model	BMP Treatment Train equation: Efficiency = Eff1 +((1-Eff1) *Eff2) or BMPTRAINS model	Draft Stormwater Treatment Applicant's Handbook, March 2010 and UCF Stormwater Management Academy BMPTRAINS model
Baffle boxes—First generation (hydrodynamic separator)[1]	2.30 %	0.50 %	First and second generation: Final Report Contract S0236 Effectiveness of Baffle Boxes Plus Media Filter: UCF and City of Casselberry studies
Baffle boxes—Second generation[1]	15.5 %	19.05 %	
Baffle boxes—Second generation plus Bold & Gold® media filter[1]	70 %	75 %	
Baffle boxes—Second generation plus Vault-Ox® media filter[1]	8 %	50 %	
Alum injection systems	90 %	50 %	DEP Evaluation/Regression of Harper, H., and D. Baker 2007

Life Cycle Costing

- Construction costs
- Land costs
- O&M costs
- Useful life
- Consistent approach

Life Cycle Costing

Project	**Crane Creek M-1 Canal Flow Restoration** Canal Diversion Weir, Pump Station, Force Main, and Stormwater Treatment Area					
Life	Project Economic Life				60	years
Construction Cost	Initial Cost				Estimated Cost Low	Estimated Cost High
	Capital Cost, Range				$8,900,000	$11,400,000
	Capital Cost Annualized over the Project Life				$ 342,529	$ 438,745
Replacement Costs	Replacement Costs		Life Years	# Replacements over project life	1 time Replacement Cost	Replacement Cost
	PUMP STATION (Mech and Elec Equip)		30	1.0	$ 919,000	$919,000
	FORCE MAIN (Partial Replacement)		50	0.2	$ 1,417,000	$283,400
	OPERABLE WEIR (Mech and Elec Equip)		20	2.0	$ 1,462,000	$2,924,000
	WETLAND, SMALL (Replanting)		30	1.0	$ 100,000	$100,000
	STA (Intake Piping and Stabilization Berm)		30	1.0	$ 287,000	$287,000
	TOTAL PRESENT WORTH OF REPLACEMENT COST					$4,513,400
	Replacement Costs Annualized over the Project Life					$174,000
Annual Costs	Annual Costs	Unit	% of initial cost	Present Worth Factor	Present Worth	Annual cost
	Maintenance Cost			25.9832		
	PUMP STATION (Mech and Elec Equip)		1.0%		$233,849	$9,000
	FORCE MAIN (Partial Replacement)		1.0%		$363,765	$14,000
	OPERABLE WEIR (Mech and Elec Equip)		1.0%		$389,748	$15,000
	WETLAND, SMALL		4.0%		$103,933	$4,000
	STA (Intake Piping and Stabilization Berm)		1.0%		$77,950	$3,000
	Other Maintenance Costs, $/unit	Unit	$/ unit	Present Worth Factor	Present Worth	Annual cost
	Pump Electrical Energy		315000	kwh	$879,013	$38,000
	TOTAL PRESENT WORTH OF ANNUAL COST				$2,048,257	
	TOTAL OF ANNUAL COSTS					**$83,000**
	Replacement + O&M Annual Cost Range		**$230,000**	**TO**	**$330,000**	