Florida Department of Environmental Protection

Indian River Lagoon (IRL) Basin Management Action Plan (BMAP) New Project Idea Feedback

July 29, 2014





Meeting Purpose

- To provide feedback on list of potential best management practices (BMPs) provided by Brevard County stakeholders for consideration by Florida Department of Environmental Protection (Department).

- To assist stakeholders in identification of potential project types as part of their planning for second phase BMAPs.

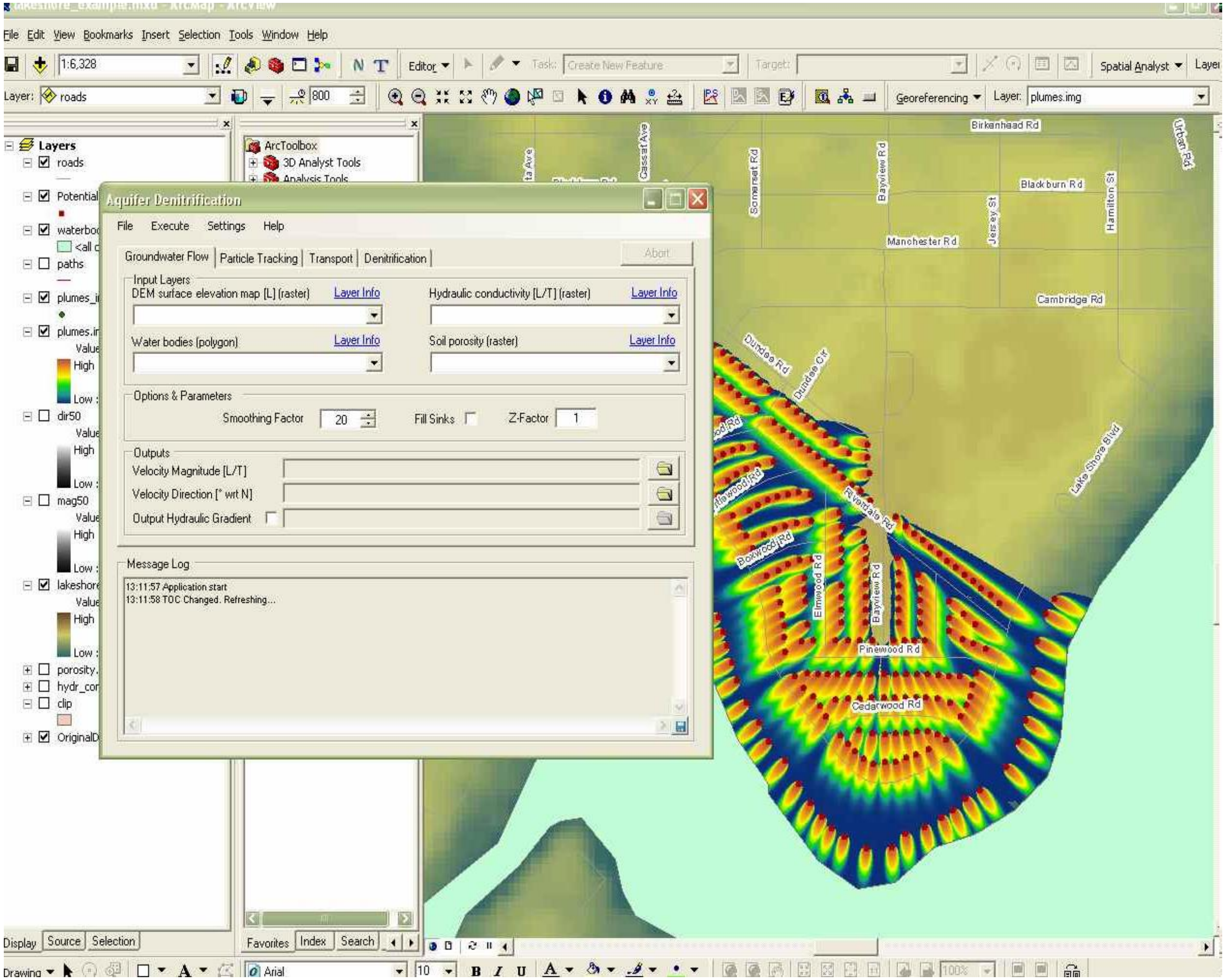
Septic Tank Phase Out

- ArcNLET is Department's preferred method for calculation of total nitrogen (TN) reductions for BMAP credits.
- Estimates concentration/loading of nitrate from an area served by septic tanks to nearby surface waters.

Septic Tank Phase Out, continued

ArcGIS-based Nitrate Load Estimation Toolkit

- Simplified conceptual model of groundwater flow and solute transport.
- Implementation as an ArcGIS extension.
- Compatible with ArcGIS 9.3, 10, and 10.1.
- Calculation of nitrate plume/load.
- ArcNLET: http://people.sc.fsu.edu/~mye/ArcNLET.



Septic Tank Phase Out: IRL Study

- Department is working with Indian River County to model influence of septic systems within canal system of Indian River Farms Water Control District.

- Groundwater seepage studies planned in different parts of IRL basin, potentially located in areas with high septic tank density.

Septic Tank Phase Outs BMAP Credits

- Removal of septic systems <u>can be</u> credited in BMAP.

- Considerations for credit:
  - Pollutant Load Screening Model (PLSM) does not have discrete septic system component, loading is implicit as loading from groundwater is included.

  - Total Maximum Daily Load (TMDL) loading is removed from load allocation and redistributed to the wasteload allocation.

Septic Tank Phase Outs BMAP Credits

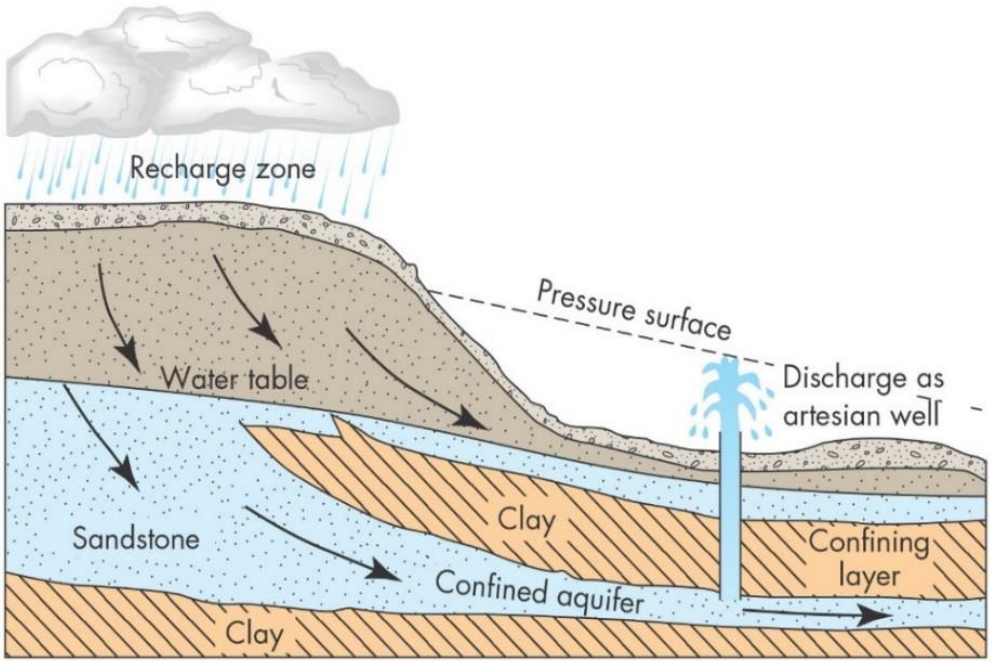
- Example of reductions from St. Lucie River and Estuary BMAP:*

Entity	Number of Septic Tanks Phased Out	Total TN Reduction (pounds/year)
City of Port St. Lucie	~5,600	34,206.5
City of Stuart	146	1,340.7
Martin County	1,084	15,369.2

*Results are specific to St. Lucie River and Estuary BMAP and its associated model.

Plugging Artesian Wells

- **What is an artesian well?**
  - Well working by natural pressure: well drilled through impermeable rocks into strata where water is under enough pressure to force it to surface without pumping.



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- **Description of BMP:**
  - Plugging abandoned, free-flowing, artesian wells.

- No data on water quality benefits.

- No BMAP credit for this project type.

Reclaimed Water

- Reuse of reclaimed water and land application rule: Chapter 62-610, Florida Administrative Code.
- Land application tool.
- Assumes reuse water goes to groundwater.
- If stakeholders show increased treatment of reuse positively affects surface waters, these data should be provided to the Department.
- No BMAP credit for wastewater reuse at this time.

Retention of Larger Storm Events

- Water quality treatment occurs largely in the first flush from storm event.

- Little water quality data, if any, exist to show benefit associated with retaining larger storm events, such as the 100-year storm event vs. 25-year storm.

- <u>No BMAP credit</u> for retention of larger storm events at this time.

Denitrification

- **What is denitrification?**
  - Microbial process that mitigates nitrate-nitrogen (N) pollution by reducing nitrate-N to N_2 or N_2O in hypoxic conditions utilizing an electron donor, e.g., organic carbon (C).

- Denitrification is an anaerobic reaction which requires the following conditions:
  - Permanently waterlogged, anaerobic soils.
  - Soils with bioavailable organic C.

Denitrification Walls

- Constructed by mixing a C source into soil below the water table as a permeable wall perpendicular to groundwater flow.
- Groundwater travels horizontally from high water table elevation to low elevation and to ditches, streams, and wetlands.
- Wall should be installed at the edge of the field, perpendicularly to the predominant flow direction.

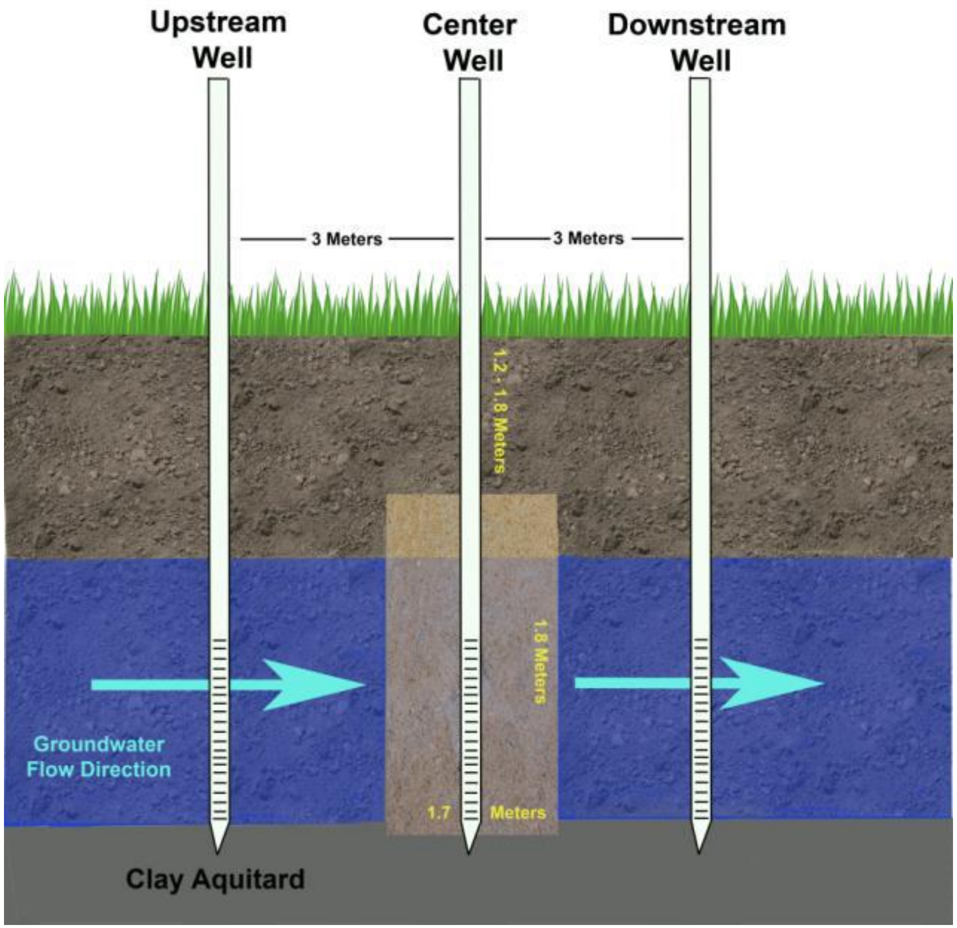
Denitrification Walls, continued

- For an effective denitrification wall installation it should be installed:
  - Within a soil layer that is underwater most of time (anaerobic conditions).
  - Down to a clay layer where groundwater is ponded ensuring entire water column treatment.
  - To capture a significant volume of groundwater.

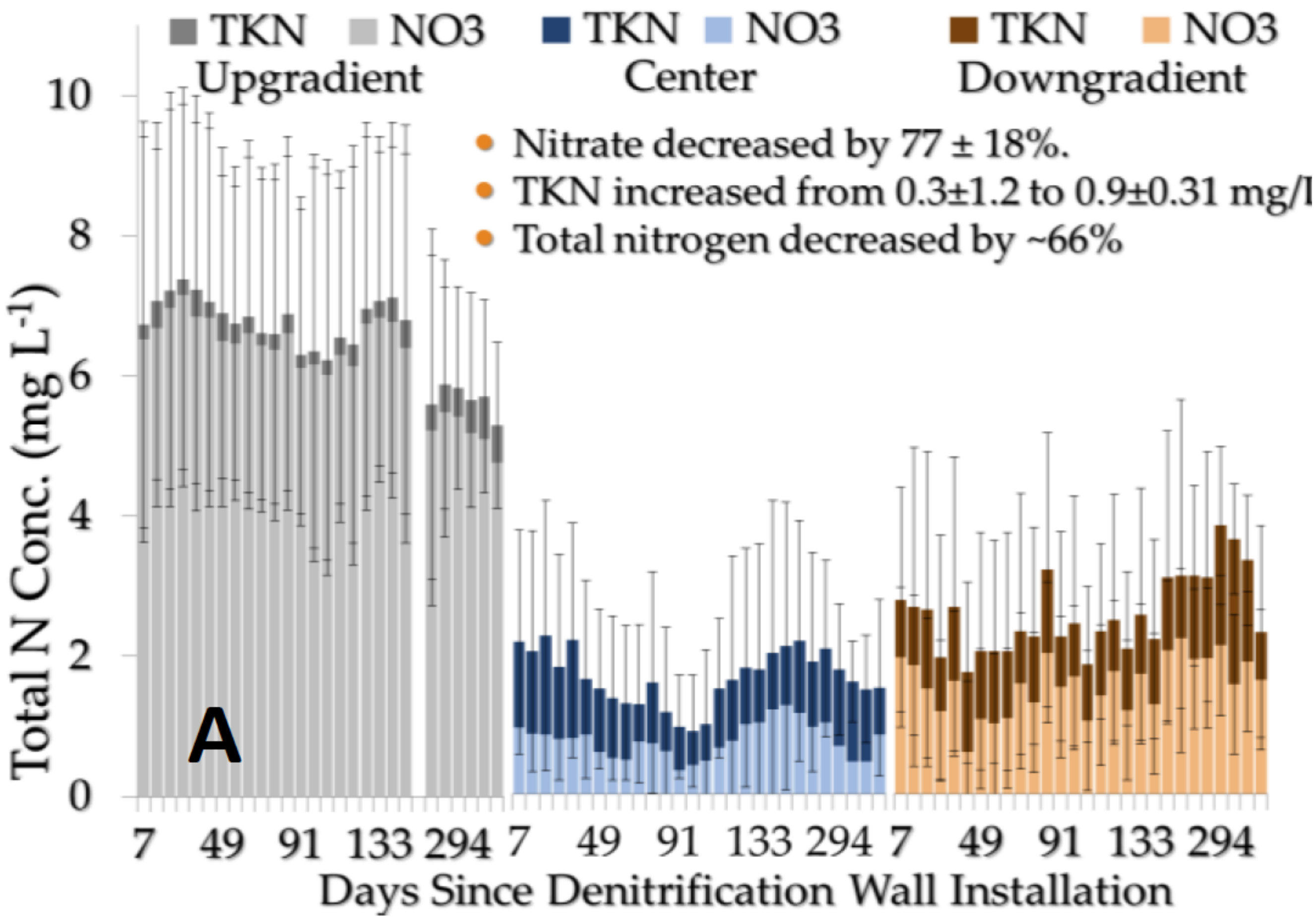
Denitrification Walls, continued

- **Literature findings:**
  - Low-cost, useful approach for removing excess nitrate-N from shallow groundwater (Schipper and Vojvodić-Vuković, 2001; Long et al., 2007).
  - Need to be maintenance free for a number of years to remain cost effective, but little is known about the longevity of these walls (Schipper and Vojvodić-Vuković, 2001; Long et al., 2007).
  - Passive treatment with minimum maintenance (Robertson et al., 2000).

Denitrification Wall



Denitrification Wall Reductions



Holly Factory (Florida nursery)

Denitrification Wall BMAP Credits

- Initial BMAP credit:
  - Use output from University of Central Florida's BMPTRAINS model.
- Additional monitoring data should be submitted to the Department for consideration to increase BMAP credit.

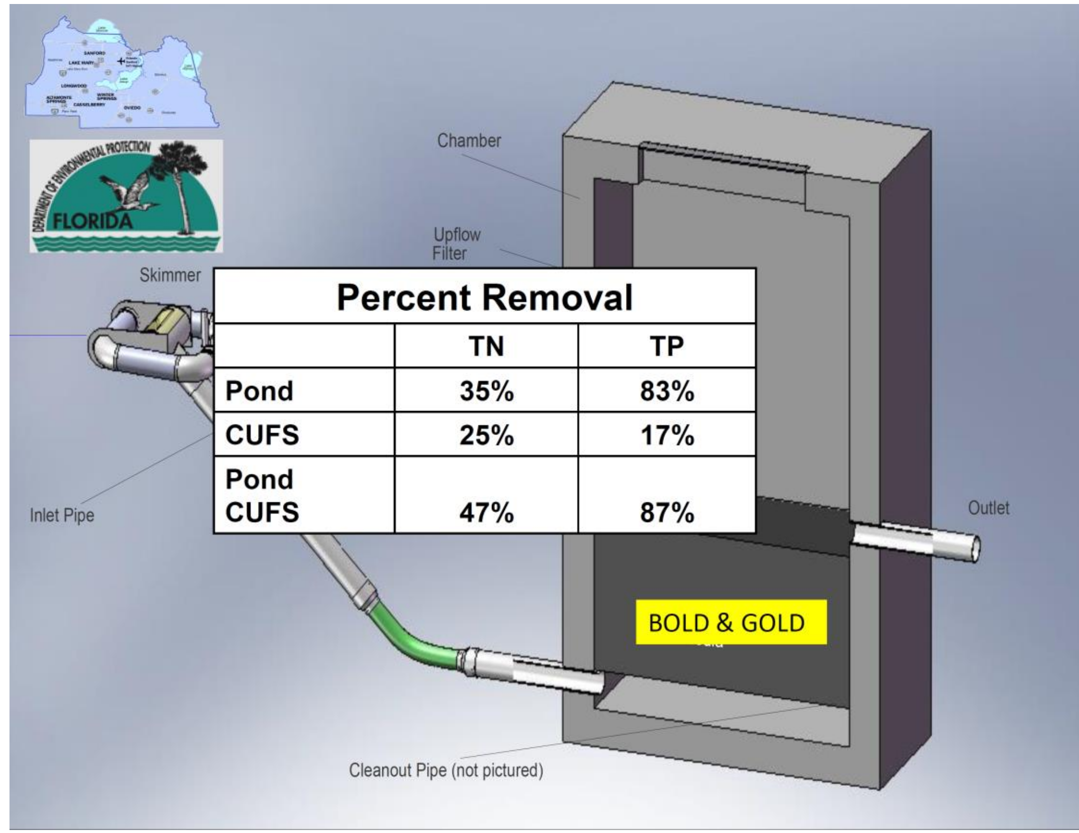
Bio-sorption Media (BAM)

- **What is BAM?**
  - Media that promotes attached microbial growth and still allows for hydraulically effective filtration.

- **Possible sources of BAM:**
  - Expanded clay.
  - Peat.
  - Palm tree frawns.
  - Tire crumb.
  - Limestone.
  - Crushed shells.
  - Compost.

BAM, continued

Chamber Up-flow Filter with Skimmer (CUFS).



Percent Removal		
	TN	TP
Pond	35%	83%
CUFS	25%	17%
Pond CUFS	47%	87%

BAM, continued

Bio-Sorption Activated Media (BAM)		
Possible Sources: Expanded Clay, Peat, Sandy/Loamy/Clayey Soils, Untreated Sawdust, Paper/Newspaper, Palm Tree Fronds, Tire Crumb or Chips, Limestone, Crushed Shells, Wood Fiber/Chips, Compost, Coconut Husk		
	Removal Rate (%)	
Application	**TN**	**TP**
Up-Flow Filtration for Wet Detention		
Average Filter Removal	42.3	43
Overall Average Removal	71	74.6
Annual Average Removal	58.6	64
Caveats: Assumed 70% of pond flow through filter		
Average based on three (3) test sites		
Life Expectancy for BAM not known		
Filter part of "treatment train" with wet detention		
CUFS - Chamber Upflow Filter and Skimmer		
Pond Only	35	83
CUFS Only	17	25
Pond + CUFS	47	87
Caveats: Based on one pilot project system, one media mix, and the Central Florida climate		

BAM, continued

Soil augmentation beneath retention treatment system

Augmentation	Material	Removal Rate (%) TN	TP	Limiting Infiltration Rate
CPS (24" deep below 6" top soil)	Compost (7.5%), Shredded Paper (7.5%), Sand (85%)	20	30	10 in/hr
OTE (24" deep, no top soil)	Organics (20%), Tire Crumb (25%), Expanded Clay (70%)	20	35	20 in/hr
CSL (24" deep all blended)	Compost (20%), Sand (50%), Local Top Soil (30%)	20	75	0.8 in/hr
COS (24" deep under 6" top soil)	Dade City Clay (10%), Organics (4%), Sand (86%)	35/60 (Add 12 inches of internal water storage at the bottom and increase the nutrient removal to 60%)	45/60	1.5 in/hr
SAT	Sand (100%)	30	60	2.0 in/hr
CTS (12" deep under 6" of top soil	Dade City Clay (27%), Tire Crumb (14%), Sand (59%)	60	90	0.25 in/hr

Caveats: From Stormwater BMP Treatment Trains program developed by the University of Central Florida Stormwater management Academy Version 7.2 updated June 4, 2014.
Recommend use of the model instead of this table for more accurate results

BAM: Marion County Study

- Tire crumb used under wet retention pond in southwest Marion County.

- Project is being monitored, but results so far indicate good success:
  - 90% TN removal.
  - 95% total phosphorus (TP) removal.

BAM BMAP Credits

- Initial BMAP credit:
  - Use output from University of Central Florida's BMPTRAINS model.
- Additional monitoring data should be submitted to the Department for consideration to increase BMAP credit.

Green Infrastructure

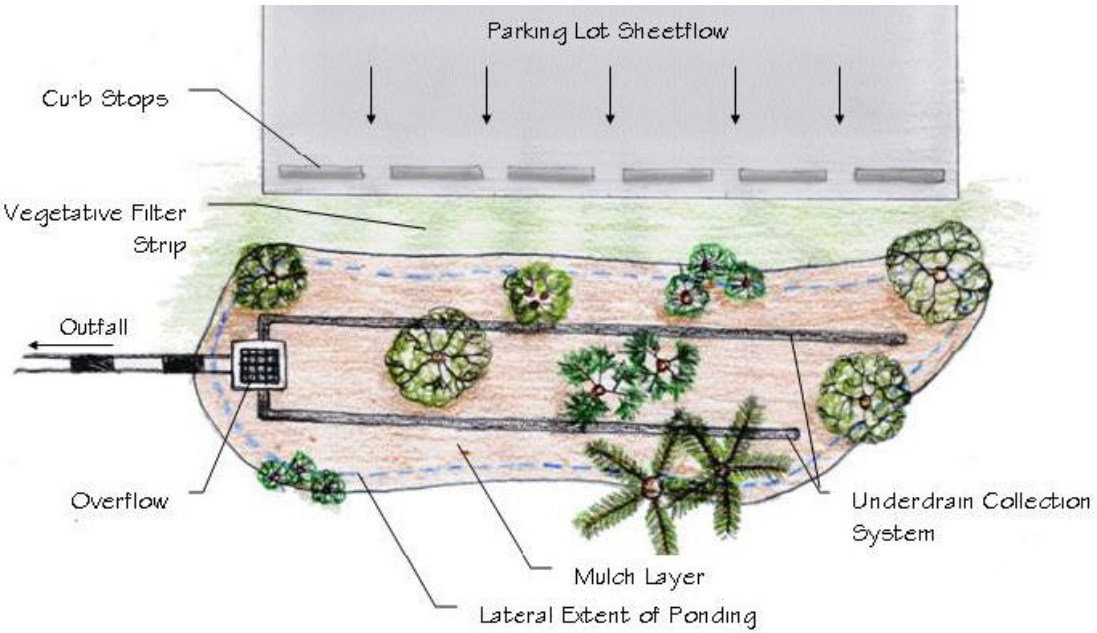
- Green infrastructure examples:
  - Bioswales.
  - Green roofs.
  - Rain gardens.
  - Tree boxes.

- Nutrient-removal effectiveness based on:
  - Retention curves and BMP design.
  - Percentage of directly connected impervious area (DCIA) and weighted curve number for non-DCIA areas.
  - Combination of vegetation and soil effects (absorption).
  - Microbiological processes from different sorption media.

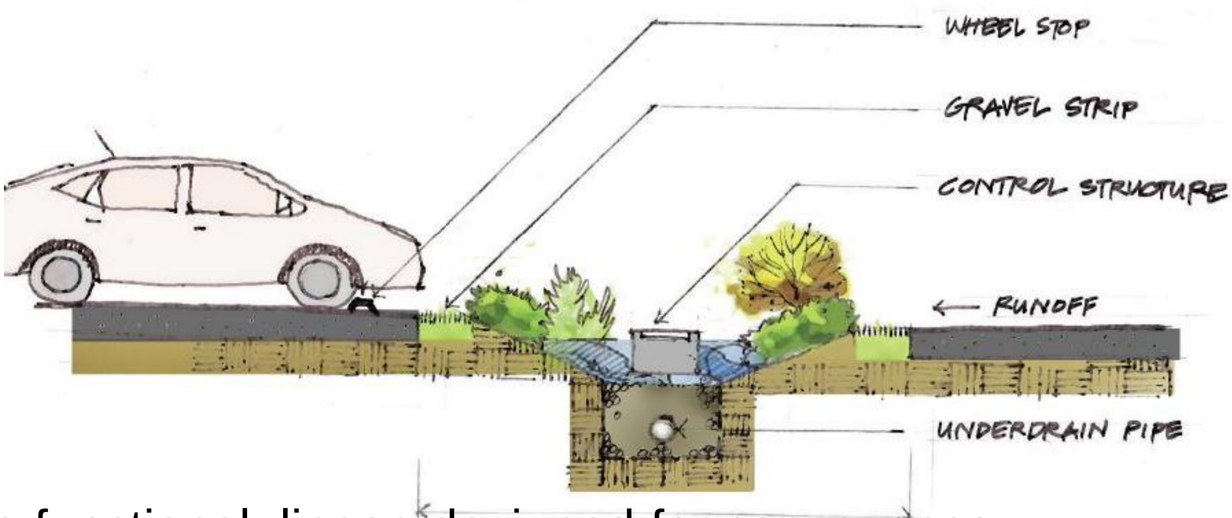
Green Infrastructure: Bioswales, continued

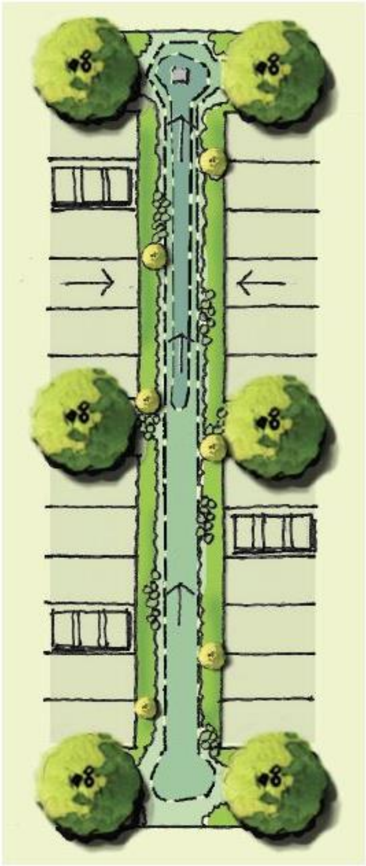
- Linear vegetated ditches that allow for collection, conveyance, filtration, and infiltration of stormwater runoff.

- Ideal for structural stormwater control for use near large impervious areas, e.g., roadway medians and parking lot islands.



Green Infrastructure: Bioswales, continued





- Must be functional, linear, designed for conveyance, greater in length than width, and have shallow slopes.
- Proper landscaping is critical for performance.
- Generally used as stand-alone stormwater BMP, but most effective when used in conjunction with other BMPs, e.g., wet ponds, infiltration strips, and wetlands.

Green Infrastructure: Bioswales, continued

http://www.stjohnsriverkeeper.org/blog/pollution-solutions-lasalle-bioswale-project/

- Treatment effectiveness directly related to:
  - System size.
  - Amount of annual stormwater volume that is infiltrated.
  - Residence time of water in swale (more time = more nutrient reduction).

- Pollutant removal range of efficiencies gathered from literature:
  - Nitrate: 38% - 89%.
  - TP: 9% - 80%.

Bioswale BMAP Credits

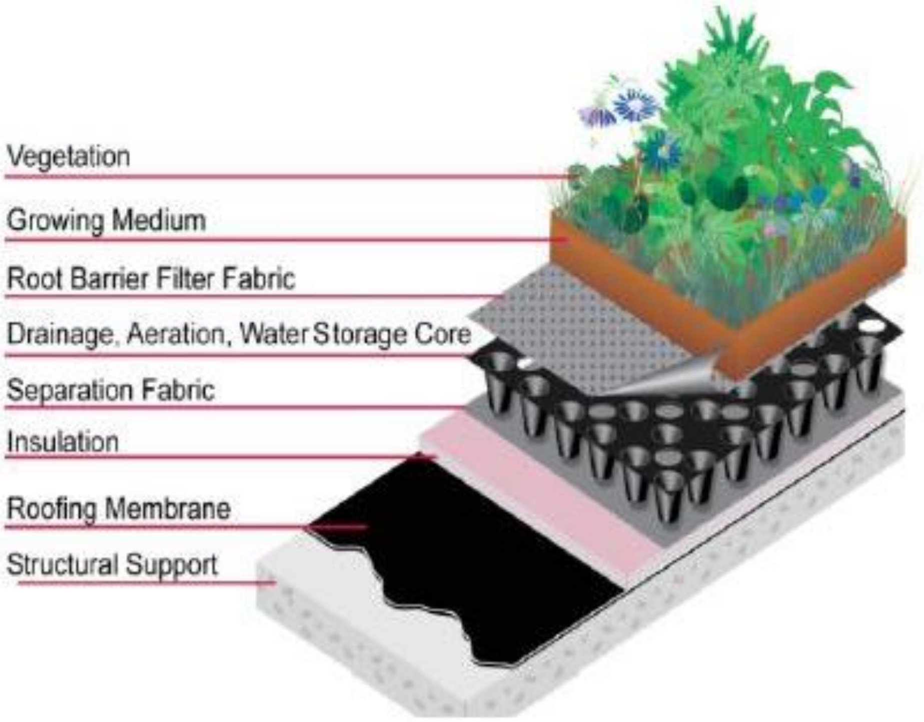
- Additional monitoring data should be submitted to the Department for consideration to increase BMAP credit.

- Initial BMAP credit:
  - Nitrate: 38%.
  - TP: 9%.

Green Infrastructure: Green Roofs

- Retention BMP covered with growing media and vegetation that enables rainfall infiltration and evapotranspiration of stored water.

- **Two types:**
  - *Extensive:* low maintenance, soil layer less than 6”, and support dense, low growing, drought-resistant vegetation.
  - *Intensive:* thick layer of soil usually greater than 6” and can support all types of vegetation.



Green Infrastructure: Green Roof Examples

Escambia County Central Office

University of Central Florida Student Union Building

Green Infrastructure: Green Roofs, continued

- Annual effectiveness related to annual volume of roof runoff that is captured, retained, reused, and size of cistern (or dedicated reuse pond) which collects and recycles runoff to irrigate roof.

- With a cistern, significant reduction in nutrients can be expected over the lifetime of the green roof system and must be used earn pollution-control or stormwater credits.

- Efficiency without cistern ~ 45% TN.

- Efficiency with cistern ~ 60-85% TN.

Green Roof BMAP Credits

- Additional monitoring data should be submitted to the Department for consideration to increase BMAP credit.

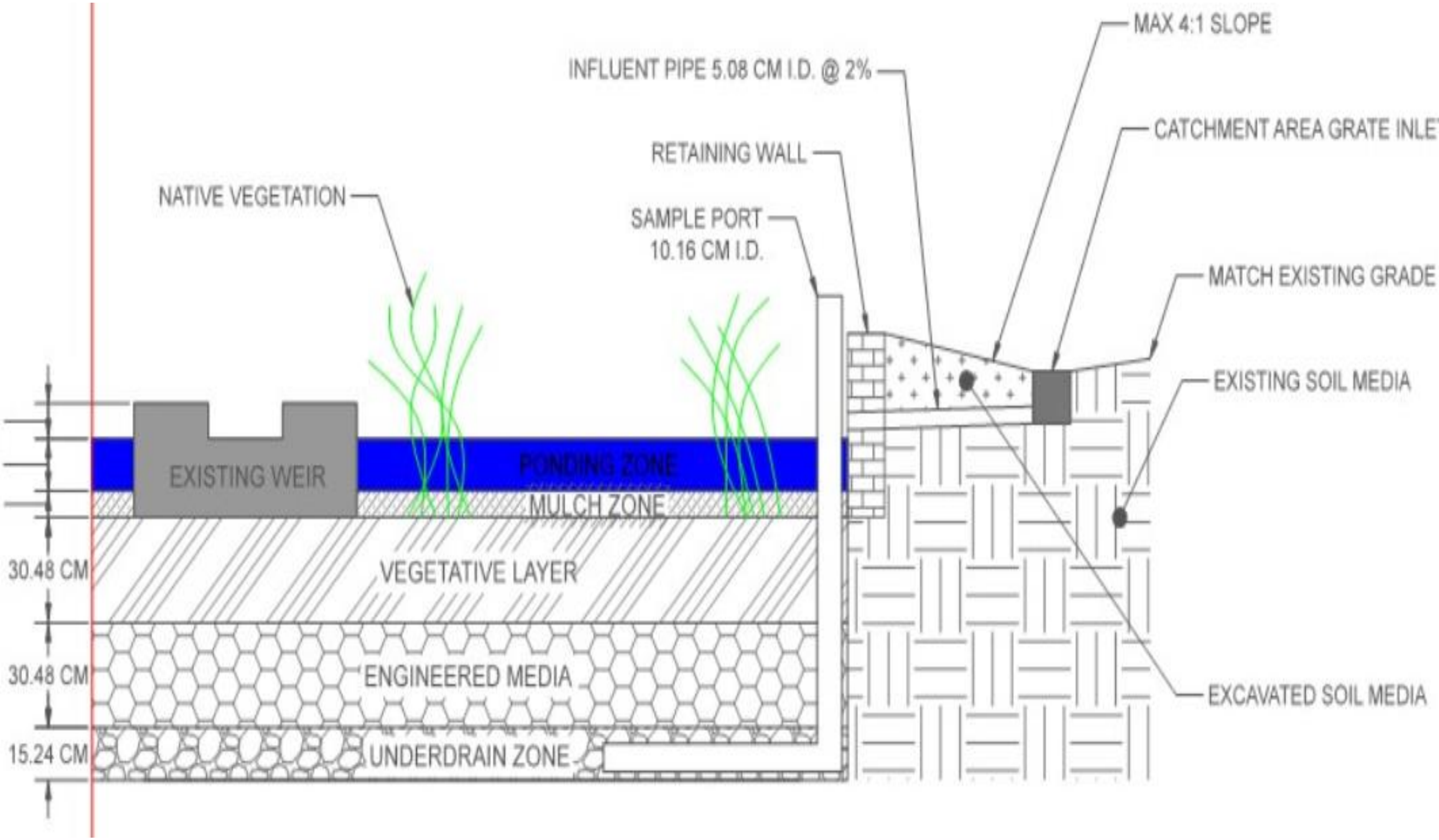
- Initial BMAP credit:
  – TN (without cistern): 45%.
  – TN (with cistern): 60%.

Green Infrastructure: Rain Garden

- Rain gardens (also known as bioretention or bioinfiltration cells) are shallow, vegetated basins that collect and absorb stormwater runoff.

- Ideally constructed adjacent to roof runoff and impervious areas, e.g., streets, rooftops, parking lots, and driveways.

Green Infrastructure: Rain Garden, continued



Green Infrastructure: Rain Garden, continued

Young Middle Magnet School in East Tampa, FL (design in previous slide)

http://usf-reclaim.org/epa-center/demonstrations/east-tampa-rain-garden/

- Rain garden estimates of annual effectiveness related to annual volume of stormwater roof runoff that is captured, retained, reused.

- N and P removal are achieved through filtration and adsorption, plant and microbial uptake, nitrification and denitrification.

- Pollutant removal range of efficiencies gathered from literature:
  - Nitrate: 30% - 50%.
  - TP: 30% - 90%.

Rain Garden BMAP Credits

- Additional monitoring data should be submitted to the Department for consideration to increase BMAP credit.

- Initial BMAP credit:
  - TN (nitrate): 30%.
  - TP: 30%.

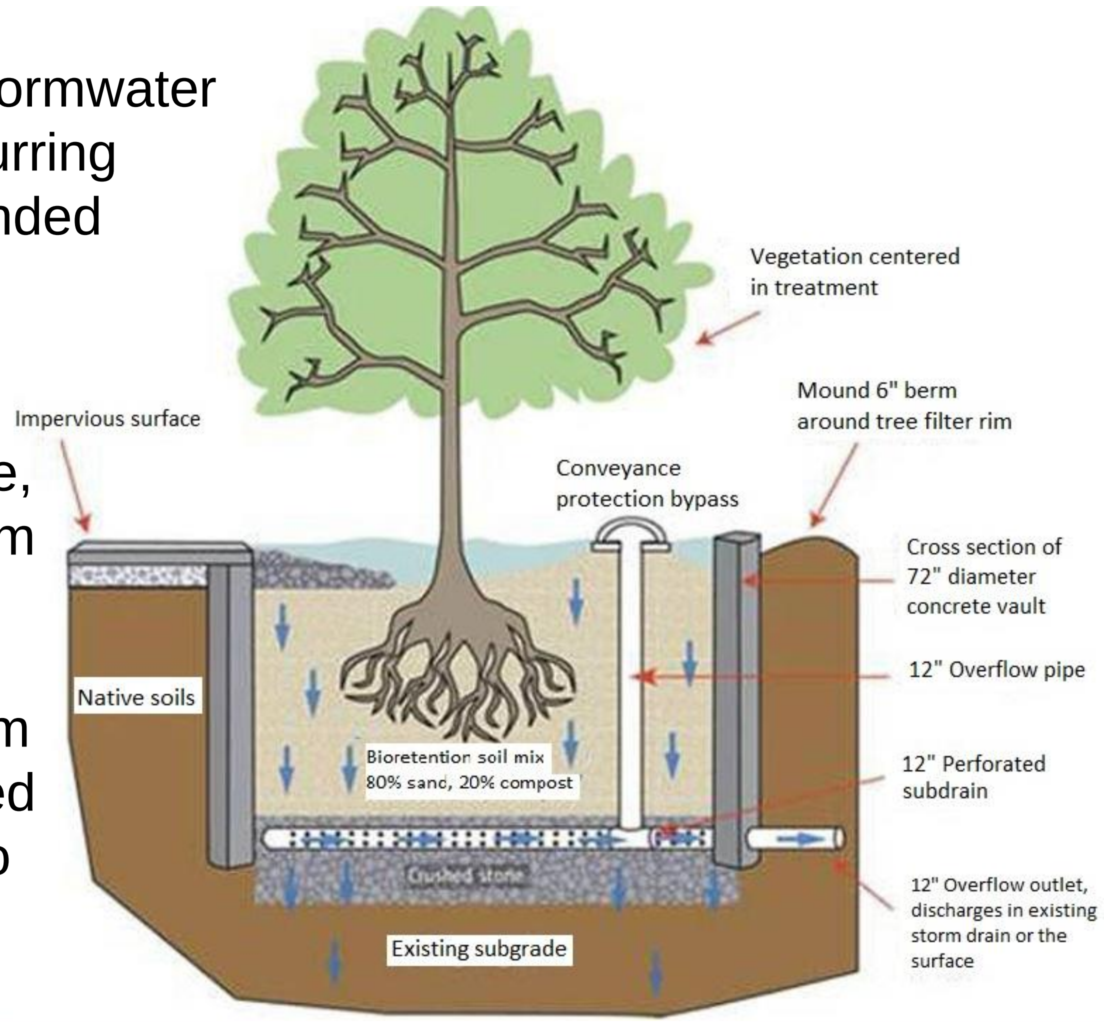
Green Infrastructure: Tree Boxes

- **What are tree boxes?**
  - Urban bioretention systems with vertical concrete walls designed to collect/retain specified volume of stormwater runoff from sidewalks, parking lots and/or streets.

- Number of tree boxes necessary is dependent on climate, topology, hydrology, and size of pre-manufactured chamber structure.

Green Infrastructure: Tree Boxes, continued

- Each tree box treats approximately 0.25 to 0.5 acres.
- Designed to capture and treat stormwater runoff from small frequently-occurring storms, not large storms or extended periods of rainfall.
- The system consists of a container filled with a soil mixture, a mulch layer, under-drain system and shrub or tree.
- Treated water flows out of system through an under drain connected to a storm drainpipe / inlet or into surrounding soil.



Green Infrastructure: Tree Boxes, continued

- Efficiency depends on specially designed filter media and sizing strategy allows treatment of very high volumes of stormwater runoff that is captured and filtered through the system.

- Stormwater tree pits have average lifespan of 25 years

- Pollutant removal range of efficiencies gathered from literature:
  - Nitrate 38-65%.
  - TP: 50-80%.

Tree Box BMAP Credits

- Additional monitoring data should be submitted to the Department for consideration to increase BMAP credit.

- Initial BMAP credit:
  - TN (nitrate): 38%.
  - TP: 50%.

Muck Removal

- Department developed guidance document, which details requirements to receive muck removal project credit.
- Muck deposit average minimum thickness should be 30 centimeters.
- Muck must be removed to natural substrate, and the material must be stored away from surface waters.
- Credit is calculated by multiplying area of muck removed by difference in nutrient flux rate of muck and natural substrate.
- Adequate source controls need to be considered in watershed as source of most muck deposits is watershed.

MUCK

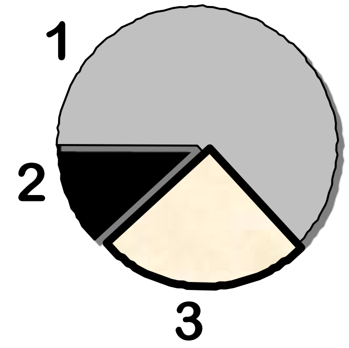
What is muck?

"…black, fine-grained…high water content, composed of partly decomposed organic matter and a considerable amount of admixed silt and clay material."

Trefry et al., 1987

1. Silt + clay >60% dry wt.
2. Organic matter >10% dry wt.
3. Sand + shell is the remainder

Trefry et al., 1990



Muck is mostly eroded upland soils (fines).

Muck Removal

- Discussed further crediting of muck removal with Dr. Trefry, Shailish Patel, Joel Steward, Whit Green, Rex Ellis, and Chuck Jacoby.
- Concluded that diffusive flux is best tool as current understanding supports.
- Dr. Trefry considered calculation of advective flux.
  - Estimated N removal for Eau Gallie Harbor is 5 metric tons as diffusive flux.
  - Propose some adjustment to crediting period or depth of deposits for removal to provide incentive for removal of deeper deposits.
  - May consider incentive credit for removal of large and deeper deposits.

Muck Research

- Research effort underway to include:
  - Sediment survey mapping;
  - Sediment diffusive nutrient flux; and
  - Meteoric submarine groundwater discharge nutrient flux.
  - Study results can answer questions about movement of nutrient from sediment; results incorporated into muck removal guidance.
  - Completion time frame FY 2015-16.
- Diffusive flux provides a minimum credit for muck removal with potential for increasing when results of study are available.

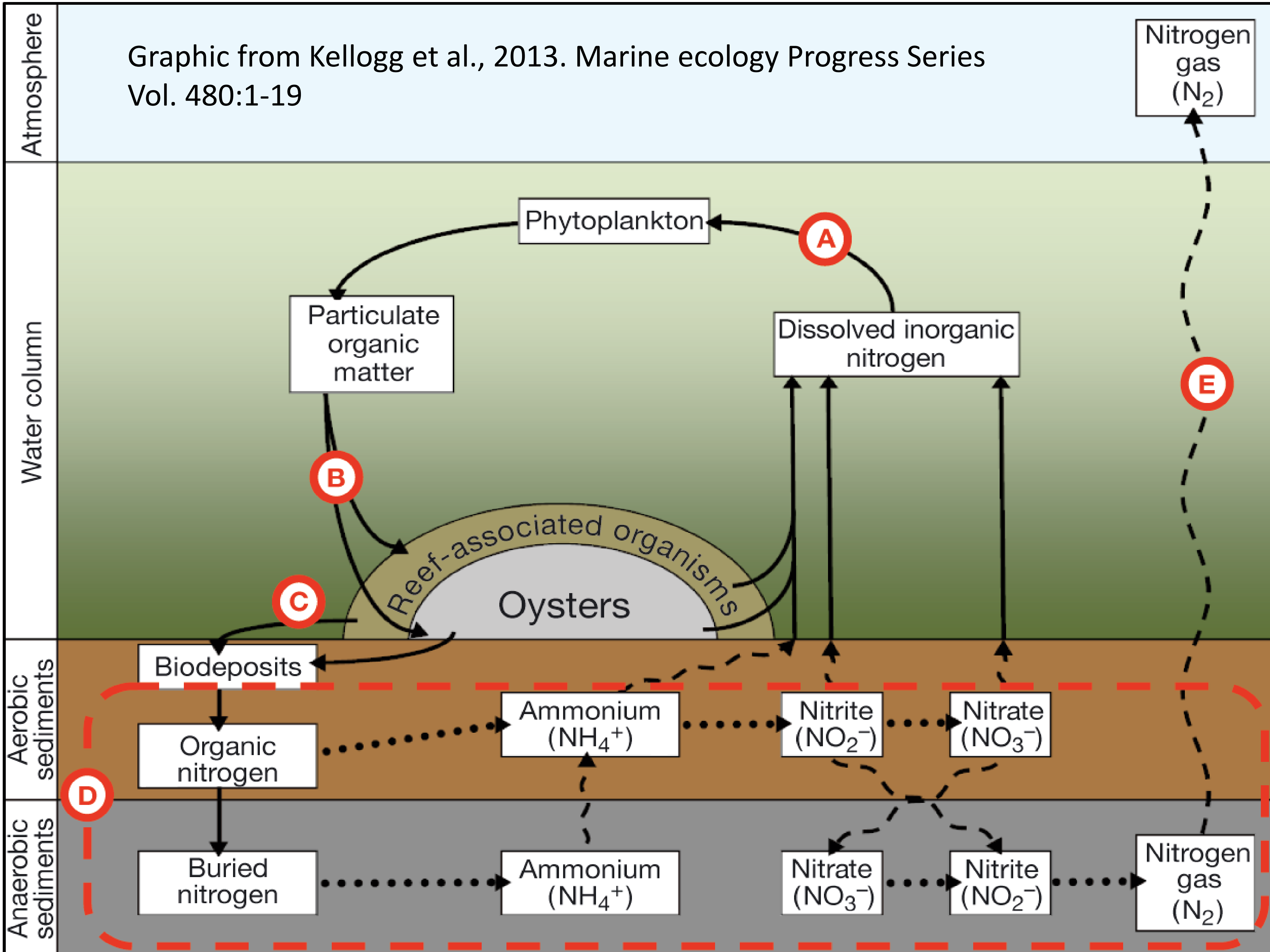
Living Shoreline

- Living shorelines use littoral vegetation and oyster reefs; shellfish feeder population enhancement in the IRL (not just along the shoreline).

- Shellfish may be a way to manage N inputs to coastal waters – evidence of denitrification and nutrient assimilation by oysters from literature.

- Oysters are filter feeders and remove suspended solids from water column.

- Department supports restoring natural communities.



Graphic from Kellogg et al., 2013. Marine ecology Progress Series Vol. 480:1-19

Project Green Shores- Pensacola Bay

Project GreenShores

- Location is Pensacola Bay, NW DEP District Project.
- Constructed in two phases.
- 2003 – 15 acres combined of oyster reef and salt marsh/seagrass Habitats.
- 2007 – added breakwaters for oyster establishment as well as salt marsh /sea grass habitats.
- Habitats have performed well.
- Water quality data available for analysis.

Living Shoreline Credits

- Department is currently working to determine how to calculate nutrient credits for this BMP.

- FARM model for aquaculture – used by Brickler et al. to estimate N removal in Chesapeake Bay. Possible tool for determining nitrogen removal.

- Department has talked with The Nature Conservancy about suggested ways to measure nutrient removal.

Buffers

- Streamside forest buffers are effective for protecting water quality, habitat, and biota in small streams and canals. (Sweeney and Newbold, Journal of the American Water Resources Association, 2014, 50(3): 560-584)

- Subsurface nitrate removal varies with subsurface water flux:
  - For >50 L/m/day, median removal efficiency at 55% (24-64% range) for a buffer less than 40 meters.
  - For buffers > 40 meters 89% median removal efficiency (27-99% range).

- Sediment trapping:
  - 65% for a 10 meter buffer.
  - 85% for a 30 meter buffer.

Aquatic Vegetation Harvesting

- Department developed guidance document, which details requirements to receive credit for aquatic vegetation harvesting.

- Credit is assigned based on type of vegetation removed, nutrient content for that type of plant, amount of plant material removed, and percent dry weight of material collected.

- Annual average TN and TP load removal can be calculated and included in BMAP as credit.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Aquatic Vegetation Harvesting, continued

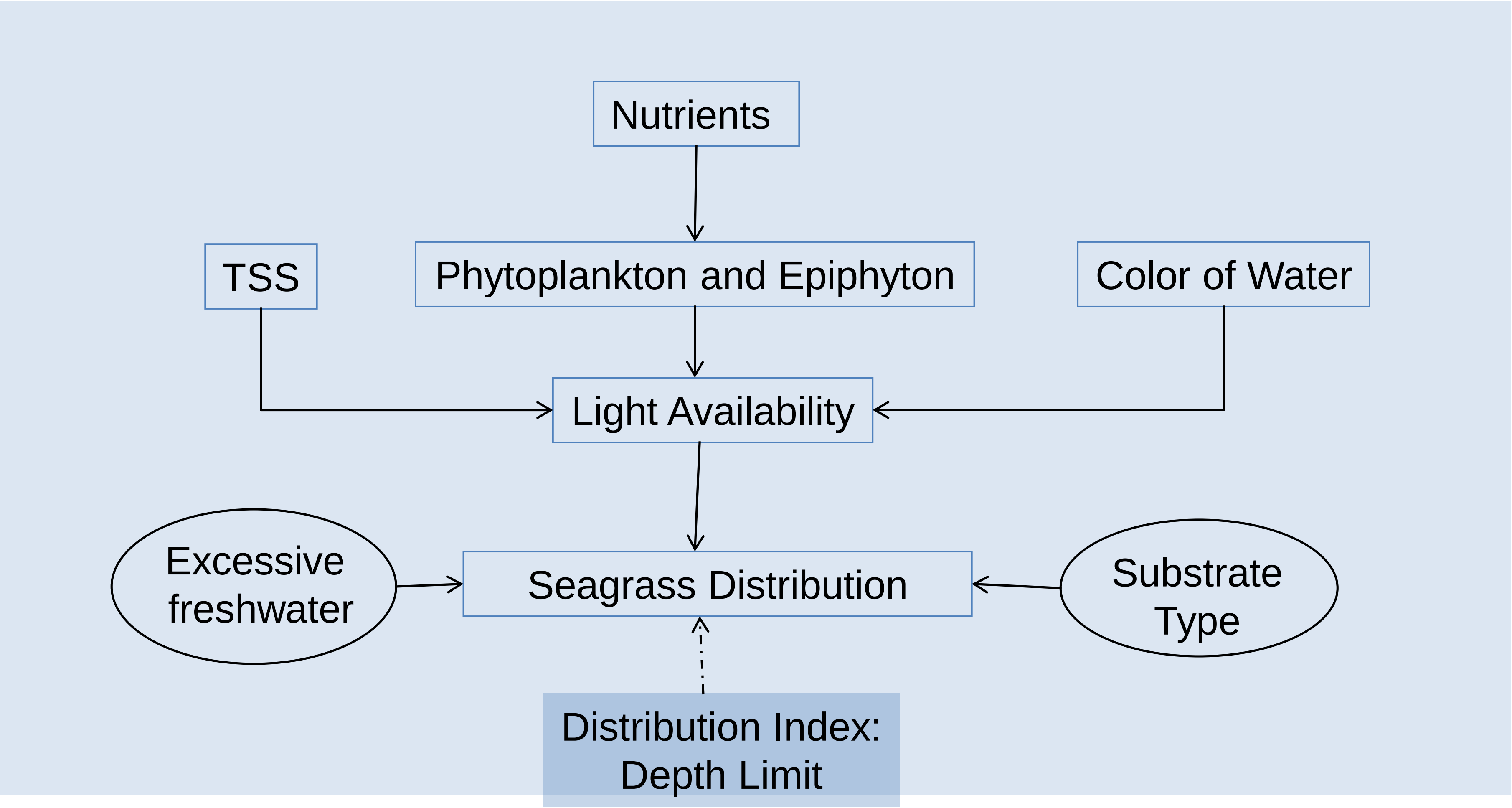
- Preferred place (but not exclusive) for aquatic plant harvesting is in canals behind control structures.
  - Floating aquatic plants help absorb nutrient from water column. Their removal exports nutrient load from waterbody.
  - Freshwater plants that enter IRL cannot tolerate increased salinity. Plants are killed by salinity change and release their nutrient content.

- Department supports freshwater plant harvesting. Second phase is to compile typical values for IRL for composite sample of multiple species.

Macroalgal Harvesting

- St. Johns River Water Management District (SJRWMD) is collecting samples of submerged aquatic vegetation for tissue nutrient content. Harvest includes:
  - *Halodule wrightii.*
  - *Syringodium filiforme.*
  - Drift algae (drift red algae, Spyridia).
- Need more information on distribution and role of macroalgae in IRL.
  - There is concern that without seagrass, macroalgae are the next best habitat.
  - Caution needs to be exercised for any manipulation of the IRL trophic structure.
  - No BMAP credit for this project type.

TROPHIC STRUCTURE MATTERS!!!



Seagrass Planting

- SJRWMD is trying different planting techniques. No conclusive results yet. Tentatively, success varies on a site by site basis. Two tests to date.
  - Tried cages around seagrass -- seagrass still eaten.
  - Captured seagrass as it drifted by to try and reattach it in a new location.
- Success has been achieved in other estuaries with planting seagrass within another bed.
- Also in other areas seagrass sodding was successful – when a machine removes a section of seagrass for planting in another area.
- In some northern locations seagrass has been propagated by seed, but grasses in IRL really don’t form seeds.
- In conclusion seagrass planting needs more testing -- not a viable methodology at this time.


Locator Map
Potential Seagrass
Transplant Sites
N
Transplant Sites
Donor and recipient (control)
Recipient
Recovery Planting Site
Kilometers
0 4 8 16 24 32
Titusville
Cape Canaveral
Rockledge
Cocoa Beach
Melbourne
Palm Bay
Roseland
Sebastian
Fellsmere
Vero Beach
ARTHUR DUNN AIR PARK
SPACE COAST RGNL AIRPORT
JOHN F. KENNEDY SPACE CENTER
CAPE CANAVERAL AFS SKID STRIP
45TH SPACE WING - CAPE CANAVERALL AFS
MERRITT ISLAND AIRPORT
45TH SPACE WING - PATRICK AFB
PATRICK AFB
MELBOURNE INTL AIRPORT
45TH SPACE WING - MALABAR TRANSMITTER ANNEX
SEBASTIAN MUNI AIRPORT
VERO BEACH MUNI AIRPORT
St Johns River
Lake Poinsett
Lake Washington
Blue Cypress Lake
12 m
20
9
87
12
BRSC02
25
BRPort
26
27
16
28
17
29
30
31
34
35
36
38
SISShoal
41
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43
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46
47
48
VB17
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520
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192
1

Code Changes and Economic Incentives

- Department supports code changes to encourage low-impact development (LID).
- At this time, we do not have a methodology for creating a scale for reductions associated with these changes.
- Along with code changes for LID can be economic incentives for modifying exiting private stormwater infrastructure to improve its effectiveness.
  - E.g., City of Gainesville.
- Department would like to work with stakeholders to identify specific changes and possible credits.

Natural Wetlands as Filters

- New development and restoration of existing wetlands have potential for receiving credits.
- For development of new treatment wetlands, efficiency expected could be applied to provide a nutrient reduction benefit.
- Protection of existing wetlands and use as natural filters. At this time, Department does not have a way to quantify this.
- Department would like to work with stakeholders to identify specific changes and possible credits.

Enhanced Education and Outreach

- Department would like to explore this further, set a minimum credit, and have stakeholder input in this process.

- Requires documentation explaining how approach used would provide more benefit than current crediting scheme.
  - Some useful information for documentation includes focus groups, surveys, social marketing techniques.
  - Education and outreach already receive credits so additional crediting would need to be beyond the current requirements.

- Department would like to work with stakeholders to identify specific changes and possible credits.

Education Crediting

Activity
Florida Yards and Neighborhoods program
Local codes and ordinances
Landscaping
Irrigation
Fertilizer
Pet waste management
Public Service Announcements (PSAs)
Informational Pamphlets
Website
Inspection program and call-in number for illicit discharges

- All 6 activities – 6% credit.
- FYN only – 3% credit.
- Ordinances only – 2% credit.
- No ordinance or FYN – 1% credit.

Proposed Monitoring Protocol

- Based on 319 monitoring requirements for structural BMPs.
- Require a Quality Assurance Project Plan (QAPP) for monitoring prior to commencement of any monitoring.
- Monitoring plan will specify sampling locations, sampling instruments, and parameters to be sampled.
- Parameters needed for BMAP crediting but are not limited to:
  - TN (lbs/yr).
  - TP (lbs/yr).
  - TSS (lbs/yr).
  - Orthophosphate.
  - Flow.
  - -NO2/NO3.
  - -TKN.
  - -NH3
  - -Rainfall.

Proposed Monitoring Protocol, continued

- Monitored events shall include a maximum of 7 – 10 discrete rain events, generally greater than 0.20 inches and less than 1.5 inches.

- Monitoring shall be performed at inflow and outflow locations of each BMP installed and in accordance with approved QAPP.

Take Home Message

- This presentation is intended to provide initial credits for proposed BMPs.
- Stakeholders should use this information to get started on project planning.
- Department would like to work with stakeholders to refine these numbers and determine numbers for certain BMPs that cannot be quantified at this time.
- Department is working to develop database of monitoring data from projects with U.S. Environmental Protection Agency 319(h) funds.

Summary

BMP	TN Reduction	TP Reduction
Septic tank phaseout	ArcNLET Model	ArcNLET Model
Plugging artesian wells	No credit	No credit
Reclaimed water	No credit	No credit
Retention of larger storm events	No credit	No credit
Denitrification wall	BMPTrains Model	BMPTrains Model
BAM	BMPTrains Model	BMPTrains Model
Bioswale	38% (Nitrate)	9%
Green roof	45% (without cistern) 60% (with cistern)	N/A
Rain garden	30%	30%
Tree box	38%	50%
Muck removal	Guidance document	Guidance document
Living shoreline	TBD	TBD

Summary

BMP	TN Reduction	TP Reduction
Oyster reefs	TBD	TBD
Buffers	22% (less than 40 m) 27% (greater than 40 m)	N/A
Aquatic harvesting	Guidance document	Guidance document
Macroalgal harvesting	No credit	No credit
Seagrass planting	TBD	TBD
Code changes/Economic incentives	TBD	TBD
Natural wetlands as filters	No credit	No credit
Enhanced education	TBD	TBD

Contacts

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Questions