City of Miami Beach
Integrated Water Management
Rising to the Challenge

Blue-Green Stormwater Infrastructure Concept Plan Update

September 25, 2019

Presented to: Miami Beach Sustainability and Resiliency Committee

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Meeting Agenda

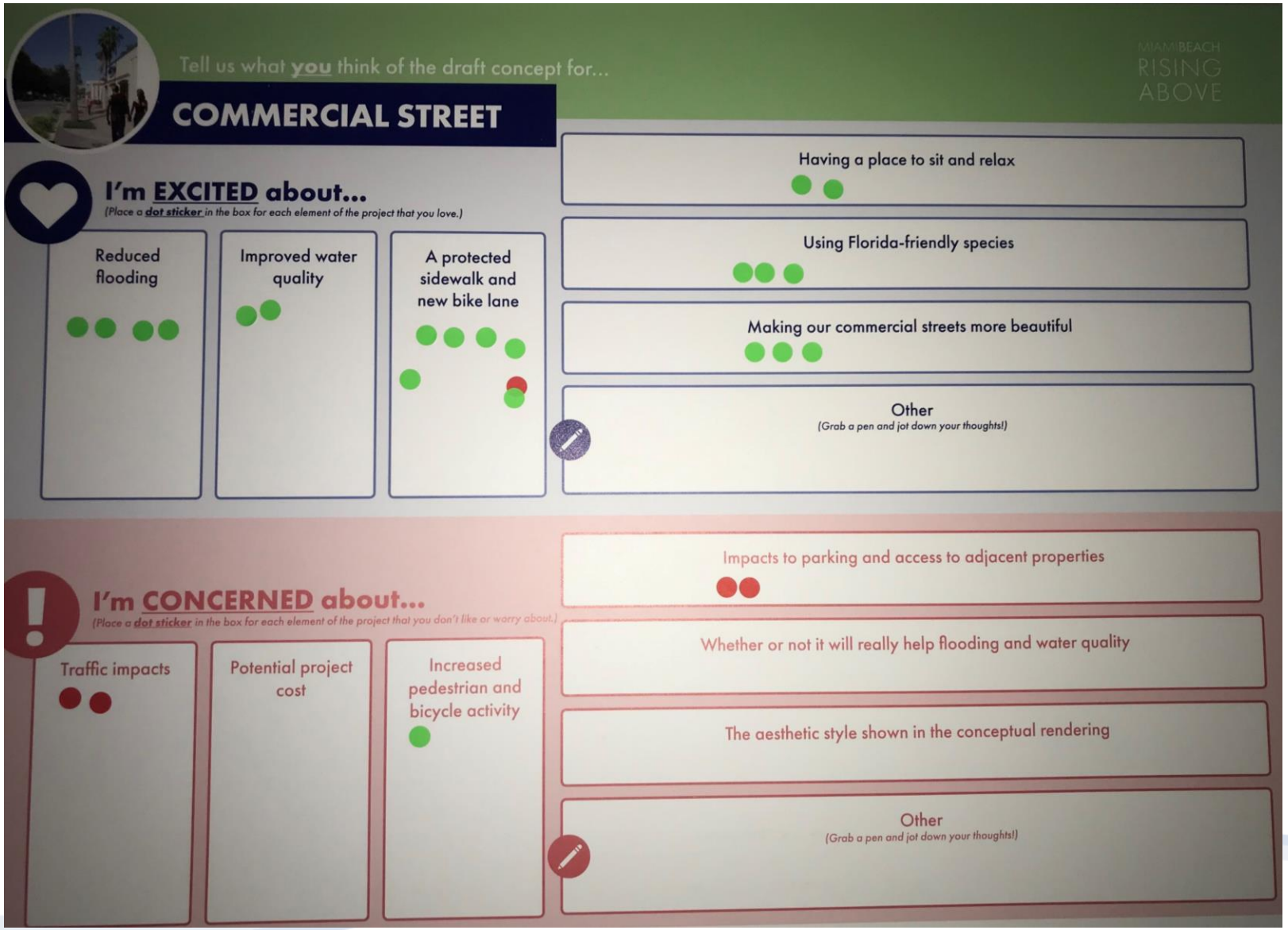
- Summary of comments from public meeting held 9/17
- Outline of blue-green stormwater infrastructure (BGSI) concept plan
- Excerpts from/sample sections of BGSI concept plan
- SRC feedback and endorsement

Initial Summary of Comments from Public Meeting

- The public comment period ended yesterday – comments are still being compiled and reviewed
- Some common themes we have heard thus far include:
  - Who will maintain BGSI?
  - How will City incentivize BGSI implementation on private property?
  - How will BGSI function with high groundwater, as sea level rises?
- A lot of feedback on concept renderings

Examples of Public Comments on Concepts

Mostly excitement about benefits/ improvements, with some concerns about traffic, parking, and access.



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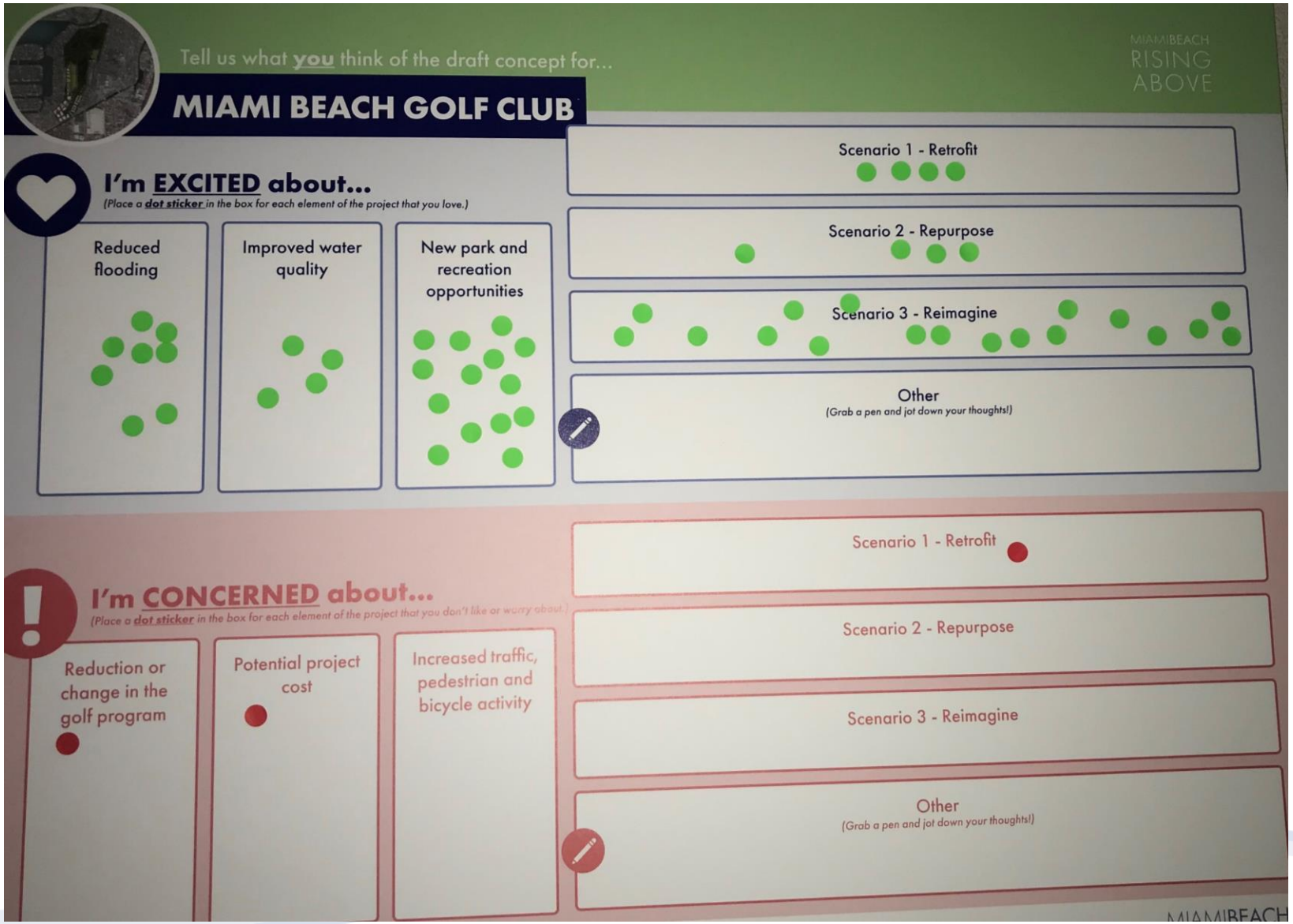
Examples of Public Comments on Concepts

A lot of excitement about the reimagine scenario in which there is no golf.



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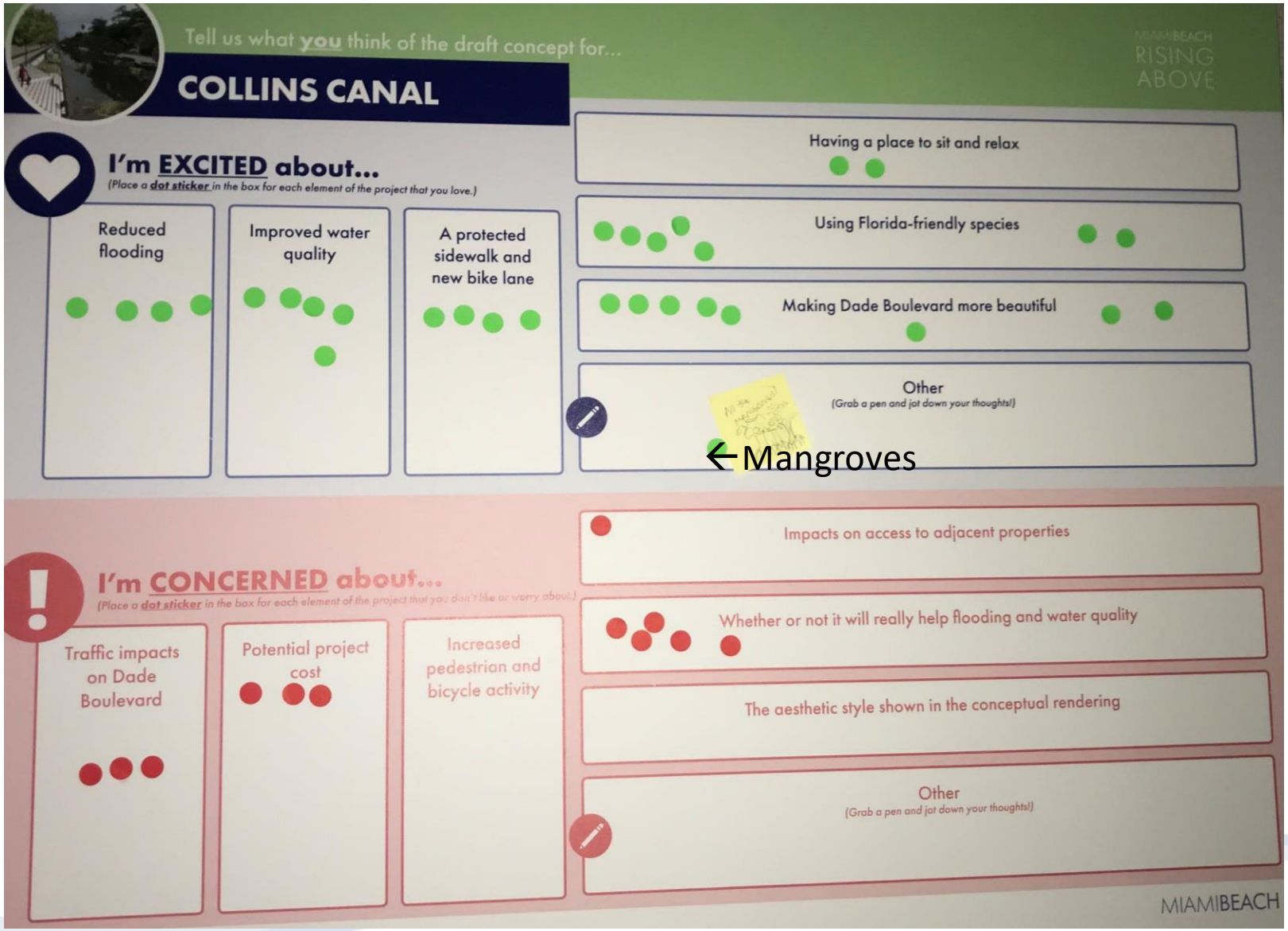
Examples of Public Comments on Concepts

Excitement about benefits and Dade Blvd improvements, but also concerns about cost, effectiveness, and traffic.



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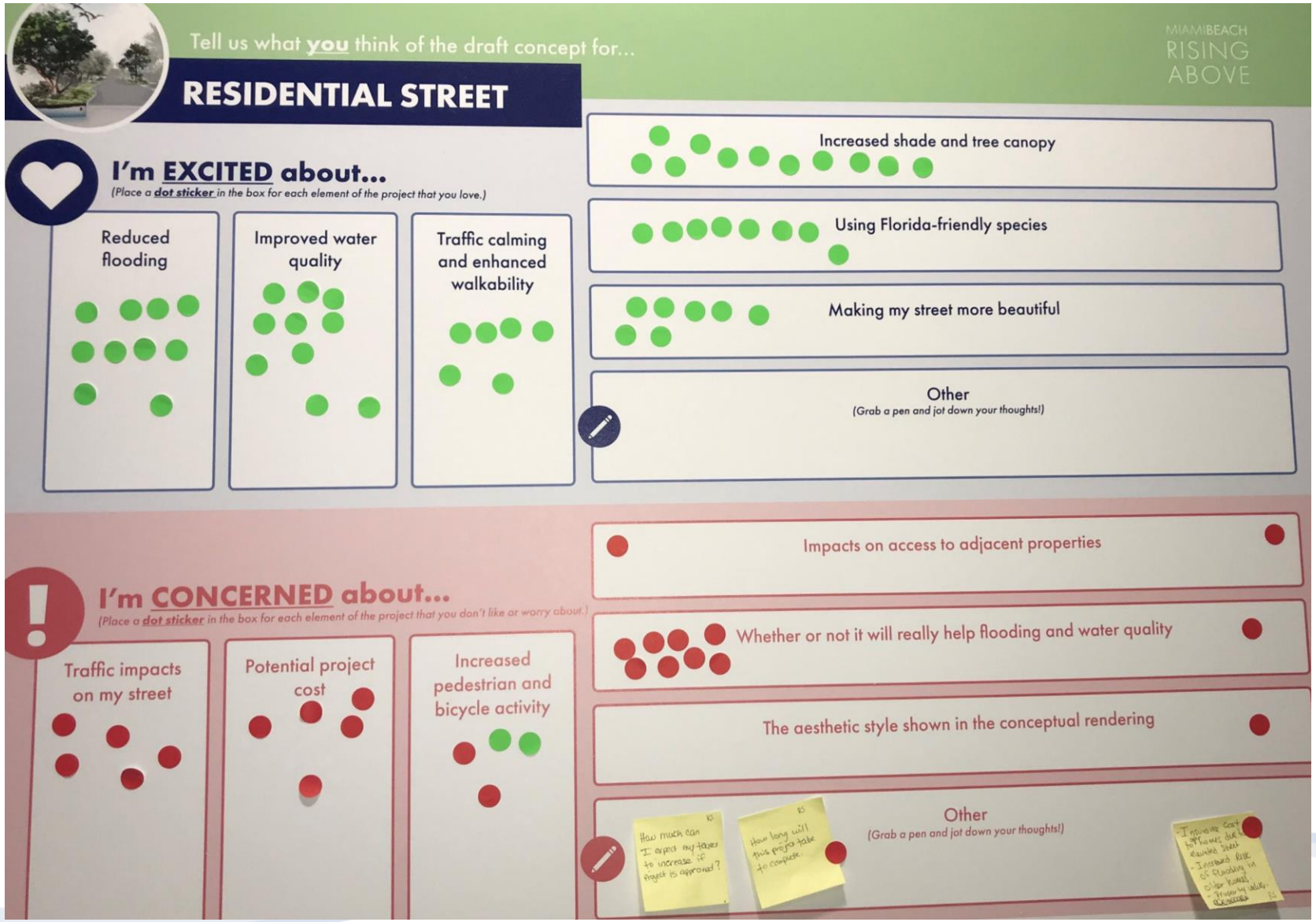
Examples of Public Comments on Concepts

Excitement about trees and benefits, tempered by concerns about cost effectiveness, traffic, etc.



Taxes, construction duration, property values

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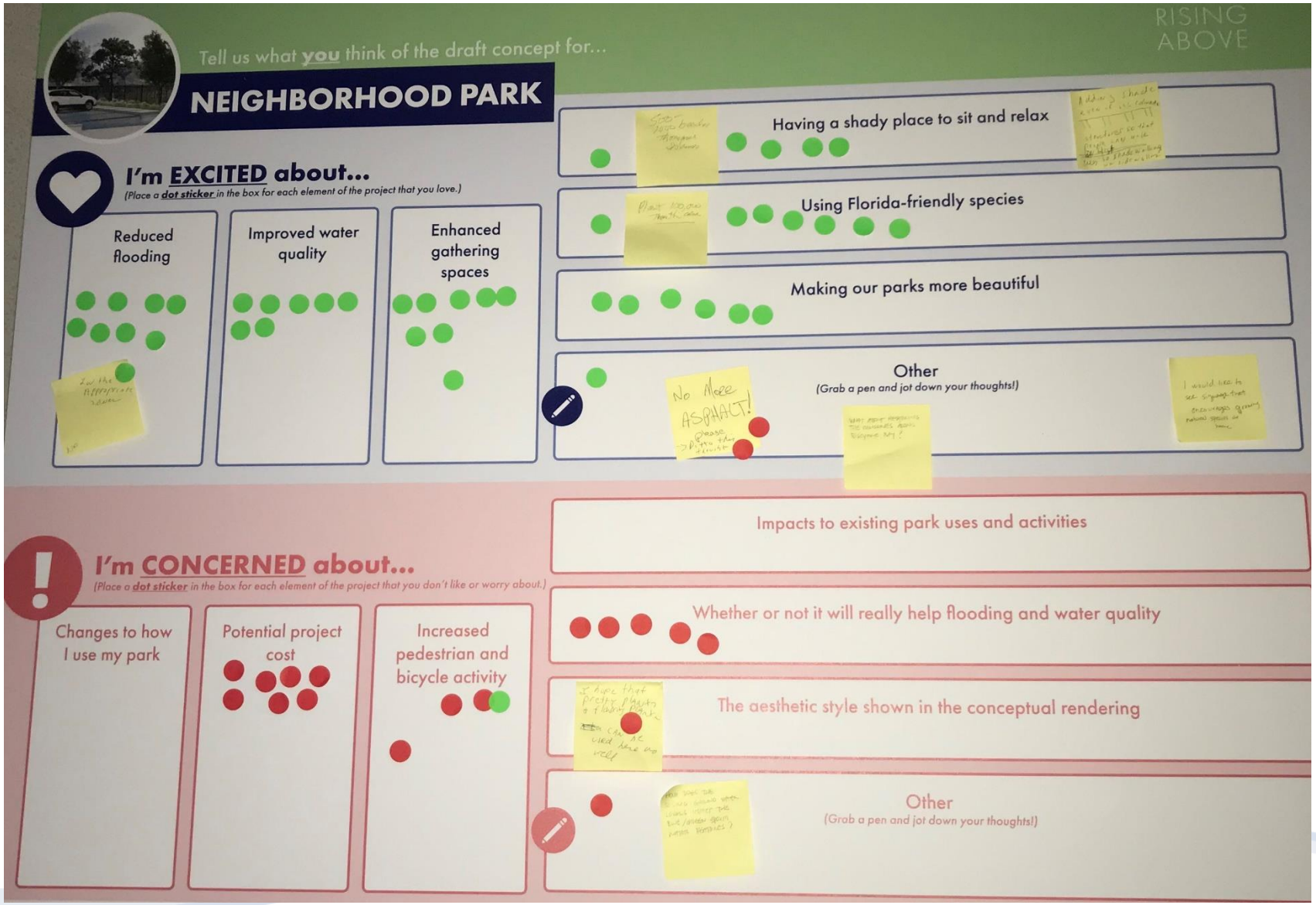
Examples of Public Comments on Concepts

Excitement about enhancing parks, benches, shade, and educational opportunities; tempered by concerns about cost effectiveness and increased bike /pedestrian activity.



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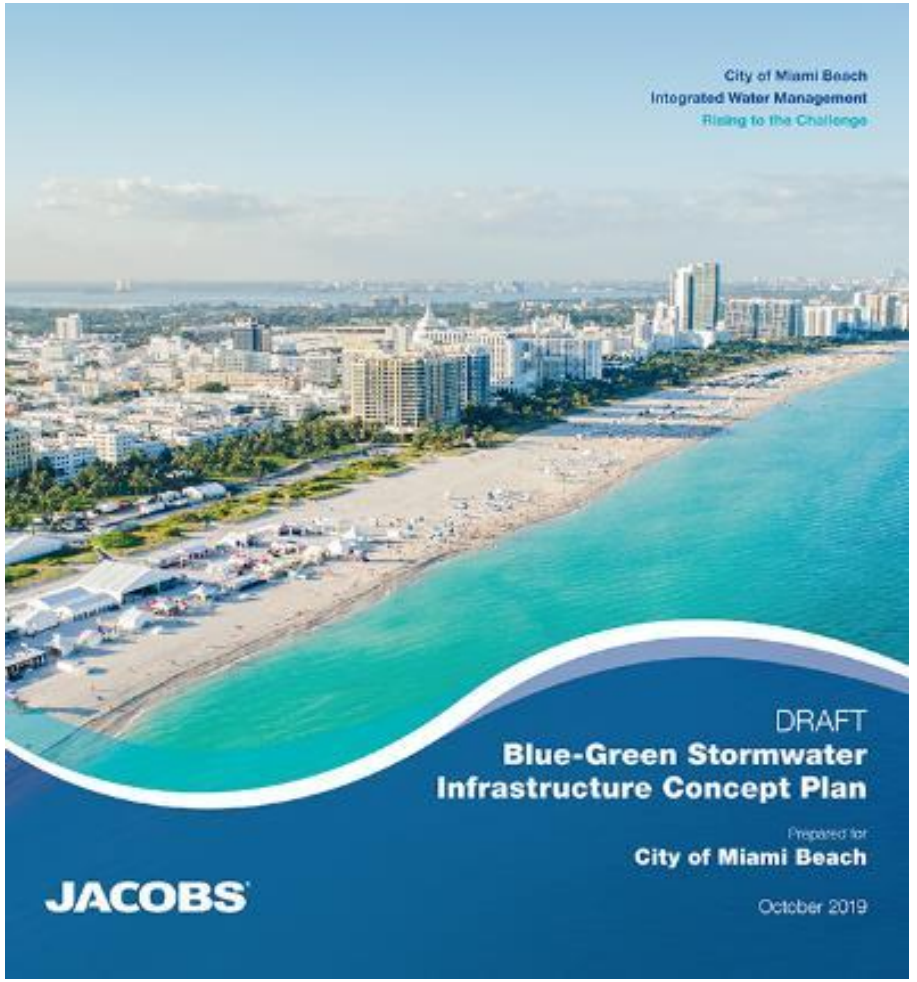
Outline of BGSI Concept Plan

- Introduction
- Miami Beach Context
- BGSI Evaluation Process (most / least applicable practices)
- BGSI Practices and Strategies
- Renderings
- Recommendations

Meant for a Wide Range of Users

Intended to inform Master Planning, CIP Planning, Design Criteria Packages (DCPs), New Development and Other Policies



Introduction

- Definitions
- Objectives
  - Water Quality
  - Groundwater Recharge
  - Detention/Flood Reduction
  - Community Benefits
- User's Guide

Pollutant Removal Varies by Pollutant and Type of BGSI Practice: Phosphorus and Nitrogen Example

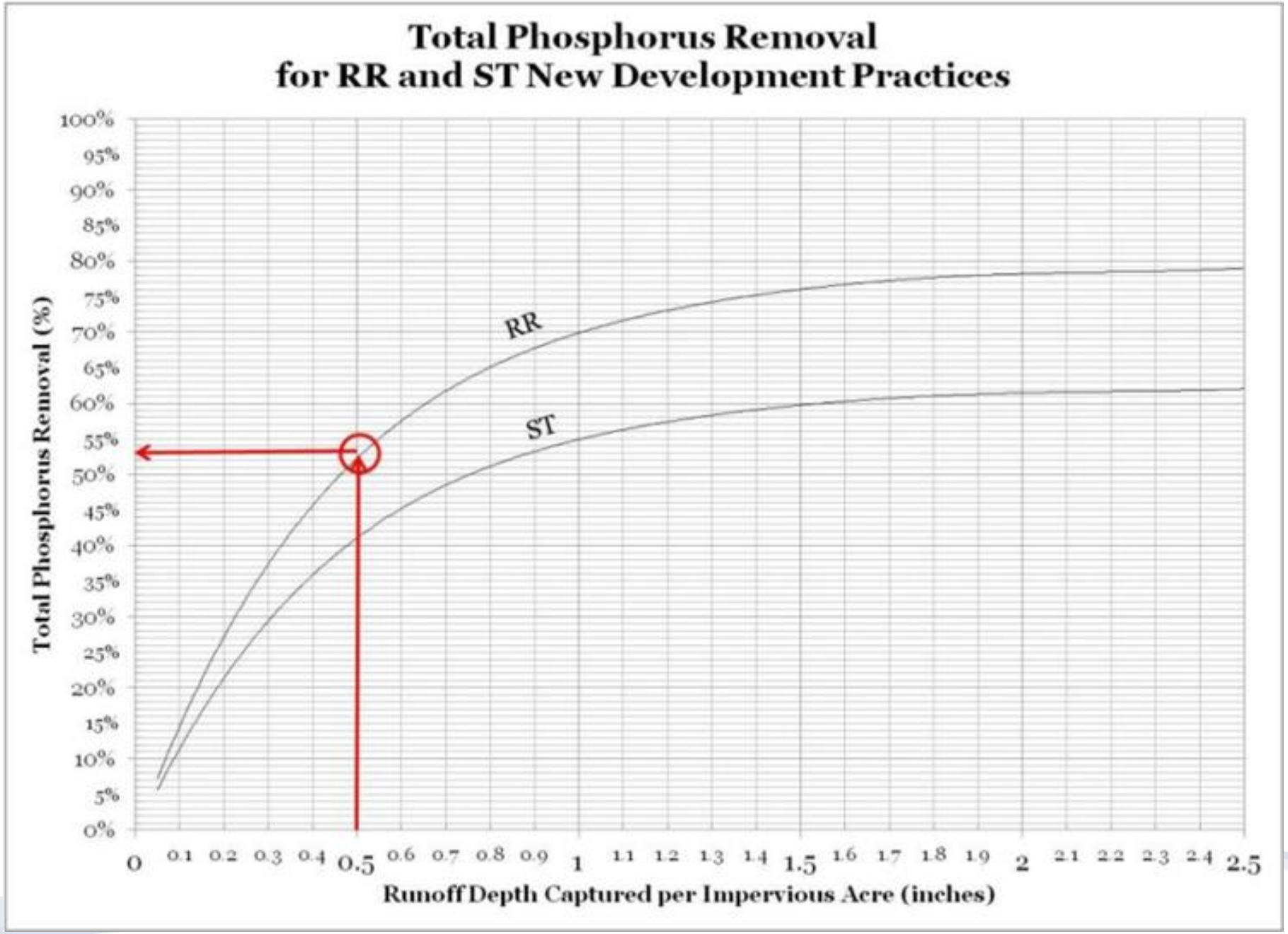
Table C-1 Composite Approach to Derive Nutrient Mass Load Reductions for RR ad ST Practices [1, 2]		
PRACTICE	TP Mass Reduction (%)	TN Mass Reduction (%)
Bioretention	73	77
Dry Swale	66	63
Infiltration	75	78
Permeable Pavers	70	70
Green Roof/Rain Tank	55	55
Average RR	**70**	**70[2]**
Wet Ponds	63	35
Const. Wetlands	63	40
Filtering Practice	63	38
Wet Swale	30	30
Average ST	**55**	**35**

Source: Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards (2015)

RR → Runoff Reduction

ST → Stormwater Treatment

Pollutant Removal Varies by Capture Depth



Source: Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards (2015)

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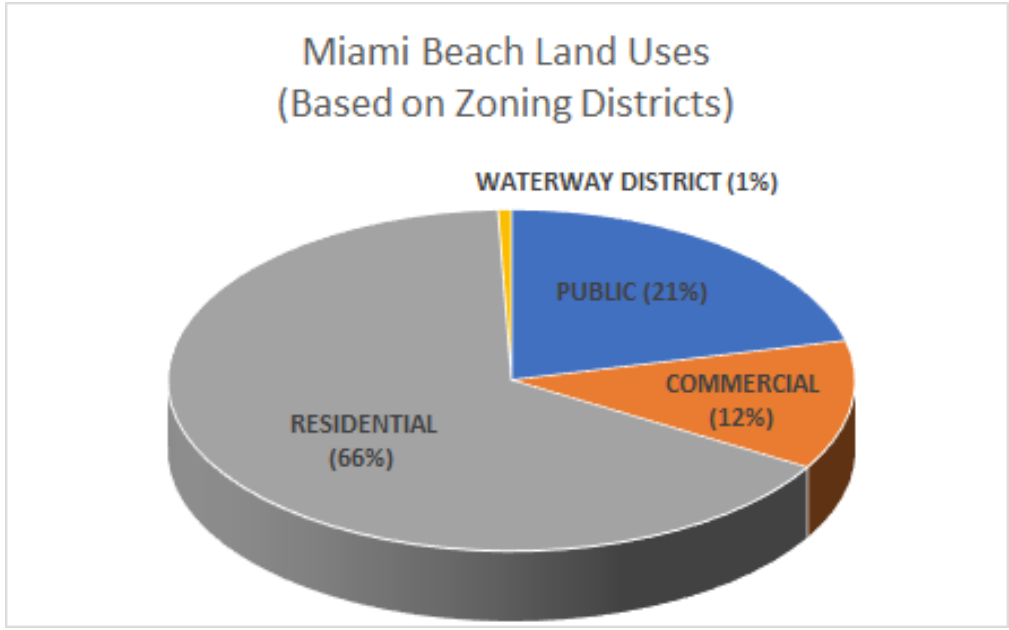
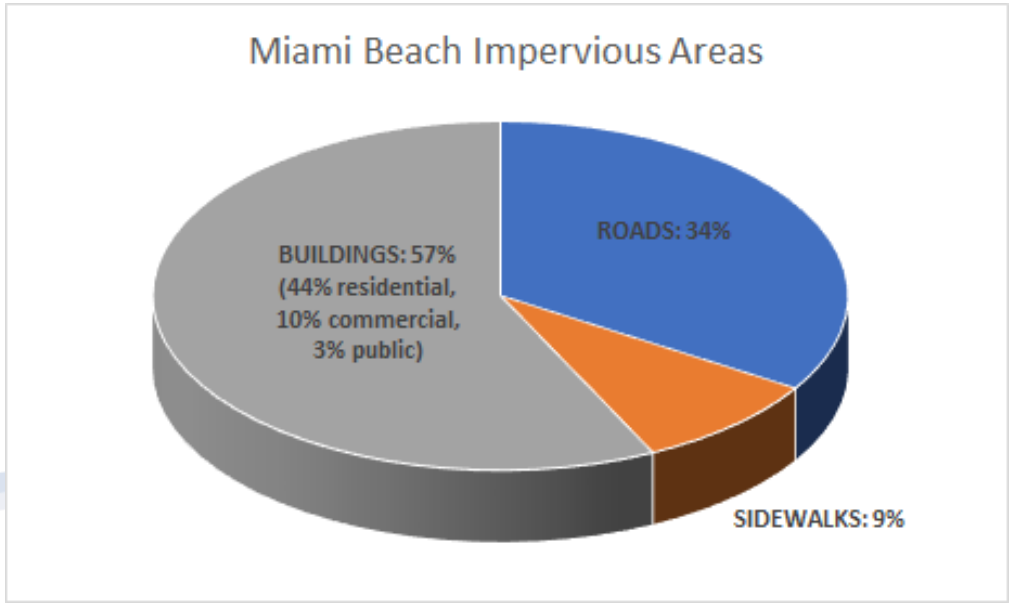
Miami Beach Context

- Land use
- Impervious cover
- Hydrology
- Groundwater
- Topography





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BGSI Practice Evaluation Process (What are the most and least applicable practices for Miami Beach?)

A wide range of BGSI practices were evaluated based on:

- City, regional, and national BGSI experience
- Stormwater performance (water quality, runoff reduction, and groundwater recharge)
- Potential applicability in the City given the Miami Beach context
- Ease of implementation and maintenance
- Community/environmental benefits
- Cost efficiency
- Climate change resilience

BGSI Practices Most Applicable to Miami Beach

- Bioretention/Bioswales/Rain Gardens
- Blue and Green Roofs
- Constructed Wetlands/Floating Wetland Islands
- Detention Basins/Surface Storage
- Enhanced Tree Pits/Trenches
- Injection Wells (Pumped)
- Permeable Pavement
- Rainwater Harvesting (Cisterns, Rain Barrels)
- Stormwater Planters
- Subsurface Infiltration/Storage
- Tree Canopy
- Wet Ponds

Note: The City is also developing an Urban Forestry Master Plan.

General BGSI Practice Information Fact Sheet

- Advantages of BGSI
- Recommended practices
- Other practices
- Mosquito control
- Applicability
- General sizing and cost discussion
- Guide to practice fact sheets
- Additional information sources

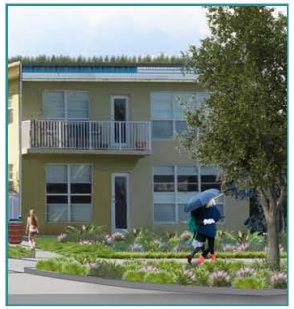
General Information on Blue-Green Stormwater Infrastructure (BGSI) Practices

Green stormwater infrastructure typically uses vegetation and/or soils to treat and reduce stormwater flows. Examples are bioretention and permeable pavement.

Blue stormwater infrastructure temporarily stores and treats stormwater above or below ground without the use of vegetation. Examples are wet ponds and detention basins.

Blue-Green Stormwater Infrastructure (BGSI) utilizes elements from both green and blue stormwater infrastructure. Implemented BGSI can vary greatly in appearance, from high-profile features to those that blend in seamlessly with the surroundings. BGSI is typically designed and sized to capture the more frequent storm events.

The focus of BGSI is stormwater runoff treatment and capture, which makes it different from coastal strategies that target stressors like wave energy, sea level rise, and storm surges (e.g. living shorelines, dunes, mangrove plantings, and oyster or artificial reefs).



Rain garden, green roof, and rain barrel at a garden apartment building

Advantages

BGSI provides several stormwater benefits, as well as co-benefits, that improve regulatory compliance and positively impact the community.

- Water quality - BGSI can reduce many of the pollutants that threaten Biscayne Bay such as heavy metals, nutrients, sediment, and pathogens.
- Groundwater recharge - BGSI recharges the freshwater lens under the island. This can help keep salt water at bay and protect the health of trees.
- Detention/flood mitigation benefits – BGSI helps mitigate flooding from smaller, more frequent storms. Note: BGSI alone will NOT reduce: "sunny day" flooding or flooding from major rainfall events/storm surges.
- Community benefits can include- urban heat island mitigation, air quality improvement, climate resiliency, enhanced aesthetics, and increased ecosystem health and biodiversity.

Permeable pavement, bioswale, and subsurface infiltration next to a park

What are the recommended BGSI practices for Miami Beach?

BGSI practice types were evaluated based on regional/national experience, stormwater performance, ease of implementation/maintenance, community/environmental benefits, cost efficiency, and climate change resilience. Practices that were determined to perform well across these areas and have practical applications in Miami Beach are as follows:

- Bioretention/Bioswales/Rain Gardens
- Blue & Green Roofs
- Constructed Wetlands/Floating Wetland Islands
- Detention Basins/Surface Storage
- Enhanced Tree Pits/Trenches
- Injection Wells (Pumped)
- Permeable Pavement
- Rainwater Harvesting
- Stormwater Planters
- Subsurface Infiltration/Storage
- Wet Ponds

When and where to use each recommended BGSI practice depends on a variety of site-specific factors, such as land use, location, topography, groundwater elevation, soil conditions, and existing infrastructure.

BGSI Practice Fact Sheets

- 1-page overview, including:
  - Description
  - Advantages and Potential Limitations
  - Applicability – where is the practice most effective?
  - Potential Enhancements for Increased Performance in Miami Beach
  - Qualitative Assessment of BGSI Practice Effectiveness

Bioretention/Bioswales/Rain Gardens

Bioretention facilities are sunken landscape beds containing plants in a special soil mix (called *engineered soil*) that sits above a gravel drainage layer. They replicate the natural water cycle by allowing water to enter the soil (*infiltration*), evaporate to the air (*evapotranspiration*), or be ponded for a period of time. Bioretention facilities use Florida-friendly plants that can withstand both occasional dry periods and flooding. Combined with engineered soil, these plants also provide natural filtration and treatment of stormwater runoff, removing many pollutants that threaten Biscayne Bay. Bioretention can take many forms including bioretention basins, bioswales, rain gardens, vegetated curb extensions, etc. and work well with infiltration/storage facilities below the ground.

Bioretention facility at the University of Florida Southwest Recreation Center

Advantages

- Excellent water quality and freshwater lens recharge capabilities
- Versatile, with broad applicability
- Enhanced site aesthetics, tree canopy, biodiversity, and wildlife habitat

Potential Limitations

- 2 ft of separation to groundwater recommended
- Higher maintenance until plants are established
- If not designed, installed, and maintained correctly, can promote mosquito breeding

Applicability

Bioretention is highly adaptable to most site types and conditions—from large and heavily landscaped features in parks, schools, and other public facilities to small and simple rain gardens at residences. Bioretention can also be implemented along roadways and in medians and parking lots.

Typical bioretention cross-section with surface depression, Florida-friendly plants, engineered soil, and gravel layer

Potential Enhancements for Increased Performance

- Real-time controls: dynamic, predictive technology that controls flows in/out of system, improving storage efficiency
- Modular/high-porosity media: increases storage capacity
- Engineered soil enhancements: improve pollutant removal
- High-flow filter media: allows rapid surface infiltration/treatment in tight spaces
- Underdrains (if needed): allow systems to drain within 72 hours

Performance		Implementation		Community/Environmental		Other	
Water Quality	💧💧💧	Capital Cost	💧💧💧	Improved Aesthetics	💧💧💧	Climate Change Resilience	💧💧
Freshwater Lens Recharge	💧💧	Maintenance Cost	💧💧	Dual Use	💧	Mosquito Vector Resistance	💧💧
Flood Mitigation	💧	Scalability	💧💧💧	Habitat Creation	💧💧		
		Constructability	💧💧💧	Urban Heat Island Reduction	💧💧		

💧 = low 💧💧 = medium 💧💧💧 = high

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A mix of BGSI practices have variable applicability to all the primary land uses in the City

Land Use	Bioretention / Bioswales / Rain Gardens	Blue & Green Roofs	Constructed Wetlands / Floating Wetland Islands	Detention Basins / Surface Storage	Enhanced Tree Pits / Trenches	Injection Wells (Pumped)	Permeable Pavement	Rainwater Harvesting	Stormwater Planters	Subsurface Infiltration / Storage	Wet Ponds
Commercial											
Commercial Sites (Office, Retail, Restaurant, Hotel, High-Rise Residential, etc.)	●	●	○	○	◐	●	◐	●	●	○	○
Institutional / Public											
Facilities (Police Stations, Fire Stations, etc)	●	●	◐	◐	●	●	●	●	●	●	○
Schools	●	●	○	◐	●	●	●	●	●	●	○

Land Use	Bioretention / Bioswales / Rain Gardens	Blue & Green Roofs	Constructed Wetlands / Floating Wetland Islands	Detention Basins / Surface Storage	Enhanced Tree Pits / Trenches	Injection Wells (Pumped)	Permeable Pavement	Rainwater Harvesting	Stormwater Planters	Subsurface Infiltration / Storage	Wet Ponds
Commercial											
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Institutional / Public											
Facilities (Police Stations, Fire Stations, etc)	●	●	◐	◐	●	●	●	●	●	●	○
Schools	●	●	○	◐	●	●	●	●	●	●	○
Parking											
Parking Garages	○	●	○	○	○	●	○	◐	●	○	○
Parking Lots	●	○	○	●	●	●	●	○	●	●	○
Parks and Open Spaces											
Golf Courses	●	○	●	●	◐	●	◐	●	○	●	●
Open Spaces (unassigned)	●	○	◐	◐	●	●	○	◐	◐	●	◐
Parks	●	◐	●	●	◐	●	●	●	◐	●	●
Pocket Parks / Parklets / Plazas	●	○	○	◐	●	●	●	◐	●	●	○
Residential											
Multi-family	●	●	○	○	○	●	●	●	●	◐	○
Single-family	●	○	○	○	○	○	●	●	◐	○	○
Rights-of-Ways (Street Types Per Miami Beach Street Design Guidelines - 2016)											
Street Ends	●	○	●	○	●	●	◐	◐	◐	○	○
Alleys (commercial)	○	○	○	○	○	●	●	○	○	◐	○
Avenues (suburban)	●	○	○	○	●	●	●	○	●	◐	○
Avenues (urban)	◐	○	○	○	●	●	●	○	●	◐	○
Boulevards	●	○	○	○	●	●	●	○	●	◐	○
Main Streets	◐	○	○	○	●	◐	●	◐	◐	◐	○
Neighborhood Streets (suburban)	●	○	○	○	●	●	●	○	◐	◐	○
Neighborhood Streets (urban)	◐	○	○	○	●	●	●	○	●	◐	○
Non-Motorized Streets	●	○	○	◐	●	●	●	◐	●	◐	○

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BGSI Strategy Fact Sheets

- 1st page: description, advantages, limitations, applicable practices
- 2nd/3rd pages: variations with photos of existing Miami Beach sites next to built BGSI in similar settings

Parks and Open Spaces

Miami Beach contains a variety of recreational areas, including golf courses, open spaces, parks, and pocket parks/plazas. These facilities are generally excellent opportunities to implement many types of BGSI practices. Parks can offer more significant water quality, flood mitigation, and freshwater lens recharge benefits by capturing runoff from adjacent areas through gravity drainage or pumping.

Successfully implementing BGSI at parks often involves a balancing act between preserving or enhancing existing recreational uses and providing the space required for BGSI. Given the challenges of Miami Beach (flat topography, high groundwater, etc.), BGSI practices at recreational sites should ideally entail temporarily storing water on the surface and/or raising the ground elevation and storing water underground.

Advantages

- Improved public spaces through aesthetics, amenities, and site restoration
- Increased tree canopy
- Natural source of irrigation for Florida-friendly landscaping
- Less restrictive with respect to existing utilities or other infrastructure
- Potential to capture large volumes of stormwater
- High visibility/educational value
- Dual-use opportunities (e.g., permeable pavement play surfaces)

Potential Limitations

- Accessibility and public safety concerns
- Sediment and trash may impact aesthetics and functionality, especially in dense drainage areas
- Diverse and sometimes unpredictable usage and preferred pathways for park vi
- Due to flat topography, directing runoff into parks can be challenging
- Working around public art/monuments and existing vegetation, especially trees

Applicable Practices

Applicable to Most Sites	Applicable to Some Sites
Bioretention/Bioswales	Constructed Wetlands
Detention Basins/ Surface Storage	Enhanced Tree Pits/Trenches (site perimeter)
Injection Wells	Permeable Pavement
Subsurface Infiltration/Storage	Rainwater Harvesting
	Stormwater Planters
	Wet Ponds

Fact Sheet Parks and Open Spaces

Golf Courses

By their size and open nature, Miami Beach's two public golf courses (Miami Beach and Normandy Shores Golf Clubs) offer unique opportunities to capture large volumes of water. Larger BGSI practices that have limited applicability at most other sites (i.e., detention basins/surface storage, wet ponds, and constructed wetlands) can be readily integrated into golf courses, especially those that can be reconfigured or repurposed. Fairways provide locations for extensive temporary surface storage behind by perimeter earthen berms. Wet ponds can store and treat water before it is used for irrigation.

Miami Beach Golf Club

Constructed wetlands for stormwater capture and treatment

Open Spaces

Miami Beach has a variety of triangular or similarly shaped open spaces that appear to have no defined usage or formal programming. These spaces provide opportunities to implement smaller-scaled BGSI practices, such as bioretention/ bioswales, enhanced tree pits/trenches, and subsurface infiltration/storage. These practices can be seamlessly integrated into the landscape, replacing unused lawn areas and avoiding impacts to existing trees and vegetation. In general, these sites are best suited to capturing stormwater runoff from adjacent streets, though some may be able to store additional runoff.

Triangular open space at 1st Street and Alton Road

Bioretention facility in unused triangular open space that was converted to a public park

Concept Renderings

- Preliminary Renderings for:
  - Residential street
  - Commercial street
  - Neighborhood park
  - MB Golf Course scenario 1
  - MB Golf Course scenario 2
  - MB Golf Course scenario 3
  - Collins Canal
  - Street end
  - Garden apartments

Note: all concepts are preliminary and subject to change during budgeting, design, permitting, etc.

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BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

RESIDENTIAL STREET

In Miami Beach residential streets vary in whether they include on-street parking, curbs, sidewalks, and other improvements, while often accommodating numerous driveways, alleys, and roadway intersections. Permeable pavement, enhanced tree pits, traffic chicanes, and other drainage features such as trench drains can be incorporated within varying residential roadway conditions to **improve water quality, calm traffic**, and **reduce flows to private property**.

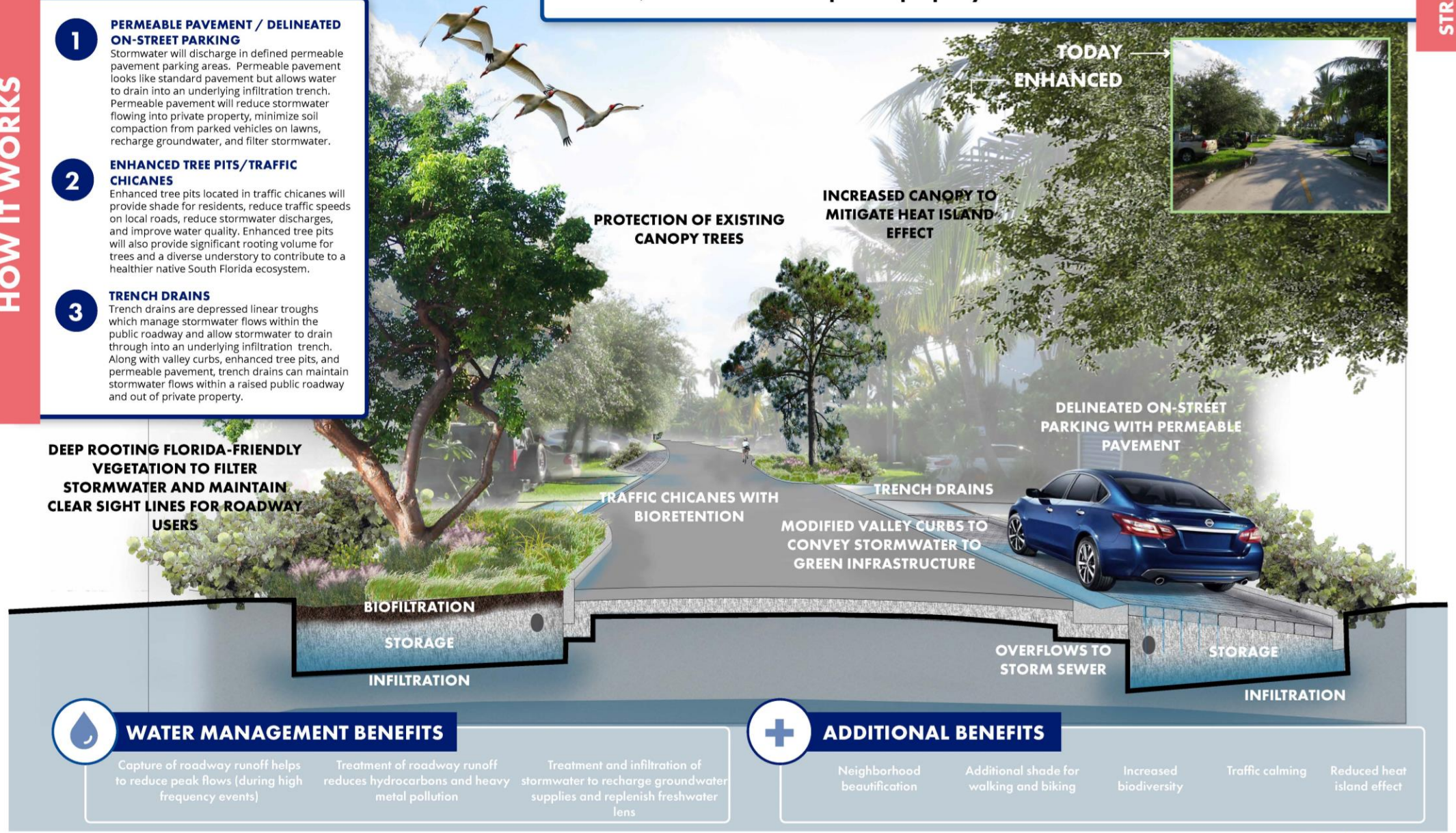
STRATEGIC VALUE

HOW IT WORKS

1. **PERMEABLE PAVEMENT / DELINEATED ON-STREET PARKING**
Stormwater will discharge in defined permeable pavement parking areas. Permeable pavement looks like standard pavement but allows water to drain into an underlying infiltration trench. Permeable pavement will reduce stormwater flowing into private property, minimize soil compaction from parked vehicles on lawns, recharge groundwater, and filter stormwater.

2. **ENHANCED TREE PITS/TRAFFIC CHICANES**
Enhanced tree pits located in traffic chicanes will provide shade for residents, reduce traffic speeds on local roads, reduce stormwater discharges, and improve water quality. Enhanced tree pits will also provide significant rooting volume for trees and a diverse understory to contribute to a healthier native South Florida ecosystem.

3. **TRENCH DRAINS**
Trench drains are depressed linear troughs which manage stormwater flows within the public roadway and allow stormwater to drain through into an underlying infiltration trench. Along with valley curbs, enhanced tree pits, and permeable pavement, trench drains can maintain stormwater flows within a raised public roadway and out of private property.



WATER MANAGEMENT BENEFITS

- Capture of roadway runoff helps to reduce peak flows (during high frequency events)
- Treatment of roadway runoff reduces hydrocarbons and heavy metal pollution
- Treatment and infiltration of stormwater to recharge groundwater supplies and replenish freshwater lens

ADDITIONAL BENEFITS

- Neighborhood beautification
- Additional shade for walking and biking
- Increased biodiversity
- Traffic calming
- Reduced heat island effect

Miami Beach Golf Course

1 RETROFIT

2 REPURPOSE

3 REIMAGINE

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BGSI Concept Plan – Draft Recommendations

1. Develop/update MB-specific BGSI design guidance, details, specs
2. Collaborate w/ regulators (DERM) to discuss permitting issues
3. Advance BGSI concepts developed to date, implement demonstration projects
4. Continue evaluating planned projects for BGSI opportunities, develop additional BGSI concepts
5. Parks/Open Space:
   - Conduct a "highest and best use" analysis of the public golf courses
   - Perform BGSI evaluation of parks

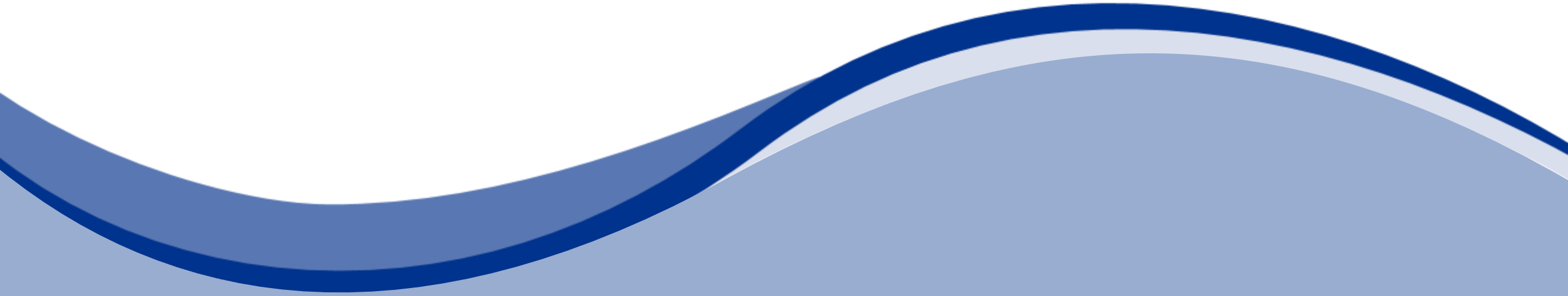
BGSI Concept Plan – Draft Recommendations

6. Residential:
   - Additional education/outreach activities, technical/funding support
   - Rain barrel and tree giveaways/sales/events (w/ Urban Forest MP)
7. Private: Evaluate/implement ways to further BGSI implementation
8. Roads:
   - Adopt alternative road sections to facilitate BGSI
   - Implement BGSI as feasible as part of other transportation projects
   - Work with the County/FDOT to implement BGSI on their roads
   - Integrate additional BGSI opportunities with Urban Forest MP

Next Steps for Blue-Green Concept Plan

- SRC feedback & endorsement
- Finish compiling and addressing public input
- Complete BGSI concept plan draft
- Present at Full Commission in October

Additional Slides



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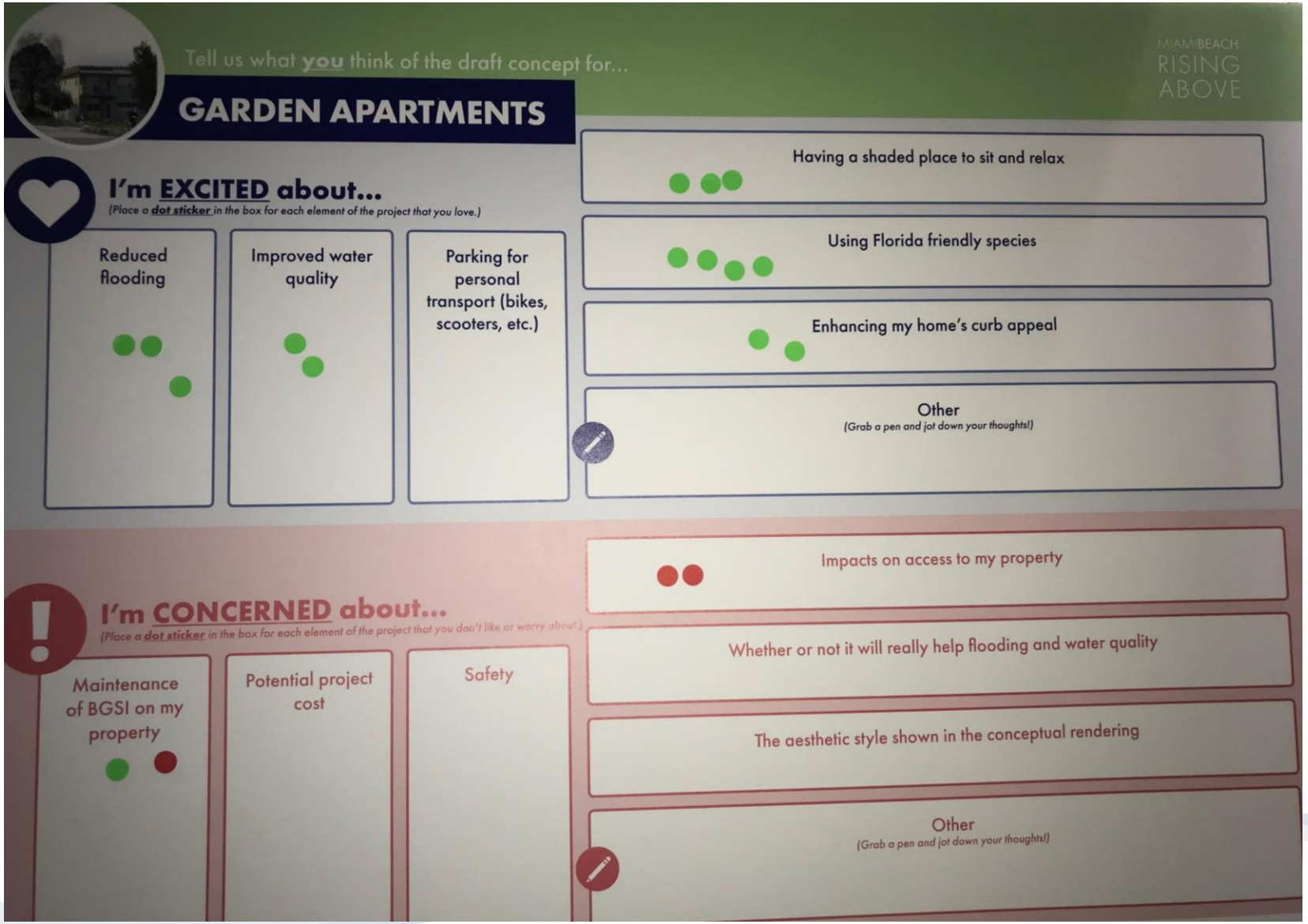
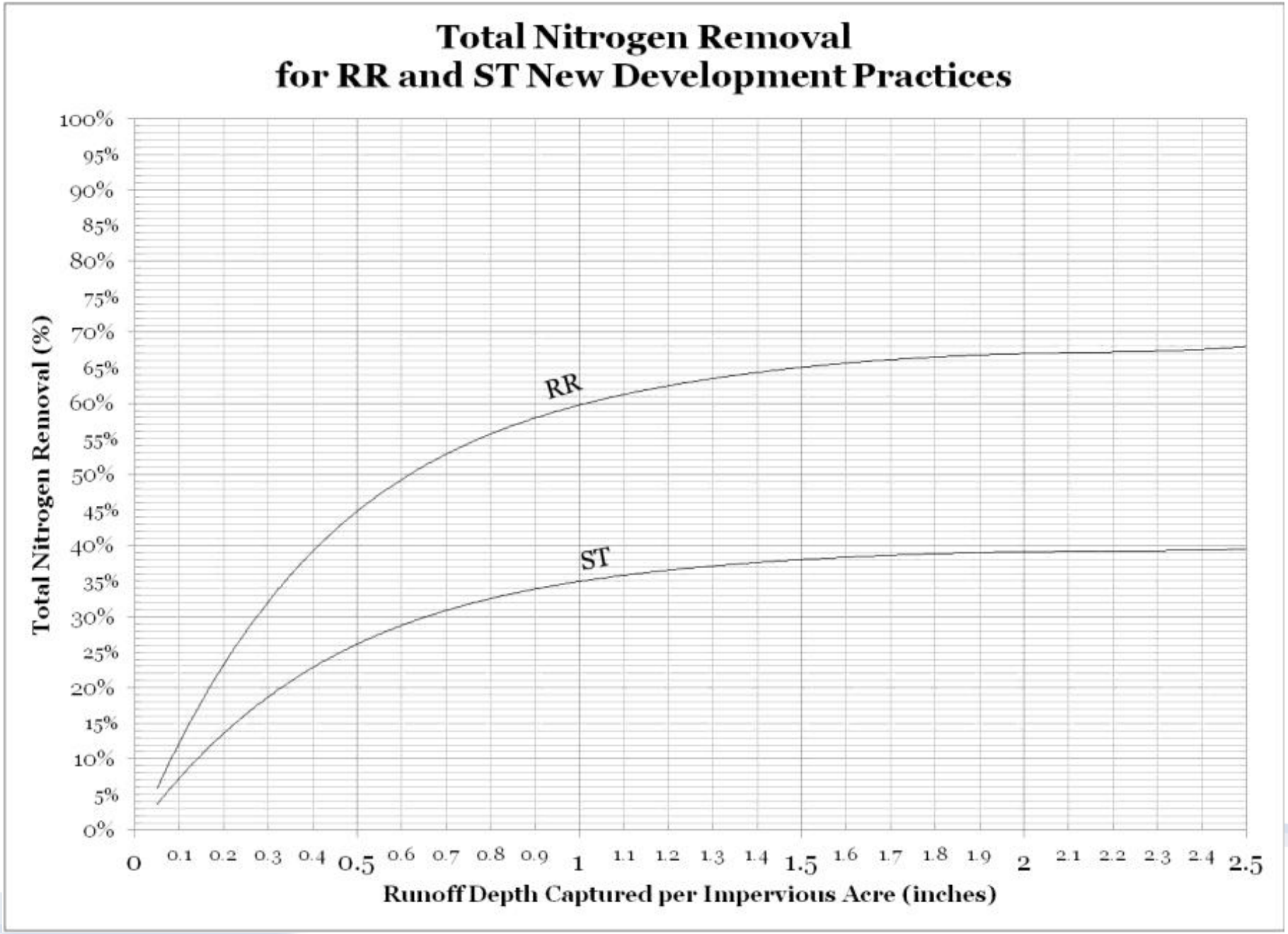
Examples of Public Comments on Concepts



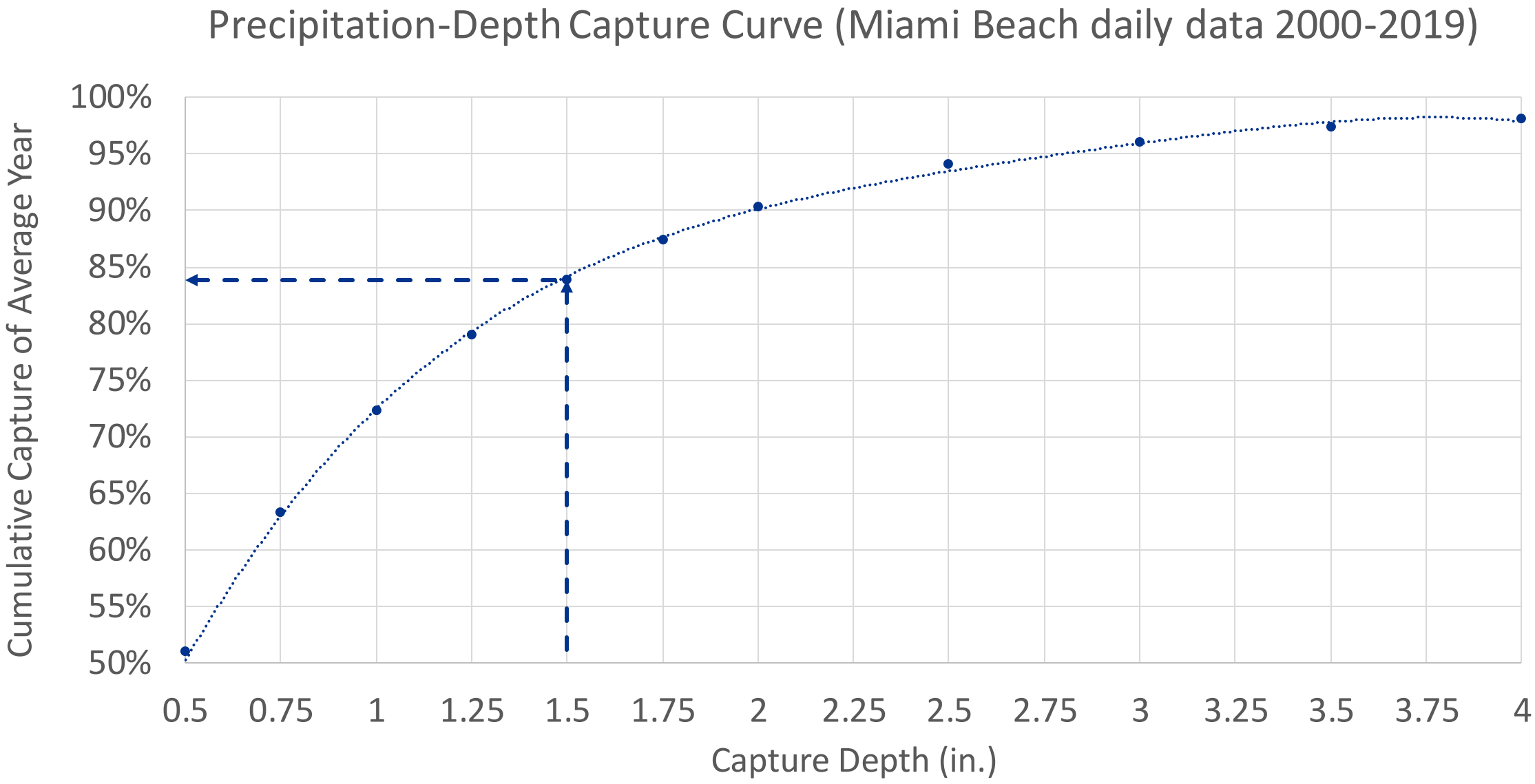
Bacteria (E. Coli) Removal Varies by Type of BGSI Practice

Stormwater Practice	Influent (MPN/100 mL)	Effluent (MPN/100 mL)	% Removal	Statistical Significance
Bioretention	1,200	240	80%	2 of 3 tests
Grass Swale	3,500	4,400	-26%	0 of 3
Retention Pond	2,000	80	96%	3 of 3
Wetland Basin	2,800	1,000	64%	2 of 3
Wetland Basin / Retention Pond	2,300	450	80%	3 of 3

Source: International Stormwater BMP Database, 2016 Summary Statistics

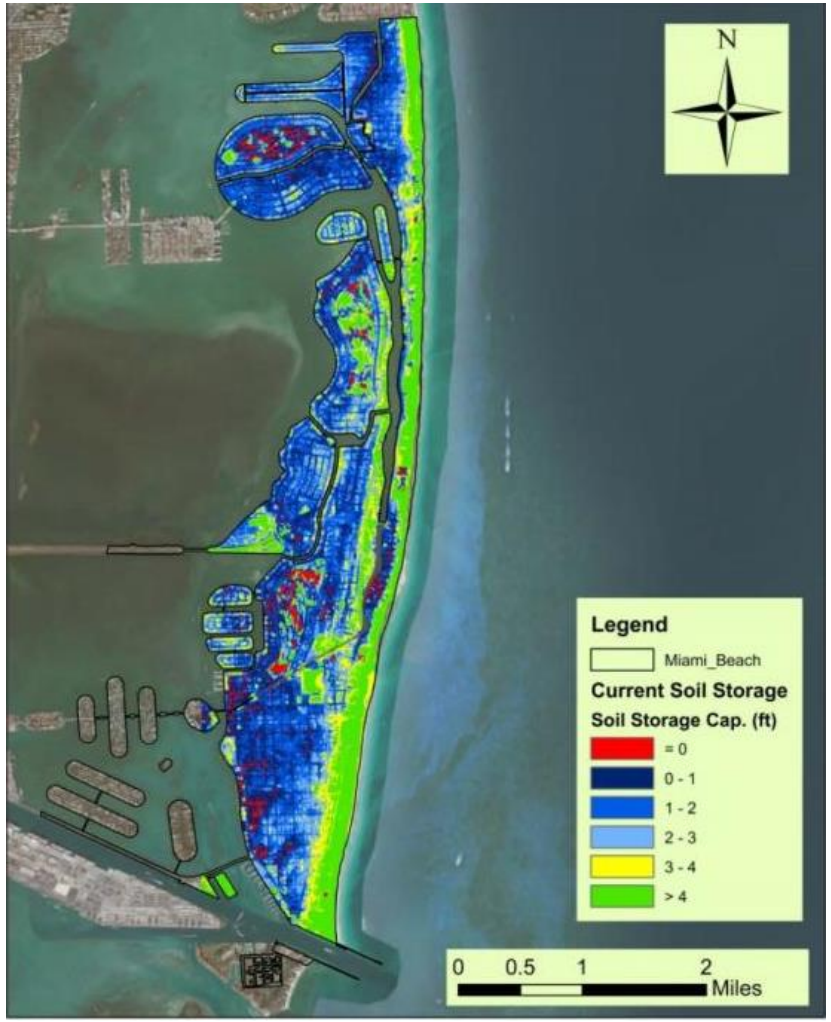

Total Nitrogen Removal
for RR and ST New Development Practices
Total Nitrogen Removal (%)
100%
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
RR
ST
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
2.4
2.5
Runoff Depth Captured per Impervious Acre (inches)

Miami Beach Context - Hydrology



Miami Beach Context

- Land use
- Impervious cover
- Hydrology
- **Groundwater**
- **Topography**



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What BGSI Practices are Less Applicable to Miami Beach?

- Although **not as readily applicable** to Miami Beach, these might still prove beneficial in certain settings:

BGSI Practice	Why Less Applicable to Miami Beach
Detention Tanks	limited water quality benefit, relatively high costs, lower effectiveness with sea level rise and high tides, proprietary, limited applicability, limited storage capacity
Exfiltration Trenches	
High-Flow Media Filters	
Living/Green Walls	
Gravity Wells	
Subsurface Flow Wetlands	

Qualitative Assessment of BGSI Practice Effectiveness

- General fact sheet for BGSI Practices discusses these criteria and ratings in further detail

Performance		Implementation		Community/Environmental		Other	
Water Quality	💧💧💧	Capital Cost	💧💧💧	Improved Aesthetics	💧💧💧	Climate Change Resilience	💧💧
Freshwater Lens Recharge	💧💧	Maintenance Cost	💧💧	Dual Use	💧	Mosquito Vector Resistance	💧💧
Flood Mitigation	💧	Scalability	💧💧💧	Habitat Creation	💧💧		
		Constructability	💧💧💧	Urban Heat Island Reduction	💧💧		

💧 = low 💧💧 = medium 💧💧💧 = high

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A mix of practices are potentially applicable to all the primary land uses in the City

Land Use	Bioretention / Bioswales / Rain Gardens	Blue & Green Roofs	Constructed Wetlands / Floating Wetland Islands	Detention Basins / Surface Storage	Enhanced Tree Pits / Trenches	Injection Wells (Pumped)	Permeable Pavement	Rainwater Harvesting	Stormwater Planters	Subsurface Infiltration / Storage	Wet Ponds
Parks and Open Spaces											
Golf Courses	●	○	●	●	◑	●	◑	●	○	●	●
Open Spaces (unassigned)	●	○	◑	◑	●	●	○	◑	◑	●	◑
Parks	●	◑	●	●	◑	●	●	●	◑	●	●
Pocket Parks / Parklets / Plazas	●	○	○	◑	●	●	●	◑	●	●	○
Residential											
Multi-family	●	●	○	○	○	●	●	●	●	◑	○
Single-family	●	○	○	○	○	○	●	●	◑	○	○

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A mix of practices are potentially applicable to all the primary land uses in the City

Land Use	Bioretention / Bioswales / Rain Gardens	Blue & Green Roofs	Constructed Wetlands / Floating Wetland Islands	Detention Basins / Surface Storage	Enhanced Tree Pits / Trenches	Injection Wells (Pumped)	Permeable Pavement	Rainwater Harvesting	Stormwater Planters	Subsurface Infiltration / Storage	Wet Ponds
Commercial											
Commercial Sites (Office, Retail, Restaurant, Hotel, High-Rise Residential, etc.)	●	●	○	○	◑	●	◑	●	●	○	○
Institutional / Public											
Facilities (Police Stations, Fire Stations, etc)	●	●	◑	◑	●	●	●	●	●	●	○
Schools	●	●	○	◑	●	●	●	●	●	●	○
Parking											
Parking Garages	○	●	○	○	○	●	○	◑	●	○	○
Parking Lots	●	○	○	●	●	●	●	○	●	●	○

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A mix of practices are potentially applicable to all the primary land uses in the City

Land Use	Bioretention / Bioswales / Rain Gardens	Blue & Green Roofs	Constructed Wetlands / Floating Wetland Islands	Detention Basins / Surface Storage	Enhanced Tree Pits / Trenches	Injection Wells (Pumped)	Permeable Pavement	Rainwater Harvesting	Stormwater Planters	Subsurface Infiltration / Storage	Wet Ponds
Rights-of-Ways (Street Types Per Miami Beach Street Design Guidelines - 2016)											
Street Ends	●	○	●	○	●	●	◐	◐	◐	○	○
Alleys (commercial)	○	○	○	○	○	●	●	○	○	◐	○
Avenues (suburban)	●	○	○	○	●	●	●	○	●	◐	○
Avenues (urban)	◐	○	○	○	●	●	●	○	●	◐	○
Boulevards	●	○	○	○	●	●	●	○	●	◐	○
Main Streets	◐	○	○	○	●	◐	●	◐	◐	◐	○
Neighborhood Streets (suburban)	●	○	○	○	●	●	●	○	◐	◐	○
Neighborhood Streets (urban)	◐	○	○	○	●	●	●	○	●	◐	○
Non-Motorized Streets	●	○	○	◐	●	●	●	◐	●	◐	○

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ADDITIONAL INFORMATION

Resource	Source/Location
Rising Above web site	http://www.mbrisingabove.com/climate-adaptation/
Best Management Practices for South Florida Urban Stormwater Management Systems	https://www.sfwmd.gov/sites/default/files/documents/bmp_manual.pdf
Florida Field Guide to Low Impact Development: Bioretention Basins/Rain Gardens	http://buildgreen.ufl.edu/Fact_sheet_Bioretention_Basins_Rain_Gardens.pdf
Florida Field Guide to Low Impact Development: Green Roofs/Eco-roofs	http://www.buildgreen.ufl.edu/Fact_sheet_Green_Roofs_Eco_roofs.pdf
Florida Department of Transportation Drainage Design Guide (Injection Wells covered in Chapter 7)	https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/roadway/drainage/files/drainagedesignguide.pdf
Sarasota County Low Impact Development Guidance Document	https://www.scgov.net/home/showdocument?id=33258
University of Florida Soil and Water Sciences Video Topics: Green Stormwater Infrastructure	https://soils.ifas.ufl.edu/extension/videos/low-impact-development/
Constructed Floating Wetlands: A review of research, design, operation and management aspects, and data meta-analysis	https://apirs.plants.ifas.ufl.edu/site/assets/files/372369/372369.pdf

Note that the City and Jacobs are not specifically endorsing all of the information provided in these sources but is providing them for general information to be used with discretion.

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

COLLINS CANAL

The Collins Canal is an existing, man-made channel that runs parallel to Dade Boulevard, connecting Indian Creek to Biscayne Bay. By adding constructed wetlands, enhanced tree pits and trenches, and permeable pavement to its design, we can **increase the amount of water that is absorbed and treated**.

STRATEGIC VALUE

HOW IT WORKS

1. **MANAGED AQUATIC PLANT SYSTEMS**
   Managed Aquatic Plant Systems (MAPS) provide habitat, enhance aesthetics, and improve water quality in the canal by reducing common pollutants such as nitrogen, phosphorus, and suspended solids. MAPS will be anchored into the canal bottom, allowing them to rise during flood/high-tide conditions and remain functional and resilient.

2. **ENHANCED TREE PITS/TRENCHES**
   Filters and stores stormwater flows to improve water quality prior to discharging into the canal, while providing significant rooting volume for street trees

3. **PERMEABLE PAVEMENT**
   Stormwater from Dade Boulevard will flow onto bike and pedestrian lanes constructed of permeable pavement, which looks similar to standard pavement but allows water to drain through its openings and into an underlying infiltration / storage trench. Permeable pavement will reduce the amount of stormwater flowing into the canal.

← **TODAY**

← **ENHANCED**

WATER MANAGEMENT BENEFITS

- Capture of roadway runoff helps to reduce peak flows (during high frequency events)
- Treatment of roadway runoff reduces hydrocarbons and heavy metal pollution
- Treatment uptakes nitrogen and phosphorus, reducing likelihood of algae blooms

ADDITIONAL BENEFITS

- Neighborhood Beautification
- Walking and biking paths
- Waterfront Seating
- Kayak drop-in points

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MIAMIBEACH RISING ABOVE

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

COMMERCIAL STREET

Commercial streets often **accommodate on-street parking**, curbs, and sidewalks serving varying land uses. Lessened driveway conflicts within these corridors provide opportunities for longer segments of **permeable pavement, trees, infiltration and storage trenches** to **improve water quality**.

STRATEGIC VALUE

HOW IT WORKS

1. **PERMEABLE PAVEMENT**
Stormwater will discharge in defined permeable pavement parking areas. Permeable pavement looks like standard pavement but allows water to drain into an underlying infiltration trench. Permeable pavement will reduce stormwater flowing into private property, minimize soil compaction from parked vehicles on lawns, recharge groundwater, and filter stormwater.

2. **ENHANCED TREE PITS/BUMP-OUTS**
Enhanced tree pits located in bump-outs will provide increased shade for residents, reduce traffic speeds on local roads, reduce stormwater discharges, and improve water quality. Enhanced tree pits will also provide significant rooting volume for trees and a diverse understory to contribute to a healthier native South Florida ecosystem.

3. **BALANCED ON-STREET PARKING**
On-street parking will serve various modes of transportation and beenhanced with bump-outs and sidewalks accommodating lush plants to mitigate elevated surface temperatures, manage stormwater, enhance walkability, and improve aesthetics for neighborhood.

4. **GREEN ROOFS**
Green Roofs accept stormwater to filter and absorb flows, as well as cool urban heat islands and provide habitat

WATER MANAGEMENT BENEFITS

- Capture of roadway runoff helps to reduce peak flows (during high frequency events)
- Treatment of roadway runoff reduces hydrocarbons and heavy metal pollution
- Treatment and infiltration of stormwater to recharge groundwater supplies and replenish the freshwater lens

ADDITIONAL BENEFITS

- Neighborhood Beautification
- Increased walking and biking opportunities
- Traffic calming
- Improved sidewalk seating opportunities

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MIAMIBEACH RISING ABOVE

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

NEIGHBORHOOD PARK

STRATEGIC VALUE

Parks provide a great opportunity to **collect, infiltrate, and store** stormwater during smaller, more frequent rain events. Permeable pavement, enhanced tree pits, bioswales and infiltration trenches may be used near park perimeters and access points. Rain gardens and constructed wetlands can be utilized within parks to **reduce** stormwater quantities, **improve** water and air quality, and **enhance** gathering spaces.

HOW IT WORKS

1. **PERMEABLE PAVEMENT**
Stormwater will discharge in defined permeable pavement areas. Permeable pavement looks like standard pavement but allows water to drain into an underlying infiltration trench. Permeable pavement will reduce stormwater flowing into private property or streets, minimize soil compaction from parked vehicles on lawns, recharge groundwater, and filter stormwater.

2. **ENHANCED TREE PITS**
Enhanced tree pits and biofiltration trenches will provide increased shade for residents, reduce stormwater discharges, and improve water quality. Enhanced tree pits will also provide significant rooting volume for trees and a diverse understory to contribute to a healthier native South Florida ecosystem.

3. **RAIN GARDENS AND BIOSWALES**
Rain gardens generally reduce stormwater discharges by absorbing storm water runoff from impervious areas such as walkways, parking lots, hard sports courts, and compacted lawn areas. Bioswales generally reduce stormwater discharges and recharge groundwater by intercepting, diverting, and absorbing storm water runoff from impervious areas such as walkways, parking lots, hard sports courts, and compacted lawn areas.

4. **CONSTRUCTED WETLANDS**
Constructed wetlands mimic natural wetlands by retaining and filtering water, cycling nutrients, while supporting habitat for a diverse range of species. They are designed to continually hold water, either at the surface or just below the soil surface.

WATER MANAGEMENT BENEFITS

- Capture of roadway runoff helps to reduce peak flows (during high frequency events)
- Treatment of roadway runoff reduces hydrocarbons and heavy metal pollution
- Treatment and infiltration of stormwater to recharge groundwater supplies

ADDITIONAL BENEFITS

- Neighborhood Beautification
- Walking and biking paths
- Additional shade along park perimeter
- Enhanced biodiversity

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

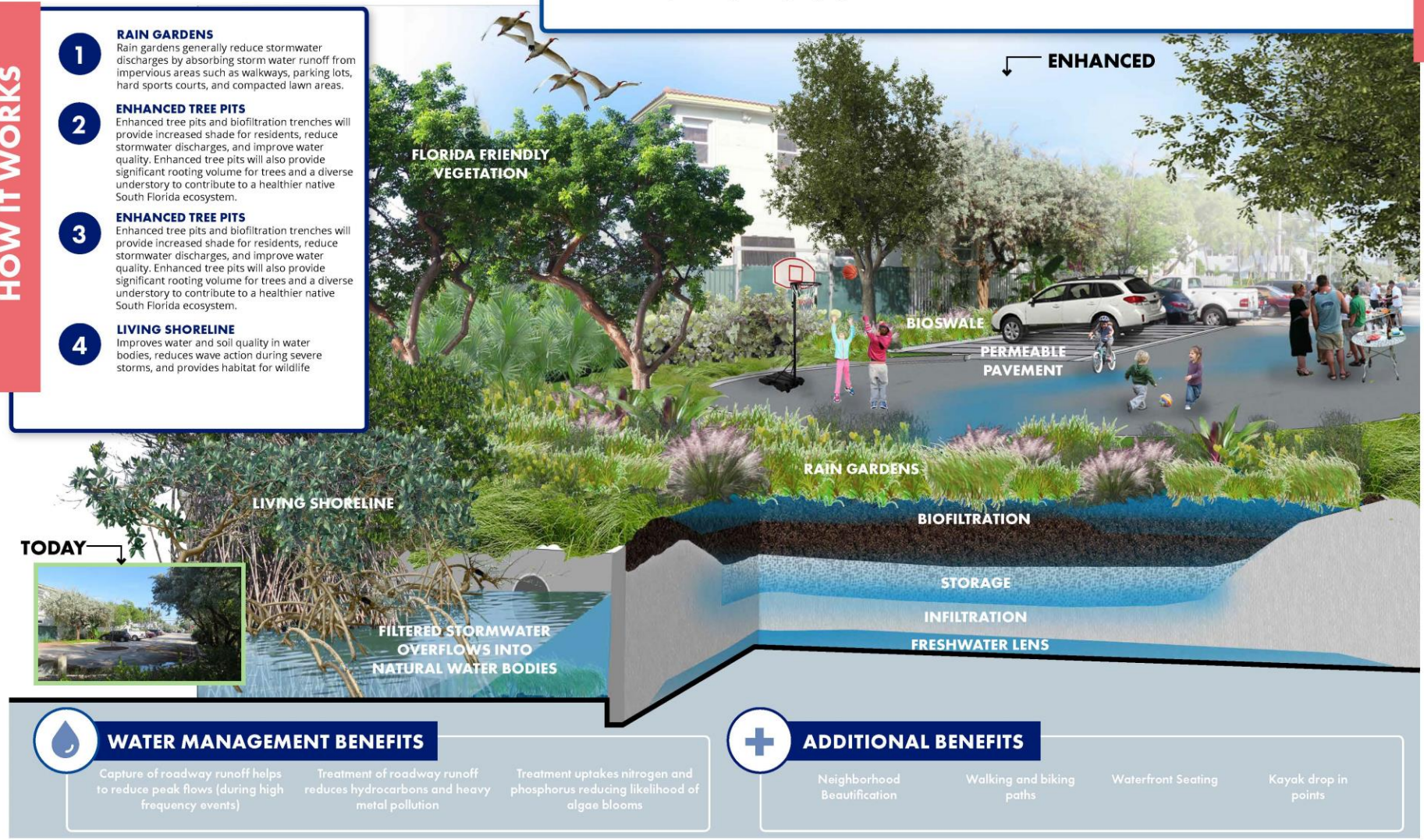
STREET ENDS

STRATEGIC VALUE

Often located at waterfront locations, street ends provide opportunities to incorporate BGSI which **absorb and filter stormwater** prior to discharging into canals, the Biscayne Bay, and the ocean, while **incorporating and enhancing habitat** for land and aquatic species, and **providing flexible parking and play spaces** for residents.

HOW IT WORKS

1. **RAIN GARDENS**
   Rain gardens generally reduce stormwater discharges by absorbing storm water runoff from impervious areas such as walkways, parking lots, hard sports courts, and compacted lawn areas.
2. **ENHANCED TREE PITS**
   Enhanced tree pits and biofiltration trenches will provide increased shade for residents, reduce stormwater discharges, and improve water quality. Enhanced tree pits will also provide significant rooting volume for trees and a diverse understory to contribute to a healthier native South Florida ecosystem.
3. **ENHANCED TREE PITS**
   Enhanced tree pits and biofiltration trenches will provide increased shade for residents, reduce stormwater discharges, and improve water quality. Enhanced tree pits will also provide significant rooting volume for trees and a diverse understory to contribute to a healthier native South Florida ecosystem.
4. **LIVING SHORELINE**
   Improves water and soil quality in water bodies, reduces wave action during severe storms, and provides habitat for wildlife



WATER MANAGEMENT BENEFITS

- Capture of roadway runoff helps to reduce peak flows (during high frequency events)
- Treatment of roadway runoff reduces hydrocarbons and heavy metal pollution
- Treatment uptakes nitrogen and phosphorus reducing likelihood of algae blooms

ADDITIONAL BENEFITS

- Neighborhood Beautification
- Walking and biking paths
- Waterfront Seating
- Kayak drop in points

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MIAMIBEACH RISING ABOVE

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

MIAMI BEACH GOLF CLUB

Scenario 1 retrofits the Miami Beach Golf Club with tactical blue green infrastructure interventions to reduce stormwater volumes and improve water quality. The existing water hazards and edges of the golf club would be enhanced and redesigned with blue green practices. **All eighteen holes and golf facilities would be maintained** more or less as they are today.

STRATEGIC VALUE

HOW IT WORKS

1. **GOLF CLUB REMAINS INTACT**
   The existing eighteen hole golf course remains largely intact and functioning much the same as it does today.
2. **RETROFIT THE WATER HAZARDS**
   The water hazards and out of bounds areas are redesigned to include BGI interventions such as stormwater detention, wet ponds and bioswales.
3. **TRANSFORM THE EDGES TO BGI**
   The edges of the golf club will be redesigned to include bioretention zones, pervious pavement and facilities may be retrofitted to include rainwater harvesting features.
4. **CONNECT TO DISTRICT SYSTEMS**
   The increased stormwater capacity and water quality treatment facilities may allow for networking the interventions to other BGI projects, such as Collins Canal.

Bioretention Edges

Permeable Pavement

Rainwater Harvesting

Wet Ponds

Detention Basin

1 RETROFIT

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BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

MIAMI BEACH GOLF CLUB

Scenario 2 repurposes the back nine holes of the Miami Beach Golf Club to create a new **signature park** focused on integrating **passive and active recreation** with a robust blue green infrastructure program to mitigate stormwater volumes and improve water quality. In this high-level concept the **front nine holes** of the Golf Club **remain** intact as an executive course.

STRATEGIC VALUE

HOW IT WORKS

1. **GOLF CLUB FRONT NINE STAYS AS-IS**
   The land area of the front nine of the golf club is kept intact and reconfigured as necessary for an executive course.
2. **REPURPOSE THE BACK NINE**
   Consider repurposing the 65 acres comprising the back nine to accommodate BGI interventions and the potential for a substantial open space improvement.
3. **CREATE A SIGNATURE PARK SPACE**
   Repurposing the back nine into a signature modern park space. A park which balances environmental, social and economic considerations and provides a framework for district-wide resiliency.
4. **LINK BGI SYSTEMS IN PARK TO THE NEIGHBORHOOD**
   Stormwater storage and water quality measures may be designed to accept and integrate with adjacent BGI improvements, such as Collins Canal.

2 REPURPOSE

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MIAMIBEACH RISING ABOVE

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

MIAMI BEACH GOLF CLUB

Scenario 3 reimagines the entire Miami Beach Golf Club to establish a 21st century **"Central Park"** for Miami Beach. This initial concept sketch explores the potential of a **new neighborhood** predicated on a **Living with Water** theme, a **recreation hub**, and a signature **wetland park** with hiking and biking trails and passive and active recreation opportunities.

STRATEGIC VALUE

HOW IT WORKS

1. **REIMAGINE ALL 145 ACRES**
   The entire publicly-owned golf club may be transformed into an amenity for all Miami Beach residents. One that responds to a holistic view of sustainability.
2. **MIAMI BEACH'S CENTRAL PARK**
   Reimagining the golf club as a new central park for Miami Beach. A 21st century open space working to bring people together while improving the city's resiliency.
3. **A POSTCARD DESTINATION**
   The potential is to create a new postcard moment for Miami Beach - one that advertises its proactive approach to mitigating climate change impacts and understanding urban placemaking.
4. **LIVING WITH WATER**
   Additional potential opportunities may include leveraging a portion of the land for public and private development, such as a mixed-use eco-district working to fulfill the City's objectives on sustainability, social equity and environmental justice.

3 REIMAGINE

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MIAMIBEACH RISING ABOVE

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

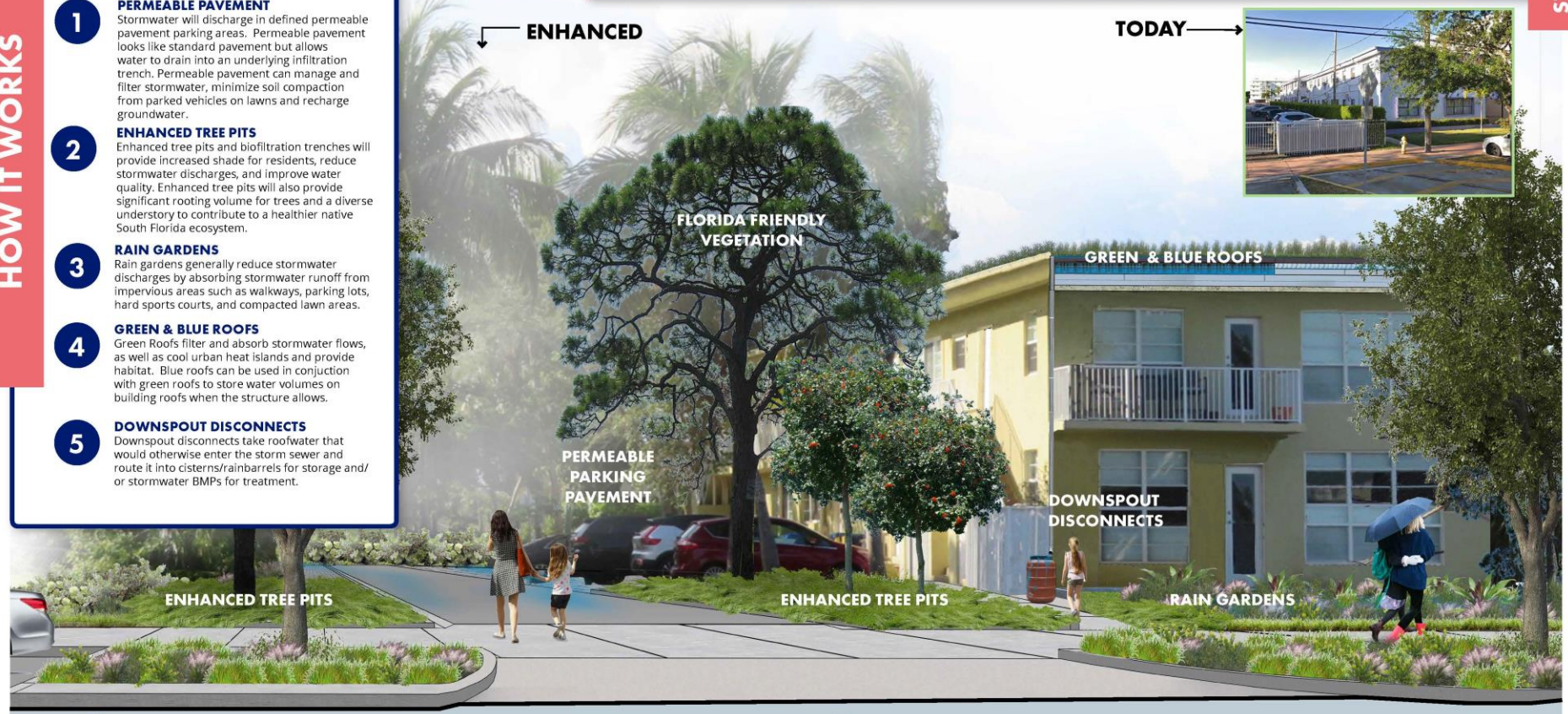
GARDEN APARTMENTS

Garden apartments as well as other **private properties** can be important partners in augmenting a comprehensive blue-green infrastructure system in Miami Beach. **Property owners can make a difference** citywide taking simple steps such as incorporating downspout disconnections, rain barrels, and tree plantings on their properties. Other BGSI BMPs such as permable pavement for parking spaces, rain gardens, green roofs, and enhanced tree pits can be used to manage stormwater on private property.

STRATEGIC VALUE

HOW IT WORKS

1. **PERMEABLE PAVEMENT**
   Stormwater will discharge in defined permeable pavement parking areas. Permeable pavement looks like standard pavement but allows water to drain into an underlying infiltration trench. Permeable pavement can manage and filter stormwater, minimize soil compaction from parked vehicles on lawns and recharge groundwater.
2. **ENHANCED TREE PITS**
   Enhanced tree pits and biofiltration trenches will provide increased shade for residents, reduce stormwater discharges, and improve water quality. Enhanced tree pits will also provide significant rooting volume for trees and a diverse understory to contribute to a healthier native South Florida ecosystem.
3. **RAIN GARDENS**
   Rain gardens generally reduce stormwater discharges by absorbing stormwater runoff from impervious areas such as walkways, parking lots, hard sports courts, and compacted lawn areas.
4. **GREEN & BLUE ROOFS**
   Green Roofs filter and absorb stormwater flows, as well as cool urban heat islands and provide habitat. Blue roofs can be used in conjuction with green roofs to store water volumes on building roofs when the structure allows.
5. **DOWNSPOUT DISCONNECTS**
   Downspout disconnects take roofwater that would otherwise enter the storm sewer and route it into cisterns/rainbarrels for storage and/or stormwater BMPs for treatment.



WATER MANAGEMENT BENEFITS

- Capture of driveway and roof runoff helps to reduce peak flows (during high frequency events)
- Treatment uptakes nitrogen and phosphorus reducing likelihood of algae blooms
- Treatment of residential runoff reduces sediment transfer, as well as fertilizer, pesticides, bacteria, and hydrocarbon pollution

ADDITIONAL BENEFITS

- Neighborhood Beautification
- Reduction in urban heat island effect / cooler ambient temperatures
- Enhanced biodiversity and habitat
- Increased shade from trees plantings

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