JACOBS

Miami Beach Integrated Water Management

Blue-Green Stormwater Infrastructure Concept Plan

Final

February 28, 2020

City of Miami Beach

RFQ 2018-312-KB

Contents

Acronyms and Abbreviations

BGSI	Blue-Green Stormwater Infrastructure
CIP	capital improvement plan
DCP	design criteria package
EPA	U.S. Environmental Protection Agency
FAQs	frequently asked questions
ft	foot (feet)
ft^2	square foot (feet)
ULI	Urban Land Institute

Executive Summary

Southeast Florida is often referred to as “ground zero” for climate change and sea level rise. In particular, the City of Miami Beach (hereafter, “the City”) has shown leadership in adapting to this change, investing in aging infrastructure and committing to use the best available information to continuously improve its approach. The City recently retained the services of the Urban Land Institute (ULI) to review its stormwater management and climate adaptation program. The ULI panel applauded the City’s commitment and encouraged several other approaches including a broader range of strategies such as blue and green infrastructure, not only pumps and pipes, in the City’s stormwater program.

The City already has a rich history in environmental stewardship through the City Commission and the Department of Environment & Sustainability. Examples include banning polystyrene, to the #PlasticFreeMB program, tree and landscape ordinances, a dune management system, progressive green building ordinances and encouraging blue and green roofs. The blue and green stormwater infrastructure (BGSI) strategies and concepts in this Plan are geared toward creating a more robust and well-rounded Miami Beach stormwater program that:

- Reduces flooding from the smaller, more frequent storms (**BGSI on its own cannot eliminate flooding);**
- Manages non-point source pollution to protect receiving waters from water quality impacts from stormwater runoff;
- Increases the infiltration of rainwater to sustain and replenish the freshwater lens under the City (thereby protecting soils and flora from being degraded by saltwater intrusion);
- Leverages innovative urban design to integrate BGSI practices into the landscape in highly aesthetic ways aligned with the culture and lifestyle of the City; and
- Provides social, environmental, and economic co-benefits that increase the value and contribution of BGSI.

On May 6, 2019, Jacobs was tasked with developing a Blue-Green Stormwater Infrastructure Concept Plan for the City of Miami Beach. In response, Jacobs assembled a multi-disciplinary team of experts including engineers, landscape architects, urban planners, and resiliency specialists to produce this Plan. The Plan included an evaluation of BGSI strategies, concepts, and locations that might be applicable in Miami Beach given its constraints as a densely built-out, low-lying coastal community and the constraints of the environmental regulatory process. The Plan recommends:

- Steps to formally **incorporate BGSI** policy into master planning, design standards, capital improvement plan (CIP) projects, codes, etc.
- Long-term **funding considerations** for successful implementation and maintenance
- Implementation of a range of **demonstration projects**
- Establishing **innovation priorities** possibilities
- BGSI **partnerships** among government, business, academia, and/or non-profits
- Advancing the **science** and modeling to better understand the interactions between flooding, precipitation, groundwater, and water quality as reported in the ULI findings
- The need for continued **community engagement**

The Plan also includes 15 BGSI practices and strategies fact sheets and 9 BSGI pilot project concept renderings, as well as potential project location maps and an inventory of FAQs from the public process.

Jacobs recommends that the City Commission accept this document and determine the extent by which to amend and incorporate BGSI into the City’s stormwater master plan, Public Works Manual, CIP standard operating procedures, language in future design packages, and guidance documents for staff project managers and consultants to ensure consideration and implementation.

1. Introduction

The coastal location of the City of Miami Beach (hereafter, the "City") is what makes it such a desirable place in which to live, work and play. Its coastal location and relatively low elevation also make it susceptible to frequent, intense storm events, rising sea levels, and extreme tidal events ("sunny day" flooding). Additionally, as with all highly urbanized areas, non-point source pollution reduction is both an environmental management priority and critical to maintaining safe and aesthetically pleasing water-oriented lifestyles and tourism.

In 2018, the Urban Land Institute (ULI) issued its *Stormwater Management and Climate Adaptation Review* report for Miami Beach. ULI praised the City for its proactive efforts and provided a series of recommendations, including further exploration and integration of blue and green stormwater infrastructure (BGSI) into the City's strategies and projects. The City is acting upon this recommendation with the development of this Concept Plan and the incorporation of BGSI solutions into several City projects currently under design or construction. These solutions harness natural processes using soils, vegetation, and the landscape as infrastructure. When thoughtfully designed, BGSI has been employed throughout the world to improve water and air quality, reduce flooding impacts, mitigate ecosystem fragmentation, reduce elevated surface temperatures, and provide many other community benefits. This document provides a compendium of BGSI practices and strategies that support the following objectives:

Stormwater planters in public right-of-way

- Reduce flooding from the smaller, more frequent storms (BGSI on its own cannot eliminate flooding)
- Better management of non-point source pollution to protect receiving waters (surface and groundwater) from water quality impacts from stormwater runoff
- Increasing the infiltration of rainwater to sustain and replenish the freshwater lens under the City (thereby helping to protect soils and flora from being degraded by saltwater intrusion)
- Leveraging innovative urban design to integrate BGSI practices into the landscape in highly aesthetic ways aligned with the culture and lifestyle of the City
- Providing social, environmental and economic co-benefits that increase the value and contribution of BGSI

The BGSI practices and strategies in this document were developed with the intent of supporting and incentivizing a broad range of stakeholders to implement BGSI such that sufficient implementation scale can be achieved and so that the collective results have meaningful impact.

1.1 Miami Beach Setting

Miami Beach lies on a barrier island running along the southeastern coast of Florida with the Biscayne Bay on its western shore, across from the City of Miami. The island of Miami Beach was once covered with mangrove and wetland plant communities that provided a natural defense for Florida's mainland against storm surge and the increased wave energy from tropical storm events. This natural protection of the Florida mainland coast allowed the Biscayne Bay ecosystem to flourish. In addition to surge and wave mitigation, the mangrove and wetland plant communities that once flourished on Miami Beach acted like a sponge in filtering and absorbing water, while providing habitat for many permanent and migratory

species. This attractive South Florida landscape and climate has resulted in dense housing and commercial development over time with surface elevations in the City that range from near 0 to an average of 4.5 feet (ft) above sea level.

Bioretention in a public park

The City sits on a bed of porous limestone and groundwater elevations closely follow sea and tide levels. With sea and groundwater levels expected to rise, coupled with more frequent and intense storm events, the City has raised some of the most flood-prone roads and implemented new policies to help protect private development.

1.2 Opportunities and Benefits of BGSI in Miami Beach

In response to such dramatic climatic changes, there is the opportunity to change the way coastal cities like Miami Beach have historically incorporated centralized, grey infrastructure systems, such as pipes, pumps, and canals to address stormwater runoff by implementing an infrastructure system that integrates natural processes within the built environment. BGSI strives for more onsite stormwater management approaches that harness the power of nature to help manage stormwater at its source, instead of at or near the ends of pipes before stormwater discharges to receiving waters like Biscayne Bay. Using Florida-friendly vegetation as infrastructure increases the urban forest canopy, with companion ground-level plants that are urban-tolerant and that mimic the natural stormwater management processes employed by South Florida ecosystems that existed prior to land development. Water quality and regional ecosystem health can be improved using a network of thoughtfully sited Florida-friendly vegetated and soil-based systems that intercept, absorb, and filter pollutants in stormwater before it reaches local waterways, Biscayne Bay, and the ocean.

Permeable pavers in outside dining area

These systems also provide increased infiltration into the City's subsurface limestone voids, mimicking the natural water cycle and recharging the City's freshwater lens. This naturally occurring freshwater supply sits below the soil surface and has a critical role in supporting the health and diversity of Florida-friendly plant communities. A lack of a freshwater recharge, paired with rising sea levels, could result in saltwater intrusion within the root zones of vegetation, including the City's beautiful trees, causing wilted growth and eventual death. Without shade and the natural cooling process of evapotranspiration from vegetation, surface temperatures will likely rise, further exacerbating the urban heat island effect.

The widespread implementation of BGSI across the City would create the opportunity to integrate innovative urban design concepts with improved stormwater management, in the process yielding multiple community and environmental benefits. Water has historically been central to public space design not

only as decorative elements but also in its capacity to provide opportunities for relaxation and respite. The incorporation of BGSI and other water features within urban spaces early in the planning process can offer many co-benefits that optimize livability and resilience in Miami Beach. Reclaiming the historically positive role water has had in Miami Beach can provide a living stage for interpretive South Florida education, while allowing alternative forms of transport, such as walking and biking to diversify Miami Beach's transportation network while reducing carbon emissions that contribute to climate change. Innovative urban design considers the critical point of view that can only be provided by users of Miami Beach public space: the community, whose experiences and preferences are critical in shaping public space planning and design. BGSI should serve as a symbol of innovation through the creation of functional and memorable public spaces, not only for the people of Miami Beach, but also for the millions of annual visitors.

1.3 Public Engagement in Concept Plan Development

Well-attended public meeting to discuss BGSI in Miami

For this BGSI approach to be successful, it is critical that solutions fit the context of not only South Florida and Miami Beach, but also the context of existing site uses. Current site usage and programming can only be understood by engaging with the public early and often through various communication forums, such as public meetings, online surveys, social media, and other ways of gathering input across various demographics and neighborhoods. Although this Concept Plan was developed over a relatively short period of time, effective public outreach was conducted and valuable input was received through presentations at two City of Miami Beach Sustainability and Resiliency Committee meetings, a well-advertised and well-attended public meeting dedicated to BGSI, and the Miami Beach Rising Above website (www.mbrisingabove.com). The input and feedback received from these stakeholders guided the selection of BGSI practices and strategies in this Concept Plan and the urban design features to be included. A frequently asked questions (FAQs) document was also prepared to address common concerns related to BGSI implementation and is included in Appendix A. A detailed summary of public outreach activities is included in Appendix B.

1.4 Implementation Strategies and Partnerships for Blue-Green Stormwater Infrastructure in Miami Beach

The success of BGSI implementation also rests with increased partnerships that engage government, private business, residents, local community groups, and non-governmental organizations. Truly integrated solutions require input and expertise across a wide set of partners not only within neighborhoods and across the community, but also among the various City departments and other agencies. Communication and alignment on a strategy across City departments will result in better informed decisions and more holistic solutions through integrated BGSI planning. This alignment will be reinforced through neighborhood-level public outreach as specific local projects are planned, designed, constructed, and maintained.

In addition to site context, public engagement, partnerships, and aligned strategies, the science of BGSI in the Miami Beach context must be further advanced. Performance and other data must be collected, analyzed, and evaluated for solutions to be intelligently designed and to perform effectively.

1.5 Intended Audience and BGSI Concept Plan Organization

This document was developed for a wide range of stakeholders and is intended to inform master planning, capital improvement plan development, design criteria packages (DCPs), and policies on new development, building codes, and zoning. Given this wide audience, the document includes the following sections that can be used individually or collectively for different users and purposes:

- **Section 2, Blue-Green Stormwater Infrastructure**: includes general information about BGSI, the BGSI evaluation process, and the most and least applicable practices for the City.
- **Section 3, Recommendations**: focuses on critical next steps that should be taken to launch BGSI in the City and to support achieving sustainable implementation at-scale.
- **Section 4, References**: provides a partial list of resources used in the preparation of this Concept Plan.

Several appendices are also provided that include FAQs, 1-page fact sheets that focus on specific BGSI practices, multi-page fact sheets that cover BGSI strategies that entail multiple practices in various settings, renderings that illustrate potential application of BGSI in different contexts, and potential project location maps:

- Appendix A BGSI FAQs
- Appendix B Public Outreach Summary Report
- Appendix C BGSI Practices and Strategies Fact Sheets
- Appendix D BGSI Plant Matrices/Plant Palette Boards
- Appendix E BGSI Pilot Project Concepts/Renderings
- Appendix F Potential Project Location Maps

2. Blue-Green Stormwater Infrastructure

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 without significant reliance on vegetation. Examples are wet ponds and detention basins.

BGSI uses 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 (for example, living shorelines, dunes, mangrove plantings, and oyster or artificial reefs) that target stressors, such as wave energy, sea level rise, and storm surges.

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

2.1 Advantages and Limitations of BGSI

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 significantly reduce: “sunny day” flooding or flooding from major rainfall events or storm surge.
- 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

While the benefits of BGSI are significant, there are also limitations as described in more detail later in this section, including:

- The difficulties of the environmental permitting process.
- The physical space limitations for BGSI given the density of development in much of the City.
- Widespread BGSI requires changes to City policies, codes, and/or standard operating procedures (refer to Section 3).

- BGSI requires a commitment to and funding for maintenance.

2.2 Qualitative Evaluation of BGSI Practice Applicability for Miami Beach

BGSI practice types were qualitatively evaluated based on city/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[1]
- Blue & Green Roofs
- Constructed Wetlands/Floating Wetland Islands[2]
- Detention Basins/Surface Storage
- Enhanced Tree Pits/Trenches
- Injection Wells (Pumped)[3]
- Permeable Pavement
- Rainwater Harvesting
- Stormwater Planters[4]
- Subsurface Infiltration/Storage
- Tree Canopy[5]
- Wet Ponds

Typical bioretention cross-section

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.

The following BGSI practices are less applicable to Miami Beach because of their reduced water quality benefits, higher costs, lack of scalability, lower effectiveness when dealing with sea level rise and high tides, proprietary designs, limited applicability, or low storage capacities:

- Aboveground Detention Tanks
- Canal Enhancements
- Canopy Trees
- Drainage/Gravity Wells
- Exfiltration Trenches
- High-Flow Media Filters
- Living/Green Walls
- Subsurface Flow Wetlands

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[1] Florida-friendly plants are strongly encouraged for vegetated BGSI practices as they are the climate-adapted, excel at ecosystem service, and enhance sense of place. Species such as duck potato, Fakahatchee grass, and red maple from the Florida wetland plant community are recommended, as are South Florida slash pine and saw palmetto from the South Florida pine flatwood plant community.

[2] *Ibid*.

[3] Although not typically thought of as BGSI, injection wells are included here as they reduce the volume of stormwater discharged, and with proper pretreatment/filtration can provide some water quality benefits.

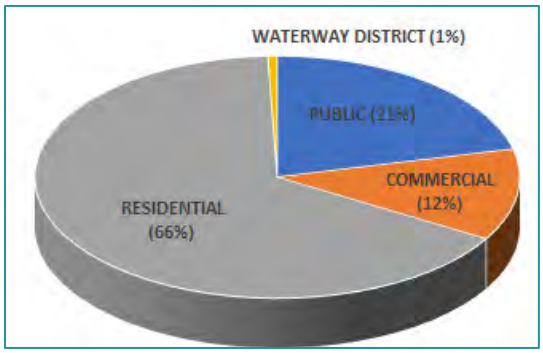
[4] Florida-friendly plants are strongly encouraged for vegetated BGSI practices as they are the climate-adapted, excel at ecosystem service, and enhance sense of place. Species such as duck potato, Fakahatchee grass, and red maple from the Florida wetland plant community are recommended, as are South Florida slash pine and saw palmetto from the South Florida pine flatwood plant community.

[5] Although a BGSI practice fact sheet has not been developed for them, trees are a key component of BGSI, and the City is developing an Urban Forest Master Plan to provide a strategic framework to guide the City in managing, maintaining, planting, and preserving its urban forest. See www.mbrisingabove.com/climate-mitigation/urban-canopy-2/urban-forestry-master-plan/.

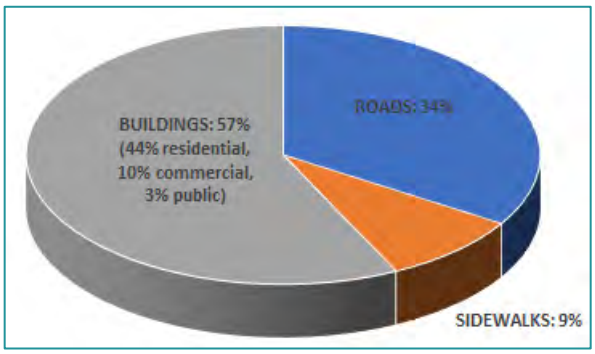
Although not as readily applicable to Miami Beach, the above BGSI practices might still prove beneficial in certain settings. As discussed previously, such coastal practices as living shorelines, dunes, mangrove plantings, and oyster or artificial reefs are not the focus of this Plan on blue-green *stormwater* infrastructure. Appendix C provides detailed fact sheets on BGSI practices.

2.3 Potential BGSI Locations

BGSI can be used on and along roads, in parks and other open spaces, at schools and other public facilities, on rooftops, and on residential and commercial properties. Approximately 40 percent of Miami Beach is covered by impervious surfaces (buildings and pavements) that prevent water from soaking into the ground (see Figure 2-1). BGSI should be employed to treat runoff from these impervious surfaces and help preserve, enhance, and increase the City's remaining pervious or "green" areas.



Miami Beach Land Uses (based on zoning districts)



Miami Beach Impervious Areas

Figure 2-1. Primary Land Uses and Impervious Cover in Miami Beach

BGSI Practices and Strategies were developed with Miami Beach's primary land uses and impervious cover distribution in mind

When choosing where to place BGSI practices, the following factors should be considered:

- BGSI is often most cost-effective when integrated with ongoing or planned City projects, such as those on the City's Capital Improvement Plan, General Obligation Bond list, Transportation Master Plan, and Blueways Master Plan.
- Shallow, increasing, and/or seasonal groundwater elevations across the City limit the soil storage capacity and infiltration required for some BGSI practices to function. However, such limitations might potentially be overcome with underdrains, fill, and/or pumping. In addition, existing soil or groundwater contamination may impact BGSI design and construction.
- Depending on the BGSI practice type, offsets from utilities, buildings, and other structures may be required to protect those features from water damage.
- Factors such as budget, permitting, site conditions, neighborhood preferences, and ownership will influence the location and types of BGSI.

Table 2-1 lists the applicability of BGSI practices based on land use.

Rendering of bioretention and permeable pavement on a typical residential street in Miami Beach

Table 2-1. BGSI Practice Applicability by Land Use

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	●	○	○	●	●	●	●	○	●	●	○
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 (where a street dead ends at a waterbody)	●	○	●	○	●	●	◐	◐	◐	○	○
Alleys (commercial)	○	○	○	○	○	●	●	○	○	◐	○
Avenues (suburban)	●	○	○	○	●	●	●	○	●	◐	○
Avenues (urban)	◐	○	○	○	●	●	●	○	●	◐	○
Boulevards	●	○	○	○	●	●	●	○	●	◐	○
Main Streets	◐	○	○	○	●	◐	●	◐	◐	◐	○
Neighborhood Streets (suburban)	●	○	○	○	●	●	●	○	◐	◐	○
Neighborhood Streets (urban)	◐	○	○	○	●	●	●	○	●	◐	○
Non-Motorized Streets	●	○	○	◐	●	●	●	◐	●	◐	○

●=yes ○=no ◐=limited

2.4 BGSI Strategies

The following BGSI strategies and their respective sub-strategies represent excellent opportunities throughout Miami Beach to implement numerous BGSI practices. These strategies address all the primary land uses in Miami Beach.

- Commercial and Public Facilities
  - Schools
  - Parking garages
  - Other facilities with building coverage greater than 90 percent of the site
  - Other facilities with building coverage less than 90 percent of the site
- Parks and Open Spaces
  - Golf courses
  - Open spaces
  - Parks
  - Pocket parks and plazas
- Right-of-Way – Streets and Alleys
  - Commercial streets
  - Residential streets
  - Street ends (where a street dead ends at a waterbody)
  - Non-motorized streets
  - Alleys
- Single-family Residential

Stormwater planters and enhanced tree trenches on a commercial street

2.5 BGSI and Water Quality

Protecting water quality for Miami Beach's beaches and waterways is a priority as they provide habitat, a great quality of life, and opportunities for tourism. Stormwater runoff from urban areas can transport pollutants—including bacteria/pathogens, nutrients (such as nitrogen and phosphorus), sediment, and heavy metals—to waterways and beaches. BGSI can reduce many of these pollutants. By retaining rainfall, BGSI reduces stormwater discharges. Lower discharge volumes translate into reduced pollutant loads (see Table 2-2). BGSI also treats stormwater that is not retained (EPA, 2019). It should also be noted that BGSI can only improve the quality of the water that it receives (that is, the runoff from the drainage area that it serves) and has the capacity to treat. Therefore, extensive BGSI coverage would typically be required to have significant overall pollutant load reductions. As with all infrastructure, BGSI must be designed, constructed, and maintained to function properly over the long term.

Table 2-2. Pollutant Load Reductions Using BGSI

	Pollutant Mass Load Reductions (%)		
BGSI Practice	Nitrogen	Phosphorus	Suspended Solids
Bioretention/Bioswales/Rain Gardens	70–80%	75–85%	80–90%
Blue & Green Roofs	55%	55%	80–90%
Constructed Wetlands	20%	45%	60%
Detention Basins/Surface Storage	20%	20%	60%
Enhanced Tree Pits/Trenches	85%	85%	95%
Injection Wells	Depends on type of pretreatment		
Permeable Pavement	80%	80%	85%
Rainwater Harvesting	Depends on amount of rainwater harvested and type of pretreatment		
Stormwater Planters	70–80%	75–85%	80–90%
Subsurface Infiltration/Storage	85%	85%	95%
Wet Ponds	20%	45%	60%

Adapted from Tables B-5 and C-1 from Schueler and Lane (2015)

2.6 Size and Cost Considerations

An analysis of daily rainfall data for Miami Beach from 2000 to 2019 indicates that slightly more than 90 percent of the total rainfall comes on days with 2 inches or less of rainfall (see Figure 2-2). BGSI is generally sized to manage runoff from these events, which also contribute much of the pollution caused by stormwater. Although representing less than 10 percent of the total rainfall from 2000 to 2019, days with more than 2 inches of rainfall occur on average five to six times per year and often lead to flooding. In addition, the frequency of these larger events is predicted to increase with climate change (CH2M HILL, 2015). Because a 2-inch rainfall event is only approximately 25 percent of the much larger storms typically used to size flood control systems, such as pipes and pumps, BGSI is not considered a replacement for traditional "grey" infrastructure, but it can complement it. BGSI systems are generally sized to manage the runoff for areas that are 10 to 20 times larger than their footprint. For example, a bioretention system that is 1,000 square feet (ft^2) can capture runoff from an area that is 10,000 to 20,000 ft^2.

The size and complexity of the design and construction influence the cost of BGSI. Examples of the factors impacting cost are project size, type(s) of BGSI, space constraints, the amount of pipe needed, presence of utilities, soil conditions, depth to water table, proximity to roadways/need for traffic control, and current site conditions.

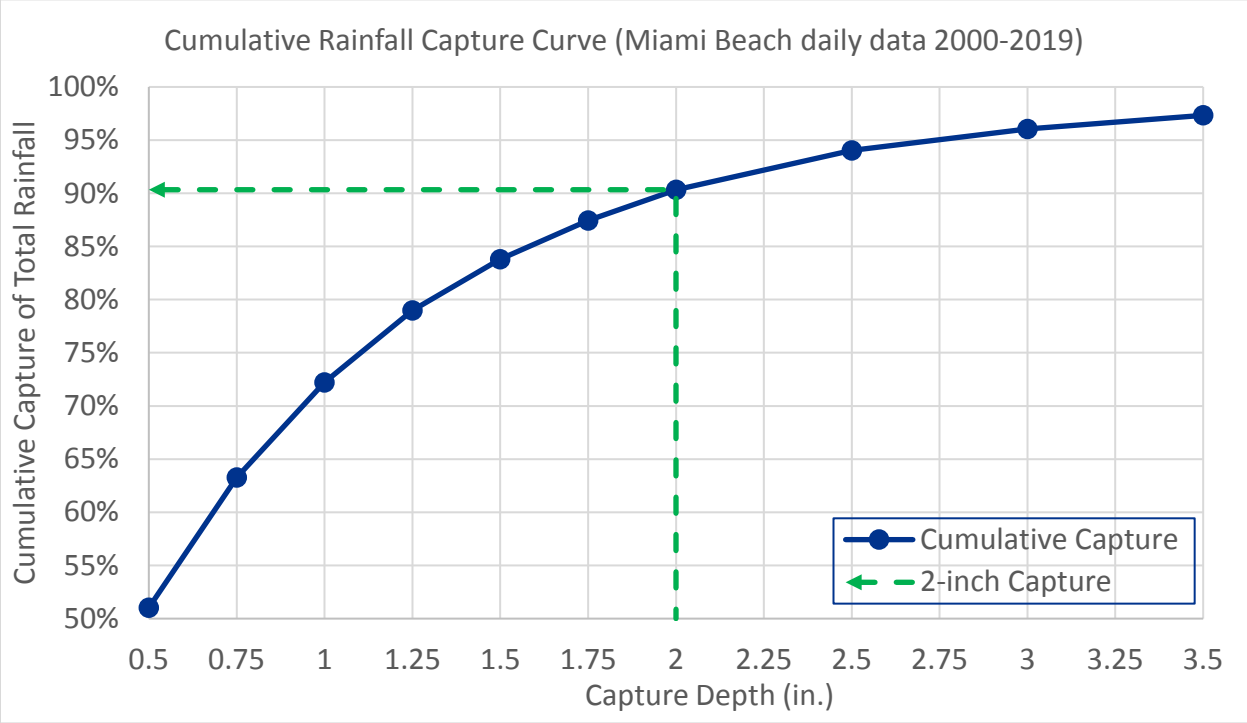
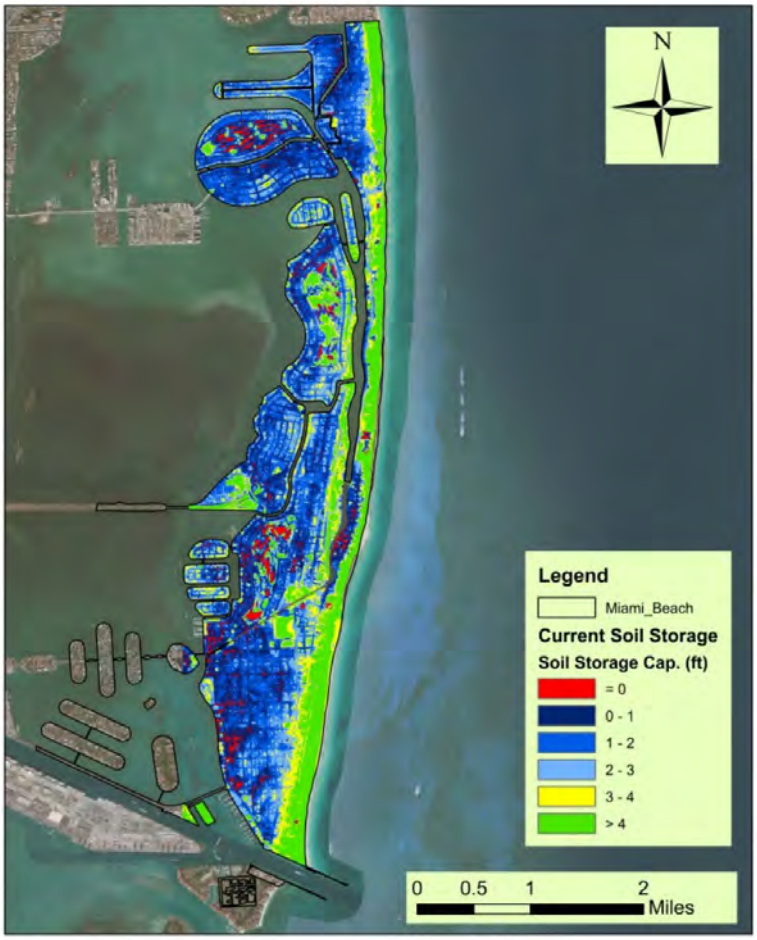


Figure 2-2. Cumulative Rainfall Capture Curve (2000 to 2019)
Just over 90% of the total rainfall comes on days with 2 inches or less of rainfall.

2.7 BGSI Performance Amid Rising Sea Levels and Shallow Groundwater

Shallow and increasing groundwater elevations in portions of the City limit the soil storage capacity (see Figure 2-3) and infiltration required for *some* BGSI practices to function effectively. However, such limitations might potentially be overcome with underdrains, fill, and/or pumping. Other practices, such as wet ponds and constructed wetlands, can continue to function with shallow groundwater although their storage capacity may be reduced as groundwater levels increase. Blue and green roofs, rainwater harvesting, and floating wetland islands would typically not be impacted by rising groundwater.

Table 2-3 summarizes BGSI applicability and feasibility in Miami Beach based on current elevations and development patterns. Note that the applicability and feasibility of infiltration-based BGSI practices can typically be increased if the area where the BGSI practices are located is raised (that is, if additional separation to groundwater is created).



Miami Beach has limited soil storage capacity, especially in the low-lying areas on its west side (Source: Paituvi, 2014)

Figure 2-3. Miami Beach Soil Storage Capacity

2.8 BGSI and Mosquitoes

Mosquitoes require standing water to be present for more than 7 days to grow. When properly designed, constructed, and maintained, BGSI will not promote mosquito breeding.

BGSI not intended to retain water is usually designed to fully drain within 3 days after a rainfall event. These BGSI practices require periodic inspections to ensure they are draining down adequately.

BGSI intended to retain water for greater than 7 days must include preventive methods to discourage mosquito growth. These methods can include:

- Screening
- Establishing a natural predator population
- Appropriate mosquito-specific larvicides

Table 2-3. General BGSI Applicability and Feasibility in Miami Beach

BGSI Practice	Low-lying Urban Areas	Low-lying Suburban Areas	Higher, Coastal Zone (east side, generally highly developed)
Bioretention (may require a shallow design in low-lying areas)	💧💧	💧💧	💧💧💧
Bioswales	💧💧	💧💧💧	💧
Blue & Green Roofs	💧💧💧	💧💧	💧💧💧
Constructed Wetlands	💧	💧💧💧	💧
Detention Basins/Surface Storage	💧	💧💧💧	💧💧
Enhanced Tree Pits/Trenches	💧 (typical, higher if ground elevation is raised)		💧💧💧
Floating Wetland Islands	💧💧	💧💧💧	💧
Injection Wells	💧💧💧 (ideally in southern and central areas, where the Biscayne Aquifer is highly absorbent)		
Permeable Pavement	💧 (typical, higher if ground elevation is raised)		💧💧💧
Rain Gardens (residential)	💧	💧💧💧	💧
Rainwater Harvesting	💧💧💧	💧💧	💧💧💧
Stormwater Planters	💧💧💧	💧💧	💧💧💧
Subsurface Infiltration/Storage	💧 (typical, higher if ground elevation is raised)		💧💧💧
Tree Canopy	💧💧💧	💧💧💧	💧💧💧
Wet Ponds	💧	💧💧💧	💧

💧=low 💧💧 =medium 💧💧💧 =high

2.9 Maintenance Requirements and Responsibilities

BGSI practices require a variety of maintenance activities depending on the type of BGSI and various site-specific factors. Landscaped BGSI requires maintenance typical of other landscaped areas, potentially including debris and trash removal, pruning, weeding, replanting, erosion repair, and mulching. Many BGSI practices include devices for pretreatment of runoff that require periodic sediment and debris removal. Permeable pavements require the surface to be periodically cleaned (for example, with a street cleaning vehicle) to prevent clogging.

A variety of entities may be involved in BGSI maintenance depending on the situation. In parks and at other City-owned properties, the City would likely lead the maintenance activities (either with City staff or contractors) although they may be supported by residents and businesses through volunteer efforts, “Friends of” groups, “adopt-a-BGSI” programs, neighborhood associations, etc. Along commercial streets, business improvement districts and similar groups may lead maintenance activities. On private property, BGSI maintenance would be the responsibility of the property owner/manager. Maintenance procedures and responsibilities for BGSI on residential roads are still being formulated.

2.10 BGSI Fact Sheets

Each of the eleven BGSI practices recommended for implementation in Miami Beach has its own fact sheet (see Appendix C). Each practice fact sheet contains the following information:

- A general description of the BGSI practice, as well as an example photograph and/or schematic
- Advantages and potential limitations of using the practice in Miami Beach

- Applicability of the practice in the Miami Beach context
- Potential enhancements that could be employed to increase the performance of the practice
- Qualitative assessment ("high", "medium", or "low") of various factors for each practice, ***evaluated relative to other BGSI practices***
  - Expected Stormwater Performance
    - Water Quality – how effective is the practice at removing typical pollutants in stormwater runoff
    - Freshwater Lens Recharge – how effective is the practice at allowing stormwater to enter the soil (infiltration) and recharging the groundwater
    - Flood Mitigation – what is the practice's potential for reducing flooding in its vicinity (that is, localized flooding)
  - Implementation
    - Capital Cost – anticipated cost to implement the practice in Miami Beach
    - Maintenance Cost – anticipated cost to maintain and/or operate the practice in Miami Beach
    - Scalability – what is the practice's potential to be easily replicated in many locations in Miami Beach
    - Constructability – how easy will it be to construct the practice in Miami Beach and can negative impacts to natural and/or human-made features, pedestrians, traffic, businesses, tourism, etc. be limited during construction, with "high" indicating the easiest or least disruptive to such considerations
  - Community/Environmental Benefits
    - Improved Aesthetics – what is the practice's potential to maintain if not enhance the unique look and feel of Miami Beach
    - Dual Use – what is the practice's potential to provide other uses in addition to stormwater runoff control (for example, permeable pavement provides useable hardscape for multiple uses)
    - Habitat Creation – how effective is the practice at providing habitat for wildlife, including both land and aquatic species
    - Urban Heat Island Reduction – what is the practice's potential to lower the ambient air temperature
  - Other Factors
    - Climate Change Resilience – how resilient and adaptive will the practice be to changing climate conditions, such as more frequent and powerful storms and sea level rise
    - Mosquito Vector Resistance – what is the practice's potential to resist or limit the propagation of mosquitoes and the diseases they spread

Each of the four BGSI strategies recommended for implementation in Miami Beach has its own fact sheet (see Appendix C). Each strategy fact sheet contains the following information:

- A general description of the BGSI strategy, as well as an example photograph
- Advantages and potential limitations of using the strategy in Miami Beach
- Table of applicable BGSI practices for sites aligning to the specific strategy (that is, summary of which practices apply to most sites, some sites, or few or no sites [limited applicability])
- Descriptions of some of the common variations (or sub-strategies) for each strategy, along with photographs of applicable Miami Beach sites and constructed BGSI practices in similar settings

2.11 Additional BGSI Resources

- Rising Above Website[6]
- Best Management Practices for South Florida Urban Stormwater Management Systems[7]
- Florida Field Guide to Low Impact Development: Bioretention Basins/Rain Gardens[8]
- Florida Field Guide to Low Impact Development: Green Roofs/Eco-roofs[9]
- Florida Department of Transportation Drainage Design Guide (Injection Wells covered in Chapter 7)[10]
- Sarasota County Low Impact Development Guidance Document[11]

Rain gardens, bioswale, and permeable pavement at a street end

- University of Florida Soil and Water Sciences Video Topics: Green Stormwater Infrastructure[12]
- Constructed Floating Wetlands: A review of research, design, operation and management aspects, and data meta-analysis[13]

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

6 http://www.mbrisingabove.com/climate-adaptation
7 https://www.sfwmd.gov/sites/default/files/documents/bmp_manual.pdf
8 http://buildgreen.ufl.edu/Fact_sheet_Bioretention_Basins_Rain_Gardens.pdf
9 http://www.buildgreen.ufl.edu/Fact_sheet_Green_Roofs_Eco_roofs.pdf
10 https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/roadway/drainage/files/drainagedesignguide.pdf
11 https://www.scgov.net/home/showdocument?id=33258
12 https://soils.ifas.ufl.edu/extension/videos/low-impact-development
13 https://apirs.plants.ifas.ufl.edu/site/assets/files/372369/372369.pdf

3. Recommendations

The preceding sections of this BGSI Concept Plan were developed to identify BGSI practices and strategies that will help manage stormwater and enhance climate resiliency by providing water quality benefits, freshwater lens recharge, and reduced localized flooding. The City has elected to achieve these goals by integrating BGSI into innovative urban designs that enhance the landscape, provide sustainability co-benefits, honor the local culture and aesthetic, add economic value, and enhance the quality of life for residents.

To achieve significant, widespread benefits, BGSI will need to be implemented throughout Miami Beach and the following recommendations aim to support the successful launch and scale-up of BGSI across the City.

- **Formalize BGSI requirements into existing policy, planning, and management systems**. For BGSI to achieve the requisite implementation scale and deliver the desired outcomes, specific requirements need to be integrated into the following:
  - ***BGSI Policy***. Develop a policy that formally states the objectives of BGSI, including specific requirements to which the City will hold itself accountable, such as how BGSI will be incorporated into both public infrastructure and private development projects as well as retrofits of existing facilities. Existing governance processes (for example, audits and management reviews) should be updated to include confirming compliance with this policy.
  - ***Codes, Ordinances, Zoning, and Permitting***. Current City codes, ordinances, and permits that affect stormwater management need to be reviewed and updated as needed to ensure they reflect a priority on BGSI solutions pursuant to the BGSI Policy that is developed. Existing relevant training and guidance for City staff and contractors should be updated to reflect the addition of BGSI priorities.

Highest and best use analyses of the public golf courses will inform potential BGSI implementation

  - ***Design standards***. Develop a design manual that updates or supplements the City's current design details, typical road sections, and specifications to include BGSI practices.

- ***Master Planning and Land Use Planning***. All relevant existing and/or in-progress master plans (water, wastewater, stormwater, transportation, urban forest, etc.) should be reviewed and updated as needed to include BGSI practices and strategies. BGSI-specific master planning should be done at the neighborhood level and support DCP development. In addition, highest and best use analyses should be conducted for the two publicly owned golf courses to inform planning discussions regarding the degree to which BGSI should be implemented at these locations.
- ***Capital Improvement Plans***. The current portfolio of capital improvement projects should be reviewed and opportunities to integrate BGSI should be identified. These already planned and funded projects represent a significant opportunity to achieve a robust start to BGSI implementation. Some projects may be good candidates for pilot projects that could demonstrate the benefits of BGSI (see Appendix E).
- ***Align City Departments on BGSI Policy and Include BGSI in Cross-Departmental Management.*** The range of BGSI implementation scenarios (for example, transportation, parks, private property, etc.) span the range of City departments, indicating the need for alignment across all Miami Beach departments on BGSI policy, planning, and implementation.

Parks like Maurice Gibbs often an excellent opportunity to demonstrate BGSI

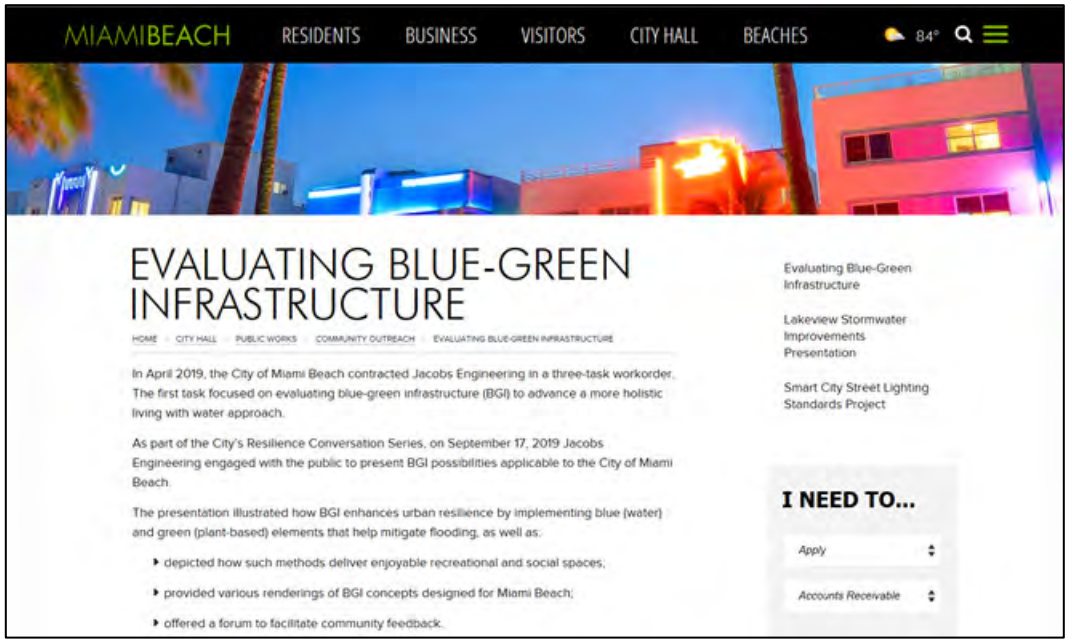
- **Ensure long-term funding for BGSI implementation and maintenance, including incentives**. The successful scale-up of BGSI across the City depends on adequate funding for construction and long-term maintenance; the City should ensure adequate budgets are established each year. Additionally, to achieve the requisite level of BGSI implementation, practices will need to be implemented on both public and private property. The City should consider funding models that provide flexibility to contribute public funds to solutions implemented on private property because in some locations adequate public land may not be available and/or private land may provide a higher performance-to-cost return on investment. The City should also consider formalizing incentives (grants/rebates and stormwater fee credits) for the private implementation of BGSI. Any increase in the City's stormwater fee should be accompanied with a credit program that not only provides a return on investment for private implementation of BGSI, but also includes a formal mechanism for the City to require maintenance of private BGSI facilities and/or encourage private maintenance of public BGSI systems in the adjacent public right of way.
- **Implement a portfolio of demonstration projects across the range of recommended BGSI strategies**. Demonstration projects are needed to provide residents, developers, regulators, contractors, and City personnel with a deeper understanding of the best ways to plan and implement BGSI. Ideally, these demonstration projects would be supported by grants such that the City can contribute to advancing the science of implementing BGSI solutions in the context of climate

adaptation. These demonstration projects could be designed considering specific innovations and in partnership with regulatory agencies, academia, and the community, so that results would build support for BGSI solutions. Capturing lessons learned and integrating these into subsequent BGSI planning and design standards will be critical to success.

- **Develop BGSI innovation priorities**. The City should identify specific innovation priorities intended to support the scale-up of high-impact BGSI practices within the unique local context, geared to overcome a variety of factors (for example, land availability, policy, technology, financial) that could impact progress. Innovation could focus on:
  - ***Technology*.** This innovation area could focus on how best to leverage smart technologies, the internet-of-things, and digital solutions to monitor performance and drive greater efficiency and effectiveness of BGSI solutions. Digital solutions could also provide efficient ways to share results with the community and interested stakeholders that increasingly receive information real-time in digital format.
  - ***One Water or Water Neutrality*.** This innovation area could focus on integration of grey, blue, and green infrastructure solutions to maximize performance and lower overall lifecycle costs. Water neutrality may offer an opportunity to incentivize the strategic and financial participation of the private sector in scaling BGSI across the City by creating methodologies and programs that enable business to offset their consumptive water use through BGSI solutions that manage/ /infiltrate equivalent volumes of water and deliver co-benefits; this could include a recognition program for businesses that achieve neutrality in support of the City's sustainability efforts.
  - **BGSI Design.** This could focus on evaluating new and innovative BGSI technologies/techniques and combinations of these that are most effective in Miami Beach and could involve engaging with companies developing cutting-edge products to address local objectives, such as removal of specific pollutants of concern (for example, nitrogen, phosphorus, pathogens, and arsenic), and overcome implementation challenges, such as high groundwater, saline soils, and mosquitoes.
  - ***BGSI Maintenance*.** This innovation area could focus on meeting long-term maintenance needs of BGSI while also contributing to the development of a green economy workforce. Innovations in BGSI maintenance could be supported by the technology innovations (for example, smart sensors, mobile phone apps) discussed above.
  - ***Alternative Delivery*.** This innovation could focus on innovative financing and project delivery options. Innovative finance could include engaging the growing socially responsible investor community that are willing to provide lower-cost financing for solutions that deliver social and environmental benefits (for example, through environmental impact bonds). Innovative project delivery could include the purchase of BGSI performance from private enterprises that deliver BGSI solutions on private land.
- **Develop BGSI partnerships.** Full-scale implementation of BGSI will greatly benefit from leveraging a range of partnerships between government, business, academia, and civil society. Each potential partner has a different value proposition, so a formal strategy is recommended to guide partnership development and management. Potential partners types include:
  - ***Conservation Organizations and Academia*** – These partners can conduct research, augment technical understanding of risks and issues as well as recommend innovative solutions; they can also add credibility to, and voice their support for, plans and actions that support mutually beneficial goals.
  - ***Regulatory Agencies*** – These partners can help anticipate regulatory obstacles to innovative solutions and provide guidance on how they can be overcome. For example, one partnership could be with the Miami-Dade Regulatory and Economic Resources with a focus on how to resolve permitting issues related to BGSI.
  - ***Technology Providers*** – These partners can provide the range of measurement, data management, analytics, and visualization technologies that can support performance management/ optimization, real-time control, management decisions, and transparency regarding BGSI practices and their performance.

  - ***Private Sector Enterprises*** – There is a broad range of potential partners from the private sector. Theses could include companies developing cutting-edge BGSI products, industry and commercial enterprises incentivized to support BGSI implementation, and socially responsible private equity firms providing low-cost financing for BGSI.
  - ***Miami-Dade County and Florida Department of Transportation***. Partnership with these agencies is recommended, given the scale of opportunity for implementing BGSI solutions on county and state roads.

- **Advance the Science**. An integrated understanding of the hydrologic, hydrogeologic, sea level rise projections, increasing rainfall intensities, and storm surge estimates is needed to provide perspective regarding how these different factors combine to influence the feasibility and performance of BGSI practices. Developing this integrated understanding may require additional hydrologic and hydro-geologic integrated modeling.



Miami Beach recently developed a website dedicated to providing information on BGSI
Source: www.miamibeachfl.gov/city-hall/public-works/community-outreach/evaluating-blue-green-infrastructure

- **Invigorate community engagement**. Miami Beach should continue community outreach on BGSI as its support will be critical to the successful scale-up of BGSI practices across the City. This could include programs that support or incentivize implementation of BGSI practices on residential property (for example, rain barrel and tree planting programs as well as assistance for rain gardens, permeable pavers, and other practices). A formal, long-term plan for continued community engagement should be developed and shared with the community so that it is aware of the process and can plan for participation. The engagement plan should consider ways to solicit meaningful input from millennials and other groups that may be less likely to attend in-person public meetings.

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Appendix A
BGSI FAQs

JACOBS®

Miami Beach Integrated Water Management

Blue-Green Stormwater Infrastructure
Frequently Asked Questions

Document Version 4

October 25, 2019

City of Miami Beach

Contents

Frequently Asked Questions Concerning Blue-Green Stormwater Infrastructure

What is blue-green stormwater infrastructure?

Green stormwater infrastructure typically uses rainwater harvesting, vegetation, and/or soils to treat and reduce stormwater flows. Examples include bioretention (rain gardens) and permeable pavement.

Blue stormwater infrastructure temporarily stores and treats stormwater without significant reliance on vegetation. Examples are wet ponds and detention basins.

Blue-green stormwater infrastructure (BGSI) encompasses both green and blue stormwater infrastructure practices. Phrases like **low-impact development** techniques, sustainable site design, and **stormwater best management practices** have also been used to describe BGSI.

BGSI is typically designed and sized to capture more frequent storm events (for example, storms up to 1.5 or 2 inches) that make up most of the total rainfall in an average year, rather than extreme events that typically happen only infrequently and lead to larger drainage and flooding issues. Conveyance systems, such as pipes and pumps, are intended to address these larger events.

The focus of BGSI is the treatment and capture of stormwater runoff, therefore **BGSI is different from coastal strategies** (for example, living shorelines, dunes, mangrove plantings, and oyster or artificial reefs) that target coastal stressors like wave energy, sea level rise, and storm surges.

Why should we use BGSI?

BGSI can provide a range of both stormwater-related benefits as well as other community benefits. Stormwater benefits can include:

- Water quality improvement (more details under the next frequently asked question [FAQ])
- Groundwater recharge and replenishment of the freshwater lens under Miami Beach, helping to reduce saltwater intrusion and protect soils and tree roots from salt damage
- Some detention and flood mitigation benefits (particularly for thunderstorm-type nuisance flooding, more information follows under the FAQ “How will BGSI fit into the city’s flood mitigation strategies?”)

Other community benefits (also known as “co-benefits”) can include:

- Urban heat island mitigation
- Air quality improvement
- Climate resiliency
- Habitat creation and improvement
- Multiple other community benefits, including job creation, improved urban aesthetics, increased property values, improved pedestrian safety, and enhanced recreational spaces.

More details on the stormwater and community benefits are included in the next 3 FAQs.

What are the water quality benefits of BGSI?

Protecting water quality for Miami Beach’s beaches and waterways is a priority as they provide habitat, a great quality of life, and opportunities for tourism. Stormwater runoff from urban areas delivers pollutants—including bacteria/pathogens, nutrients (such as nitrogen and phosphorus), sediment, and heavy metals—to waterways and beaches. BGSI has been shown to reduce many of these pollutants. By

retaining rainfall, BGSI reduces stormwater discharges. Lower discharge volumes translate into reduced pollutant loads. BGSI also treats stormwater that is not retained.[1] It should be noted that BGSI can only improve the quality of the water that it receives (that is, the runoff from the drainage area that it serves) and has the capacity to treat. Therefore, extensive BGSI coverage would typically be required to have significant overall pollutant load reductions.

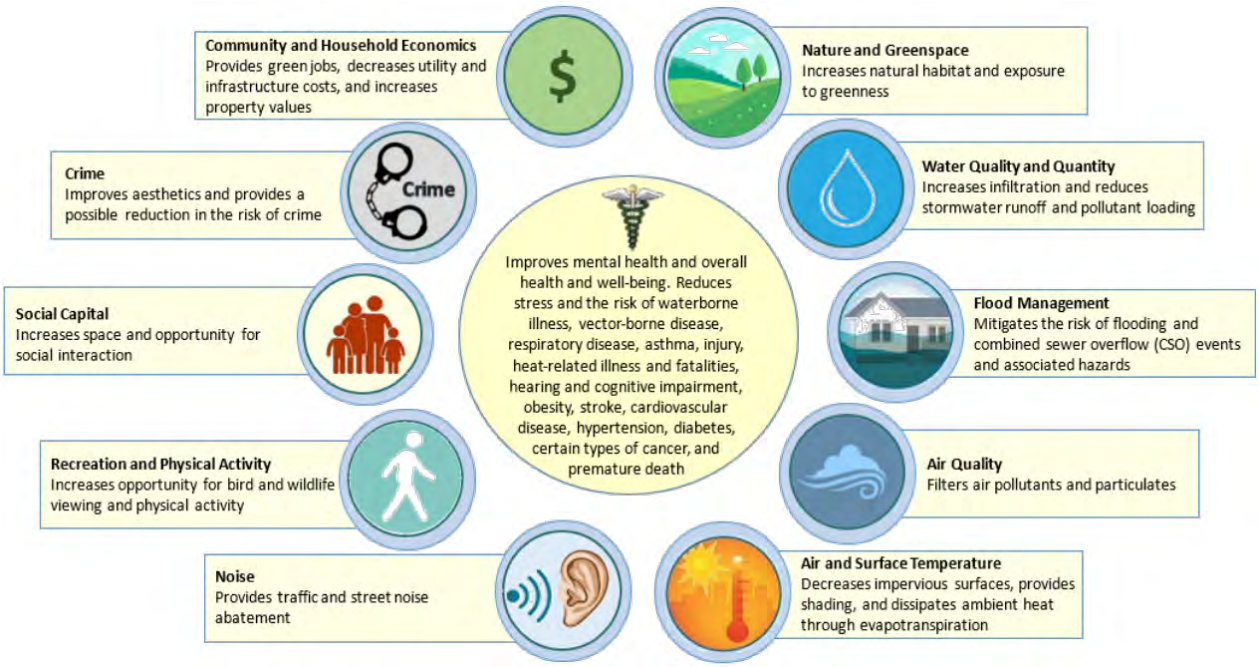
Like all infrastructure, BGSI must be designed, constructed, and maintained to function properly over the long term (for more on maintenance, see the FAQ "How does BGSI get maintained?").

How will BGSI fit into the city's flood mitigation strategies?

BGSI can complement "grey" infrastructure such as pipes and pumps. BGSI can provide some detention and flood mitigation benefits (particularly for thunderstorm-type nuisance flooding), but alone will provide little or no benefit for "sunny day" flooding resulting from king tides, flooding from major rainfall events, or flooding caused by storm surge from the Atlantic Ocean or Biscayne Bay. BGSI is typically designed for storms 2 inches or less (for the drainage area it serves), which is approximately 25 percent of the much larger storms typically used to size flood control systems, such as pipes and pumps.

What community benefits can BGSI potentially provide?

BGSI can potentially provide a suite of community benefits, as shown below in the graphic from the U.S. Environmental Protection Agency. The benefits vary significantly depending on the project location and setting, BGSI practice type(s), level of implementation, maintenance practices, etc.



Potential Environmental, Social, Economic, and Public Health Benefits of Green Infrastructure
Source: https://www.epa.gov/sites/production/files/2017-11/documents/greeninfrastructure_healthy_communities_factsheet.pdf

[1] U.S. Environmental Protection Agency. Benefits of Green Infrastructure. Accessed August 16, 2019. https://www.epa.gov/green-infrastructure/benefits-green-infrastructure

What BGSI practices are most applicable to Miami Beach?

A wide range of BGSI practice types were evaluated based on city/regional/national experience, stormwater performance, ease of implementation/maintenance, community/environmental benefits, cost efficiency, and climate change resilience. The recommended practices were determined to perform well across these areas and have potential applicability in Miami Beach given the local context (soil and groundwater conditions, land uses, development patterns, climate, etc.).

The most applicable BGSI practices are:

- Bioretention/Bioswales/Rain Gardens
- Blue and Green Roofs
- Constructed Wetlands/Floating Wetland Islands
- Detention Basins/Surface Storage
- Enhanced Tree Pits/Trenches
- Injection Wells (Pumped)[2]
- Permeable Pavement
- Rainwater Harvesting (Cisterns, Rain Barrels)
- Stormwater Planters
- Subsurface Infiltration and Storage
- Tree Canopy[3]
- 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.

What BGSI practices are less applicable to Miami Beach?

The following BGSI practices are less applicable to or less effective in Miami Beach due to their reduced water quality benefits, higher costs, lack of scalability, lower effectiveness when dealing with sea level rise and high tides, proprietary designs, limited applicability, or low storage capacities:

- Detention Tanks
- Exfiltration Trenches
- High-Flow Media Filters
- Living/Green Walls
- Gravity Wells
- Subsurface Flow Wetlands

Although not as readily applicable to Miami Beach, the above BGSI practices might still prove beneficial in certain settings.

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[2] Although not typically thought of as BGSI, injection wells are included here as they reduce the volume of stormwater discharged, and with proper pretreatment/filtration can provide water quality benefits.

[3] Trees are a key component of BGSI, and the City is developing an Urban Forest Master Plan to provide a strategic framework to guide the City in managing, maintaining, planting, and preserving its urban forest. See www.mbrisingabove.com/climate-mitigation/urban-canopy-2/urban-forestry-master-plan/.

What does BGSI look like?

BGSI can take many different forms, from landscaping elements such as rain gardens to permeable pavements that can look like normal pavements to wet ponds to blue and green roofs atop buildings. BGSI practices can vary from being dominant, high-profile features to blending in seamlessly with the surroundings. Some example images with established vegetation are provided on the next page (vegetated BGSI, like other landscaping, requires time to get established).

Where can BGSI be used?

BGSI can be used on and along roads, in parks and other open spaces, at schools and other public facilities, on rooftops, and on residential and commercial properties. Approximately 40% of Miami Beach is covered by impervious surfaces (buildings and pavements) that prevent water from soaking into the ground. BGSI should be employed to treat runoff from these impervious surfaces and help preserve, enhance, and increase the City's remaining pervious or "green" areas.

When choosing where to place BGSI practices, the following factors should be considered:

- Depending on the BGSI practice type, offsets from utilities, buildings, and other structures may be required to protect those features from water damage.
- Factors such as budget, permitting, site conditions, neighborhood preferences, and ownership will influence the location and types of BGSI.

A rendering of bioretention and permeable pavement on a typical residential street in Miami Beach

Examples of BGSI Applications

Pervious Concrete Parking Lot

Wet Pond
Source: Southwest Florida Water Management District

Rain Garden

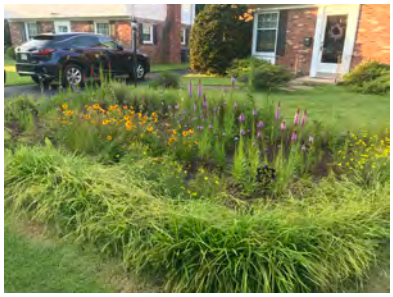
Normal (left) and Porous Asphalt (Right)

Infiltration Trench

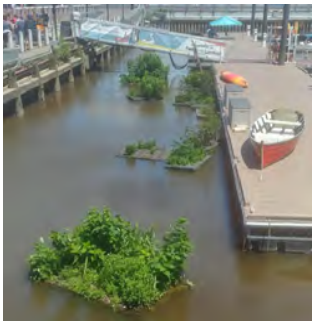
Blue-Green Roof Plaza

Green Roof (in foreground) Adjacent to Marina

Residential Rain Barrel



Residential Rain Garden



Floating Wetland Islands

Stormwater Planter

Permeable Paver Driveway

Where is the City planning to implement BGSI?

The City is planning to implement BGSI along roads, in parks and other open spaces, and at public facilities. City projects currently under design with BGSI components include Maurice Gibbs Park, Community Park (former par 3 golf course), 59th Street bioswale, and 1st Street stormwater improvements. In addition, preliminary concept renderings have been developed for the following:

- Residential street
- Commercial street
- Neighborhood park
- Miami Beach Golf Course (three scenarios)
- Collins Canal
- Street end (where a street dead ends at a waterbody)
- Garden apartments

There is also an opportunity to make policy and code changes to further encourage and/or require public and private BGSI implementation.

How will BGSI function with rising sea levels and shallow groundwater?

Shallow and increasing groundwater elevations in portions of the City limit the soil storage capacity and infiltration required for *some* BGSI practices to function effectively. However, such limitations might potentially be overcome with underdrains, fill, and/or pumping. Other practices, such as wet ponds and constructed wetlands, can continue to function with shallow groundwater although their storage capacity may be reduced as groundwater levels increase. Blue and green roofs, rainwater harvesting, and floating wetland islands would typically not be impacted by rising groundwater.

How does BGSI get maintained?

BGSI practices require a variety of maintenance activities depending on the type of BGSI and site-specific factors. Landscaped BGSI requires maintenance typical of other landscaped areas, potentially including: debris and trash removal, pruning, weeding, replanting, erosion repair, and mulching. Many BGSI practices include devices for pretreatment of runoff that require periodic sediment and debris removal. Permeable pavements require the surface to be periodically cleaned (for example, with a street cleaning vehicle) to prevent clogging.

Who will do the maintenance for BGSI?

A variety of entities may be involved in BGSI maintenance depending on the situation. In parks and at other City-owned properties, the City would likely lead the maintenance activities (either with City staff or contractors) although they may be supported by residents and businesses through volunteer efforts, “Friends of” groups, “adopt-a-BGSI” programs, neighborhood associations, etc. Along commercial streets, business improvement districts and similar groups may lead maintenance activities. On private property, BGSI maintenance would be the responsibility of the property owner/manager. Maintenance procedures and responsibilities for BGSI on residential roads are still being formulated.

Will BGSI promote mosquito breeding and the spread of disease?

If properly designed, constructed, and maintained, BGSI should not promote mosquito breeding. BGSI systems that are not intended to have prolonged ponding should typically empty within 3 days (mosquitoes require standing water to be present for greater than 7 days to grow) and should be checked frequently to ensure they are emptying as expected. BSGI that holds water for prolonged periods (for example, wet ponds, wetlands, and cisterns) must use other methods to prevent mosquito growth, such as screening, establishing a natural predator population, and/or appropriate mosquito specific larvicides.

It should be noted that mosquitos are present in Miami Beach regardless of BGSI and people should take appropriate precautions to prevent getting bitten (for information from Miami-Dade County, see www8.miamidade.gov/global/solidwaste/mosquito/home.page).

Will BGSI reduce parking?

Impacts to parking will be evaluated and discussed with stakeholders on a project-by-project basis. Some BGSI may reduce parking along streets and in parking lots if areas along them are used for vegetated BGSI. However, BGSI is often strategically located in areas where parking is not permitted already (for example, near fire hydrants and intersections) to minimize impacts to parking. In most cases there are BGSI options (for example permeable pavements) that do not reduce parking.

Will BGSI reduce recreational space?

Locations for BGSI in parks and other open spaces will be carefully considered to minimize impacts to the usage of the sites. In many cases, BGSI may serve both recreational and stormwater purposes (for example, a permeable pavement basketball or tennis court). BGSI can also enhance recreational spaces by providing additional landscape features.

What can the public do to promote BGSI in Miami Beach?

Private properties will be a key partner in the successful implementation of BGSI in Miami Beach. Residents and businesses can implement several types of relatively low-cost, low-maintenance BGSI practices on their properties, including rain gardens, trees, cisterns, and rain barrels. Property owners can also maintain, preserve, and enhance their existing green space, trees, and roadside swales. In addition, the public may be able to volunteer to help protect and maintain City-installed BGSI practices through grassroots adoption programs, if those programs are developed.

Where can I find more information on BGSI?

More information can be found at the following links/sources.

Resource	Source/Location
MB Rising Above Website	www.mbrisingabove.com
Best Management Practices for South Florida Urban Stormwater Management Systems	www.sfwmd.gov/sites/default/files/documents/bmp_manual.pdf
Florida Field Guide to Low Impact Development: Bioretention Basins/Rain Gardens	buildgreen.ufl.edu/Fact_sheet_Bioretention_Basins_Rain_Gardens.pdf
Florida Field Guide to Low Impact Development: Green Roofs/Eco-roofs	www.buildgreen.ufl.edu/Fact_sheet_Green_Roofs_Eco_roofs.pdf
Florida Department of Transportation Drainage Design Guide (Injection Wells covered in Chapter 7)	fdotwww.blob.core.windows.net/sitefinity/docs/default-source/roadway/drainage/files/drainagedesignguide.pdf
Sarasota County Low Impact Development Guidance Document	www.scgov.net/home/showdocument?id=33258
University of Florida Soil and Water Sciences Video Topics: Green Stormwater Infrastructure	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	apirs.plants.ifas.ufl.edu/site/assets/files/372369/372369.pdf

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

Appendix B
Public Outreach Summary Report

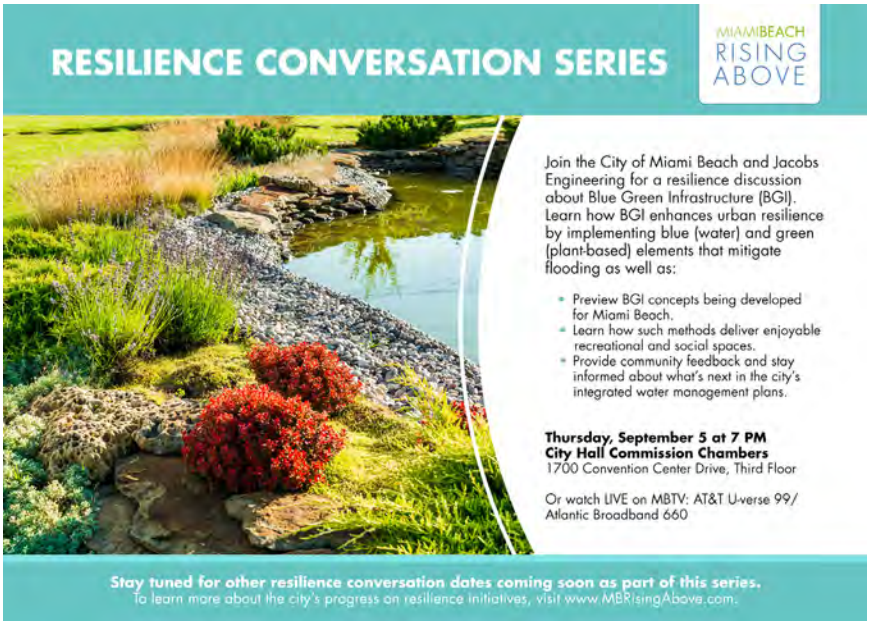
Resilience Conservation Series
Blue Green Infrastructure Public
Outreach Report
October 2019

Resilient, Integrated,
Strategic Engagement

MIAMIBEACH
RISING
ABOVE

Table of Contents

MEETING NOTICES



Initial Meeting

Rescheduled Meeting

WEBSITE PROJECT PAGE

EVALUATING BLUE-GREEN INFRASTRUCTURE

HOME > CITY HALL > PUBLIC WORKS > COMMUNITY OUTREACH > EVALUATING BLUE-GREEN INFRASTRUCTURE

UPDATE: On Tuesday, January 21, 2020, the City held its second resilience conversation meeting. Click here to download the meeting presentation.

In April 2019, the City of Miami Beach contracted Jacobs Engineering in a three-task workorder. The first task focused on evaluating blue-green infrastructure (BGI) to advance a more holistic living with water approach.

As part of the City's Resilience Conversation Series, on September 17, 2019 Jacobs Engineering engaged with the public to present BGI possibilities applicable to the City of Miami Beach.

The presentation illustrated how BGI enhances urban resilience by implementing blue (water) and green (plant-based) elements that help mitigate flooding, as well as:

- depicted how such methods deliver enjoyable recreational and social spaces;
- provided various renderings of BGI concepts designed for Miami Beach;
- offered a forum to facilitate community feedback.

Stay tuned for future public meetings to discuss tasks 2-3 of the workorder.

Download the meeting presentation: Jacobs Engineering Presents Blue-Green Infrastructure CMB

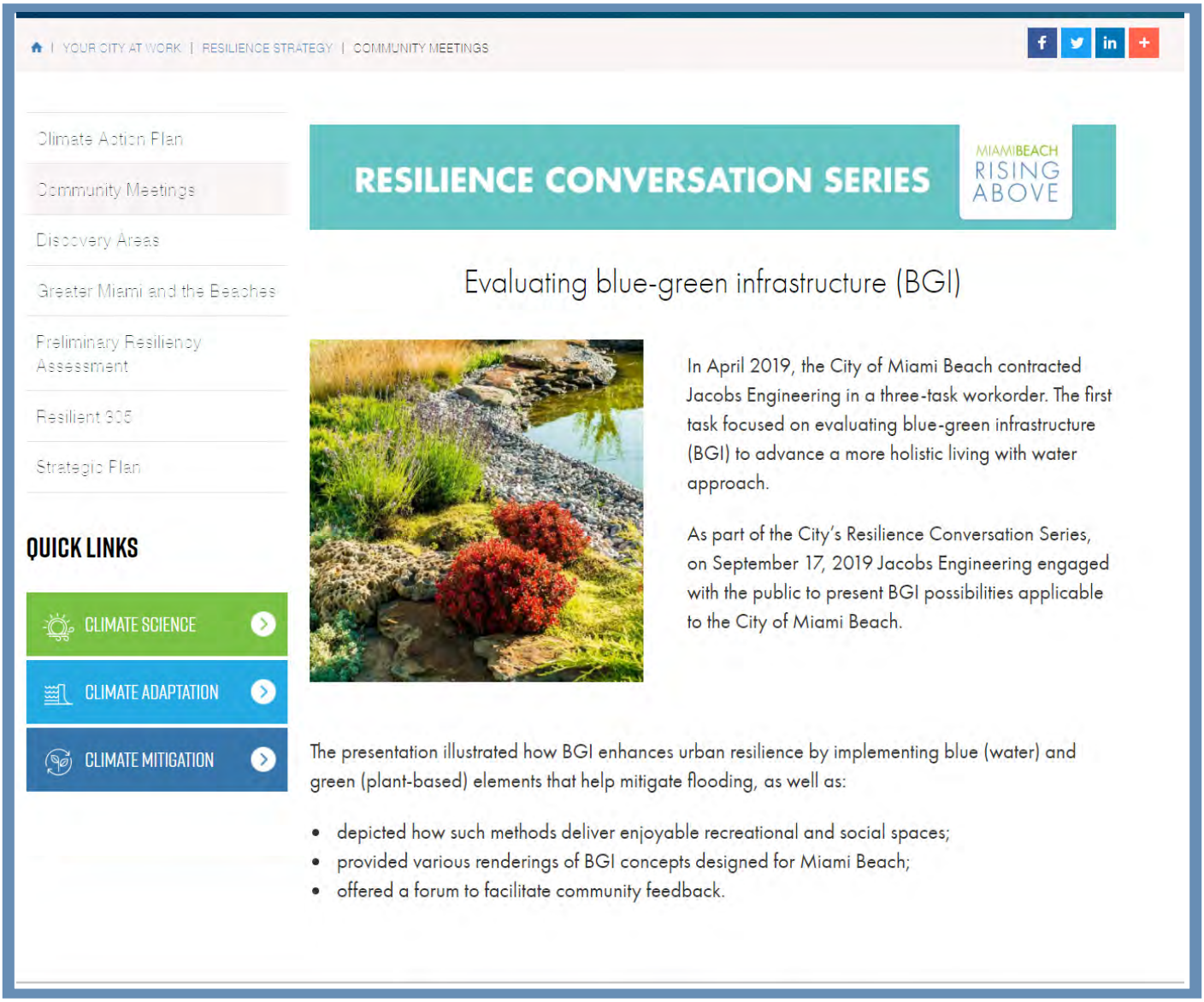
Review the BGI renderings: What is possible with BGI – Boards

Topic Q&A: BGI Q&A

https://www.miamibeachfl.gov/city-hall/public-works/community-outreach/evaluating-blue-green-infrastructure/

Resilience Conversation Series
Blue Green Infrastructure

MIAMIBEACH RISING ABOVE



http://www.mbrisingabove.com/your-city-at-work/resilience-strategy/community-meetings/

COMMUNITY OUTREACH

Every Door Direct Mail
Email Blast
Social Media Posts
Advertisement
Door-to-Door Photos

Resilience Conversation Series
Blue Green Infrastructure

MIAMIBEACH RISING ABOVE

Every Door Direct Mail (EDDM) - 59,000 residents in Miami Beach

LEARN MORE ABOUT BLUE & GREEN INFRASTRUCTURE

For the City's Stormwater Management Program

Join the City of Miami Beach and Jacobs Engineering for a discussion on Blue & Green Infrastructure (BGI) to advance a more holistic living with water approach. Learn how BGI enhances urban resilience by implementing blue (water) and green (plant-based) elements that mitigate flooding as well as:

- Preview BGI concepts being developed for Miami Beach.
- Learn how such methods deliver enjoyable recreational and social spaces.
- Provide community feedback and stay informed about what's next in the city's integrated water management plans.

Thursday, September 5 at 7 PM
City Hall Commission Chambers
1700 Convention Center Drive, Third Floor

Or watch LIVE on MBTV
AT&T U-verse 99/ Atlantic Broadband 660

For more information on the city's resilience initiatives, visit www.MBRisingAbove.com.
Stay tuned for upcoming resilience conversations.

CONOZCA MÁS SOBRE LA INFRAESTRUCTURA AZUL Y VERDE

Para el Programa de Manejo de Aguas Pluviales de la Ciudad

La Ciudad de Miami Beach y Jacobs Engineering le invitan a participar en una conversación sobre la Infraestructura Azul y Verde, conocida en la industria como BGI. Aprenda cómo BGI mejora la resistencia urbana al cambio climático mediante la implementación de elementos azules (agua) y verdes (basados en plantas) que mitigan las inundaciones:

- Vista previa de los conceptos de BGI que se están desarrollando para Miami Beach.
- Aprenda cómo estos métodos proporcionan una experiencia agradable, con espacios recreativos y sociales.
- Proponga su opinión sobre estos proyectos de la comunidad y permanezca informado sobre los próximos pasos en los planes integrados de la ciudad para la gestión del agua.

Jueves, 5 de septiembre a las 7 PM
Cámaras de la Comisión del Ayuntamiento
1700 Convention Center Drive, Tercer Piso

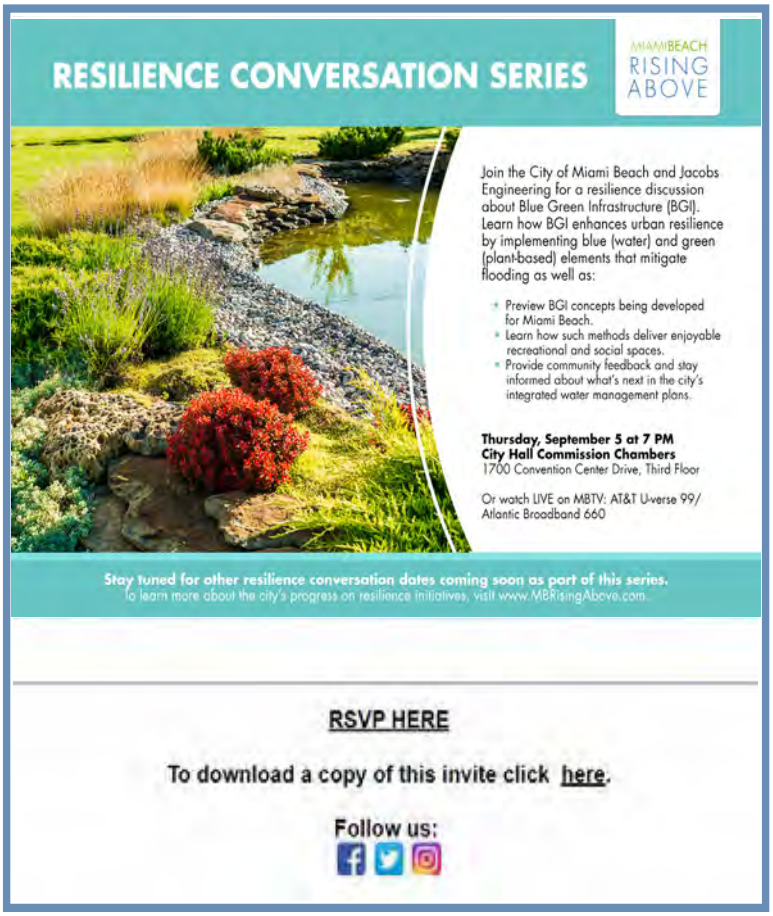
O vea el evento en vivo por MBTV
AT&T U-verse 99/ Atlantic Broadband 660

Manténgase al día sobre las próximas conversaciones con la comunidad. Para más información sobre las iniciativas de resiliencia de la ciudad, visite: www.MBRisingAbove.com.

Resilience Conversation Series
Blue Green Infrastructure

MIAMIBEACH RISING ABOVE

Email Blast - Constant Contact



Eblast sent on 08/13/2019 - "You're Invited"
Eblast sent on 08/26/19 - "You're Invited"

Eblast sent on 09/03/2019 - "Date Changed"
Eblast sent on 09/05/2019 - "Date Changed"
Eblast Sent on 09/12/2019 - "Reminder"
Eblast sent on 09/16/2019 - "See you Tomorrow"

Resilience Conversation Series
Blue Green Infrastructure

MIAMIBEACH RISING ABOVE

Email Blast - City of Miami Beach

Join the City of Miami Beach and Jacobs Engineering for a resilience discussion about Blue Green Infrastructure (BGI). Learn how BGI enhances urban resilience by implementing blue (water) and green (plan-based) elements that mitigate flooding as well as:

- Preview BGI concepts being developed for Miami Beach.
- Learn how such methods deliver enjoyable recreational and social spaces.
- Provide community feedback and stay informed about what's next in the city's integrated water management plans.

Thursday, September 5 at 7 PM
City Hall Commission Chambers
1700 Convention Center Drive, Third Floor

Or watch live on MBTV:
AT&T U-verse: Channel 99 | Atlantic Broadband: Channel 660

Stay tuned for other resilience conversation dates coming soon as part of this series.

VISIT MIAMIBEACHFL.GOV

Eblast sent on 08/12/2019 - "Save the Date"

Due to Hurricane Dorian, we have had to postpone this meeting that was initially scheduled for this Thursday, to **Tuesday, September 17 at 6:30 p.m.**

Join the City of Miami Beach and Jacobs Engineering for a discussion on Blue & Green Infrastructure (BGI) to advance a more holistic living with water approach. Learn how BGI enhances urban resilience by implementing blue (water) and green (plant-based) elements that mitigate flooding as well as:

- Preview BGI concepts being developed for Miami Beach.
- Learn how such methods deliver enjoyable recreational and social spaces.
- Provide community feedback and stay informed about what's next in the city's integrated water management plans.

Tuesday, September 17 at 6:30 PM
City Hall Commission Chambers
1700 Convention Center Drive, Third Floor

Watch live on MBTV
AT&T U-verse: Channel 99 | Atlantic Broadband: Channel 660 or visit:
miamibeachfl.gov/government/mbtv/ to stream online.
Stay tuned for other resilience conversation dates coming soon.

VISIT MIAMIBEACHFL.GOV

Eblast sent on 09/11/2019 - "Resilience Discussion"

Social Media Posts

Posted on August 12, 2019 - Facebook

Posted on August 19, 2019 - Facebook

Posted on August 19, 2019 - Twitter

Posted on August 22, 2019 - Facebook

Resilience Conversation Series
Blue Green Infrastructure

Posted on August 22, 2019 - Twitter

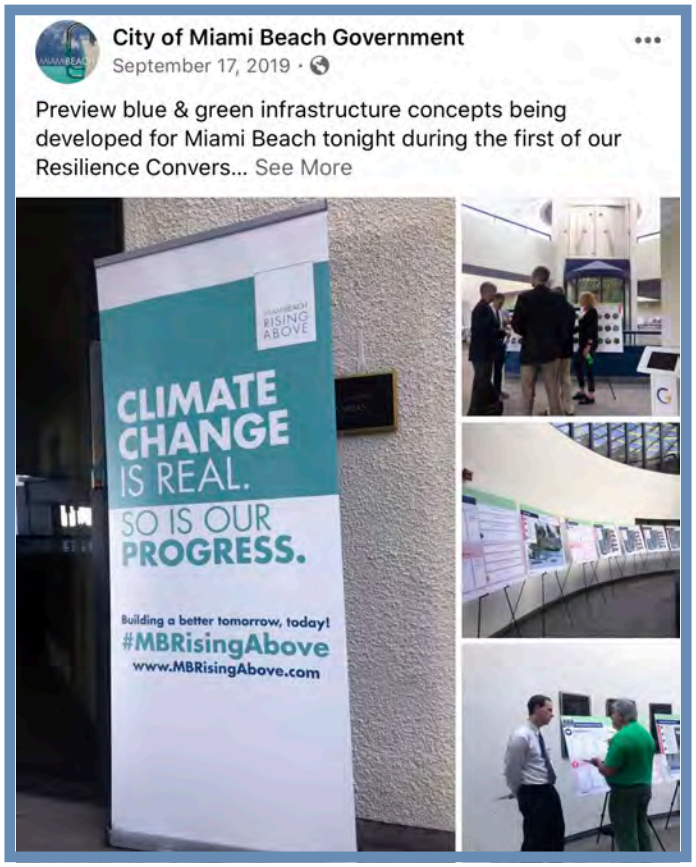
Posted on September 9, 2019 - Twitter

Posted on September 10, 2019 - Facebook

Posted on September 16, 2019 - Twitter

Posted on September 17, 2019 - Twitter

Posted on September 17, 2019 - Facebook



Posted on September 17, 2019 - Facebook

Weekly Meeting Notices Ad for the Week of September 16 - 20, 2019
Miami Herald

MEETING NOTICES

September 16 - 20, 2019

MONDAY, September 16

8:30 a.m.	Design Review Board*	Commission Chamber 3rd Floor, City Hall
6:00 p.m.	Health Advisory Committee	City Manager's Large Conf. Room, 4th Floor, City Hall

TUESDAY, September 17

9:30 a.m.	Art in Public Places Committee	TCED Conf., Room, 5th FL. 1755 Meridian Avenue
3:30 p.m.	Disability Access Committee	City Manager's Large Conf. Room, 4th Floor, City Hall
5:00 p.m.	Affordable Housing Advisory Committee	Housing & Comm. Services Conf., Room, 555 17th Street
5:00 p.m.	Animal Welfare Committee (Pets Allowed)	Mayor's Conference Room 4th Floor, City Hall
6:00 p.m.	Police/Citizens Relations Committee	MBPD Community Room 1100 Washington Avenue
6:30 p.m.	Blue/Green Infrastructure for the City's Stormwater Management Program	Commission Chamber 3rd Floor, City Hall

WEDNESDAY, September 18

8:30 a.m.	Ad Hoc Inspector General Selection Committee	City Attorney's Conf., Room 4th Floor, City Hall
9:00 a.m.	Land Use and Development Committee**	Commission Chamber 3rd Floor, City Hall
6:00 p.m.	Miami Beach Smart City Street Lighting Design Standards Public Meeting	Miami Beach Regional Library 227 22nd Street

THURSDAY, September 19

8:30 a.m.	City of MB Fire & Police Officer's Pension Board	Fire & Police Pension Office Suite 355, 1691 Michigan Av.
9:00 a.m.	Special Master Hearings*	Commission Chamber 3rd Floor, City Hall
3:00 p.m.	Audit Committee	Parking Dept., Conf., Room 2nd FL., 1755 Meridian Ave.
5:00 p.m.	General Obligation (G.O.) Bond Oversight Committee	City Manager's Large Conf. Room, 4th Floor, City Hall

FRIDAY, September 20

8:00 a.m.	Finance and Citywide Projects Committee**	Commission Chamber 3rd Floor, City Hall

For any and/or all of the above meetings, one or more members of the Miami Beach City Commission, and or City board/committee members may be in attendance and participate in discussions.

* Aired live on MBTV: AT&T U-verse 99, Atlantic Broadband 77,Digital 90 & 107.3

** Commission Committee Aired Live on MBTV

No. 0003997528-01

MIAMIBEACH

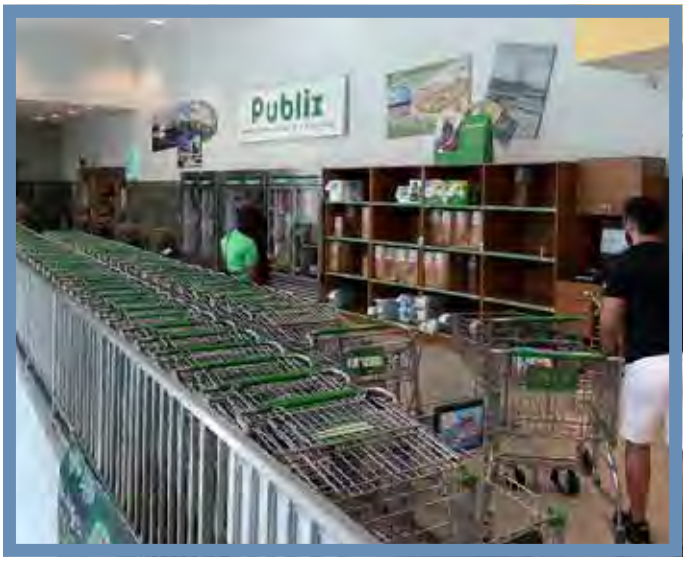
We are committed to providing excellent public service and safety to all who live, work and play in our vibrant, tropical, historical community.

Members of the public may present audio/visual (AV) materials relating to Agenda Items at televised meetings held in the Commission Chamber by utilizing the City's AV equipment, provided that materials are submitted to the Department of Marketing and Communications by 8:30 A.M., one (1) business day prior to the meeting. Advance submittal of a presentation will allow the Communications Department to plan for the use of the appropriate AV equipment. AV materials may be submitted via email at communications@miamibeachfl.gov; or hand delivered in a jump drive, CD or DVD to: Attention: Department of Marketing and Communications, 1701 Meridian Avenue, Fifth Floor, Miami Beach, FL 33139. Presentations, videos or links must include a label noting the name or group, contact person, daytime telephone number, email address, description/title of the presentation and Agenda Item Title as well as the Agenda Item number. Acceptable formats for electronic submission are .pdf, .ppt, .pptx, .pps, .ppsx, .wmv, .avi and .mov. (Note that .pdf is the preferred format for PowerPoint presentations.)

City Hall is located at 1700 Convention Center Drive; and the Miami Beach Convention Center is located at 1901 Convention Center Drive. Any meeting may be opened and continued, and under such circumstances, additional legal notice will not be provided. To request this material in alternate format, sign language interpreter (five-day notice required), information on access for persons with disabilities, and/or any accommodation to review any document or participate in any City-sponsored proceedings call 305.604.2489 and select 1 for English, then option 6; TTY users may call via 711 (Florida Relay Service). A meeting not noticed in the Weekly Meeting Notice ad and determined to be an emergency meeting will be posted on the bulletin boards throughout City Hall and will be available on the City's website at: **http://web.miamibeachfl.gov/cityclerk/default.aspx?id=1776**

Pursuant to Section 286.0105, Fla. Stat., the City hereby advises the public that if a person decides to appeal any decision made by the board, agency, or commission with respect to any matter considered at such meeting or hearing, he or she will need a record of the proceedings, and that, for such purpose, he or she may need to ensure that a verbatim record of the proceedings is made, which record includes the testimony and evidence upon which the appeal is to be based.

Door-to-Door Photos




Manolo
FAMILY
STYLE
RESTAURANT


PUBLIC MEETING

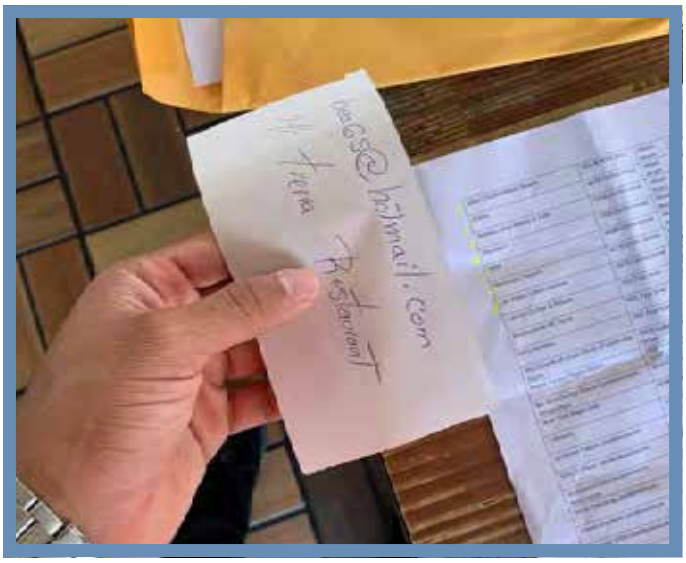

IHOP
YORDANKA YEAR


NORMAN'S
AMERICAN BAR & GRILL


Las Vegas
WE CATER
PARTIES
URBAN CUISINE
Email: comments@lasvegascubancuisine.com
www.LasVegascubancuisine.com

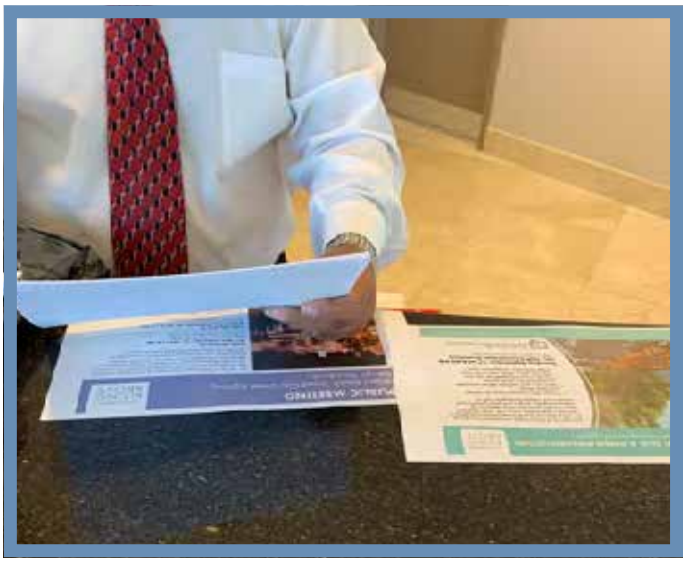

PUBLIC MEETING
RISING ABOVE


251
OPEN

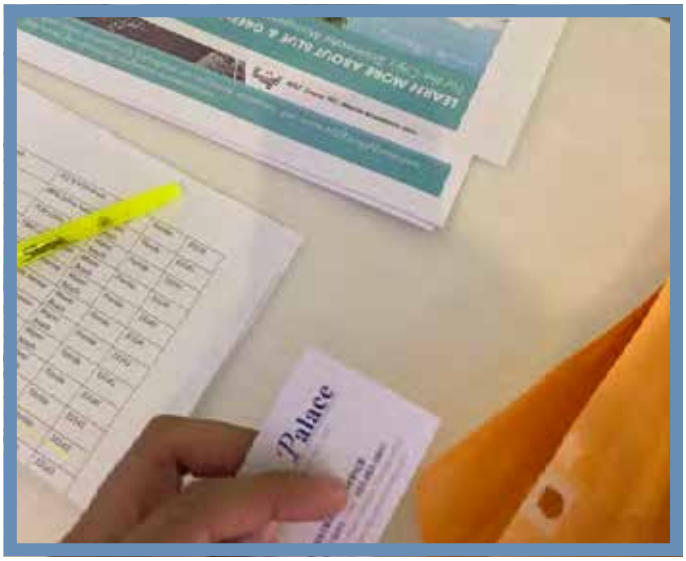



LA FAMILIA
MI Colombia
"The hunger for love is much more difficult to remove than the hunger for bread." Pls
Mother Teresa
Check us out on these review sites
PEOPLE LOVE US ON
yelp
tripadvisor


Elaine Roden
Executive Director
MIAMI BEACH ROWING CLUB
Miami Beach Watersports Center
6500 Indian Creek Drive, Miami Beach FL 33141
305.861.8876
Elaine@rowmiamibeach.com
rowmiamibeach.com
@rowmiamibeach
@miamibeachrowingclub

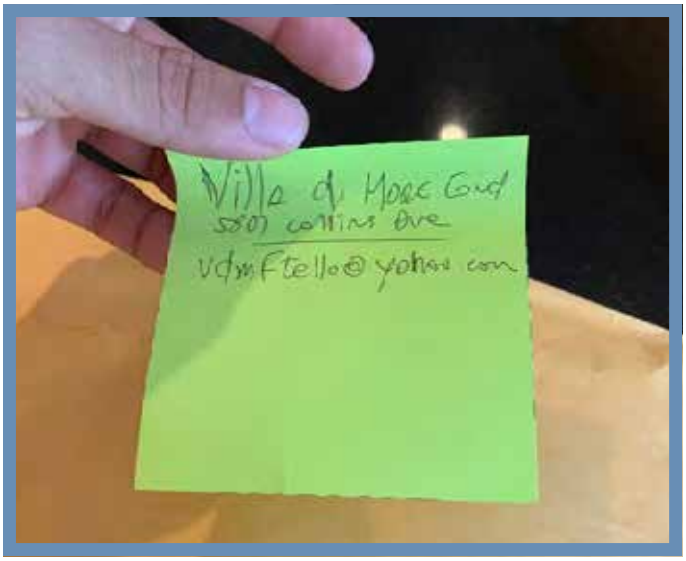



ANIANA PAGAN, LCAM
Community Association Manager
6515 Collins Ave
Miami Beach, FL 33141
TEL 305.866.4804
FAX 305.865.7152
Bel Aire
on the ocean
BEL-AIRE ON THE OCEAN CONDOMINIUM ASSOCIATION


Palace


La Gorce Palace
CONDOMINIUM ASSOCIATION
ADMINISTRATIVE OFFICE
Office 305.867.1665 | Fax 305.865.0657
6301 Collins Avenue Miami Beach, Florida 33141


PUBLIC MEETING


Villa di Mare Condo
5801 Collins Ave
vdmftello@yahoo.com

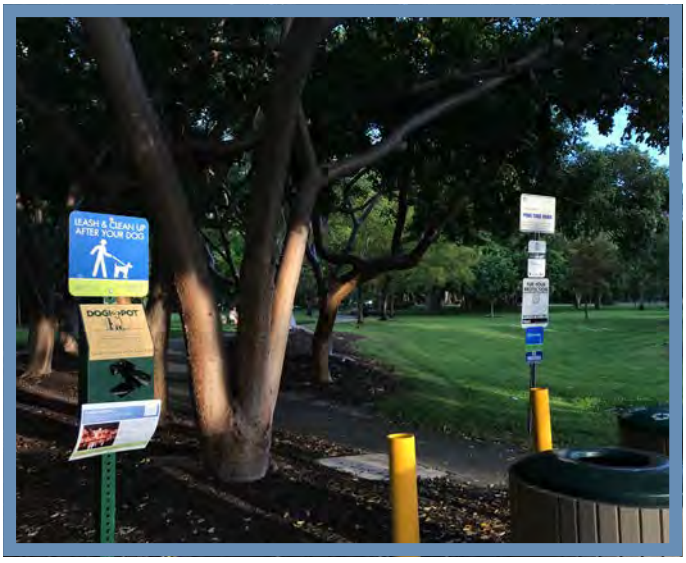

Royal Embassy Condominium Association, Inc.
www.royalembassymb.com
Sheebra Brown
Property Manager, LCAM
Sheebra.royalembassy@gmail.com
5750 Collins Avenue
Miami Beach, FL 33140
Office (305) 868-3488
Fax (305) 397-1445

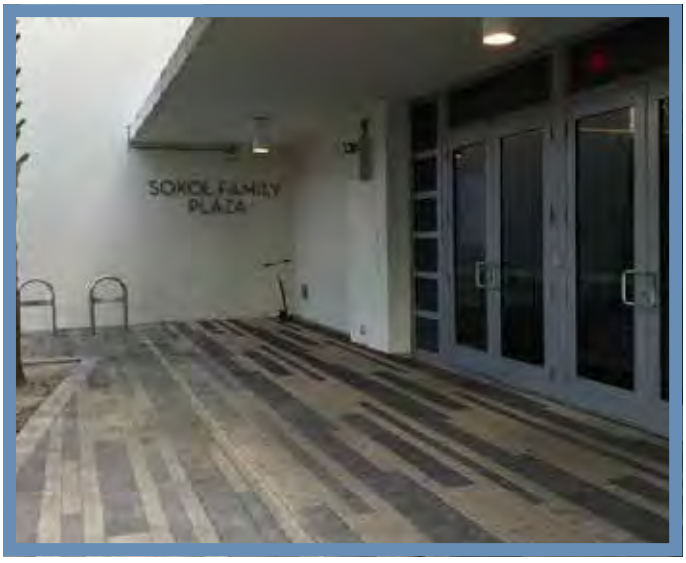

PUBLIC MEETING


SEACOAST
5700
Jhoanne Dorce
PROPERTY MANAGER
SEACOAST 5700
CONDO ASSOCIATION
5700 Collins Avenue
Miami, Florida 33140


PUBLIC MEETING


XIMENA LAMA, LCAM
Property Manager
5601 Collins Ave. CU10
Miami Beach, FL 33140
TEL 305.861.4600
FAX 305.861.0430
Pavilion
Pavilion Condominium Association, Inc.


LEASH & CLEAN UP AFTER YOUR DOG
DOG POT

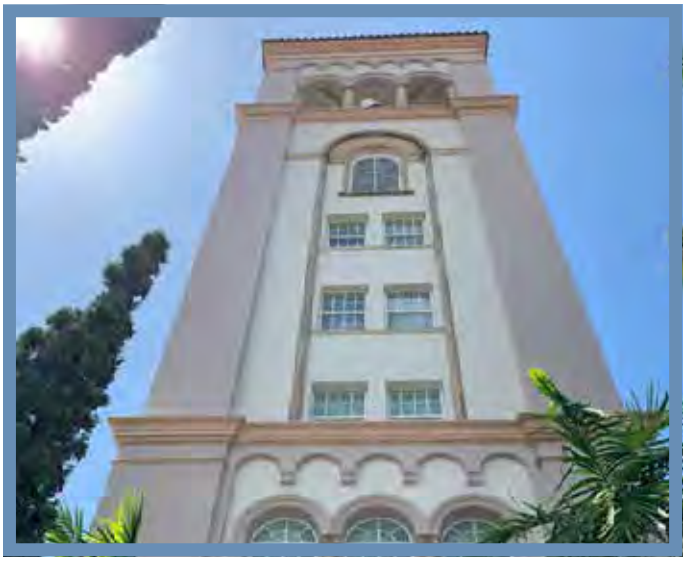

SOKOL FAMILY PLAZA


SUCCESS UNIVERSITY
SAFE
MIAMIBEACH
POLICE


GO


BUSES ONLY
SCOTT RAKOW YOUTH CENTER


SOKOL FAMILY PLAZA




ANATOM
1220


Publix


BAY CLUB


SWEAT 440

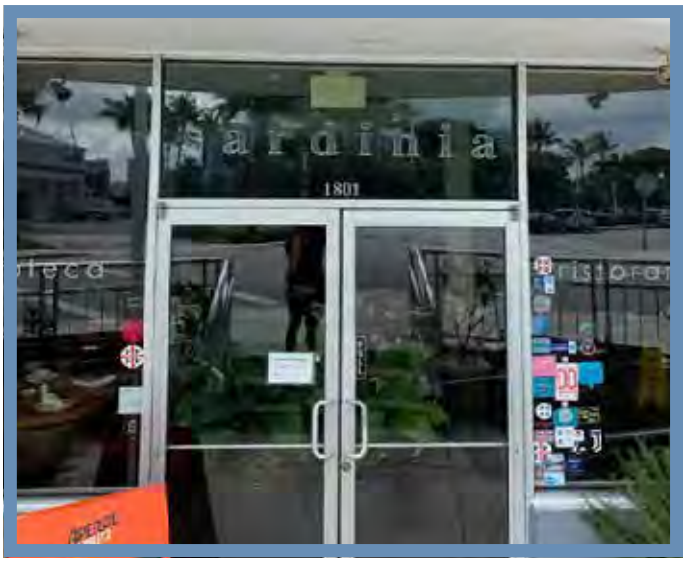

1894


1884
TeQuiztlán


PANTHER


ICE
BOX
CAFE


1845


Sardinia
1801


THE HEALTH COMPANY
Dr SMOOD
ART FOOD FOR A GOOD MOOD


RADER JOE'S

PUBLIC MEETING

Summary
Sign-in Sheets
Comment Cards
Social Media Posts
Photos

Discussion Briefing Summary

September 17, 2019 | 6:30 p.m.
City of Miami Beach City Hall Commission Chambers 1700
Convention Center Drive, Miami Beach, FL 33139

Staff:
Jacobs Engineering
Infinite Source Communications
City of Miami Beach Staff
See the attached sign-in sheets for attendees

Key items Discussed:

- Mayor Dan Gelber started the presentation giving a brief introduction of what the City of Miami beach plans were regarding the project. He also introduced Jacobs Engineering and explained the overall goal of the briefing.
- The Public Works Director Roy Coley explained the purpose of the briefing, which was to review Blue and Green infrastructure. He also mentioned that the overall goal was to obtain public opinion, thoughts, and questions regarding the topic.

Presentation:

- Matt Alvarez of Jacobs Engineering introduced each team member and gave a project overview stating that together they evaluated all the possible options for Blue and Green Stormwater Infrastructure (BGSI) and looked at which of these options were most applicable in Miami Beach.

- The Jacobs Engineering team presented each slide and provided a detailed explanation on each topic, as well as encouraging feedback from the audience.

  - What is BGSI?
  - The following topics where discuss during the presentation
  - Why should we use BGSI?
  - What are the water quality benefits?
  - How will the BGSI fit into the city's flood mitigation strategies?
  - Community (Co-Benefits) of BGSI.
  - What BGSI practices are less applicable to Miami Beach?
  - What BGSI practices are most applicable to Miami Beach?
  - What does BGSI look like?
  - Where can BGSI be used?
  - Where is the city planning to implement BGSI?
  - Preliminary concepts for:
    - Residential street
    - Collins canal

- Commercial Street
- Neighborhood park
- Street ends
- Miami Beach Golf course
- Garden Apartments

- Will BGSI reduce parking?
- Will BGSI promote mosquito breeding?
- Where can the public do to promote BGSI in Miami Beach?
- What are the next steps?

- Resident, Louise Bauer, stated that she would like to propose a solution that will be beneficial to the residents as well as to the City. She mentioned that the city had a violation on her neighborhood with Miami-Dade County on April 11, 2019 and that five months passed, and they still have not received a detailed response. Ms. Bauer said she feels that it is fair for all neighborhoods to finish the projects that started and after she will be in favor of advancing with future projects. She also stated that she is interested in Blue and Green infrastructure, but that she would like the City to first complete construction in her neighborhood and all other neighborhoods.

- Resident, Lizette Hassell, asked if the team also speaking with condos and hotels to have them look at what they can contribute. Ms. Hassel also asked how these proposals can be incorporated at a condominium or a hotel.
  - Public Information Officer, Ms. Monica Diaz, responded that part of the outreach process discussed is that there will be a series of opportunities, one-on-one meetings, briefings and also public meetings where they will be able to address these topics and also meet with stakeholders to make sure everybody is aware of these practices.
  - Mr. Andy Potts of Jacobs Engineering stated that as part of the project plan they will have residential strategies with property owners and businesses. The team is also looking at potential opportunities to improve policies to encourage implementation on private properties.

- Resident, Lily Furst, asked who was going to be responsible for the maintenance of the rain gardens at the street ends. She also inquired if in the case the residents have saltwater intrusion, would that type of vegetation be able to handle saltwater, and if the plants will survive. Furthermore, Ms. Furst also asked how the team will get developers to implement the green roofs and all options into their projects.
  - Mr. Potts responded that maintenance is highly essential, the specific maintenance procedures are not set at this stage, but he explained that there will be a variety of entities and techniques that will help with the maintenance.
  - A Jacobs team member added that on the outside of the room there where different boards, which display different vegetation options that are applicable for Miami Beach, which can survive the climate conditions of the City.
  - Ms. Furst asked if there would be any flowers?
    - A Jacobs team member responded that there would be a few, but these gardens were going to be less flowering.

- Resident, Gary Martinez, stated that it would be helpful to get a better idea on how this project is related to the Miami Beach's overall efforts both in terms of infrastructure and conditions of cost. He inquired what would happen to this project, for example, if there was a storm surge, and if it would be able sustain some of the other treats that might be part of the environment. Mr. Martinez inquired if the residents are considering spending money on the project, how this would fit cost-wise, and what else should be considered in balancing the total cost.
    - Mr. Potts responded that there are things that are going through an evaluation process, but in terms of costs, there are ways cost can be reduced by integrating other improvements such as the Capital Improvement Projects that are currently going on. This often is very cost-effective and improves green strategies as part of those ongoing projects. He stated that in addition to costs, the City is also looking to the values that it brings.
    - Mr. Potts referenced the storm surge and stated that BGSI should be designed with this in mind although some damage would likely occur as it would to other landscaped systems and maintenance protocols will need to be developed for restoring systems after surge events.

- Resident, Glenna Norton, asked if the bioswales and rain gardens that the team are proposing encourage mosquitos, and how will this mosquito growth be prevented. Ms. Norton also asked how the high grasses and plants will impact the environment in terms of security, since this will probably encourage wildlife that can be attracted to this vegetation.
    - Mr. Potts responded that all the different projects that are being proposed are something that needs to be designed appropriately, so it will not create that type of environment. For example, if a system is meant to be dry most of the time, we must make sure it is working correctly, and that water leaves the surface within three days, so the mosquitos cannot grow. He further explained that the environment in more significant systems will generate or establish natural predators that will control mosquito growth.
    - Ms. Jade Paul of Jacobs Engineering added that these systems do get some predators or critters that will take care of the mosquitos.
    - Ms. Norton asked what a critter is.
    - Ms. Paul explained they are wildlife native to South Florida.

- Resident, Michael Laas, asked how this will evolve overtime and how this infrastructure will grow as things move up regarding the built environment, as well as the actual infrastructure itself.
    - A Jacob Engineering team member explained that the purpose is to integrate this project into the resident's decision making, into the planning and overall capital improvement program, as well as in existing processes that are currently established. This is not something that will typically stand alone, it is something that will be integrated.

- Resident, Robert Kunst, mentioned that he is the president of We Love Lakeview Inc., and he stated that he was unhappy with the fact that they are meeting there for the first time on that level. Mr. Kunst said they asked several times to comply with the team before and to answer several questions on how the residents will deal with these issues. He also stated that for a year and a half, the City planned to initiate work in their neighborhood to have the streets raised even though their streets do not flood. He said the team needs to have real meetings with all the neighborhoods in the community, and he suggested that there should not be any rush decisions.
    - Mr. Joe Rozza of Jacobs Engineering explained that the whole purpose of Blue and Green infrastructure is to protect the environment. Mr. Rozza also mentioned that they are currently going through the process of getting feedback from the community and trying to create a vision of what is possible. He stated that what they are putting together now is a series of good practices that should be applied in the context of Miami Beach.

- Resident, Jeff Bercow, mentioned it floods by his house, down the street and most parts of his neighborhood. He would like to know if there is an opportunity within the design criteria management to also address the aging and deteriorating underground infrastructure on a neighborhood by neighborhood bases.
    - Mr. Potts responded that he could not give a specific answer at that stage, but he believes that the City is planning to address neighborhood needs comprehensively.

- Resident, Peter Luria, stated the city has a history of not listening to residents. The massive destruction of the mature tree canopy across the island and the main roads among Collins Canal and Indian Creek are prime examples of the City's substantial focus on engineering solutions and dismiss residents' concerns about the need to protect and enhance green infrastructure and help improve stormwater management. He expressed his concern that Jacobs engineering is repeating this behavior by refusing to listen to the Lakeview residents. He further stated that keeping the streets dry by pumping stormwater into Biscayne Bay and polluting this natural resource and economic engine of the local economy is misguided and short-sided. He continued by stating that the Blue and Green infrastructure discussion needs to address how to minimize harm to the environment. This does not resolve from the City resiliencies efforts. He stated that he is counting on the BGSI plan also to include a recommendation to averse the existing Miami Beach landscape order in section 126-16, requiring the adjacent property owner to be responsible to maintain trees. He also asked why Miami Beach was the only city in Miami Dade and Broward counties that does not keep the trees in their right-of-way. Planting large canopy trees in the right-of-way and requiring the adjacent property owners to be responsible for their maintenance is counter-productive for implementing and maintaining the healthy tree canopy. He stated this is a critical component of any action plan. Residents want to make sure that the city learns from their past mistakes.

- Resident, Ben Mosthoff, stated that over the past five years, Biscayne Bay's entire ecosystem has transformed, and it is now dying, and stormwater is a contributing factor. He explained that Miami Beach should be serving as a role model for stormwater management. It is not sustainable and not blue; there should not be any discharge of stormwater in the Bay.

- Resident, Jennifer Kaiser asked what the overall cost was, and she stated there was not a budget presented. Ms. Kaiser also mentioned that the City has already the highest taxes and she asked if there was a possibility to create a volunteer maintenance program where the community can give back; that way the taxes do not need to go up. She also asked how long the project would take from start to finish and if they are planning to remove any trees.
    - Mr. Rozza of Jacobs Engineering responded that there should be an understanding of the relationship between cost and value because sometimes there is a need to focus on the value of things. Most of these issues relate to understanding the full picture of cost and benefits.
    - He further explained, in terms of how long this will take, and stated it is about going back to the process. He mentioned that they were on the stage of just bringing ideas, practices, and implementation strategies and trying to get a sense of what is going to work best in Miami Beach. The next step would be the design criteria packages, and that is when the ideas and concepts become specific. The transformation will happen over a long period, looking at gradual change, and as this evolves, the community will be able to see the benefits.
    - Ms. Paul of Jacobs Engineering added the goal is certainly to preserve as many trees as is feasible. She also mentioned they will perform an assessment to determine the quality of the tree. She explained saving a diseased tree would not be worthwhile at times.

- Resident, Alexander Zastera, stated that there would be a level of discomfort when it comes to some of the things residents are going to have to take on, but they are investing in the future.

- Resident, Alec Jimenez, asked how long a project like option two and option three for the Miami Beach Golf Course would take to be completed.
    - Mr. Matt Friesen of Jacobs Engineering responded that there are different factors to consider, but he stated that realistically they are looking at an approximately 10-year period.

- Resident, Rick Kendle, asked what the average cost of a bio-swale is. Moreover, he also asked how sea-level rise would be fixed when politicians dictate where sea level projects should be done.

- Resident, Chi-Chi Truong, asked if there was a possibility of a more permanent groundwater management solution or if the intent is that the vertical development will out phase sea level rise. Mr. Truong also asked if the team is looking at other storm events as well such as cloud bursts, because that happens a lot and he wants to know if the Blue and Green strategies can handle its capacity.
    - A Jacobs Engineering team member responded that in terms of the cloud burst events, the team is looking at those and completed an analysis over the County on how storms are projected to intensify or change over time, and it would be considered as part of the project. In terms of groundwater management, there is a variety of options to maintain that separation from the ground over time.

- Resident, Abraan Gonzalez, stated that there are a large amount if problems for the residences and that in every neighborhood they will be assessing, people are living in these problems every day. Most importantly, the result will impact these people's lives and their quality of life. He encouraged the team to include the residents in the process.
    - Ms. Paul responded by stating that reaching the residents will be part of the next steps because they want the input from the community.

- Resident, Ebru Ozer, stated that her comments would be related to the education component related to the project. She asked if they are considering an educational facility or school ground component, where one can also integrate this, because most of the problems that the community is seeing here today are because of the lack of education, no signages or perspectives. She added that the team should make this visible for the community. Ms. Ozer proposed school grounds to allow easy maintenance and monitoring, and she also asked how these projects would be monitored.
    - Ms. Paul responded that there are amazing opportunities to integrate Blue and Green to school grounds.
    - A Jacobs Engineering team member responded that they love the idea of education to create awareness; there is also an excellent opportunity to involve universities and conservation organizations.

- Resident, Jonathan Welsh, stated that he looks forward to working on this project with the team because it is the future.

- Resident, Francois Monot, stated that as a resident, he does not want streets torn down and raised. He believes it is a bad project that will not be helpful. He also mentioned that it looks like the is going forward with the project without consulting all the residents.
    - A Jacobs Engineering team member responded that the Blue and Green infrastructure does provide some flood relief and it also offers many water quality benefits. There is a cost associated with this benefit, but it can be very valuable.

- Resident, Dave Duebuer, stated he was very excited with the project because of the water quality benefits. However, there are some concerns about the current designs of pump stations and infrastructure. He asked if there was an opportunity to investigate ways on how it might be able to build additional Blue and Green infrastructure into the pump stations.
    - Mr. Potts responded that there are opportunities and that the team will be looking at those.

The Public Information Officer Ms. Diaz thanked the participants for attending the meeting and participating, and she encouraged them to continue providing feedback on the boards outside the room.

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Blue Green Infrastructure Discussion

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Lauren Seg.n	Self		
Randolph Gumerick	Self		
Staci Kanter	Self		
Rachel Cohen	Commissioner Higgins	(786) 747-2321	rachel.cohen@miamidade.gov
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David Ettman	Biscayne Env / self	305.710.2359	

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NIGEL/GLENNA NORTON	HOME OWNER	305 975 2975	GSN5252@AOL.COM
PAUL DEANGELI	home owner	305-613-7982	P.DEANGELI7@gmail.com
DAVE DOEBLER	SUSTAINABILITY CMTE & VOLUNTEERCLEANUP.ORG	954-415-7434	dave.doebler@gmail.com
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Nicole Florin	[redacted] self	786-512-9214	nflorin@florinlaw.com
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Beatriz Alchalaby	self	(3) 804-9191	balch001@fiu.edu
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Donna MacDonald	President	305 864 8098	
Misael Soto	Resident		
Erick Chioles	CMB		
Benjamin Enfield	self		

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Randy Wessberg	Self	305.867.9197	rwessberg@dgmanagement.net
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STAFF SIGN-IN

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Malcolm Alexander	ISC		assistant@iscprgroup.com
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Joe Rozza	Jacobs		joe.rozza@jacobs.com
JADE PAUL	JACOBS		JADE.PAUL@JACOBS.COM

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Nelson Perez	CMB PWD		
GARY MARTINEZ		(310) 347-8942	yonsider@msn.com.
Rudy delatorre	cm-pwd		

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Margarita Kuyff	CMB Environmental		
Mitche Dalberiste	CMB Environmental		

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COMMENT CARD

☐ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

MIAMIBEACH RISING ABOVE

Name/Nombre: _____ Date/Fecha: _____

Address/Dirección: _____

Phone/Teléfono: _____ E-mail/Correo Electrónico: _____

Questions or Comments / Preguntas o Commentarios:

FPL storing nuclear waste under "bins" under Biscayne Bay. Approved by local & Tallahassee? Potential spill risk?

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

☑ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

MIAMIBEACH RISING ABOVE

Name/Nombre: Chi Chi Trueny Date/Fecha: 9/17/19

Address/Dirección: 14050 Biscayne Blvd #916

Phone/Teléfono: _____ E-mail/Correo Electrónico: _____

Questions or Comments / Preguntas o Commentarios: What is your ground water management strategy to maximize storage potential soil, given the dependence of permeable pavers and bio swales etc. on flood protection?

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO NO Spam

COMMENT CARD

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☐ IN-PERSON ☐ FACEBOOK LIVE ☑ E-MAIL

Name/Nombre: Lily Frost Date/Fecha: Sept 19, 19

Address/Dirección: 800 Lakeview Dr.

Phone/Teléfono: (305) 519-1415 E-mail/Correo Electrónico: LOF1ST@aol.com

Questions or Comments / Preguntas o Comentarios: Heard tonight

We ~~keep~~ heard ~~s~~ about ~~the~~ BOSI and the reduction of heat island effect — but all I see is bigger & more buildings.

Q. Where is the balance How does one

Q. What would the appropriate ~~bldgs~~ →

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

to land ratio/etc to truly Accomplish your reduction in heat island effect? ○

COMMENT CARD

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☒ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

Name/Nombre: Patrick Shearer Date/Fecha: 9/17/19

Address/Dirección: 2016 Bay Dr #207

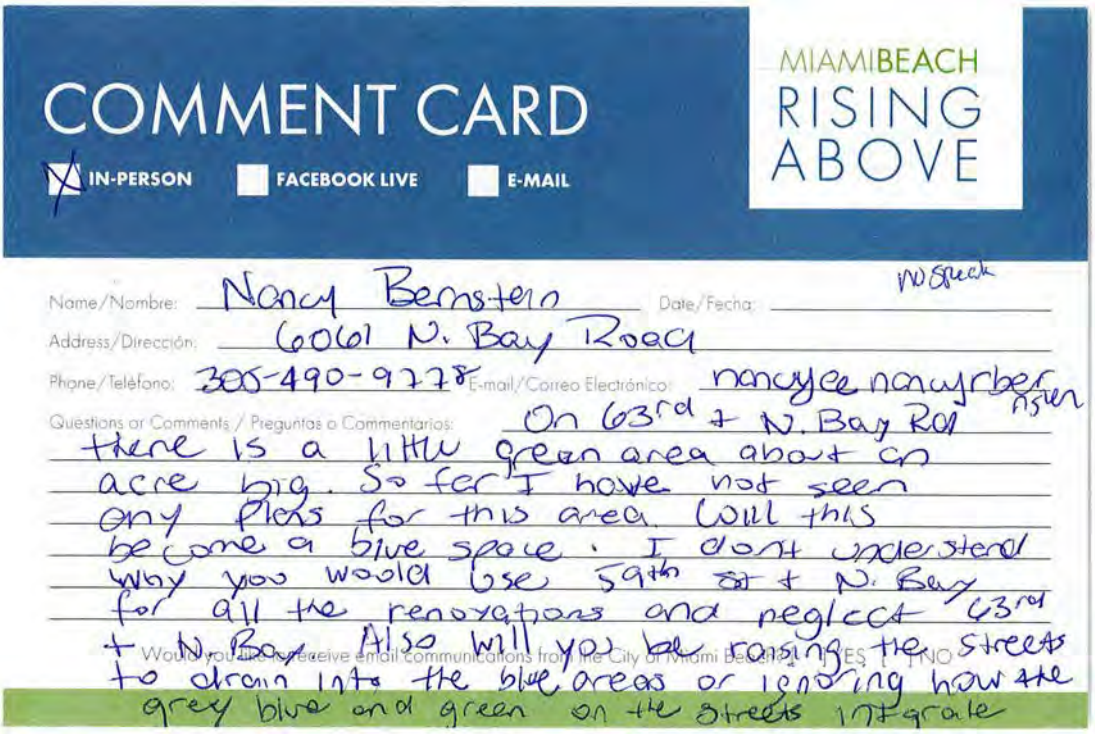
Phone/Teléfono: 786 517-2632 E-mail/Correo Electrónico: pshearer@esciencesinc.com

Questions or Comments / Preguntas o Comentarios: Are any of the Jacobs folks LOCAL?!

What about Pervious Paver Roads? Raised w/ storage in roadbase and infiltrates into subsoil - create head to force water down w/ underground cutoff walls so water doesn't bubble up through ground in surrounding lower areas. Hickory St. in Melbourne FL is a complete pervious street using PaveDrain. Miami Beach should do this. Already Do

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

Sort of failed to mention we need to create depressed areas for all storms to drain to - Regardless of size. No Speak



COMMENT CARD

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[X] IN-PERSON [ ] FACEBOOK LIVE [ ] E-MAIL

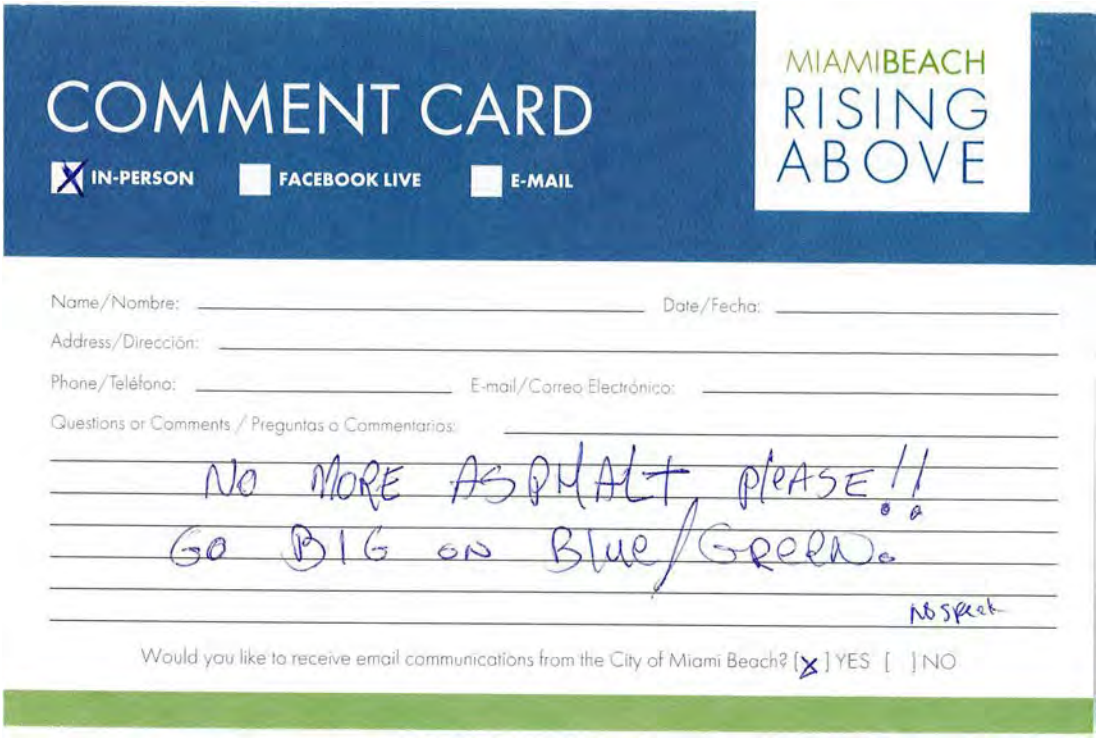
Name/Nombre: Nancy Bernstein Date/Fecha: No speak

Address/Dirección: 6061 N. Bay Road

Phone/Teléfono: 305-490-9778 E-mail/Correo Electrónico: nancyee nancyrber Listen

Questions or Comments / Preguntas o Comentarios: On 63rd + N. Bay Rd there is a little green area about an acre big. So far I have not seen any plans for this area. Will this become a blue space. I dont understand why you would use 59th st + N. Bay for all the renovations and neglect 63rd + N. Bay. Also will you be raising the streets to drain into the blue areas or ignoring how the grey blue and green on the streets int grate

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO



COMMENT CARD

MIAMIBEACH RISING ABOVE

[X] IN-PERSON [ ] FACEBOOK LIVE [ ] E-MAIL

Name/Nombre: Date/Fecha:

Address/Dirección:

Phone/Teléfono: E-mail/Correo Electrónico:

Questions or Comments / Preguntas o Commentarios:

NO MORE ASPHALT PLEASE!!
GO BIG on Blue/Green.

No speak

Would you like to receive email communications from the City of Miami Beach? [X] YES [ ] NO

COMMENT CARD

☐ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

MIAMIBEACH RISING ABOVE

Name/Nombre: DAVE DUEBLER Date/Fecha: _____

Address/Dirección: _____

Phone/Teléfono: _____ E-mail/Correo Electrónico: _____

Questions or Comments / Preguntas o Commentarios: _____

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

☑ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

MIAMIBEACH RISING ABOVE

Name/Nombre: FRANCOIS MONOT Date/Fecha: 9/17

Address/Dirección: 777 LAKE VIEW DR

Phone/Teléfono: 7862127631 E-mail/Correo Electrónico: FRANCOISMONOT@YAHOO.FR

Questions or Comments / Preguntas o Commentarios:

WHEN ARE WE GOING TO BE CONSULTED NEIGHBORHOOD TO SEE IF THE STREETS HAVE TO BE TEARED A PART IN LAKEVIEW OR IF A CHEAPER SOLUTION ECOLOGICALY AND ECONOMICALY CAN BE IMPLEMENTED INSTEAD?

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

☐ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

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Name/Nombre: Jonathan Welsh Date/Fecha: 9/17/2019

Address/Dirección: 1022 Euclid Ave. Apt #12

Phone/Teléfono: 954 793 5817 E-mail/Correo Electrónico: VoteJonWelsh@gmail.com

Questions or Comments / Preguntas o Commentarios:

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

☐ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

MIAMIBEACH RISING ABOVE

Name/Nombre: EBRU ÖZER Date/Fecha:

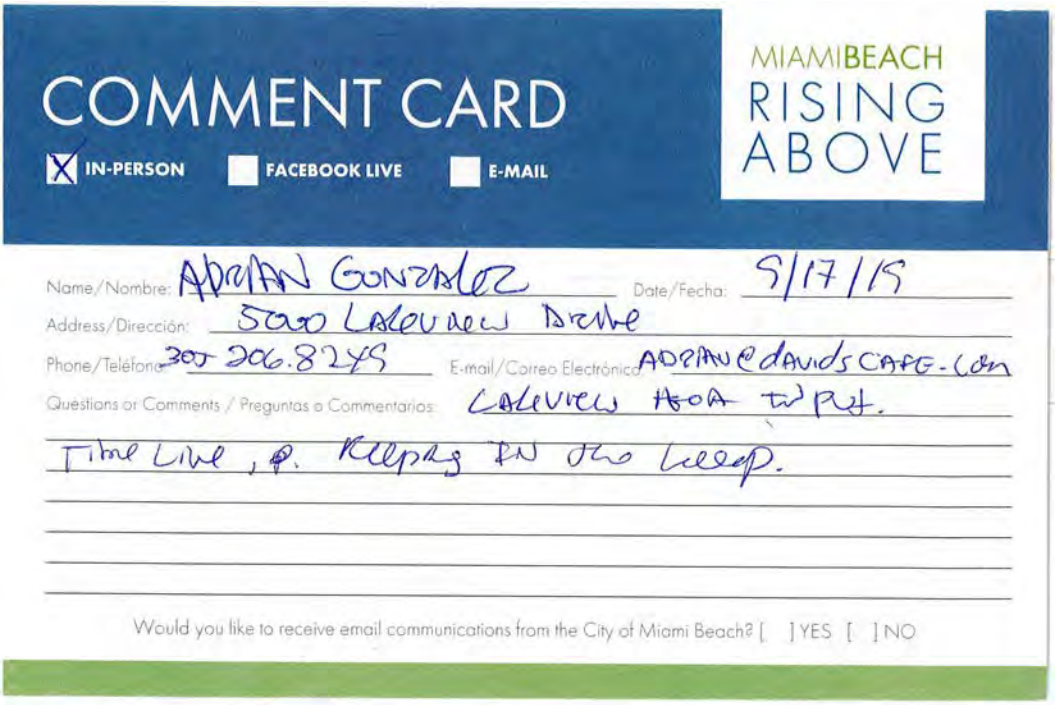
Address/Dirección:

Phone/Teléfono: E-mail/Correo Electrónico:

Questions or Comments / Preguntas o Commentarios:

Education Component?
How to make it more understandable?

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO



COMMENT CARD

MIAMIBEACH RISING ABOVE

[X] IN-PERSON [ ] FACEBOOK LIVE [ ] E-MAIL

Name/Nombre: ADRIAN GONZALEZ Date/Fecha: 5/17/15

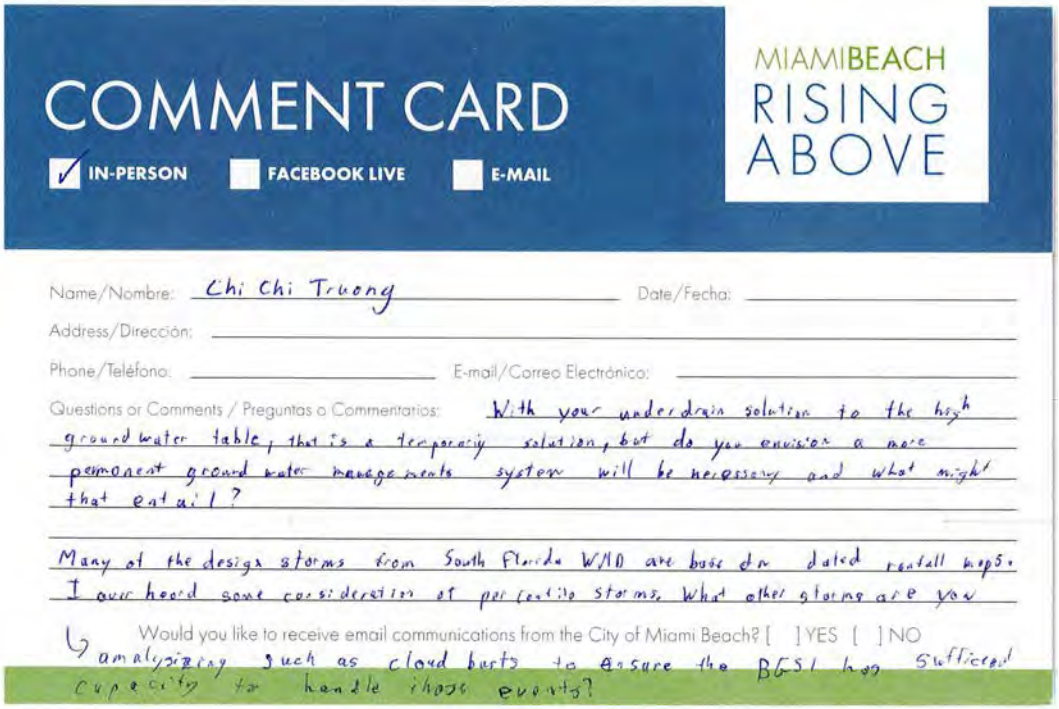
Address/Dirección: 5000 Lakeview Drive

Phone/Teléfono: 305 206.8245 E-mail/Correo Electrónico: ADRIAN@DAVIDSCAFE.COM

Questions or Comments / Preguntas o Commentarios: LAKEVIEW HOA INPUT.

Time Line, P. Keeping IN the Loop.

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO



COMMENT CARD

MIAMIBEACH RISING ABOVE

[✓] IN-PERSON [ ] FACEBOOK LIVE [ ] E-MAIL

Name/Nombre: Chi Chi Truong Date/Fecha:

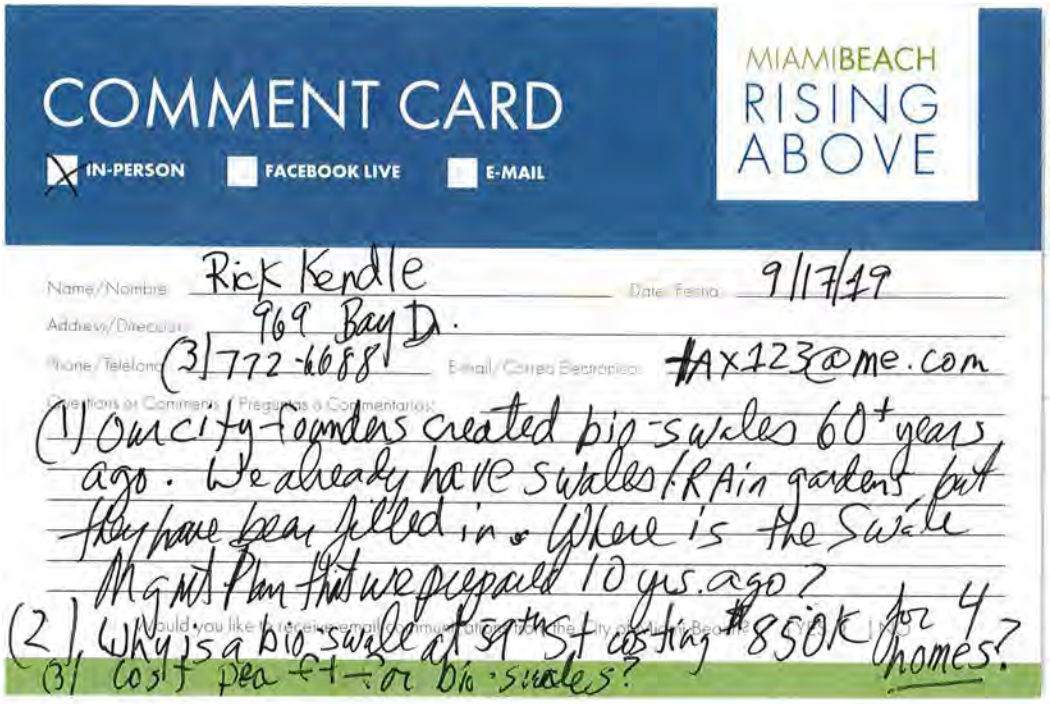
Address/Dirección:

Phone/Teléfono: E-mail/Correo Electrónico:

Questions or Comments / Preguntas o Commentarios: With your underdrain solution to the high ground water table, that is a temporary solution, but do you envision a more permanent ground water manage ments system will be necessary and what might that entail?

Many of the design storms from South Florida WMD are based on dated rainfall maps. I over heard some consideration of percentile storms. What other storms are you analyzing such as cloud bursts to ensure the BGSI has sufficient capacity to handle those events?

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO



COMMENT CARD

MIAMIBEACH RISING ABOVE

[X] IN-PERSON [ ] FACEBOOK LIVE [ ] E-MAIL

Name/Nombre: Rick Kendle Date/Fecha: 9/17/19

Address/Dirección: 969 Bay Dr.

Phone/Teléfono: (3)772-6688 E-mail/Correo Electrónico: TAX123@me.com

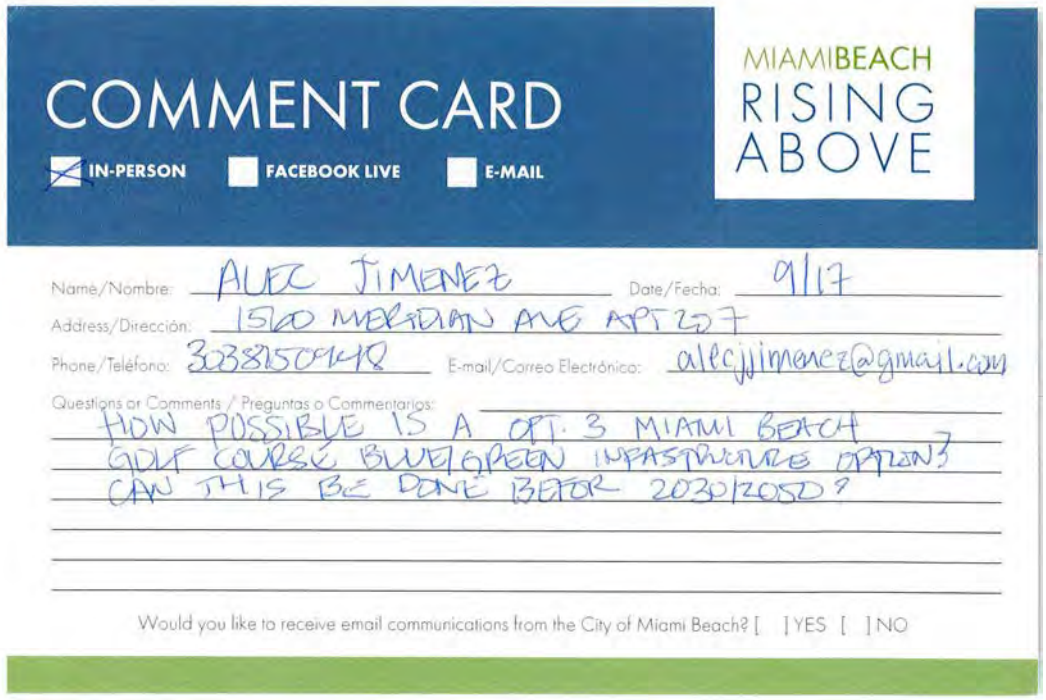
Questions or Comments / Preguntas o Comentarios:

(1) Our city-founders created big-swales 60+ years ago. We already have swales/RAin gardens but they have been filled in. Where is the Swale Mgmt Plan that we prepared 10 yrs. ago?

(2) Why is a big swale at 59th St costing $850K for 4 homes?

(3) Cost per ft. for big swales?

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO



COMMENT CARD

MIAMIBEACH RISING ABOVE

[X] IN-PERSON [ ] FACEBOOK LIVE [ ] E-MAIL

Name/Nombre: ALEC JIMENEZ Date/Fecha: 9/17

Address/Dirección: 1560 MERIDIAN AVE APT 207

Phone/Teléfono: 3038150448 E-mail/Correo Electrónico: alecjjimenez@gmail.com

Questions or Comments / Preguntas o Commentarios:

HOW POSSIBLE IS A OPT. 3 MIAMI BEACH GOLF COURSE BLUE/GREEN INFRASTRUCTURE OPTION? CAN THIS BE DONE BEFOR 2030/2050?

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

MIAMIBEACH RISING ABOVE

[X] IN-PERSON [ ] FACEBOOK LIVE [ ] E-MAIL

Name/Nombre: Alexander Zastera Date/Fecha: 9/17/19

Address/Dirección: 900 North st, apt 207

Phone/Teléfono: _____ E-mail/Correo Electrónico: zasteraa@gmail.com

Questions or Comments / Preguntas o Commentarios:

Reminder of future generations

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

MIAMIBEACH RISING ABOVE

[ ] IN-PERSON [ ] FACEBOOK LIVE [ ] E-MAIL

Name/Nombre: Jennifer Kaiser Date/Fecha: Sept 17, 2019

Address/Dirección: 1100 N. Hibiscus Dr. Miami Beach 33139

Phone/Teléfono: 786-252-4031 E-mail/Correo Electrónico: JenniferKaiserRE@gmail.com

Questions or Comments / Preguntas o Commentarios:

Overall cost?
Long term maintenance cost?
Tax increase?
How long from start to finish?

Would you like to receive email communications from the City of Miami Beach? [X] YES [ ] NO

COMMENT CARD

MIAMIBEACH RISING ABOVE

☐ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

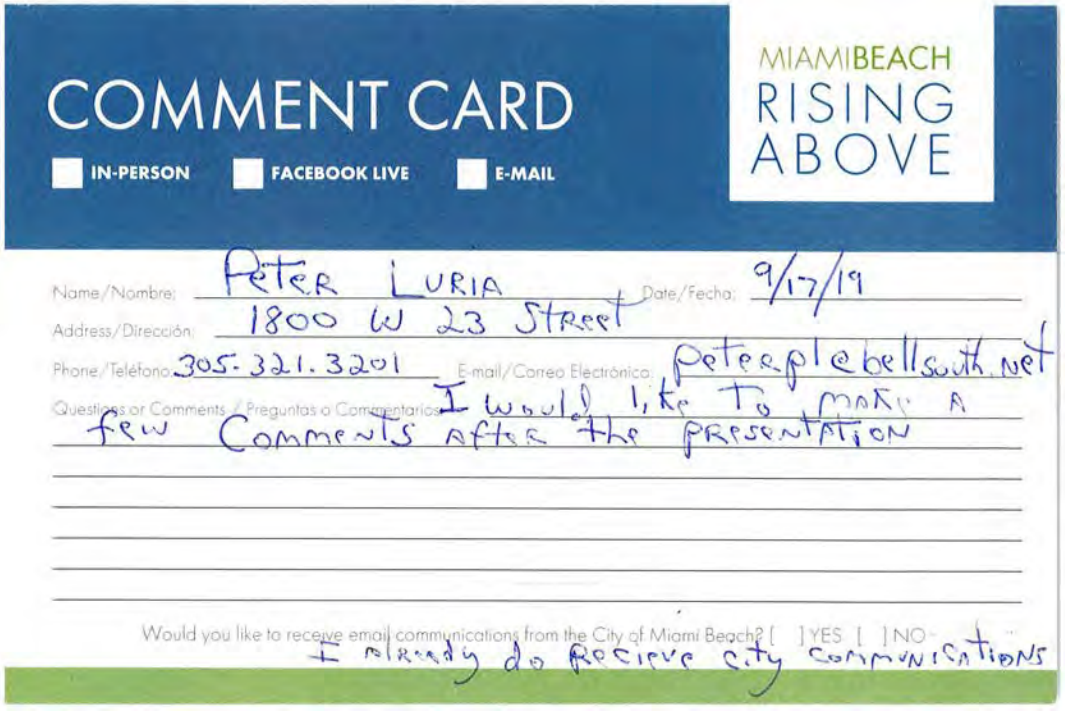
Name/Nombre: BEN MOSTHOFF Date/Fecha: 9/17/2019

Address/Dirección: 4900 LAKEVIEW DRIVE

Phone/Teléfono: E-mail/Correo Electrónico:

Questions or Comments / Preguntas o Comentarios: MIAMI BEACH IS SETTING THE NEW STANDARDS RELEASE OF STORM WATER INTO BISCAYNE BAY

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO



COMMENT CARD

MIAMIBEACH RISING ABOVE

☐ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

Name/Nombre: PETER LURIA Date/Fecha: 9/17/19

Address/Dirección: 1800 W 23 STREET

Phone/Teléfono: 305-321-3201 E-mail/Correo Electrónico: peterpl@bellsouth.net

Questions or Comments / Preguntas o Comentarios: I WOULD LIKE TO MAKE A FEW COMMENTS AFTER THE PRESENTATION

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO I already do RECEIVE city COMMUNICATIONS

COMMENT CARD

MIAMIBEACH RISING ABOVE

[✓] IN-PERSON [ ] FACEBOOK LIVE [ ] E-MAIL

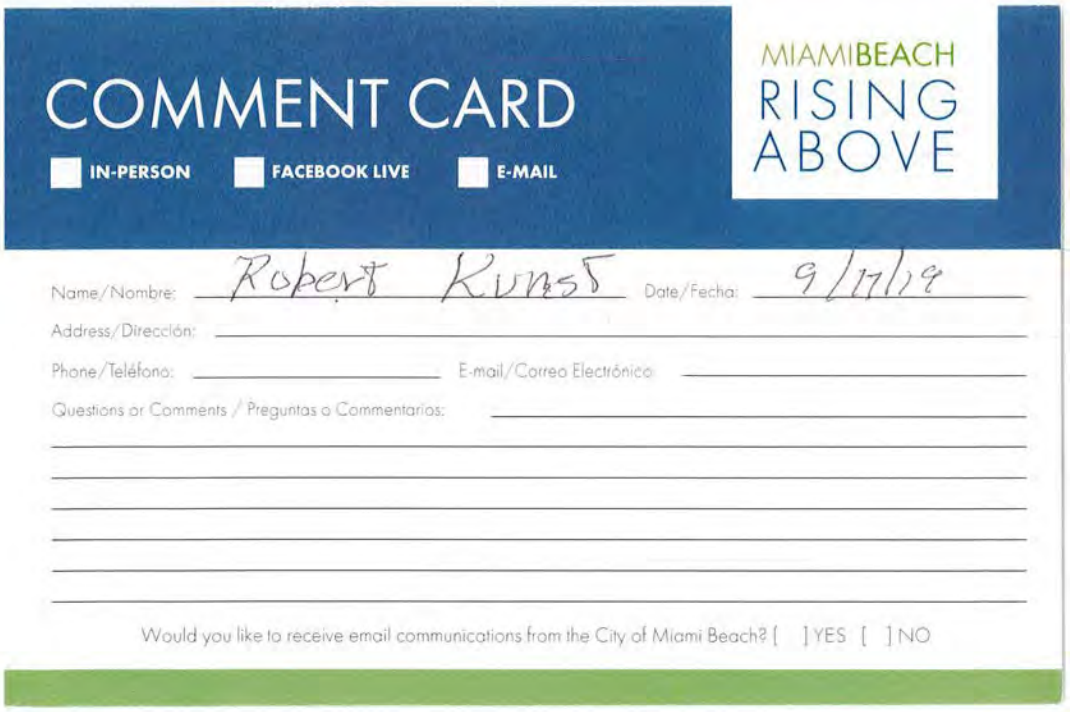
Name/Nombre: Jeff Bercow Date/Fecha: _____

Address/Dirección: _____

Phone/Teléfono: _____ E-mail/Correo Electrónico: _____

Questions or Comments / Preguntas o Commentarios: _____

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO



COMMENT CARD

MIAMIBEACH RISING ABOVE

[ ] IN-PERSON [ ] FACEBOOK LIVE [ ] E-MAIL

Name/Nombre: Robert Kunst Date/Fecha: 9/17/19

Address/Dirección: _____

Phone/Teléfono: _____ E-mail/Correo Electrónico: _____

Questions or Comments / Preguntas o Commentarios: _____

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

MIAMIBEACH RISING ABOVE

☐ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

Name/Nombre: Michael Laas Date/Fecha: 9/17/19

Address/Dirección:

Phone/Teléfono: E-mail/Correo Electrónico: michael.laas@gmail.com

Questions or Comments / Preguntas o Commentarios:

- How will BGSI adapt to rising seas ~~when~~ and the base elevation will need to be raised frequently
- ~~How~~. How does BGSI interact with the built environment, meaning water ~~for~~ management from building ~~&~~ runoff

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

MIAMIBEACH RISING ABOVE

☒ IN-PERSON ☒ FACEBOOK LIVE ☒ E-MAIL

Name/Nombre: Glenna Norton Date/Fecha: 9/17/19

Address/Dirección: 5242 North Bay Road

Phone/Teléfono: E-mail/Correo Electrónico: glennanorton@me.com

Questions or Comments / Preguntas o Commentarios:

1. Most Residential streets are not wide enough for cranes
2. does this vegetation encourage mosquito ~~snake~~ & alligators (reworded)
3. How do you control mosquitos? who is checking??
4. what ~~is~~ the life span of pervious roads
5. Collins Canal — when does the water drain to?
   Filthy canal — always has been — how clean to enjoy?
6. Code must change to enforce Blue/Green.

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

☐ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

MIAMIBEACH RISING ABOVE

Name/Nombre: GARY MARTINEZ Date/Fecha: 09/17/2019

Address/Dirección: 1061 EUCLID AVE. #102

Phone/Teléfono: (310) 347-8942 E-mail/Correo Electrónico: yonsider@msn.com

Questions or Comments / Preguntas o Commentarios:

Would like information on how this project aligns with the overall resiliency plans; figures, percentages related to flood mitigation. Properties have a useful life; how is it being affected by sea-level rise and various kinds of mitigation. What incentives are available for homeowners.

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

☑ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

MIAMIBEACH RISING ABOVE

Name/Nombre: Lily Furst Date/Fecha: Sept 17, 19

Address/Dirección: 800 Lakeview Drive

Phone/Teléfono: (305) 519-1415 E-mail/Correo Electrónico: LOFIst@aol.com

Questions or Comments / Preguntas o Commentarios:

Q. Who will maintain these public rain gardens? ex end of streets

Q. How will you get developers to implement these beautiful green roofs and all these devices in their projects (All those pictures you showed on the screen)

Q What flooding (salt water) exists in the public rain gardens?

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

☐ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

MIAMIBEACH RISING ABOVE

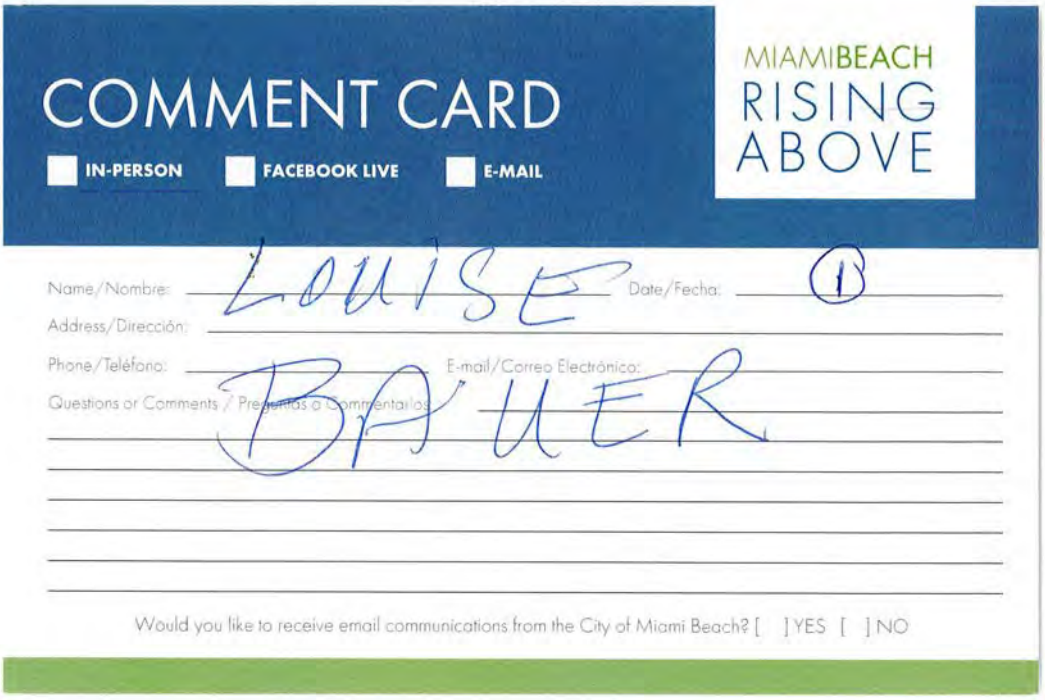
Name/Nombre: Lizette Hassell Date/Fecha: (2)

Address/Dirección:

Phone/Teléfono: E-mail/Correo Electrónico:

Questions or Comments / Preguntas o Commentarios:

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO



COMMENT CARD

☐ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

MIAMIBEACH RISING ABOVE

Name/Nombre: LOUISE Date/Fecha: (1)

Address/Dirección:

Phone/Teléfono: E-mail/Correo Electrónico:

Questions or Comments / Preguntas o Commentarios: BAUER

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

☐ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

MIAMIBEACH RISING ABOVE

Name/Nombre: JEFF GALE Date/Fecha: 9/17/19

Address/Dirección: 4360 ROYAL PALM AVENUE, MB 33140

Phone/Teléfono: 305/904-5637 E-mail/Correo Electrónico: JEFFGALELAW@BELLSOUTH.NET

Questions or Comments / Preguntas o Commentarios:

No comment in mtg

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

COMMENT CARD

☒ IN-PERSON ☐ FACEBOOK LIVE ☐ E-MAIL

MIAMIBEACH RISING ABOVE

Name/Nombre: Luz Latorre Date/Fecha: 9/17/19

Address/Dirección:

Phone/Teléfono: E-mail/Correo Electrónico: luzgache@bellsouth.net

Questions or Comments / Preguntas o Commentarios: With so much money being spent to improve our city parks, are canopy trees planned to shade these parks?

Re: Golf course – garden center a new Meridian/convention center park only a few blocks away, why take away here golf course.

Would you like to receive email communications from the City of Miami Beach? [ ] YES [ ] NO

Not spoke

Social Media Posts

Posted on September 17, 2019 - Facebook

Posted on September 17, 2019 - Twitter

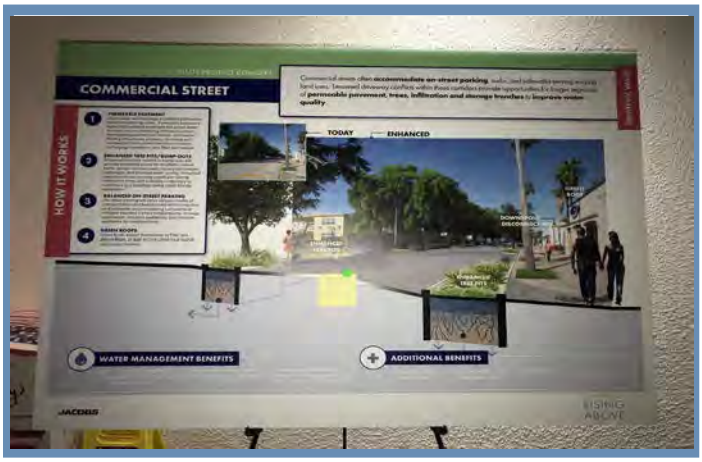
Posted on September 17, 2019 - Facebook

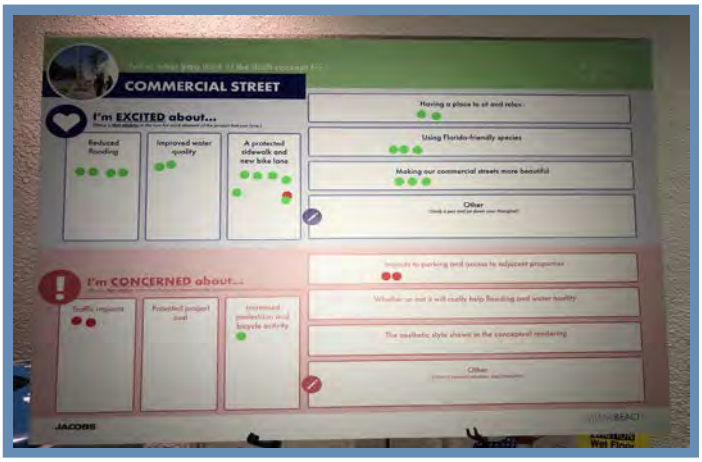
Posted on September 17, 2019 - Facebook

Posted on September 17, 2019 -Facebook

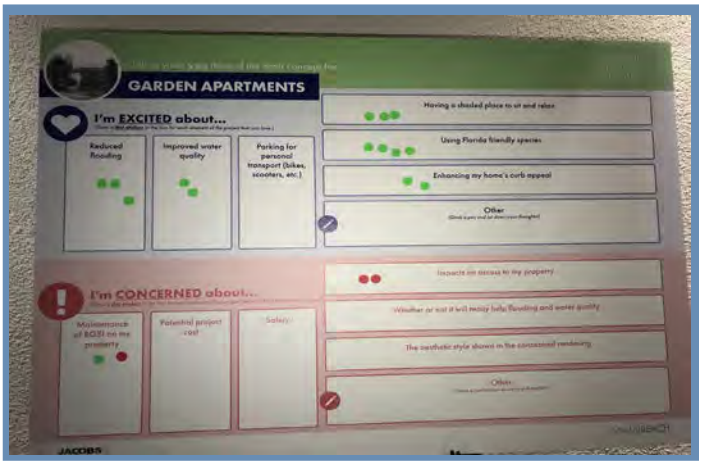
Posted on September 17, 2019 - Twitter

Photos

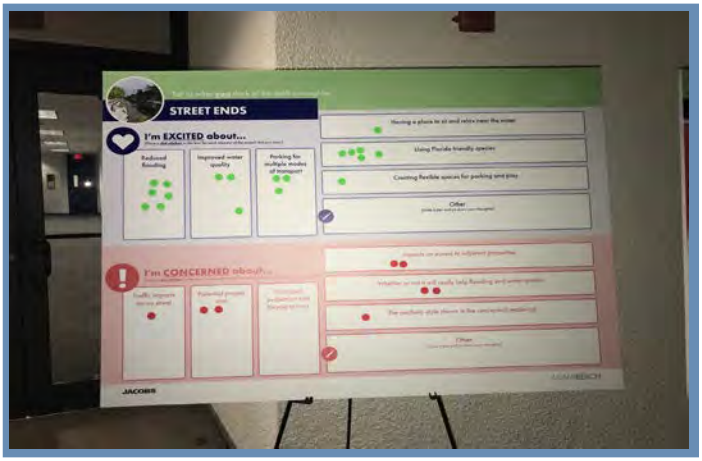

COMMERCIAL STREET
HOW IT WORKS
TODAY
ENHANCED
WATER MANAGEMENT BENEFITS
ADDITIONAL BENEFITS
JACOBS
RISING ABOVE


COMMERCIAL STREET
I'm EXCITED about...
Reduced flooding
Improved water quality
A protected sidewalk and new bike lane
Having a place to sit and relax
Using Florida-friendly species
Making our commercial streets more beautiful
Other
I'm CONCERNED about...
Traffic impacts
Potential project cost
Increased pedestrian and bicycle activity
Impacts to parking and access to adjacent properties
Whether or not it will really help flooding and water quality
The aesthetic style shown in the conceptual rendering
Other
JACOBS

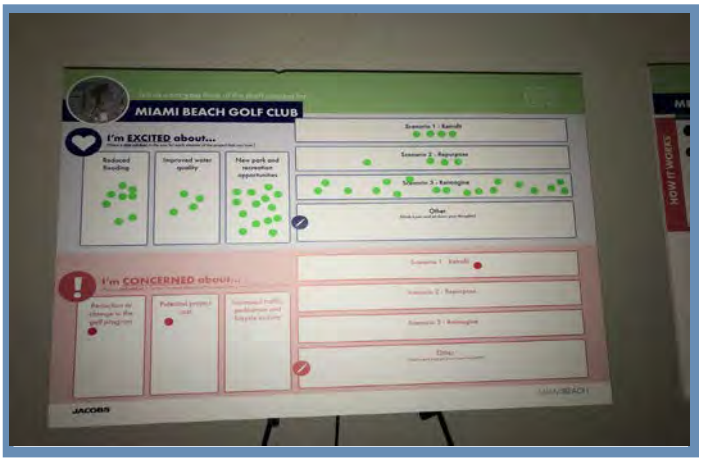

GARDEN APARTMENTS
HOW IT WORKS
ENHANCED
TODAY
WATER MANAGEMENT BENEFITS
ADDITIONAL BENEFITS
JACOBS
RISING ABOVE


GARDEN APARTMENTS
I'm EXCITED about...
Reduced flooding
Improved water quality
Parking for personal transport (bikes, scooters, etc.)
Having a shaded place to sit and relax
Using Florida friendly species
Enhancing my home's curb appeal
Other
I'm CONCERNED about...
Impacts on access to my property
Whether or not it will really help flooding and water quality
The aesthetic style shown in the conceptual rendering
Other
JACOBS


STREET ENDS
HOW IT WORKS
ENHANCED
TODAY
WATER MANAGEMENT BENEFITS
ADDITIONAL BENEFITS
JACOBS

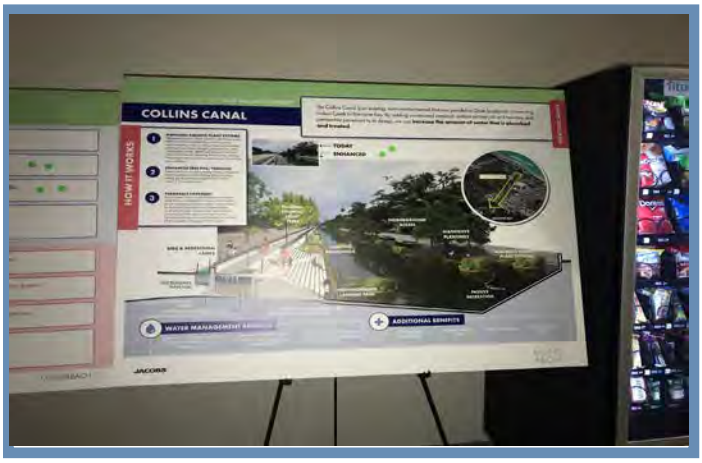

STREET ENDS
I'm EXCITED about...
Reduced flooding
Improved water quality
Parking for multiple modes of transport
Other
I'm CONCERNED about...
Traffic impacts on my street
Potential project cost
Impacts on access to adjacent properties
Whether or not it will really help flooding and water quality
The aesthetic style shown in the conceptual rendering
Other
JACOBS

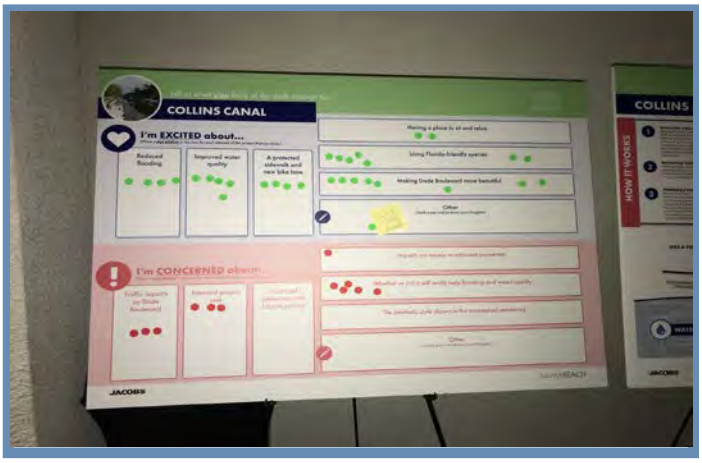

MIAMI BEACH GOLF CLUB
HOW IT WORKS
1 RETROFIT
JACOBS


MIAMI BEACH GOLF CLUB
I'm EXCITED about...
I'm CONCERNED about...
HOW IT WORKS
JACOBS

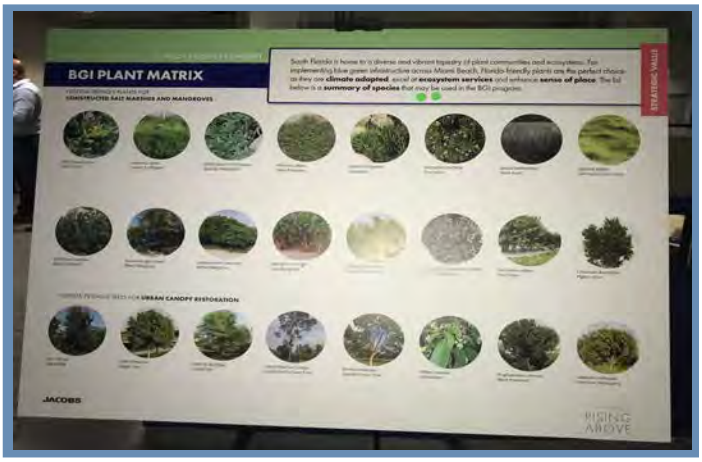

MIAMI BEACH GOLF CLUB
HOW IT WORKS
3 REIMAGINE
JACOBS

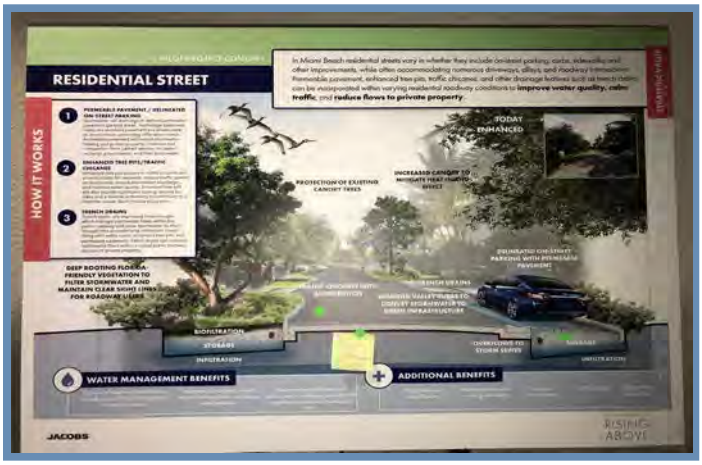

MIAMI BEACH GOLF CLUB
HOW IT WORKS
1 RETROFIT
JACOBS

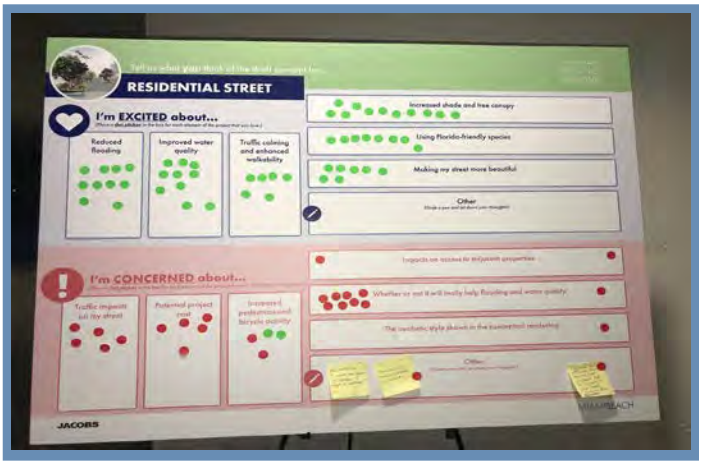

COLLINS CANAL
HOW IT WORKS
JACOBS


COLLINS CANAL
I'm EXCITED about...
I'm CONCERNED about...
HOW IT WORKS
JACOBS


BGI PLANT MATRIX
JACOBS


BGI PLANT MATRIX
JACOBS


RESIDENTIAL STREET
HOW IT WORKS
WATER MANAGEMENT BENEFITS
ADDITIONAL BENEFITS
JACOBS

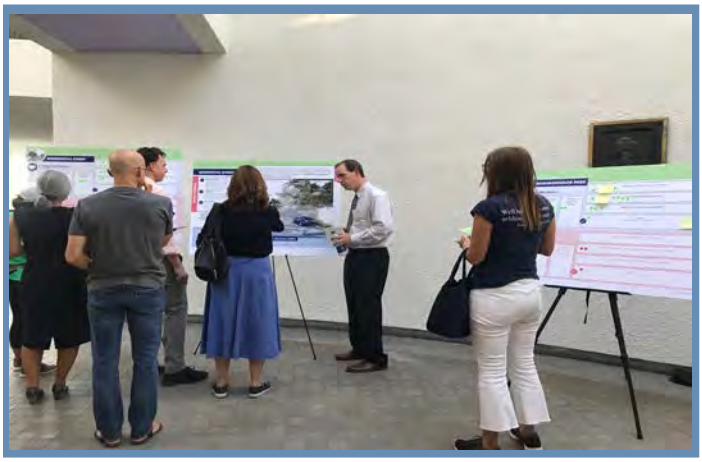

RESIDENTIAL STREET
I'm EXCITED about...
I'm CONCERNED about...
JACOBS

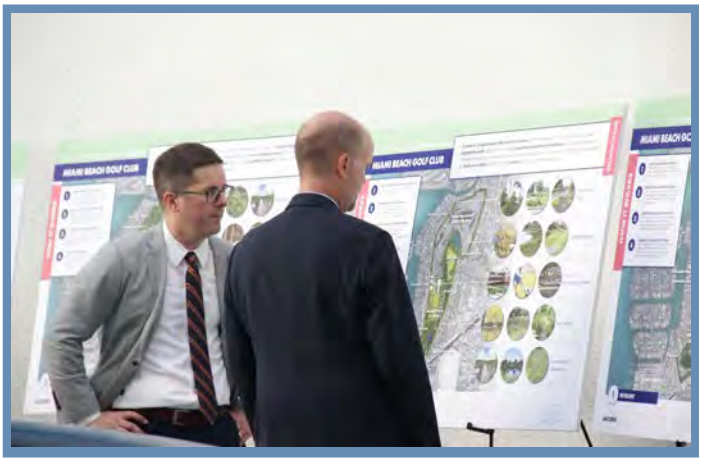

NEIGHBORHOOD PARK
HOW IT WORKS
WATER MANAGEMENT BENEFITS
ADDITIONAL BENEFITS
JACOBS


NEIGHBORHOOD PARK
I'm EXCITED about...
I'm CONCERNED about...
JACOBS

Resilience Conversation Series
Blue Green Infrastructure

MIAMIBEACH RISING ABOVE






EXIT


Miami Beach

APPENDIX

Presentation
Boards
FAQ

RESILIENCE CONVERSATION SERIES: BLUE-GREEN INFRASTRUCTURE

September 17, 2019

MIAMIBEACH
RISING
ABOVE

Project Leadership Team

25 years

Matt Alvarez

Project Manager

30 years

Tom Ryburn

Deputy Project Manager/ Implementation Task Lead

30 years

Laurens van der Tak

Climate Adaptation Advisory Panel

19 years

Jason Bird

Planning Task Lead

19 years

Andy Potts

Blue-Green Infrastructure Task Lead

25 years

Joe Rozza

Blue-Green & Sustainability

15 years

Monica Diaz

Public Outreach

13 years

Matt Friesen

Urban Design

19 years

Jade Paul

Urban Design

REMINDER – PLEASE SUBMIT QUESTIONS AND COMMENTS TONIGHT!

- Submit Question Card
- Online viewers email questions to: MBRisingAbove@miamibeachfl.gov
- Open comment period through September 24, 2019

Questions on Citywide Stormwater Management? Please contact:

Liz Bello-Matthews
Public Information Officer – Public Works Department
305-673-7000 ext. 6902
E-mail: LizBello-Matthews@miamibeachfl.gov

AGENDA

- What is BGSI? Why is it used?
- Where can it be used?
- How does it impact:
  - Parking?
  - Mosquitoes?
- How can the public get involved?
- What are the next steps?
- Questions and Answers

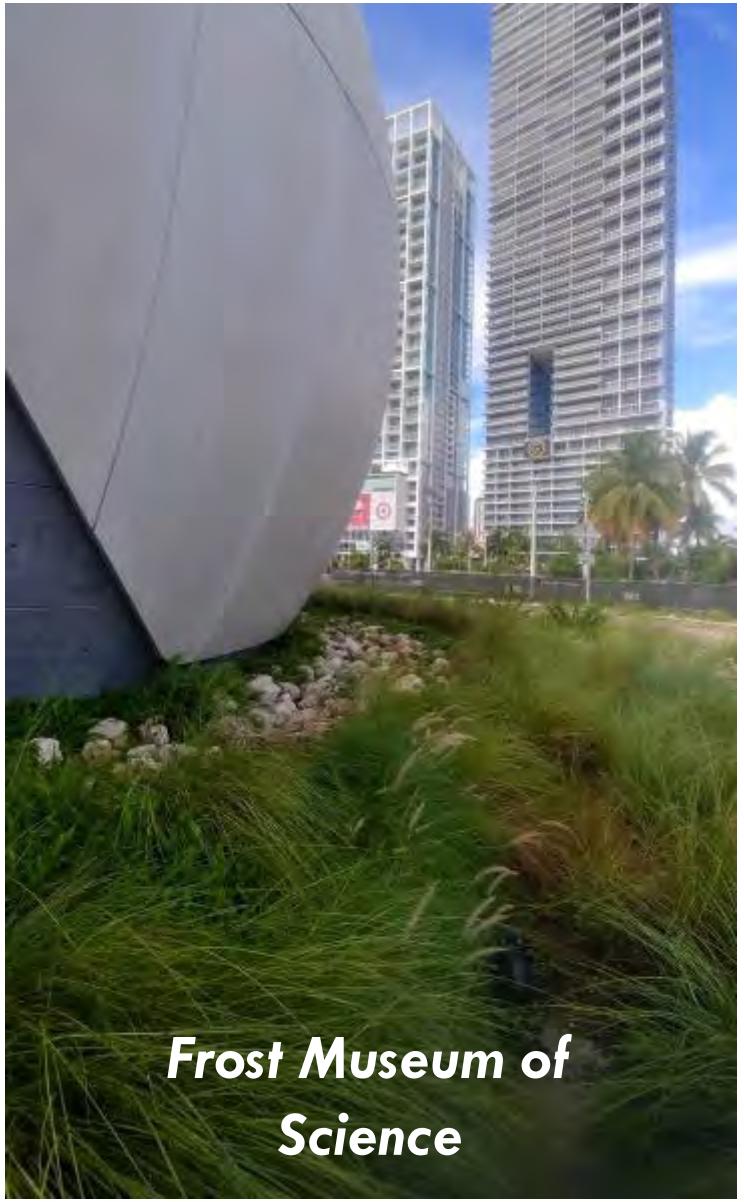
WHAT IS BGSI?

- **Green stormwater infrastructure** typically uses vegetation and/or soils to treat and reduce stormwater flows
- **Blue stormwater infrastructure** temporarily stores and treats stormwater
- BGSI is typically designed and sized to capture more frequent storm events
- Different from coastal strategies, such as living shorelines, dunes, mangrove plantings, and oyster or artificial reefs

Rain Garden

WHY SHOULD WE USE BGSI?

- **Stormwater benefits**
  - Water quality (WQ)
  - Groundwater recharge
  - Some detention/flood mitigation
- **Community benefits**
  - Urban heat island mitigation
  - Air quality
  - Climate resiliency
  - Ecosystem health/biodiversity


Frost Museum of Science

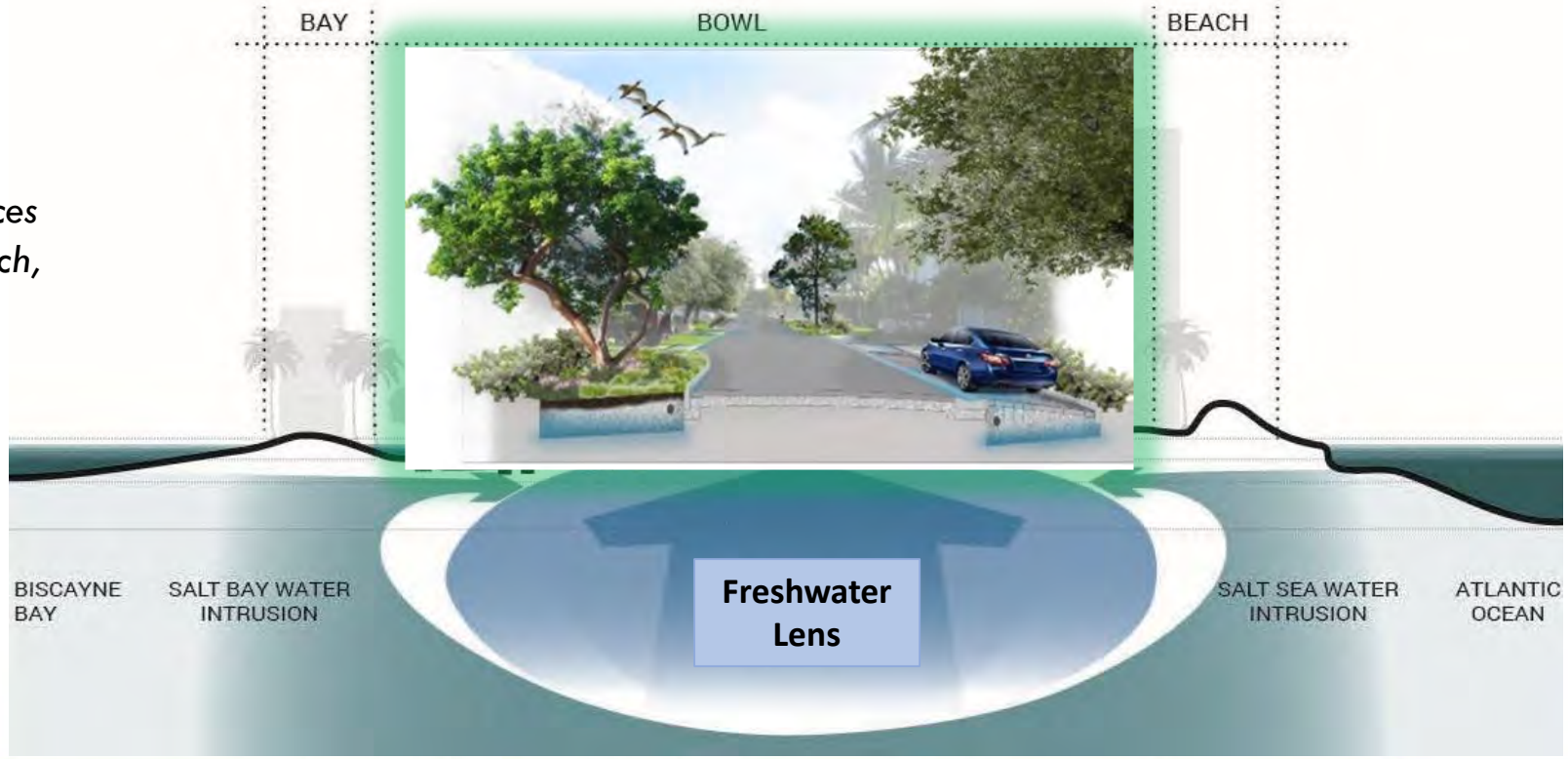
WHAT ARE THE WATER QUALITY BENEFITS?

- BGSI can **reduce pollutants** that threaten the Bay, such as metals, nutrients, sediment, and pathogens
- By retaining rainfall, BGSI **reduces stormwater discharges** and pollutant loads
- BGSI can also **filter stormwater that is not retained**

Biscayne Bay at Maurice Gibbs Park

BY RECHARGING THE FRESHWATER LENS, BGSI CAN HELP KEEP SALT WATER AT BAY TO PROTECT OUR TREES

Source: ULI Advisory Services Panel Report on Miami Beach, 2018 (adapted)



HOW WILL BGSI FIT INTO THE CITY'S FLOOD MITIGATION STRATEGIES?

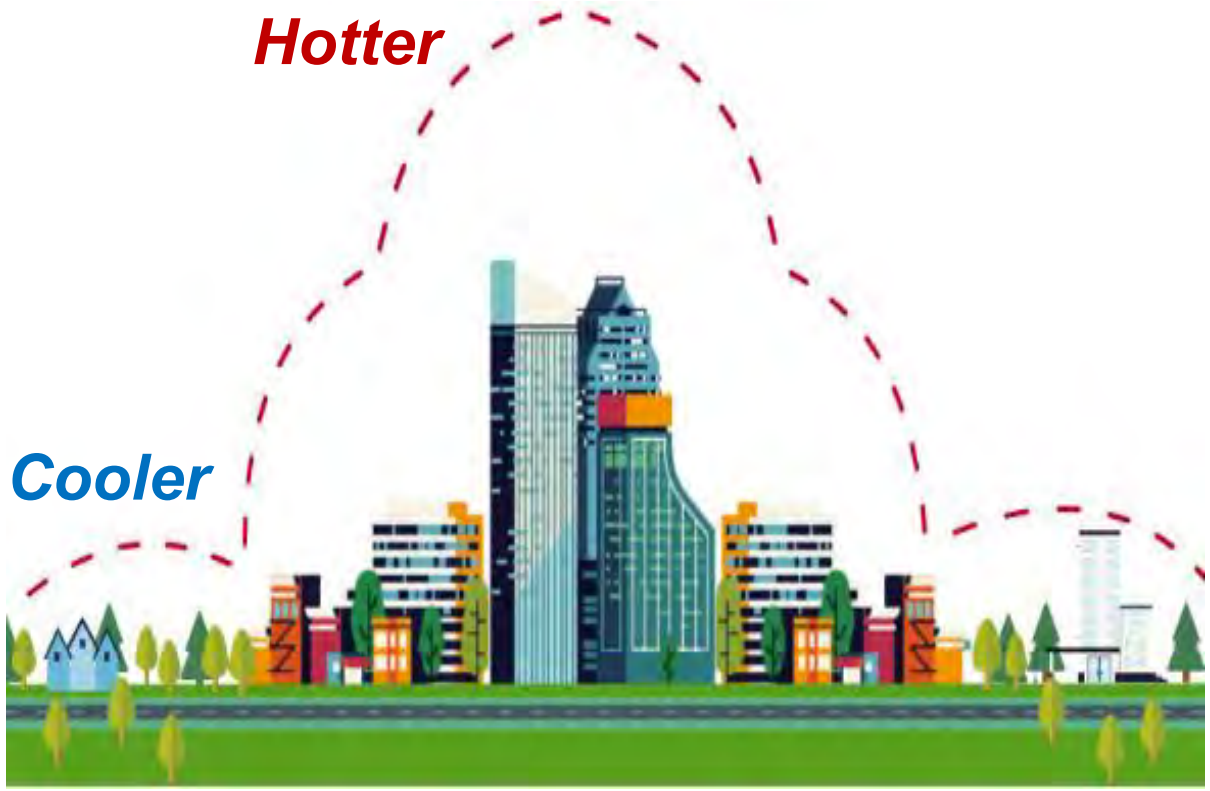
- Complements "grey" infrastructure
- Provides some detention/flood mitigation, but alone will **provide little or no benefit for:**
  - "sunny day" flooding
  - flooding from major rainfall
  - storm surge
- Designed for storms **2 inches** or less, which is about **25% of the much larger storms** typically used for flood control

Flooding on May 16, 2019

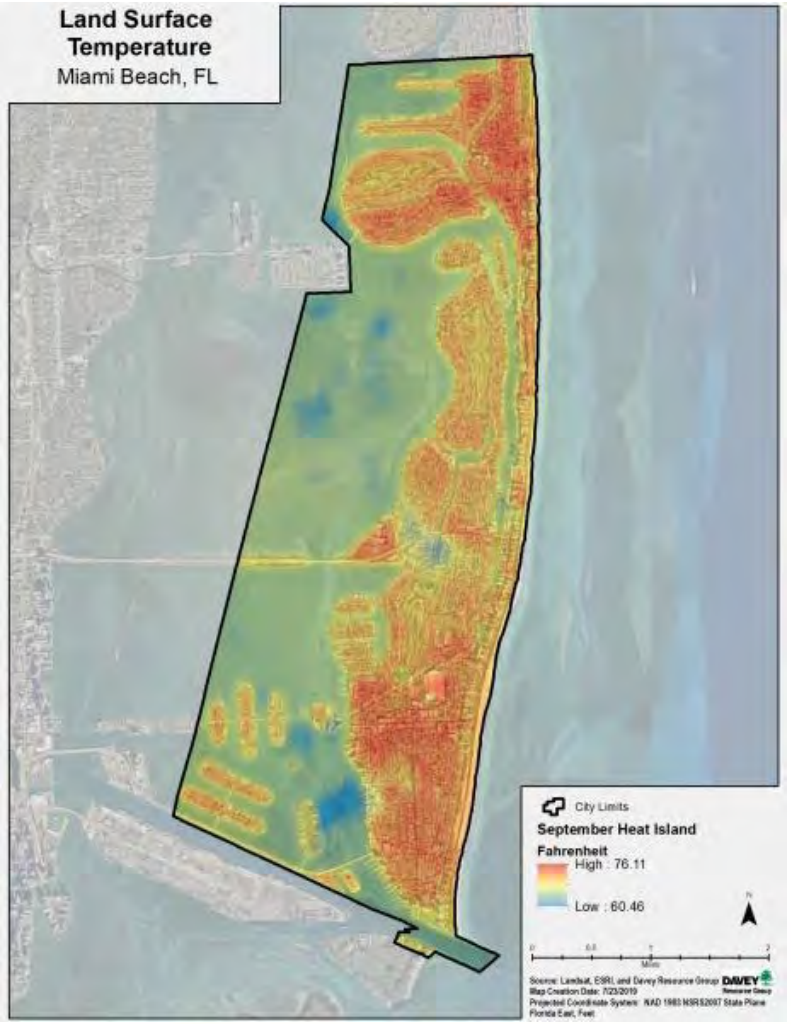
COMMUNITY (CO-BENEFITS) OF BGSI

Source: Potential Environmental, Social, Economic, and Public Health Benefits of Green Infrastructure by U.S. Environmental Protection Agency (2017)

BGSI CAN HELP MITIGATE THE URBAN HEAT ISLAND IN THE CITY



Heat Island Effect: higher temperatures in developed areas



Map source: Davey Resource Group

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	

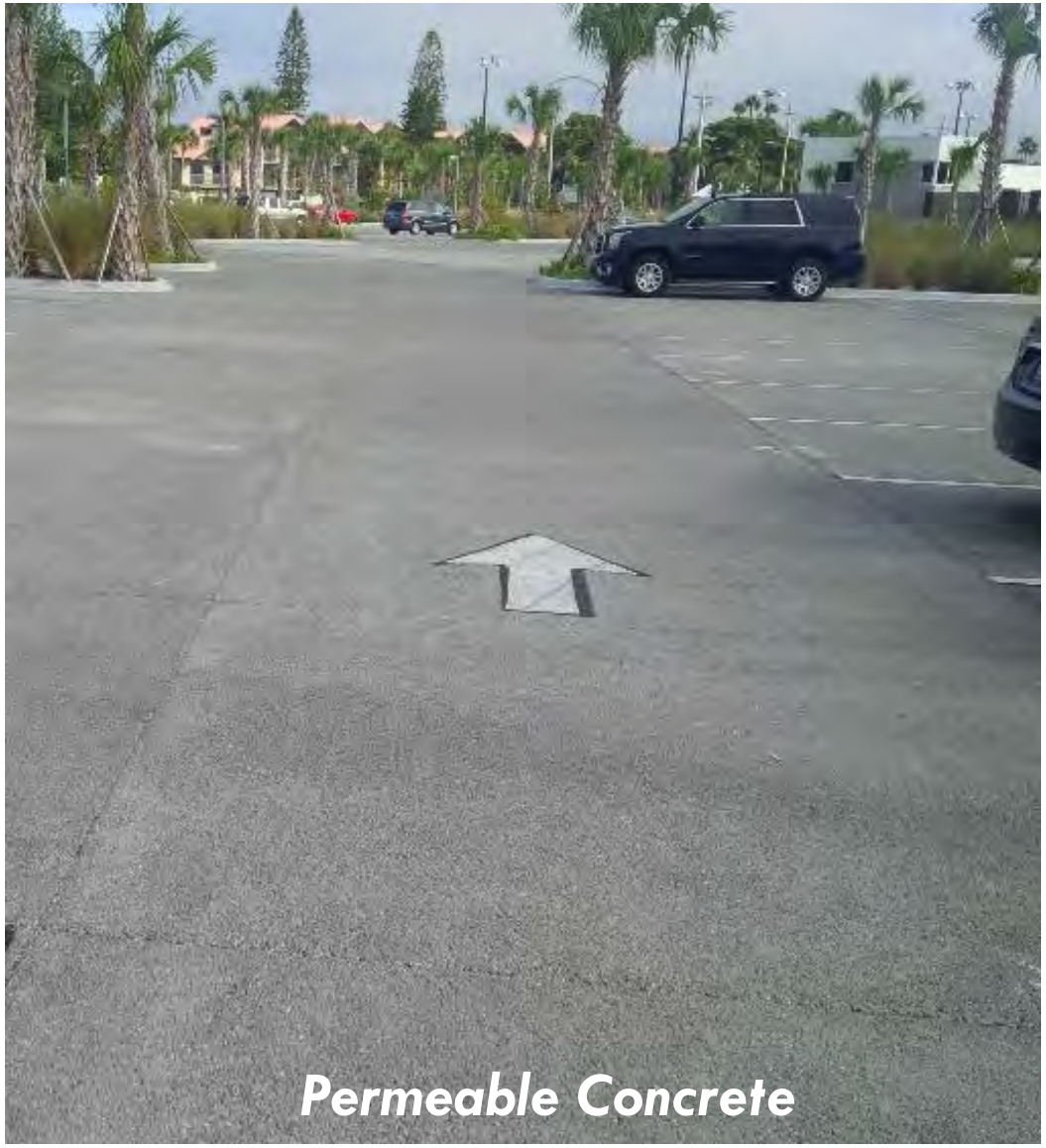
WHAT BGSI PRACTICES ARE MOST APPLICABLE TO MIAMI BEACH?

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

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

WHAT DOES BGSI LOOK LIKE?

- Takes **many different forms,** from **landscaping** elements to **permeable pavements** to **ponds** to **green roofs**
- Can **vary greatly in appearance,** from high-profile features to those that blend in
- Vegetation **requires time to get established**


Permeable Concrete


Permeable Pavers


Blue-Green Roof Plaza


Subsurface Infiltration Trench

Bioretention (Rain Garden)

Stormwater Planters


Vegetated (“Green”) Roof

Residential Rain Garden

Residential Rain Barrel

Floating wetland islands in Florida and similar settings

WHERE CAN BGSI BE USED?

- In a **variety of locations:**
  - Roads
  - Parks and other open spaces
  - Schools/public facilities
  - On rooftops
  - Residential and commercial properties
- Miami Beach is approximately **40% impervious** area
- Goal is to preserve and increase pervious ("green") area


Street Ends

WHERE IS THE CITY PLANNING TO IMPLEMENT BGSI?

- Roads, parks/open spaces, public facilities; integrated with other planned improvements
- City projects with BGSI under design:
  - Community Park (former Par 3)
  - Maurice Gibbs Park
  - 59th Street Bioswale
  - 1st Street Stormwater Improvements
- Preliminary concepts for:
  - Residential and commercial streets
  - Neighborhood parks
  - Golf Courses
  - Collins Canal
- There is an opportunity to make **policy/code changes** to further encourage/require private BGSI implementation

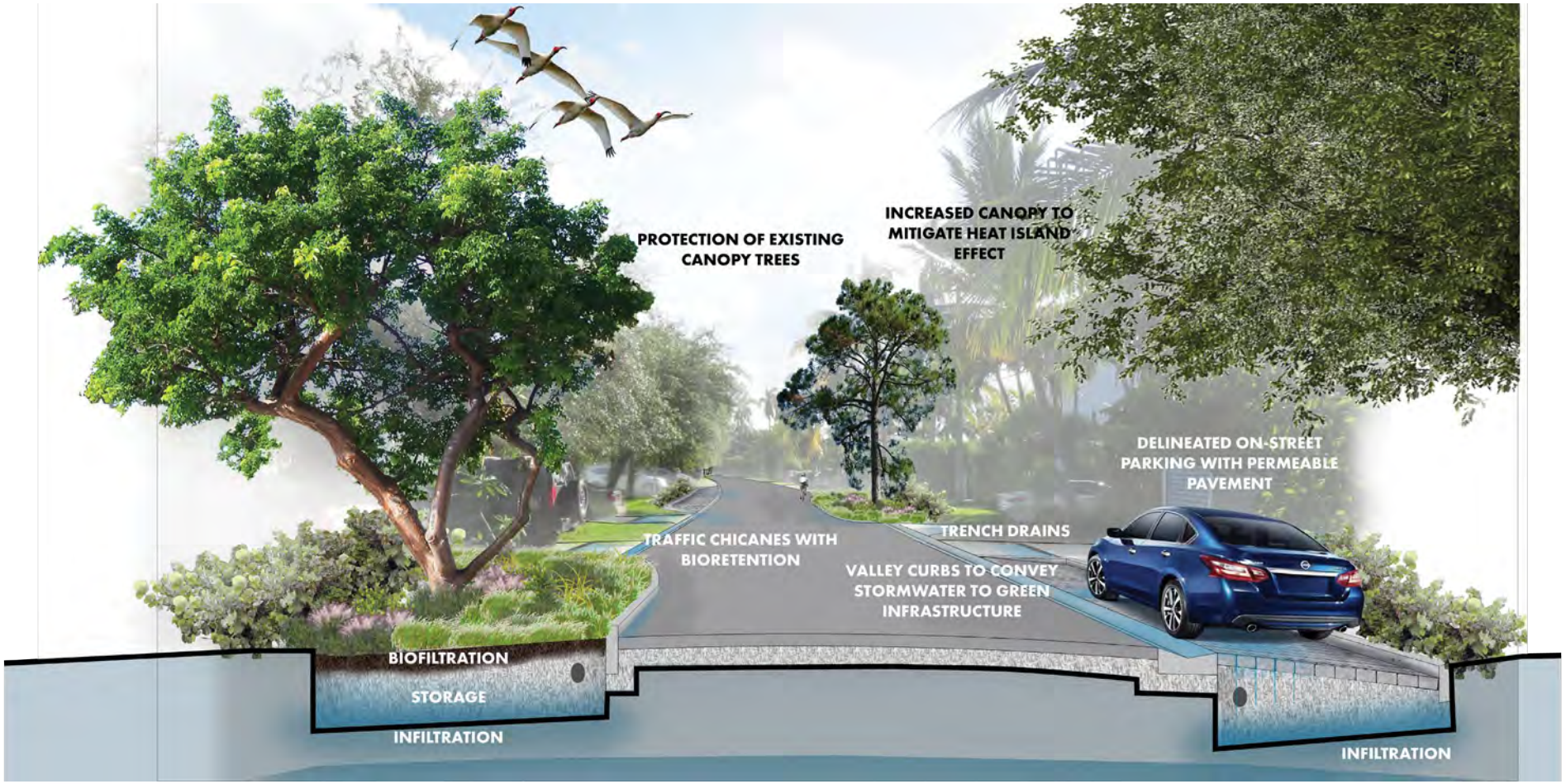
RENDERING OF PAR 3 COMMUNITY PARK POND COURTESY OF SAVINO MILLER

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

COLLINS CANAL

COMMERCIAL STREET

RESIDENTIAL STREET



NEIGHBORHOOD PARK

MIAMI BEACH GOLF COURSE
THE ART OF THE POSSIBLE

MIAMI BEACH GOLF COURSE

The Art of the Possible

Scenario 1 – Retrofit

- Bioswales
- Detention Basins
- Wet Ponds
- Permeable Pavement
- Rainwater Harvesting
- 18 Holes of Golf

MIAMI BEACH GOLF COURSE

The Art of the Possible

Scenario 2 – Repurpose

- Bioretention Edges
- Detention Basin
- "Green" Recreation Center
- Wet Ponds
- Constructed Wetlands
- 9 Holes of Golf

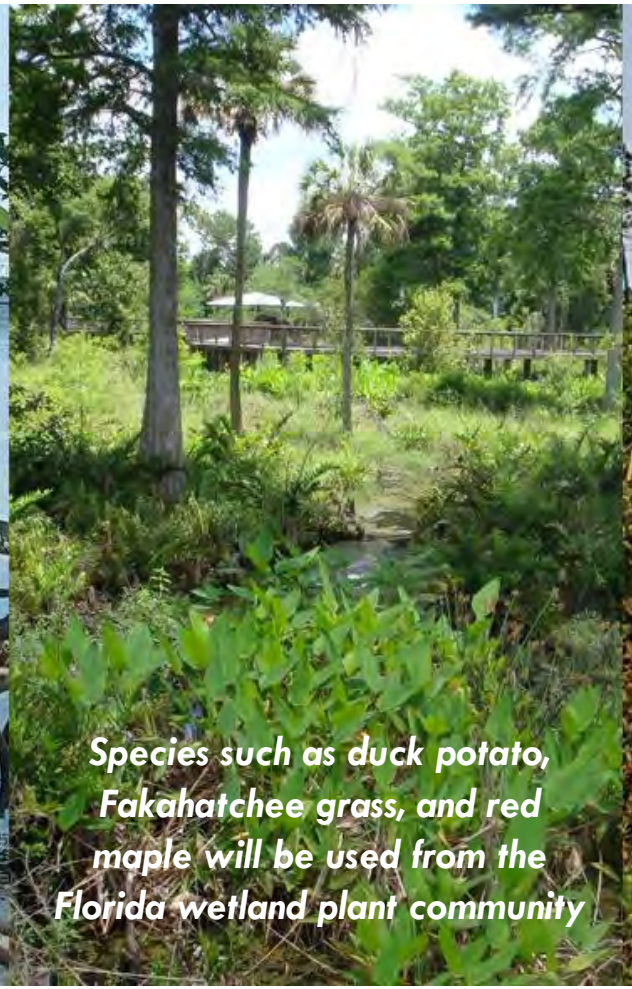
MIAMI BEACH GOLF COURSE

The Art of the Possible

Scenario 3 – Reimagine

- Wetland Park
- "Green" Edges
- "Green" Recreation Hub
- Living Machine Gardens
- "Living with Water" Eco-District

Species such as mangroves will be used for living shoreline environments



Species such as duck potato, Fakahatchee grass, and red maple will be used from the Florida wetland plant community

Species such as South Florida slash pine and saw palmetto will be used from South Florida pine flatwood plant community

For implementing blue-green infrastructure across Miami Beach, Florida-friendly plants are the perfect choice as they are climate-adapted, excel at ecosystem services, and enhance sense of place.

Note: suggestions are subject to budgetary and other constraints.

WILL BGSI REDUCE PARKING?

- Parking will be **evaluated and discussed** with stakeholders on a project-by-project basis
- BGSI is often strategically located in areas where **parking is already not permitted** to minimize impacts

- Some BGSI may reduce parking along streets and in parking lots if vegetated BGSI is used
- In most cases there are options that do not reduce parking

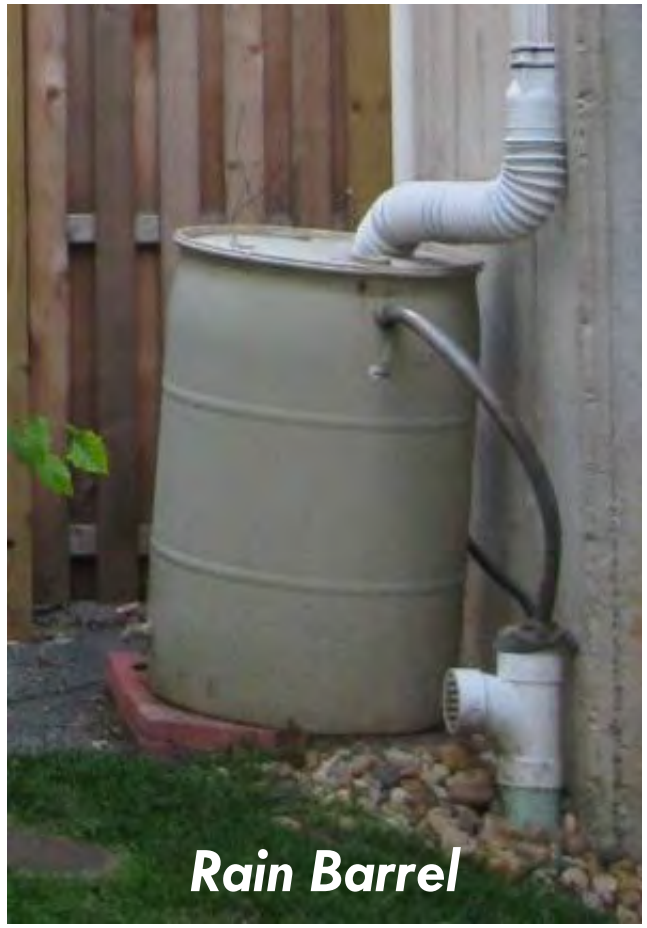
WILL BGSI PROMOTE MOSQUITO BREEDING?

- **No, if properly designed, constructed, and maintained**
- BGSI that is typically dry should **empty within 3 days,** and should be checked frequently
- BSGI that holds water over 7 days must use **other methods to prevent mosquito growth**
  - Screening
  - Natural predator populations
  - Mosquito-specific larvicides

Note: Appropriate precautions against mosquitoes should be taken whether there are BGSI practices present or not.

WHAT CAN THE PUBLIC DO TO PROMOTE BGSI IN MIAMI BEACH?

- Advocate for it
- Implement/maintain it on your property:
  - Roadside swales
  - Rain barrels
  - Rain gardens
  - Trees
- Help protect and maintain public BGSI (once it is constructed) through grassroots adoption programs
- Residents and businesses will be a **key partner** for BGSI



Rain Barrel

Residential Rain Garden

Existing Grass Swales and Trees in Neighborhoods are Important to Stormwater Management

WHAT ARE THE NEXT STEPS?

- Compile and incorporate public input
- Additional opportunities for input:
  - Public comment period (9/17 - 9/24)
  - Sustainability & Resiliency Committee (9/25)
  - Commission meeting (10/16)
  - Future neighborhood meetings for specific projects
  - Grassroots efforts neighborhood by neighborhood
  - Website updates - www.MBrisingAbove.com

Questions on BGSI? Please contact:
Monica R. Diaz
Infinite Source Communications Group
305-573-0089
E-mail: Monica@iscprgroup.com

Questions on Citywide Stormwater Management? Please contact:
Liz Bello-Matthews
Public Information Officer – Public Works Department
305-673-7000 ext. 6902
E-mail: LizBello-Matthews@miamibeachfl.gov

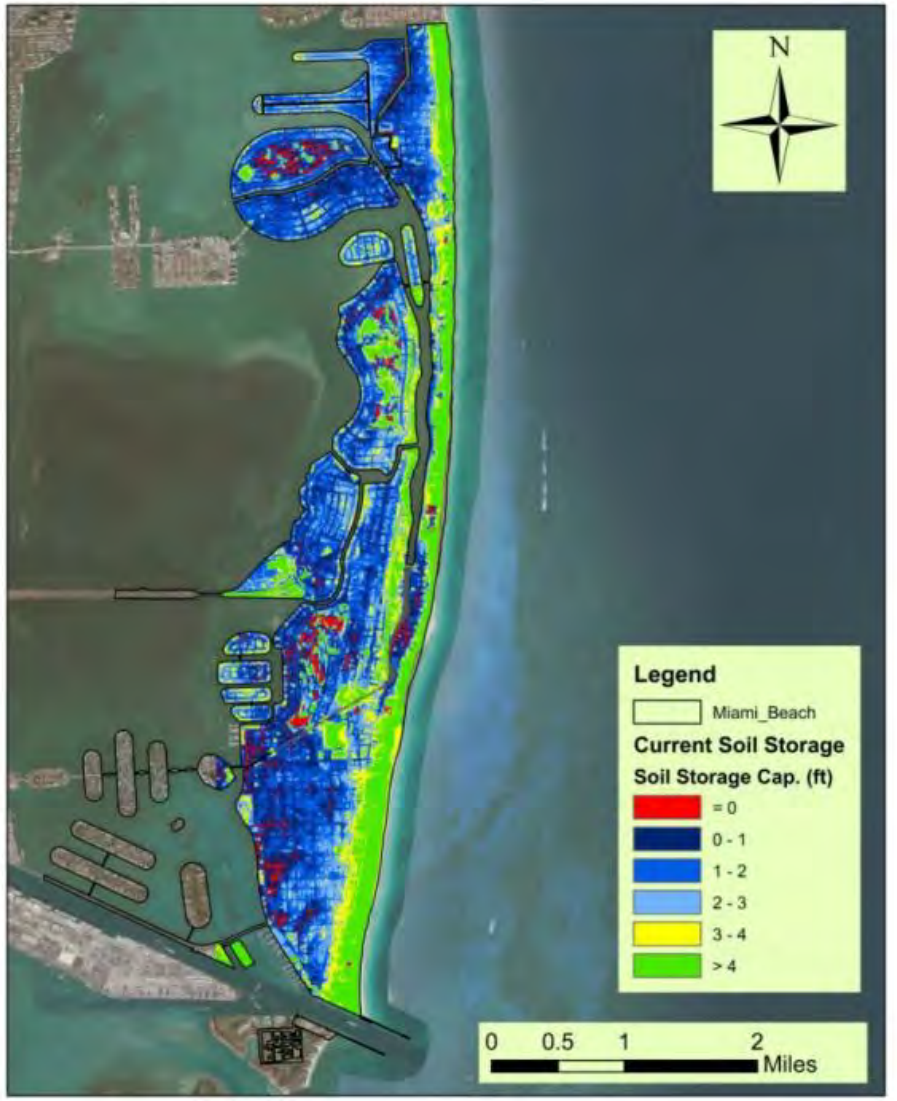
RESILIENCE CONVERSATION SERIES: BLUE-GREEN INFRASTRUCTURE

September 17, 2019

MIAMIBEACH
RISING
ABOVE

ADDITIONAL SLIDES FOR Q&A

SHALLOW GROUNDWATER ELEVATIONS MAY LIMIT USE OF SOME BGSI PRACTICES



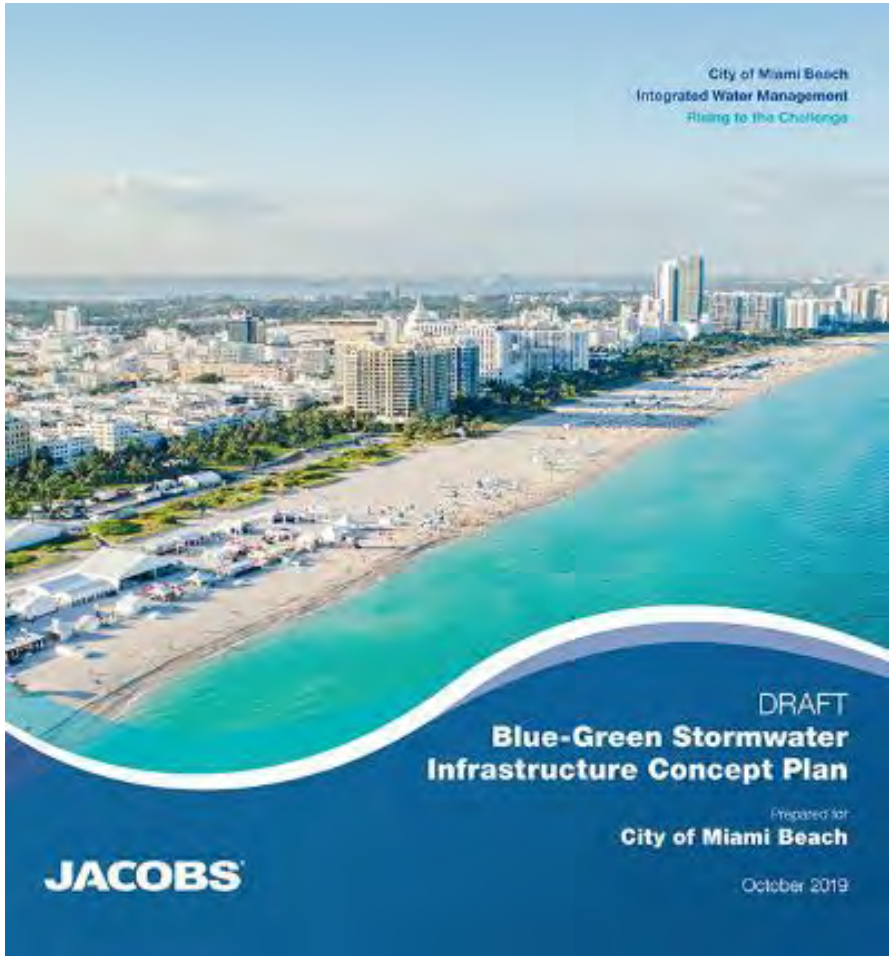
Source: Groundwater Elevation Monitoring and Mapping (E Sciences, 2014)

OUTLINE OF BGSI CONCEPT PLAN

- Introduction (Objectives, User's Guide)
- Miami Beach Context (land use, hydrology, topography, etc.)
- Blue-Green Infrastructure Practices and Strategies
  - 1-page Fact Sheets of Practices
  - 2-page Fact Sheets of Strategies/Scenarios
- Site Concepts and 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



Residential Rain Garden

Garden Apartments

ADDITIONAL BGSI FAQs

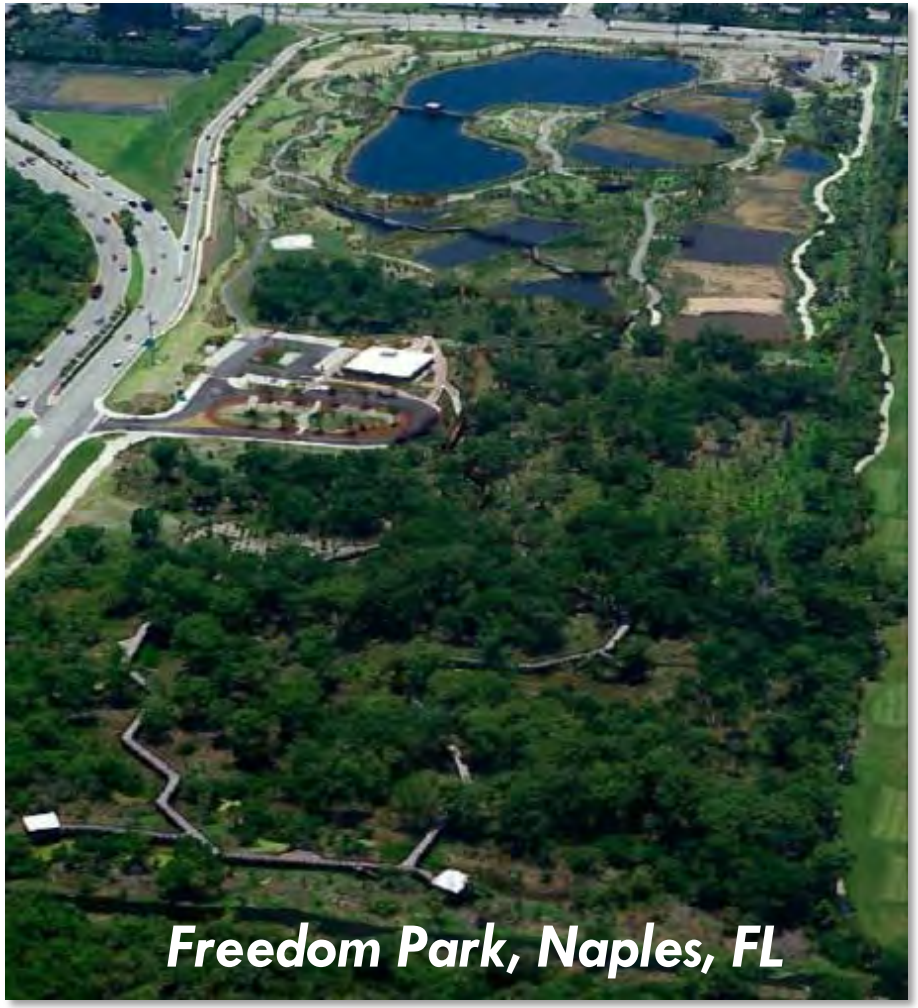
- How does BGSI get maintained?
- Will BGSI reduce recreational space?
- Where can I find more information on BGSI?
- How much will BGSI cost?
- What other City projects might incorporate BGSI?

HOW DOES BGSI GET MAINTAINED?

- BGSI practices require a **variety of maintenance activities** depending on the type of BGSI and site-specific factors
- Landscaped BGSI require maintenance **typical of other landscaped areas,** potentially including trash removal, pruning, weeding, and erosion repair
- Many BGSI practices include devices for pretreatment of runoff that require **periodic sediment and debris removal**
- Permeable pavements require the **surface to be cleaned** to prevent clogging

WILL BGSI REDUCE RECREATIONAL SPACE?

- Locations for BGSI in parks and other open spaces will be carefully considered to **minimize impacts** to the usage of the sites
- In many cases, BGSI may **serve both recreational and stormwater purposes** (for example, a permeable pavement basketball or tennis court)
- BGSI can also **enhance recreational spaces** by providing additional landscape features



Freedom Park, Naples, FL

HOW MUCH WILL BGSI COST?

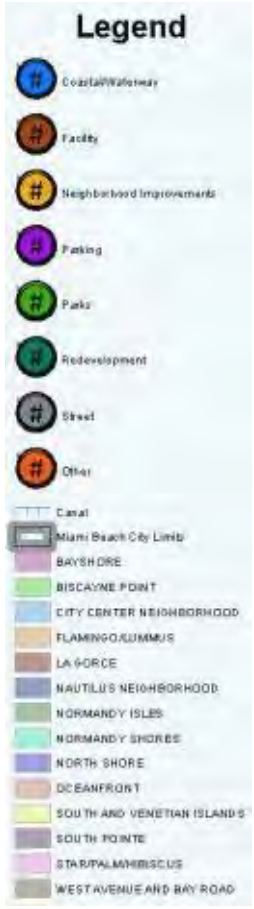
- BGSI is about **value**
- Specific BGSI project costs will be determined in future phases
- Costs vary greatly based on practice type, site conditions, sizing, type of site, etc.
- BGSI is less expensive when part of development/redevelopment vs. retrofitted in later
- Potential cost reduction strategies include:
  - Integrate with other infrastructure projects/planned improvements
  - Standardize designs and streamline implementation
  - Seek economies of scale through
    - Practices that hold a greater volume or manage larger drainage areas
    - By bundling projects
    - Through neighborhood-scale projects

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.

POTENTIAL BGSI *(INTEGRATED W/ PLANNED CITY PROJECTS)*



ADDITIONAL POTENTIAL BGSI *(INTEGRATED W/PLANNED TRANSPORTATION IMPROVEMENTS AND TRIANGULAR OPEN SPACES)*

WELCOME TO THE CITY OF MIAMI BEACH'S
RESILIENCE CONVERSATION SERIES ON

MIAMIBEACH
RISING
ABOVE

BLUE GREEN INFRASTRUCTURE

Did you know Miami Beach is implementing creative infrastructure techniques to mitigate flooding and improve our water quality as part of our Integrated Water Management Strategy?

Tonight, you'll get a sneak peek at the overall approach and draft concepts for specific projects.

1

Join us for a presentation to discuss the proposed approach to blue green infrastructure and the potential co-benefits for recreation and social spaces.

30 min.

2

Following the presentation there are displays of proposed concepts that could help our city live with water, including:

Small interventions that will be employed throughout the city, often on private property

Typical interventions that will be recommended in the City's upcoming Blue Green Infrastructure Concept Plan

+

Alternative conceptual designs for transformative, city-scale, blue green infrastructure projects.

These major projects are high-impact interventions, generally on public property

Share your thoughts by voting with dot stickers and writing your comments on the boards.

30 min.

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

BGI PLANT MATRIX

South Florida is home to a diverse and vibrant tapestry of plant communities and ecosystems. For implementing blue green infrastructure across Miami Beach, Florida-friendly plants are the perfect choice as they are **climate adapted**, excel at **ecosystem services** and enhance **sense of place**. The list below is a **summary of species** that may be used in the BGI program.

STRATEGIC VALUE

FLORIDA-FRIENDLY PLANTS FOR **BIORETENTION + BIOSWALE APPLICATIONS**

Conoclinium coelestinum
Blue Mistflower

Stachytarpheta jamaicensis
Blue Porterweed

Erythrina herbacea
Coralbean

Heliotropium angiospermum
Scorpion Tail

Tripsacum dactyloides
Fakahatchee Grass

Tripsacum floridanum
Florida Gamagrass

Muhlenbergia capillaris
Muhly Grass

Serenoa repens
Saw Palmetto

FLORIDA-FRIENDLY PLANTS FOR **CONSTRUCTED WETLANDS**

Ilex cassine
Dahoon Holly

Coccothrinax argentata
Silver Palm

Thrinax morrisii
Key Thatch Palm

Lysiloma latisiliquum
Wild Tamarind

Quercus virginiana
Live oak

Pontederia cordata
Pickerelweed

Nymphaea odorata
Fragrant Water Lily

Sagittaria latifolia
Arrowhead

Crinum americanum
Swamp Lily

Sagittaria lancifolia
Duck Potato

Eleocharis cellulosa
Spikerush

Eleocharis interstincta
Knotted Spikerush

Iris virginica
Blue Flag Iris

Canna flaccida
Golden Canna

Spartina bakerii
Sand Cord Grass

Taxodium ascendans
Pond Cypress

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BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

BGI PLANT MATRIX

South Florida is home to a diverse and vibrant tapestry of plant communities and ecosystems. For implementing blue green infrastructure across Miami Beach, Florida-friendly plants are the perfect choice as they are **climate adapted**, excel at **ecosystem services** and enhance **sense of place**. The list below is a **summary of species** that may be used in the BGI program.

STRATEGIC VALUE

FLORIDA-FRIENDLY PLANTS FOR **CONSTRUCTED SALT MARSHES AND MANGROVES**

Borrichia arborescens
Sea Ox-Eye

Helianthus debilis
Beach Sunflower

Heliotropium currasavicum
Seaside Heliotrope

Portulaca pilosa
Hairy Portaluca

Salicornia bigelovii
Glasswort

Strumphia maritima
Strumpfia

Juncus roemerianus
Black Rush

Spartina patens
Salt Marsh Cord Grass

Amphitecna latifolia
Black Calabash

Avicennia germinans
Black Mangrove

Languncularia racemosa
White Mangrove

Rhizophora mangle
Red Mangrove

Conocarpus erectus
Green Buttonwood

Conocarpus erectus var. sericeus
Silver Buttonwood

Coccoloba uvifera
Sea Grape

Coccoloba diversifolia
Pigeon plum

FLORIDA-FRIENDLY TREES FOR **URBAN CANOPY RESTORATION**

Acer rubrum
Red Maple

Codia sebestena
Geiger Tree

Quercus laurifolia
Laurel Oak

Pinus elliottii var. densa
South Florida Slash Pine

Bursera simaruba
Gumbo Limbo Tree

Ocotea coriacea
Lancewood

Krugiodendron ferreum
Black Ironwood

Swietenia mahagoni
American Mahogany

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MIAMIBEACH RISING ABOVE

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**

FLORIDA-FRIENDLY STREET TREES

NEIGHBORHOOD ACCESS

MANGROVE PLANTINGS

BIKE & PEDESTRIAN LANES

FLOATING BOARDWALK

MANAGED AQUATIC PLANT SYSTEMS

OLD ROADWAY ELEVATION

NEIGHBORHOOD LANDING PARK

PASSIVE RECREATION

SUBSURFACE INFILTRATION TRENCH

SUBSURFACE INFILTRATION WITH SUSPENDED PAVEMENT FOR TREE GROWTH

OVER FLOW THROUGH BULKHEAD WALL BEFORE AND BEYOND LANDINGS

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**

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

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MIAMIBEACH RISING ABOVE

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

COMMERCIAL STREET

STRATEGIC VALUE

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**.

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.

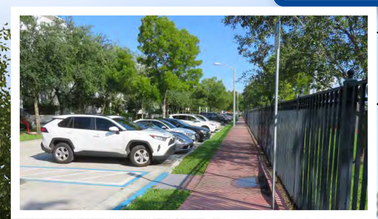
HOW IT WORKS

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

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MIAMIBEACH RISING ABOVE

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

MIAMI BEACH GOLF CLUB

The Art of the Possible - below are **three high-level scenarios** exploring the redevelopment of the Miami Beach Golf Club into a blue green infrastructure asset: 1) a **retrofit** scenario - keeping all eighteen holes; 2) a **repurpose** scenario - converting the back nine holes into a signature park; and 3) a **reimagine** scenario - converting the club into a central park with potential development opportunities.

STRATEGIC VALUE

1 RETROFIT

2 REPURPOSE

3 REIMAGINE

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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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MIAMIBEACH RISING ABOVE

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

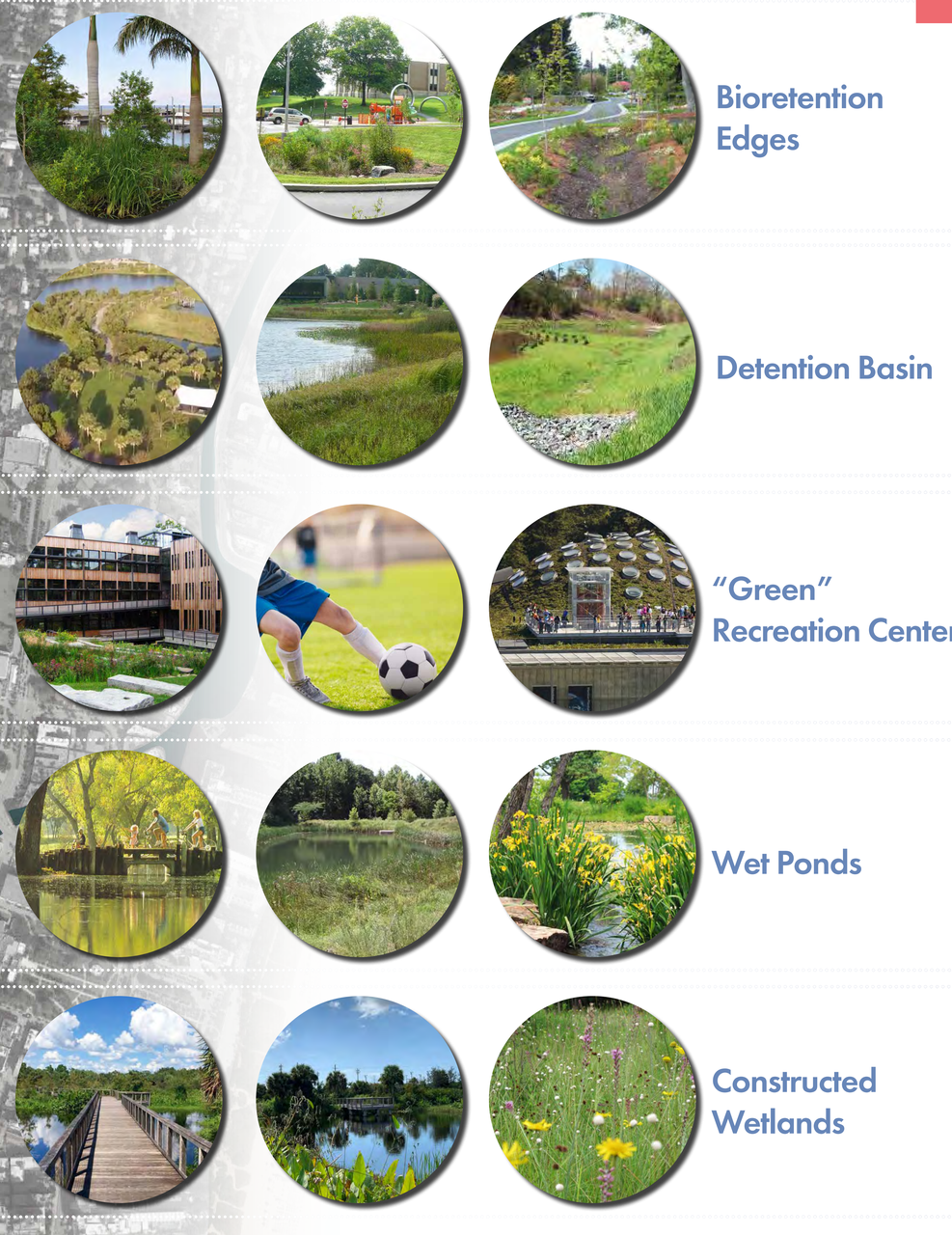
HOW IT WORKS

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.



Bioretention Edges

Detention Basin

"Green" Recreation Center

Wet Ponds

Constructed Wetlands

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.




Wetland Park




"Green" Edges




"Green" Recreation Hub




Living Machine Gardens




"Living with Water" Eco-District

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

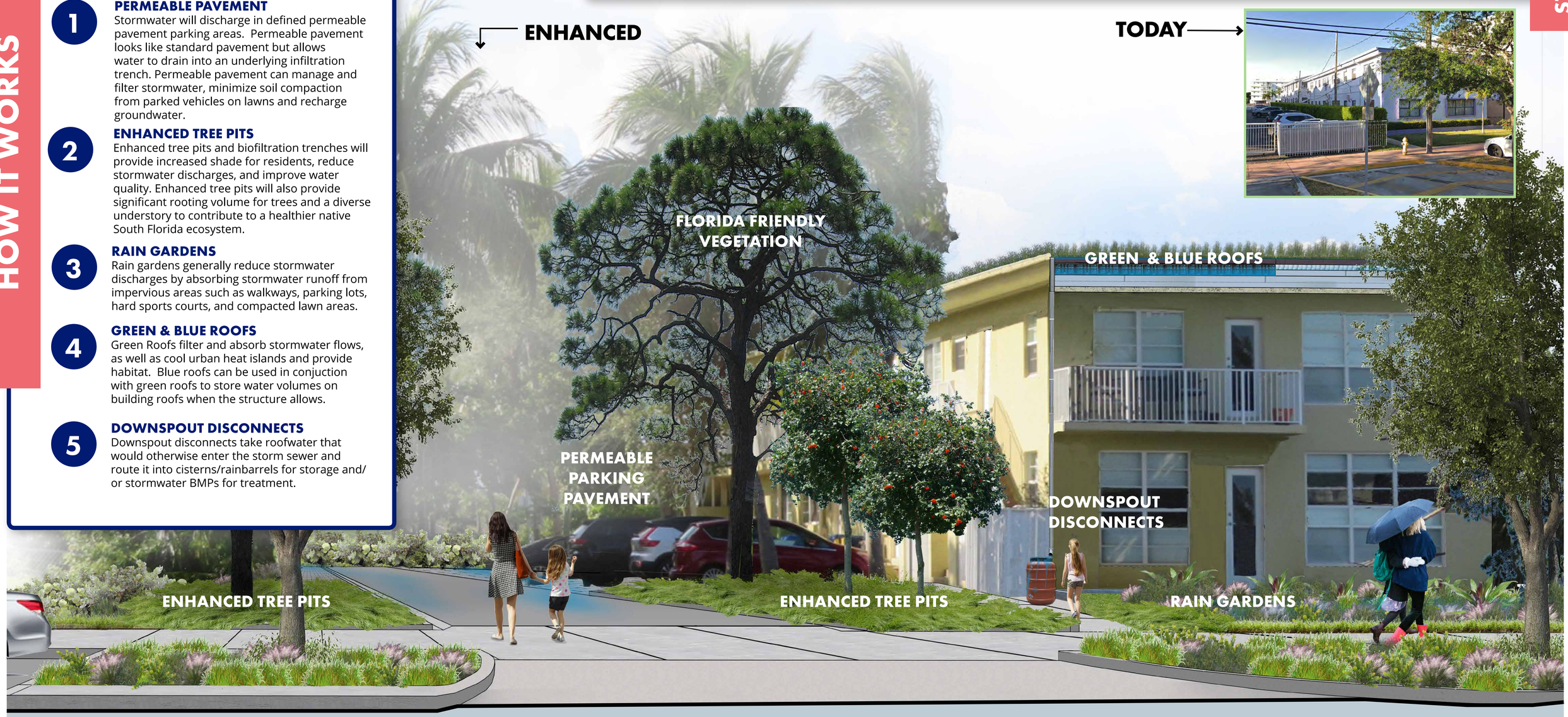
1 PERMEABLE PAVEMENT
Stormwater will discharge in defined permeable pavement parking areas. Permeable pavement looks like standard pavement but allows water to drain into an underlying infiltration trench. Permeable pavement can manage and filter stormwater, minimize soil compaction from parked vehicles 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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MIAMIBEACH RISING ABOVE

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

STREET ENDS

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.

STRATEGIC VALUE

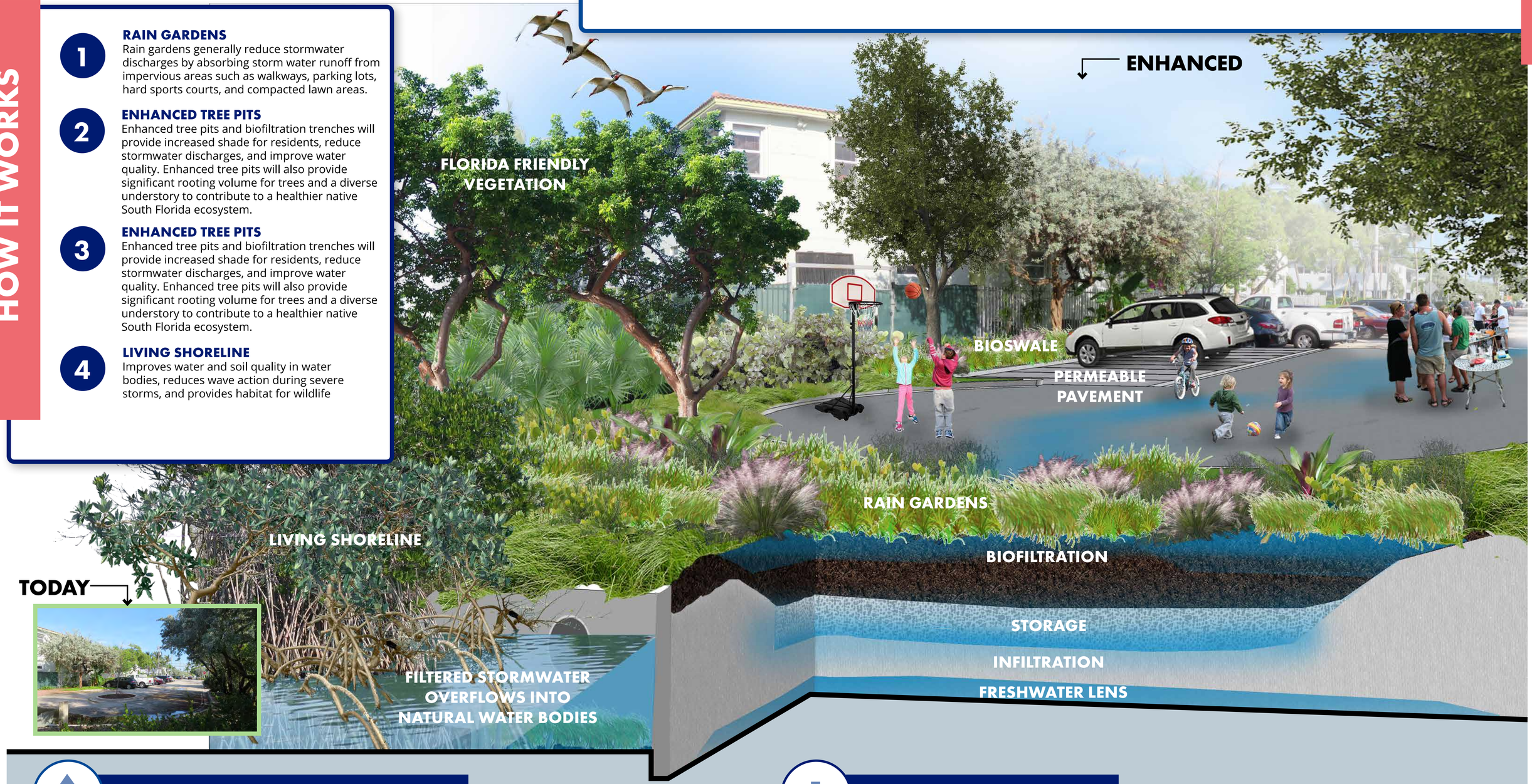
HOW IT WORKS

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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Miami Beach Integrated Water Management

Blue-Green Stormwater Infrastructure
Frequently Asked Questions

Document Version 3

City of Miami Beach

Contents

Frequently Asked Questions Concerning Blue-Green Stormwater Infrastructure

What is blue-green stormwater infrastructure?

Green stormwater infrastructure typically uses rainwater harvesting, vegetation, and/or soils to treat and reduce stormwater flows. Examples include bioretention (rain gardens) and permeable pavement.

Blue stormwater infrastructure temporarily stores and treats stormwater without significant reliance on vegetation. Examples are wet ponds and detention basins.

Blue-green stormwater infrastructure (BGSI) encompasses both green and blue stormwater infrastructure practices. Phrases like **low-impact development** techniques, sustainable site design, and **stormwater best management practices** have also been used to describe BGSI.

BGSI is typically designed and sized to capture the frequent storm events that make up most of the total rainfall in an average year (storms of up to 1.5 or 2 inches of rain). Extreme events that happen less frequently are often associated with flooding and will require larger stormwater infrastructure such as stormwater pump stations and conveyance systems to address them.

The focus of BGSI is the treatment and capture of stormwater runoff, therefore **BGSI is different from coastal strategies** (for example, living shorelines, dunes, mangrove plantings, and oyster or artificial reefs) that target coastal stressors like wave energy, sea level rise, and storm surges.

Why should we use BGSI?

BGSI can provide a range of both stormwater-related benefits as well as other community benefits. Stormwater benefits can include:

- Water quality improvement (more details under the next frequently asked question [FAQ])
- Groundwater recharge and replenishment of the freshwater lens under Miami Beach, helping to reduce saltwater intrusion and protect soils and tree roots from salt damage
- Some detention and flood mitigation benefits (particularly for thunderstorm-type nuisance flooding, more information follows under the FAQ “How will BGSI fit into the city’s flood mitigation strategies?”)

Other community benefits (also known as “co-benefits”) can include:

- Urban heat island mitigation
- Air quality improvement
- Climate resiliency
- Habitat creation and improvement
- Multiple other community benefits, including job creation, improved urban aesthetics, increased property values, improved pedestrian safety, and enhanced recreational spaces.

More details on the stormwater and community benefits are included in the next three (3) FAQs.

What are the water quality benefits of BGSI?

Protecting water quality for Miami Beach’s beaches and waterways is a priority as they provide habitat, a great quality of life, and opportunities for tourism. Stormwater runoff from urban areas can deliver pollutants—including bacteria/pathogens, nutrients (such as nitrogen and phosphorus), sediment, and

heavy metals—to waterways and beaches. Where these pollutants are present, BGSI can play an important role in partially removing them from the runoff.

BGSI reduces stormwater discharges by retaining rainfall. Lower discharge volumes translate into reduced pollutant loads. BGSI also treats stormwater that is not retained.[1] It should be noted that BGSI can only improve the quality of the water that it receives (that is, the runoff from the drainage area that it serves) and has the capacity to treat. Therefore, extensive BGSI coverage would typically be required to have significant overall pollutant load reductions.

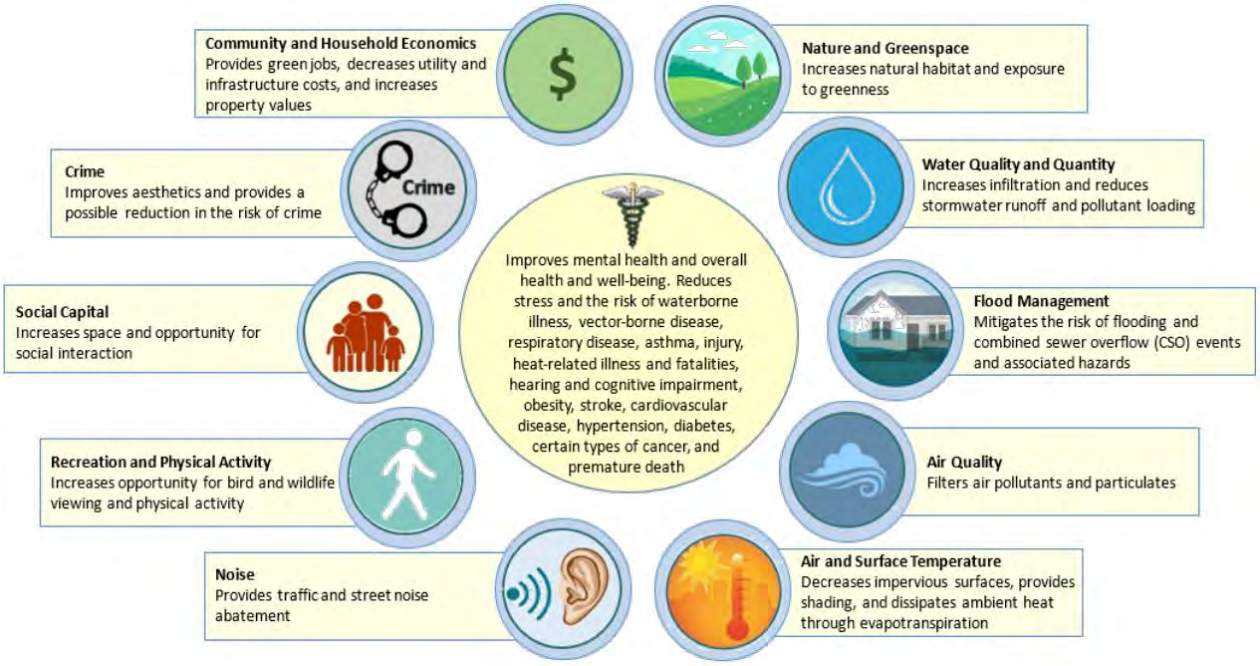
Like all infrastructure, BGSI must be designed, constructed, and maintained to function properly over the long term (for more on maintenance, see the FAQ "How does BGSI get maintained?").

How will BGSI fit into the city's flood mitigation strategies?

BGSI can complement "grey" infrastructure such as pipes and pumps. BGSI can provide some detention and flood mitigation benefits (particularly for thunderstorm-type nuisance flooding). Alone, BGSI will provide little or no benefit for "sunny day" flooding resulting from king tides, flooding from major rainfall events, or flooding caused by storm surge from the Atlantic Ocean or Biscayne Bay. BGSI is typically designed for storms of 2 inches or less (for the drainage area it serves), which is approximately 25 percent of the much larger storms typically used to size flood control systems, such as pipes and pumps.

What community benefits can BGSI potentially provide?

BGSI can potentially provide a suite of community benefits, as shown below in the graphic from the U.S. Environmental Protection Agency. The benefits vary significantly depending on the project location and setting, BGSI practice type(s), level of implementation, maintenance practices, etc.



Potential Environmental, Social, Economic, and Public Health Benefits of Green Infrastructure
Source: https://www.epa.gov/sites/production/files/2017-11/documents/greeninfrastructure_healthy_communities_factsheet.pdf

[1] U.S. Environmental Protection Agency. Benefits of Green Infrastructure. Accessed August 16, 2019. https://www.epa.gov/green-infrastructure/benefits-green-infrastructure

What BGSI practices are most applicable to Miami Beach?

A wide range of BGSI practice types were evaluated based on city/regional/national experience, stormwater performance, ease of implementation/maintenance, community/environmental benefits, cost efficiency, and climate change resilience. The recommended practices were determined to perform well across these areas and have potential applicability in Miami Beach given the local context (soil and groundwater conditions, land uses, development patterns, climate, etc.).

The most applicable BGSI practices are:

- Bioretention/Bioswales/Rain Gardens
- Blue and Green Roofs
- Constructed Wetlands/Floating Wetland Islands
- Detention Basins/Surface Storage
- Enhanced Tree Pits/Trenches
- Injection Wells (Pumped)[2]
- Permeable Pavement
- Rainwater Harvesting (Cisterns, Rain Barrels)
- Stormwater Planters
- Subsurface Infiltration and Storage
- Tree Canopy[3]
- 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.

What BGSI practices are less applicable to Miami Beach?

The following BGSI practices are less applicable to or less effective in Miami Beach due to their reduced water quality benefits, higher costs, lack of scalability, lower effectiveness when dealing with sea level rise and high tides, proprietary designs, limited applicability, or low storage capacities:

- Detention Tanks
- Exfiltration Trenches
- High-Flow Media Filters
- Living/Green Walls
- Gravity Wells
- Subsurface Flow Wetlands

Although not as readily applicable to Miami Beach, the above BGSI practices might still prove beneficial in certain settings.

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[2] Although not typically thought of as BGSI, injection wells are included here as they reduce the volume of stormwater discharged, and with proper pretreatment/filtration can provide water quality benefits.

[3] Trees are a key component of BGSI, and the City is developing an Urban Forest Master Plan to provide a strategic framework to guide the City in managing, maintaining, planting, and preserving its urban forest. See www.mbrisingabove.com/climate-mitigation/urban-canopy-2/urban-forestry-master-plan/.

What does BGSI look like?

BGSI can take many different forms, from landscaping elements such as rain gardens to permeable pavements that can look like normal pavements to wet ponds to blue and green roofs atop buildings. BGSI practices can vary from being dominant, high-profile features to blending in seamlessly with the surroundings. Some example images with established vegetation are provided on the next page (vegetated BGSI, like other landscaping, requires time to get established).

Where can BGSI be used?

BGSI can be used on and along roads, in parks and other open spaces, at schools and other public facilities, on rooftops, and on residential and commercial properties. Approximately 40% of Miami Beach is covered by impervious surfaces (buildings and pavements) that prevent water from percolating into the ground. BGSI should be employed to treat runoff from these impervious surfaces and help preserve, enhance, and increase the City's remaining pervious or "green" areas.

When choosing where to place BGSI practices, the following factors should be considered:

- Depending on the BGSI practice type, offsets from utilities, buildings, and other structures may be required to protect those features from water damage.
- Factors such as budget, permitting, site conditions, neighborhood preferences, and ownership will influence the location and types of BGSI.

A rendering of bioretention and permeable pavement on a typical residential street in Miami Beach

Examples of BGSI Applications

Pervious Concrete Parking Lot
Source: Jacobs

Wet Pond
Source: Southwest Florida Water Management District

Rain Garden
Source: Jacobs

Normal (left) and Porous Asphalt (Right)
Source: Jacobs

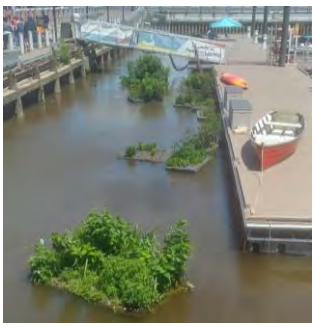
Infiltration Trench
Source: Jacobs

Blue-Green Roof Plaza
Source: Jacobs

Green Roof (in foreground) Adjacent to Marina
Source: Jacobs

Residential Rain Barrel
Source: Jacobs

Residential Rain Garden
Source: Jacobs



Floating Wetland Islands
Source: Jacobs

Stormwater Planter
Source: Jacobs

Permeable Paver Driveway
Source: Jacobs

Where is the City planning to implement BGSI?

The City is planning to implement BGSI along roads, in parks and other open spaces, and at public facilities. City projects currently under design with BGSI components include Maurice Gibbs Park, Community Park (former par 3 golf course), 59th Street bioswale, and 1st Street stormwater improvements. In addition, preliminary concept renderings have been developed for the following:

- Residential street
- Commercial street
- Neighborhood park
- Miami Beach Golf Course (three scenarios)
- Collins Canal
- Street end (where a street dead ends at a waterbody)
- Garden apartments

There is also an opportunity to make policy and code changes to further encourage and/or require public and private BGSI implementation.

How will BGSI function with rising sea levels and shallow groundwater?

Shallow and increasing groundwater elevations in portions of the City limit the soil storage capacity and infiltration required for *some* BGSI practices to function effectively. However, such limitations might potentially be overcome with underdrains, fill, and/or pumping. Other practices, such as wet ponds and constructed wetlands, can continue to function with shallow groundwater although their storage capacity may be reduced as groundwater levels increase. Blue and green roofs, rainwater harvesting, and floating wetland islands would typically not be impacted by rising groundwater.

How does BGSI get maintained?

BGSI practices require a variety of maintenance activities depending on the type of BGSI and site-specific factors. Landscaped BGSI requires maintenance typical of other landscaped areas, potentially including: debris and trash removal, pruning, weeding, replanting, erosion repair, and mulching. Many BGSI practices include devices for pretreatment of runoff that require periodic sediment and debris removal. Permeable pavements require the surface to be periodically cleaned (for example, with a street cleaning vehicle) to prevent clogging.

Who will do the maintenance for BGSI?

A variety of entities may be involved in BGSI maintenance depending on the situation. In parks and at other City-owned properties, the City would likely lead the maintenance activities (either with City staff or contractors) although they may be supported by residents and businesses through volunteer efforts, “Friends of” groups, “adopt-a-BGSI” programs, neighborhood associations, etc. Along commercial streets, business improvement districts and similar groups may lead maintenance activities. On private property, BGSI maintenance would be the responsibility of the property owner/manager. Maintenance procedures and responsibilities for BGSI on residential roads are still being formulated.

Will BGSI promote mosquito breeding and the spread of disease?

If properly designed, constructed, and maintained, BGSI should not promote mosquito breeding. BGSI systems that are not intended to have prolonged ponding should typically empty within 3 days (mosquitoes require standing water to be present for more than 7 days to grow). BGSI systems should be checked frequently to ensure they are emptying as expected. Systems that hold water for prolonged periods (for example, wet ponds, wetlands, and cisterns) must use other methods to prevent mosquito

growth, such as screening, establishing a natural predator population, and/or appropriate mosquito specific larvicides.

It should be noted that mosquitos are present in Miami Beach regardless of BGSI. Residents and visitors should take appropriate precautions to prevent getting bitten (for information from Miami-Dade County, see www8.miamidade.gov/global/solidwaste/mosquito/home.page).

Will BGSI reduce parking?

Impacts to parking will be evaluated and discussed with stakeholders on a project-by-project basis. However, BGSI is often strategically located in areas where parking is not permitted (for example, in swale areas, near fire hydrants and close to intersections). In many cases there are BGSI options that can be implemented (for example permeable pavements) that do not affect parking. Some BGSI systems may reduce parking along streets and in parking lots if areas along them are used for vegetated BGSI.

Will BGSI reduce recreational space?

Locations for BGSI in parks and other open spaces will be carefully considered to minimize impacts to the usage of the sites. In many cases, BGSI may serve both recreational and stormwater retention purposes (for example, a permeable pavement basketball or tennis court). BGSI can also enhance recreational spaces by providing additional landscape features.

What can the public do to promote BGSI in Miami Beach?

Private properties will be a key partner in the successful implementation of BGSI in Miami Beach. Residents and businesses can implement several types of relatively low-cost, low-maintenance BGSI practices on their properties, including rain gardens, trees, cisterns, and rain barrels. Property owners can maintain, preserve, and enhance their existing green space, trees, and roadside swales. In addition, the public may be able to volunteer to help protect and maintain City-installed BGSI practices through grassroots adoption programs, if those programs are developed.

Where can I find more information on BGSI?

More information can be found at the following links/sources.

Resource	Source/Location
MB Rising Above Website	www.mbrisingabove.com
Best Management Practices for South Florida Urban Stormwater Management Systems	www.sfwmd.gov/sites/default/files/documents/bmp_manual.pdf
Florida Field Guide to Low Impact Development: Bioretention Basins/Rain Gardens	buildgreen.ufl.edu/Fact_sheet_Bioretention_Basins_Rain_Gardens.pdf
Florida Field Guide to Low Impact Development: Green Roofs/Eco-roofs	www.buildgreen.ufl.edu/Fact_sheet_Green_Roofs_Eco_roofs.pdf
Florida Department of Transportation Drainage Design Guide (Injection Wells covered in Chapter 7)	fdotwww.blob.core.windows.net/sitefinity/docs/default-source/roadway/drainage/files/drainagedesignguide.pdf
Sarasota County Low Impact Development Guidance Document	www.scgov.net/home/showdocument?id=33258
University of Florida Soil and Water Sciences Video Topics: Green Stormwater Infrastructure	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	apirs.plants.ifas.ufl.edu/site/assets/files/372369/372369.pdf

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

Appendix C
BGSI Practices and Strategies Fact Sheets

Blue-Green Stormwater Infrastructure Practices

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 up to 2 to 3 days. 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 often found in stormwater runoff. Bioretention can take many forms including bioretention basins, bioswales (or bioretention swales), 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 (Source: Stephen Hofstetter, Alachua Co. Env.Protection Dept.)

Advantages

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

Potential Limitations

- 6 to 18 inches 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

Blue-Green Stormwater Infrastructure Practices

Blue and Green Roofs

Blue and green roofs provide stormwater storage on flat roofs or those with up to 30-degree slopes. If feasible, they can be especially useful in the areas of Miami Beach where ground-level BGSI practices are not feasible because of limited space, utility conflicts, and/or high groundwater. Blue and green roofs typically only capture direct rainfall and not runoff diverted from other areas but can still provide meaningful water quality and runoff reduction benefits. **Blue roofs** store water either directly on the roof or in chambers beneath raised decking. **Green roofs** (or *vegetated roofs*) consist of vegetation on top of several other layers (growing, drainage, and storage media) and are divided into three types, varying in their complexity and thickness: *extensive*, *semi-intensive,* and *intensive*. Extensive roofs are the lightest, simplest, and thinnest type of green roof, while intensive roofs are the most elaborately vegetated, attractive, and thickest type. Semi-intensive green roofs fall between extensive and intensive types.

Example of a green or "vegetated" roof (on roofs in the foreground)

Advantages

- Use a generally otherwise unused space with fewer conflicts than may be on the ground
- Reduce urban heat island and noise levels and provide potential energy savings for the building
- Provide enhanced site aesthetics, biodiversity, and wildlife habitat

Potential Limitations

- Roof must be capable of supporting additional weight, therefore it may be difficult to implement on existing buildings
- Reduced stormwater capture potential compared to other BGSI practices, as drainage area is limited to the roof area
- Potentially high maintenance needs until vegetation is established

Applicability

Blue and green roofs can be adapted to fit many different roof sizes, shapes, slopes (up to 30 degrees), weight limitations, and levels of wind exposure. Extensive systems can be used on roofs with more limited structural capacities, while intensive ones can be used on roofs capable of supporting more weight.

Potential Enhancements for Increased Performance

- Use a wide variety of different plants
- Modular/high-porosity media: increases storage capacity
- Integrating with rainwater harvesting to increase effectiveness and have a source of irrigation during dry periods

Example of a building with sections of both blue and green roof systems (Source: NYC Environmental Protection)

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

💧 = low 💧💧 = medium 💧💧💧 = high

Blue-Green Stormwater Infrastructure Practices

Constructed Wetlands/Floating Wetland Islands

Constructed wetlands are shallow marshes planted with native vegetation that improve water quality through plants absorbing pollutants in their roots (called *uptake*) and water evaporating to the atmosphere (called *evapotranspiration*). Constructed wetlands maintain a permanent water surface using flow control structures that regulate stormwater runoff discharges from the wetland. They remain constantly wet and are planted with Florida-friendly plants that thrive in such conditions. The plants provide natural filtration and treatment of stormwater runoff, removing many common pollutants like phosphorous and nitrogen that can degrade water bodies like Biscayne Bay. **Floating wetland islands** (FWI) are a type of constructed wetland that mimics natural aquatic ecosystems where emergent plants grow on the surface in floating mats. Over time, the plant roots grow beneath the mats in the water and improve water quality through biofilms that attach to the roots and through plant uptake. Wetlands are Florida's "original stormwater treatment systems" and both constructed wetlands and FWI have moderate to high applicability in Miami Beach.

Constructed wetland at Freedom Park, Naples, FL

Advantages

- Good water quality improvement benefits
- Enhanced aesthetics, biodiversity, and wildlife habitat
- Wetlands are good for sites with high groundwater; FWI provides treatment in without additional land areas (since they are located in the ponds or channels)

Floating wetland islands at Homosassa Springs, FL

Potential Limitations

- Higher maintenance until plants are established
- Requires larger land area than other BGSI practices (or an open waterbody or channel for FWI systems)
- If not designed, installed, and maintained correctly, can promote mosquito breeding

Applicability

Constructed wetlands are best suited for locations that have lots of land, a relatively large contributing drainage area, and high groundwater. Soil type will also impact applicability, with loamy and silty soils typically being the most ideal for establishing wetland vegetation.

Potential Enhancements for Increased Performance

- Real-time controls: dynamic, predictive technology that controls flows in/out of system, improving storage efficiency
- Can be designed with additional storage capacity to aid with flood reduction
- Consider the use of an iron enhanced sand filter for additional nutrient removal

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

Blue-Green Stormwater Infrastructure Practices

Detention Basins/Surface Storage

Detention basins are dry ponds that fill up with stormwater runoff during rain events. Stormwater is then slowly released (over 2 to 3 days) to minimize downstream flooding. They're typically geared more towards flood control than improved water quality. However, they can be enhanced with native vegetation and configured as "infiltration basins", if conditions allow.

Detention basin planted with dense native vegetation and designed for infiltration

Surface storage facilities, like detention basins, can provide some flood protection benefits, especially in the low-lying areas of Miami Beach where working below ground is challenging due to high groundwater conditions. Through subtle integration into the existing landscape, especially at parks/open spaces, surface storage can be blended into the site, appearing as dry and usable space most times and filling up during rain or high water events. By directing stormwater to sites with detention basins or surface storage, other parts of the City could experience reduced flooding.

Advantages

- Potentially significant flood control benefits
- Typically less costly to construct compared to other BGSI practices
- Potentially allows for the "dual use" of stormwater capture and recreation

Potential Limitations

- Larger storage volumes for flood control require more land area
- Provides less freshwater lens recharge and low water quality improvements
- Since it involves temporarily flooding public land, requires community acceptance and education

Example of a plaza designed to provide temporary surface storage during storm events (Source: De Urbanisten)

Applicability

Detention basins are best suited for locations with lots of open land and a relatively large contributing drainage area (at least 10 acres). Surface storage facilities are most applicable where it is acceptable to construct perimeter earthen berms (or similar structures) for temporary surface inundation.

Potential Enhancements for Increased Performance

- Real-time controls: dynamic, predictive technology that controls flows in/out of system, improving storage efficiency
- Can be designed as "infiltration basins", as well as vegetated with Florida-friendly plants to improve water quality

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

Blue-Green Stormwater Infrastructure Practices

Enhanced Tree Pits/Trenches

Enhanced tree pits/trenches combine the stormwater capture benefits of sub-surface infiltration/storage systems with the water and air quality benefits of trees. This BGSI practice can be subtly integrated into most sites, appearing as either a single tree (pit) or a row of trees (trench) in pavement, lawn, or landscaping. These structures typically capture stormwater runoff that is piped in from street or parking lot drains or runoff that flows through permeable pavement. The runoff then slowly enters the underlying soil (called *infiltration*) or drains into the City's drainage system within 2 to 3 days. Trees selected for these systems are hardy Florida-friendly species that can withstand both extended dry and wet conditions. Tree pits/trenches are well suited to the look and feel of Miami Beach because they can help maintain a high visual appeal.

Example of an enhanced tree trench with permeable pavers

Typical enhanced tree trench section using suspended pavement system/ modular soil cells (Source: Viridian Landscape Studio)

Advantages

- Increased tree canopy, evapotranspiration (water evaporating into the air), and site aesthetics, as well as reduced urban heat island
- Flexibility to be configured and sized for a variety of specific site conditions
- Can be integrated with planned streetscape or utility improvements to reduce construction cost

Potential Limitations

- 6 to 18 inches of separation to groundwater recommended
- Utilities in sidewalks should be avoided/protected
- Regular watering required until trees are well rooted and established

Applicability

Enhanced tree pits/trenches are applicable on most streets, commercial/public facilities, parking lots, and open spaces in Miami Beach where their use would not hinder vehicular or pedestrian circulation. They are often most effective when seamlessly integrated into streetscapes or within parking lot islands and can also work well with road raising, which creates the opportunity for greater stormwater storage capacity above groundwater.

Potential Enhancements for Increased Performance

- Sand-based structural soil or suspended pavement system with modular soil cells: increases rooting volume and enhances tree health/longevity
- Modular/high-porosity media: increases storage capacity
- Underdrains (if needed): allow systems to drain and minimize the time tree roots are kept saturated (overly wet)

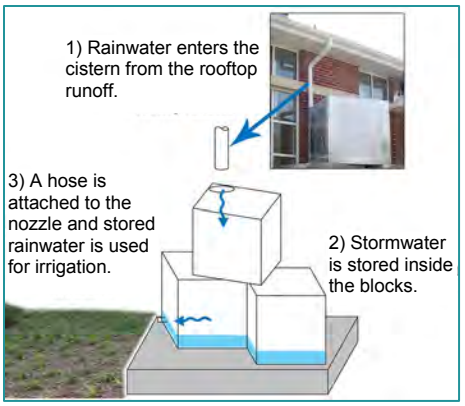
Performance		Implementation		Community/Environmental		Other	
Water Quality	💧💧💧	Capital Cost	💧💧💧	Improved Aesthetics	💧💧💧	Climate Change Resilience	💧💧💧
Freshwater Lens Recharge	💧💧	Maintenance Cost	💧💧	Dual Use	💧💧	Mosquito Vector Resistance	💧💧💧
Flood Mitigation	💧	Scalability	💧💧💧	Habitat Creation	💧◖		
		Constructability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

💧 = low 💧💧 = medium 💧💧💧 = high

Rainwater Harvesting

Rainwater harvesting involves capturing rainwater from roofs or other surfaces and reusing it as an alternative or supplement to *potable water* (water that is safe to drink/use). Rainwater harvesting systems intercept water, typically from roof drains, before it drains to municipal stormwater pipes and store it in either rain barrels (above ground) or in *cisterns* (water storage tanks above or below the ground). Rain barrels and cisterns are made from a variety of materials (wood, concrete, plastic, fiberglass, etc.) and the water they store can be reused for non-potable applications, such as landscape irrigation or toilet flushing. Although stormwater benefits can be limited when the systems are partially full, they also can reduce potable water use, which lowers both individual water bills and the demand on the public water system.

This cistern at a restaurant reuses roof runoff to irrigate a vegetable garden in a raised planter (also shown)



Schematic/photo of an artistic cistern at a library used for landscape irrigation

Advantages

- Wide applicability with respect to different types of roofs and storage options (type, size, shape, and location – above or below ground, inside or outside)
- Can be integrated with site features, such as artwork, stairs, and benches
- Less impacted by high groundwater in Miami Beach

Potential Limitations

- Requires space to install storage system and a use for the captured rainwater
- Typically sized for smaller rainfall events (to refill often) and therefore may need to be coupled with other BGSI practices
- Depending on the anticipated use of rainwater (for example, toilet flushing) and/or the source of runoff (whether roof or other surface), enhanced treatment, permitting, or additional maintenance may be required

Applicability

With its ability to fit many shapes, sizes, and aesthetic standards, rainwater harvesting has wide applicability in Miami Beach. Implementation can range from small aboveground rain barrels used for landscape irrigation at homes to larger above/belowground cisterns used for toilet flushing or other non-potable uses at commercial or public facilities. Many other factors influence applicability and feasibility, including accessibility of roof drains, demand for harvested rainwater, and size of the area generating runoff.

Potential Enhancements for Increased Performance

- Water treatment systems (filtration and/or disinfection) or “first flush” diverters: improve pollutant removal and allow more applications for water re-use (toilet flushing)
- Real-time controls: dynamic, predictive technology that controls flows in/out of system, improving system efficiency

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

💧 = low 💧💧 = medium 💧💧💧 = high

Blue-Green Stormwater Infrastructure Practices

Subsurface Infiltration/Storage

Subsurface infiltration/storage systems temporarily hold stormwater runoff underground in material like gravel, high-strength plastic boxes/arches, large-diameter pipes, and concrete chambers. This allows the stormwater to be detained until it either infiltrates into the soil or drains into Miami Beach's existing drainage system, emptying within 2 to 3 days. The systems can be placed under almost any type of finished surface, whether pavement, grass, landscaping, or other material and are often "fed" by surface drains and pipes or potentially by pumping from other (lower) areas.

Subsurface infiltration/storage system with plastic chambers being installed along with the raising of a playfield at a school

Advantages

- Depending on the storage media, potential to capture large volumes of stormwater runoff and thus reduce localized flooding (caused by rainfall)
- Freshwater lens recharge
- Allows for the "dual use" of stormwater capture and a variety of surface treatments such as pavement (including raised roads), lawn, and landscaping

Typical cross-section for subsurface infiltration/storage system filled with gravel

Potential Limitations

- 6 to 18 inches of separation to groundwater recommended for infiltration (from bottom of system)
- Given the high groundwater conditions common in Miami Beach, these systems would typically need to be constructed near or above the existing ground elevation, which could limit the amount of water they capture without pumping
- Depending on site conditions, pretreatment structures (filters, sediment storage chambers, etc.) intended to capture trash, sediment, and other materials with high clogging potential may require frequent maintenance

Applicability

These practices are applicable to locations in Miami Beach with adequate separation between their lowest elevations and groundwater, or in those areas where such separation could be achieved by raising the ground surface and installing them at or above the existing ground surface. These practices can be readily combined with other BGSI practices, such as permeable pavement, bioretention, and rainwater harvesting.

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: increase storage capacity
- Sand (or other media) filter layer at bottom to enhance pollutant removal, especially when close to groundwater

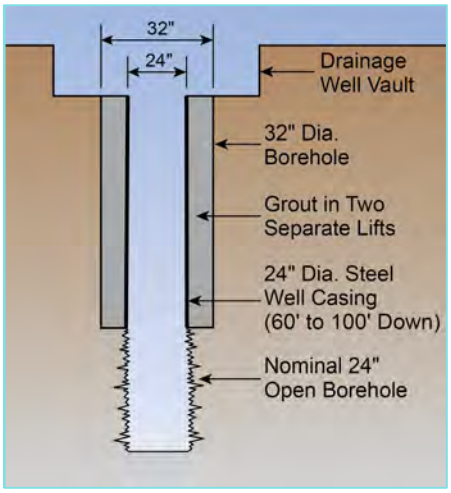
Performance		Implementation		Community/Environmental		Other	
Water Quality	💧💧	Capital Cost	💧💧💧	Improved Aesthetics	💧	Climate Change Resilience	💧💧
Freshwater Lens Recharge	💧💧💧	Maintenance Cost	💧	Dual Use	💧💧💧	Mosquito Vector Resistance	💧💧💧
Flood Mitigation	💧💧	Scalability	💧💧	Habitat Creation	💧		
		Constructability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

💧 = low 💧💧 = medium 💧💧💧 = high

Blue-Green Stormwater Infrastructure Practices

Stormwater Injection Wells (Pumped)

Stormwater injection well systems collect stormwater runoff in an underground tank or basin and pump the water to one or several shallow injection wells. The systems don't treat stormwater before it enters the aquifer but often contain baffles or other devices that settle debris and grit before pumping. In the City of Miami Beach, most injection wells consist of a 24-inch-diameter steel casing set to a depth between 60 and 100 ft below the ground, with the open space around the casing grouted to the land surface. Injection wells in the City typically feature open-hole construction in the Biscayne Aquifer, drilled to depths of 80 to 200 ft. In southern and central portions of the City, the aquifer is composed of coralline limestone that receives water at rates over 1,000 gallons per minute (gpm). While injection wells don't provide all the stormwater and community benefits of the other recommended BGSI practices, they can still prove beneficial in the City.



Typical pumped injection well section

Example of a small injection well installation

Advantages

- Can help manage flooding during moderate storms or during the rainy season
- Where the capacity to absorb is high, gets rid of stormwater runoff rapidly
- Occupy little space, once wells and collection systems installed
- May help recharge the freshwater lens from below in areas where present

Potential Limitations

- Sea level rise makes stormwater injection more difficult/less effective
- The ability to absorb water (called *permeability*) of the Biscayne Aquifer declines in northern portions of the City, limiting injection to about 50 gpm
- May require annual maintenance to remove debris and prevent clogging
- Reliance on collection and pumping systems to deliver water to wells

Applicability

Injection well systems work most effectively in the southern and central portions of the City, where the aquifer is highly absorbent. Injection wells offer an alternative method of disposing stormwater runoff from roofs, parking lots, streets, and other non-porous (*impermeable*) surfaces.

Potential Enhancements for Increased Performance

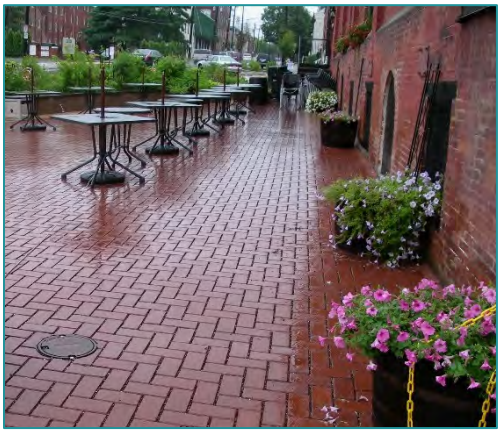
- Enhanced pretreatment and storage before injection reduces chances of clogging in injection wells
- Maximizing the length of the open interval increases potential disposal rates
- Regular well rehabilitation can restore injection well performance to near-new levels

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

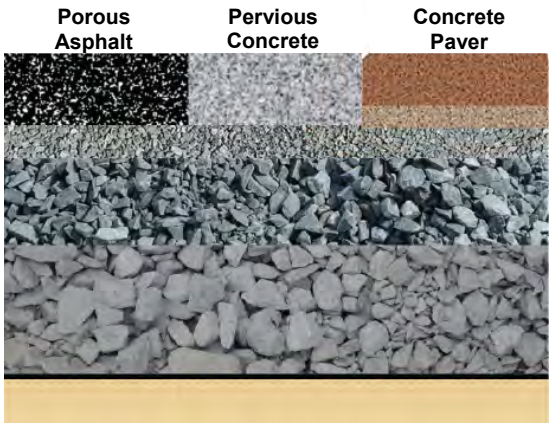
💧 = low 💧💧 = medium 💧💧💧 = high

Permeable Pavement

Permeable pavement often looks like ordinary pavement but allows stormwater to drain through it and into an underlying storage system (or *reservoir*). The storage reservoir under the permeable pavement provides a place for the stormwater to be retained until it can infiltrate into the soil, filtering out pollutants in the process. The storage reservoir typically consists of clean and evenly sized stone that can store water in its gaps (typically 40 percent of its volume), though pipes or different types of chambers (plastic or concrete) can also be used to increase storage capacity. A variety of permeable pavement types can used depending on the specific characteristics of a site including concrete, asphalt, paver blocks, and reinforced turf or gravel systems, among others. Permeable pavement has high applicability in Miami Beach, where it can reduce stormwater that would otherwise run off pavement surfaces and into streets, private properties, or receiving waters like Biscayne Bay.



Permeable paver in outside dining area



Typical permeable pavement cross section for common pavement types (Source: Eban Bean, UF/IFAS)

Advantages

- Stormwater runoff capture and freshwater lens recharge
- Versatile, with broad applicability
- Allows for "dual use" of hard surface and stormwater capture

Potential Limitations

- 6 to 18 inches of separation to groundwater recommended (from bottom of stone subbase)
- Careful design, construction, and maintenance necessary to ensure long-term performance
- Permeable pavements not suitable for all sites (for example, high-speed roadways or certain land uses with high potential pollutant loads like gas stations)

Applicability

Permeable pavement provides stable and reliable surfaces for vehicles and pedestrians, while providing freshwater lens recharge, water quality benefits, and even localized flood reduction. Permeable pavement is well suited for parking lots (especially the parking spaces), bike/walking paths, sidewalks, playgrounds, plazas, tennis or basketball courts, and other similar uses. It can also be used on low-volume (minimally used) residential roadways and/or parking lanes.

Potential Enhancements for Increased Performance

- Real-time controls: dynamic, predictive technology that controls flows in/out of system, improving storage efficiency
- 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

Blue-Green Stormwater Infrastructure Practices

Stormwater Planters

Stormwater planters are similar to bioretention facilities; both are sunken landscape beds containing Florida-friendly plants in a special soil mix (called *engineered soil*) that sit above a gravel drainage layer. But unlike bioretention facilities, stormwater planters are enclosed by concrete, brick, wood, or other materials, and can be placed either above or below the ground elevation. Depending on the specific site conditions, they can be either flow-through or infiltration planters. **Flow-through planters** typically have sealed bottoms to detain water for up to 3 days. **Infiltration planters** have open bottoms to allow water to enter (or *infiltrate*) the soil beneath the planter. Both provide filtration and treatment of stormwater runoff, which flows into them from nearby paved areas, such as sidewalks or roadways, or is piped in from roof downspouts. Because stormwater planters are irrigated by rainfall, they can provide a more sustainable alternative to traditional landscaping that uses *potable* water (water that's safe to drink).

Stormwater planter between a sidewalk and roadway

Advantages

- Flow-through planters can be placed in areas of the City with high groundwater
- Flexible design allows them to be elevated and/or configured to fit in tight spaces
- Increased water quality, as well as enhanced site aesthetics and biodiversity

Potential Limitations

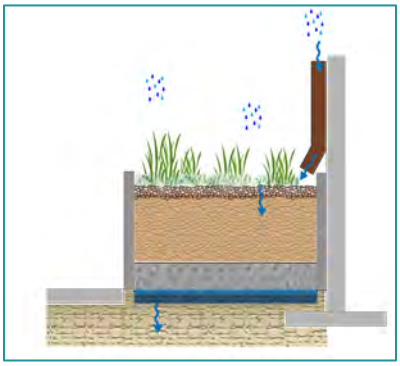
- 6 to 18 inches of separation to groundwater recommended for infiltration planters
- Higher maintenance until plants are established, and regular maintenance after
- Utilities in roadway and sidewalks should be considered

Applicability

Stormwater planters are highly applicable throughout Miami Beach as they can be placed along many roadways, sidewalks, and parking lots, as well as adjacent to buildings where they can capture roof runoff. Planters can often be installed in conjunction with planned sidewalk or roadway improvements, including road raising.

Potential Enhancements for Increased Performance

- Modular/high-porosity media: increases storage capacity
- Engineered soil enhancements/high-flow filter media: improve pollutant removal, increase surface infiltration rates
- Underdrains: allow systems to drain within 72 hours
- Enhanced pretreatment (for example, screens/filters to pretreat roof runoff)
- If possible, elevate planters in areas with high groundwater



Typical cross-section of an elevated stormwater planter against a building, with roof leader, surface depression, Florida-friendly plants, engineered soil, and gravel layer

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

Blue-Green Stormwater Infrastructure Practices

Wet Ponds

Wet ponds are among the most recognizable BGSI practices in Florida. They accept and hold stormwater runoff long enough to allow pollutants to settle out, resulting in cleaner water. Wet ponds are designed to maintain a permanent water surface (or *permanent pool*) through flow control structures that regulate discharge from the pond. Aeration systems are often installed in wet ponds to introduce oxygen into the water, which encourages growth of beneficial aerobic bacteria that consume nutrients and improve water quality. Water quality can also be improved by placing aquatic and wetland plants around the pond perimeter or on floating wetland islands. Vegetation filters runoff and helps reoxygenate the water, which further improves water quality. Vegetation also provides habitat for fish and other aquatic organisms.

Wet pond in Naples, Florida

Advantages

- Good water quality improvement benefits
- Good option for sites with high groundwater
- Potential for enhanced site aesthetics, biodiversity, and wildlife habitat opportunities

Rendering of a wet pond in a Miami Beach park that will capture and store neighborhood stormwater (Source: Savino & Miller Design Studio)

Potential Limitations

- Larger storage volumes for the permanent pool and flood control require more land area.
- Infiltration and freshwater lens recharge are minimal, and so runoff volume reduction is minimal.
- Invasive species and vector control are often necessary.

Applicability

Wet ponds are best suited for locations with large open areas, a relatively large contributing drainage area, and high groundwater conditions. They are generally implemented in residential, commercial, or open space areas. Some of the existing water features at golf courses may function as, or could potentially be converted to, wet ponds. Ponds can be lined to help address soil/groundwater contamination concerns.

Potential Enhancements for Increased Performance

- Real-time controls: dynamic, predictive technology that controls flows in/out of system, improving storage efficiency
- Can be designed with additional storage volume to help reduce flooding (often called an *extended-detention wet pond*)

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

Blue-Green Stormwater Infrastructure Strategies

Commercial and Public Facilities

BGSI has wide applicability at Miami Beach's many commercial and public facilities, whether they are sites dominated by buildings, sites that balance buildings with other needs (such as parking and landscaping), schools and other educational facilities, parking garages, or other facilities. These locations range from highly visible and visited (schools, apartment buildings, and restaurants) to more utilitarian (storage/maintenance yards and police/fire stations).

Various BGSI practices can be applied at these facilities, with careful consideration given to their specific opportunities and constraints. While some facilities may only be able to capture their own stormwater runoff, other facilities—especially larger public ones—may be able to capture significant volumes from adjacent areas.

Bioswale adjacent to a public library

Advantages

- Improved commercial or public spaces through aesthetics, amenities, site restoration, and/or increased tree canopy
- Improved water quality, reduced stormwater runoff volume, and increased freshwater lens recharge
- Reduction of urban heat island
- Potential to capture large volumes of stormwater and thus reduce localized flooding
- High visibility/educational value
- Dual-use opportunities (for example, permeable pavement parking areas)
- Other potential advantages for BGSI at buildings: reduced *potable* water use (water that's safe to drink) and reduced need for cooling (less energy use)

Potential Limitations

- Accessibility and public safety concerns, especially at schools
- Cost of implementation
- Due to flat topography, directing runoff into public facilities can be challenging
- Capturing roof drainage might be challenging due to inaccessible downspouts
- Limited maintenance capabilities (budget, experience, and/or resources) depending on owner
- Construction and maintenance activities might need to be scheduled around operating hours, especially at schools
- Other limitations: building utilities, structural loading capacity (for blue or green roofs), limited ground space (for other types of BGSI practices), future expansion/redevelopment plans, etc.

Applicable Practices

Applicable to Most Sites	Applicable to Some Sites	Limited Applicability
Bioretention/Bioswales (except parking garages, which have limited applicability)	Blue & Green Roofs (limited to sites with suitable buildings)	Constructed Wetlands
Injection Wells	Enhanced Tree Pits/Trenches (site perimeter)	Detention Basins/Surface Storage
Rainwater Harvesting	Permeable Pavement	Wet Ponds
Stormwater Planters	Subsurface Infiltration/Storage	

Facilities with Building Coverage Greater Than 90% of the Site

Many commercial and public facilities with large building footprints and thus limited ground space present unique challenges for BGSI. BGSI practice feasibility generally depends on the type of building, the accessibility of its roof drains (whether they are internal or external to the building), and even its water demand (if considering rainwater harvesting and reuse). Blue and green roofs can be well suited to these sites if the roof is able to support them. Stormwater planters can be placed against exterior building walls if there is space and roof drains are external or can be re-directed. *Cisterns* (water storage tanks) can also be placed next to buildings or even in unused spaces inside them to allow rainwater to be harvested for non-potable uses like toilet flushing and/or landscape irrigation. In some cases, opportunities for managing runoff outside the parcel (for example, in the right-of-way) should be explored.

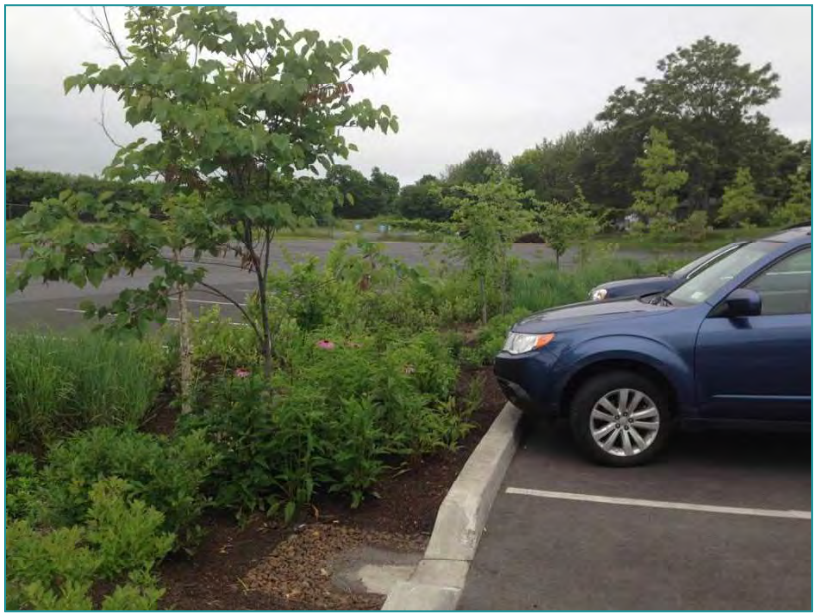
New World Symphony Building

Vegetated rooftop plaza

Facilities with Building Coverage Less Than 90% of the Site

Commercial and public facilities with a smaller percentage of building space and larger areas for parking, walkways, landscaping, courtyards, or other uses provide many opportunities to integrate BGSI and enhance their use and aesthetics. Existing green spaces at such sites may be well suited to BGSI practices, such as bioretention/bioswales, enhanced tree trenches, stormwater planters, subsurface infiltration/storage, and constructed wetlands (though on a much more limited basis). Parking lots—especially relatively large ones, those with minimal underground utilities, and those without significant landscaping or trees—are ideal candidates for BGSI implementation and for maximizing capture of stormwater runoff generated both within and potentially outside the site. Permeable pavement and subsurface infiltration/storage systems can be cost-effectively coupled with parking lot repaving or reconstruction efforts. Bioswales and enhanced tree trenches can be incorporated into islands, no parking zones, or in paved areas slated for removal (based on a reduced need for parking). In some cases, parking lots (or portions of them) can be allowed to temporarily pond, providing surface storage.

Scott Rakow Youth Center Parking Lot



Bioswale in a parking lot

Schools

Miami Beach's schools and other educational institutions provide many compelling opportunities for BGSI in ways that potentially enhance their value. Such sites typically have ample areas for recreation and/or parking. These sites can typically be feasibly, safely, and cost-effectively adapted for a variety of BGSI practices, especially bioretention, permeable pavement, and subsurface infiltration/storage. In addition to managing stormwater generated onsite, BGSI at schools can often be made large enough to capture stormwater runoff from adjacent areas. These sites can also provide unique opportunities to educate students and the public about BGSI (for example, educational signage and observation platforms) and to demonstrate different BGSI technologies and variations (for example, interactive rainwater cisterns). Such demonstrations can give the City useful and practical information that yields more streamlined and cost-effective BGSI projects in the future.

Miami Beach Senior High School

Bioretention (above middle) and permeable pavement (asphalt) parking lot at school sites

Parking Garages

Similar to locations dominated by buildings, Miami Beach's parking garages provide both significant challenges to BGSI implementation and also unique opportunities to use practices with more limited applicability at other sites. In general, if there is sufficient space (especially landscaping) next to parking garages, the most suitable (and cost-effective) BGSI practices are bioretention/bioswales or stormwater planters. For sites that are more constrained (and more likely in Miami Beach), exterior practices such as permeable pavement or subsurface infiltration/storage may prove feasible if roof drains are accessible. Otherwise, practices such as blue roofs (possibly on the upper-most parking level), green roofs (on non-parking areas or canopies on the upper-most parking level), or rainwater harvesting cisterns (placed in unused space and assuming there is a demand for such water) could be further explored.

Parking garage in Miami Beach

Bioretention adjacent to parking garage

Blue-Green Stormwater Infrastructure Strategies

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.

Bioretention adjacent to a permeable asphalt basketball court at a public park

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 urban areas and sites with large drainage areas
- Diverse and sometimes unpredictable usage and preferred pathways for park visitors
- Due to flat topography, directing runoff into parks can be challenging
- Working around public art/monuments and existing vegetation, especially trees

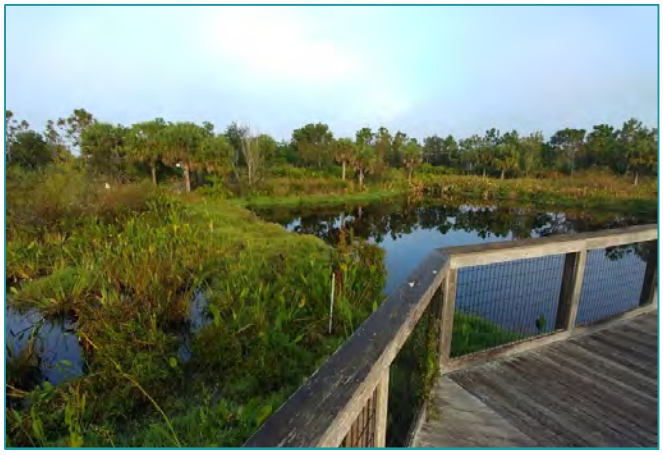
Applicable Practices

Applicable to Most Sites	Applicable to Some Sites	Limited Applicability
Bioretention/Bioswales	Constructed Wetlands	Blue & Green Roofs (limited to sites with suitable buildings, but have high educational value)
Detention Basins/Surface Storage	Enhanced Tree Pits/Trenches (site perimeter)	
Injection Wells	Permeable Pavement	
Subsurface Infiltration/Storage	Rainwater Harvesting	
	Stormwater Planters	
	Wet Ponds	

Golf Courses

By their size and open nature, Miami Beach's two public golf courses (Miami Beach and Normandy Shores Golf Courses) 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 surrounded by perimeter earthen berms. Wet ponds can store and treat water before it is used for irrigation.

Miami Beach Golf Course



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

Parks

Miami Beach's larger parks provide a wide variety of opportunities for virtually all types of BGSI practices. BGSI can be integrated into the corners, edges, and other underutilized areas of parks to both enhance and avoid disrupting existing uses—from larger practices like wet ponds and constructed wetlands to smaller practices like bioretention and bioswales. Permeable pavements can provide dual-use benefits by creating stable surfaces for basketball courts, tennis courts, and walkways, while also capturing stormwater. Detention basins/surface storage can also allow dual use by temporarily storing water on depressed athletic fields or those enclosed by perimeter earthen berms. Some parks can be raised off the ground to create significant underground storage of water that is piped in from outside the site.

Fairway Park

Bioretention facility near the entrance to a public park

Pocket Parks/Plazas

By definition pocket parks and plazas are the most space-limited recreational areas. However, Miami Beach's pocket parks and plazas provide ample opportunities for BGSI. For pocket parks with little green space and dominated by hardscape surfaces, such as pavement or pavers, BGSI practices such as permeable pavement and subsurface infiltration/storage facilities are most applicable. Another option for such sites is to turn them into "water plazas" that temporarily store stormwater on the surface during rain events. Such sites may also serve as "floating parks" that have platforms and other features that rise and fall with changing water elevations. Other types of pocket parks may be well-suited to BGSI practices such as bioretention, enhanced tree pits/trenches, and stormwater planters.

Rue Vendome/Normandy Isle Monument

Permeable pavers and enhanced tree pits in urban plaza

Blue-Green Stormwater Infrastructure Strategies

Right-of-Way/Streets and Alleys

Miami Beach's right-of-way (ROW) takes many forms (commercial and residential streets, street ends, pedestrian streets [also called *non-motorized streets*], alleys, etc.) and is vital to its economy, quality of life, and unique nature. The City's ROW offers many opportunities to implement BGSI to enhance usage, improve aesthetics, and integrate with existing and planned drainage infrastructure. BGSI practices provide many stormwater benefits when placed in the ROW, which is among the City's largest sources of stormwater runoff.

While the ROW contains numerous challenges to BGSI implementation (see Potential Limitations), several practices can often be seamlessly located in or along ROW shoulders, grass strips and swales, sidewalks, no parking zones, landscaped or paved islands, and medians. BGSI can also be integrated with roadway improvements, including potential road raising. Practices employing Florida-friendly vegetation such as bioretention/bioswales, stormwater planters, and enhanced tree pits/trenches, as well as permeable pavements, are often the most effective BGSI in the ROW. Such practices can potentially be implemented at lower overall costs when they are incorporated into other capital improvements, such as road repaving/ reconstruction, utility work, or other streetscape improvements.

Stormwater planter between a road and newly constructed sidewalk

Potential Advantages

- Improved water quality, reduced stormwater runoff volume, and increased freshwater lens recharge
- Improved streetscape aesthetics
- Increased tree canopy, as well as enhanced tree health/longevity; potential to align with City's Urban Forest Master Plan
- Compatible with various road improvements, such as road width reductions, 1- to 2-way conversions, road raising, etc.
- High visibility/educational value
- Opportunity to help reduce nuisance street flooding
- Improved safety resulting from traffic calming and increased pedestrian buffers
- Reduction of urban heat island
- Opportunity to reduce impervious (non-porous) cover by converting pavement (no parking zones, paved medians, etc.) to landscaped areas or using permeable pavement

Potential Limitations

- Competing with other demands, such as pedestrian accessibility, bicycling, parking, bus stops, loading zones, etc.
- Working around existing features, such as utilities, trees, signs, benches, mailboxes, etc.
- Conventional standards for roadway materials, construction, compaction, etc., which may reduce BGSI effectiveness
- Limited ROW width
- Vehicular mobility, especially with respect to turning radii, emergency vehicle access, and sight clearances at corners
- Increased maintenance requirements

Applicable Practices

Applicable to Most Sites	Applicable to Some Sites	Limited Applicability
Bioretention/Bioswales Enhanced Tree Pits/Trenches (not in alleys) Injection Wells Permeable Pavement (parking and bike lanes, sidewalks) Stormwater Planters	Subsurface Infiltration/Storage (in areas with higher elevations or integrated with road raising)	Blue & Green Roofs Constructed Wetlands (applicable to street ends only) Detention Basins/Surface Storage Rainwater Harvesting Wet Ponds

Commercial Streets

Miami Beach's commercial streets, which encompass its avenues, boulevards, and main streets, are some of the City's most visible and heavily traveled. While perhaps the most challenging of the City's ROW with respect to BGSI, they also provide rich BGSI opportunities. Bioretention/bioswales and stormwater planters can be carefully located in "underused" ROW spaces, where they can effectively treat stormwater runoff and also create visual interest through an attractive, layered planting scheme. Subsurface infiltration/storage systems, especially when integrated with road raising, can store and infiltrate runoff to help reduce localized flooding. Enhanced tree pits/trenches, when coupled with suspended pavement systems or structural soil, can greatly increase urban canopy and tree health. Permeable pavements can be used in many ways, whether in sidewalks, around tree pits, or in parking lanes, but their selection and design must appropriately consider the anticipated vehicular use, loading, and frequency, as well as the City's unique aesthetic character. In general, implementing BGSI in commercial streets has great potential, and should maintain or even enhance existing public uses, safety, and accessibility.

Typical commercial street in Miami Beach

Artistic rendering of stormwater planters and enhanced tree trenches

Residential Streets

Compared to Miami Beach's commercial streets, the City's residential streets generally have more space and less utility and other constraints for BGSI. Their grass strips and swales, as well as landscaped or paved islands, represent good opportunities for BGSI practices, such as bioswales, rain gardens, and stormwater planters. Subsurface infiltration/storage systems may also be viable, especially when integrated with road raising. Vegetated BGSI practices would likely be

focused in locations where parking is not currently permitted to minimize parking impacts for residents. Permeable pavements can provide the "dual use" benefits of a stabilized parking surface and stormwater capture. In general, implementing BGSI in residential streets can have a variety of stormwater quality and volume benefits, while being seamlessly integrated into the landscape, enhancing streetscape aesthetics, and potentially increasing property values.

Typical residential street in Miami Beach

Artistic rendering of bioswales and permeable pavers

Street Ends

Typically located at waterfront locations, Miami Beach's numerous street ends provide unique opportunities to incorporate BGSI that absorbs and filters stormwater immediately prior to discharging into Indian Creek, canals, and Biscayne Bay. At the same time, such locations have the potential for incorporating and enhancing habitat for land and aquatic species, as well as providing flexible parking and active or passive recreational spaces for residents. BGSI practices, such as bioretention/bioswales/rain gardens, constructed wetlands, enhanced tree pits/trenches, permeable pavement, and stormwater planters, can all be implemented at street ends, but their use will depend on the size, location, and intended purpose of the street ends.

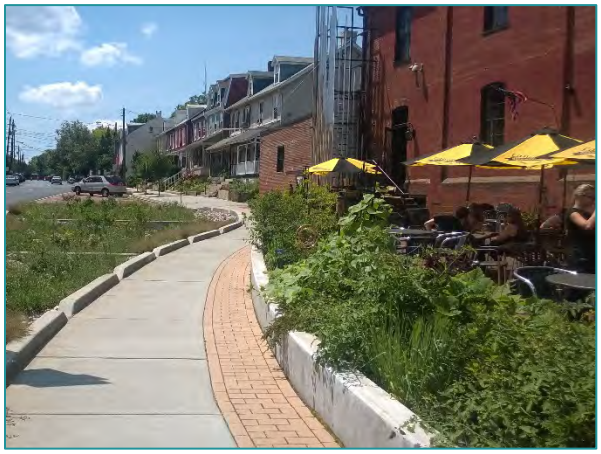
Typical street end in Miami Beach

Artistic rendering of bioretention, bioswales, and permeable pavement at a street end

Non-motorized Street

Non-motorized streets, also known as pedestrian malls or pedestrian streets, are not very common in Miami Beach. However, the non-motorized streets that do exist in the City, most notably Lincoln Road, are important cultural landmarks, as well as key shopping, dining, and strolling destinations. Bioretention/bioswales, stormwater planters, enhanced tree pits/trenches, and permeable pavement can be implemented in such streets, but their placement and sizing must balance stormwater improvements with high aesthetic standards and passive recreational needs. In addition, such practices must consider existing trees and vegetation, public artwork, water features, and the many other amenities often found on these streets.

Lincoln Road in Miami Beach (Source: Kevin Sprague, Lincoln Road Business Improvement District)



Bioretention, permeable pavers, and stormwater planters in non-motorized ROW

Alleys

Compared to the City's other ROWs, Miami Beach's alleys offer more limited opportunities for BGSI. However, implementing BGSI practices, such as permeable pavement and subsurface infiltration/storage systems, especially when integrated with road raising, can still provide meaningful stormwater runoff improvements, as well as improved alley aesthetics and resilience. The proximity of alleys to buildings can pose challenges to BGSI implementation, both during construction and with respect to long-term foundation impacts. However, such constraints can often be overcome by waterproofing the sides of BGSI installations and being extra careful when they're installed. As with other ROW areas, permeable pavements must carefully consider the anticipated vehicular use, loading, and frequency, as well as fit within the City's unique aesthetic character.

Typical alley in downtown Miami Beach

Permeable pavers above an infiltration trench in an urban alley

Blue-Green Stormwater Infrastructure Strategies

Single-Family Residential Parcels

Miami Beach's single-family residential parcels provide unique opportunities to directly engage and educate the public on BGSI practices. Single-family residential parcels have more limited space for BGSI practices, but implementing BGSI in residential locations can still provide meaningful improvements to stormwater quality and freshwater lens recharge, especially if widely employed across neighborhoods.

The most applicable BGSI practices at single-family residential parcels are vegetated systems (rain gardens and bioswales) planted with Florida-friendly plants, rainwater harvesting with rain barrels, and permeable pavements. BGSI practices in these settings are usually simpler and easier to maintain than those implemented in public or commercial sites. What these relatively low-tech practices may lack in storage capacity, they can make up for in aesthetic beauty and educational value. Ultimately, significant stormwater improvements in Miami Beach will require public engagement and adoption of BGSI practices on residential parcels.

Residential rain garden

Advantages

- Improved water quality and increased freshwater lens recharge
- Improved aesthetics and potentially increased property values
- Reduced localized flooding
- Reduced potable water use, especially when rain barrels are used to harvest rainwater for landscape irrigation, downspouts are directed into landscaped areas, and when Florida-friendly plants are used
- Multiple public resources available, including Miami-Dade County's free Adopt-a-Tree program and Rain Barrel Workshops[1]

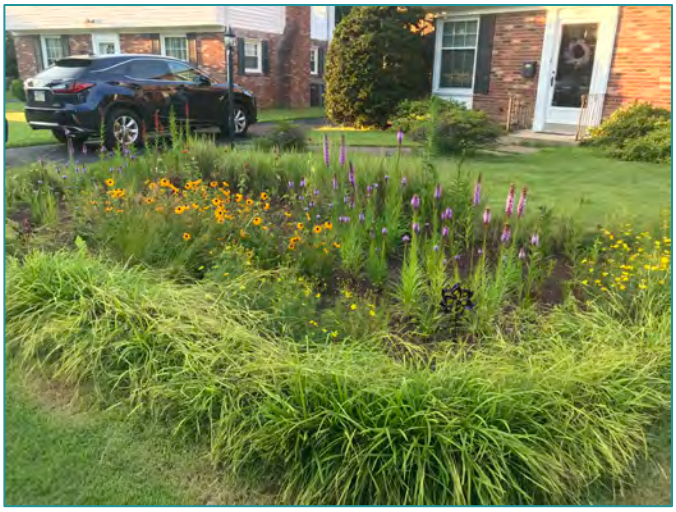
Potential Limitations

- Cost of installation
- Lack of experience with design and/or installation
- Lack of existing drainage infrastructure to connect overflow or underdrain pipes from BGSI practices
- Limited stormwater storage capacity, as well as smaller contributing drainage areas
- Routine and/or restorative maintenance needs

Applicable Practices

Applicable to Most Sites	Applicable to Some Sites	Limited Applicability
Bioretention/Bioswales/Rain Gardens	Stormwater Planters	Constructed Wetlands
Permeable Pavement (driveways and patios)	Blue & Green Roofs	Detention Basins/Surface Storage
Rainwater Harvesting (rain barrels)		Enhanced Tree Pits/Trenches
		Injection Wells
		Subsurface Infiltration/Storage
		Wet Ponds

[1] Information about these programs can be found on Miami-Dade County's web site at www.miamidade.gov



Front yard rain garden

Downspout that has been disconnected from a stormwater pipe and directed toward landscaped area (Source: Wisconsin Department of Natural Resources)

Rain barrel connected to residential downspout

Permeable pavement driveway

Appendix D
BGSI Plant Matrices/Plant Palette Boards

BGI PLANT MATRIX

STRATEGIC VALUE

South Florida is home to a diverse and vibrant tapestry of plant communities and ecosystems. For implementing blue green infrastructure across Miami Beach, Florida-friendly plants are the perfect choice as they are **climate adapted**, excel at **ecosystem services** and enhance **sense of place**. The list below is a **summary of species** that may be used in the BGI program.

FLORIDA-FRIENDLY PLANTS FOR **BIORETENTION + BIOSWALE APPLICATIONS**

Conoclinium coelestinum
Blue Mistflower

Stachytarpheta jamaicensis
Blue Porterweed

Erythrina herbacea
Coralbean

Heliotropium angiospermum
Scorpion Tail

Tripsacum dactyloides
Fakahatchee Grass

Tripsacum floridanum
Florida Gamagrass

Muhlenbergia capillaris
Muhly Grass

Serenoa repens
Saw Palmetto

FLORIDA-FRIENDLY PLANTS FOR **CONSTRUCTED WETLANDS**

Ilex cassine
Dahoon Holly

Coccothrinax argentata
Silver Palm

Thrinax morrisii
Key Thatch Palm

Lysiloma latisiliquum
Wild Tamarind

Quercus virginiana
Live oak

Pontederia cordata
Pickerelweed

Nymphaea odorata
Fragrant Water Lily

Sagittaria latifolia
Arrowhead

Crinum americanum
Swamp Lily

Sagittaria lancifolia
Duck Potato

Eleocharis cellulosa
Spikerush

Eleocharis interstincta
Knotted Spikerush

Iris virginica
Blue Flag Iris

Canna flaccida
Golden Canna

Spartina bakerii
Sand Cord Grass

Taxodium ascendans
Pond Cypress

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

BGI PLANT MATRIX

FLORIDA-FRIENDLY PLANTS FOR
CONSTRUCTED SALT MARSHES AND MANGROVES

South Florida is home to a diverse and vibrant tapestry of plant communities and ecosystems. For implementing blue green infrastructure across Miami Beach, Florida-friendly plants are the perfect choice as they are **climate adapted**, excel at **ecosystem services** and enhance **sense of place**. The list below is a **summary of species** that may be used in the BGI program.

STRATEGIC VALUE

Borrichia arborescens
Sea Ox-Eye

Helianthus debilis
Beach Sunflower

Heliotropium currasavicum
Seaside Heliotrope

Portulaca pilosa
Hairy Portaluca

Salicornia bigelovii
Glasswort

Strumphia maritima
Strumpfia

Juncus roemerianus
Black Rush

Spartina patens
Salt Marsh Cord Grass

Amphitecna latifolia
Black Calabash

Avicennia germinans
Black Mangrove

Languncularia racemosa
White Mangrove

Rhizophora mangle
Red Mangrove

Conocarpus erectus
Green Buttonwood

Conocarpus erectus var. sericeus
Silver Buttonwood

Coccoloba uvifera
Sea Grape

Coccoloba diversifolia
Pigeon plum

FLORIDA-FRIENDLY TREES FOR **URBAN CANOPY RESTORATION**

Acer rubrum
Red Maple

Codia sebestena
Geiger Tree

Quercus laurifolia
Laurel Oak

Pinus elliottii var. densa
South Florida Slash Pine

Bursera simaruba
Gumbo Limbo Tree

Ocotea coriacea
Lancewood

Krugiodendron ferreum
Black Ironwood

Swietenia mahagoni
American Mahogany

JACOBS

MIAMIBEACH
RISING
ABOVE

Appendix E
BGSI Pilot Project Concepts/Renderings

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

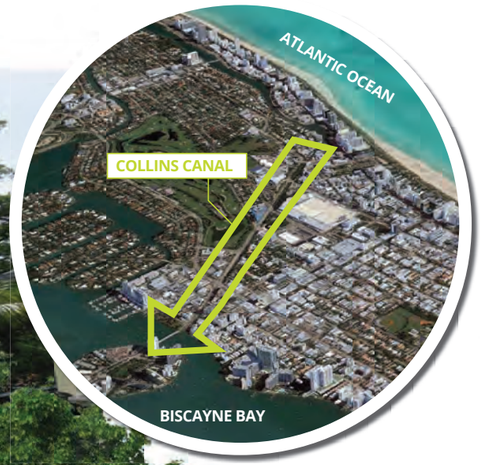
1 MANAGED AQUATIC PLANT SYSTEMS
Managed Aquatic Plant Systems (MAPS) provide habitat, enhance aesthetics, and improve water quality in the canal by reducing common pollutants such as nitrogen, phosphorus, and suspended solids. MAPS will be anchored into the canal bottom, allowing them to rise during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

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**.

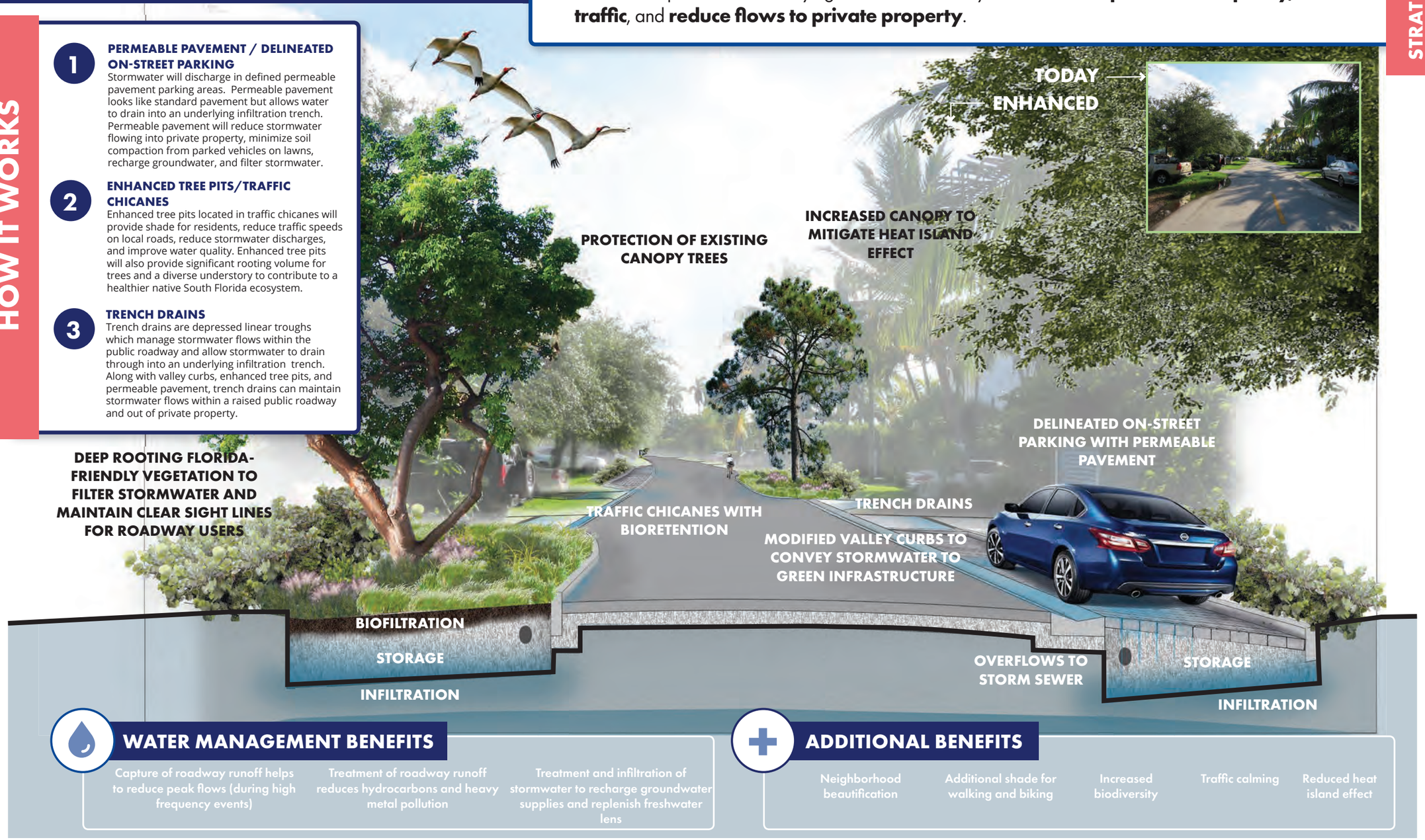
STRATEGIC VALUE

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

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MIAMIBEACH RISING ABOVE

BLUE GREEN INFRASTRUCTURE **PILOT PROJECT CONCEPT**

COMMERCIAL STREET

STRATEGIC VALUE

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**.

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.

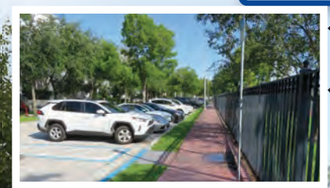
HOW IT WORKS

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

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MIAMIBEACH RISING ABOVE

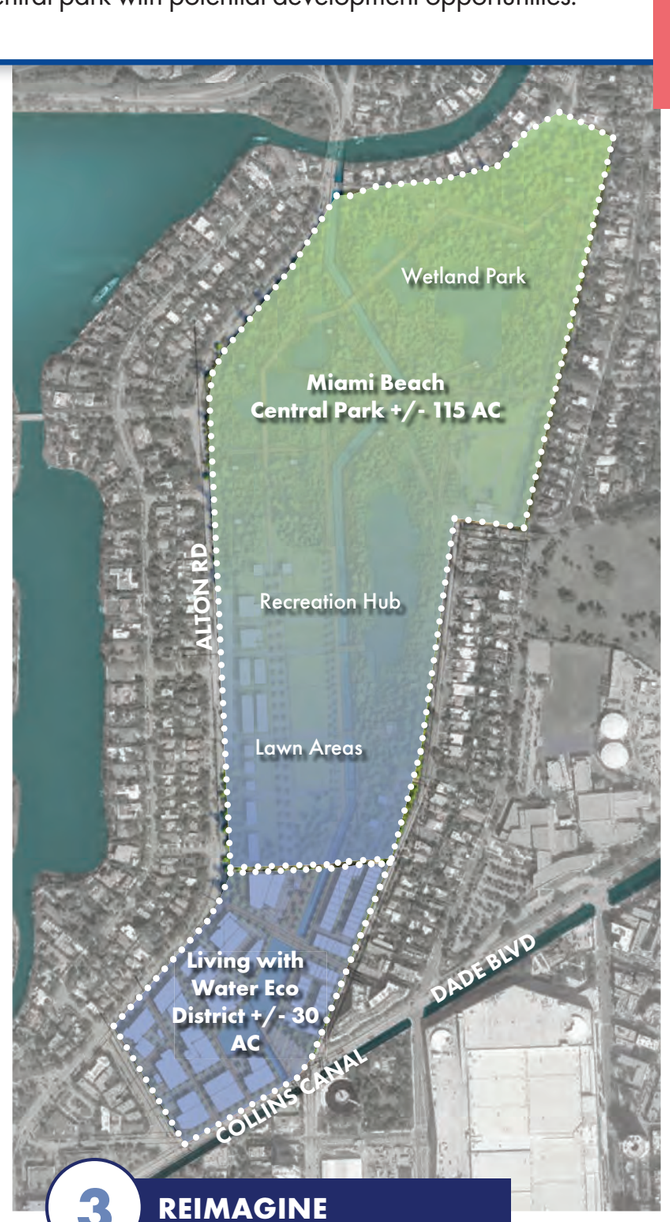
MIAMI BEACH GOLF CLUB

The Art of the Possible - below are **three high-level scenarios** exploring the redevelopment of the Miami Beach Golf Club into a blue green infrastructure asset: 1) a **retrofit** scenario - keeping all eighteen holes; 2) a **repurpose** scenario - converting the back nine holes into a signature park; and 3) a **reimagine** scenario - converting the club into a central park with potential development opportunities.

STRATEGIC VALUE

1 RETROFIT

2 REPURPOSE



3 REIMAGINE

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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

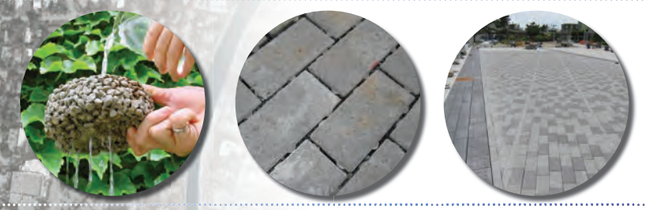
1. **GOLF CLUB REMAINS INTACT**
   The existing eighteen hole golf course remains largely intact and functioning much the same as it does today.

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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MIAMIBEACH RISING ABOVE

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.

Bioretention Edges

Detention Basin

"Green" Recreation Center

Wet Ponds

Constructed Wetlands

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.


Wetland Park


"Green" Edges


"Green" Recreation Hub


Living Machine Gardens


"Living with Water" Eco-District

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

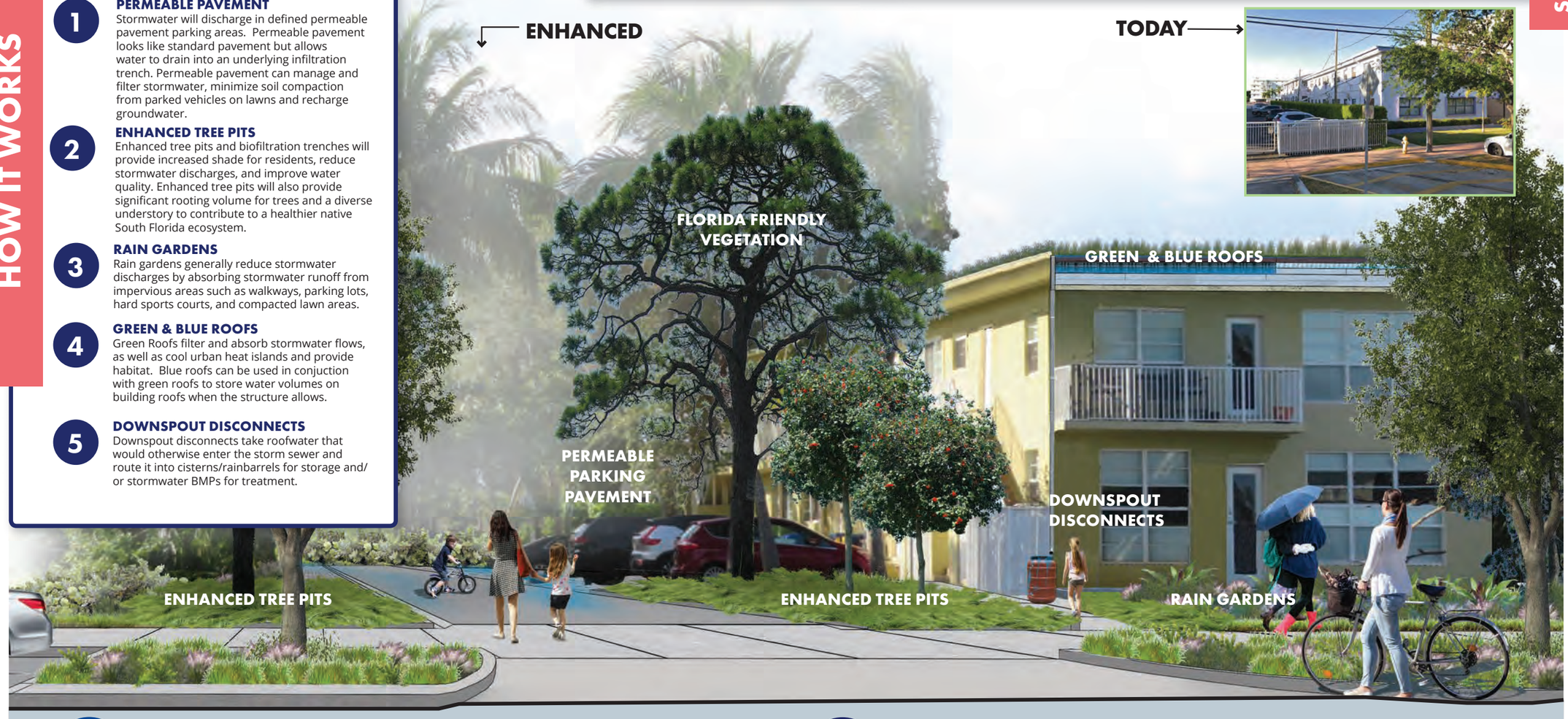
1. **PERMEABLE PAVEMENT**
Stormwater will discharge in defined permeable pavement parking areas. Permeable pavement looks like standard pavement but allows water to drain into an underlying infiltration trench. Permeable pavement can manage and filter stormwater, minimize soil compaction from parked 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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MIAMIBEACH RISING ABOVE

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.

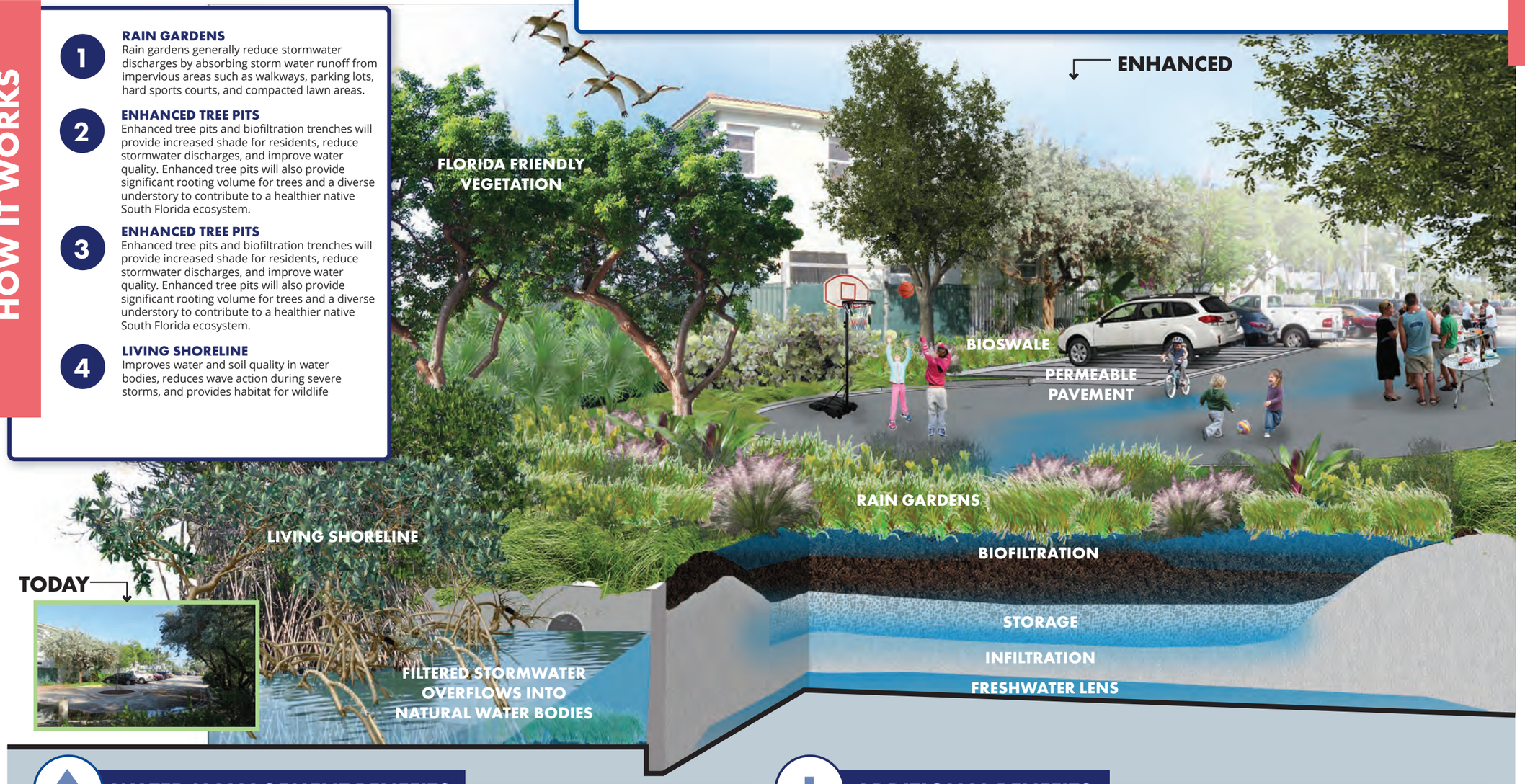
HOW IT WORKS

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

Appendix F
Potential Project Location Maps

Project	Site Name	Source
1	1 Street between Alton Road and Washinton Avenue	CMB Website
2	11 Street	CMB Website
3	27th Street Waterfront Area	Blueways MP
4	40th Street and Indian Creek Street Side	Blueways MP
5	41st Street Corridor	G.O. Bond List
6	Above Ground Improvements - City center	G.O. Bond List
7	Above Ground Improvements - LaGorce Island	G.O. Bond List
8	Above Ground Improvements - Indian Creek Pathway	G.O. Bond List
9	Above Ground Improvements -Above Ground Improvements - Nautilus & Middle North Bay	G.O. Bond List
10	Above Ground Improvements - Normandy Isle South	G.O. Bond List
11	Above Ground Improvements - South Pointe	G.O. Bond List
12	Above Ground Improvements - Sunset Island 1 and 2	G.O. Bond List
13	Above Ground Improvements - Belle Isle	G.O. Bond List
14	Alexander Muss Park	CMB Website
15	Altos Del Mar Park	CMB Website
16	Art Deco Museum Expansion	G.O. Bond List
17	Baywalk	G.O. Bond List
18	Beachwalk Phase II	CMB Website
19	Bike Paths	CMB Website
20	Brittany Bay Park and Seawall	CMB Website
21	Carl Fisher Clubhouse Restoration	CMB Website
22	Central Bayshore South	CMB Website
23	Chase Avenue Parking Lot	Blueways MP
24	Collins Canal	Blueways MP
25	Collins Park Garage	CMB Website
26	Collins Park Performing Arts Venue	CMB Website
27	Convention Center Park	CMB Website
28	Crespi Kayak Launch	CMB Website
29	Crespi Street End Pocket Parks	Blueways MP
30	Espanola Way Bollard Installation	CMB Website
31	Fairway Park (Artificial Turf Soccer Field, Drainage and Playground Replacement)	CMB Website
32	Fire Station #1	G.O. Bond List
33	Fire Station #3	G.O. Bond List
34	Fisher Park	G.O. Bond List
35	Flamingo Park - Phase II	CMB Website
36	Flamingo Park - Phase III	CMB Website
37	Flamingo Park Master Plan Improvements	CMB Website
38	Indian Beach Park	Blueways MP
39	Indian Creek Drive Flooding Mitigation Project	CMB Website
40	La Gorce and Lakeview	CMB Website
41	La Gorce Park	G.O. Bond List
42	La Gorce Street End	Blueways MP
43	La Gorce Vacant Corner	Blueways MP
44	Lake Pancoast	Blueways MP
45	LED Lighting in Parks - Flamingo Park	G.O. Bond List
46	LED Lighting in Parks - North Shore Park & Youth Center	G.O. Bond List
47	LED Lighting in Parks - Normandy Isle Park	G.O. Bond List
48	LED Lighting in Parks - Tatum Park	G.O. Bond List
49	LED Lighting in Parks - Stillwater Park	G.O. Bond List
50	LED Lighting in Parks - Crespi Park	G.O. Bond List
51	Lincoln Road between Collins Avenue and Lenox Avenue	CMB Website
52	Meridian between Lincoln Road and 17th Street	CMB Website
53	Drexal between Lincoln Road and 17th Street	CMB Website
54	Pennsylvania Avenue between Lincoln Road and 17th Street	CMB Website
55	Lincoln Road Street End	Blueways MP
56	Log Cabin Reconstruction	G.O. Bond List
57	Lot P2 at Ocean Drive and 1 Street (Nikki Beach)	CMB Website
58	Lummus Park	G.O. Bond List
59	Marjory Stoneman Douglas Park	G.O. Bond List
60	Maurice Gibb Park Redesign	CMB Website
61	Miami Beach Marina	Blueways MP
62	Middle Beach Recreational Corridor Phase 3	CMB Website
63	Monument Island	Blueways MP
64	Mount Sinai South Open Space	Blueways MP
65	Muss Park	G.O. Bond List
66	Neighborhood Traffic Calming and Pedestrian-Friendly Streets - Nautilus	G.O. Bond List
67	Neighborhood Traffic Calming and Pedestrian-Friendly Streets - Bayshore	G.O. Bond List
68	Neighborhood Traffic Calming and Pedestrian-Friendly Streets - Normandy Isle	G.O. Bond List
69	Neighborhood Traffic Calming and Pedestrian-Friendly Streets - Palm View	G.O. Bond List
70	Normandy Isle Park Turf Replacement	CMB Website
71	Normandy Isle Phase II - Marseille Drive from Trouville Esplanade to Rue Notre Dame	CMB Website
72	Normandy Isle Phase II - Calais Drive between Trouville Esplanade and Rue Bordeaux	CMB Website
73	Normandy Isle Street End	Blueways MP
74	Normandy Shores Park	Blueways MP
75	Normandy Shores Street End	Blueways MP
76	North Bay Street End (North Bay Road)	Blueways MP
77	North Bay Street End (West 23rd Street)	Blueways MP
78	North Beach Ocean Side Park Renovation	CMB Website
79	North Beach Police Sub-Station	Blueways MP
80	North Beach Waterfront Street End (Bay Drive)	Blueways MP
81	North Beach Waterfront Street End (Hagen Street)	Blueways MP
82	North Beach Waterfront Street End (Jones Street)	Blueways MP
83	North Beach Waterfront Street End (North Henedon Avenue)	Blueways MP
84	North Beach Waterfront Street End (North Rue Granville)	Blueways MP
85	North Beach Waterfront Street End (North Rue Notre Dame)	Blueways MP
86	North Beach Waterfront Street End (North Shore Drive)	Blueways MP
87	North Beach Waterfront Street End (Ray Street)	Blueways MP
88	North Beach Waterfront Street End (Rue Bordeaux Drive)	Blueways MP
89	North Beach Waterfront Street End (Rue Versailles Drive)	Blueways MP
90	North Beach Waterfront Street End (South Henedon Avenue)	Blueways MP
91	North Beach Waterfront Street End (South Rue Granville)	Blueways MP
92	North Beach Waterfront Street End (South Rue Notre Dame)	Blueways MP
93	North Beach Waterfront Street End (Trouville Esplanade)	Blueways MP
94	North Beach Waterfront Street End (Vardon Street)	Blueways MP
95	North Beach Yard	CMB Website
96	North Shore Neighborhood Improvements	G.O. Bond List
97	North Shore Park Tennis Facility	CMB Website
98	Ocean Rescue North Beach Facility	G.O. Bond List
99	P16 Parking Garage	CMB Website
100	P86 Surface Lot	CMB Website
101	Palm and Hibiscus Islands Right of Way Improvements	CMB Website
102	Palm Island Park	G.O. Bond List
103	Parkview Island Waterfront Street End	Blueways MP
104	Parkview Park Annex	Blueways MP
105	Pinetree Park	G.O. Bond List
106	Pocket Park at 20 Street & Sunset Drive	CMB Website
107	Polo Park	G.O. Bond List
108	Roof Replacements at Cultural Facilities - Bass Museum	G.O. Bond List
109	Roof Replacements at Cultural Facilities - Colony Theater	G.O. Bond List
110	Rue Vendome Public Plaza	CMB Website
111	Scott Rakow Youth Center	GO Bond List
112	Security Cameras in Entertainment District	GO Bond List
113	Security Cameras on Beachwalk	GO Bond List
114	Security for Public Spaces - MB Convention Center	GO Bond List
115	Security for Public Spaces - Lincoln Road	GO Bond List
116	Security for Public Spaces - Ocean Drive	GO Bond List
117	Security for Public Spaces - SoundScape Park	GO Bond List
118	Security for Public Spaces - South Pointe	GO Bond List
119	Shane Boating Center	Blueways MP
120	Shared Path on Parkview Island Park (73-77 streets)	CMB Website
121	Skate Park	G.O. Bond List
122	SoundScape Park	G.O. Bond List
123	South Beach Street End	Blueways MP
124	South Beach Street End (Bay Road)	Blueways MP
125	South Pointe Park	G.O. Bond List
126	Stillwater Park	G.O. Bond List
127	Sunset Islands 1 & 2 Guardhouse	CMB Website
128	Sunset Islands III and IV	CMB Website
129	Sunset Lake	Blueways MP
130	Surface Lot at Biscayne Beach	CMB Website
131	Tatum Park	G.O. Bond List
132	Tent (Canopy) for the North Shore Bandshell	CMB Website
133	Venetian Islands Right of Way Improvements	CMB Website
134	W 42 Sheridan Street to Pine Tree Druve Reconfiguration	CMB Website
135	Washington Avenue Corridor	G.O. Bond List
136	Water Maine Installation on 63	CMB Website
137	West Avenue Bridge	CMB Website
138	West Lots Redevelopment	G.O. Bond List

N W E S

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City of Miami Beach
Potential Locations to Integrate BGSI with GO Bond, Capital Improvement Plan, and Blueways Master Plan Projects

0 0.5 1 Mile

Data Sources:
ESRI, City of Miami Beach

October 2019

Legend

- Transportation Management Plan Projects
- Triangular Open Spaces
- Canal
- Miami Beach City Limits
- Building Footprints
- Parcels
- Parks

Triangular Open Spaces

ID	NAME
2	Fisher Park
3	Normandy Isle Monument
4	Crespi Park
5	Tatum Park
6	Stillwater Park
16	Triangle at Sheridan Ave and Pine Tree Dr
17	Triangle at W 46th St and Sheridan Ave
18	Triangle at Alton Rd and W 51st St
19	Triangle at La Gorce Dr and Pine Tree Dr
20	La Gorce Park
21	Triangle at La Gorce Cir and Pine Tree Ln
22	Triangle at La Gorce Cir and Brevity Ln
23	Pana de Bryan
24	Triangle at John F Kennedy Causeway and Bay Dr
25	Triangle at Biarritz Dr and 71st St
26	Triangle at Normandy Dr and 71st St
27	Triangle at Daytonia Rd and S Biscayne Point Rd
28	Triangle at Crespi Rd and Hawthorne Ave
29	Triangle at Stillwater Dr S and Hawthorne Ave
30	Triangle at Tatum Waterway Dr and 80th St
31	Triangle at Indian Creek Dr and Dickens Ave
32	Triangle at Bonita Dr and 71st St
33	Triangle at Indian Creek Dr and W 63rd St
34	Triangle at Indian Creek Dr and Collins Ave

Transportation Master Plan Projects

ID	NAME
42	73rd St One Way Protected Bicycle Lanes
43	72nd St One Way Protected Bicycle Lanes
44	Byron Avenue Protected Bicycle Lanes/Neighborhood Greenway
45	North Bay Rd Neighborhood Greenway
47	51st St Green Bicycle Lanes
48	63rd St: Feasibility Study for Bicycle Alternatives
54	La Gorce Dr/Pine Tree Dr Protected/Buffered Bicycle Lanes
57	Dickens Ave and SR 934/71st St Geometric Modifications
59	SR 907/Alton Road's Feasibility Study of Adaptive Signal Controls
62	Intersection of SR A1A/Indian Creek Dr and 63rd St Feasibility Study of Intersection Improvements
64	SR 934/71st St/Normandy Dr Safety Improvements
66	85th St Neighborhood Greenway
68	SR A1A/Collins Ave and Indian Creek Dr Signal Optimization Study
69	SR 934/71st Street Feasibility Study
77	81st St Neighborhood Greenway
78	81st St Neighborhood Greenway
79	77th St Neighborhood Greenway
80	Tatum Waterway Dr Neighborhood Greenway
84	47th Street Enhanced Bicycle Lane
86	Bay Drive Neighborhood Greenway
92	69th Street Buffered Bicycle Lanes
94	63rd Street Protected/buffered bicycle lanes
95	SR 934/71st St/Normandy Dr Exclusive Transit Lanes/Protected/buffered bicycle lanes
102	Fairway Drive Shared-Use Path
107	SR 934/79th St Cswy Exclusive transit, Shared Uses Path, and protected/buffered bicycle lanes
109	77th Street Shared Path
110	77th Street Neighborhood Greenway
115	SR 907/Alton Rd Exclusive transit lanes
118	Biarritz Drive Protected/buffered bicycle lanes
119	Wayne Avenue Shared Path
120	SR A1A Collins Ave/Indian Creek Dr/Harding Ave Exclusive transit lanes protected bicycle lanes
121	Hawthorne Avenue Neighborhood Greenway
129	Crespi Avenue Neighborhood Greenway

N W E S

JACOBS®

City of Miami Beach
Potential Locations for BGSI in Transportation Master Plan Projects and in Triangular Open Spaces

0 0.25 0.5 Mile

Data Sources:
ESRI, City of Miami Beach

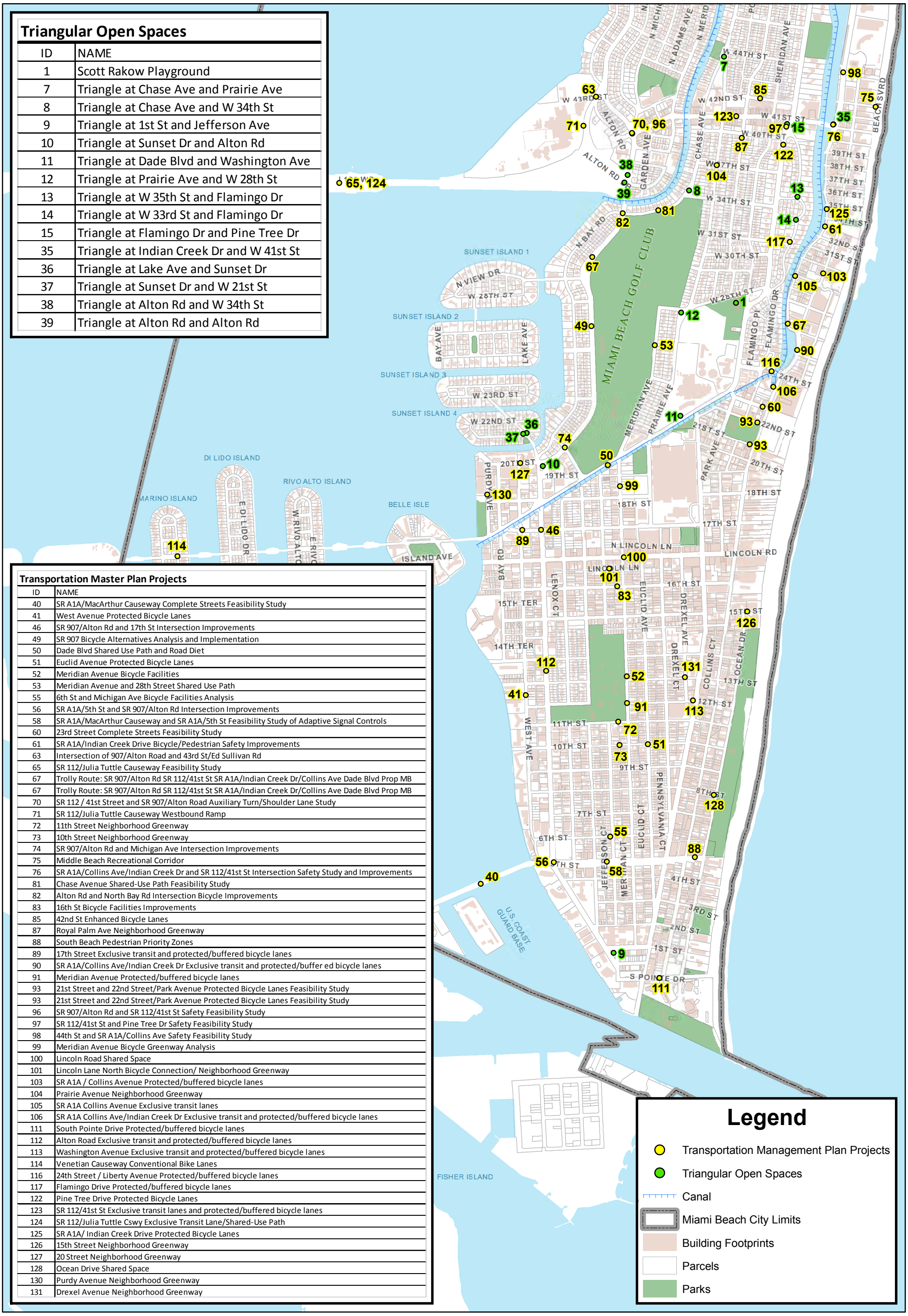
October 2019

Triangular Open Spaces

ID	NAME
1	Scott Rakow Playground
7	Triangle at Chase Ave and Prairie Ave
8	Triangle at Chase Ave and W 34th St
9	Triangle at 1st St and Jefferson Ave
10	Triangle at Sunset Dr and Alton Rd
11	Triangle at Dade Blvd and Washington Ave
12	Triangle at Prairie Ave and W 28th St
13	Triangle at W 35th St and Flamingo Dr
14	Triangle at W 33rd St and Flamingo Dr
15	Triangle at Flamingo Dr and Pine Tree Dr
35	Triangle at Indian Creek Dr and W 41st St
36	Triangle at Lake Ave and Sunset Dr
37	Triangle at Sunset Dr and W 21st St
38	Triangle at Alton Rd and W 34th St
39	Triangle at Alton Rd and Alton Rd

Transportation Master Plan Projects

ID	NAME
40	SR A1A/MacArthur Causeway Complete Streets Feasibility Study
41	West Avenue Protected Bicycle Lanes
46	SR 907/Alton Rd and 17th St Intersection Improvements
49	SR 907 Bicycle Alternatives Analysis and Implementation
50	Dade Blvd Shared Use Path and Road Diet
51	Euclid Avenue Protected Bicycle Lanes
52	Meridian Avenue Bicycle Facilities
53	Meridian Avenue and 28th Street Shared Use Path
55	6th St and Michigan Ave Bicycle Facilities Analysis
56	SR A1A/5th St and SR 907/Alton Rd Intersection Improvements
58	SR A1A/MacArthur Causeway and SR A1A/5th St Feasibility Study of Adaptive Signal Controls
60	23rd Street Complete Streets Feasibility Study
61	SR A1A/Indian Creek Drive Bicycle/Pedestrian Safety Improvements
63	Intersection of 907/Alton Road and 43rd St/Ed Sullivan Rd
65	SR 112/Julia Tuttle Causeway Feasibility Study
67	Trolly Route: SR 907/Alton Rd SR 112/41st St SR A1A/Indian Creek Dr/Collins Ave Dade Blvd Prop MB
67	Trolly Route: SR 907/Alton Rd SR 112/41st St SR A1A/Indian Creek Dr/Collins Ave Dade Blvd Prop MB
70	SR 112 / 41st Street and SR 907/Alton Road Auxiliary Turn/Shoulder Lane Study
71	SR 112/Julia Tuttle Causeway Westbound Ramp
72	11th Street Neighborhood Greenway
73	10th Street Neighborhood Greenway
74	SR 907/Alton Rd and Michigan Ave Intersection Improvements
75	Middle Beach Recreational Corridor
76	SR A1A/Collins Ave/Indian Creek Dr and SR 112/41st St Intersection Safety Study and Improvements
81	Chase Avenue Shared-Use Path Feasibility Study
82	Alton Rd and North Bay Rd Intersection Bicycle Improvements
83	16th St Bicycle Facilities Improvements
85	42nd St Enhanced Bicycle Lanes
87	Royal Palm Ave Neighborhood Greenway
88	South Beach Pedestrian Priority Zones
89	17th Street Exclusive transit and protected/buffered bicycle lanes
90	SR A1A/Collins Ave/Indian Creek Dr Exclusive transit and protected/buffer ed bicycle lanes
91	Meridian Avenue Protected/buffered bicycle lanes
93	21st Street and 22nd Street/Park Avenue Protected Bicycle Lanes Feasibility Study
93	21st Street and 22nd Street/Park Avenue Protected Bicycle Lanes Feasibility Study
96	SR 907/Alton Rd and SR 112/41st St Safety Feasibility Study
97	SR 112/41st St and Pine Tree Dr Safety Feasibility Study
98	44th St and SR A1A/Collins Ave Safety Feasibility Study
99	Meridian Avenue Bicycle Greenway Analysis
100	Lincoln Road Shared Space
101	Lincoln Lane North Bicycle Connection/ Neighborhood Greenway
103	SR A1A / Collins Avenue Protected/buffered bicycle lanes
104	Prairie Avenue Neighborhood Greenway
105	SR A1A Collins Avenue Exclusive transit lanes
106	SR A1A Collins Ave/Indian Creek Dr Exclusive transit and protected/buffered bicycle lanes
111	South Pointe Drive Protected/buffered bicycle lanes
112	Alton Road Exclusive transit and protected/buffered bicycle lanes
113	Washington Avenue Exclusive transit and protected/buffered bicycle lanes
114	Venetian Causeway Conventional Bike Lanes
116	24th Street / Liberty Avenue Protected/buffered bicycle lanes
117	Flamingo Drive Protected/buffered bicycle lanes
122	Pine Tree Drive Protected Bicycle Lanes
123	SR 112/41st St Exclusive transit lanes and protected/buffered bicycle lanes
124	SR 112/Julia Tuttle Cswy Exclusive Transit Lane/Shared-Use Path
125	SR A1A/ Indian Creek Drive Protected Bicycle Lanes
126	15th Street Neighborhood Greenway
127	20 Street Neighborhood Greenway
128	Ocean Drive Shared Space
130	Purdy Avenue Neighborhood Greenway
131	Drexel Avenue Neighborhood Greenway



N W E S

JACOBS

City of Miami Beach
Potential Locations for BGSI in Transportation Master Plan Projects and in Triangular Open Spaces

0 0.25 0.5 Mile

Data Sources:
ESRI, City of Miami Beach

October 2019