Low Impact Development Implementation Guidebook

FLORIDA DEPARTMENT of ECONOMIC OPPORTUNITY

EAST CENTRAL FLORIDA REGIONAL PLANNING COUNCIL EST. 1962

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Volusia County FLORIDA

Contents

Low Impact Development (LID) Implementation Guidebook

Introduction to the LID Implementation Guidebook and LID Ordinance Recommendations

The LID grant project, described in the following *Project Background* section, created two documents: LID Ordinance Recommendations and this LID Implementation Guidebook. Policy and code research along with lessons learned during the process of creating the ordinance recommendations are presented in this LID Implementation Guidebook (Guidebook). Implementation in the Guidebook is twofold, addressing LID projects and the mechanisms to allow for LID within a jurisdiction. The LID Ordinance Recommendations and Guidebook are intended to be used primarily by local government staff, advisory committees, and other appointed and elected officials who are considering implementation of a LID Ordinance. The companion documents aim to support LID integration across not only the East Central Florida region but also the state of Florida.

The project used the regional roundtable findings, Best Management Practices (BMPs), and feedback from the Volusia County (VC) Environmental and Natural Resources Advisory Committee (ENRAC) to draft LID Ordinance recommendations, a LID Ordinance template, and this companion LID Implementation Guidebook.

Project Background

In 2018, VC staff began educating residents about Green Infrastructure and LID through a Florida Department of Environmental Protection 319 education grant to address pollution impacts to our springs. In 2019, VC adopted the East Central Florida Regional Resiliency Action Plan (RRAP) and became a member of the East Central Florida Regional Resilience Collaborative (R2C). The RRAP prioritizes Green Infrastructure (GI) as a first line of defense for addressing climate change impacts and a mechanism to improve water quality and enhance resiliency of stormwater systems. GI is a broad concept that encompasses the integration of natural and built systems for various purposes, including stormwater management. Low Impact Development (LID) is an approach within GI that emphasizes minimizing the impact of development on the environment by using sustainable design techniques. Green stormwater infrastructure (GSI) is a subset of GI that specifically focuses on sustainable stormwater management and treatment practices. Together, these approaches promote the use of nature-based and sustainable strategies to manage stormwater and improve the environmental sustainability of community development and population growth.

VC completed several projects that promoted LID and GSI and provided demonstration sites for their implementation. While these initiatives sparked community discussion about best practices for implementation of LID and GSI projects, VC staff was made aware of potential barriers to the implementation of these strategies. VC was awarded a Florida Department of Economic Opportunity (FDEO) Community Planning Technical Assistance (CPTA) grant to collaborate with the East Central Florida Regional Planning Council (ECFRPC) and University of Florida's Program for Resource Efficient Communities (PREC). The grant project aimed to develop mechanisms to incorporate LID and GSI into VC's ordinances to incentivize and/or require LID practices for on-site stormwater management for development and redevelopment projects.

With a project timeline of approximately six months, the project team engaged experts from stormwater-related disciplines and VC environmental practitioners concerned with the natural environment to gain an understanding of current LID implementation challenges. The team organized a regional roundtable meeting with technical experts from across the region as well as meetings with VC staff and the Environmental and Natural Resource Advisory Committee (ENRAC), a group tasked with providing input on policy and goal setting as well as ordinance implementation regarding growth management, environmental resource management and future development.

Regional Roundtable Discussion

The project kicked off with a regional meeting of technical experts in stormwater-related disciplines held to inform the development of the LID Ordinance recommendations. The event attracted seventy-nine technical experts including local stormwater engineering, planning, resilience and sustainability staff, developers, academia, and permitting agencies. Attendees were familiarized with the project background, LID/GSI best practices, and example LID challenges from VC. Participants were divided into nine roundtable groups to allow for facilitated discussions of LID barriers, challenges, opportunities, and strategies related to LID/GSI implementation. Discussions also focused on mechanisms and incentives to incorporate and emphasize LID/GSI in site planning, development, and stormwater management.

Figure 1 Regional Roundtable participants from across the East Central Florida region

Challenges ranged from local to state level influence and highlighted the need for educating practitioners, developers, elected officials, and the general public. A summary of LID/GSI challenges includes:

- Local code inhibits LID/GSI;
- Enforcement of code is minimal or lacking;

- The design process is misunderstood and needs to be streamlined;
- Maintenance is costly and labor is untrained;
- The region lacks uniform policies and codes;
- Regulations don't foster LID/GSI innovation;
- Practitioner training is lacking; and
- Public education is lacking.

At the local level, regulatory code requiring or incentivizing LID practices is rare. Occasionally, there's mention of LID and GSI in the local comprehensive plan; however, follow through in the Code of Ordinances/Land Development Code is lacking or contradictory. Builders and developers often opt for conventional stormwater practices due to lack of LID/GSI requirements – even if incentivized, lack of design tools and knowledge, and lengthy design review timelines can prove to be a disincentive to implementation. Finally, without education, maintenance, and code enforcement, implemented LID/GSI installations become ineffective over time.

Differences in policies, codes, and enforcement practices across the region create another level of LID/GSI challenges. With more uniform codes, permit applicants could streamline their processes from design through installation. The RRAP offers potential for regional collaboration on LID/GSI policies and codes. Furthermore, the region could benefit through public sector demonstration projects.

At the state level, regulations are perceived to conflict with LID/GSI best practices. Innovative LID/GSI techniques are not recognized or credited, perhaps because their pollution reduction benefit is more difficult to demonstrate with traditional modeling. This may be an opportunity for local jurisdictions to address this with their own requirements.

Figure 2 Rain garden and pervious pavers at P.F. Chang's avoided need for retention pond (Source: Sarasota County Government)

At all levels, more education and training are paramount. Academia could be involved in design solutions, pilot LID/GSI demonstration projects, cost-benefit analyses, and practitioner outreach and training. Staff with the University of Florida designed a LID maintenance certification class for landscape practitioners that provides a strategy to address the maintenance challenge. Local governments can identify partners to target public education and outreach to homeowner associations, business owners, students, realtors and elected officials through a

variety of methods including social media, newsletters, civic events, workshops and webinars, and storytelling.

Volusia County (VC) Meetings

Following the Regional Roundtable discussion, the project team attended two monthly ENRAC meetings to introduce LID concepts and ordinance considerations, LID/GSI implementation projects, and LID/GSI policies and codes from around the state. Examples of LID projects and municipal code requirements and incentives proved valuable to the committee in understanding the importance and potential for LID improvements in VC.

The project team presented examples of LID/GSI implementations around the state for various land uses including commercial (*Figure 2*), residential (multi-family and single-family), and municipal (*Figure 3*). Several sources highlighting LID/GSI implementation include:

The Nature Conservancy GSI Photo Library. This tool features photos of functional and aesthetic GSI sites throughout the state. It exemplifies projects with photos, information, interviews, and resources about GSI implementations of basin, bioretention, biofiltration, curb cut, green roof, green wall, landscaping, pervious pavement, rain gardens, and more.

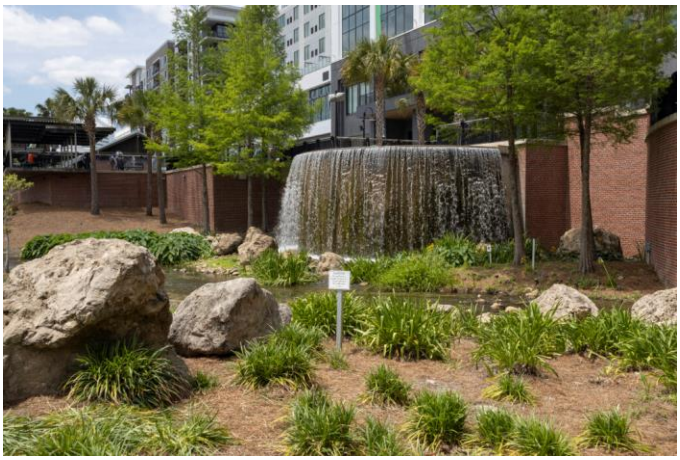


Figure 3 Biofiltration, bioretention, rain garden, and wetland at Cascades Park (Source: The Nature Conservancy GSI Photo Library, Photo credit: Tyler Jones)

Sarasota County (LID) Green Infrastructure Map. This clickable map features images of bioswales, rain gardens, cisterns and rain barrels, pervious surfaces, native and Florida-Friendly landscaping, green roofs, and living shoreline projects. The images include definitions of the LID/GSI technique utilized, benefits, and projects in Sarasota County.

Virtual Tour of the City of Winter Haven's Rain Gardens This clickable map features images and descriptions of 24 rain gardens located throughout the city.

LID Benefits and Best Management Practices

LID and GSI are sustainable approaches to managing stormwater runoff that aim to reduce the negative impacts of traditional gray stormwater management practices including increased risk

of downstream flooding; degradation of water quality and aquatic habitats through erosion, sedimentation and pollutants; and increased urban heat island effects through reduced vegetative cover and increased impervious surfaces.

LID and GSI have a range of community benefits, including flood mitigation, improved water quality by reducing sediment, elimination or reduction of chemical inputs (e.g., fertilizers and pesticides), reduced nutrient and pollutant loads, creation of attractive natural and multifunctional public spaces, reduced infrastructure costs (streets, curbs, gutters, sidewalks), reduced stormwater management costs, preservation of open space and natural vegetation, enhanced aesthetics and biodiversity, increased groundwater recharge, reduced irrigation and potable water consumption, heat island effect mitigation, and reduced energy consumption. Moreover, the development community can benefit from LID through reduced land clearing and grading costs, improved aesthetics offering increased lot and community marketability, reduced on-site retention/detention area, reduced upfront site infrastructure costs, reduced liability and risk of downstream flooding, reduced irrigation costs, help with green buffer requirements, opportunity to showcase their commitment to sustainability and the environment, and potential for incentives discussed in the *LID Policies and Codes* section.

LID and GSI Best Management Practices (BMPs) are typically grouped into three categories – site evaluation and planning, source controls, and structural stormwater practices. BMP descriptions, applications, and benefits are summarized in the *Appendix A - Low Impact Development (LID) and Green Stormwater Infrastructure (GSI) Best Management Practices (*BMPs). More details, including introductory videos and fact sheets, are located in the *Resources* section.

LID Policies and Codes

A primary goal of LID is to mitigate the harmful effects of mismanaged stormwater runoff. In order to facilitate this, municipalities implement policies that require or encourage on-site water retention and nature-based solutions. As a goal of LID and GSI is to design new development and revert existing development and redevelopment stormwater drainage systems to a more natural state, these policies are crucial to new development and redevelopment projects by taking a less negatively impactful and more creative approach in their designs and stewardship of stormwater. This ranges from green-building features such as vegetated roofs to pervious surface parking lots and rainwater capture systems. Another aspect of stormwater management is to reduce flooding. Common techniques involve bioswales, retention ponds, and rain gardens. Note that all of the above involve restoring natural and beneficial functions of native vegetation.

Minimizing stormwater pollutants through source controls is paramount. Ordinances that require or encourage sustainable landscape, fertilizer, and irrigation practices dramatically reduce the amount of water used to maintain traditional turf landscapes in addition to detrimental fertilizer ingredients (i.e., nitrogen, phosphorus). Increasing Florida-Friendly and native vegetation is also crucial in reducing impervious surface area, allowing more natural drainage and less runoff.

Projects that reduce pollutants entering surface waters, and prevent erosion are important as well. Strategies such as requiring setbacks from shorelines and wetlands, and augmenting ponds with vegetation can be crucial to removing pollutants and protecting ground water and surface water.

Comprehensive Plan Goals, Objectives, and Policies (GOPs) and Land Development Codes throughout and beyond the East Central Florida region were examined for LID and GSI related content. Results of this search were compiled in the *LID GSI Policies and Codes* spreadsheet. The spreadsheet contains 129 sample GOPs (85 from the region) and 116 codes (49 from the region), exhibiting sample language for use in policies and codes. While the spreadsheet offers an extensive list of sample language, this serves as a summary of key points.

Local governments can offer incentives to encourage developers and property owners to implement LID and GSI techniques. Some common incentives include:

- Technical assistance such as site analysis, conceptual design, cost estimates, or construction documentation for LID practices
- Plan review fees reduced or waived
- Permitting/site development credits
- Expedited permitting process
- Additional density, height, or lot coverage
- Setback reductions
- Parking space numbers and dimensional reductions
- Stormwater fee credit to non-SFH property owners to operate and maintain onsite detention or retention stormwater management systems
- Stormwater fee credit to non-residential property owners who reduce water pollution by implementing LID and GSI practices
- Rebates for Florida-Friendly landscaping, irrigation, rain gardens, and rain barrels
- Stormwater on-site mitigation loan program to prevent or reduce future interior flooding for residents

The following examples of LID and GSI incentives offered by Florida local governments are detailed in the *LID GSI Policies and Codes* spreadsheet or incentivized through local government and utility programs. These incentives help promote sustainable development and protect natural resources while also providing financial benefits for property owners and developers:

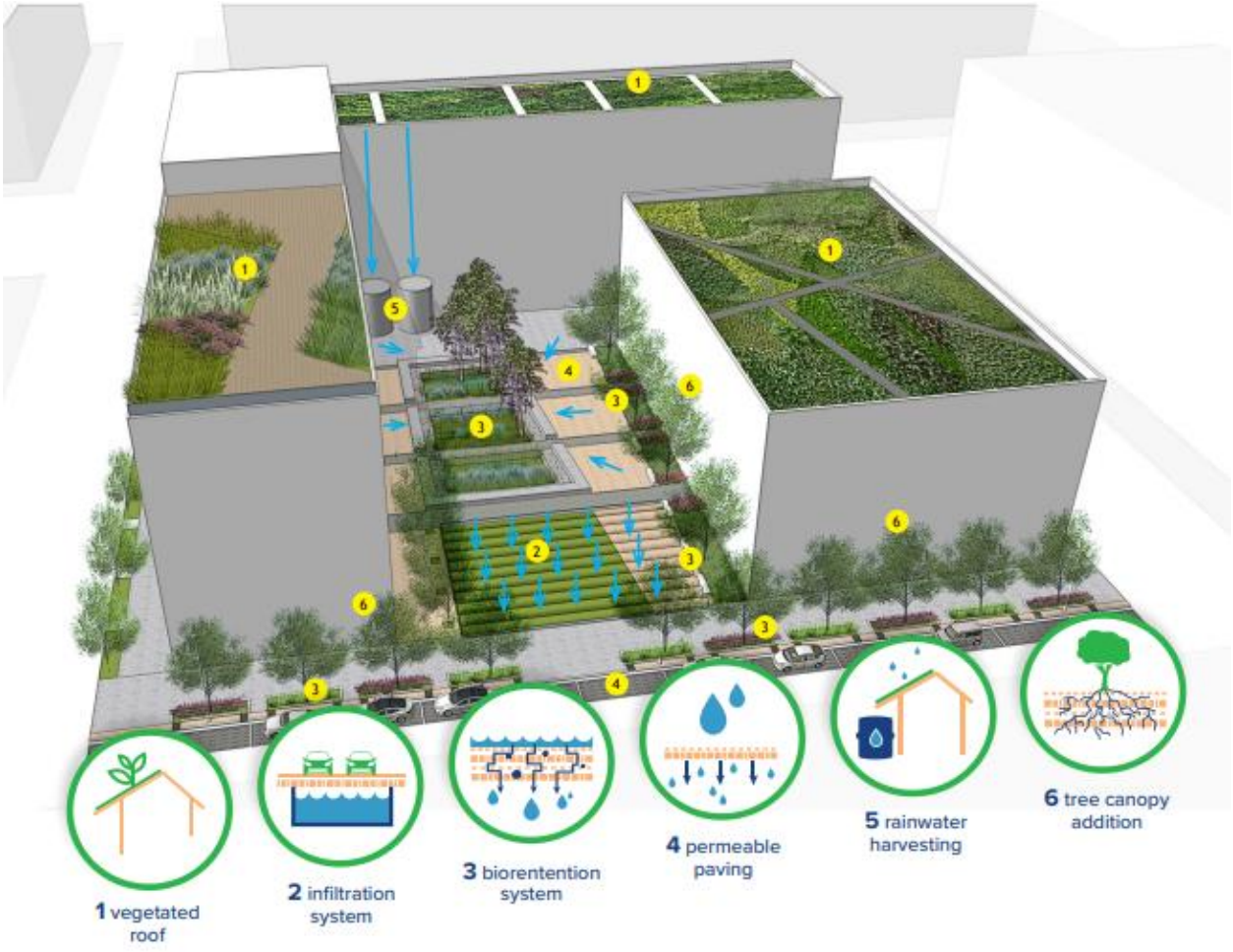
- City of Apopka: The City of Apopka offers height, lot coverage, and parking reduction incentives for green building features including LID/GSI projects like vegetated roofs, pervious pavement, rain gardens, street-side swales, cisterns, underground storage basins, and rain gardens[1].

[1]https://library.municode.com/fl/apopka/codes/code_of_ordinances?nodeId=PTIIILADECO_ART5DEST_S5.12GRBUIN

- City of Orlando: The City of Orlando offers rebates to property owners for Florida-Friendly landscaping, irrigation, and rain barrels[2] as well as reduced stormwater fees[3] and permitting/site development credits[4] for certain LID-GSI projects.
- City of Titusville: The City of Titusville adopted an LID ordinance[5] encouraging the use of LID site planning, source control, and structural stormwater Best Management Practices through parking reductions, setback reductions, additional density, expedited applications, and other incentives.
- City of St. Petersburg: The City of St. Petersburg offers a stormwater fee credit[6] of up to 52% to non-single-family property owners to operate and maintain onsite detention or retention stormwater management systems. Additionally, a tidal water discharge credit is offered to non-single-family properties that discharge stormwater runoff directly into Boca Ciega Bay or Tampa Bay such that stormwater waters does not pass into or through City-maintained drainage systems.
- City of Sebastian: The City of Sebastian offers a stormwater fee credit[7] of up to 50% to non-residential property owners who reduce water pollution by implementing LID and GSI practices such as rain gardens, bioswales, cisterns, and vegetated swales, buffers, and strips.
- City of Tallahassee: The City of Tallahassee offers residents a stormwater on-site mitigation loan program[8] to prevent or reduce future interior flooding. This provides an opportunity for homeowners to incorporate LID and GSI techniques such as rain barrels, rain gardens, and permeable pavement.
- City of Tampa: The City of Tampa offers a fast-track review[9] for green commercial and residential construction implementing LID and GSI techniques that improve water quality and provide for on-site water catchment.
- Orange County: Orange County offers free rain barrels.[10]
- Alachua County: Alachua County offers a stormwater fee credit for properties that implement LID practices, as well as technical assistance and a rebate program for rain barrels and rain gardens.

[2] https://www.ouc.com/residential/save-energy-water-money/residential-rebates-information
[3] https://www.orlando.gov/Initiatives/Downtown-South-Neighborhood-Improvement-District/Your-Guide-to-Green-Development-in-SoDo#section-3
[4] https://www.orlando.gov/files/sharedassets/public/departments/edv/sodo-nid/sodo-trifold-development-brochure_green-infrastructure_20-04-15_digital.pdf
[5] https://titusville.com/DocumentCenter/View/3247/LID-Ordinance-clean-ADOPTED?bidId=
[6]https://www.stpete.org/residents/grants___loans/stormwater_utility_fee_credits.php#:~:text=Properties%20that%20operate%20and%20maintain,property%20to%20the%20City%20system.
[7] https://www.cityofsebastian.org/DocumentCenter/View/1570/SW-Fee-Credit-Program-Brochure
[8] https://www.talgov.com/Uploads/Public/Documents/you/stormwater_loan_booklet.pdf
[9] https://www.tampa.gov/green-tampa/infofast-track-permitting
[10] https://blogs.ifas.ufl.edu/orangeco/2022/05/18/orange-county-florida-friendly-landscaping-rebates-and-incentives/

Another important consideration are impervious parking lots. With this in mind, some of the region's local governments have updated their parking standards to reduce parking requirements and create greener parking lots for stormwater management (*Figure 4*)**.**



PERMITTING/SITE DEVELOPMENT CREDITS AND INCENTIVES

Properties that have existing stormwater management facilities in accordance with the Orlando Urban Stormwater Management Manual (OUSWMM), or those planning such facilities, may have their fee reduced or pro-rated as determined by the Streets & Stormwater Division Manager. Developed properties, which meet the OUSWMM criteria, will have their annual utility fee discounted. Those properties with on-site mitigation, which do not fully meet OUSWMM criteria, may receive a partial discount as determined by the division manager.

Figure 4 Orlando LID GSI Incentives (Source: https://www.orlando.gov/files/sharedassets/public/departments/edv/sodo-nid/sodo-trifold-development-brochure_green-infrastructure_20-04-15_digital.pdf)

- City of Apopka: The City of Apopka offers height, lot coverage, and parking reduction incentives for use of pervious pavement on at least 50 percent of parking lot and driveway area[11].
- City of Cape Canaveral: Through the land development code, the City of Cape Canaveral encourages sustainable green parking lots to promote infiltration and natural water retention systems through the use of alternative pavement materials, implementing safe and healthy planting practices, incorporating watering and natural moisture delivery and drainage systems to sustain plantings, and incorporating bioretention areas.
- City of Groveland: The City of Groveland requires the application of permeable parking lot surfaces for commercial developments proposed within high aquifer recharge areas.
- City of Winter Haven: The City of Winter Haven requires all off-street parking lots to provide for the attenuation and treatment of stormwater and landscape and buffer areas to be designed and located to filter, store and/or convey the expected stormwater flows from surrounding paved areas through the use of LID techniques.
- Orange County: Through the comprehensive plan, Orange County is exploring LID parking solutions designed to maximize the capture, management, and treatment of parking lot stormwater runoff, and to best maintain and enhance the pre-development hydrologic regime of urban and developing watersheds. Incentives to incorporate and maintain LID techniques, including porous asphalt, pervious concrete, grass pavers, or other permeable paving materials, are being considered.

Throughout the United States, communities (*Figure 5*) are reclaiming parking lots for greener spaces through the de-pave movement that started in Portland, Oregon in 2007[12]. Florida communities have ample opportunity to embrace this movement.

Figure 5 Depave Nashville Brown's Creek Project: Removing 18,000 sf parking lot, Native vegetation replaces parking lot (Source: https://cumberlandrivercompact.org/portfolio/browns-creek-depave-project/)

[11]https://library.municode.com/fl/apopka/codes/code_of_ordinances?nodeId=PTIIILADECO_ART5DEST_S5.12GRBUIN_5.12.6MEGRBUFE

[12] https://www.resilience.org/stories/2019-05-16/the-softening-of-cities/

Requirements vs. Incentives

The LID Ordinance Recommendations document advises new development and redevelopment projects that require a development permit **must** implement integrated GSI + LID stormwater strategies as part of the development design. The goal of this requirement is to achieve a post-development stormwater quality and quantity that is equal to or better than exists pre-development.

Required

The City of Doral is leading the way, requiring LID for new development and redevelopment. The City of Doral Land Development Code, Article XVI - Low Impact Development Practices[13] states:

- Developers **shall** implement the following non-structural LID practices to the maximum extent practical
- Developers **shall** implement a minimum of two structural LID practices from the following list, where one meets the water quantity requirement and the other meets the water quality requirement, per Section 11.0 of the 2021 LID Master Plan Update and the SFWMD ERP Applicant's Handbook Volume II.
- **Maintenance is required** to preserve the efficacy of the implemented LID practice(s).

Furthermore, the municipality also incentivizes LID practices beyond the requirements:

> To encourage developers to design site plans using **more than the minimum required LID** practices, the City **may offer the following incentives**: Expedited review of permits, Implementation of open space credit, Reduced application fee, Award recognition program.

Required non-structural LID BMPs includes preservation of site topography and soil, preservation and use of native and local vegetation, open space design and conservation, minimization of total impervious area, and reduction of directly connected impervious areas. The required selection of structural BMPs includes bioretention basins or rain gardens, tree box filters or infiltration planters, vegetated swales, filter strips or vegetated buffers, infiltration trenches, exfiltration trenches or French drains, green roofs or rain barrels/cisterns, permeable pavement, retention pond, detention pond, wet detention or retention pond with aquatic vegetation, and parking stormwater chambers. The ordinance also requires maintenance to preserve efficacy of the LID strategies implemented. Design standards are referred to in the City of Doral Low Impact Development Master Plan Update (2021).

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13 https://library.municode.com/fl/doral/codes/code_of_ordinances?nodeId=SPBLADECO_CH74MISURE_ARTXVILOIMDEPR

Incentivized

The municipalities of Titusville and Ormond Beach, both located within the East Central Florida region, have incentivized LID ordinances. Titusville's LID ordinance[14] includes a LID incentives matrix (*Appendix B – City of Titusville LID Incentives Matrix*) in which 14 incentives are offered for 26 LID BMPs. The BMPs are grouped into three categories – nine in site planning, six in source control, and 11 in structural stormwater. Incentives are grouped into three categories including parking; open space, landscape, buffers, and setbacks; and other (additional building height, additional density, expedited application, etc.).

Ormond Beach has voluntary standards in the city's Comprehensive Plan[15] with an entire goal of the Conservation Element dedicated to LID: Ormond Beach addresses LID/GSI strategies in several elements in Goal 12:

GOAL 12. LOW IMPACT DEVELOPMENT

FOR NEW DEVELOPMENT AND REDEVELOPMENT, APPLY BETTER SITE DESIGN AND LOW IMPACT DEVELOPMENT (LID) TECHNIQUES, AND PURSUE COMMITMENTS TO REDUCE STORMWATER RUNOFF VOLUMES AND PEAK FLOWS, TO INCREASE GROUNDWATER RECHARGE, AND TO INCREASE PRESERVATION OF UNDISTURBED AREAS.

And, the Ormond Beach Land Development Code[16] refers to the Technical Manual as advised in the LID Ordinance Recommendations.

> Sec. 1-20. - Codes and standards adopted by reference.
>
> (e) *Low Impact Development Manual for the City of Ormond Beach*.
> The Low Impact Development Manual as published by the city planning department, is adopted.

Ten Steps for Creating Effective Incentives

Incentive programs get mixed reviews and success depends greatly on what behavior is being incentivized, what incentives are available, and how the incentive program is managed and enforced by staff. GSI and LID standards adopted to improve stormwater management and water quality will not be as effective in accomplishing that goal if some development employs the standards and avails themselves to the incentives and other development continues to proceed in a "conventional" or legacy approach.

The Guidebook review of existing ordinances in Florida indicates that the majority of GSI and LID regulations are incentive based. The best incentive programs are developed with participation from affected stakeholders. With stormwater, that is the entire community: the development

[14] https://library.municode.com/fl/titusville/codes/technical_manuals?nodeId=CD_S11LOIMDELI
[15] https://www.ormondbeach.org/DocumentCenter/View/24370/2025-Comp-Plan_rv022122
[16] https://library.municode.com/fl/ormond_beach/codes/land_development_code?nodeId=CH1GEAD_ARTIIADEN_S1-20COSTADRE

community must understand how it will affect the bottom line and what is to be gained from the tradeoff; the community as a whole—and all the various special interests within—need to understand the exchange as well. Bringing these varying interests together to develop the incentive program will better ensure a successful program implementation.

Here is a ten-step process to guide the development of a more successful incentive program:

1. **Determine Objectives – Set goals and measures**
   Before implementing an incentive program, it is essential to establish clear objectives. For LID, the objective is to improve stormwater management and water quality through effective implementation of GSI and LID standards and strategies from the local government's adopted Technical Manual in new development and redevelopment projects; and wherever else possible. The measurement factors are generally reduced flood risk and improved water quality.

2. **Analyze the Audience**
   Identifying the key stakeholders who can influence the desired objectives is critical. Developers, engineers, home builders, property owners, public regulators, enforcers, officials, and the general public are all significant audiences to consider.

3. **Fact Finding and Audience Involvement**
   To gain a deeper understanding of how we can improve stormwater management and water quality, it is important to involve the audience (VC ENRAC, etc.). Engaging in activities like fact-finding and seeking input from stakeholders can provide valuable insights for shaping the incentive program.

4. **Create Rules Structure and Develop Budget**
   To ensure the success of the incentive program, a well-defined set of rules and a budget must be established. This step involves determining the program's fixed and variable costs, allocating resources for its administration, and establishing appropriate management processes.

5. **Select Awards**
   Choosing the right incentives is crucial for motivating the audience. The selected awards should align with GSI and LID techniques outlined in the adopted Technical Manual. Examples of incentives could include density caps with bonus density incentives, reduced dimensional regulations, fee waivers, property tax abatements, priority permit processing, and compliance grants.

6. **Communicate the Program**
   Effectively communicating the incentive program is essential for expanding the audience and encouraging participation. Utilizing appropriate media channels and

outreach strategies can help raise awareness among the public, developers, and other stakeholders. Leveraging existing educational efforts, such as those used to promote local National Flood Insurance Program (NFIP) regulations to capture credits for the Community Rating System, can be beneficial. The local government must lead the way by implementing LID and GSI compliant projects as examples to the community as a whole.

7. **Monitoring**
   Tracking and monitoring the progress of the incentive program is crucial. This step involves regular updates on the program's results and outcomes. The success of this stage depends on the available budget, capacity, and resources.

8. **Fulfill the Awards**
   Promptly delivering the awarded incentives enhances their effectiveness. Ensuring a smooth and efficient process for granting incentives can further encourage participation and compliance.

9. **Evaluate and Measure**
   Evaluating the incentive program's effectiveness and measuring its impact is vital. This step involves assessing whether the objectives are being accomplished and identifying any external factors and unintended consequences that may influence the program's outcomes. Evaluation should be an ongoing process, intertwined with steps 4 (Rules) and 7 (Monitoring).

10. **Celebrate Success!**
    Acknowledging and rewarding the achievers is a powerful way to provide additional incentives to participate, whether through regulatory (LDRs) or voluntary compliance. Celebrating the success of the incentive program through annual events, awards ceremonies, and public recognition can motivate participants and inspire others to follow suit. Nominating local government GSI and LID-compliant projects for local and national project awards can serve as an additional incentive.

By following these ten steps for effective incentives, local governments can create a robust program that not only promotes stormwater management and water quality improvements but also inspires and rewards stakeholders for their contributions.

Recommendations:

The project team believes that successful implementation of an LID program is most likely when the program is required through regulation rather than being voluntary. If regulatory standards are not feasible, a well-designed incentive program can also be effective in encouraging LID behavior and projects.

LID Design

To the extent that the average citizen gives any thought at all to stormwater management, visions of gray concrete curbs and gutters covered with prison-like grates are most likely. Stormwater management is all too often directed by public works departments instructed to keep expenses down. LID design offers opportunities to think differently about managing stormwater. Designing with nature to mimic natural hydrological processes to manage stormwater can provide multiple benefits. Landscapes utilizing native plants are more water-efficient, lower maintenance, and require fewer—if any—chemical inputs to improve community aesthetics and bolster property values. Street trees, planted strategically to provide additional shade, minimize urban heat island effects. Development that reduces the need for vehicular traffic and parking improves walkability and reduces pollution.

This Guidebook does not delve into the details necessary for LID design; however, stormwater runoff pollutant load formulae referred to in the LID Ordinance Recommendations are included in this section following the review of existing Florida local government Technical Manuals.

Technical Manuals - Florida Local Government Examples

The project team reviewed Technical Manuals that address LID and GSI from Florida counties and municipalities. The list below includes Technical Manuals from five counties and four municipalities selected as examples for local governments to consider when adopting an LID ordinance. Three of the municipalities—Doral, Ormond Beach, and Titusville—have adopted LID ordinances.

- Alachua County Stormwater Treatment Manual (2018)
- Brevard County LID Retrofit Guide for Commercial & Light Industrial Facilities (2020)
- Pinellas County Stormwater Manual (2021)
- Sarasota County LID Guidance Document (2015)
- Walton County LID Technical Manual (2019)
- City of Doral LID Master Plan (2019)
- City of Ormond Beach LID Design Manual (2013)
- City of Titusville LID Technical Manual (2021)
- City of Winter Haven From Gray to Green: Enhanced Stormwater Permit Design Manual (2021)

Details of the Technical Manuals including chapter headings, release date, number of pages, and internet links are detailed in the *LID Technical Manuals – Florida County and Municipal Examples* spreadsheet. The manuals range in release date from 2013 (Ormond Beach) to 2021 (Titusville, Winter Haven, and Pinellas County). Several are more comprehensively detailed including Alachua County (308 pages), Pinellas County (268 pages), and Doral (296 pages). The Brevard manual (28 pages) is geared towards LID retrofits for commercial and light industrial facilities. A

local government aspiring to encourage greater LID implementation could select and modify the most suitable manual or choose components from several manuals.

Site Planning, Source Control, and Structural Best Management Practices as they were addressed in the nine manuals' tables of contents are listed in *Appendix C – Technical Manual LID / GSI BMP Matrix*. The majority of the manuals addressed the following:

- Site planning,
- Best Management Practices of inventorying site assets (hydrology, topography, soils, and vegetation),
- Preserving open space,
- Protecting surface waters and wetlands,
- Conserving natural areas,
- Cluster design, and
- Minimizing total impervious surface area and directly-connected impervious area.

Some of the newer manuals detail impervious area minimization with road narrowing, alternative parking design, and road layout. Doral included removal of exotic vegetation, reducing construction on permeable soils, and locating new buildings, parking, and ponds in areas that have lower hydrologic function.

The Source Control Best Management Practices that were most often listed include retaining natural landscape depressions, using selective site clearing and grading, minimizing disturbance and compaction of soil, building with landscape slope, retaining native landscape at lot level, and use of Florida-Friendly Landscaping and rainfall interceptor trees. Soil amendments and education of the community and homeowner appeared in a couple of the manuals.

The Structural Best Management Practices are typically what comes to mind for LID/GSI. Rain gardens, bioswales, biofiltration systems, rainwater harvesting, and pervious pavement were addressed in the majority of manuals. A few of the less addressed techniques include constructed wetlands, managed aquatic plant systems, underground storage and retention systems, and soil reforestation.

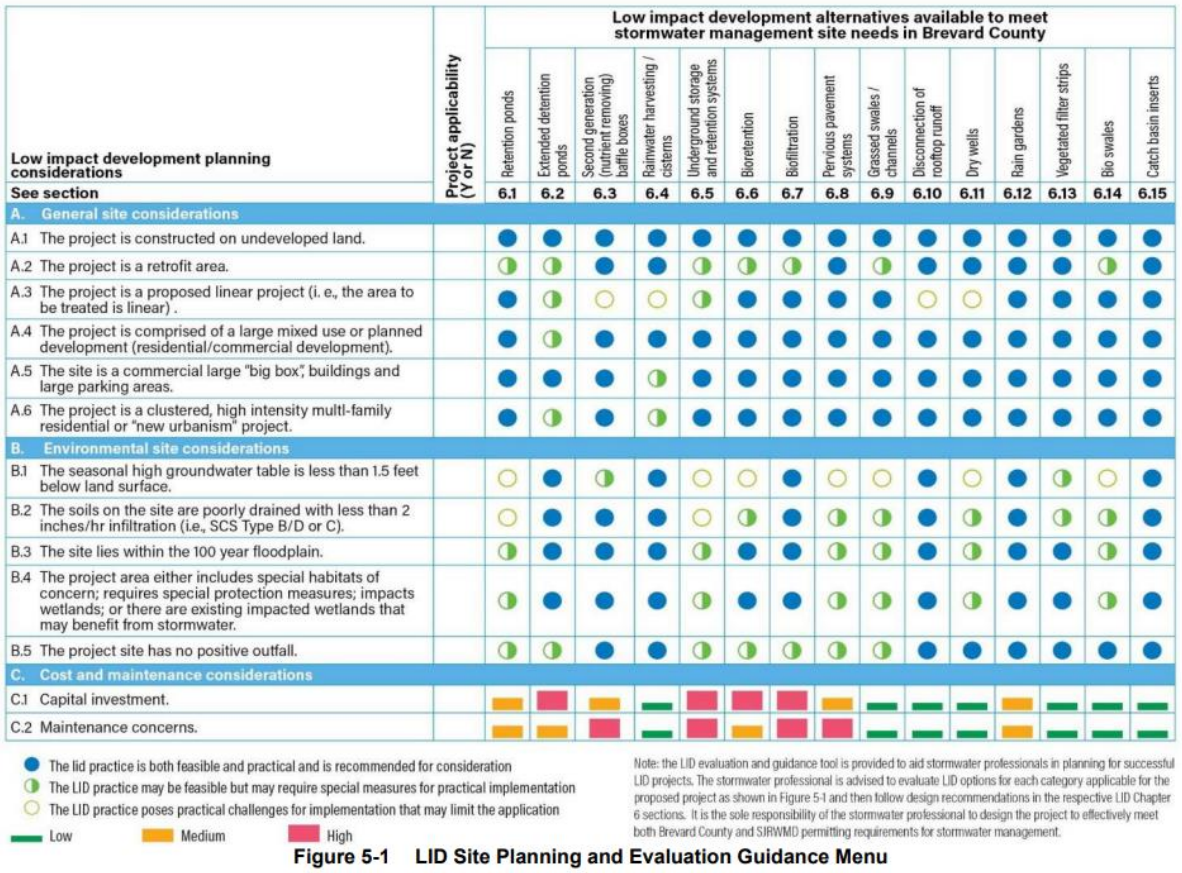
The Technical Manuals overlap in many of the BMPs; however, the amount of detail varies widely. There is typically an aspect highlighted in each manual that is not addressed in the other manuals. A few examples include:

- Alachua County Stormwater Treatment Manual – *Table 2.1 Functional Aspects and Timing of LID* details the functional aspects and of 16 LID BMPs and when the technique is implemented during construction.
- Brevard County Low Impact Development Retrofit Guide for Commercial and Light Industrial Facilities – *Figure 5-1 LID Site Planning and Evaluation Guidance Menu* (*Figure 6*) rates LID planning considerations (general site considerations, environmental site

considerations, cost and maintenance considerations) for 15 LID BMPs for feasibility and practicality of implementation.

- Pinellas County Stormwater Manual – *Table 4.0.1 LID/GSI Benefits for Developers and Public* lists benefits to developers and public for 11 LID BMPs.
- Sarasota County Low Impact Development Guidance Document – Key Considerations, pollutant removal potential, stormwater management suitability, and implementation considerations (*Figure 7)* for six LID BMPs are detailed.
- Walton County Low Impact Development Technical Manual – *Table 1 Overview of LID BMPs for Optimal Parameters and Maintenance* contains water table, soil type, water storage capacity, slope, and maintenance considerations for eight LID BMPs. The manual also contains a LID Stormwater certification form which shall be completed by the homeowner or a representative of the homeowner once the LID practice is constructed and another one when ownership transfers. These forms need to be submitted to the County and recorded with the deed.

Figure 6 LID Site Planning and Evaluation Guidance Menu (Source: Brevard County LID Retrofit Guide for Commercial and Light Industrial Facilities)



Low impact development planning considerations	Project applicability (Y or N)	Low impact development alternatives available to meet stormwater management site needs in Brevard County													
		Retention ponds	Extended detention ponds	Second generation (nutrient removing) baffle boxes	Rainwater harvesting / cisterns	Underground storage and retention systems	Bioretention	Biofiltration	Pervious pavement systems	Grassed swales / channels	Disconnection of rooftop runoff	Dry wells	Rain gardens	Vegetated filter strips	Bio swales	Catch basin inserts
See section		6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	6.10	6.11	6.12	6.13	6.14	6.15
A. General site considerations																
A.1 The project is constructed on undeveloped land.		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
A.2 The project is a retrofit area.		◑	◑	●	●	◑	◑	◑	●	◑	●	●	●	●	◑	●
A.3 The project is a proposed linear project (i. e., the area to be treated is linear) .		●	◑	○	○	◑	●	●	●	●	○	○	●	●	●	●
A.4 The project is comprised of a large mixed use or planned development (residential/commercial development).		●	◑	●	●	●	●	●	●	●	●	●	●	●	●	●
A.5 The site is a commercial large "big box", buildings and large parking areas.		●	●	●	◑	●	●	●	●	●	●	●	●	●	●	●
A.6 The project is a clustered, high intensity multl-family residential or "new urbanism" project.		●	◑	●	◑	●	●	●	●	●	●	●	●	●	●	●
B. Environmental site considerations																
B.1 The seasonal high groundwater table is less than 1.5 feet below land surface.		○	●	◑	●	○	○	●	○	○	●	○	●	◑	○	●
B.2 The soils on the site are poorly drained with less than 2 inches/hr infiltration (i.e., SCS Type B/D or C).		○	●	●	●	○	◑	●	◑	◑	●	◑	●	◑	◑	●
B.3 The site lies within the 100 year floodplain.		◑	●	●	●	◑	●	●	◑	◑	●	◑	●	●	◑	●
B.4 The project area either includes special habitats of concern; requires special protection measures; impacts wetlands; or there are existing impacted wetlands that may benefit from stormwater.		◑	●	●	●	◑	●	●	◑	◑	●	◑	●	●	◑	●
B.5 The project site has no positive outfall.		◑	◑	●	●	◑	◑	◑	◑	◑	●	●	●	●	●	●
C. Cost and maintenance considerations																
C.1 Capital investment.		▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬
C.2 Maintenance concerns.		▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬

● The lid practice is both feasible and practical and is recommended for consideration
◑ The LID practice may be feasible but may require special measures for practical implementation
○ The LID practice poses practical challenges for implementation that may limit the application

▬ Low ▬ Medium ▬ High

Note: the LID evaluation and guidance tool is provided to aid stormwater professionals in planning for successful LID projects. The stormwater professional is advised to evaluate LID options for each category applicable for the proposed project as shown in Figure 5-1 and then follow design recommendations in the respective LID Chapter 6 sections. It is the sole responsibility of the stormwater professional to design the project to effectively meet both Brevard County and SJRWMD permitting requirements for stormwater management.

Figure 5-1 LID Site Planning and Evaluation Guidance Menu

Low Impact Development Retrofit Guide for Commercial and Light Industrial Facilities Page 11 of 28

Figure 7 Key Considerations for Pervious Pavement Systems (Source: Sarasota County LID Guidance Document)

3.2 PERVIOUS PAVEMENT SYSTEMS

Key Considerations	**Practice Intent:** ▪ Reduce stormwater runoff production while supporting traffic loading. **Design Criteria:** ▪ Must use a certified installer. ▪ Must use a flat or minimal slope area. ▪ Must incorporate a perimeter edge restraint. ▪ Must use in-situ infiltration measurements. ▪ Typically include a surface pavement overlaying a reservoir. **Advantage/Benefits:** ▪ Has potential to reduce the size of or eliminate stormwater structures from impervious areas. ▪ Increases usable/developable space or decreased developed footprint. ▪ May increase aesthetic value. **Disadvantages/Limitations:** ▪ May have increased maintenance requirements and costs. ▪ Typically has higher construction cost than conventional impervious pavements. ▪ Not suitable for all site soil conditions. ▪ If the surface fails, it must be reconstructed, not resurfaced. **Maintenance Requirements:** ▪ Vacuum the surface layer as needed when infiltration measurements are lower than 1.5 inches per hour for the pervious pavement system. ▪ Designate a legally responsible authority for maintenance.
Pollutant Removal Potential	**H** **Total Suspended Solids** **M-H** **Nutrients**—Total Phosphorus/Total Nitrogen Removal (with additional nutrient absorption media) **H** **Metals**—Cadmium, Copper, Lead, and Zinc removal **No data** **Pathogens**—Coliform, Streptococci, E. Coli removal
Stormwater Management Suitability	☒ **Water Quality** ☒ **Volume and Flood Attenuation**
Implementation Considerations	**Residential Subdivision Use:** Yes **High-Density/Ultra-Urban:** Yes **Traffic Considerations:** Typically for light duty and low-frequency traffic. **Shallow Water Table:** Precautions needed. **Soils:** Well-drained soils.
Other Considerations:	ADA and Florida Building Code Compliance

L—Low, **M**—Moderate, **H**—High

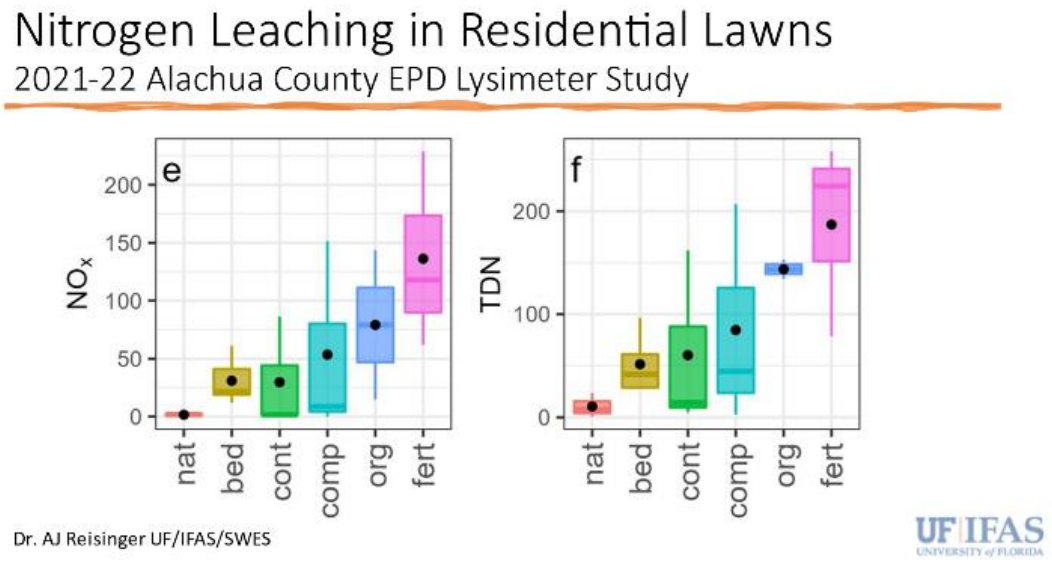
Stormwater Runoff Pollutant Load

A 2020-21 University of Florida | Institute of Food and Agricultural Sciences (UF|IFAS) Study looked at Nitrogen concentrations in leachate resulting from natural rainfall events under actual homeowner lawns[17]. The Study compared natural areas, plant beds, and lawns with

1. nothing applied,
2. compost applied,
3. organic fertilizer applied, and
4. mineral fertilizer applied.

The data showed that average loading from mineral fertilizer was considerably—and statistically significantly—higher than the other treatments documenting nitrogen was escaping from the landscape into groundwater (*Figure 8)*. Nitrogen fertilizer treatments applied every other month can negatively affect groundwater quality.

Figure 8 Nitrogen Leaching in Residential Lawns (Source: UF/IFAS/SWES 2021-22 Alachua EPD Lysimeter Study)



Consequently, fertilizer use is in fact a major source of nitrogen coming into the environment. **Eliminating fertilizer use is source control,** as is eliminating irrigation with reclaimed water. As it develops in phases, the Sunbridge community in Central Florida is implementing landscape practices that eliminate the need for and use of mineral fertilizer, thereby reducing nitrogen (and phosphorus) loading to the environment (*Figure 9)*.

[17] Quantifying nitrogen leaching from residential soils in Alachua County, FL Phase 2: Effects of different landscape management practices on nutrient and organic contaminant leaching Final Report, University of Florida | IFAS

Figure 9 Sunbridge Weslyn Park Community Landscape Standards (Source: https://issuu.com/tdc6900/docs/sb_communitystandards_landscaping_weslynpark_final)

This "front-end" LID approach, utilizing the landscape design and plant palate to eliminate chemical fertilizers, is most effective in removing these nutrient pollutants from stormwater than any combination of curb cuts, filters, porous pavers, and swales, because the nutrients are unnecessary to the maintenance of the landscape and are eliminated from the landscape in the first place. Landscape design and implementation practices that eliminate mineralized fertilizers and reduce the need for irrigation are the first and best LID practice.

EPA's National Stormwater Calculator (SWC) is a software application tool that estimates the annual amount of rainwater and frequency of runoff from a specific site using green infrastructure as low impact development controls. The SWC is designed for use by anyone interested in reducing runoff from a property, including site developers, landscape architects, urban planners, and homeowners.[18]

Another common method for estimating stormwater runoff pollutant loads is the *Simple Method*. The following is an excerpt from Scheuler's *The Simple Method to Calculate Urban Stormwater Loads*[19]

[18] https://www.epa.gov/water-research/national-stormwater-calculator

[19] https://scdhec.gov/sites/default/files/media/document/Schueler%20Simple%20Method%20to%20Calculate%20Urban%20Stormwater%20Loads.pdf

The Simple Method estimates stormwater runoff pollutant loads for urban areas. The technique requires a modest amount of information, including the sub watershed drainage area and impervious cover, stormwater runoff pollutant concentrations, and annual precipitation. With the Simple Method, the investigator can either break up land use into specific areas, such as residential, commercial, industrial, and roadway and calculate annual pollutant loads for each type of land, or utilize more generalized pollutant values for urban runoff. It is also important to note that these values may vary depending on other variables such as the age of development.

The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as:

L = 0.226 * R * C * A

Where:

L = Annual load (lbs)
R = Annual runoff (inches)
C = Pollutant concentration (mg/l)
A = Area (acres)
0.226 = Unit conversion factor

For bacteria, the equation is slightly different, to account for the differences in units. The modified equation for bacteria is:

L = 103 * R * C * A

Where:

L = Annual load (Billion Colonies)
R = Annual runoff (inches)
C = Bacteria concentration (1,000/ ml)
A = Area (acres)
103 = Unit conversion factor

Conclusions

Properly designed, constructed, and maintained green infrastructure practices provide the greatest benefit to water resources and the community. Because LID/GSI can be the first line of defense when addressing water quality and quantity, utilizing natural infrastructure that mimics and enhances natural processes to minimize flooding, erosion, and manage runoff will be important. Additionally, as Florida grows (*Figure 10)*, managing development will protect water availability from adverse impacts caused by withdrawals while also ensuring that there is enough water to support future growth.

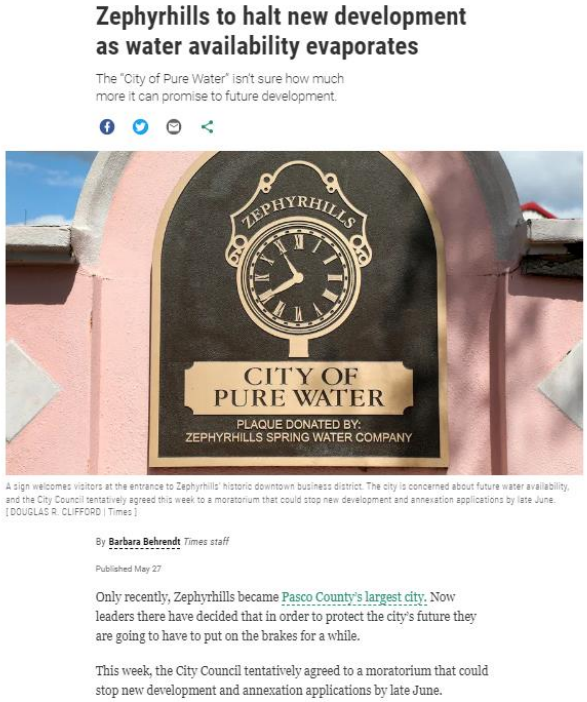


Figure 10 Zephyrhills to halt new development as water availability evaporates (Source: Tampa Bay Times, Barbara Behrendt, 5.27.23)

Implementing a comprehensive Low Impact Development (LID) ordinance can have a transformative impact on land development and stormwater management practices, leading to more sustainable and environmentally friendly communities. The following section outlines essential steps involved in creating an effective LID ordinance that aligns with local government objectives and promotes the adoption of LID principles.

1. **Establish a team**.
   Establish a team of local government staff that is familiar with and responsible for administering the local government's codes and ordinances including planning, stormwater management, and environmental staff.

2. **Review ordinance framework**.
   To begin the process of creating a LID ordinance, it is crucial to review the existing ordinance framework. This step involves assessing the current land development and stormwater management regulatory scheme to identify strengths, weaknesses, and areas of improvement.

3. **Identify barriers in ordinance framework**.
   Conducting a comprehensive LID code audit provides a valuable assessment to evaluate the alignment of existing regulations with LID and GSI principles. This step involves a detailed examination of the current ordinance framework to identify

specific gaps or inconsistencies in addressing LID principles. Questions to consider include:

a. What aspects of LID are currently not addressed in the Land Development Code (LDC)?
b. Are there any inconsistencies or conflicts within the existing LDC?
c. How can LID provisions be effectively incorporated into the local government's LDC?

Tools such as the UF Code Audit Spreadsheet Tool (CAST) can assist in this process[20]. CAST allows for a thorough review of regulatory provisions, covering various topic areas related to planning and policy, protecting nature, stormwater and water quality challenges, and the built environment. By assigning scores to different aspects of LID and GSI, the audit helps identify potential barriers to LID and GSI in the existing comprehensive plan and LDC and provides opportunities for improvement in areas that require attention and potential modifications.

4. **Select or create a Technical Manual.**
   A Technical Manual plays a crucial role in providing clear guidelines and standards for implementing LID and GSI practices. Review existing local government Technical Manuals related to stormwater management and consider adopting or creating a new manual that aligns with LID principles. The Technical Manual should, at a minimum, address site planning, source controls, and structural BMPs with consideration of maintenance and educational strategies.

5. **Address education and training.**
   Recognizing the importance of education, ensure that staff, the development community, elected officials, and residents receive proper education and training on LID principles and practices. Consider adopting educational practices such as offering regular staff and professional training on maintaining LID and GSI implementations to maintain efficacy. Additionally, consider educational criteria detailed in Florida Green Building Coalition's (FGBC) development standards for education including on-site green specialists, environmental education in marketing materials, demonstration green buildings, and outdoor environmental education signs.[21] By providing professional training and community educational resources, local governments can foster a better understanding of LID and encourage its adoption within the community.

[20] LID+GSI Code Audit Tool (CAST): See Planning and Design section of site - https://gsi.floridadep.gov/resources/technical-resources/
[21] https://floridagreenbuilding.org/land-development/

6. **Adopt an ordinance.**
   Now that the groundwork has been laid, the elected officials can adopt an Ordinance that requires utilization of GSI and LID standards and strategies from the adopted Technical Manual for new development and redevelopment projects; e.g., residential subdivisions; large multi-family and non-residential projects. The Ordinance can also incentivize existing development to retrofit their existing stormwater management strategies with an effectively designed GSI and LID incentive program.

7. **Consider additional projects, partners, and funding**.
   Creating a robust LID ordinance may require additional resources, partnerships, and funding. This step involves exploring opportunities for collaboration with relevant stakeholders, such as other government agencies, community organizations, and experts in the field. Additionally, considering the need for a complete overhaul of the LDC and identifying potential funding sources will contribute to the successful implementation of the LID ordinance.

By following these steps, local governments can create an effective LID ordinance that aligns with their objective to improve stormwater management and water quality through effective implementation of GSI and LID standards and strategies from the local government's adopted Technical Manual in new development and redevelopment projects; and wherever else possible. The process requires collaboration, careful analysis, and a commitment to incorporating LID principles into the regulatory framework.

Appendix A - Low Impact Development (LID) and Green Stormwater Infrastructure (GSI) Best Management Practices (BMPs)

Low Impact Development (LID) and Green Stormwater Infrastructure (GSI) are both sustainable approaches to managing stormwater runoff that aim to reduce the negative impacts of traditional gray stormwater management practices such as increased risk of downstream flooding, degradation of water quality and aquatic habitats through erosion, sedimentation and pollutants, and increased urban heat island effects through reduced vegetative cover and increased impervious surface. Both LID and GSI have a range of benefits, including reducing flooding, improving water quality, and enhancing the aesthetics and biodiversity of urban areas.

Figure 11 Rain Garden (Source: Hillsborough County 5 Steps for Creating a Rain Garden, 2022)

LID is a comprehensive land use planning and engineering design approach that emphasizes conservation and use of natural site features to manage stormwater runoff. It includes a range of techniques such as cluster design, low impact site preparation, resource efficient landscapes and irrigation, stormwater reuse, green roofs, rain gardens, permeable surfaces, and bio-retention areas that mimic natural hydrological processes to capture, treat, and infiltrate stormwater runoff on-site. GSI, on the other hand, refers to the use of natural or engineered systems to manage stormwater runoff including techniques such as rain gardens, bioswales, rain barrels, green roofs, tree box filters, and permeable surfaces. GSI emphasizes the integration of vegetation and soils into urban infrastructure to capture, treat, and infiltrate stormwater runoff.

LID and GSI Best Management Practices (BMPs) are typically grouped into three categories – site evaluation and planning, source controls, and structural stormwater practices.

Site Evaluation and Planning. Site evaluation and planning involve assessing and designing land development projects with a focus on avoidance and minimizing environmental impact. These non-structural practices aim to manage stormwater runoff, protect water quality, and enhance natural ecosystems. Key aspects of site evaluation and planning include assessment of existing conditions, preservation of natural features, retaining natural hydrology and topography, and minimizing impervious surfaces such as concrete and asphalt.

Source Controls. Source control techniques involve minimizing the quantity of stormwater runoff from a site and minimizing the pollutant load carried by stormwater. These non-structural techniques include minimizing soil disturbance and compaction, building with landscape slope, disconnecting impervious areas, using Florida-Friendly landscapes and fertilizers, and installing efficient irrigation systems.

Structural Stormwater. Structural stormwater management practices involve mitigating development impacts. The practices are designed to mimic the way nature manages rainfall by capturing, infiltrating, filtering, storing, transpiring, evaporating, and containing runoff close to its source. This can be accomplished by using a combination of LID and GSI techniques such as permeable pavements, rain gardens, bioretention areas, and green roofs to capture, infiltrate, and treat stormwater runoff.

Commonly used LID and GSI structural stormwater techniques, their benefits, and applications are detailed *Table 1.* The techniques are hyperlinked to provide greater detail on design considerations, operations and maintenance, relative cost, and additional sources. Techniques that are both LID and GSI include rain gardens, which are shallow depressions planted with native vegetation to capture and filter stormwater; bioswales, which are gently sloping, vegetated channels that slow, filter, and infiltrate stormwater; permeable surfaces, which allows water to infiltrate through the surface into a gravel bed beneath; rain barrels, which collect and store rainwater runoff from rooftops; and green roofs, which use plants and soils to capture and retain stormwater on rooftops. Applications of these sustainable techniques address the entire community from the individual homeowner with a rain barrel and rain garden to public parking lots with permeable surfaces, tree box filters, rain gardens, and resource efficient landscape and irrigation.

Figure 13 Powderpuff mimosa groundcover on green roof at Escambia County Office Complex (Source: https://gsiphotosflorida.org/)

Figure 12 City of Melbourne Rain Barrel Rebate Program (Source: https://www.melbourneflorida.org/departments/public-works-utilities/environmental-community-outreach/rain-barrel-rebate)

By combining multiple BMPs, which may include Site Planning BMPs, Source Control BMPs, and Structural BMPs in a sequence, each with its specific function, a treatment train maximizes the overall effectiveness of stormwater treatment. The concept of a treatment train (*Figure 12*) in LID refers to a sequential and integrated approach to managing stormwater runoff through a combination of treatment practices. The treatment train concept recognizes that a single stormwater management practice may not be sufficient to adequately address all the potential pollutants and hydrological concerns. This integrated and multi-step approach maximizes the

overall effectiveness of stormwater treatment, leading to improved water quality, reduced downstream flooding, and better protection of ecosystems and water resources.

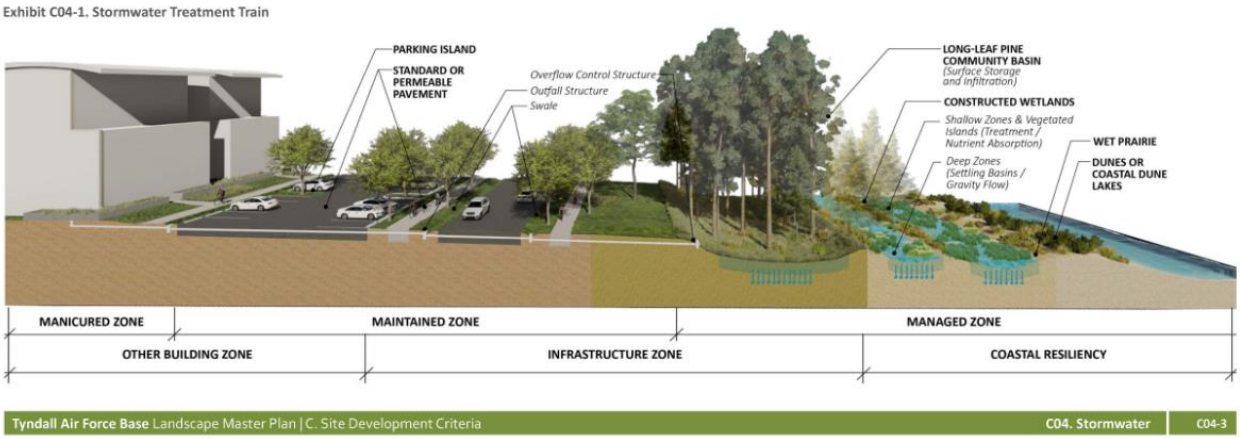


Figure 14 Stormwater Treatment Train (Source: Tyndall AFB Landscape Master Plan Exhibit C04)

LID and GSI approaches can provide significant cost savings for local governments and taxpayers when compared to traditional stormwater management methods, as they require less maintenance and can be less expensive to install. For example, permeable pavement requires less excavation and material than traditional impervious pavement, which can result in installation cost savings. Once established, rain gardens and bioswales require minimal maintenance beyond occasional weeding and debris removal, while traditional gray infrastructure requires regular cleaning and repair. Furthermore, LID and GSI techniques often require less land than traditional stormwater practices, which can result in cost savings related to land acquisition.

Although LID and GSI have numerous benefits, they also have some challenges and limitations ranging from site suitability through public education. The following list is a compilation of challenges from LID and GSI literature and the East Central Florida 2022 LID Regional Roundtable discussion:

- District regulations don't give credit for LID and GSI innovation.
- Local code inhibits LID.
- Code enforcement is minimal or lacking.
- Lack of uniform policies and codes throughout the region create more work for developers and builders resulting in continued use of conventional practices.
- LID and GSI techniques are designed to manage small to moderate storm events and may not be able to handle large or frequent storms.
- Site specific challenges including land use, adequate space, soil type, and topography may prohibit implementation feasibility.
- The design process is often misunderstood and needs to be streamlined by local government.

- Maintenance and practitioner training is often lacking resulting in ineffective LID and GSI techniques.
- Public education and outreach efforts are necessary to increase awareness and understanding of LID and GSI practices at all levels throughout the community – including individual homeowner.

Despite these challenges and limitations, LID and GSI remain an important and effective approach to managing stormwater runoff in a more sustainable and cost-effective way that benefits both the environment and communities. With proper planning, implementation, and maintenance, LID and GSI can help protect water resources and mitigate flooding.

Table 1. LID/GSI Techniques, Applications, and Benefits Matrix

Technique	LID/GSI	Applications	Benefits
Bioretention Basins / Rain Gardens	LID GSI	• Residential yards (smaller, urban sites) • Commercial development • Parking lot islands • Roadways (off-line cells adjacent to roadways accessed by curb cut)	• Pollutant removal through infiltration & plant absorption • Reduction of water runoff from site • Reduced irrigation for planting beds • Increased biodiversity and aesthetic values
Bioswales / Vegetated Swales	LID GSI	• Parking lot island & medians • Residential roadside swales • Highway medians • Landscape buffer	• Treat water quality using soil, vegetation, and microbes • Reduce total volume of stormwater runoff • Increase infiltration & groundwater recharge • Multifunctional conveyance system • Can be aesthetic par of landscape & improve biodiversity
Cisterns / Rain Barrels	LID GSI	• New construction • Retrofits • Commercial • Residential communities	• Reduces use of potable water for irrigation • On site reuse reduces quantity of stormwater runoff
Cluster Design	LID	• New construction • Commercial • Residential communities	• Preservation of natural open space for recreation • Common open space • Preservation of environmentally sensitive features
	LID	• Common areas in residential communities	• Retention • Detention • Sedimentation

Enhanced Stormwater Basins		• Commercial development	• Metals & nutrient retention • Increases wildlife habitat & biodiversity • Community amenity • Passive recreation • Educational opportunity
Exfiltration Tanks / Trenches	LID	• Residential lots • Commercial development • Parking lots • Green spaces • Golf courses	• Detention • Infiltration • Stormwater reuse • Groundwater recharge • Runoff attenuation • Reduction in peak velocity • Reduction in stormwater runoff volume • Possible reduction size of centralized stormwater retention ponds
Green Roofs / Eco-roofs	LID GSI	• Commercial buildings • Industrial buildings • Residential buildings	• Reduces stormwater volume (50-80%) • Improves stormwater quality through load reduction • Saves water by harvesting rain • Reduces heat island effect • Lowers surface temperatures by 40-50 degrees (F) • Energy savings can reach 15-30% • Reduces noise for building occupants • Increases life of the roof and reduces roof maintenance costs • Contributes to biodiversity & creates habitats for birds and invertebrates • Filters air pollutants & captures airborne particles
Low Impact Site Preparation	LID	• New construction • Residential communities • Commercial	• Lower irrigation & fertilization requirements • Reduction in runoff volume • Preserving quality of stormwater • Enhanced biodiversity
Permeable Surfaces	LID GSI	• Parking lots • Low traffic streets • Walkways • Driveways	• Retention • Detention • Reduce water runoff volume • Reduce pollutant loads
Resource Efficient	LID	• New construction • Retrofits	• Reduction of pollutant load • Reduced water consumption

Landscapes and Irrigation		• Commercial • Residential communities	
Soil Moisture Sensors	LID	• New construction • Retrofits • Commercial • Residential communities	• Reduced water consumption • Can be set to lower and upper thresholds to maintain optimum soil moisture saturation and minimize plant wilting • Can contribute to deeper plant root growth, reduced soil runoff/leaching, and less favorable conditions for insects and fungal diseases
Stormwater Reuse	LID	• New construction • Retrofits • Commercial • Residential communities	• Conservation of potable water • Maintains hydrologic balance • Improved water treatment
Tree Box Filter	GSI	• Parking lots • Sidewalks	• Reduces quantity of stormwater runoff • Reduces water pollution and improves quality of ground and surface waters • Reduces urban heat island effect • Improves aesthetics of communities • Improves water and air quality

Sources: UF/IFAS Fact Sheets (https://buildgreen.ifas.ufl.edu/LID_fact_sheets.htm) and https://www.stormwaterassociation.com/tree-box-filters

Appendix B – City of Titusville LID Incentives Matrix

Source:
https://library.municode.com/fl/titusville/codes/technical_manuals?nodeId=CD_S11LOIMDELI_11.6LOIMDEINMA)

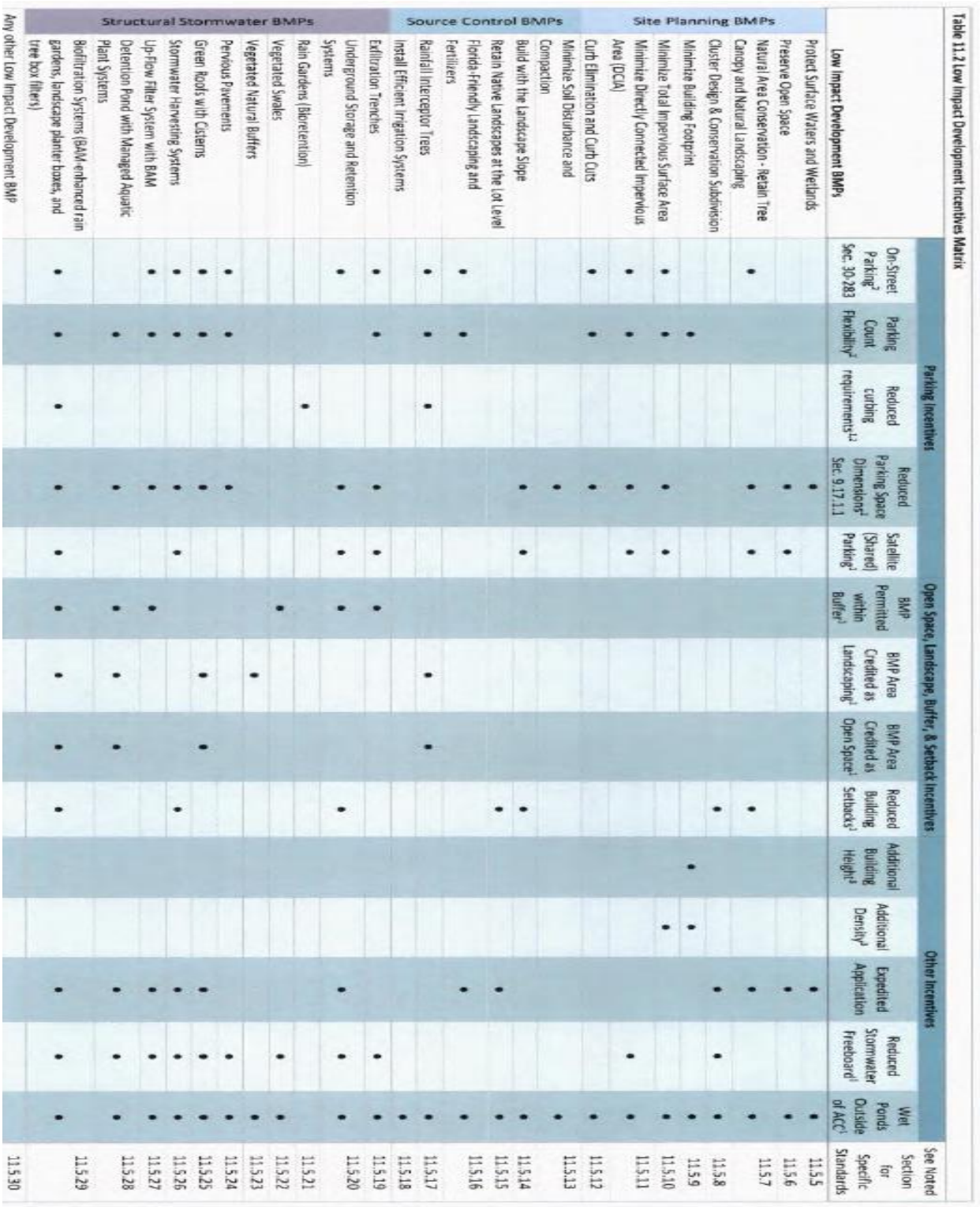


Table 11.2 Low Impact Development Incentives Matrix

Low Impact Development BMPs	Parking Incentives: On-Street Parking[2] Sec. 30-283	Parking Incentives: Parking Count Flexibility[2]	Parking Incentives: Reduced curbing requirements[1,2]	Parking Incentives: Reduced Parking Space Dimensions[2] Sec. 9.17.1.1	Open Space, Landscape, Buffer, & Setback Incentives: Satellite (Shared) Parking[2]	Open Space, Landscape, Buffer, & Setback Incentives: BMP Permitted within Buffer[3]	Open Space, Landscape, Buffer, & Setback Incentives: BMP Area Credited as Landscaping[3]	Open Space, Landscape, Buffer, & Setback Incentives: BMP Area Credited as Open Space[3]	Open Space, Landscape, Buffer, & Setback Incentives: Reduced Building Setbacks[3]	Other Incentives: Additional Building Height[3]	Other Incentives: Additional Density[3]	Other Incentives: Expedited Application	Other Incentives: Reduced Stormwater Freeboard[1]	Other Incentives: Wet Ponds Outside of ACC[1]	See Noted Section for Specific Standards
Site Planning BMPs															
Protect Surface Waters and Wetlands				•								•		•	11.5.5
Preserve Open Space				•	•							•		•	11.5.6
Natural Area Conservation - Retain Tree Canopy and Natural Landscaping	•			•	•				•			•		•	11.5.7
Cluster Design & Conservation Subdivision									•			•	•	•	11.5.8
Minimize Building Footprint		•								•	•			•	11.5.9
Minimize Total Impervious Surface Area	•	•		•	•						•			•	11.5.10
Minimize Directly Connected Impervious Area (DCIA)	•	•		•	•								•	•	11.5.11
Curb Elimination and Curb Cuts	•	•		•										•	11.5.12
Minimize Soil Disturbance and Compaction				•	•									•	11.5.13
Build with the Landscape Slope				•	•				•			•		•	11.5.14
Retain Native Landscapes at the Lot Level									•			•		•	11.5.15
Florida-Friendly Landscaping and Fertilizers	•							•				•		•	11.5.16
Rainfall Interceptor Trees	•	•	•				•							•	11.5.17
Install Efficient Irrigation Systems														•	11.5.18
Exfiltration Trenches	•	•		•	•	•						•	•	•	11.5.19
Underground Storage and Retention Systems	•			•	•	•			•			•	•	•	11.5.20
Rain Gardens (Bioretention)			•												11.5.21
Vegetated Swales						•							•	•	11.5.22
Vegetated Natural Buffers							•							•	11.5.23
Pervious Pavements	•	•		•									•	•	11.5.24
Green Roofs with Cisterns	•	•		•			•	•				•	•	•	11.5.25
Stormwater Harvesting Systems	•	•		•	•			•	•			•	•	•	11.5.26
Up-Flow Filter System with BAM	•	•		•		•						•	•	•	11.5.27
Detention Pond with Managed Aquatic Plant Systems		•		•		•	•	•				•	•	•	11.5.28
Biofiltration Systems (BAM-enhanced rain gardens, landscape planter boxes, and tree box filters)															11.5.29
Any other Low Impact Development BMP															11.5.30

Appendix C – Technical Manual LID / GSI BMP Matrix

LID / GSI Best Management Practices	County					Municipality			
	Alachua	Brevard	Pinellas	Sarasota	Walton	Doral	Ormond Beach	Titusville	Winter Haven
Site Planning BMPs									
Inventory Site Assets: Hydrology	■		■	■	■	■	■	■	■
Inventory Site Assets: Topography & Watershed	■		■	■		■		■	■
Inventory Site Assets: Soils	■		■	■	■	■	■	■	■
Inventory Site Assets: Vegetation	■		■	■		■	■	■	■
Protect Surface Waters & Wetlands	■		■	■			■	■	■
Preserve Open Space	■		■			■	■	■	■
Natural Area Conservation - Retain Tree Canopy & Natural Landscaping	■		■	■		■		■	■
Removal of exotic vegetation (recommended when greater than 5%)						■			
Cluster Design & Maximize Gross Density	■		■	■				■	
Fill Material			■						
Minimize Building Footprint	■		■					■	
Locate new buildings, parking, and ponds in areas that have lower hydrologic function						■			
Reduce construction on permeable soils						■			
Minimize Total Impervious Surface Area	■		■	■		■		■	■
Shared driveways in residential applications				■					
Narrower roads with pervious shoulder and/or right of way				■		■			
Road layout that minimizes linear impervious area				■		■			
Alternative parking lot design that minimizes total impervious area				■		■			
Limit the installation of sidewalks to one side of roadways						■			
Minimize Directly-Connected Impervious Area (DCIA)	■	■	■	■		■	■	■	■
Curb Elimination & Curb Cuts	■		■					■	
Source Control BMPs									
Retain Natural Landscape Depressions	■		■	■		■	■		
Use Selective Site Clearing & Grading	■		■	■		■			
Minimize Soil Disturbance & Compaction	■		■	■		■		■	
Soil Amendment						■	■		
Build with the Landscape Slope	■		■			■		■	
Retain Native Landscapes at the Lot Level	■		■	■		■		■	

Florida-Friendly Landscaping & Fertilizers	■		■	■				■	
Rainfall Interceptor Trees	■		■					■	■
Install Efficient Irrigation Systems	■		■	■				■	
Use Non-Potable Water Supply for Irrigation	■		■	■					
Community & Homeowner Education	■		■						
Structural Stormwater BMPs									
Retention Basin	■	■	■			■			■
Exfiltration Trench	■		■	■		■		■	
Underground Storage & Retention Systems	■	■				■		■	
Bioretention / Rain Gardens	■	■	■	■	■	■	■	■	■
Bioswales / Vegetated Swales	■	■	■		■	■	■	■	■
Vegetated Natural Buffers	■		■		■	■		■	
Pervious Pavement Systems	■	■	■	■	■	■	■	■	■
Green Roof with Cistern Systems	■		■	■		■		■	■
Rainwater Harvesting	■	■	■	■	■		■		■
Wet Detention Systems	■	■	■	■		■			
Stormwater Harvesting Systems	■		■	■				■	
Filter Systems / Tree Box	■		■			■		■	
Managed Aquatic Plant System (MAPS)	■		■					■	
Biofiltration Systems	■	■	■	■	■	■		■	
Second Generation Baffle Boxes		■							
Vegetated Filter Strips		■				■	■		
Catch Basin Inserts		■							
Dry Well		■							
Extended Detention Ponds		■							
Constructed & Pocket Wetlands					■				■

Resources

Introduction to LID

UF/IFAS Video Series

General Best Management Practices

- Introduction to Low Impact Development (LID)
- Traditional Stormwater Retention Basins
- Conventional Stormwater Retention Basins: Improvements Over Traditional Designs
- Enhanced Stormwater Basins: Ecological Enhancement Project
- Developing a Better Way: An Alternative Approach to Stormwater Management
- Green Stormwater Infrastructure (GSI) Approach to Stormwater Management
- Bioretention at Innovation Square and Southwest Recreation Center
- Stormwater Harvesting and Reuse: Rinker Hall Cisterns
- Permeable Surfaces
- Green Roofs: Gainesville Regional Utilities Eastside Campus

Commercial

- Vegetated Swales: Commercial Parking Lot
- Exfiltration Tanks: Commercial Parking Lot
- Stormwater Harvesting and Reuse: Commercial Cisterns

Residential

- Stormwater Harvesting and Reuse: Rain Barrels
- Bioretention Basins & Rain Gardens
- Hillsborough County 5 Steps for Creating a Rain Garden
- Permeable Paving: Residential Driveway
- Resource Efficient Landscapes: Madera Subdivision
- Sanibel DIY Floating Treatment Wetlands for Homeowners (Manual)

UF/IFAS LID Fact Sheets

- Bioretention Basins/Rain Gardens
- Bioswales/Vegetated Swales
- Cisterns/Rain Barrels
- Enhanced Stormwater Basins
- Exfiltration Tanks / Trenches
- Green Roofs/Eco-roofs
- Low Impact Site Preparation
- Permeable Surfaces
- Soil Moisture Sensors
- Stormwater Reuse
- Tree Box Filter (Stormwater Association)

The Nature Conservancy GSI Photo Library (with project descriptions and interviews)
Virtual Tour of the City of Winter Haven's Rain Gardens
Sarasota County (LID) Green Infrastructure Map

City of Cape Canaveral Low Impact Development Guidelines (2021)
Browns Creek Depave Project in Nashville, TN

Resource Efficient Landscaping, Irrigation, and Landscape Maintenance

- Resource Efficient Landscapes: UF/IFAS Extension Alachua County (video)
- Resource Efficient Landscapes and Irrigation (fact sheet)
- Quantifying nitrogen leaching from residential soils in Alachua County, FL Phase 2: Effects of different landscape management practices on nutrient and organic contaminant leaching Final Report, University of Florida | IFAS (study)
- A New Database on Trait-Based Selection of Stormwater Pond Plants (document)
- OUTSIDE Sustainable Landscape Collaborative New Yard Pattern Book for Florida's Sustainable Single-Family Homes
- Florida-Friendly Landscaping Resources for Homeowners, Communities, and Professionals
- Florida-Friendly Interactive Yard Tool
- Be Floridian Now Florida-Friendly yard quick-start guide
- Orange County Florida-Friendly Landscaping Rebates and Incentives

Design and Maintenance Technical Manuals

FDEP Resources GI/LID Manuals

County

- Alachua County Stormwater Treatment Manual (2018)
- Brevard County LID Retrofit Guide for Commercial and Light Industrial Facilities (2020)
- Pinellas County Stormwater Manual (2021)
- Sarasota County Low Impact Development Guidance Document (2015)
- Walton County LID Technical Manual (2019)

Figure 15 UGA Stormwater Treatment Maintenance Checklist (Source: https://gacoast.uga.edu/uga-creates-stormwater-management-tools-to-help-reduce-flooding-in-coastal-communities/)

City

- City of Doral LID Master Plan (2019)
- City of Ormond Beach LID Design Manual (2013)
- City of Titusville LID Technical Manual (2021)
- Winter Haven From Gray to Green: Enhanced Stormwater Permit Design Manual (2021)

Rain Gardens: A Manual for Central Florida Residents (2010)
Conservation Subdivision: Construction Phase—Low Impact Development (LID) and Stormwater Treatment (document)

UGA Stormwater Treatment Maintenance Checklist