Chapter 5. Storm Water Low Impact Development Practices

Operationally, economically and aesthetically, the use of LID practices offers significant benefits over treating and controlling storm water downstream.

The City makes every effort to consistently meet clean water standards.

LID practices include a number of site design techniques such as preserving natural features and resources, effectively laying out the site elements to reduce impact, reducing the amount of impervious surfaces, and utilizing natural features on the site.

City of Birmingham Post Construction Storm Water Design Manual
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5.1 General Principles

When used in the context of storm water management, Low Impact Development (LID) is defined as an approach to land development (both new development and redevelopment) that works with nature to manage storm water as close to its source as possible, ideally using natural hydrologic processes such as infiltration, interception, and evapotranspiration. Storm water LID practices employ principles like preserving and recreating natural landscape features and minimizing effective imperviousness to create functional and appealing site drainage that treats storm water as a resource rather than a waste product. **Reduction of adverse storm water impacts using storm water LID practices should be the first consideration of the site designer for every land development, including redevelopments.** Operationally, economically, and aesthetically, LID practices can offer significant benefits over treating and controlling storm water onsite or downstream. Therefore, feasible opportunities for using these methods should be explored and exhausted before considering the use of the Green Infrastructure Practices (GIPs) or Total Suspended Solids (TSS) Removal Best Management Practices (BMPs) detailed in Chapter 6.

Land developments can be designed to reduce, and sometimes even eliminate, storm water impacts when careful efforts are made to conserve natural areas, reduce impervious cover, and better integrate storm water management techniques. By implementing a combination of these nonstructural approaches, it is possible to reduce the amount of storm water, and therefore pollutants, that are generated from a development after construction. This overall reduction in storm water can yield multiple benefits, such as minimizing costs for infrastructure construction and long-term post-construction maintenance. *The City of Birmingham Comprehensive Plan* and supporting framework plans also encourage these general principles and should be taken into consideration in the preliminary phase of planning a land development, ideally well before the layout of impervious and pervious areas is envisioned.

In general, storm water LID practices are based on the following general goals:

- Early communication and coordination between the City and the development’s multi-disciplinary design team;
- Prioritization of infill and redevelopment to capitalize on use of vacant properties and existing infrastructure;
- Management of storm water (quantity and quality) as close to the point of origin as possible resulting in minimized collection and conveyance;
- Prevention of negative impacts that can result from post-development storm water, so that mitigation is unnecessary;
- Utilization of simple, nonstructural methods for storm water management that are lower cost and lower maintenance than structural controls;
- Creation of a multifunctional landscape that can manage storm water and address or benefit other development needs; and
- Reliance on hydrology as a framework for land development design.

Storm water LID practices include several site design techniques such as preserving natural features and resources, effectively laying out the site elements to reduce impact, reducing the number of impervious surfaces, and utilizing natural features on the site for storm water management. The aim of using LID practices is to reduce the environmental impact “footprint” of the site while retaining and enhancing the owner/developer’s purpose and vision for the site. Many of the LID practices and concepts can reduce the cost of infrastructure while maintaining or even increasing the value of the property.
The reduction in storm water and pollutants using LID practices can reduce the required peak discharges and volumes that must be conveyed and controlled on a site and, therefore, the size and cost of necessary drainage infrastructure and GIPs. In some cases, the use of LID practices may eliminate the need for structural controls entirely. Hence, LID practices can be viewed as both a water quantity and water quality management tool. Some of the practices described in this section provide incentives and reductions for compliance with Birmingham’s storm water performance standards established in Chapter 2 of this manual. Specific storm water LID practices are presented and addressed in detail later in this chapter.

The use of LID practices can also have several other ancillary benefits:

- Reduced construction costs through lower overall costs for land clearing and total infrastructure materials and construction;
- Improved overall marketability and property values;
- More open space for recreation;
- More pedestrian-friendly neighborhoods;
- Protection of sensitive forests, wetlands, and habitats;
- More aesthetically pleasing and naturally attractive landscape;
- Reduced need for irrigation using native plants and/or rainfall storage and reuse;
- Opportunities for education, community involvement, and community stewardship;
- Early identification of storm water management opportunities or obstacles;
- Easier compliance with wetland and other resource protection regulations; and
- Possibility to obtain Leadership in Energy & Environmental Design (LEED) points.

The next section provides insight into the process that should be used to consider and successfully implement storm water LID practices.

### 5.2 The LID Implementation Process

**Figure 5-1** depicts the process that should be used to evaluate and implement storm water LID practices when preparing a land development site design. There are several significant elements in the figure that should be noted by the site designer.

- First, moving step-wise through the process, one can see that successful **LID practice implementation ENDS when a designer begins the analyses and computations for infrastructure design**. Stated differently, all the effort in LID practice planning takes place very early, so that **the site layout is established using storm water LID concepts**. Thus, the site layout will consist of a relative placement to buildings and roads to pervious areas, preserved green spaces, and conservation areas which optimizes natural processes for storm water management.

  This early planning approach is critical for the successful use of storm water LID practices because it strives to fit the development’s buildings and pavement to the existing property’s topography and hydrology, thus taking advantage of natural features and processes to do the work of storm water management. In contrast, site designers who attempt to fit the existing property to a pre-conceived or “cookie-cutter” layout, or who wait to consider LID practices until after the site grading and layout are established, are not likely to have a high degree of success with LID.

- Note also that Figure 5-1 depicts the relationship between the storm water LID implementation process and Birmingham’s storm water pre-concept planning process. The storm water pre-concept process includes the development of a report that characterizes the existing condition hydrology of a potential development site and a collaborative meeting with Birmingham staff to examine site conditions, consider the vision for the future development, and gain perspective on the feasibility of LID practices and GIPs.
Ideally, the outcome of the meeting will be a mutual understanding of the potential storm water management approach for the site and any limitations to the use of specific practices. Based on this understanding, the site designer can proceed with the site layout with inclusion of the LID practices that have been identified as worthy of consideration. Thus, the site design team’s participation in the pre-concept process is of value to both the private developer and City staff, and certainly fits within a normal LID implementation process. The pre-concept process is described more fully in Section 5.4.2 and Chapter 2 of this manual.

**Figure 5-1. Storm Water LID Implementation Process**

Each step in Figure 5-1 is summarized below.

**Step 1 – Site Design Team.** Step 1 of the storm water LID process involves identifying a multi-disciplinary design team to be used throughout the site storm water planning, design, and construction process. Storm water LID practices and GIPs demand that soil and vegetation be considered design elements for storage and volume reduction. As a result, storm water management design is no longer the sole domain of the civil engineer, and professionals knowledgeable of several key disciplines can add great value to a site design. Such disciplines include hydrology, ecology, landscape architecture, land use planning, soil science, geomorphology, horticulture, and even forestry. This step is further discussed in Section 5.4.1 of this chapter.

**Step 2 – Feature Identification.** The identification of hydrologic and natural features, conservation areas, and other resources on a development site is vital to understanding the existing hydrology of the area and how such features can serve a storm water management function after development. Features to be inventoried include undisturbed forest areas, stream buffers, and steep slopes. A full list of items that should be inventoried is included in the pre-concept sketch checklist, which is provided in Appendix B.

**Step 3 – Maximize Natural Areas.** After inventory of the site’s hydrologic and natural features, the site layout can begin to take shape as the site design team collaborates. This is the ideal time to hold the pre-concept meeting with City staff. Several storm water LID practices can be considered in this step to maximize preservation of these features, including the avoidance of floodplains and stream buffers, location of buildings and pavement on soils that are less porous, minimal plans for clearing/grading, and use of an open space layout.

**Step 4 – Minimize Impervious Cover.** Maximization of preserved natural areas is then followed by application of LID practices that target the reduction of the overall imperviousness of the development site. These techniques directly minimize the storm water that will be generated from the development. Such practices include roadway width minimization and reducing parking and building footprints.

**Step 5 – Use Preserved Natural Features.** As the site layout is established, the site designer should also consider those LID practices that target the use of preserved natural features, conservation areas, and
other pervious surfaces for the management of storm water that is discharged from impervious surfaces. For example, discharging storm water from a small parking area into a well-draining forested area or using natural, vegetated swales to convey storm water are both less expensive storm water management options than the construction and maintenance of ditches and pipes.

**Step 6 – Begin Storm Water Design.** Once all storm water LID practices are considered and exhausted, the site designer should have a site layout that effectively minimizes the volume (and in many cases the peak discharges) of storm water that will be discharged from the development and maximizes the use of less costly, lower maintenance techniques to manage storm water. At this point, the site designer can begin the data preparation and analyses required for the design and specification of the man-made on-site storm water drainage system, GIPs, and BMPs.

### 5.3 Overview of LID Practices

The storm water LID practices addressed in this chapter are listed in Table 5-1. The table groups the practices into three major categories that can align with Steps 1, 2, and 3 of the LID implementation process presented in the previous section. These categories are described after the table.

More detail on each of the LID practices in the table is provided on the LID Practice Fact Sheets that comprise Section 5.4 of this chapter. The fact sheets are one to two-page guides that explain the key benefits of each practice, identify where incentives may be available, and provide examples and details on how to apply them in land development design.

<table>
<thead>
<tr>
<th>Table 5-1. Storm Water LID Categories and Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary</strong></td>
</tr>
</tbody>
</table>
| Early Coordination, Collaboration, and Communication | - Work with multi-disciplinary design team (civil engineers, landscape architect, ecologist, etc.)
- Participate in the storm water pre-concept process |
| Conservation of Natural Features and Resources | - Tree and stream buffer protection and restoration *(incentive available)*
- Soil Restoration *(incentive available)* |
| “Build with the Land” Design Techniques | - Implement Retrofits *(incentive available)*
- Reduce Impervious Surface *(incentive available)*
- Redevelopment and Infill *(incentive available)* |
| Greenspace Enhancement | - Complete Streets
- Greenway Connections
- Pocket Parks |

#### 5.3.1 Early Coordination, Collaboration, & Communication

As mentioned previously, early coordination, collaboration, and communication is critical to successful implementation of LID practices. For this category, two LID practices are recognized: use of a multi-disciplinary design team and participation in the storm water pre-concept process. Early coordination with engineering, science, and planning professionals who know storm water can result in an innovative site design that optimizes multi-functional spaces and storm water designs and potentially minimizes the need for costly grading and storm water infrastructure.

#### 5.3.2 Conservation of Natural Features and Resources

Conservation of natural features is integral to the success of a LID site design. This category of LID practices involves the identification and preservation of natural features and hydrologic resources on a site for
the purposes of reducing storm water volume, pollutants, and peak flow; providing storm water storage; reducing flooding; preventing soil erosion; and promoting infiltration and evapotranspiration. Note that all of these purposes align fully with the storm water policies and performance standards that are established in Chapter 3. Thus, the conservation of natural features and resources should be a first thought for site design teams who are focused on ease of compliance with storm water performance standards. Some of the natural features that should be considered are listed below.

- Areas of undisturbed vegetation
- Floodplains and riparian areas
- Ridgetops and steep slopes
- Natural drainage pathways
- Intermittent and perennial streams
- Wetlands
- Aquifers & recharge areas
- Soils
- Shallow bedrock
- High water table
- Other natural features or critical areas

Storm water LID techniques that conserve natural features and resources include the following:

- Preserve undisturbed natural areas,
- Preserve riparian buffers,
- Avoid floodplains, and
- Avoid steep slopes.

Mapping of natural features is typically done through a comprehensive site analysis and inventory before any site layout design is performed. From this site analysis, a concept plan for a site can be prepared that provides for the conservation and protection of natural features. An example of a natural features map is shown in Figure 5-2.

### 5.3.3 “Build With the Land” Site Design Techniques

After a site analysis has been performed and conservation areas have been delineated, there are numerous opportunities to reduce both storm water quantity and quality impacts as the site layout is prepared. The storm water LID practices that can be used at this stage primarily deal with the location and configuration of impervious surfaces or structures on the site and their location relative to natural features and preservation/conservation areas. These LID practices include the following:

- Fit the design to the terrain,
- Locate development in less sensitive areas,
- Reduce limits of clearing and grading,
- Utilize open space development, and
- Consider creative development design.
The goal of techniques that “build with the land” is to position the elements of the development project in such a way that the site design (i.e., placement of buildings, parking, streets and driveways, lawns, undisturbed vegetation, buffers, etc.) is optimized for effective storm water management. That is, the site design takes advantage of the site’s natural features, including those placed in conservation areas, as well as any site constraints and opportunities (topography, soils, natural vegetation, floodplains, shallow bedrock, high water table, etc.) to prevent both on-site and downstream storm water impacts.

Figure 5-3 shows a development that has utilized several “build with the land” site design techniques in its overall layout and design. In the figure, the rough site layout (right) seeks to: 1) **reduce the limits of clearing and grading** to only the area needed for impervious surfaces, setbacks, infrastructure, and utilities; and 2) **locate the development in less sensitive areas** by preserving the forested buffer that bounds a stream located along the left boundary of the property.

**Figure 5-3. Site Layout Utilizing “Build with the Land” Techniques**

5.3.4 **Greenspace Enhancement**

The disappearance of undeveloped greenspace can be a negative consequence of development. An overall decrease in natural and pervious land area can lead to an increase in storm water runoff and a decrease in storm water quality. Greenspace also contributes to livability and is an important community asset that has been shown to promote fitness, health benefits, and community involvement. Creating connected and livable development promotes living and working in Birmingham and encourages investment. These overarching goals are stated in the *City of Birmingham Comprehensive Plan*. Storm water LID practices that promote the use of green spaces should be considered for all projects. These practices include the following, which are described in detail later in this chapter.

- Complete Streets
- Greenway Connections
- Pocket Parks

**Figure 5-4** provides an example of a greenspace enhancement strategy used in an urban environment.

**Figure 5-4. Pocket Park Incorporated into an Urban Area**
5.3.5 Other Design Techniques

Other common design techniques can be used to maximize a site designer’s success using the storm water LID practices itemized above. These techniques are listed in Table 5-2, along with the Birmingham resource document that can be used to assess the technique’s feasibility for a particular site design. These site design techniques target the reduction of impervious surfaces (generally, rooftops and pavement) and the use of natural features to manage storm water that is generated from the impervious surfaces that are constructed. The site design team can consult Section 5.4 and Chapter 6 of this manual to learn more about techniques that involve the use of GIPs.

Table 5-2. Common Site Design Techniques Used to Enhance the Success of Storm Water LID Practices

<table>
<thead>
<tr>
<th>Site Design Technique</th>
<th>Resource Document</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reduction of Impervious Cover</strong></td>
<td></td>
</tr>
<tr>
<td>◆ Reduce roadway lengths &amp; Widths</td>
<td>Birmingham Zoning Ordinance</td>
</tr>
<tr>
<td>◆ Reduce building footprints</td>
<td>Conservation Subdivision &amp; Cottage Development Ordinance</td>
</tr>
<tr>
<td>◆ Reduce the parking footprint</td>
<td></td>
</tr>
<tr>
<td>◆ Reduce setbacks and frontages</td>
<td></td>
</tr>
<tr>
<td>◆ Use fewer or alternative cul-de-sacs</td>
<td></td>
</tr>
<tr>
<td>◆ Create parking lot storm water &quot;Islands&quot;</td>
<td></td>
</tr>
<tr>
<td><strong>GIPs that Reduce and Disconnect Impervious Surfaces</strong>*</td>
<td>City of Birmingham Post Construction Storm Water Design Manual, Chapter 6</td>
</tr>
<tr>
<td>◆ Green roof</td>
<td></td>
</tr>
<tr>
<td>◆ Permeable paver system, pervious concrete, porous concrete</td>
<td></td>
</tr>
<tr>
<td>◆ Downspout disconnection</td>
<td></td>
</tr>
</tbody>
</table>

* Incentive available for use of these techniques. See Chapter 3 for more information on design incentives.

5.4 Storm Water LID Practice Fact Sheets

Section 5.4 provides fact sheets for the storm water LID practices listed in Table 5-1. Each of the fact sheets includes an identification and description of the practice, any design or community improvement incentives that can be realized by its use, a discussion of practice benefits, and guidance on the planning and physical feasibility of the practice.

With the exception of Participation on the Storm Water Pre-Concept Process, all of the LID practices discussed in the following pages are not mandatory requirements for storm water management in Birmingham. However, each of these practices, along with the additional techniques listed in the previous section are strongly...
encouraged by the Birmingham Department of Planning, Engineering & Permits. Not only can implementation of these practices and techniques potentially save land development costs and increase property values, but many of them can also provide larger community benefits such as cleaner water resources, long-lasting, sustainable developments, and opportunities for enjoyable private and public spaces.

With greater interest in storm water LID practices across the globe, significantly more information and ideas for all the practices discussed in the following pages can be found on the internet. The reader is also encouraged to contact the Department of Planning, Engineering & Permits for questions and assistance on local opportunities.

References


5.4.1 Multi-Disciplinary Design Team

Description:
A multi-disciplinary design team is used throughout the site storm water planning, design, and construction process to optimize multi-functional spaces and storm water designs and potentially minimize the need for costly grading and storm water infrastructure. The members of the multi-disciplinary design team need to be selected based on the technical needs of the site and may include storm water managers, engineers, hydrologists, ecologists, landscape architects, land use planners, soil scientists, geomorphologists, horticulturalist, and foresters.

Benefits:
With the implementation of LID practices and GIPs, storm water management design is no longer the sole domain of the civil engineer and a multi-disciplinary approach is needed. The main benefits of utilizing a multi-disciplinary design team include:

✔ Optimization/maximization of multi-functional LID practices and GIP designs;
✔ Robust understanding of how local, state, and federal requirements can be creatively met;
✔ Reduction of the use of, and costs associated with, constructed storm water GIPs and infrastructure;
✔ More robust storm water design and lower maintenance storm water management system; and
✔ Preservation of the site's natural character and aesthetic features.

Also refer to the following chapter in the Alabama LID Handbook for additional information.

❖ Chapter 3: Low Impact Development and Community Planning
Planning and Physical Feasibility:

Impervious surfaces, pervious surfaces, soil, and vegetation are multi-functional site elements which must comply with design specifications to ensure their proper storm water function. As a result, a number of other technical disciplines are training professionals on storm water management. These include engineering, hydrology, ecology, landscape architecture, land use planning, soil science, geomorphology, horticulture, and forestry.

Table 5-3 presents the disciplines and knowledge of a well-rounded site design team. While all of these disciplines may not be necessary for every site design, developers who use multi-disciplinary teams to craft a site’s storm water management approach can often produce more cost-effective, yet highly functional drainage designs.

Table 5-3. Site Design Team Disciplines and Relevant Skills

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Storm Water Design &amp; Construction Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer</td>
<td>Hydrology, hydraulics, infrastructure design, GIP design, storm water quality and quantity control, design plan preparation</td>
</tr>
<tr>
<td>Landscape Architecture</td>
<td>Multi-functional space design, open space function and design, hydrology, landscape design, planting templates</td>
</tr>
<tr>
<td>Soil Science</td>
<td>Soil health, profiles, textures, porosity, storage capacity, restoration techniques</td>
</tr>
<tr>
<td>Horticulture</td>
<td>Functional landscape planning, local temperate conditions, plant varieties and needs, native plants, plant/soil health, stream buffer restoration, and long-term plant management</td>
</tr>
<tr>
<td>Forestry and Ecology</td>
<td>Existing tree stand management, stream buffer restoration/enhancement, reforestation, wildlife/pest management</td>
</tr>
<tr>
<td>Geomorphology</td>
<td>Stream restoration, stream bank stability, and management in a built environment</td>
</tr>
</tbody>
</table>

At a minimum, the site design team should include an engineer and landscape architect. However, expanding the team beyond these professionals to those identified in Table 5-3 will likely provide substantial benefits, as the team can better maximize the use of natural features for storm water management, possibly minimizing constructed features and their associated construction and maintenance costs. All team members should be knowledgeable of, and preferably experienced in, storm water management mechanisms, LID approaches, and green infrastructure practices. Local technical knowledge is preferred, and the redevelopment project should be discussed with the City early in the design process. Refer to Chapter 2 for more information on participating in the pre-concept planning process. The following tips can aid in facilitating the use of a multi-disciplinary design team:

- Involve the whole team very early in the process, ideally before the site layout is developed
- Ensure that the team stays involved throughout design and construction to ensure the protection of LID practices and the proper design and construction of GIPs.
5.4.2 Pre-Concept Planning Process

Description:
The City of Birmingham Post Construction Storm Water Ordinance requires the submittal of the pre-concept sketch and attendance at the pre-concept conference. This process does not require design calculations or analyses, nor does it result in a plan approval. Rather, the process is used to characterize the hydrologic aspects of the property in its existing condition with the objective of optimizing the future on-site storm water system design and plan review process. Applications for a Storm Water Post Construction Permit will not be considered without proof that the pre-concept process has occurred for the proposed development.

Benefits:
The pre-concept sketch and conference determines the opportunities and limitations of the site in terms of the use of GIPs. The process occurs early in the site planning process and aims to identify the site hydrology, minimize impervious surface, maximize the use of LID practices, and minimize the need for constructed drainage features. The main benefits of utilizing a multi-disciplinary design team include:

- Early identification of opportunities or limitations for LID and GIPs;
- Optimize the storm water infrastructure design by taking full advantage or avoiding natural hydrologic features;
- Potentially reduce grading, construction, and maintenance costs through early planning of storm water LID practices; and
- Early interaction with City staff can result in more efficient development plan reviews, potentially reducing plan approval times.

Incentives:
Utilizing the pre-concept process benefits both the developer and the community.

Requirements:
Participation in the pre-concept process prior to submittal of a post-construction storm water plan is required in Birmingham. Refer to Chapter 2, Section 2.3 for policies pertaining to the process.

Also refer to the following chapter in the Alabama LID Handbook for additional information:
- Chapter 3: Low Impact Development and Community Planning
Planning and Physical Feasibility:
Storm water management should be comprehensive and designed to achieve multiple storm water objectives. Preparation of a pre-concept sketch will include the identification and location of features of the development that are important for effective storm water management. These features include, but are not limited to, land cover, hydrologic soil groups, streams, steep slopes, sinkholes, floodplains, bedrock, and existing on-site and adjacent manmade features or storm water systems. Environmentally impaired waters (due to pollutants) and environmentally-sensitive areas (e.g., due to the presence of threatened or endangered species) will also be included.

The pre-concept sketch is required early in the site planning process, ideally before a site design is created for a future land development and definitely before clearing, grading, and construction begin. Early preparation is advantageous for a number of reasons:

- An early understanding of the site’s hydrology can reveal potential opportunities to naturally reduce storm water volumes using non-structural LID techniques and structural GIPs. In turn, natural reduction of storm water volumes can potentially decrease the size, cost, and maintenance of the future onsite storm water system.

- A pre-concept sketch can be useful for site layout planning by allowing the site designer to optimize the location of impervious areas (buildings and pavement), GIPs, and BMPs based on the site's natural vegetation and soils. This early planning can significantly increase the development’s ability to meet storm water control standards using less costly and more natural approaches.

- A pre-concept sketch allows both the site designer and city plan reviewers to identify and understand very early in the site planning process any limitations to LID and GIPs that may exist. This early recognition can result in the avoidance of design analyses (and associated costs) for unfeasible storm water practices and can allow a more efficient design and plan review experience.

- A pre-concept sketch and conference can allow the site designer and city plan reviewers to identify the potential need for additional data or information to support the eventual design, thus putting everyone “on the same page” and facilitating a more efficient design and plan review process.

![Identification and mapping of existing land cover and other hydrologic features on the pre-concept sketch can help to identify opportunities and limitations to natural storm water management. Such features include streams, steep slopes, soil types, and karst areas.](image)
5.4.3 Reduce Impervious Area

Description:
The practices of reducing and disconnecting impervious surface increase the rainfall that infiltrates into the ground. Impervious areas should be reduced by maximizing landscaping and using green roofs and pervious pavements. In addition, the amount of impervious areas hydraulically connected to impervious conveyances (e.g., driveways, walkways, culverts, streets, or storm drains) should be reduced as much as possible. Runoff from remaining impervious surfaces should be directed to pervious areas and GIPs.

Benefits:
Minimizing impervious surface benefits both the City, the developer, and the community. Less impervious surface means less storm water runoff to manage both onsite and downstream. Reducing and promoting green space can also facilitate recreational and community activities and enhance people’s quality of life. The main benefits of reducing impervious surface include:

- A holistic approach to storm water management that minimizes water velocity, run-off, and storm water pollutants;
- Less storm water runoff to manage with onsite GIPs;
- Reduction of on-site erosion and associated maintenance;
- Reduction in the size and cost of storm water management practices and storm water infrastructure; and
- Increased green space and improved aesthetics.

Also refer to the following resources for additional information.

- *City of Birmingham Post Construction Storm Water Design Manual*, Chapter 6, Sections 6.6, 6.10, and 6.11
- Alabama LID Handbook, Chapter 3
- *The City of Birmingham Comprehensive Plan*
Planning and Physical Feasibility:
Total site impervious surface is minimized through the use of the following GIPs and design elements:

- Installation of green roofs (see Chapter 6, Section 6.10)
- Using porous pavements where permitted (see Chapter 6, Section 6.11)
- Installing shared driveways that connect two or more homes or installing residential driveways with center vegetated strips
- Allowing for shared parking in commercial areas
- Encouraging developers to increase the number of floors in a building (increase the vertical density) instead of the building’s impervious footprint

Infiltration of runoff from impervious surfaces is maximized through use of the following GIPs and design elements:

- Direct roof downspouts to vegetated areas, bioretention, cisterns, or planter boxes, and routing runoff into vegetated swales instead of gutters (see Chapter 6, Section 6.6)
- Install curb cuts to convey storm water into vegetated areas such as roadside swales, parking lot islands, or bioretention areas.
- Convey storm water to bioretention and urban bioretention areas (see Chapter 6, Sections 6.3 and 6.4).
- Convey storm water to other GIPs, as appropriate for onsite storm water management (see Chapter 6).

Above: Utilizing a green roof not only helps reduce the impervious surface foot print of site development, but also provides other benefits including a reduction in heating and cooling. Depending on design, the roof can also become an aesthetic amenity to building occupants or for adjacent taller buildings and can provide habitat for desired wildlife. *(Photos courtesy of Nashville-Davidson County Metro Water Services.)*
5.4.4 Redevelopment and Infill

Description:
Urban redevelopment or infill is defined as new development that is sited on vacant or undeveloped land within an existing community and that is enclosed by other types of development. The term "urban infill" illustrates that the existing area is mostly built-out and what is being built is "filling in" the gaps. The term refers to building single-family homes in existing neighborhoods, building multi-family homes in existing neighborhoods, and building new development in commercial, office, or mixed-use areas.

Redevelopment and infill development includes:

- Developing one or more areas on an undeveloped or underutilized site within an existing, established urban area;
- Redeveloping an existing neighborhood;
- Subdividing an existing lot into two or more building lots and developing or redeveloping the newly created lots; and
- Demolishing an existing structure on a lot and building a new structure in its place.

Benefits:
Through the strategies identified in the City of Birmingham Comprehensive Plan, the City is actively engaged in identifying areas that would benefit from redevelopment and working to remove obstacles and incentivize redevelopment due to its numerous benefits. These benefits arise from increasing the density of where people live, work, shop, and conduct business. Positive results are seen through less transportation and commuting costs, less required infrastructure, and less vacant properties. The main benefits of redevelopment and infill development are listed below.

- More efficient use of existing infrastructure such as: roads, sidewalks, water, sewer, storm sewers, and electric lines;
- Lower costs of public services such as: schools, police, fire, and ambulance service;
- Better use of urban land supplies while reducing consumption of forest and agricultural land. This, in turn, facilitates conservation of non-urban land;
Increased access of people to jobs and jobs to labor force;
Less time, money, energy, and air pollution associated with commuting;
Replacement of brownfields, abandoned industrial areas, and vacant buildings with functioning assets;
Stronger real estate markets and property values;
Renewal of older areas of the City; and
Support of cultural, arts, educational and civic functions, such as museums, theaters, and universities by locating new businesses near these attractions.

Planning and Physical Feasibility:
Discuss the redevelopment project with the City early in the design process. Refer to Sections 5.4.1 and 5.4.2 for more information on using a multi-disciplinary design team and participating in the pre-concept plan process. The following tips can aid in planning redevelopment and infill projects.

- Work with existing topography, street and sidewalk layouts, and utilities to accommodate building and parking areas.
- Incorporate mixed use and multi-level buildings to optimize usable space.
- Orient buildings toward the street to promote walkability and an attractive streetscape. Provide easy building access for pedestrians.
- Look for opportunities for shared parking, mass transit use, and bicycle parking.
- Reduce the visual impact of new development on established neighborhoods by incorporating and enhancing existing neighborhood elements such as building details, massing, proportions, materials, and landscaping.
- Provide activity and interest along the street. This can be achieved through design features such as large display windows, highlighted entrances with architectural elements, and landscape and hardscape features.
- Increase visibility of businesses from the street for both pedestrians and drivers.

Above: Railroad Park is an excellent example of how an infill project designed to be the “living room of the city” and a green space destination spurred a flurry of redevelopment projects and new businesses around the area.
5.4.5 Tree and Stream Buffer Preservation and Restoration

Description:
Trees and stream buffer vegetation perform important natural functions including: slowing runoff velocities, creating diffuse flow, and reducing non-point source pollution. Tree and stream buffer protection and restoration refer to the practices of maintaining and restoring native vegetation and its benefits to storm water. Trees, shrubs, and other native vegetation are planted or protected to restore areas to their pre-development conditions. The process can be used to establish or maintain mature native plant communities (e.g., forests) in pervious areas on disturbed sites or in buffer areas adjacent to development sites.

Benefits:
- The benefits of tree and stream buffer protection and restoration include:
  - Restoring pre-development hydrology on development sites and reducing post-construction storm water runoff rates, volumes, and pollutant loads;
  - Restoring habitat for priority plant and animal species;
  - Stabilizing stream banks and prevents erosion; and
  - Providing attractive scenery for the development.

Planning and Physical Feasibility:
Mature plant communities intercept rainfall, increase evaporation and transpiration rates, slow and filter storm water runoff, and help improve soil porosity and infiltration rates which leads to reduced post-construction storm water runoff rates, volumes, and pollutant loads. The site reforestation/revegetation process can also be used to provide restored habitat for high priority plant and animal species.

Also refer to the following chapters in the *Alabama LID Handbook* for additional information.
- Chapter 2: Site Selection
- Chapter 11: Riparian Buffers
Impacts to natural features should be minimized by reducing the extent of construction and development practices that adversely impact predevelopment hydrology functions. This includes:

- Avoiding mass clearing and grading and limiting the clearing and grading of land to the minimum needed to construct the development and associated infrastructure.
- Avoiding disturbance of vegetation and soil on slopes and near surface waters.
- Leaving undisturbed stream buffers along both sides of streams.
- Preserving sensitive environmental areas, historically undisturbed vegetation, and native trees.
- Conforming to watershed, conservation, and open space plans.
- Help create contiguous, interconnected green infrastructure corridors on development sites by connecting reforested or revegetated areas with one another and with other primary and secondary conservation areas through the use of nature trails, bike trails, and other greenway areas.

**General Planning and Design**

- Reforested/revegetated/preserved areas shall have a contiguous area of 10,000 square feet or more.
- Reforested/revegetated/preserved areas shall not be disturbed after construction (except for disturbances associated with landscaping or removal of invasive vegetation).
- Reforested/revegetated/preserved areas shall be protected, in perpetuity, from the direct impacts of the land development process by a legally enforceable conservation instrument (e.g., conservation easement, deed restriction).

**Landscaping**

- A soil test shall be performed to determine what type of vegetation can be supported by the soils in the area to be reforested/revegetated and/or what soil amendments will be required.
- A landscaping plan shall be prepared by a qualified licensed professional for all reforested/revegetated areas.
- Landscaping commonly used in site reforestation/revegetation efforts includes native trees, shrubs, and other herbaceous vegetation. Because the goal of the site reforestation/revegetation process is to establish a mature native plant community (e.g., forest), managed turf cannot be used to landscape reforested/revegetated areas.
- Methods used for site reforestation/revegetation shall achieve at least 75% vegetative cover one year after installation.
- A long-term vegetation management plan shall be developed for all reforested/revegetated/preserved areas. The plan shall clearly specify how the area will be maintained in an undisturbed, natural state over time. Plan shall include method for watering during plant establishment period of one to two years. Turf management is not considered to be an acceptable form of vegetation management. Consequently, only reforested/revegetated areas that remain in an undisturbed, natural state are eligible for storm water incentives (i.e., pervious areas consisting of managed turf are not eligible).

Examples of the use of reforestation and stream buffers in urban developments, along with several other LID practices are presented on the following page.
Reforestation & Stream Buffer Examples:

Top left: Seattle, WA. Thornton Place before redevelopment. The abandoned lot was in a blighted area. Thornton Creek ran under the impervious area. Source: Landscape Architecture Foundation. Middle left: Land use map for Thornton Place multi-use redevelopment, circa 2008. Note the plans for a buffer along the stream, creating a “water quality channel”. Source: Seattle Condos and Lofts.com. Top right: Thornton Place after redevelopment, as seen from the walkway through the stream buffer. Source: Wikimedia Commons.

Bottom left: Cincinnati, OH. One of the nation’s very first urban reforestation projects, Mt. Airy Forest is the largest within the Cincinnati park system at 1,459 acres. It consists of varied topography and landscapes, including ridges, wooded hillsides, ravines, creeks, a lake, and open meadows, and includes walking trails, boardwalks, and bridal paths. Source: CincinnatiRefined.com. Bottom right: Austin, TX. The Festival Beach Food Forest is Texas’s first food forest located on park, school, and residential properties near the Colorado River. It includes a variety of fruit and nut trees, and many other types of plants, bearing fruits, vegetables, and herbs. Source: AmericanForests.org.
5.4.6 Soil Restoration

Description:

Soil restoration refers to the process of tilling and adding compost and other amendments to soils to restore them to their predevelopment conditions, which improves their ability to reduce post-construction storm water runoff rates, volumes, and pollutant loads. The soil restoration process can be used to improve the hydrologic conditions of pervious areas that have been disturbed by clearing, grading, and other land disturbing activities.

Organic compost and other amendments can be tilled into soils in these areas to help create healthier, un-compacted soil matrices that have enough organic matter to support a diverse community of native trees, shrubs, and other herbaceous plants.

Soil restoration can also be used to increase the storm water management benefits provided by other GIPs on sites that have soils with low permeability (i.e., hydrologic soil group C or D soils). The soil restoration process can be used to help increase soil porosity and improve soil infiltration rates on these sites, which improves the ability of these and other low impact development practices to reduce post-construction storm water runoff rates, volumes, and pollutant loads.

Benefits:

- Soil restoration helps restore pre-development hydrology, which implicitly reduces post-construction storm water runoff rates, volumes and pollutant loads. The benefits of soil restoration include:
  - Restoration of predevelopment hydrology on development sites and reduces post-construction storm water runoff rates, volumes, and pollutant loads; and
  - Promotion of plant growth and improvement of plant health, which helps reduce storm water runoff rates, volumes, and pollutant loads.

Also refer to the following resources for additional information.

- Remainder of the *City of Birmingham Post Construction Storm Water Design Manual*
- *Alabama LID Handbook, Chapter 2* (Site Selection)
Planning and Physical Feasibility:
Soil restoration is ideal for use in pervious areas that have been disturbed by clearing, grading, and other land disturbing activities and/or have soils with low permeability (i.e., hydrologic soil group C or D). Soil restoration should not be performed in areas that have undisturbed, permeable soils (i.e., hydrologic soil group A or B).

Planning and Design Guidance and Policies:
- To the degree possible, buildings, pavement, and construction should be located on the least porous and/or previously disturbed soils.
- Limit soil compaction by: reducing disturbance through design and construction practices; limiting areas of access for heavy equipment; avoiding extensive and unnecessary clearing and stockpiling of topsoil; and maintaining existing topsoil and/or using quality topsoil during construction.
- To avoid damaging existing root systems, soil restoration shall not be performed in areas that fall within the drip line of existing trees.
- Compost shall be incorporated into existing soils, using a rototiller or similar equipment, to a depth of 18 inches and at an application rate necessary to obtain a final average organic matter content of 8%-12%.
- Only well-aged composts that have been composted for a period of at least one year shall be used to amend existing soils. Composts shall be stable and show no signs of further decomposition.
- Composts used to amend existing soils shall meet the following specifications (most compost suppliers will be able to provide this information):
  - Organic Content Matter: Composts shall contain 35% to 65% organic matter.
  - Moisture Content: Composts shall have a moisture content of 40% to 60%.
  - Bulk Density: Composts shall have an “as-is” bulk density of 40-50 pounds per cubic foot (lb/cf). In composts that have a moisture content of 40% to 60%, this equates to a bulk density range of 450-800 pounds per cubic yard (lb/cy) by dry weight.
  - Carbon to Nitrogen (C:N) Ratio: Composts shall have a C:N Ratio of less than 25:1.
  - pH: Composts shall have a pH of 6-8.
  - Cation Exchange Capacity (CEC): Composts shall have a CEC that exceeds 50 milliequivalents (meq) per 100 grams of dry weight.
  - Foreign Material Content: Composts shall contain less than 0.5% foreign materials (e.g., glass, plastic), by weight.
  - Pesticide Content: Composts shall be pesticide free.
- The use of biosolids (except Class A biosolids) and composted manure to amend soil is prohibited.
- Composts used to amend existing soils should be provided by a member of the U.S. Composting Seal of Testing Assurance program. Additional information on the Seal of Testing Assurance program is available on the following website: http://www.compostingcouncil.org.

Landscaping:
- Vegetation typically planted on restored pervious areas includes turf, shrubs, trees, and other herbaceous vegetation. Although managed turf is commonly used, trees, shrubs, and/or other native vegetation is encouraged to help establish mature, native plant communities (e.g., forests) in restored areas.
- Methods used to establish vegetative cover within a restored pervious area shall achieve at least 75% vegetative cover one year after installation. Bare soil is prohibited.
- To help prevent soil erosion and sediment loss, landscaping shall be installed immediately after the soil restoration process is complete. Temporary irrigation may be needed to quickly establish vegetative cover on a restored pervious area.
5.4.7 Retrofits

**Description:**
A storm water retrofit is a practice designed and implemented on an existing development to address storm water issues that arise after construction is completed. Such issues occur for sites that are developed prior to storm water requirements, have untreated or inadequately treated storm water, or where the owner desires additional storm water control.

**Benefits:**
- Storm water retrofits can have many benefits, including:
  - Addressing storm water or flooding concerns that became apparent after initial site development;
  - Providing an opportunity to break up impervious surface with greenspace; and
  - Creating an educational feature or pilot project.

Additional guidance is available from the *Alabama LID Handbook*, in the following chapters:
- Chapter 5: Constructed Stormwater Wetlands
- Chapter 6: Permeable Pavement
- Chapter 7: Grassed Swales, Infiltration Swales, and Wet Swales
- Chapter 10: Green Roofs
- Chapter 12: Rain Gardens
- Chapter 13: Curb Cuts

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**Above:** rooftops on existing buildings can provide an opportunity for a storm water retrofit, such as a green roof, and an additional amenity for building occupants. *(Source: EnvironmentalLeader.com)*

**Right:** Before and after pictures for a street tree retrofit project. With proper installation, street trees can provide substantial storm water benefits, even in urban settings.
Planning and Physical Feasibility:
A retrofit project can incorporate a GIP into an already developed site to help with a flooding problem, manage a pollutant, or reduce storm water runoff. Examples are listed below. Requirements and specifications for each GIP are provided in Chapter 6.

- Sediment basins on construction sites can be cleaned out and converted to storm water wetlands.
- Transportation projects can include bioretention areas, permeable pavement, and other GIPs.
- Concrete or asphalt parking lots, patios, and walkways can be replaced with permeable pavement.
- Some rooftops can be converted to green roofs with rooftop garden amenities.
- Curb cuts can route storm water to a landscaped area or a GIP.
- Parking lot islands can be converted to bioretention areas.

Top: Parking lot retrofit with a vegetated filter strip. *(Source: Chesapeake Stormwater Network)*

Middle: Bioretention bump-out used for street calming on 39th Street South in Birmingham, AL.

Bottom: A complete street was designed for the reconstruction of Bagby Street in Houston TX. The street includes numerous features for storm water management. *(Credit: Design Workshop)*
5.4.8 Complete Streets

**Description:**
The objective of “complete streets” is to create roadways and related infrastructure that provide safe travel for all street users. The design process takes into account parking, vehicle traffic, pedestrian/bicycle traffic, public transit, storm water management, people with disabilities, and other community needs.

**Benefits:**

- Creating a community asset and attracting people to the area;
- Providing some greenspace or creating areas for storm water managements;
- Providing attractive scenery for a development or streetscape;
- Increasing safety, accessibility, opportunities for fitness for the community; and
- Improving the value and livability of nearby properties.

Also refer to the following chapters in the *Alabama LID Handbook* for additional information.
- Chapter 2: Site Selection
- Chapter 11: Riparian Buffers

**Above:** Complete street in Edmonston, MD where, through the help of grants and EPA funds, the community turned a derelict street into a thriving neighborhood asset. *(Credit: Eastern Shore Land Conservancy)*

**Above:** Complete street view. Numerous municipalities across the United States are allowing the use of complete street concepts and designs in their communities. *(Source: Tri-County Regional Planning Commission, Harrisburg, PA)*
Planning and Physical Feasibility:
According to the National Complete Streets Coalition, typical elements that make up a complete street include sidewalks, bicycle lanes (or wide, paved shoulders), shared-use paths, designated bus lanes, safe and accessible transit stops, and frequent and safe crossings for pedestrians, including median islands, accessible pedestrian signals, and curb extensions. GIPs are often incorporated to manage storm water, increase greenspace, and urban habitat. Complete streets can be used for greenway connections (see Section 5.4.9).

Birmingham’s Department of Planning, Engineering, and Permits supports and encourages the implementation of complete street designs. Further, the City is working to allow more complete streets options to ease the path toward design acceptance and permitting. Some steps to designing complete streets include:

- Consider the availability and accessibility of pedestrian access points to businesses, roadways, and walkways. This should include navigation by bicycle, wheelchair, and on foot.
- Examine vehicle, pedestrian, bicycle, and transit circulation for all projects with the goals of reducing congestion and reducing parking needs.
- Consider opportunities to use vegetated curbs, right-of-way bump outs, landscape islands, and GIPs along streets and parking areas.
- Look for opportunities to add complete street elements to projects. For example:
  - A new pedestrian trail can be added along a new water quality swale
  - A new bike lane can be added to a road resurfacing project
  - Curb cuts can be added to new landscaping islands
  - Bicycle racks can be added to parking lot rehabilitations

**Upper Right:** The Cultural Trail in Indianapolis, IN featuring pedestrian and bicycle lanes, planters, and urban bioretention.

**Lower Right:** A typical Complete Street profile (top) and plan (bottom) views incorporating vehicular, bicycle, and pedestrian traffic, and areas for parking, greenspace, and storm water management. (Source: Green Streets for Canada)
5.4.9  Greenway Connections

Description:
Greenway connections link various parts of the City with pedestrian paths, bicycle trails, and multi-use trails along linear vegetated routes. Greenways encourage fitness and recreation while also providing corridors for vegetation and wildlife. When greenway connections are incorporated, the design process should consider connectivity within the community, pedestrian/bicycle traffic, public transit, people with disabilities, and other community needs.

Benefits:
The benefits of greenway connections include:

✔ Creating a community asset and attracting people to the area;
✔ Providing greenspace or storm water management areas;
✔ Providing attractive scenery for a development or streetscape;
✔ Increasing safety, accessibility, opportunities for fitness for the community; and
✔ Obtain Leadership in Environmental and Energy Design (LEED) Points.

Planning and Physical Feasibility:
Through the *City of Birmingham Comprehensive Plan*, community framework plans, land development regulations, and various public projects, Birmingham is working to achieve its goal of providing recreational opportunities within a ten-minute walk of every resident. Having safe, connected pedestrian pathways is fundamental to this goal. Land developers, both public and private, can further the greenway connectivity throughout the City by considering greenways and potential connectivity in all projects. Some steps to help create greenway connections include the following measures.

Also refer to the following chapter in the *Alabama LID Handbook* for additional information.

❖ Chapter 3: Low Impact Development and Community Planning
Become familiar with the Red Rock Ridge & Valley Trail System Plan, which involves creating and connecting six primary greenways and trails along the Birmingham area’s waterways, including Shades Creek, Five-Mile Creek, Turkey Creek, Valley creek, and the Cahaba River. Nearly 750-miles of greenway trails are envisioned (RedRockTrail.org).

Consider if the project is connected to other complementary properties or projects or to a park, greenway, or other public property and work with the Department of Planning, Engineering, and Permits to find ways to connect properties.

Work with the Department of Planning, Engineering, and Permits to remove obstacles that disconnect residents from greenspace and promote connectivity to these resources.

Greenways don’t have to involve park-like settings. Look for connections via pedestrian paths, bicycle trails, and multi-use trails along streets and parking areas (see figure to the right).

Examine vehicle, pedestrian, bicycle, and transit circulation for all projects with the goals of reducing congestion and reducing parking needs.

Look for opportunities to enhance greenway connections near development projects. For example:

- Curb cuts can be added to landscaped islands.
- A pedestrian trail can be added along a water quality swale.
- A new bike lane can be added to a road re-surfacing project.
- Bicycle racks can be added to parking lot rehabilitations.

Above: The Homewood Shades Creek Greenway (also called Lakeshore Trail) is a three-mile-long multi-use trail meandering through floodplain forest along the banks of Shades Creek. The paved trail is frequented by joggers, bikers, and walkers during most daylight hours of the year and provides a chance to explore floodplain habitats of one of the most important streams in the Birmingham metropolitan area. The greenway is connected to Jemison Park and the Homewood Forest Preserve and will be eventually connected with Birmingham. (Source: trekbirmingham.com)
5.4.10 Pocket Parks

**Description:**
Pocket parks are small parks, with typically less than two acres of greenspace, in urban areas. They often incorporate community enrichment, fitness, or opportunities to interact with nature. They also feature storm water management elements and are a good opportunity for public education. Because of their size and versatility, there are many opportunities to provide green space on vacant lots, within existing right-of-way, or adjacent to development sites.

**Benefits:**
- Creating a community asset and attracting people to the area for economic development;
- Can provide an opportunity to break up impervious surface with greenspace;
- Providing storm water management benefits; and
- Providing attractive scenery for a development or streetscape.

**INCENTIVES**
Storm water management elements in pocket parks may receive storm water from disconnected downspouts (see Chapter 6, Section 6.6).

Small-scale GIPs, such as bioretention (see Chapter 6, Section 6.3), urban bioretention (see Chapter 6, Section 6.4), and permeable pavement (see Chapter 6 Section 6.11) can be incorporated into the design of pocket parks.

Green space used in pocket parks generate very little runoff and can ease the path to compliance with storm water performance standards.

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Also refer to the following chapter in the *Alabama LID Handbook* for additional information.

- Chapter 3: Low Impact Development and Community Planning

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Above: Example of a pocket park on an urban street.

Above: Jemison Flats Pocket Park in Birmingham, AL. (Courtesy: Macknally Land Design)
Planning and Physical Feasibility

Pocket parks are most often created to provide gathering places for the community and to break up the urban landscape. Pocket parks can be a way to preserve urban trees or small landscaped areas and provide shade, evapotranspiration, and greenspace in an urban area. LID storm water elements, such as infiltration areas, tree boxes, or small cisterns can also be incorporated. If more tangible storm water benefits are desired, urban bioretention should be considered. Proper planning and implementation can make pocket parks an asset to the community. Some steps include:

- Become familiar with the Birmingham Comprehensive Plan, community frame work plans, parks plans, and the Red Rock Ridge & Valley Trail System Plan. These resources can lead to opportunities for partnerships in the creation of pocket parks.
- Consider where vacant lots or other empty space could be used for a pocket park and what areas would get the most use by the community.
- Identify partners for the project, such as community members, landscape architects, and other professions, service groups, and city representatives. Design and maintenance should be discussed with partners to garner support.
- Consider the uses of the pocket park and needs of the neighborhood. Pocket parks can be used for fitness, recreation, small events, gatherings, children's play areas, art displays, and other uses.
- Pocket parks often incorporate interesting focal points to attract people, such as: art, water features, landscaping, sun shades, interesting textures, varying platform levels, and use of vertical space.
- Help create connections between greenspace with sidewalks, nature trails, bike trails, and other pathways.
- A long-term management plan shall be developed for all landscaped areas and areas used for storm water management. The plan shall clearly specify how the area will be maintained over time. Because pocket parks are a community asset, often community groups or residents can participate in maintenance as volunteer activities.

Above left: Pocket park opportunity in Birmingham, AL. This mature, downtown green space could be redesigned to make a great urban pocket park. Exchange the raised planters for urban bioretention areas, add seating, and perhaps a water element or decorative art. (Credit: Bhamarchitect’s Blog) Above right: Pocket Park in Manhattan NY. (Credit: John Glines) Lower right: Pocket park design for Matthews NC, near the town’s Four Mile Creek Greenway. (Courtesy: Town of Matthews)