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Choosing a Green Infrastructure Framework? Consider Light Imprint.

Photo: Habersham, with master plan designed by Duany Plater-Zyberk & Company, is a New Urbanist traditional neighborhood development that
uses many Light Imprint stormwater management
techniques (Beaufort, SC).

By Thomas Low, Guy Pearlman, Monica Carney-Holmes, Nora Black, Paul Crabtree

Whenever environmental services professionals gather at conferences around the world, both the sessions and networking conversations highlight the convergence of global warming, depletion of fossil fuels, problems with water quality and quantity, and the failure of automobile-centric policies. Advancements in urban design and well-planned infrastructure investment are two ways to address the problems. Light Imprint is an approach to neighborhood design that presents actual techniques now being used in new and infill developments. Like many green initiatives, Light Imprint may be even more cost effective than established, conventional practices over the long term.

The Light Imprint framework has been compiled and assembled into a practical matrix in the *Light Imprint Handbook: Integrating sustainability and community design* and the interactive Web site, *www.lightimprint.org*. Light Imprint utilizes more than 60 techniques for paving streets and walkways, channeling and storing water, and filtering surface runoff before release into the aquifer. Done thoughtfully, this seemingly mundane engineering work not only improves the environmental impact, but also makes communities more beautiful and livable. Light Imprint is a strategy for sustainability and pedestrian-friendly design that provides economical results.

Light Imprint for Traditional Neighborhood Development
When applied comprehensively, Light Imprint is an intrinsically green design strategy, producing a compact, connected design that respects nature and site terrain. It recognizes the importance of public civic spaces and connectivity. This approach developed from a need to coordinate engineering concerns with traditional neighborhood design principles. The techniques are compiled and assembled into a practical matrix in the *Light Imprint Handbook* and the interactive Web site.

Light Imprint introduces a tool set for addressing stormwater runoff through natural drainage, conventional engineering infrastructure, and innovative infiltration practices. These tools are used jointly at the sector, neighborhood, and block scale.

The matrix organizes this information by dividing the landscape into sections representing urban to rural conditions based on the transect. More than sixty Light Imprint tools and resources are clearly organized in the matrix by the appropriateness of their use in each zone. The matrix includes urban to rural (transect) conditions, initial costs, long-term maintenance factors, soil hydrology, slope conditions, and climate.

These tools can also significantly lower construction and engineering costs. When used in conjunction with traditional engineering methods, they can reduce the need for the typical solution of inlet, pipe, and pit infrastructure. A primary objective of Light Imprint is to filter stormwater at its origination point. Then it can be absorbed to help recharge the local aquifer and stabilize the local water table. It contrasts with conventional engineering that directs water to an inlet, where it flows through a pipe and is released into a pit at the back of the site.

The success of Light Imprint can be measured in studies of stormwater runoff quality, quantity discharge volume rates, and percolation rates that promote aquifer recharge. Studies have found measurable positive progress in all these categories with the use of Light Imprint.

The planning principles of regional scale, context-sensitive design using transect-based and Light Imprint techniques, when combined with standard hydrology practices including source control principles, result in simple and inexpensive short-, mid-, and long-term solutions. Studies conducted by municipalities and governmental authorities to measure factors such as sedimentation, erosion control, floodplain encroachment, post-construction consequences, and buffer safeguards provide valuable data for calculating costs versus return on investment.

Planning for Traditional Neighborhood Development in the New Economic Climate

During a congressional hearing on March 18, 2009, Congressman John W. Olver, chairman of the House Appropriations Subcommittee on Transportation, Housing, and Urban Development, made a pointed call for green infrastructure. Olver said, “In my mind, a livable community is a neighborhood that links the transportation mobility needs of the old and young alike with affordable housing, shopping, job opportunities, and green infrastructure. In my view, transportation, housing, and energy policy have been conducted as separate spheres, like silos, with little or no coordination on the federal, state, or local level for far too long. Improving federal policies among agencies and creating a federal partnership with local communities to build livable communities that combine traditional neighborhood development, affordable housing, and green infrastructure should be a national priority.”

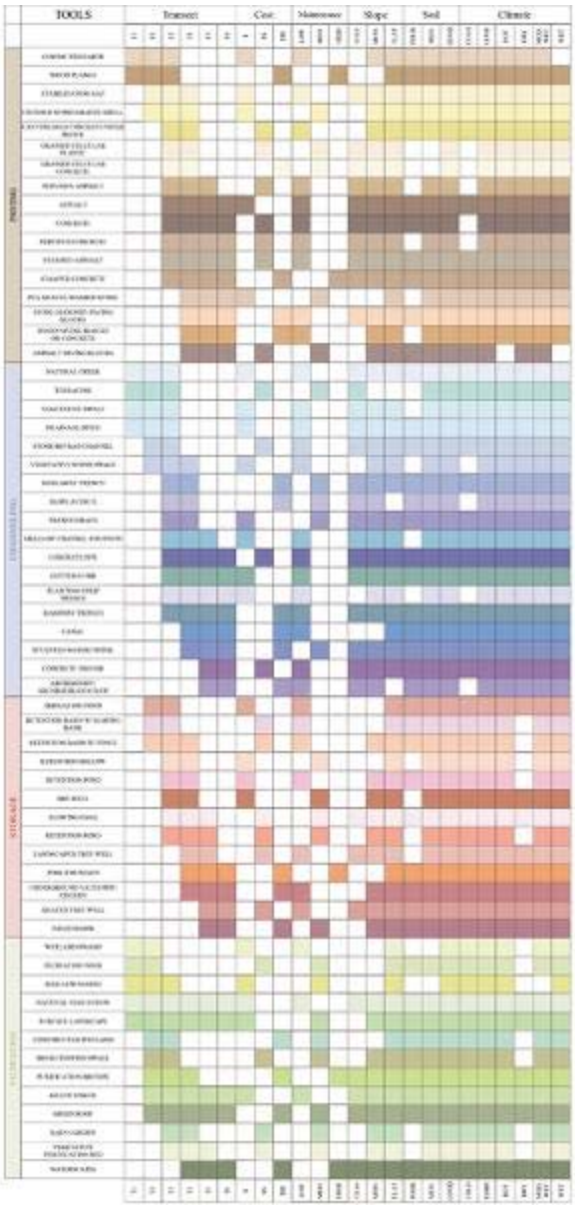
Olver’s remarks make it clear that he believes the federal government’s program for housing all citizens should be aimed at developing pedestrian-friendly neighborhoods. Baby Boomers (born between 1946 and 1964) and Millennials (born between 1977 and 1996) comprise the two largest generations in American history. The residential self-selection habits of these two groups show a preference for traditional neighborhood developments that take a proactive, multidisciplinary approach to restoring existing communities and creating new neighborhoods. Market analyst Todd Zimmerman of Zimmerman/Volk Associates noted in a *New Urban News* article that those two generations would lead the demand for residential development over the next 10 years. His research indicates that most empty-nest Baby Boomers want to downsize from large-lot, suburban housing. Likewise, Millennials are showing little interest in suburbia. “The confluence of Baby Boomers and Millennials is just beginning,” Zimmerman wrote, “so the market will be there as we move out of this [current economic] crisis.

Planners, developers, architects, engineers, public officials, investors, and community activists, including members of the Congress for the New Urbanism (CNU), can influence programs and plans for developments to turn dying malls into vibrant mixed-use neighborhoods, connect isolated public housing projects to surrounding neighborhoods, and bring restorative plans to disaster-stricken communities. Transportation for America called the American Recovery and Reinvestment Act signed by President Obama “a down payment on a new direction for America’s infrastructure.”

Georgio Tachiev, an environmental engineer and professor at Florida International University, explains that networks advocated for traditional neighborhood developments create connections between the built and natural environments. Dr. Tachiev says, “The methods we apply to design our built environment affect the balance of environment, society, economy, and energy. From an engineering point of view, traditional neighborhood development implements sustainability in all four of those aspects. When discussing sustainability, we need to emphasize watersheds since they are the natural containers hosting the human habitat. Because its compact form allows more of a watershed to be maintained in its natural condition, traditional neighborhood development ensures that watersheds can continue to give high-quality services. These services include biodiversity, water quality and quantity, and assimilative capacity [the amount of water the watershed can contain].”

Traditional Neighborhood Development Can Be Integrated With Green Infrastructure

Traditional neighborhood developments are beginning to integrate green infrastructure practice, but this is usually on a



Light Imprint Classification Matrix

case-by-case approach. The United States Green Building Council (USGBC), which developed the Leadership in Energy and Environmental Design (LEED) green building rating system, has recognized this fact. In partnership with the Congress for the New Urbanism and the Natural Resources Defense Council, the USGBC used traditional neighborhood development principles to create the LEED for Neighborhood Development (LEED-ND) rating system. A large number of Light Imprint tools meet LEED requirements for stormwater credits. The urban transect zones of T4, T5, and T6 on the Light Imprint matrix are especially relevant for traditional neighborhood developments.

Comparison of Light Imprint to Other Stormwater Management Strategies

As more people develop an environmentally conscious viewpoint, organizations that serve the public have begun promoting their own frameworks based on different development practices. The techniques are sound in individual situations, but few offer the comprehensive approach of Light Imprint. Even if planners and developers choose another overall approach, they can still dip into the Light Imprint toolbox.

Leading planner Andres Duany, a founder of Duany Plater-Zyberk & Company, describes the layout of a typical traditional neighborhood as an open-mesh network where a system of connected streets mitigates traffic congestion and reinforces community and transit connections. Since Light Imprint is based on these planning principles, it differs significantly from other infrastructure approaches.

Greenway Fingers Are Organizing Spines for Green Urbanism

In the United States, landscape architects initially promoted Green Urbanism as an environmentally viable alternative to traditional neighborhood development. It emphasizes an increased amount of open space within a site, usually 60% or more per project.

Greenway fingers serve as organizing spines, with stormwater filtration mechanisms placed outside of and around these green spaces. When compared with traditional neighborhood developments, Green Urbanism developments are less connected; they compromise social and community connectivity. Because a significant amount of land is reserved for open space, the second problem results from the reduction of the amount of developable land. Thus the project may not be economically viable.

Recently Green Urbanism has evolved toward excellent European examples of compact and sustainable community, but it still suffers from the initial perceptions within the industry.

Theory of Landscape Urbanism for Planning and Urban Design

The phrase *landscape urbanism* describes a theory that the landscape, rather than architecture, should organize cities and enhance urban experiences. At the first landscape urbanism conference, critics questioned the small-scale strategies for turning leftover gaps in cities into commons like those found in many Anglo-Saxon villages. They felt it would be a challenge for landscape urbanists to craft urban streets that respond to many Europeans and Americans who live in idyllic suburbs. Others believe that small-scale, bottom-up approaches will not address the fundamental issues found in the foundations of true urbanism. Landscape urbanism has produced a large body of theoretical texts, but mostly unbuilt—paper—proposals. In this theory, however, two sophisticated cultures meet at the right time. One is explained in *Design with Nature* in which Ian McHarg investigated “the place of nature in man’s world.”

The second is New

Conventional TND Stormwater Plan

Light Imprint TND Stormwater Plan

KEY

- Stormwater Inlet
- Manhole
- Stormwater Pipe
- Storm Water Discharge
- Underground Stormwater Storage
- Rain Garden

Griffin Park: Light Imprint TND stormwater plan comparison to conventional TND stormwater plan

Conventional TND Engineering				
Material	Quantity	Unit	Cost/Unit	Total
Erosion Control				
Silt Fence	8,450	LF*	$4.00	$33,800.00
Rip Rap	200	Tons	$55.00	$11,000.00
Total				$44,800.00
Stormwater				
Inlets	101	Ea.	$2,500.00	$252,500.00
Pipes	9,434	LF*	$30.93	$291,793.62
Retention Pond	1	Lump	$48,400.00	$48,400.00
Total				$592,693.62
Pavement				
Curb & Gutter	18,910	LF*	$7.60	$143,716.00
Sidewalk	8,276	SY*	$25.00	$206,900.00
Paved Road	26,705	SY*	$18.64	$497,781.20
Paved Alley	6,470	SY*	$13.36	$86,439.20
Total				$934,836.40
Grand Total				$1,572,330.02
Cost per Lot	176			$8,933.69

Light Imprint TND Engineering				
Material	Quantity	Unit	Cost/Unit	Total
Erosion Control				
Silt Fence	8,450	LF*	$4.00	$33,800.00
Rip Rap	200	Tons	$55.00	$11,000.00
TPF*	4,225	LF*	$4.00	$16,900.00
Total				$61,700.00
Stormwater				
Inlets	24	Ea.*	$2,500.00	$60,000.00
Pipes	4,182	LF*	$30.93	$129,349.26
Rain Gardens	20	Ea.*	$5,120.00	$102,400.00
Total				$291,749.26
Pavement				
Curb & Gutter	13,091	LF*	$8.00	$104,728.00
Sidewalk	7,000	SY*	$25.00	$175,000.00
Paved Road	20,515	SY*	$18.64	$382,399.60
Crushed Stone Alley	5,765	SY*	$12.00	$69,180.00
Total				$731,307.60
Grand Total				$1,084,756.86
Cost per Lot	174			$6,234.23

Engineering Comparison

Project	:	Light Imprint New Urbanism Study
Date	:	December 06, 2006
Details:		Phase 1, 42 Acres, 176 Lots

Conclusions

Overall	31%	Savings
Per Lot	30%	Savings

* Notes:
TPF -Tree Protection Fence
LF - Linear Feet
SY - Square Yard
Ea. -Each

Griffin Park cost comparison

Urbanism for the 21st Century, which is based on principles of planning and architecture that work together to create human-scale, walkable communities. Both of these timely movements address climate change, the new world economic situation, and the craving humans experience for community. Similar to Light Imprint, landscape urbanism is the landscape architects' initiative to reconcile ideals and methodology from Green Urbanism with New Urbanism. It is possible that this initiative might develop characteristics that could converge with many of the best characteristics of Light Imprint.

Conflict Between Sustainable Design and LID

Another popular development strategy is low-impact development. This approach manages stormwater quality using

onsite design techniques and best management practices. Some municipalities have adopted or are considering the adoption of the low-impact development strategy without understanding the conflict between stormwater management tools and sustainable community design.

Low-impact development originated in conventional automobile-oriented suburban development. Its techniques can be applied without significant variation to conventional suburban residential developments, to conventional suburban commercial developments, and even to some urban areas with suburban characteristics (such as Portland, OR, and Seattle, WA).

This strategy offers similar techniques for use in low-density subdivisions, high-density apartment complexes, and strip shopping centers. This lack of distinction is one shortcoming of low-impact development.

Residents of conventional suburban developments rely heavily on automobiles for transportation to provide daily needs. Attempts to make these developments environmentally friendly ignore the larger issues of exhaust pollution and congestion. From a planning and sustainability perspective, rather than creating clusters of single-entry housing cul-de-sacs, a better strategy is to weave compact, walkable, connected, pedestrian-friendly neighborhoods into the larger community.

Finally, many standards and practices of low-impact development involve lot-based, rather than block- or neighborhood-based, solutions; that increases the need for large lots. For instance, despite their environmental benefits, rain gardens located in front of houses increase the front setback significantly. To foster walkable urbanism, houses should be close to the sidewalk.

BMPs Result in Lack of Connectivity
Best management practices (BMPs) focus on engineering rather than planning and design. Though the EPA proposes using BMPs for stormwater management, the mechanical characteristics are not always successful.

Compact development suffers when BMPs result in stormwater detention areas in front of or beside buildings. This approach prevents social connectivity. In addition, detention areas in front of buildings interfere with the customers' access to goods, services, and public transit.

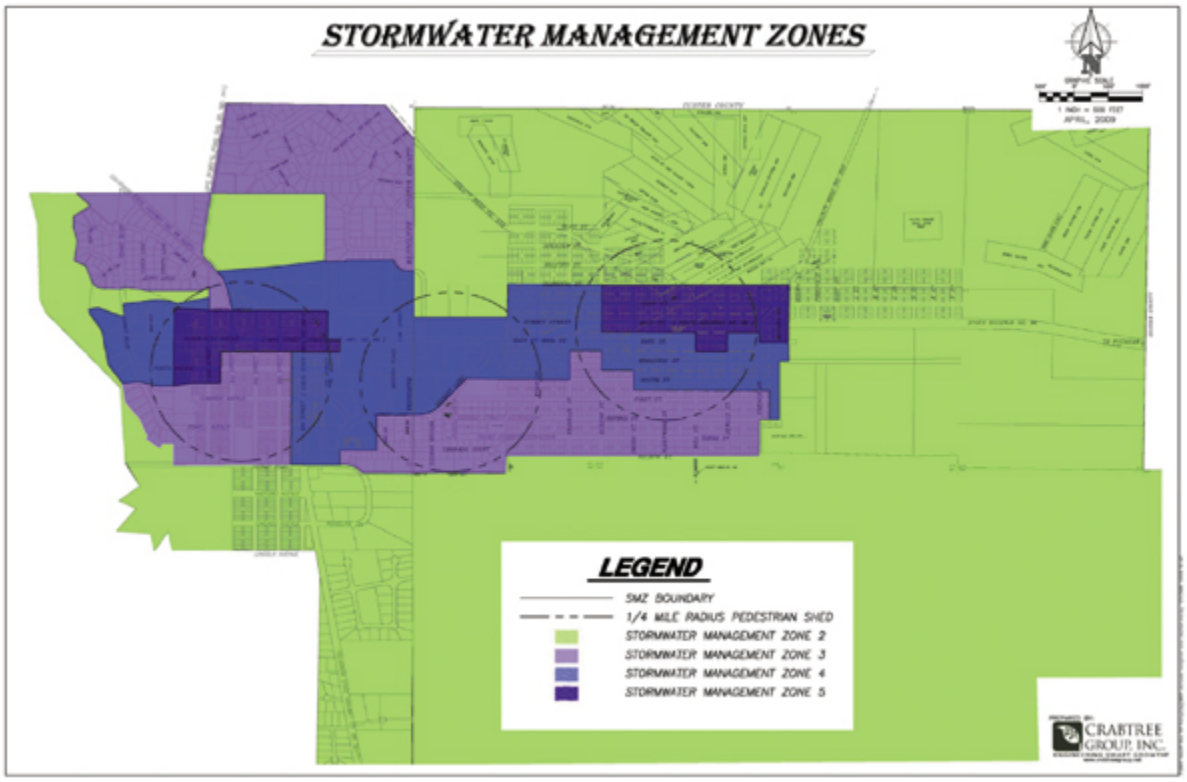
Other Environmental Initiatives Can Use the Light Imprint Approach
Light Imprint supports other environmental initiatives for planning, development, and infrastructure implementation. It supplements LEED-ND, Sustainable Sites, and the EPA Smart Growth Initiative.

Traditional Neighborhood Conventional Engineering Differs from Light Imprint
When Light Imprint is integrated with traditional neighborhood engineering, it deviates from conventional engineering practices. It can accommodate more of the development standards necessary for community-oriented design, which include dense mixed-use blocks, walkable yet urban streets, and more alleys. Municipalities reviewing development plans are often interested in embracing the traditional neighborhood development approach. Their governing bodies, however, may be concerned about accepting different zoning standards. The Light Imprint approach offers a broad, comprehensive framework that can be used to jump-start this transition.

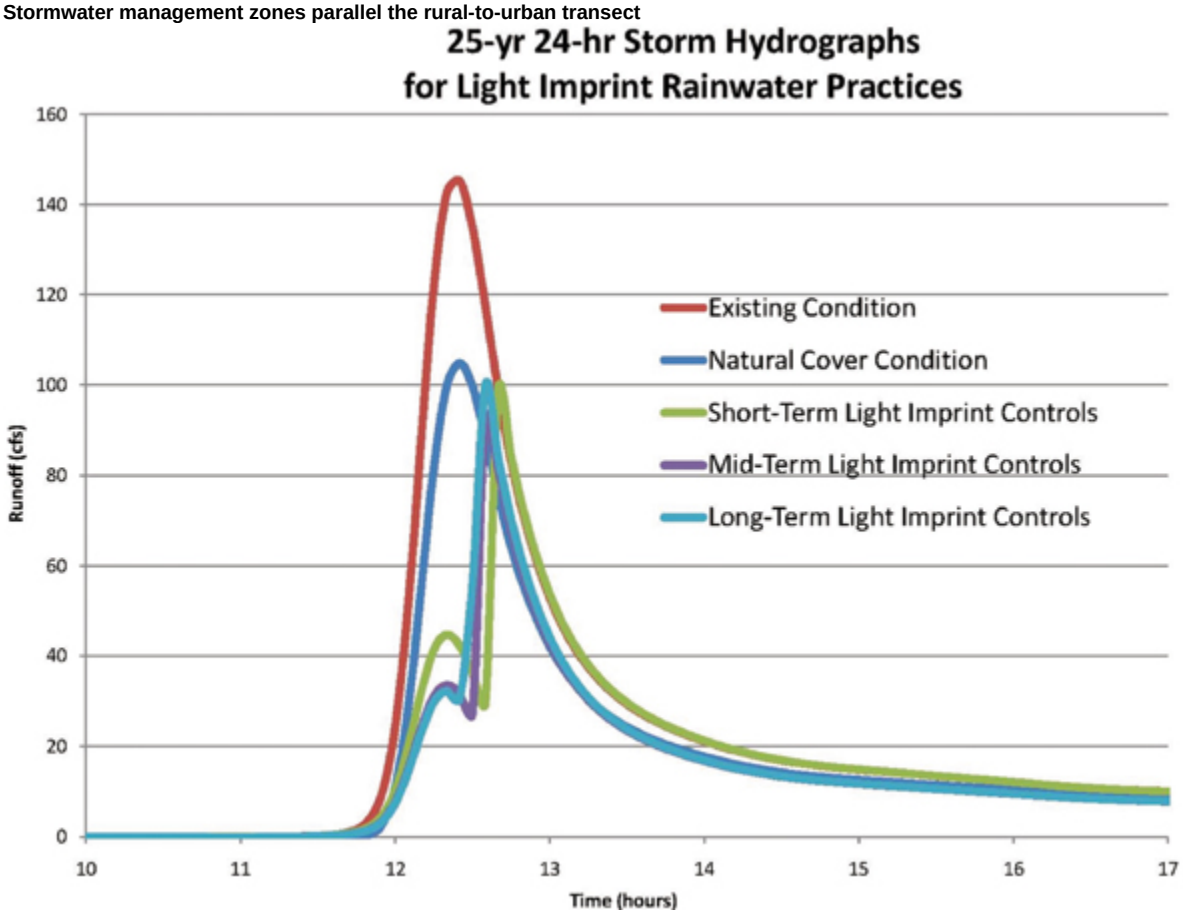
Light Imprint developments may use stormwater management techniques that initially seem at odds with conventional engineering. For example, at some locations there might ordinarily be a paved sidewalk, but a shallow channel footpath could provide a similar walking surface that also channels stormwater during heavy rainfall.

Another example is the paving material used for parking areas. The conventional approach is to use one type of impervious surface for the entire parking lot, but other pervious surface materials can be considered. A constraint that is often mentioned is rutting of the surface caused by heavy vehicles and the necessity of a solid pad for handicap parking and dumpsters sites. By specifically addressing each of these special conditions separately, the overall design can be more flexible.

Paving is a frequent target of some critics of New Urbanism. They point to the increase in linear feet of pavement in traditional neighborhoods when compared to conventional suburban developments. Using only the linear feet of



Stormwater management zones parallel the rural-to-urban transect



Hydrographs for the 25-year storm for the watershed for full buildout

pavement as a measure, those critics overlook the already inherently green qualities of traditional neighborhoods. While the linear footage may be greater overall, the more apt comparison is the square footage of pavement per residential unit.

The EPA found in a recent study that a traditional neighborhood design yields 634 square feet of pavement per dwelling unit. In contrast, a conventional suburban design on the same site requires 2,018 square feet per dwelling unit. Eliminating that extra 1,384 square feet of paving per dwelling unit highlights one of the many advantages of traditional neighborhood development.

Gold-Plated Overcompensation and Bad Timing Increase Infrastructure Costs
Other problems occur when designers and engineers attempt to overcompensate for perceived stormwater management deficiencies by increasing infrastructure standards and design criteria. This overcompensation, often called gold plating, can be a deterrent to the successful implementation of a traditional neighborhood community. Project delays, infrastructure duplication, and additional costs can ultimately prevent the realization of good community development.

Light Imprint Neighborhood Case Study: Griffin Park
Unlike these other development strategies, Light Imprint employs different tools in each transect zone (T-zone). It is not limited to one approach for environmentally sensitive development. Rather, Light Imprint offers context-sensitive design solutions that work together at the community level.

According to Tachiev, Light Imprint reduces infrastructure on the neighborhood scale in terms of roads, public works, and facilities. On the block scale, its implementation results in reduced building footprint and stormwater runoff. The application of additional Light Imprint techniques at the individual lot and building scale add to the increased level of sustainability.

Griffin Park is a community in Greenville, SC, designed by Duany Plater-Zyberk & Company; it offers one example of Light Imprint development. While numerous studies compare conventional suburban developments with traditional neighborhood developments, few compare standard traditional neighborhoods to Light Imprint traditional neighborhoods.

Guy Pearlman, a landscape architect for Duany Plater-Zyberk & Company, and designer Patrick Kelly, formerly of the same firm, developed the Light Imprint overlay of techniques for Griffin Park. The goal is to create an environmentally sensitive community while lowering construction costs during the first development phase. Pearlman explains, “The conventional traditional neighborhood engineering plan is for both county review and bidding purposes; it reaches an extensive level of detail. The Light Imprint engineering plan is based on many variables developed in the conventional plan. Added consideration is given to environmental and preservation factors. Those factors enhance the value of the community and lower the cost of construction.”

Light Imprint overlay strategies for Griffin Park include the introduction of tools for stormwater storage, channelization, filtration, and paving options. Additional protection for natural areas is provided during the construction phase. Through the use of different tools within different T-zones, the need for infrastructure is reduced while lessening the environmental impact of development.

To achieve Light Imprint goals within the traditional neighborhood plan, tree-protection fences used in the erosion control phase protect existing natural areas including mature trees. That strategy results in a 27% cost increase compared to the conventional method. Yet, using Light Imprint, there is a 50% cost saving in the stormwater management phase. The introduction of bioretention swales, rain gardens, and vegetative surface filtration areas add aesthetically pleasing natural areas and neighborhood recreation areas. Rain gardens filter runoff to remove pollutants before they reach the adjacent creeks and river.

Two road pavement techniques reduce costs. First, building roads that are 24 feet wide instead of 26 feet wide results in a significant reduction of paving costs. Second, substituting crushed stone for asphalt for rear lane surfacing saves over 20% of this development cost.

The following summary outlines the application of various tools by T-zones in Griffin Park:

T4 Neighborhood Center Zone: 1) introduction of an underground stormwater storage system; 2) reduction of the amount of pipe required as well as reduction in pipe lengths; and 3) reduction in the number of stormwater inlets.

T3 Neighborhood General Zone: 1) use of pervious pavement in rear lanes; 2) reduction of the street widths; 3) reduction of the amount of pipe required and reduction in pipe lengths and size; 4) reduction in the number of stormwater inlets; and 5) introduction of small-scale, multiple-lot, communal bioretention swales.

T2 Neighborhood Edge Zone: 1) elimination of curb and gutter in strategic edge areas; 2) replacement of the proposed large retention ponds with smaller-scale natural filtration ponds; 3) introduction of vegetative surface filtration areas along the perimeter; and 4) elimination of stormwater inlets and pipe.

Pearlman summarizes, “Implementing the LI overlay results in over 30% engineering cost savings in actual construction dollars for the first phase. That savings is in addition to the added community value of preserved mature trees and communal rain gardens.”

Habersham parking lot with Light Imprint features

Rigorous Engineering Calculations Validate the Light Imprint Methodology

A regional watershed management plan for towns in Colorado, Silver Cliff and Westcliffe, utilized Light Imprint to analyze and implement watershed-based improvements and regulations. Crabtree Group Inc., a civil engineering and town planning firm, mapped the rural-to-urban transect zones within the watershed. As part of the plan, the company performed hydrological modeling to analyze areas of impairment to determine key leverage points to reduce impairments. It then formulated simple regulations to obtain long-term watershed improvements.

Computer modeling revealed that green street interventions at key locations by the municipality would significantly reduce flooding issues in the downtown area on an immediate basis. For the longer term, regulations were established that required retention volumes depending on the site’s location across the transect. Stormwater management zones (SMZs) were established based on the location within the transect, each of which has its own hydrologic characteristics. Iterative runs of the hydrology model using differing volumetric metrics, shown in 25-year, 24-hour storm hydrographs, resulted in a “tuning” of the watershed that will eventually result in an emulation of natural hydrological conditions for the watershed.

Specifically, SMZ 2 (rural type development) requires 0.21 cubic feet of onsite retention for every square foot of impervious surface added, SMZ 3 (single-family) requires 0.14, SMZ 4 (multi-family and mixed use) requires 0.07, and downtown required no onsite retention. This simplified methodology enhances public acceptance of the regulations by obviating the need for further engineering for the usual development circumstances. Developers simply determine which SMZ their parcel is located in, look up the required volume of retention, and select rainwater methodologies from the *Light Imprint Handbook*.

Table 1. Comparison of Environmental Development Initiatives

	Light Imprint	Low-Impact Development	Green Urbanism	Conventional Engineering
Walkable	√			√
Compact	√			√
Connected	√			√
Mixed Use	√			√
Mixed Income	√	√	√	√
Economical	√	√	√	
Sustainable	√	√	√	
Intrinsically Green	√	√	√	

Summary of Light Imprint Benefits

Light Imprint uses a variety of tools appropriate for specific transect zones, installation costs, maintenance costs, climate, slope, and hydrology (soils). Instead of limiting itself to one environmentally sensitive development approach, it offers a set of contextually appropriate design solutions. This strategy simplifies design decisions and implementation—a crucial advantage, as only a limited number of traditional neighborhood development practitioners have significant implementation experience.

On the block scale, the implementation of Light Imprint methods reduces stormwater runoff by decreasing the overall footprints of buildings. This enhances the community both aesthetically and environmentally.

It will take time for Light Imprint to become the norm rather than the exception. Designers and developers may not be able to implement all Light Imprint elements right away, but they could implement them in incremental stages as certain components are approved. Because of the pace of development and the need for projects to succeed, it is especially important to plan for incremental implementation.

Joe W. Jelks III, developer and founder of Griffin Park, sees the value in applying Light Imprint. He explains, “For Griffin Park, the case study for the first phase was compelling enough to lead our development team to apply Light Imprint techniques even after construction had started. The case study also convinced us to work with local stakeholders and approval agencies to holistically apply the Light Imprint approach for the next phases.”

Ultimately, the success or failure of Light Imprint is measured by its life. The ability of a community built with Light Imprint ideals and techniques to function, flourish, and endure is the gauge by which it—and by extension, Light Imprint—will be judged a success.

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Topics: Program management,Low-impact development,BMP Post Construction