Appendix B - Case Studies

The case studies on the following pages have been prepared to illustrate planning and design concepts relevant to the US 19 corridor planning effort. The case studies include two describing suburban shopping malls that have been redeveloped into multi-use town centers, one highlighting Low Impact Development design strategies, and a final describing a district-wide redevelopment effort incorporating sustainable design and planning strategies.

CASE STUDY 1: WINTER PARK VILLAGE

Project Overview

Located four miles north of downtown Orlando and two miles east of I-4, Winter Park Village is a 525,000 square foot mixed-use redevelopment located on the site of the former Winter Park Mall. Completed in 1963, the 400,000 square foot Winter Park Mall was the region's first enclosed mall. The mall opened in competition with nearby Park Avenue, Winter Park's traditional main street. Typical of other enclosed regional malls surrounded by surface parking, the mall did well for several decades, but steadily lost tenants and customers during the 1980s and 1990s. Most of the mall was demolished, except the Dillard's department store.

Developed in 1997, Winter Park Village was designed to extend and increase the intricacy of the grid system to integrate the site with existing neighborhoods and to provide civic space. A "Main Street" lined with two-story buildings with ground-level retail was created through the center of the site terminating at a movie theater. Secondary streets were also created to provide connectivity within the site.

The primary objective of the development team was to establish an "urban sense of place in what had been a typical 1960s-era enclosed shopping mall set in a sea of asphalt." After original redevelopment plans were submitted, the City pushed for new urbanist, mixed-use project that would transform the site into an urban village that could complement downtown Winter Park and recently renovated Park Avenue. Although the project was eligible for funding from the City due to its location in a blighted area within a CRA district, the developer decided not to pursue a public-private partnership. The developer changed the original plans, which removed the need for this partnership to obtain public funding to support additional residential development and structured parking.

Mix of Uses

Designed around a Dillard's department store that was not demolished along with the rest of the enclosed mall, the property is centered by a

Project Data

- Location: US 17-92 and Webster Road, Winter Park, Florida
- Site Area: 40 acres
- Total Square Footage: 525,000 sf
  - Retail: 350,000 sf (including an 84,000 sf movie theater)
  - Office: 115,000 sf (including 80,000 sf over retail space)
  - Residential: 58 loft residential units over retail space
- Developer: Don M. Casto Organization/Casto Southeast
- Design Team: Dover, Kohl & Partners; Dorsky Hodgson + Partners (now Dorsky Hodgson Parrish Yue); Glatting Kercher Anglin Lopez Rinehart; Gibbs Planning Group

hybrid retail center with 350,000 square feet of retail and 140,000 square feet of office space featuring national chain retail and entertainment uses. Initially, Dillard's was the only tenant to remain, however, the department store chose not to renew its lease in 1999. The former Dillard's building was reused with additional retailers and restaurants on the ground floor and residential and commercial lofts on the second story in 2001.

Today, the retail and entertainment anchors include Regal Winter Park Village Stadium 20 cinema, Publix, and many high-end national retailers and restaurants. The site includes the Lofts at Winter Park Village, 58 loft for-lease residences and commercial space above ground-floor retail in the old Dillard's. Offices are located throughout the site including space on the second floor of buildings along the main street. A proposal to redevelop a large vacant out-parcel building formerly occupied by a Borders bookstore was approved in March 2012. The large building will be replaced with a smaller footprint drive-thru coffee shop and bank.

Form & Character

The project includes a central pedestrian-scale streetscape with mostly two-story buildings aligned along a main street and several secondary streets, many of which tie into the city's existing street grid. The project's street system restores the street grid that was obliterated when Winter Park Mall was constructed. The central shopping street is organized as a "T" intersection and is lined with small shops with second story offices. At the end of the "T," centered on the main street, is the movie theater that is lined with small street-facing eateries.

The plan originally included a substantial amount of public green space, but this was eliminated during the design phase. The remaining space located across from the cinema and, although small at roughly 7,700 square feet, offers grass, trees, benches, and a fountain. Landscaping and benches are scattered throughout the development.

The perimeter of the site is filled with large, surface parking lots that do not provide the same pedestrian-friendly walking environments as the internal

retail streets. Separate out-parcel buildings and big-box stores are adjacent to the peripheral arterial roadways, and many of the building facades are oriented towards the interior of the site, leaving multiple blank walls facing outwards.

The site in general is not well integrated with the surrounding uses, which includes strip retail centers, suburban office buildings, other commercial structures and both single-family homes and low-rise apartment buildings. Additional uses and density, especially at the periphery of the site, could be included in future phases to fully transform the site into a walkable, low-rise, mixed-use district.

Project Resources

- Ellen Dunham-Jones and June Williamson, *Retrofitting Suburbia: Urban Solutions for Redesigning Suburbs.*
- Winter Park Village. www.shopwinterparkvillage.net.
- Lofts at Winter Park Village. www.theloftsatwpv.com.

CASE STUDY 2: THE STREETS AT SOUTHGLENN

Project Overview

The Streets at SouthGlenn is the redevelopment of regional SouthGlenn Mall site that was originally constructed in 1974 in unincorporated Arapahoe County, approximately 11 miles south of Denver. In 1999, Chicago-based Walton Street Capital, LLC acquired the property and quickly began exploring redevelopment options. The City of Centennial was incorporated in 2001 and included the SouthGlenn Mall site. The site is in close proximity to Denver-area premier neighborhoods.

In 2005, the property was sold to Alberta Development Partners, LLC who worked with the City to revise development regulations to allow for a high-end, mixed-use project. The City rezoned the property in late 2005 and formed the Centennial Urban Redevelopment Authority (CURA). The SouthGlenn Metropolitan District was formed with a detailed service plan that allows the District to raise up to $85 million for public infrastructure improvements through the sale of bonds. The District has the power to impose an additional property tax to finance improvements for transportation, flood control, utilities and other public needs.

Construction began in 2006 on the Streets at SouthGlenn, a 77-acre complex offering 1.8 million square feet of retail, office, and residential space. The majority of the mall was removed, except the Macy's and Sears department stores. The $308 million project was completed in August 2009, and is now a regional, urban shopping destination as varied and vital as the city with upscale retail and restaurant offerings and as convenient and comfortable as the suburbs with luxury apartments, parks and promenades. The Streets at SouthGlenn energizes the area by providing distinctive shopping, dining, working and living experiences.

Mix of Uses

The Streets at SouthGlenn features a gourmet natural foods market, a cinema, and high-end national and local restaurants and retailers. The

Project Data

- Location: South University Boulevard and East Arapahoe Road, Centennial, Colorado
- Site Area: 73 acres
- Total Square Footage: 2.1 million sf total project (including 1.7 million sf new construction)
  - Retail: 917,000 sf (including 196,000 sf of major anchors, 122,000 sf of junior anchors, 282,000 sf of specialty retail and restaurants, and 33,000 sf pad sites)
  - Office: 140,000 sf (including 97,000 sf Pearson eCollege)
  - Public Library: 19,000 sf
  - Residential: 202 for-rent luxury apartments
- Developer: Alberta Development Partners, LLC in partnership with Walton Street Capital, LLC
- Design Team: SEM Architects, CommArts Design, Mulhern & Associates, CLC Associates, Russell Davis Associates, Saunders Construction, Inc., The Weitz Company, Ledcor, Colorado First Construction, Catamount Constructors, The Beck Group

site's major tenants include two department stores (Macy's and Sears) that remained open in their existing structures during the redevelopment. Other major tenants include Whole Foods Market, Dick's Sporting Goods, Best Buy, and Staples. The development includes numerous national chain and local restaurants, a 24-Hour Fitness, and a 14-screen Hollywood Theaters. A large retail space intended for a Barnes and Noble remains vacant. The site is served by a 1,700-space parking structure and additional surface parking.

Redevelopment during a recession resulted in a delayed completion and a change in the original plans from 350 for-sale condominiums to 202 luxury for-rent apartments in the The Portola at SouthGlenn.

A Silver LEED certified building, the Offices at SouthGlenn is a 140,000 square foot, five-story office building with ground-floor retail and is currently 100 percent occupied. Pearson's eCollege is the principal tenant with 97,000 square feet on three stories. The building offers free structured parking with 4 spaces per 1,000 square foot. Other public and institutional uses within the site include a Southglenn Public Library branch and University of Phoenix.

Form & Character

The site plan was designed around two existing department store structures from SouthGlenn Mall and was developed around an internal street grid that connects to the surrounding area with buildings located within nine development blocks. Mixed uses are vertically integrated into the nine blocks, with 22 new buildings with ground-floor retail with office and residential space on the upper floors of two buildings.

At the heart of the property is an open-air village centered around Commons Park, an urban park with mature landscaping, including transplanted trees from the existing site, and a grand fountain. The two-acre park features a fireplace, a living Christmas tree, hosts a farmer's market, a holiday ice rink, and seasonal entertainment fully funded by the developer.

Miscellaneous Features

The formation of CURA in November 2005 and definition of an urban renewal area allowed the use of tax increment financing (TIF) to fund public infrastructure at the Streets of SouthGlenn. This included streets, lighting, stormwater drainage structures, parking garages, surface parking, fire protection improvements, and other public-related needs. The TIF is implemented through a public finance agreement between the City of Centennial, CURA, the SouthGlenn Metropolitan District, and SW Southglenn, LLC signed March 20, 2006.

The SGMD is responsible for executing the sale of bonds to raise a maximum of $85 million for the funding of public improvements. All revenues from the property tax increment and 76 percent of the revenues from the sales tax increment will be used to repay the bonds, expected within 18 years. The remaining 24 percent of the sales tax increment will be used by the City of Centennial for general City purposes. The SGMD will impose a 20 mill property tax levy on property within the project boundaries to augment revenues available for debt service and an additional small mill levy assessment to fund operating and property maintenance expenses.

According to the Denver Business Journal, City of Centennial officials reported that the center generated $2.4 million in sales tax revenue in 2011. According to the developer, the center has some great local restaurants and retailers who are preforming well; some retailers increased comparable-store sales year-over-year 8 or 9 percent, and as much as 26 to 29 percent for others. The center's foot traffic increased 40 percent from 2009 to 2010, and another 20 percent from 2010 to 2011.

In 2009, a 51-member group of business partners joined together to form the Streets at SouthGlenn Business Association. This organization works in partnership with South Metro Denver Chamber of Commerce to promote and market the businesses and other tenants within the property.

Resources

- Streets at SouthGlenn. www.shopsouthglenn.com; www.shopsouthglenn.com/uploaded-files/Redevelopment%20Story%20rev5.pdf.
- Denver Business Journal (1.13.2012). www.bizjournals.com/denver/print-edition/2012/01/13/denver-area-outdoor-shopping-areas.html.
- Alberta Development Partners. www.albdev.com/images/pics/StreetsatSGfactsheet091609.pdf.
- Colorado Construction. http://colorado.construction.com/features/archive/2009/0609_Ca_SouthGlenn.asp.
- CLC Associates. www.clcassoc.com/pdf/CPW_StreetsAtSouthGlenn.pdf.
- Portola at SouthGlenn. www.shopsouthglenn.com/leasing/residential
- City of Centennial. www.centennialcolorado.com/DocumentCenter/Home/View/2687.

CASE STUDY 3: BEST PRACTICES IN LOW IMPACT DEVELOPMENT

Low Impact Development Strategies

Overview of LID

Sprawling commercial and housing developments with large impervious surface areas—roofs, roads, and parking lots—drastically affect the hydrology of an area. As stormwater flows across these surfaces, sediment, pollutants, and fertilizers are picked up and carried to streams, ponds, wetlands, and bays. And pollutants are not the only problem—impervious surfaces block the natural infiltration of a large portion of rainfall into the ground. As natural filtration is blocked, rainwater runs off, travels through pipes, and is discharged into receiving wetlands and surface water bodies. Although traditional stormwater management systems are effective in reducing peak runoff rates, their design typically allows the full volume of runoff to be discharged. Even if contaminant concentrations are reduced, most standard designs allow high amounts of pollutants to run off into receiving water bodies.

The old paradigm that viewed stormwater as a waste product requiring management is being replaced by a new paradigm that views stormwater as a valuable, beneficial resource. New practices and design strategies, known as Low Impact Development (LID), are being developed to mimic natural processes. LID designs allow rainfall to filter through vegetation to remove sediments and pollutants and provide for longer detention periods to allow time for infiltration. LID designs which employ multiple small treatment measures distributed throughout a watershed can be more effective and less costly than traditional systems that collect stormwater in pipe systems and transports large volumes to centralized ponds and basins.

LID Goals

LID approaches area designed to achieve the following broad goals:

- Reduce impervious area (e.g., roads, parking lots, and roofs) to the maximum extent possible. Examples include minimizing the size of parking lots and building vertically to lessen building footprints.
- Increase infiltration by replacing standard pavement with pervious pavement or vegetation.
- Lengthen flow paths, slow down runoff and detain water onsite with parking lot islands, vegetated depressions (rain gardens) or bio-retention ponds/enhanced wetlands.
- Promote livable, aesthetically pleasing concentrated development surrounded by green spaces.

LID designs by Ekistics Design Studio for parking at the Florida Aquarium.

LID Benefits

Benefits of using LID approaches to manaage stormwater include the following:

- Reduced stormwater infrastructure costs—retaining more stormwater on-site allows smaller collection pipes and treatment ponds, and swales can reduce curb and gutter costs.
- Reduced long-term maintenance through use of distributed infiltration.
- Improved water quality as physical and biological processes reduce nutrient loads and metals.
- Conservation of potable water and reduced expense of irrigation and fertilizer.
- Enhanced aesthetics improves property values.
- Restoration of natural habitats improves biodiversity.
- Increased water recharge to groundwater.

Costs: LID vs. Traditional Design

Although LID is often perceived as being more expensive than traditional stormwater management this is not always the case. While a LID measure such as pervious pavement will cost more than standard pavement, the reduced cost of other stormwater infrastructure may make it less expensive overall. Detailed cost comparisons of conventional versus LID development in 17 case studies examined by the Environmental Protection Agency found capital cost savings of 15 to 80 percent with LID, with only a few exceptions. Other studies estimate LID capital cost savings in the range of 25 to 30 percent over conventional stormwater management. Research conducted in 2001 by the U.S. Department of Housing and Urban Development showed the cost of curb, gutter and piping systems to range from $40 to $50 per linear foot. The elimination of one mile of curb and gutter can decrease infrastructure and storm conveyance costs by approximately $230,000 (assuming an average of $45 per linear foot). By retrofitting an area experiencing periodic flooding with rain gardens, Maplewood, Minnesota saved about 10 percent over upgrading the existing system with a curb and gutter system.

Example Cost Estimates for LID Measures

Type of Best Management Practice	Cost per sf[(1)]	Cost per Gal.[(2)]
Distributed Bio-Retention		
Swales	$5 - $20	
Rain Gardens	$10 - $17	
Curb Bumpouts, New	$30	$10.86
Bio-retention Planter Boxes	$8 - $15	$26.83
Tree Boxes	$10 - $15	$10.80 - $23.36
Pervious Pavement with Gravel Bed	$7 - $15	$4.62
Green Roofs - Extensive & Intensive	$5-50	$22.68

(1) Lancaster, PA, Green Infrastructure Plan, 2011.
(2) Kansas City Green Solutions Unit Costs, 2009.

In cost/benefit analyses it is appropriate to use only extra or marginal costs of LID over a standard alternative. In other words, if a green roof is considered when a new roof is planned, the extra cost of the green roof should be compared to its benefits, since the roof must be replaced anyway. In a 2011 study published in Stormwater Journal, the marginal capital cost for a green roof was estimated at $14 per square foot.

Although costs and savings vary by site and design specifics, evidence suggests the use of LID can result in significant savings in both initial construction and life-cycle project costs.

Pervious Pavement & Vegetated Swales

Project Example: LID at the Florida Aquarium

In 1995, three elements of LID were incorporated into the design of parking and landscape areas at the Florida Aquarium in Tampa. The 11.25 acre parking lot for the Aquarium was divided into four pavement/swale types, one of which served as a control consisting of standard asphalt paving and an asphalt paved collection swale. The other three sections used vegetated swales to collect runoff from standard asphalt, concrete pavement, and pervious pavement. Runoff from the parking areas was directed into larger channels planted with wetland trees (strands) and finally through a small treatment pond before being discharged into Tampa Bay.

To assess the effectiveness of the designs, more than 50 storms were observed over a two year period. Runoff volume and water quality data was collected at the exit from each swale, the strand, and the final pond outlet to isolate performance data for each LID feature. Compared with the asphalt pavement and asphalt swale (the control section), results showed moderate decreases of about 36 percent in runoff volume by adding the vegetated swales to standard asphalt and concrete pavement. The section integrating both pervious pavement and a vegetated swale produced the least runoff, in the range of 80 to 90 percent reduction in volume. Other results showed that significant infiltration continued in the strand and pond, so that only one storm discharged from the pond into Tampa Bay. Runoff from all other storms was completely retained on-site.

Levels of pollutants, including suspended solids, ammonia, nitrate, total nitrogen, ortho-phosphorus, total phosphorus, copper, iron, lead, and zinc were also monitored. Water quality data analysis showed large load reductions, especially from the pervious pavement and vegetated swale, where more than 75 percent of suspended solids and metals were removed, when compared to the control asphalt section. Phosphorus was the exception, as its concentration increased after passing over the vegetated areas. Nitrogen concentration reductions were modest; however, due to the large volume reduction, the total loads of nitrogen and phosphorous discharged were very small.

Pervious pavements and vegetated swales at the Florida Aquarium.

Design Considerations

Pervious pavements are often a key feature in LID designs. Pervious pavement allows water to flow through them, filtering some pollutants and providing surfaces for bacterial removal of nutrients. Some strength is sacrificed in exchange, making them most suitable for low traffic areas such as parking lots and driveways. Many types of pervious pavement are available with differing permeability, appearances, and cost, but all are capable of detaining and treating stormwater to a similar degree. Pervious asphalt and concrete contain similar materials to standard pavements, but have little or no fine aggregate, creating void spaces typically around 20 percent. Other types of pavers or flexible plastic grid systems can have voids of 10 to 40 percent. Initial rates of permeability usually decline over time with partial clogging, but with proper maintenance, almost full function can easily be restored.

Soil with an infiltration rate of at least 0.5 inches/hour is suitable for use under pervious pavement, but perforated drainage pipe may be used in areas with unsuitable soil. In some locations, the soil may have sufficient permeability for infiltration, but a high groundwater level may constrain the use of pervious pavement. A depth of one foot between the aggregate storage bed and seasonal high groundwater is needed, and drainage pipes must be above the seasonal high groundwater table to maintain positive drainage.

Since pervious pavement relies on open pore spaces for water to flow through, it is important pores are not blocked or sealed. To ensure this, pervious paving systems must be properly designed and installed by an experienced contractor. Sites must also be graded to prevent soil from washing onto pavement and the open pores both during and after construction. Pervious pavements have been shown to outlast standard asphalt and equal or exceed the life of concrete. Some installations have now been functioning well for 15 to 20 years.

Maintenance

Periodic inspection and cleaning are required to maintain structural integrity and porosity of pervious pavement systems. Annual inspections should be completed to evaluate structural integrity, and periodic inspections, especially after large storms, should be completed to assess ponding and if sediment is washing onto pavement. Where erosion is evident, landscape and drainage improvements should be completed. Cleaning also may be required. Blowers can be used to remove leaves and pine needles as needed and vacuum street sweepers may be used annually or as needed to remove dirt from pavement voids. Pressure washers can also be used, but runoff from pressure washing should be treated at a waste water treatment plant to avoid introducing pollutants into receiving waters.

Pervious Pavement Pollutant Removal & Unit Costs

Pollutant Type	Percent Removal
Total Suspended Solids (TSS)	85% - 95%
Total Phosphorus (SRP)	65% - 85%
Total Nitrogen (TN)	80% - 85%
Nitrate (as N)	30%
Metals	98%
Material Type	**Cost**
Pervious Asphalt	$0.5 - $1 per sf
Pervious Concrete	$2 - $7 per sf
Concrete Pavers	$5 - $10 per sf
Excavation	$8 - $10 per sy
Aggregate	$30 - $35 per sy
Geotextile Fabric	0.70 - $1.00 per sf

Some clogging from dust and fine particles is acceptable, as pavement voids are many times greater than in the underlying soil, and partial clogging does not mean sealing. However, maintenance can not be ignored, and materials such as mulch and sand should never be placed on top of pervious pavements.

Data published by the Wisconsin DOT from a series of studies of various pervious pavements have shown similar abilities to remove pollutants. The results are shown below, along with a sample of costs (from 2005 data) reported for the pavements. Other studies have shown lower levels of nutrient removal, but generally agree that high levels of total suspended solids (TSS), metals, and hydrocarbons are removed.

Photo of rain garden capturing roof runoff on Portland, Oregon.

Bio-retention & Detention Options

Design Strategies

Bio-retention (e.g., swales, rain gardens, parking lot islands) has been shown to be an effective method of managing stormwater. Water is directed into a depressed vegetated area where it either infiltrates into the soil or is taken up by plants. Total runoff volume can be drastically reduced as rainfall from small and moderate sized storms is captured and retained (kept and not released). Alternately, bio-detention methods are similar, but after water is filtered by plants and soil, it is collected in a pipe and discharged off the site. Each bio-retention area generally serves two acres or less.

Although rain gardens are often thought of for use in residential areas, they are equally suitable for commercial sites. Rain gardens can be used in a range of landscaped areas, including in parking lot islands and in infiltration planters along buildings, streets, and sidewalks.

With detention methods, water quality benefits come primarily from sedimentation and filtration. Retention methods have additional benefits capturing and infiltrating stormwater. As the Florida Aquarium case study illustrated, almost all runoff can be retained on site. Nutrient concentrations in runoff from vegetated areas at times can actually be increased (particularly from swales) over baseline concentrations, but total nutrient loads are much less due to decreases in discharge volumes.

Project Example: Rain Gardens in Burnsville, Minnesota

The community of Burnsville, in the Minneapolis-Saint Paul metropolitan area, compared runoff volumes from two adjoining residential neighborhoods to measure the effectiveness of small distributed rain gardens. In one neighborhood 17 individual lots were retrofitted to add rain gardens; the second neighborhood provided a control with no changes. For the retrofitted lots, existing curb and gutters were modified so that stormwater from the streets would travel across a filter strip and flow into a rain garden. A drop of about six inches between the street and the filter strip provides positive drainage, and the rain gardens are 12 to 18 inches deep. The design captures and infiltrates at least the first 0.9 inch of runoff. Flow data were collected over a three year period (2002-2005) beginning one year before the retrofit project. This verified that the hydrology of the neighborhoods was very similar (they produced almost the same amounts of runoff from any storm).

Attempts were made to collect runoff samples for water quality analysis; however the amount of runoff was reduced so significantly that it was difficult to obtain samples, and equipment problems led to too few water quality samples being obtained for statistical analysis. However, initial results of the flow monitoring reported in 2006 showed the rain gardens reduced the total runoff volume about 90 percent. Total nutrient and pollutant loads were assumed to be reduced by a similar amount.

After five years, a follow-up study was done. While infiltration rates in the rain gardens were still satisfactory, inspection showed that sediment from the street was building up on the filter strips, and in many cases partially blocking entry into the rain garden. Overall, about half of the stormwater was bypassing the rain gardens and not being captured. To correct this problem, the City decided to install structural pre-treatment devices in small sumps below the curb cuts. Sediment collects in the sump before water enters the rain gardens rather than being deposited on the filter strips. The City then uses a vacuum truck to remove accumulated material from the sumps. The initial cost for each of the pre-treatment units was about $1,700, and maintenance is expected to cost about $50 per unit (2010 costs).

An analysis was done to estimate the cost per pound of removing total suspended solids (TSS) and total phosphorous (TP) and the cost per acre-feet to reduce runoff volume over a 20 year life. The rain gardens were found to be a cost effective method to remove TSS, comparable to unit costs for removal in a constructed wetland. Unit costs to remove TP in rain gardens were found to be about 70 percent more than in wetlands. New construction was found to be about 20 to 30 percent less expensive than retrofit projects.

Maintenance

Homeowners maintain the rain gardens in Burnsville. Similar to other landscaped areas, periodic weeding, pruning, replacement of mulch and any dead plants is needed. With a careful selection of plants, little or no extra irrigation is needed after establishment. Sediment will collect at points where stormwater enters the rain garden (or other bio-filtration). It should be removed as needed, possibly every two to three years. With training, landscaping companies or municipal employees could do this work. However, the experience in Burnsville illustrated that pre-treatment collection may be an easier, but still cost-effective method to maintain bio-filtration treatment for stormwater.

Enhanced Stormwater Ponds & Constructed Wetlands

Design Strategies

Wet detention ponds have been the mainstay for stormwater management and treatment in much of Florida. Wet ponds usually detain 0.5 inches of runoff and function to reduce peak runoff from the contributing site. While these ponds meet minimum permit requirements for water quality treatment, with modification they can provide additional benefits.

Project Example: The Stormwater Ecological Enhancement Project

The Stormwater Ecological Enhancement Project (SEEP) on the University of Florida campus began as a standard three acre retention pond with minimal biological diversity. Large buildings, roads and parking lots in a 40 acre watershed drain to SEEP- impervious areas that generate about 478,000 cubic feet of runoff annually above natural conditions.

In 1995 the previous flat bottom basin was recontoured to create a forebay (an initial pool) where water enters, slows, deposits most suspended material, and is discharged through a weir to the rest of the basin. Water then follows a winding path through varying depths. The recontoured basin was planted with native wetland plants capable of removing pollutants, which also enhances aesthetic and ecological values.

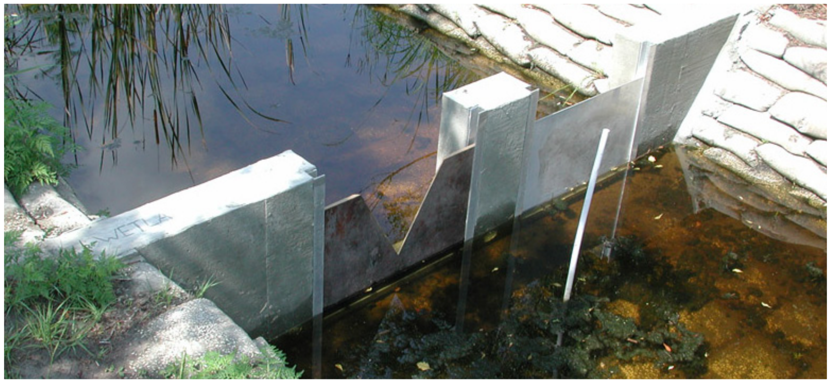
The variety of plants and aquatic habitats attract abundant wildlife, including birds, mammals, reptiles and amphibians to the site. In 1997, prior to re-contouring and planting, there were 32 plant species that had recruited naturally into the basin consisting mostly of cattails. In 2004 the plant diversity had increased to more than 120 species distributed across a range of hydrologic tolerances. The appearance and function of the SEEP has changed to that of a well-developed natural wetland.

The quality of water discharged from the SEEP is improved through several processes. About 85 percent of runoff entering the SEEP passes through the forebay where the majority of suspended sediment and contaminants are deposited. Water slowly exits the forebay into a cypress swamp, then flows into a shallow marsh and finally into a deep water pond. The winding flow path and multiple cells of varying depths prevent short-circuiting, lengthen detention time, and promote a variety of physical and biological processes to increase the uptake of nutrients and removal of pollutants.

The SEEP also serves as an educational asset for the community. A boardwalk and interpretive signs are posted around the perimeter. Visitors learn about the role of wetlands in filtering stormwater, the plant and aquatic species in the SEEP, water quality parameters and the influence of human activities on surface and groundwater.

Water Quality

The deep pools were originally expected to hold a permanent pool of water, but instead the pools regularly draw down during dry seasons. This is not a particular problem, as many wetlands experience wet and dry cycles, but nitrogen (N) and phosphorous (P) levels typically increase as water levels rise following dry periods as mineralization of organic matter in the wetland releases some of the previously absorbed N and P into the water. However, the initial flux of nutrients is not discharged from the basin; instead it is trapped in the ponds and re-assimilated. Nitrogen concentrations are significantly higher in the forebay, dropping as water travels through the SEEP. When the basin is continuously flooded, P concentrations follow the same pattern. Data indicates that the forebay captures most sediment



Photos of the Stormwater Ecological Enhancement Project (SEEP) at the University of Florida' showing deep pools (top) and elements of the weir system (bottom).

and metal contaminants. Zinc and cadmium levels are elevated within the forebay and total suspended solids (TSS) are high near each of the four inflow points.

Average monthly water quality values within the SEEP forebay and at the final outlet are provided in the table below. Ammonia (NH_4), the most common form of nitrogen in stormwater, is converted to other forms within

SEEP Water Quality Data Compared with Other Wetlands

Nutrient	Forebay Concentration mg/L	Outlet Concentration mg/L	Fraction Removed in Lower SEEP	Median In /Out Concentrations in Wetlands[1] mg/l
NH4[2]	0.057	0.034	33%	NA
NOx[3]	0.018	0.012	27%	0.24 / 0.08
TN[4]	0.699	0.899	-29%	NA
SRP[5]	0.156	0.069	55%	0.08 / 0.05
TP[6]	0.27	0.178	45%	0.13 / 0.08

(1) International Stormwater BMP Database, July 2012.
(2) Ammonia.
(3) Nitrogen Oxide.
(4) Total Nitrogen.
(5) Soluble Reactive Phosphorous.
(6) Total Phosphorous.

the wetland. Nitrogen oxides (NOx) are present in the atmosphere due to the combustion of fossil fuels and are picked up by rainwater. Soluble reactive phosphorous (SRP) is the form phosphorous most readily available to plants and algae.

Nitrogen levels in the SEEP forebay are lower than the median inflow N value for other wetlands, but the forebay samples are taken after reductions due to sediment deposition have already occurred. Actual concentrations in the SEEP influent will be higher. SEEP phosphorous levels are somewhat higher, likely due to high phosphate content in the underlying rock (the percent removed is also higher). Nutrient removal levels appear to be reasonable when compared to other wetlands.

Design Considerations

Recommendations for constructed wetlands in the Florida Administrative Code 40C-42 include a residence time no less than 14 days, less than 70 percent open water and inlets designed to capture suspended solids. Wetlands should be designed to maintain a permanent water pool.

Maintenance

Periodic inspections, clearing of trash and removal of dead vegetation are the primary maintenance tasks after plants are established. The 2010 draft Stormwater Quality Applicant's Handbook for Florida contains lists of suitable plants for littoral and freshwater aquatic plants and other design information. Sediment should be removed from the forebay after 10 percent of the water quality treatment volume has been filled. The SEEP has not required sediment removal, but it is difficult to estimate the actual volume reduction.

Green Roofs

Design Strategies

Green roofs are a multi-purpose stormwater management technique, which provide many other benefits, as detailed below. Life-cycle cost analysis shows they are investments that provide a much greater chance of financial reward than of loss. Green roofs are classified as extensive or intensive based on their depth of growing media which determines the type of plants they will support. The vast majority of green roofs in the US are extensive (less than six inches depth of root zone).

Incorporating green roofs has the potential to provide major benefits, including the following:

- Reduces Peak Volume of Stormwater Runoff. The reduction is primarily a function of the depth of media and cistern storage capacity, but total runoff volume can be reduced by 65 to 85 percent for extensive green roofs.
- Improves Building Energy Efficiency. Typically 10 to 20 percent for low-rise buildings, depending on the building design and media depth. Intensive roofs with greater media depth offer better energy performance, but also increase weight and structural costs to support the roof. Poorly insulated

buildings with a large portion of their cooling loads attributed to heat transfer through the roof can benefit the most. Well insulated buildings with cooling requirements heavily influenced by ventilation, internal heat sources or solar gain through windows, should expect lower energy efficiency gains from green roofs.

› Mitigates Heat Island Effect. Buildings and areas of dark pavement absorb more heat than vegetation. Urban areas with populations of one-million people can have average daily temperatures of about 2 to 5°F warmer than surrounding rural areas, and evening temperatures as much as 22°F higher. Air conditioning energy costs, greenhouse gasses and air pollution are all increased by this phenomenon. Green roofs help to reduce surrounding air temperatures.
› Extends Roof Life. A green roof significantly enhances the life of roofing materials by mitigating the peak temperatures from about 145°F to a much more tolerable range of 85-95°F. Green roofs are expected to have lifespans of 40 to 55 years.
› Improves Water Quality. Urban rainwater contains air pollutants such as mercury, sulfur and nitrogen oxides. Asphalt shingles and other roofing materials are also sources of pollutants, which stormwater from green roofs is able to avoid, since these materials are not used in green roof construction.
› Supports Biodiversity. A variety of plants may be grown, attracting pollinators and birds.
› Improves Aesthetics. If located where the green roof can be viewed (or accessed) by employees or the public, this can be an unquantifiable, but significant benefit.

Project Example: Charles R. Perry Construction Yard

The Charles R. Perry Construction Yard at the University of Florida (UF), constructed in 2007, is an extensive green roof with a surface area of 2,600 square feet and a media depth of five inches. Excess rainwater is collected in cisterns, capable of storing 3,100 gallons. This serves about 70 percent of the irrigation needs for the roof; the remainder is supplied by campus reclaimed water.

Experience with UF's green roof has emphasized the importance of plant selection for withstanding Florida heat. Plants will be exposed to higher temperatures on roofs than when planted in landscapes. The temperature of exposed green roof media at UF has been measured up to 165°F. Also, root systems and depth of growing media must be considered. Native wildflowers, grasses and succulents (primarily sedums) are used on green roofs. However, sedums may prefer cooler, dryer conditions and less organic material than Florida natives. Annual plants should be avoided as they leave bare spaces in the winter.

Green roof photos from University of Florida's Charles R. Perry Construction Yard.

A study of the effects of hurricane strength wind on green roofs was completed at UF in 2012. Various plants grown in modular trays and in built-in-place (BIP) trays typical of extensive green roofs were subjected to 120 miles per hour wind. Failures occurred with the modular trays, but not the BIP units. Although some scouring of growing media was experienced, it was not severe. Damage to plants was mostly limited to loss of flowers and some leaves, but no catastrophic losses occurred, and plants would generally be expected to recover. Designed correctly, green roofs can withstand significant wind.

Design Considerations

University of Florida's LID manual recommends that runoff volume calculations for green roofs be based on National Resource Conservation Service curve number values for open space and hydrologic soils group A (Standard designations A - D describe how permeable soil is to water), for rainfall volumes equal to about three times the media's maximum water retention volume.

To assist in design of green roofs, a study for the Florida Department of Environmental Protection by the Stormwater Management Academy at the University of Central Florida calculated the volume reductions that can be expected for a range of cistern storage sizes for green roofs at various locations in Florida. Their results indicated that in the Tampa Bay area, a roof system with two inches of storage would reduce runoff by 77 percent, while a system with 5 inches of storage could achieve up to an 86 percent stormwater volume reduction.

Maintenance

Maintaining the plants is the primary requirement for extensive green roofs. Appropriate drought tolerant plants will require little maintenance after establishment. They should be inspected monthly and weeded as needed. The drains and irrigation system should be checked to ensure they are clear and operating correctly. Inspection of the cistern, pump, and piping to the roof should be performed. The waterproofing membrane will need inspection, especially around roof penetrations and edges.

Additional Information & Resources

Incentives to Promote LID

- Reduce stormwater fees.
- Restructure stormwater fees to be based on percent of impervious area.
- Use grant or city funds to cover increased marginal costs from some LID measures, such as green roofs or pervious pavement.
- Construct demonstration projects on private property.
- Offer priority review of development submission.
- Waive re-submission fee if additional review is required for LID inclusion.
- Credit vegetated or infiltration LID areas toward required open space.
- Publicly recognition – signs on site and on-line on city's website.
- Education programs with rain barrel giveaways and painting events.

Implementation Steps

- Engage all interested parties in setting short and long-term goals for the community.
- Research and adapt suitable ordinances/development policies.
- Educate the development community, business owners and the public.
- Jointly identify real or perceived obstacles to LID and any administrative or other changes needed to remove them.
- Decide what incentives the City can provide.
- Develop demonstration projects on public or private properties.
- Locate funding if needed to implement LID development program.
- Reevaluate and adapt policies or regulations as needed.

Sample Municipal Ordinances

- Jennifer Bitting and Christopher Kloss, Low Impact Development Center, Managing Wet Weather with Green Infrastructure, Municipal Handbook, Green Infrastructure Retrofit Policies, Dec 2008. http://www.seswa.org/Files/Services/Links/National/incentivemechanismssept08.pdf.
- Managing Wet Weather with Green Infrastructure, Municipal Handbook, Green Infrastructure Retrofit Policies. This is one in a series to help local officials implement green infrastructure. http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_munichandbook_retrofits.pdf.

- Local Government Environmental Assistance Network has many resources to offer. http://www.lgean.org/water/stormwater.htm.

Cities Promoting LID Retrofits

- Alpharetta, GA – Constructed demonstration projects include a green roof, permeable pavement, wetland, and bio-retention at a city park in 2007. http://www.alpharetta.ga.us/index.php?p=426.
- Bremerton, WA. The City of Bremerton , Washington is implementing LID along a major transportation route serving downtown commercial and residential areas in a fully developed urban area. One example: the design for 300 feet of conventional stormwater catch basins and pipes serving a parking lot was changed to pervious pavement over an infiltration trench at a competitive price. The City found that LID has the potential for large cost savings. http://www.ecy.wa.gov/programs/wq/stormwater/municipal/LID/Creating anLIDEnvironUltraUrbanSettingPart2.pdf.
- Chicago, IL. The City of Chicago's Green Permit Program uses a 2-Tier incentive system to promote LID and other green building through LEED certification. Tier 1 is an expedited permitting process and reduced fees; Tier 2 is an additional fee reduction, to a $25,000 limit. http://energy.gov/savings/chicago-green-permit-and-green-homes-programs.
- Kansas City, MO. Kansas City's education and marketing program called "10,000 Rain Gardens Initiative" has been implemented using LID measures. Rather than funding projects, they have focused on an education program for professionals and the public, and some demonstration projects. A case study and presentation for public education are available at http://www.werf.org/liveable communities/studies_kc_mo.htm and http://www.epa.gov/region7//newsevents/events/pro ceedings/om_green_infrastucture/KC_Metro_initiatives_and_O_M_solutions_rain_garden.pdf.
- Lakeland, FL. In the City of Lakeland, Florida, the Circle B Bar Reserve Nature Center installed a permeable pavement parking lot. http://www.dep.state.fl.us/water/nonpoint/docs/319h/FY04-319h_Project_Summary.pdf.
- Lancaster, PA. The City of Lancaster, Pennsylvania's Green Infrastructure plan is a long term plan combining multiple LID strategies, including developing 468 blocks of 'green streets', increasing tree canopy from 28 to 40 percent, retrofitting 130 acres of parking lots with permeable pavement, increasing green roofs and park areas. http://www.saveitlancaster.com/resources/green-infrastructure-plan/. http://www.saveitlancaster.com/resources/city-ordinances/.
- Orlando, FL. Through it's Urban Stormwater Retrofit program, the City of Orlando uses a multi-disciplinary team to evaluate specific sites for stormwater retrofits, identifying pollutants and options to improve water quality. Many stormwater treatment lakes and wetlands are now amenities within mixed land use areas, including commercial and multi-family housing. Green spaces are connected into a framework of parks. Greenwood Urban Wetlands Park adjoins both a major highway and residential neighborhoods. http://www.werf.org/liveablecommunities/studies_orlando_fl.htm.
- Portland, Oregon. Portland Oregon's Green Streets Program is replacing an all piped stormwater management system with one that incorporates LID. http://www.portlandonline.com/bes/index.cfm?c=44407&.
- Wilmington, NC. The City of Wilmington, North Carolina received an EPA 319 grant for stormwater retrofits, creating stormwater wetlands and bio-retention in an urban mixed-use basin with successful partnerships between city, state and community groups. http://ascelibrary.org/doi/abs/10.1061/41009%28333%29115.

General LID References

- Water Environment Research Foundation, Using Rainwater to Grow Livable Communities, Sustainable Best Management Practices (BMPs), http://www.werf.org/liveablecommunities/index.htm.
- FDEP, Stormwater Quality Applicant's Handbook, March 2010 Draft. http://publicfiles.dep.state.fl.us/dwrm/stormwater/stormwater_rule_development/docs/ah_rule_draft_031710.pdf.
- Sarasota County Low Impact Development Manual, Nov. 2011 Draft, https://www.scgov.net/WaterServices/Low%20Impact%20Development%20Resources/Draft%20LID%20Manual.pdf.
- University of New Hampshire, "Forging the Link: Linking the Economic Benefits of LID and Community Decisions". http://www.unh.edu/unhsc/resource-manual-and-fact-sheets.
- American Society of Civil Engineers Stormwater BMP Database, http://www.bmpdatabase.org/.
- Low Impact Development Center. www.lowimpactdevelopment.org/.
- Center for Watershed Protection. www.cwp.org/.

Pervious Pavement References

- General Design Information. http://www.perviouspavement.org/design/hydrological.html.
- Betty Rushton, Ph.D. Enhanced Parking Lot Design for Stormwater Treatment. In Proceedings of 9th International Conference on Urban Drainage, September 8-13, 2002 EWRI/IWA/ASCE.
- Wanielista and Chopra, Construction & Maintenance Assessment of Pervious Concrete Pavements. http://www.stormwater.ucf.edu/research/Final%20Report%202%20of%204%20Construction%20and%20Maintenance%20Jan.pdf.

Bioretention References

- Sarasota County Low Impact Development Manual, Nov. 2011 Draft, Sections 3.1 and 3.6. https://www.scgov.net/WaterServices/Low%20Impact%20Development%20Resources/Draft%20LID%20Manual.pdf.

Green Roof Examples and Resources

- Glenn Acomb, ASLA, Department of Landscape Architecture, at the University of Florida may be contacted as an additional resource for green roof design. acomb@ufl.edu.
- Breaking Ground Green Roof, Jacksonville, FL. http://breakinggroundgreenroof.com/.
- Taco Boy, Charleston, SC, http://www.xeroflora.com/green-roof-projects/commercial/taco-boy/.
- Chicago has about 300 green roofs, totaling more than 4 million square feet. The City of Chicago City Hall's green roof saves $5,500 annually on energy costs and reduces runoff by 50%. http://www.epa.gov/owow/NPS/lid/gi_case_studies_2010.pdf.
- Wind Uplift Study. Acomb, Glenn, University of Florida, http://www.floridabuilding.org/fbc/commission/FBC_0812/HRAC/Task_2_Final_Report_Green_Roof.pdf.
- Sonne, J. and Parker, D., "Energy Performance Aspects of A Florida Green Roof, Part 2", University of Central Florida, 2008, http://www.fsec.ucf.edu/en/publications/pdf/FSEC-PF-442-08.pdf.

CASE STUDY 4: SUSTAINABLE REDEVELOPMENT IN GAINESVILLE

Recent projects along the SW/SE 2nd Avenue corridor in Gainesville, Florida showcase how innovative building, land use, urban design, and financial strategies can work together to spark investment and create more sustainable, competitive destinations. What follows is a three-part case study highlighting innovative redevelopment and design strategies incorporated in projects along the corridor.

Sustainable Infill at Union Street Station

Project Details

In 2000, McGurn Management, Inc. built Union Street Station at a cost of $15,000,000. This five story, 140,000 square foot redevelopment project brought high density, mixed-use, multi-family building infrastructure to downtown Gainesville at a time when most of the residential options were older single-family detached structures and when many downtown businesses were struggling to stay in service. The project covers a one-acre block on the southeast corner of the intersection of SE 2nd Avenue and SE 1st Street in the Central City District , which allows up to 150 dwelling units per acre in a maximum of 12 stories. Viewed retrospectively, this award winning project has become a catalyst for a wave of improvements throughout the Downtown Redevelopment District and down the SW/SE 2nd Avenue Corridor.

Designing for Diversity & Efficiency

Inspired by the architectural style prominent in the French Quarter of New Orleans, Union Street Station includes a human-scale mixture of diverse uses and energy efficient spaces. National and local restaurants and retailers with sidewalk seating and window shopping line the ground floor. Offices and 51 ENERGY STAR® qualified condominiums with large balconies and downtown views on all four sides line the second through fifth floors. Originally priced between $110,000 to $240,000, the residential spaces include single story house flats (1, 2, and 3 bedroom units) and two-story townhomes (3 bedroom/3 bath units).

UNION STREET STATION HIGHLIGHTS

Use Mix

- Commercial
- Office
- Residential

Green Technology

- ENERGY STAR® Features in Condominiums
  - tightly sealed high efficiency HVAC space conditioning systems and ductwork
  - code-exceeding insulation values
  - specially-insulated water heaters with optimized hot water piping runs
  - double-glazed windows
  - reflective solar films on high exposure glazing surfaces
  - shade trees for the street facing commercial spaces
  - solar photovoltaic in adjacent parking garage

Financial Incentives

- Union Street Station
  - tax increment financing (available through the Community Redevelopment Agency)
- Adjacent Downtown Gainesville Parking Garage
  - local utility rebate ($1.50/watt)
  - renewable energy rebate from State ($4.00/watt)
  - federal tax credits (30%)

Promoting energy-efficiency was an important objective of the project. To support the project's efficiency goals, a number of innovative features were incorporated in the project (see details in text box above). In addition, research conducted in the Gainesville region indicates that multi-family residential buildings consume about half the annual energy per dwelling unit than do their similar vintage (i.e., year built) single-family detached counterparts.

Tax Increment Financing

Located within the jurisdiction of the Downtown District of the Gainesville Community Redevelopment Agency (CRA), the Union Street Station project leveraged a local government incentive process called tax increment financing. While no money was provided to the developer in advance of the project construction, $3.2 million in total tax reimbursements were to be provided over a specified period of time after construction was completed. As is common in tax increment financing incentives, the developer provided aesthetic improvements to the project design at the request of the City of Gainesville in exchange for the reimbursement. This incentive helped the developer to mitigate some of the risks associated with higher property costs and other uncertainties surrounding the potential for success of a redevelopment project of this type in a downtown region that was underutilized at the time.

Since Union Street Station became one of the first of its kind in Gainesville to utilize this redevelopment incentive, other projects along the SW/SE 2nd Avenue Corridor have leveraged this financing option. The Jefferson on Second Avenue, a graduate student and professional multi-family rental housing project, received $9.5 million while the Hampton Inn hotel on the northeast corner of the shared intersection with Union Street Station received $700,000 for adding street level retail and restaurant space, façade upgrades, and other infrastructure improvements. However, these types of incentives are not without their critics and are best used in ecologically, socially, and economically context specific conditions.

Building-Integrated Solar Photovoltaics

Starting in 2009, McGurn Management Company utilized a mix of local, state and federal incentives available for solar photovoltaics (PV) which varied across different phases of the project. A capacity of 98,700 watts, at an average cost of $5.50 per watt (i.e., starting at $6.50 per watt in the first phase but dropping to $4.15 per watt by the final phase), was installed

Union Station street frontage looking Northeast. ***(Source: City of Gainesville)***

across four separate systems on the Downtown Gainesville Parking Garage connected to Union Street Station via an elevated walkway. Designed and installed by Solar Impact, Inc. and its subcontractors, each of the four systems was designed around 136 Suntech brand solar PV modules (175 watts/module) served by three SMA brand 7000 watt inverters for a combined capacity of approximately 24 kilowatts per system. This grid-tied, net metered system used locally fabricated structural metal framing to raise the modules above the parking spaces on the top deck of the existing garage. The solar PV system produces 145,000 watts per year saving $0.265 per watt of installed capacity (i.e., approximately $38,425 annually). Combined with energy efficiency lighting retrofits and other garage improvements, the renewable energy produced has effectively offset the annual energy consumption of the garage. To date, the McGurn Management Company's collective project portfolio has approximately 542,000 watts of installed solar PV capacity, including 250,000 watts within their Downtown Gainesville holdings.

Solar photovoltaics harvest energy while shading vehicles atop the Downtown Parking Garage. ***(Source: Solar Impact, Inc. and McGurn Management Company)***

Progressive Planning for the Innovation Square District

Project Details

The Innovation Square District (ISD) is a 40-acre, mixed-use, sustainability-focused, mixed use district designed to serve as a knowledge-based economic engine for the City of Gainesville, Florida.

Innovation through Collaboration

Development of the ISD along Gainesville's 2nd Avenue Corridor is guided by a strategic redevelopment master plan crafted through collaboration between the Gainesville Community Redevelopment Agency (CRA), the City of Gainesville, the University of Florida (UF), Shands Hospital at UF, and Gainesville Regional Utilities. The combined challenges of the global economic downturn, the local decommissioning of a former hospital site, and the realization by the public, private, and academic sectors that collaboration would prove more successful than competition led to the reinvention happening along the corridor today. The holistic, progressive planning approach followed by this unique public/private partnership helped the ISD win the 2012 "Out of the Box Award" and "President's Award" for statewide best practices from the Florida Redevelopment Association.

Rezoning for Adaptive Reinvention

The ISD is within the College Park/University Heights District of the Gainesville CRA. Early in the collaborative process, project partners realized the limitations of existing zoning and worked with the City of Gainesville planners to draft a new district allowing more intensive, mixed use development. The new district, the Urban Mixed-Use 2 (UMU-2) Zoning District, is designed to achieve the following:

- provide mixed uses complementary to existing residential;
- encourage high quality adaptive reuse;
- promote pleasant, walkable, multi-modal mobility options and streetscapes;
- enhance the viability of existing mixed uses; and
- promote office/research uses to serve the community and university.

INNOVATIVE SQUARE DISTRICT HIGHLIGHTS

Connectivity

- The district links Downtown Gainesville with the University of Florida along 12 blocks of the 2nd Avenue Corridor.

Uses & Parking

- 40% Science and Technology Labs (2,130,000 SF/4,267 people)
- 19% Science and Technology Office (696,000 SF/1,740 people)
- 33% Residential and Hospitality (881,000 SF/1,996 people)
- 6% Commercial Retail (249,000 SF/1,243 people)
- 2% Institutional (340,000 SF/850 people)
- 11%+ Unassigned/Flexible (573,000 SF/1,371 people)
- 5,300 Parking Spaces (224 on-street/545 surface/4,531 deck)

Financial Incentives

- $8.3 million federal grant
- $5 million UF grant match

The new zone allows for up to 100 dwelling units per acre (or up to 125 dwelling units per acre by special use permit) and up to six stories (or up to eight stories by special use permit). Non-single-family buildings must have a minimum height of 24 feet and a minimum of 70-percent building frontage. Limits of three or four stories are placed on all buildings within 50 feet of a nearby historic district to maintain consistency and relationships of existing low-rise, human-scale infrastructure.

The goal of the UMU-2 Zoning District is to "make appropriate development as easy as possible…to remove roadblocks hindering the [urban] development and economic development of the City…[and to create] flexibility within the private realm through the creation of a lasting public framework that is adaptable to change."

Planning Principles & Themes

The adaptive plan for the ISD has been guided by a series of planning, design, and development principles addressing the following:

- Livability. The ability to meet base lifestyle needs to eat, to move, to dwell, and to commune within a perception of beneficial outcomes.
- Walkability. The ability to reach desired destinations on foot and within pleasing human-scale infrastructure.
- Adaptability. The ability to flow with the inevitability of ever-present change across interacting scales.
- Sustainability. The ability to maintain what appears to fit today via an active and unending problem solving process.
- Connectivity. The ability to engage and interact with others in productive and proficient ways.
- 24/7 Serviceability. The ability to provide useful goods and services at all potential temporal points across all major spatial nodes.
- Wellbeing. The ability to maintain physical health and wellness with ease.

ISD's planning is also generally consist with "healthy community" objectives published by US Centers for Disease Control and Prevention (CDC). The CDC's objectives favor projects designed to promote independence and social engagement, and allow users to meet major needs (e.g., food, water, shelter, mobility, community) without reliance on motorized travel.

ISD Public Realm Planning

The ISD includes a linear urban greenway, utilizing stormwater low impact development (LID) techniques, which connects University Avenue to Innovation Square Park and Tumblin Creek Park. A planned future interconnection will link Depot Park, a US EPA supported brownfield assessment and restoration project, to the Gainesville-Hawthorne Rail Trail. There are many types of green spaces within the ISD, which are delineated and integrated into the plan as follows:

- Greenway. Interconnected urban and natural vegetated spaces.
- Squares. Public open spaces bounded by buildings and/or streets.
- Streetscapes. Designed based on frontage type.

Green infrastructure along SW 2nd Avenue in the Innovation Square District. ***(Source: Perkins + Will)***

The ISD plan includes a interconnected network of outdoor public spaces.
(Source: Perkins + Will)

- Plazas. Urban public spaces bounded by buildings and streets
- Parks. A Mix of active and passive spaces.
- Courtyards. Private and semi-private informal gathering spaces.
- Trails. Local and regional multi-modal, multi-user mobility corridors.

Integrated Design Processes & Strategies

The approach to ISD's high-performance buildings is guided by an integrated design process, a desire for human collaboration and interaction, space adaptability, and lean occupancy management. The UF Innovation Hub , the first new building within Innovation Square, opened on the former decommissioned site of Shands at Alachua General Hospital (AGH). This 48,000 square foot technology business incubator was constructed through an $8.3 million grant from the federal Economic Development Administration along with a $5 million match from UF. INSPIREation Hall (Innovation Space for Imagination, Research, and Entrepreneurism) is expected to open in 2014 and become the nation's first residence hall designed around an active and participatory live/learn concept of "collision and collaboration," focused on fostering future business leaders in a mixed-use environment, and offering residential, research, retail, restaurant, and ultra-high speed communications amenities. Thus far, this project has been made possible, without state funds, by the consistent expectations for public-private partnerships at nearly every stage of the plan, design, construction, and occupancy phases of this urban renewal.

Traffic Calming: Modern Roundabouts @ SW 2nd Avenue

Project Details

In 2010, the City of Gainesville, Florida conducted a traffic warrant analysis for five intersections along the SW/SE 2nd Avenue Corridor, each controlled by traffic signals at the end of their useful life. Reconstruction for new traffic signal controls was estimated to cost approximately $350,000 per intersection. Yet the analysis determined these five traffic signals were unwarranted and induced unnecessary delays along the corridor and its cross streets.

Further analysis suggested converting the three aging traffic signals along SW 2nd Avenue to modern roundabouts would be cost neutral (e.g., the roundabout at SW 2nd Avenue and SW 6th Street cost $364,235, Figure 4), yet save $4,000 per intersection in annual operating costs when compared to replacement traffic signals. The two aging traffic signals along SE 2nd Avenue were best served by conversion to all-way stop signage.

Beneficial Outcomes

Since their completion, these modern roundabouts have improved traffic flow along the SW 2nd Avenue Corridor as well as the SW 6th, SW 10th, and SW 12th crossing streets. Pedestrian mobility and safety has been enhanced due to the crosswalk and refuge island improvements integral to each roundabout design. A supportive study by Stone, Chae, and Pillalamarri (2002, 40) found, "a single-lane roundabout can handle more pedestrians more safely than a four-lane signalized intersection…[due to the] lower speeds and fewer conflict points of roundabouts…[as well as the] traffic diversion [from the lane reduction]." Community feedback has been positive for both the transportation functionality and the visual aesthetics of the discrete intersections as well as the long, linear SW/SE 2nd Avenue Corridor. Additionally, the City of Gainesville realized the immediate and ongoing benefits of removing unwarranted traffic signals and reducing the Public Works Department's operational energy consumption.

Functional Aesthetics

Unlike older traffic circles and rotaries designed for vehicle speeds of 25 mph or more, modern roundabouts designed for very low traffic speeds, such as 15 mph, can serve as a positive traffic calming and human safety strategy that complements broader urban redevelopment goals. This strategy is especially beneficial when utilized within walkable environments and mixed use destinations. Recent studies have identified a "safety in numbers-effect" for bicyclists, moped riders and, with less certainty, for pedestrians, at roundabouts locations. The greatest opportunities for functional aesthetics of modern roundabouts reside within the central island, splitter islands, and along approaches to the intersections. Though

Multi-modal users share the roundabout at SW 2nd Avenue and SW 12th Street in Gainesville. ***(Source: Hal Knowles, UF)***

sculptures and other structures can be used in these spaces, landscaping is ideal for many reasons, such as the following:

- Roundabout Landscaping: Mobility Functions
  - Accentuates the central island.
  - Visually and structurally calms traffic flows by indicating that drivers, cyclists, and pedestrians must pass around the island.
  - Obscures irrelevant view sheds and focuses traveler sight lines and attention onto potential traffic conflict areas.
- Roundabout Landscaping: Beautification Functions
  - Adds visual distinction and vegetated beauty to intersections.
  - Increases shade and reduces the monotony of pavement.

  - Reduces signal lighting, wiring, poles, and other infrastructure.
- Roundabout Landscaping: Environmental Functions
  - Reduces the urban heat island effect.
  - Creates opportunities for integration into Low Impact Development (LID) treatment systems.
- Reduces localized air pollutants and global greenhouse gas emissions via reduced intersection idling times. (Evidence from recent studies shows a 16 to 59 percent decrease in CO2 emissions (kg/h) for AM/PM traffic periods along modern roundabouts.)

Safety

Several recent studies confirm the safety benefits of roundabouts. Evidence from systematic meta-analyses suggests area-wide traffic calming", including installation of roundabouts, can reduce both fatal and non-fatal road traffic injuries between 11 percent to 15 percent, a recent study by Retting et al. (2001), evaluated injury crashes before and after the conversion of 24 intersections from pre-existing signalization to modern roundabouts and found high significance for the following safety benefits:

- 38 percent reduction of all crash severities combined.
- 75 percent reduction of all injury crashes.
- 90 percent reduction of fatal and incapacitating injury crashes.

However, it is important to note, that while roundabouts generally show evidence of reductions in injury crashes over signalization, the safety impact of roundabouts is context specific and can vary based on considerations such as road user type, existing cross road speed limits, and existing pre-roundabout signalization situation.

Additional Information & Resources

Technical References

- De Brabander, Bram, and Lode Vereeck. 2007. "Safety Effects of Roundabouts in Flanders: Signal Type, Speed Limits and Vulnerable Road Users." Accident Analysis and Prevention 39 (3) (May): 591–599. doi:10.1016/j.aap.2006.10.004. http://dx.doi.org/10.1016/j.aap.2006.10.004.
- Bunn, F, T Collier, C Frost, K Ker, I Roberts, and R Wentz. 2003. "Traffic Calming for the Prevention of Road Traffic Injuries: Systematic Review and Meta-analysis." Injury Prevention: Journal of the International Society for Child and Adolescent Injury Prevention 9 (3) (September): 200–204. doi:10.1136/ip.9.3.200. http://dx.crossref.org/10.1136%2Fip.9.3.200.
- Daniels, Stijn, Tom Brijs, Erik Nuyts, and Geert Wets. 2010. "Explaining Variation in Safety Performance of Roundabouts." Accident Analysis and Prevention 42 (2) (March): 393–402. doi:10.1016/j.aap.2009.08.019. http://dx.doi.org/10.1016/j.aap.2009.08.019.
- Gottlieb, Paul. 2012. "Port Angeles' First Roundabouts Also Will Be Designed to Curb Flooding." Peninsula Daily News, August 26, Online edition, sec. News. http://www.peninsuladailynews.com/article/20120826/news/308269985.
- Mandavilli, S., M.J. Rys, and E.R. Russell. 2008. "Environmental Impact of Modern Roundabouts." International Journal of Industrial Ergonomics 38 (2) (February): 135–142. http://dx.doi.org/10.1016/j.ergon.2006.11.003.
- Retting, R A, B N Persaud, P E Garder, and D Lord. 2001. "Crash and Injury Reduction Following Installation of Roundabouts in the United States." American Journal of Public Health 91 (4) (April): 628–631. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1446639/.
- Rice, Ed. 2010. Roundabouts - FHWA Safety Program. Technical Summary. Safe Roads for a Safer Future: Investment in Roadway Safety Saves Lives. McLean, Virginia: Federal Highway Administration, Office of Safety. http://safety.fhwa.dot.gov/intersection/roundabouts/fhwasa10006/.
- Robinson, Bruce W., Lee Rodegerdts, Wade Scarborough, and Wayne Kittelson. 2000. Roundabouts: An Informational Guide. Safety. Techbrief. McLean, Virginia: Federal Highway Administration, Office of Safety. http://www.fhwa.dot.gov/publications/research/safety/00068/.

- Stone, John R., KoSok Chae, and Sirisha Pillalamarri. 2002. The Effects of Roundabouts on Pedestrian Safety. University of Tennessee - Knoxville: The Southeast Transportation Center. http://stc.utk.edu/STCresearch/completed/PDFs/rndabt.pdf.

Union Street Station References

- City of Gainesville Community Redevelopment Agency. http://www.gainesvillecra.com/.
- Jacob, J. S., R. Lopez. 2009. Is Denser Greener? An Evaluation of Higher Density Development as an Urban Stormwater-Quality Best Management Practice. JAWRA Journal of the American Water Resources Association 45:3, 687-701. http://dx.doi.org/10.1111/j.1752-1688.2009.00316.x.
- Jones, Christopher M., and Daniel M. Kammen. 2011. "Quantifying Carbon Footprint Reduction Opportunities for U.S. Households and Communities." Environ. Sci. Technol. 45 (9): 4088–4095. doi:10.1021/es102221h. http://pubs.acs.org/doi/abs/10.1021/es102221h.
- Norman, J., H. MacLean, and C. Kennedy. 2006. "Comparing High and Low Residential Density: Life-Cycle Analysis of Energy Use and Greenhouse Gas Emissions." Journal of Urban Planning and Development 132 (1): 10–21. doi:10.1061/(ASCE)0733-9488(2006)132:1(10). http://ascelibrary.org/doi/abs/10.1061/%28ASCE%290733-9488%282006%29132%3A1%2810%29.
- Rowland, Ashley. 2002. "Developing One Man's Dream." The Gainesville Sun, December 17, sec. Local. http://www.gainesville.com/article/20021217/LOCAL/212170329.

Innovation Square District References

- Innovation Square District. http://www.innovationsquare.ufl.edu/.
- UF Innovation Hub. http://www.floridainnovationhub.ufl.edu/.
- UF INSPIREation Hall. http://www.ufinspireationhall.com/.
- UF News – Innovation Square Wins State Redevelopment Awards. http://news.ufl.edu/2012/10/03/innovation-square-wins-awards/.

Modern Roundabouts References

- Florida Department of Transportation – Florida Roundabout Guide. http://www.dot.state.fl.us/TrafficOperations/Doc_Library/PDF/roundabout_guide8_07.pdf.
- Insurance Institute for Highway Safety / Highway Loss Data Institute – Roundabouts. http://www.iihs.org/research/topics/roundabouts.html.
- Jacquemart, Georges. 1998. Modern Roundabout Practice in the United States. National Cooperative Highway Research Program. Synthesis of Highway Practice. Washington, DC: National Academy Press. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_264.pdf.
- Roundabouts: An Informational Guide. http://www.fhwa.dot.gov/publications/research/safety/00068/.

This page intentionally blank.