Harris County Improvement District No. 18 (HCID18) is honored to present an application for the **National Association of Flood & Stormwater Management Agencies (NAFSMA) 2018 Green Infrastructure Award**. HCID18 proudly serves as the municipal management district to Springwoods Village, North Houston's most forward-thinking mixed-use master planned community. Spanning over 2,000 acres, Springwoods Village is conveniently situated at the confluence of I-45, the Hardy Toll Road, and the Grand Parkway in north Harris County. Since its first public announcement in 2010, Springwoods Village has experienced tremendous growth attracting major corporate campuses such as ExxonMobil, Southwestern Energy, ABS, and HP, Inc.

As a municipal management district, HCID18 is empowered to purchase, construct, operate and maintain all works, improvements, facilities and plants necessary for the supply of water; the collection, transportation and treatment of wastewater; and the control and diversion of stormwater, among other things. HCID18 and Springwoods Village operate and maintain an array of mixed-use facilities throughout community.

With sustainability as the foundation of our expansion, the development team continuously works to revolutionize the concept of sustainable development and strives to go above and beyond Harris County's Low Impact Development (LID) and Green Infrastructure (GI) minimum requirements.

The following encapsulates **Drainage Corridor 1 (DC-1)**, a multi-functional urban park in the heart of a 60-acre mixed-use dense urban district called ***CityPlace***.

PROJECT DESCRIPTION

DC-1 operates as the essential water control channel for the east region of Springwoods Village. With the drainage elements of **DC-1** heavily camouflaged by a diverse landscape, the uninformed pedestrian simply knows this greenspace as ***CityPlace Park.*** This venture has created an extraordinary and diverse ecosystem in which various groups benefit from the existence of one another.

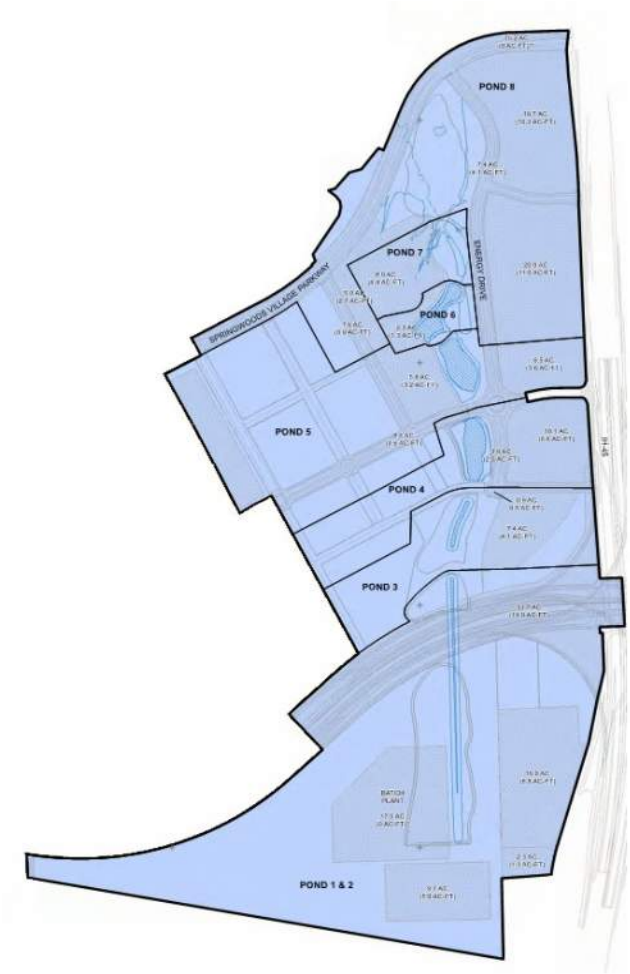


Figure 1

The municipal aspects of **DC-1 (**along with the surrounding areas and roadways) comprise an intricate system that implements numerous low impact development and green infrastructure practices. This system methodically accepts, detains, decontaminates, desilts, and transports storm and effluent water from *Drainage Area 1* (reference Figure 1), to Spring Creek. A number of early projects throughout HCID18 were driving the need for an ultra-effective yet aesthetically appealing stormwater system. Most notably these include The Grand Parkway – Houston's new 184-mile looped highway; major corporate campuses including ExxonMobil, Southwestern Energy, HP Inc, and ABS; CityPlace – the Springwoods Village high density 60-acre mixed-use urban district; as well as the many roadways linking these areas together. The design and development teams worked together to create a system capable of handling stormwater runoff on a massive scale, while maintaining the naturalized aura of this vibrant hub of the Springwoods Village community.

LID Elements – In addition to moving effluent water treated at HCID18's state-of-the-art Waste Water Treatment Plant, **DC-1** is responsible for receiving, controlling, detaining, and moving stormwater runoff from 400+ acres of surrounding LID areas and roads that comprise *Drainage Area 1* (see Table 1).

Drainage Area 1									
Roadway	LID Feature								
	Impervious Surfaces Disconnect	Vegetative Filter Strip	Vegetated Swale	Tree Box Filter	False Inlet (Rock Filter)	Rock Filter Dam	Permable Load-Bearing Surface	Bioswales	Bioretention Cells
Energy Drive	★	★	★	★	★				
Belvedere Point	★	★	★		★				
Crossington Way	★	★	★		★				
Lake Plaza Drive	★	★	★	★			★		
City Plaza Drive	★	★	★	★			★		
Springwoods Village Pkwy	★	★	★	★	★	★	★	★	★
East Mossy Oaks	★	★	★		★	★		★	

Table 1

In addition to the areas listed in Table 1, stormwater runoff from segments of Spring Pine Forest Drive and Grand Parkway, are directed to the eight-ponds that make up **DC-1** (See figure 2).

ENVIRONMENTAL BENEFITS

At a Glance: GI Elements of **DC-1/** ***CityPlace Park***

- **Natural Land Preservation:** The development team made it a priority to conserve an adjacent 5-acres of revered pine forest. The construction management team conducted daily inspections to ensure that the preserve was not disturbed during the project.
- **Low Impact Development through regenerative plantings:** The carefully selected plant pallet consists of 100% native Gulf Coast plants. All native grass and plants species are low maintenance, self-sustaining, and adaptable to prolonged periods of high heat and low precipitation. Three species of aquatic plants were installed to assist in absorbing non-natural impurities from the water and discourage the growth of undesirable plants and algae. The vegetation planted in the corridor helps naturalize the space and produces a tranquil and inviting habitat for a variety of wildlife.
- **Eco-minded park system and drainage corridor:** More than just a vital drainage corridor, the park's trail system, nature observation boardwalks, flexible greenspace and abundance of plants and wildlife creates a one-of-a-kind public amenity in which ecology and development are carefully balanced.

Figure 2

- **Extensive reforestation initiatives:** Nearly 600 trees were transplanted from the HCID18 tree farm, sequestering an estimated 60,000 pounds of carbon dioxide per year. HCID18 is currently in the process of transplanting an additional 225 trees to the adjacent ***CityPlace*** area. Sections disturbed during development have been heavily reforested with a blend of tree species and understory shrubs native to the area. In addition to progressive climate impacts, these trees act as a buffer from bordering roadways, create wildlife habitat, and provide shade for the park users.
- **Erosion control:** The dense native grasses, groundcovers, shrubs, and trees were installed to help stabilize soil and naturally filter storm water. Locally sourced rip-rap was strategically placed along the bank to provide stabilization against potential disturbances, trap silts and floatables, and create a habitat for fish and wildlife.
- **Water filtration and transportation:** The series of ponds transport stormwater and treated effluent water north to Spring Creek. Staying true to our principles of sustainability and a greener way of life, **DC-1** was designed to leverage the landscape to help manage collected water. Runoff not captured by tree box filters must flow through the vast vegetative buffer of groundcovers, shrubs, and native grasses/ wildflowers planted between all impermeable surfaces and the ponds. These act as the initial line of filtration, catching floatables, heavy metals, oils and other pollutants.

The vegetation also decreases water velocity, which increases the absorption rate of the permeable subgrade. Planting shelves with robust aquatic wetland vegetation continue to polish water quality by stripping nitrates and phosphates from water that reaches the pond system. Three cascading waterfalls utilize a combination of gravity and supplemental pumps (when needed) to create the relaxing sights and sounds of natural water flow, but also to recirculate the water, lengthening exposure limits, and prevent stagnation during periods of low-flow. Lastly, the ponds were drastically over-excavated to allow for sediment accumulation that might otherwise be pushed in to Spring Creek.

A resident family of Black-bellied Whistling Ducks grazing on the water's edge

The beautifully diverse habitat created in *CityPlace Park*

ECONOMIC IMPACT

At the earliest stages of HCID18's expansion, the development team conceptualized a transformation of the existing natural drainage topography, into an unconventional multi-use area that would enhance the livability of the community. By combining the low-impact obligatory master stormwater system, with a naturalized central greenspace, the development team was able to retain more buildable land that would have otherwise been wasted on conventional detention. This increased footprint for future development will positively impact HCID18 through the generation of additional tax revenue.

Early Economic Benefits: As previously discussed, **DC-1/ *CityPlace Park*** offers a dynamic naturalized experience to an array of current and future luxury residential properties, corporate campuses, high-end retail shops and restaurants, and full-service hotels. Although the development of surrounding areas will be ongoing for several years, the economic impacts of this multipurpose park are already evident. ***CityPlace Park*** played a pivotal role in attracting the first residential and commercial property owners, such as ExxonMobil and Southwestern Energy. The park continues to be a powerful draw to potential buyers.

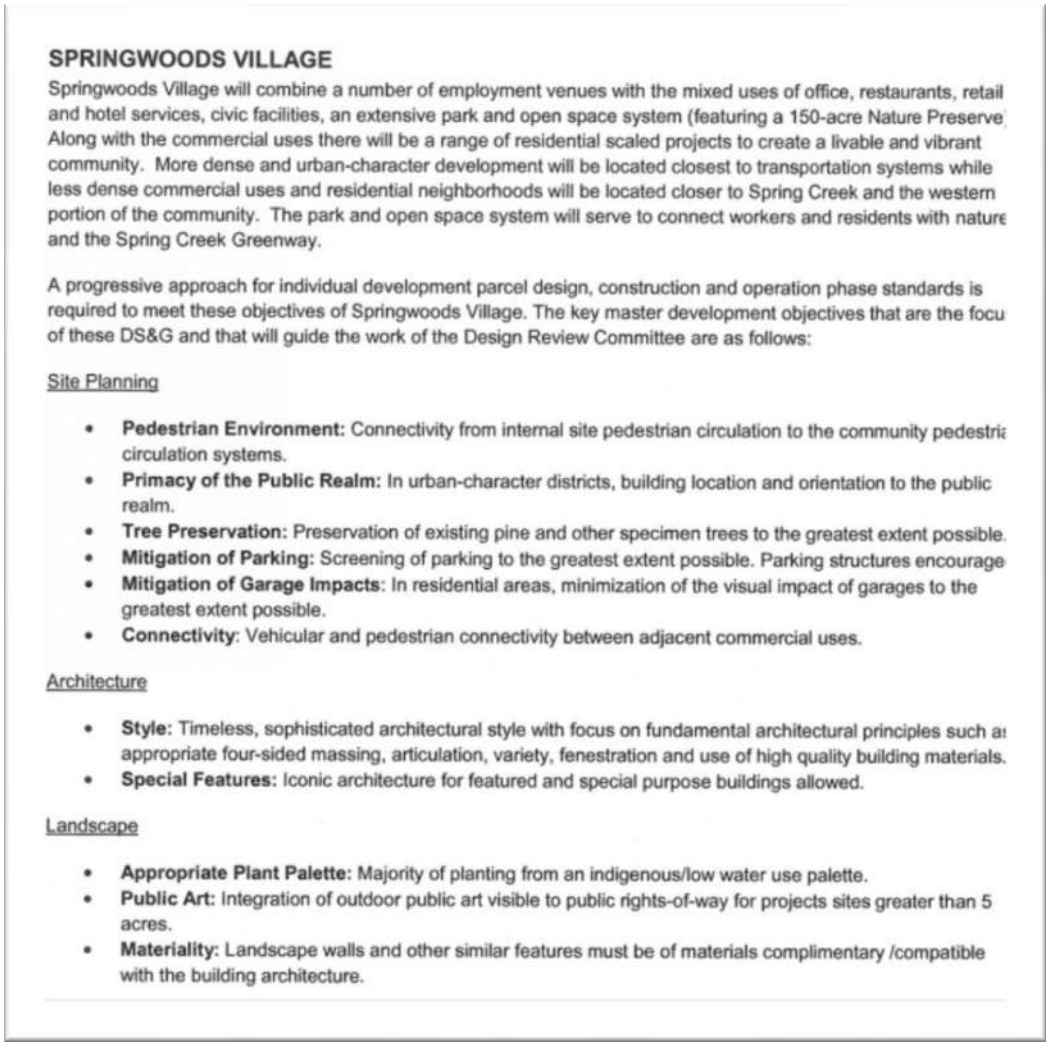
Impact on Infrastructure Costs: Even with project costs exceeding the $12 million mark, this centralized master stormwater management system brought significant economic advantages to HCID18. In addition to the numerous qualitative benefits and significant land savings, the LID elements used in the project eliminated the need for an estimated $1.5 million in storm water inceptors other gray infrastructure on other projects.

OUTREACH EFFORTS

Public Engagement and Education: On April 20, 2018, HCID18 and Springwoods Village partnered with *Trees for Houston* and *Bayou Land Conservancy,* two local non-profit organizations, for the inaugural ***Springwoods Village – Earth Day Tree Giveaway & Celebration***. These non-profit organizations specialize in environmental awareness and educate the public to encourage conservation and sustainability. District representatives, along with the *Trees for Houston* and *Bayou Land Conservancy* staff, used Q & A sessions, nature walks, and dip netting activities to engage and educate over 325 participants on the LID/ GI initiatives going on in their community. Each participant left with a free tree, several plants, and an understanding of how LID/ GI to plant in their yards. We expect that this creative community outreach program to continue to grow each year increasing the number of trees and awareness throughout the community.

The first participants arriving to the Springwoods Village – Earth Day Tree Giveaway & Celebration

Transferability to Sub-Developers: To ensure that the principles of sustainability and a greener way of life are not overlooked as HCID18 rapidly grows, Springwoods Village operates strict development standards and guidelines that hold all sub-developers to high standards for energy efficiency and environmental sustainability (see Figure 3). Although the standards and guidelines may seem excessive and unorthodox to some sub-developers, HCID18 and Springwoods Village use **DC-1** to exemplify that the development standards and guidelines implement effective methods that are scalable to projects of any size.



SPRINGWOODS VILLAGE

Springwoods Village will combine a number of employment venues with the mixed uses of office, restaurants, retail and hotel services, civic facilities, an extensive park and open space system (featuring a 150-acre Nature Preserve) Along with the commercial uses there will be a range of residential scaled projects to create a livable and vibrant community. More dense and urban-character development will be located closest to transportation systems while less dense commercial uses and residential neighborhoods will be located closer to Spring Creek and the western portion of the community. The park and open space system will serve to connect workers and residents with nature and the Spring Creek Greenway.

A progressive approach for individual development parcel design, construction and operation phase standards is required to meet these objectives of Springwoods Village. The key master development objectives that are the focu of these DS&G and that will guide the work of the Design Review Committee are as follows:

Site Planning

- **Pedestrian Environment:** Connectivity from internal site pedestrian circulation to the community pedestri circulation systems.
- **Primacy of the Public Realm:** In urban-character districts, building location and orientation to the public realm.
- **Tree Preservation:** Preservation of existing pine and other specimen trees to the greatest extent possible.
- **Mitigation of Parking:** Screening of parking to the greatest extent possible. Parking structures encourage
- **Mitigation of Garage Impacts**: In residential areas, minimization of the visual impact of garages to the greatest extent possible.
- **Connectivity**: Vehicular and pedestrian connectivity between adjacent commercial uses.

Architecture

- **Style**: Timeless, sophisticated architectural style with focus on fundamental architectural principles such a appropriate four-sided massing, articulation, variety, fenestration and use of high quality building materials.
- **Special Features:** Iconic architecture for featured and special purpose buildings allowed.

Landscape

- **Appropriate Plant Palette:** Majority of planting from an indigenous/low water use palette.
- **Public Art:** Integration of outdoor public art visible to public rights-of-way for projects sites greater than 5 acres.
- **Materiality:** Landscape walls and other similar features must be of materials complimentary /compatible with the building architecture.

Figure 3 – An excerpt from the Springwoods Village Development Standards and Guidelines

RESULTS

Encouraging LID/ GI – A Push in the Right Direction: As mentioned above, Springwoods Village has established set development standards and guidelines applicable to all new construction and improvements throughout HCID18. By implementing these requirements, sub-developers are compelled to align with the *'sustainable-development'* mindset that has helped shaped HCID18 to what it is today.

In order preserve the LID/ GI mentality long term, all personnel responsible for maintaining **DC-1/ *CityPlace Park*** are educated on the overall design and purpose of the project. This training allows maintenance personnel to understand how each intricate element of the project plays an important role in the overall success of system. By gaining this broader understanding, the maintenance team recognizes that improper maintenance of a component(s) can adversely affect other components of the system.

Sustaining LID/ GI Through Maintenance: When planning for this eco-minded, multipurpose project, the design team made it a priority to ensure that the maintenance requirements of the park and drainage corridor would not be so impractical, so as to outweigh the benefits to the public. Through extensive research and collaboration, the design team created a LID/ GI design that would both meet the county criteria for allowable runoff and have tolerable maintenance requirements. The design incorporated features, such as over excavated ponds to allow for sediment deposits, auxiliary pumps responsible for clearing algae/ buildup off recirculation pump screens, high-density wood decking that boasts a 50-year useful life, and self-sustaining plants and trees. These low maintenance elements will greatly assist in lowering the maintenance and replacements costs in the years to come.

An Efficient Use of Public Resources: The extensive list of positive economic impacts confirms the efficient use of district monetary resources. The quantitative value created by **DC-1/ *CityPlace Park***, will far exceed the dollars expended during construction. Perhaps the most obvious and measurable efficient use of resources, is the amount of precious land saved by creating multipurpose greenspace. Most development professionals will agree that land is the most important and valuable resource. By combining a community amenity and vital drainage corridor/ detention system within a single footprint, the saved land was able to be reallocated for nature preserve buffers, and future community growth.

MAINTENANCE

Drainage and Water Control Components: As previously mentioned, **DC-1** development team took special consideration to reduce future maintenance burdens. The self-cleaning pumps are controlled by a state-of-the-art automated controller that activates as needed to recirculate and improve water quality. As a precautionary measure, the controllers and pumps are inspected regularly to ensure they are operating properly. All inlets and outfall structures are inspected regularly to ensure they are cleared of obstructions and allowing water to freely flow.

Pond Maintenance: HCID18 has created a pond maintenance plan and has procured the services of a lake management company to carry out the tasks specified in this plan. As part of this lake maintenance plan, the contractor conducts a weekly water quality analysis, testing for pH, Copper, Ammonia Nitrogen, and Dissolved Oxygen, among many other things. Additionally, during each site visit the lake management company removes trash and debris collected by our LID features and treats any invasive pests that could be detrimental to the park's eco-system.

Landscape Maintenance: At first glance, maintaining the landscape may seem overwhelming. The vast areas of planted native grasses and shrubs, over 600 reforested trees, and stringent regulations against popular synthetic chemicals and fertilizers, truly makes ***CityPlace Park*** one of the most unique and unconventional landscapes in the region. A team of maintenance professionals worked to create a customized plan of best management practices and a detailed maintenance scope for this one-of-a-kind park. Examples of practices specified in the management plan include:

a) Manual removal of all noxious and invasive weeds (twice monthly)
b) Biannual applications ALL-ORGANIC MicroLife Fertilizers. This line of products is manufactured by the Houston based company, *San Jacinto Environmental Supply.*
c) Strategically scheduled biannual native grass "cut-backs" to maximize regenerative self-reseeding
d) Weekly inspection and debris removal of LID/ GI features

Since the implementation of these landscape management practices just over one year ago, the monthly time required to maintain the landscape of **DC-1/ *CityPlace Park*** has decreased by over 50%, confirming the goal of a sustainable landscape was achieved.

Conclusion

Challenges Throughout the Project: All large-scale construction projects are expected to encounter challenges; however, the uniqueness of **DC-1** amplified the constraints and challenges the design and construction teams had to overcome. By employing a team highly capable and experienced engineers and landscape architects, the team was able to work through the challenges of moving significant amounts of water, through a high-density community focal point.

Due to the fundamental role **DC-1** would eventually have in accepting, detaining, decontaminating, and transporting storm and effluent water from a very prominent area, the construction management team needed to ensure that every part of the project was precisely constructed in accordance with the plans. To overcome this challenge, experienced construction engineers and inspectors were assigned to the project full time. In addition to vigilantly inspecting and documenting all construction progress, the construction management team advised the contractors throughout all stages of the project.

Challenges After Completion: After the completion of **DC-1,** the operations and maintenance team faced a number of challenges as they worked to generate a maintenance plan for this unconventional area. Through trial and error, and collaboration with maintenance and management specialists, a series of maintenance plans were established and implemented to ensure the system would operate properly, even during the most significant events. In August 2018, **DC-1** faced the ultimate test. as Hurricane Harvey ripped through Central Texas, it dumped an unprecedented 30 inches of rainfall on the Springwoods Village Community over a 4-day period. Although *Drainage Area 1* was completely inundated, **DC-1** far exceeded expectations as it managed to contain the massive amounts of water and prevent nearby residents and businesses from flooding. All structural components held strong, and filtration mediums aided in trapping trash and debris. Although some erosion and reeling did occur, the LID/ GI methods incorporated in the design significantly reduced the degree of damage.

DC-1 Normal Static Water Level vs. Hurricane Harvey

FEMA has determined that during Hurricane Harvey the Houston area experienced the largest amount of rainwater ever recorded in the continental United States from a single storm. The remarkable performance of **DC-1** during this event, substantiates the overall success of the project and proves that LID/ GI can drastically enhance the livability of our urban areas. **Drainage Corridor 1** is an extraordinary example of how forward thinking and the latest techniques in sustainable stormwater management can contribute to flood control, place making, and economic development.

Drainage Corridor 1 – Project Team

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District Engineer: Halff Associates
Construction Engineer: Jones & Carter
General Contractor: L.N. McKean
Operations & Management: Mike Stone Associates, Inc.
Landscape Maintenance Contractor: Shooter & Lindsey