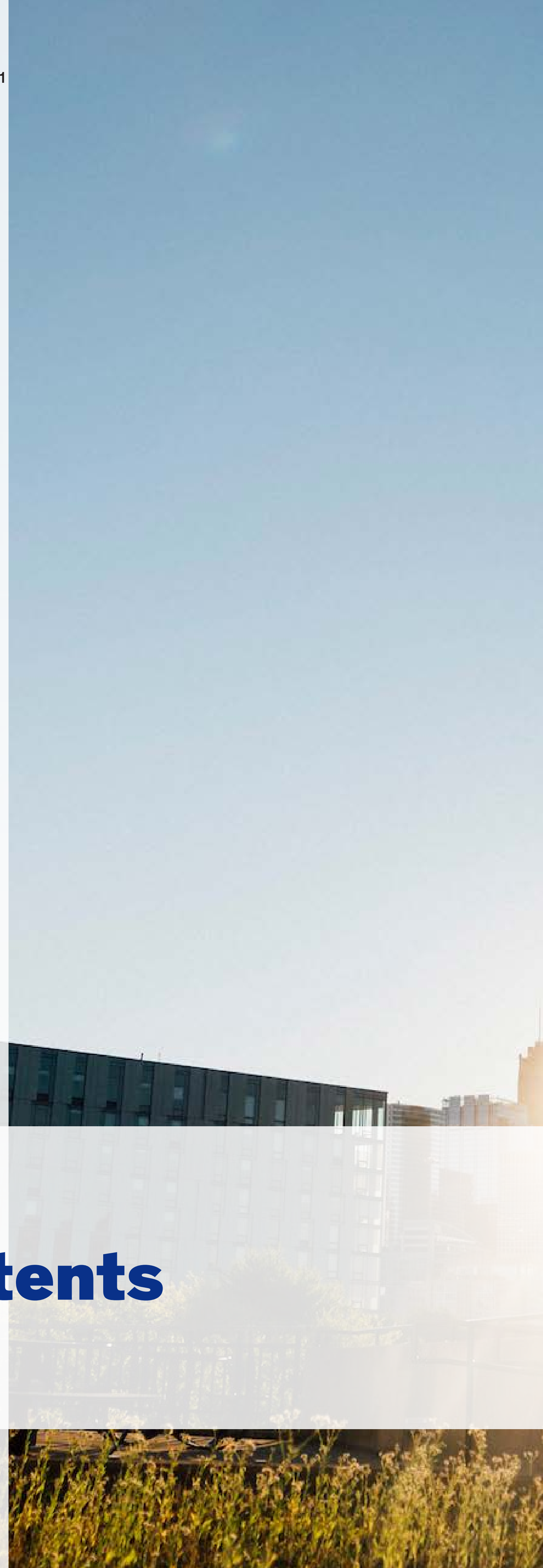
UIC

Urban Transformations 2.0

Green Stormwater Infrastructure Implementation Plan



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Executive Summary

The purpose of this plan is to develop and demonstrate an incremental, scalable, and adaptive approach to implementing green infrastructure (GI) in a highly-urbanized context. Transforming UIC's campus with green infrastructure will help mitigate flooding and will model how cities can manage water flow in a more sustainable way.

Using an urban campus as the location for this model also provides access to research and teaching opportunities. The plan integrates modeling outputs from a stormwater calculator with GI techniques, stakeholder interviews, expert advice, analysis of pilot projects, and a collaborative planning process. The result is a plan that balances effectiveness with feasibility, provides direction and guidance on potential reduction, most efficacious measures, implementation phasing, and the benefits, not just to the Great Lakes watershed, but to UIC students, to UIC as an institution, to the Metropolitan Water Reclamation District of Greater Chicago (MWRD), and to the City of Chicago.

The Urban Transformations 2.0: Green Stormwater Infrastructure Implementation Plan includes a 3-phased implementation plan. Phase 1: Demonstrate and Analyze, Phase 2: Expand and Standardize, Phase 3: Transform and Upgrade.

Three Phase Overview

Phase 1: Demonstrate and Analyze (2010-2017)

Increasing general awareness is the first step in transitioning towards any new planning paradigm, concept or approach. Although GI demonstration projects are often criticized for being expensive, ineffective, uncoordinated, they are critical for generating public awareness, practical know-how, learning and feedback processes needed to scale up GI implementation. Phase 1 began in 2010 with the installation of the bioswales and rain garden as part of the Lincoln Hall renovation project. The first phase of Urban Transformations is focused on the demonstration of GI. Investments in GI demonstration projects should be targeted towards highly-visible and cost-effective projects to increase awareness and support for GI and to maximize the potential for successful projects.

Photo: The bioswale south of Lincoln Hall attracts birds and pollinators with deep-rooted native plants. The 2010 Lincoln Hall renovation project earned LEED-Gold certification.

UIC utilized a collaborative, inter-departmental processes to cultivate a collective understanding of the campus' water management problems, as well as a shared vision for a sustainable and resilient future and an alignment of goals. Additionally, monitoring systems were integrated into the Lincoln Hall rain garden in order to monitor efficacy.

Phase 2: Expand and Standardize (2017-2027)

During Phase 2, UIC installs and studies several more demonstration projects, with real time monitoring systems, like the systems at Arthington Mall. Campus planners and managers would use that data for adaptive management and design of future projects. New GI investments and installations should expand on successful projects from Phase 1. However, unsuccessful projects may be permitted to revert back to the conventional infrastructure or land uses, if cost effective.

The collection of high-quality and highly-resolved time-series data during Phase 1 greatly enhanced the capacity for planners to assume an adaptive management approach. The data can also be leveraged when applying for grants funding allocated for green stormwater infrastructure, watershed improvements and environmental education (e.g. Chi-Cal Rivers Fund, Sustain Our Great Lakes, and the Urban Waters Federal Partnership.)

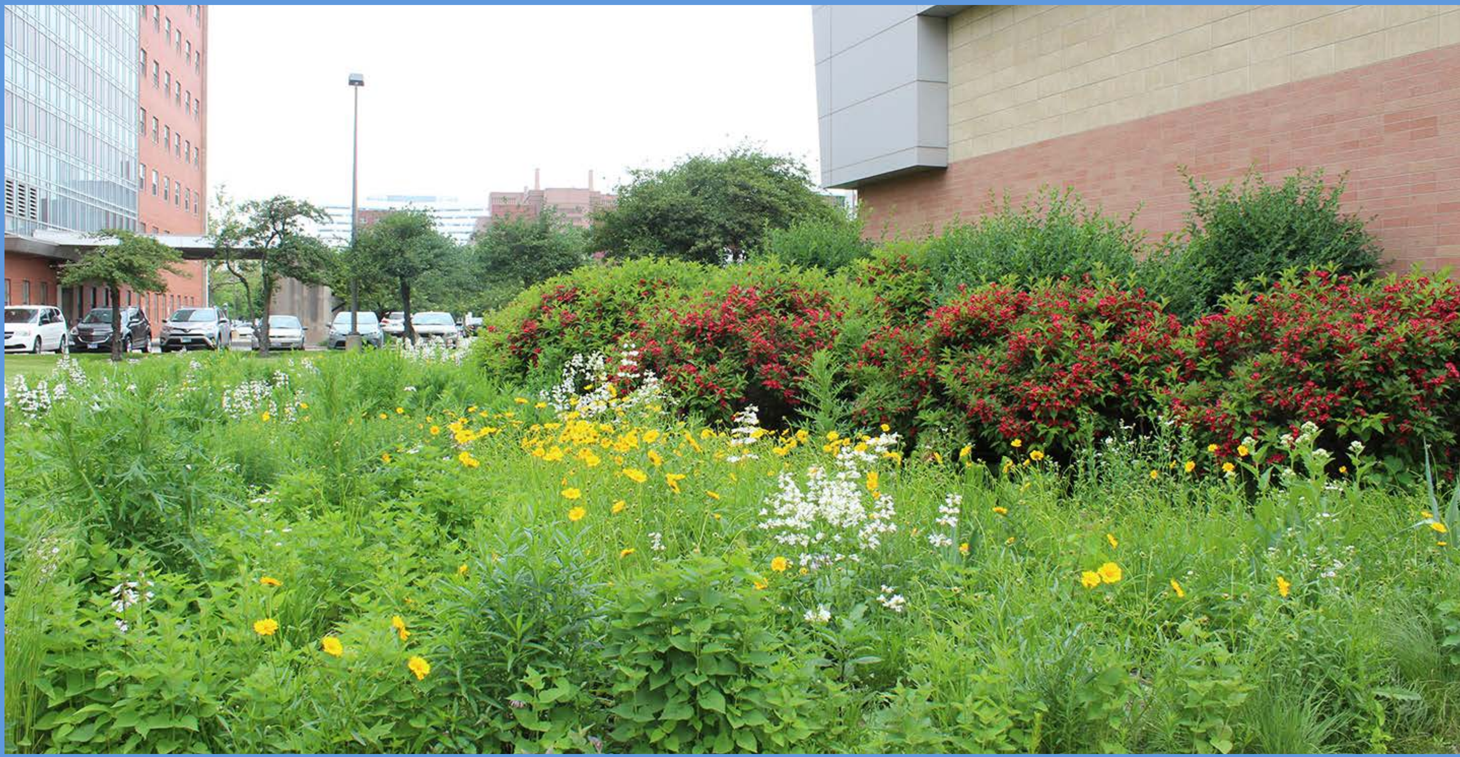


Photo: Deep-rooted native flowers and plants in the "Little Prairie on the Campus" garden near the School of Public Health and Psychiatric Institute building attract pollinators as well as reduce thousands of gallons of stormwater annually. This 2017 project was made possible through the National Fish and Wildlife Foundation.

Phase 3: Transform and Upgrade (2027-2050)

By the end of Phase 3, green infrastructure — both the biophysical infrastructure and planning concept — should be institutionalized into UIC's campus and governance. GI should be considered in all building standards, planned maintenance projects and capital improvement and master planning processes. Educational signage and other outreach continue to be key to inform the UIC and surrounding community about the benefits and real-life metrics of the benefits of green infrastructure.

Photo: Rendering of the Health Sciences Greenway Extension and Drug Discovery Expansion. The 2018 UIC Master Plan includes a long-term plan to expand green spaces, to connect facilities, create pride in place, and provide a safe pedestrian network for patients, students, faculty, staff and visitors.

This broad understanding of the value of GI will translate into increased willingness of the various stakeholders to include funding for installation of green infrastructure in project budgets. The development of a long-term comprehensive plan for integrated green and gray infrastructure capital improvement projects will also expand the university's access to grant funding and other forms of assistance and innovative, market-based financing like a stormwater retention credit trading system.

GI Coverage and Stormwater Reduction in 3 Phases

Each Phase of this Plan increases both the amount of coverage of green infrastructure on campus, as well as reduces the amount of stormwater runoff. Figure 1 shows the proposed amount of new green infrastructure to be installed on campus throughout each phase. Phase I and Phase II illustrate what happens when only implementing GI on UIC-owned property, and Phase III illustrates the expansion of both GI coverage runoff reduction when incorporating City-owned infrastructure. Details of this data are discussed further in the Proposed GI Master Plan section: Phase III.

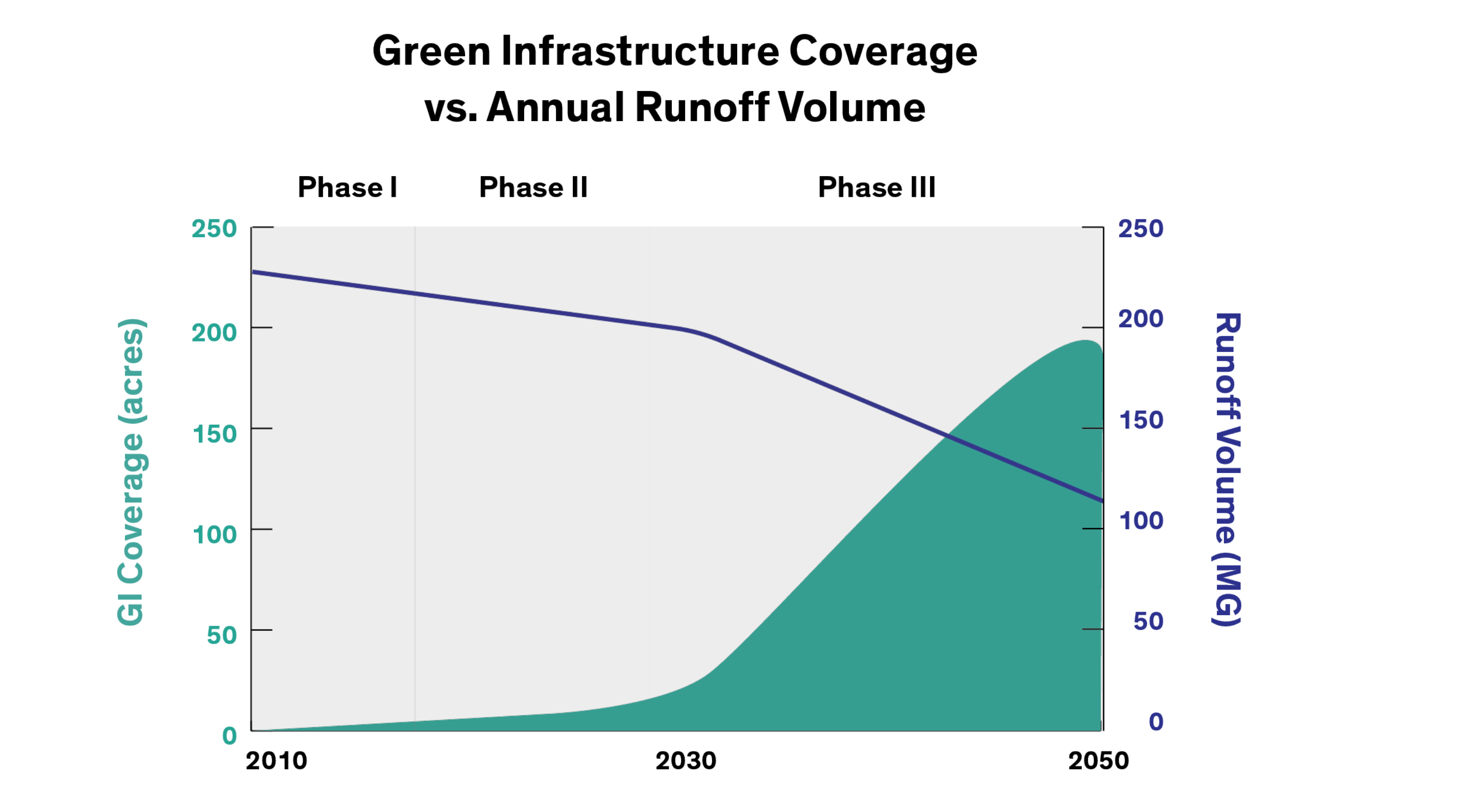


Figure 1. Acres of green infrastructure coverage and the millions of gallons (MG) of annual stormwater runoff volume reduced. In Phase 1, only 4 acres of GI covered the UIC campus, reducing stormwater by just 4.2 MG/year. By the end of Phase 2, it is calculated for UIC to cover 32 acres of its campus with GI, reducing just over 30 MG of stormwater per year. In Phase 3, if UIC were to partner with the City of Chicago, there could be 184 acres of GI measures that could reduce over 175 MG of stormwater each year.

I. Introduction

Water is Chicago's most vital natural resource. Chicago is nestled on the shores of the Great Lakes which comprise 20% of the world's fresh water. Yet its combined sewage and stormwater collection system threatens the quality of its waterways via stormwater overflow events and starves Lake Michigan of a recharge source. An interdisciplinary team of UIC researchers from the Complex and Sustainable Urban Networks Laboratory, Department of Civil and Materials Engineering, and the Department of Earth and Environmental Sciences, show that "climate change will impact urban infrastructure networks by changing precipitation patterns in a region" (Kermanshah et al, 2017).

Like other cities, Chicago's water management system is increasingly stressed because of climate change, urban expansion, deferred maintenance, and aging infrastructure resulting in flooding, pollution, and leaks in the distribution systems. Consequently, urban flooding in Chicago is chronic, systemic, and costly (CNT, 2013).

There is growing acceptance of the need to transition towards a more sustainable urban water management practices such as green infrastructure (City of Chicago, 2014). Yet acceptance has not shifted to action. The challenge remains to demonstrate and implement scientifically robust and politically nuanced strategies that institutionalize green infrastructure (GI) from concept to execution. It is only through integration of GI into every step of the planning and design process that Chicago will become resilient and sustainable in an uncertain future (Ferguson et al., 2013a).

The University of Illinois at Chicago (UIC) is strategically positioned—both geographically and institutionally—to facilitate the transformation of Chicago into a more water sensitive, adaptive, and resilient city (Ferguson et al., 2013a). UIC is Chicago's only public research university and is one of the most ethnically and culturally diverse campuses in the U.S.. Situated near the center of a global city, UIC enjoys the space and the infrastructure to grow and develop insights into the performance, scalability, longevity, and viability of GI at the city scale. UIC is poised to pioneer innovative and inventive GI strategies that can then be woven into the planning process and made operational across the city's interconnected bio-physical, socio-technical, and political landscape.

UIC Climate Commitments and Related Plans

Policies and suggestions outlined in this plan should be observed in order to further the goals of the UIC Climate Commitments, which were designed to offset the campus-wide carbon footprint and ultimately benefit the environment and campus community. UIC has committed itself to aggressive Climate Commitments: Carbon Neutral Campus, Zero Waste Campus, Net Zero Water Campus and Biodiverse Campus.

Carbon Neutral Campus

For many types of vegetation, there is a net draw down of carbon from the atmosphere. Thus, types of green infrastructure that utilizes plants such as bioswales and rain gardens have the potential to reduce the campus carbon footprint. There is some evidence that the widespread implementation of green roof areas, ie. plants on top of a building, can reduce the urban heat island effect. Light-colored permeable pavement has better solar reflectivity than typical dark-gray or black top pavement, also helping to reduce the urban heat island effect.

Net Zero Water Campus

The Net Zero Water Campus goal emphasizes that UIC shall use no more water in its operations than what falls naturally on its footprint, which includes retaining water for campus plumbing operations. The Net Zero Water goal also recognizes the need for the campus to play a part in urban stormwater runoff. Green infrastructure diverts damaging stormwater and prevents flooding. This plan outlines specific ways to reduce stormwater runoff.

Biodiverse Campus

It is important that the campus landscaping remain resilient to infestation by insect, fungal, and viral pests, and to storm damage. This concern can be addressed by planting a variety of different species in plant-based green infrastructure such as bioswales and rain gardens.

UIC Tree Care Plan

Both the root systems of trees and their canopies are able to intercept and divert damaging stormwater and prevent flooding. A mature tree can intercept hundreds of gallons of rainfall per year in their crowns and can intercept more than twice that amount in their pit, particularly when designed with an inlet to accept stormwater runoff (U.S. Forest Service). The Tree Care Plan encourages UIC to preserve mature trees, especially near streets and sidewalks, since mature trees exponentially have more benefits of reducing stormwater runoff than new trees.

Campus Pollinator Habitat Plan

Along with proper soil management, the root systems of native plants intercept and divert damaging stormwater and prevent flooding. Native plant species can also reduce the need for traditional irrigation. Many native plant species have deep root systems and can tap water sources that are unavailable to more traditional managed cultivars. If managed well, areas with native plants can be quite beautiful and self-sustaining with very little maintenance required, thus reducing the need for irrigation.

Benefits of Green Infrastructure

There are numerous benefits that can be achieved through the proper design and implementation of integrated GI solutions throughout the campus of the University of Illinois at Chicago. These types of integrated solutions maximize economic, social, and environmental benefits and provide opportunities for the University to create high profile public demonstration projects that showcase the multiple benefits associated with the integration of GI systems throughout campus. A range of GI interventions can be creatively and cost effectively incorporated into a wide variety of applications throughout campus.

Environmental

Global climate change has significant impacts on change in precipitation patterns as an outcome of a warming climate. A warmer atmosphere holds more moisture, increasing the likelihood of heavier and more frequent rainfall events. High atmospheric moisture levels increase the likelihood for precipitation events. During the most recent 5-year period (2010–2014), Illinois experienced a record high number of extreme precipitation events. (NOAA). Flooding intensity and frequency have increased in the northeast Illinois region, leading to property damage, traffic congestion, sewer overflow, and power outages.

Because water and natural water systems are vital resources, it is imperative to take action to maintain a healthy water system. However, the current built environment disrupts natural water systems, causes flooding, contributes to storm sewer overflows, and has negative impacts on aquifers. The City of Chicago's water management systems are increasingly stressed due to the effects of climate change, aging infrastructure, and deferred maintenance. Consequently, urban flooding in Chicago is chronic.

GI measures are an effective way to help mitigate urban flooding but need to be integrated into all institutional processes. Green infrastructure practices are defined as stormwater management techniques utilized in urban areas that rely on natural systems to retain more stormwater on-site through infiltration, evapotranspiration, and harvesting for reuse (Jaffe et. al., 2010).

Through partnerships with other public agencies like the City of Chicago Department of Transportation, and the MWRD, UIC can expand opportunities to facilitate the design and implementation of "Complete Green Streets" that incorporate street, parkway, and walkway systems that safely accommodate vehicular, pedestrian, and bicycle transportation (complete streets), coupled with innovative sustainable GI measures that integrate on-site rainwater management, wastewater, alternative energy, and high performance lighting systems, also known as "green streets."

Social Justice

As a Minority Serving, Asian-American and Native American Pacific Islander-Serving, and a Hispanic-Serving Institution, UIC has a student body that is particularly attuned to issues of social and environmental justice. As green infrastructure measures are implemented, promoted, and integrated into educational opportunities, students will gain knowledge that is crucial for addressing the environmental issues of today and tomorrow. The GI represents solutions they can take back to their neighborhoods to potentially ameliorate flooding and other problems that environmental justice communities frequently experience. This could provide an extra advantage when students face the job market. Many students seek out and highly value a sustainability-related credit or skill for their resumes.

It has been stated that Illinois will see more severe floods. Besides causing property damage, floods also impact health. Mold damage to homes – which often happens after homes are flooded – can cause breathing problems. Injuries are common when people drive in floodwaters (BRACE- Illinois). Thus, implementing a robust GI program on campus could have an indirect benefit to the immediate surrounding Chicago community as it would divert stormwater runoff water from downstream neighborhoods and into the sewers, thus freeing up sewer capacity elsewhere.

Wellness, Educational and Aesthetic Value

GI treatments can be activated landscapes that provide beauty year-round (native plants and grasses). They create a sense of calm, opens the community to the restorative value of nature, and connects people back to the natural history of the region. The World Health Organization notes the beneficial effects of urban green spaces on health such as improved mental health, reduced cardiovascular morbidity and mortality, obesity and risk of type 2 diabetes, and improved pregnancy outcomes (WHO, 2016). University of Illinois researchers scientifically prove that green spaces both have the capacity to reduce crime (Kuo and Sullivan, 2010) as well as elevate attention performances on exams (Faber and Kuo, 2009).

An important aspect of this plan is the ability to promote research and educational outreach associated with the design, construction, and performance of various green infrastructure systems. these important opportunities for critical research, and new curriculum and educational development within the UIC community.

The GI measures will have an educational value as well. Solution 6.2.1, “Learning Opportunities” of Strategy 6.0 of the Climate Action Implementation Plan calls for the university to “utilize every sustainable infrastructure project as an opportunity to create the campus as a learning lab”. The plants in the GI interventions can be used by departments like Biological Sciences to illustrate biodiversity and urban land use in comparison to wildlife interactions for both classes and student research projects, much like teachings of the UIC Plant Research Laboratory. Educational signage can also be included for highly visible GI projects to alert the campus community at large the steps the university is taking to ensure a sustainable future.

The Vision of Urban Transformations v2.0

The purpose of Urban Transformations 2.0 is to develop and demonstrate an incremental, scalable, and adaptive approach to implementing green infrastructure in a highly-urbanized context, while achieving UIC's net zero water and biodiversity goals.

Transforming UIC's campus with the principles and techniques of green infrastructure will not only help mitigate urban flooding in Chicago, but will also influence a global dialogue on how cities can manage water in a more sustainable way. It is with this contextual framework that UIC recognizes the need to partner with the City of Chicago and the MWRD to create a coalition of public serving entities to develop green infrastructure strategies that represent the paradigm shift of city planning and development; it is through this coalition that Chicago, the MWRD, and UIC can position themselves and the region as world renowned experts in green infrastructure design, implementation, monitoring, and maintenance.

Photo: A student walks in the rain on permeable pavement in the Chicago Circle Memorial Grove. This area was renovated in 2013 to replace the deteriorating asphalt walking path, update native plant landscaping and to mark the area as a gateway to the campus to welcome visitors to relax amongst the trees and native plants.

II. Existing Conditions

UIC provides an ideal site to demonstrate incremental, scalable, and adaptive green infrastructure (GI) in a highly-urbanized context. UIC's geographic area, spanning approximately 280 acres situated just southwest of Chicago's main business center the "Loop", is comprised of more than 60% impervious land cover (Figure 2). More than 75% of the annual precipitation that falls on UIC's grounds becomes runoff in the city's combined sewer system (managed by the Metropolitan Water Reclamation District of Greater Chicago, or MWRD). While the campus enjoys a significant open space ratio in such a densely urbanized setting, its current land cover is unable to manage the first flush of a 100-year, 24-hour storm event. Even small rain storm events cause flooding on campus.

The UIC Superintendent of Grounds (Facilities Management) has acknowledged that their department and team spend a non-trivial amount of time and effort using a front-end loader to clear water from street crossings and main walkways after rain events. During cold weather, snow and subsequent melt pools in the same areas as rain during warm weather, causing safety hazards in the form of ice sheets. The maps on pages 17 and 18 highlight areas identified by the Department of Grounds as some of the most chronically flooded problem areas on campus (Figure 3).

GI often enables the recharging of subsurface and surface water resources. However, natural geology and geography limit some areas in the UIC footprint to do this. The water table on the east side of UIC's campus lies approximately 2-6 feet below the surface according to information from the National Resources Conservation Service Web Soil Survey (NRCS Soil Survey). In many areas, the clay and loamy soil prevents significant drawdown of the water table due to low hydraulic conductivity. These soil conditions limit the efficacy of green infrastructure to provide infiltration and storage benefits. Given these conditions, most green infrastructure projects on campus will need an underdrain to help transport excess water to other nearby storage locations (i.e.. stormwater wetlands) and eventually the sewer system. In locations with no additional nearby storage to redirect water, GI projects would be less effective and therefore less likely to be installed. Well-designed sites will utilize the water on-site to hydrate plants and for evapotranspiration (returning water to the atmosphere).

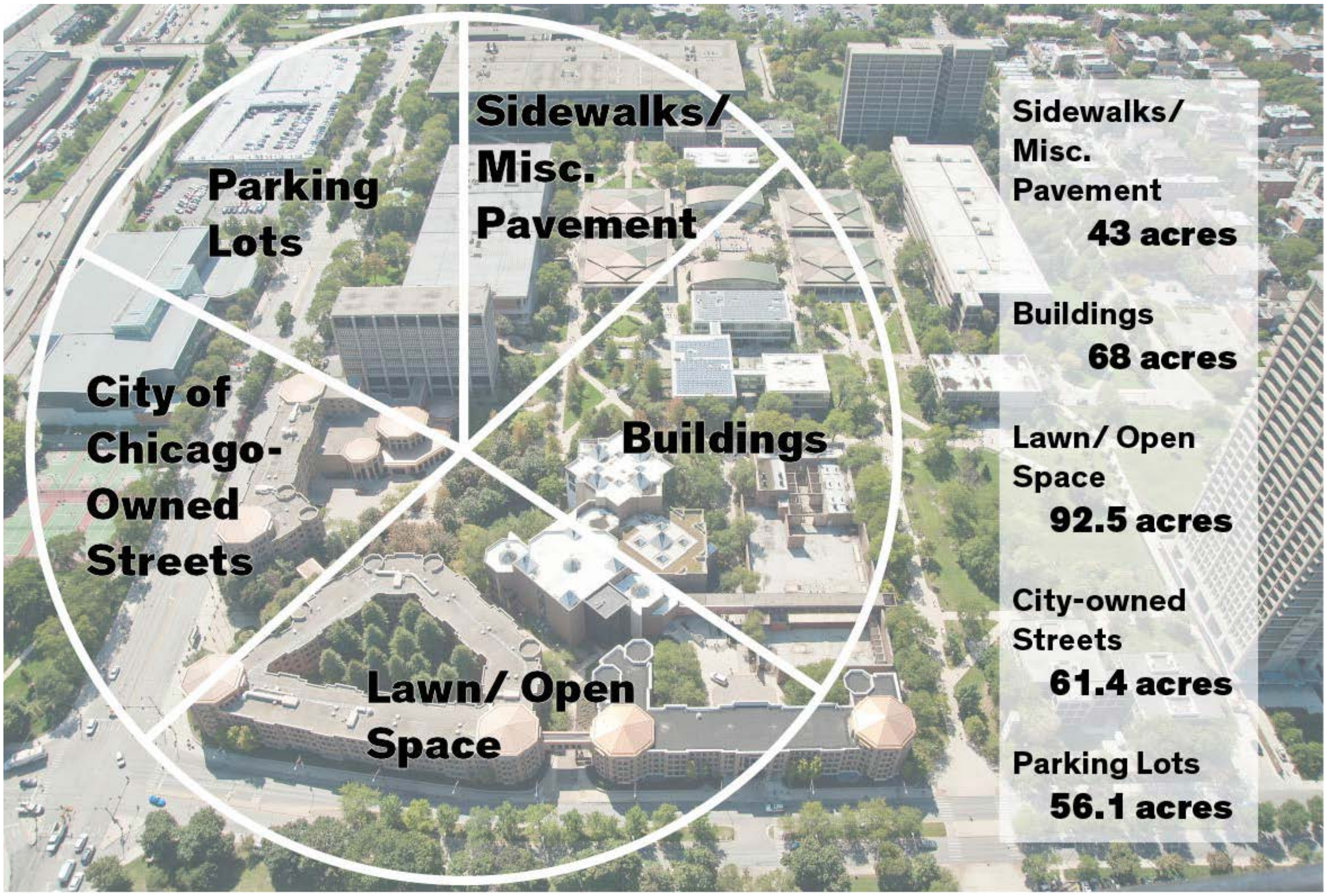


Figure 2. Existing (2018) land cover conditions (in acres) as calculated by land use GIS data layers from the University, the City of Chicago, and other regional sources.

UIC needs accurate data to properly plan for stormwater management. Using simulations and analyses will broaden understanding of our current conditions. A program that was developed in-house by faculty in the College of Urban Planning and Policy (L-GrID) guides GI implementation. UIC needs to recognize the interaction between stormwater management, and landscaping operations, and maintenance to increase the productivity of the native plants around campus that effectively capture stormwater. UIC also needs to recognize the water quality issue of stormwater runoff. When using fertilizers to maintain the grass (especially in the athletic fields), the runoff can cause a pollution problem in the sewer system.

Looking for the optimal solution can create resistance when simply outsourced to a computer or a limited set of experts. Finding a good-enough solution that stakeholders can all live with might be more practical in supporting the necessary transformations towards sustainability.

This plan proposes using GI as the primary strategy to manage stormwater. GI is stormwater management which decreases runoff by returning water to the natural hydrologic cycle, supplementing traditional infrastructure. It achieves runoff reductions through a process called retention. Retention stands in stark contrast to traditional stormwater management; traditional stormwater management at most detains water on site. Detention of stormwater does not promote water returning to the natural hydrologic cycle, but instead attenuates the peak of the hydrograph (the rate at which stormwater enters into the sewer system) through delaying the release of stormwater into the sewer system. Generally, detention sends the same amount of water to the combined sewer system as if there was no storage on site, while controlling the rate at which it enters the system.

One goal of this plan should be to measure and then reduce stormwater runoff to the City of Chicago's Combined Sewer Overflow (CSO) system from surfaces owned by UIC through tested green infrastructure techniques such as bioswales, green roofs, greenways, native landscaping with soil amendments, rain gardens, rainwater catchment, and/or the removal of paving and structures.

Photo: Stormwater from a heavy rain event in 2017 floods not only City-owned streets, but also UIC property like sidewalks such as this one near the entrance of the Daley Library.

Not only does Figure 3 show areas of chronic flooding issues identified by UIC Facilities Management via City of Chicago (311) as problem areas (denoted by the plus signs), it also demonstrates the effectiveness of GI at various locations as a means of reducing surface flooding (as determined by the Landscape Green Infrastructure (L-GrID) model).

For areas identified by L-GrID, the areas adjacent to roads had a higher weighting of suitability. Problem areas where the modeling showed green infrastructure would be less effective might be better addressed with improvements to grey infrastructure or street grading.

West Side of Campus

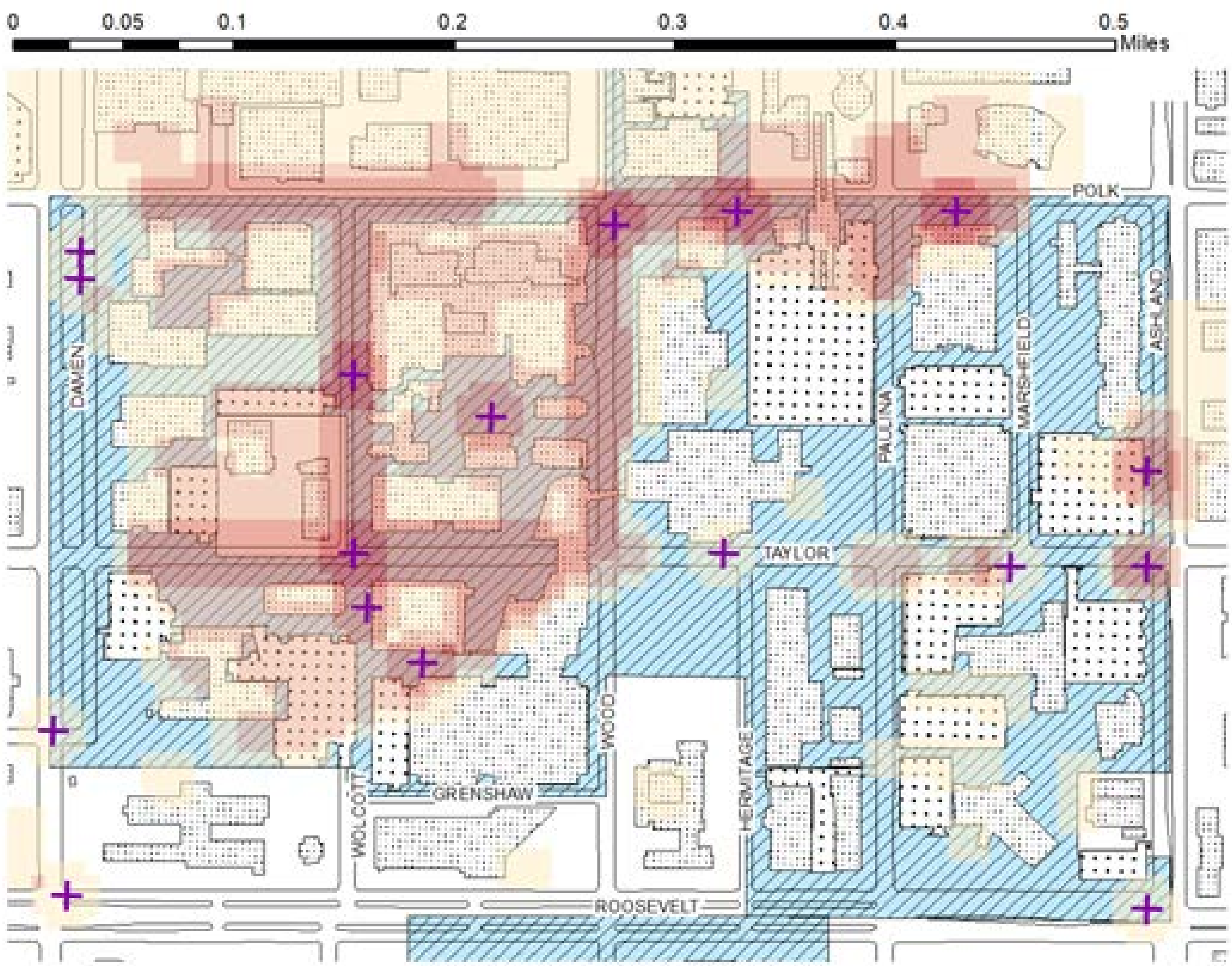
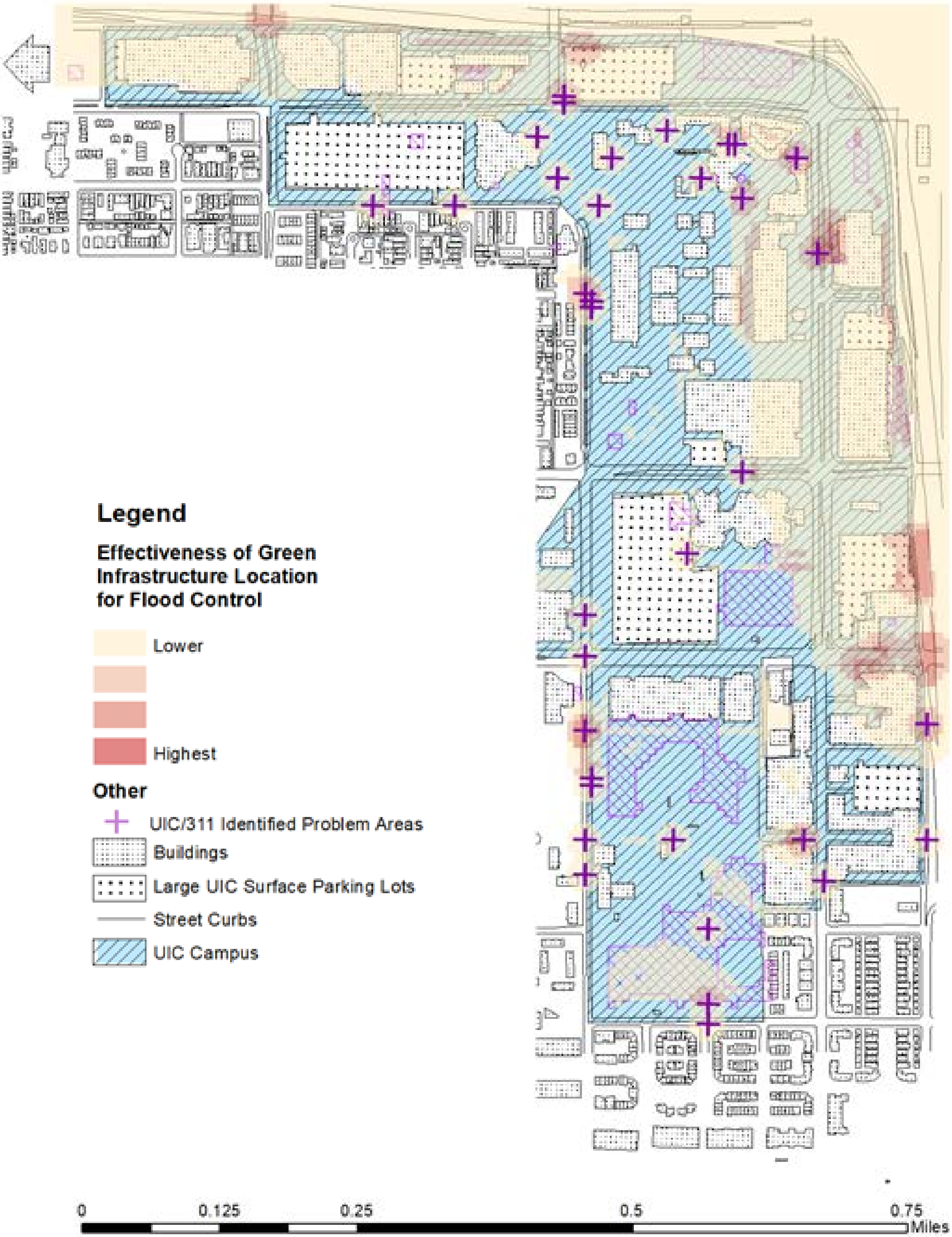


Figure 3 The most chronically flooded problem areas on campus owned either by UIC or by the City of Chicago, as identified by UIC Grounds (plus signs). L-GrID modeling shows surface flow visualized during a simulated storm. Prepared by Dean Massey, Institute for Environmental Science and Policy, in association with the Office of Planning, Sustainability, and Project management, July 2019.

East Side of Campus

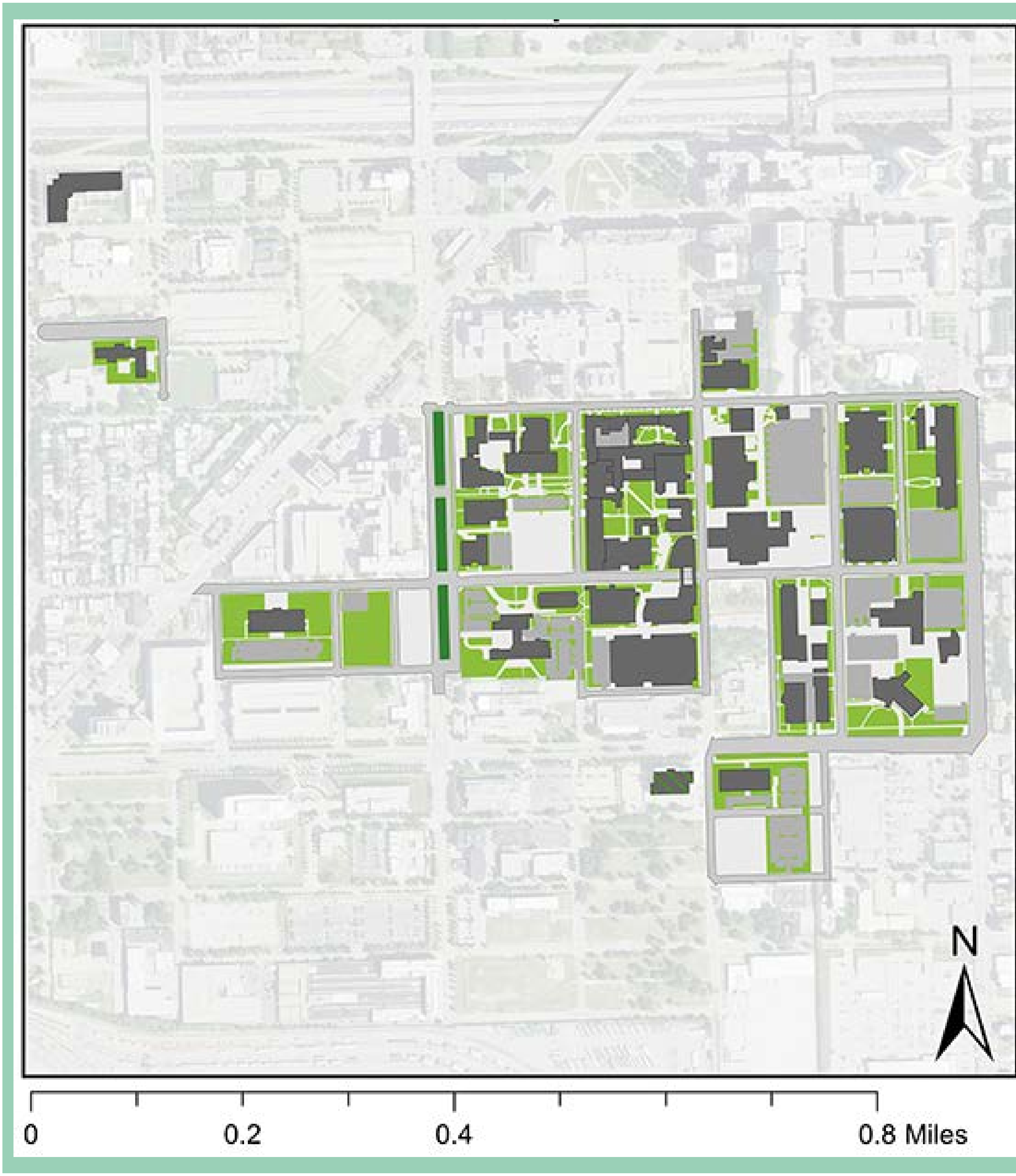


III. Proposed GI Master Plan

Recognizing the institutional barriers and physical complexity of a city's urban fabric (e.g. zoning ordinances, street layout, and water infrastructure), a strategic, incremental, and adaptive approach to green infrastructure (GI) implementation was developed for the east side of UIC's campus, as described in the award-winning Urban Transformations (UT v1.0) (see Appendix II. Planning Process). The team behind the development of UT v1.0 framed this as "The Four Phases of Urban Transformation": Phase 1) Demonstrate; Phase 2) Optimize & Adapt; Phase 3) Integrate; and Phase 4) Transform. Since the completion of this project, UIC has implemented some of the GI interventions and recommendations outlined in UT v1.0. More demonstration projects have come online and continual monitoring has allowed for feedback and adaptation to occur in the designing of GI on campus. This design plan restructures the phases of UT v1.0 to incorporate lessons learned thus far and to expand the planning boundaries to all of UIC, including the east, west, and south sides of campus. Through integration, partnership with the City of Chicago and the MWRD, and continued research, UIC and the surrounding neighborhood will be transformed into a 21st century urban neighborhood, serving as a model for other urban areas.

Phase 1: Demonstrate and Analyze (2010 - 2017)
Phase 2: Expand and Standardize (2017 - 2027)
Phase 3: Transform and Upgrade (2027 - 2050)

Phase 1: Demonstrate and Analyze



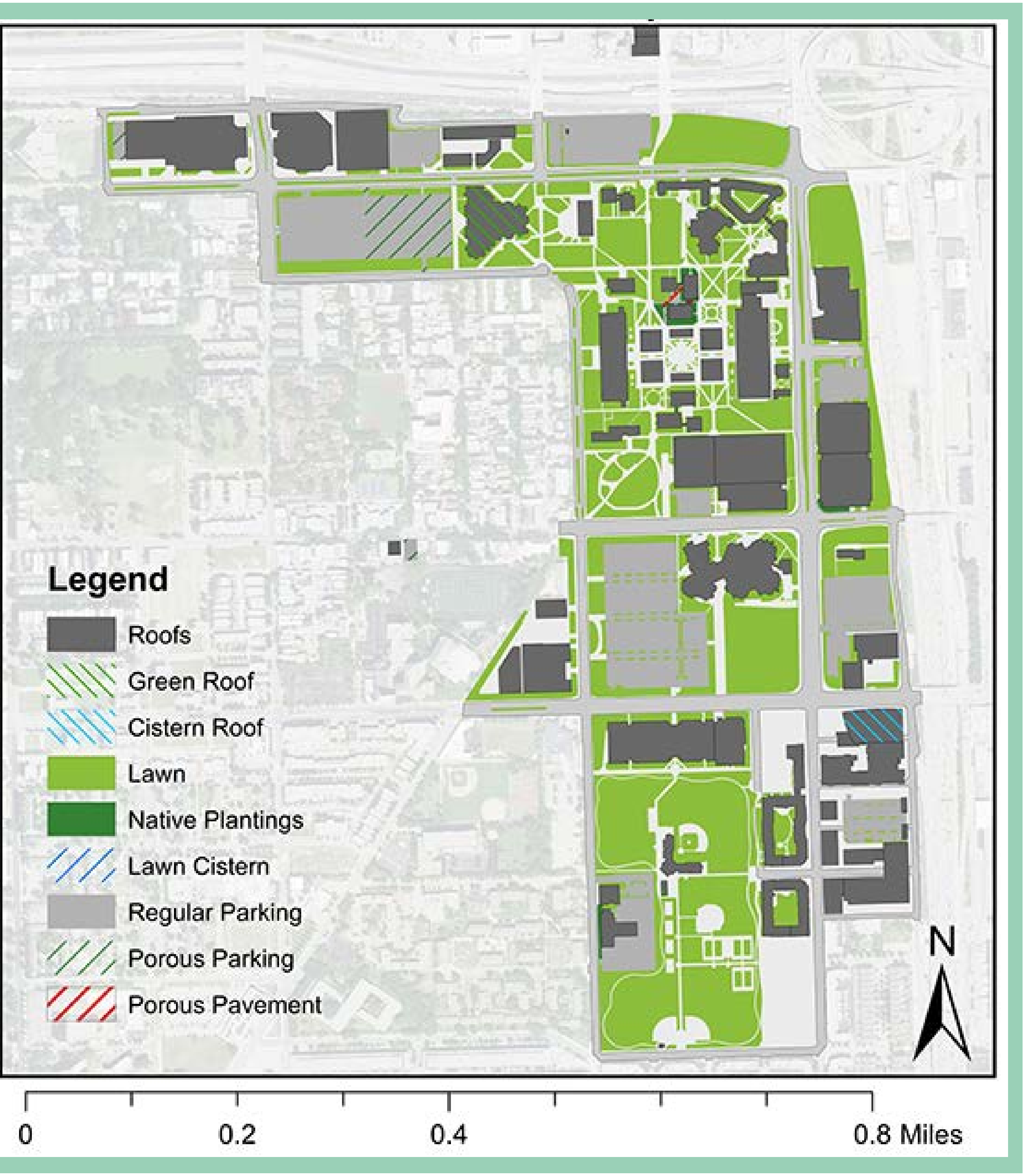


Figure 4. Map of the representation of sample GI projects in Phase 1 that reflects GI projects already in place.

Phase 1: Demonstrate and Analyze

Over the years, the University has begun to explore the sustainability ideas across different categories. In doing so there has been an introduction of small scale, demonstration GI projects on campus. Examples of these projects include the green roofs on the Behavioral Science Building, Education, Theater, Music, and Social Work building, the prairie restoration at the School of Public Health, permeable pavers and rain gardens outside Lincoln, Douglas, and Grant Hall, and permeable pavers, rain gardens, and green roof at Mile Square Health Center.

Larger scale demonstration projects have also been introduced to campus. There is a rainwater cistern that collects runoff from the UIC Forum roof; permeable pavers were added into the reconstruction of the Memorial Grove; and a 3-acre parking lot (Lot 1A) was reconstructed as a porous parking lot. These applications currently reduce runoff by approximately 4.2 million gallons (MG) per year (see Table 1).

It is important to note that although trees have not been used as examples of GI in the past, UIC is home to thousands of trees, and each have the capability of reducing stormwater runoff. Trees, as well as shrubs, intercept precipitation, while their root systems promote infiltration and storage in the soil. The trees and shrubs of UIC help to reduce runoff by an estimated 0.38 MG a year (i-Tree Ecosystem Analysis, 2018). This data was analyzed using the i-Tree Eco model developed by the U.S. Forest Service, Northern Research Station. For more information about trees and stormwater reduction, please refer to the UIC Tree Care Plan.

Photo: Students from the Sustainability Internship Program stand near the extensive green roof on the Mile Square Health Center Building, which earned LEED-Gold certification in 2014.

GI Practice	UIC Area (acres)	UIC Runoff Reduction (MG/year)	Total Runoff Reduction Ratio (MG/year/acre)
Porous Pavement	3.5	3.6	1.04
Rain Gardens	0.05	0.04	0.84
Street Planters	0	0	0
Green Roof	0.2	0.04	0.2
Infiltration Basins	0.3	0.3	1.1
Cisterns	0	0	0
All Types	4.0	4.2	1.0

Table 1. Phase I (2018) Green Infrastructure runoff reduction numbers.

Data Monitoring and the Porous Concrete of Parking Lot 1A

In addition to embracing these GI projects, there has also been an effort to begin monitoring and understanding the performance of some of these projects in situ. Monitoring sensors were placed within the porous parking Lot 1A during its reconstruction. Additionally, monitoring sensors were retrofitted into the green infrastructure outside of Lincoln, Douglas, and Grant Halls 5 years after installation. This data is being collected and analyzed to inform the University on the long-term performance of different green infrastructure practices across multiple different weather conditions. This data and research informs the researchers when a practice needs maintenance; this information can be passed along to the proper departments within the university. Research into Lot 1A identifies the performance over different types of precipitation events. This type of information and analysis can lead to improved, more effective and efficient designs of future GI projects installed on campus.

The combined hyetograph-hydrograph for Lot 1A shows how quickly the parking lot responds to precipitation (Figure 3). Flashiness (quick system response) in the outflow represents the design and placement of the underdrains at the lowest points in the storage space underneath the parking lot.

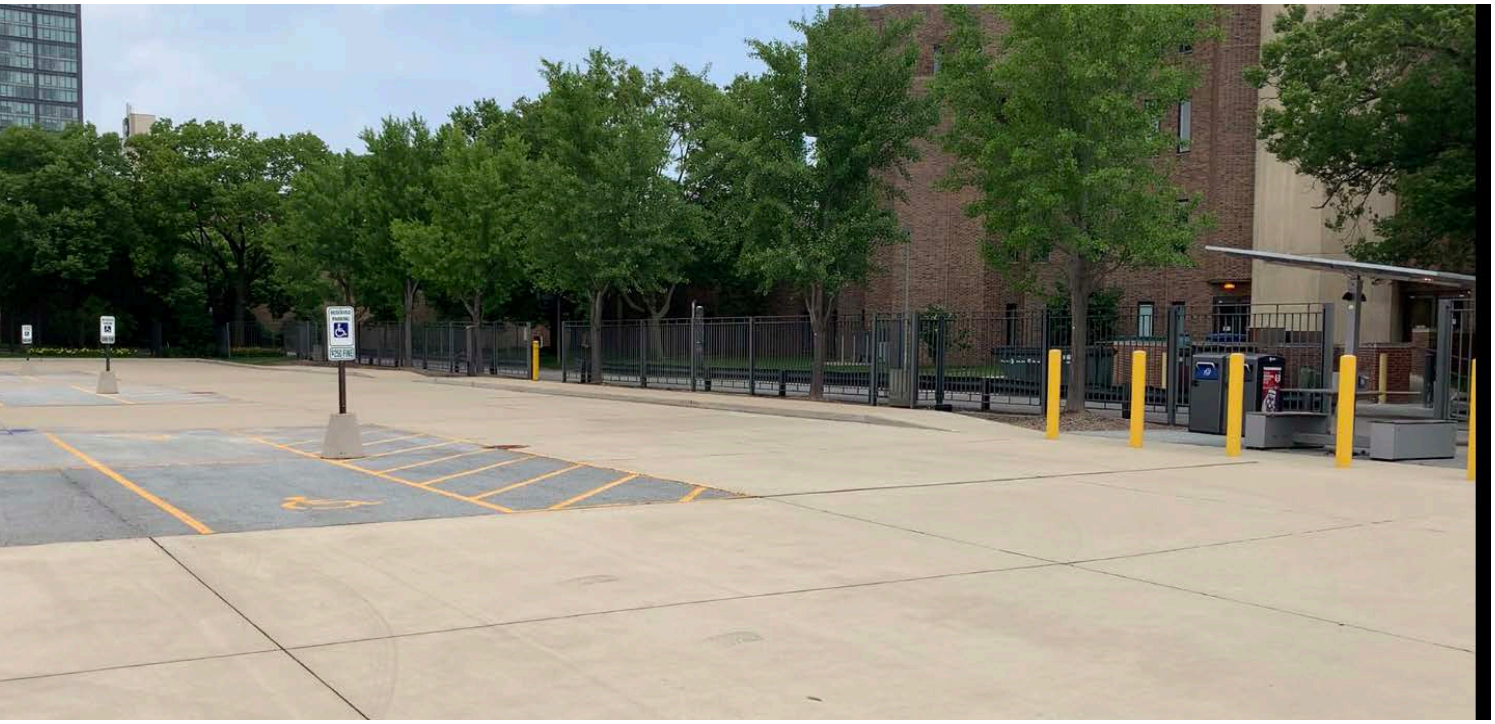


Photo: During the 2016 reconstruction of Parking Lot 1A, parking stalls were designed with porous concrete while the drive lanes were constructed with traditional paving.

Precipitation is designed to quickly move through the porous pavement into the storage space below. The storage space is comprised of highly porous (n = 0.48) gravel (CA 7 stone); this gravel has a high hydraulic conductivity meaning that precipitation moves quickly from the porous pavement-gravel interface to the bottom of the gravel storage space. The bottom of the storage space is lined with an impermeable filter fabric, promoting water to quickly flow laterally towards the underdrains. Once in the underdrain, the runoff flows to the outlet where it exits the system into the combined sewers through an orifice plate restrictor.

This orifice plate restrictor is the only component of the system currently causing it to achieve short term storage of runoff; long term storage and promotion of infiltration and evapotranspiration are not achieved with the orifice plate. This owes to the design of the parking lot as a detention facility and not a retention facility. The combined hyetography-hydrograph shows that while the system reduces the peak flow entering into the sewer system and surface flooding, it does not appreciably reduce the volume of runoff entering the sewer system (Figure 5).

Funding would be needed to convert the parking lot into a below-grade retention basin with a real-time control, actuated gate valve retrofitted over the outlet orifice. This inexpensive retrofit shows promise to almost eliminate stormwater inflow into the combined sewer system. Research and data collection on this retrofit could lead to retrofits on other projects in the future.

In addition to these design challenges, maintenance challenges also arose with the use of the new technology. Facilities Management was unaware that the warranty for permeable concrete is violated by the use of salt products to melt ice and snow. Thus, inadequate snow removal was attempted, causing the parking lot to freeze over and become unusable during the first winter. However, there are treatments available to deal with snow removal. Since the university community has zero tolerance for snow on parking lots and walkways, finding viable snow removal techniques are extremely important.

The current technology of Lot 1A will not be repeated in future university parking lots in order to avoid maintenance issues. As such, future porous pavement interventions need to not only reconfigure the location of underdrains and to be designed as retention and not detention basins, but to also consider maintenance requirements with full stakeholder engagement.

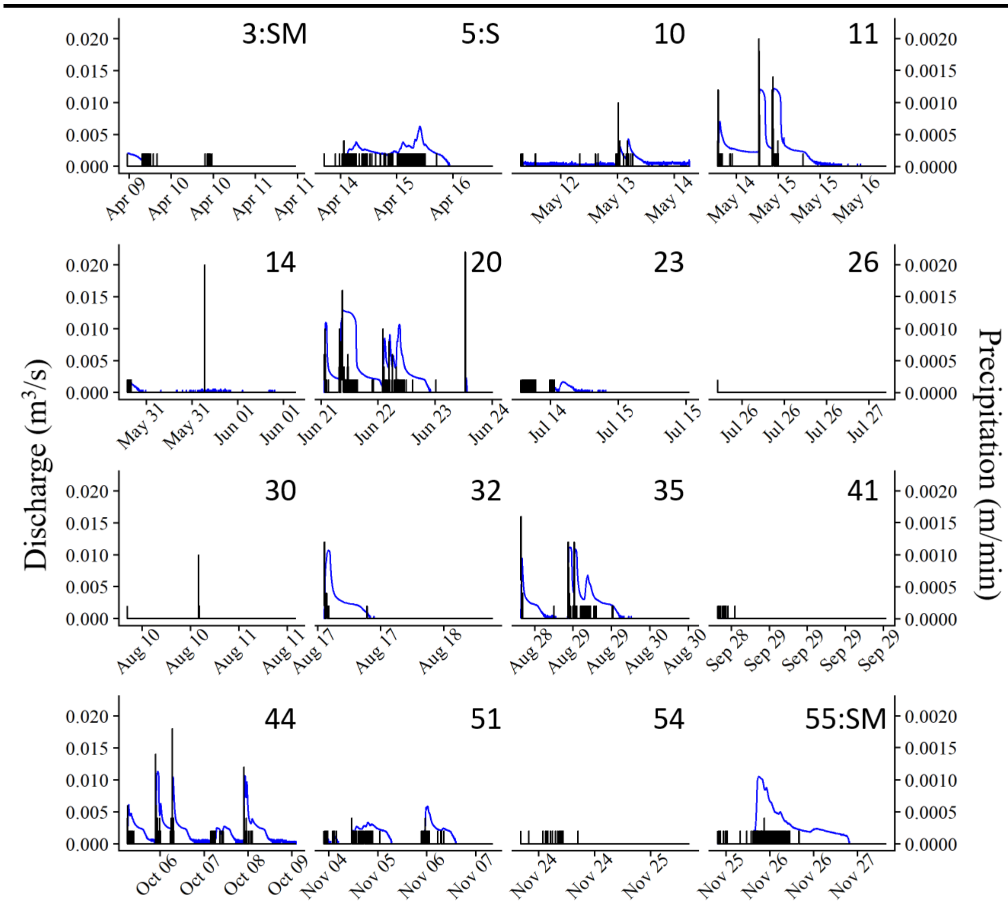
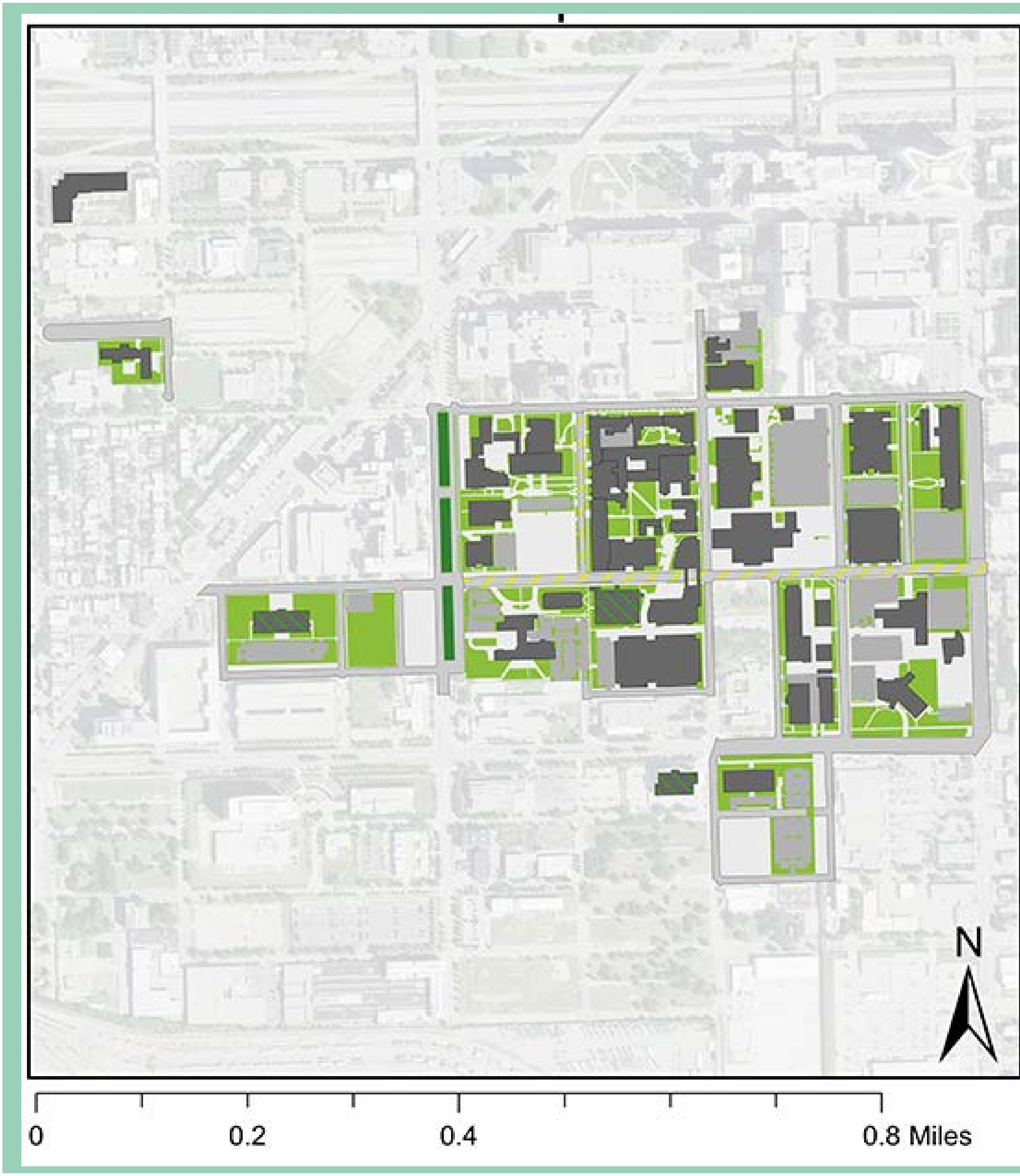


Figure 5. This figure shows 16 precipitation events and the corresponding discharge response in Parking Lot 1A on East Campus in 2018.

Phase 2: Expand and Standardize



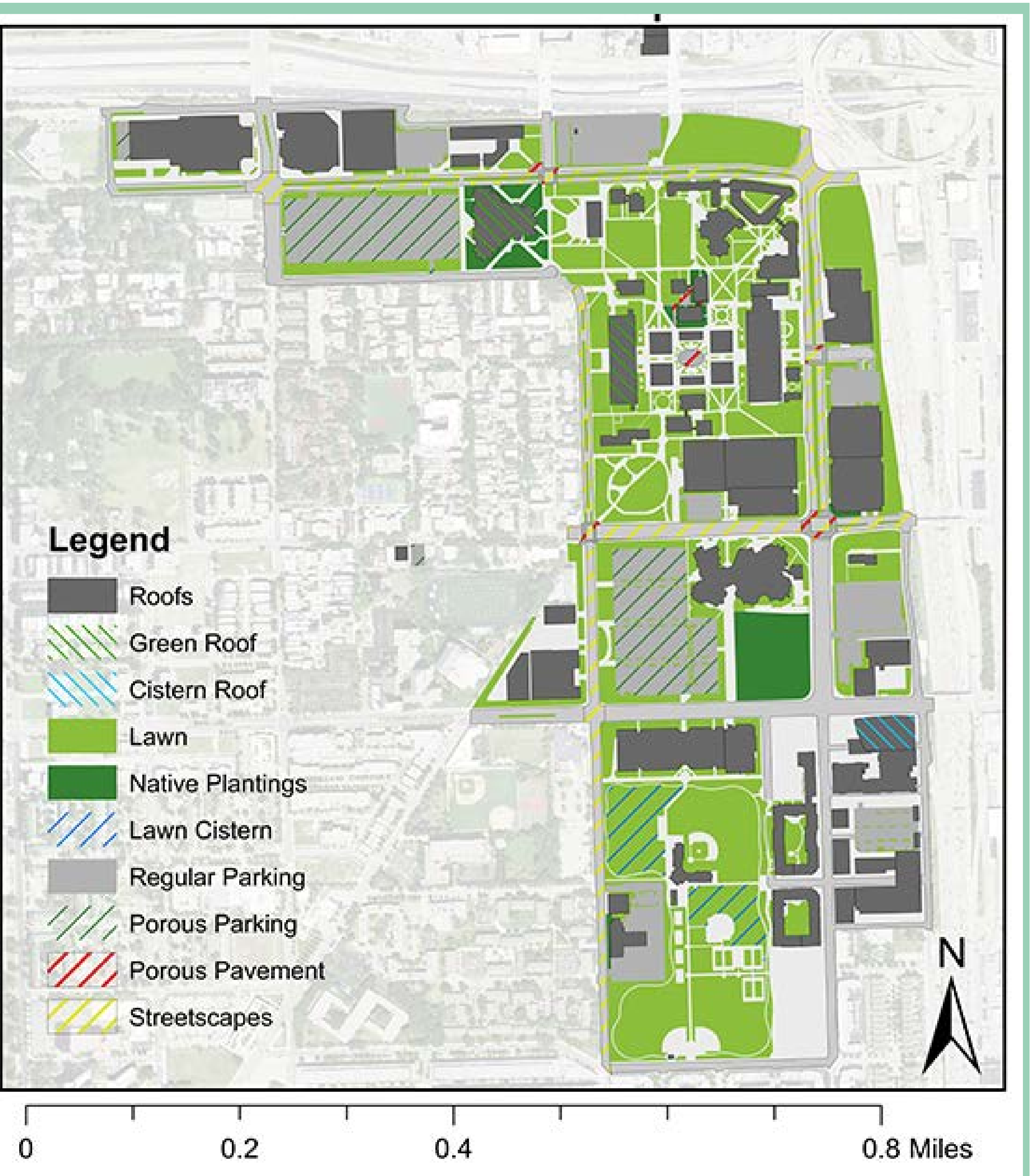


Figure 6. Map of the representation of sample GI projects in Phase 2 that coincide with the Campus Master Plan 2017-2027. Some of the GI projects have not yet been approved or funded.

Phase 2: Expand and Standardize

To demonstrate the magnitude of potential stormwater retention through standard campus planning, a comprehensive design was created by overlaying the Master Plan 2017-2027 Executive Summary campus map with Facilities Planning map of "problem flooding areas" during precipitation events. GI applications were selected based on upcoming construction and primary safety concerns. To continue the introduction and expansion of GI on campus, the Office of Planning, Sustainability and Project Management (PSPM) has been encouraging the integration of GI into new buildings and reconstruction projects such as the Arthignton Mall Plaza renovation and the Engineering Innovation Building.

Arthington Mall Plaza

Arthington Mall Plaza is one of the highest pedestrian traffic corridors within the west side of campus and serves as an open, common area for students, faculty, staff and visitors. Users of the plaza enjoy the space for leisure and also access the plaza to travel on campus and to surrounding facilities. Historically, the plaza has experienced urban flooding during heavy rain events which has caused the pavers to deteriorate over the years. Improvements to Arthington Mall showcase a variety of GI applications in this high visibility corridor including, but not limited to, permeable pavement, the integration of rain gardens and bio-retention areas, and the inclusion of native and drought tolerant ornamental landscape plantings.

Photo: Arthington Mall Plaza is the first project at UIC to register for SITES certification, which promotes comprehensive land design and development via a rating system that ensures projects meet high standards of demonstrating a high level of environmental and social sustainability.

PSPM and researchers from the Department of Civil and Materials Engineering were awarded multiple grants to completely overhaul Arthington Mall and to install monitoring equipment which allows the project to quantify the water balance for the site. Preliminary estimates of storm water reduction suggest an overall stormwater runoff volume reduction of 23%, and an increase in infiltration of 24%. The monitoring system includes a rain gauge, soil probes, and drain gauges that quantify infiltration and evapotranspiration processes of the water budget. The advantage of using this monitored-based hydrologic model is that extreme flood and drought events can be simulated to see how the green infrastructure performs and if any modifications should be considered which can help in decisions regarding maintenance and future green infrastructure implementations. Because of these innovative monitoring technologies and expansive GI measures, the renovation is expected to earn SITES certification - the first at UIC.

Engineering Innovation Building

Expanding and standardizing GI is not a straightforward path. Opportunities for integration of GI may be missed through lack of understanding of what it is, how it functions, and the added benefit GI brings to the campus community. Another challenge to expansion and standardization of GI on campus is the construction of the College of Engineering's new Engineering Innovation Building. This building broke ground for construction in December 2017 and was designed with traditional stormwater engineering practices. Due to different interpretations of the site constraints of a clay cap and seasonally high water table, the design incorporates minimal GI interventions and represents the design standard of 50 years ago. This unfortunately does not embrace the wealth and breadth of research pointing to the benefits of green infrastructure and does not capitalize on the research efforts on campus, even within the College of Engineering itself.

However, as is the case with Lot 1A there is still potential for the traditional design to be retrofitted with a real-time control structure turning it from a detention design into a retention design. This experience points to the need for new building standards and criteria in the selection of design teams with green infrastructure experience to achieve campus stormwater goals.

Site Intervention Considerations

Obtaining buy-in of university administrators and other decision makers is fundamental to ensuring the expansion and standardization of green infrastructure on campus; therefore, implementation of green infrastructure needs to be done in a methodical and efficient manner. To achieve efficacy and establish a method of intervention and site selection, prioritization of sites and intervention types needs to be examined. Not prioritizing sites and intervention types could lead to over design, reducing the runoff reduction efficacy per unit of GI installed and increasing the overall capital and maintenance cost per gallon of runoff eliminated from entering the combined sewer system.

Recommendations that were developed using the L-GrID model for the types of GI that are most effective include the types of layouts are most effective and specific recommendations for the different campuses. (Massey and Zellner, 2019). Specific recommendations from the L-GrID stormwater modeling for each side of campus optimize stormwater reduction. Rather than clustering all GI at major construction and redevelopment sites, the University should attempt a more nuanced approach that involves concentrating some GI where flooding is worst, but also placing the GI where it intercepts flows along streets and other channels to lower elevation areas – called the flow path layout. The following considerations were determined through stakeholder meetings, existing conditions, and stormwater modeling.

Rain Gardens and Bioswales

Rain gardens and bioswales with native plantings are efficient area-to-runoff-reduction GI practices, when maintained properly, and can easily be added during routine landscaping, in new construction, and as part of renovations. The L-GrID model showed that in all simulations, rain gardens/ bioswales were the most effective per unit area of coverage at reducing area flooded, reducing runoff to downstream areas, and reducing the stormwater burden on sewers. They are also more robust in poor weather conditions that limit infiltration if the bioswales are designed with large surface water storage capacities. They are the most effective, however, when placed where water is flowing or where water is ponding. This means that bioswales should be placed along roads with curb cuts to allow water to move freely from streets to bioswales.

Aesthetics and Education

High visibility practices increase educational opportunities and provide for increased aesthetic value. Bioswales and tree islands as well as landscaping strategies around the edges of impermeable surfaces are extremely visible. Native plantings and rain gardens provide protection against nuisance flooding and add aesthetic value to the campus landscaping. These practices are highly visible and can be used to educate the campus community and greater public through the inclusion of signage.

Photo: A permanent sign at the Little Prairie on the Campus. Text on sign: ***Thanks to a grant from the National Fish and Wildlife Foundation, this area is restored with native plants, much like those that once dominated the Illinois landscape. Not only do these native plants' deep roots soak up stormwater, they also attract pollinators and wildlife, creating a pollinator-friendly urban habitat, contributing to our goal to become a Biodiverse Campus.***

Stormwater Reuse

Reuse of rainwater is most useful in helping UIC to achieve its Net-Zero Water Climate Commitment. Cisterns, whether on roofs or in underground collection vaults, offer value by reducing stormwater runoff in less visible ways. What cisterns lack in visibility they make up in the ability to reuse rainwater harvested inside. This water can replace the potable water extracted from Lake Michigan that the university currently purchases and uses for irrigation. On-site stormwater retention for university buildings is a promising solution as well. If buildings capture and retain water that falls on them rather than diverting runoff to sewers, it frees up space in the sewer system for runoff from other impervious surfaces, which is a benefit for the entire surrounding neighborhood. Thus, retention is a promising strategy to consider for new construction or retrofits of existing campus buildings.

Maintenance Requirements

GI is only truly effective when maintained properly. For example, although green roofs are still listed as a GI measure, it is no longer a recommended strategy as proper maintenance of the green roofs have been near impossible and thus loose all effectiveness. Maintenance considerations of permeable pavement and porous concrete should also be discussed with all operators to align expectations and outcomes. There needs to be a focus on maintenance, grading of streets and cleaning of sewers to prevent localized flooding issues.

Partnering with the City of Chicago

Additionally, some of the problem flooding areas that UIC must contend with occur on streets under the jurisdiction of the City of Chicago, not the university. Curb cuts are an effective GI measure as streets are designed to channelize runoff and direct it to sewer inlets. If there are areas with especially large flooding problems, such as areas of low elevations, then it would be appropriate to have some clustering in those locations. Moreover, despite the City ownership, UIC facilities need to maintain the adjacent sidewalks in rain and snow events for people traveling to university owned buildings. Partnering with the City on infrastructure planning will alleviate wet weather issues for UIC and the surrounding neighborhoods along with further reducing the amount of runoff into sewers. Partnership between the City and UIC will increase the efficacy of interventions and reduce the chance of ineffective site selection and intervention performance.

Considering UIC's urban setting, working with multiple stakeholders, including the general public, finding optimal scenarios especially in regards to spatial configuration, and incorporating innovative and new green infrastructure techniques is particularly wise to determine the best plan of action, both for the university and the city. Combining the tools of large scale runoff volume estimations and small-scale infrastructure network considerations with ongoing data analysis of GI applications, UIC can confidently design with more awareness, maintain GI with faster knowledge of their conditions, and plan for a campus with better water management.

Envisioning Phase II

The UIC campus covers approximately 260 acres (not including city streets and right of ways) and currently encounters 229 million gallons per year in stormwater runoff. The Urban Transformations 2.0 plan covers 32.0 acres, or approximately 11.4% of campus with green infrastructure applications. Full implementation of this plan yields a runoff volume of 198.6 MG, resulting in an additional runoff reduction of 30.3 MG/year (13.2%) from the 2017 baseline.

As defined here, efficiency is the ratio of volume of runoff captured compared to the physical area the GI application covers. This allows for a normalized comparison between interventions of different sizes and applications where larger efficiencies indicate more successful and cost-efficient choices. Table 2 notes the efficiency of each green infrastructure application.

To envision cooperative community planning between UIC and the City of Chicago, the project team identified opportune city streets for streetscape/complete street treatment. Streetscapes usually include an assortment of green infrastructure. Additionally, streetscapes inherently include boundaries between the University and another entity. Many times, the other entity is the university itself. But there are a few boundaries where streetscapes would be implemented on a boundary between the university and single-family homes, apartment buildings, and other residential buildings. This provides an opportunity where the university could be a research lab where innovative technologies (e.g. green catch basins) are installed and tested to see their impact on individual neighborhood buildings. This would allow the university to assist the MWRD in assessing different designs, their effectiveness, and the impact these designs might have at a citywide scale.

It can be noted that green infrastructure becomes more efficient when working in combination with additional applications, as seen in Table 3. For the design presented, and for the ability to estimate the impact of streetscapes, the impermeable area of streets was transformed. Out of 61.4 acres of roads approximately 19 acres were modeled as streetscapes. Runoff captured-to-area-constructed efficiency ratios demonstrate which GI interventions should be given higher priority. Some organizations base their investment in water resources projects on cost per gallon saved, aiming to spend only a few dollars per gallon. Public serving entities can collaborate to create more efficient, economical, and sustainable urban planning solutions.

The Phase 2 design would add nine more acres of green infrastructure applications adjacent to and running through UIC campus, resulting in a total runoff volume reduction of 28.69 MG/yr or a non-trivial increase of 68% from the design plan for only UIC property. It can be noted that green infrastructure becomes more efficient when working in combination with additional applications.

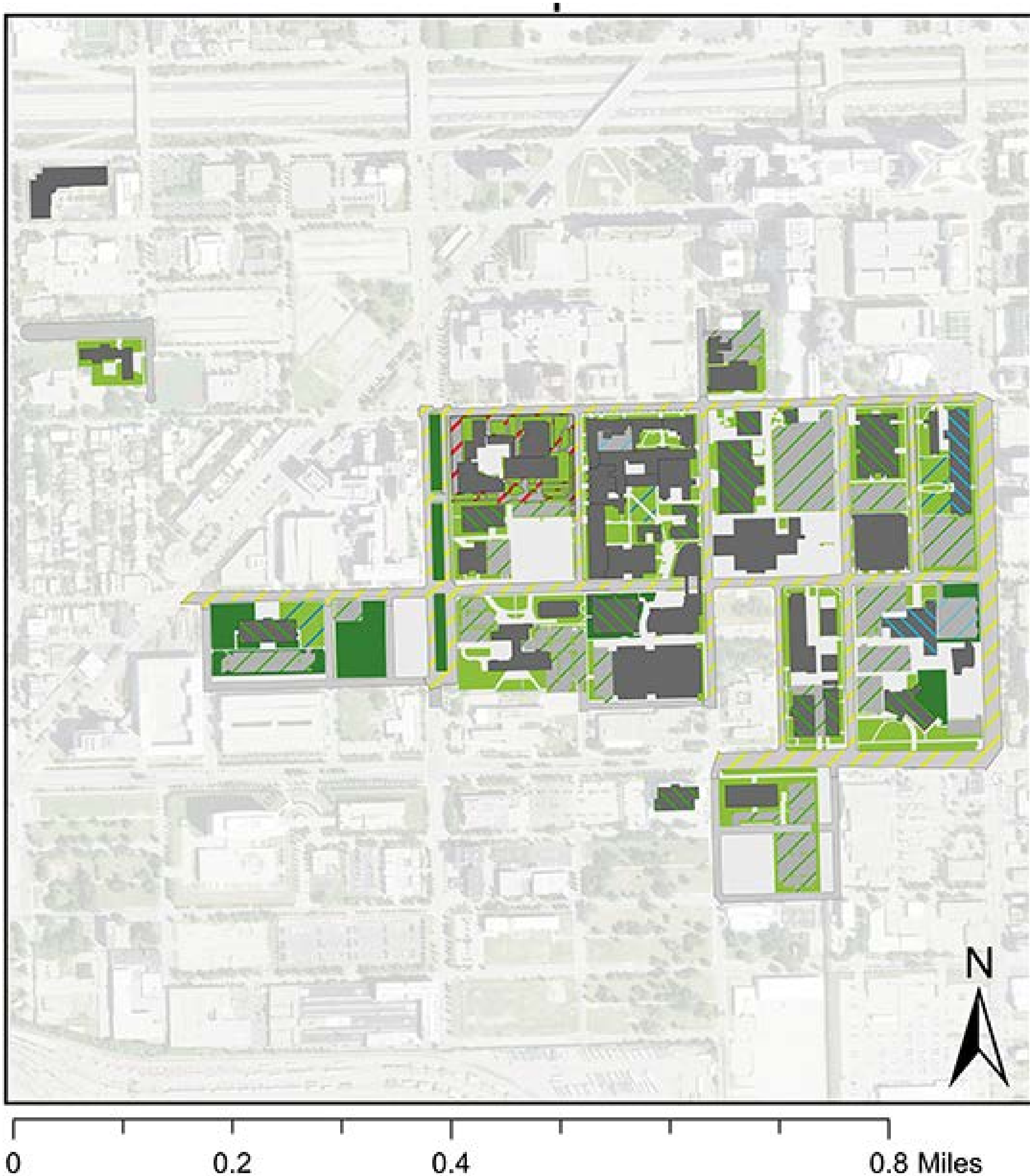
GI Practice	UIC Area (acres)	UIC Runoff Reduction (MG/year)	Total Runoff Reduction Ratio (MG/year/acre)
Porous Pavement	14.8	10.4	0.7
Rain Gardens	6.5	6.4	0.99
Street Planters	0	0	0
Green Roof	4.7	0.8	0.16
Infiltration Basins	0.3	0.2	1.6
Cisterns	5.8	1.8	0.31
All Types	32.1	30.3	0.94

Table 2. Phase 2 – Expand and Standardize Runoff Reduction Estimation as modeled using the EPA Storm Water Management Model (SWMM).

GI Practice	City Area (acres)	Runoff Reduction (MG/year)	Total Area (UIC + City) (acres)	Total Runoff Reduction (UIC + City) (MG/year)	Total Runoff Reduction Ratio (MG/year/acre)
Porous Pavement	5.7	5.8	20.5	19.8	0.97
Rain Gardens	0.7	1.4	7.2	7.8	1.08
Street Planters	1.3	2.0	1.3	2.1	0.39
Green Roof	0	0	4.7	1.0	0.18
Infiltration Basins	0	0	0.3	0.3	1.14
Cisterns	0	0	5.8	2.2	0.39
All Types	7.6	9.1	39.6	32.2	0.81

Table 3. Implementing GI when partnering with adjacent City property, assuming 40% permeable pavement (bike lanes and parking spaces); 10% rain gardens or native plantings (in medians); 15% street planters (such as tree grates or bioswales in the right of way), and the remaining 35% as traditional concrete using SWMM.

Phase 3: Transform and Update



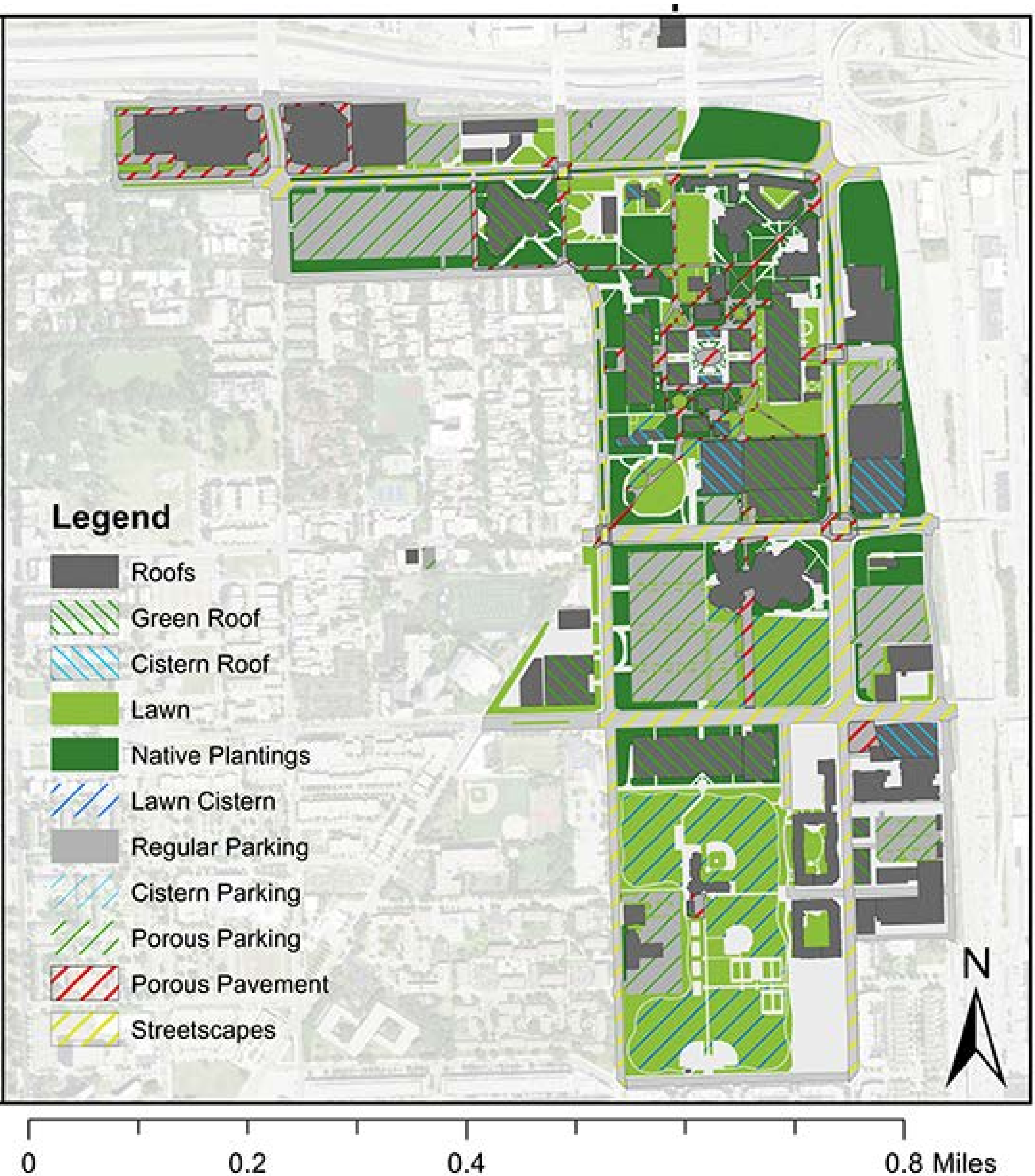


Figure 7. Map of the representation of sample GI projects in Phase 3. The GI projects have not yet been approved or funded.

Phase 3: Transform and Update

Phases 1 and 2 of this plan will bring UIC to the forefront of green infrastructure practice as these phases will standardize building codes to include GI interventions when efficient and after methodical consideration, in all construction and reconstruction moving forward. Phases 1 and 2 will provide researchers with a breadth of data and knowledge on the performance of GI interventions over time and a myriad of different weather conditions, specifically on long term performance in cold weather (snow) regions. Establishing a partnership between UIC, the City of Chicago, and the MWRD to address urban flooding conditions creates positive benefits for each constituency.

By situating UIC, the City of Chicago, and the MWRD at the forefront of green infrastructure practice, knowledge, and research, each partner will benefit in increased attention on the efforts as outlined. Research, travel, and tourism dollars may be generated by scientists, policy makers, and tourists from around the world. In order to stay at the forefront of the green infrastructure field, UT v2.0 must see to the full execution of this visionary plan. This is where Phase 3 comes into play.

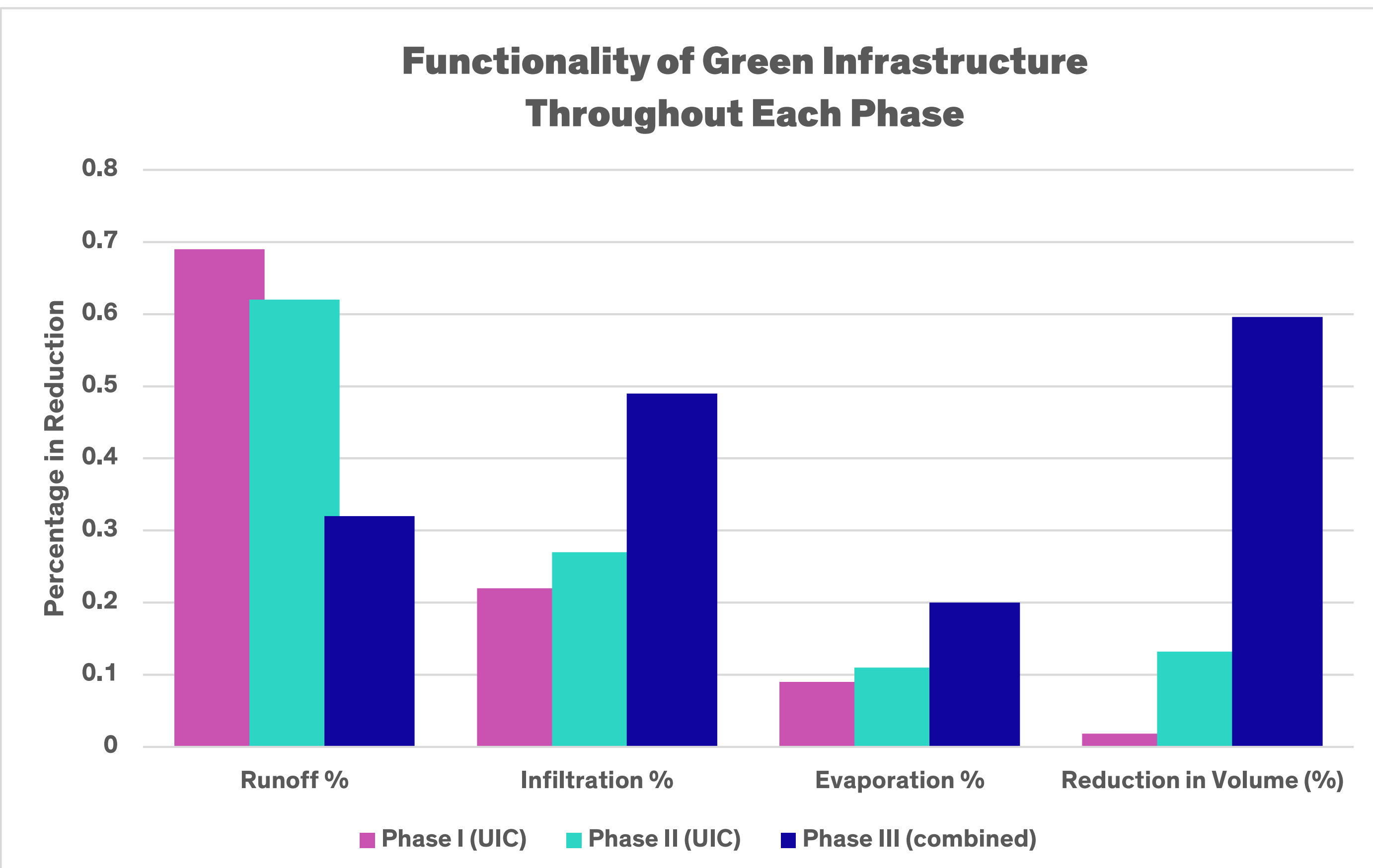


Figure 8. Green Infrastructure efficacy throughout each phase of the Plan. Phase 3 shows stormwater runoff reduces to just over 30%, infiltration increases to almost 50%, evaporation increases by double to 20% and the total percent in reduction in volume increases to nearly 60%.

GI Practice	UIC Area (acres)	UIC Runoff Reduction (MG/year)	Total Runoff Reduction Ratio (MG/year/acre)
Porous Pavement	80	81.8	1.02
Rain Gardens	32	34	1.06
Street Planters	15	12.7	0.85
Green Roof	27	4.6	0.17
Infiltration Basins	5	4.5	0.9
Cisterns	25	22.4	0.9
All Types	184	176.7	0.96

Table 4. Aspirational GI coverage. Note that the efficiency of green roofs is low for stormwater but they represent a large benefit for energy efficiency.

Phase 3 looks to transform and update the university campus and adjacent neighborhood to be as fully saturated and integrated with GI interventions as is economically and feasibly efficient. Only through effective planning and integration of green infrastructure interventions on campus can UIC achieve its Net-Zero Water Climate Commitment. Phase 3 is an aspirational plan; it is also a plan that spans more than 2 decades.

Figure 8 shows the great transformation in water reduction on campus once Phase 3 is fully implemented: the percentage of stormwater runoff reduces to just over 30%, infiltration increases to almost 50%, evaporation also increases by double. In total, the reduction of stormwater runoff increases immensely when UIC partners with the City of Chicago and the MWRD.

We are proud to be the University for Chicago and we are proud to help the City of Chicago live up to the Motto, Urbs in Horto, meaning "City in a Garden". Phase 3 really would place UIC and the surrounding neighborhood as champions to be a university in a city in a garden, "universitas in urbs in horto".

The Phase 3 campus map (Figure 7) shows a glimpse of what the campus and surrounding areas could look like if Phase 3 is actualized: representing the possibilities for achieving a true Urbs in Horto.

IV. Opportunities and Next Steps

For full plan implementation, UIC must establish standards and processes that ensure the integration of GI that goes beyond the regulatory requirements of Chicago. The City of Chicago Stormwater Management Ordinance has three primary stormwater management objectives for development sites to (1) reduce impervious areas, (2) capture stormwater on site, and (3) either use or retain the stormwater on site for evaporation and absorption into the ground. Stormwater that is not used or retained, may be discharged into a City-owned combined sewer, storm sewer, or open waterway.

While the ordinance appears to focus on control and limiting the rate at which water leaves the property through on-site stormwater detention and controlling the release rate, it encourages developments to treat stormwater as a resource through volume control by reducing the imperviousness of a site or installing best management practices (BMP's) that enhance onsite retention and absorption of water. Chicago's preferred BMPs are green roofs, planter boxes, rain barrels and cisterns, permeable paving, natural landscaping, vegetated filter strips, bio infiltration systems, and drainage swales. An Infiltration Vault is used for detention but above ground techniques listed above are preferred. If used, these vaults must include a design for pretreatment and a long-term maintenance plan is required for the removal of the sediment. (Chicago Stormwater Management Ordinance)

UIC's preferred BMP's are rain gardens, bioswales, permeable pavement, infiltration basins and cisterns, but is subject to change based on research. Analyzing previous GI interventions is also a valuable tool for future considerations, as detailed in the Parking Lot 1A porous concrete pilot project and the stormwater detention system of the Engineering Innovation Building.

UIC's position as the only public Carnegie Research 1 institution in the region lends itself perfectly to the promotion of understanding and educational outreach to the greater Chicago community. UIC will be a valuable partner with the MWRD and the City of Chicago in the design, implementation, and post construction monitoring of a full cross-section of green infrastructure innovations.

Recommendations of UT V2.0: Green Infrastructure Stormwater Implementation Plan

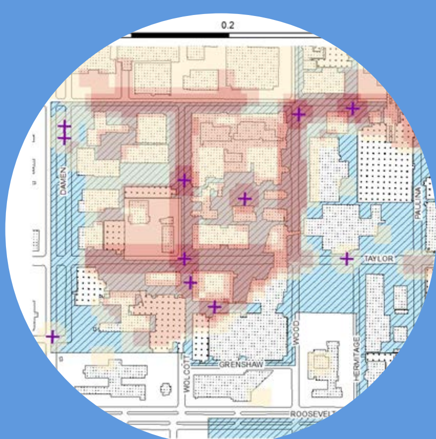
UIC should focus on the results of case studies, pilot projects, calculations and stormwater model predictions performed by university and professional experts.

Install GI at every opportunity during new construction and major renovation projects.

This shall include all paving projects, landscaping, walkways, parking lots, and building projects. Stormwater for reuse in irrigation and plumbing should be designed into infiltration basins and cisterns to use as stormwater retention, and not simply stormwater detention.

Evaluate effectiveness and maintenance requirements of each GI intervention.

Monitor stormwater reduction aat each new GI project. Give preference to rain gardens and bioswales for GI interventions due to their effectiveness, lower maintenance requirements, and educational, aesthetic, and pollinator value.



Consult the L-GrID model for optimal placement of GI during design.

Additionally, when contracting for design services - whether as a job order contracting (JOC), retainer, or through a request for proposal (RFP) - require the proven experience with green infrastructure within the City of Chicago of those professionals.

Seek partnerships from the City of Chicago and the Metropolitan Water Reclamation District.

These partnerships should include funding opportunities as well as opportunities to further integrate GI to maximize stormwater runoff reduction as a community-wide benefit.

Appendices

I. Analysis Approach and Methods

Land Use Analysis: Baseline

One of the first and most important steps in analyzing the potential for GI implementation on UIC's campus was to determine what constitutes UIC's campus. The project team that developed this plan - an interdisciplinary team of UIC administrators, researchers and the award winning 2014 EPA RainWorks Challenge team winners and professionals - obtained land cover and land use GIS data layers from the University, the City of Chicago, and other regional sources. These layers were assembled into a geodatabase which was used to map and analyze existing campus conditions and the various green infrastructure implementation phases. This mapping exercise yielded an approximate area of 260 acres of University owned land (not including City of Chicago streets and rights of way), approximately 320 acres of University, City, and rights of way land. Total impervious surfaces without roads amounting to 228.5 acres, or 167 acres if City-owned streets are excluded from the analysis.

Stormwater Runoff Analysis

The EPA National Stormwater Calculator was used to calculate the percent change in stormwater runoff from the study area for baseline conditions through each phase. The calculator uses the EPA Storm Water Management Model (SWMM) as its computational engine. Although this model is mathematically simple, it permits the rapid modeling and comparison of plausible stormwater management benefits that can be attained by different low impact development (LID) controls scenarios. The EPA National Stormwater Calculator outputs include runoff reduction, changes in infiltration and evaporation rates, and reduction in impervious area.

SWMM analysis considers local soil conditions, topography, land cover, and meteorology. Selecting Soil Type D and a soil drainage rate of 0.04 inches/hour was determined though the United States Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) SSURGO database. Local knowledge of the topography of the area is determined to be flat with less than a 2% grade and was further validated by the SSURGO database. Precipitation and evaporation rates were obtained from the National Weather Service's (NWS) National Climatic Data Center (NCDC). The Midway Airport rain gauge was chosen to be the most appropriate source of rainfall data for the site because of its proximity to the campus. Ten years of precipitation data from the Midway Airport rain gage were used to run the different scenarios.

Design criteria for sizing the LID's were in accordance with local conditions and stormwater management goals and requirements such as the MWRD watershed management ordinance (WMO), the City of Chicago's 2014 Stormwater Management Ordinance Manual, and Green Stormwater Infrastructure Strategy. Rain gardens and infiltration basins had capture ratios of 100%, a capture ratio is the ratio of the green infrastructure's area to the impervious area that drains onto it. Street planters had a capture ratio of 63% due to variations in street drainage design and topography. For permeable pavement, a 100% capture ratio (conversion of 100% of the pavement to permeable) was used. These ratios were then applied by the Stormwater Calculator to the area of green infrastructure implementation.

Another optimization tool, Optimizer, uses genetic algorithms (a data analysis technique modeled on evolution and a subset of evolutionary algorithms) to inspect thousands to millions of spatial, type, and density arrangements of green infrastructure to find an optimal solution based off predetermined solution criteria. This is useful in comparing multiple scenarios to find the best design, balancing cost-effectiveness with optimal water savings. Such optimization can help guide the deliberations and narrow down the large solution space. It is important, however, to allow stakeholders to inspect this solution space, and the model and values that generate it, particularly when model outputs do not match stakeholder expectations.

Landscape Green Infrastructure Design Model

Estimating the results of complex urban planning into a simple number can be useful in demonstrating a comparison between traditional and green infrastructure. However, the Stormwater Calculator is limited in resolution and spatial configuration and lacks the ability to consider optimizing site selection and overall performance.

To analyze spatial configuration, site selection, and overall performance, the Landscape Green Infrastructure Design model (L-GrID), developed by Dr. Zellner at UIC in 2016, is more useful. L-GrID is a neighborhood level, spatially explicit, process-based model developed to answer questions about how much GI is needed to mitigate urban flooding, and in what spatial configurations given different storm and landscape conditions (Zellner et al. 2016). The model allows users to modify storm duration and intensity, landscape size, placement of green infrastructure, sewer configuration, and proportions for different land cover types (with corresponding soil types) in the landscape. While other models are primarily either site specific (e.g., stormwater calculators for particular land parcels), or watershed-scale and data-intensive, L-GrID was meant to simulate hypothetical conditions, where surface flow could be easily visualized during a simulated storm, without needing as much data (and therefore, resources) to run, and stylized enough to simulate controlled experiments to generalize recommendations towards policy.

For the UIC model, L-GrId modeling analyzed criteria for GI suitability that included low elevation, proximity to areas, and areas identified by modeling with the L-GrID model as being prone to serious flooding.

II. Planning Process

Urban Transformations – A Phased Approach to Green Infrastructure Implementation at the University of Illinois at Chicago

The planning process draws on a progression of work conducted on campus over a three-year period. It began with “Urban Transformations – A Phased Approach to Green Infrastructure Implementation at the University of Illinois at Chicago” (UT v1.0). This student-driven plan was written in response to the 2014 United States Environmental Protection Agency (EPA) Campus RainWorks Challenge in 2014. The project team, an interdisciplinary group of undergraduates advised by a UIC faculty member, described the problem of urban flooding in Chicago as chronic, systemic and costly. They noted that urban water systems are increasingly stressed by effects of climate change and impervious land covers. Scientifically robust and politically nuanced strategies are needed to transition cities toward more sustainable water practices. The planning process laid out an incremental, scalable, and adaptive approach to implementing green infrastructure on the east side of the UIC campus, a highly urbanized area. This project placed first in the National RainWorks Competition for its category.

UT v1.0 details its planning process, analysis approach, existing conditions on campus, proposed implementation phasing, expected outcomes, analysis of benefits and costs, barriers and challenges, and opportunities for education and leadership. UT v1.0 received the endorsements of the Vice Chancellor for Administrative Services. While it was not formally adopted as a campus plan, the approach presented has been carried forward in this plan.

Photo: The faculty and student team from the College of Engineering and Urban Planning were presented with the U.S. EPA’s Campus RainWorks Challenge by US EPA Regional Administrator and the UIC Chancellor.

Visioning Workshop

In Spring, 2017, planning commenced to develop the UIC Climate Action Implementation Plan (CAIP) from the UIC Climate Commitments. UIC engaged CCJM Engineers and Conservation Design Forum to conduct a visioning workshop with the Office of Sustainability, in collaboration with key stakeholders – UIC faculty, staff, students, alumni, and experts from the area – to explore options for furthering the Net Zero Water goals of the UIC Climate Commitments within the Urban Transformations framework. A preliminary meeting was held with 20 attendees from UIC on April 20, 2017. The consultants provided an overview of green infrastructure successfully implemented in various parts of the Midwest, and identified specific opportunities on campus to implement them and minimize the adverse stormwater impacts on many areas of the campus. Stakeholders emphasized integration with the Campus Master Plan "Envisioning Our Futures – 2017-2027 Plan". A coordinated effort was recommended and the opportunities for interdisciplinary research should be detailed in the plan.

The visioning workshop was held on May 30, 2017 with 20 attendees from UIC and 10 from agencies, non-profits, and consultants. An overview of the UIC Climate Commitments and Campus Master Plan projects was presented, followed by a similar overview of green infrastructure with specific ideas for the campus, followed by a presentation by Biomimicry Chicago. A representative from the MWRD also reviewed the results of the Blue Island corridor green infrastructure project. Afterwards, attendees worked in groups to review proposed plans for the campus and provide feedback. The outcome was a specific grant request to the MWRD and a Visioning Workshop Summary Report.

National Fish and Wildlife Federation Funding

The UIC Office of Sustainability received funding from the National Fish and Wildlife Foundation to restore a small prairie habitat on the West side of campus. The funding also supported two training sessions for 26 capital project and facilities managers conducted by a subject matter expert from YR & G (now WSP USA). This company provides a broad spectrum of sustainability services and master planning. The presentations provided the historical and ecological context of Chicago-specific water issues, and examples of how other cities have worked to manage rainwater and reduce flooding. The co-benefits of these projects include increased biodiversity, reduced maintenance costs, facilitating natural aesthetics, reduced heat island effects, and increased resilience. Green infrastructure goals can be integrated to advance walkability and bicycle infrastructure, create open and social spaces, and support urban wildlife. The project managers were also introduced to local green infrastructure strategies, and examples of effective design criteria which advance rainwater management. The presentation also touched on LEED credits, water budget tools, metering, Living Building Challenge, toxic chemicals, tree mapping, and engineered barriers.

This funding also supported 4 undergraduate interns during Summer and Fall, 2017 who, under the guidance of a graduate student, performed the some of the analyses provided in this document.

CCSE Grounds Subcommittee Meetings

The Grounds subcommittee of the Chancellor's Committee on Sustainability and Energy (CCSE) met in the summer of 2017 to discuss how a comprehensive stormwater management plan could be implemented at UIC addressing the most egregious issues on campus. An interdisciplinary group of faculty, staff and students discussed that this new plan should have 4 focus areas of (1) controlling excess surface water after a rain event, (2) stormwater capture through retention, (3) using collected water for irrigation coupled with a smart (wi-fi enabled) irrigation system and finally (4) aesthetics. It was noted that a comprehensive analysis of UIC's current conditions should be visualized so that stormwater and green infrastructure interventions can be properly addressed. The Grounds subcommittee recommended that the innovative vision be integrated into the UIC Campus Master Plan.

The subcommittee acknowledged that current stormwater issues cannot be addressed alone. After rain events the Grounds department invests significant manpower clearing standing water from sidewalks and streets owned by the City. A comprehensive plan to test out innovative and effective methods to manage stormwater will mutually benefit both parties. When re-landscaping university property, UIC can capture opportunities to align the Campus Master Plan (2017-2027) with target problem area via pilot green infrastructure interventions.

UIC needs accurate data to properly plan for stormwater management. Using simulations and analyses will broaden understanding of our current conditions. A program that was developed in-house by faculty in the College of Urban Planning and Policy (L-GrID) guides GI implementation. UIC needs to recognize the interaction between stormwater management, and landscaping operations, and maintenance to increase the productivity of the native plants around campus that effectively capture stormwater. UIC also needs to recognize the water quality issue of stormwater runoff. When using fertilizers to maintain the grass (especially in the athletic fields), the runoff can cause a pollution problem in the sewer system.

Therefore, one goal of this plan should be to measure and then reduce stormwater runoff to the City of Chicago's Combined Sewer Overflow (CSO) system from surfaces owned by UIC through tested green infrastructure techniques such as bioswales, green roofs, greenways, native landscaping with soil amendments, rain gardens, rainwater catchment, and/or the removal of paving and structures.

III. Additional Data Tables

Table 5. Percentage of runoff reduction and by each phase through the lens of working alone or with a partner.

	No GI (UIC)	No GI (combined)	Phase 1 (UIC)	Phase 1 (combined)	Phase 2 (UIC)	Phase 2 (combined)	Phase 3 (combined)
Average Annual Rainfall (in.)	46	46	46	46	46	46	46
Average Annual Runoff (in.)	32.5	34	31.9	33.6	28.2	29.7	13.7
Runoff %	70	73	69	72	62	65	32
Infiltration %	21	17	22	18	27	23	49
Evaporation %	9	10	9	10	11	12	20
Annual Runoff Volume (acre-ft)	703.4	909.8	690.4	899.1	610.3	794.7	367.7
Annual Runoff Volume (MG)	229.2	296.5	225	293	198.9	259	119.8
Reduction in Volume (MG)	-	-	4.2	3.5	30.3	37.5	176.7
Reduction in Volume (%)	-	-	1.8	1.2	13.2	12.7	59.6

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Photography:

Map of the Chicago area waterway system including Lake Michigan, the Chicago River and the Chicago Sanitary and Ship Canal. The UIC logo covers the geographical area which the university covers, to scale. (Cover)

Dawn on the east side of UIC. (Background image) Photo: UIC Staff Photographer, 2020. Copyright University of Illinois Board of Trustees (p. 1 - 2)

Bioswale south of Lincoln Hall. Photo: Lisa Sanzenbacher 2020. (p. 3)

Native flowers and plants in the Little Prairie on the Campus just south of the School of Public Health and Psychiatric Institute building. Photo: Kate Yoshida 2017. (p. 4)

Artist rendering of the Health Sciences Greenway Extension and Drug Discovery Expansion. UIC Campus Master Plan Executive Summary 2017 – 2027. (p. 5)

Aerial view of UIC campus, skyline, and Lake Michigan (Background image) Photo: Brad Cavanaugh 2012. Copyright University of Illinois Board of Trustees (p. 7 - 8)

Student walking through the rain on permeable pavement in the Grove. Photo: Lisa Sanzenbacher , 2017 (p.13 - 14)

Native plants outside of Mile Square Health Center. (background image) Photo: Lisa Sanzenbacher 2017 (p. 13 - 14)

Puddling outside of the sidewalks and streets just west of the Daley Library after a rain event . Photo: Lisa Sanzenbacher 2017 (p. 16)

Chicago Memorial Grove with view of Chicago skyline, native plantings, permeable pavement, and mature trees. (Background image). Photo: © UIC Creative & Digital Services, 2020 (p. 19 - 20)

Students from the Sustainability Internship Program near the green roof on top of Mile Square Health Center. Photo: Eric Dangoy, 2016. (p. 23)

Porous concrete in the parking stalls in Parking Lot 1A. Photo: Lisa Sanzenbacher, 2020. (p. 25)

People sitting near the native plant rain garden at Arthington Mall. Photo: Kevin Sheehan (p. 29)

Sustainable University sign illustrating the pollinator and stormwater-reducing benefits of the prairie garden known as the Little Prairie on the Campus. Photo: Lisa Sanzenbacher, 2020 (p. 31)

Bike racks, permeable pavers, rain gardens, and the facade of the Academic Residential Complex. (Background Image). Photo: Lisa Sanzenbacher, 2020 (p. 41 - 42)

Faculty and staff and the US EPA Region 5 administrator with a group of students who won awards from the U.S EPA for winning the Campus RainWorks Challenge speaking at EcoJam. Photo: Joshua Clark 2014. Copyright University of Illinois Board of Trustees (p. 48)

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