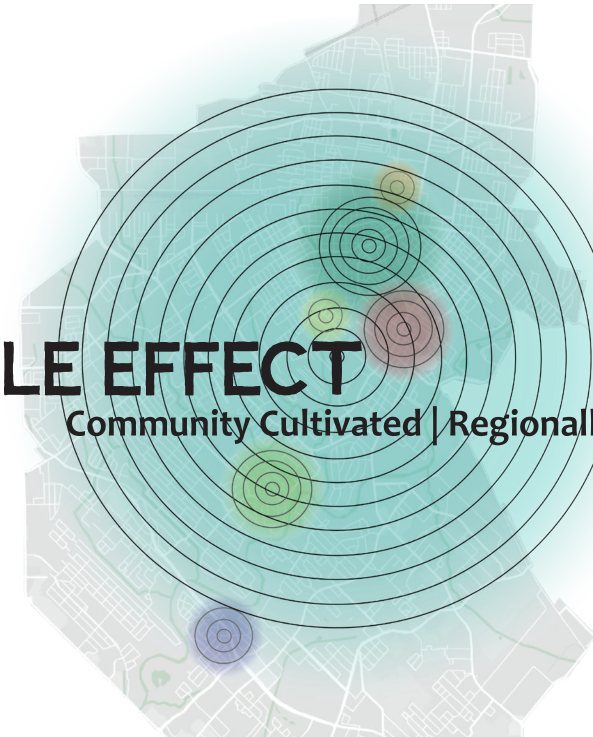

THE RIPPLE EFFECT

Community Cultivated | Regionally Replicated

UNIVERSITY OF LOUISIANA AT LAFAYETTE
PROJECT REGISTRATION # M42

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Abstract

Last month, the U.S. Global Change Research Program released "Volume II: Impacts, Risks, and Adaptation in the United States" from the Fourth National Climate Assessment (NCA4). It emphasizes that the threats to our natural, economic, and social systems are highly interconnected, and points out the critical need for regional adaption efforts to reduce our vulnerability. Many of the potential threats to the southeast region are already upon our communities, including increasing risks from extreme rain events and oppressive heat, and decreasing economic resiliency.

Our University, and especially our community, is hindered by previous decades of unsustainable development decisions. Grey infrastructure systems cannot adequately handle extreme rain events. Though Lafayette residents have a deep appreciation for nature, our urban areas lack green spaces that could provide eco-services and recreation opportunities.

Our team believes that when faced with extensive problems and limited resources, our solutions must provide numerous benefits. We are determined to view expected population and enrollment growth as an opportunity and the impetus to adapt with green infrastructure that will make our region more resilient and improve our quality of life.

The catastrophic flood of 2016 demonstrated that our region is not adequately prepared for the threats we face. However, the flood reconfirmed a deep-rooted trait in our culture – a resilient spirit, eager to collaborate for the greater good. Our goal is to use our campus as a living lab for developing site-appropriate green infrastructure strategies, and then engage our community and region to cultivate a ripple effect of resiliency.

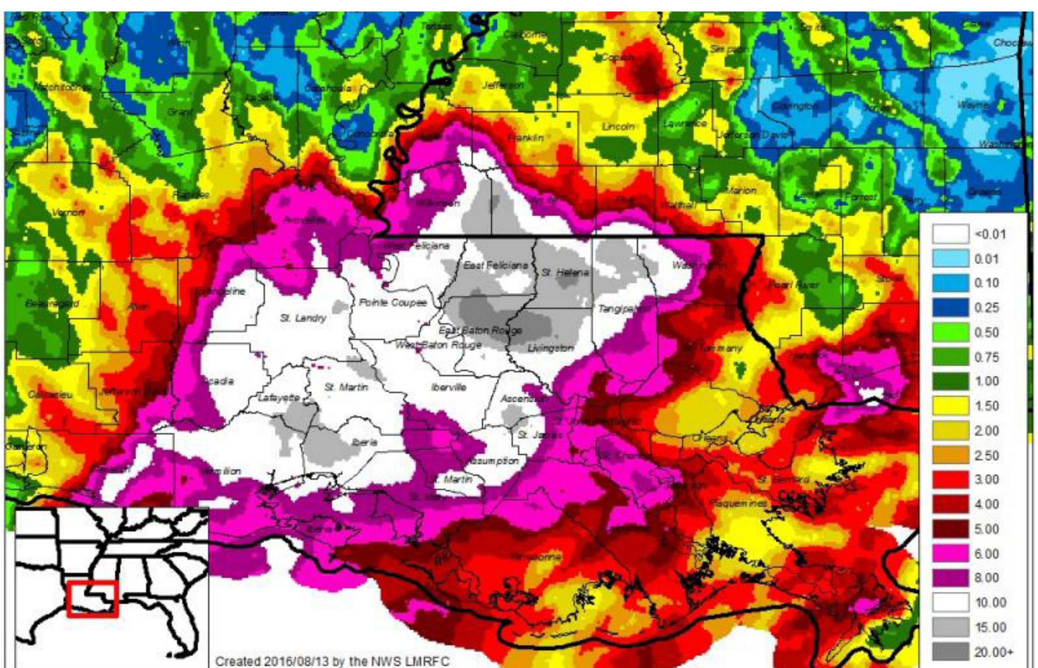
Introduction

"Just as ripples spread out when a single pebble is dropped into water, the actions of individuals can have far-reaching effects." - His Holiness the Dalai Lama. (Official twitter page of the Office of His Holiness the 14th Dalai Lama.)

The morning of August 11, 2016 seemed unremarkable to most in Lafayette Parish as residents prepared for their day. "First day of school" pictures had already been taken the day before for K-12 students. Athletes, band members, and small groups of incoming UL Lafayette freshmen were already moved into residential halls. Local weather services cautioned that flash flooding was possible, but the people of south Louisiana are a weather-tested crowd, having experienced historic hurricanes in recent years. Living in our beloved Acadiana region meant living with the rain, and most had come to expect the occasional route adjustments during their commutes due to flooded roadways. So they grabbed an umbrella, and headed out the door to start their day. Everyone quickly realized this "no-name" storm was, indeed, remarkable.

In the days to come, a stalled upper level low-pressure system with a pool of very deep tropical moisture would dump unrelenting, torrential rain (www.weather.gov). Extraordinary rainfall totals occurred over the three-day period, exceeding amounts that are typically expected to occur only once every 1,000 years in some areas. Nearly half of the lowest-lying southern portion the state received at least 12-14 inches of rain. Lafayette and Baton Rouge, were hit with upwards of 30 inches of rainfall (Fig 1). The unnamed storm flooded an estimated 75,000 structures, caused $10.1 billion in damages, and was attributed with 13 fatalities (NCA4, Ch. 19).

Figure 1: Estimated Rainfall in South Louisiana, August 11-13, 2016.



National Weather Service

During the event and in the aftermath, the response and resilient spirit of our communities was equally remarkable and extraordinary. Ordinary people with boats showed up in droves to help emergency responders with water rescues and distributing sandbags to trapped residents. As soon as the water receded, neighbors helped neighbors "muck out" their homes, tearing out drywall, insulation, and flooring. In the hardest hit areas, UL students and student athletes showed up in busloads to deliver donated supplies and help strangers recover. Alumni donated thousands and thousands of dollars to help affected students stay enrolled. Our hope is to capture this spirit demonstrated during the response and channel it into a proactive response that will prepare our community for better outcomes during future events, while also improving quality of life with green spaces that can appreciated and enjoyed by community members.

Image from August 16, 2016 of volunteers pitching in to help neighbors fill sand bags against flooding from the Vermilion River in Lafayette, La.
Featured in "Flooding in the South Looks a Lot Like Climate Change." www.NYTimes.com, Photo Credit: Scott Clause/The Daily Advertiser, via Associated Press,

The findings and message of the Fourth National Climate Assessment (NCA4) for the southeast region are clear. The assessments align with conclusions from recent planning efforts at the University, city, and parish scale. Our geographic place, historic development patterns, and lack of economic resiliency have left our communities and University especially vulnerable to environmental threats.

Many of the projected risks from more frequent extreme rain events are already impacting our Lafayette community and the state of Louisiana. Heavy rainfalls, not associated with hurricanes, in 2014, 2016, and 2017 caused widespread flooding (Fig. 2), shut down commerce, damaged homes, schools, businesses, and infrastructure, and were attributed with 18 fatalities. Furthermore, it confirmed what the newest FEMA flood maps, effective December 21, 2018 have determined: inland, low-lying areas are especially vulnerable to the projected extreme rainfall events of our future. 4,500 additional Lafayette parish properties were added to flood zones (Taylor, TDA).

Figure 2: Billion- Dollar Flood Events in the Southeast

EVENT	DATE	DAMAGES	FATALITIES
Southeast Tornadoes and Flooding (FL,AL,AR)	April 27 - 28, 2014	$1.8 Billion	33
Hurricane Matthew	October 1-5, 2015	$10.1 Billion	49
Northern Louisiana Flood	March 8-12, 2016	$2.4 Billion	5
Southern Louisiana Flood	August 11-13, 2016	$10.1 Billion	13

Values are Consumer Price Index adjusted and are in 2017 dollars. Source: NOAA NCEI 2017.84; Adapted from Fourth National Climate Assessment: Chapter 19 Southeast.

Population growth, rapid development in low-lying areas, and growing enrollment at UL Lafayette could compound this environmental risk, and more. The NCA4, UL Lafayette research, and recent parish-wide assessments all point to additional potential threats to our University and communities. We are already witnessing impacts from the urban heat island effect, depletion of our Chicot Aquifer, loss of habitats, impaired water quality in the Teche-Vermilion watershed from non-point pollution carried by stormwater runoff, and deteriorating, outdated infrastructure.

However, we are not defenseless, nor have we given up hope for a better outcome. Shortly before the catastrophic flooding events, the University and Lafayette Consolidated Government recognized the need for more sustainable development to accommodate expected enrollment increases and population growth. Both parties created complementary long-term master plans. The establishment of the Living Lab initiative through the University's Sustainability Strategic Plan provides a pathway and funding for short-term and medium-term projects.

This submission will be dually submitted to both the EPA Rainworks Challenge and the Louisiana Department of Environmental Quality, which recently mandated the University and City-Parish submit a Stormwater Masterplan in order to maintain our Municipal Separate Storm Sewer System (MS4) permits. A primary focus of this team is to align this Green Infrastructure Master Plan and its proposed strategies and decision-making methodology with the University's Master Plan, Strategic Sustainability Plan, and Lafayette Consolidated Government's Plan Lafayette Comprehensive Plan. These plans are critical to our progress, and clearly support the implementation of green infrastructure.

Our Rainworks Challenge Green Infrastructure Master Plan aligns these existing plans and calls for action with focused, positive intention. The Living Lab initiative, Facilities Management, and University Ecology Center have already committed funding and resources to actualize several of these strategies on our campus in spring and fall 2019. We have already engaged alumni and business owners in partnering with our students during community service events to cultivate projects throughout our community and parish. Finally, we intend to increase our ripple effect of resiliency by campaigning for the adoption of polices and funding to replicate our efforts on a regional scale.

Existing Conditions and Threats

Decades of unsustainable development decisions at the campus, city, and regional scale, compounded by increasingly heavy rain events that threaten property, public quality of life, and safety define the context of the The Ripple Effect: Community Cultivated, Regionally Replicable proposal.

Plan Lafayette, the city and parish's 20-year master plan adopted in 2014, identified four key trends, each of which impact and guide our Green Infrastructure Master Plan. First, our population is growing. From the mid-90's to 2014, Lafayette Parish's population increased by about 34%, from approximately 164,000 to more than 221,000 residents (Plan Lafayette, Executive Summary, xii). This is expected to continue with an expected 30% growth from our current population to 310,000 people by 2030. Second, development persistently continues in low-lying areas, increasing impervious surfaces downstream and increasing risk of property damages from floods. We view this growth as an opportunity for implementation of green infrastructure.

Inadequate funding for new infrastructure and repair to deteriorating infrastructure is another key trend identified by Plan Lafayette. On-site stormwater management was not included in building codes until the late 1990's, nearly one hundred years after our University's founding. Historic, developed areas of Lafayette and campus have outdated infrastructure that cannot handle the heavy rain events. The cost of replacing this entire infrastructure makes it very unlikely, and the resulting impacts of moving more runoff downstream to lower-lying areas, more quickly, is not acceptable. We view this as a key reason to adapt our historic areas of campus with on-site, green infrastructure projects, from rainwater harvesting to a series of rain gardens and/or bioswales.

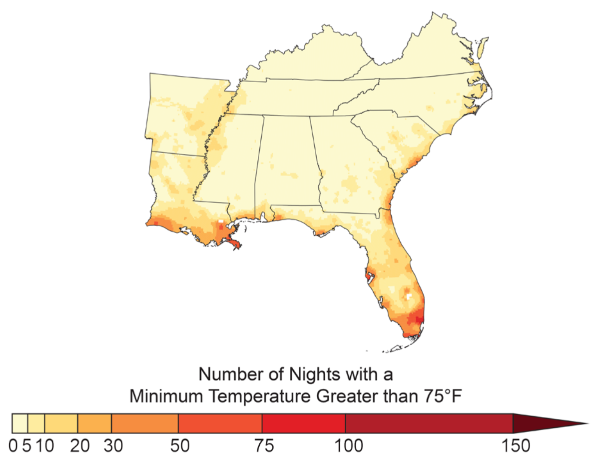
Plan Lafayette identifies a lack of investment in key issues that can improve our quality of life as the fourth key trend in our parish. Our current park inventory totals 1,500 acres, or 6.7 acres per 1,000 population in the parish. This is well below many comparably sized communities. The increasing frequency of heavy rain events and our infrastructure's inability to handle the capacity of runoff have become an everyday disruption to quality of life for our entire community. Disabled students in wheelchairs cannot cross campus when St. Mary Boulevard floods. Students often walk through water over their ankles on campus, and faculty, staff, and commuter students often cut their day short because of anxiety that they may not be able to get home through flooded roadways. Even the threat of heavy rains cause local schools to close for fear of stranding students at schools or the difficulty busses face by navigating through flooded streets. We believe the integration of green infrastructure on campus and in public spaces, through University community service projects, will enhance our green spaces and reduce some of the frequent localized flooding on campus.

While we are more increasingly faced with the threats of extreme rain events and flash flooding, a diminishing Chicot aquifer also threatens our population and agricultural economy. The Chicot aquifer is the most-used source of fresh groundwater in Louisiana, and covers an area of 23,000 km2 (Borrok, 2016). The aquifer accounts for 41% of all groundwater withdrawals and is being overdrafted by an estimated 1,320,000 m3 per day (Sargent, 2011).

While agricultural practices are a massive contributor to this issue, the University has practices we must address to reduce our own impacts. One of our most loved natural spaces on campus, Cypress Lake, requires potable water to maintain its levels. Since 2015, we have pumped an average of 1.7 million gallons of water annually into this managed wetland. While we appreciate the beauty, educational resources, and natural value Cypress Lake brings to our campus, we believe it is imperative that we implement water-balancing strategies to reduce our impacts on the Chicot aquifer.

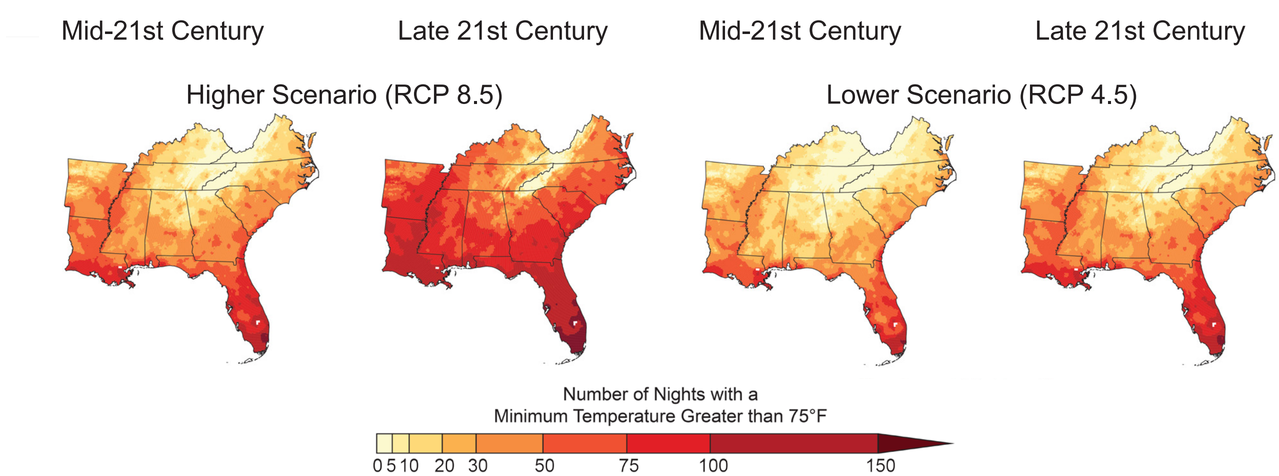
In addition to flood risks and a diminishing aquifer, our community is experiencing other measurable environmental impacts from urbanization, development, and climate change. The urban heat island effect is noticeable during warm weather months on campus and the urbanized parts of the city (Fig. 3). The oppressive heat reduces the quality of life for our residents and reduces time spent outdoors. In recent years, reduced air quality has also been measured, prompting the University, Lafayette Consolidated Government, and Lafayette-based company CGI to submit an EPA Smart City Challenge proposal that was selected . We are now distributing a network of air quality sensors throughout our campus and community. We plan to decisively combat both these challenges by drastically increasing our urban forest canopy on and off campus, as well as actively pursuing the integration of green roofs.

Figure 3: Projected Changes in Warm Nights



The map above shows the historical number of warm nights (days with minimum temperatures above 75°F) per year in the Southeast, based on model simulations averaged over the period 1976–2005. Below, Sources: NOAA NCEI and CICS-NC.; Adapted from Fourth National Climate Assessment: Chapter 19 Southeast.

Projected Number of Warm Nights



ALIGNMENT WITH CURRENT PLANS AND CAPTURED MOMENTUM

University Master Plan and Guiding Principles

In 2014, after a year-long planning period, the University adopted a Master Plan and Guiding Principles intended to guide the development of the campus into the 2030's. This plan arose from the aspiration of a vision to improve the environment of the University and make it one of the most comfortable and inspiring academic institutions in America. The master plan defines a code to clearly guide decision-making processes while allowing for adaptation to changing influences and demands (Architects Southwest, 7).

The plan was developed with several goals in mind. First, the plan guides the University in adapting for expected enrollment growth and the growing need for on-campus housing. This was informed by high-level assessments surrounding academic space needs, as well as market dynamics focused on potential demand-side analysis. Second, the plan proposes strategies to successfully weave three currently incongruent adjacent landmasses – the Main Campus (145 acres), the St. Landry Corridor, and University Common (388 acres) – into one cohesive University District, through an articulation of uses, patterns, and environmental sensitivity (Architects Southwest, 7).

Finally, the plan broadly proposes the "Path of Knowledge" (Fig. 4), a figurative and physical greenway that links the University Common through the St. Landry Corridor to the Main Campus, serving to define and connect the University. The "Path of Knowledge" is intended to integrate Urbanism into the fabric of the district, while providing for a natural bioswale and community park system along an existing drainage lateral. The intention is to enhance the quality of life for inhabitants, beautify our community, and proactively address stormwater management with site enrichments (Architects Southwest, 64).

Figure 4: Proposed "Pathway of Knowledge" from University Master Plan

The "Path of Knowledge" is intended to integrate Urbanism into the fabric of the district, while providing for a natural bioswale and community park system along an existing drainage lateral.

The Master Plan describes a development with natural land features and created amenities from parks, playgrounds, and quadrangles distributed throughout the district, all linked by the greenway, but stops short of proposing specific green infrastructure design details for implementation. However, the Master Plan does utilize the "Urban Transect", a system of land classifications and development patterns described in The Lexicon of the New Urbanism. The Transect proposes "finding the proper balance between natural and human-made environments along the rural-to-urban Transect (Architects Southwest, 57)."

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These characteristics serve to create the Master Plan's structure for recommendations regarding land use, streetscapes, building design, landscape design, parking, and other development features. For example, along the aforementioned Path of Knowledge exists St. Mary Boulevard, the most urban part of campus, which has pedestrian thoroughfares and bike lanes, planter strips, and historic live oak trees. Also along the Path of Knowledge is a 40-acre green space dissected by an existing open drainage canal with concrete walls.

This Green Infrastructure Master Plan further develops the goal of the greenway with specific strategies that are appropriate for the varied existing landscapes, as well as proposes additional strategies for development outside of the Path of Knowledge. Detailed approaches for integrating green infrastructure into the existing landscape were developed to align with the "District Regulating Instructions" for each of the various land classifications of the Master Plan. We believe aligning the green infrastructure and plant specification with the existing guidelines of the Master Plan is critical to long-term adoption and implementation.

Figure 5: Urban Transect

The Urban Transect guides the development intensity from nature (T1) to the most urban (T6).

University Sustainability Strategic Plan

On July 1, 2018, University President, Dr. E. Joseph Savoie, launched the University's first Sustainability Strategic Plan. This plan sets out strategic, time-constrained objectives that will guide the entire University in continuing our steady progress toward achieving our sustainability goals through 2021. Faculty, staff, students, and administrators worked together to incorporate principles of sustainability and strategies for progress into all areas of our institution, including our operations, our mission of education and research, and engagement of our campus community.

A primary goal and the centerpiece of the plan is to utilize our campus and region as a living laboratory to inform and inspire our students, faculty, staff and community to create positive, systemic changes for a sustainable future. Recognizing the transformative potential, President Savoie rededicated 25% of funds raised through alumni giving to the University Annual Fund to the Living Lab initiative. These funds will be utilized for interdisciplinary project-based learning and applied research that will improve our campus, prepare tomorrow's leaders, and develop innovative solutions to sustainability challenges we face.

The establishment of the Living Lab initiative has brought together experts from our classrooms and labs, students eager for hands-on experiences, and staff members who work daily to operate our campus. In this first year of funding, green infrastructure was chosen as one of three projects, making this Green Infrastructure Master Plan immediately relevant and actionable. In years to come, the staff and faculty of this team will guide students in applying for additional funding through the Living Lab Request for Proposals process.

The Plan positions the University to prioritize green infrastructure during the next three years. The shared benefits of green infrastructure are woven into each of the four major goals of the sustainability plan. This Green Infrastructure Plan and its proposed strategies directly support the objectives that are key to achieving each of the University's four sustainability goals (Figure 6).

Figure 6: Goals from the Sustainability Strategic Plan and Objectives Supported by the proposed startegies of this Green Infrastructure Master Plan .

Operations Goal: Cultivate a healthier, more resilient campus community and mitigate our negative environmental impacts affecting current and future generations by fully institutionalizing sustainability principles and best practices into all areas of university operations and development.
Water Use and Watershed
Objective 1: Reduce potable water usage on campus by 10% below 2007, weighted baseline, including process, irrigation, and consumer water usage by July 1, 2021. Objective 2: Improve local Teche-Vermilion watershed by reducing stormwater runoff and potential sources of non-point pollution.
Landscape and Habitats
Objective 1: Develop and manage campus grounds as a paradigm of a diverse, urban landscape that provides the University and community with environmental, economic, and social benefits, while supporting biodiversity.
Buildings and Planning
Objective 1: Develop and manage the campus as a paradigm of a sustainable University that recognizes the environmental, economic, and social impacts and opportunities of the built environment.
Health and Wellness
Objective 1: Enhance the personal health, well-being, and quality of life for our students, faculty, and staff by providing access to healthy lifestyle options and properly maintaining our built environment. Objective 2: Foster a culture of wellness among students, faculty, and staff by promoting healthy lifestyles and providing holistic wellness resources.
Air and Climate
Objective 1: Reduce adjusted net Scope 1 and Scope 2 GHG emissions associated with campus operations by 15% below 2015 levels by July 1, 2021. Objective 2: Monitor, report, and develop strategies with stakeholders to protect local and regional outdoor air quality and minimize ground level ozone and particulate matter pollution.

Figure 6, continued: Goals from the Sustainability Strategic Plan and Objectives Supported by the proposed startegies of this Green Infrastructure Master Plan .

Academics and Research Goal: Educate, inspire, and foster students' development into change agents who are informed and capable of implementing thoughtful, effective solutions to the environmental, social, and economic challenges we face at the local, national, and global scales.
Education and Professional Development
Objective 1: Prepare students for successful careers that leave a positive impact on the environment, society, and the economy.
Research
Objective 1:Enhance sustainability research and the University's reputation as an institution that specializes in applied research that solves real-world problems or improves people's lives.

Engagement Goal: Lead discussions and initiatives that will increase awareness, foster positive lifestyle changes, and inspire active involvement from the entire University community.
Campus Engagement
Objective 1: Lead discussions and initiatives that will increase awareness, foster positive lifestyle changes, and inspire active involvement from the entire University community.
Community Engagement
Objective 1: Increase sustainability engagement beyond campus grounds and work with our partners to translate sustainability awareness into action that will improve our community, region, and state.

Our Opportunity and Plan

Our diverse, transdisciplinary team of students, faculty, and staff came together under serendipitous circumstances. Staff and students working in the Office of Facilities Management and Office of Sustainability have been working together for several years to make small green infrastructure improvements on campus. The recent launch of the Sustainability Strategic Plan and Living Lab provided the perfect opportunity to expand our scope of projects on campus.

However, we realized we lacked a clear plan for decision-making and fund allocation. Architecture graduate students working in the Office of Sustainability and Office of Community Service proposed the EPA Rainworks Challenge as an opportunity to formalize our efforts and bring additional staff, faculty, and students into the process. While forming our team and defining our work, the Louisiana Department of Environmental Quality notified the University and all institutions that maintain Municipal Separate Storm Sewer System (MS4) permits that new Stormwater Management Plans (SWP) were required to continue our permit.

This project's group of students and faculty members from the Colleges of Science, Arts, and Liberal Arts; along with staff from the Office of Sustainability, Office of Facility Management, and Ecology Center; seized the opportunity. We have developed a proposal for the EPA Rainworks Challenge that simultaneously strengthened our SWP for LA Department of Environmental Quality. The strategies for green infrastructure align with our Master Plan and Sustainability Strategic Plan, which both have dedicated funding sources, and created a new Living Lab project that already has funding. Finally, we have coalesced around the following vision:As representatives of an institution of higher education dedicated to environmental, social, and economic sustainability, this team believes it is our responsibility to:

- *Analyze the environmental risks and threats to our University, community, and southeastern region.*
- *Utilize our campus for transdisciplinary project-based learning, applied research, and hands-on partnerships to implement site-specific green infrastructure projects and demonstrate readily adoptable strategies for our community and region.*

- *Engage our neighbors in creating positive, systemic changes to our natural environment through community service projects.*
- *Advocate for regional and state-wide adoption of green infrastructure policies that support our continued adaption and increased resiliency.*

Our plan aims to solve multiple problems with dynamic, strategic solutions. Our expected outcomes from the green infrastructure strategies are as follows:

- *Reduced quantity of stormwater runoff from existing buildings, streets, parking garages, and parking lots.*
- *Improved quality of stormwater runoff from existing buildings, streets, parking garages, and parking lots.*
- *Reduced use of potable water.*
- *Reduced impacts from the urban heat island effect and a more comfortable outdoor environment.*
- *Recharged Chicot Aquifer.*
- *Increased natural habitat areas and biodiversity.*

Tiered Approach

The team developed a tiered approach to defining our green infrastructure strategies, starting with projects that are in the process of implementation or can be implemented within one year, then medium-term to long-term projects. Tier 1 of the proposed design strategies includes increasing our urban forest tree canopy and our Coulee Prairie Planting. The project utilizes native prairie grass, grown by our Ecology Center, as buffer strips along the edge of the coulee that runs through campus. The Coulee Mine is a concrete storm water collection system that runs through the city and empties the water it collects into the Vermillion River. The prairie grass planting will help strengthen the soil along the coulee, the grass would increase the amount of infiltration to the Chicot Aquifer, and filter the water runoff before draining into the stormwater system thereby improving the water quality of the Vermillion River.

Tier 1 also includes increasing our rainwater harvesting and retention projects. This includes installing more rain barrells and/or cisterns. Tier 1 also includes installing rain gardens and bioswales, at multiple scales, that would be located along the exterior and interior of campus, especially focusing on areas developed prior to the introduction of onsite stormwater management codes. The raingardens have been designed to accommodate the first inch of rainfall to prevent the stormwater from flooding onto adjacent streets, buildings, and sidewalks.

Tier 2 includes the utilization of permeable pavement on campus for sidewalks and parking areas. These strategies will be implemented over time as new sidewalks and parking lots are built. Discussions have begun about replacing small areas of parking lots with multiple versions of permeable pavement to act as test sites to determine long-term viability and effectiveness of different materials and techniques.

Managing human comfort in the hot-humid south is extremely resource demanding. To address occupant comfort in campus buildings the University utilizes a chilled water system of air conditioning that requires millions of gallons of municipally-sourced water, annually. The collective footprint of the 11 ground chillers takes up 30,000 sqaure feet of otherwise permeable surface. Tier 3 of our plan is to couple chillers with University parking towers and/or quads. For future development, chillers would be located either adjacent to quads or on the rooftop of parking garages. In each instance, diverted stormwater collected from nearby buildings would be stored in a subterranean large capacity water tank and held until needed by the chilled water system. An added benefit of the thermal grounding of the water tank is that water stored would already be cooled to a near useable temperature for the system. As the system cycles, captured stormwater would evaporate, closing the loop on the fresh water cycle and preventing valuable fresh water rainfall from being shunted to the tidal saline marshes of the Gulf of Mexico.

Tier 4 is an innovative and sustainable practice for storing water known as Aquifer Storage and Recovery (ASR). ASR is the process of collecting surplus water and injecting it into an underground aquifer through a dual-purpose well capable of both injection and abstraction. The source water remains in a storage zone within the aquifer and is available for retrieval when needed. An illustration of an ASR well and it's components are included in Figure 7. A common concern in many coastal areas today is saltwater migration into freshwater aquifer systems and land subsidence due to over drafting of groundwater supply. Recharging the aquifer through ASR could provide a barrier to saltwater intrusion and reduces the progression of subsidence by increasing groundwater baseflow (CDM Federal Programs Corp., 2017).

Figure 7: ASR Project Components (Parker, 2016).

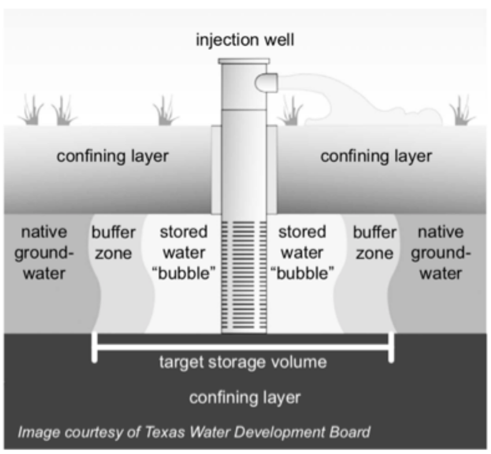
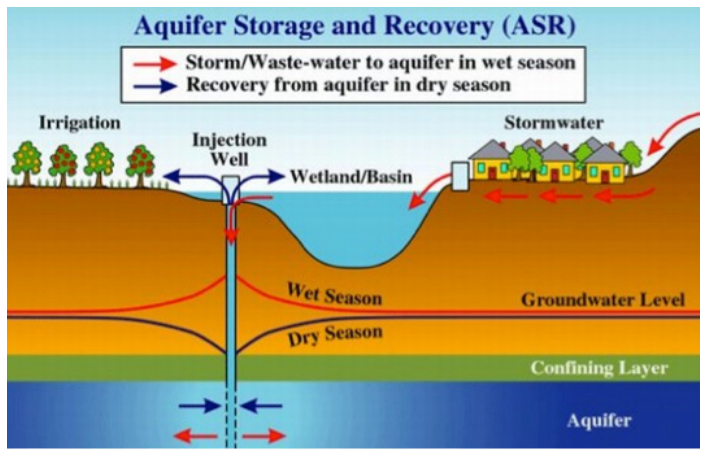


Figure 8: Stormwater ASR Project (Lingvai, 2014).



This technology is an efficient and economical alternative to other storage techniques. It is resilient, cost effective, and not as intrusive to the environment as other existing alternatives. Storing water through ASR prevents losses from evaporation or seepage and preserves the water quality longer than a surface reservoir (CDM Federal Programs Corp., 2017). An ASR project typically reduces land acquisition costs since it requires less space and therefore prevents destruction of habitat and property.

Aquifer Storage and Recovery has been effective with the use of water sources such as potable water, reclaimed water, partially treated surface water, and raw groundwater (CDM Federal Programs Corp., 2017). In the case of using surface water as the source of stored water, an ASR project could also mitigate flooding impacts by reducing peak stormwater flow (CDM Federal Programs Corp., 2017). Figure 8 shows a depiction of how stormwater would be used in an ASR project.

Decision Making Model

The team wanted a responsive and adaptable decision matrix (Fig. 9) to aid decision making under different circumstances. We believe this is imperative for the long-term implementation of our strategies on campus. We also developed the matrix to empower residents, business owners, and non-profits administrators to cultivate their own projects throughout the community.

Strategies of the four tiers were put through the matrix to determine their viability and effectiveness. Each strategy was evaluated according to its anticipated outcomes in four key areas: stormwater management efficacy, integrated stormwater management effectiveness, the value of other ecosystem services, and the social value that it provides. Cost estimates for each strategy help to choose the most appropriate strategy according to available funding.

The team then developed a second layer of evaluation for the strategies, specific to the University's needs. First, we assessed how each strategy aligns with the Campus Master Plan and Guiding Principles, the Sustainability Strategic Plan, and Plan Lafayette. Estimated costs and alignment of the specific strategies with each plan aided the team in determining the most appropriate funding source. These parameters, as well as considerations for permitting and future development plans, resulted in recommendations for a timeline of implementation .

Community Engagement and Service

The identifying factor of this Green Infrastructure Masterplan is the way in which our team plans to engage both students and the community with the outlined strategies and projects. Our goal is to not just better manage stormwater on University property and surrounding areas, but to educate and influence the way that community members, developers, and government officials in Lafayette and throughout Acadiana look at and handle stormwater and runoff moving forward.

Our plan utilizes service-learning and community-based social marketing techniques to achieve this goal. The projects we have identified to take place on campus will serve to model responsible stormwater management behavior. We will use signage, public communications via press releases and social media, and direct contact with key community leaders to demonstrate the effectiveness of and provide community education on green infrastructure.

Our interdisciplinary team of students, faculty, and staff will then garner commitment from local businesses to install rain gardens in visible, but needed, areas of their property. The first of these community rain gardens will be installed by student volunteers during the University's flagship service event, "The Big Event", and will serve to start the ripple effect outward from campus. Two local businesses owned by involved community members have already shown interest in participating, one in Lafayette and one in the neighboring city of Scott, LA. Incorporating green infrastructure outside of campus, working with community leaders who will talk about their benefits and experiences, will help to norm and diffuse the practice within the region.

This is THE RIPPLE EFFECT. By using the University to demonstrate green infrastructure and low impact development projects, we will raise awareness and create a norm for the implementation of sustainable storm water management strategies throughout South Louisiana. We will improve water quality in local waterways, encourage ground water recharge, and engage our community and region to cultivate a ripple effect of resiliency.

Figure 9: Decision Making Model for Implementation of Green Infrastructure Strategies.

Strategy	Anticipated Outcomes				Estimated Costs	Plan Alignment	Funding Strategy	Timeline for Implementation
	Stormwater Management	Integrated Water Management	Other Ecosystem Services	Social Value	<$1,000 $1,000- $2,500 $5,000 - $10k $10k - $20k $20k - $40k >$40k	-University Sustainability Strategic Plan (USSP) -University Master Plan (UMP) -Plan Lafayette (PL)	-Living Lab (LL) -Annual Cost Share (ACS) -MAP Fee (MAP) -KLB Grant (KLB) -Construction Budget (CB)	-1-2 Years - 2-5 Years -5-10 Years -10- 15 Years
Rainwater Harvesting:	.028% Reduction in Stormwater Peak Flow in a one year 24 hour storm:			Economic Benifits				
55 gal rain barrel		7128 gallons per year reduced from municipal supply for irrigation		Flood Reduction	$1,000-$2,500	SSP	LL	5/ 1-2 Years
Cisterns		30,000 ft^2 of restored soils and native plant communities		Water Recycling for Irrigation	$5K-$10K	SSP	LL	2/ 2-5 Years
ASR		1.481 million gallons per year reduced from municipal supply for irrigation			>$40K	UMP/SSP	CB	5-10 Years
Rainwater Retention:	3.3% Reduction in Stormwater Peak Flow in a one year 24 hour storm:			Eco Tourism Beautification				
Rain Garden: Small-Large		110,752 gallons per year recharged into aquifer & 14,400 ft^2 of restored soils and native plant communities		Generator for Polinators & Wildlife	$1,000-$2,500 to $2,500-$5,000	SSP/UMP/ PL	LL/ACS/KLB	3/1-2 Years
Bioswale: Small-Large		6,000 ft^2 of restored soils and native plant communities			$1,000-$2,500 to $2,500-$5,000	SSP/UMP/ PL	LL/ACS/KLB	3/1-2 Years
Vegetative Planting:	.003% Reduction in Stormwater Peak Flow in a one year 24 hour storm:			Slow Water Runoff				
Natural Buffer Zone: Small - Large		6191 gallons per year recharged into aquifer		Eco Tourism Beautification	$2,500-$5,000 to $10K- $20K	SSP/UMP/ PL	LL/ACS/MAP	1-2 Years
Prairie Grass Seeding: Small - Large		805 ft^2 of restored soils and native plant communities		Generator for Polinators & Wildlife	$1,000-$2,500 to $2,500-$5,000	SSP/UMP/ PL	ASC	1-2 Years
Increase Urban Forestry Canopy		1000 trees to be added to the main campus & research park in the next five years		Enhanced Infiltration	$5K-$10K	SSP/UMP/ PL	ASC	1-5 Years
Architectural Building System:	25.12% Reduction in Stormwater Peak Flow in a one year 24 hour storm:			Reduction of Water from Municipal Supply				
Green Roof		30,000 ft^2 of restored soils and native plant communities		Beautification of Campus	>$40K	SSP/ UMP	LL/CB	1/5-10 Years
Chillers		4.81 MGY reduced from municipal supply for indoor use		Reclaimed Public Space	>$40K	SSP	CB	1/5-10 Years

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