DESIGN -ING WITH WATER

REBECCA COOK, BSLA CANDIDATE

Designing With Water: An Exploration of Sustainable Stormwater Management Practices for Rutgers University's Cook/Douglass Campus

by

Rebecca Cook '14

A thesis submitted to the Honors Committee of the
School of Environmental and Biological Sciences, Rutgers University
in partial fulfillment of the requirements
of The George H. Cook Scholars Program

Written under the direction of

Holly Nelson

Department of Landscape Architecture

New Brunswick, New Jersey

May, 2014

Designing With Water: An Exploration of Sustainable Stormwater Management Practices for Rutgers University's Cook/Douglass Campus

I have reviewed the project conducted by Rebecca Cook and endorse its consideration for the George H. Cook Scholar award.

Holly Nelson, Project Advisor
Department of Landscape Architecture

Everything on the earth bristled, the bramble
pricked and the green thread
nibbled away, the petal fell, falling
until the only flower was the falling itself.
Water is another matter,
has no direction but its own bright grace,
runs through all imaginable colors,
takes limpid lessons
from stone,
and in those functionings plays out
the unrealized ambitions of the foam.

WATER, PABLO NERUDA

ACKNOWLEDGMENTS

This thesis would not have been possible without the help of a number of individuals, all of whom dedicate themsleves designing a better world each and everyday.

To my tireless advisor, Holly Nelson, who devoted a great deal of her own time to helping me further my research and thought process, I am incredibly grateful. Without her guidance and constant support through to the end I could not have created a dissertation of this caliber.

I would also like to thank Dr. Laura Lawson, Dr. Wolfram Hoefer, Dr. JeanMarie Hartman, Richard Alomar and Tobiah Horton with Rutgers University's Department of Landscape Architecture, all of whom made themselves available for questions, research support, and periodic presentations and critiques.

A special thanks goes to Jeremiah Bergstrom and Jess Brown with the Rutgers Cooperative Extension Water Resources Program for their assistance, guidance, and enthusiasm concerning green infrastructure and water sustainability. Additionally, I would like to thank Seth Richter with Rutgers Universities Facilities for helping to further my campus research.

I am thankful to Kate Higgins and my Material Tectonics classmates for all of their hard-work and collaboration in creating the sustainable bus shelter structure. Finally, I express appreciation to my G.H. Cook Scholar colleagues Jessie Woods and Michelle Hartman for helping foster a feeling of community and teamwork between our respective theses. This dynamic helped provoke me to forge on during the times when I felt uninspired.

CONTENTS

Source: Esri, DigitalGlobe, GeoEye

INTRODUCTION

This thesis investigates water sustainability from the perspective of design. Moreover, it considers the point of view of an “insider” of the site’s community, a Rutgers University School of Environmental Sciences student, which helps inform design solutions that are cognizant and sensitive in retaining the campus’ “sense of place.”

Water management is an interesting topic to consider through the lens of landscape architecture. The topic inherently has close ties to engineering and planning which makes moving from design to implementation an interesting and rewarding challenge. There are three main components this project wishes to address: understanding and proposing artful water resource management solutions, designing thoughtful, appropriate, and multifunctional campus design solutions, and exploring how this type of sustainable investigation could promote recreation and education.

Ecologically, mindfully managing and accounting for stormwater reduces runoff, reduces rates of peak- flow in nearby streams, improves the health of the project’s watershed, reduces “urban heat island” effect, reduces erosion, improves air quality, improves groundwater recharge rates, improves local ecosystem habitat, and addresses pollution into local waterways and gray infrastructure systems. Monetarily, it can cut costs by harvesting water and using it for new purposes- costs resulting from stormwater related damage and costs of fixing erosion and pollution problems in areas where stormwater is not adequately accounted for.

As New Jersey’s largest educational institution, Rutgers has an obligation to lead in environmental consciousness and green practices education. Through the type of inventory and analysis of environmental and social conditions on Cook/Douglass and then through suggested design solutions, this thesis begins to explore how Rutgers being to address this initiative.

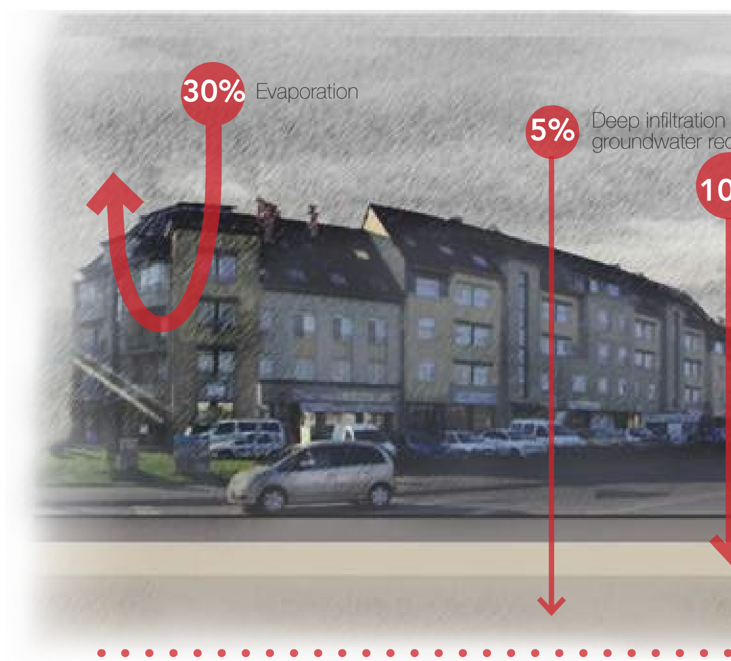
PERSONAL STATEMENT

I find the relationships humans have with water to be strange one. As children, we are taught that to overcome water we must push it aside to propel ourselves forward and swim. If you think about this relationship metaphorically, you can see a similar relationship between water and the built environment. The most conventional infrastructure systems of today focus on capturing water from the sky, piping it below ground and releasing it to a nearby waterway or cleaning facility. In doing so, there is little interplay between people and stormwater and thus little understanding of water systems, processes, and its role in the natural environment. This pattern leaves stormwater as something to be maintained and discarded rather than an multidimensional asset with infinite applications and uses. As children grow, they are able to better understand the nature of water and, then, can learn to float-- coexisting with water calmly and harmoniously. Green infrastructure and sustainable water practices are the infrastructural equivalent of this. Everyday they are becoming more relevant considerations across the landscape architecture, architecture, engineering and city and regional planning disciplines as designers are working to better unify the built and natural environments.

RESEARCH QUESTION

From my experience, it seems that stormwater management is viewed a rigid, dense engineering exercise in landscape architecture. This thesis questions how the fundamental principles of stormwater management and green infrastructure can be analyzed in concurrence with historical and environmental site analysis to propose a new and innovative means for activating Cook/Douglass campus. This thesis aims to provide a fluidity in sustainable water topics as means for furthering research that could propose a set of recommendations for best organizing and applying these topics.

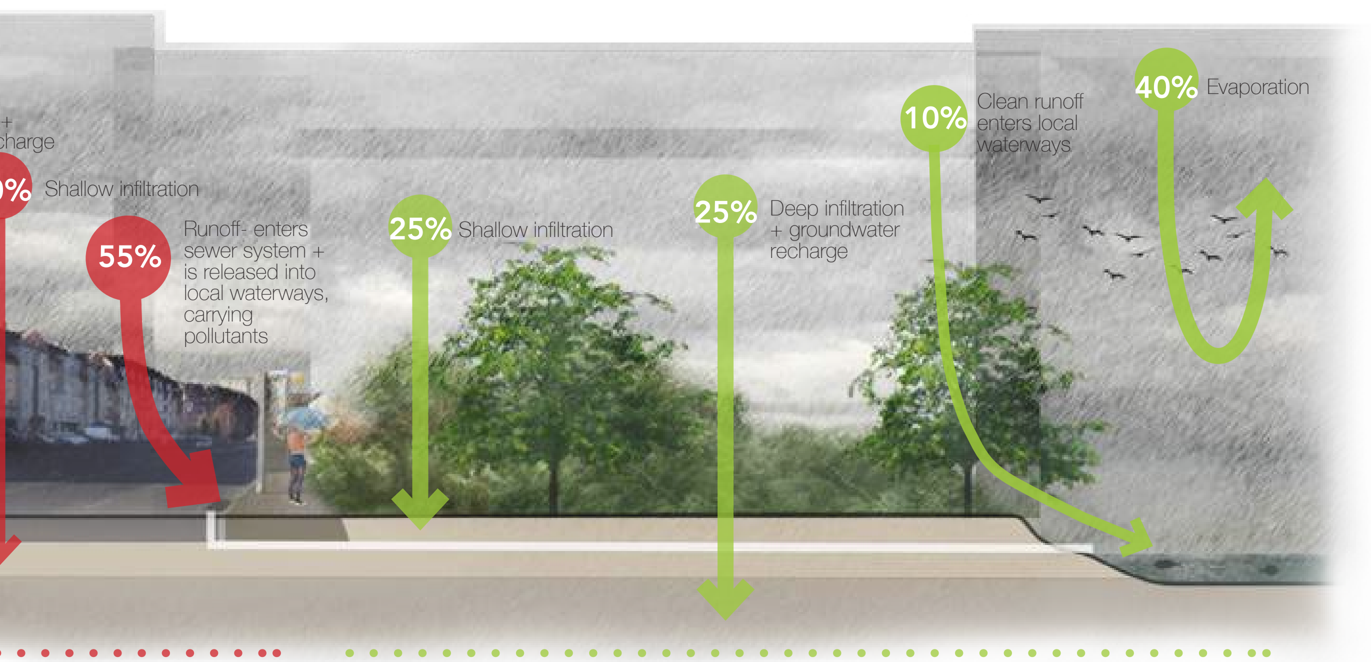
URBAN WATER CYCLE



ABSTRACT

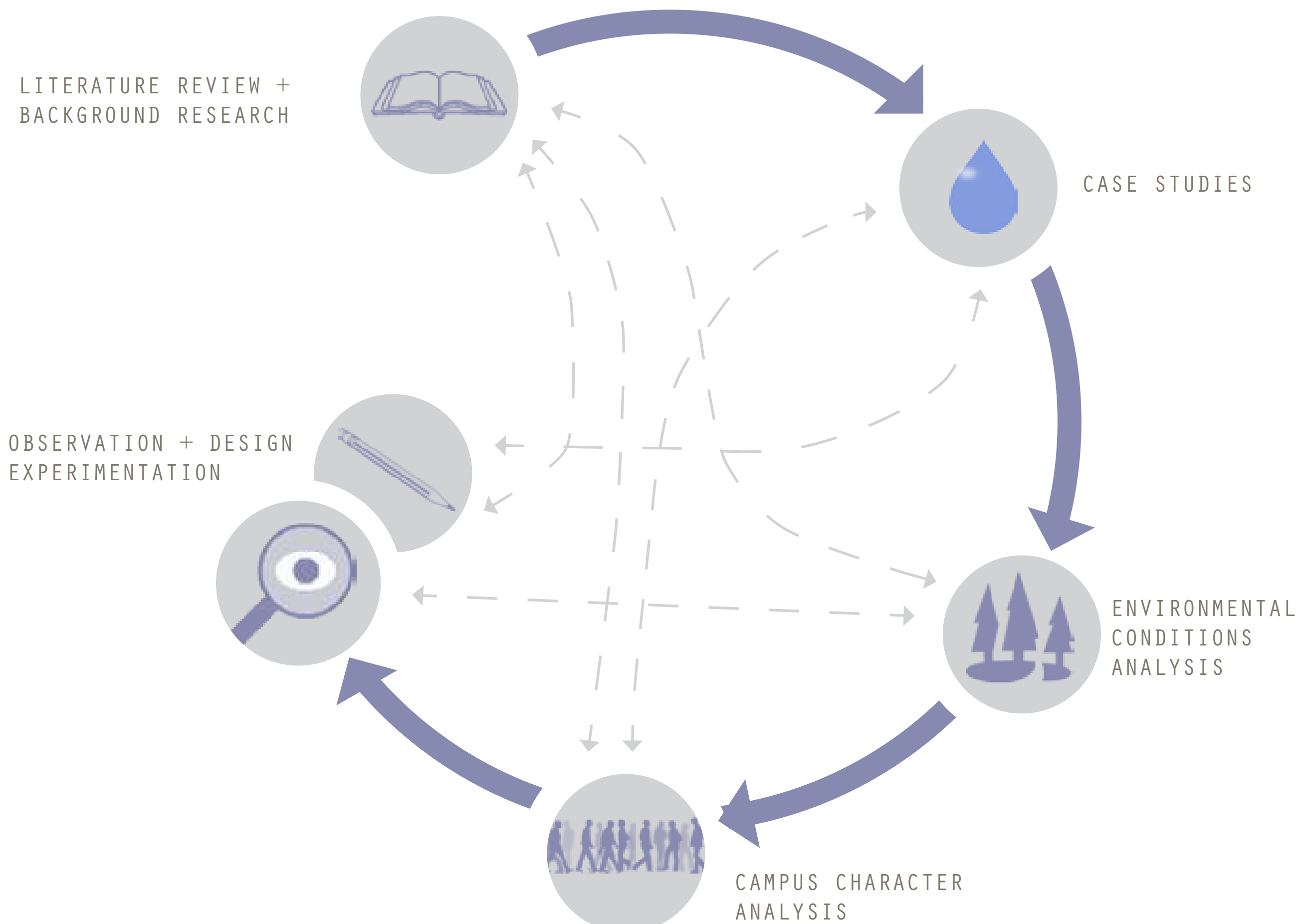
This thesis explores what green infrastructure is and how it works. After establishing a firm understanding of sustainable water systems, it considers the environmental conditions of Cook/Douglass campus and how these are informed by the history and unique characters of the campus' sense of place. It ends with considerations of how sense of place and stormwater management can be married by design to create a didactic and dynamic landscape.

NATURAL WATER CYCLE



METHODS

My research process was iterative and comprised of five parts, each of which represents a different approach to investigating sustainability, Cook/Douglass campus, and design.



My research began in the summer of 2013 when I started working as a design intern with the Rutgers Cooperative Extension Water Resources Program. Here, I worked with engineers and other designers to assist in design, installation and maintenance of green infrastructure projects across New Jersey. I conducted a literature review which delved into relevant texts and water management plans to identify and analyze the key principles of water sustainability and the ways these principles shape the landscape and people's understanding of the water systems.

Next I evaluated case studies of sustainable water projects ranging in scope and scale to understand how these projects worked infrastructurally and fit within the landscape of their local communities to foster stewardship and promote education.

Analyzing environmental and ecological campus conditions begins to establish areas of interest for development of water sustainability projects. Since this topic is so heavily connected to water, a vital natural resource, understanding the dynamics and attributes of the landscape is key in developing a suitable design solution to the proposed problem.

Since the project's site, Cook/Douglass campus, is by nature a social space with extensive history and public visibility, researching the campus' character is an important area to consider.

Personal observation of the site's conditions and typical uses is a tool I was able to utilize that an outside researcher would not be able to. As a current School of Environmental and Biological Sciences student, I am a regular member of the campus community and have a perspective that allows me to easily relate to a main user group being designer for and as the designer who is conscious of the site's environmental needs and potential.

All of the previous methods culminate to inform the creation of a master plan and site design. Not only will this design propose a method for furthering the campus' aim to act as a leader in sustainability and scientific-innovation amongst the state, but it will summarize all the conclusions of the previous research into a physical design manifestation that can continually be shared and reevaluated to address more goals and further the discussion of crafting a more sustainable campus for Rutgers University.

UNLIKE TYPICAL GH COOK SCHOLAR THESES, MY APPROACH AIMED TO DEFINE A RESEARCH METHOD THAT ADDRESSED THE SAME POINTS AS A SCIENTFIC EXPERIMENT WHILE USING DESIGN AS A LENS.

ROLE OF DESIGN

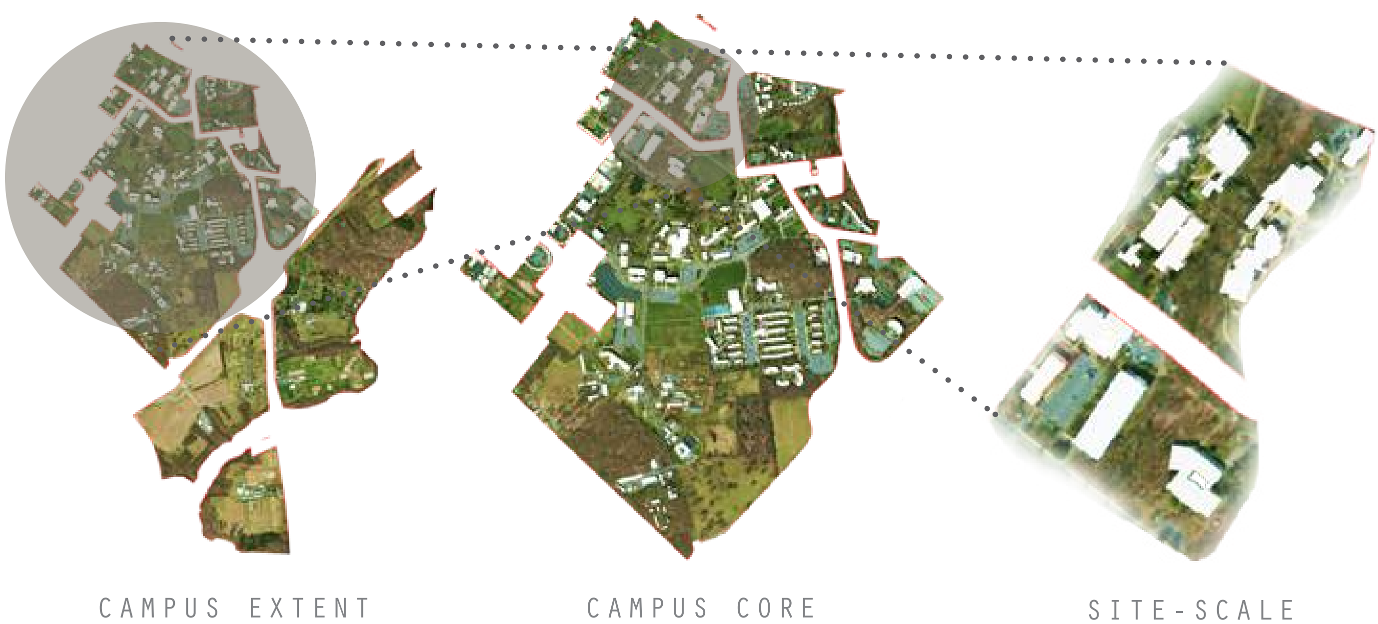
Scientific research is generally designed and conducted according to the Scientific Method. The process of landscape architectural design varies a bit and strays away from the contrived organizational form of the Scientific Methods but shares many of the iterative and critical thinking aspects required in devising and performing a typical scientific research experiment project. This thesis' experimentation takes place in the form of design. Rather than creating a hypothesis, after observation takes place a design problem is identified and a solution is crafted through spatial, social, ecological, environmental, and experiential consideration of a site. A proposed design is never a be-all-end-all resolution to the given design problem but instead it acts as one possible option for rethinking a strategy to understanding, addressing and resolving the initial problem.

SCOPE OF RESEARCH

Creating this thesis was a way for me to synthesize science and design in a way that showcases the knowledge and skills I have attained throughout my studies in Landscape Architecture. Looking at water sustainability through the lens of design, I took an atypical approach to crafting a thesis. This thesis does not aim to propose an engineered solution to all of Cook/Douglass campus' water resources issues but rather it begins to explore how the campus could utilize water sustainability as means for establishing itself as a living laboratory, a model of environmental sustainability and stewardship, while also uncovering the narrative the campus site's landscape is yearning to tell. Seeing as Rutgers University is the land-grant college of the state of New Jersey and considering its importance as an educational and historical institution, this thesis aims to explore how sustainable water management practices could work within the larger framework of a college campus to provide its users with an educational experience and set of environmental and programmatic amenities.

SCALE

Through its process, this thesis explores the campus at three distinct scales. The conditions of the entire campus are analyzed to gain an understanding of its environment and character. It then zooms into the campus core to identify particular areas of interest on campus and their relationship to one another. Finally, the thesis culminates with an even smaller, selected site scale.


CAMPUS EXTENT
CAMPUS CORE
SITE-SCALE

LITERATURE REVIEW

Water is an incredibly vital resource with millions of uses and applications worldwide. Freshwater is a limited resource and in densely populated regions, like New Jersey, where most of the land is covered with impervious surfaces such as buildings, roads and parking lots, it is increasingly important to consider how water landing on these surfaces can be managed sustainably- avoiding dependence on costly and bulky subgrade infrastructure systems. Additionally, designing and implementing sustainable practices and green infrastructure has a great deal of potential to entice and educate site users if done thoughtfully. How does, then, a community or institution develop a water sustainability plan that addresses its distinct water issues while also considering the necessary steps between creation and implementation of a sustainability plan? Equally importantly, how can design be used to redefine and focus user experience around the topic of interest?

There is no way one could evaluate current water-centric sustainability plans without calling attention to Philadelphia Water Department's "Green City Clean Waters" plan to "protect and enhance [Philadelphia's] watersheds by managing stormwater with innovative green infrastructure" (Philadelphia Water Department, 2014). This plan is a program that reevaluates Philadelphia's "land-water-infrastructure philosophy," shying away from traditional methods of infrastructure, which are "cost prohibitive [and] missing the restoration mark." Instead, the city's current plan focuses on finding a harmonious balance between ecology, economics, and equity. Using the city's water resources projects as amenities that supply citizens and the local environment with the most beneficial possible outcome, they become exponentially more valuable as they are integrated within the "socioeconomic fabric of the city." Green City Clean Waters (GCCW) is a revolutionary plan in that its inception and application began before the onslaught of hurricanes over the past couple of years devastated the East Coast—inspiring much conversation and project planning focused around the topic of resiliency. Many of GCCW's goals can be used as a model for developing water sustainability plans and are directly applicable to creating such a plan for Rutgers' Cook/Douglass campus. Some of these principles include:

> "Utilizing rainwater as a resource by recycling, re-using, and recharging long neglected groundwater aquifers rather than piping it away from our communities into our already stressed tributaries; Collaborating to revitalize our City with an emphasis on sustainability; Energizing our citizens, partnerships, public and regulatory partners to adopt and join us in this watershed-based strategy."

GCCW is a model for large-scale water sustainability and green infrastructure plans not only because of its resiliency and ecologic benefits, but also because of its social benefits to its community. As the city's plan moves forward, green stormwater infrastructure projects are raising local property values, supplying trees, parks, and green space that improve the aesthetic quality of communities, converting open space into more desirable public, recreation amenities, and reducing excessive heat through creation of shade and reduction of heat island effect.

Many inspiring institutions have created plans similar to the Philadelphia Water Department's GCCW but on for the scale and scope of individual universities. Villanova University's Department of Civil and Environmental Engineering partnered with Pennsylvania's Department of Environmental Protection, private industry, and other nearby colleges to create a didactic stormwater network across the university's campus and beyond. The focus of this partnership, founded in 2002, is to promote research and educate the public in the field of stormwater management. This partnership is able to design and construct green infrastructure projects and then monitor their own installations to see how it's functioning towards its management and environmental goals. The university promotes stormwater education with walking tours of their research facilities and their very own Demonstration Park. Here, students are exposed to a stormwater wetland, rain gardens, pervious pavements, a green roof, and a few other forms of green infrastructure. Not only does this partnership prove that a unified group of dedicate students and stormwater professionals can come together to inspire a change of thought and action, but it shows that students from different universities can work on cross-disciplinary research and outreach to better their shared community.

Princeton University is a nearby case of a college's sustainability initiative adding a new use for the campus' landscape—using it is a laboratory. A sensor-monitored green roof, UV treatment system for the university's pool, an expansive rain garden, a daylight stream restoration project (the only one in New Jersey), a solar energy collection field, and ground water recharge system underneath an athletic stadium are all examples of sustainability projects on Princeton's campus. These projects are actively used by faculty and students alike to inform sustainability studies and allow for hands-on exploration into use of sensors for environmental monitoring and determination of project's efficacy. Another innovative portion of Princeton's efforts is the dedication the Office of Sustainability has to using strategic planning as means for unifying the school's academic departments with its branches of facilities and operations. This relationship is key in the success and longevity of campus green infrastructure and sustainability projects.

While much of the literature I reviewed dealt with the logistics of managing stormwater and detailed the water sustainability plans of various institutions and communities, it is important to juxtapose thinking of the landscape as tool for promoting a certain goal with considerations of how people actually experience the landscapes around them. In James Corner's essay "Eidetic Operations and New Landscapes," Corner considers the relationship between the physical landscape and the image which is defined by the environment is "conceptualized and shaped" (Corner, 1999, p. 153) by the world and the site's users. Corner, a distinguished landscape architect and theorist, suggests that design "imbues the landscape with allusions to regional and cultural identity enabling its occupants to believe that they are actually part of a collective, refined, and enlightened society" (Corner, 1999, p. 157). He goes on to point out that in many cases that notion is untrue because commonly people act as a consumer of an environment is unalienably tied to "the marketplace." (Corner, 1999, p. 157) It is true that the landscape of Rutgers is a tool of value that is used by the university in Rutgers marketing and advertisements to attract people to Cook/Douglass' picturesque scenery but it is also true that the community of this campus identifies to the cultural identify of being a student of these two distinct schools within Rutgers.

There are a few key factors that play a big part in the establishment and continued understanding of a landscape. Time is an interesting factor as "[the] landscape decontextualizes its artificiality and takes on the appearance of something natural." (Corner, 1999, p. 157) Thinking about this quote within the Cook/Douglass context, many students of today don't know the origins of Passion Puddle and believe this pond to be a naturally occurring body of water—totally unknowing of the site's rich history as an agricultural pond used by farmers in the 1800s and early 1900s to provide their livestock with water to its use today as a retention pond. It is interesting to think that the people interacting with a landscape most may be just as inept to its natural history and characteristics as a newcomer during their first visit. This raises a question about the significance of a site's history and natural state and the value (or lack thereof) of capitalizing on or ignoring it. It is my own belief as a landscape architecture student and a designer that enforcing a site's history and using the landscape as a tool for education adds meaning to a site, despite the chance it may be diminishing the whimsical, however misguided, impressions some have about a sites natural origins. As the official state university and as the School of Environmental and Biological Sciences inhabits Cook campus, designing a landscape such as this begs exploration into the true nature of a site and the potential ecologic, economic and educational value to be gained by restoring and promoting a site's true identity

Another important factor in understanding the landscape proposed by Corner is that everyday user experience, and thus understand, their surroundings to establish an eidetic image of place differently than a temporary or periodic visitor. Since everyday inhabitants use spaces habitually, they move "in a state of distraction" and their "eidetic image of place is bound into a greater phenomenal range of significance than vision or contemplation affords." Conversely, visitors to a place are able to view a landscape as an "object" and can view it as an ideological "thing to behold." (Corner, 1999, p. 155) Considering this thought in conjunction with Corner's claims that time decontextualizes a landscape and the view of artificiality becomes skewed into a false sense of reality, something interesting could be said about design—especially in a campus setting. Regular users, in this case students, staff and faculty, consider their landscape through a lens that encompasses much more than just its path system, history, vegetation, water and social space but with the unique character they develop for the space as they establish a routine throughout it. For this reason than a sporadic visitor who considers the landscape an ideological object, which suggests it has a greater impact on them over time. As result, there visitors have a great deal of potential from learning from and being influenced by the landscape they travel to. This difference in experiences based on time spent in a landscape is an influential in its design and educational goals set out by planners and designers of the space.

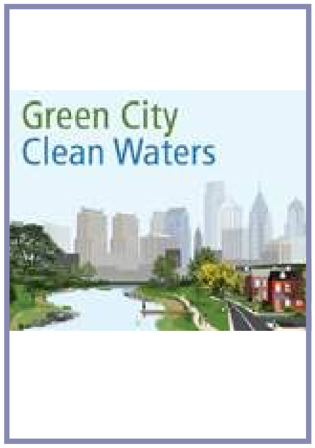
Considering successful principles of stormwater management plans with similar sites and scales to Rutgers' Cook/Douglass campus helps frame the philosophical exploration of an indiviuals' establishment of a place's "eidetic image." Exploring and understanding successful plans throughout the region can begin to inform a narrower topic so both can be adapted into a unified way of thinking. In terms of water management as a whole, understanding the philosophy behind how and why people understand a space the way they do, designers can being to account for the user experience in a better informed manner. Designing this way ensures that the aim of the site's design, which is this exploration focuses around being aware of water systems and understanding water sustainability, will have the optimal effect on the site's users.

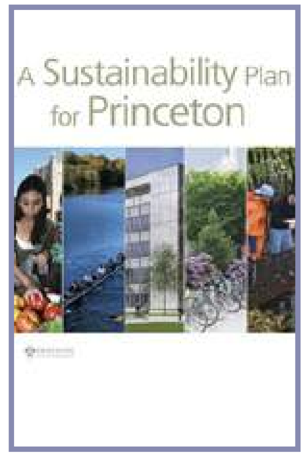
Corner, James. *Recovering Landscape: Essays in Contemporary Landscape Architecture.* New York: Princeton Architectural, 1999. Print.

Philadelphia Water Department. "Green City, Clean Waters." *Green City, Clean Waters*. Philadelphia Water Department, 2014. Web. 11 Apr. 2014.2)

"Sustainability at Princeton." *Sustainability at Princeton*. Office of Sustainability, Princeton University, 2014. Web. 11 Apr. 2014.4)

"Villanova Urban Stormwater Partnership." *VUSP.* Villanova University College of Engineering, 2013. Web. 11 Apr. 2014.





ABOUT GREEN INFRASTRUCTURE

Rutgers University is one of the nation's oldest colleges and is located within the most densely populated state in the country. As result, many of the infrastructural problems facing the state also face the school's campus. Infrastructure is aging at a quicker rate than it can be repaired and sprawl is occurring as Rutgers study body is growing within its confined spatial parameters. Traditional infrastructure, or "gray" infrastructure, focuses on channeling stormwater from impervious surfaces, including roads, parking lots and roofs, into subgrade systems of pipes and carrying that water to filtration facilities or, more commonly, releasing that water into local rivers and streams. As stormwater is channeled to these pipes, it runs off the land causing erosion and picking up pollution which subsequently enters local waterways. During extreme storm events this method of infrastructure cannot handle the unusually large quantities of water and flooding occurs as a result.

Green infrastructure (GI) strategies are inspired by processes in nature to manage stormwater. Stormwater is one of the main factors contributing to water pollution in New Jersey[1]. GI "at the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water."[1] GI challenges local codes to be reevaluated to consider more sustainable and cost-effective ways to modify infrastructure systems. While this issue has been addressed by the New Jersey Department of Environmental Protection's New Jersey Stormwater Best Management Practices Manual, this thesis is a vital investigation in how to retrofit a college campus to promote water sustainability, emphasizing exploration into GI systems. In efforts to "[weave] natural processes into the built environment1" GI systems showcase the flow of water and use of plants, among other methods, to filter runoff and promote infiltration to the ground, keeping this water from entering the systems gray infrastructure is engineered to promote.

GI systems are valuable projects that can be used for education. With Rutgers University acting as the state's land-grant university and as a world-renowned research institution, it is our obligation to be forward thinking and environmentally conscious. Using GI projects to address the water issues on campus and using the campus as a place to showcase these technologies make research into this topic especially valuable. Projects on Rutgers' campus can be used as models for visitors and have the potential to inspire this type of sustainable development across the state and nation. In addition, Rutgers has the potential to become a further contributor to GI projects. Implementing these projects on campus can be a source of multidisciplinary collaboration- calling on academic departments and students already on Cook/Douglass campus to contribute to their design, upkeep and monitoring.

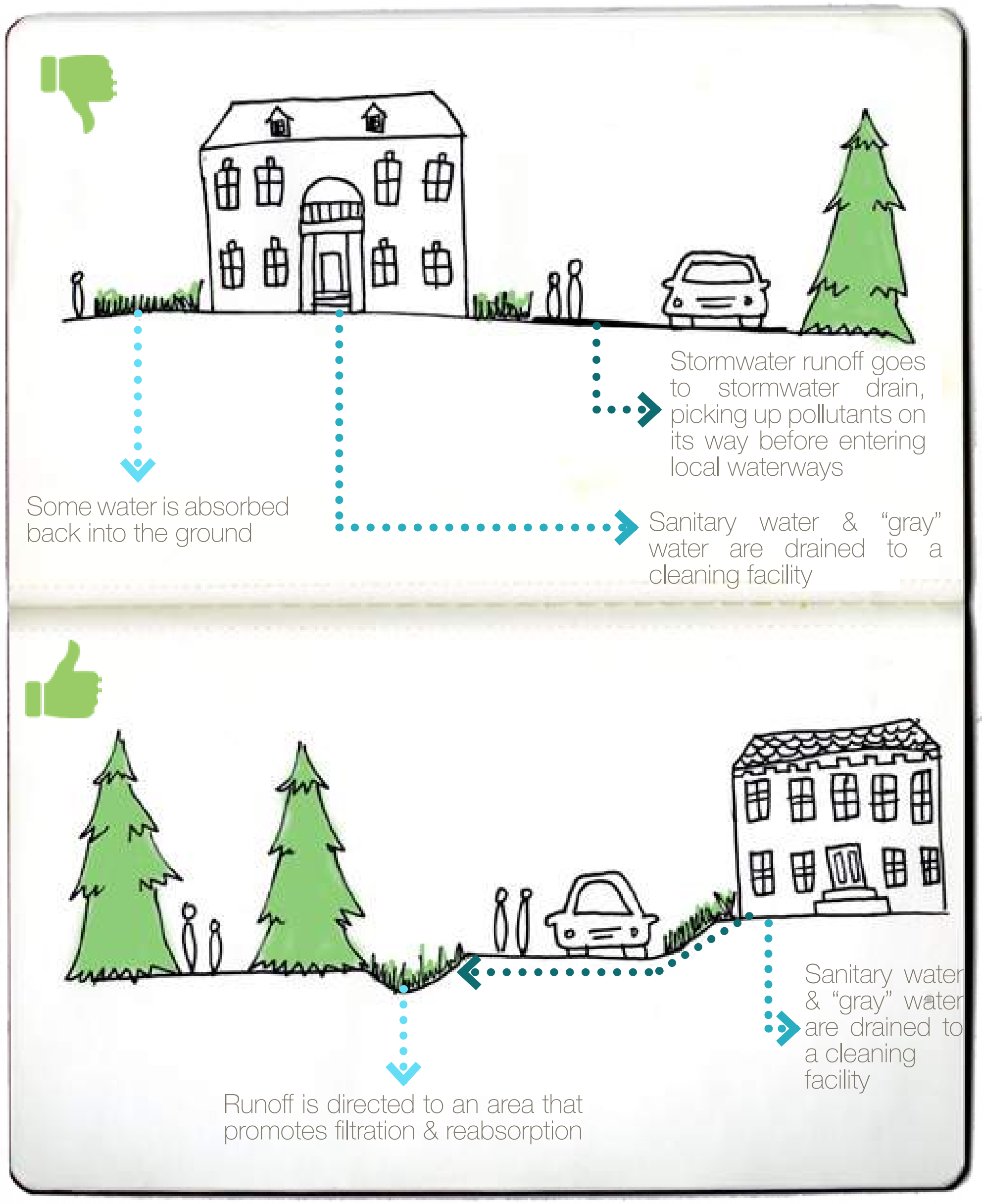
1) United States Environmental Protection Agency. (2014). Green infrastructure. Retrieved from United States Environmental Protection Agency website: http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm

WHAT IS STORMWATER?

Stormwater is water resulting from a rain or snow event that doesn't infiltrate into the ground.[2]

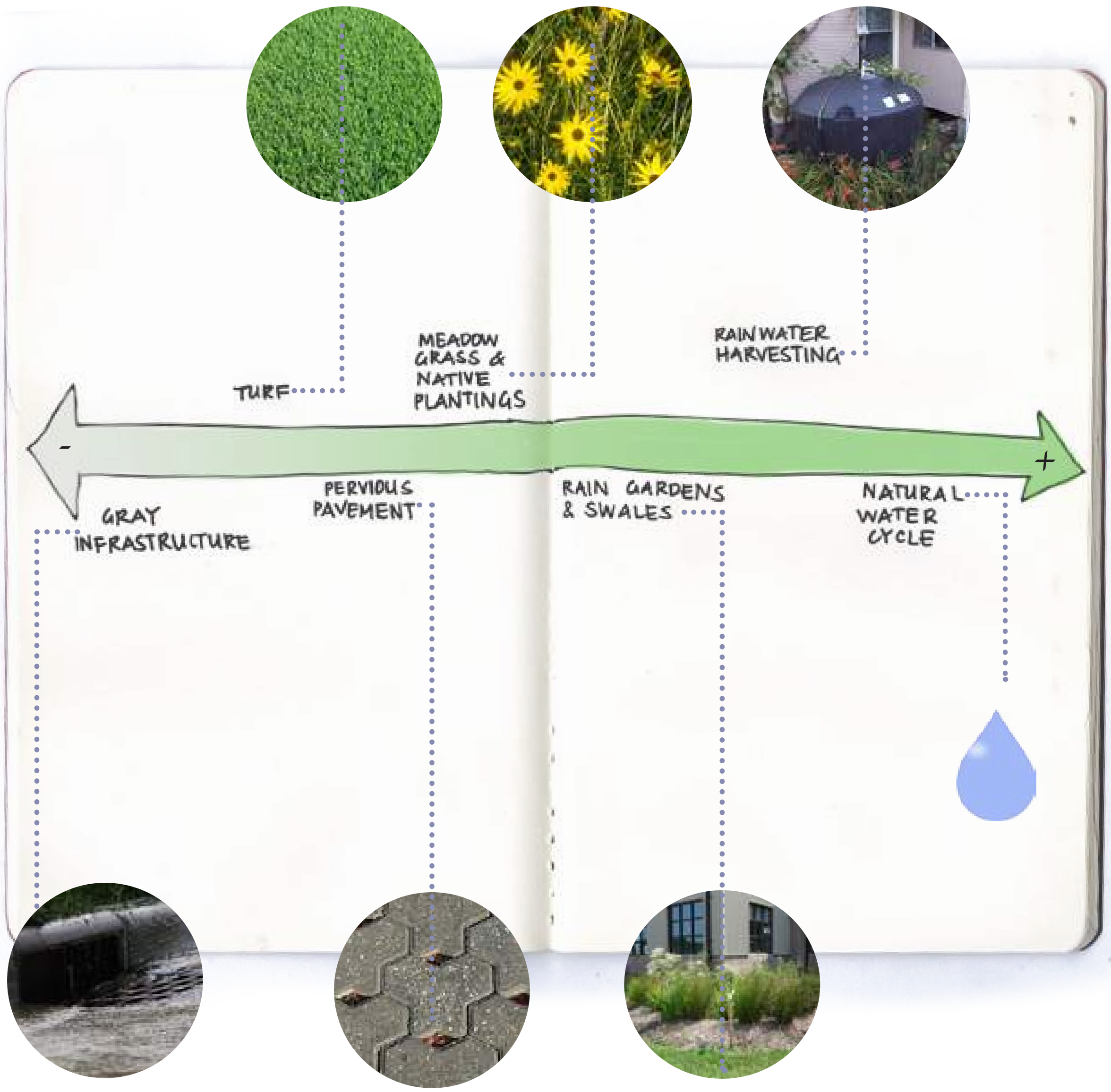
WHAT IS RUNOFF?

Runoff is the movement of water and any contaminants across the soil surface. It occurs when irrigation, rain or snow melt adds water to a surface faster than it can enter the soil. Water running off the land towards local waterways and can cause erosion and flooding.[3]



2) Persyn, R., Griffin, M., & Williams, A. (2014). What is stormwater?. Retrieved from http://texaswater.tamu.edu/stormwater/what-is-stormwater
3) Gardner, R. (n.d.). The problem of runoff. Retrieved from http://pesticidestewardship.org/water/Pages/Runoff.aspx

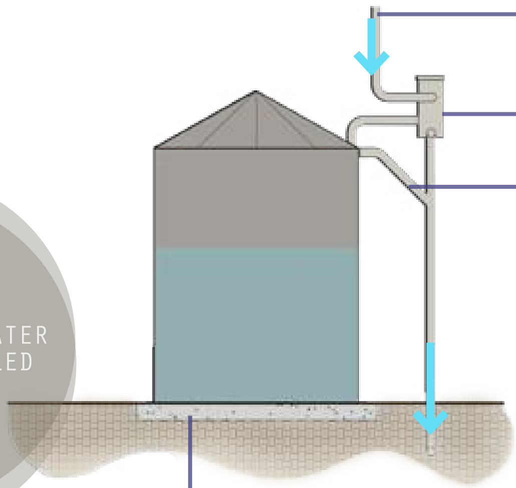
WATER SUSTAINABILITY



Below are some of the most commonly used engineered solutions for sustainable stormwater management.

CISTERN

+ HARVESTS RAINWATER
+ SUPPLIES RECYCLED WATER FOR ANY NONPOTABLE USE

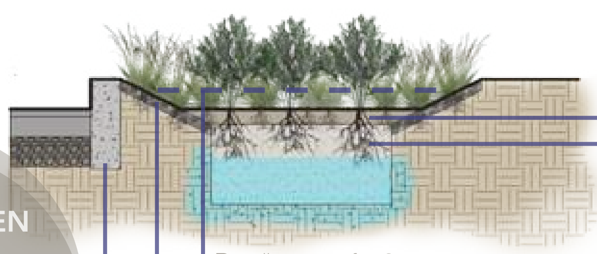


PERVIOUS PAVEMENT

+ FILTERS WATER
+ PROMOTES INFILTRATION
+ GROUND WATER RECHARGE

RAIN GARDEN

+ FILTERS WATER
+ PROMOTES INFILTRATION
+ GROUND WATER RECHARGE
+ CREATES HABITAT



Details referenced from construction documents with thanks to Rutgers Cooperative Extension Water Resources Program

LOW-IMPACT TOOLS TO IMPROVE WATER QUALITY

MYCOFILTRATION refers to the use of mushrooms and their mycelia as means for improving water quality and watershed health. Mycorrhizal mushrooms interact with the roots of vascular plants[4], in doing so this interaction reduces common stormwater runoff pollutants and eliminates bacteria from animal waste that would otherwise enter the watershed. Adding Mycorrhizal mushrooms to existing stormwater management projects, including rain gardens and bioswales, would add to those projects' ability to manage and filter runoff. Additionally, growth of Mycorrhizal mushrooms near native plants will allow them to grow healthier as the mushrooms absorb and filter pollutants that would have previously stunted their growth. This method is extremely easy to apply, cost-effective, and sustainable.[5] Paul Stamets, a mycologist with Olympia, Washington's Fungi Perfecti Research Lab, is attributed with this biotechnological finding. This development came to be as result of Stamets effort to lower fecal-coliform discharge into the local watershed as result of animal waste from his farm's livestock. One year after planting a 200 foot bioswale, filled with mycorrhizal mushrooms, at the farm's edge there was a 99% decrease in the fecal coliform level, as reported by water quality inspectors. Later lab tests conducted by Stamets and team revealed the ability of these mushrooms to reduce amounts of E. Coli in urban stormwater runoff in addition to heavy metals and polycyclic aromatic hydrocarbons, both of which are converted by the mushrooms into nutrients. [6]

4) Kirk, P. M.; Cannon, P. F.; David, J. C. & Stalpers, J. (2001). Ainsworth and Bisby's Dictionary of the Fungi (9th ed.). Wallingford, UK: CAB International.
5) Vogel, M. (2014, January 10). [Web blog message]. Retrieved from http://plangreen.net/mushrooms-can-help-save-planet-lets-start-river/
6) Strunin, S. (2013, November 13). Can mushrooms help fight stormwater pollution?. Earthfix. Retrieved from http://www.earthfix.info/water/article/could-mushrooms-be-the-answer-to-stormwater-pollut/
Photo by Rich DuBose

MEADOW GRASSES have potential for improving water quality when planted in place of turf or as buffers between impervious or turf grass areas and inlets to water sources or sewer drains. These grasses have long, fibrous roots that filter out pollutants while also promoting groundwater infiltration and preventing flooding.[7] These grasses, growing in a variety of heights from around that of turf grass to upwards of three feet high, are excellent replacements for turf grass because they are low maintenance and have many ecological benefits. Turf grasses require constant upkeep and often call for application of fertilizers and pest-controlling chemicals. Stormwater runoff carries these chemicals into local watersheds, continuously polluting them. There is also a notable amount of carbon-emissions released as result of lawn mower usage on typical turf grassed areas. Only considering these conditions, meadow grasses are more cost-effective to implement than turf lawns. Other benefits to the watershed, local ecology, and site's aesthetic are insurmountable. At the Environmental Protection Agency's facility in Duluth, Minnesota, a landscaping meadow is used to filter runoff from an adjacent parking lot from running into Lake Superior.[8] Creating buffers such as this in areas where turf grass cannot be substituted, like on athletic fields, is an easy and logical means for improving water quality, among many other benefits.

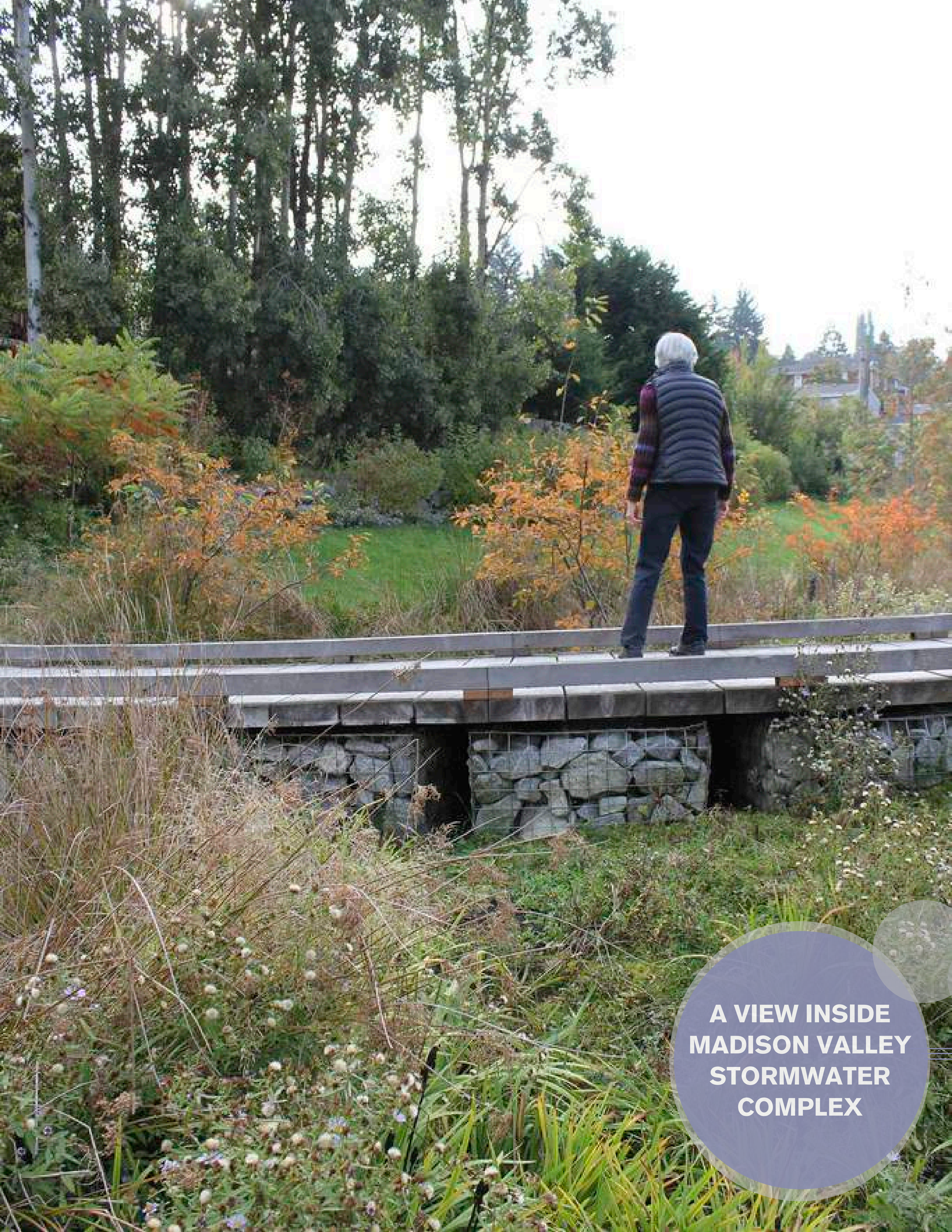
7) Philadelphia Water Department. (2014). Wildflower meadow. Retrieved from Philadelphia Water Department website: http://www.phillywatersheds.org/whats_in_it_for_you/residents/wildflower-meadow
8) U.S. EPA. United States Environmental Protection Agency, (2012). Stormwater management at EPA facilities. Retrieved from website: http://www.epa.gov/greeningepa/stormwater/stormwatermanagementepafacilities.htm
Photo by Anders Einarsson

WETLANDS are naturally occurring areas but also can be constructed to promote for stormwater management and other sustainable pursuits. They have countless benefits. Water purification takes place as wetlands contain sediments, heavy metals and nutrients that damage the watershed (such as nitrogen and phosphorus). Wetlands lower peak flooding by capturing excess stormwater and slowly releasing it overtime, acting somewhat like a "sponge"[1]. Wetlands adjacent to lakes and river banks reduce erosion and stabilize the bank's with complex root systems associate with their vegetation. The soils and vegetation of wetlands work together, also, to promote groundwater recharge which helps maintain necessary water levels during times of drought. The habitats provided in wetland areas are invaluable, especially in providing native and endangered species of plants and animals with a safe place to establish themselves and reproduce. Finally, wetlands provide infinite educational and recreational benefits as they make perfect places to develop walkways, parks, and other forms of programmed passive recreation.

For these reasons, it's especially critical that wetlands are preserved and restored when they fall into states of disrepair. They are an extremely important ecological asset which are influenced greatly by nearby developments but can work to mitigate many of the negative impacts of development. In fact, wetlands are such a valuable asset that artificial wetlands are constructed to mimic and recreate some of the benefits incurred by natural wetlands. constructed stormwater wetlands are created to remove pollutants from runoff. It is important to realize there is a difference between the uses and benefits of natural and constructed wetlands. Constructed wetlands' chief purpose to to collect and manage stormwater runoff. When stormwater is directed to a natural wetland it is often detrimental to the plant and wildlife habitats as it irreparably changes the site's hydrology [2] This is not to say that natural wetlands do not have positive benefits to stormwater runoff- in fact, natural wetlands are contributing factors to managing runoff and reducing flood but on a regional scale rather than a site scale (which is more adept to constructed wetlands.)

Constructed wetlands are not suitable for all sites. They do not function well in arid climates because the water evaporates from the system, making systems there difficult or impossible to maintain. Similarly, they cannot function in extremely urban environments due to spatial restrictions. A third deterrent of developing constructed wetlands is their maintenance regimens are more demanding than some alternative or that of natural wetlands. Despite these minor drawbacks, constructed wetlands remain a promising and positive form of low impact development in promoting healthy, sustainable environments.

1) Michaud, J.P. (1990). *At Home with Wetlands- A Landowners Guide.* Bellington, Washington: Washington State Department of Ecology
2) U.S. Environmental Protection Agency (2012, August, 12). *National Pollutant Discharge Elimination System*. Retrieved April 1 2014. Web.
Photo, left, by Doug Kerr



A VIEW INSIDE MADISON VALLEY STORMWATER COMPLEX

CASE STUDIES

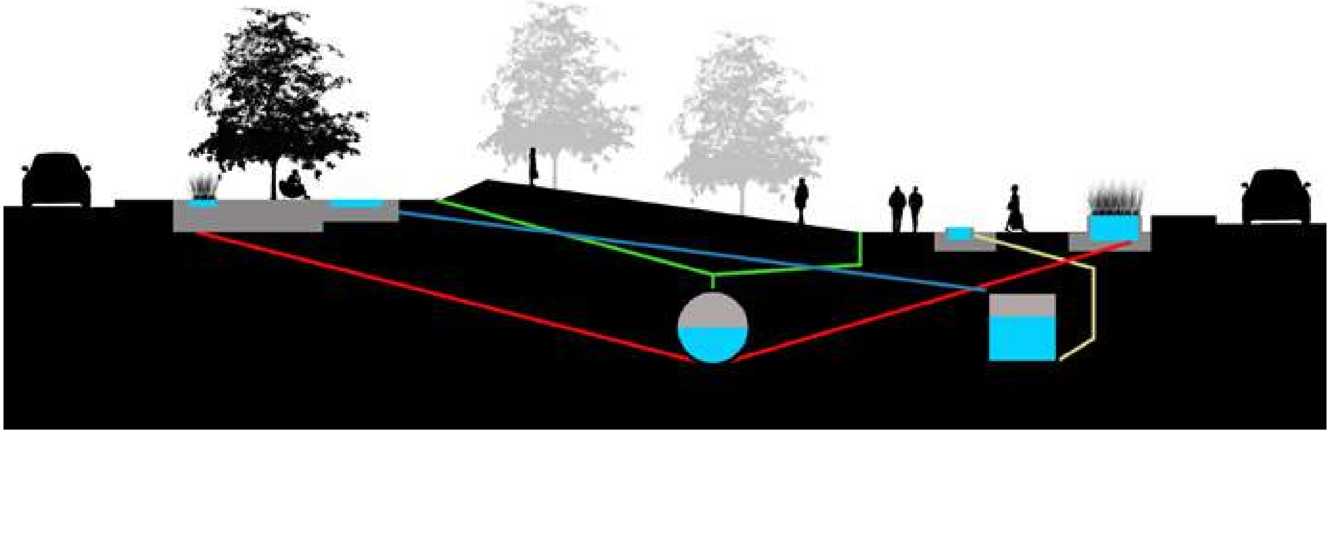
Case studies are important for beginning to understand what exemplary sustainable water projects look like. Furthermore, investigating projects of this type establishes an understanding of they work infrastructurally. Equally importantly, these projects begin to suggest what sorts of environments and programmatic activities are best suited for this type of design. The projects introduced fall into three main categories: restorative, architectural, or artful with overlapping present between all categories. After thorough analysis, a set of "Lessons Learned" concludes this section.

Photo, left, by Wes Reeder

THE CIRCLE IN UPTOWN
NORMAL, ILLINOIS

The Circle in Uptown collects, cleans and recycles runoff in a beautiful, interactive way while also helping to recharge groundwater to the local aquifer. Runoff from nearby streets is collected underground and directed into the park's large circular water feature and into a filtration bog. This feature allows for people to interact with water- to touch and play in it, to hear the sound of it flowing, and to walk or sit beside it. 1.4 million gallons of stormwater are recycled annually and kept from the municipality's sewer system[9]. This project, on a site a little less than five acres, helps to put small scale water design solutions into a quantifiable perspective.

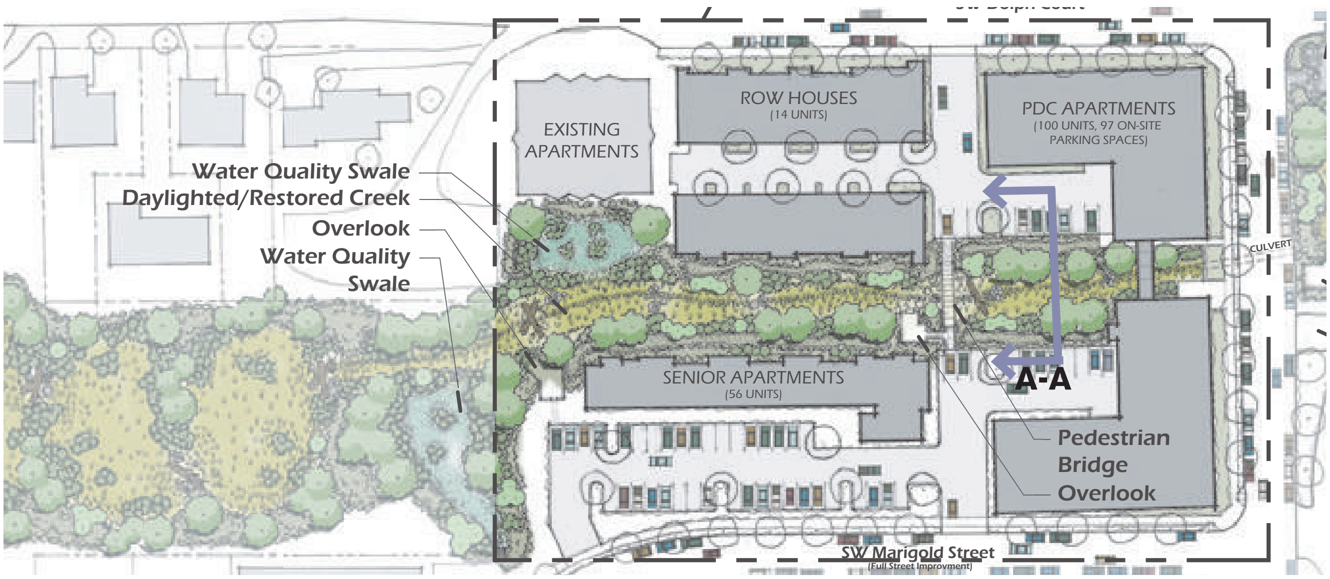
9) Landscape Architecture Foundation, . "Uptown Normal Circle and Streetscape." Landscape Performance Series: Case Study Breifs. n.d. n. page. Web. 20 Jan. 2014.
Photos property of Uptown Normal



HEADWATERS AT TRYON CREEK
PORTLAND, OREGON

Tyron Creek has a tributary that runs through a high density housing development in Portland. When the stream's tributary was daylighted from underground pipes, the new residential developments were designed to be integrated with the daylighting along with other green infrastructure, including: porous pavement in parking lots; "flow-through planters" for impervious runoff; greenroofs; and Green Street solutions to be applied throughout the new development.[10] This is a helpful example of integrating green strategies with an intensely engineered water solution. In addition, this design made the stream into an amenity for the community, adding aesthetic value and also giving residents a change to interact with GI and thus learn what it does and how it works.

10) Greenworks. "Headwaters and Tryon Creek." Works: Stormwater Retrofitting. Greenworks. Web. 13 Jan 2014. Photographs above property of Greenworks

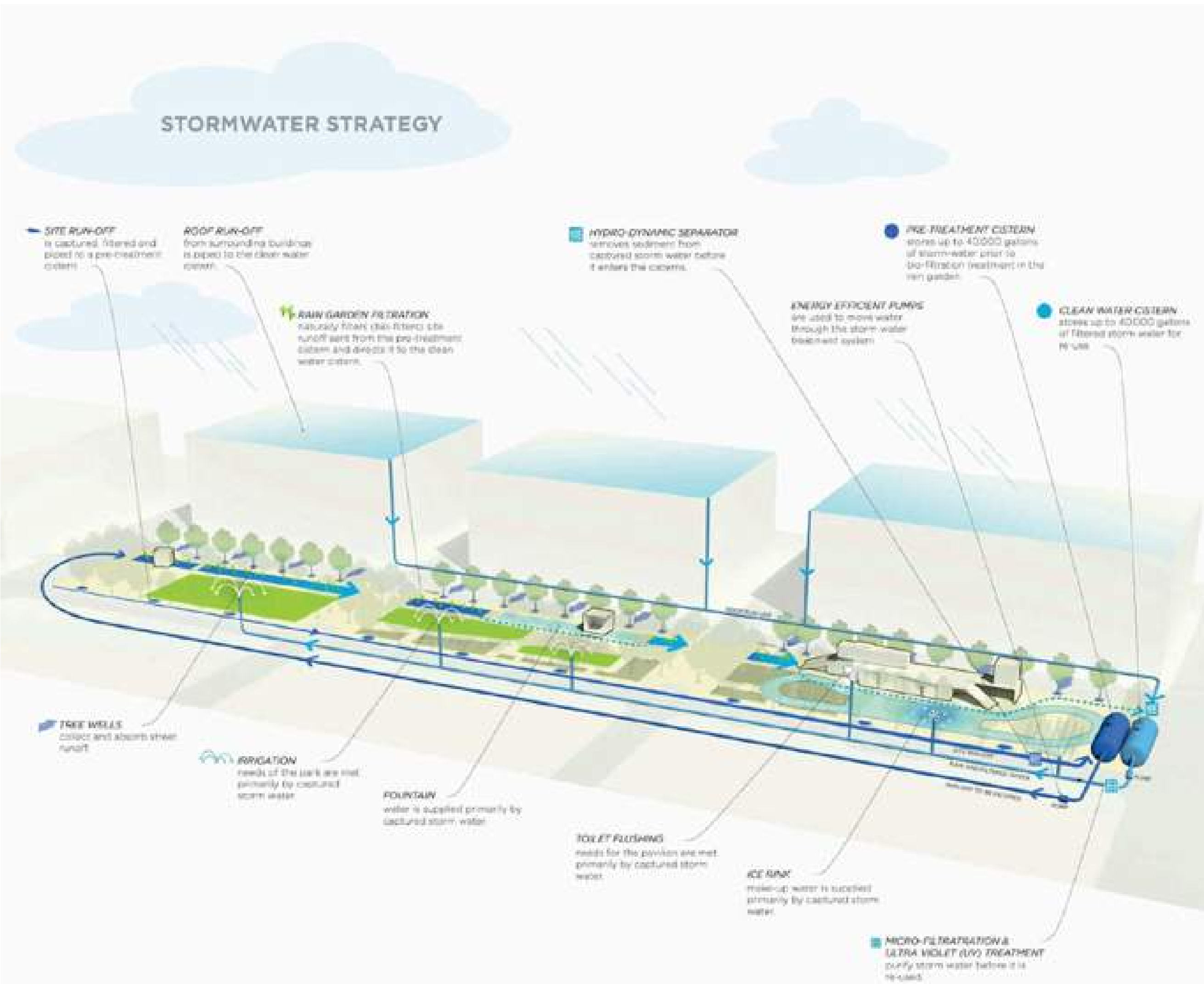


(Source: GreenWorks PC & Sullivan Architects)

CANAL PARK
WASHINGTON D.C.

Stormwater runoff captured from the new urban park site and adjacent private buildings will be harvested, cleansed and reused. The park was designed as a pilot project for the Sustainable Sites Initiative. Originally part of a canal, it was converted into a parking lot in the 1970's.[11] This site is a relevant case study for ideas of how to convert a large, impervious area into something more people-friendly while still applying green infrastructure strategies on top of a brownfield and restoring the site's ecosystem. The park has various programs with different uses based on season, including an ice skating rink, a few water features that kids can run through and play with in the summer, and showcase areas for art and sculpture.

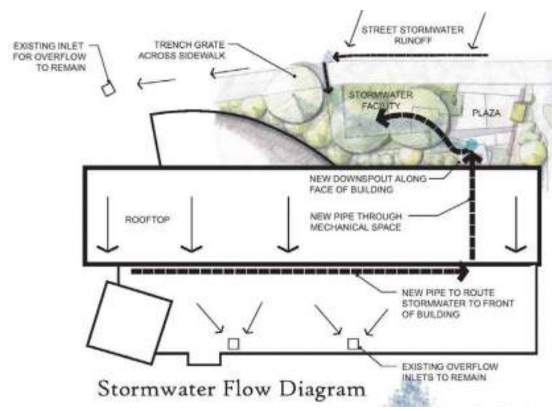
11) CPDA . "Sustainability." Canal Park. Canal Park Development Association. Web. 20 Jan 2014.
Images on pages 28-29 are property of Olin Landscape Architecture/ Urban Design/ Planning



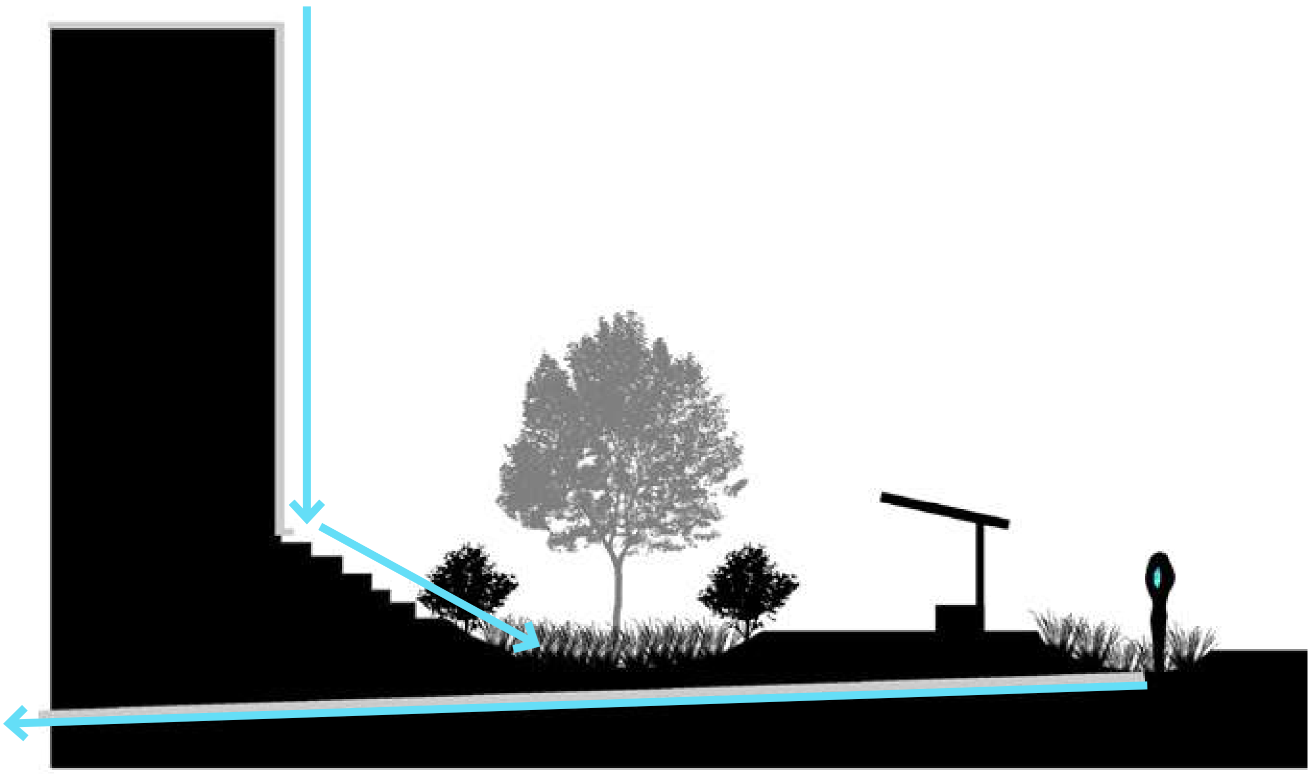
Above diagram property of Olin Landscape Architecture/ Urban Design/ Planning

STORMWATER EDUCATION PLAZA
PORTLAND, OREGON

This plaza redirects downspouts from a nearby building into a newly designed stormwater plaza. The plaza has a rain garden that collects 8000 square feet of runoff from adjacent streets and roofs. A seating structure, equipped with a green roof, houses information signage about the plaza's purpose. Stormwater is routed in front of the building and onto the plaza- showcasing water's movement as opposed to hiding it. A sculpture was placed within the plaza to add interest to the space. Slabs of stone stacked upon each other allow people to recognize flood heights during storm events. As the space fills with water, slabs at lower heights are submerged and only higher ones are visible.12 This flooding and receding changes the visitor's interaction with the site in a recognizable and dynamic way.



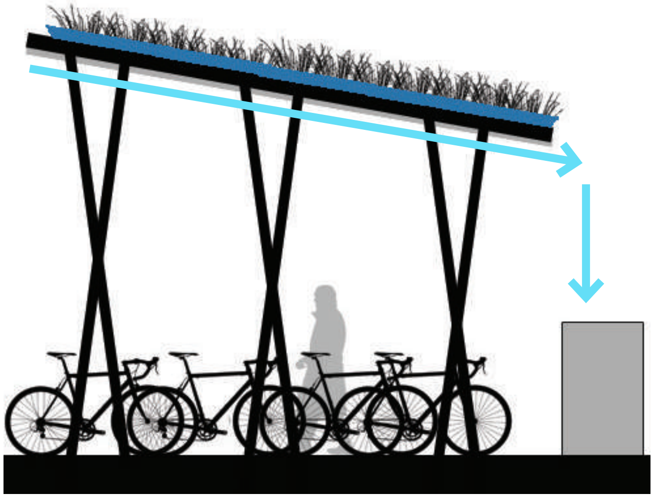
12) Wysong, Linda. "Art of Stormwater." Water Conservation Showcase. US Green Building Council . San Francisco, California. 19 03 2013. Lecture. Photos and Stormwater Flow Diagram sourced from Linda's presentation.



Overflow directed to sewer

BICYCLE RACK INSTALLMENT
PORTLAND, OREGON

A structure in Northern Portland was created to support a sustainable action (biking) with another (green infrastructure). Designers crafted covered bicycle parking using repurposed planters. These planters, used as containers to grow plants suspended in the air without rooting in grounded soil, were placed over metal bars to create a unique green roof. Beneath this overhang is open space where (pictured left) seating can be placed or bike racks can be housed.[13] The structure serves dual functions while also being a public and educational piece of art.



13) O'Brien, Lindsay. "Portland gets creative with stormwater project, adds bikes and art." Daily Journal of Commerce [Portland] 16 02 2012, n. pag. Web. 20 Jan. 2014. Photos from the Daily Journal of Commerce.

MADISON VALLEY STORMWATER COMPLEX
SEATTLE, WASHINGTON

Due to high levels of stormwater flooding and sewer backups in the Madison Valley neighborhood of Seattle, a few best management practices were implemented at the Stormwater Storage Facility. Among them, artist Adam Kuby created a series of sculptures. The left photo shows a piece that allows trees, stone and water to work together over time to crack and change form as a way to display their relationship and effect on each other. On the right is a water holding tank (14' tall) with downspouts and weep holes to deliver runoff into a rain garden at its base. The wall has 29 nesting bird houses built into it covered with faux bird facades.[14] By adorning the cistern in this way, it is able to store water, provide habitat, and act as a piece of art with an interesting water feature.

14) Manzano, Grace. "Adam Kuby's artwork at celebration for new Madison Valley Stormwater Project, May 22." Art Beat. 16 May 2013: n. page. Web. 14 Jan. 2014.
Photos property of Adam Kuby
See Appendix for more Case Studies

LESSONS LEARNED

Case studies are a valuable tool for understanding precedents of today's exemplary stormwater management projects. Not only does this analysis help establish the common tools used by designers to create sustainable and enjoyable, water-conscious spaces, the process of seeking out noteworthy projects and further examining them is a good way to begin to understand how the water management systems deal with water above and below the ground. Several key lessons came about as result of my case study exploration. In coming up with each lesson, it was vital to me that I was able to conceptualize each into a verbal and visual component. By generalizing these lessons learned, either into a diagrammatic section or into a perspective that superimposes aspects of the case study projects into sites within Rutgers' Cook/Douglass campus, they become a set of design principles or kit of parts that can be used to inform sustainable water designs.

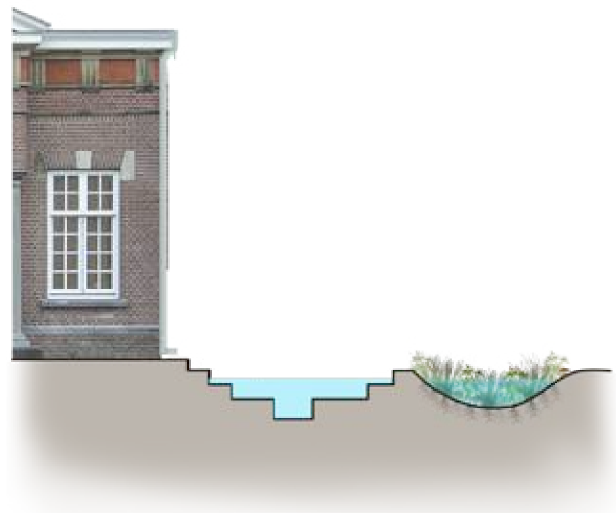
01 *SITE LOCATION IS JUST AS IMPORTANT AS WATER MANAGEMENT INTENT*

The most successful GI projects are those that consider all of the "Lessons Learned" mentioned above and are also located in public places that generate the appropriate amount of traffic for their scale. The most wonderfully designed stormwater management and education plaza could be built in the backyard of a private residence but its impact will not be great because it will not be made available to the public that would benefit most from exposure to it. Locating projects in areas that have a dire need for water resource intervention is just as important as locating them in places that will be accessible to community members. Once citizens are interested in visiting a project, they can learn of its purpose and process which will enviably change the way they think about water's impact on our world.

A stormwater education plaza imagined at Lipman bus stop

02 *SHOWCASE THE FLOW OF WATER*

Architecture allows a designer to affect how a person feels within and moves through a given space. On the flipside, it also allows a designer to control how other entities (such as water) move through a space. By designing places where people and water move in a similar way or cross paths, a designer can influence the way a person may feel about water by guiding them to see it and (hopefully) begin to think about where it came from and where it is going. In this respect, designers have the ability to use progression through space as a way to increase people's interaction with flowing water in a way that maybe new to them.



A hypothetical section

03 *CREATE SOMETHING THAT IS EYE CATCHING, INTERESTING, & INTERACTIVE*

People will gravitate towards a space that is fun and inviting. For this reason, it is important to engage as many people as possible. Doing so will promote a project's support and longevity. Having an interactive water feature for hot summer days, like the Circle in Uptown, or showcasing natural relationships of the site's ecosystem with built in bird-boxes, like the Madison Valley Stormwater Facility, will draw a crowd. The more people that come to visit and enjoy a project site, the more important maintaining and improving that project site will be to its stakeholders.

An interactive water feature imagined at Antilles Field

04 *MAKING FUNCTIONAL STRUCTURES MORE BEAUTIFUL ADDS VALUE TO THEM*

In many cases water management infrastructure is strictly utilitarian: a rain barrel is made from a re-purposed garbage can, a cistern is a large plastic cylinder that sits against a building's hidden outer wall. Projects like these are the ones people quickly forget about because they have no personal connection to them and possibly no understanding of their purpose (aside from being an eyesore). Just like lush and colorful plants add to a home's property value, artfully constructed green infrastructure adds value to the open space it is built in.

An artful rainwater harvesting citern imagined infront of the Marine and Coastal Sciences Building

05 *DESIGN FOR NATURE BUT PLAN FOR PEOPLE*

In designing to restore natural ecology, concessions make a site most appropriate for human users. This type of design takes research. It is important to know how to create desirable environments for flora and fauna and to understand their environmental and spatial requirements and understand stakeholder user preference. There is a strategic way to create circulation through preservation spaces that protects the wildlife and offers people an interesting and educational experience as they move throughout preserves. Designers must balance human impacts that mindfully addresses their proposed, desired, current and possible future uses of the space and create joyful places that people want to explore.


A hypothetical section

05 *ART IS A FORM OF SITE SPECIFIC PLACEMAKING*

Art is a feature that can attract people to a water management project while also promoting education that allows its viewers to better understand water systems. Adding art to water designs is a way to give a new layer of meaning to a project, the space it is located within and the nature nearby. A large piece of art, like the cistern pictured above in St. Paul, Minnesota can also be used as a way-finding device and community icon.

A hypothetical section

06 *ART CAN ATTRACT INTEREST FROM PEOPLE TO TOPICS THAT THEY MAY NOT HAVE INITIALLY HAD INTEREST IN*

Art is one of the universal languages. It can help people to understand complex ideas (such as what happens to water after it runs off an impervious surface) in a simple and direct way. Even if people cannot understand the complicated ideas a piece of work maybe saying, they can still capture the attention or intrigue of a passer-by. Additionally, art is a medium that helps to get the community involved- both in its creation, its acquisition and its appreciation. It is rare in many cases that a community has the opportunity to be a part of a creative method of public advocacy and this is one of the unique benefits artful stormwater management strategies offers. For example, the 3 Rivers 2nd Nature project used art such as photography, paintings and drawings to draw interest to post-industrial sites that would foster the support of preserving these lands and creating new community parks on such sites.

Interpretive sculptures imagined near New Gibbons residence halls

08 DEVELOP AN ARTFUL RELATIONSHIP BETWEEN OPPOSITIES: HARD & SOFT, GREEN & GRAY

Developing a relationship between hard and soft/ green and gray (permeable and impermeable, plant material and manmade material) helps to make a more cohesive environment. Instead of envisioning GI projects as add ons to other types of built projects it is important to consider the importance of how the two work together. If designed thoughtfully, building users maybe able to recognize water movement and management in action without altering their daily routine or create networks of these spaces on a larger scale.

A stormwater education plaza with green space imagined outside the entrance of Phillip Levin Theater

09 USE WATER MANAGEMENT TECHNOLOGY TO CREATE SPACE, NOT JUST INCREASE FUNCTIONALITY

Many water management practices are implemented after some failure of a given system to properly collect, clean and recharge water to its source. As result, management practices are tacked on as an isolated addition to the site they are brought to. Thoughtfully retrofitting these types of sites to use GI will result in addressing water resource issues while simultaneously adding a structural and spatial component to the landscape. Think of the Martin Hall rain garden. It makes the building more beautiful and solves its previous flooding issues. New infastructure projects should be multifunctional: to address water issues, beautify a space, make projects more "green," reduce human impacts and also to add to the spatial quality of the site they are a part of human enjoyment.


A hypothetical section

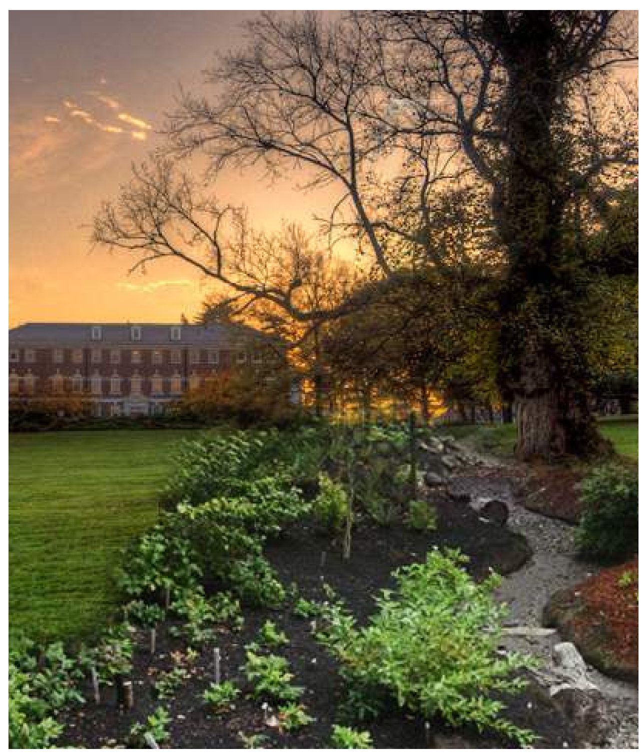
10 *ANALYZE EXISITING INFRASTRUCTURE BEFORE INSTALLING NEW INFRASTRUCTURE*

As seen in green infrastructure (GI) projects on Cook/Douglass, despite a project's good intentions, if it is not properly managed it will not function correctly and people become interested in it. This issue of creation and abandonment is not found only on this campus, because it is easier to create new solutions than to revisit and remedy the old. Moving forward with any type of new water management plan, designers should consider what strategies were used before (but failed) and how those previous efforts can be rejuvenated rather than ignored and left in disrepair.


A hypothetical section

11 *AIM TO RESTORE NATURAL ECOLOGY*

Many environmental issues today are result of development altering the natural systems. While using hard infrastructure is a key component of dealing with these issues, another less obvious one is the efforts designers make to restore natural ecology and employ GI applications. This can be done in any number of ways: by using native plant material, providing safe and desirable habitat for local fauna, protecting the banks and quality of local waterways, and more. All of the "natural" case studies and most projects in the other categories of case studies I investigated addressed the site's natural ecology. In essence, stormwater management is man's way of trying to un-do the harm caused by our own development and provide hospitable conditions for plants and animals to live within the built environment. Designers have the ability to accomplish this and make places that people enjoy.

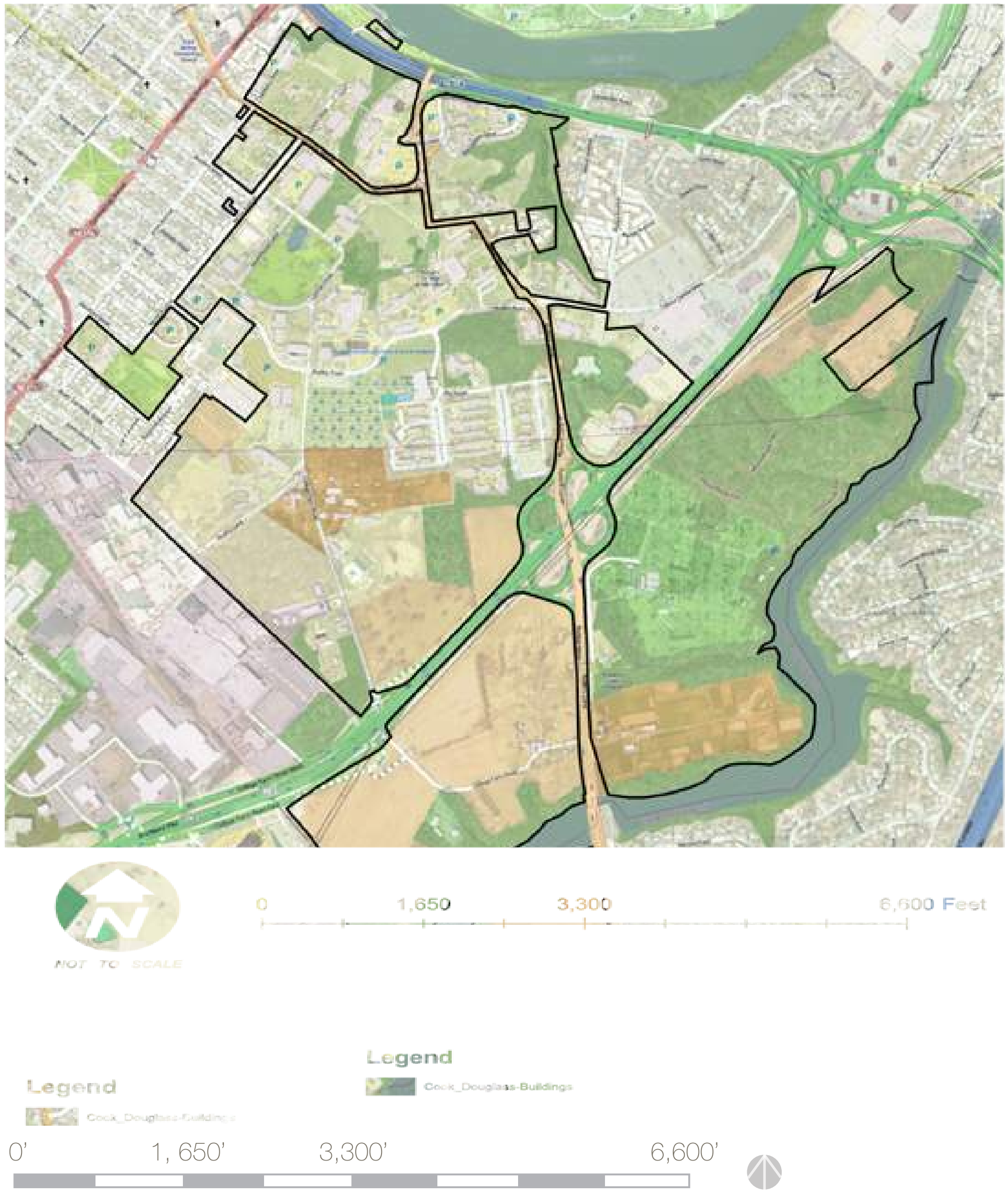

A restorative stream bed leading to Passion Puddle


RARITAN RIVER
ANTILLES FIELD
GEORGE STREET
NICHOL AVENUE
PASSION PUDDLE
RECREATION PARK
COMMUNITY GARDEN
SKELLEY FIELD
COLLEGE FARM ROAD
ROUTE ONE
Donaldson Park
Elmer B Boyd Park
RIVERVIEW AVE
TABERNACLE WAY
REMSEN AVE
HASSART ST
CARMAN ST
WELTON ST
THROOP AVE
REDMOND ST
TOWNSEND ST
COMMERCIAL AVE
SUYDAM ST
HANDY ST
BALDWIN ST
VOORHEES ST
MEMORIAL PKY
CARPENDER RD
NEWELL AVE
PHELPS AVE
CHAPEL DR
RED OAK LN
LIPMAN DR
RYDERS LN
COBB RD
DUDLEY RD
BIEL RD W
CONSTITUTION SQ
RUTGERS PLZ
SHEEPFOLD LN
COLLEGE FARM RD
POULTRY LN
RESERVOIR AVE
CR-617
LOG CABIN RD
171
1

CAMPUS CONDITIONS

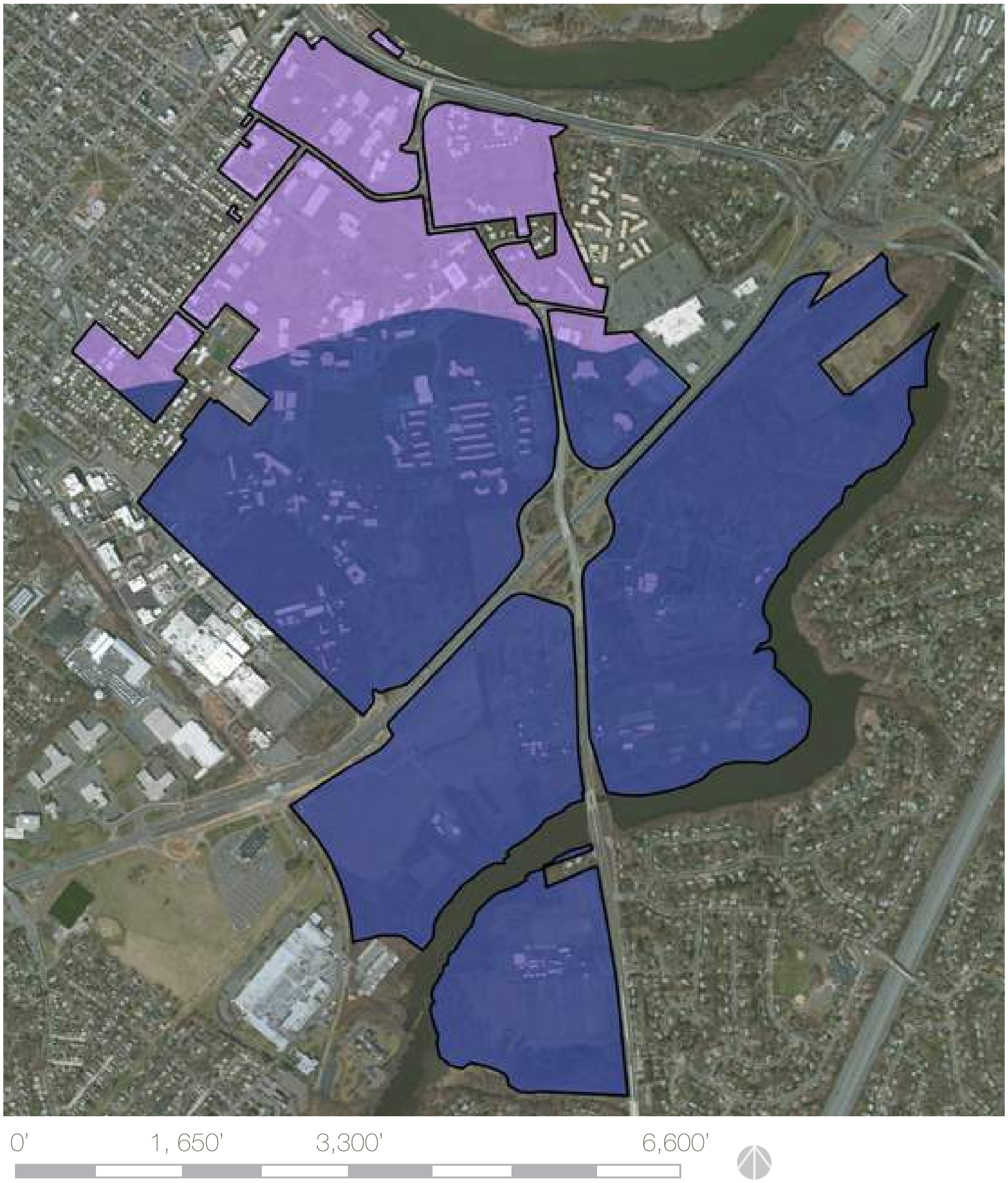
How many rivers are located on campus? Where are the wetlands? Are there any green infrastructure projects currently at work in the landscape? These questions and more can be answered by analyzing campus conditions. This type of analysis is very important in understanding what the site's environmental conditions are. In doing so, an inventory of different conditions of interesting can begin to tell the story of the campus' landscape. Employing mostly mapping techniques, the follow section presents factors relevant to water and its movement, along with identifying places on campus where green infrastructure is present and places where it may be needed. While there are hundreds of relevants maps that can be created to better understand the campus' environment, the selected maps are shown to give a quick and diverse overview of the current conditions present. This type of analysis is key in using design-experimentation to draw campus conclusions and present a possible design solution or set of design recommendations.

CAMPUS CONTEXT



Cook/Douglass campus is located south of the Raritan River and is laterally divided by the US Route 1 highway. The majority of development is located in the northwestern region of campus. Subsequently, the school's bus system only services this portion of the campus. The southern portion of campus is adjacent to the Lawrence Brook.

WATERSHED CLASSIFICATIONS



AFTER ANALYZING THIS MAP I BECAME INTERESTED IN THE BOUNDARY BETWEEN COOK AND DOUGLASS AND ITS RELATIONSHIP TO THE BOUNDARY BETWEEN THE TWO WATERSHEDS. I STARTED WONDERING IF THE TWO DISTINCT WATERSHED AREAS CORRESPOND IN ANY WAY TO THE SENSE OF PLACE OF COOK AND DOUGLASS RESPECTIVELY.

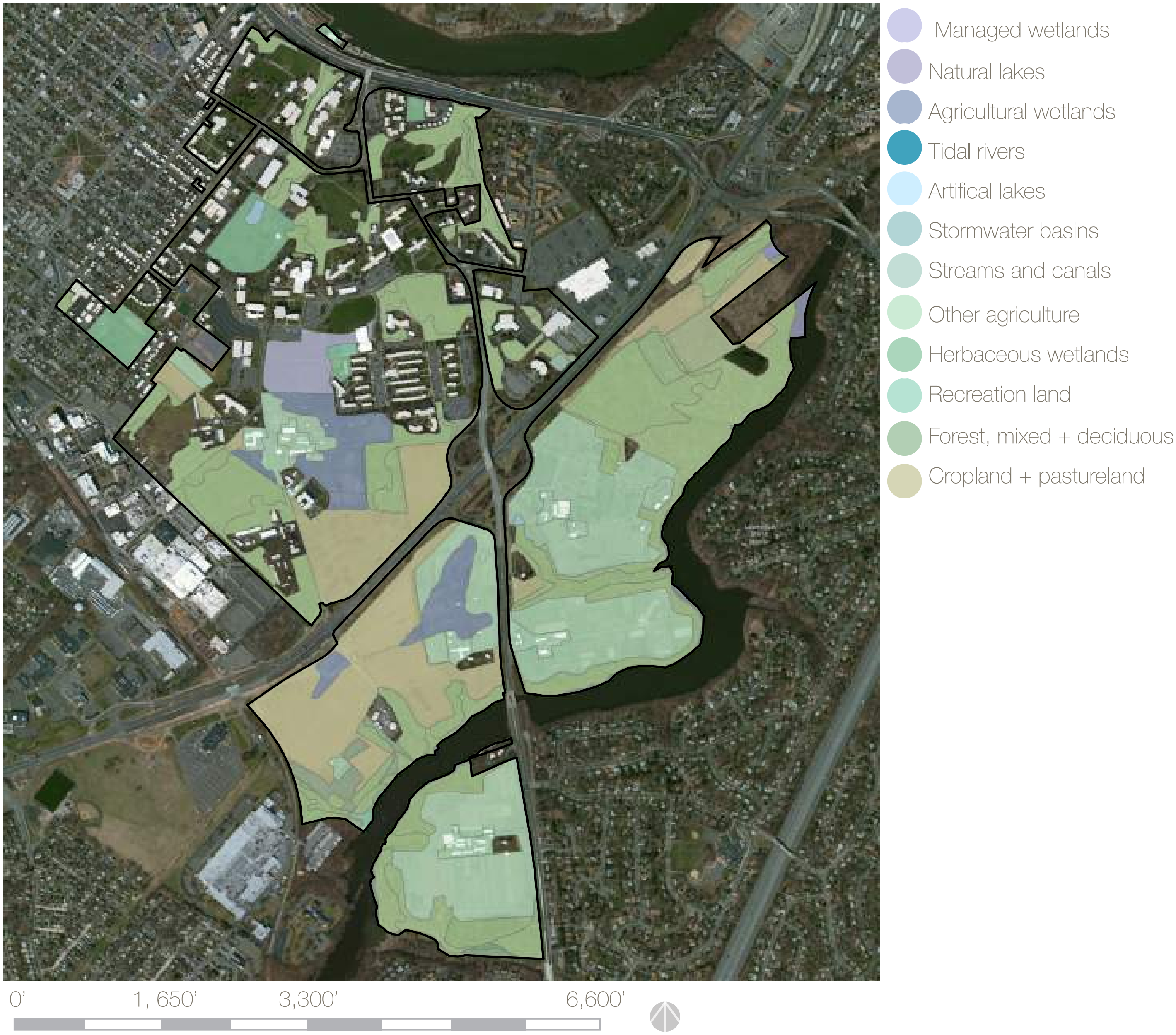
Cook/Douglass campus lies within two watersheds. Most all of Douglass and a good portion of Cook are within the Raritan watershed and thus flow into the Raritan River. Even so, the majority of the campus area is part of Lawrence Brook Watershed. Within this portion is a lower frequency of university buildings and student inhabitant/use areas. Also, this area of campus is sliced by a major highway, Route 1. This map helps to understand where water flows when it lands on a particular part of campus and helps further distinguish the areas of Cook and Douglass.

LAND USE TYPE

I WAS SUPRISED BY ALL THE AREA DEEMED URBAN ON THIS MAP. PASSION PUDDLE FOR EXAMPLE IS URBAN BUT IS A GREEN, SPRAWLING LAWN. AFTER CONTACTING UNIVERSITY FACILITIES FOR MORE INFORMATION THE REASON FOR THIS CLASSIFICATION BECAME CLEAR...

The majority of the academic and residential buildings on campus are located on urban land. Through investigation of earlier landuse and landcover maps it can be seen that some of this urban land has been reclassified as development occured from wetland to it's current urban title. This suggests the natural history of this campus was largely composed of wetlands with wet-site tolerant forest areas. While some wetland and forest areas remain, they are fragmented and disjointed from one another. Much of the agriculture on campus takes place southeast of Route 1.

LANDCOVER



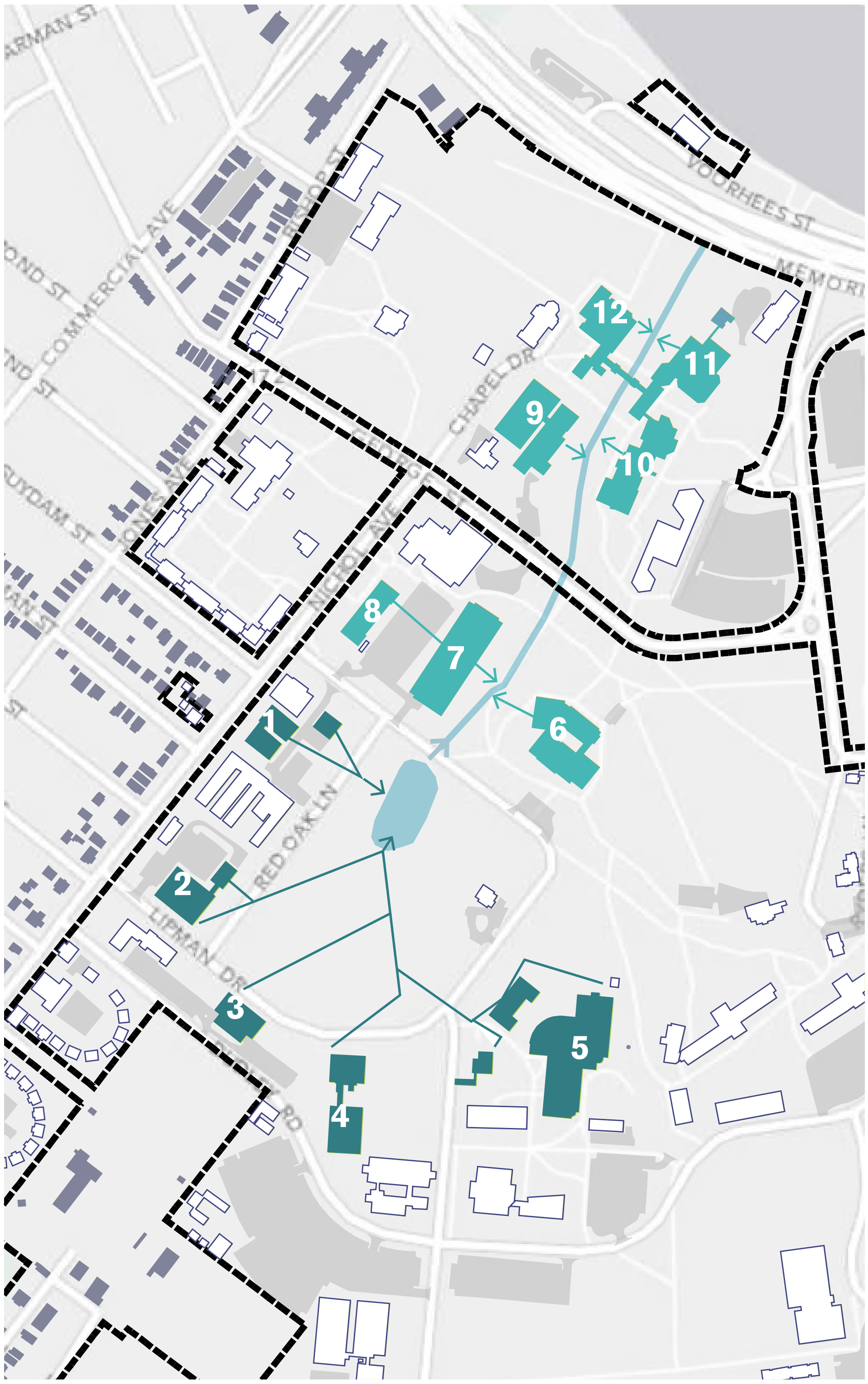
Here the various ecological landcover zones can be seen. This helps to give an idea of the zonation of environmental conditions and the spread of various habitats. It's also helpful in seeing a more detailed interpretation of the land use types.

RUTGERS COOK/DOUGLASS DRAINAGE AREAS

This map shows the seven Drainage Areas located on Cook/Douglass campus' main development area, located north of Route 1. In addition, it displays the points of discharge for each area, marked with an asterisk. A light thin gray line denotes an underground pipe.

Drainage Areas Map courtesy of Rutgers University Facilites and Capital Planning

DRAINAGE OF THE CAMPUS CORE



Runoff piped to Passion Puddle

1 Waller Hall
2 Blake Hall
3 Martin Hall
4 Bartlett Hall
5 Foran Hall, Lipman Hall + Plant Physiology Building

Runoff piped to ravine

6 Loree Hall
7 Douglass Parking Deck
8 Douglass Student Center
9 Douglass Library
10 Victoria Mastrobuono Theater
11 Phillip Levin Theater
12 Walters Hall + Art History Building

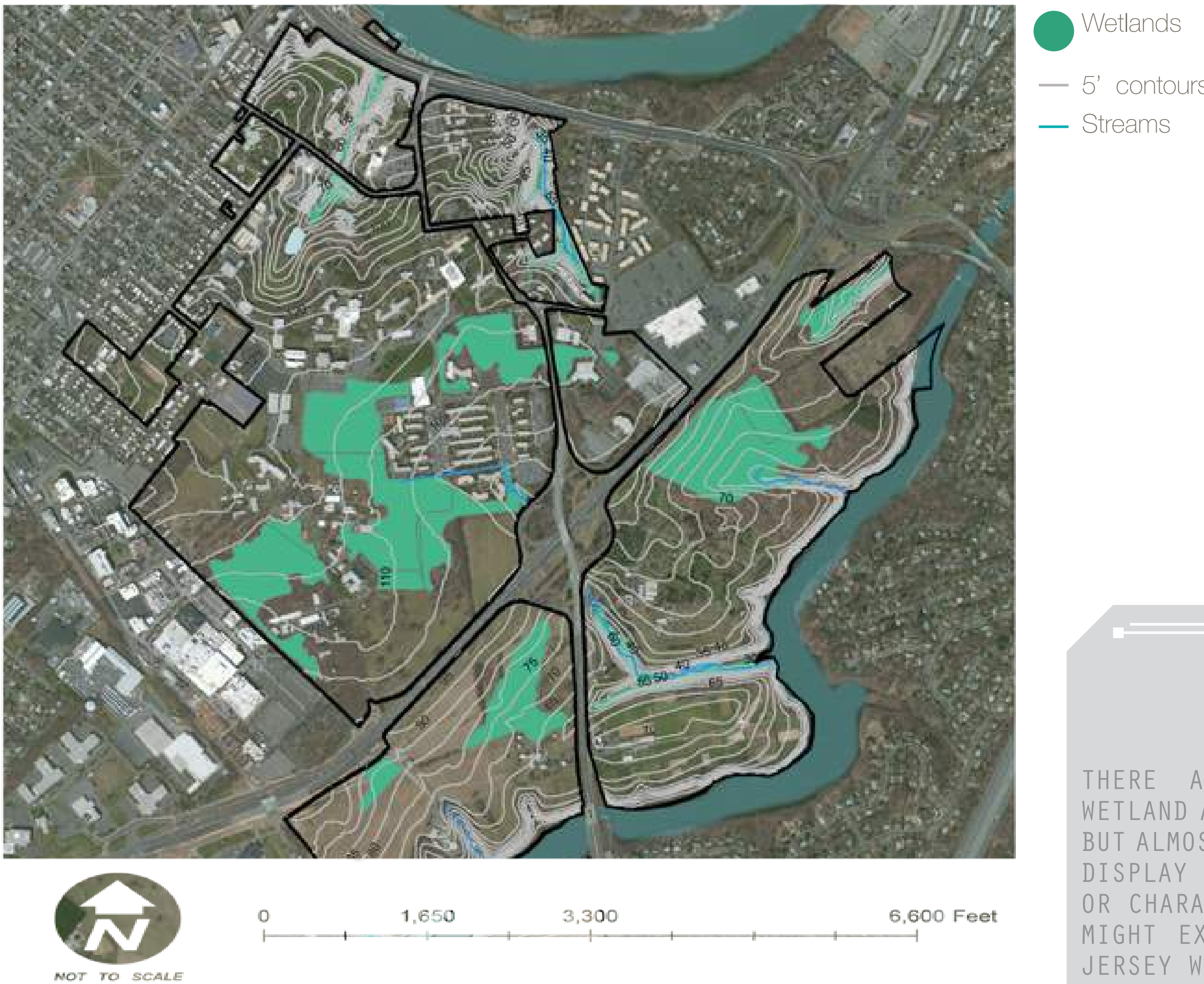
A more detailed look in Drainge Area 2 (DA2) from the Drainage Area Map shows the underground pipes of the campus' core, many of which connect academic buildings (and show some signs of stormwater-related erosion) and overflow their runoff into to Passion Puddle and the ravine, then ultimately into the Raritan River.

Schematic representation of underground pipe system

DIGITAL ELEVATION MODEL

The above map shows the topographic changes within campus. There is about 100 feet change between the highest and lowest points. The lowest points are at -2' below sea level and the highest are at 100'. This map helps model how water would flow when it falls over the campus. The southern area of campus has the greatest elevation changes and water will run faster down a slope here than on a more northern spot on campus.

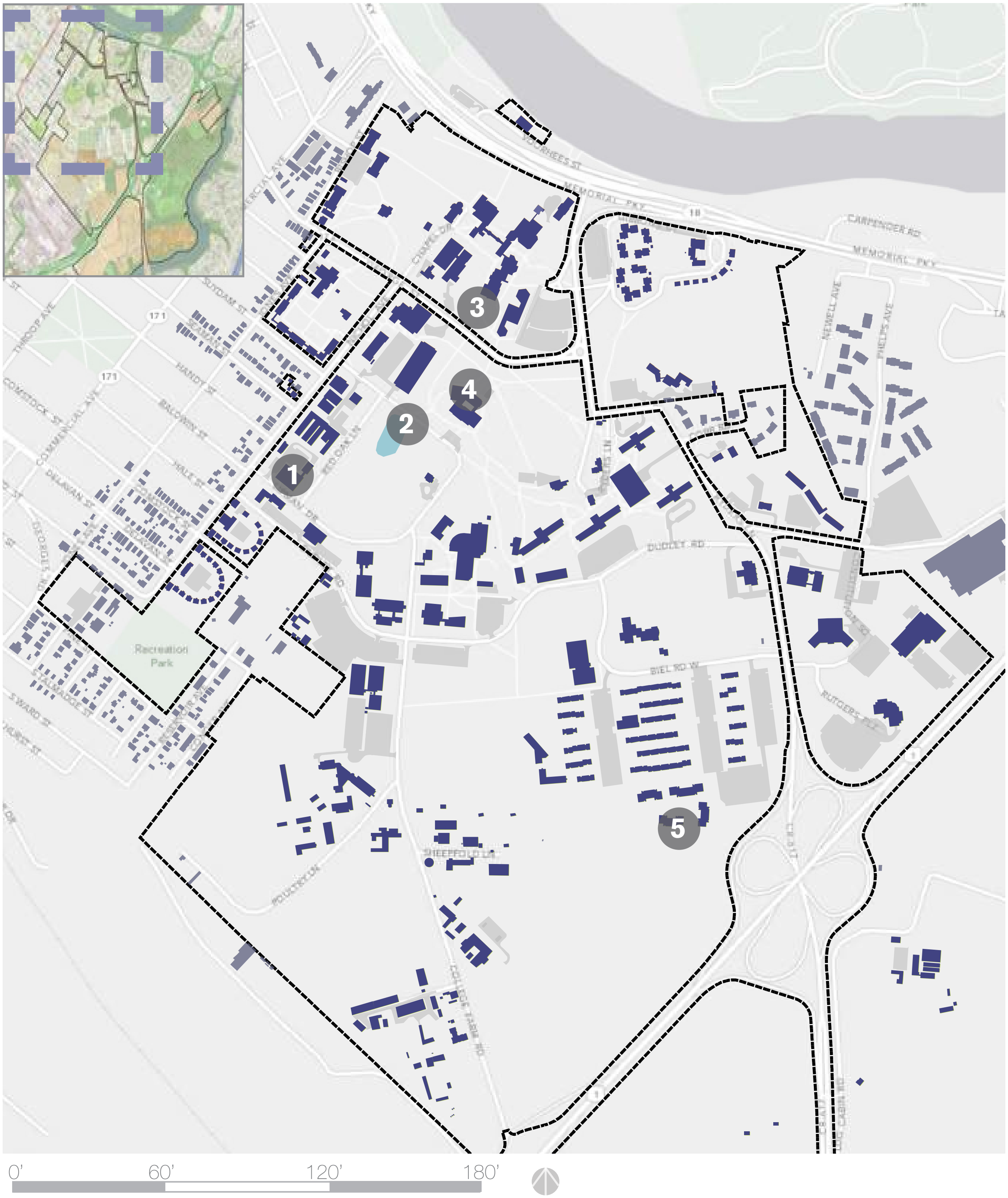
WETLANDS, STREAMS + CONTOURS



THERE ARE A LOT OF WETLAND AREAS ON CAMPUS BUT ALMOST NONE OF THESE DISPLAY THE VEGETATION OR CHARACTERISTICS ONE MIGHT EXPECT OF A NEW JERSEY WETLAND

The relationships between wetlands, streams, and contours are important in understanding how water moves through the campus and where the remaining wetland areas are. It is also important for quantifying elevation changes displayed in the Digital Elevation model.

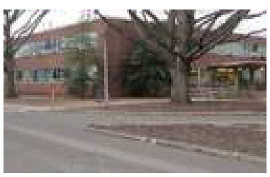
STORMWATER RUNOFF EROSION

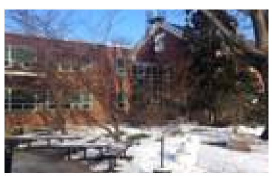


In the summer of 2013, Landscape Architecture students Chris Perez, Gwen Heerschap, Ryan Goodstein, Jenny Burkhalter and Josh Mieloch worked under professor Tobiah Horton, researching "The Chemistry and Control of Reused Concrete." They conducted an erosion inventory that identified sites on campus which have been degraded by stormwater runoff. Four of their identified sites were located on Cook/ Campus. Interestingly enough, two of these four sites were sites noted previously in this report as ones containing "Green Infrastructure on Campus." Below these degregated sites are identified and findings are explained. [15]

01 BLAKE HALL

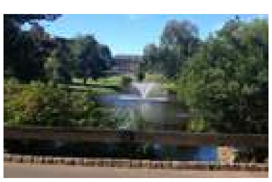
The retaining wall behind Blake is crumbling. It was predicted that the high runoff of nearby surface parking is the main cause for the damage.

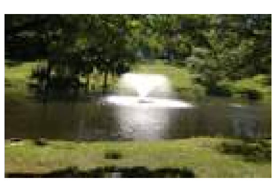




02 PASSION PUDDLE

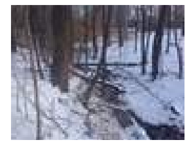
The pond and headwalls are eroding. The water in the pond is often murky and brown in color. The area has heavy foot traffic and tuf lawn maitenance crews. Runoff enters the pond from the lawn from pipes close to Red Oak Lane.





03 OVERFLOW RAVINE

Water enters the ravine from pipes coming from Passion Puddle and redirected under Lipman Drive and other stormwater overflow pipes from the parking deck and Loree building. Land here is eroded, harming nearby plant material.



04 LOREE HALL

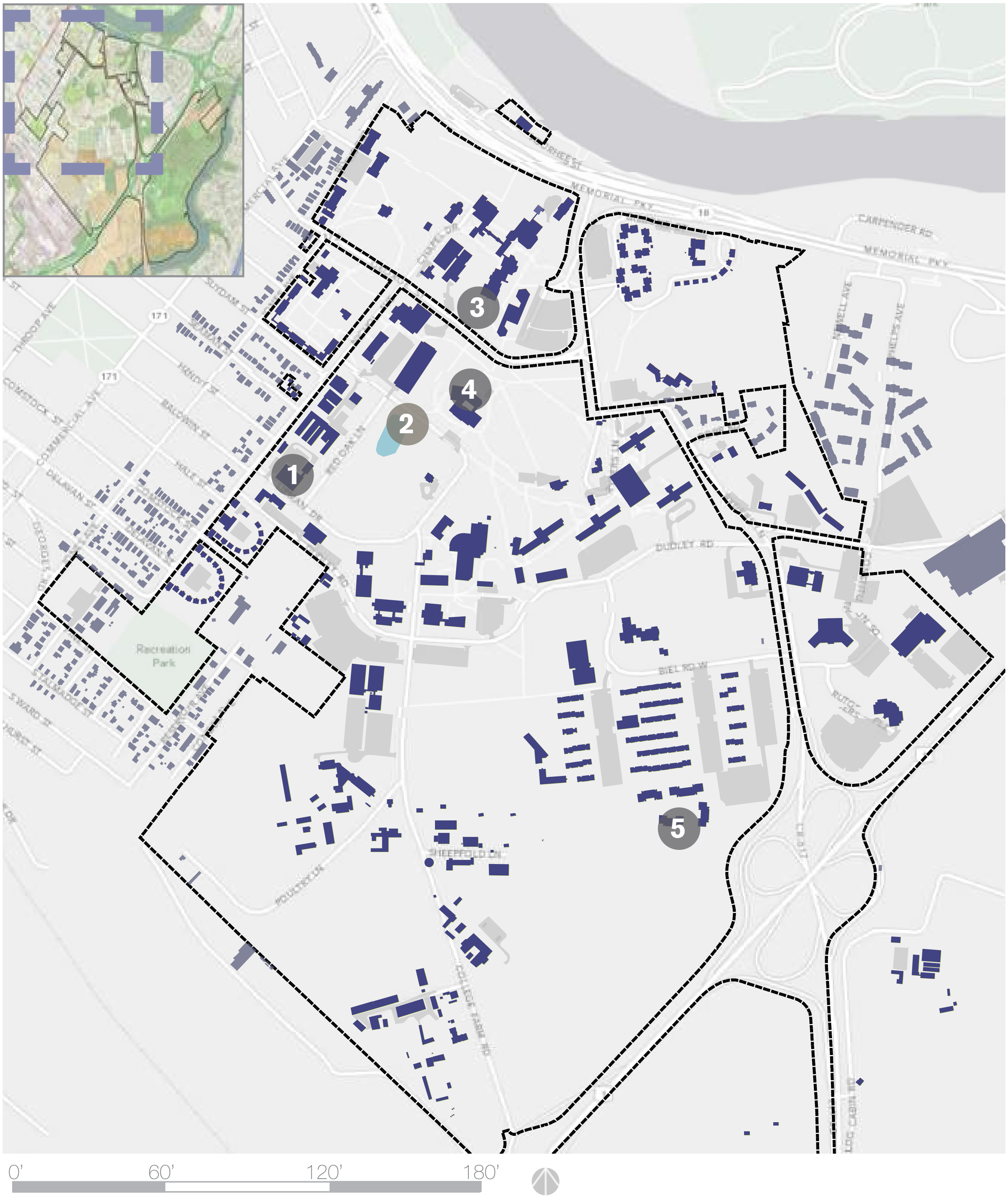
There are exposed drain pipes in front of the building where there is heavy foot traffic and lawn maintenance. There are sedimentation blockages in the current stormwater systems here.

05 STARKEY APARTMENTS

A drainage ditch turns into a stream and begins by the horse farm and continues all the way to the parking lot of the apartments. Water is directed, unfiltered, into the stream after running off paved surfaces and turf.

15) Horton, Tobiah, et al. "The Chemsity and Control of Reused Concrete." Diss. Rutgers University, 2013. Print.

SELECTED GREEN INFRASTRUCTURE ON CAMPUS



01

CISTERN, Blake Hall

02

HABITAT GARDEN, Foran Hall

03

RAIN GARDEN, C/D LECTURE HALL

04

RETENTION POND, Passion Puddle

05

RAIN GARDEN + POROUS PAVEMENT, Martin Hall

EVALUATION OF SELECTED CAMPUS GREEN INFRASTRUCTURE

01

-

CISTERN,
Blake Hall

The Blake Hall cistern was installed in 2003 and was intended to capture stormwater to be used in a drip irrigation system to water landscaping in front of the building. It is a self-sustaining system, supplying its own energy with solar panels. The system hasn't functioned properly in years due to lack of stewardship and education of the system.

02

-

HABITAT GARDEN,
Foran Hall

The habitat garden has an attractive wild quality about it not seen much around campus. There is little signage about its purpose and usage as a community garden. There is much potential for promoting this project and making it more water-conscious and student friendly. The garden was once called a "stewardship garden" but much like Blake Hall's cistern, there are currently no stewards to be spoken of.

03

0

RAIN GARDEN,
C/D LECTURE HALL

The rain garden around the Cook/Douglass Lecture Hall is appears to be overgrown and looks messy. It has saturated soil and ponding much of the time. These issues could be ameliorated with additional site engineering. A bit more manicuring could go a long way in terms of aesthetics for this garden.

04

+

05

+

RETENTION POND, Passion Puddle

Passion Puddle is an icon for Cook/Douglass campus and is loved and enjoyed by many. The pond has taken on many other uses in addition to its function as a retention pond for storing excess water on campus and retaining stormwater. The main water quality problems with the Puddle are a result of fertilizers and geese and subsequent waste. Efforts to plant along the Puddle's edge to deter geese have failed due to maintenance issues and herbivory of local animals.

RAIN GARDEN + POROUS PAVEMENT, Martin Hall

In 2012, a rain garden was planted around Martin Hall and a porous pavement walkway was installed next to the building. Both additions are beautiful and function well. These two projects have great potential to act as tools for raising awareness of green infrastructure.

+ HIGH QUALITY
0 MEDIUM QUALITY
- LOW QUALITY

The criteria used for qualitative assessment of sites based on functionality and aesthetic quality based on my knowledge and perspective as a Landscape Architecture student and designer.

GREEN INFRASTRUCTURE SUCCESS STRATEGY

CREATE EDUCATIONAL PROGRAM FOR MAINTENANCE EMPLOYEES

One of the main reasons cited as the reason failure of current green infrastructure (GI) projects is a disconnect between designers and the maintenance crew working on the project. There is a different maintenance strategy for typical campus plants and those in GI projects- workers are accustomed to keeping plants very neat looking but wet-site herbaceous material has a wilder look. Teaching employees to identify and understand the nature of these newly implemented plants will help keep projects functional.

FOSTER LASTING STEWARDSHIP

The cistern and habitat garden both began to fail when the original students involved with the projects graduated from Rutgers. The original stewards left their projects behind without passing the responsibility onto other interested parties. To ameliorate this, instead of having individuals head the efforts of GI projects, departments or Rutgers funded clubs/organizations must be the main parties responsible for maintenance of these projects. Since these constituents are more permanent, they can assign stewardship to the appropriate student individuals but there will be a line tracing each project to an accountable source if its maintenance begins to go astray.

IMPLEMENT A CONSISTENT,THOUGHTFUL + SITE SENSITIVE PLANT PALETTE

A large part of educating people and users of space near GI projects is using a defined, redundant plant palette that will be easily recognizable to them. This will enforce the idea of managing water across the entire campus and get people thinking about how water moves and the complex relationship it has with plant life. In addition, the plants have to be appropriate for the site's conditions (its microclimate, water levels, soil condition, and natural predators) so choosing hardy NJ native plants that have many features of interest is of upmost importance.

EDUCATE BUILDING USERS ON PURPOSE OF GREEN INFRASTRUCTURE

Another common reason for failure of GI projects is that people are not used to seeing them. The plant material is a bit unconventional and people tend to think it looks messy. If people using the spaces the projects are planted closest to were educated (through signage, a web app., or maybe a movement through the space that inspires learning about water processes for example) on its purpose and benefits, they would be able to look at the plant material in a new and more valuable way.

INTEGRATE PURPOSE OF GREEN INFRASTRUCTURE PROJECTS WITH USER PROGRAMS

Rethinking the way GI is implemented will help give it added value. Instead of just applying a rain garden around the foundation of a building receiving a lot of runoff, why not create a garden room with rain garden edges that offers building users an enjoyable place to meet and snack? Using GI in a more multidimensional way will allow projects to leave a strong impression.

MAKE IT A PLACE THAT PEOPLE ENJOY!

By creating enjoyable spaces, people will want to visit it more and foster stewardship for that particular place.

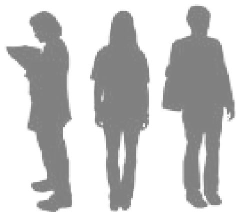

Photo by Flickr's Kevin41589

CAMPUS CHARACTER

Cook/Douglass campus has a unique character shaped by a long and interesting history. Situated on mostly wetlands converted to farm land and then urbanized over time, the landscape we know on campus today does not resemble its natural origins very closely. The landscape known today however has been fairly consistent over the past century. Analysis of historical maps suggest that the development of the road system shaped much of the campus' land use, pedestrian circulation, and vegetative zones- as can be seen to the right in the campus 25 Year Master Plan map from 1950. Other references to the site's history can be seen in the materials, vegetation, signage and historical references that can be seen across Cook and Douglass campus areas respectively. While remnants such as these remain, the unique characters of Cook and Douglass is muddled as the two are almost always grouped together and unintentionally assigned a unified image which overlooks their distinct histories and collegiate origins. The following chapter explores who are the general users of the campus space, how history has shaped the Cook/Douglass known today, and what similar and unique attributes exist that give the campus its current identity.

TYPICAL CAMPUS USERS

STUDENTS



Students are the primary users of the campus space both in frequency, range of use and density of users. Their program needs range from walking between all points of interest on campus, utilizing open space and large fields for both passive and active recreation, and being able to learn from built and natural processes.

INSTRUCTORS + FACULTY

Faculty forms a long-term relationship with the campus as they discover short-cuts to get to their destination points. Additionally, they need spaces to sit, reflect, and rest. Outdoor classroom spaces could provide professors with a unique learning tool that engages students and can add a new dimension of interest to a class period. In some cases, the landscape may act as a living laboratory.

STAFF

Staff are employees of the university and fill a wide range of positions, from grounds maintenance to food service. They are required to come to campus for work even on days when classes are cancelled and students/ faculty are not required to come, as result of inclement weather or scheduled breaks from classes. They may interact with campus differently based on their job (if they work in the same building each day they may not know is as well as someone who works in a variety of buildings.

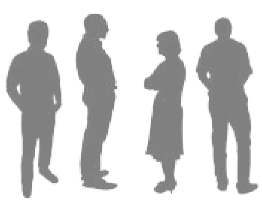
NEW BRUNSWICK COMMUNITY MEMEBERS

Members of the New Brunswick community are an intregral group to consider. These citizens often utilize campus' open space during nights and weekends for recreational purposes. They are not always considered in university design but their close proximity to campus makes them an important demographic in the scope of users.

FAMILY + FRIENDS OF REGULAR USERS

When alumni visit, they tend to bring along their family and/or friends. These users require attractive spaces that are easy to understand and circulate between since they are all mostly unfamiliar with the campus layout. Wayfinding is especially important for this group. They visit in large quantities usually for events such as the graduation for students of the School of Environmental and Biological Sciences in the field adjacent to Passion Puddle or Rutgers Day. These visitors may also be small children who would enjoy play areas.

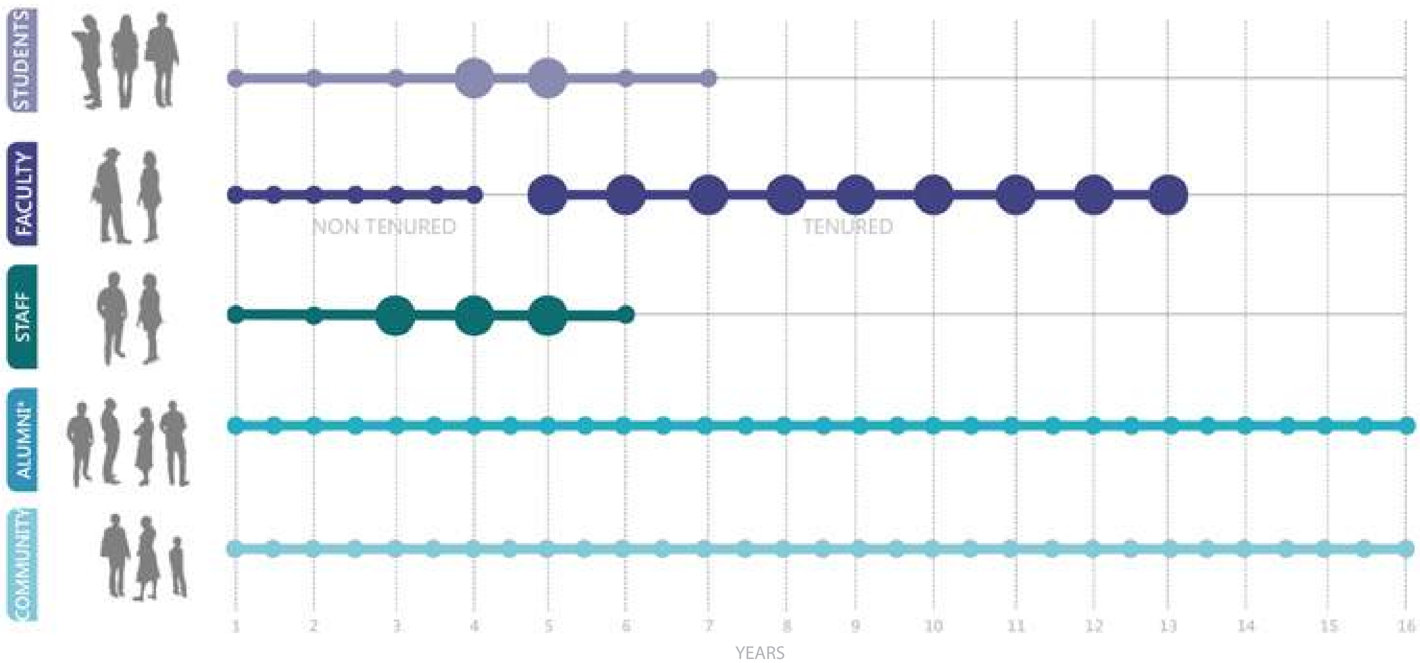
ALUMNI



Alumi visit Rutgers less frequently than students and faculty but are equally as important because they help fund Rutgers. Creating spaces that appeal to them, especially in popular places they visit such as Passion Puddle or the sites used for Rutgers Day, will help promote their return and continued university support.

THERE ARE 6 MAIN CATEGORIES OF CAMPUS USERS. *DAILY USERS,* WHICH ARE COMPOSED OF STUDENTS, FACULTY + INSTRUCTORS, AND STAFF AND *OCCASIONAL USERS* WHICH ARE COMPOSED OF NEW BRUNSWICK COMMUNITY MEMBERS, FAMILY + FRIENDS OF REGULAR USERS, AND ALUMNI.

USER TIMELINE

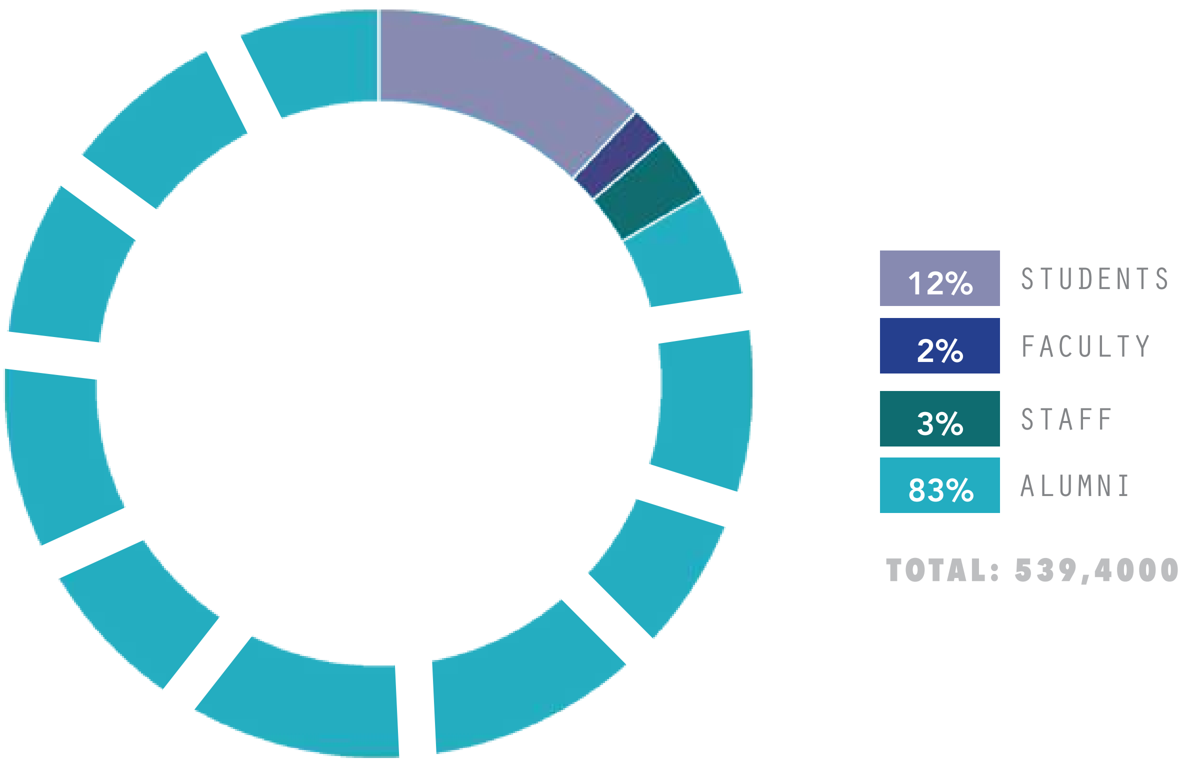


This figure shows the time each stakeholder interacts, on average, with campus. Students are on campus for as long as they attend the university until they graduate, an average between four and six years, according to the National Center for Education Statistics'. Faculty have a range of average times they hold positions on campus, depending on if they're a visiting/temporary instructor, with an average of five or a tenured faculty member, with an significantly higher average. Alumni and their friends and family have a lifetime relationship with the university and thus have potential during that entire time to come back and visit campus.

These findings are significant in designing interactive and educational green infrastructure for campus because the longer green infrastructure is relevant to visitors the more sustainable it will be. This research suggests that appealing to annual or even less frequent visitors (such as alumni and their loved ones) is valuable because their relationship with campus is the most prolonged. Based on this data, events such as Rutgers Day can be valuable opportunities to showcase campus sustainability projects. These findings inspired a closer look into the proportion of each user type to the total number of campus users. Without knowing how significant each type is to the whole, it is hard to put the findings of the timeline into perspective.

* Alumni accounts for both alumni and frields + family of regular users Bureau of Labor Statistics. Number of Jobs Held, Labor Market Activity, and Earnings Growth: Results from a Longitudinal Survey. U.S. Department of Labor, 2012. Print. National Center for Education Statistics' Integrated Postsecondary Education System. Graduation rates by state. The Chronicle of Higher Education, 2010. Web. 18 Jan. 2014.

USER RATIO



This figure shows the number of user types within the Rutgers University community in relation to each other. Alumni is the most expansive group, but its intermittent. Students are also a significant portion of the community. This goes to show that people who currently attend or attended the university make up the majority of the community. Both faculty and staff represent a minute portion of the total number of community members. It is important to note that there was no data on number of family and friends associated with students and alumni but it can be assumed their presence is represented proportionally to the number of students and alumni.

The most significant group to design for is students of the past and present. As result, design focuses should be around places students use most because these are places they can best learn from and also the ones they will remember when they revisit as alumni. Additionally, spaces where alumni come (spaces used for receptions and events) are key focus areas. They must address and resolve water issues while also inspiring learning in the time the alumni is there, which could be just a few hours or even in momentary passing. In conjunction with the findings of the timeline, it can be concluded that alumni are an extremely important user group to consider when designing for Cook/Douglass campus.

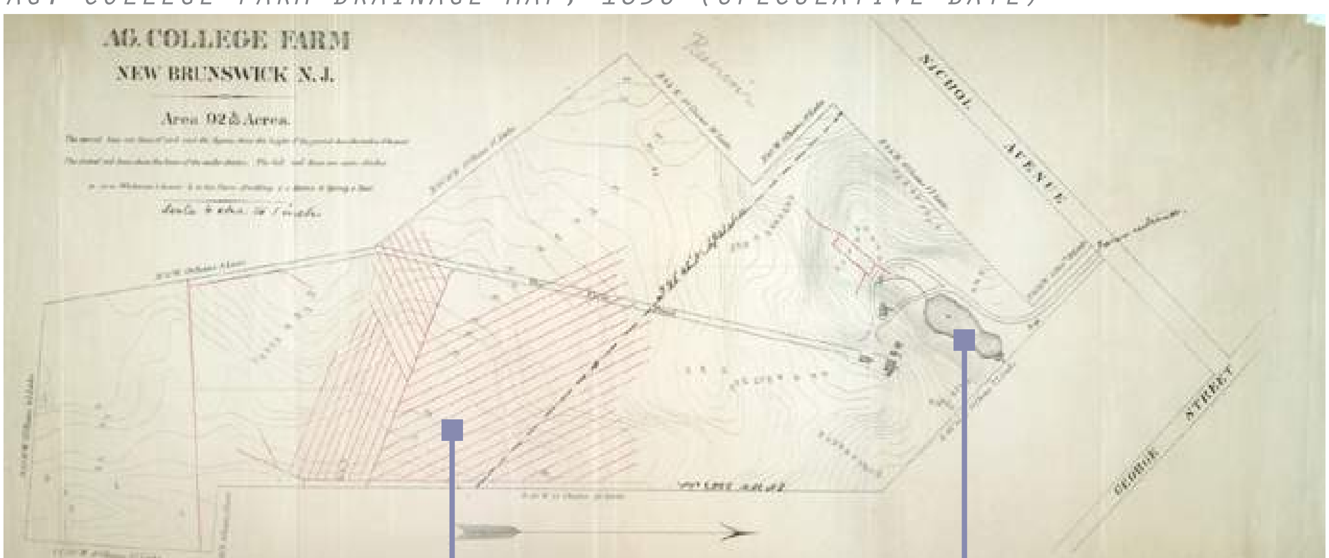
"Facts & Figures Rutgers, The State University of New Jersey." N.p., Web. 18 Jan. 2014.

HISTORICAL OVERVIEW

The landscape of Cook/Douglass campus has changed considerably over time. While much of the urban area around Douglass campus has been urban since Rutgers' inception, the overall land has changed from wetlands and forest to what we know today. As development occurs, analysis of old land use data will show that wetland and forest lands are continuously being reclassified as "urban" land. Based on research into old campus and New Brunswick maps, it can be seen that much of the land we know as Cook/Douglass campus housed farms before Cook College, now The School of Environmental Sciences, expanded. The fact that Passion Puddle, which acted as an agricultural retention pond for the landowner so his livestock could have access to water even in times of drought, remains an icon of the campus' picturesque identity, speaks to the present (albeit muddled) connection between the campus as we know it and the campus' historical origins. In the map below, a small spring is noted at the southern end of Passion Puddle.

Campus development, and the subsequent infrastructure required to maintain it, is a major factor in the current drainage system of Cook/Douglass. The system is much different from the days when most of Cook campus operated as farmland. The drainage system from that time, between 1800-1900, consisted of agricultural tiles. These tiles were typically made of clay and were installed by farmers to pull surface moisture below grade to supply plant's roots with extra water. It is no surprise that surface water was a problem in those days based on the site's historical classification as wetland. Remnants of this tile system still exists today and wet-sites that required tile installation, like Skelly Field, still remain abnormally wet today.

AG. COLLEGE FARM DRAINAGE MAP, 1850 (SPECULATIVE DATE)

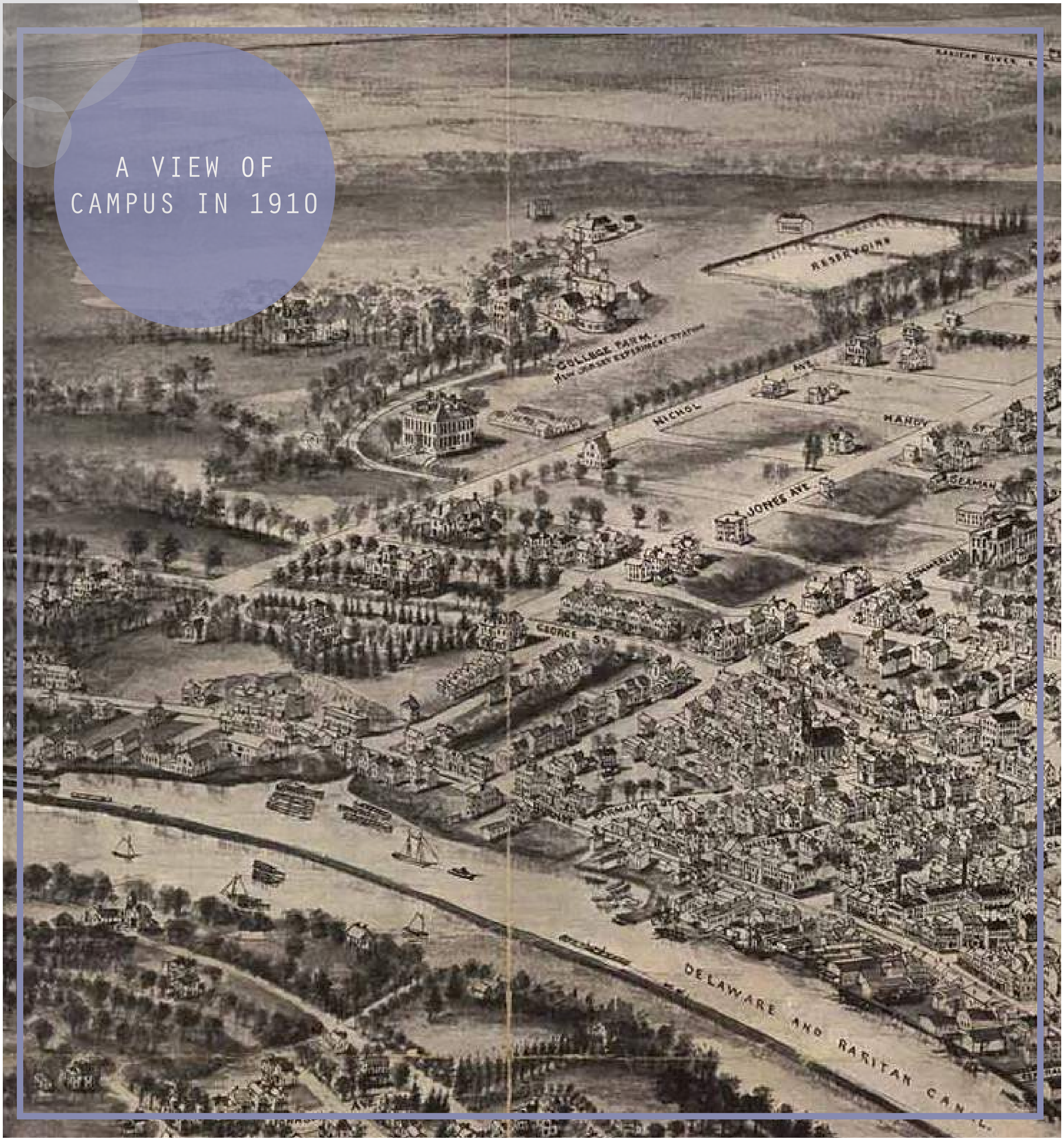


PRESENT DAY SKELLY FIELD

PASSION PUDDLE

Map courtesy of Rutgers University Archives, Red dashed lines represent drainage tiles

A VIEW OF CAMPUS IN 1910



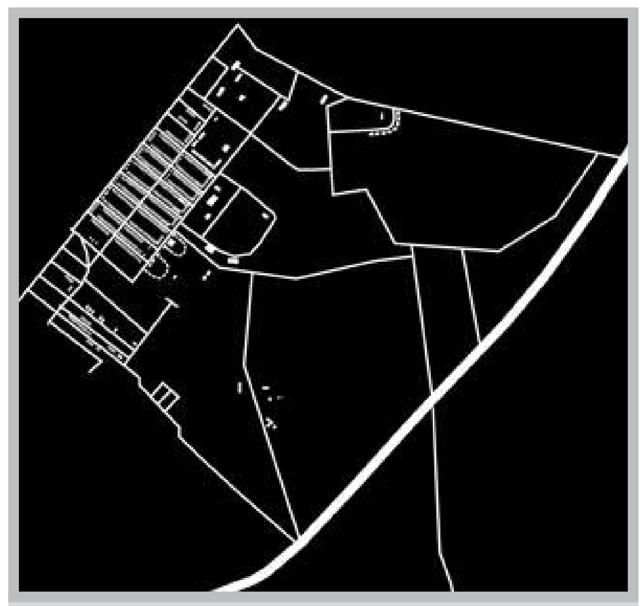
Rendering by Hughes and Bailey Publishers
See Appendix for more historical images and maps

CHANGE

TIME

1931

Most of campus is farm land with some scattered forests. Most development is in the north part of campus within the Raritan River watershed.



1931

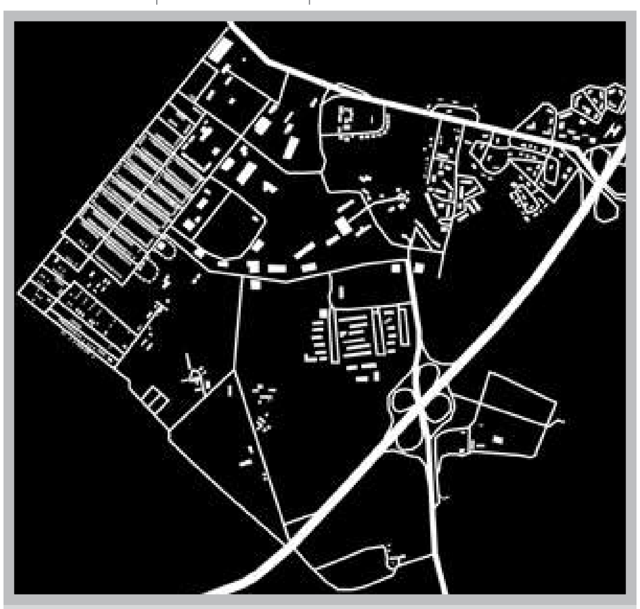
Most development is in the northwestern part of campus. The residential neighborhood is very dense while the rest of campus has little to no impervious cover.

1979

There is a lot more development and much of the farmland has disappeared. Some scattered forests remain and development has moved into the middle part of campus.

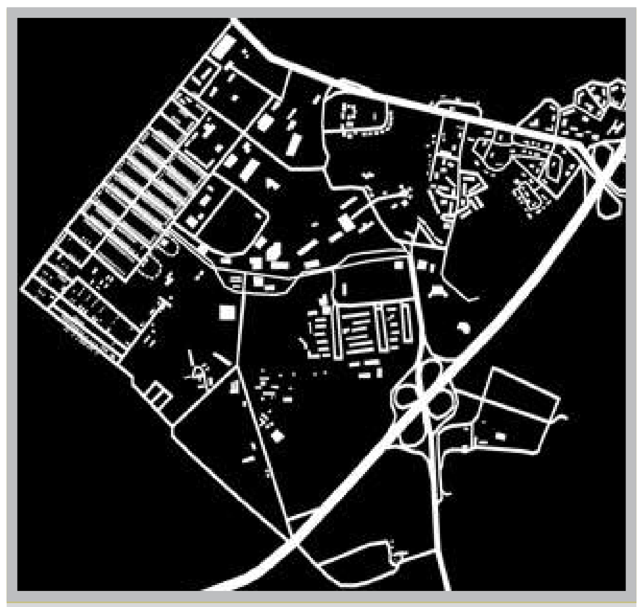
2007

The forest area has decreased. There seems to be a similar amount of open green space and some changes to building and roads.



1979

There is a massive increase in development across the entire campus. The roadway system has become more complex and there are many buildings constructed within the university's territory.

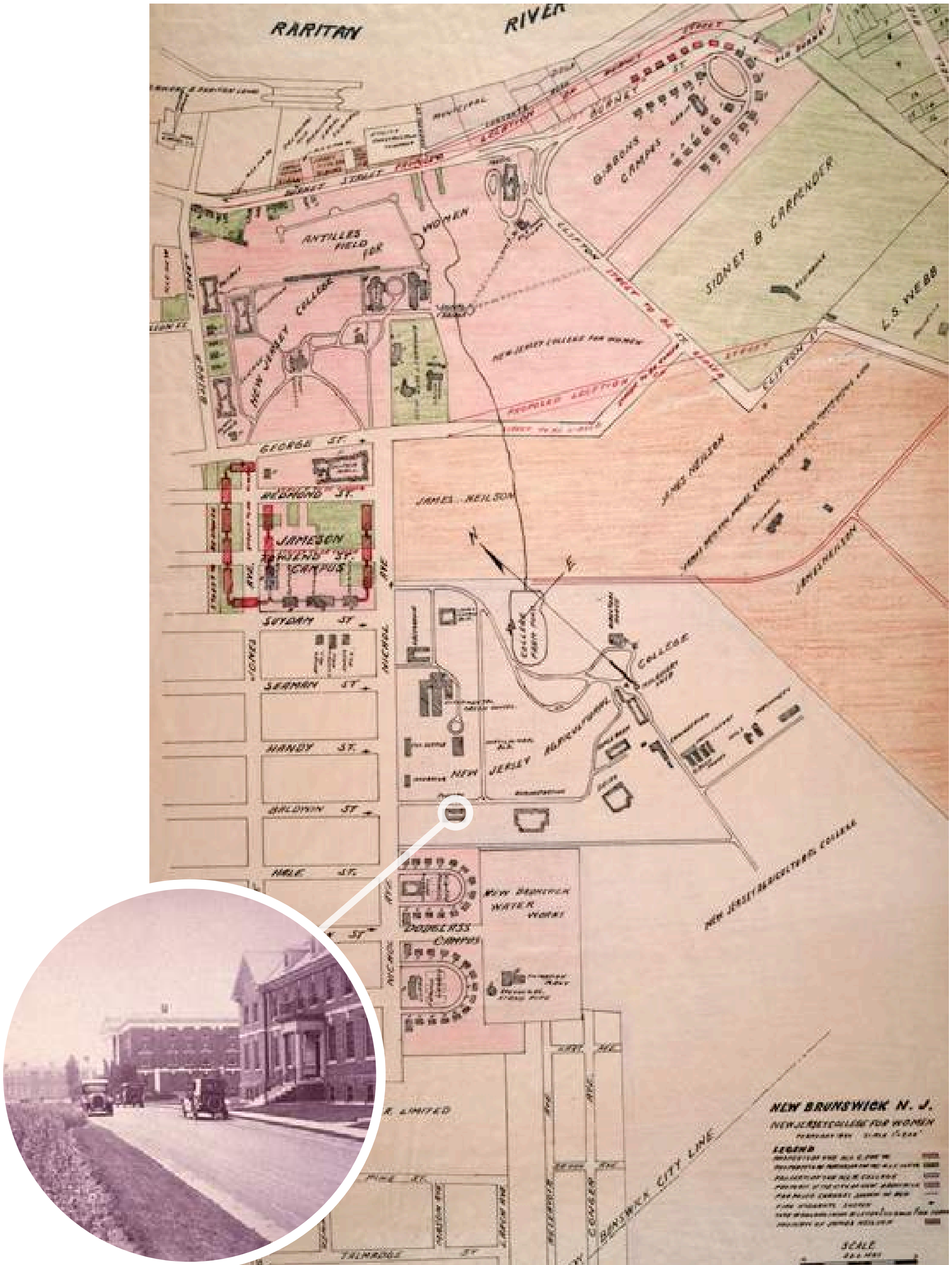


2007

Additional buildings are constructed within and adjacent to campus. New surface roads are constructed.

Aerial photos: National Environmental Title Research, LLC (NETR), Historical aerials. 2009. Photograph. Historic Aerials Web. 18 Jan 2014.
Diagrams used based on historical aerial photographs. Note: Not all structures within the diagram are affiliated with Rutgers University. They are shown to give perspective to where outside runoff enters campus from.

CAMPUS MAP, 1929



A view of Thompson Hall, then home of New Jersey Agricultural College's poultry department, down Lipman Drive

Map courtesy of Rutgers University Archives.
Photo of Thompson Halll from
See Appendix for additional historical maps

One notable change to the cultural landscape of the campus was the union of Cook and Douglass from separate entities to a more unified, boundary-less unit. This union and the individual characteristics of Cook and Douglass became a key topic of investigation for this thesis. Based on the research I have conducted there is no exact date this happened but rather it was a conglomeration of their respective identities into one based on their close proximity and visual similarities.

The School of Environmental and Biological Sciences (SEBS) was founded in 1864, then called "New Jersey Agricultural College" and later "Rutgers Scientific School."[16] This campus spanned from north of present day Route 1 to Lipman Drive adjacent to Passion Puddle. Much of the agriculture now takes place south of Route 1 on Rutgers Horticulture Farms, including the Turf Grass research facility and the Student Organic Farm. The highway divide and lack of university transportation to those farms has disconnected SEBS students a bit from the school's origins as an agricultural college. Driving Cook and Douglass campuses was a large plot of land owned by James Neilson, shown in the map to the left in orange. This land was later acquired by Rutgers and split between Cook and Douglass ownership.

Douglass College, formally The New Jersey College for Women, was founded in 1918. They later acquired the Sidney B. Carpender and L.S. Webb estates. Douglass College was officially merged with the other Rutgers-New Brunswick undergraduate liberal arts colleges in 2007.17 Douglass Residential College was formed to carry on the legacy of Douglass College by promoting women's leadership and offering enrollees special housing options and membership into women-centric organizations. Aside from the Residential College, much of Douglass' unique history is diluted by Rutgers University's

The acquisition of the Neilson estate and the later merge of Douglass College into the Rutgers-New Brunswick undergraduate liberal arts system are two principle reasons for the lack of distinct identity between the two campuses. There is no official boundary between Cook and Douglass although there are speculations that it is across George Street, a diagonal line through Neilson dining hall, or south of the Douglass Campus Center. Using design to reinforce the two campus' distinct identities could help better define each's sense of place and also act as a way-finding device that would make the campus easier to navigate.

16) DeBoer, R. (2005, March 1). Cook college timeline. Cook History Project, Retrieved from http://aesop.rutgers.edu/~cookhistory/cooktimeline.html
17) Douglass Residential College. (n.d.). History: Douglass college through the decades. Rutgers Douglass Residential College, Retrieved from http://douglass.rutgers.edu/history

CAMPUS UNIFICATION

This diagram begins to examine which core characteristics of Cook/Douglass as a unified entity are most important to its established identity. To develop this method, I created a variation of the Project for Public Spaces' "The Place Diagram" which uses four key attributes: image, sociability, uses, and access as themes for identifying the intangible qualities that give space a sense of feeling.

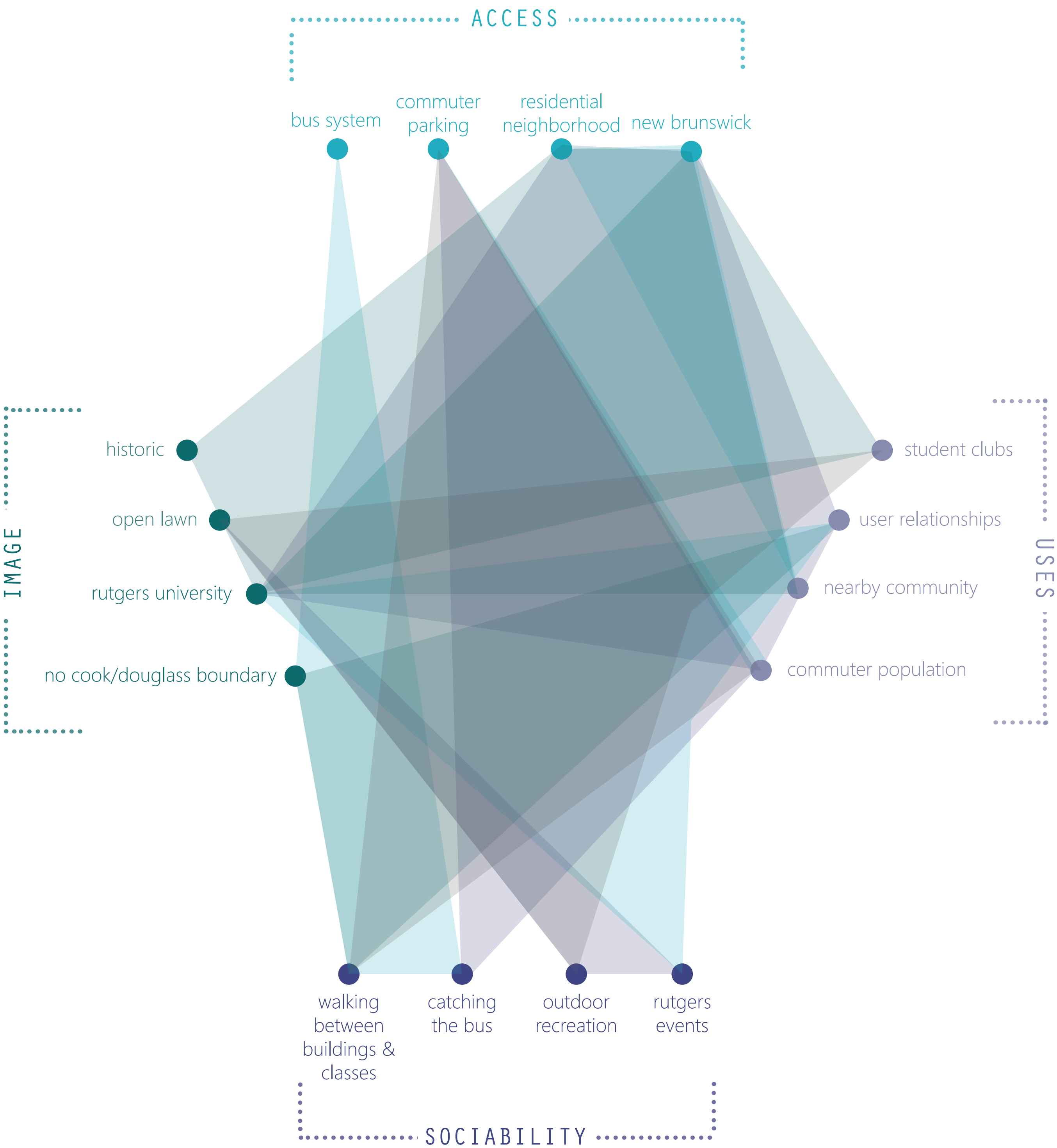
I identified the intangible attributes based on my own personal interaction with the campus as a student and through observation as part of my overall campus analysis and place them as a dot. Drawing links between the intangible quality dots, relationships between characteristics can be seen. I determined that dots with the most links to other dots are the key attributes of Cook/Douglass' image as a unified body and thus those traits should be enhanced or remain unchanged after any sort of planning or design intervention is put into place.

The key attributes of a unified Cook/Douglass are:

+ The commuter population
+ An unavoidable walk between points of interest on campus (which suggests any intervention must be composed of a dynamic network of interventions--not isolated sites)
+ Rutgers University is a fundamental aspect of Cook/Douglass' unique identity overall
+ Open lawns have purpose, especially for big programmed events like Rutgers Day and SEBS Commencement
+ The campus is located in the city of New Brunswick and thus inevitably impacts/is impacted by the surrounding community

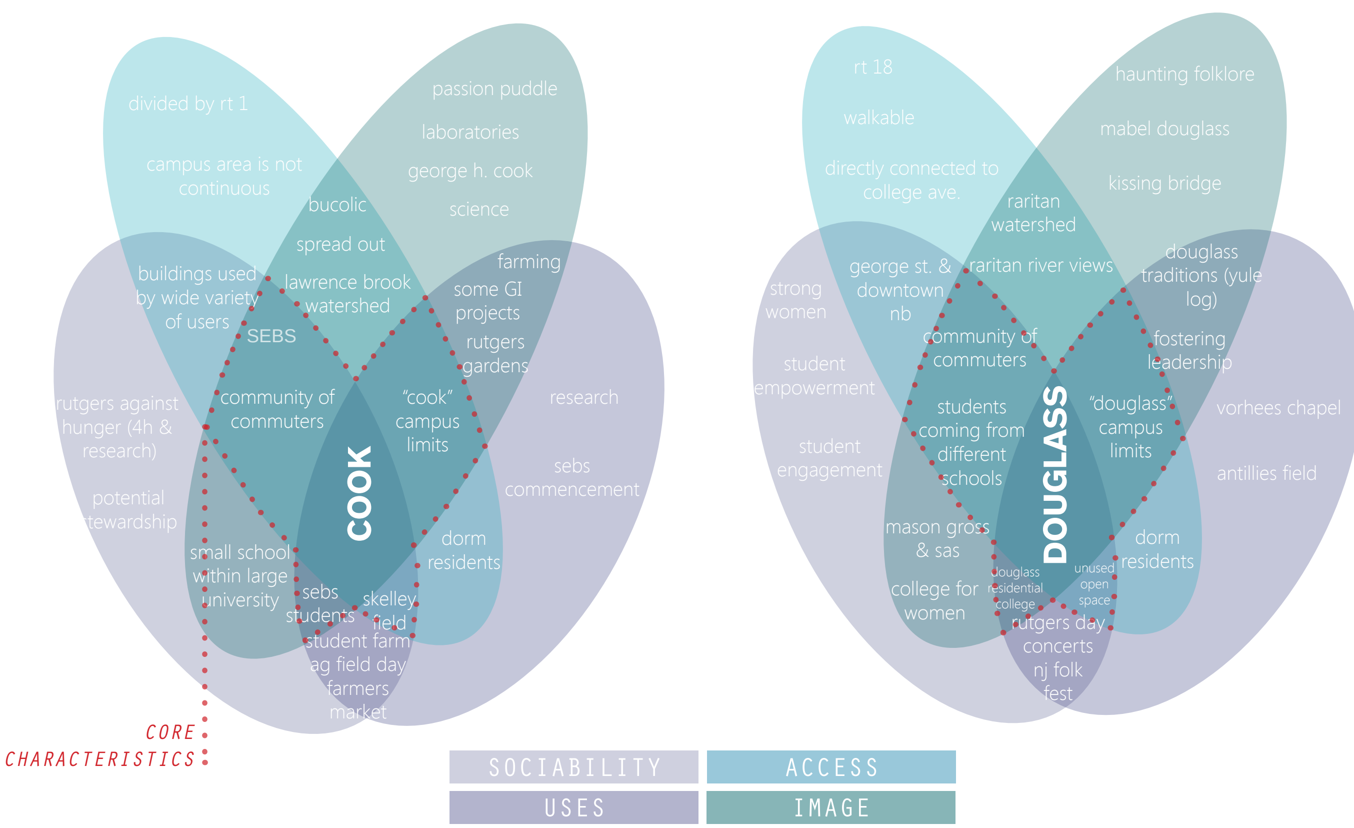
These attributes became important aspects of my network considerations in the proposed intervention of this research.

The Project for Public Spaces (PPS) is a non profit planning, design and educational organization founded in 1975 to further William Holly Whyte's research into small, urban spaces. PPS is a pioneer in defining "sense of place" as means for creating public spaces that highlight a site's assets and best serve its users.


ACCESS
bus system
commuter parking
residential neighborhood
new brunswick
IMAGE
historic
open lawn
rutgers university
no cook/douglass boundary
USES
student clubs
user relationships
nearby community
commuter population
walking between buildings & classes
catching the bus
outdoor recreation
rutgers events
SOCIABILITY

Welcome to the George H. Cook Campus, home to the *SCHOOL OF ENVIRONMENTAL AND BIOLOGICAL SCIENCES* and the New Jersey *AGRICULTURAL EXPERIMENT STATION.* The campus is named after *GEORGE H. COOK*, the first head of the *RUTGERS SCIENTIFIC SCHOOL* (later to become the School of Environmental and Biological Sciences). Find links to information about events and services on and around the campus. If you have questions or comments, please feel free to contact us.[18]

Welcome to the *BEAUTIFUL AND HISTORIC* Douglass Campus. Douglass is home to many academic departments in both the *SCHOOL OF ARTS AND SCIENCES AND THE MASON GROSS SCHOOL OF ARTS*, as well as research centers such as the nationally prominent Eagleton Institute for Politics. Originally New Jersey College, in 1918, the name changed to Douglass College in 1955 in honor of the first dean, *MABEL SMITH DOUGLASS.* Rutgers has maintained its *COMMITMENT TO WOMEN'S EDUCATION* through the programs on Douglass Campus, primarily *DOUGLASS RESIDENTIAL COLLEG.* Douglass campus also houses the striking *VOORHEES CHAPEL AND THE UNIVERSITY INN AND CONFERENCE CENTER.*[19]



CAMPUS DISTINCTION

The diagrams to the left begin to distinctify Cook and Douglass. To begin to do so, I consulted each campus' mission statement as was posted on their websites. Pulling out key terms from these statements, along with adding terms based on my understanding of each place as a student on campus over the last four years, I developed a set of terms that were unique to each campus. Ultimately, a few of these selected terms ended up becoming important focus areas for the later design portion of my research. Divided into the same four intangible categories as was developed my the Project for Public Spaces, the items on the interior of each diagram became the key areas of focus in creating more unique identities for Cook and Douglass respectively.

The key attributes of a diversified Cook/Douglass are:

COOK

+SEBS, Cook campus limits, Skelly Field, science students occupying the campus and participating in clubs reflective of those academic majors

DOUGLASS

+Students on campus are from different academic schools/background, open space is underutilized at times (i.e. Antilles Field and Woodlawn), Douglass College for Women has historical significance as do some iconic infrastructure (i.e. the Kissing Bridge and Vorhees Chapel)

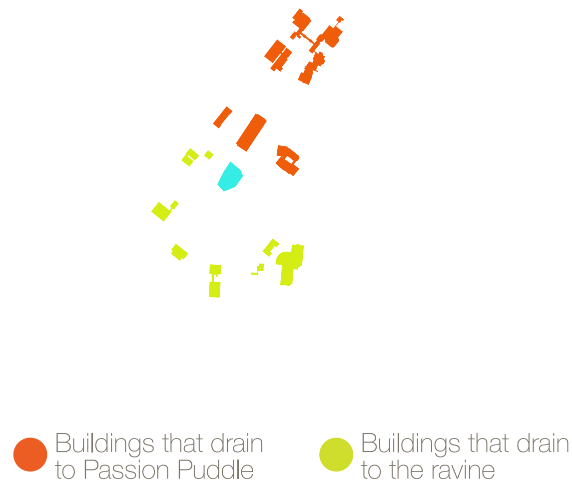
18) Rutgers, the State University of New Jersey. (2010, Sept 8). Welcome.*Douglass campus,* Retrieved from http://douglasscampus.rutgers.edu/
19) Rutgers, the State University of New Jersey. (2014, May 1). Welcome.*George H. Cook campus,* Retrieved from http://cookcampus.rutgers.edu/

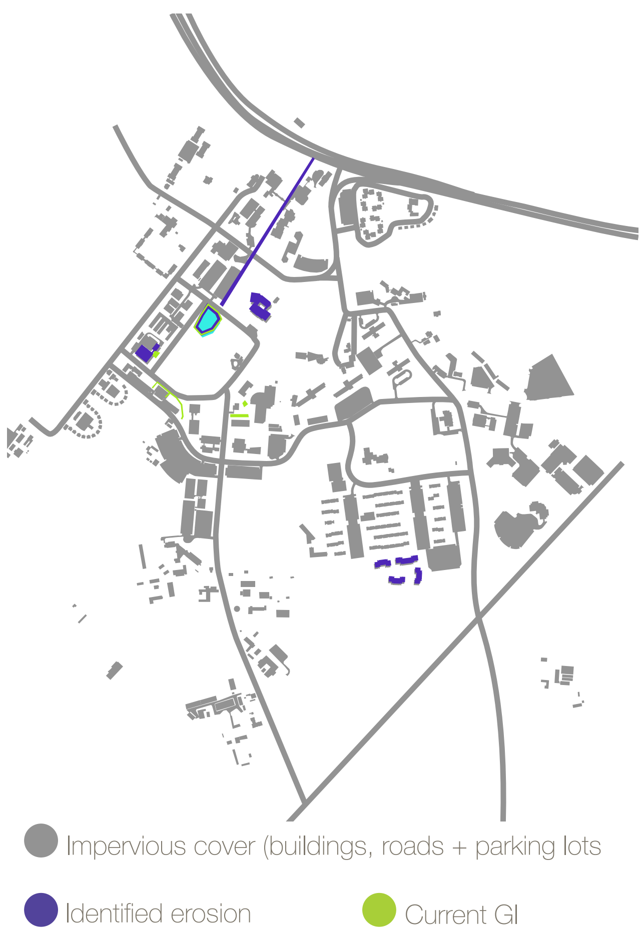
DESIGN EXPERIMENTATION

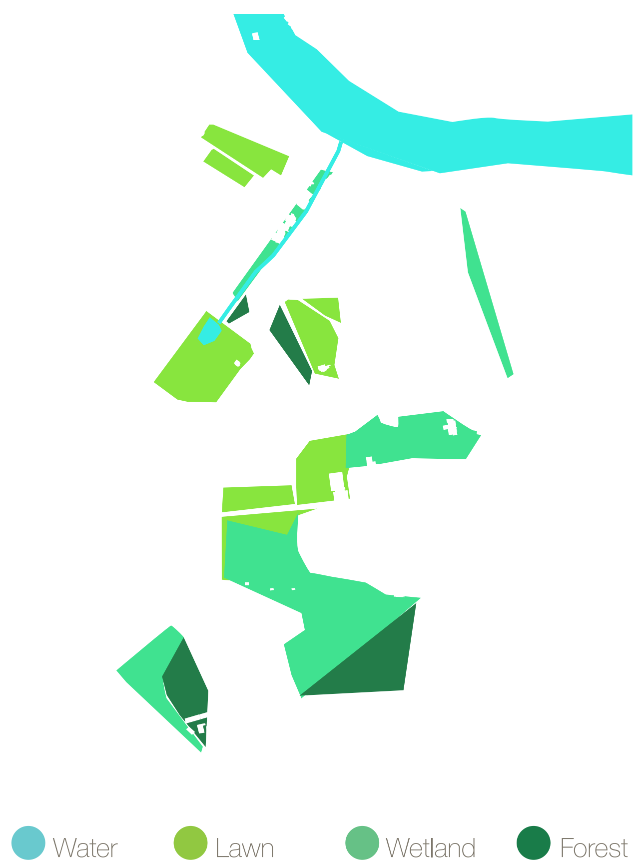
After completing the inventory and analysis of Cook/Douglass campus I was able to derive a design philosophy to inform my efforts moving forward in suggesting a sustainable water plan for camps. The plan I've developed uses the relationship between the camps' landscape and the campus' history to reorient users consciousness of both topics and hopefully their effect on each other. Not only will this reestablish the unique identities of Cook and Douglass but it will address the degradation of the environment overtime and consider how green infrastructure and sustainable water design can work to ameliorate those types of issues. In this way, my plan is a wholly restorative nature. What I mean by that is that restoring portions of Cook/Douglass' landscape, however interpretively, to a time in history that was influential in shaping the spatial and environmental conditions seen on campus today. This restoration is inspired by many factors: the historical land ownership which formed a division between the Cook and Douglass campuses; the land use origins of the campus with wetland and agricultural roots; and the sprawl of urban lands as university development continues. Aside from its environmental, ecological and cost benefits, the design experimentation will strive to promote scenarios that will provide countless educational opportunities and allow the campus to act both as a "living lab" of sustainability and as a model of how green infrastructure can be retrofitted to a variety of conditions for residents of New Jersey and beyond.

NETWORK AREAS

In creating a master plan focusing around sustainable water development, it is important to consider a variety of key factors. Knowing where people are concentrated, how vehicular traffic moves through space, and what important green space and water in present. These inputs will be incredibly influential in finalizing a circuit through the campus space to create a didactic green infrastructure network which could also be designed to educate users about Cook and Douglass' unique sets of history and conditions.







High student use buildings + pedestrian pathways

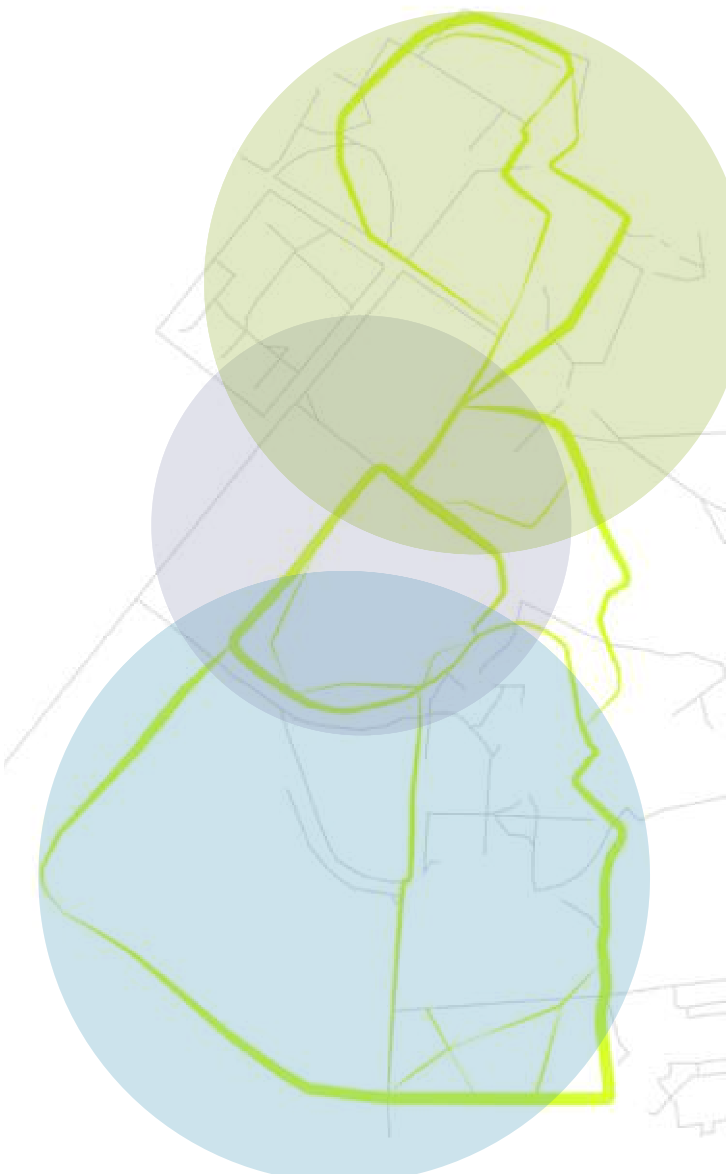
Cook campus Douglass campus

CREATING THE NETWORK...

The network I created is for pedestrian and aims to bring users around campus in a way that connects with as many areas of interest as possible, is centrally located so it also brings them to other desired destinations, and it addresses areas suitable for intervention both on Cook and Douglass that could become project focus areas and potential future site designs. These projects would focus on water sustainability but also bolster the campus' sense of place and provide novel social space to be enjoyed by all user types.

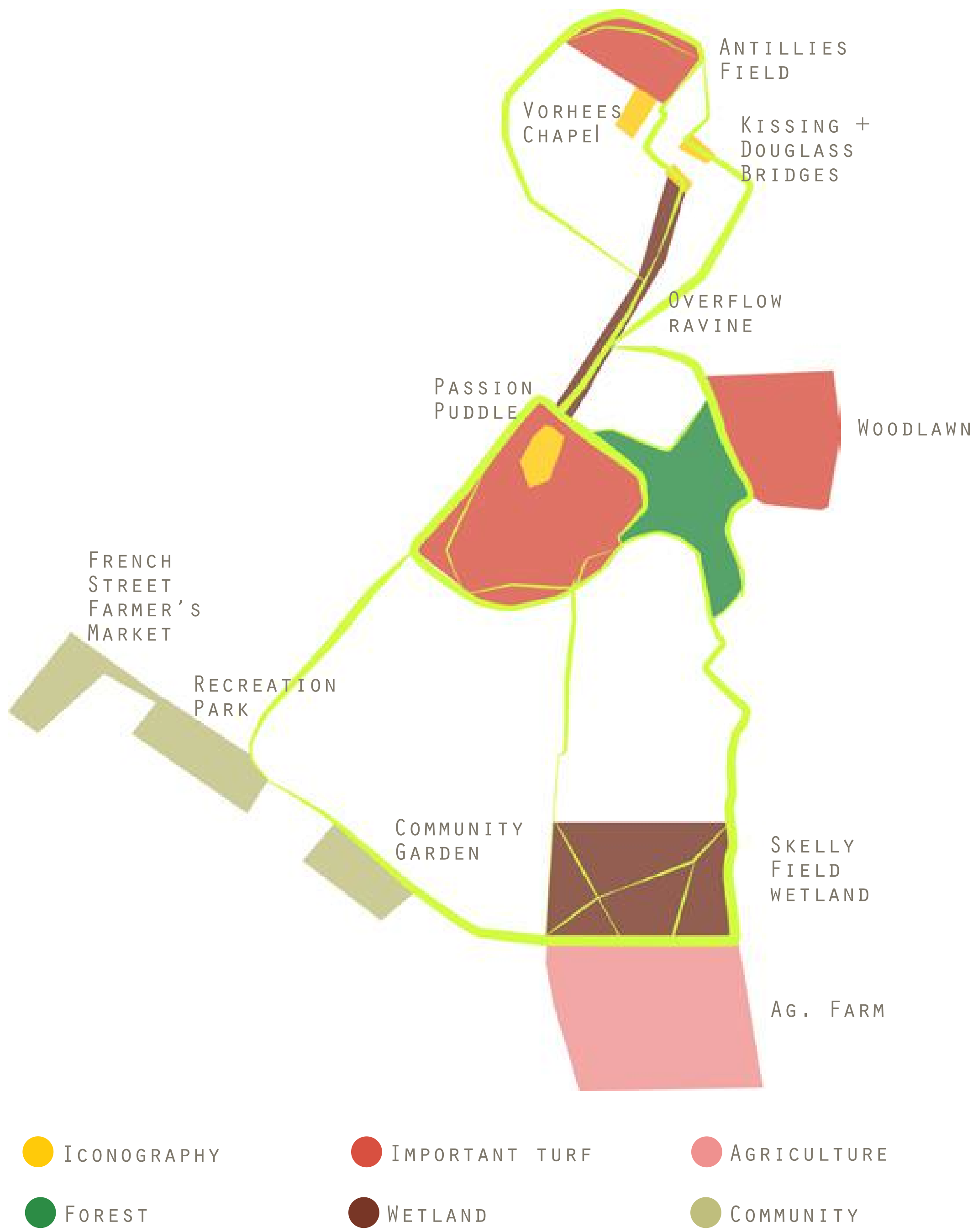
PEDESTRIAN

CAMPUS IDENTITY ZONES

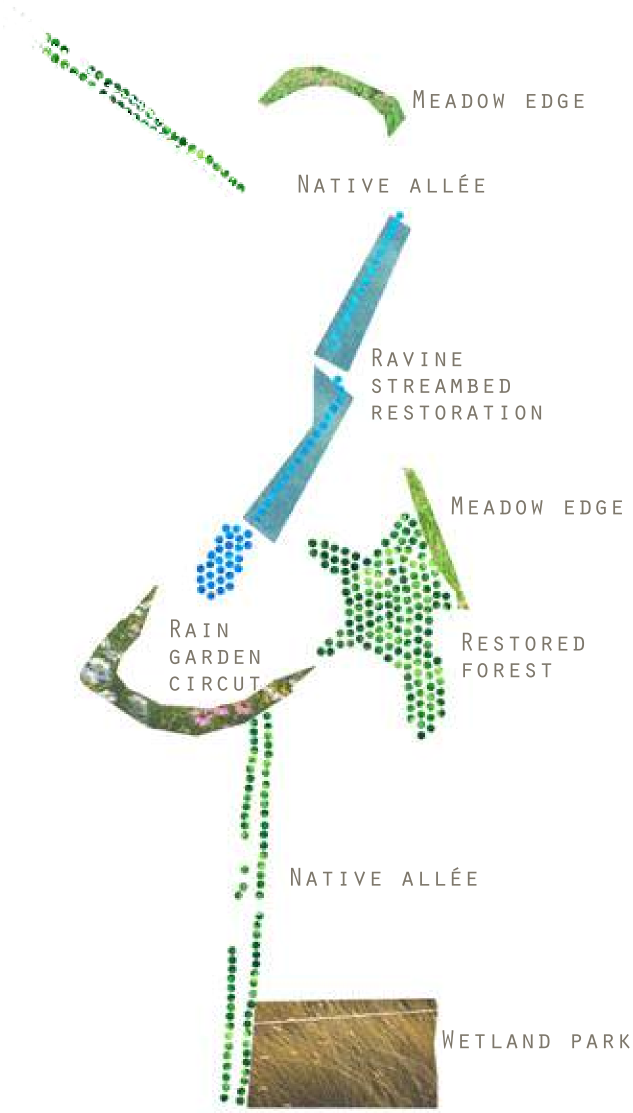


COOK DOUGLASS CAMPUS CORE

IMPORTANT CONNECTIONS



INTERVENTIONS

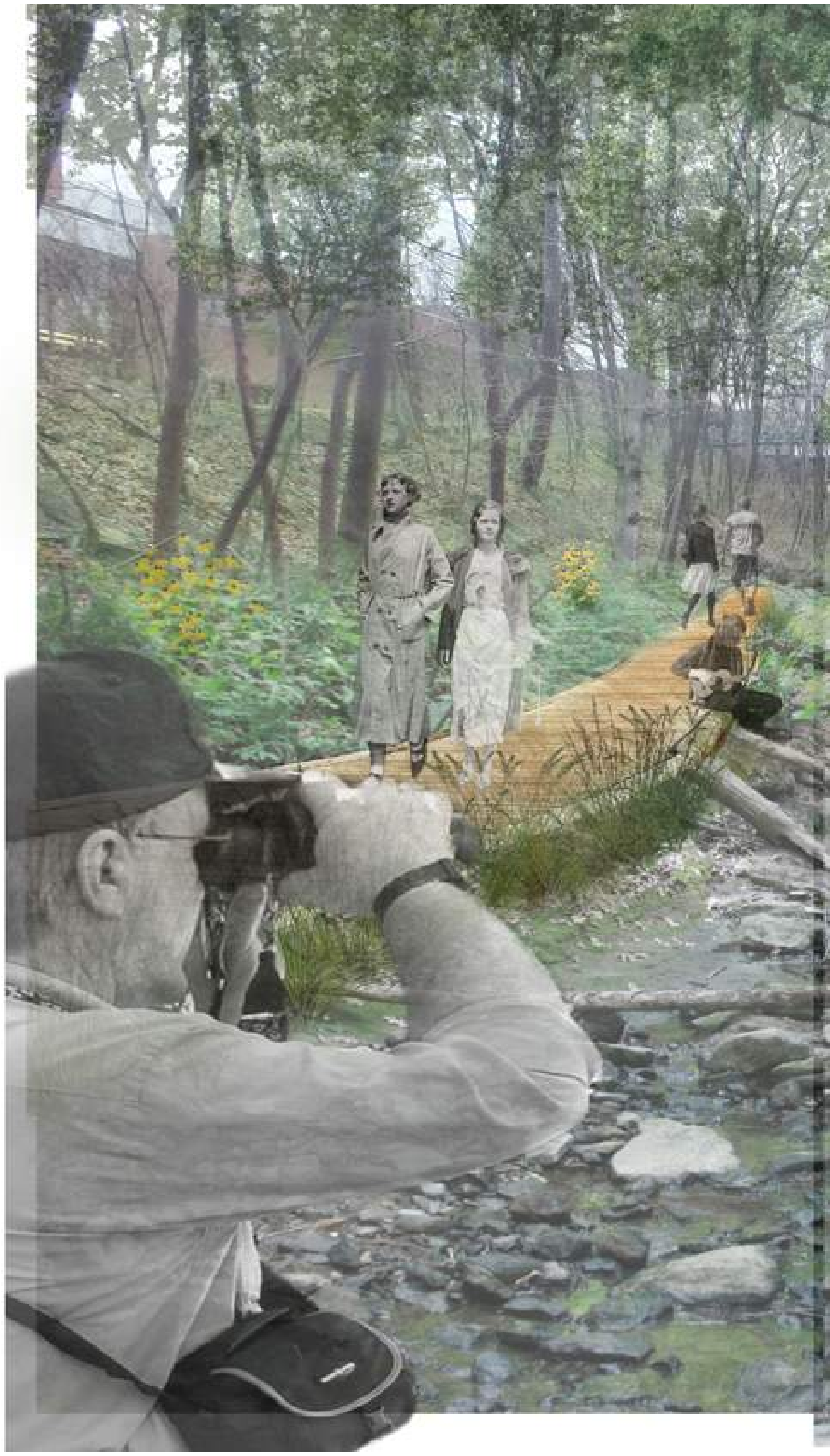



IMAGING
THE NETWORK

PASSION PUDDLE RAIN GARDEN CIRCUT

This image visualizes what a rain garden circuit could make walking along Lipman feel like if their stormwater was let into flowering gardens instead of underground and directly into Passion Puddle.

RAVINE RESTORATION



This image visualizes what a restored stream bed in the ravine might be like if a boardwalk was built along it. People could see water piped from Douglass buildings into the ravine and notice how the stream's water level changes through various weather events.

SKELLY FIELD WETLAND PARK

This image visualizes how a wetland could transform a portion of Skelly Field into a beautiful park while also allowing it to proudly showcase its natural wetland condition.

BUS SHELTER DESIGN

In working on a sustainable bus shelter design I was able to think about sustainable design at the human scale. The structure's design had 3 main goals:

+Provide an accessible example of green infrastructure

+Teach a sustainability lesson by allowing students to interact with it firsthand

+Inspire a behavioral change (minimizing consumption, harvesting + reuse of rain water)

The structure was designed to channel rainwater from the roof into a cistern which sat between two L-shaped benches. Based on time and budget constraints, the structure was edited to contain just one bench. It was installed for Rutgers Day and received a great deal of attention and positive reception. Thinking back to some of the case studies I conducted, transit design is an extremely important consideration to make. Transit areas (bus stops, bicycle parking areas, parking lots, paths between the three) are highly trafficked and constantly used which give them a lot of potential to educate and influence people who visit them frequently. Using moments such as these to promote sustainability is multi-functional and a great place-making tool. For instance, the bus shelter's tin roof references the architecture of Cook campus' history as a farm. Furthermore, the tin roof is a sensory experience that creates a unique sound when rain hits the roof-- drawing users' attention to the flow of water and thus teaching them a lesson about stormwater.

Design and model created as a group with Josh Mieloch, Deanna Lu, Mike Ticker, Areli Perez + myself.




Design edited and fabricated with Josh Mieloch, Deanna Lu, Mike Ticker, Areli Perez, Alex Duro, Crystal Vega, Marlon Davis, Alyssa Viani, Andrew Blackburn, Sam Saydak, Jack Peters, Sara Yildirm, Gwen Heerschap, Kate Higgins + myself

CONCLUSIONS + LESSONS LEARNED

Photo by Dendroica Cerulea

The first thing this thesis taught me was the importance of designing at a human scale. As much research as I was able to do towards creating a masterplan network, only during creation of the bus shelter was I able to really hone in on user experience and consider what space might be like at that zoomed in scale. This attention to detail is something that is often times disregarded in campus masterplanning due to lack of time or designers being outsiders to that campus' community. If you have ever followed a path on a map that's brought you to a destination in a way that you later found out was not the most ideal route then you have witnessed masterplanning done at too small of a scale.

Next, this research reiterated the important of collaboration to me. Being able to work alongside two other GH Cook scholars conducting similar research helped me to so much better understand the research process when I seemed to have lost my way. Sharing data and information between the three of us was infinitely helpful in gaining a holistic understanding of Cook/Douglass.

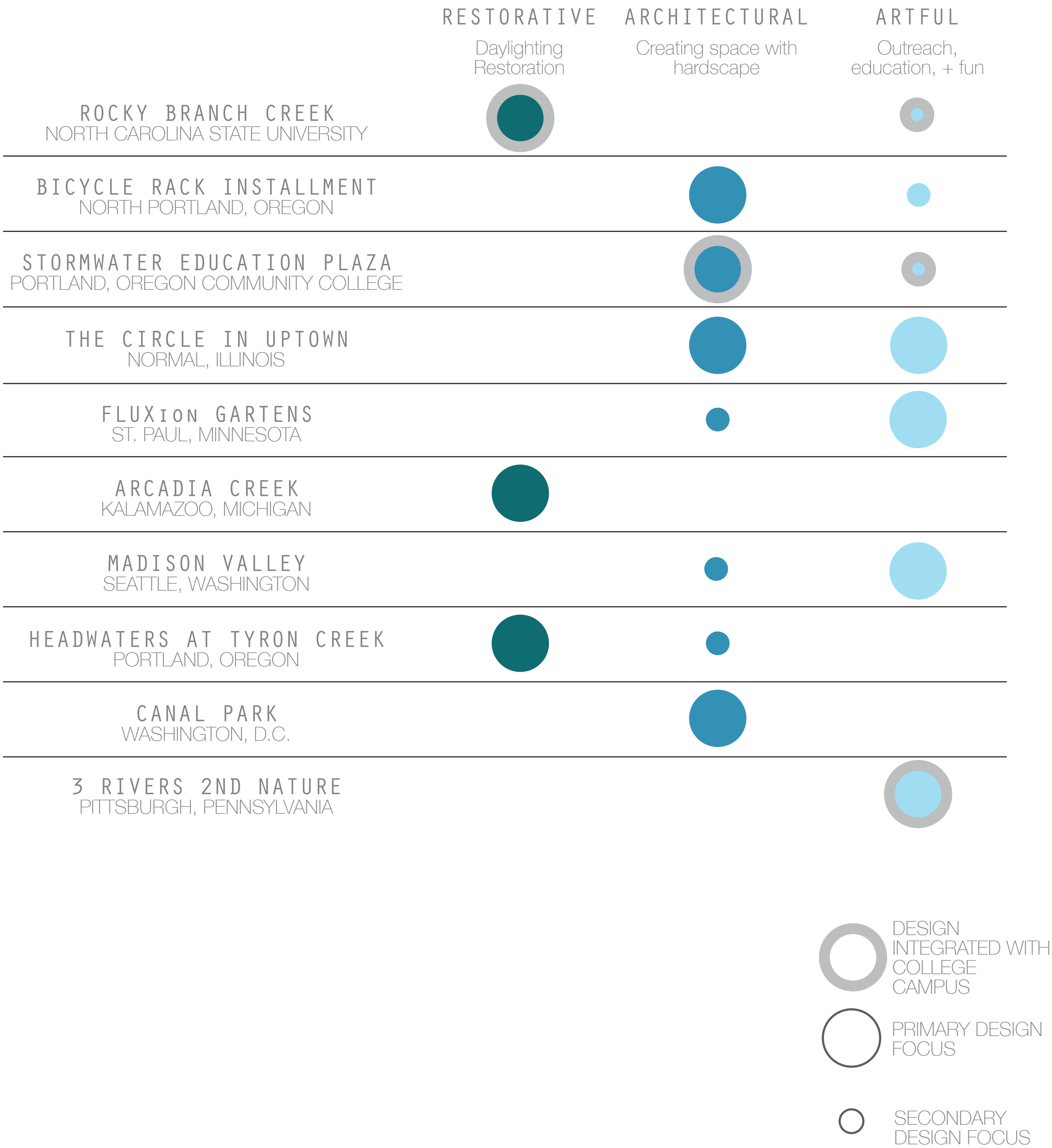
I learned that just because a landscape may have important ecological value- often times it may not be treated as such in the interest of space. Cook campus for instance has so much land classified as wetlands, an ecosystem that is as beautiful as it is functional in managing and cleansing stormwater, yet still these areas remain swampy and programmed for unfit activities and have been for over two centuries. In cases like it can be seen how much more important the built environment can become than the natural and begs for attention to find a better balance between the two. There must be a paradigm shift in the minds of decision makers and all campus users alike to understand the value of each given landscape character time and the need to preserve and enhance these precious areas.

Rutgers acts as the state University of New Jersey and thus has unlimited potential to educate and influence residents of NJ. This includes not only students and university employees but almost everyone who lives in the state and reaps the benefits of Rutgers' scientific research and many publications. For this reason, it's important that the campus be designed to be as sustainable and environmentally friendly as possible. Not only could this type of design save the school money and act as a marketing-tool to draw in people who are concerned with environmental health, it could also inspire new design ideas for residents state-wide who maybe unfamiliar with green infrastructure and other current sustainable technologies.

> The voyage of discovery is not in seeking new landscapes but in having new eyes.
>
> MARCEL PROUST

APPENDIX

CASE STUDY MATRIX



ROCKY BRANCH CREEK
North Carolina State University

Rocky Branch Creek Restoration was composed of a three phase stream restoration with a greenway designed along throughout campus. The design created an accessible outdoor teaching laboratory, stabilized the creek, improved water quality, aquatic and wildlife habitat, and integrated the creek into the campus environment. The stream is used as an educational tool- the Zoology Dept. and Environmental Club run water quality tests and monitor aquatic inhabitants. The Biological and Agricultural Engineering Department uses the creek for class exercises, and students in the Landscape Architecture Dept. have focused on Rocky Branch's restoration and greenway path in several design studio classes. [1]

ARCADIA CREEK
Kalamazoo, Michigan

This daylighting project reduced flooding and improved the urban environment of Kalamazoo. The project increased value of the area 10x and attracted business from private developers 1. Daylighting of Arcadia Creek occurred along five blocks of the downtown area. For three of the five blocks, the daylighted creek runs through an open, 20-foot-wide and 12 foot-deep concrete channel. A stream walkway parallels the daylighted stretch and links this pedestrian path with walking paths that are part of a larger pedestrian/bicycle path system in the region.[2]

1) NC State University, . "Stream Restoration Program." NC State University Stream Restoration Program. North Carolina State University. Web. 20 Jan 2014.
2) Buchholz, Tracy, and Tamim Younos. "Urban Stream Daylighting Case Study Evaluations." Virginia Water Resources Research Center. Blacksburg, Virginia. 2007.

FLUXION GARTENS
St. Paul, Minnesota

This project was created as part of St. Paul's study of "Strategic Stormwater Solutions for Transit-Oriented Development." Its goal is to harvest stormwater along a network of green art spaces including gardens, public art works, and pocket parks. Ideally, the new installations of public art would promote a "community narrative" and foster stewardship of the new spaces. The photo depicts an example of this type of art in the form of a decorated cistern. "The impact of integrating public art and stormwater management is very clear: it makes an impression, creates a destination, and most importantly, sparks curiosity and discussion." 1

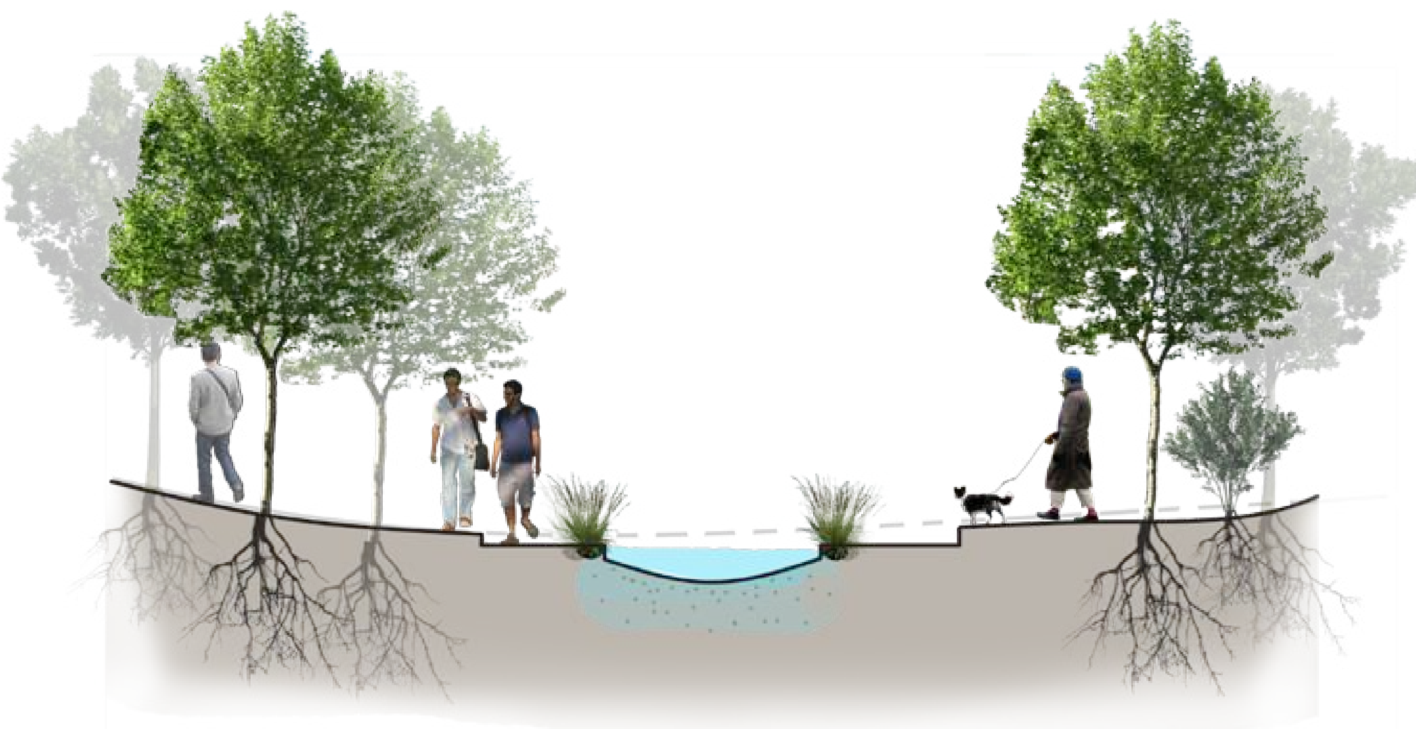
3 RIVERS 2ND NATURE
Pittsburgh, Pennsylvania

3 Rivers 2nd Nature is a ecological-arts project dealing with rivers and streams of Allegheny County, Pennsylvania. Over five years, a team of artists, scientists, and policy-makers worked together to create a "creative discourse about places." These "places" are post-industrial sites and will be highlighted by art. The aim of art in this project was to have artists working as "cultural agents" to educate and influence community members to support the health of their urban ecosystem by affecting public policy and economy2. The project team analyzed and mapped streams of their county based on aesthetics, function and value to ultimately advocate for new parks and preserved lands and also zoning to protect current open space.

1) Saunders-Pearce, Wes. "Open Space as Public Art to Support Stormwater Management." Corridors of Opportunity . City of Saint Paul, 11 Oct 2013. Web. 13 Jan 2014.
2) Collins, Tim. "3 Rivers 2nd Nature." Art, Ecology, Community. Carnegie Mellon University, 26 Dec. 2010. Web.

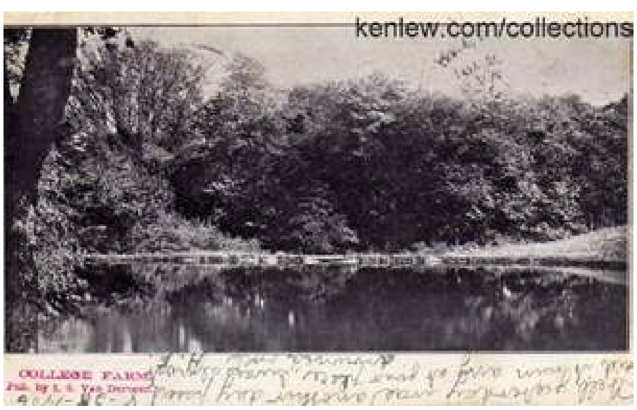
WHAT'S DAYLIGHTING?


BEFORE



AFTER

HISTORICAL IMAGES OF COOK/DOUGLASS



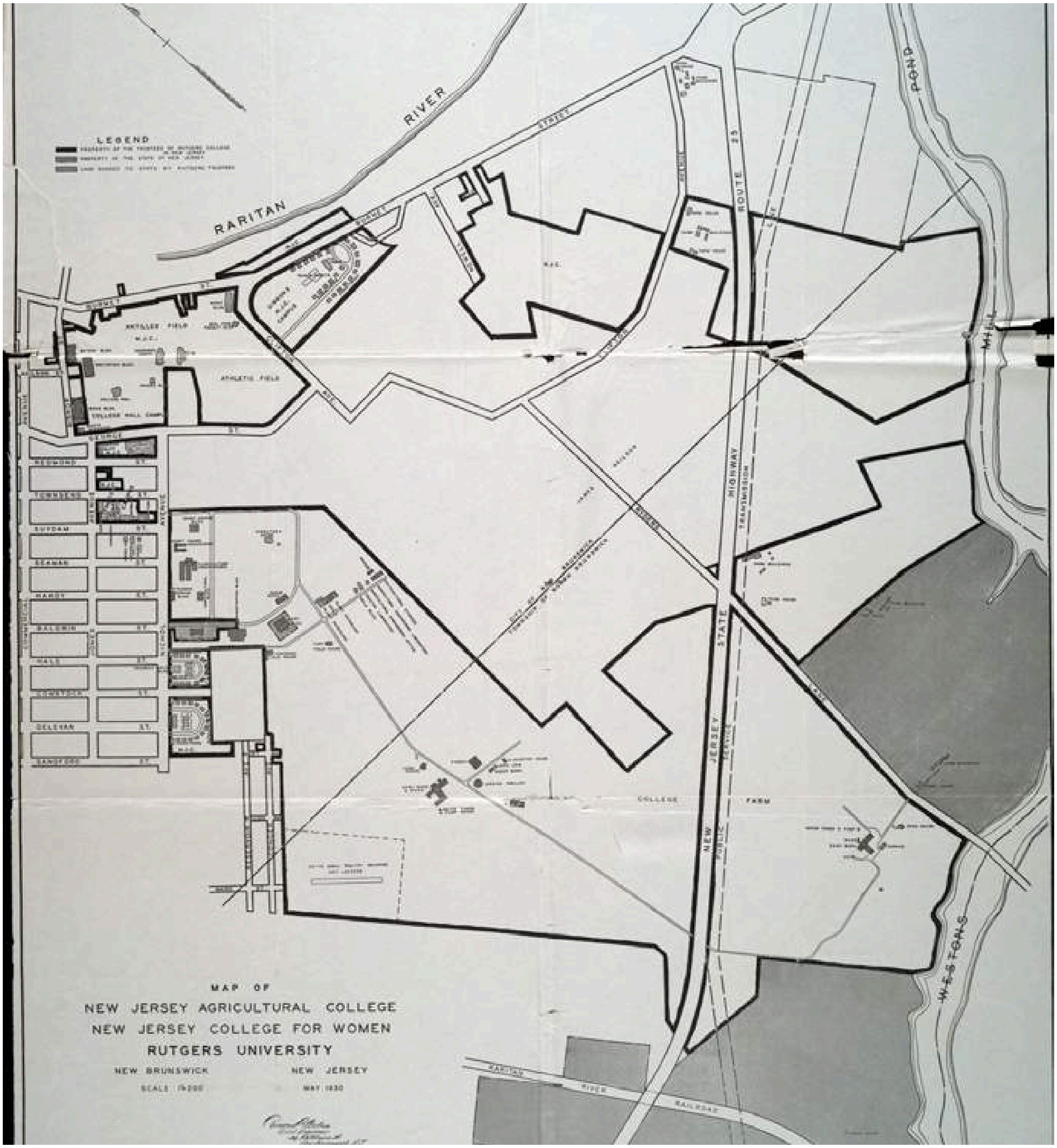
All photos courtesy of the Ken Lew collection

Rutgers University also includes a College for Women— which makes possible informal fun and lasting friendships.

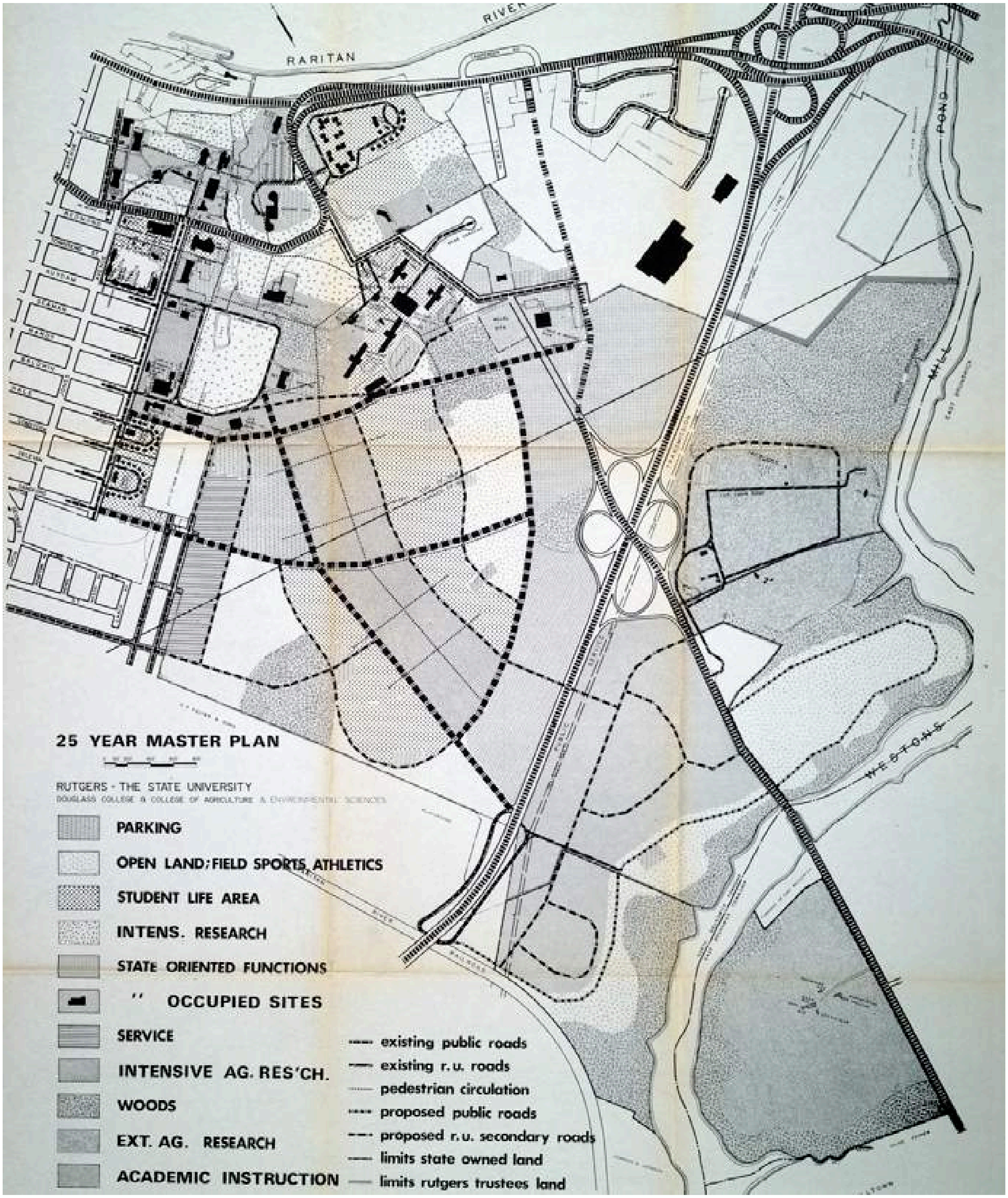
COLLEGE HALL IN 1865
(From an old print)

HISTORICAL CAMPUS MAPS

CAMPUS MAP, 1930



CAMPUS MAP + 25 YEAR MASTERPLAN, 1950



Maps courtesy of Rutgers University Archives.


THE NETWORK'S
RELATION TO
"HOTSPOT"
BUILDINGS ON
CAMPUS