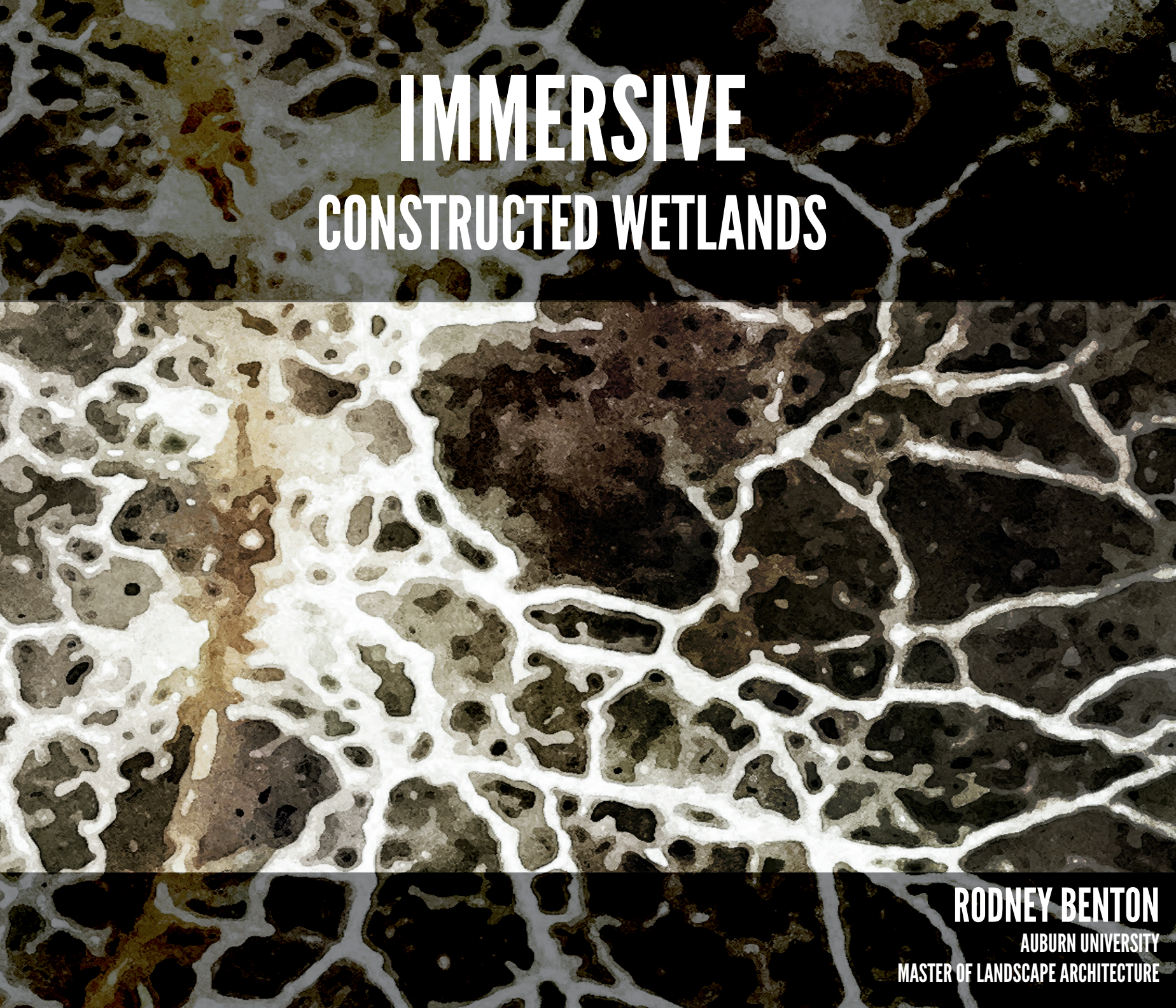

IMMERSIVE
CONSTRUCTED WETLANDS

RODNEY BENTON
AUBURN UNIVERSITY
MASTER OF LANDSCAPE ARCHITECTURE

Rodney Benton
Master of Landscape Architecture Thesis
Auburn University | Spring 2014

Dedication

To my wife, Alexis, for all of her hard work and patience. To my children, Tre and Victoria, for giving up time with me so I could study. To my parents, Wayne and Judy, for their support and encouragement. To Charlene, for her guidance without which I wouldn't have made it.

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Abstract

Urban stormwater runoff has historically been managed through engineered systems designed to move stormwater out of the urban environment and into the outlying stream and river systems. This had a negative impact on natural systems and local water quality. Recently, through low impact development and best management practice policies, green stormwater infrastructure solutions are making inroads into repairing and remediating the negative effects of these historical practices. One of the most efficient best management practices is the use of constructed stormwater wetlands. However, these spaces are generally designed with limited accessibility to the wetland component.

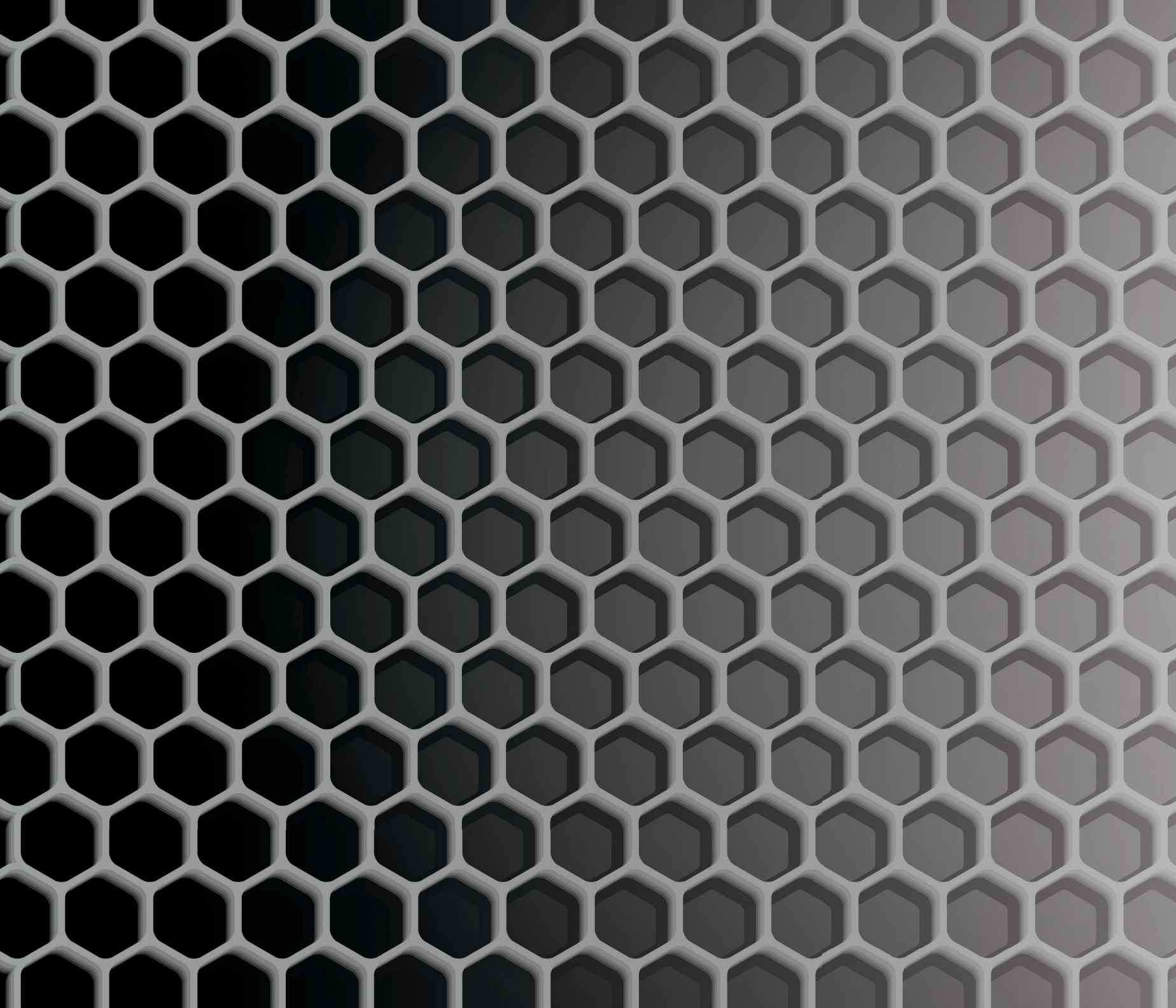
Natural wetlands provide a very immersive aesthetic experience, with its own specific sights and sounds. My thesis proposes a way to bring this same experience to urban environments by asking, "How can constructed stormwater wetlands be designed in a more immersive way to emphasize the characteristics of natural wetlands?"

My research approach uses situational analysis, overlay mapping, digital site modeling, and design iteration. The test area is located in Columbus, Georgia. Situational analysis was used to determine hydrologic characteristics, social connections, and urban infrastructure. These were mapped, overlaid, and analyzed for potential areas of intensity and interaction between the systems. Design iterations were created, reviewed, and edited to test the spatiality of potential designs throughout the research process.

The final design shows the ability to take stormwater management infrastructure and allow for immersion through the integration of these two systems. Further, by eliminating the need to choose between the two systems, opportunities for unique design solutions that take advantage of the positive features from both systems can arise.

This research is not intended to provide a "one-size-fits-all" solution to the creation of immersive constructed wetland landscapes. It is intended to provide a precedent for further research opportunities. Rather than isolating constructed wetlands from their counterparts, we should strive to seek solutions that take advantage of the qualities of the natural system and combine them to create something new and unique.

Keywords: Constructed Wetlands, Modular, Immersion



Chapter

1

one

immersion

Prologue

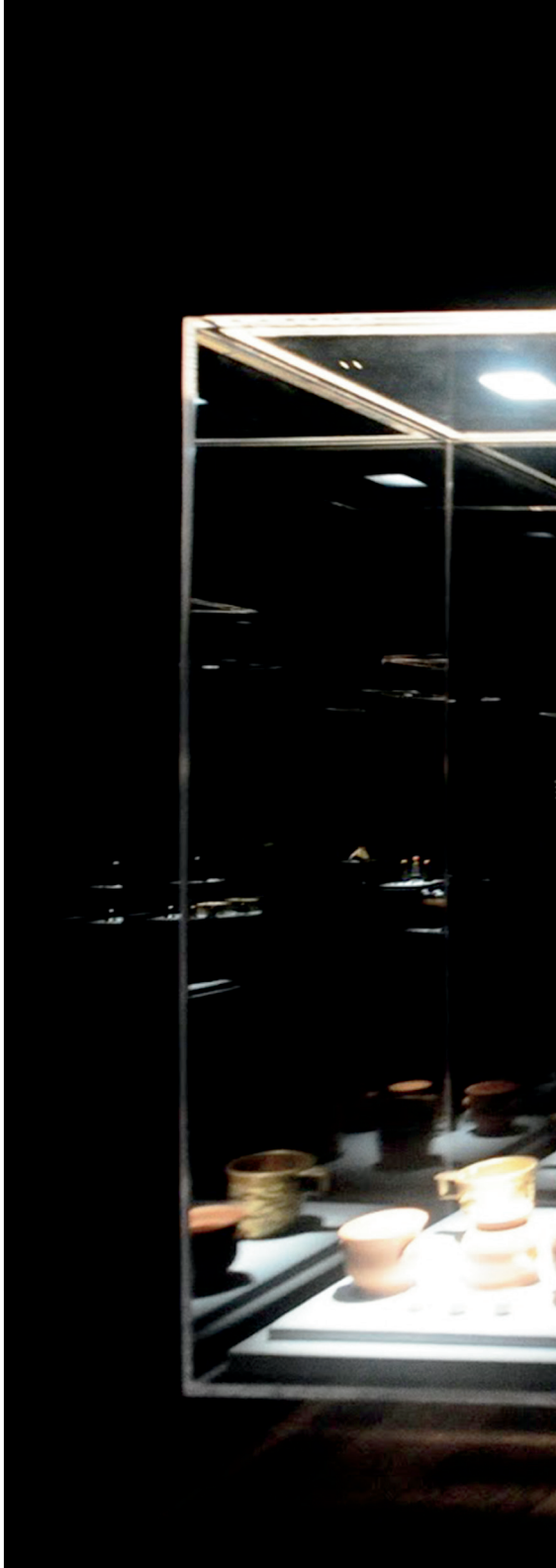
What is immersion?

Immersion

1. An act or instance of immersing.

   mid-15c., from Late Latin *immersionem* (nominative *immersio*), noun of action from past participle stem of *immergere*, from assimilated form of *in-* "into, in, on, upon" + Latin *mergere* "plunge, dip." Meaning "absorption in some interest or situation" is from 1640s.

You walk into a museum and begin a tour. You move from exhibit to exhibit, looking through glass cases or standing behind velvet ropes, surrounded by signs that say, “Do not touch!”

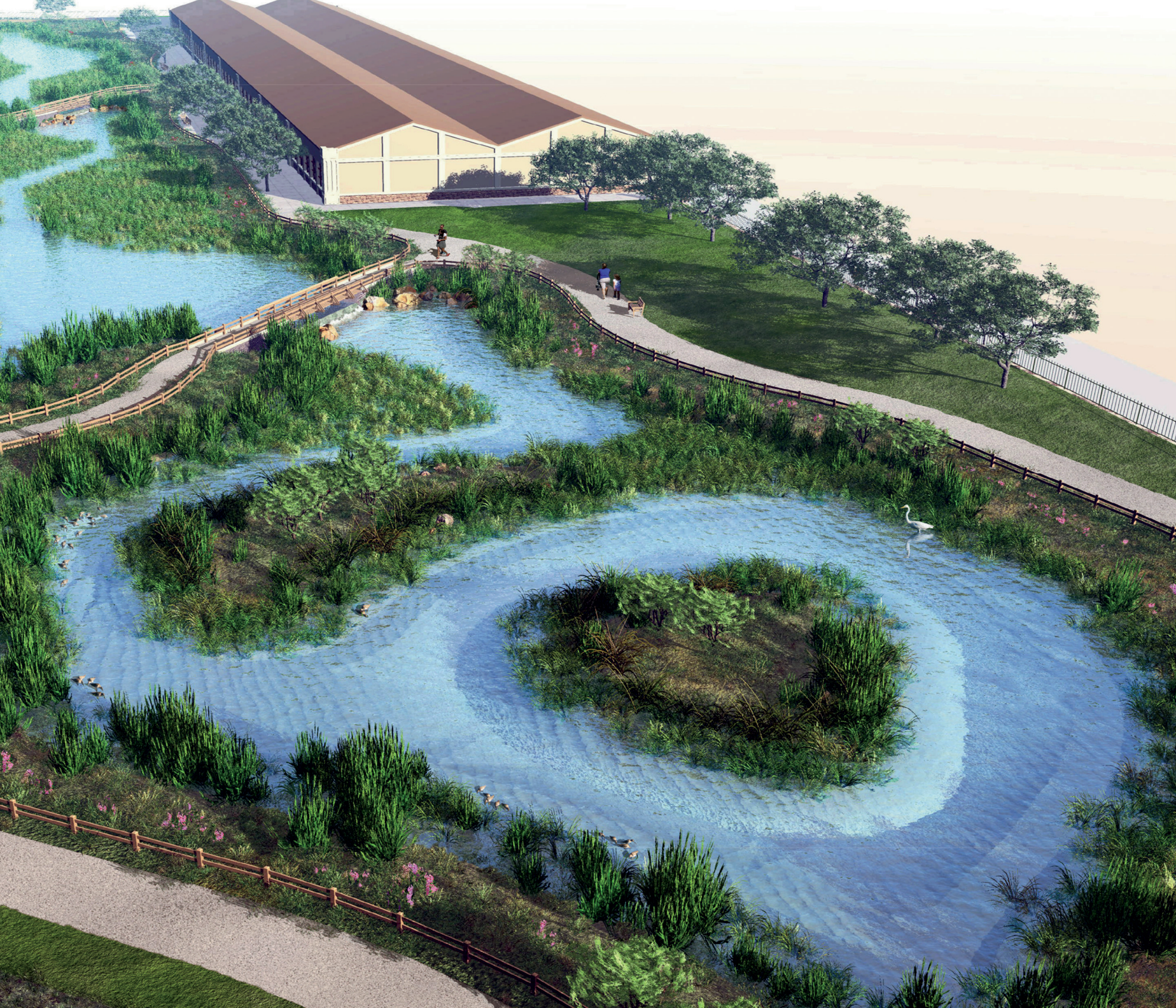


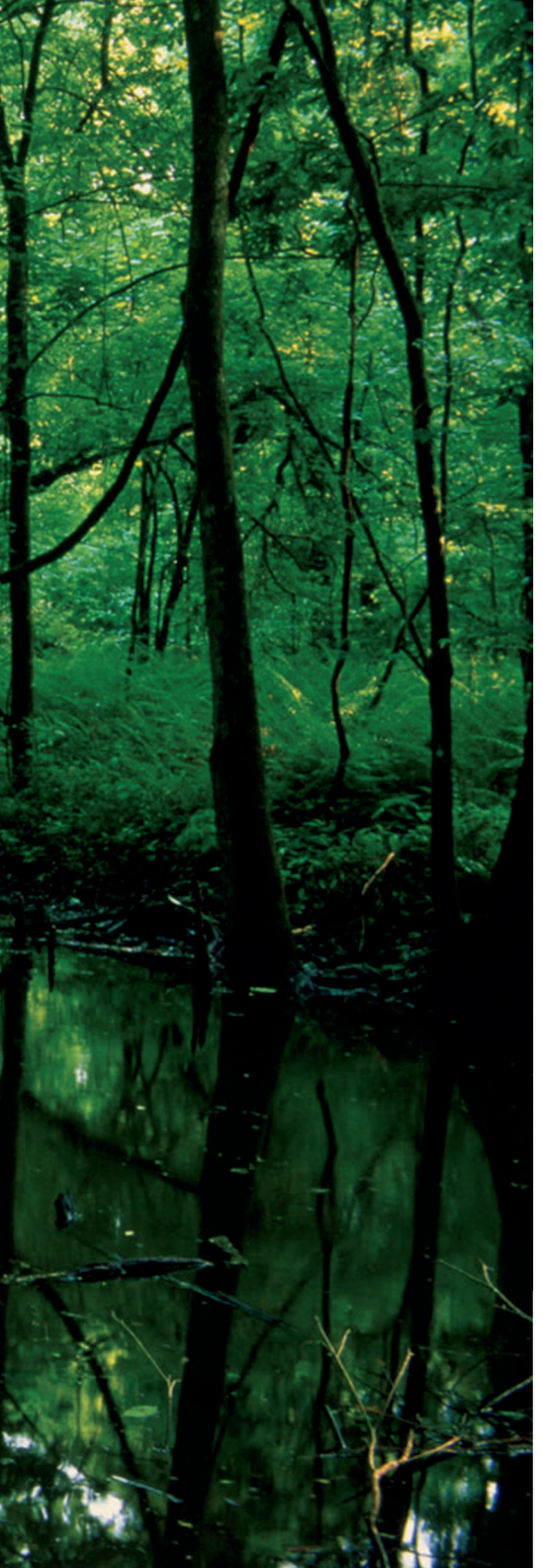
EXIT
McBEE and
DAYNE

Our Active Earth
Touch To Explore
ACTIVE EARTH
EXPLORING MIDCONTINENT EARTHQUAKES

Now imagine walking into that same museum, but right as you walk in there is a giant exhibit with kids crawling over and interacting with it. Instead of looking through a glass divider at an object, you pick up a replica designed to closely match the original. You feel its weight and texture and begin to get a better understanding of what it must have been like to use. This is immersion. Your interaction becomes more meaningful and impactful. That experience will be remembered long after a single visual one.

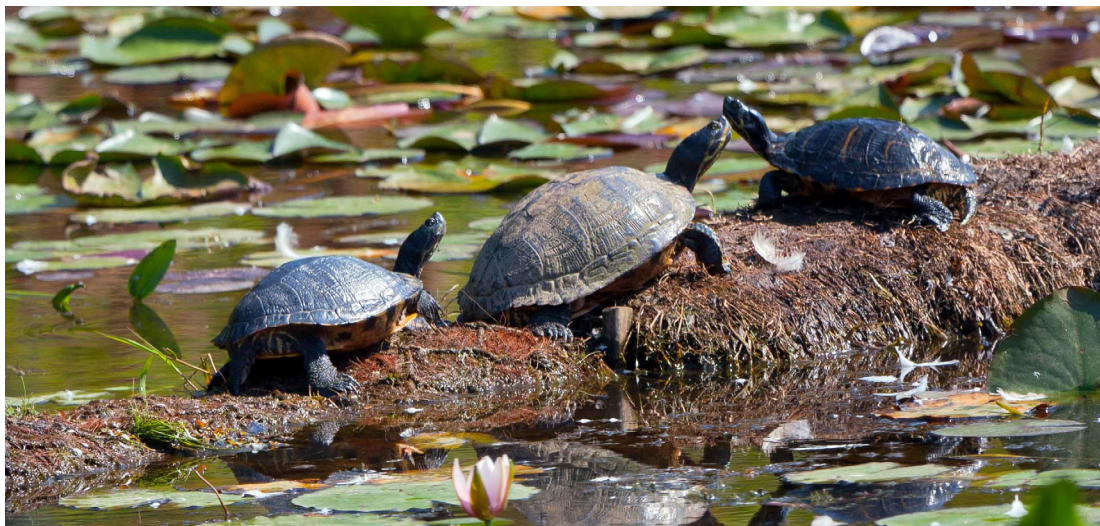
Constructed wetlands are highly efficient, sustainable solutions to the treatment of urban stormwater runoff. They buffer flood runoff, recharge groundwater, remove sediments and pollutants, develop primary production, and provide habitat for a plethora of flora and fauna. However, due to the way they are generally designed, they become inaccessible to humans and are only observed from a distance.

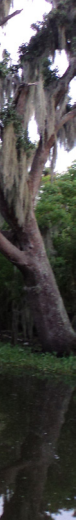




My research examines a way to move people into the wetland environment, which provides a very different aesthetic quality compared to other environments.

The more immersive a landscape becomes, the stronger the aesthetic qualities become.





Case Studies

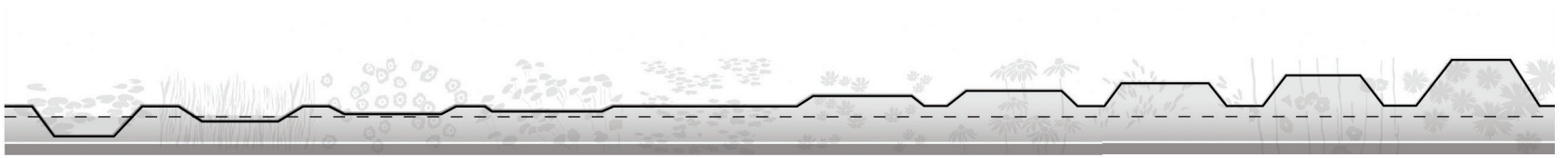
Investigations into immersive constructed landscapes.

Tianjin Qiaoyuan Wetland Park

[Tianjin City, China | 2008 | Turenscape]

This study shows the variation of wetland cell types and presents how they offer different types of remediation based on those types. The site has high interactivity, there are no fences or barriers and people move throughout the part between the individual wetland cells putting them in the middle of the restoration process. The use of native plant material in large monoculture applications depending on the type of remediation that is being performed is interesting. The scale of the site is quite large. With this much area the traditional wetland is probably the best choice. I am interested in developing the wetland process in a much smaller space.

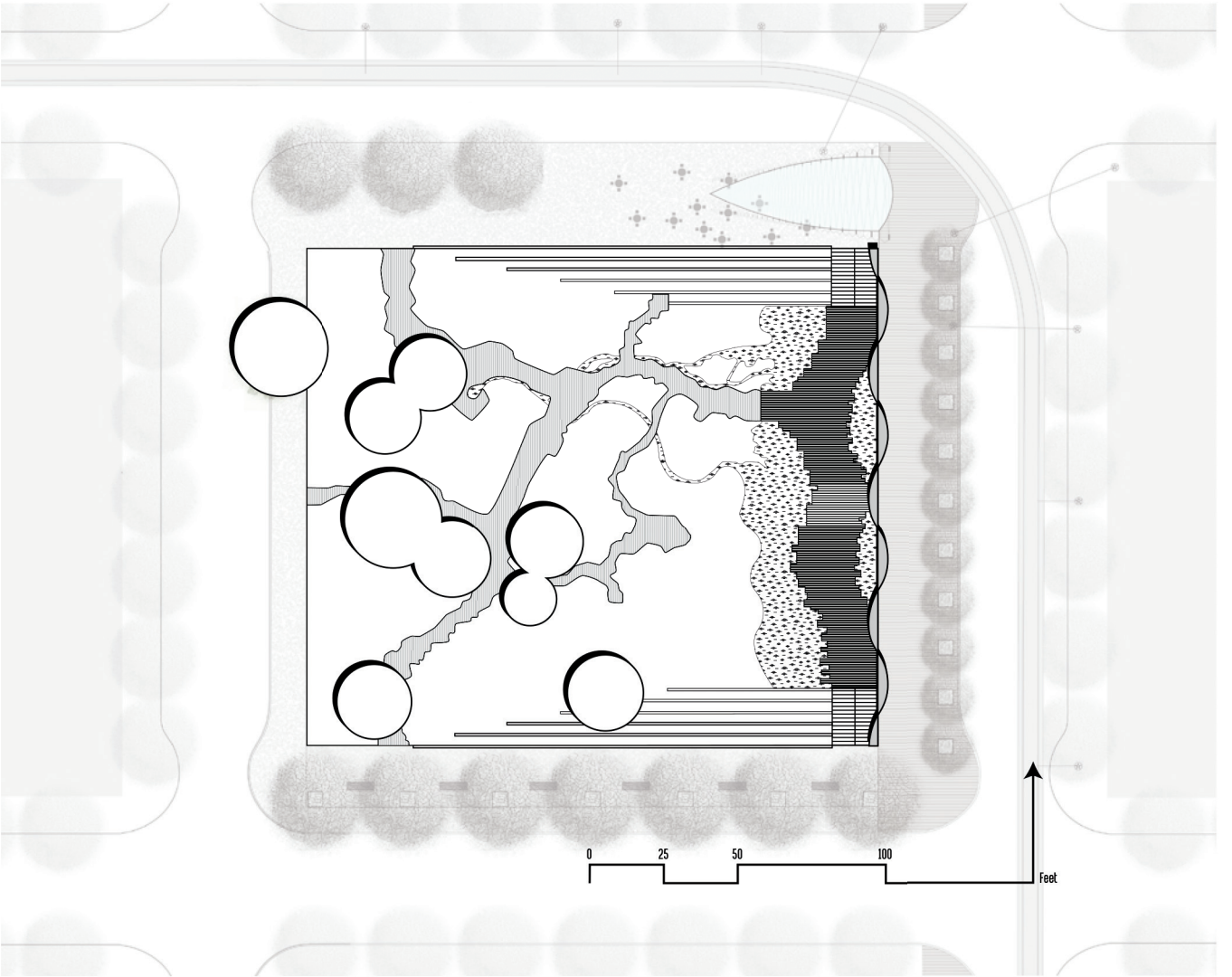
0 10 30 50
Meters



Tanner Springs Park

[Portland, OR | 2010 | Atelier Dreiseitl]

This case study is an example of a highly engineered wetland device in a small urban space. It uses a variety of plant material, representing four separate biomes, across different levels of topography. This study also offers an example of a didactic landscape and how one might go about making the processes legible. Signage is used to explain the process. The site is not directly connected to a greater watershed. It is "self-sufficient," as all water collected from the surrounding area is kept on-site with the exception of major storm events. During these events, the water flows directly into the storm water drainage system for the city.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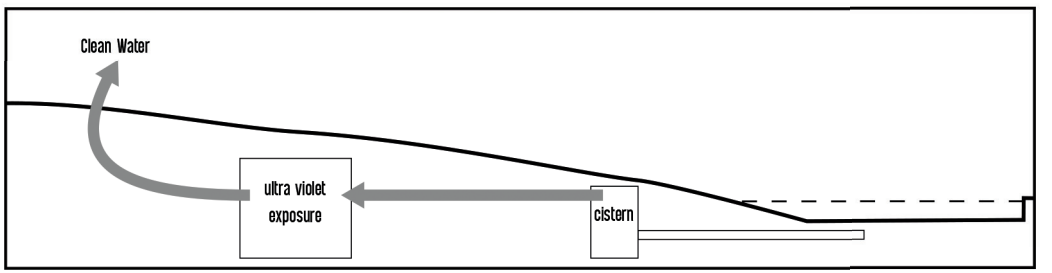
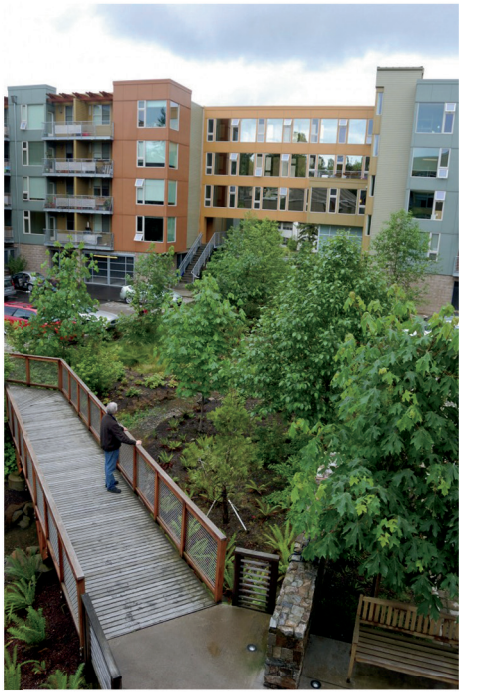
Feet

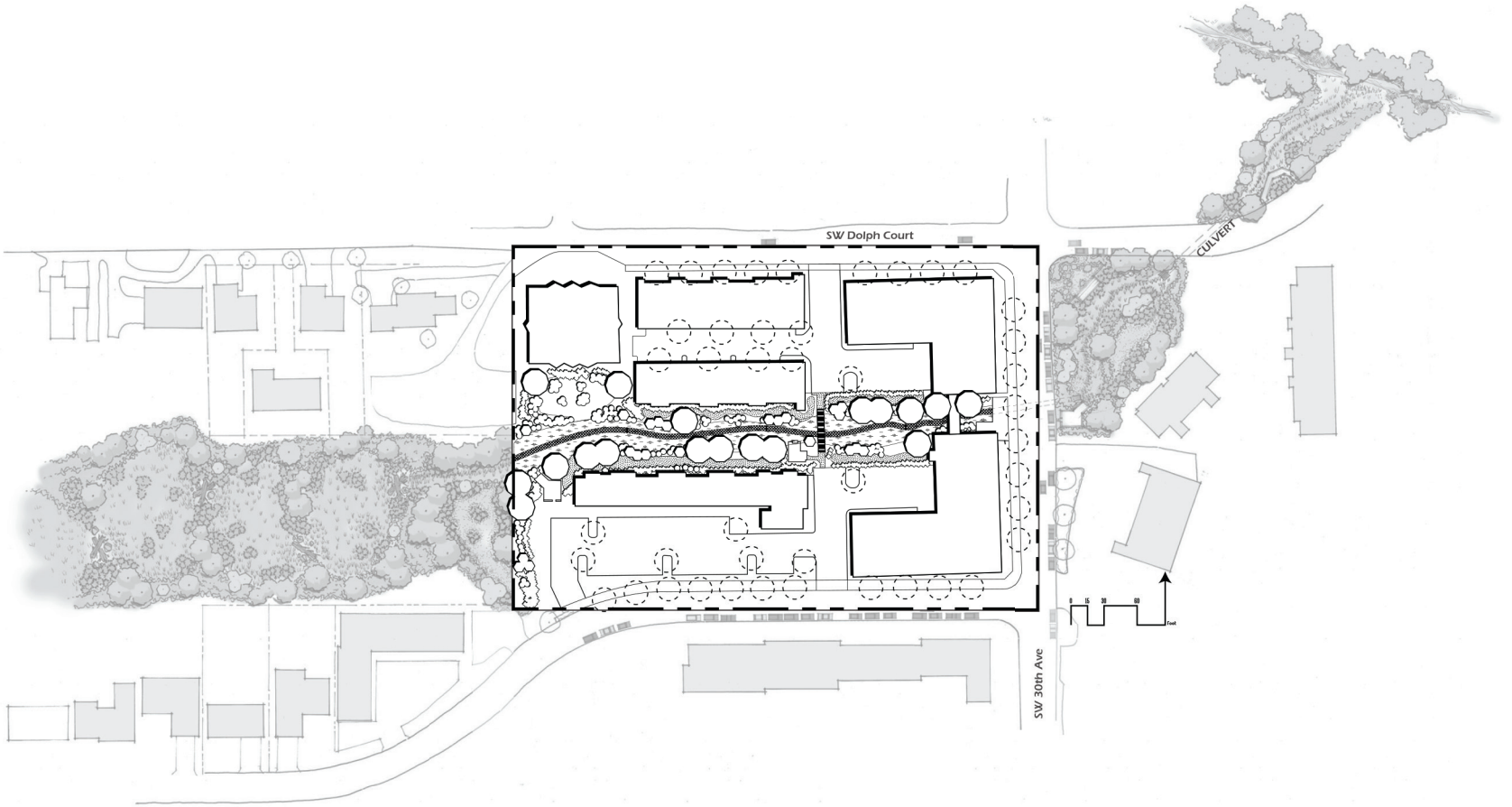

Clean Water
ultra violet
exposure
cistern

Headwaters at Tryon Creek

[Portland, OR | 2008 | GreenWorks PC]

Although stormwater mitigation takes place slightly upstream from this site, the close proximity of the surrounding community to the stream is what drew me to the project. The space is very intimate and immersive. There is no buffer between the adjacent housing structures and the stream ecosystem. This project blurs the lines between built/ constructed systems and natural systems.




SW Dolph Court
CULVERT
SW 30th Ave
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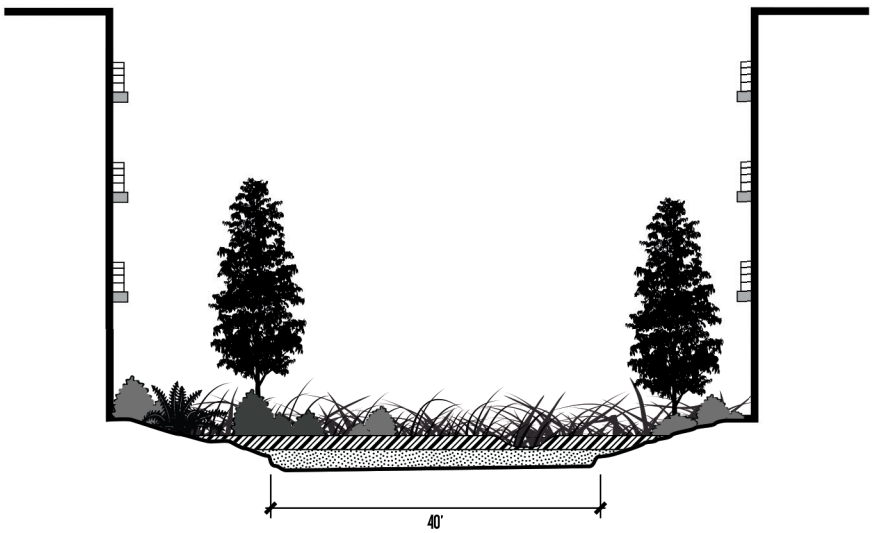
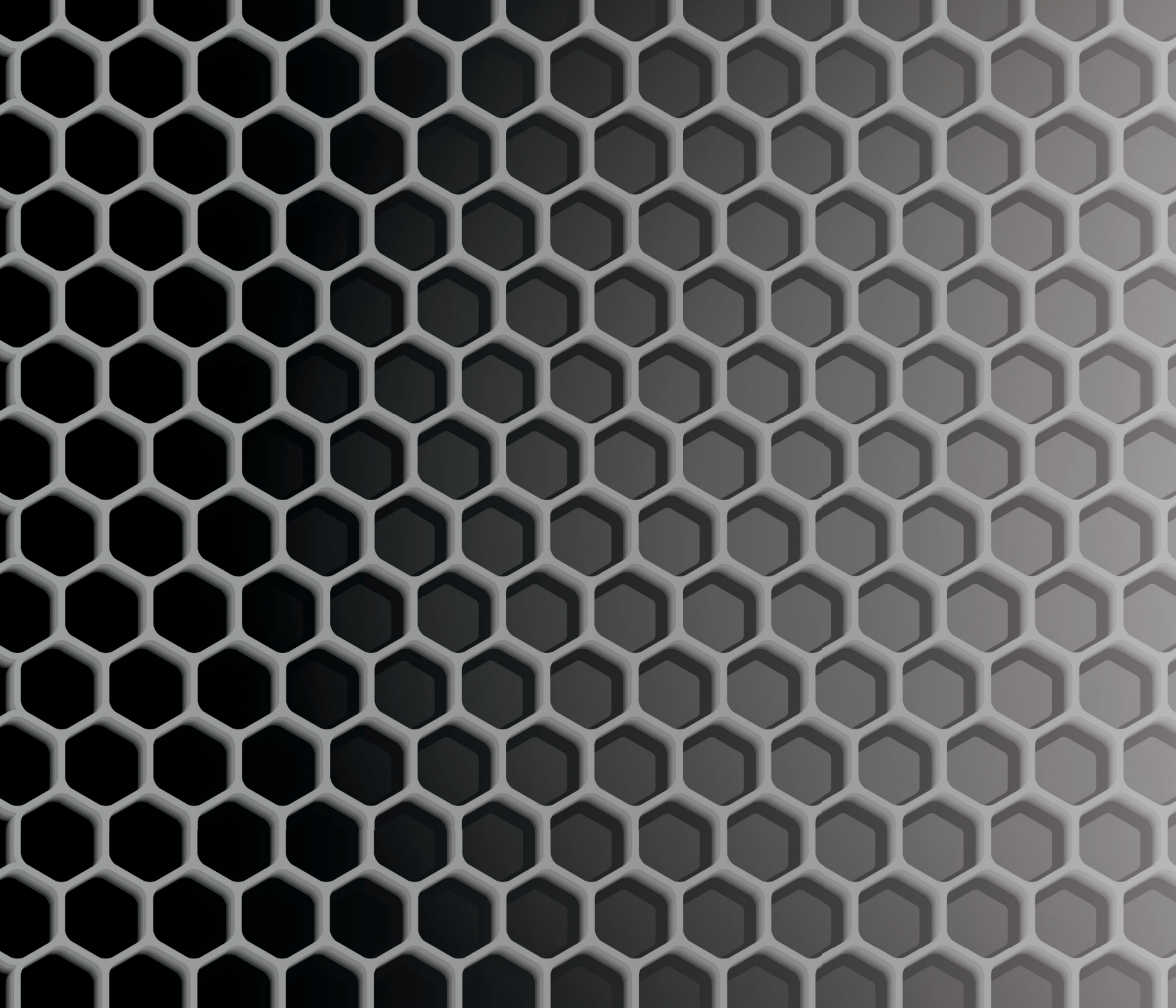
15
30
60
Feet


40'

Moving Forward

Based on the characteristics of natural wetlands and what I've learned from my case studies, I am using the following criteria to guide my design research:

- A heavily vegetated enclosed space that creates a sense of isolation from the outside world.
- Interaction at the same level of the landscape, i.e. in very close proximity.
- The ability to move through the landscape unimpeded by barriers.



Chapter

2

two

design investigation

Proof of Concept

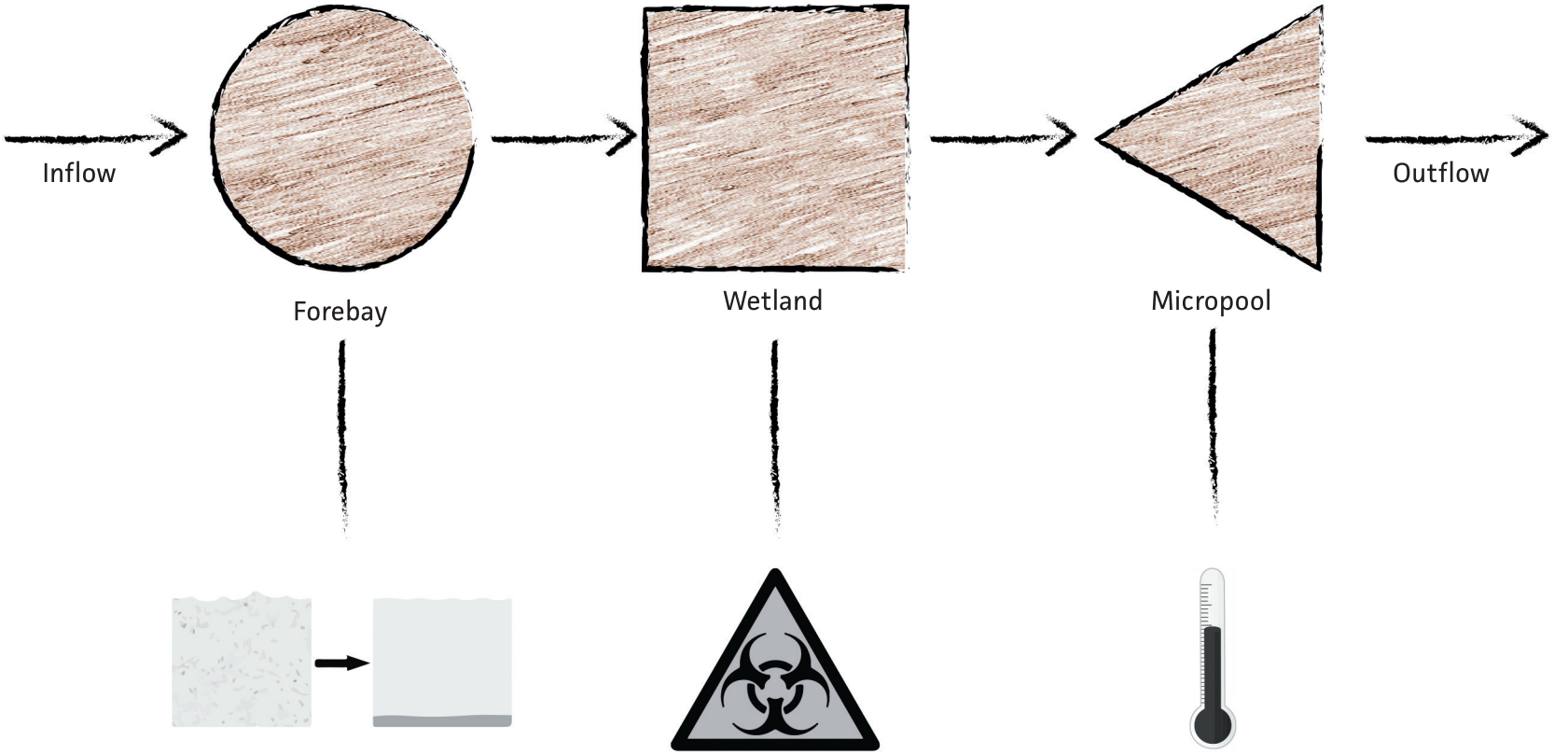
How to get into the landscape.

Walking in a Wetland

With respect to immersive experience, the primary obstacle to overcome is movement through the wetland environment. To truly experience a wetland, you would need special equipment, such as rubber boots or hip waders. A bridge over the wetland might be a potential solution. However, a bridge is an environment in itself. It has its own materiality. It has handrails that separate you from the landscape. It is also elevated to allow for high water events to flow under it. Another option is a device that would allow you to walk directly on top of the wetland just inches above the water's surface. The challenge here is to imagine such a device that would allow for movement above the water while not restricting or impeding the operatic wetland effects below the water. In addition to allowing movement through a wetland, what other services can this device provide?

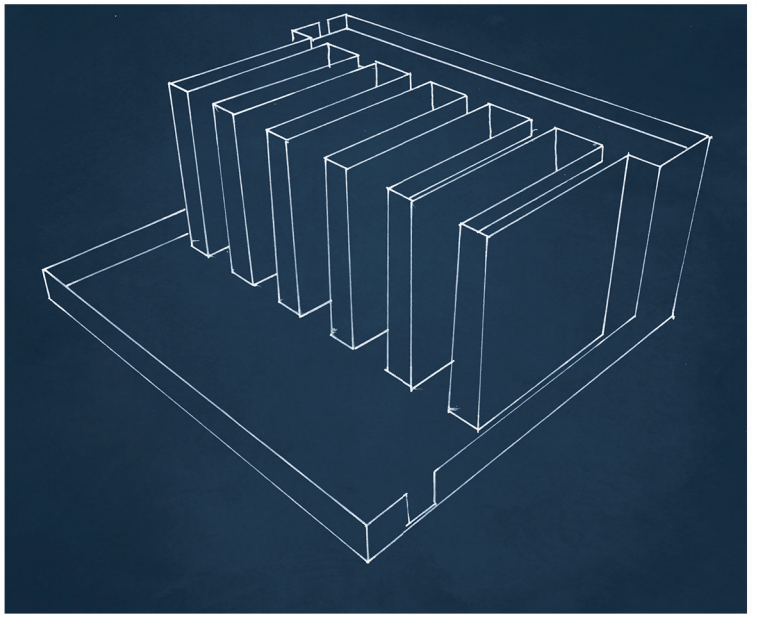
Constructed Wetland Processes

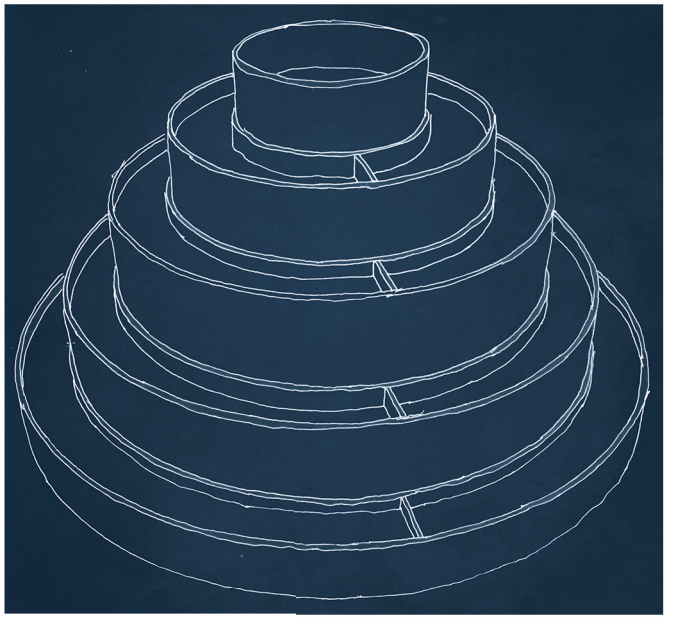
Before considering how to get into the wetland landscape, the primary functions of a constructed stormwater wetland must be considered. A CSW is composed of three general components: a forebay, the main wetland, and a micropool. The forebay, located at the point of inflow, is the primary component involved in sediment removal. As water flows into the forebay, which is usually deeper and wider, energy is dissipated resulting in sediment falling out of the water column and remaining in the forebay as water exits into the main wetland. The main wetland, through a variety of processes, is responsible for biochemical pollutant removal. This includes nitrogen, phosphorus, ammonia, heavy metals, and pathogens to name a few. The final component, the micropool, is responsible for lowering water temperature down to a safe level so as not to harm flora and fauna further downstream.

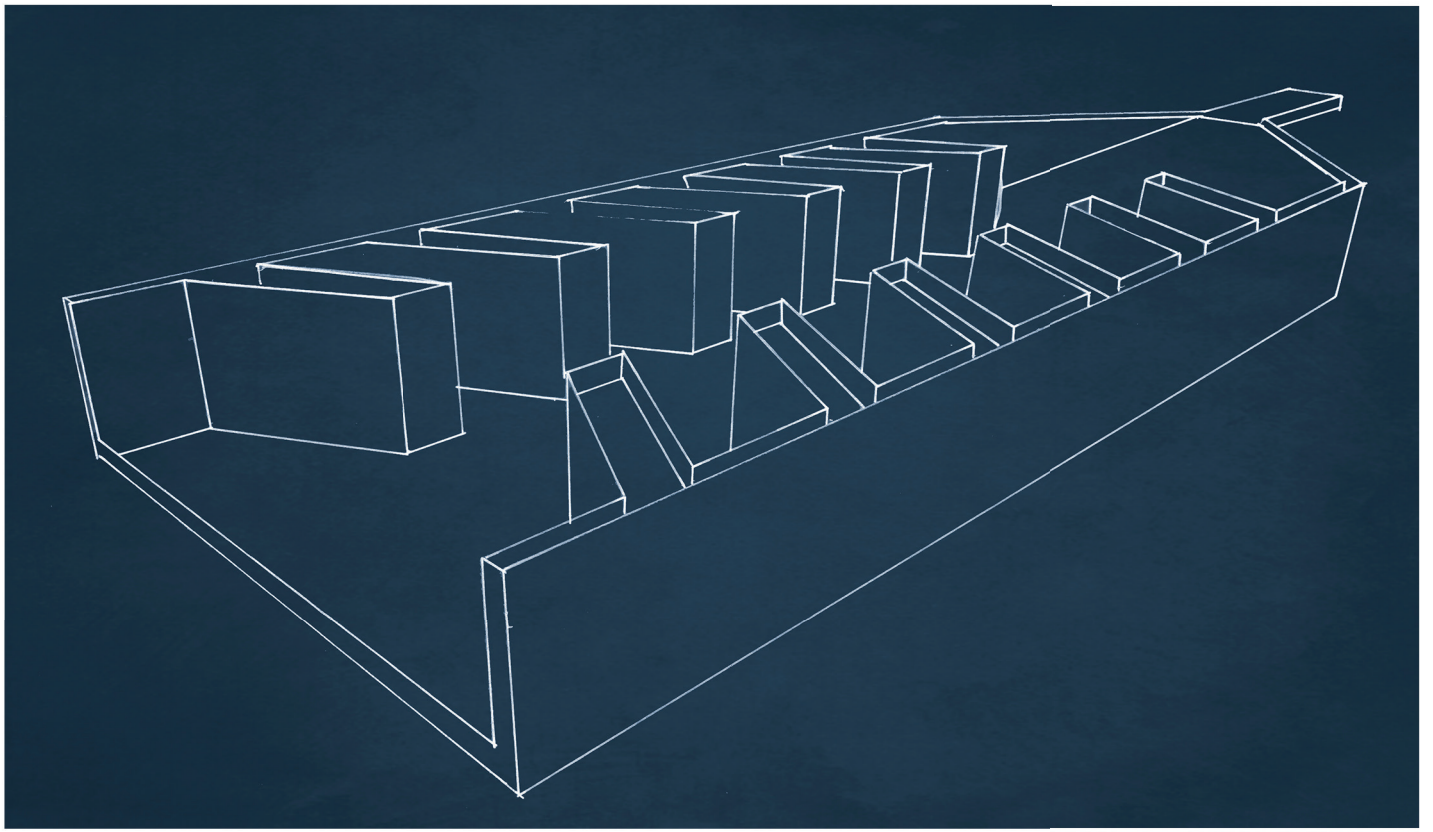

Inflow
Forebay
Wetland
Micropool
Outflow
Removal of coarse sediments, trash, and debris
Removal of nitrogen, phosphorus, ammonia, and heavy metals
Reduction of temperature

Concept

My earlier research was focused on combining horizontal and vertical constructed wetlands. In doing this research, I looked at various shapes and forms that the systems might take. As my research question evolved, I revisited these earlier designs and allowed these forms to influence the concept of a modular design.

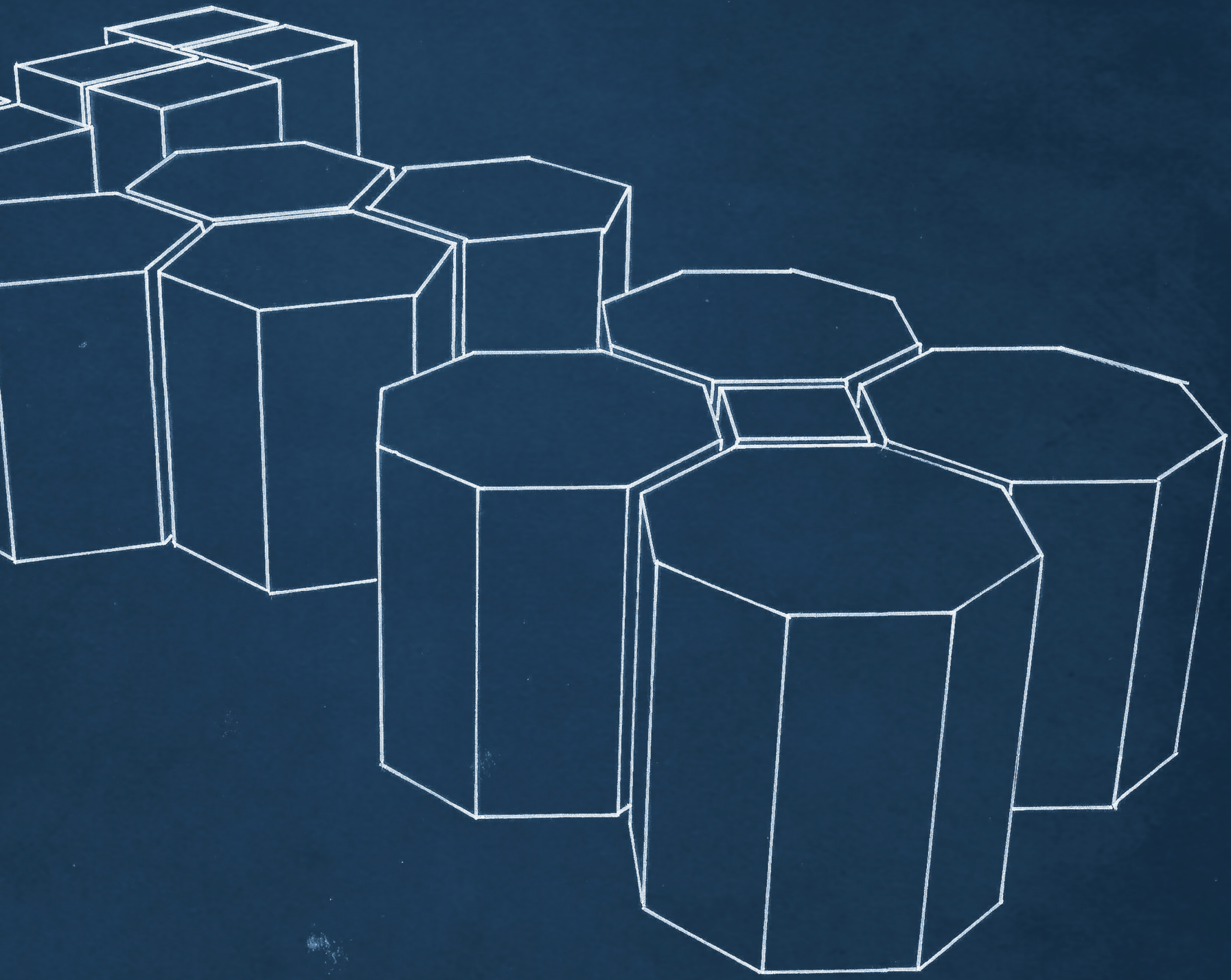






Shapes

I analyzed different shapes to determine how the modules could fit together cohesively. I determined through this research that the form of the module was not critical and that it could be determined by either the site or designer and still function as intended.

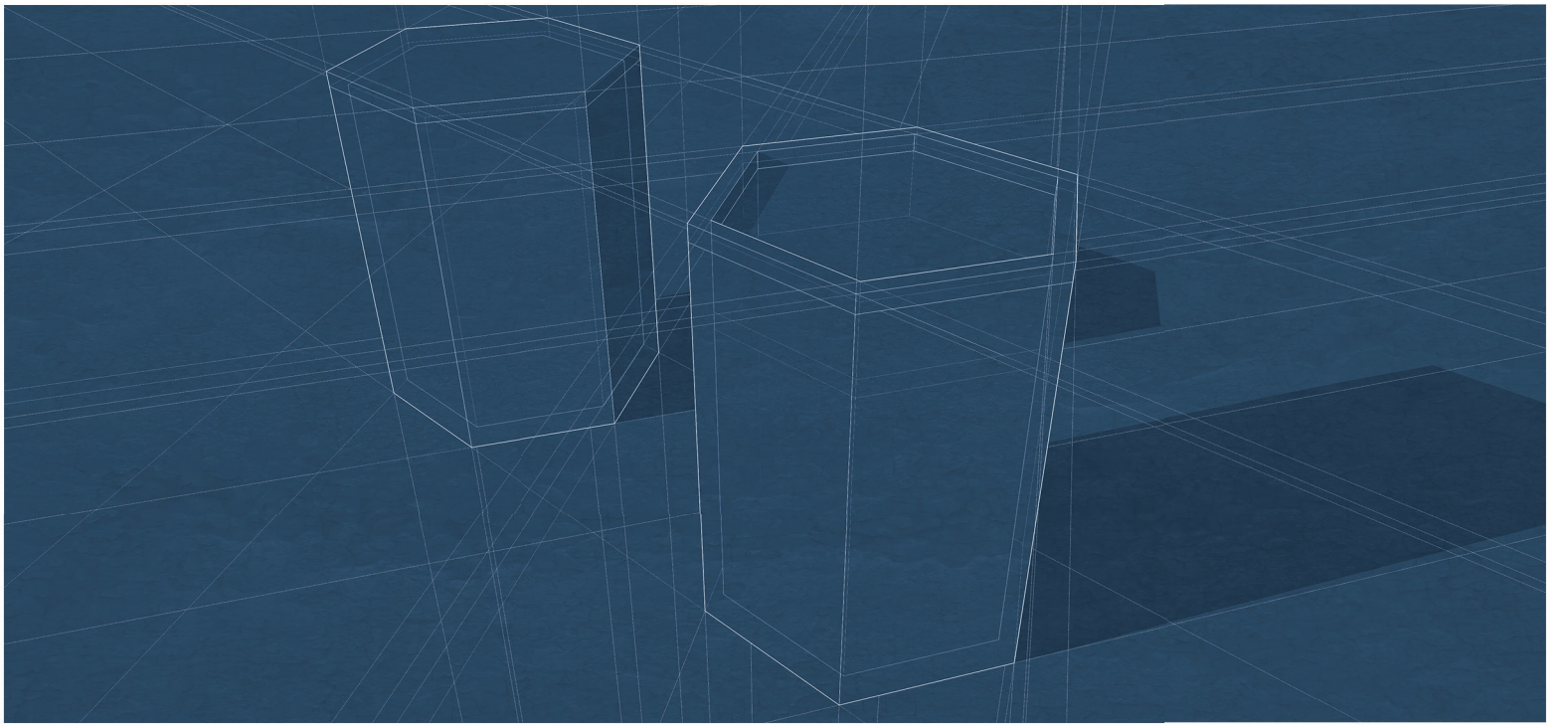


Adaptable

The module can be adapted in both height and width depending on the needs of the design or landscape. The use of interconnecting modules also allows for topographic manipulation.

Form

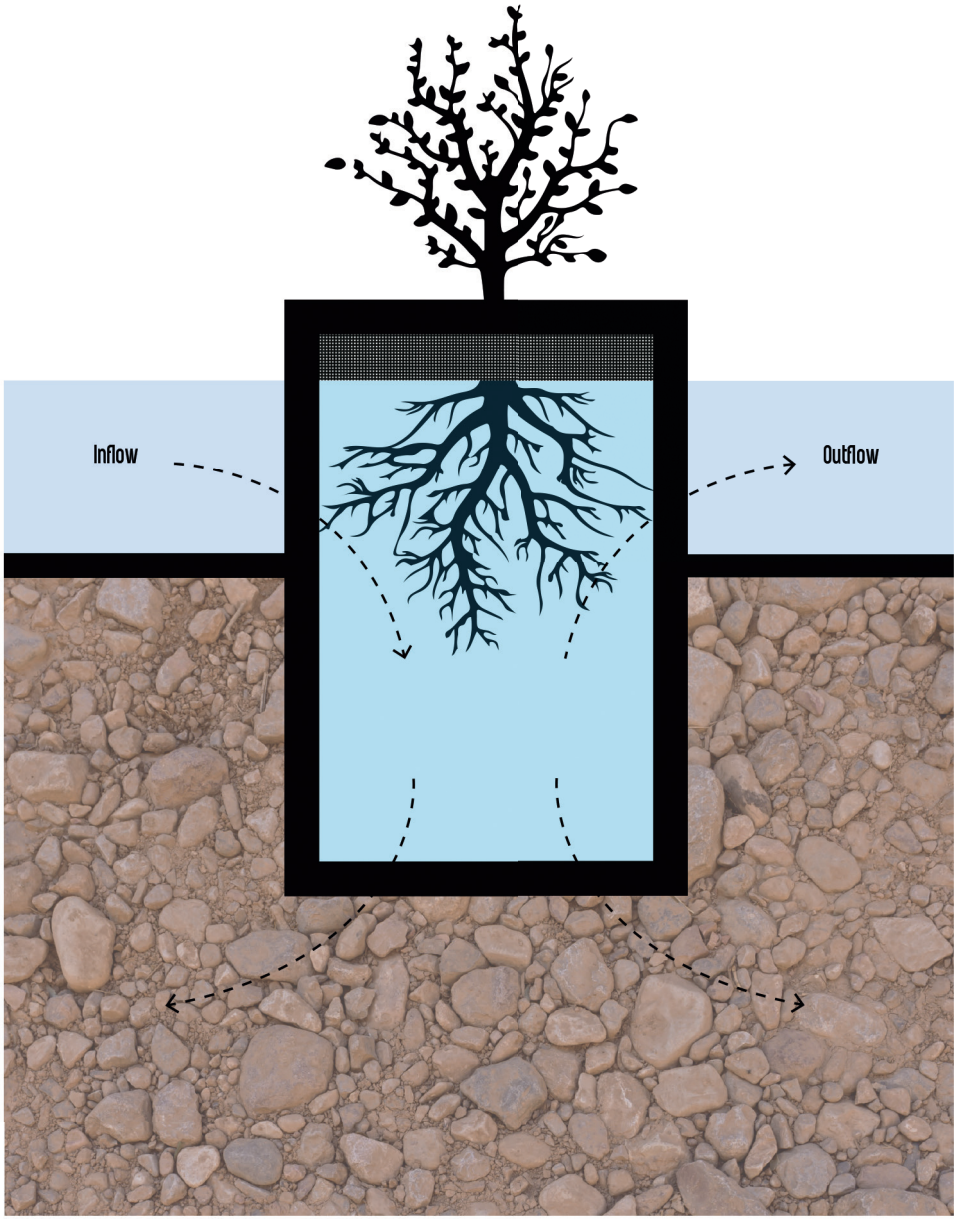
The final module form I decided on is a hex shape design 4 feet tall by 3 ft. in diameter. It consists of a planter and a path module. The path module has a solid surface to allow for movement through the wetland landscape. However, it has the same porous sides to allow for water movement.

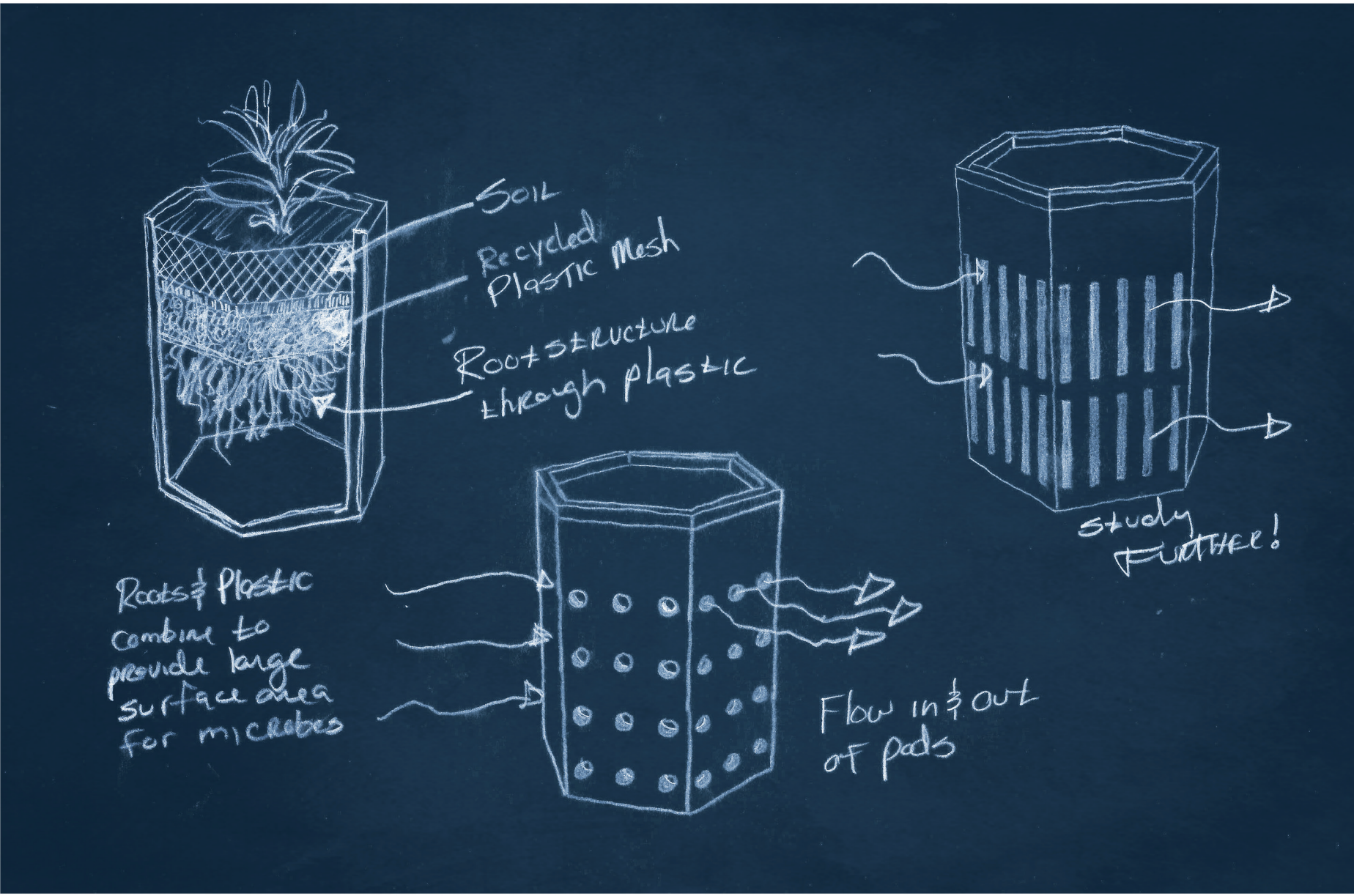


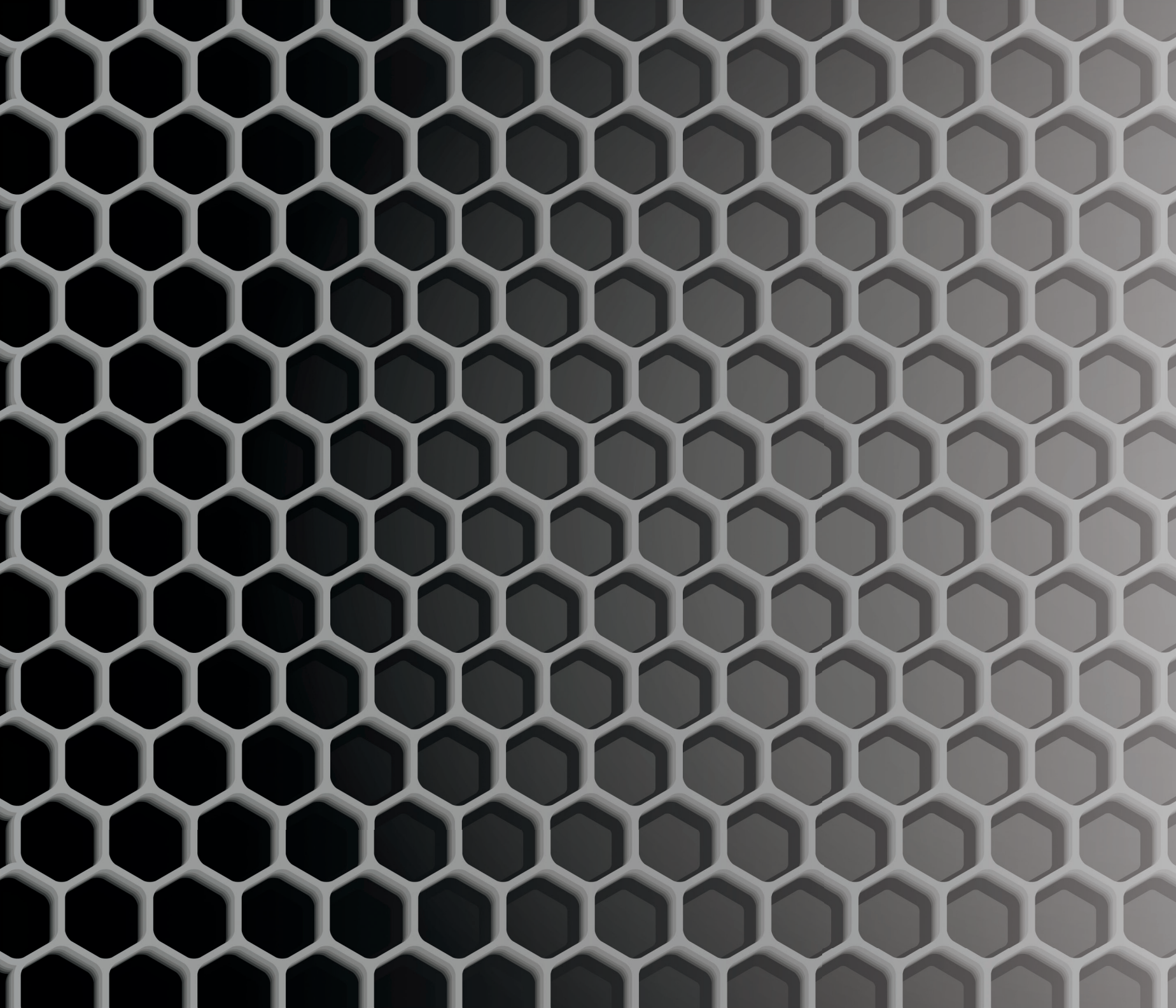
3"
4' 2"

Remediation

The planter module allows water to enter and exit through porous sides. While the water is passing through the module, which contains a medium of soil and recycled plastic mesh, it is filtered by a combination of plant uptake and microbial activity.




Soil
Recycled Plastic Mesh
Root structure through plastic
Roots & Plastic combine to provide large surface area for microbes
Flow in & out of pads
study further!



Chapter

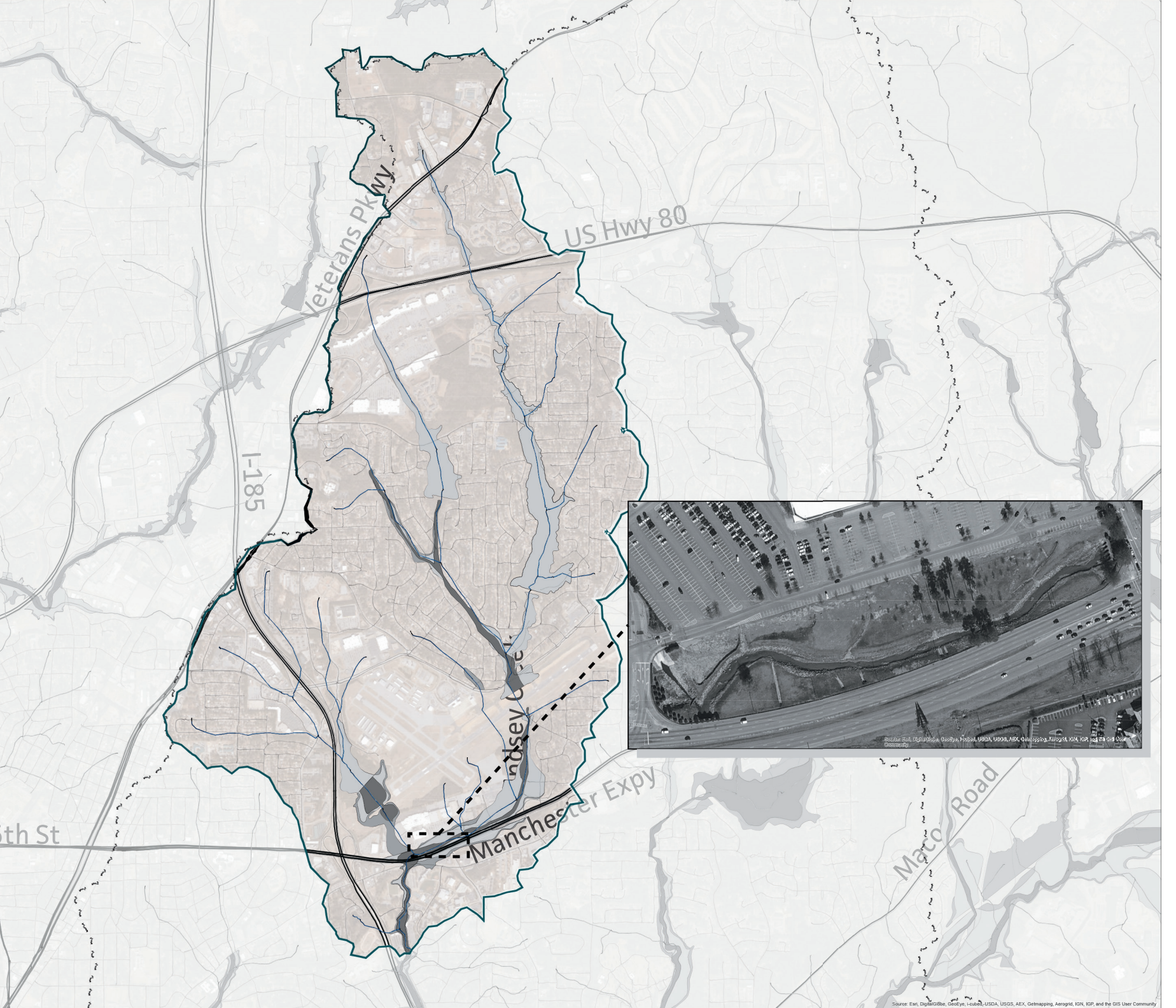
3

three

site investigation

Existing Site Conditions

The test site is located in Columbus, GA, east of the Chattahoochee River, in the Cooper Creek-Bull Creek Watershed. Lindsey Creek and an unnamed tributary converge here and continue on south under Manchester Expressway creating the outflow point of the upper Lindsey Creek sub watershed. The site sits in the middle of several neighborhoods with Peachtree Mall directly north and Columbus State University directly south..


Veterans Pkwy
US Hwy 80
I-185
Manchester Expy
Macco Road
th St

Site Photos

Panorama 01 – The site from the West end facing southward towards Columbus State University. It presents a good overall view of the western half of the site.

Erosion Control Structure – Several areas along this section of Lindsey creek feature poured concrete erosion control structures. These structures are meant to prevent bank erosion where water enters the creek from the adjacent parking lot. However, during high runoff events, the stream is undercutting these structures causing erosion.

Upstream – Through the middle of the site, the stream is narrow and deep. Here we can see down cutting to the bedrock caused by heavy sediment load during high runoff events.

Unnamed Tributary – An unnamed tributary merges with Lindsey Creek here. The tributary flows from the north where it enters a pipe as it travels under the Peachtree Mall parking lot.

Erosion Control Structure

Panorama 01

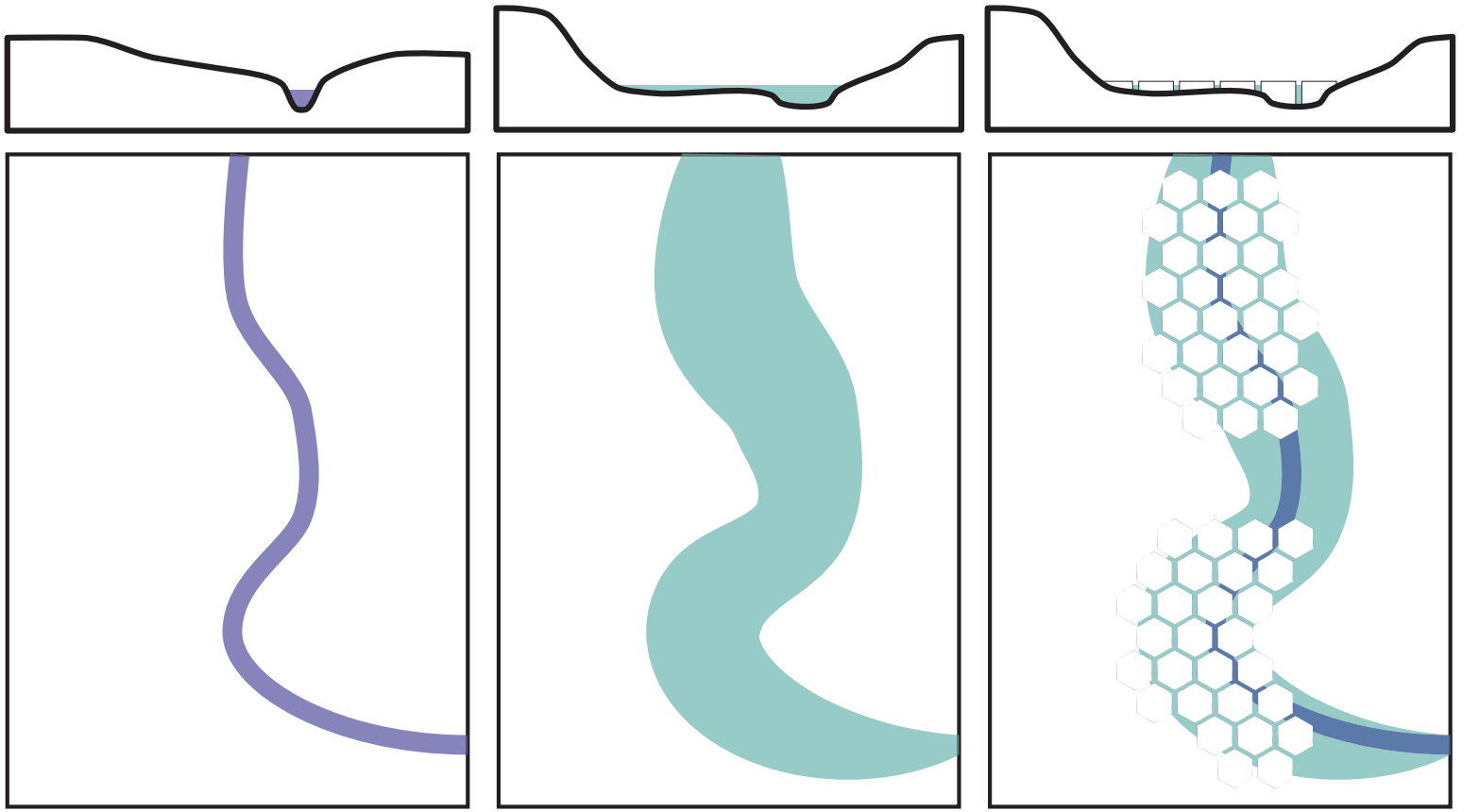
Upstream

Unnamed Tributary

Panorama 02 – As you move closer to the stream edge, the elevation drops allowing the site to become more dominant than the surrounding landscape.

Stream Profile

Currently, the stream profile is narrow and deep. This creates a high energy situation that has high erodibility potential. During the design process, the primary goal is to spread the water out, dissipating its energy and lowering the potential for erosion. This can be accomplished by widening the stream profile. The module installation will also create a barrier that will dissipate water energy, as well.



— High energy
— Deep channel
— High erodability
— Low storage

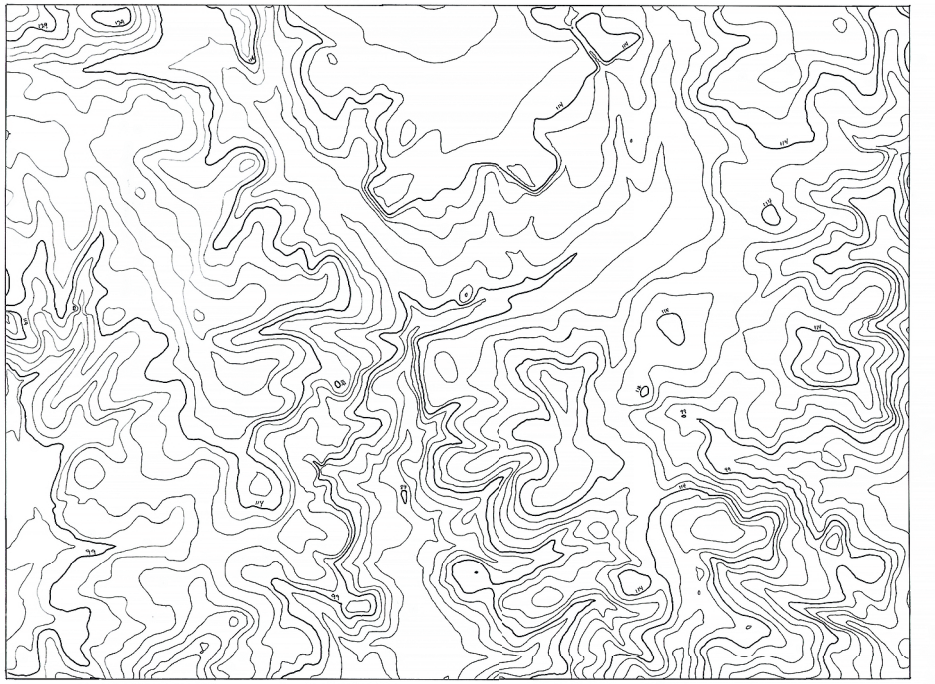
— Moderate energy
— Shallow channel
— Low/moderate erodability
— Moderate storage

— Low energy
— Shallow channel
— Low erodability
— High storage

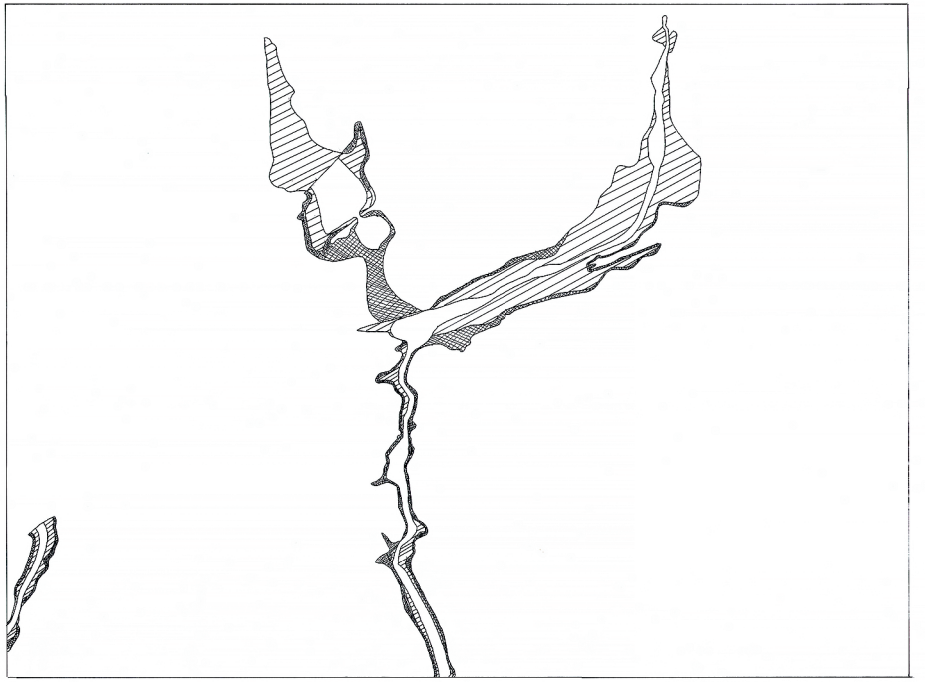
Site Analysis

Using an overlay mapping technique, the individual systems in the area were hand drawn and layered to analyze for social connectivity, impervious surfaces, water flow accumulation, and ecological connectivity.

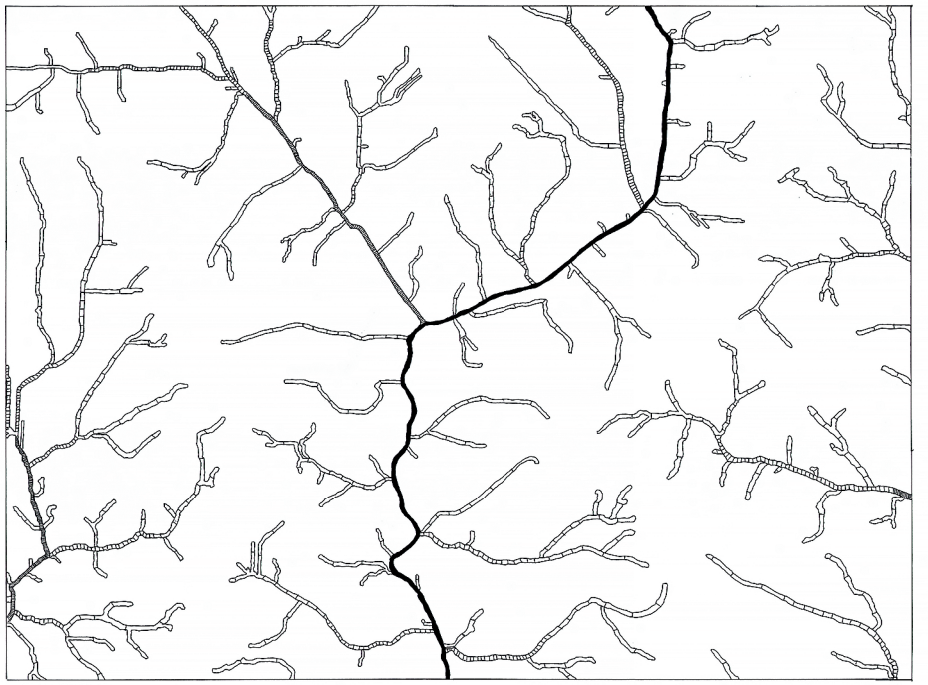
Topographic Map



Streams



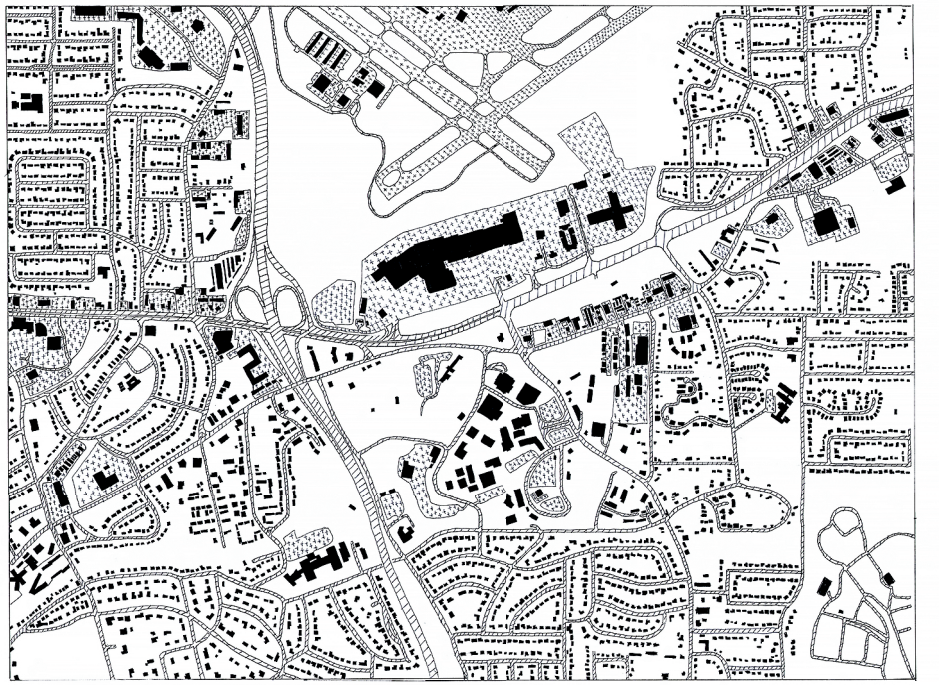
Flood Zones



Flow Accumulation

Roadways

Impermeable Surfaces

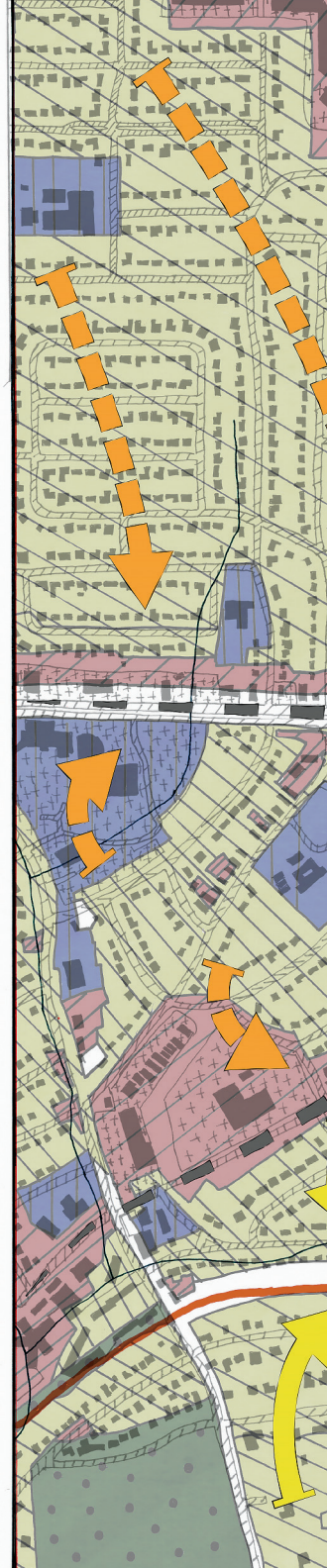


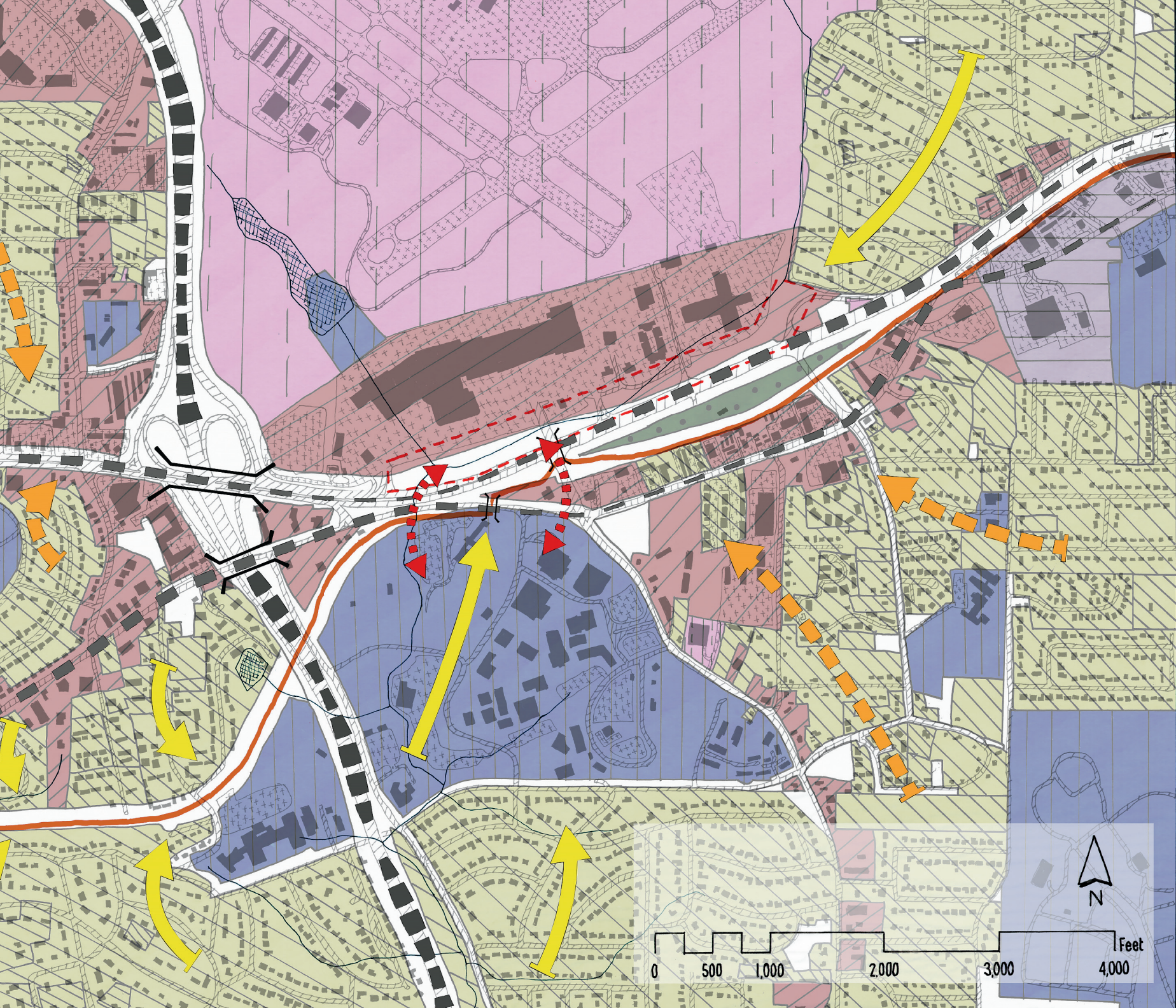
Canopy Cover

Land Use

Social Connectivity

Interstate 185, Manchester Expressway, and Warm Springs Road create barriers that make pedestrian movement through the area difficult. The crossings over and under the interstate highway at Manchester Expressway and Warm Springs Road have zebra crossings and sidewalks, but they are in close proximity to traffic. Fall line Trace, a rail-to-trails project, offers good connectivity between the neighborhood to the southwest and adjacent areas along its length. The neighborhood to the northeast and the Peachtree Mall parking lot have direct connectivity to the proposed site. Due to the high volume of automobile traffic, access to the site from the southern area will offer a challenge. Overall, the area has poor pedestrian connectivity and/or walkability.

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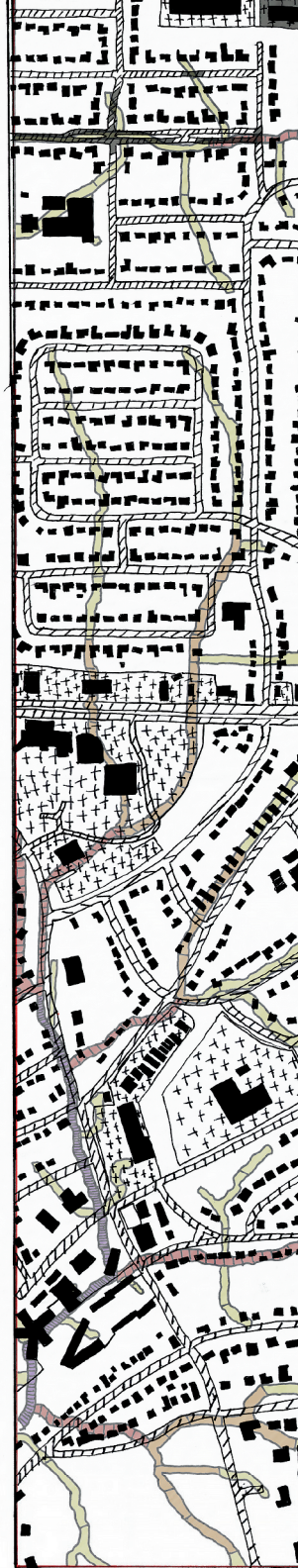
Feet

Impermeable Surfaces

The general area around the proposed site, with the exception of the airport to the north, is moderately dense urban development with a moderate to low permeability. The airport area has moderate to high permeability. Natural flow patterns immediately adjacent to the site are disrupted by two highways to the south and a massive parking lot to the north. In these areas, the stream has either been piped or relocated to accommodate structures. A high volume of water is drained into the creek during high rain events from the parking lot and adjacent Manchester Expressway.



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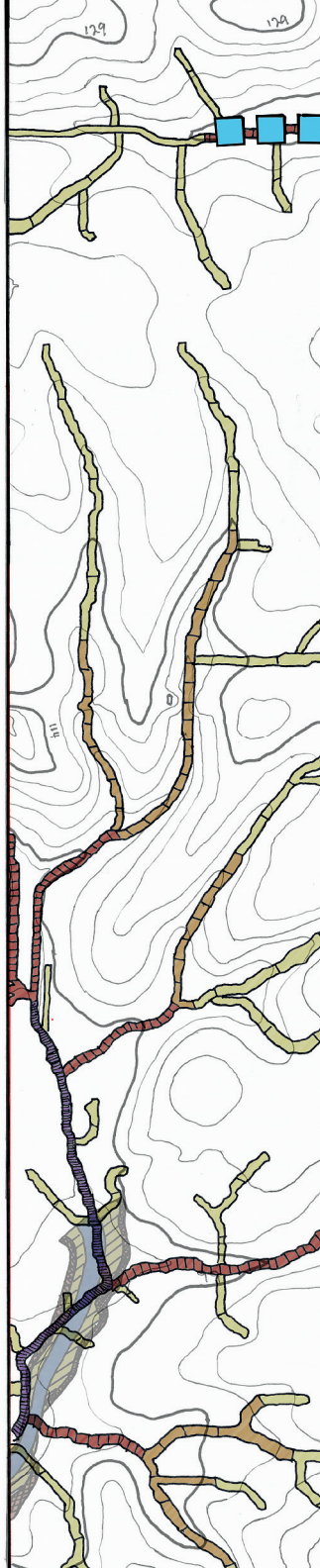
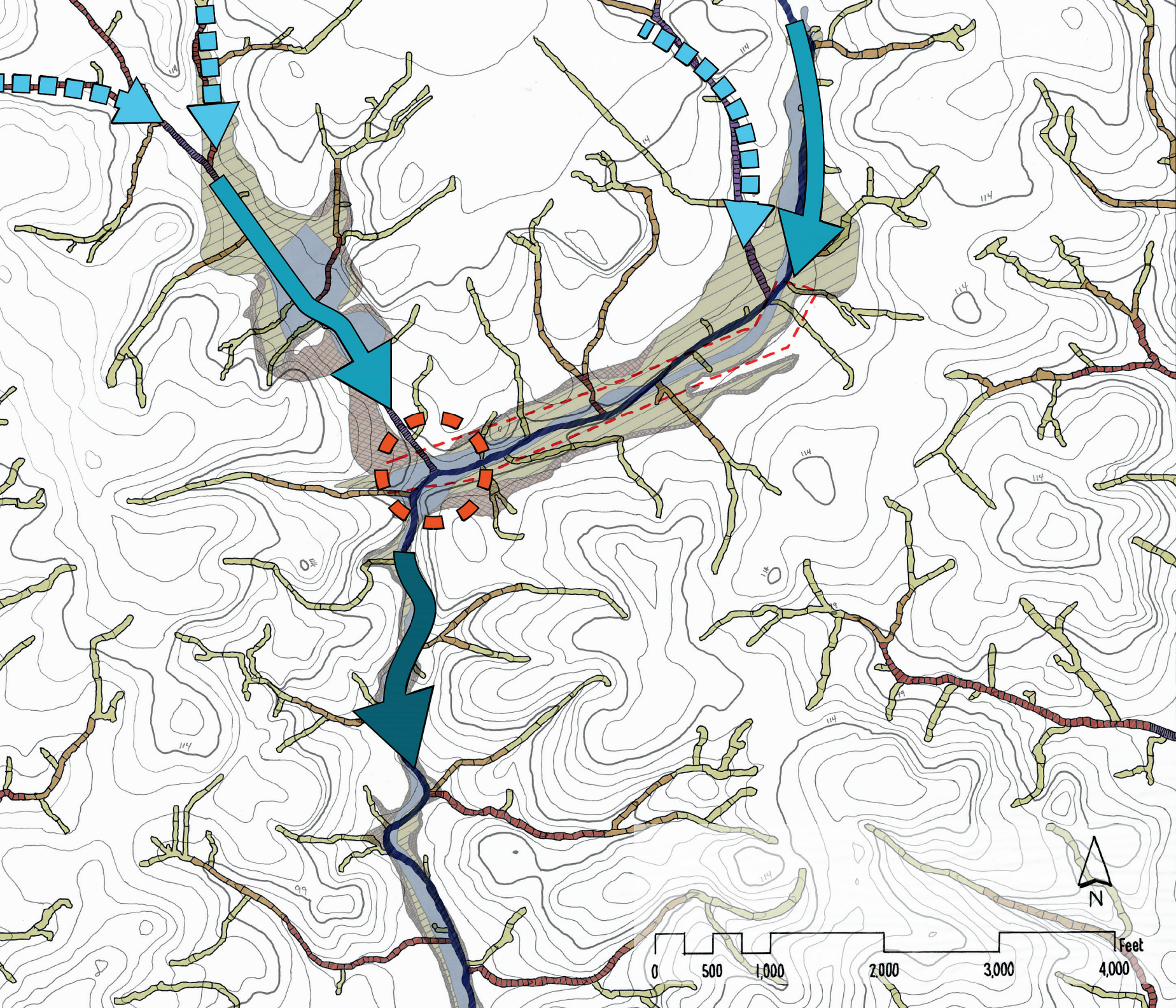
3,000
4,000
Feet

Natural Flow Accumulation

The site sits adjacent to Lindsey Creek, which flows from a larger watershed to the northeast, and merges with an unnamed tributary at the southwest edge of the proposed site. At the point where the two tributaries meet, the main stream continues under the highway creating a choke point that could potentially see flooding during high rain events. The proposed site is located in a floodway, which must be maintained for the purpose of flood containment.

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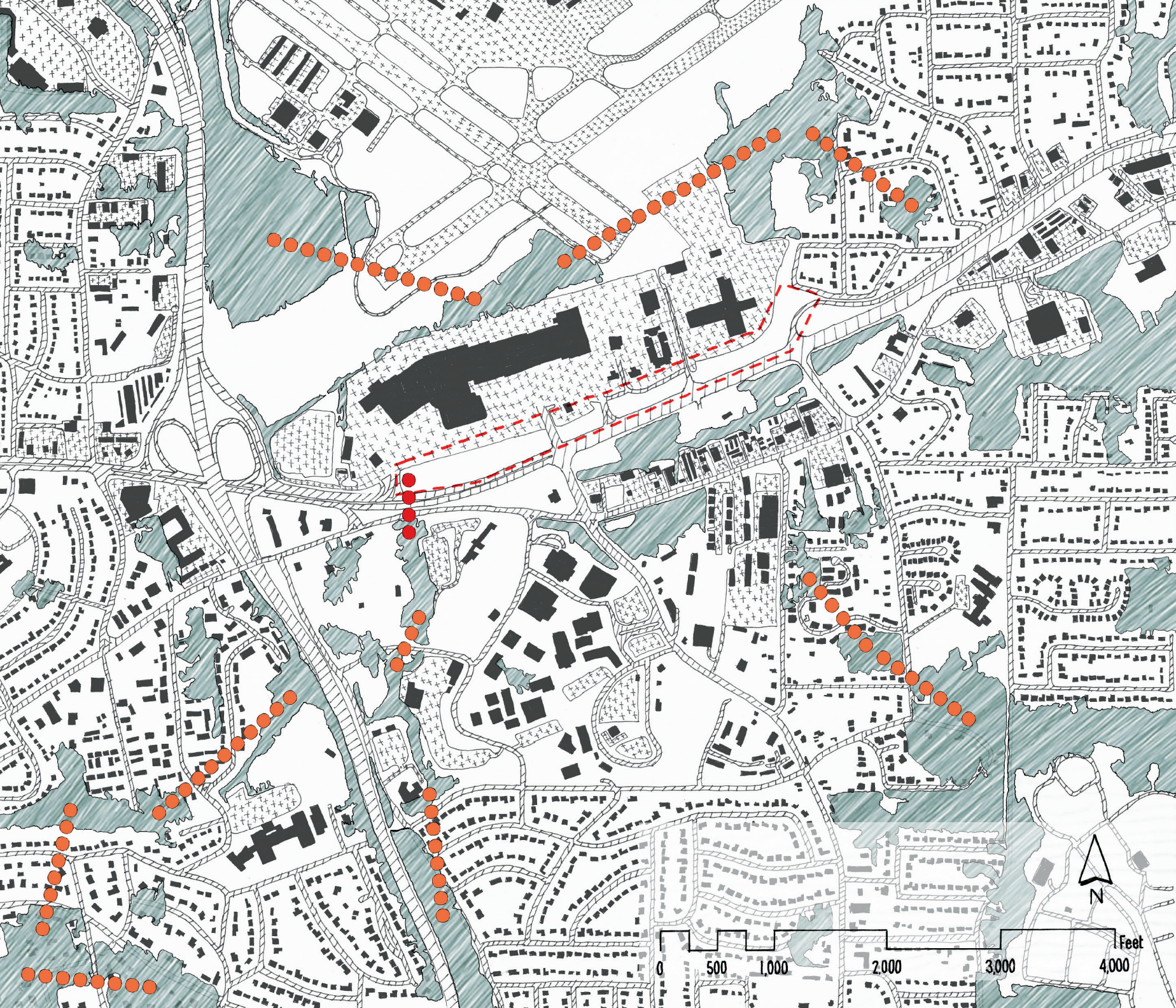
Ecological Connectivity

The majority of the study area, with the exception of the airport to the north, has some form of tree and canopy presence. However, it is sporadic and sparse throughout the neighborhoods and would not offer enough cover and protection for ecological connectivity throughout. Also, similar to social connectivity, the major highways in the area create barriers to passage between dense forested areas. The majority of proposed connections cross low-volume streets, but could potentially offer passage. As for the site itself, a forested infill in this area would offset the heat island effect from the parking lot, but would not offer much in connectivity due to its proximity to Manchester Expressway and the Peachtree Mall parking lot.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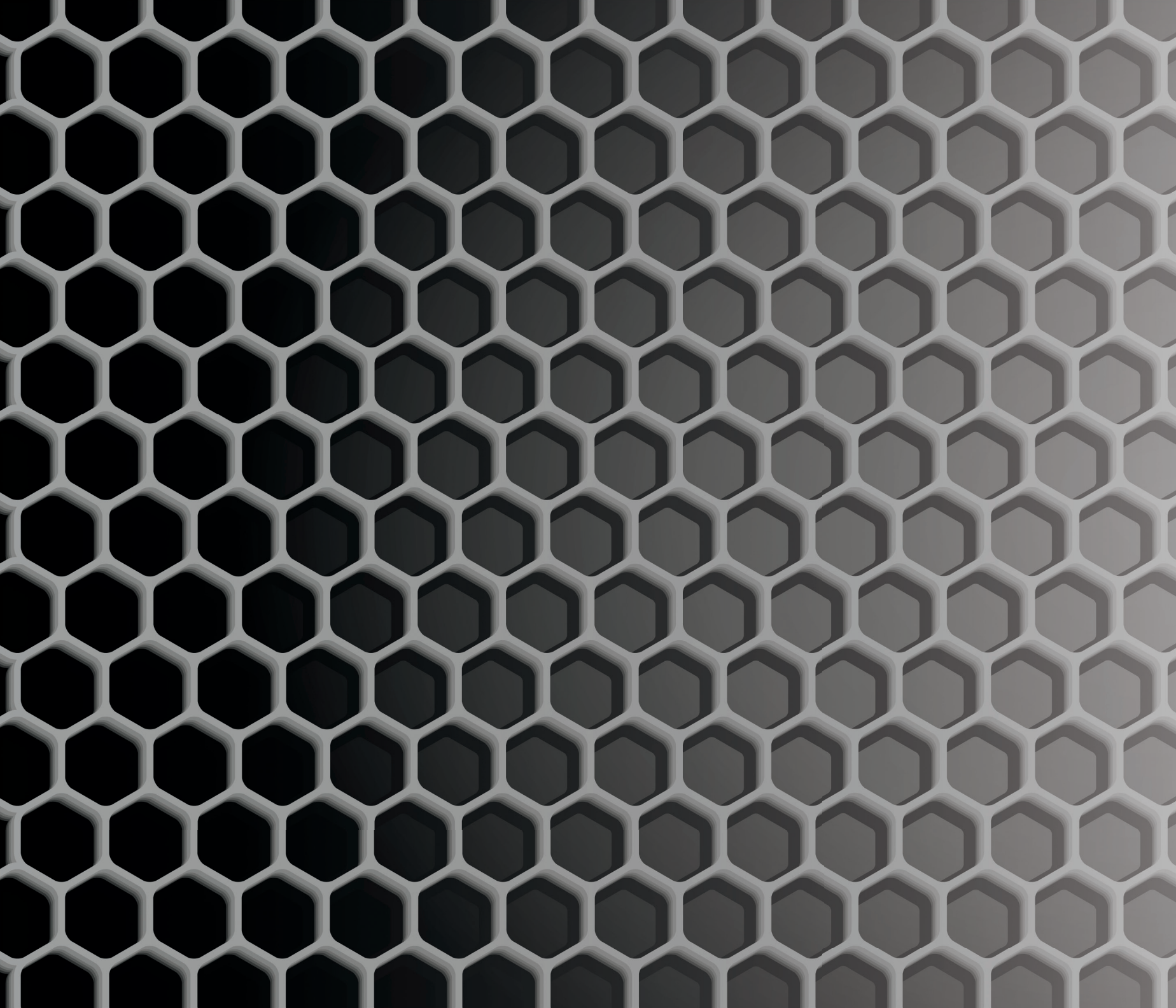


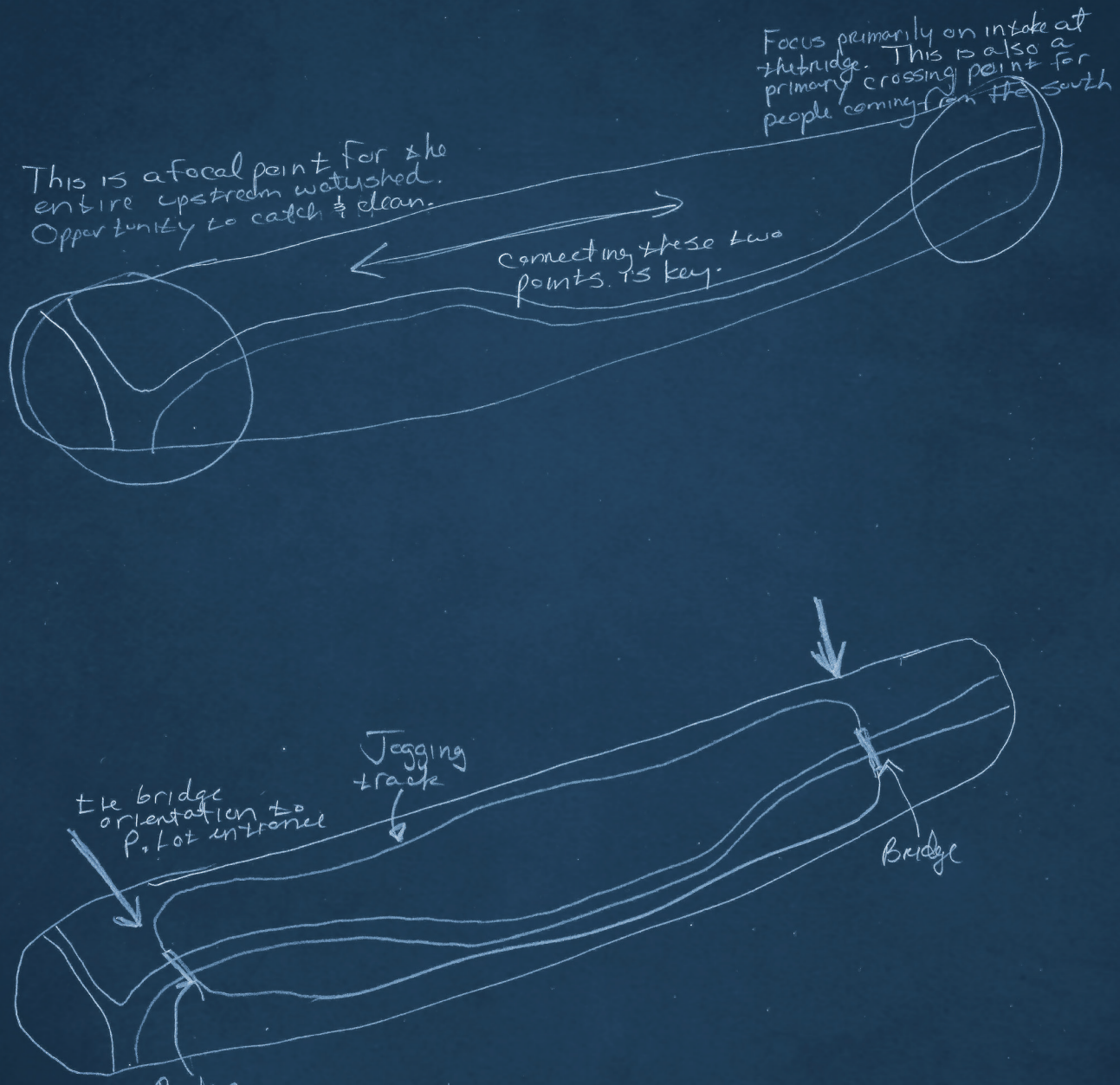
Chapter

4 four

concept design

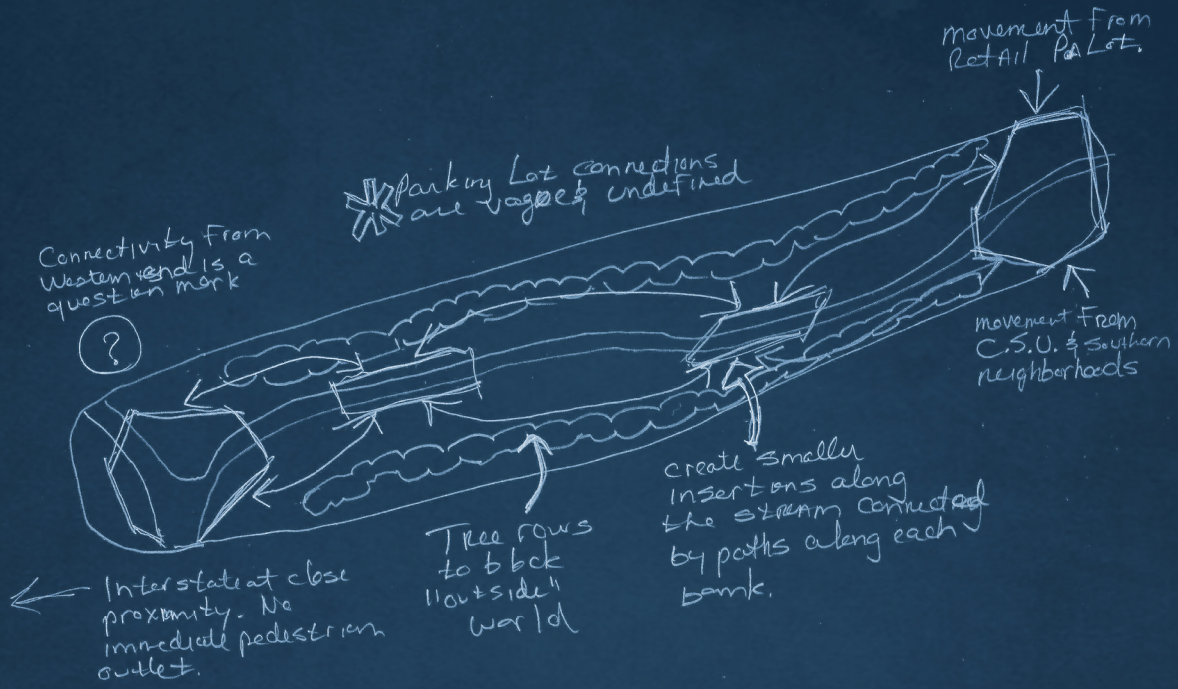
Initially, I looked at what areas of the site I should focus on first. The east end of the site is a primary access point for people moving from the south and allows for an area to initially slow the water flow. On the western end of the site, an unnamed tributary merges with Lindsey Creek creating a point of intensity before exiting under Manchester Expressway. My goal was to use these two focal points to lay out a design connecting them.

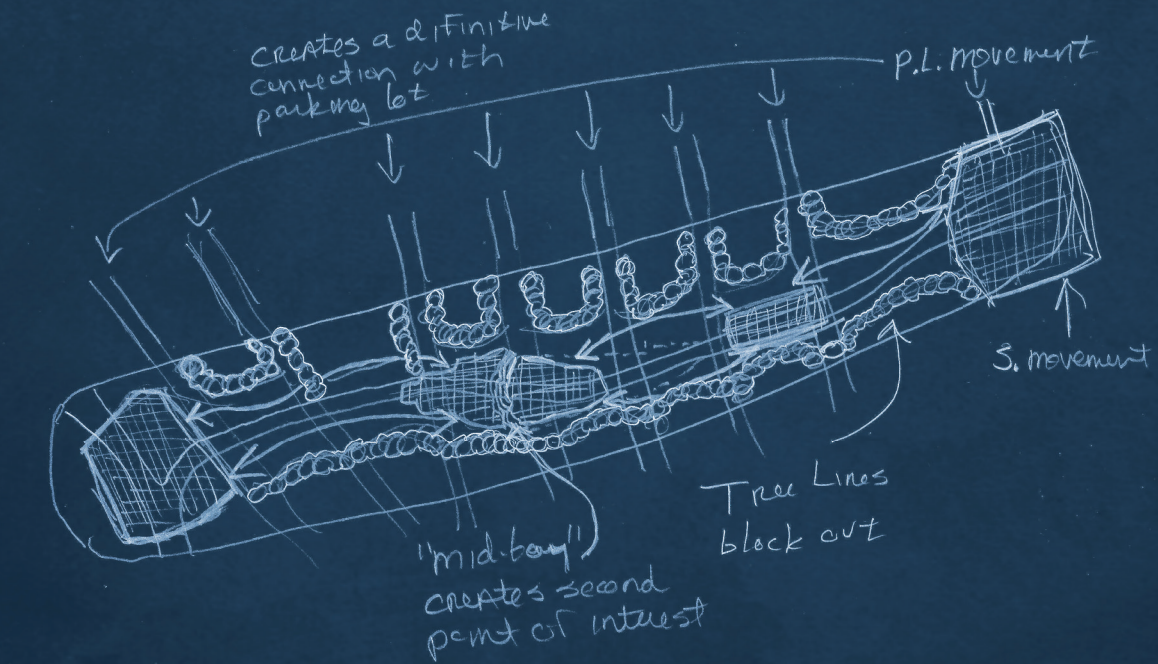
Before laying out the wetland park, I wanted to examine a potential route that would allow a user to move along the perimeter of the park allowing multiple access points to the wetlands as well as views into the wetlands from outside.

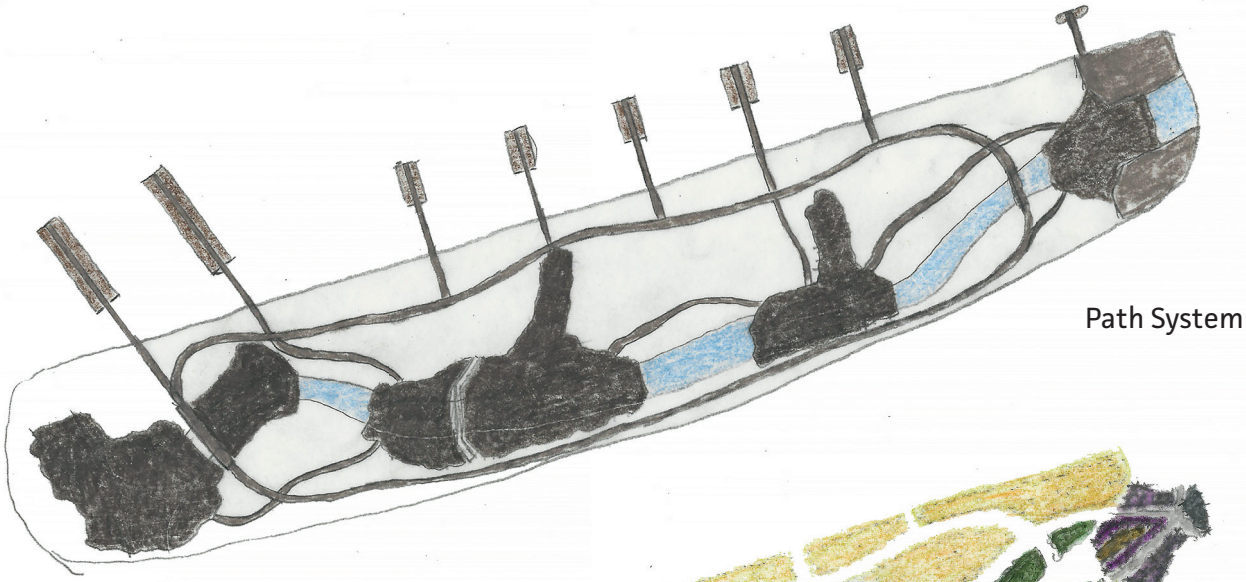

Focus primarily on intake at the bridge. This is also a primary crossing point for people coming from the south
This is a focal point for the entire upstream watershed. Opportunity to catch & clean.
connecting these two points is key.
Jogging track
the bridge orientation to Pilot entrance
Bridge
Bridge overlooks wetland devices. Juxtaposes "immersive"

I created smaller insertions primarily where the stream enters and exits the site as well as drainage entry points from the parking lot. I then connected those insertions with paths along each side of the stream. In order to maintain a sense of enclosure, I wanted to create a barrier of trees along the perimeter of the site between the urban landscape and the wetlands.

Next, I extended the path system into the parking lot in order to create definitive entry points and a connection that extended off site.


movement From Retail P&L ot.
Parking Lot connections are vague & undefined
Connectivity From Western end is a question mark
?
movement From C.S.U. & Southern neighborhoods
create smaller insertions along the stream connected by paths along each bank.
Tree rows to block "outside" world
Interstate at close proximity. No immediate pedestrian outlet.

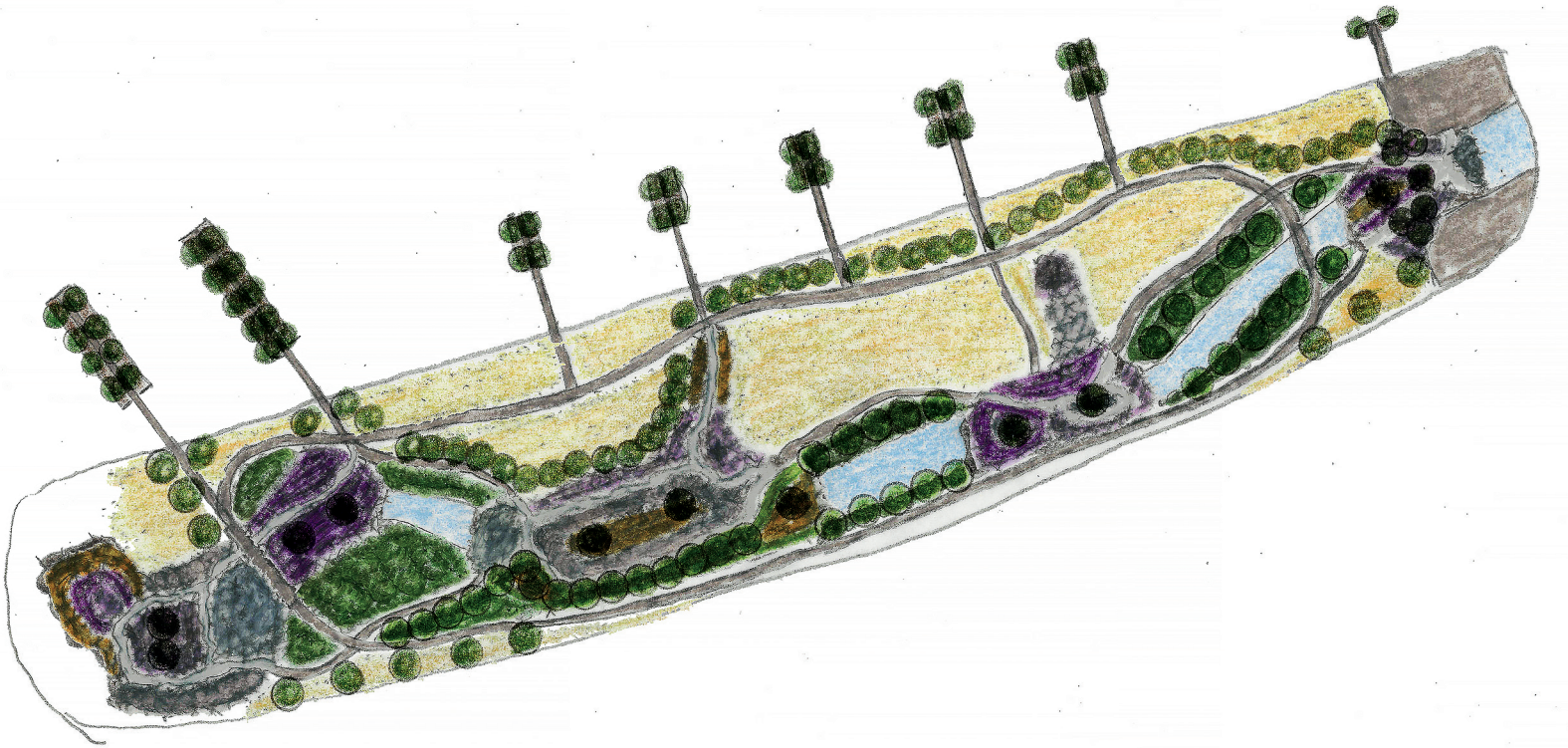

creates a definitive connection with parking lot
P.L. movement
S. movement
Tree Lines block out
"mid-bay" creates second point of interest

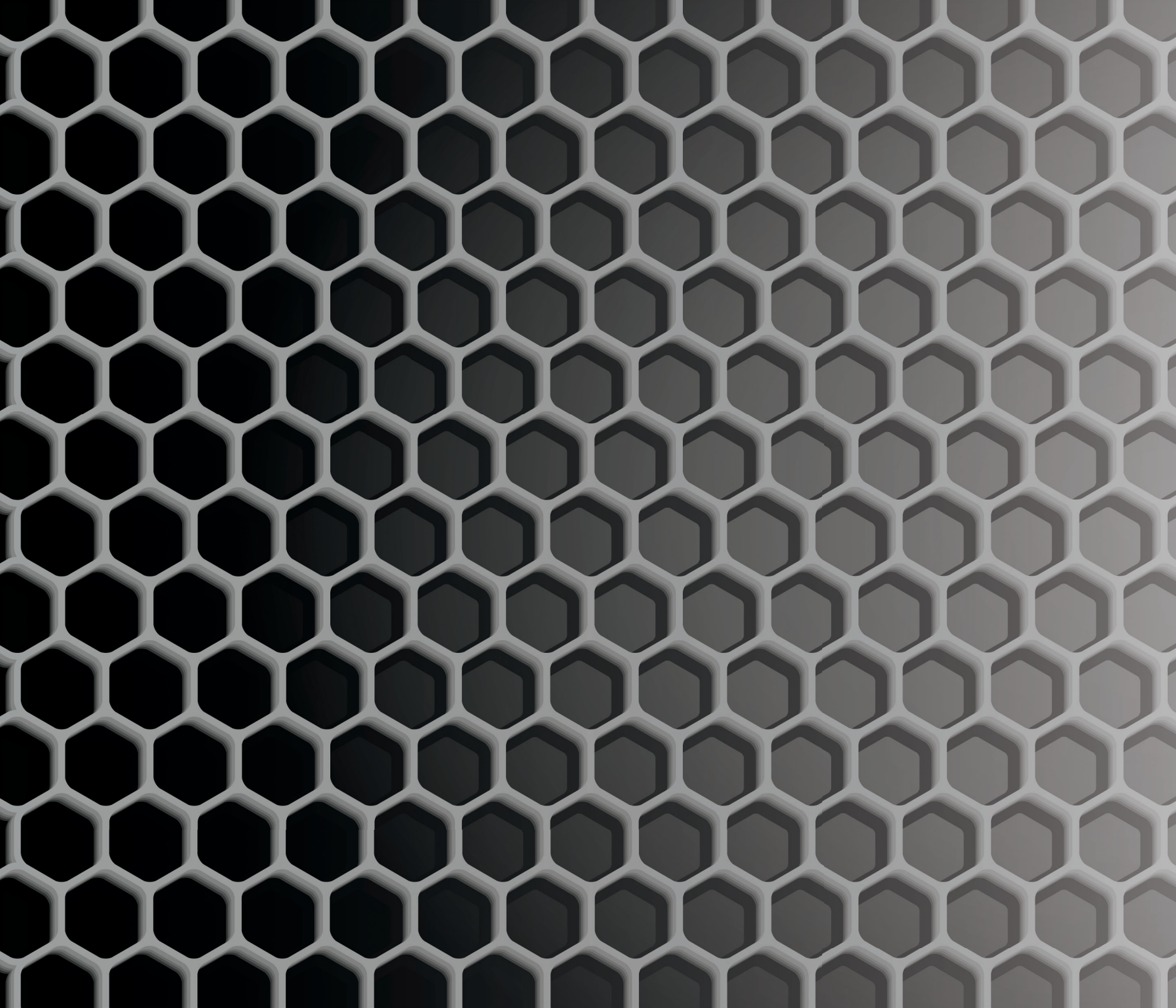


Path System

Planting Layout

Canopy Trees





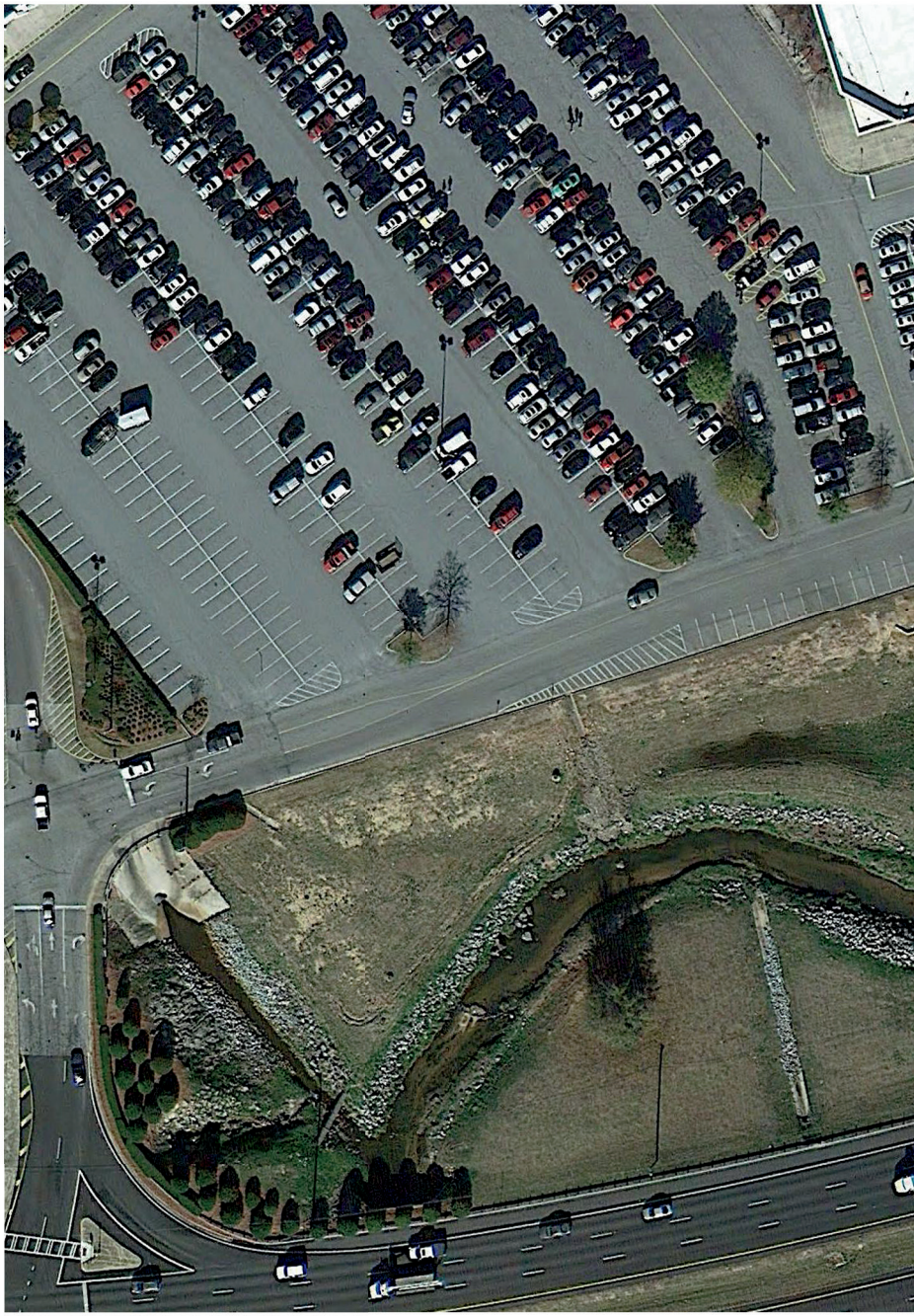
Chapter

5

five

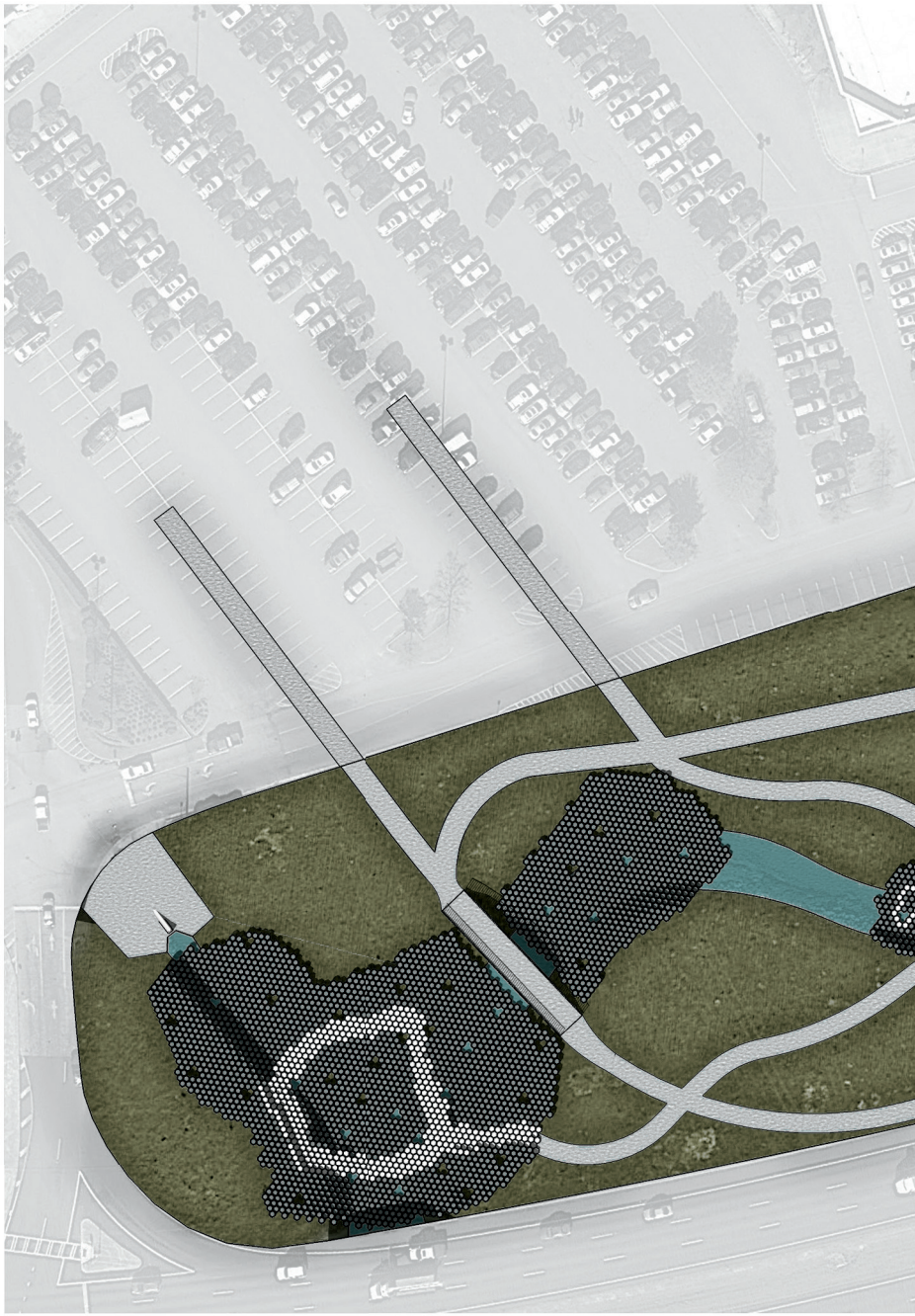
final design

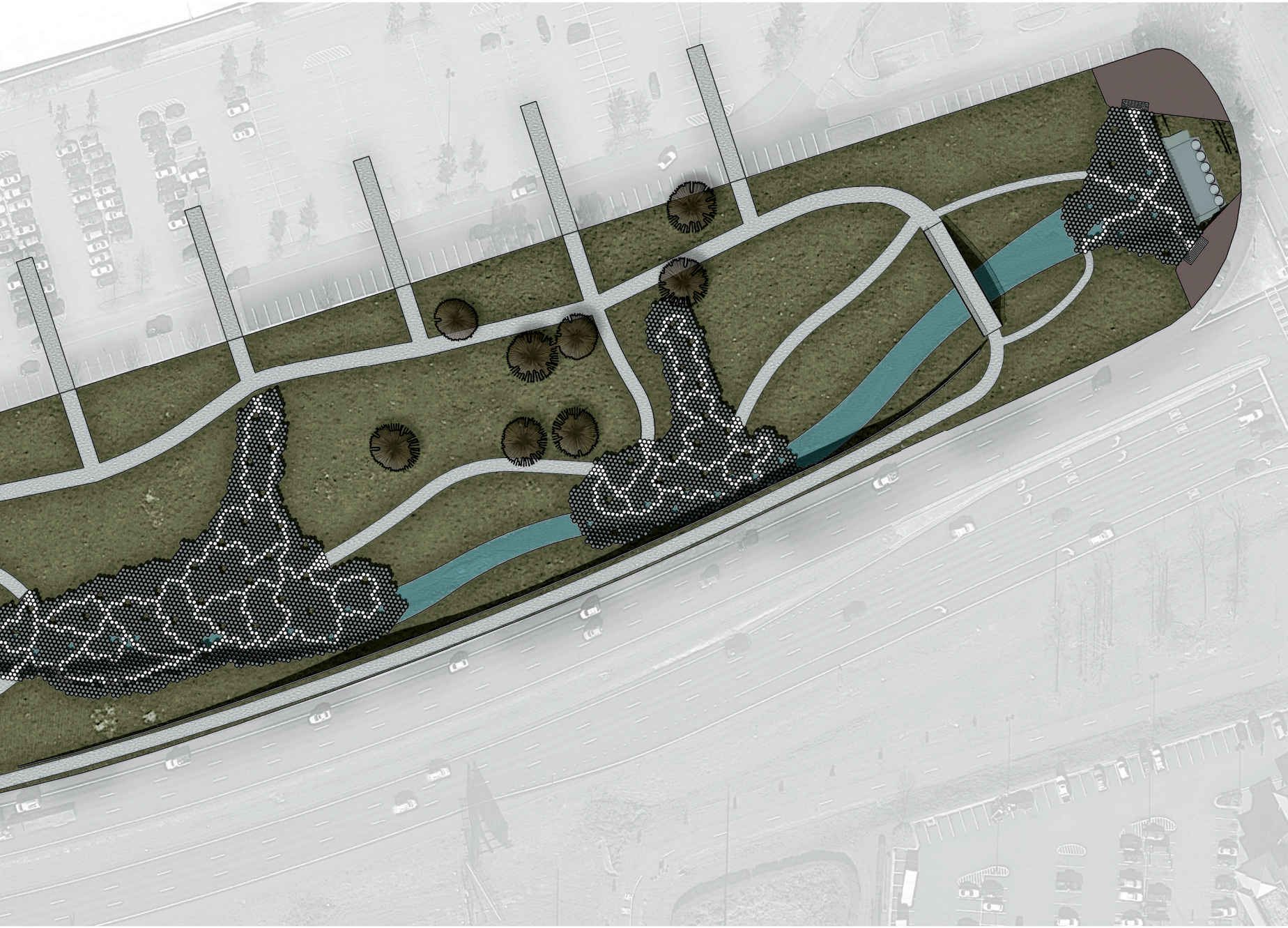
Existing Condition



Wetlands and Paths

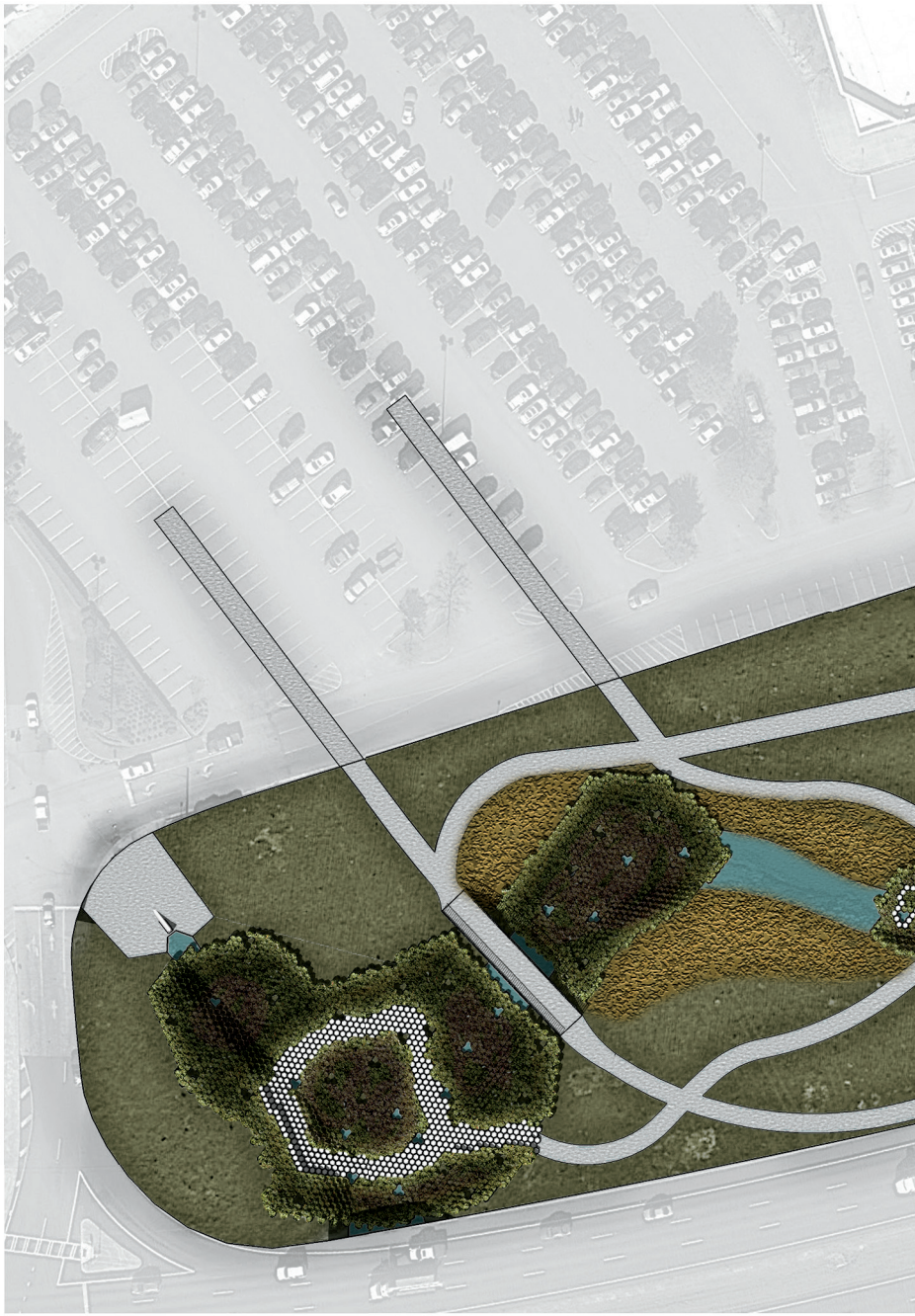
In the final design, I started with the existing site conditions and laid out the modules and path system. The paths in the wetland areas, created by the path modules, create choices in how a user may move through and experience the wetland. For the perimeter path, a retaining wall was required for the southern edge of the site to maintain an even grade. Access points for the park are located along the northern and eastern sides.

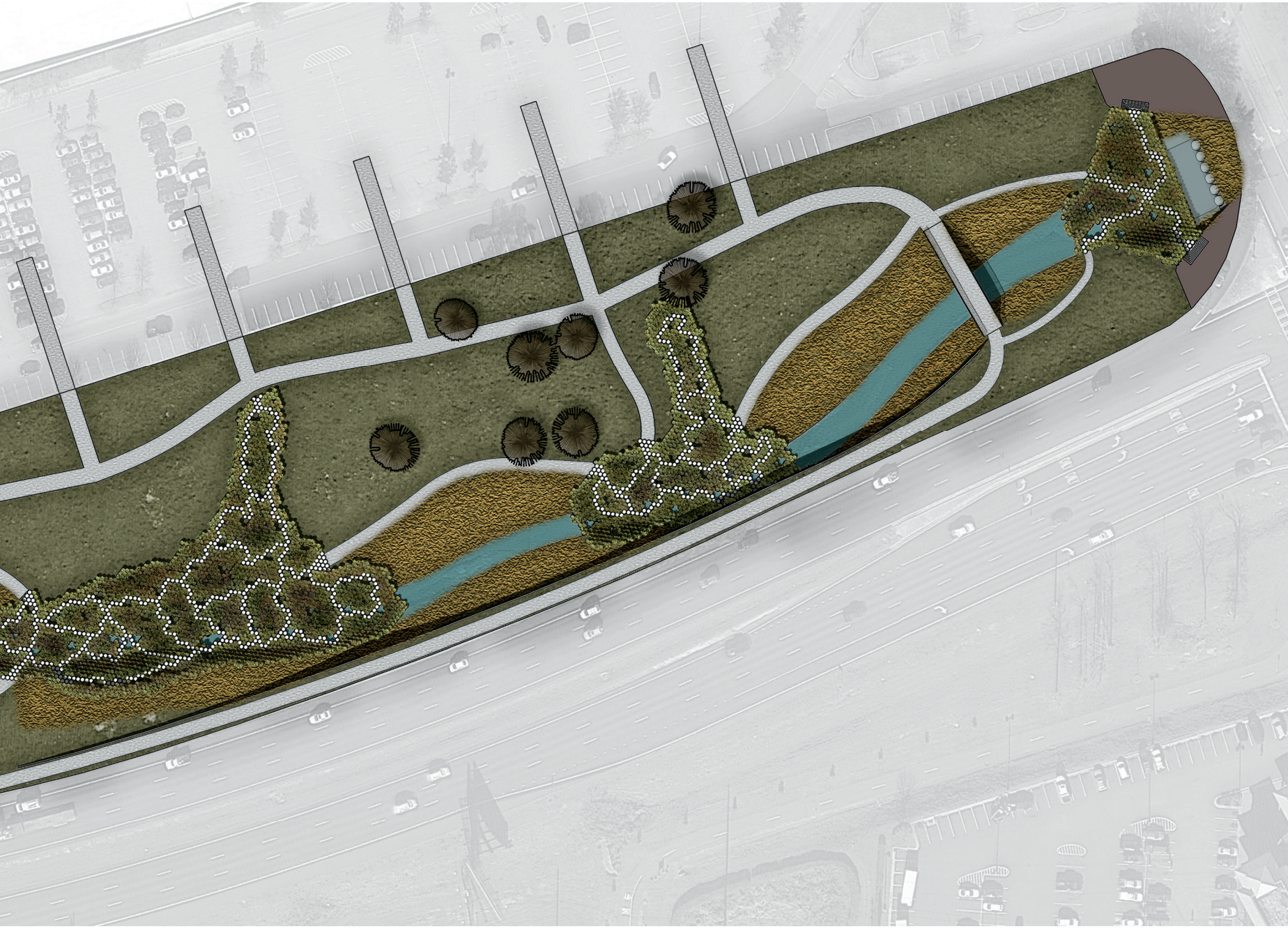




Wetland Plants

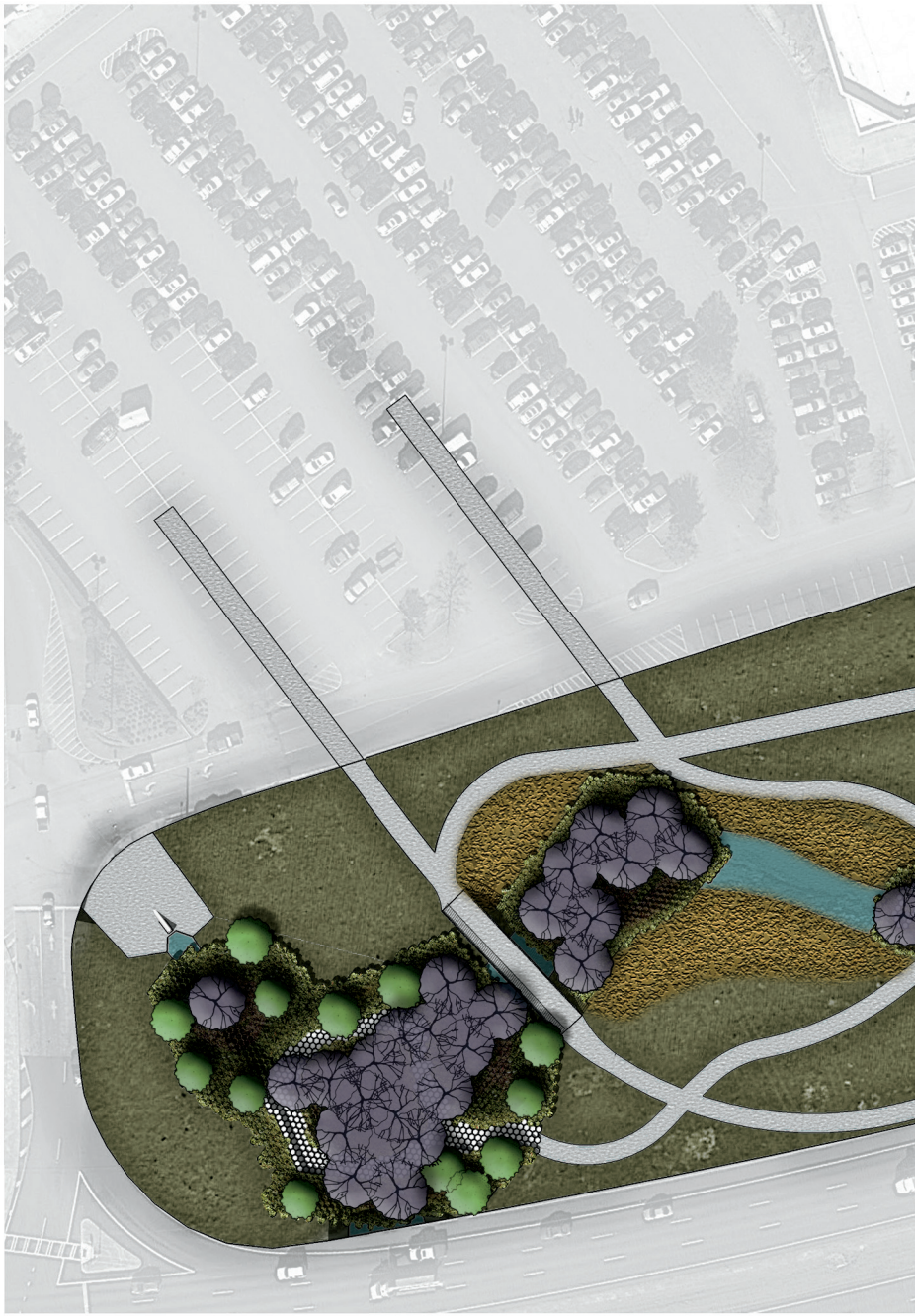
The wetland areas are planted with a variety of flowering and non flowering plants that propagate mainly through seed dispersal. This will allow for less planting in the initial stages and a more naturalized environment as the wetland develops over time. Along the stream banks, Northern Sea Oats, which spreads rhizomatically, have been placed to increase soil stability.





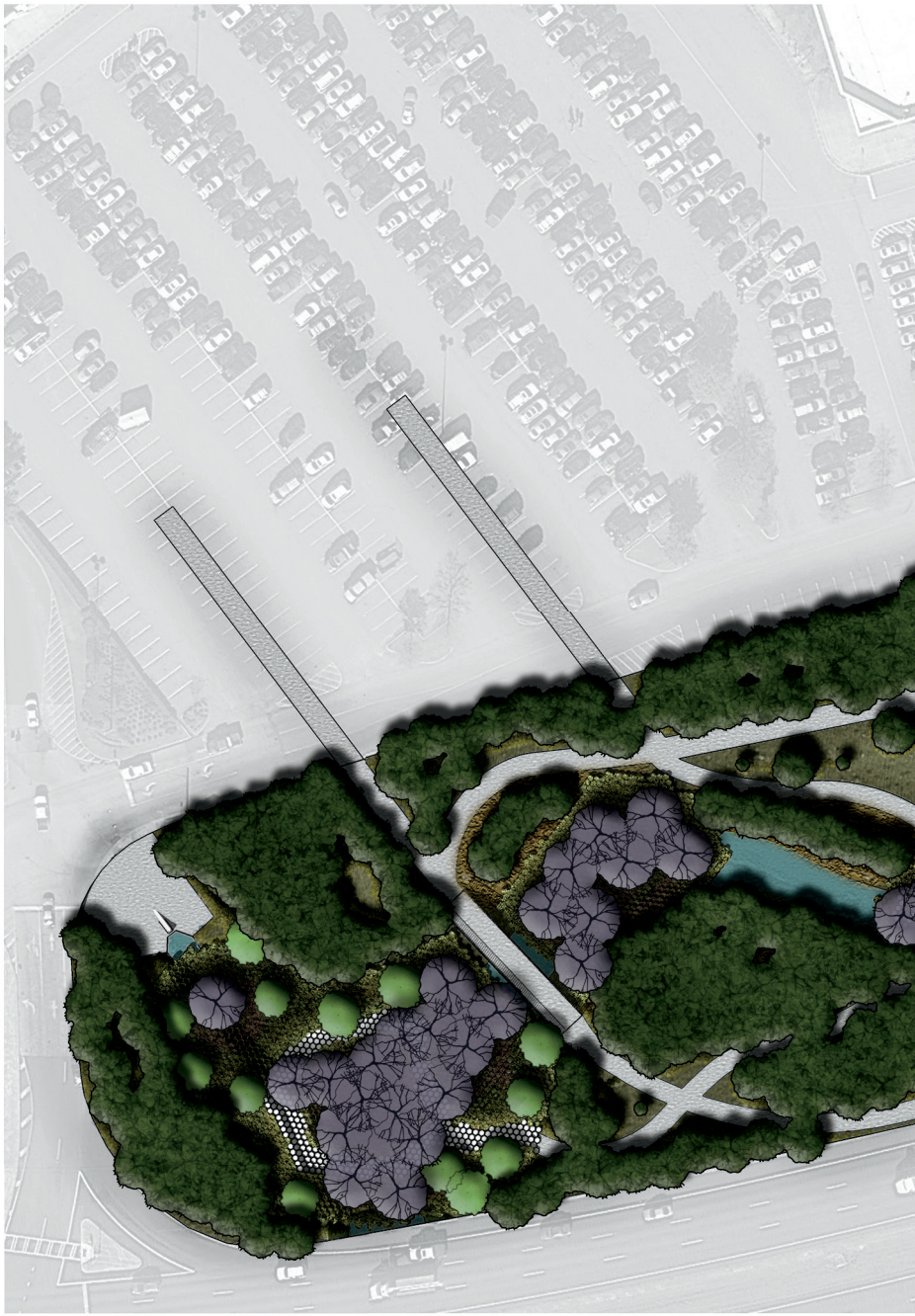
Wetland Trees

The wetland trees are Bald Cypress and Black Tupelo. The Bald Cypress are planted in the wetter areas with the Black Tupelo further up the banks. As you explore the wetland areas, you move from one tree type to another, creating different aesthetic characteristics.



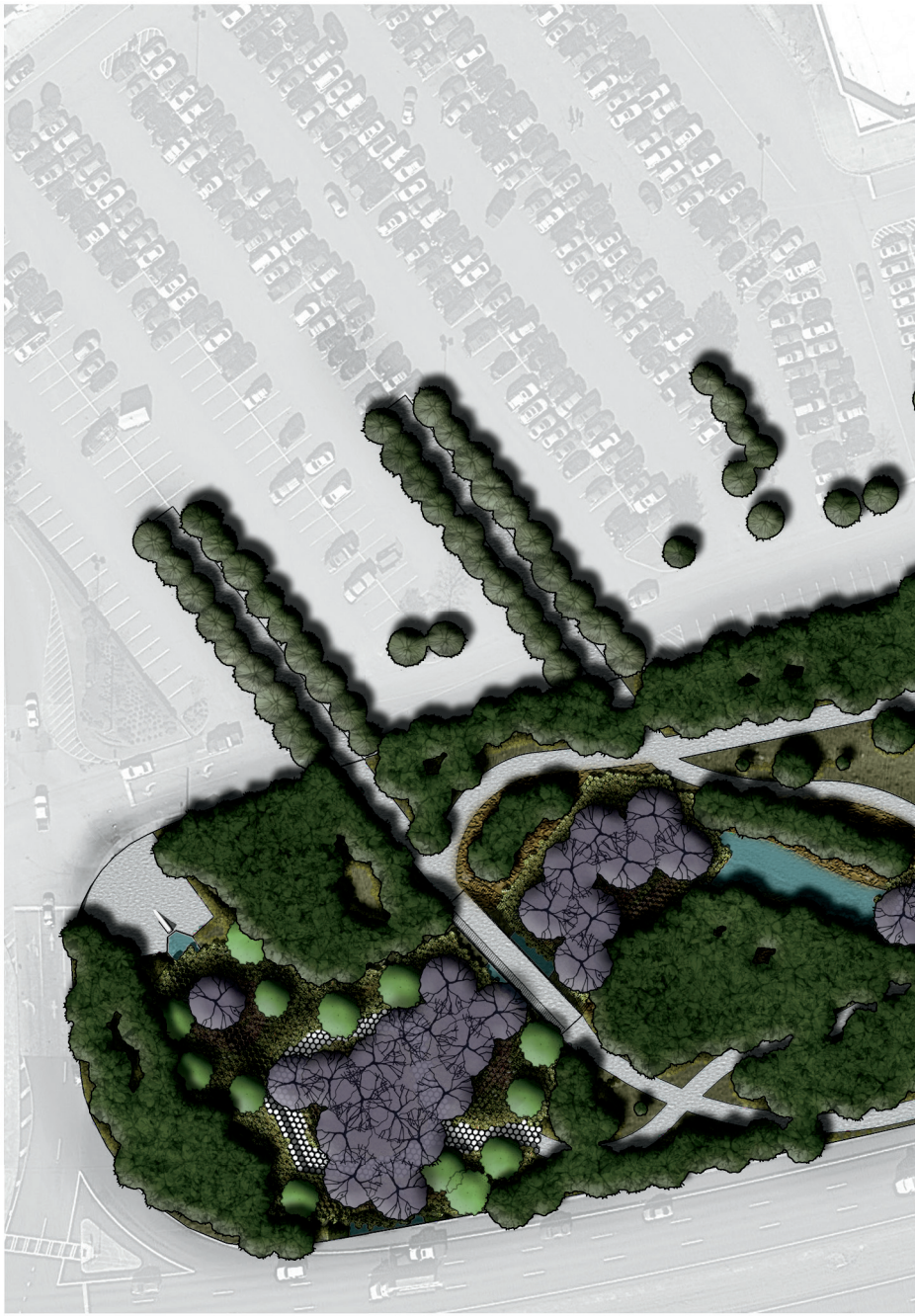
Upland Trees

Planted in the upland areas of the park are mixed fast-growing hardwoods, such as Sweetgum, Sycamore, and Tulip Poplar. These trees grow and spread quickly, allowing the upland to have a more mature quality sooner. As it matures, the forest will have a dense canopy that will serve to enclose and isolate the wetlands.



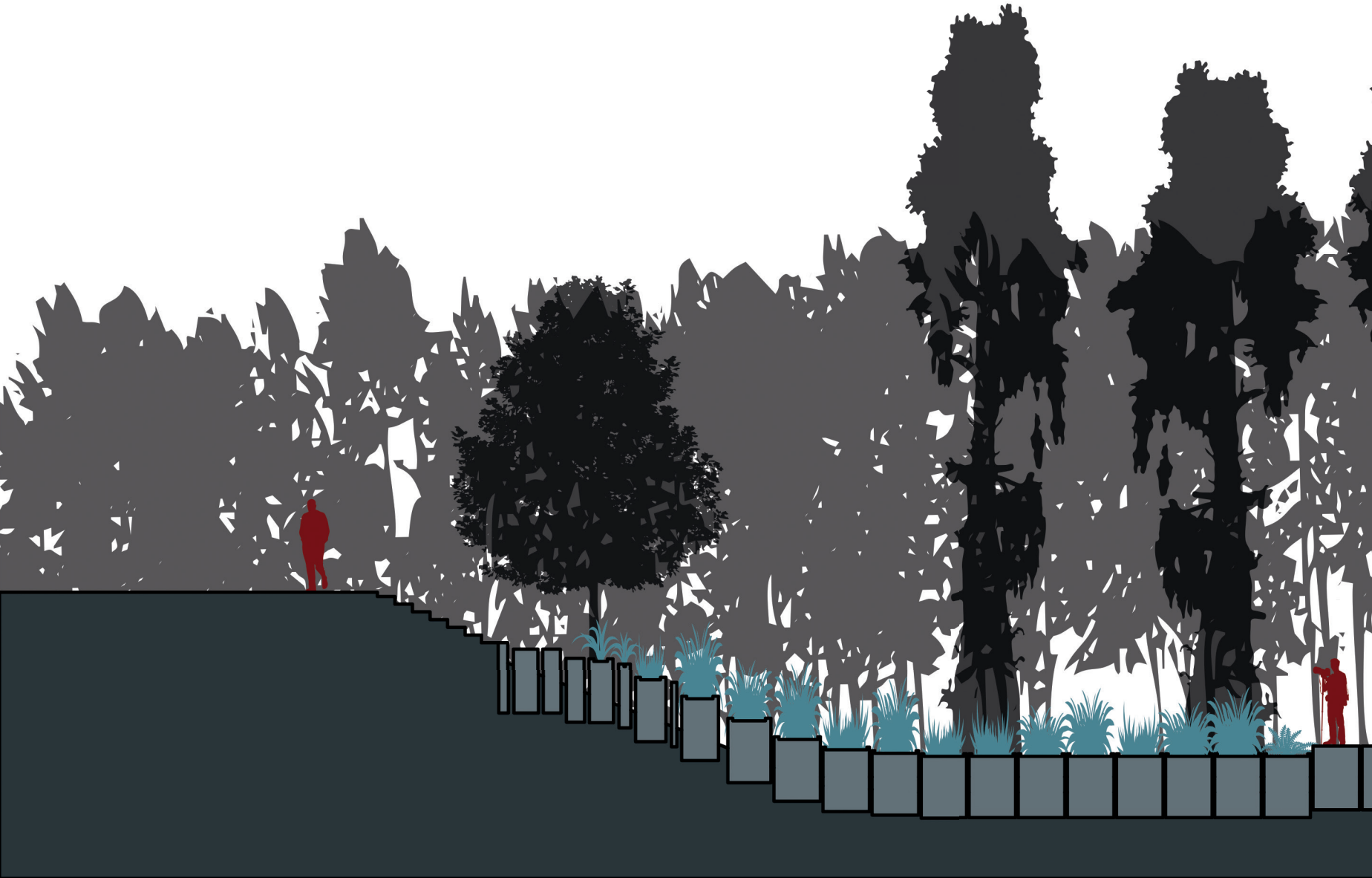
Parking Lot

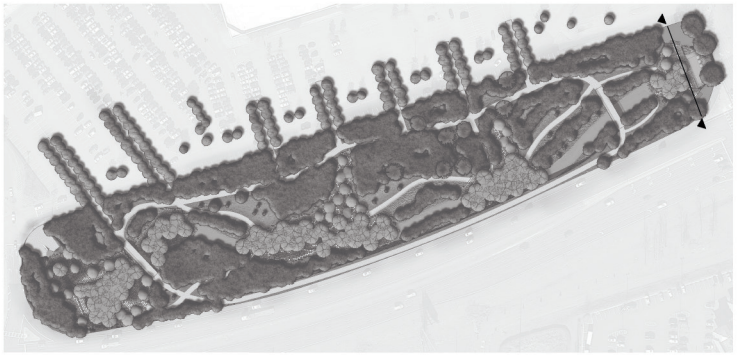
Finally, I've removed several of the parking spaces and replaced them with tree lined walkways. These are here to establish parking areas for the park as well as create a distinct connection between the park and the retail area to the north.



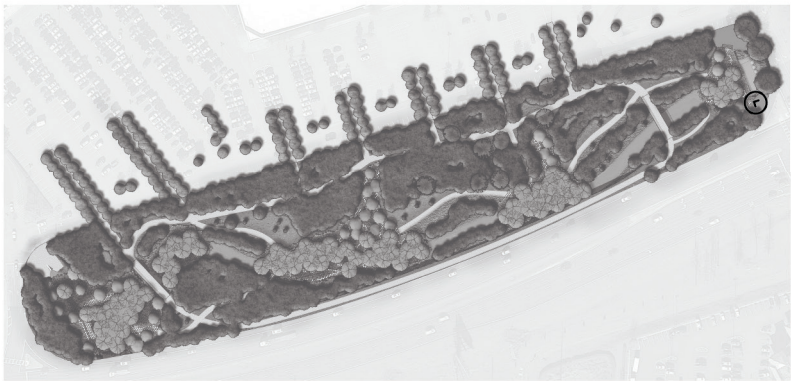
Tour Through the Wetland

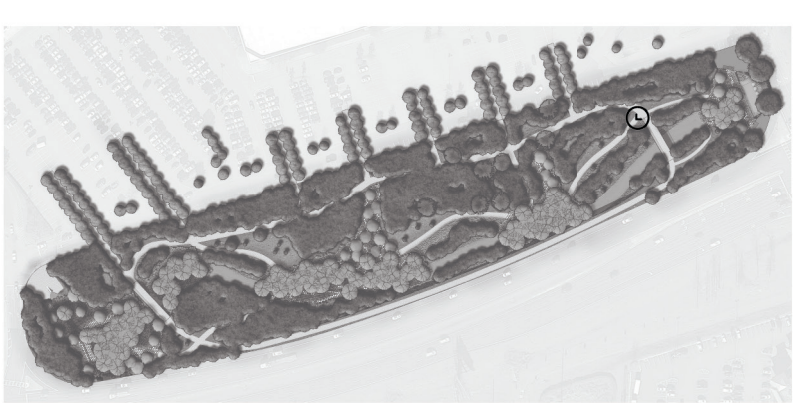
The following series of images will allow you to “walk” though the wetland starting from the southeastern entrance to the site.



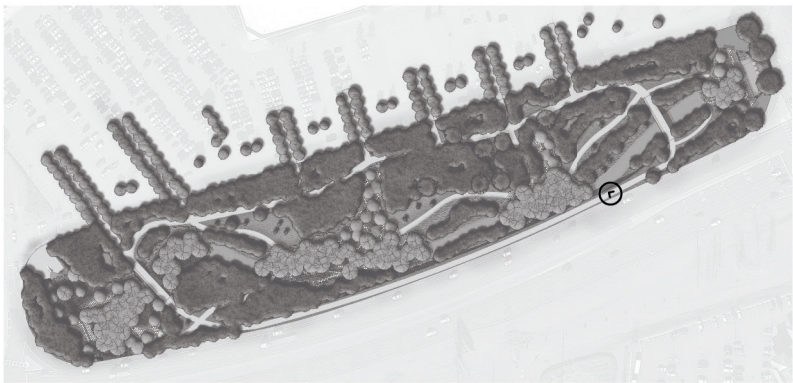


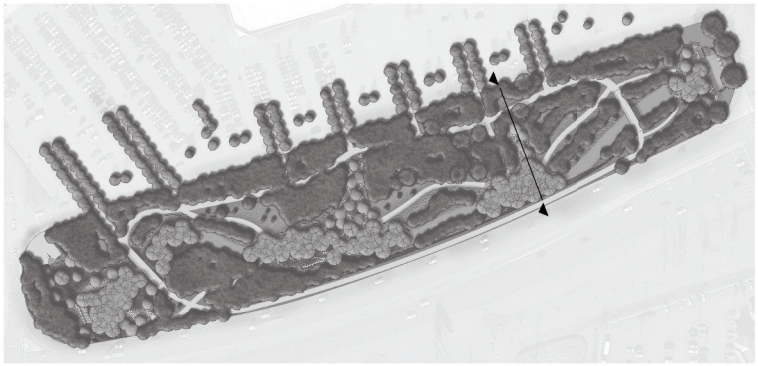
Starting from the overlook area, you move down into the first wetland. This section is a bit more open, but the site becomes thicker and more enclosed as you move deeper into it, creating a sense of transition.

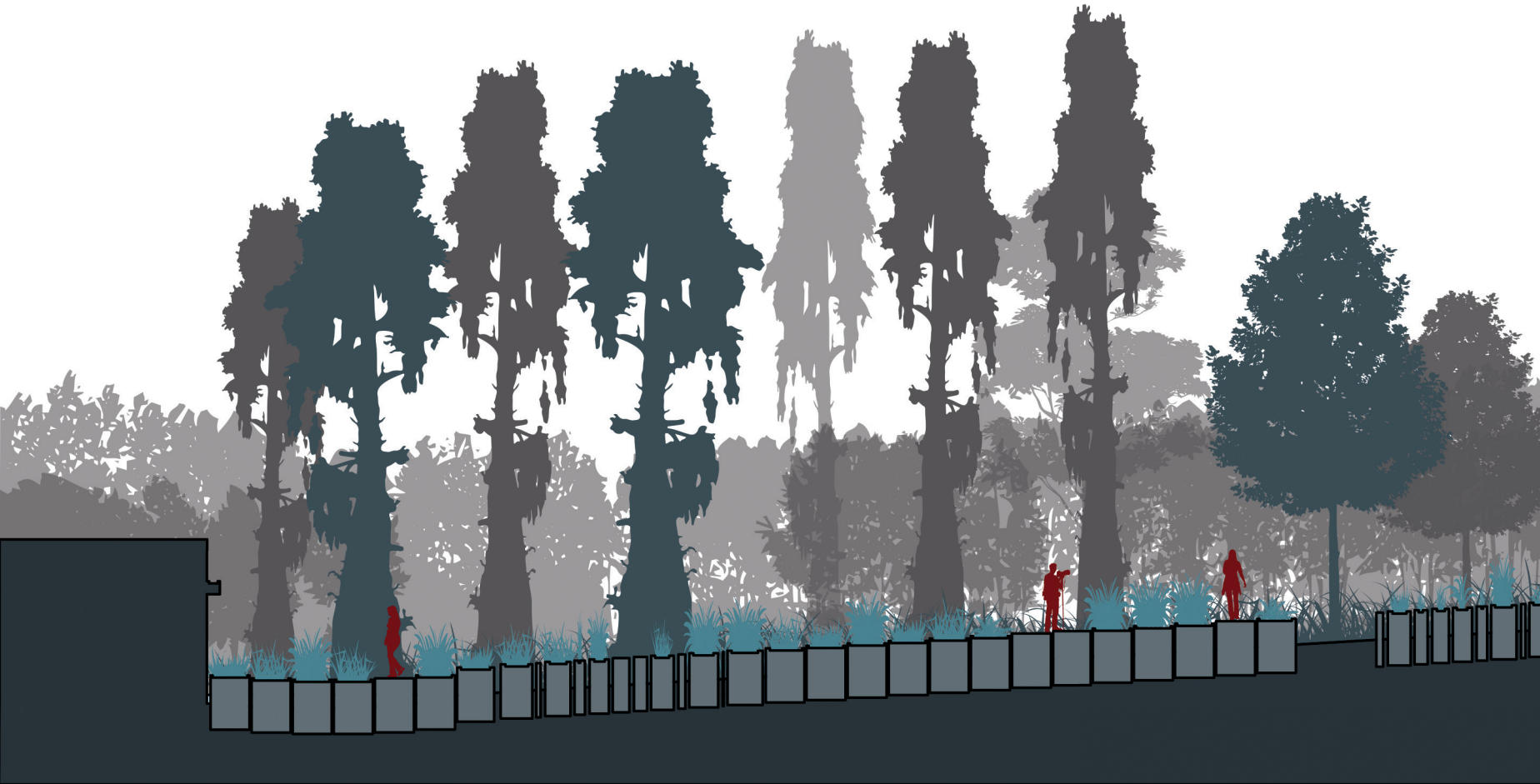




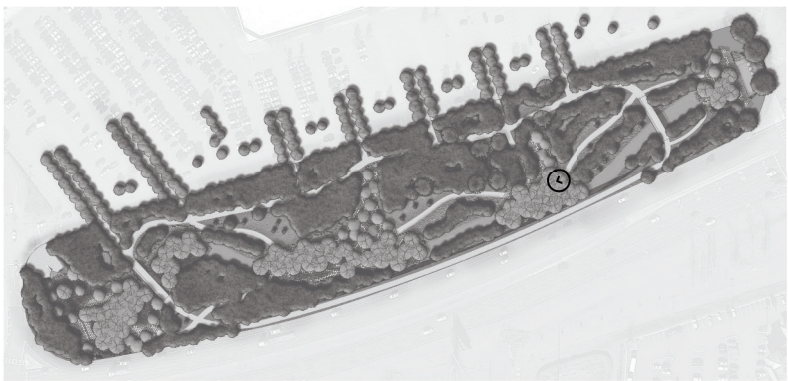
This view is from the main path the runs along the perimeter of the park. Here you can view the different aspects of the park: the hardwood forest, wetland area, as well as the open stream.



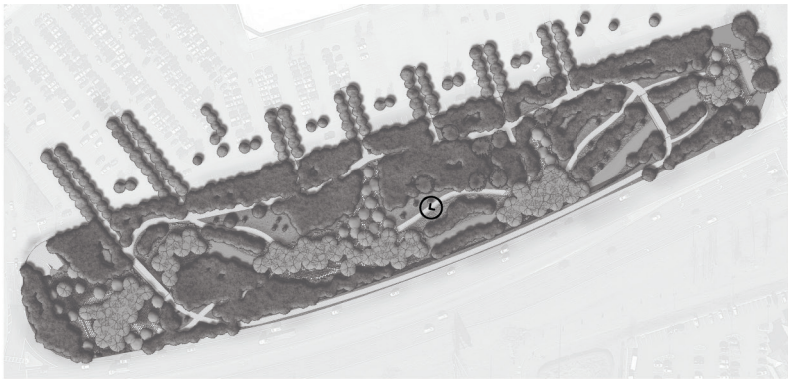




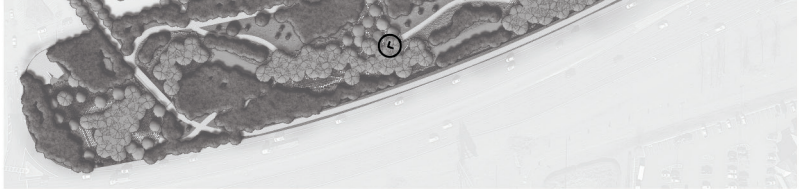
Here is a wetland section near the middle of the park. There is a retaining wall to the south that maintains a level walking path. This drastic change in elevation helps block the intrusion of the expressway further contributing to the immersive characteristic.

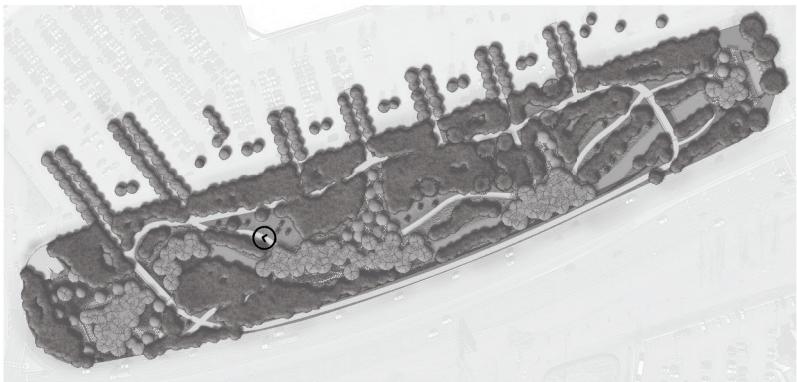


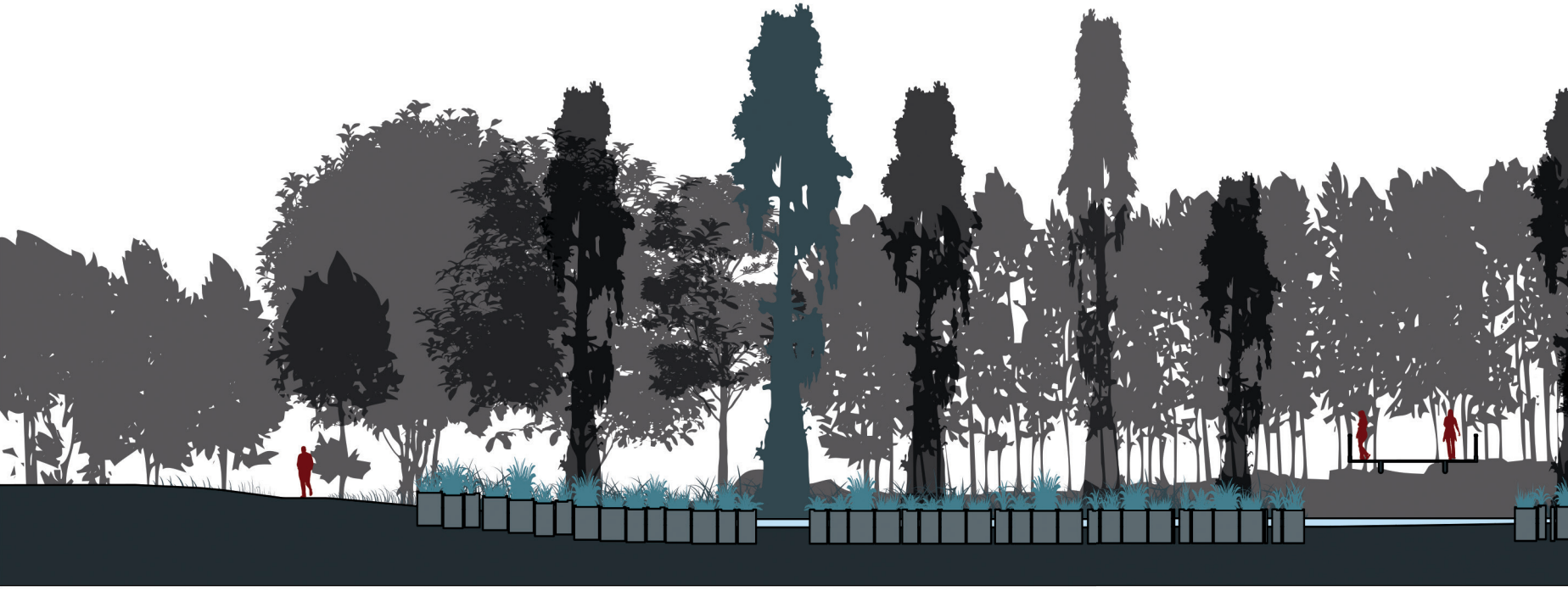
As you move between wetlands, the transition area consists of the mixed hardwood forest on either side of the paths. The forest opens up in areas along the path creating a feeling of release before moving back into the next series of wetlands where the path narrows and the space becomes more intimate.

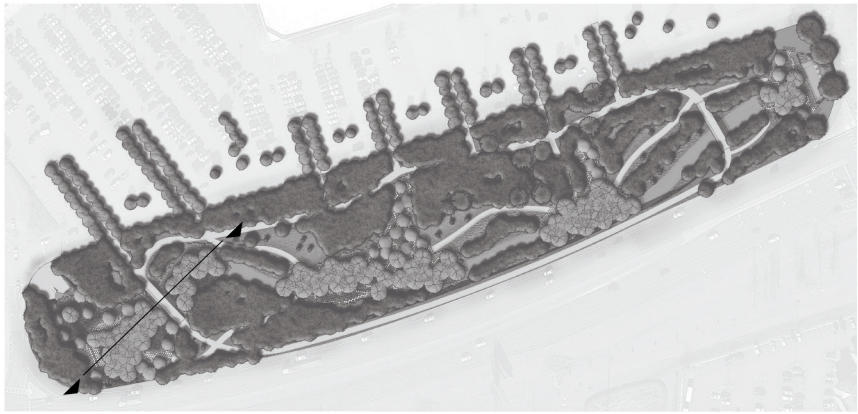


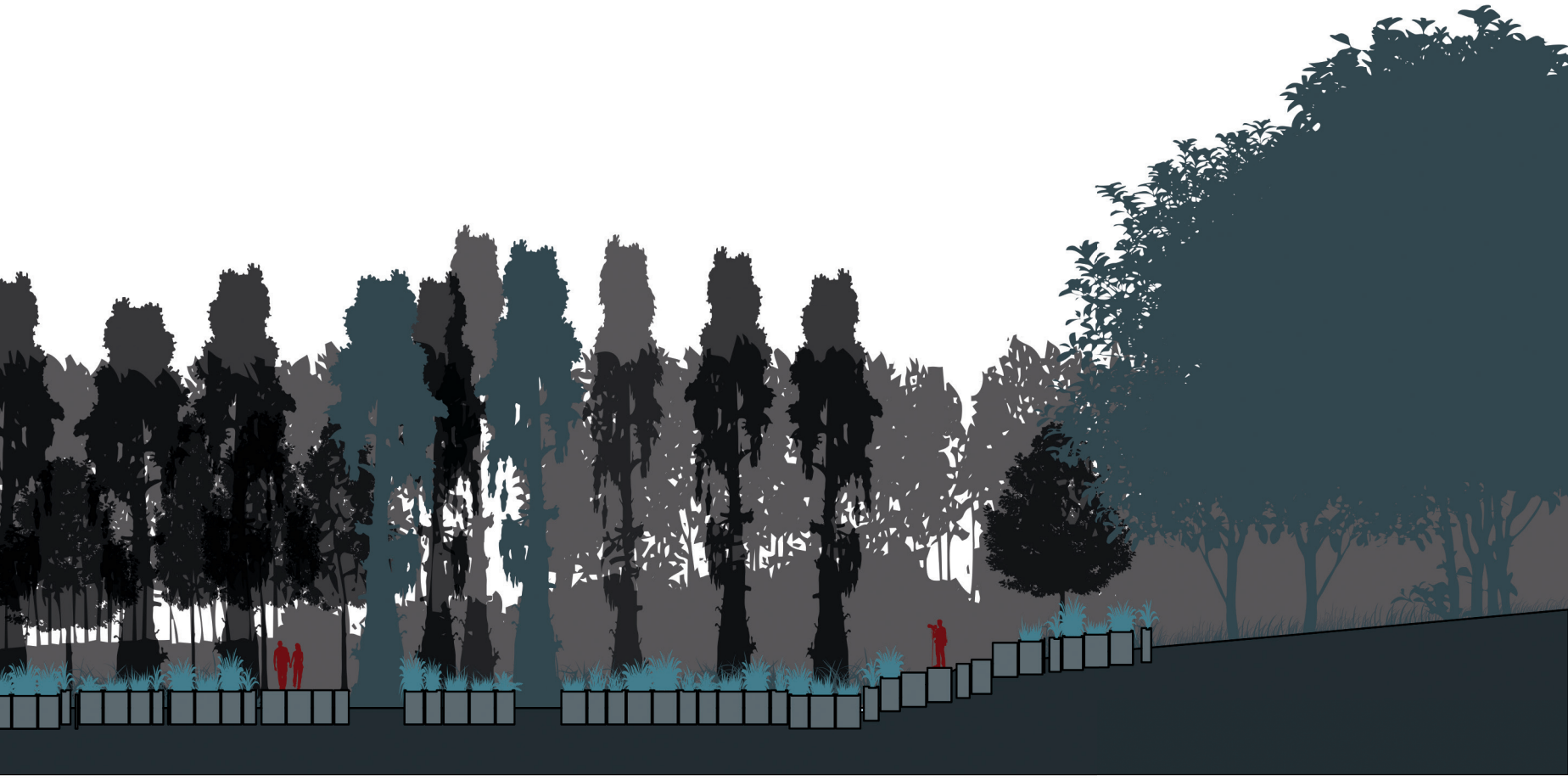
While you are in the wetland sections, there are various paths to choose from that allow you to explore the wetland in whatever way you choose. Also, the vegetation type changes as you move between these landscapes emphasizing the different aesthetic qualities.



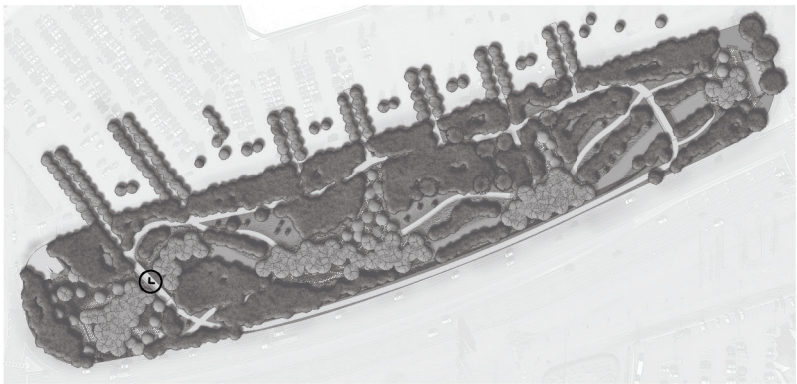








Looking back at my original criteria for creating an immersive wetland, I was able to design an immersive landscape that allows people a choice in how they want to explore and experience the site.



Reflections

Module Design

There are several areas concerning the module design that I would revisit. First, the shape. Although I looked at different shapes and determined that it wasn't critical to the design, the final hex shape seems to be troublesome. Throughout the course of the project, some of the primary critique that I received was about the hexagon shape of the module. I am curious as to whether or not a different shape would had evoked similar critiques. Although, physically, I do not believe the form of the module is critical to its function, I believe that, psychologically, it may affect reception.

Second, the module's technical details. Here, there were several areas that needed further research. The porosity of the module is one troublesome area. There are several options to consider, such as drilling holes in solid concrete sides or creating modules with slots for water to pass through, and how each idea may affect the mitigation properties. Also, the soil/recycled mesh mixture used to hold the plant material. The recycled plastic mesh design comes from floating wetland applications. This allows the mesh to stay in contact with the water regardless of its level. However, its use in the modules would be in a fixed position and, therefore, I do not know how low water levels might affect microbial activity on the mesh surface. This would also apply to plant viability if the roots become exposed to air during low water levels. Also, further research would need to be done on the hydraulic characteristics of the modules during high rain/flood events. The narrow space between and the movement through the modules may not be sufficient enough to allow water to pass during high water events. This would lead to a back up of water until, finally, it began passing over the modules, defeating the idea of being able to walk through the wetland without special equipment to protect clothes and shoes.

The Site

The two main concerns regarding the site are the scale and connectivity. This site, although in need of stormwater management, is much larger than I had initially desired. Due to the large size, it was difficult to work through multiple design iterations because of the amount of space I was having to manage for each design. Also, the nature of the modular design lends itself more easily to a smaller site. The final design has upwards of 1,000 modules, which would not be practical in a real world application. Looking at the connectivity, the site is located in a moderately dense urban area. However, due to the heavy automobile traffic through the area, pedestrian accessibility is limited. A site located in a more walkable area would have alleviated some of the connectivity issues.

Conclusions

Overall, I feel that the concept of creating immersive constructed wetlands is a very real possibility. However, a designer will need to look closely at materials as well as location to determine whether this type of environment would be beneficial to the surrounding community.

Illustrations

Pg. 13	Arendt, Boni. "Immersion." [Online image] 2011. <http://fineartamerica.com/featured/immersion-boni-arendt.html>.
Pg. 15	Smail, Deborah. “The Exhibit Cases...they float!” [Online image]. 2010. <http://blog.hmns.org/2010/02/abracadabra-magic-exhibit-now-open/>.
Pg. 16	Mindsplash. “Airmaze.” [Online image] 2013. <http://uafcornerstone.net/childrens-museum-joins-exhibits-uamn/>.
Pg. 16	University of Alabama. IRIS Active Earth Monitor Kiosk. [Online image] 2013. <https://www.as.ua.edu/home/technology-allows-public-to-explore-earth/>.
Pg. 16	Liene. Upcountry History Museum. [Online image] 2014. <http://femmeaufoyer2011.blogspot.com/2014/03/the-upcountry-history-museum-and.html>.
Pg. 17	Myers, Justin. Mindbender Mansion. [Online image] 2008. <http://www.discoverykidslv.org/exhibits/traveling-featured-exhibit/>.
Pg. 19	LA Prop O. “Aerial-southeast.” [Online image] 2008. <http://www.lapropo.org/sitefiles/lariver.htm>.
Pg. 20	Ducks Unlimited. Atchafalaya Wetlands. [Online image] 2010. <http://www.ammoland.com/2010/08/ducks-unlimited-improves-atchafalaya-wetlands/#axzz2zWmBFzCz>.
Pg. 22	Sell, Jeremy. “Swamp Buttercup.” [Online image]. 2011. <http://thelifeofyourtime.wordpress.com/2011/05/09/random-plant-swamp-buttercup/>
Pg. 22	Anderson, Ashley. Bayou Gauche. [Online image]. 2010. <http://dienu.wordpress.com/2010/06/10/louisiana-swamp-surfin/.
Pg. 22	Birdingva. “Palamedes Swallowtails.” [Online image]. 2010. <http://onthewingva.blogspot.com/2010/05/more-critters-from-great-dismal-swamp.html>
Pg. 22	Bollinger, Catherine. “Turtles bask in early October sunshine.” [Online image]. 2011. <http://piedmontgardener.com/2011/10/09/early-autumn-at-the-nc-zoo/>
Pg. 22	DenPro. “Sweet-scented Water-lily.” [Online image]. 2010. <http://piedmontgardener.com/2011/10/09/early-autumn-at-the-nc-zoo/>
Pg. 23	Pugh, Dorothy E. “Flowering Lotus Plants.” [Online image]. 2006. <http://www.dpughphoto.com/habitats>
Pg. 23	Harder, Douglas Wilhelm. “A Northern Leopard Frog found in the Laurel Creek Conservation Area.” [Online image]. 2011. <http://commons.wikimedia.org/wiki/File:Northern_Leopard_Frog_(Lithobates_pipiens).jpg>
Pg. 23	Ehmke, Glenn. “Blue Ringtail.” [Online image]. 2014. <http://www.enviroactive.com.au/images/blue-ringtail>
Pg. 23	Repash, Katelyn. “Cypress Swamp.” [Online Image]. 2009. <http://blogs.dickinson.edu/luce09/2009/11/>

Pg. 23	Meohman1. “Great Blue Heron in flight.” [Online image]. 2010. <http://photos.nola.com/photogallery/2010/03/great_blue_heron_in_flight.html>
Pg. 23	Pinson, Nicole. “Swamp Hibiscus.” [Online Image]. 2011. <http://hcgreenthumb.wordpress.com/2011/03/25/feed-your-spring-gardening-fever-this-weekend/>
Pg. 23	Bartok, Joe. Swamp Vervain. [Online image]. 2011. <http://joebartok.blogspot.com/2011/07/pics-of-summer-flowers-fields.html>
Pg. 26	Yu, Kongjian. Birds Eye View. [Online image]. 2008. <http://www.turenscape.com/English/projects/project.php?id=339>
Pg. 26	Yang, Cao. Birds Eye Fall. [Online Image]. 2008. <http://www.turenscape.com/English/projects/project.php?id=339>
Pg. 26	Yang, Cao. Fall Plants. [Online image}. 2008. <http://photo.zhulong.com/ylmobile/detail41947.html>
Pg. 26	Yang, Cao. Summer Plants. [Online image}. 2008. <http://photo.zhulong.com/ylmobile/detail41947.html>
Pg. 26	Yang, Cao. Pathing. [Online image}. 2008. <http://photo.zhulong.com/ylmobile/detail41947.html>
Pg. 27	Yu, Kongjian. Master Plan. [Online Image]. 2008. <http://www.turenscape.com/english/projects/project.php?id=339>
Pg. 28	Jackson, Janeese. “Tanner Springs Park in the Pearl.” [Online image]. 2010. <http://fabulousportland.com/2010/02/19/sunshine-makes-me-happy/>
Pg. 28	Greenworks PC. “Tanner Springs Park at Dusk.” [Online image]. 2012. <http://greenworkspc.com/2012/07/30/tanner-springs-park-featured-in-the-oregonian/>
Pg. 28	Senville, Wayne. Perspective. [Online image]. 2013. <https://plannersweb.com/2013/08/a-tale-of-three-parks/>
Pg. 28	Another Believer. “Tanner Springs Park, Portland, OR 2012.” [Online image]. 2012. < http://commons.wikimedia.org/wiki/File:Tanner_Springs_Park,_Portland,_OR_2012.JPG>
Pg. 29	Greenworks PC. “Master Plan.” [Online image]. 2010. <http://www.bioarch.tv/progetti/tanner-springs-park.php?continua#titolo>
Pg. 30	Greenworks PC. Perspective. [Online image]. 2007. <http://greenworkspc.com/works/stormwater-retrofitting/headwaters-at-tryon-creek/>
Pg. 30	Greenworks PC. Perspective. [Online image]. 2007. <http://greenworkspc.com/works/stormwater-retrofitting/headwaters-at-tryon-creek/>
Pg. 30	Greenworks PC. Perspective. [Online image]. 2007. <http://greenworkspc.com/works/stormwater-retrofitting/headwaters-at-tryon-creek/>
Pg. 31	Greenworks PC. “Master Plan.” [Email Image]. 2004
Pg. 31	Greenworks PC. “Section.” [Email Image]. 2004

References

ATELIER DREISEITL. (n.d.). Retrieved October 9, 2013, from http://www.dreiseitl.com/index.php?id=54&lang=en

Campbell, C. S., & Ogden, M. H. (1999). Constructed Wetlands in the Sustainable Landscape. John Wiley & Sons.

COE, J. (1994). Landscape Immersion–Origins and Concepts [in:] Landscape Immersion Exhibits: How Are They Proving as Educational Settings? J. Coe, Moderator, 1994 AZA Convention Proceedings. American Zoo and Aquarium Association, Bethesda, MD.

Dahl, T. E., & Allord, G. J. (1994). History of Wetlands in the Conterminous United States (No. United States Geological Survey Water Supply Paper 2425). Retrieved from http://water.usgs.gov/nwsum/WSP2425/history.html

Easton, V. (2006, November 5). Artfully Embraced. The Seattle Times. Seattle, Washington. Retrieved from http://seattletimes.com/html/homegarden/2003338651_pacificplife05.html

Floating Island International. (n.d.). Retrieved from http://www.floatingislandinternational.com/

Headwaters at Tryon Creek. (n.d.). GreenWorks. Retrieved from http://greenworkspc.com/works/stormwater-retrofitting/headwaters-at-tryon-creek/

Jameson, H. (2012, November 7). Tianjin's Qiaoyuan Park: Enabling Resilience and a New Aesthetic. BiophilicCities. Retrieved from http://biophiliccities.org/tianjins-qiaoyuan-park-enabling-resilience-and-a-new-aesthetic/

Kinkade-Levario, H. (2007). Design for Water. Retrieved from http://www.publish.csiro.au/nid/288/pid/5754.htm

Kullmann, K. (2011). Thin parks / thick edges: towards a linear park typology for (post)infrastructural sites. Journal of Landscape Architecture, 6(2), 70–81. doi:10.1080/18626033.2011.9723456

Meyer, E. K. (2008). Sustaining beauty. The performance of appearance. Journal of Landscape Architecture, 3(1), 6–23. doi:10.1080/18626033.2008.9723392

Mitsch, W. J., & Gosselink, J. G. (2007). Wetlands. John Wiley & Sons.

Rottle, N., & Lacson, D. (2011, December). Tianjin Qiaoyuan Park: The Adaptation Palettes. Landscape Architecture Foundation. Retrieved October 10, 2013, from http://www.lafoundation.org/research/landscape-performance-series/case-studies/case-study/425/

Shannon, M. E. (2008, April). Landscapes of Modernity: Class, Power & the Production of Natural Space. Lewis & Clark College, Portland, Oregon. Retrieved from http://enviro.lclark.edu/students/theses/2007-2008/MeganShannonThesis.pdf

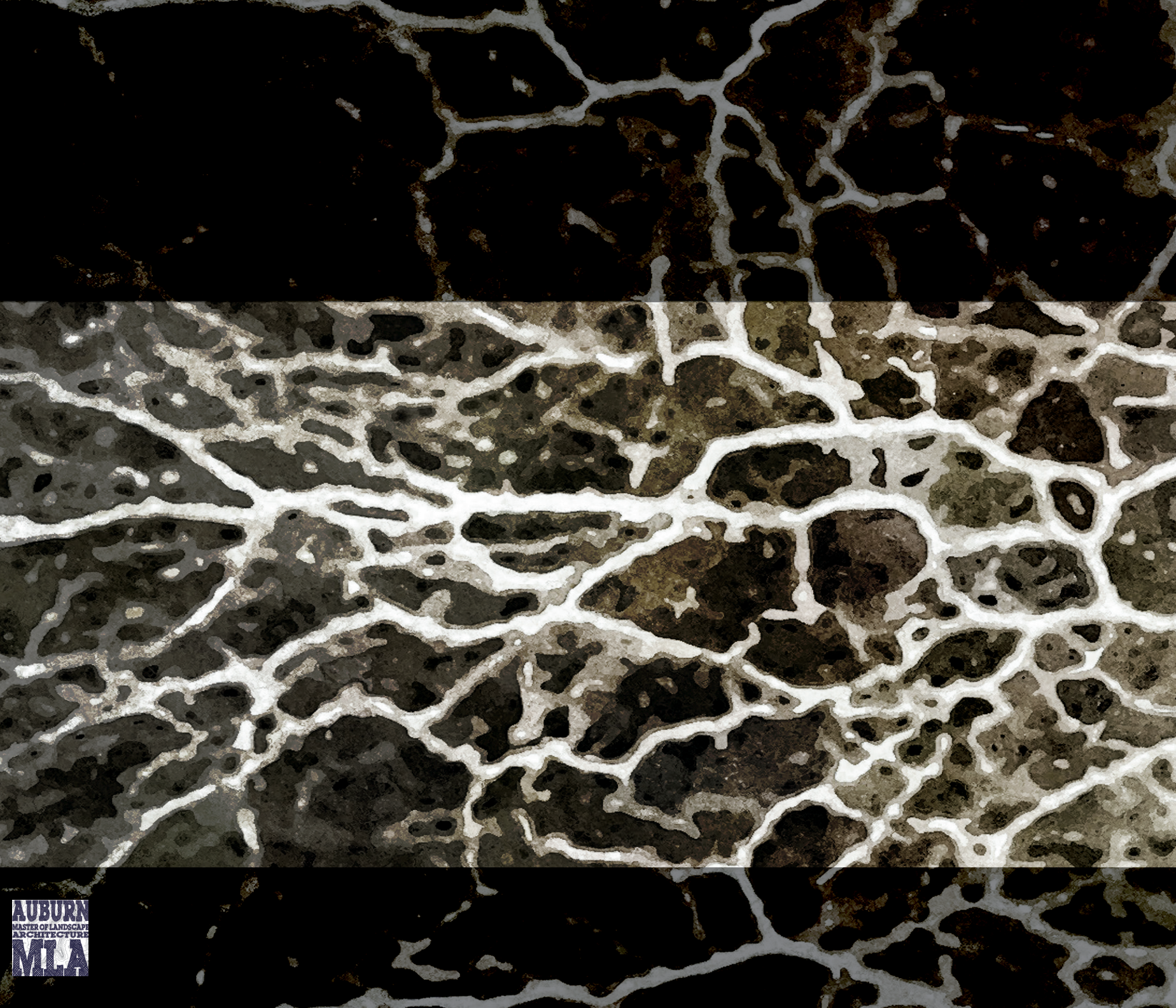
Thompson, J. W., & Sorvig, K. (2007). Sustainable Landscape Construction: A Guide to Green Building Outdoors, Second Edition. Island Press.

Tianjin Qiaoyuan Park: The Adaptation Palettes. (2010). American Society of Landscape Architects. Retrieved October 10, 2013, from http://www.asla.org/2010awards/033.html

Tianjin Qiaoyuan Wetland Park. (n.d.). Turenscape. Retrieved October 19, 2013, from http://www.turenscape.com/english/projects/project.php?id=339

Tianjin Qiaoyuan Wetland Park by TURENSCAPE ARCHITECTS. (n.d.). New Park Culture. Retrieved October 19, 2013, from http://newparkculture.com/en/news/tianjin-qiaoyuan-wetland-park-turenscape-architects

Wang, L. (2013, January 10). Tanner Springs Park | Portland, OR. Retrieved from http://land8.com/profiles/blogs/tanner-springs-park-portland-or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