M41/University of Oklahoma Team Members
MLA Candidates Christopher C. Gibbs College of Architecture
Aman Golshani, BS Architecture
Bradley Anderson, BS Environmental Design
Samin Shokoohi, BS Agricultural Economy
Yi-Wen Yeh, BS Landscape Architecture

Faculty Advisors
Bret Betnar, PLA, ASLA
Lecturer, Division of Landscape Architecture

Faculty and Professional Advisors
Leehu Loon, PLA, ASLA
Associate Dean of Administration for the Christopher C. Gibbs College of Architecture, Associate Professor, Graduate Liaison, Director of the Division of Landscape Architecture
Carrie J. Evenson, Ph.D, P.E., CFM
Stormwater Division Manager, City of Norman
Sarah Little, Ph.D, PLA
Assistant Professor, Division of Landscape Architecture
Robert Nairn, Ph.D
Associate Director, Division of Engineering WaTER Center

Facilities Advisors
Brandon Cox
Assistant Director, Landscaping and Grounds
Kyle McGhee
Associate Director of Planning and Engineering
Jason Reeves
Irrigation Supervisor, Landscaping and Grounds

SIMBLUECITY

Abstract

The University of Oklahoma's north campus is the central meeting point for all in resident students, administrators, and visitors. Academic buildings are located on the south oval and they are watched over by the Bizzell Memorial Library. The administrative buildings are located on the north oval and they are watched over by Evans Hall. These buildings sit on the highest elevation points at the center of the 204-acre north campus. They overlook vast green spaces, historic buildings aligned on the sidewalks, and see all the good or bad that comes with a 130-year-old campus.

As you look at the campus it is easy to see miles of sidewalks, buildings, and vegetation. Some sidewalks weave in amongst themself in areas were buildings or where something of importance once existed. In many of these locations on campus there is localized ponding of water. By reducing the redundant pathways and installing native plants in the retention gardens the amount of ponding would be reduced.

From the highest elevations on campus the storm water is directed towards the stormwater management system. This system collects surface runoff and discharges it directly into the Bishop Creek watershed. The parking lots adjoined to educational facilities on north campus also use the stormwater management system in this manner. The exception to this is the surface runoff for the Duck Pond parking lot. This parking lot flows unimpeded directly into the watershed. Rain gardens would slow down the flow of water and improve water quality being discharged into it.

CAMPUS OVERVIEW
& SITE SELECTION

CAMPUS OVERVIEW

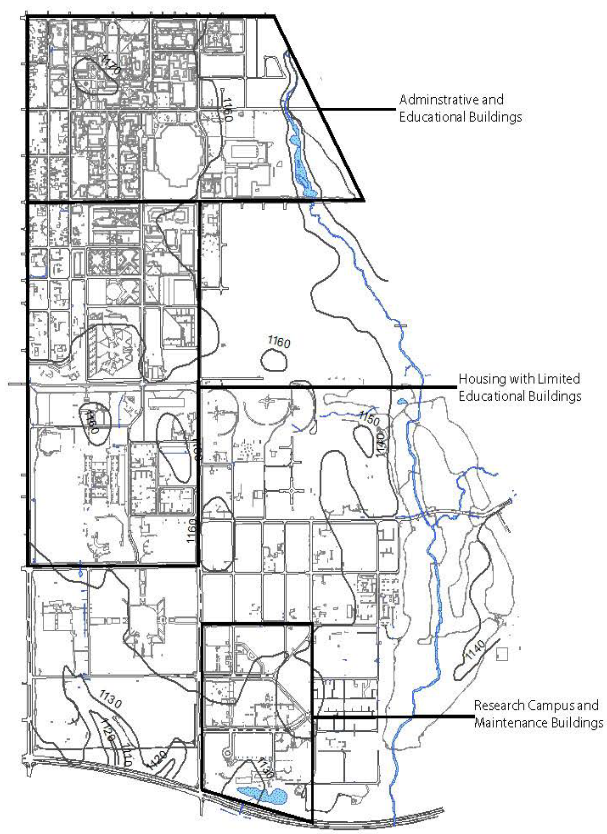

FIGURE 1 CAMPUS MAP

The University of Oklahoma (OU) is located 20 miles south of Oklahoma City in Norman, Oklahoma. OU's Norman campus is broken up into three distinct spaces: administrative and educational buildings (in the northern quarter of the map), housing with limited educational buildings (in the central section of the map), and the research campus and maintenance buildings (in the southeastern corner of the map). The elevation for the campus is highest at 1173 feet above sea level in the administrative and educational facilities area, and lowest at 1108 feet above sea level in an open area adjacent to the research campus. There is minimal elevation change on campus but the elevations that exist greatly impact directional flow of water during hydrological events on campus. Campus water will transit 2 miles from the north to the south thru a series of ditches and culverts. Water movement will eventually end when it reaches a campus low- point or temporary ponding space on the southernmost edge of campus. Water that is collected in the north the south drainage system will be collected in the main campus storm drain system and discharged into the Bishop Creek watershed to the east. The Bishop Creek watershed will then carry this water 3.5 miles south until it merges with the Canadian River.

Water management for OU's main campus is changing slowly and in a limited capacity. When buildings or parking lots are being constructed underground water storage containers are installed. These containers are designed to contain and limit the flow of water into the Bishop Creek watershed. This container and other water containment methods across campus are slowing water movement but not limiting the amount of ponding across campus.

SITE SELECTION

FIGURE 2 SEPTEMBER 2020 RAIN PONDING (.14 INCHES)

Over the last 2 years, ponding has caused flooding within the lower levels of 2 academic buildings. Both facilities are in the center of the north campus and is often frequented for classes by the student population. OU facility maintenance was able to quickly rectify, renovate, repair, and change the slope around these academic buildings. In addition to the lower floor flooding of these two academic buildings, there are many other spaces near the buildings that have severe ponding issues.

Ponding and drainage on OU's north campus is localized to several of the transportation nodes across campus. Many of the transportation nodes are adjacent to campus drainage, academic facilities, or near historic facilities. There have been very few campus interventions to alleviate hydrological issues on campus. In addition to the limited campus interventions, there is not a campus master plan to identify areas in need improvement or future construction projects.

The site selected for this project is 204-acres on OU's north campus. The north campus is located between Boyd Street to the north, Lindsey Street in the south, Elm Avenue to the west, and Classen Boulevard to the east. In between these streets are administrative buildings, educational facilities, sporting arenas, parking lots, housing, parks, and the Bishop Creek watershed. This area is the main focal point for OU's Norman campus. Students use the green spaces as gathering areas for campus activities, gathering spaces, and for special events. The sidewalks of north campus are used as main thoroughfares between campus dormitories, visitor housing, libraries, educational facilities, and off campus activities. Alumni and visitors to the campus use this area in a similar manner as the student body. Students and alumni are committed to preserving the beauty of the north campus and devoted to keeping it as a special space.

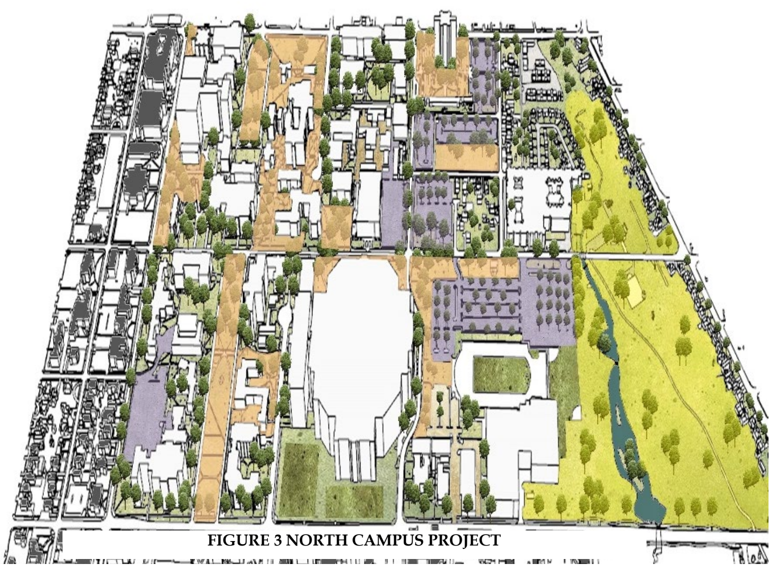

FIGURE 3 NORTH CAMPUS PROJECT

SITE ANALYSIS

CAMPUS DISCOVERY

When visiting OU for the first time it is easy to be overwhelmed by the mix of building architectural designs, large trees, and vast green spaces. Attractive features such as these distract you from looking deeper into the campus. The site analysis for the north campus assessed campus surfaces, circulation, water quality, soil conditions, vegetation, and sunlight environments. The completed analysis was completed based on OU's facility maintenance inputs during a site selection meeting.

SURFACES

The surface types for the project site is crucial in determining the flow of water across the space and areas with which ponding occurs. OU's north campus is calculated to have 52% of the surface types as being impervious. The areas included in this calculation are the pavements or sidewalks, buildings, parking areas, and the roadways transiting thru the campus. Figure 4: Impervious Surfaces – Pavements, highlights the pavements or sidewalks map used in determining the surface area. Each subject area was calculated separately using Auto Cad and Normalized Difference Vegetation Index (NDVI).

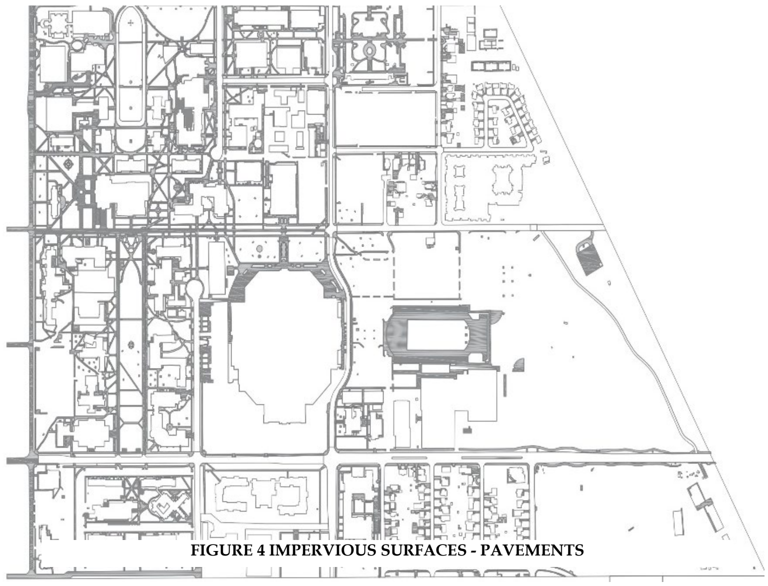

FIGURE 4 IMPERVIOUS SURFACES - PAVEMENTS

CIRCULATION

Traveling around campus is as easy as standing up and putting one foot in front of the other. The Dart bus system that is used in the region has three stops: next to stadium, on Brooks Street, and in the Brooks Street parking lot. These bus stops will put you within a short walk to the center of campus. Drivers have multiple parking lots to choose from to gain access to the campus. Pedestrians, bicyclists, and scooter user have the most ways to get around campus. There is an overabundance of pathways an individual could take to get on campus. Most students housed in the dormitories will approach from the south and cross Lindsey Street. Traffic lights, vehicle patterns, and pedestrian usage makes this one of the busiest roads around the north campus. Student living in private residence who walk or bike to north campus approach from the neighborhood in the north, east, and west.

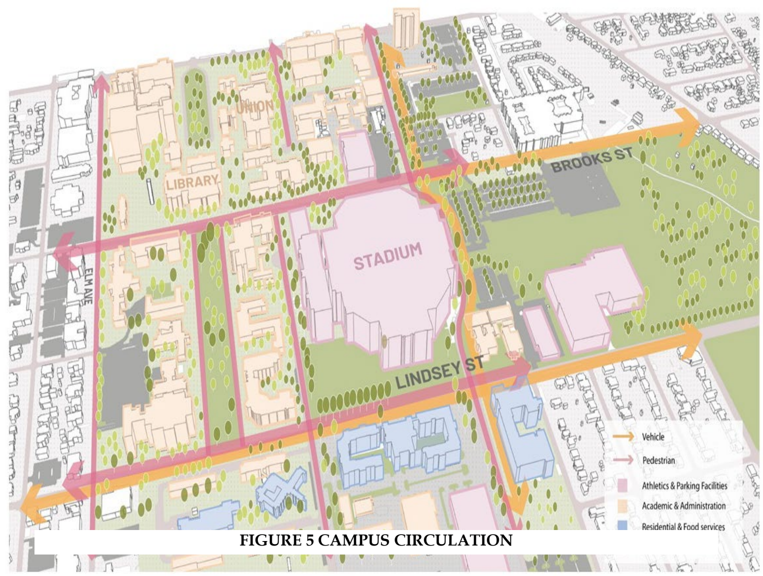

FIGURE 5 CAMPUS CIRCULATION

WATER QUALITY

OU's receives water from multiple sources: Lake Thunderbird and the Garber-Wellington aquifer. The water sourced from Lake Thunderbird by the City of Norman is for public consumption. In a 2019 first quarter report on drinking water, provided to the Environmental Working Group from the Oklahoma Department of Environmental Quality, 29 contaminants were identified as being in the universities drinking water (EWG, 2020). Many of the contaminants are associated with the chlorination of drinking water and with the watering of vegetation. Table 1 below identifies 5 contaminants that are on the states watch list to ensure they do not exceed Environmental Protection Agencies legal limits.

TABLE 1: UNIVERSITY DRINKING WATER

Pollutants	*Health Guidelines*	*Current Levels*	*Legal Limit*
Arsenic	0.004 ppb	3.48 ppb	10 ppb
Haloacetic acids	0.1 ppb	60 ppb	6.60 ppb
Nitrate	0.14 ppm	0.382 ppm	10 ppm
Radium	0.05 pCi/L	0.75 pCi/L	5 pCi/L
Total trihalomethanes	0.15 ppb	7.91 ppb	80 ppb

The Garber-Wellington Aquifer located underneath central Oklahoma has been recommend being used for non-drinking uses. The Oklahoma Groundwater Report published by the Oklahoma Water Resource Boars identified Arsenic, Beryllium, Chromium, Iron, Lead, Manganese, and Selenium as exceeding water standards (OWRB, 2019). OU facility maintenance is aware of the contaminants in the water pumped from the aquifer and use it for watering the campuses vegetation. When over watering occurs or during periods of heavy rain, aquifer water used for the campus vegetation may runoff into north campus's storm drain system.

Figure 6 demonstrates the direction and flow of water in the storm drain system across north campus. Most campus water is deposited directly into the Bishop Creek watershed, east of north campus. When water is discharged into the watershed it is untreated and contains the contaminants off the pervious and impervious surfaces. During a planning meeting with OU facility maintenance, they identified this as being an issue for the Bishop Creek watershed. In addition to the campus runoff being deposited into the watershed, lawn fertilizers, trash, oil, and grease from homes and golf courses are being deposited into the watershed. There is also a health concern associated with the watershed, higher than normal levels of phosphorus and nitrate have been tested for. This portion of the watershed has an overabundance of ducks that reside along the banks and in the creek. OU's facility maintenance has determined that the Bishop Creek watershed needs to be dredged and has requested funding for the project.

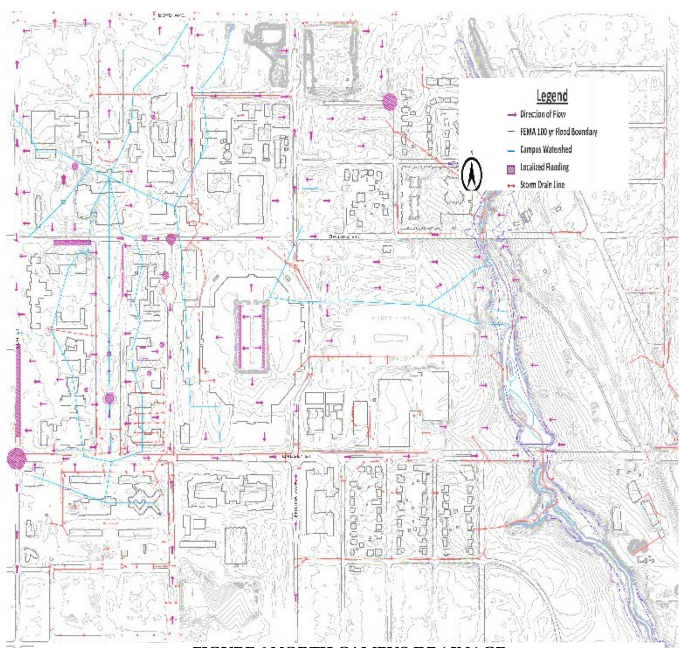

FIGURE 6 NORTH CAMPUS DRAINAGE

SOILS

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the UniversalSoil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheetand rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soilstructure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher thevalue, the more susceptible the soil is to sheet and rill erosion by water."Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

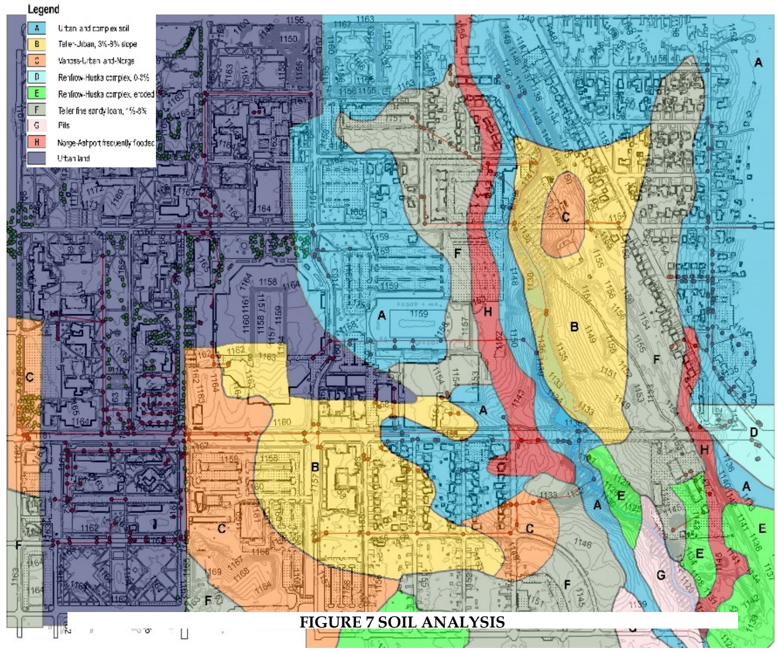

FIGURE 7 SOIL ANALYSIS

SUNLIGHT

To have a healthy campus a balance needs to be achieved between water and sunlight. The analysis below of OU's campus identifies the areas of campus with greatest amount of light exposure from sunrise to sunset during the summer and winter seasons. During the summer months, sunlight is the most direct in parking lots and on pathways that transit east to west. Campus structures block or hinder the amount of sunlight on north to south pathways. During the winter months, parking lots and pathways without structures receive the most sunlight. Areas in this analysis that receive the greatest amount of sunlight are areas where vegetation is necessary or parts of campus with elevated temperatures.

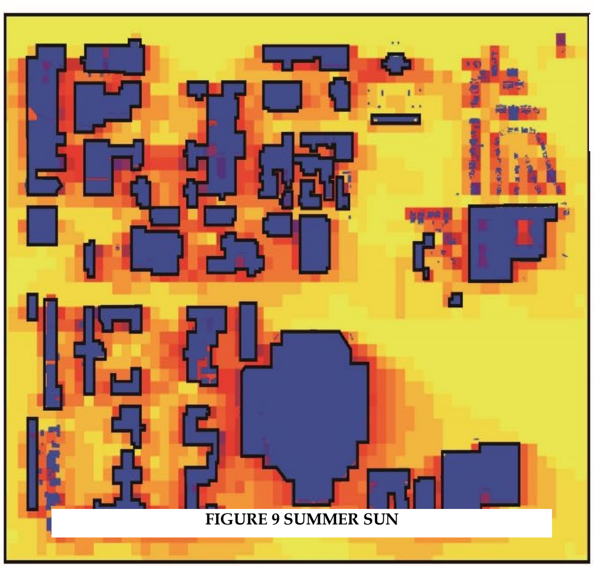
FIGURE 9 SUMMER SUN

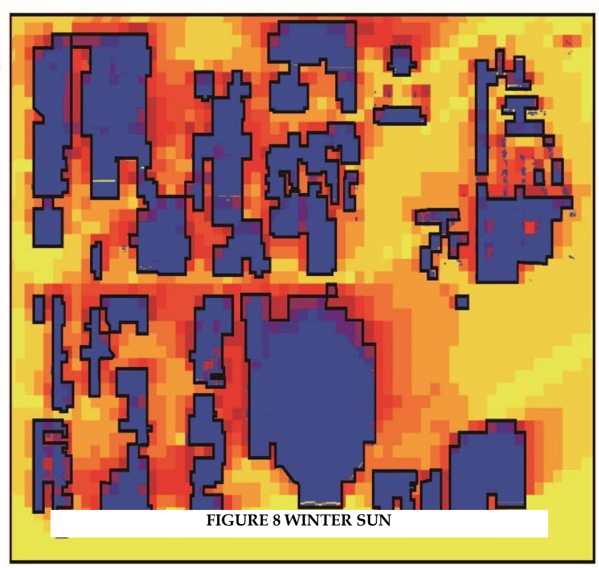
FIGURE 8 WINTER SUN

VEGETATION

FIGURE 10 GARDEN VIEW OF THE BIZZELL LIBRARY (SUSAN)

The University of Oklahoma's landscape and grounds office is very active in managing the vegetation on the campus. Each fall the main gardens are filled with mums; that gives way to barren ground for tulips to bloom in the spring, only to be replaced by Marigolds for the summer. The off the beaten path or hidden gardens provide various types of vegetation not normally found in the main gardens. Lurking on the edges of the gardens are a mixture of non-native and native trees and shrubs. In many of the gardens the combination of trees, shrubs, and flowers gives the visitor the feel of an enclosed space.

In the past few years, there has been many changes made in OU's landscape and grounds office. These changes have affected how often plants are rotated in the gardens, the campus's plant palette, and opened discussions of the types about the type of plants used on campus. Budgetary concerns have spawned these changes and inclusion in departmental projects have broaden the discussion of plant diversification.

To determine the overall health of campus vegetation, aerial photography was processed to determine the NDVI. Figure 11 is an aerial photograph taken for the National Agricultural Imagery Program. False color was applied to this image to highlight the vegetation on north campus. Figure 12 was processed in ENVI to determine the NDVI. The orange, yellow, and red color spectrum are inanimate objects, such as water, parking lots, buildings, or roads. The various shades of green indicate plant life and vegetative health. When the pixels for the image were calculated, 53.0% were assessed to be inanimate, 37.3% were assessed to be in poor health, and 9.7% assessed to in moderate health. This result was unexpected considering most of north campus is on a watering schedule from the campus irrigation system. Variances in this data could be attributed to the plants health, canopy obstruction at the time the image was taken, or amount of plant reflectivity.

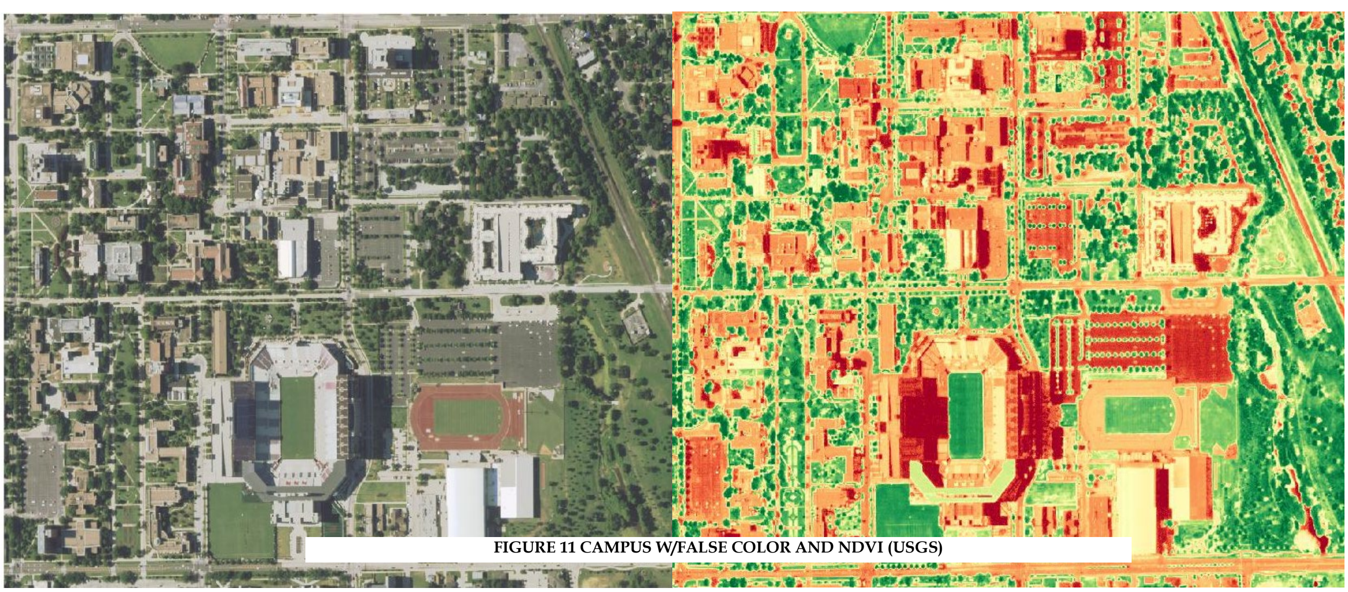

FIGURE 11 CAMPUS W/FALSE COLOR AND NDVI (USGS)

GUIDELINES AND OBJECTIVES

CONCEPT OVERVIEW

After completing the analysis of OU's north campus, the sustainable campus guidelines diagram was created. This diagram assists the master planning team with selecting the best locations for an intervention. Perspective site interventions were then categorized into one of four primary guidelines with attainable objectives for each space. Most sites could be categorized into multiple guidelines or objectives. The four areas used in the sustainable campus guidelines diagram are impervious surface treatments, plant diversification, enhancing circulation, and improving the water quality on campus. Each sustainable campus guidelines identifies specific objectives that are attainable over the short term with quantifiable results over the long term. When a sustainable campus guideline is introduced to a space on campus, OU's administrators, alumni, students, and visitors will benefit by enhanced circulation patterns, reduced ponding of water, and improved water quality.

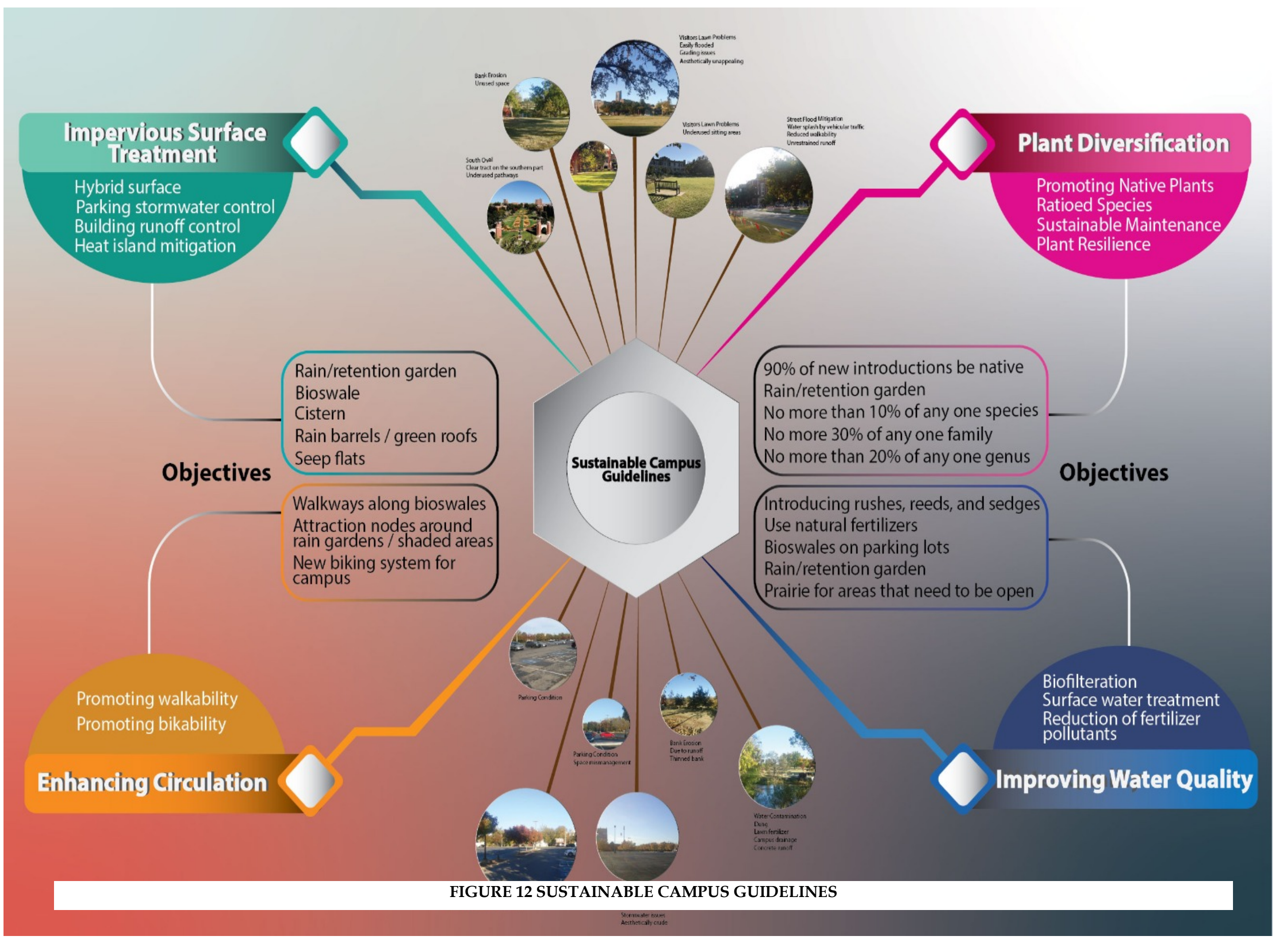

FIGURE 12 SUSTAINABLE CAMPUS GUIDELINES

IMPERVIOUS SURFACE TREATMENT

The impervious surface treatment guideline examines the application of hybrid surfaces, stormwater control, controlling water runoff, and heat island mitigation. North campus hardscapes or parking lots are primarily constructed from asphalt and concrete. Many of the campus parking lots have limited vegetation to hinder stormwater runoff. These surfaces allow contaminated water from the hardscape to run into the storm drains or watershed. In addition to this, the lack of vegetation in parking lots is causing heat islands to occur in various locations on campus.

Replacing these surfaces with pervious material would promote the infiltration of stormwater and reduce the amount of water collected on hardscape surfaces. To further stormwater control, a rain or retention garden would be used in conjunction with the pervious surface. Native plants in the rain garden would reduce the temperature felt on the hardscapes and parking lots.

PLANT DIVERSIFICATION

The current plant palette for OU's north campus consist primarily of a mix of plants native to North America, China, and Japan. Many of the nonnative plants have adapted well to the climate and soil conditions. In some cases, this survival is dependent on OU's landscaping and grounds watering schedule. This watering schedule assist the plants with enduring the hot Oklahoma summers and dry drought conditions. By introducing native plants to the current plant palette, it would reduce the amount of required watering's, less maintenance, and make the gardens more sustainable.

ENHANCING CIRCULATION

Traveling around OU's north campus is easy. There are pathways to take you anywhere you want to go. Main pathways are large enough to accommodate a walker, bicyclist, and scooter riders. The secondary pathways are not as accepting. These pathways are normally narrow and can only accommodate two people traversing. In many areas these pathways are redundant. On path breaks into three different pathways, the crosses back and forth with each other just to end at the same point. These pathways would be consolidated into one large pathway with rain or retention gardens to assist with runoff.

IMPROVING WATER QUALITY

Improving the water quality on OU's north campus starts with reducing the number of contaminants entering the storm drains and watershed. The first step would be to reduce or use chemical free lawn fertilizers. The second step would be to direct surface runoff to a rain or retention garden. The final step would encompass a place to clean water with the use of a biofiltration system before it reaches the storm drain or watershed.

MASTERPLAN

IDEAS FOR CHANGE

To have a clear idea of what areas will be impacted greatest by a campus intervention, the site analysis information and sustainable campus guidelines where combined. Areas in need of intervention stood out by having fallen into multiple categories of the sustainable campus guidelines. Objectives from each category were then placed into each intervention area. In figure 13, there are 3 areas identified as requiring the greatest need of an intervention: the landing adjacent to the Bishop Creek watershed, parking lot spaces, and the areas around multiple facilities. These 3 areas work in conjunction with each other in the management of hydrology of campus.

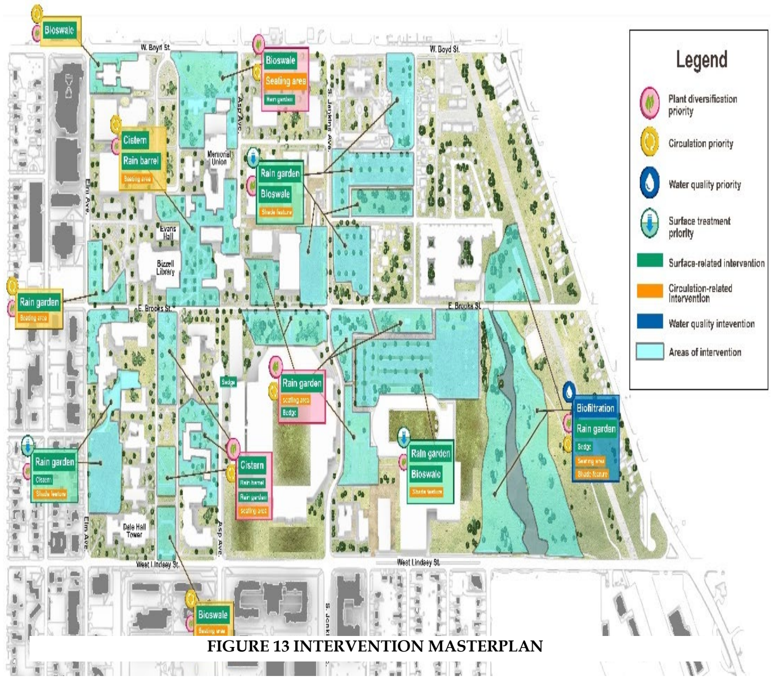

FIGURE 13 INTERVENTION MASTERPLAN

MASTERPLAN GOALS

Figure 14 combines the site analysis information, sustainable campus guidelines, and intervention masterplan to form one cohesive map that prioritizes the goals to specific sections of campus. Each area in need of intervention on OU's north campus is categorized by its primary sustainable campus guideline with corresponding objectives that pertain to the needs of that area or space. Each space identified on the masterplan goals map will benefit the student population, enhance the plant diversity, improve the water quality, and increase the overall health of the campus.

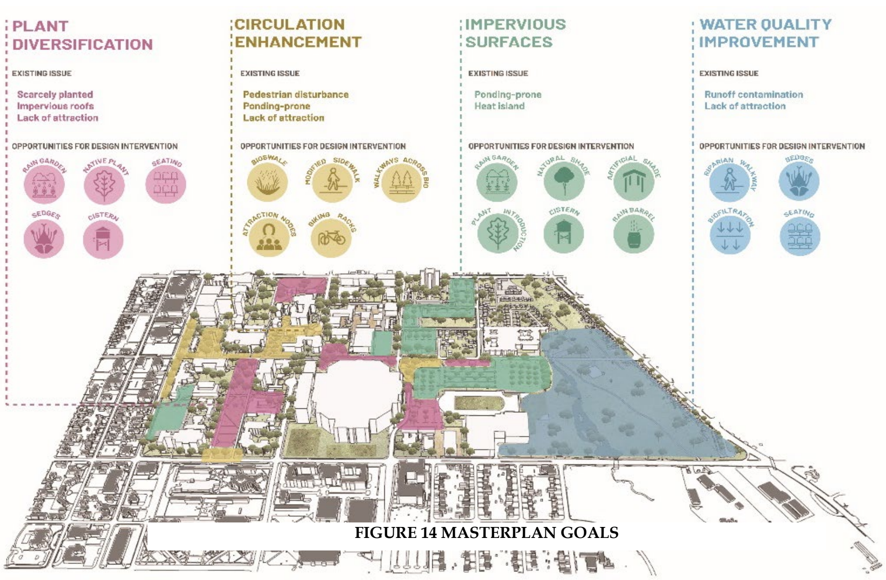

FIGURE 14 MASTERPLAN GOALS

IMPLENTATION

CIRCULATION ENHANCEMENT

All the main pathways and sidewalks of OU's north campus run towards the center of campus. The secondary pathways around the center of campus are disjointed and weave in among main pathways. Figure 15 is an example of a disjointed secondary pathway on the eastside of the buildings in the center of campus. This 250-foot pathway consists of 2 large parallel sidewalks with 6 smaller sidewalks crossing back and forth. In this area, the sidewalks slope towards the grass, is broken from the tree roots, and is prone to ponding after heavy rains.

FIGURE 15 SECONDARY PATHWAYS IN THE CENTER OF CAMPUS (GOOGLE)

INSTALLATION STRATEGY

The pedestrian routes or main pathways around campus allow the user to have direct route in any direction on campus. When the user leaves a main pathway, the secondary pathway should provide a direct route to a space, building, or put the user back onto a main pathway. To accomplish this on a campus that has had many of its pathways formed since the early 1900's will be difficult.

To accomplish this intervention a small area must be selected that is a nuisance or problem area to the student body and alumni. Then the idea must be demonstrated on a small scale and prove that the problem has been removed. This would lead to more areas being looked at for a new circulation pattern.

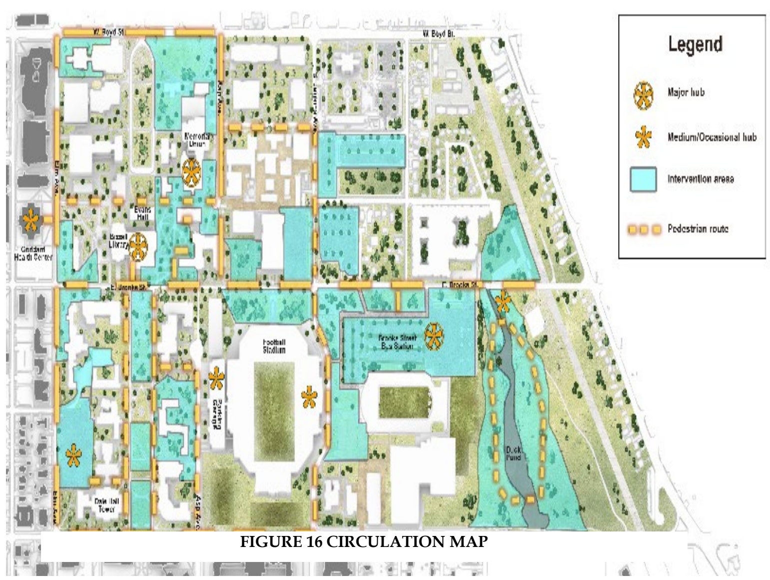

FIGURE 16 CIRCULATION MAP

The first space to attempt this type of intervention is in the picture above (figure 15). This area is located next to the Bizzell Library star in figure 16. To accommodate the extra foot traffic, the 2 large exterior sidewalks would be expanded from 8 feet to 10 feet. The number of interior sidewalks would be reduced from 6 to 2. This would add 1,892 square feet of green space to the area. With this newfound space, a bio-swale and cistern would be added to the area. The bio-swale would be designed to collect stormwater runoff with the excess being stored into a cistern. This water would then be pumped into the irrigation system for reuse.

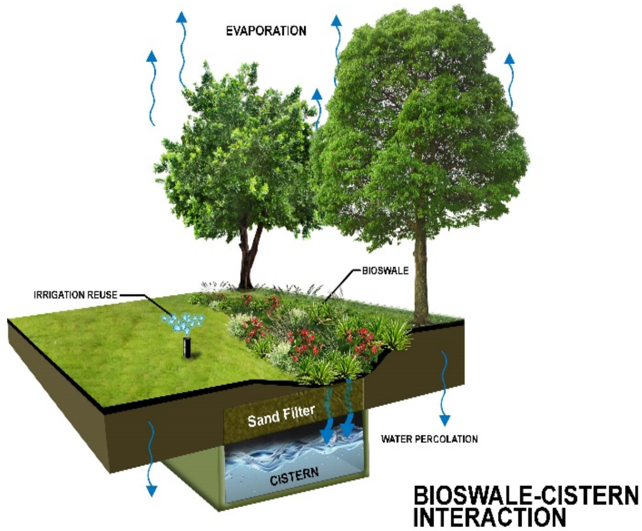

FIGURE 17 BIOSWALE

CAMPUS BENEFIT

The goal of this project is to increase the circulation flow of the area while decreasing the water ponding and increasing the plant diversity of the space. By extending the exterior sidewalks more people will be able to transit thru the space. The removal of interior pathways will reduce pass through confusion in the space.

By removing the interior sidewalks there is a 47% reduction of impervious surfaces in this space. This would lead to fewer pooling areas but increased water runoff into the vegetative areas. But water runoff increased from 10.2 gallons per minute to 12.9 gallons per minute during a .25-inch rain per hour storm on the extended pathways. If rain came off the concrete unobstructed, a 775-gallon cistern would be needed to store 1 hour of storm water runoff. To reduce the needed storm water storage capacity, it must first be filtered into a 400 square foot rain garden.

PLANT LIST

The plants selected for this space are sun tolerant and thrive in wet ground. Very little water will be required for the plants once they are established. This will reduce the quantity of water being used on the campus and limit the amount of stormwater runoff.

Table 2 Plant List

Botanical Name	**Origin**	**Size**
Aquilegia hinckleyana	Texas	2′ x 2′
Chelone glabra	Missouri	2′ x 3′
Eutrochium purpureum	Oklahoma	5′x7′
Hibiscus coccineus	Southeast	3′x6′
Spigelia marilandica	Southeast	2′x2′
Celtis occidentalis	North America	40′- 60′

COST ESTIMATE

Table 3 Cost Estimate

ITEM	*ESTIMATED QTY*	*PRICE*	*COST*
Concrete Installation	18.5 cu. yd.	$113.00 cu. yd.	$2090.50
Concrete Removal	1892 sq. ft.	$3.00 sq. ft.	$5676.00
Grading/Fill	2892 sq. ft.	$4.86	$14,068.00
Cistern	1	1756.00	$1756.00
Water Pump	1	$1,000.00	$1000.00
Plants	Varies	$150.00	$150.00
Rain Garden Prep	400 sq. ft.	$45.00	$18,000.00
		TOTAL COST	$42,740.50

The cost estimate reflects potential estimates for project completion. The budgetary impact in many areas should be substantially less with construction professionals on staff or under contract of the university.

PONDING

The elevation of north campus and distance from a significant water body greatly reduces the possibility of flooding on OU's main campus. Ponding by water from heavy rains or standing stormwater from a backed-up drain is the greatest danger to the campus's facilities. In figure 18, the ponding map identifies areas that have ponded and buildings that are flood prone. For this topic, flood prone is defined as a building with a lower level that has been impacted in the past by ponding or stormwater.

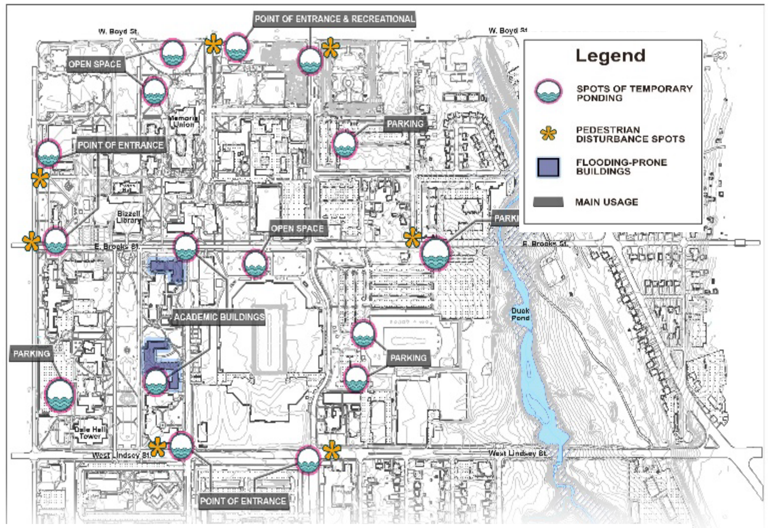

FIGURE 18 PONDING MAP

INSTALLATION STRATEGY

To prevent ponding around campus facilities, you must reduce the amount of water being directed and collected in that space. This could be done by diverting rainwater from the roof into a rain barrel or cistern. For example, Evans Hall in figure 19 has the potential to collect 19.7 gallons per minute of water during a .25-inch rain per hour storm. In this example, the system could collect over 1100 gallons of usable water. The limitation to this idea for OU's landscaping and grounds is placement of the pump and where to install the storage container. In addition to this, there is a little hesitation to install an unproven system.

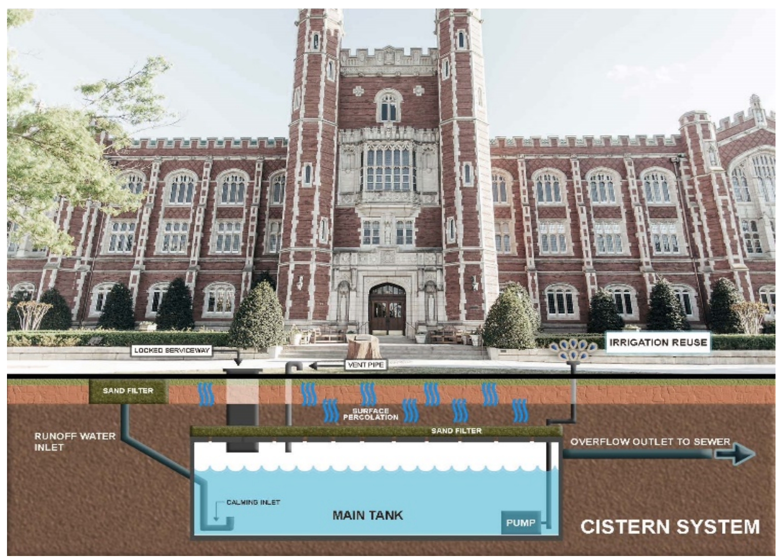

FIGURE 19 PONDING CISTERN

CAMPUS BENEFIT

A unused resource for water collection on OU's north campus is the facilities roofs. By collecting roof water runoff there would be a reduction in the number of ponded surfaces, and it reduces the amount of stormwater runoff. This project will improve pedestrian circulation on campus, by removing ponding water on pathways and sidewalks.

Table 4 Ponding Cistern Cost

ITEM	*ESTIMATED QTY*	*PRICE*	*COST*
Ground Prep	100 sq. ft.	$4.86	$468.00
Cistern	1	1756.00	$1756.00
Water Pump	1	$1,000.00	$1000.00
Plants	100 sq. ft.	$90.00	$90.00
Labor	8 hrs.	$40.00	$400.00
		TOTAL COST	$3714.00

WATER QUALITY

There is not much to be done for the drinking water being pumped to campus. But there are many things that can be done to the water running off the campus. Water improvement begins with filtering water thru rain gardens before it is discharged into the Bishop Creek watershed.

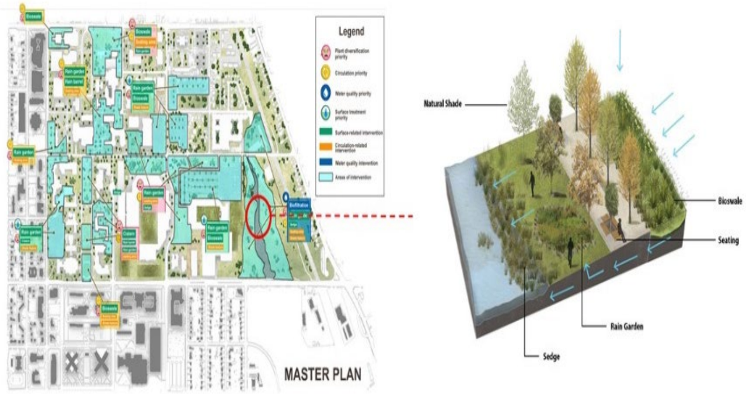

FIGURE 20 BISHOP CREEK WATER SHED

INSTALLATION STRATEGY

The installation strategy for water being discharged into the Bishop Creek watershed is a 2-part plan. Part 1 (figure 20) is to install rain gardens on the exterior perimeter of parking adjacent to the watershed. Working in conjunction with existing grasses and trees, rain garden would provide a preventive barrier and slow the flow of water into the watershed. Part 2 (figure 21) is a complete redesign of the current parking lots with green infrastructure. It is unfortunate that this option is not a viable plan with current budgetary constraints.

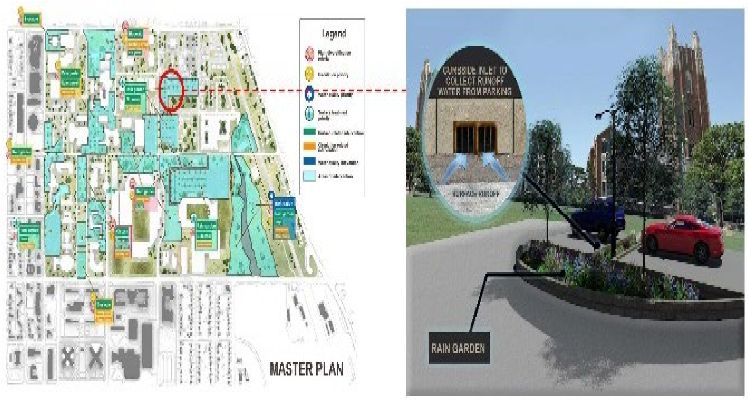

FIGURE 21 PARKING LOT RAIN GARDENS

The parking known as the Duck Pond parking lot is adjacent to the Bishop Creek watershed in figure 20. This parking lot is 3.6 acres in size and slopes in 2 directions: towards Brooks Street and the watershed. Once water reaches Brooks Street it flows downhill directly in the Bishop Creek watershed. The Duck Pond parking lot will collect and runoff 409 gallons per minute of water during a .25-inch rain per hour storm. To contain a portion of this water runoff, 2 rain gardens would be installed. One will 345 feet long x 4-foot-wide x 1 foot deep and the second will be 390 feet long x 4-foot-wide x 1 foot deep. These two gardens would be capable of managing over 20,000 gallons of water.

COST

Table 5 Rain Garden Cost

ITEM	*ESTIMATED QTY*	*PRICE*	*COST*
Ground Prep	2940 sq. ft.	$4.86	$14288.40
Plants	100 sq. ft.	$90.00	$2700.00
Labor	50 hrs.	$40.00	$2000.00
		TOTAL COST	$18988.40

This garden could be applied to the planned dredge of the Bishop Creek watershed. The dredging is a recurring event for the watershed. Without preventative actions this will continue to be a recurring event for OU's landscape and grounds.

PROJECT VIABILITY AND FUNDING

Short Term Plan

The short-term plan for this project is to work with OU's landscape and maintenance to determine a native plant palette. During our last review, they discussed having internal conversations about instituting native plant in the established gardens. Nothing was mentioned about type, quantity, or location. Any conversations about planting native plants is good. Most will need to be plated in early spring to be established by next winter.

There is great deal of planning that still needs to be accomplished for any of the before mentioned ideas can be instituted. It would be beneficial to work with OU's landscape and maintenance for a test area to prove our ideas on a small scale before bringing them to main campus. Having more data to back up our ideas would strengthen the case for change.

Long Term Plan

The long-term plan is to institute change as problem occur, add these ideas to new campus projects, or gain support and funding to address a problem area. If one of the projects is applied to an area, there are not many additional maintenance items to accomplish above what is being accomplished now. An example of new maintenance item is checking the water level in the cistern.

Funding

For project funding, the easy answer is asking alumni or the university to help. But the events from the last year have tightened everybody's budgets. Last year, the state Oklahoma received a $1.2 billion dollar grant from the United States Department of Agriculture funding for water infrastructure projects. This funding is currently open and accepting applications. In addition to this grant, the United States Bureau of Reclamation is accepting applications for a Water Smart Grant program. This government program opens in of Jan 2021 and it has two grants available for campus projects. The first grant is called the Watershed Management Program. This grant will award an applicant $1,000 to $100,000 towards watershed reclamation. The second grant is a Drought Contingency Planning grant. This grant will award an applicant $1,000 to $200,000 towards long term drought resilience projects that improve water management. A state agency that assists with funding for water projects is the Oklahoma Resource Board. This agency has an open application period for funding of community water projects.

CONCLUSION

The process of exploring the University of Oklahoma for deficiencies in stormwater management took many turns. From the northern most point of campus on Boyd Street to the southern point of campus on Route 9, each area of campus revealed how stormwater effects the space. Spaces on campus were singled out by how water effected the surfaces, circulation flow, water quality, soil conditions, vegetation, and the sunlight environments. When these analyses were combined, they identified OU's north campus as site with many hidden problems.

To combat the problems of north campus, a set of sustainable campus guidelines created. The sustainable campus guidelines identified four main areas that could benefit the most by this project. The sustainable campus guidelines are impervious surface treatments, plant diversification, enhancing circulation, and improving the water quality on campus.

From these guidelines, ideas and goals for improvement were set forth with potential areas of improvement. Strategies were formed to create designs to fit into the current campus environment with a focus on a sustainable campus guideline. All the spaces we selected could fit into more than one guideline. When this happened, objectives or more centrally focused tasks for the guideline was applied. This pressed the designs into having one focus with three additional objectives.

During meetings with OU's landscape and grounds a clear idea was presented, and clear opinion of feasibility was returned. Short term solutions, long term projects, and budgetary considerations impacted how design projects are implemented on a university that spans multiple campus and countries. This process led to great discussions and open dialogue that will benefit future campus interventions.

REFERENCES

EWG Tap Water Database, Environmental Working Group. 2019, https://www.ewg.org/tapwater/system.php?pws=OK3001414, Accessed 7 December 2020

Google*, University of Oklahoma,* Retrieved from https://www.google.com/maps/@35.2083581,-97.4450944,40m/data=!3m1!1e3, Accessed 7 December 2020

Oklahoma Ground Water Report, Oklahoma Water Resource Board. 2019, https://www.owrb.ok.gov/quality/monitoring/bump/pdf_bump/Reports/GMAPReport.pdf, Accessed 7 December 2020

Patterson, Susan. Pinterest Images, 2020, https://www.pinterest.com/pin/107945722288312950/, Accessed 8 December 8, 2020

Planning and Community Development. City of Norman, 2020, https://www.normanok.gov/your government/departments/planning-and-community-development/gis-services. Accessed September 2020

Strom, S. (2013*). Site Engineering for Landscape Architects*, John Wiley and Sons.

CALCULATIONS

Figure 4 Impervious Surface
AutoCad Area Surface Breakdown

Pavement	12.34%
Building	18.12%
Road	9.71%
Parking	12.02%
Total	**52.18%**

Figure 11 NDVI

	-1 – 0 (Dead or Inanimate)	**0 – 0.33 (Unhealthy)**	**.33 - 0.66 (Moderately Healthy)**	**.66 – 1 (Very Healthy)**
Pixel Count	1708863	1202034	311998	0
Percentage	53.03%	37.29%	9.68%	0

Figure 17*
Area Square Feet= Length x width
8 x 250=2000, 10 x 250=2500, 20x20=400
Gallons Per Minute=Runoff Coefficient x Rainfall x Square Feet/Flow Rate
12.9=1.0 x .25 5000/96.23
Storage Container Requirement
GPM x 60 minutes = Container Requirement
12.9 x 60 =774 Gallon Container
Percentage formula=Part divided by the Whole
47%=892/1892
* Formulas referenced in Site Engineering for Landscape Architects

Figure 19
Area Square Feet = Length x width
9500=190 x 50
Gallons Per Minute=Runoff Coefficient x Rainfall x Square Feet/Flow Rate
19.7=.8 x .25 x 9500/96.23

Figure 19
Area Square Feet = Length x width
157500= 450 x 350
Acre
Acre=Total Square Feet / Acre size
3.6=57500/43560
Gallons Per Minute=Runoff Coefficient x Rainfall x Square Feet/Flow Rate
409=1 x .25 x 157500/96.23
Volume
Length x width x depth x volume
345 x 4 x 1 x 7.481=10323
390 x 4 x 1 x 7.481=11398

The University of Oklahoma
Facilities Management
Planning & Engineering
160 Felgar Street, Norman
Oklahoma 73019
405.325.2976

Dear Sir/Madam,

Recently I was approached by Lecturer Bret Betnar from the Gibbs College of Architecture asking for participation from Facilities Management in a class project. The project, EPA Campus Rainworks Challenge is being completed by second-year graduate students in Landscape Architecture Intermediate Studio 3. The Norman campus consists of many landscaped beds, open grass areas, old growth treed areas, retention ponds, buildings and parking lots. Rainwater is affected by and affects all of these areas differently. The rain water runoff is currently controlled by an extensive storm water system that directs the flow to retention ponds and the City of Norman storm water system. Any rainwater that is not controlled by these systems ponds and is eventually absorbed into the ground. During our first meeting we worked together to identify and discuss some problem areas. The project team analyzed these areas and presented potential solutions to resolve these problem areas. Impervious Surface Treatment, enhancing circulation, plant diversification and improving water quality. The report clearly identifies options and potential solutions for all four of these categories. Locations were mapped and identified. The report is very informative, easily understood and was well presented. Facilities Management looks forward to continuing work with the Gibbs College of Architecture to improve rainwater run-off and usage as we address these areas in future campus projects.

Sincerely,

Kyle McGehee

Kyle McGehee
University of Oklahoma
Facilities Management
Planning & Engineering
405.325.2976
kmcgehee@ou.edu