THE WEST UNIVERSITY WASH REVIVAL

2017 EPA RainWorks
Competition Submission
University of Arizona, Tucson
Registration #M46

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ABSTRACT

This green infrastructure (GI) design proposal addresses one of the top-10 flooded areas at the University of Arizona. The campus struggles with dangerous and damaging flooding during the monsoon season and inefficient management of water resources, problems which can only be exacerbated in the face of climate change. These situations are further complicated by historic buildings that lay within the 100-year floodplain, and historic trees and landforms that fall under the protection of the campus's Historic District. The site of the historic West University Wash is just such an example.

Key components of our integrated GI design include: a network of xeroriparian basins as an interpreted daylighted wash, the removal of turf and the implementation of hydrozones, and cisterns and basins which allow the strategic active and passive utilization of water resources. Site verification of soil infiltration capacities were conducted. Through a series of modeling analyses, we anticipate that the design would reduce the 100-year flood plain area by 75%, reduce the peak discharge from 624 CFS to 151 CFS, reduce surface water runoff by 50%, reduce irrigation use by 58%, and harvest 2.4 acre-feet of water on-site.

In addition to these water-centric improvements, other added benefits are enormous, such as the adaptation of arboretum and historic vegetation and landforms to changing climatic conditions, improving circulation and accessibility while maintaining emergency routes, and enhancing and creating a variety of social spaces and educational opportunities. In summary, this project mitigates a major flooding problem for the University while layering green infrastructure with social, ecological, and economic improvements.

SITE CONTEXT + SELECTION

The project site is an historic waterway called West University Wash, now a paved, one-way road called James E. Rogers Way. Challenges of the site are characterized primarily by stormwater management, high irrigation use, and missed opportunities for water resources.

Most notably, our site encompasses one of the top ten problem flooding areas as designated by the University of Arizona (UA) Stormwater Management Plan. One historic buildings on-site (the Yuma Residence Hall) has a finished floor elevations below the current 100-year floodplain.[1]

Our site also occurs completely within the Campus Historic District, which includes buildings, landscapes, and landscape features. According to the UA Historic Preservation Plan, the orange grove, olive allee, and landscape terracing are all currently potential historic district additions. Most trees on-site are part of the Campus Arboretum, which showcases species significant at the local and state level.[2]

Climate change will affect the University of Arizona campus differently than most campuses around the country. Southwestern cities, which house more than 90% of the region's population, will have higher threat and costs to public health due to temperature increase and urban heat island effect. Disruptions to rigid infrastructures will exacerbate these threats and costs. Water resources will be severely strained by drought, stressing not only cities but the Southwest's singular and rich biodiversity and ecosystems.[3] Our design seeks to imbue our campus with resiliency through green infrastructure.

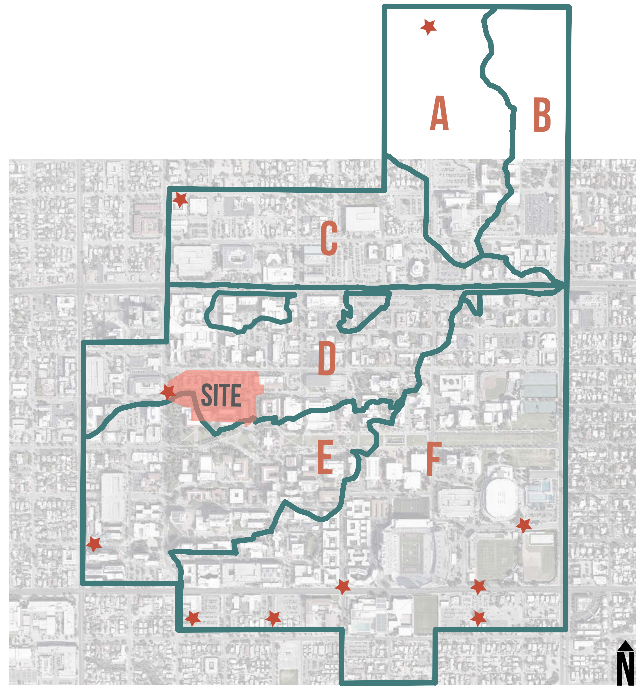


Figure 1: Campus watersheds
The UA Stormwater Management Plan designates these six watersheds (A-F) within the UA campus as well as the sub-watersheds (see Fig. 3). Our site occurs primarily in Watershed D, with two small areas along the northern edge of Watershed E. The top ten problem flooding areas are shown with red stars.

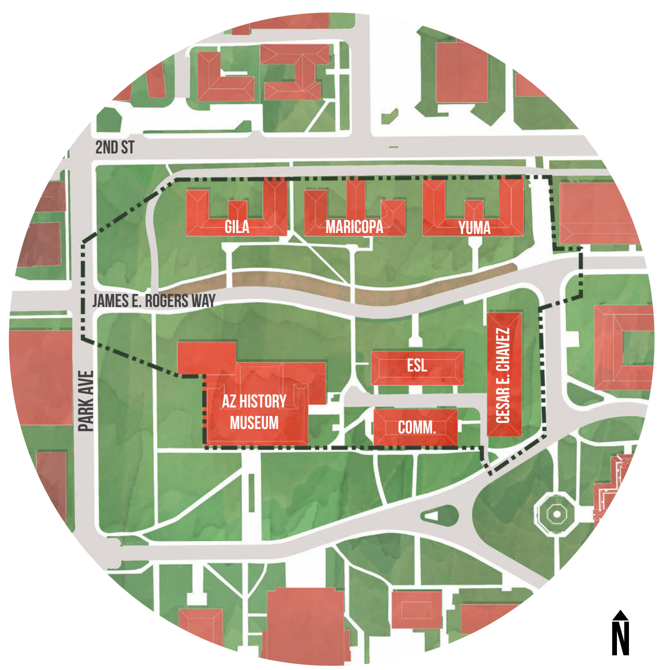


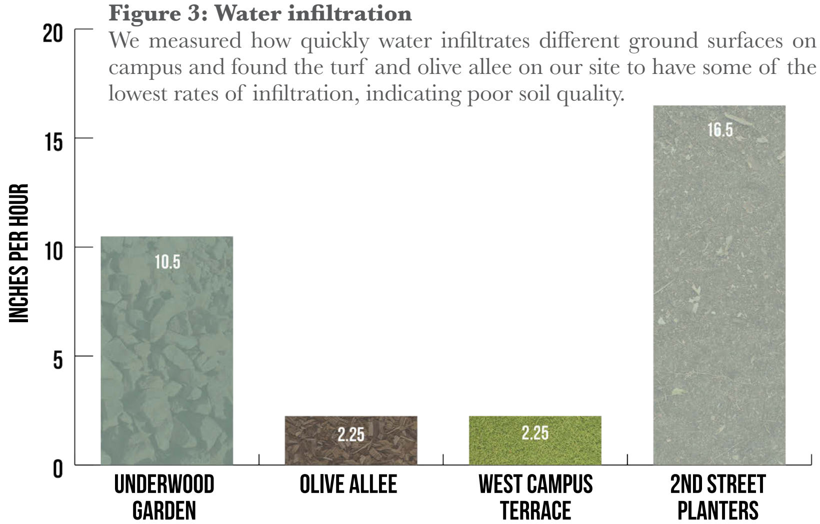
Figure 2: Site outline
The site occurs at the southeast corner of the intersection of Park Avenue and 2nd Street, encompassing a major portion of James E. Rogers Way. Three dormitory buildings line the north edge of the site, while educational buildings line the south edge.

SITE ASSESSMENT

Inefficient management of water resources and dangerous seasonal flooding.

Stormwater flows concentrate along James E. Rogers Way and 2nd St, causing the intersection of Park Ave and James E. Rogers Way to be one of the **top ten worst flooding areas** on campus with 3.84 acre-feet of water in a 100-year storm event. 3.84 acre-feet

Figure 3: Water infiltration
We measured how quickly water infiltrates different ground surfaces on campus and found the turf and olive allee on our site to have some of the lowest rates of infiltration, indicating poor soil quality.



Low-grade turf grass blankets our site at 41% of the total land use. Site surface consists of 41% turf grass, 20.5% mulch, 8% sidewalk, 8.5% roadway, and 29% roof. With an area of 302,320 sq ft, a total of **4.05 acre-feet of precipitation** falls on-site over 60 min in a 100-year storm event. With landscape intervention, the current **100-year floodplain can be reduced** from 624 CFS to 151 CFS.

The proposed green infrastructure plan would reduce the current 100-year floodplain area by XX% and a reduction of the peak discharge from 624 CFS to 151 CFS. These performance benefits meet/exceed the University of Arizona's goals as outlined in the Stormwater Management Plan

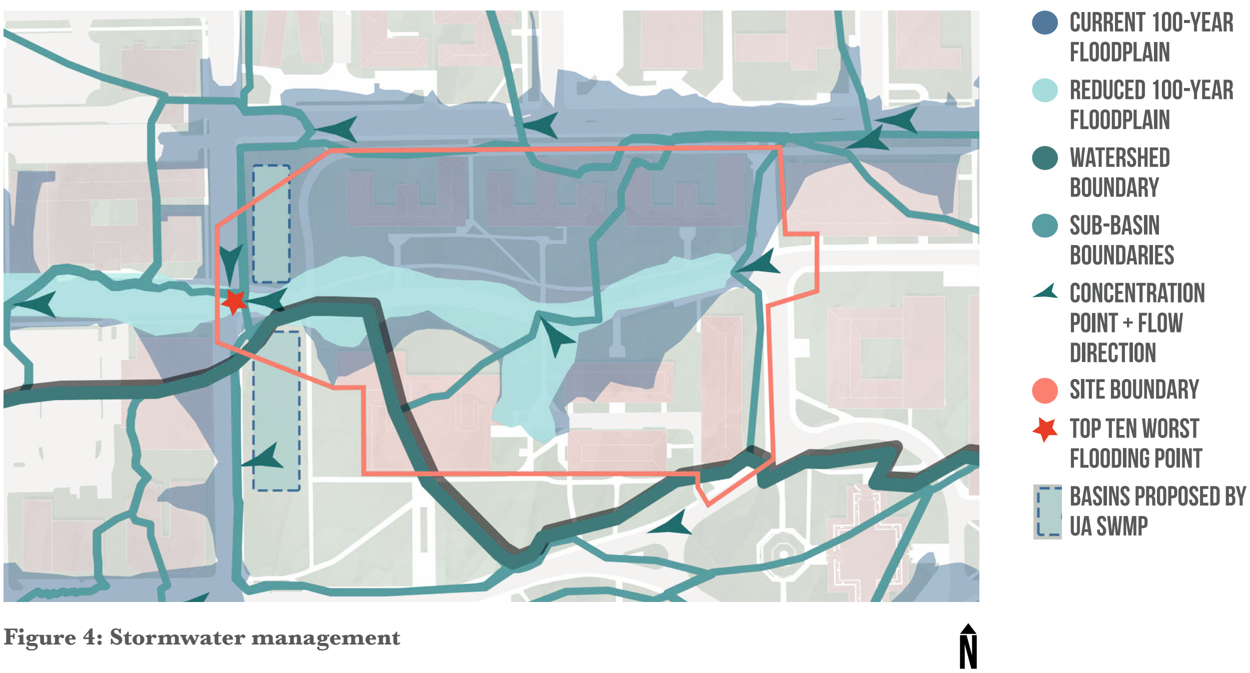


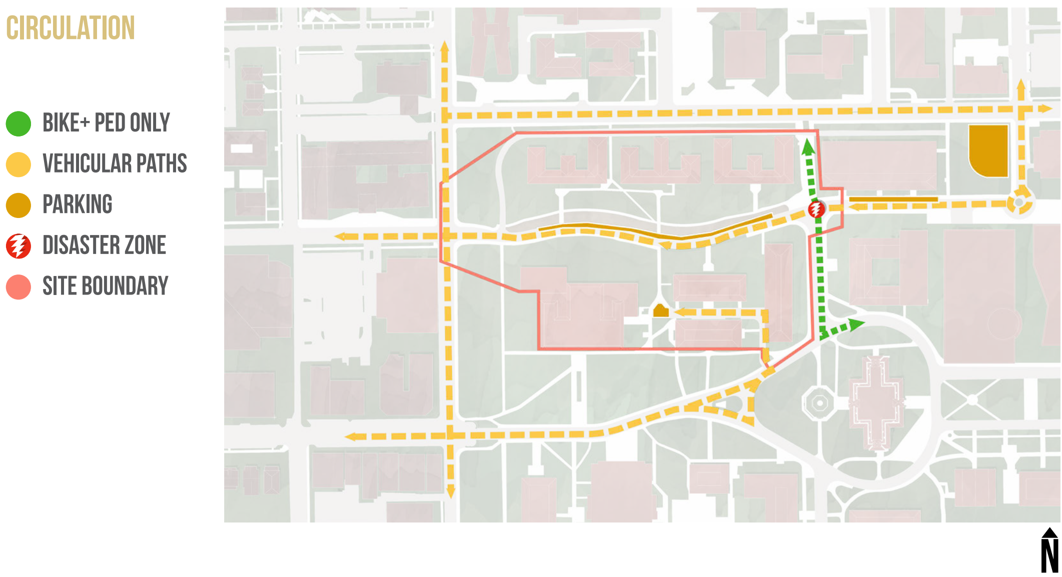
Figure 4: Stormwater management

SITE ASSESSMENT, CONT.

There are a total of **35 parking spaces** within the site. These consist of 4 service permit spaces, 2 loading zones, 12 paid parking spaces, 9 handicapped spaces, and 7 motorcycle spaces. Removal of spaces along James E. Rogers Way may be offset by increasing parking to the south.

A **chaotic choke point** occurs on-site where a bike and pedestrian -only path intersects James E. Rogers Way. This problem can be alleviated by removing or modifying vehicular flow at this intersection.

Issues can be solved holistically through proposed green infrastructure



DESIGN PROGRAM

#1 MANAGE STORMWATER

- Slow rate of flow
- Reduce floodplain
- Capture stormwater

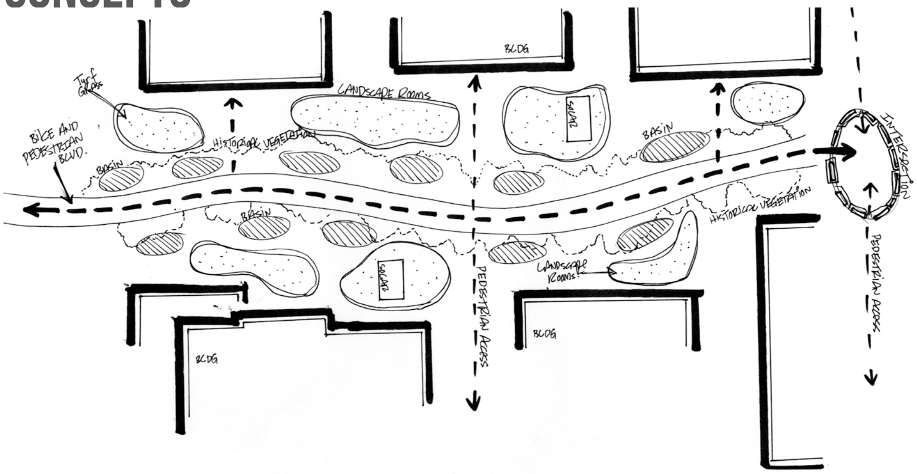
#2 IMPROVE CLIMATE RESILIENCE

- Preserve historic and arboretum trees
- Reduce irrigation needs
- Hybridize the built and natural environments

#3 ACTIVATE SITE

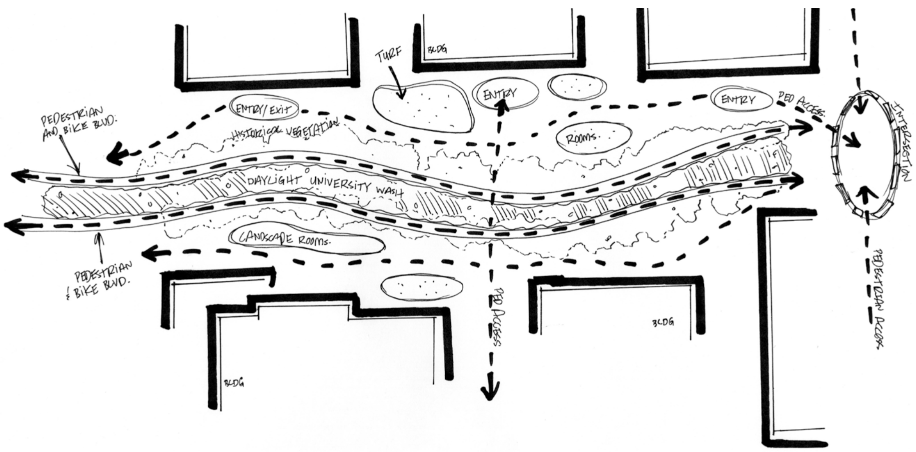
- Facilitate educational activity
- Facilitate social activity
- Improve site walkability

CONCEPTS



PARK WATER, NOT CARS

Concept 1: Park Water Not Cars employs the designation of a series of catchment basins along a central axis. These basins intercept water as it flows to the west down pedestrian only pathways.



ILLUMINATED H20

Concept 2: Illuminated H2O exchanges the main arterial roadway for an opportunity to daylight University Wash. Pedestrian circulation is adjacent to the wash along with reduced turf and irrigated landscape.

FEEDBACK AND DEVELOPMENT

The design development of the West University Wash Revival benefited with input from multiple partners and team ground work. Eric Scharf, Former Principal of Wheat Design Group, assisted the development of our conceptual work by asking that we continually hold both end users and water movement in mind while designing. Professor Grant McCormick allowed our team the opportunity to present schematic design ideas to his undergraduate water harvesting class, receiving feedback on student use, educational opportunities, and historic interpretation. Dr. Tanya Quist Director of the University of Arizona Arboretum, was also able to review our schematic design preparations and whole heatedly endorsed the removal of turf grass and its redirection to appropriately sized landscape rooms for exercise and activity. She also appreciated the care that was taken to design landscaping that sank more water into the soil near the historic olive plantings along James E. Rogers Way. Lastly, as a team, we regularly visited the site to visualize design ideas as well as conduct appropriate tests to support quantitative conclusions. This is best exemplified in our use of an infiltrometer to record water infiltration rates on the various surfaces that surrounding the site.

MASTER PLAN

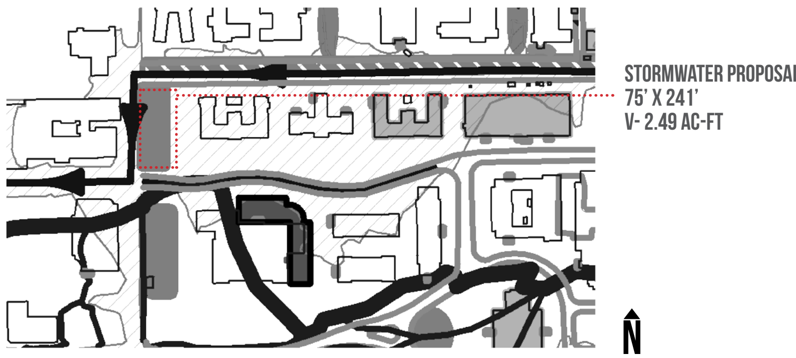
A dynamic green infrastructure design that integrates social, environmental, and economic benefits to the U of A.

WATER MANAGEMENT

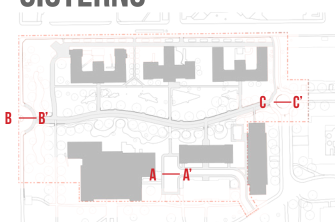
GREEN INFRASTRUCTURE + RESILIENCY + PERFORMANCE

The West University Wash Revival is a layered and sensitive approach to mitigating stormwater. It meets standards set by the University management plan and exceeds EPA performance standards.

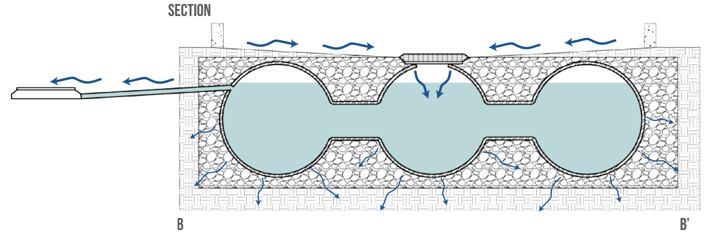
Our site contains one of the University's top ten problem flooding areas. One of the University's proposals to solve this is a single large open air basin on the west end of the site. While effective, this blindly cuts through the historic landscape and provides no supplementary benefits for students or visitors.



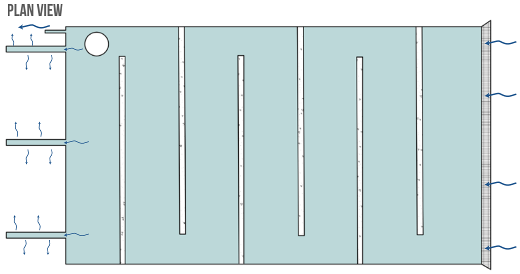
CISTERNS



EAST CISTERN .45 ACRE FT.
SECTION



SOUTH PARKING LOT CISTERN .96 ACRE FT.
PLAN VIEW



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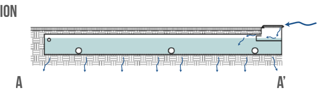
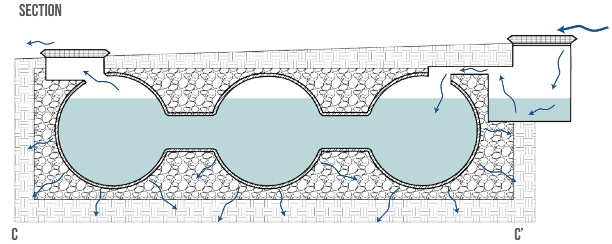


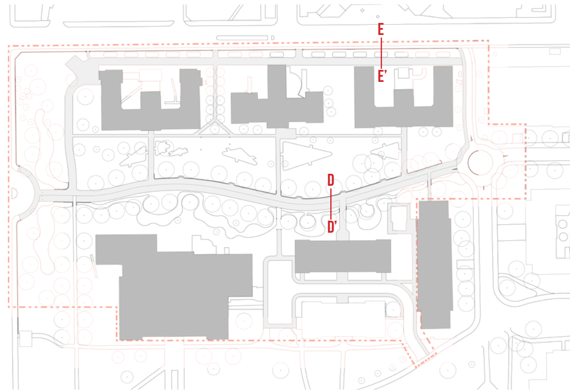
WEST CISTERN .37 ACRE FT.
SECTION



Using that stormwater management plan as a metric for quantitative success (2.49 ac-ft) , we decided to mitigate a large bulk of our water capturing needs with underground cisterns in three strategic places targeting sub-shed inflows in areas least likely to disturb the campus' historic landscape. This tiered system treats and uses water across our site through permeable tanks and pipes that contribute to the revitalized wash once storage meets capacity.

WATER MANAGEMENT
GREEN INFRASTRUCTURE + RESILIENCY + PERFORMANCE

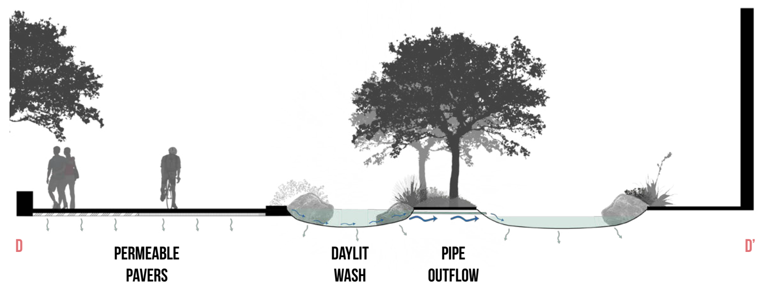
PHASE I of project implementation lays down the physical infrastructure of underground water cisterns, above ground micro-basins, connected basins of the day-lighted wash, porous pavers, and above ground rain-water catchment cisterns. This initial infrastructure creates a hydrologically enriched landscape that functions to support subsequent project phasing.



DAYLIT WASH

The natural topography of the site dictated that the wash run along the southern end of James E Rogers Way. This opportunity allows us to move surface water and cistern overflow through our wash, which is comprised of surface basins connected by arroyos and smaller pipes. These act like check damns to maximize capacity and minimize runoff while passively informing visitors of water movement, not just in storm events, but during dry seasons as well.

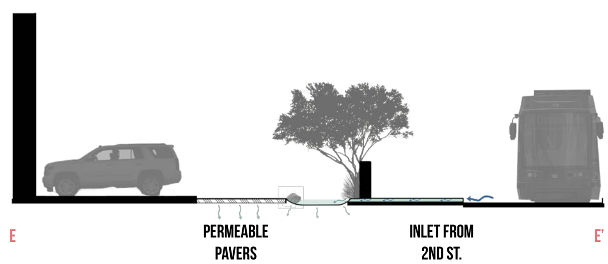
- TOTAL OF .39 ACRE FEET OF STORAGE
- OUTFLOW REDUCED BY 1.23 INCHES
- SUPPORTS OLIVE ALLE & XERO-RIPARIAN AREA



TURF + SURFACE BASINS

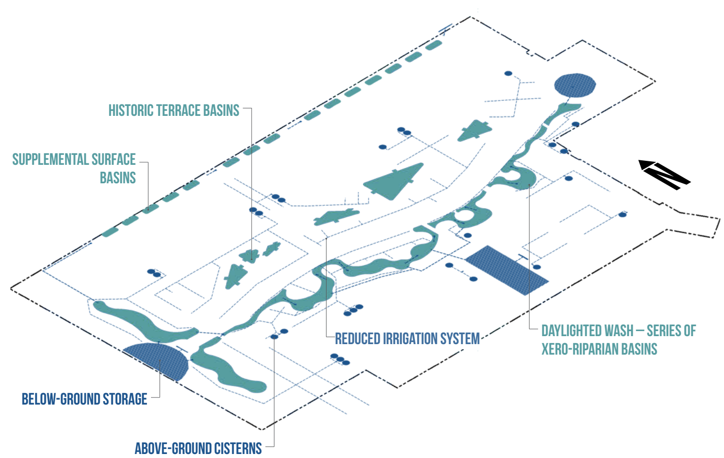
Cisterns and washes aren't the only interventions being proposed; as we have conserved the terracing from the historic landscape to enable our turf areas to act as basins. We've also proposed a string of detention basins along the northern alley which pulls water off 2nd St, slowing it, treating it and using it to vegetate and enhance the overall street scape experience.

- 13,560 GALLONS OF STORAGE
- FILTERS 2ND STORM WATER
- SUPPORTS NEW STREET TREES



RAIN TANKS

Attached to the adjacent buildings along the site are a collection of rain-tanks that collect roof-water during storm events through redirecting roof storm drains into the tanks. This further mitigates runoff rates and supplements irrigation needs later on as water is fed, using gravity, into a network of arroyo gutters and pipes.

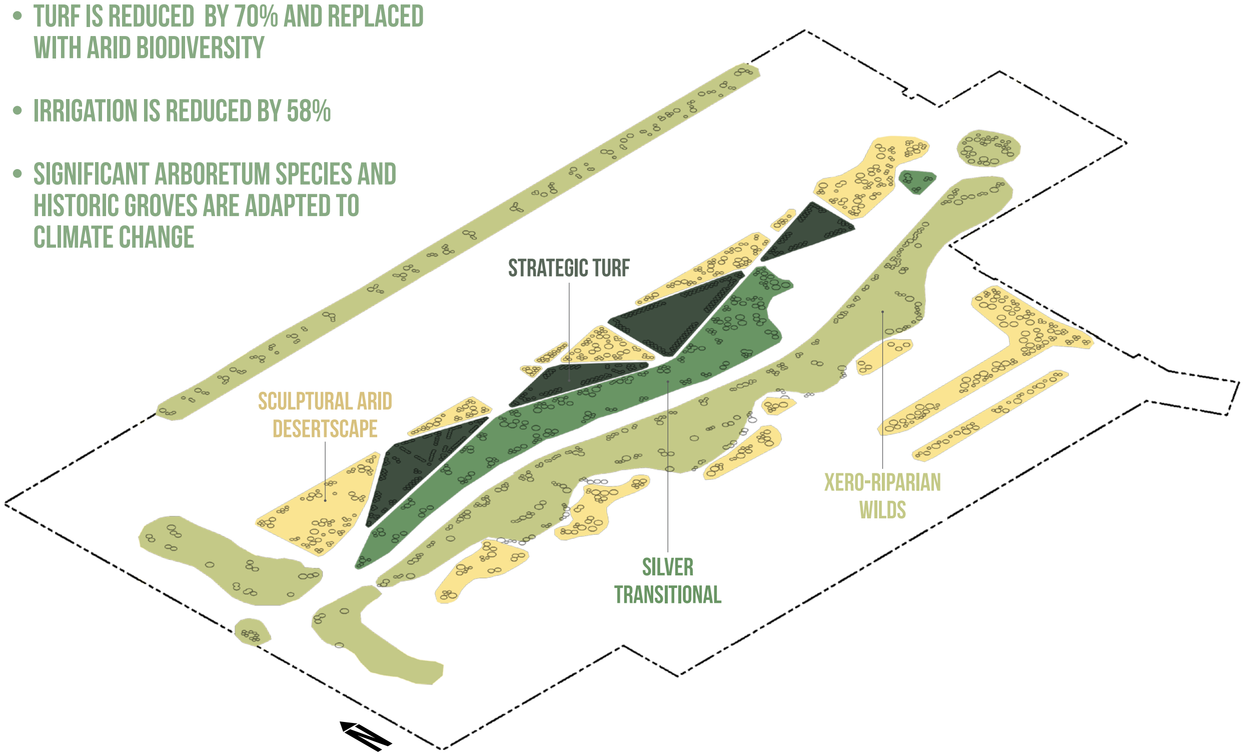


ECOLOGICAL RESILIENCE

PERFORMANCE + RESILIENCY

We have created a multi-dimensional green infrastructure design by layering infrastructure with opportunities for the campus community and public to appreciate and participate in the exploration of a richly meaningful site.

- TURF IS REDUCED BY 70% AND REPLACED WITH ARID BIODIVERSITY
- IRRIGATION IS REDUCED BY 58%
- SIGNIFICANT ARBORETUM SPECIES AND HISTORIC GROVES ARE ADAPTED TO CLIMATE CHANGE



HYDROZONES

Harvesting water is not the only strategy we use to imbue our site with ecological resilience. Our design reduces turf by 70% and implements hydrozones, reducing irrigation by 58%. These hydrozones are strategically designed to preserve irrigation for historic and arboretum vegetation as designated by the University's Historic Preservation Plan. They also provide "landscape rooms" of turf that can be arrived to (instead of just blanketing the area), and increase biodiversity and aesthetic richness of the site.

PHASE II of project implementation activates the site by the strategic plantings of hydrozoned plant materials and specific turf areas. These ecological amendments enhance historic plant materials, improve water infiltration, reduce irrigation by 59% while also improving climate resilience by promoting biodiversity.

DESERT SCRUB

Species are characterized by drought tolerance and low water use. All species selected are Sonoran Desert native plant materials.

XERO-RIPARIAN

Species selected are adapted to survive along ephemeral watercourses. They require minimal irrigation and are desert adapted.

TRANSITIONAL

Species selected are heat and drought tolerant displaying green-gray foliage characteristic of Mediterranean plantings. Irrigation demands are greater for certain exotic and naturalized species.

ACCENT

Encelia farinosa
Brittlebush

Ericameria laricifolia
Turpentine Bush

Dasylirion wheeleri
Desert Spoon

Mulenbergia rigens
Deer Grass

Rosemary officinalis
Rosemary

Ruellia brittoniana
Katie Ruellia

Dalea pulchra
Bush Dalea

Sphaeralcea ambigua
Globe Mallow

Muhlenbergia dumosa
Bamboo Muhly

Agave vilmoriniana
Octupus Agave

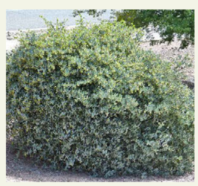
Aloe vera
Aloe

Hesperaloe funifera
Giants Hesperaloe

SHRUB

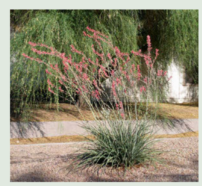
Larrea tridentata
Creosote

Ambrosia deltoidea
Triangleleaf Bursage



Simmondsia chinensis
Jojoba

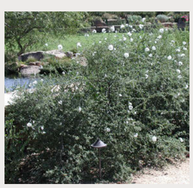
Lycium fremontii
Wolfberry



Hesperaloe parviflora
Red Yucca

Artemisia ludoviciana
White Sage

Calliandra eriophylla
Pink Fairy Duster



Cordia parvifolia
Little Leaf Cordia

Luecophyllum laevigatum
Chihuahuan Sage

Ruellia peninsularis
Baja Ruellia

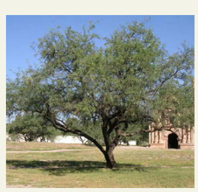
Dondonaea viscosa
Hop Bush

Feijoa sellowiana
Pineapple Guava

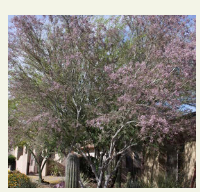
TREE

Acacia farnesiana
Sweet Acacia

Parkinsonia microphyllum
Foothill Palo Verde



Prosopis velutina
Velvet Mesquite



Olneya tesota
Ironwood

Olea europaea
Olive

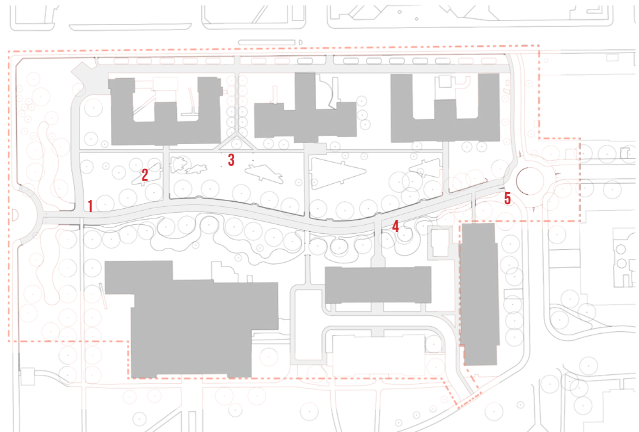
Quercus virginiana
Live Oak

SOCIAL ACTIVATION

PERFORMANCE + INNOVATION AND VALUE TO CAMPUS

PHASE III of project implementation takes the foundation that has been laid by the enhancement of water and plant resources and adds the final layer of sociability. This is accomplished by the introduction of interpretive sculptures, social spaces, educational stations, and seating.

Other ecological features of our design are integrated into the changes in circulation we propose. Permeable pavement makes up the handicap parking extension and the pedestrian sidewalks and bike-way which replace the one-way road along James E. Rogers Way. Bike stations are placed at the Park Ave drop-off circle, and the previously congested vehicular intersection is converted into a safe, legible bike and pedestrian -only roundabout.



Social activation of underutilized spaces and the educational functionality of our site are also major components of our green infrastructure design. We provide a diversity of functional social areas, including the solar ramada workstation, the grass "landscape rooms", the "observation decks" along the bikeway, and the naturalized, discoverable spaces throughout the daylighted wash. Our team reached out to Technicians for Sustainability, a Tucson local solar installation company who assisted us in analyzing what our photo voltaic output would be. With 16 430 watt modules our ramada would produce a conservative output of 6.1 KwHrs. This is plenty of power to charge several electronic devices at a time while charging a small battery bank to power lights and make the space usable at night for students to work.

1. CAT-WHEELS BIKE SHARE STATION

2. INTENTIONAL LANDSCAPE ROOMS

3. BOTANO-VOLTAIC RAMADA

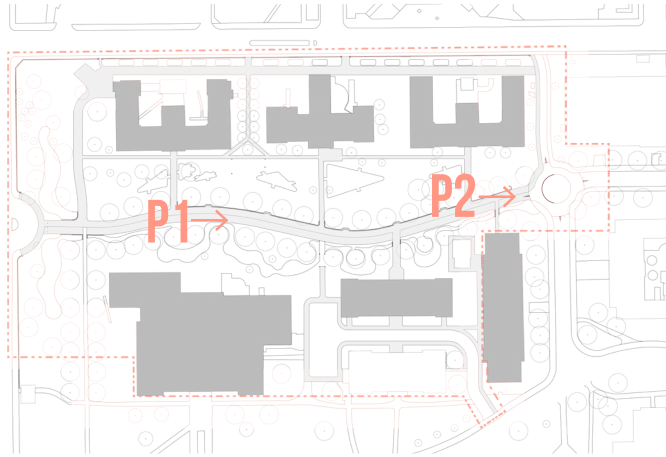
Throughout the site, interpretive sculptural art pieces and educational signage boost landscape literacy by showcasing the site's arboretum trees, the infrastructural components of our design that students and visitors can interact with, and stories about the site's Historic District features.

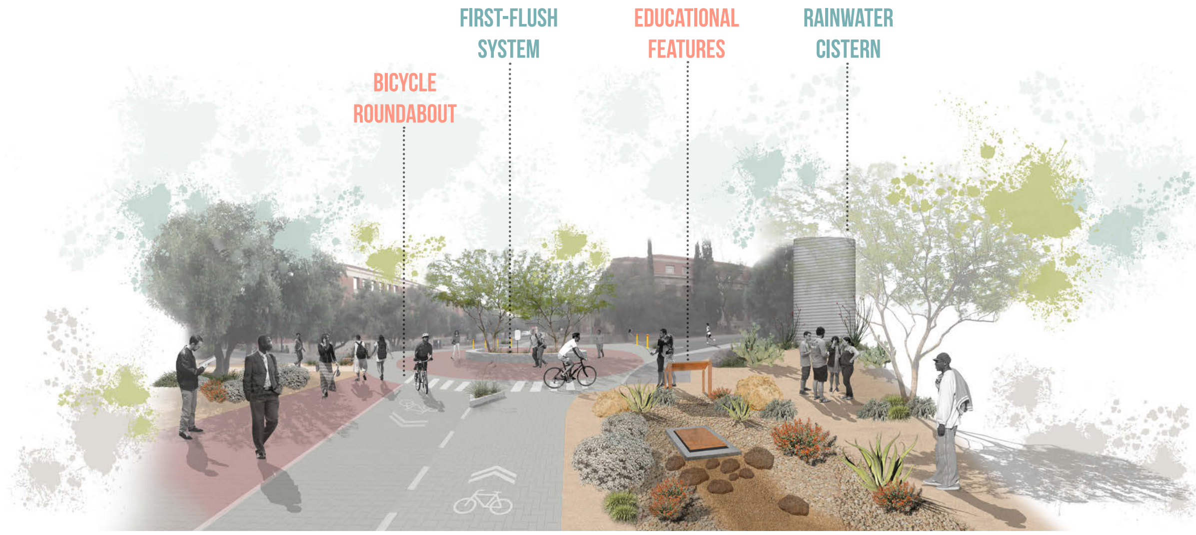
4. INTERPRETIVE SCULPTURAL PIECES

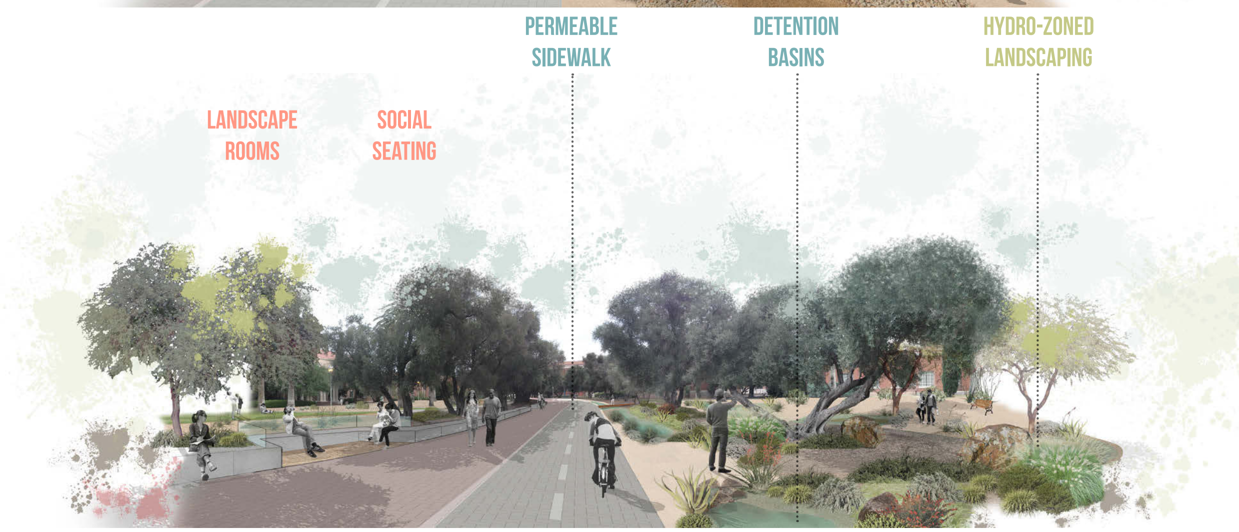
5. INTERPRETIVE EDUCATIONAL SIGNS

PERSPECTIVES

When completed all three phases act in synergy to support the University of Arizona's interconnected ecological, social, and economic systems.







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1 – Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

2 – Risk Management Services. *University of Arizona Stormwater Management Plan*. Revised February 17, 2017. Accessed November 2017. https://risk.arizona.edu/storm-water-management.

CALCULATIONS

SURFACE & SUBSURFACE BASINS

BASIN ID	CUBIC FEET	GALLONS	ACRE-FT
Street 1	1280.5	9578.3	0.029
Street 2	487	3642.7	0.011
Street 3	1639.3	12262.2	0.038
Street 4	229	1712.9	0.005
Street 5	1645	12304.6	0.038
Street 6	958.2	7167.3	0.022
Street 7	167	1249.1	0.004
Street 8	746.333	5582.5	0.017
Street 9	187	1398.7	0.004
Street 10	128.667	962.4	0.003
Street 11	807	6036.6	0.019
Street 12	452	3380.9	0.010
Street 13	434.745	3251.8	0.010
E Roundabout	19848	148463.1	0.456
Parking Lot	41855	313075.4	0.961
SW Surface Basin	6465	48358.2	0.148
NW Surface Basin	8819	65966.12	0.202
W Roundabout	16380	122522.4	0.376
2nd street	1812.9	13560.1	0.042
TOTAL	104341.7	780475.6	2.395

ROOFTOP STORAGE

BUILDING	ROOF AREA SQ. FT.	100 YEAR RUNOFF (FT^3)	GALLONS
Gila	13674	2552.4	19092.5
Maricopa	10983	2050.1	15335.1
Yuma	13226	2468.8	18467.0
AZ State Museum	39604	7392.7	55297.7
ESL	10325	1927.3	14416.4
Comm.	9936	1854.7	13873.3
Caesar Chavez	14485	2703.8	20224.9
	TOTAL	**0.624 AC-FT.**	

HYDROZONES: EPA WATERSENSE BUDGET TOOL

PRE

AREA	LANDSCAPE TYPE	WATER DEMAND	IRRIGATION TYPE	EST. MONTH WATER USE (GAL)
84009	Turfgrass	Medium	Rotor	650,987
42003	Mulched Trees	Medium	Drip	232,165
			TOTAL	**883,072**

POST

AREA SQ. FT.	LANDSCAPE	WATER DEMAND	IRRIGATION TYPE	EST. MONTH WATER USE (GAL)
28,507	Turfgrass	Medium	Rotor	220,874
42,003	Mulched Trees	Low	Drip	92,249
4,846	Ornamental Grasses	Low	Drip	10,643
9,251	Meddt.	Low	Drip	20,137
18,531	Desert Scrub	None	None	0
4,435	Xero Riparian	Medium	Drip	24,514
18,439	Non-Veg	None	None	0
			TOTAL	**368,597**

SURFACE RUNOFF: CURVE METHOD

$$Q = \frac{(P-0.2S)^2}{P+0.8S} \qquad S = \frac{1000}{CN} - 10$$

P= the 24-hour rainfall depth for a storm of a selected frequency in inches

S= the potential maximum storage of the site in inches

Q=the total runoff depth in inches

CN= the curve number

I_a=0.2 S

PRE

WATERSHED	TOTAL SQ. FOOTAGE	PAVEMENT (98)	ROOF (98)	GRASS (84)	MULCH (83)
D23	182,155	21,652	53,681	80,996	15,879
D24	213,820	38,058	29,362	102,902	19,178

POST

WATERSHED	SQ. FOOTAGE	ROOF (98)	GRASS (84)	MULCH (83)	IMPROVED SOIL (58)	PERMEABLE PAVERS (58)
D23	182,155	53,681	6,491	15,789	78,388	27,806
D24	213,820	29,362	1,039	19,178	103,302	29,404

WATERSHED	CURVE NUMBER	S	Q RUNOFF INCHES	
D23 PRE	85.1	1.74	1.44	
D24 PRE	78.7	2.69	1.04	**IMPROVED**
D23 POST	77.0	2.99	0.94	**34.5%**
D24 POST	61.0	6.39	0.29	**71%**