READY! SET! ACTIVATE!

Using Green Infrastructure to Promote Health Equity in South Phoenix

Arizona State University

Demonstration Project: D3

Student Design Team
Amanda Trakas, Master of Landscape Architecture, ASU
Elizabeth Ferguson, Master of Landscape Architecture, ASU
Kevin Scholfield, Master of Landscape Architecture, ASU

Faculty Advisor
Dr. Chingwen Cheng, Assistant Professor, Landscape Architecture, ASU

Advising Team
Dr. Jennifer Vanos, Assistant Professor of Sustainability, ASU
Dr. Paul Coseo, Assistant Professor of Landscape Architecture, ASU
Dr. Aaron Hess, Assistant Professor of Rhetoric and Communication, ASU
Dr. Allison Ross, Assistant Research Professor, School of Community Resources & Development, ASU
Dr. Brian Winsor, Founder, Paideia Academy

ABSTRACT

Ready! Set! Activate! is a research-based schoolyard redesign proposal as part of an ongoing collaboration between Arizona State University and Paideia Academy, a K-8 public charter school located in south Phoenix, Arizona. The five-acre school property experiences persistent environmental justice issues endemic to the greater South Phoenix area, including flooding, excessive urban heat, and poor air quality. These issues stem from discriminatory land development practices that have left this area of the city with limited investment in terms of flood control infrastructure and development of public green space. Because South Phoenix is located on an alluvial floodplain of South Mountain, green infrastructure interventions, including the creation of bioswales and bioretention for stormwater along with the use of native vegetation, are critical to mitigate seasonal flooding and improve environmental site conditions.

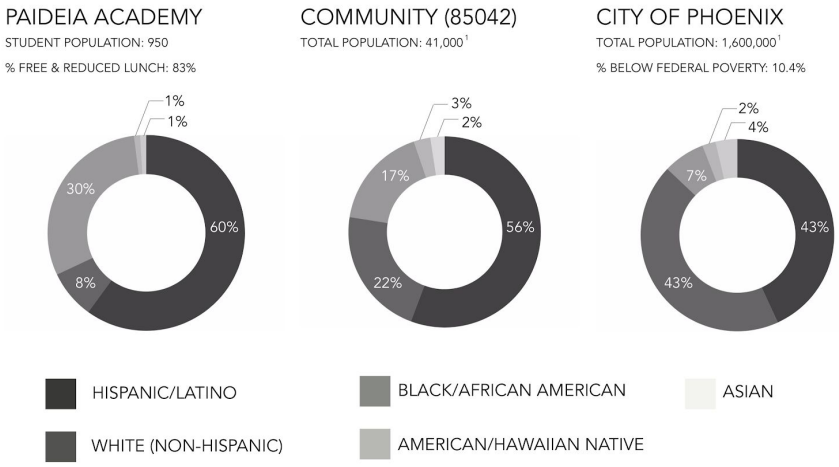
Beginning with a series of community engagement workshops, this project envisions the use of green infrastructure at Paideia to create resilient natural learning and play landscapes that promote health equity by improving the quality and access to green space for the student community. Using Padeia's whole-person education paradigm to guide the goals of the project, the hope is to begin the conversation on how school landscapes can address the immediate health equity challenges of the site while creating a welcoming and healthful green space amenity for the community.

CONTEXT

HISTORY

The City of Phoenix was established in the late 1860's as an agricultural hub in the Salt River Valley. As the city grew, white middle and upper class residential areas moved north while non-white residents of Phoenix who were mainly agricultural and industrial workers, were confined by restrictive deeds to South Phoenix.[1] This area was already designated for heavy industry and waste treatment and was not annexed by the city of Phoenix until 1959, resulting in a lack of basic urban services and infrastructure development[1] for the majority Black/African American and Latino residents living there. There is persistent evidence that these discriminatory development policies have led to segregated and inequitable neighborhoods in contemporary South Phoenix. Recent research indicates residents of South Phoenix demonstrate a

vulnerability to extreme heat[2], unequal distribution and inaccessibility of green space[3], along with a high incidence of air pollution[4].



Paideia's racial demographic makeup mirrors the surrounding community with a larger percentage of Black/African American students and smaller percentage of White (non- Hispanic) students. Both Paideia and it's community reflect a higher percentage of minority students and residents compared to the City of Phoenix overall.
https://factfinder.census.gov

PAIDEIA ACADEMY

Paideia Academy was founded in 2013 by Dr. Brian Winsor. The mission of the school is to implement a "whole-person" educational paradigm focused on the body, mind, heart, and spirit of each student. The demographic makeup of the school's approximate 950 students reflects the greater South Phoenix area with about 90% minority students, 83% of whom qualify for free and reduced lunch. Dr. Winsor intentionally chose to open Paideia Academy in South Phoenix to serve the majority Black/African American and Latino residents there, with a more holistic education curriculum that attempts to cultivate confidence and the building of good habits into adulthood.

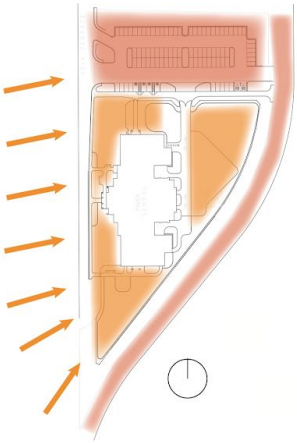
SITE ANALYSIS

The current orientation of the school, along with its proximity to large urban roadways increases the exposure of students, staff and community to a myriad of environmental concerns. These include elevated levels of urban heat along with air and noise pollution. Low tree canopy or shade coverage do little to mitigate these concerns, especially surrounding large sections of concrete meant for sports like basketball and foursquare.

EXPOSURE - AM

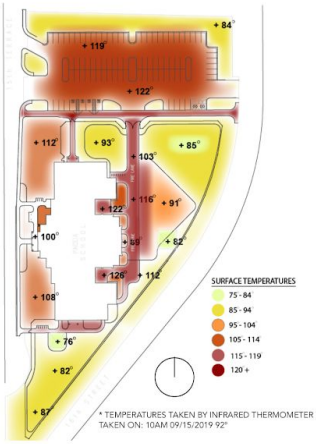
There is significant morning sun exposure on the school yard, students confine themselves to small areas of shade.

EXPOSURE - PM



There is also significant afternoon sun exposure on the school yard, especially on the south side of the building.

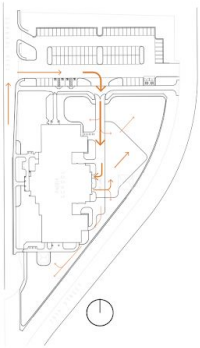
SURFACE TEMPS.



There parking lot and areas of impermeable hardscape demonstrate the highest temperatures on the site.

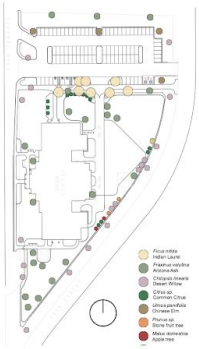
The only other schoolyard amenities are small grassy areas meant for soccer and other running activities. These areas are affected by on site and regionally generated flooding that not only render them unusable, but expose the site users to accumulated contaminants brought on site by traveling water and sedimentation. The resulting school landscape is both limited in the recreational opportunities offered to students, creating crowded and uncomfortable outdoor play experiences, and does not address the environmental concerns that affect the health of the site users and broader community.

CIRCULATION



Strong centralized schoolyard circulation. Morning play represents the longest and most concentrated play time during the day.

VEGETATION

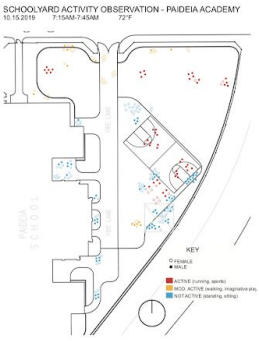


Existing vegetation features a wide variety of tree species, including many edible varieties. Very few native species.

HYDROLOGY

Current retention areas have the potential to support schoolyard vegetation. High incidence of flooding indicates issues with initial grading.

OBSERVATIONS



Students are observed playing in very small concentrated areas of the schoolyard because of limited offerings or water drainage issues.

Since 2016, Dr. Winsor has partnered with ASU to monitor the environmental quality of the schoolyard to explore what role the schoolyard could play in addressing regional environmental concerns. Monitoring stations have been set up at different locations to

collect data on air quality, noise, and urban heat. The goal is to collect baseline data of the immediate concerns that currently affect the site to see what improvements are made after any modification to the schoolyard are put in place.

LARGE SECTIONS OF CONCRETE

16TH STREET EQUESTRIAN EASEMENT

FLOODING - SE CORNER OF SCHOOL

FLOODING - PLAY FIELD

These site challenges offer a unique opportunity to engage the school community in a redesign of the schoolyard that address the social and environmental concerns of the landscape while creating a more interesting, easily accessed, and healthful natural landscape.

COMMUNITY ENGAGEMENT

WORKSHOP I

Community engagement workshops were held at two different stages of this design process in an effort to get a better idea of how the schoolyard is currently being used and to also envision how it could serve the students and community better in the future. The first workshop featured interactive activities in which the students, faculty and staff created collages for an intuitive representation of their desired outdoor environment and how they would move within it. They also identified and explained their favorite and least favorite areas of the current schoolyard and built idealized outdoor learning environments that included their preferred elements for the schoolyard redesign.

GOALS + OBJECTIVES

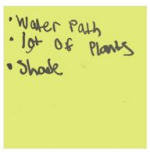
The experience and feedback received at the first community engagement workshop was synthesized with the site analysis and collected observations. A set of goals was developed and aligned with Paideia's whole-person educational paradigm to assure that the landscape would serve the mission of the school.

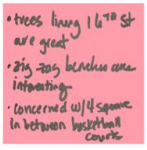
PAIDEIA'S WHOLE PERSON EDUCATIONAL PARADIGM	READY! SET! ACTIVATE! GOALS + OBJECTIVES
MIND	PROVIDE OPPORTUNITIES FOR LEARNING Creation of outdoor learning environments. Study + exposure to native ecology. Gardening education.
BODY	REDUCE URBAN HEAT Reduction of impervious paving. Increase tree + vegetation coverage.
HEART	ENHANCE HEALTH + WELLBEING Mitigate air + noise pollution. Spaces for community gathering + education. Natural play environment.
SPIRIT	CREATE A RESILIENT NATIVE LANDSCAPE Manage on-site stormwater. Support native vegetation + schoolyard landscape. Conserve water resources.

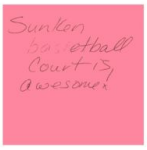
WORKSHOP II

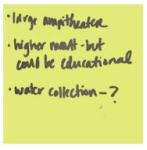
With established goals and objectives along with in-depth knowledge of how the schoolyard is utilized by the students and school community, three different conceptual redesigns were prepared for a second community engagement workshop. These focused on offering diverse play opportunities, reducing urban heat, and creating edible and learning landscapes. These plans were presented to see which design elements best represented the desires of the students, staff, and community for the redesign of the schoolyard.









The final redesign, Ready! Set! Activate!, represents a synthesis of required interventions necessary to address the environmental and public health conditions of the site with the desired aesthetic and programmatic elements voiced by the community.

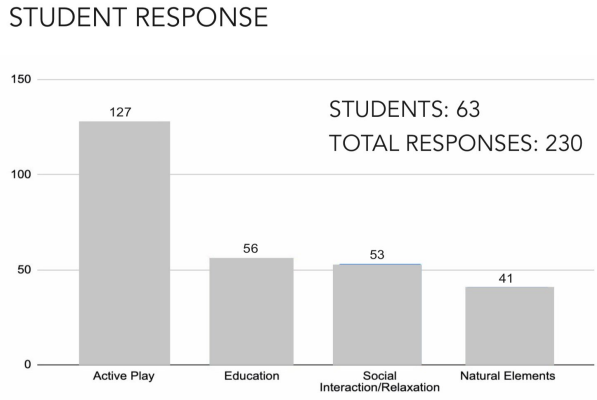
RESEARCH

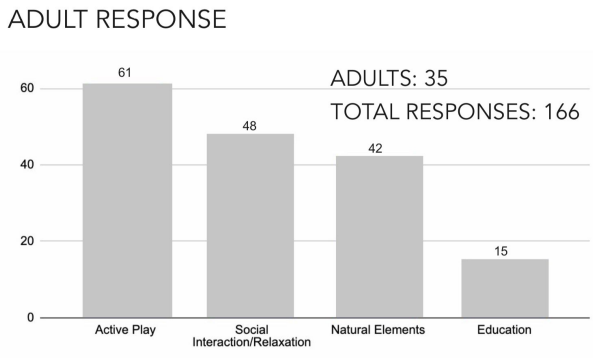
To begin to address the environmental concerns and social determinants of health in South Phoenix at Paideia Academy, additional research was necessary to identify and qualify the benefits of green infrastructure that could support a redesigned school landscape. The lack of access to quality green space in South Phoenix and the missing associated health benefits were vital considerations to this project. Public green space has shown a correlation with increased physical activity, improved mental health, and social cohesion. Air quality is also improved as are associated cases of asthma and/or allergies.[5] Landscapes maintained by green infrastructure interventions have the ability to improve general health including immune[6] and cognitive function[7].

To get an idea of what specific types of elements should be included in the final design of the school yard at Paideia Academy, surveys were distributed at the community workshops to both student and adult participants.

Among a variety of questions, students and adults were specifically asked:

WHAT WOULD YOU LIKE TO SEE ADDED TO THE SCHOOLYARD?





Active play elements, areas for social interaction and relaxation, education and natural elements were the most reported as desired additions to the schoolyard. The inclusion of educational areas in the landscape required additional research to confirm the benefit for the integration of environment-based learning into the curriculum. Research suggests that students learn more effectively with environment-based learning than traditional education frameworks and cultivate advanced thinking skills, problem solving

abilities, and awareness[8]. An outdoor learning environment provides concrete experiences to clarify abstract concepts[9] and can provide localized environments to study native ecology. Additionally, a section for additional comments on the adult surveys revealed an overwhelming desire by the community for the new school landscape to support community social and educational events.

MASTER PLAN

The culminating design aims to reduce exposure to the sun and excessive heat, as well as localized air and noise pollution to create a comfortable and healful landscape. Green infrastructure, including bioswales and bioretention for stormwater, will be implemented to sustain native vegetated landscapes that support mental restoration, positive social interaction, creative play and integrated classroom learning.

VISION

Use green infrastructure at Paideia to create resilient natural learning and play landscapes that promote health equity by improving the quality and access to green space for the student community.

ACTIVE PLAY + RETENTION

This area features a large amphitheater for school and community gathering events, along with an enlarged recreation field. A pathway of decomposed granite for four square play covered by a steel shade structure divides the field from a recessed basketball court and monsoon rain garden.

NATURE PLAY + MENTAL RESTORATION

This area has walking paths and play mounds with buried tunnels at grade for mental restoration and natural play. This area is heavily vegetated and also features a circular swingset or “Sun Swing”.

NATIVE SONORAN RAIN + STUDY GARDENS

The west side of the site features a diverse array of native plantings for the creation and study of sonoran ecology. There is classroom seating provided along with a path at the north end to give students an immersive desert experience on their way into school.

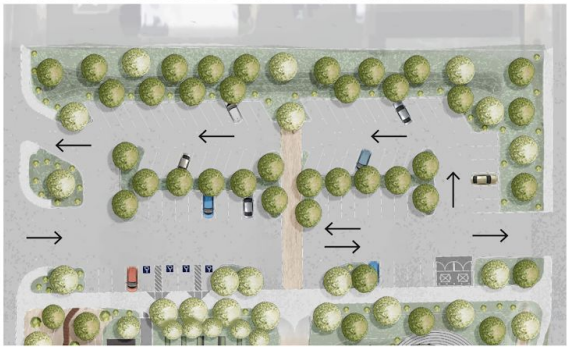
COMMUNITY GARDEN EDUCATION AREA

This area features a relocated chicken coop and newly constructed compost resource bays and raised garden beds. Moving the chickens and school gardening to the north end of the school site offers increased protection from heat to ensure a healthier and more productive educational environment.

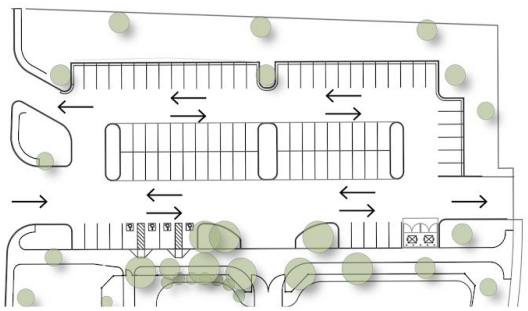
COOL PARKING LOT DESIGN

The parking lot represented some of the highest recorded surface temperatures during our site analysis. By modifying the current circulation of the parking lot, adding a vegetated median to support additional tree plantings, along with a designated pedestrian path the new design offers a safer and cooler alternative to the existing design. 7,300ft^2 of asphalt is removed in the proposed plan, increasing the tree count by 250%, with the reduction of only four parking spots.

PROPOSED CIRCULATION + CANOPY COVERAGE



EXISTING CIRCULATION + CANOPY COVERAGE



STORMWATER MANAGEMENT

Using a series of symbols to represent the functions of the green infrastructure stormwater plan, flow control, detention, retention, along with filtration and infiltration have been identified. **Retention volume was increased 65% with proposed design.**

GREEN INFRASTRUCTURE TO ADDRESS REGIONAL FLOODING

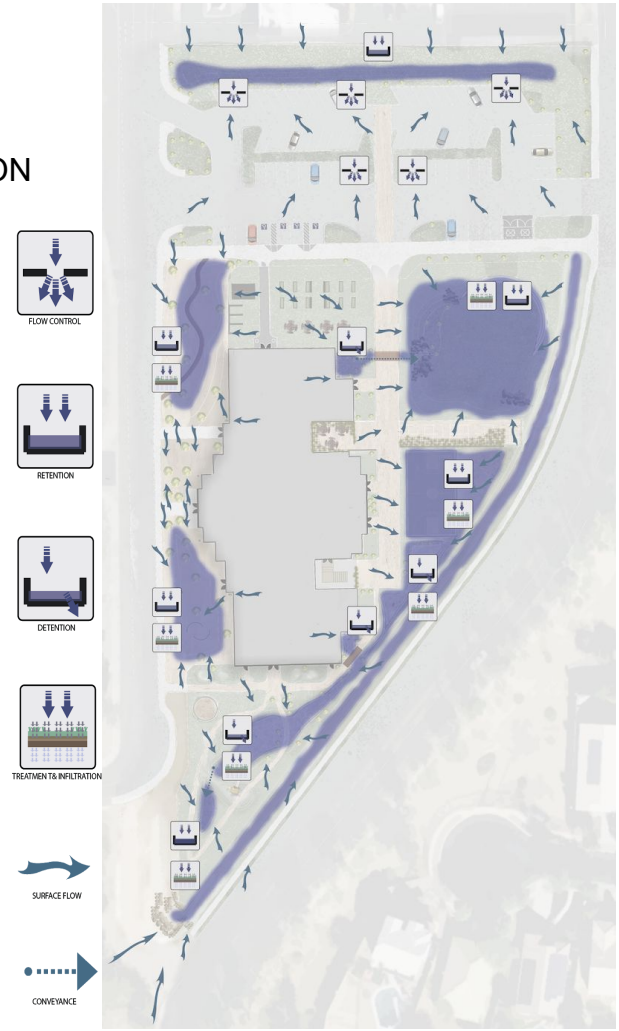
The easement off 16th street includes a bioswale to intercept regional stormwater coming north from South Mountain and prevent it from flooding the schoolyard.

GREEN INFRASTRUCTURE IN DESIGN PROGRAM

Stormwater will be used to support a natural landscape for play at Paideia and is integrated into the community amphitheater, recessed basketball court, and through the earthen play mounds.

GREEN INFRASTRUCTURE FOR EDUCATION

The hydrological cycle will be on display with rock paths used to convey stormwater through rain gardens and into bio re/detention areas. It will also serve as the primary support for the Native Sonoran Rain and Study Gardens along the west of the school.



RETENTION CAPACITY		
EXISTING	PROPOSED	DIFFERENCE
51,868 ft3	85,595 ft3	33,727 ft3

PERFORMANCE + BENEFITS

By managing stormwater on site it can be used to sustain the proposed landscape and create a vibrant schoolyard at Paideia. This will also reduce the necessity of additional water and energy use, once the plantings are established, along with reducing the cost of stormwater infrastructure and contaminants downstream.

Using green infrastructure along with reduction in hardscape will address the comfort and health of the students by reducing the exposure to the sun and excessive heat, as well as localized air and noise pollution. Native wildlife areas will be created as an engaging way to connect students to the natural world and serve as reflection of local context with **over 15 native species introduced**. Students will be better able to see the naturalized areas of their schoolyard as a product of local ecosystems and site conditions influenced by local climate and microclimate, elevation, rainfall.[9] Schoolyard agriculture will serve to reconnect students and the community with local agricultural systems while creating vibrant learning environments[10] and the building of social capital.

	Existing	Proposed	Difference
Concrete	93,296	42,570	-50,726
Asphalt	34,747	28,998	-5,749
Gravel/DG	44,472	66,952	22,480
Grass	32,596	66,591	33,995

Resources have been collected and revised to create the most ecologically robust design for Paideia to enjoy for both recreation and education. List of native species, location in bioswales and the wildlife they will attract.[11]

Scientific Name	Common Name	Location in Bioswale/retention	Wildlife
Shrubs			
Calliandra eriophylla	Pink Fairy Duster	Terrace	birds, pollinators
Justicia califonica	Chuparosa	Terrace	birds, pollinators, mammals
Hyptis emoryi	Desert Lavender	Bottom	birds, pollinators, mammals
Simmondsia chinensis	Jojoba	Terrace	large + small mammals
Larrea tridentata	Creosote	Terrace	birds, pollinators, mammals
Celtis pallida	Desert Hackberry	Terrace/Bottom	birds, pollinators, mammals
Trees			
Parkinsonia velutina	Velvet Mesquite	Terrace	birds, pollinators, mammals
Parkinsonia microphylla	Foothills Palo Verde	Top	birds, pollinators, mammals, desert tortoise
Olnea Tesota	Desert Ironwood	Top	birds, pollinators, mammals
Chilopsis linearis	Desert Willow	Bottom	birds, pollinators
Prosopis pubescens	Screwbean Mesquite	Bottom	birds, pollinators, mammals
Succulents			
Carnegia gigantea	Saguaro	Top	birds, pollinators, bats
Ferocactus acanthodes	Compass Barrel	Terrace	birds, pollinators, mammals
Fouqueria splendens	Ocotillo	Terrace	birds, pollinators
Opuntia engelmannii	Prickly Pear	Terrace	birds, pollinators, mammals, desert tortoise

PHASING

PHASE I + II

Installation of the Community Education Area and Native Sonoran Rain and Study Gardens will offer Paideia the quickest and most immediate impact with the least of invested resources. These areas require little to no earth work and only the relocation of the chicken coop, construction of raised garden beds (which are already in progress) and compost resource bays. The planting of the Native Sonoran Rain and Study Gardens will also beautiful the west-facing front entrance of the school, reduce its direct exposure to the sun and provide an immediate educational resource and green space amenity to the students and community that is even accessible when the school is not open.

PHASE III + IV

The Nature Play and Mental Restoration Area along with the Active Play and Retention Area are next for development as they require the removal of significant amounts of hardscape and will involve significant changes in grading. These areas represent the main schoolyard where students recreate before and during school and will change the experience of the schoolyard.

PHASE V

The parking lot redesign will serve a significant contribution to the reduction of heat felt on campus. Because it is used daily by faculty and staff however, it is phased as a last step in the redesign process to make plans for the installation of the vegetated median and restriping.

BUDGET

Currently, Paideia has received $100,000 in grant funding to begin the retrofit of their schoolyard. To begin to meet the requirements of the total budget, there are research funding opportunities available through ASU along with additional local funding opportunities available specifically for schools that are listed below.

ITEM	UNITS	QTY.	COST/UNIT	TOTAL
Demolition and Site Preparation				
Demolition of Asphalt/Concrete	SF	28,901	$3.00	$86,703.00
On-Site Earthwork	CY	15,000	$5.00	$75,000.00
Site Amenities				
Concrete Paving, includes subgrade	SF	3,312	$4.00	$13,248.00
Corten Steel Trellis System	SF	1,000	$2.00	$2,000.00
Swing Set	EA	1	$2,900.00	$2,900.00
Planting Beds	EA	12	$300.00	$3,600.00
Educational Signage	EA	7	$90.00	$630.00
Concrete Seatwall	LF	240	$50.00	$12,000.00
Landscape				
Native Desert Hydro-Seeding	SF	53,326	$0.10	$5,332.60
Trees (15 gallon)	EA	103	$125.00	$12,875.00
Shrubs (1 gallon)	EA	250	$10.00	$2,500.00
1/4" Minus D.G.	SF	19,742	$0.40	$7,896.80
Rip-Rap	SF	250	$6.00	$1,500.00
Boulder	EA	19	$250.00	$4,750.00
			Subtotal	$224,685.40
			12% Contingency	*$26,962.45*
			TOTAL	**$251,647.85**

ADDITIONAL FUNDING OPPORTUNITIES

GRANT OPPORTUNITY	AWARD
ARIZONA GAME & FISH Heritage Grant Funds - Schoolyard Habitat, Urban Wildlife/Habitat	$10,000 + Wildlife Education and Conservation
WATERSHED MANAGEMENT GROUP Schoolyard Water Conservation Education Program	$4,000 Must be matched by school funds
TREES MATTER Trees for Schools Program	Provide and Plant 30+ Trees Planting with students, staff, and community.
AZ DEPARTMENT OF FORESTRY AND FIRE MANAGEMENT TREE Resource Enhancement and Engagement Grants	$1,500- $5,000 Management, Improvement, and Conservation
ARIZONA COMMUNITY FOUNDATION Various Grant Opportunities	Varies

MAINTENANCE

Maintenance of the school landscape will be part of the ongoing collaboration between Paideia Academy and ASU. To begin the development of a more sustainable and appropriate maintenance approach on a majority native school landscape, we have sourced reference material from the Watershed Management Group's *City of Avondale | Low Impact Development Street Tree Master Plan Supplement for Integrating Green Stormwater Infrastructure*.

Maintenance Item	Current Frequency	Recommendation
Cleaning/Weed Control	Bi-weekly to Monthly	Focus on trash removal and manual removal of problematic weeds (no spray or raking options). Frequency should be greater during wetter months.
Mulch replenishment	Every 2-5 years	Inspect for need to replenish organic mulch if not sufficiently replenished during plant pruning and chipping process. Typically, plant leaf litter and pruning chippings are sufficient to maintain organic mulch cover.
Pre-Emergence	Semi-annual	Shift to an Integrative Pest Management system to eliminate/minimize need for herbicide applications.
Post-Emergent	Semi-annual	Shift to an Integrative Pest Management system to eliminate/minimize need for herbicide applications.
Shrub/Groundcover Maintenance	Quarterly	No topiary pruning or hedging; replace groundcover as needed to maintain minimum 25% coverage.
Tree Maintenance	Annually	Years 1-3: Conducted semi-annually before and after growing season, light pruning to maintain site visibility and clearance, overseen by certified arborist Years 4+: Annual pruning, overseen by certified arborist; avoid summer pruning
Irrigation Inspection & Maintenance	Monthly	Years 1-2: Regular irrigation schedule Years 3-5: Reduce/eliminate irrigation during winter months (Nov – Feb) Years 5+: Reduce/eliminate irrigation for most of year unless abnormally dry & hot or to maintain aesthetics May – June. Supplemental watering 1/month during warm, dry season may be desired to maintain plant aesthetics
GSI Performance Inspection & Maintenance	Semi-annual / Periodic	Sediment: accumulation of sediment in the sediment trap or basin bottom should be removed only if it reduces the ability to meet performance objectives of the GSI feature from either a water quality or retention volume perspective. Often sediment acts as a mulch as long as vegetative cover is present to reduce evaporative water loss and infiltration rates are not impacted. Ponding: check for ponded water 2-3 days following rain events. If ponding persists then take appropriate action to A) decompact underlying soil, B) integrate organic mulch or compost, and C) re-establish native plants (i.e. native grasses) to facilitate infiltration

REFERENCES

1. Bolin, B., Grineski, S., & Collins, T. (2005). The Geography of Despair: Environmental Racism and the Making of South Phoenix, Arizona, USA. Human Ecology Review, 12(2), 156.

2. Chow, W., Chuang, W., & Gober, P. (2012). Vulnerability to Extreme Heat in Metropolitan Phoenix: Spatial, Temporal, and Demographic Dimensions. The Professional Geographer, 64(2), 286-302.

3. Cutts, Darby, Boone, & Brewis. (2009). City structure, obesity, and environmental justice: An integrated analysis of physical and social barriers to walkable streets and park access. Social Science & Medicine, 69(9), 1314-1322.

4. Pope, R., Wu, J., & Boone, C. (2016). Spatial patterns of air pollutants and social groups: A distributive environmental justice study in the phoenix metropolitan region of USA. Environmental Management, 58(5), 753-766. Oregon Health and Outdoors Initiative. Green Infrastructure and Health Guide. 10 July 2018

5. Oregon Health and Outdoors Initiative. Green Infrastructure and Health Guide. 10 July 2018

6. Taylor, Andrea Faber, and Frances E. Kuo. “Children With Attention Deficits Concentrate Better After Walk in thePark.” Journal of Attention Disorders, vol. 12, no. 5, 2009, pp. 402–409.

7. N.M. Wells. At home with nature. Effects of “greenness” on children’s cognitive functioning Environ. Behav., 32(2000), pp. 775-795

9. Danks, Sharon Gamson. Asphalt to Ecosystems: Design Ideas for Schoolyard Transformation. New Village Press, 2012.

10. Evergreen.ca “The Outdoor Classroom: Benefits to Using the School Grounds for Learning Using the Schoolyard as a Teaching Space”

11. Lancaster, Brad, et al. *Rainwater Harvesting for Drylands and Beyond*. Rainsource Press, 2020.