Case Studies
Low Impact Development
Green Infrastructure

LOW IMPACT DEVELOPMENT/
GREEN INFRASTRUCTURE

LID Working Group
January 2015

CITY OF TUCSON FOUNDED 1775

PIMA COUNTY

PIMA COUNTY
FLOOD CONTROL

WHY DO WE NEED CASE STUDIES?

The Pima County Regional Flood Control District (RFCD) is compiling Case Studies reflecting design solutions embracing the evolving mandate for sustainable design: Low Impact Development (LID) and Green Infrastructure (GI) practices.

The Case Studies will be available to help groups, professionals or individuals learn more about the value of LID/ GI development, what worked, lessons learned, etc. Inclusion of relevant company logos in the top title block is strongly encouraged. We must rely on the Tucson professional community to provide data on as many relevant projects as possible. If you have a project that can contribute to the education of Tucson designers, homebuilders and homeowners, please contact us:

- Evan Canfield, Chief Hydrologist, REFCD Evan.Canfield@pima.gov
- Sandra Bolduc, Registered Landscape Architect, RFCD Sandy.Bolduc@pima .gov

We have an outline to guide the gathering of information. Projects can be New or Retro-fit. We will be happy to help you create the Case Study spreadsheet, or you can create it yourself. We have spreadsheet templates for every category as follows:

- Commercial- Office-Retail / Small, Medium or Large
- Industrial/ Distribution, Manufacturing
- Institutional/ Education K-12, Non-Profit, Medical, Municipal or Utility
- Recreational/ Linear Park, Neighborhood Park, Regional Park, Retention Basin
- Residential/ Single Family, Multi-dwelling, Subdivision, Master Planned Community
- Transportation/ Local, Collector or Major, Terminal (bus, airport)

Photos that illustrate the LID principals and goals described in the text are very useful- *please label the principals used*. Dated photos, especially Before and After of the same location, are very helpful to see the progress of vegetation growth. Arrows indicating changes to drainage flow (redirection to natural areas, landscaping, harvesting swales, etc.) further explain the principals in the photos.

We appreciate any efforts to provide updates to these Case Study spreadsheets once completed. It is especially easy to show LID benefits on projects that are retrofit. Be sure to retain photographs, water and energy bills, and property value for the "Before" condition. The value of LID is the transformation it generates upon a site for both new construction and retro-fit; 3 to 5 years can show incredible improvements! This data will be of great interest and possibly motivation to someone just learning about LID/ GI. Lessons continually learned are invaluable.

If you have any projects you would like to have included, just let us know the category and the appropriate template(s) will be provided.

Thank-you!

FIRMS AND OWNERS WHO HAVE PARTICIPATED TO DATE

Certificate of Appreciation
Awarded to the 18 original Case Studies
At the
2015 LID/ GI Workshop

LID Categories

	COMMERCIAL- OFFICE- RETAIL- MEDICAL
	Small NEW
	Small RETRO
	Medium or Grouped Use NEW
	Medium or Grouped Use RETRO
	Large NEW
	Large RETRO
	INDUSTRIAL
	Distribution NEW
	Distribution RETRO
	Manufacturing- Fabrication NEW
	Manufacturing- Fabrication RETRO
	INSTITUTION
	Education- K12- College NEW
	Education- K12- College RETRO
	Non-Profit NEW
	Non-Profit RETRO
	Medical NEW
	Medical RETRO
	Municipal Facilities NEW
	Municipal Facilities RETRO
	RECREATION
	Linear Park NEW
	Linear Park RETRO
	Neighborhood Park NEW
	Neighborhood Park RETRO
	Regional Park NEW
	Regional Park RETRO
	Basin NEW
	Basin RETRO
	RESIDENTIAL
	Single Family NEW
	Single Family RETRO
	Multi-Dwelling NEW
	Multi-Dwelling RETRO
	Subdivision NEW
	Subdivision RETRO
	Master Planned Community NEW
	Master Planned Community RETRO
	TRANSPORTATION
	Local Neighborhood NEW
	Local Neighborhood RETRO
	Collector NEW
	Collector RETRO
	Terminal NEW
	Terminal RETRO

I

ICONS FOR LID PRACTICES

SYM	PRACTICE
	Berms and vegetated or rock swales direct stormwater runoff to plants
	Curb openings to allow street or parking lot runoff to access landscaped areas
	Roof Runoff is directed to Landscape
	Native or low-water use vegetation is planted
	Pathways are raised allowing runoff into the landscape
	Impervious surfaces have been disconnected to slow runoff and allow percolation
	Rainwater is stored in a cistern or underground storage cells for future use- especially April, May and June in Tucson
	Pervious pavement allows stormwater infiltration
	Infiltration trenches intercept larger stormwater volumes
	Condensate is collected and used for landscape

COMMERCIAL

OFFICE ■ RETAIL ■ MEDICAL

SMALL

MEDIUM

LARGE

I

	COMMERCIAL- OFFICE- RETAIL- MEDICAL
	NEW Small
	RETRO Small
	NEW Medium or Grouped Use
	RETRO Medium or Grouped Use
	NEW Large- Mall, Campus
	RETRO Large- Mall, Campus

Under consideration: Cat Mountain Lodge Bed & Breakfast
Ewing Irrigation
Rob Paulus Office
Target- Oracle Road

INDUSTRIAL

DISTRIBUTION

MANUFACTURING - FABRICATION

I

	INDUSTRIAL
	NEW Distribution
	RETRO Distribution
	NEW Manufacturing- Fabrication
	RETRO Manufacturing- Fabrication

INSTITUTION

EDUCATION- K THRU COLLEGE

NON-PROFIT

MEDICAL

MUNICIPAL FACILITY

I

	INSTITUTION
	NEW Education- K12- College
	UofA CAPLA (College of Architecture, Planning and Landscape Architecture)
	UofA Residence Halls (Arbol de la Vida and Likins Hall)
	RETRO Education- K12- College
	UofA Visitor's Center
	NEW Non-Profit
	RETRO Non-Profit
	Nature Conservancy, Tucson Office
	NEW Medical
	RETRO Medical
	TMC East Campus Renovation
	NEW Municipal Facilities
	TPD Forensic Crime Laboratory
	Tucson Water- Eastside Service Center
	Water & Energy Sustainability Center- Pima County
	RETRO Municipal Facilities

Under consideration:
Aerospace & Mechanical Engineering
Community Food Bank
Habitat for Humanity
La Paloma Family Services
Manzo Elementary School
National Outdoor Leadership School
Tanque Verde Elementary School
U of A Student Recreation
UMC Cancer Center

PROJECT NAME: U of A CAPLA College of Architecture, Planning and Landscape Architecture Tucson, AZ

PROJECT TYPE: INSTITUTIONAL ■ Educational K12- College ■ New

Ten Eyke

Low Impact/ Green Infrastructure

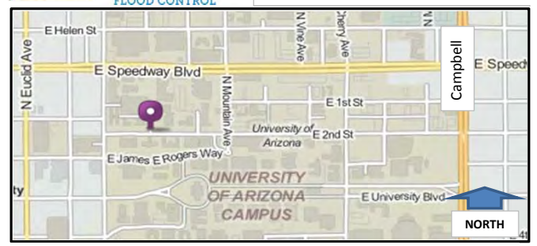
LID/ GI DEVELOPMENT

DATA

LOCATION	1040 N. Olive Road, UA campus
ACRES	0.21 Acres (9,066 sft)
CLIENT	Arizona Board of Regents on behalf of University of Arizona CAPLA (College of Architecture + Planning + Landscape Architecture)
CONTACT	Ron Stoltz, Professor CAPLA rstoltz@email.arizona.edu
DESIGNED BY	Ten Eyck Landscape Architects, Austin
COMPLETED	2007

COST

ESTIMATED COST	$650,000- planting, irrigation, lighting
FUNDING SOURCE	Many sources
ACTUAL COST	CONSTRUCTION: Hardscape professionally constructed for about $200,000. LABOR: Remainder was volunteer, primarily AAA Landscape MATERIALS: Majority were salvaged from site or donated from local suppliers: Mountain States Nursery, Rainbird Irrigation, Ewing Irigation Supply, Fx Luminaires, Netafim USA, Western Tree, Arid Zone Trees, Kalamazoo Materials, Landscape Forms
MAINTENANCE	AAA Landscape (donated)
COMPARE TO CONVENTIONAL	This project shows that a high performance design that harvests water, mitigates urban heat island, reduces urban flooding, increases urban wildlife habitat and provides an aesthetic and comfortable environment can be achieved at a relatively low cost.
TIME TO BUILD	2.5 months



LOCATION MAP

GOALS

REGULATORY: Regulatory requirement unknown

STAKEHOLDERS: ►CHALLENGE- CAPLA faculty wanted an interpretive learning experience with a range of materials. ■ A fun oasis and attraction for existing and future students, and professors of the CAPLA program. ■ Parking lot runoff all seemed to drain to future building entry space.
► SOLUTION- A new entry and garden/outdoor classroom to provide cleansing biosponge garden for adjacent runoff and discarded building water.

PROJECT RECOGNITION: ASLA Honor Award for General Design, 2010. A tribute to Ten Eyck Landscape Architects

PERFORMANCE MEASURES: ■ Use local materials. ■ Conserve water by totally integrating building mechanical systems waste water: roof runoff, drinking fountain greywater, university well 'blow off' (backwash from well's sand filter) and HVAC condensate, into landscape. ■ Create sustainable livable space. ■ Reduce Urban Heat Island (UHI) effect ■ Reduce flooding around building

SUMMARY

FINISHED PROJECT DESCRIPTION: ■ Reclaimed 1.2 acres of parking lot to create a Sonoran Desert biotic community landscape. ■ Native fauna introduced (endangered fish and frogs) or immigrated (road runner; gray fox) have thrived. ■ Repopulation and active predation activities have been observed. ■ Establishment period (first 3-5 years) reduced potable water use by 83% (280,000 gallons annually). ■ After establishment, use of potable water should be eliminated. ■ Reused brick and concrete, salvaged from the partial building demolition, to line the Desert Riparian channels.

DESIGN FEATURES: ■ Stormwater runoff is reduced significantly in the landscape. ■ Landscape fully integrated with building mechanical systems. ■ ET rates integrated into high-efficiency drip irrigation system. ■ Significant terrestrial and aquatic habitat created. ■ Utilizes up to 250 gallons/day of well water backwash that previously went to stormwater drainage system. ■ High-efficiency drip irrigation system is controlled by monitoring ET rates ■ 11,500 gallon water tank (7' diameter x 38' tall)

LESSONS LEARNED

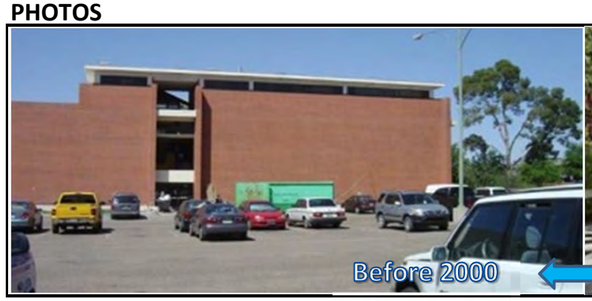
SOMETHING TO BE PROUD OF

■ Five distinct Sonoran Desert biomes are flourishing: Arizona Wetland, Canyon, Desert Riparian, Mesquite Bosque, and Upland Sonoran. ■ Building mechanical system's greywater is harvested and stored in a vertical 11,600-gallon cistern for use in irrigation. ■ Stormwater runoff is reduced by 2 desert arroyo 'micro-basins' and the lower patio with a 5,500-gallon retention capacity total. ■ Over 3000 visitors have been hosted on formal tours. ■ All guiding principals have been realized. ■ Reused brick and concrete from the partial building demolition line the Desert riparian channels.

SOMETHING TO BE DONE DIFFERENTLY:

■ Connection from the ET irrigation controller and the booster pump have been resolved by installation of a larger industrial cistern water filter. ■ Unwanted goldfish had to be removed from the pond before introduction of the native species. Use of native vine has been problematic- sometimes non-natives may be required to fulfill design

PHOTOS



PHOTOS

PROJECT TYPE: INSTITUTIONAL

■ Education College
■ New

PROJECT NAME:

UA CAPLA

The Underwood Family Sonoran Landscape Laboratory

PROJECT NAME: UNIVERSITY OF ARIZONA SIXTH STREET RESIDENCE HALLS

Tucson, AZ

PROJECT TYPE: ■ INSTITUTIONAL ■ Education- College ■ New

Low Impact/ Green Infrastructure

LID/ GI DEVELOPMENT

DATA

LOCATION	Two Residence Halls: Arbol de la Vida -NE corner 6th Street and Tyndall Likins Hall- NE corner of 6th Street and Highland Ave
ACRES	Arbol do la Vida: 2 AC; Likins Hall: 2.2 AC
CLIENT	The University of Arizona
CONTACT	Debra Johnson, University of Arizona Project Manager email: debraj@email.arizona.edu | phone: (520) 626-2420
DESIGNED BY	NAC Architects Stantec Engineering, Civil Wheat Scharf Associates, Landscape Architect Carl Kominsky, irrigation design (subconsultant to WSA)
COMPLETED	Dec. 2011

COST

ESTIMATED COST	N/A
FUNDING SOURCE	Private
ACTUAL COST	DESIGN COST: N/A CONSTRUCTION COST: 123 million (total cost for both sites)
MAINTENANCE	Private - University
COMPARE TO CONVENTIONAL	N/A
TIME TO BUILD	12 months

LOCATION MAP

GOALS

REGULATORY: ► 2003 Comprehensive Campus Plan: Open Space Guidelines (addresses shading, diversity of use; circulation – pedestrian & bicycle corridors; way-finding; water management & sustainability).
► UA Manual of Design & Specifications Standards - Surface Water Procedures.

STAKEHOLDERS:

The University of Arizona

PROJECT RECOGNITION:
The project received attention as the first residence halls in the state to achieve LEED Platinum certification.

PERFORMANCE MEASURES:
LEED: Goal was to achieve a LEED Silver rating (a LEED Platinum rating was achieved)

SUMMARY

FINISHED PROJECT DESCRIPTION:
■ Arbol de la Vida at Tyndall Avenue and Likins Hall at Highland Avenue together provide new on-campus housing along 6th Street for 1,088 undergraduate students. ■ The landscape concept for both buildings was influenced by local elements: at Arbol de la Vida, a "slot canyon" orients rooms around oblique courtyards; at Likins the buildings are situated along the path of a former urban drainage corridor, expressing the arroyo in a more natural form.

■ The landscape design uses Sonoran Desert plant materials, and implements passive water harvesting techniques. ■ Drought tolerant Sonoran desert scrub species are used in the planting areas at the building perimeter and along the Sixth Street corridor, and meso-riparian species are used in the shaded courtyards. ■ The courtyards include comfortable outdoor seating and amenities such as grills and benches, making them desirable spaces to relax and gather.

DESIGN FEATURES:
■ Numerous passive water harvesting techniques were implemented. ■ Traditional practices such as micro-basins, swales, check-dams, and recessed grading were employed. ■ Given the deep rooting characteristic of mesoriparian tree species, a Deep Water Distribution System (DWDS) for distributing harvested stormwater to sub-surface soil depths was devised in collaboration with Stantec Civil Engineers. The Deep Water Distribution System is a buried, sloped manifolded system comprised of 4" – 6" solid and perforated PVC piping which distributes stormwater to a soil depth of 3+ feet. Clean outs and elbow sweeps were included for maintenance purposes.

■ To improve water delivery effectiveness and reduce water consumption, separate valves for the meso-riparian tree species were installed. ■ Soil moisture sensors were installed at depths of 8 and 24 inches and linked to the irrigation controller prevent both under and over-watering.

LESSONS LEARNED

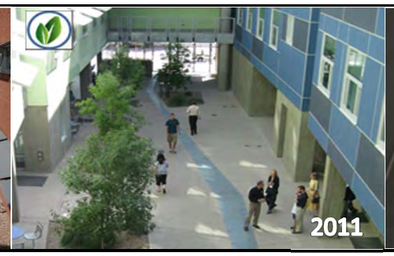
SOMETHING TO BE PROUD OF:

■ Successful team collaboration led to the development and installation of the innovative Deep Water Distribution System which provides supplemental irrigation to the deep-rooted meso-riparian trees used in the canyon-like courtyards of the buildings.
■ The first residence halls in the state to achieve LEED Platinum certification.

SOMETHING TO BE DONE DIFFERENTLY:

■ WSA's design process balanced landscape water needs (demand) and supply options to create landscapes that could be irrigated only by on-site sources (including stormwater runoff and HVAC condensate). ■ Unfortunately, the project budget could not accommodate active harvesting. ■ All passive components were installed, but were unable to meet all water demands. ■ Ideally, buy-in from the client and team members should be obtained early in the dsign pocess to support a balanced, self-sufficient landscape design.

PHOTOS- Arbol de la Vida on Tyndall



PHOTOS- Likins on Highland

PROJECT TYPE: INSTITUTIONAL
■ Education - College
■ New

PROJECT NAME: U OF A RESIDENCE HALLS

PROJECT NAME: U of A VISITOR CENTER

PROJECT TYPE: INSTITUTIONAL ■ Educational College ■ Retrofit

Tucson, AZ

Low Impact/ Green Infrastructure

LID/ GI DEVELOPMENT

DATA

LOCATION	811 N. Euclid Avenue, Tucson AZ 85721
ACRES	32,158 sf 0.74 acre
CLIENT	University of Arizona
CONTACT	Grant McCormick, PDC, grantmc@email.arizona.edu Heather Lukatch, Visitor Center, 520-621-5130
DESIGNED BY	UA Planning, Design and Construction, in collaboration with students, faculty, staff, and West University Neighborhood representatives
COMPLETED	Fall 2007

COST

ESTIMATED COST	$25,000 - $30,000
FUNDING SOURCE	Funding provided by the UA Visitor's Center. Some funding of student labor was provided via a grant from the UA WRRC (Water Resources Research Center)
ACTUAL COST	DESIGN COST: Cost absorbed in staff salaries. CONSTRUCTION COST: Construction was completed by UA FM shops/staff, PDC staff, the UA Arboretum, student employees, and a number of related volunteers. Portions of this work were paid for while some was volunteered and/or absorbed in staff salaries. Most of the project cost shown above was for materials, fabrication of gutters and cistern lids, purchase of plants, etc. VOLUNTEER TIME: Actual volunteer hours were not specifically tracked although the project success depended on volunteer efforts.
MAINTENANCE	Maintained by UA Facilities Management Grounds Services
COMPARE TO CONVENTIONAL	These costs were not estimated.
TIME TO BUILD	4 months

LOCATION MAP

GOALS

REGULATORY: The project design was guided by the University's Design Specification Standards manual (DSS) provisions for surface water and was intended to serve as an illustration of a best practice installation designed in accordance with the DSS. The project was subject to City/Neighborhood historic review and West University Neighborhood review.

STAKEHOLDERS: ► Primary stakeholder: UA Visitor's Center. ■ Goals: Improve the site's landscape for Center employees and visitors. ■ Create a demonstration of sustainable landscape. Prior to the project there was a sparsely planted gravel landscape that was a relic of a prior water-intensive Mediterranean-style commercial landscape. ► West University Neighborhood representatives. ■ Goals: Create a forum to educate the community about water harvesting. ■ Include the possibility to sustain higher water-use crops such as citrus, due to the savings from remaining plants.

PROJECT RECOGNITION: No LEED points sought. Recognition received through dedication ceremony and the site is a frequent stop on campus tours as well as tours for sustainability/water harvesting conferences.

PERFORMANCE MEASURES: ■ Historic review affirmed appropriateness of the design. ■ Almost all rain from most events is retained, mitigating runoff from the existing parking. ■ A good example of minimizing and disconnecting paved surfaces to provide greater infiltration. ■ A good example of passive irrigation catchments and flow paths keyed to the eventual spread of the mature landscape. ■ Goal to remove native plants from drip irrigation is progressing.

SUMMARY

FINISHED PROJECT DESCRIPTION: ■ Existing landscape was renovated using native plants and water harvesting, including addition of two cisterns. ■ Project designed Spring 2007 and installed summer/fall 2007. ■ Drip irrigation was provided to allow native plants to become esablished. Eventually they will be weaned from irrigation. ■ The citrus will remain on irrigation which will be used during harshest months in case rainfall or stored catchment is not adequate.

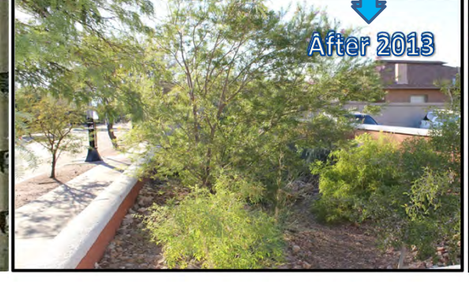
DESIGN FEATURES: ■ Roof gutters and corrugated metal cisterns. ■ Electronic valve actuated gravity flow irrigation system for cistern water. ■ From the cistern, the water is delivered to planting terraces via bubblers. ■ Recessed water harvesting basins were designed in response to a number of site conditions. ■ Native landscape plants were selected due to their character to use harvested water as passive irrigation.

LESSONS LEARNED

SOMETHING TO BE PROUD OF: ■ Natural/ecological characteristics of the site have been enhanced. ■ Edible fruit tree (Lemon) included in project to demonstrate use of harvested cistern water in supporting edible landscape. ■ Project users have been pleased with the result, both as a work environment and as a demonstration/education site. ■ The collaboration of students, faculty, and staff in made this project feasible. ■ The project continues to serve as a demonstration for visitors as well as for the design of subsequent campus projects.

SOMETHING TO BE DONE DIFFERENTLY: ■ Much of the passive water harvesting (basin excavation, landforming, surfacing) and planting was completed by student labor. Implementing a project of this scope using student labor is challenging. Subsequent student projects have been more modest in scope. ■ It may have been helpful to provide a specific maintenance plan and schedule to help clarify planting goals for future maintenance staff as well as to help in transitioning from drip irrigation to only harvested water.

PHOTOS



PROJECT TYPE: INSTITUTIONAL

■ Education- College

■ Retrofit

PROJECT NAME:

U OF A VISITOR CENTER

PROJECT NAME: NATURE CONSERVANCY

PROJECT TYPE: ■ Non-Profit ■ Retrofit

Tucson, AZ

The Nature Conservancy

Low Impact/ Green Infrastructure

PIMA COUNTY FLOOD CONTROL

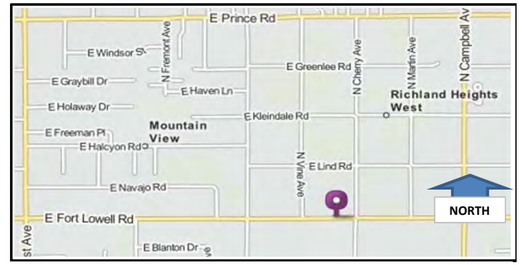
LID/ GI DEVELOPMENT

DATA

LOCATION	1510 E. Ft. Lowell Road
ACRES	2.29 acre
CLIENT	Nature Conservancy, Tucson Office Dorothy Boone Dboone@pnc.org
CONTACT	Water Harvesting Solutions 304 South Lincoln St., Suite 100 Hinsdale, IL 60521
DESIGNED BY	Water Harvesting Solutions
COMPLETED	2009 with upgrades through 2012

COST

ESTIMATED COST	Donation
FUNDING SOURCE	Donation
ACTUAL COST	DESIGN COST: CONSTRUCTION COST:
MAINTENANCE	Volunteer
COMPARE TO CONVENTIONAL	NA
TIME TO BUILD	NA



LOCATION MAP

GOALS

REGULATORY: City of Tucson

STAKEHOLDERS: Tucson Nature Conservancy and its partner

PROJECT RECOGNITION: None was sought.

PERFORMANCE MEASURES: The Tucson Nature Conservancy has a long history of sustainable practices that have been used to demonstrate sustainable landscaping, vegetated swales and rainwater harvesting. The updated system is expected to save 60-70,000 gallons per year with updated drip irrigation system and expanded cistern.

SUMMARY

FINISHED PROJECT DESCRIPTION: ■ The Tucson Nature Conservancy has a long history of sustainable practices that demonstrate sustainable landscaping, water harvesting and solar power. ■ The site includes both active and passive rainwater harvesting techniques: three above-ground cisterns, vegetated swales, basins, curb cuts, dirt berms and permeable paving. ■ In 2012, an underground cistern (30,000 gallons capacity) was added to the project site, because the existing above-grade cistern (3,800 gallons capacity) was not large enough to store the rainwater needed for irrigation, and there was no room on the property for a larger tank. ■ The updated system's passive water quality management uses natural thermal and capillary action to keep water in the cistern moving with a circulation pump, and a natural bio-film on the plates and in the sand layer improves the quality of the water in storage. ■ The system is expected to save 60-70,000 gallons per year while providing a demonstration project to the visiting public on rainwater harvesting storage and treatment methods.

DESIGN FEATURES: ■ The new underground cistern was constructed on-site out of 85% recycled polypropylene crates (Atlantis Underground Tank System from Wahaso). Rainwater is collected from both the building rooftop and off the solar car shade surfaces. ■ A dual filtration step with U.V. sanitation filters the water to 5 microns and essentially sterilizes the water exiting to the irrigation system to minimize any risk to public health. ■ The long dry season required a system that could store the water for months without the risk of it going anaerobic with the associated issues of bad odors and color.

LESSONS LEARNED

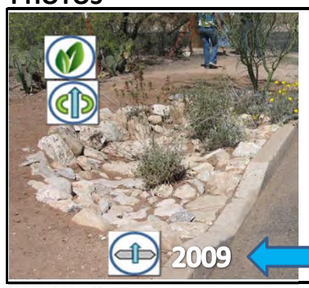
SOMETHING TO BE PROUD OF:

■ The rainwater harvesting project helps to promote appropriate rainwater harvesting and demonstrate beneficial effects of designing with nature, while it also contributes to reducing potable water use and soil erosion. ■ The Nature Conservancy sees the grounds as a community asset where one can learn about sustainability and common sense approaches to sustainable design and practices.

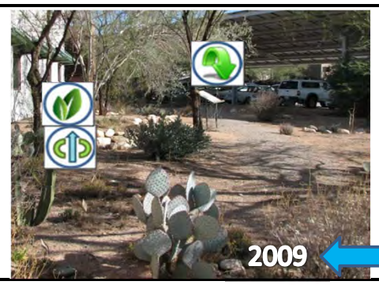
SOMETHING TO BE DONE DIFFERENTLY:

Nothing

PHOTOS



New photos coming Spring 2014



PHOTOS

PROJECT TYPE: INSTITUTIONAL

■ Non-Profit
■ Retrofit

PROJECT NAME:

TUCSON NATURE CONSERVANCY

PIMA COUNTY

PROJECT NAME: TMC EAST CAMPUS

Tucson, AZ

PROJECT TYPE: INSTITUTIONAL ■ Medical Campus ■ Retrofit

Low Impact/ Green Infrastructure

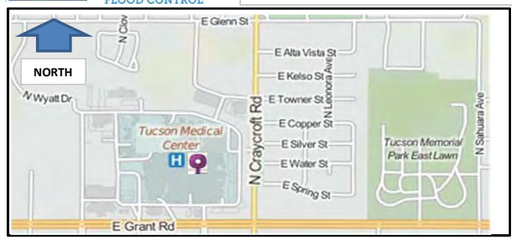
LID/ GI DEVELOPMENT

DATA

LOCATION	5301 E. Grant Road, Tucson, Arizona 85712 Northwest corner Craycroft Road and Grant Road
ACRES	15.38 Acres (670,051 SF)
CLIENT	TMC Judith F. Rich, President, Chief Executive Officer Richard Prevallet, VP, Facilities and Construction
CONTACT	Richard Prevallet
DESIGNED BY	RBF Consulting - Engineer Kimley-Horne - Landscape Architect DLR Group - Design Manager
COMPLETED	2010

COST

ESTIMATED COST	Project scope changed monthly- no initial estimate requested.
FUNDING SOURCE	TMC
ACTUAL COST	DESIGN COST: $154,451 (Landscape) CONSTRUCTION COST: 12.5 M (All project)
MAINTENANCE	TMC Grounds Maintenance
COMPARE TO CONVENTIONAL	Not evaluated
TIME TO BUILD	18 months



LOCATION MAP

GOALS

REGULATORY: ■ Design had to fulfill the PAD (Planned Area Development), a document that surrounding neighbors helped draft with the COT Planning Department. ■ The Alamo Wash complied with the City of Tucson W.A.S.H. and Native Plant Preservation (NPP) Ordinances. ■ Although no regulations mandate water harvesting for this type of Institutional project, TMC and the design team strongly endorsed and followed Tucson's Water Harvestin guidelines. ■ View Corridor compliance at Grant and Craycroft.

STAKEHOLDERS: ► TMC wanted a design to both beautify the campus and create a welcoming presence. ► The surrounding neighbors wanted minimal visual impact to their communities. The low profile of the view corridor and perimeter parking complied with this goal. ■ They also requested a pathway along the Alamo Wash to provide continuity to the paths both up and down stream of the campus. Less than a mile to the north, the Alamo Wash reaches the Rillito Riverpark and The Loop path system which, when completed in the near future, will circumvent the entire city.

PROJECT RECOGNITION: 2011 Engineering News Record Southwest Best Healthcare Project Award of Merit

PERFORMANCE MEASURES:
Not determined.

SUMMARY

FINISHED PROJECT DESCRIPTION: ■ The civil and landscape improvements provide a fresh face to the TMC east campus which had not been upgraded for some time. Since many of the shrubs were overgrown, creating hiding spaces, each area was evaluated to determine whether pruning or removal was required. ■ A new bridge allowed access from Craycroft Road. ■ A 10' multi-use path was created along the Alamo Wash and has become a well traveled route by visitors and employees of the hospital, as well as local neighbors. ■ Previously , all runoff was directed to the concrete lined Alamo Wash. The landscape design provides numerous opportunities for the stormwater to be slowed and allowed to infiltrate into the ground. ■ The large angular rock used in the water harvesting swales not only functions to slow the water so plants can access it more easily, but it provides an aesthetic textural relief in contrast to the smoother asphalt and decomposed granite surfaces nearby.

DESIGN FEATURES: ■ Required parking lot landscaping was provided in linear medians located at the head-end of the parking rows. All medians have flush curbs allowing surface runoff access to landscape areas, plus a raised curb on the opposing side to delay the rainfall and allow greater infiltration. ■ The corner of Craycroft and Grant was designed without structures to provide a view corridor to the Santa Catalina Mountains. The creation of a winding swale, lined with angular rock allows slowing of the stormwater flow and optimal infiltration to support the adjacent landscaping.

LESSONS LEARNED

SOMETHING TO BE PROUD OF: ■ Early in the project, COT DOT called and offered a large saguaro from the adjacent roadway widening project that would have to be destroyed because it was too large to move. TMC accepted the saguaro and it was carefully integrated into the early design so no impacts would occur during construction. ■ Teamwork was very positive on the project: the Civil Engineer at RBF worked closely with the Landscape Architect at KHA, to provide effective water harvesting throughout the parking and perimeter landscaping. This coordination and teamwork allowed the functional and aesthetic sides of the project's drainage/ water harvesting system to be fully blended. The contractor, Borderland Construction, also was diligent to clarify design issues rather than make assumptions that could alter the integrity of the design.

SOMETHING TO BE DONE DIFFERENTLY:
Although it was out of the question at the time of the project, the ultimate acheivement would have been to naturalize the Alamo Wash from its concrete-lined channel back to the earthen channel as found on the upstream and downstream ends.

PHOTOS

PHOTOS

PROJECT TYPE: INSTITUTIONAL
- Medical Campus
- Retrofit

PROJECT NAME:
TMC EAST CAMPUS

PROJECT NAME: TPD FORENSIC CRIME LABORATORY

PROJECT TYPE: INSTITUTIONAL ■ Municipal Facility ■ New

Tucson, AZ

Low Impact/ Green Infrastructure

LID/ GI DEVELOPMENT

DATA

LOCATION	1306 W. Miracle Mile, Tucson, Arizona 85705	Northeast corner Miracle Mile and Flowing Wells Road
ACRES		Building - 62,377 SF Site - ~8.6 acres
CLIENT		City of Tucson Joe Loranger, Project Coordinator
CONTACT	Michael Becherer RA	mbecherer@wsmarch.com
DESIGNED BY		WSM - Architects, DOWL HKM - Engineering, Kimley-Horn - Landscape Architecture
COMPLETED		August, 2011

COST

ESTIMATED COST	$ 20 Million
FUNDING SOURCE	Public
ACTUAL COST	DESIGN COST: $45,000 (Landscape) CONSTRUCTION COST: $23M (Total)
MAINTENANCE	City of Tucson
COMPARE TO CONVENTIONAL	Not evaluated
TIME TO BUILD	18 months

LOCATION MAP

GOALS

REGULATORY: ■ Design had to blend with the adjacent Westside Police Substation. ■ Compliance with City of Tucson Development Standards was required, including the addition of landscape borders and compliance with the Native Plant Preservation Ordinance. ■ While the City's Commercial Rainwater Harvesting Ordinance had not yet taken effect, this project was asked to comply as closely as possible to serve as a model for future municipal construction projects.

STAKEHOLDERS: ■ All irrigation for the project must come from on-site sources, including rainfall captured from the roof, HVAC condensate (which minimizes waste and recovers energy), backwash from a large scale reverse osmosis system, and graywater from fixture waste. ■ This harvested water is stored in a series of underground tanks. ■ Must allow adjacent Tucon Police substation to use excess harvested water. ■ A weather station will be incorporated into the irrigation controller so that the system can effectively monitor the precise amount of irrigation that is required based on the local weather conditions and on the needs of the plants.

PROJECT RECOGNITION: 2012 Merit Award Winner for "Best Of" Government/Public Buildings in Arizona/Nevada/New Mexico - ENR-Southwest Contractor

PERFORMANCE MEASURES: For the first two years, a spreadsheet will be generated to show expected inflows and outflows on a weekly basis. ■ Total water use for the baseline case was determined to be 1,150,729 gallons. ■ After evaluating the irrigation efficiencies for each area, the total water use for the design case was determined to be 218,925 gallons. This figure results in an 81% water savings when compared to the baseline case.

SUMMARY

FINISHED PROJECT DESCRIPTION: ■ The project was designed with a high-tech drip irrigation system including a state-of-the-art weather monitoring equipment that adjusts irrigation based on localized weather data. This system will assure establishment of the low water-use drought tolerant plants selected from the Arizona Department of Water Resources plant list. ■ Most likely, within three years, on-site plants will be independent of potable water. ■ Water collected from the Crime Lab site and used for the on-site vegetation will also be shared with the adjacent Tucson Police Substation. ■ When collected levels are below anticipated, the available water will be shared per an agreed upon schedule. ■ Condensate and water from other building systems are being drained into the tanks in addition to harvested stormwater.

DESIGN FEATURES: ■ The expectation is to collect about 1.1 million gallons of non-potable water each year and store it in (2) 40,000 gallon underground tanks. ■ A baseline design scenerio using typical plant materials projected the water demand to be 1,150,729 gallons per year. ■ The actual design, using low-water plant materials and zoning higher water use exclusively in high visitbility/ high-use areas, and selecting low to no water-use plants to the fringe of the site reduced the projected water demand to 218,925 gallons per year. ■ The adjacent existing Tucson Police Substation currently uses 260,000 gallons of potable water for irrigation every year. ■ The goal is neither site will use any potable water for landscape vegetation.

LESSONS LEARNED

SOMETHING TO BE PROUD OF:
The unique approach of requiring the Crime Lab site to use no potable water for landscaping *plus* providing sufficient non-potable/ harvested water for the adjacent Police Substation landscaping resulted in receipt of the 2012 Merit Award Winner for "Best Of" Government/Public Buildings.in Arizona/Nevada/New Mexico - ENR-Southwest Contractor.

SOMETHING TO BE DONE DIFFERENTLY:
The biggest challenge that the project has faced post-construction is the quality of the water that is originating from the rainwater harvesting tanks. Recent analysis has shown excessive amounts of sodium which is negatively impacting the plants. The high sodium content is likely due to the addition of water draining from the cooling tower blowdown or the Reverse Osmosis Reject water . Efforts are underway to improve water quality by preventing water from these sources from entering the tanks.

PHOTOS - Before

PHOTOS -After

PROJECT TYPE: **INSTITUTIONAL**
- ■ Municipal Facility
- ■ New

PROJECT NAME:
TPD FORENSIC CRIME LABORATORY

PROJECT NAME: Tucson Water Department- Eastside Service Center

PROJECT TYPE: INSTITUTIONAL ■ Municipal Facility ■ New

Tucson, AZ

ARCHITECTURAL*fusion*

Low Impact/ Green Infrastructure

LID/ GI DEVELOPMENT

DATA

LOCATION	10445 E Golf Links (at Houghton Rd)
ACRES	6.14 Acres / 267,324 SF
CLIENT	City of Tucson Water Department
CONTACT	Jim Meskan, Tucson Water Project Manager Jim.Meskan@tucsonaz.gov 837-2194
DESIGNED BY	aba Architects with consultants: i. Urban Engineering, Civil Engineers ii. Structural Concepts, Structural Engineers iii. ARC Studios, Landscape Architects - Eric Barrett T: 520-882-9655 iv. Architectural Fusion, LEED Consultant
COMPLETED	16-Dec-11

COST

ESTIMATED COST	$7,968,621
FUNDING SOURCE	COT Water Department Capitol Improvement Funds
ACTUAL COST	TOTAL PROJECT COST: $7,968,621 TOTAL PLANNING & DESIGN COST: $794,425 TOTAL CONSTRUCTION COST: $5,952,540 (Lang Wyatt Construction)
MAINTENANCE	COT Facilities Management, funded by Tucson Water operations budget
COMPARE TO CONVENTIONAL	No specific breakdown available but within budget estimated & allocated, which was based on comparables to conventional construction & development.
TIME TO BUILD	14 Months and 24 Days (450 Days)

LOCATION MAP

GOALS

REGULATORY: Properly placed drainage basins minimize disturbance to the natural topography; fulfill Native Plant Preservation Ordinance using Open Space set aside option.

STAKEHOLDERS: ■ Include water conservation with use of smart irrigation controllers in the landscape irrigation system; by incorporating LID rainwater harvesting principals; by including low-flow toilets, faucets, showerheads, and waterless urinals; use evaporative cooler "waste" gray water for landscape irrigation. ■ Provide Urban Heat Island Mitigation through careful siting of building structures and placement of canopy trees and use of reflective roofing ■ Reach out to the community with information on sustainability elements.

PROJECT RECOGNITION: ■ COT Mandate for all new COT Facilities: minimum LEED Silver Certification level. Final LEED Certification Level : Silver ■ US EPA's "Designed to Earn the ENERGY STAR" certified.

■ Annual Star Builders (manufacturer of custom designed metal building systems) Conference, Master Builder category awards for: "Best of Government" and "Best of Pacific Southwest"

PERFORMANCE MEASURES have all been met except: ■ Buildings have been sited & canopy trees placed appropriately, but the newly planted trees have yet to mature. ■ Tucson Water has just begun developing their educational program and has yet to make it available to the community. ■ Reduced fossil fuel consumption. ■ Constructability Acceptable

SUMMARY

FINISHED PROJECT DESCRIPTION: Construct satellite facility for eastside Metering & Maintenance staff, housed in a 15,925 SF Office/Shop Building with an on-site 6,975 SF Warehouse. ■ Water Conservation: 1. Landscaping irrigation system incorporated LID structural rainwater harvesting (cisterns) and non-structural (swales) plus c. "Real Time" smart irrigation controllers monitor local weather data to adjust watering times and duration. 2. Building plumbing included low-flow toilets, faucets & showerheads, as well as waterless urinals. 3. Mechanical system conserved evaporative cooler "waste" gray water by piping to landscape irrigation system. ■ Urban Heat Island Mitigation: 1. Siting of building structures & placement of canopy trees will shade 50% of vehicle use area during summer solstice peak heating hours. 2. Solar reflective roofing ■ Education: 1. Tucson Water is planning on creating materials/information highlighting the sustainability elements for distribution via brochures and/or bill mailing inserts, and the Tucson Water website.

DESIGN FEATURES: ■ Rainwater Harvesting Cisterns: Twelve (12) rainwater collection cisterns line the south elevations of both buildings (down slope side of the roof) for irrigating new native plant landscaping: Total water capacity storage of cisterns: 40,176 gallons Potential annual rainwater yield from roof surfaces: 157,648 gallons (based on average historical rainfall data)

■ Landscape set-aside: 7.86 acres of native vegetation preserved as Natural Undisturbed Open Space (NUOS) for perpetuity, by recorded plat.

LESSONS LEARNED

SOMETHING TO BE PROUD OF: The twelve rain water collection cisterns lining the south elevations of both buildings are visible from both major roadways establishing their placement as an architectural enhancement and promoting a new community aesthetic. The water conservation achievements are especially important to Tucson Water as part of the City Department/Utility's mission statement to manage this precious resource wisely. The TW Satellite concept provides an office & support facility in the Water Service Areas that field staff actually work in, on a daily basis. This will conserve fuel for sixty (60) field staff service vehicles & five (5) heavy construction vehicles, and

SOMETHING TO BE DONE DIFFERENTLY:
Spend more time considering & finding funding for incorporating solar collector energy generation into the project. In 2007 during preliminary design, solar energy technology was considered too expensive and the collectors were considered an unattractive architectural feature by most of the public.

PHOTOS

After- 2015

PROJECT TYPE: INSTITUTIONAL

■ Municipal Facility

■ New

PROJECT NAME:

TUCSON WATER -

Eastside Service Center

PIMA COUNTY

PROJECT NAME: WATER & ENERGY SUSTAINABILITY CENTER, aka ROMP LAB

Tucson, AZ

PROJECT TYPE: ■ INSTITUTIONAL ■ Municipal Facility ■ New

Low Impact/ Green Infrastructure

LID/ GI DEVELOPMENT

DATA

LOCATION	3035 W El Camino del Cerro, Tucson, AZ 85745
ACRES	11 AC
CLIENT	Pima County Regional Wastewater Reclamation Department
CONTACT	Adam Bliven, Pima County Regional Wastewater Reclamation Department email: Adam.Bliven@wwm.pima.gov; phone: 520-690-2745
DESIGNED BY	Wheat Scharf Associates - Planting, Hardscape and Water Harvesting design Stantec Consulting Services - Civil Engineer HDR- Architect Pattison Evanoff Engineering - Geotech
COMPLETED	December, 2011

COST

ESTIMATED COST	28 million
FUNDING SOURCE	Public - Pima County
ACTUAL COST	DESIGN COST: $123,000 Irrigation; $137,000 Pathways $50K Gabion; $63K Site furnishings $46K Riprap; $75K Plantings CONSTRUCTION COST: $28,870,000.
MAINTENANCE	Public - Pima County
COMPARE TO CONVENTIONAL	N/A
TIME TO BUILD	12 months

LOCATION MAP

GOALS

REGULATORY: Pima County Regulations as well as City of Tucson regulatory requirements for a critical facility

STAKEHOLDERS: ►Pima County Regional Wastewater Reclamation Department.
■ Goal : LEED Certification.

PROJECT RECOGNITION: Registered with USGBC; nominated for Common Ground award

PERFORMANCE MEASURES: LEED Certification: Reduce potable water consumption for irrigation by 50% from a calculated mid-summer baseline case (LEED for New Construction)

SUMMARY

FINISHED PROJECT DESCRIPTION: ■ Part of Pima County's Regional Wastewater Reclamation complex, this project's charge included demonstrating and showcasing County sustainability goals including water harvesting and the use of indigenous landscape plants. ■ WSA developed the overall landscape concept with pedestrian circulation and interpretive trails including interface with The Loop, and incorporating passive water harvesting throughout. ■ Techniques and features include microbasins, gabion weirs, curb cuts, and swales with check dams. ■ Fine grading directs site and parking stormwater runoff to recessed planting areas. ■ Secondary stabilized DG pathways are raised above landcape areas. ■ Roof drains direct storm water through a water feature into a sequence of planted water harvesting basins linked by weirs. ■ Sonoran Desert plant species, including a diverse collection of cacti, showcase the beauty of native, low-water usage plants.

DESIGN FEATURES: ■ Water harvesting techniques include microbasins, weirs using rock-filled gabions, curb cuts, and swales with check dams. ■ Water is collected from the roof and directed to a rain-event water feature and site runoff is directed through the weirs to recessed planting areas. ■ The trees and shrubs selected are primarily arid adapted, desert plant species. Mesquite and Palo Verde figure prominently in the planting design and are keystone Sonoran Desert native plants. ■ A large detention basin features native species like Net-leaf Hackberry and Arizona Walnut that are adapted to periodic inundation. ■ All supplemental water used for landscape irrigation is reclaimed. ■ Pervious pavement allows additional water capacity on-site.

LESSONS LEARNED

SOMETHING TO BE PROUD OF:

■ An existing site, devoid of vegetation, has been transformed into a showcase of sustainability .■ The landscape has been embraced by the staff - soon after the landscape was installed, WSA was asked to create a brochure detailing plant material and water harvesting features in order to assist staff when giving tours to the public.

■ Supported by extensive water harvesting, the landscape is primed to endure and inspire for many years.

SOMETHING TO BE DONE DIFFERENTLY:

■ Setting the correct height of the leveling pipe and overflow outlet drains (used to provide overflow from a basin and prevent flooding) can be challenging. ■ Early coordination with the Civil Engineer is suggested.

PHOTOS

PHOTOS

PROJECT TYPE: INSTITUTIONAL

■ Municipal Facility
■ New

PROJECT NAME:

Water & Energy Sustainability Center

RECREATION

LINEAR PARK

NEIGHBORHOOD PARK

REGIONAL PARK

BASIN

I

	RECREATION
	NEW Linear Park
	RETRO Linear Park
	NEW Neighborhood Park
	RETRO Neighborhood Park
	Blue Moon Community Garden- Tucson House* (Residential)
	Highland Vista
	NEW Regional Park
	RETRO Regional Park
	NEW Basin
	RETRO Basin
	Kolb Road Basin

*Cross category

Under consideration:
Broadmoor Pocket Park
Centennial Park
Julian Wash River Park- Kolb to Rita Ranch
KERP (Kino Environmental Restoration Park)
Manuel Herrera Park
Paseo de las Iglesias
Star Valley Dog Park
Tohono Chul Sin Agua Garden
Tucson Botanical Garden

PROJECT NAME: BLUE MOON COMMUNITY GARDEN (Tucson House) Tucson, AZ

PROJECT TYPE: RECREATION ■ Neighborhood Park ■ Retrofit

Cross Category: Residential- Multi-Dwelling

NORRIS DESIGN

Low Impact/ Green Infrastructure

LID/ GI DEVELOPMENT

DATA

LOCATION	1501 North Oracle Road
ACRES	1 Acre +/-)
CLIENT	TUCSON HOUSING AND COMMUNITY DEVELOPMENT 301 N. COMMERCE PARK LOOP TUCSON, ARIZONA 85726
CONTACT	GINA CHOROVER (520) 837-6946 Gina.Chorover@tucsonaz.gov
DESIGNED BY	Norris Design 418 N. Toole Ave Tucson, AZ 85701 (520) 622-9565
COMPLETED	5/30/2012

COST

ESTIMATED COST	$288,000.00
FUNDING SOURCE	CCBG Grant, Tucson Water Grant, HCD Grant, CPPW Funds
ACTUAL COST	DESIGN COST: $28,000.00 CONSTRUCTION COST: $307,000.00
MAINTENANCE	Community Gardens of Tucson
COMPARE TO CONVENTIONAL	Cost increases were a result of the addition of tapping the condensate lines, meter devices and the interpretive signage for the rainwater harvesting system.
TIME TO BUILD	3 months

LOCATION MAP

GOALS

REGULATORY: City of Tucson

STAKEHOLDERS:

► Tucson House, a high rise development which is home to over 600 low-income, disabled, elderly residents and adjacent neighbors.

► Community Gardens of Tucson

PROJECT RECOGNITION: AZ ASLA Honor Award for General Design 2013

PERFORMANCE MEASURES: ■ ADA Accessibility. ■ Passive and active rainwater harvesting from 1/4 of the Tucson House roof and condensate from HVAC. ■ Reuse existing fire suppression 15,000 gal water tank. ■ Pump harvest water to second on-site cistern. ■ Metering devices for both potable and harvested rainwater, and power. ■ Tucson Water Demonstration Garden. , Community Gardens of Tucson design and equipment standards.

SUMMARY

FINISHED PROJECT DESCRIPTION: ■ The Blue Moon Community Garden is the first fully-accessible community garden in Tucson. ■ The 42,500 square foot site includes 36 garden beds, a citrus grove, butterfly garden, a central promenade, gathering areas with a shade ramada, barrier free design, and a loop trail with connectivity to the Tucson House. ■ The landscape architect developed interpretive signage to educate residents and visitors about the garden and the active water harvesting system that provides irrigation to the garden beds. ■ In addition, a 15,000 gallon rainwater harvesting tank captures rainwater and A/C condensate from a 17- story building, providing water for the landscape plants and fruit trees. ■ The garden was selected as a Tucson Water Demonstration Garden.

DESIGN FEATURES: ■ Reclaimed approximately 1 acre of existing parking lot. ■ Reused existing 15,000 gal water tank. ■ Added a second cistern and pump with brain boxes to irrigate with harvested rainwater. ■ Installed meters for potable and reclaimed water and the power used on-site. ■ Installed soil moisture sensing devices and controller which automatically adjusts water time using on-site soil moisture as a basis. ■ Tied into HVAC condensate line which is also metered. ■ Through a charrette process designed garden beds of varying heights and styles to accommodate a variety of disabilities. ■ Provided lockers for garden users and a compost station.

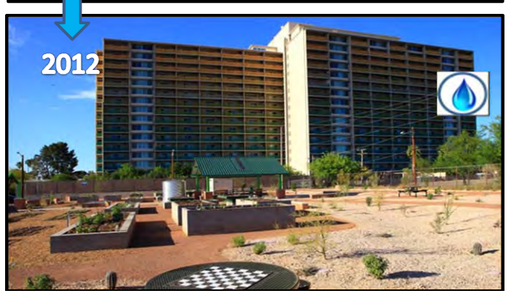
LESSONS LEARNED

SOMETHING TO BE PROUD OF: ■ The garden was selected as a Tucson Water Demonstration Garden and received AZ ASLA Honor Award for General Design 2013. ■ The garden is at capacity and provides an inexpensive food source for a neighborhood that has been described as located in a food desert. ■ Through post design assessments we determined the garden has become a gathering place for the Tucson House residents and neighbors. ■ This project has been designed with metering devices to become a study site with the potential to determine everything from the cost of a harvested gallon of water to the toxicity levels of fruit harvested from the citrus grove.

SOMETHING TO BE DONE DIFFERENTLY: ■ The raised still garden beds which provide accessibility to people in wheelchairs created a drainage issue with the method of construction and the amount of over-watering by it users. ■ The center should be wider to provide more drain rock between the CMU cells and or vertical gravel sumps should be installed in future beds of this kind.

PHOTOS - Before

PHOTOS - After



PROJECT TYPE: RECREATION
- ■ Neighborhood Park
- ■ Retrofit

Cross Category: Residential

PROJECT NAME: BLUE MOON COMMUNITY GARDEN (Tucson House)

PIMA COUNTY

PROJECT NAME: HIGHLAND VISTA

PROJECT TYPE: RECREATION ■ Neighborhood Park ■ Retrofit

Tucson, AZ

Low Impact/ Green Infrastructure

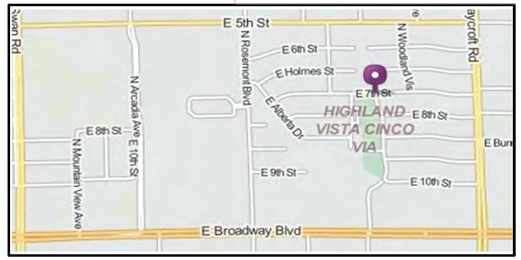
LID/ GI DEVELOPMENT

DATA

LOCATION	5300 E Seventh Street. Nearby the 20/30 Club.
ACRES	1.16 Acres (50,700 sft)
CLIENT	City of Tucson Parks and Recreation
CONTACT	Joe O'Neill joe.o'neill@tucsonaz.gov 837-8035
DESIGNED BY	Wheat Scharf Associates
COMPLETED	2010

COST

ESTIMATED COST	Not calculated
FUNDING SOURCE	Neighborhood Reinvestment Bonds
ACTUAL COST	TOTAL: $64,797 DESIGN: $9,335 Concept and Construction Documents CONSTRUCTION: $55,462
MAINTENANCE	City of Tucson Parks and Recreation- Focus on reduction of Bermuda Grass.
COMPARE TO CONVENTIONAL	Not calculated
TIME TO BUILD	Estimate 4 months



LOCATION MAP

GOALS

REGULATORY: Community Initiative, no regulatory requirement

STAKEHOLDERS: (Neighborhood): Develop a passive recreation park ■ Use water harvesting techniques to mitigate storm water flow in the residential neighborhood ■ Transform a problematic stormwater drainage situation into an aesthetic improvement ■ Create a Natural Area Enhancement ■ Education ■ Preservation of natural corridors ■ Habitat restoration ■ Recreation ■ Eliminate ponding water and associated mosquito habitat ■ Reduce pollutants flowing into washes ■ Reduce erosion, runoff and sedimentation

PROJECT RECOGNITION: Project did not seek LEED designation.

PERFORMANCE MEASURES: Constructed per plans and specifications. Stakeholder goals met. Greater infiltration has reduced mosquito habitat and runoff.

SUMMARY

FINISHED PROJECT DESCRIPTION: The project is a riparian restoration for an area in the south portion of 20/30 Park bordered by Arcadia Wash to the south and an existing walking path to the north. Additional paths increase the site's recreational value. The design includes a system of passive water harvesting basins and plantings to mitigate issues with storm water flow in the area.

DESIGN FEATURES: 'Boomerang Berms' for water harvesting ■ Micro-catchment basins for catching water in shallow depressions ■ Infiltration Basins with Check Dams for catching off-site runoff and infiltrating it ■ Preservation of existing vegetation ■ Walking path ■ Educational display ■ Native plant pallet. ■ Inclusion of Brad Lancaster, author of Rainwater Harvesting for Drylands and Beyond, for design review gave additional insight to the solution.

LESSONS LEARNED

SOMETHING TO BE PROUD OF:

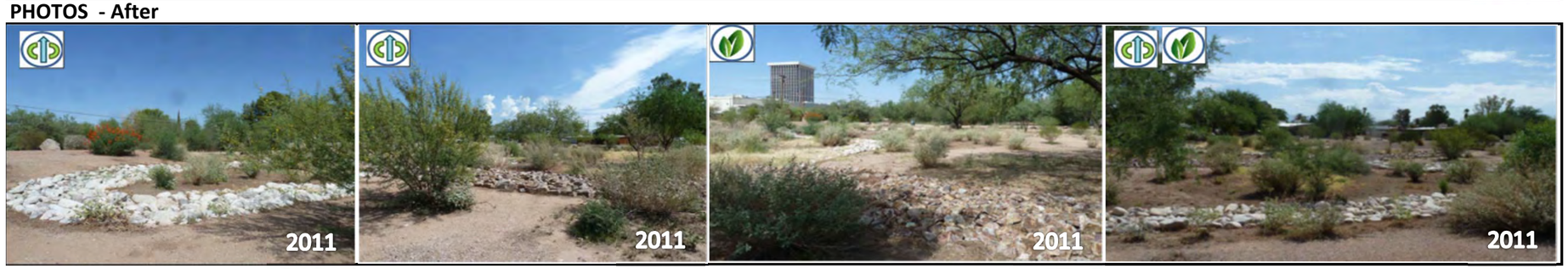
Transformation of a former City of Tucson Department of Transportation storage facility ■ Increased wildlife habitat ■ Community loves it ■ Many water harvesting design elements in a small space ■ Nice signage ■ Artistic use of rock (white rock reflects path of water and brown rock are the check dams) ■ Neighborhood kids enjoy hiking along the different rock paths

SOMETHING TO BE DONE DIFFERENTLY:

Add more seating under shade trees; include a variety of seating opportunities (in shady spots, open areas, elevated, quiet for bird watching). ■ Subtle grade changes are hard for contractors who are inexperienced with water harvesting to embrace. These subtleties must be emphasized or re-work will be required. ■ Older neighborhoods conribute a lot of noxious weed seed during rain events. Growth of invasive Bermuda grass and palm tree seed has been an on-going

PHOTOS - Progression

PHOTOS - After



PROJECT TYPE: RECREATION

■ Neighborhood Park
■ Retrofit

PROJECT NAME:

HIGHLAND VISTA

PROJECT NAME: KOLB DETENTION BASIN RETROFIT

PROJECT TYPE: RECREATION ■ Detention Basin ■ Retrofit ■ Riparian Habitat Restoration / Mitigation

Tucson, AZ

GRANITE

Low Impact/ Green Infrastructure

LID/ GI DEVELOPMENT

DATA

LOCATION	7700 S Kolb Road, East side, South of Julian Wash
ACRES	16 acres
CLIENT	Pima County and Granite Construction Company
CONTACT	Novak Environmental, Inc., 520-206-0591, Karen Cesare
DESIGNED BY	Novak Environmental, Inc. with input from UA Landscape Architecture Student Matthew Bossler
COMPLETED	January, 2012

COST

ESTIMATED COST	$118,000 - Grading, Landscape, Irrigation
FUNDING SOURCE	Private Funding--Granite Construction Company
ACTUAL COST	DESIGN COST: $35,000 CONSTRUCTION COST: $118,000
MAINTENANCE	$18,700 for years 1-5
COMPARE TO CONVENTIONAL	None
TIME TO BUILD	3-4 Months

LOCATION MAP

GOALS

REGULATORY: Riparian mitigation for land disturbed by Granite Construction at another site.

STAKEHOLDERS:

► Pima County Flood Control District is the owner and primary stakeholder. ■ The District wanted to minimize long-term operations and maintenance commitment by implementing a plan that conserved water, and preserved the existing natural corridor while also enhancing natural areas while limiting the spread of invasive species.

PROJECT RECOGNITION: No specific project recognition and no LEED points sought.

PERFORMANCE MEASURES: ■ The project was completed in January 2012, so it is too early to determine its long-term success. ■ The innovative mid-slope bench water harvest basin is functioning as designed and young revegetative plantings are becoming established.

SUMMARY

FINISHED PROJECT DESCRIPTION: ■ The Kolb Basin Riparian Habitat Mitigation Project is located near I-10 and Kolb Road, between the Julian Wash Greenway multi-use path and the University of Arizona Science and Technology Park. ■ The project is a public/private partnership between Pima County Regional Flood Control District and Granite Construction Company with the goal of compensating for impacts to riparian habitat at Granite's nearby sand and gravel facility. ■ Granite and their consultant, Novak Environmental, Inc. worked with University of Arizona Landscape Architecture Masters student, Matthew Bossler, to design an off-site riparian habitat mitigation project that used stormwater runoff to enhance and establish riparian vegetation within the Kolb Road Detention Basin.

DESIGN FEATURES: ■ Approximately 16 acre project site. ■ 6" deep water harvest basins to capture stormwater entering the site from the Julian Wash and small upstream watersheds. ■ Constructed basins provide about 7 acre feet of stormwater storage. ■ Constructed basins were placed within sparsely vegetated areas containing native and non-native invasive plant species (buffelgrass, Johnsongrass, African lovegrass, desert broom). ■ "Planting bench" was constructed to control erosion by collecting stormwater along basin sideslopes and establishing vegetation there. ■ The vegetation planted included 1,329 tall pot plants and about 14 acres of hydroseed. ■ Buffelgrass was removed from areas of existing vegetation to remain. ■ A temporary irrigation system was installed to establish the plantings (approx. 2-3 years)

LESSONS LEARNED

SOMETHING TO BE PROUD OF:

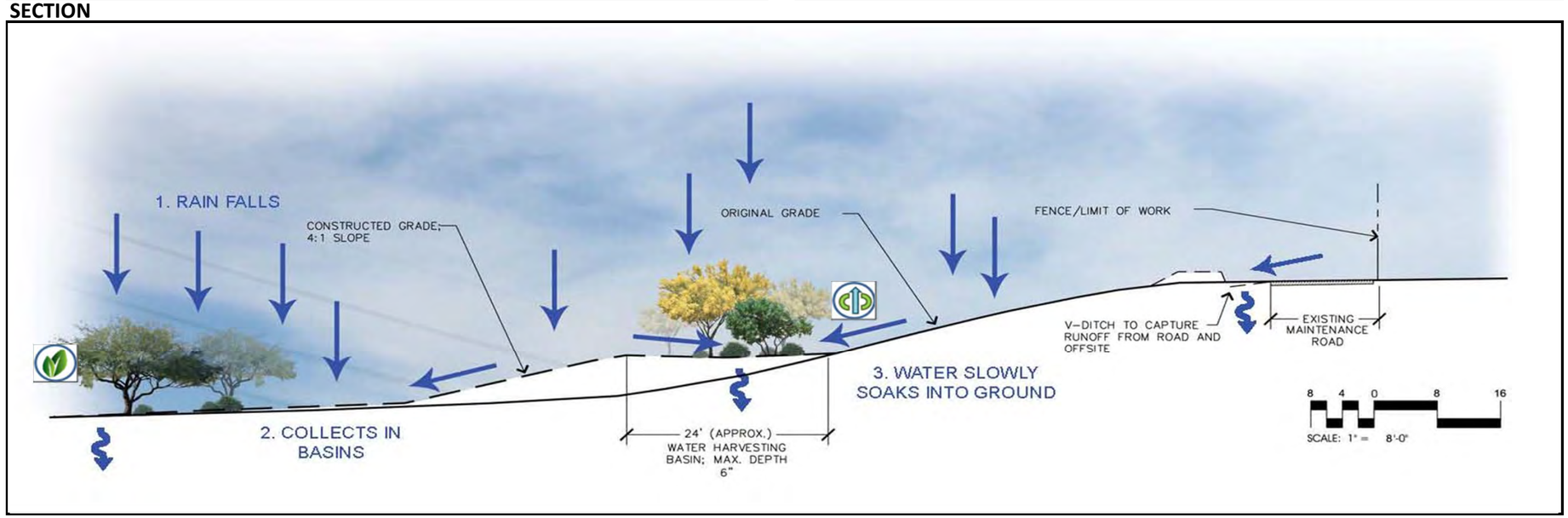
■ This project was a cooperative effort between government and private industry that also included a thesis project for a Master's student at the University of Arizona. ■ Mitigation for one site 's impacts on riparian habitat was allowed to be provided off-site. ■ Through this effort, Pima County Regional Flood Control District received a list of plants that can withstand varying amounts of inundation.

SOMETHING TO BE DONE DIFFERENTLY:

■ The temporary irrigation lines should be installed deeper to minimize the damage by wildlife chewing the tubing.

■ There is some ponding behind the berms and it is unclear whether this will become a long-term problem.

SECTION



PROJECT TYPE: RECREATION

- Riparian Habitat Restoration/Mitigation
- Detention Basin
- Retrofit

PROJECT NAME:

KOLB DETENTION BASIN RETROFIT

PIMA COUNTY

RESIDENTIAL

SINGLE FAMILY

MULTI-DWELLING

SUBDIVISION

MASTER PLANNED COMMUNITY

I

	RESIDENTIAL
	NEW Single Family
	Cole/ Townsend Residence
	RETRO Single Family
	Brad Lancaster Residence
	NEW Multi-dwelling
	RETRO Multi-dwelling
	Tucson House- Blue Moon Community Garden- * (Recreation)
	NEW Subdivision
	RETRO Subdivision
	NEW Master Planned Community
	RETRO Master Planned Community

*Cross category

Under consideration:
Civano
Milagro
Simpson House
Sonoran Co-Housing
Stone Curves
Willowridge Commons HOA

PROJECT NAME: THE COLE/ TOWNSEND RESIDENCE Cistern for Household Use

PROJECT TYPE: RESIDENTIAL ■ Single Family ■ New ■ *Suitable to any project type and retro-fit*

Tucson, AZ *Contractor, Alain Provost*

LID / GI DEVELOPMENT

Low Impact / Green Infrastructure

DATA

LOCATION	6381 W. Sweetwater Drive, Tucson 85745
ACRES	Lot = 4.3 acres. Roof = catchment area = 5,250 square feet.
CLIENT	Charles J. Cole (Jay) and Carol R. Townsend
CONTACT	Jay Cole cole@amnh.org
DESIGNED BY	Alain Provost, Contractor, Tucson, AZ alainprvst@yahoo.com
COMPLETED	2003

COST

ESTIMATED COST	N/A
FUNDING SOURCE	Homeowner
ACTUAL COST	DESIGN COST: N/A CONSTRUCTION COST: $35,000 for all water harvesting elements: Gutters, downspouts, collection pipes, first flush filters, pumps, cistern, fine-grade filters, reverse osmosis system
MAINTENANCE	Homeowner pays ~$64 a month to a local professional water company to cover all water treatment system maintenance costs: filter replacements (first flush filter replaced every 7 years), filter flushing and general plumbing. Do-it-yourself would be very inexpensive.
COMPARE TO CONVENTIONAL	Comparative costs from other homes will include monthly water bill plus some or all of the following: reverse osmosis and/ or water softener and/ or iron filter and/ or bottled water.
TIME TO BUILD	Installation of water harvesting features only- 3 to 4 weeks as new construction. Retrofit would take longer.

LOCATION MAP

GOALS

REGULATORY: Regulations were not developed at construction.

STAKEHOLDER GOALS (OWNERS): Charles J. Cole (Jay) and Carol R. Townsend.
SINGLE GOAL: Provide high-quality water for all household uses without accessing city or CAP water. **HISTORY:** During parts of many years, Jay and Carol stayed in Guyana, South America which is located in a tropical rainforest. A remote ranch house they lived in was built on stilts, and captured rainwater in a giant rubber bucket cistern beneath the house. This primitive collection system had no filtration, the water was used for all household needs and no one ever got sick. Now inspired, Jay and Carol hired a contractor and had their Tucson home built, fully independent of a city water system.
Their contractor, Alain Provost, based his design on: Pfeiffer, P. L., *"Rainwater-Collection Systems."* Fine Homebuilding. November, 2001: pp. 84—89. The Cole's home was his first with a rainwater harvesting system.

PROJECT RECOGNITION: No recognition sought.

PERFORMANCE MEASURES: ► Wonderful drinking water! ► It took 2 years to have consistent capacity in cistern. From 2005 on, no city, CAP, reclaimed, bottled or well water used for drinking, household, pool and garden uses. Well water is used for landscape. 2013 drought precluded gardening capability. ► On 8/15/2014 the tank was 58% full (14,900 gall). By 9/11/2014 it was at 80% with 21,000 gall. In that period rainfall was sporadic with only 0.15" from hurricane Norbert. ► 1.7" of rain fell from 1/29 to 2/01/2015- the cistern overflowed.

SUMMARY

FINISHED PROJECT DESCRIPTION: • A custom home designed and built to collect rainwater from the 5,200 sft metal roof and provide for entire household's uses. • Rainwater flows into gutters along entire roof perimeter. • Water is directed by enclosed downspouts by gravity flow, passes through a preliminary filter, then deposited into a water-tight, enclosed cistern. • Upon pressure tank demand, water is automatically pumped to the garage and passes through several filters before entering the house for all household uses.

OWNERS' NOTES: • Would be easy to install or retrofit similar water harvesting systems in multi-family housing or other large projects such as solar panel fields! • Most rain that falls disappears quickly in evaporation and evapotranspiration, but capturing it allows its constructive use before sending it on its way.
• Extend roof to max limits: to maximize capture: extend eves, over patios, etc.
• Go to Brad Lancaster http://www.harvestingrainwater.com for cistern volume calculator.
Examples: 1000 sft roof could collect 6732 gallons of water in a year

DESIGN FEATURES: ■ **Cistern** • 26,000 gallon • interior is 19' dia x 10' deep • majority located in-ground • constructed of ferro-cement like many swimming pools. • sealed with a cement lid. ■ **Mechanics** • 2 horsepower pump serves the pressure tank in the garage ■ **Water Filtration** • first flush through mesh screen and 2 fabric filters, then (2) 30-micron filters before pumped to garage ■ **Treatment for Household Use** • 5 micron sediment filter • ultraviolet radiation • 10 micron filter • activated charcoal ■ **Treatment for Human Consumption** • small reverse osmosis system under kitchen sink.

LESSONS LEARNED

SOMETHING TO BE PROUD OF:
• Delicious drinking water! Roof to cistern through filters to tap. Has only 27 ppm (parts per million) dissolved solids *before the reverse osmosis (R-O) step;* 3 to 4 ppm after R-O! City water often 575 ppm. • Constructed before it's time- before "rainwater harvesting" and "sustainability" had become household terms.
• Rainwater used for ALL household applications:
☼ 12,500 gallon lap pool ☼ all cooking and drinking
☼ 70 sft garden ☼ all bathing and washing
• There is no access to potable, CAP or reclaimed water.
• No calcium build-up on any hose connections (including washing machine)
• Additional Inspiration from Brad Lancaster

SOMETHING TO BE DONE DIFFERENTLY:
• Well water is site -specific and could be non-existent or of very poor quality. This location was poor -usage should not have been initiated but it's impossible to test and know this without spending the money to drill. Well water was briefly added to household water but high iron ruined filters. In last 4 years, used only for landscape (not garden). Filtration for this well water is an excessive expense.
• Rainwater collected here has such high quality, the need for all currently

PHOTOS -All photos taken in 2014

PROJECT TYPE: **RESIDENTIAL**
■ Single Family/ ■ New ■ Note: Goal for water use was drinking/ household/ garden.
Not general landscape

PROJECT NAME:
COLE RESIDENCE
Cistern for Household Use

PROJECT NAME: LANCASTER RESIDENCE and RIGHT-OF-WAY

PROJECT TYPE: RESIDENTIAL ■ Single Family/Public Right-of-Way ■ Retrofit

Tucson, AZ

Low Impact/ Green Infrastructure

LID/ GI DEVELOPMENT

DATA

LOCATION	813 N. 9th Avenue, Tucson, AZ 85705
ACRES	0.14 acre (1/8 acre)/ 5445 sf
CLIENT	Brad Lancaster
CONTACT	Brad Lancaster, bradlank@gmail.com
DESIGNED BY	Brad and Rodd Lancaster
COMPLETED	Ongoing since 1994

COST

ESTIMATED COST	Water-harvesting earthworks:$600, cisterns: $5,000, Compost toilet: $350, Greywater-harvesting system: $400, Solar system: $7,800, Retractable south-side awning: $1,285
FUNDING SOURCE	Private (home owners)
ACTUAL COST	The vast majority of the design was installed by the home owners. An architect drew up the workshop expansion plans ($2,033). A local designer designed the solar water heater ($100).
MAINTENANCE	Family member
COMPARE TO CONVENTIONAL	More time was needed for planning and design than a conventional non-integrated plan due the need to think through and plan how the various elements of our plan could integrate with one another for maximum effectiveness
TIME TO BUILD	All has been ongoing since 1994

LOCATION MAP

GOALS

REGULATORY: City of Tucson

STAKEHOLDERS: ► Brad, Rodd, Chi, and Vaughan Lancaster ►Dunbar/Spring neighbors.
Key Objectives: ■ **1** Mitigate Urban Heat Island effect. ■ **2** Eliminate all use of virgin potable water for landscape. ■ **3** Live solely with renewable power generated on-site.

PROJECT RECOGNITION: First Place – Homeowner Landscape under $10,000, Best Water Harvesting, and the J.D. DiMeglio Artistry in Landscaping awards in the 2005 Arizona Department of Water Resources/Tohono Chul Park Xeriscape Contest

PERFORMANCE MEASURES: ►**1** Summer temperatures in shaded areas along right-of-way are reduced 10° from those of pre- development ► **2** All native plantings along public right-of-way and on the property are irrigated solely with passively harvested rainwater and street runoff. ■ Six exotic fruit trees are irrigated primarily with on-site rainwater and greywater (95% in year of normal rainfall, 75% in dry years). ■ Vegetable garden is irrigated primarily with on-site rainwater collected in cisterns (95% in year of normal rainfall, 80% in dry years). ■ Total cistern volume is 5,000 gallons. ■ Over 95,000 gallons of rainfall per year of normal rainfall is harvested on our 1/8th-acre site and adjoining public right-of-way. ■ 100% of the household's greywater is recycled within the landscape. ► **3** Currently the grid-tied rooftop 3.1 KW solar PV system produces 3 times as much energy as the household uses. The surplus goes directly to neighbors' homes during the day. At night, power is currently drawn from the grid. ■ All the hot water comes from a passive solar batch heater.

SUMMARY

FINISHED PROJECT DESCRIPTION: A retrofit of a single-family home, yard, and surrounding public right-of-way maximizing the harvest of free, high-quality, on-site resources in a way that reduces or eliminates the need to import costly, lower-quality, off-site resources, while enhancing the true health and wealth of its residents, neighbors, and the larger ecosystem.

DESIGN FEATURES: ■ Passive water-harvesting earthworks and rain gardens ■ Passive heating and cooling of structures, gardens, and walkways ■ Gravity-fed greywater systems ■ On-site recycling of on-site green "waste"; composting toilet ■ Small livestock (chickens); annual and perennial food production ■ Water-harvesting traffic-calming ■ Street trees irrigated by street runoff captured with curb cuts. ■ The shade cast from cisterns (from which we get the rainwater to irrigate the garden) and tree west of garden shade and cool the garden at the hottest time of the day, resulting in up to a 50% reduction in irrigation needs for the garden. ■ All planting areas are sunken, and all pathways, accessways, and gathering areas are raised. This results in pathways becoming runoff water source for the plantings that grow (when trees) to shade those using the path. ■ Leaf-drop mulch also migrates via gravity from the bath to the vegetated basins.
■ Effective Strategy Begin with simple, low-cost to free, passive strategies working with natural systems/flows. Passive solar design principals immediately save energy and money (correct orientation/design of buildings and placement of shade trees to both maximize winter sun exposure and summer shade) . Simple mulched earthworks or rain gardens easily capture the water in the soil. These methods reduce the need for expensive tanks or drip irrigation systems.

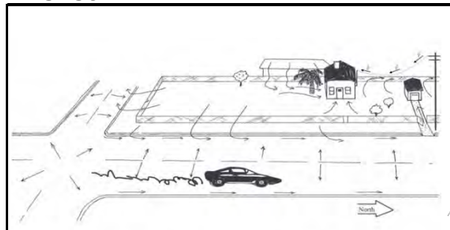
LESSONS LEARNED

SOMETHING TO BE PROUD OF:
■ This residence is a living demonstration garden and an inspiration to the Dunbar neighborhood, as well as the greater Tucson community.
■ Every possible means to minimize the human impact on and provide support to the local environment has been investigated and implemented when possible. Improvement to water haresting strategies are continually under evaluation .
■ These principals are clearly illustrated in **Rainwater Harvesting for Drylands and Beyond,**Volumes 1 and 2 by Brad Lancaster.
■ Websites : **www.HarvestingRainwater.com**
www.DesertHarvesters.org

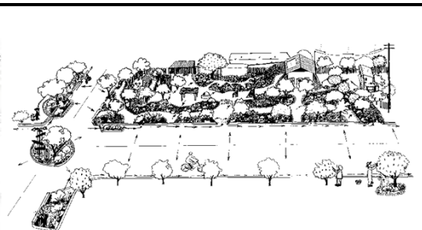
SOMETHING TO BE DONE DIFFERENTLY:
Design and install a greater capacity for the water-harvesting earthworks . Plant higher-water-use fruit trees only after the greywater-harvesting system was installed, and use greywater as the sole source for those fruit trees. Before choosing vegetation, estimate the site's water income (rainfall, runon, and greywater). Then plant a landscape with water demand that could be met solely by that on-site income.

PHOTOS

Reprinted with permission from Rainwater Harvesting for Drylands and Beyond, Volumes 1 and 2 by Brad Lancaster, www.HarvestingRainwater.com



Before : Property & ROW



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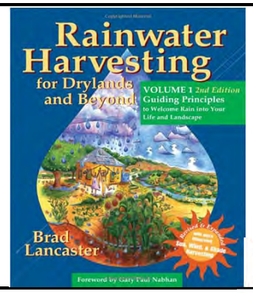
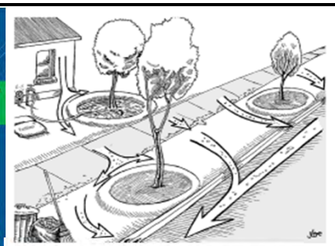
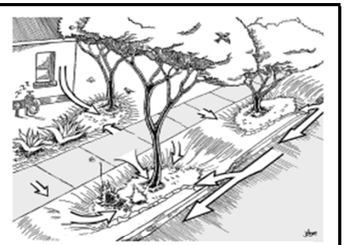


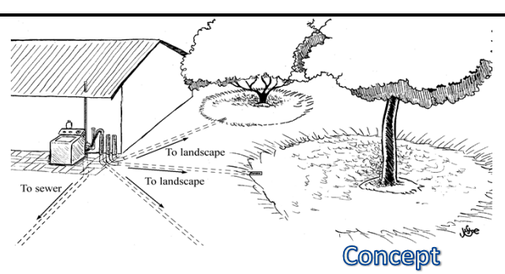


Before : ROW Concept

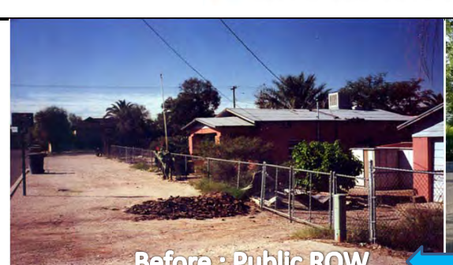


After : ROW Concept

PHOTOS



Concept



Before : Public ROW

After : Public ROW

PROJECT TYPE: **RESIDENTIAL**
■ Single Family dwelling ■ Public right-of-way
■ Retrofit

PROJECT NAME:
LANCASTER RESIDENCE and RIGHT-OF-WAY

PROJECT NAME: BLUE MOON COMMUNITY GARDEN (Tucson House)

Tucson, AZ

PROJECT TYPE: RESIDENTIAL ■ Multi-unit Dwelling ■ Retrofit

Cross Category: Recreation

NORRIS DESIGN

Low Impact/ Green Infrastructure

LID/ GI DEVELOPMENT

DATA

LOCATION	1501 North Oracle Road
ACRES	1 Acre +/-)
CLIENT	Tucson Housing and Community Development 301 N. Commerce Park Loop TUCSON, ARIZONA 85726
CONTACT	Gina Chorover (520) 837-6946 Gina.Chorover@tucsonaz.gov
DESIGNED BY	Norris Design 418 N. Toole Ave Tucson, AZ 85701 (520) 622-9565
COMPLETED	5/30/2012

COST

ESTIMATED COST	$288,000.00
FUNDING SOURCE	CCBG Grant, Tucson Water Grant, HCD Grant, CPPW Funds
ACTUAL COST	DESIGN COST: $28,000.00 CONSTRUCTION COST: $307,000.00
MAINTENANCE	Community Gardens of Tucson
COMPARE TO CONVENTIONAL	Cost increases were a result of the addition of tapping the condensate lines, meter devices and the interpretive signage for the rainwater harvesting system.
TIME TO BUILD	3 months

LOCATION MAP

GOALS

REGULATORY: City of Tucson

STAKEHOLDERS:

► Tucson House, a high rise development which is home to over 600 low-income, disabled, elderly residents and adjacent neighbors.

► Community Gardens of Tucson

PROJECT RECOGNITION: AZ ASLA Honor Award for General Design 2013

PERFORMANCE MEASURES: ■ ADA Accessibility. ■ Passive and active rainwater harvesting from 1/4 of the Tucson House roof and condensate from HVAC. ■ Reuse existing fire suppression 15,000 gal water tank. ■ Pump harvest water to second on-site cistern. ■ Metering devices for both potable and harvested rainwater, and power. ■ Tucson Water Demonstration Garden. , Community Gardens of Tucson design and equipment standards.

SUMMARY

FINISHED PROJECT DESCRIPTION: ■ The Blue Moon Community Garden is the first fully-accessible community garden in Tucson. ■ The 42,500 square foot site includes 36 garden beds, a citrus grove, butterfly garden, a central promenade, gathering areas with a shade ramada, barrier free design, and a loop trail with connectivity to the Tucson House. ■ The landscape architect developed interpretive signage to educate residents and visitors about the garden and the active water harvesting system that provides irrigation to the garden beds. ■ In addition, a 15,000 gallon rainwater harvesting tank captures rainwater and A/C condensate from a 17- story building, providing water for the landscape plants and fruit trees. ■ The garden was selected as a Tucson Water Demonstration Garden.

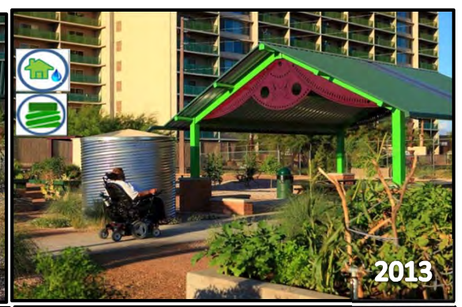
DESIGN FEATURES: ■ Reclaimed approximately 1 acre of existing parking lot. ■ Reused existing 15,000 gal water tank. ■ Added a second cistern and pump with brain boxes to irrigate with harvested rainwater. ■ Installed meters for potable and reclaimed water and the power used on-site. ■ Installed soil moisture sensing devices and controller which automatically adjusts water time using on-site soil moisture as a basis. ■ Tied into HVAC condensate line which is also metered. ■ Through a charrette process designed garden beds of varying heights and styles to accommodate a variety of disabilities. ■ Provided lockers for garden users and a compost station.

LESSONS LEARNED

SOMETHING TO BE PROUD OF: ■ The garden was selected as a Tucson Water Demonstration Garden and received AZ ASLA Honor Award for General Design 2013. ■ The garden is at capacity and provides an inexpensive food source for a neighborhood that has been described as located in a food desert. ■ Through post design assessments we determined the garden has become a gathering place for the Tucson House residents and neighbors. ■ This project has been designed with metering devices to become a study site with the potential to determine everything from the cost of a harvested gallon of water to the toxicity levels of fruit harvested from the citrus grove.

SOMETHING TO BE DONE DIFFERENTLY: ■ The raised still garden beds which provide accessibility to people in wheelchairs created a drainage issue with the method of construction and the amount of over-watering by it users. ■ The center should be wider to provide more drain rock between the CMU cells and or vertical gravel sumps should be installed in future beds of this kind.

PHOTOS



PROJECT TYPE: **RESIDENTIAL**

■ Multi-unit Dwelling

■ Retrofit

Cross Category: Recreation

PROJECT NAME: BLUE MOON COMMUNITY GARDEN (Tucson House)

PIMA COUNTY

TRANSPORTATION

LOCAL NEIGHBORHOOD

COLLECTOR

TERMINAL

I

	TRANSPORTATION
	NEW **Local Neighborhood**
	RETRO Local Neighborhood
	Cambio Grande
	Rincon Heights_ 9th and 10th Avenues from Park to Campbell
	Scott Avenue
	U of A Lester
	NEW Collector
	Downtown Links PH II: St. Mary's Road
	RETRO Collector
	NEW Terminal
	RETRO Terminal

Under consideration:
Camino Campestre
Craycroft Road- River Road to Sunrise
Fourth Avenue Bike Boulevard- Grant to Ft. Lowell Rd
Iron Horse Neighborhood
Mountain Avenue Medians
Rio Nuevo Grande Roundabout
San Gabriel Median Park

PROJECT NAME: CAMBIO GRANDE STREETSCAPE ENHANCEMENT

Tucson, AZ

PROJECT TYPE: TRANSPORTATION ■ Local Neighborhood ■ Retrofit

LID / GI DEVELOPMENT

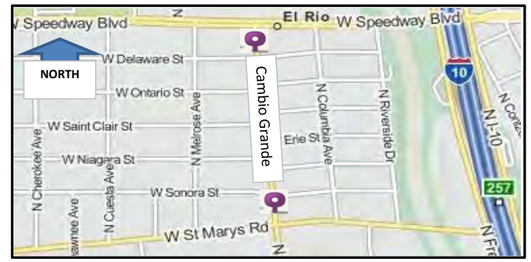
Low Impact / Green Infrastructure

DATA

LOCATION	Grande Avenue-St. Mary's Rd to Speedway Blvd. (0.4 miles)
ACRES	Project area ~33,905 sf
CLIENT	City of Tucson Department of Transportation
CONTACT	City of Tucson DOT M.J. Dillard mj.dillard@tucsonaz.gov
DESIGNED BY	Parson's Brinckerhoff Inc. - Engineer Kimley-Horn (SAGE) - Landscape Architect
COMPLETED	May, 2011

COST

ESTIMATED COST	$500,000 to $1,000,000
FUNDING SOURCE	ADOT Transportation Enhancement Grant and a Pima County Neighborhood Reinvestment Grant $963,905
ACTUAL COST	DESIGN COST -Landscape Architecture: $11,600 Phase 1 (DCR, 30% plans) $23,200 Phase II design (construction documents, NPP, etc.) CONSTRUCTION COST: $529,871.50
MAINTENANCE	City of Tucson
COMPARE TO CONVENTIONAL	Not evaluated
TIME TO BUILD	120 days of construction



LOCATION MAP

GOALS

REGULATORY: ■ City of Tucson Department of Transportation guidelines for non-irrigated landscaping

STAKEHOLDERS:

- ► Barrio Hollywood Neighborhood
- ► Arizona School for Deaf and Blind (ASDB)

PROJECT RECOGNITION:

2012 APWA (Arizona Public Works Assocation) Chapter Sustainability Award Winner

PERFORMANCE MEASURES:

Not determined

SUMMARY

FINISHED PROJECT DESCRIPTION:

■ This enhancement changed a typical urban street into a more aesthetic and pedestrian environment. ■ There is no permanent landscape irrigation system. ■ Plants will be hand watering for duration of establishment period. ■ Planting areas are depressed by 6" to capture rainwater.

DESIGN FEATURES: ■ Improvements include landscape nodes irrigated using water harvesting principals only. ■ ADA compliant sidewalk upgrades. ■ Installation of pedestrian amenities (benches, drinking fountain, lighting, trash receptacles). ■ Public art. ■ Neighborhood gateway entry. ■ Electrical facilities.

LESSONS LEARNED

SOMETHING TO BE PROUD OF:

Many of the shrubs and trees show considerable growth in just two years using only harvested water. Although the landscape was limited on the project due to the amount of utility conflicts, the vegetation has grown in quite well and creates a pleasant pedestrian experience along the sidewalk.

SOMETHING TO BE DONE DIFFERENTLY:

Initially the design plans included scuppers that directed drainage from the roadway into the planting areas. These were unfortunately eliminated due to budget constraints. Ideally, water from the roadway would have provided additional irrigation to the plant materials.

PHOTOS

PHOTOS

PROJECT TYPE: TRANSPORTATION

- ■ Local Neighborhood
- ■ Retrofit

PROJECT NAME:

CAMBIO GRANDE ENHANCEMENT

PROJECT NAME: RINCON HEIGHTS: 9TH and 10TH STREETS- CAMPBELL to PARK AVENUE

Tucson, AZ

PROJECT TYPE: TRANSPORTATION ■ Local Neighborhood ■ Retrofit

LID / GI DEVELOPMENT

Low Impact / Green Infrastructure

DATA

LOCATION	9th Street from Park Avenue to Campbell Avenue, just south of the University of Arizona.
ACRES	(acreage or SF)
CLIENT	City of Tucson Department of Transportation (COT DOT)and Rincon Heights Neighborhood
CONTACT	Gary Wittwer Gary.Wittwer@tucsonaz.gov
DESIGNED BY	EEC and COT DOT
COMPLETED	2011

COST

ESTIMATED COST	$315,000
FUNDING SOURCE	Neighborhood Reinvestment Grant, Back to Basics Grant
ACTUAL COST	DESIGN COST: $51,800 CONSTRUCTION COST: $335,517 (NIC Planting) PLANTING: $50,000 Back to Basics Grant (Neighborhood applied for)
MAINTENANCE	Rincon Heights Neighborhood
COMPARE TO CONVENTIONAL	No comparison estiamted
TIME TO BUILD	90 days

LOCATION MAP

GOALS

REGULATORY: None

STAKEHOLDERS:

► City of Tucson Department of Transportation ►Rincon Heights Neighborhood

■ Objectives: Create safer pedestrian crossings by slowing and calming traffic, as well as pinching the crossing corners with bump-outs. ■ Beautify the streetscape with native plant materials. ■ Provide habitat and food for wildlife such as birds, bees and butterflies. ■ Mitigate heat from the wide expanse of asphalt. ■ Provide shade for both pedestrians and parked cars and reduce ambient temperatures in the area. ■ Create an aesthetic, comfortable environment. ■ Harvest rainwater for the plants, lessen street flooding, and improves the quality of water going into High School Wash.

PROJECT RECOGNITION: No awards were pursued.

PERFORMANCE MEASURES: No specific measures weer put in place, but plant growth is a true indicator of success.

SUMMARY

FINISHED PROJECT DESCRIPTION:

■ 9th Street was originally configured to easily carry 4 lanes of traffic, but its residential status never generated such volumes. ■ This allowed portions of the road to be narrowed; some intersection corners were bumped toward the roadway centerline so pedestrains have less exposure to traffic when crossing. ■ Mid-block bump-outs allow protection to parked cars as well. ■ Selection of plant materials was critical because the City cannot maintain irrigation on residential streets. ■ Plants only receive rainwater, and occasionally supplemental water from the neighbors. ■ The City watered the plantings for one year with a water truck.

DESIGN FEATURES:

■ Curbed chicanes were used to narrow the street width. The curb protects the plant materials but curb cuts allow street runoff to easily enter the swaled planting area. ■ The swales are curved when space allows, and lined with chunky 4" to 8" rock to slow the flow and allow rainfall addtional time to permeate. ■ Native and low water-use plant materials were installed because no City maintained irrigation is allowed on residential streets

LESSONS LEARNED

SOMETHING TO BE PROUD OF:

This project was the first in Tucson to showcase how a neighborhood street could be transformed from a wide, hard asphalt corridor that promoted a hot, uncomfortable environment, to a more flowing vegetated and shady boulevard.

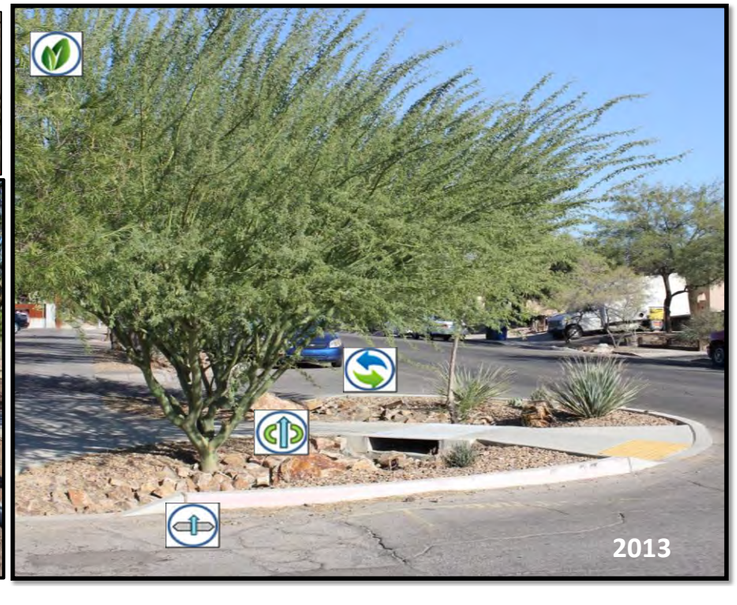
SOMETHING TO BE DONE DIFFERENTLY:

■ Be selective about plant species. An open planting design using contrasting form and color is more pleasing than a dense tangled mass.

■ The propagation of weed seed is always an issue on any site. The City of Tucson DOT cannot maintain residential streets; therefore, the neighbors must pledge to keep the vegetated chicane (bump-out) areas clear of weeds. Although neighbors may enthusiatically pledge at the beginning of a project, resident turn-over, as well as lost interest, may ultimately result in lack of maintenance and a weedy appearance. Some areas are maintained and some are not.

■ Lack of maintenance results in plants growing to heights that can obscure site visibility triangles.

PHOTOS



PROJECT TYPE: TRANSPORTATION

■ Local Neighborhood

■ Retrofit

PROJECT NAME:

RINCON HEIGHTS: 9TH & 10TH ST- CAMPBELL to PARK

PROJECT NAME: SCOTT AVENUE REVITALIZATION

PROJECT TYPE: ■ TRANSPORTATION ■ Local Neighborhood ■ Retrofit

Tucson, AZ

Low Impact/ Green Infrastructure

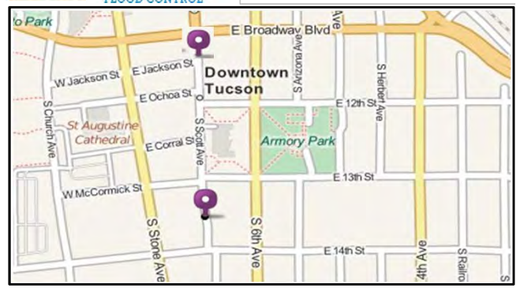
LID/ GI DEVELOPMENT

DATA

LOCATION	Scott Avenue, from Broadway to Cushing/ 14th Street
ACRES	Three blocks; approximately 1/4 mile long
CLIENT	City of Tucson Department of Transportation
CONTACT	City of Tucson Department of Transportation
DESIGNED BY	Stantec Consulting, civil engineering and Project Prime Wheat Scharf Associates, planting, water harvesting, and hardscape design Ten Eyck Landscape Architects, landscape design associate firm Kittelson & Associates, signing and marking Hines Irrigation Consultants, Inc., irrigation design
COMPLETED	5/1/2009

COST

ESTIMATED COST	N/A
FUNDING SOURCE	City of Tucson
ACTUAL COST	DESIGN COST: N/A CONSTRUCTION COST: 37 million
MAINTENANCE	City of Tucson Downtown Partnership
COMPARE TO CONVENTIONAL	N/A
TIME TO BUILD	12 months



LOCATION MAP

GOALS

REGULATORY: City of Tucson Land Use Code and Development Standards

STAKEHOLDERS:

- ► Downtown business owners
- ► Developers
- ► Neighborhood associations
- ► City staff

PROJECT RECOGNITION: N/A

PERFORMANCE MEASURES: N/A

SUMMARY

FINISHED PROJECT DESCRIPTION: ■ Scott Avenue is an appealing, shadey pedestrian way. ■ Sidewalks are a comfortable 8' minimum; they accomodate crowds attending the theater due to their spacious width and the tree canopies provide climate control. ■ Landscape is lush but comprised of native materials. ■ The natives have low water requirements which are supplemented by water harvesting practices which capture significant flows from rainfall events. ■ New site furnishings include benches, bicycle racks, trash/recycling receptacles, drinking fountains (with a separate pet bowl). ■ Solar powered art created a welcoming statement at the entrance to Scott Avenue. ■ These gateway features illustrate through pictures and text the historic and cultural significance of Scott Avenue. ■ A portion of the Presidio Trail, an historic walking trail throughout downtown, was highlighted with glass aggregate pavers and solar powered paver lights.

DESIGN FEATURES: ■ Pedestrians were the focus of the design. ■ The pavement section was narrowed from 55' curb to curb, to a varied 22' to 33' width. ■ This allow for wider sidewalks and pedestrian walkways. ■ Water harvesting was an integral part of the design, not an add on. ■ The harvesting principals supplememted the plant water requirements, but also mitigated storm events by decreasing water in the street. ■ New, more comprehensive and energy efficient street and pedestrian lighting, fitted with white lighting for better color rendition.

LESSONS LEARNED

SOMETHING TO BE PROUD OF:

■ Tucsonans see great value in the transformation of Scott Avenue. Its sustainable features are a functioning lesson of the benefits these practices provide. ■ Signature Sonoran desert species were utilized to showcase the diversity of the flora and fauna in this region of the United States. ■ Existing sidewalks were demolished and much of that concrete was crushed and reused within the planting areas as a mulch cover.

SOMETHING TO BE DONE DIFFERENTLY:

■ Widening the curb cuts as well as providing a solid surface just inside the cut would have made maintenance easier. ■ In current designs, we are providing sufficient area for maintenance to shovel out collected debris at the curb cut entry.

PHOTOS

PHOTOS

PROJECT TYPE: TRANSPORTATION

- ■ Local Neighborhood
- ■ Retrofit

PROJECT NAME:

SCOTT AVENUE REVITALIZATION

PROJECT NAME: U of A LESTER STREET LANDSCAPING

PROJECT TYPE: ■ TRANSPORTATION ■ Local Neighborhood ■ Retrofit

Tucson, AZ

LID / GI DEVELOPMENT

Low Impact / Green Infrastructure

DATA

LOCATION	SW corner Lester and Martin
ACRES	0.31 Acres (13,661 sft)
CLIENT	University of Arizona
CONTACT	Grant McCormick, PDC grantmc@email.arizona.edu
DESIGNED BY	UA Planning, Design, and Construction
COMPLETED	2010

COST

ESTIMATED COST	$60,000 to $70,000
FUNDING SOURCE	UA administration in conjunction with adjacent UA parking lot development (south of the landscape project).
ACTUAL COST	DESIGN COST: Absorbed by U of A departments. BASE CONSTRUCTION: Contractor provided asphalt demolition and rough grading. FINISH CONSTRUCTION COST: UA Facilities Management Grounds Services provided fine grading, planting, boulder placement, paths, walks and irrigation.
MAINTENANCE	Maintained by UA Facilities Management Grounds Services.
COMPARE TO CONVENTIONAL	Not calculated
TIME TO BUILD	5 months

LOCATION MAP

GOALS

REGULATORY: Compliance with Univesity of Arizona's Design Site Standards (DSS) provisions for surface water management.

STAKEHOLDERS:

► UA Administration, Facilities Management, Parking and Transportation Services, and Planning, Design and Construction.

► The visitors and employees of the Arizona Health Sciences Center.

► The Jefferson Park Neighborhood to the north.

■ Objectives included providing a forum to educate the community about water harvesting.

■ Mitigate sediment transport due to excessive rain event flows off site.

PROJECT RECOGNITION: Project did not seek LEED designation.

PERFORMANCE MEASURES: ■ Approximately 1" of rain will be held in the landscape basins. ■ Natural ecology of the site will be increased as a result of the project – plant materials and canopy cover will promote urban cooling and habitat creation; root structure and extended flow path will increase water infiltration; stabilization of soils due to root kniting and decreased run-off due to plant cover will decrease soil sediment transport.

SUMMARY

FINISHED PROJECT DESCRIPTION: ■ A series of carefully graded, sculpted landforms create the setting for stormwater harvesting and mitigation. ■ All 1:5 or less basin slopes are covered with 1/2" crushed rock and acccented on steeper 1:3 slopes with 3" to 6" rip rap. Fractured rock boulders further accent the design. ■ They are designed to passively irrigate carefully selected, native plant species. ■ The stabilized decomposed granite pathways permit access within the garden-like basin area.

Estimated Annual Rainfall: 242,000 gallons
Estimated Rainfall Held On site: 132,000 gallons
Total Site Area: 31,900 sf
-Rooftop: 6,500 sf 75% Impervious
-Paved: 17,575 sf
-Unpaved: 7,825 sf

DESIGN FEATURES: ■ A series of interconnected basins were created to capture, slow, and infiltrate storm water collecting on an adjacent parking lot and building to the south. ■ Terraces and spillways were designed to maximize the flowpath between the source watershed and the outflow, allowing the ideal dispersal of rainwater for beneficial infiltration to plant roots. ■ Plant selection included drought tolerant species. ■ Drip irrigation was installed. ■ Decomposed granite paths were raised to create dry passage during rain events and further retain the rainfall. ■ There is a standard City of Tucson sidewalk along Lester Street.

LESSONS LEARNED

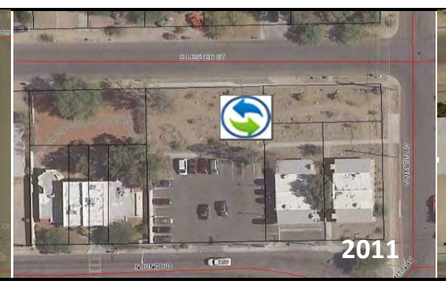
SOMETHING TO BE PROUD OF:

The project provided an opportunity to experiment with a number of fine grading techniques that blend water harvesting with stormwater management. User/stakeholder feedback has been very positive about the results. A valuable asset for the University and adjacent neighborhoods has been created which will serve as a template for future campus edge/buffer landscape projects.)

SOMETHING TO BE DONE DIFFERENTLY:

The planting plan was developed over top of a conceptual grading basemap which led to the need for more field interpretation of plans when planting locations did not appear to fit with the actual landform that was created. This suggests it is preferable to develop planting designs over top of the actual grading detailed plan (or develop these plans iteratively).

PHOTOS - Progression



PHOTOS

PROJECT TYPE: TRANSPORTATION

■ Local Neighborhood

■ Retrofit

PROJECT NAME:

U of A LESTER STREET LANDSCAPING

PROJECT NAME: DOWNTOWN LINKS PHASE II: ST. MARY'S ROAD Tucson, AZ

PROJECT TYPE: ■ TRANSPORTATION ■ Collector ■ Retrofit

HDR | WHEAT DESIGN GROUP LANDSCAPE ARCHITECTS

CITY OF TUCSON | PIMA COUNTY FLOOD CONTROL

Low Impact/ Green Infrastructure

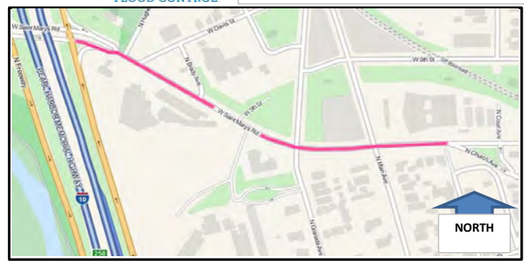
LID/ GI DEVELOPMENT

DATA

LOCATION	St. Mary's Road from I-10 to Church Avenue, Tucson, AZ
ACRES	1/2 mile long
CLIENT	City of Tucson Department of Transportation
CONTACT	Sam Credio- Sam.Credio@tucsonaz.gov City of Tucson Department of Transportation
DESIGNED BY	HDR, Inc. and Wheat Design Group, Inc.
COMPLETED	4/10/2014

COST

ESTIMATED COST	$7,265,702 Construction
FUNDING SOURCE	Regional Transportation Authority
ACTUAL COST	DESIGN COST: $200,000 Landscape Architecture design CONSTRUCTION COST: $6,554,521
MAINTENANCE	City of Tucson Department of Transportation
COMPARE TO CONVENTIONAL	N/A
TIME TO BUILD	1 year and 5 months



LOCATION MAP

GOALS

REGULATORY: City of Tucson Active Practice Guidelines

STAKEHOLDERS: ■ Downtown Links Citizen Advisory Committe ■ Davis Elementary School ■ Tucson Water ■ Pima County Regional Wastewater Reclamation Department ■ Arizona Department of Transportation ■ Downtown Partnership ■ Dunbar Springs Neighborhood ■ El Presidio Neighborhood ■ Ironhorse Neighborhood ■ 4th Avenue merchants

PROJECT RECOGNITION: N/A

PERFORMANCE MEASURES: ■ Water harvesting inlets and basins have performed as anticipated per design. ■ Plants are receiving supplemental water from roadway stormwater runoff. ■ The flexible delineators have been well received by the cycling public who believe the safety of the on-road bike lane has increased.

SUMMARY

FINISHED PROJECT DESCRIPTION: This new four-lane roadway will connect Barraza-Aviation Parkway at Broadway Boulevard to I-10. Improvements include the new 6th Street Underpass at UPRR, the 9th Avenue Deck Plaza, Links Avenue Overpass at 6th Avenue, and enhanced pedestrian and bicycle access routes. Several sustainability goals were achieved in Phase 2 such as the reuse of existing materials (sidewalk, brick pavers, curbs, and fencing); boulders, rip rap, and screened rock were sourced from within 15 miles of the project; microbasins and swales were incorporated for water harvesting; and Sonoran Desert plant species were used, including 84 shade trees and 900+ understory plants. Irrigation for this desert landscape is supplemented by passive rainwater harvesting features made from recycled sidewalk and curb..

DESIGN FEATURES: A main goal of the project was to increase bicyclist and pedestrian safety. Protective bike lanes include flexible delineators, creating a barrier between bicyclists and vehicles. A high-intensity activated crosswalk (HAWK) was installed on St. Mary's Rd, between Hughes St and Brady Ave allowing pedestrians and bicyclists to cross the street safely. Additionally, Davis St, from St. Mary's Rd to Brady Ave, is permanently closed to vehicular traffic improving the safety of children using the crosswalk to access the school. Sidewalks along St. Mary's Road have been improved and now are 8-12 ft. in width.

LESSONS LEARNED

SOMETHING TO BE PROUD OF:

■ Downtown Links was constructed on the practice of sustainability.It developed into an underlying goal for the entire project and was used as a standard for many major decisions that were made.

■ LID sustainability practices led to an extremely efficient construction process which allowed for the total cost to be reduced by $711,181.

■ Sustainable design saved money.

SOMETHING TO BE DONE DIFFERENTLY:

Benches contructed with salvaged sidewalk were very labor-intensive; therefore, not an efficient use of resources.

PHOTOS - Progression

PHOTOS - After

PROJECT TYPE: TRANSPORTATION

■ Collector

■ Retrofit

PROJECT NAME:

DOWNTOWN LINKS

PHASE II: ST. MARY'S RD : I-10 to CHURCH AVE

PIMA COUNTY