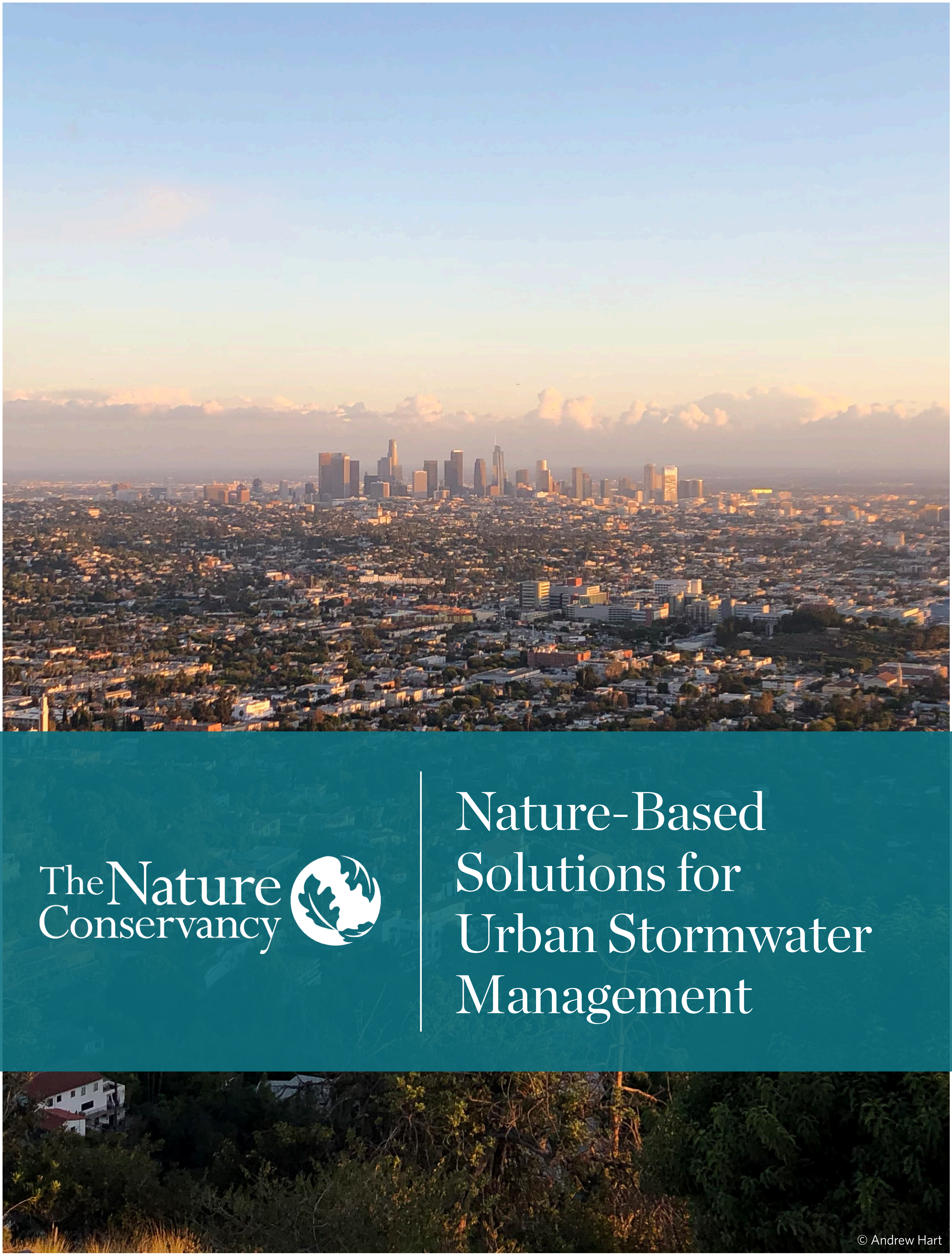

The Nature Conservancy

Nature-Based Solutions for Urban Stormwater Management

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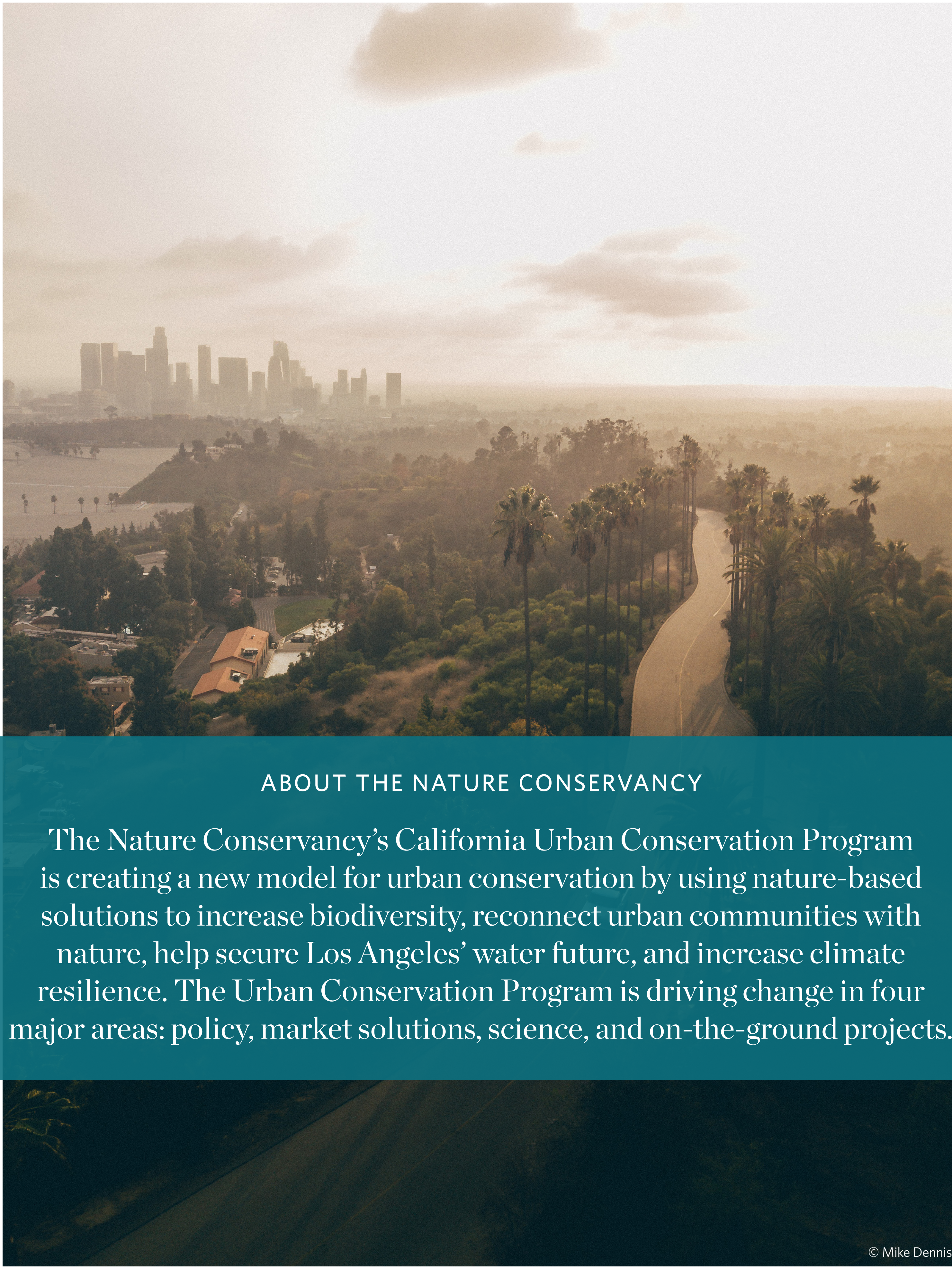

ABOUT THE NATURE CONSERVANCY

The Nature Conservancy's California Urban Conservation Program is creating a new model for urban conservation by using nature-based solutions to increase biodiversity, reconnect urban communities with nature, help secure Los Angeles' water future, and increase climate resilience. The Urban Conservation Program is driving change in four major areas: policy, market solutions, science, and on-the-ground projects.

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ACKNOWLEDGMENTS

TNC thanks the following people for their contributions to this report. We greatly appreciate the time they spent sharing information and discussing their projects with us.

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Jonathan Francis, Orange City Council
Sarah Hurteau, The Nature Conservancy
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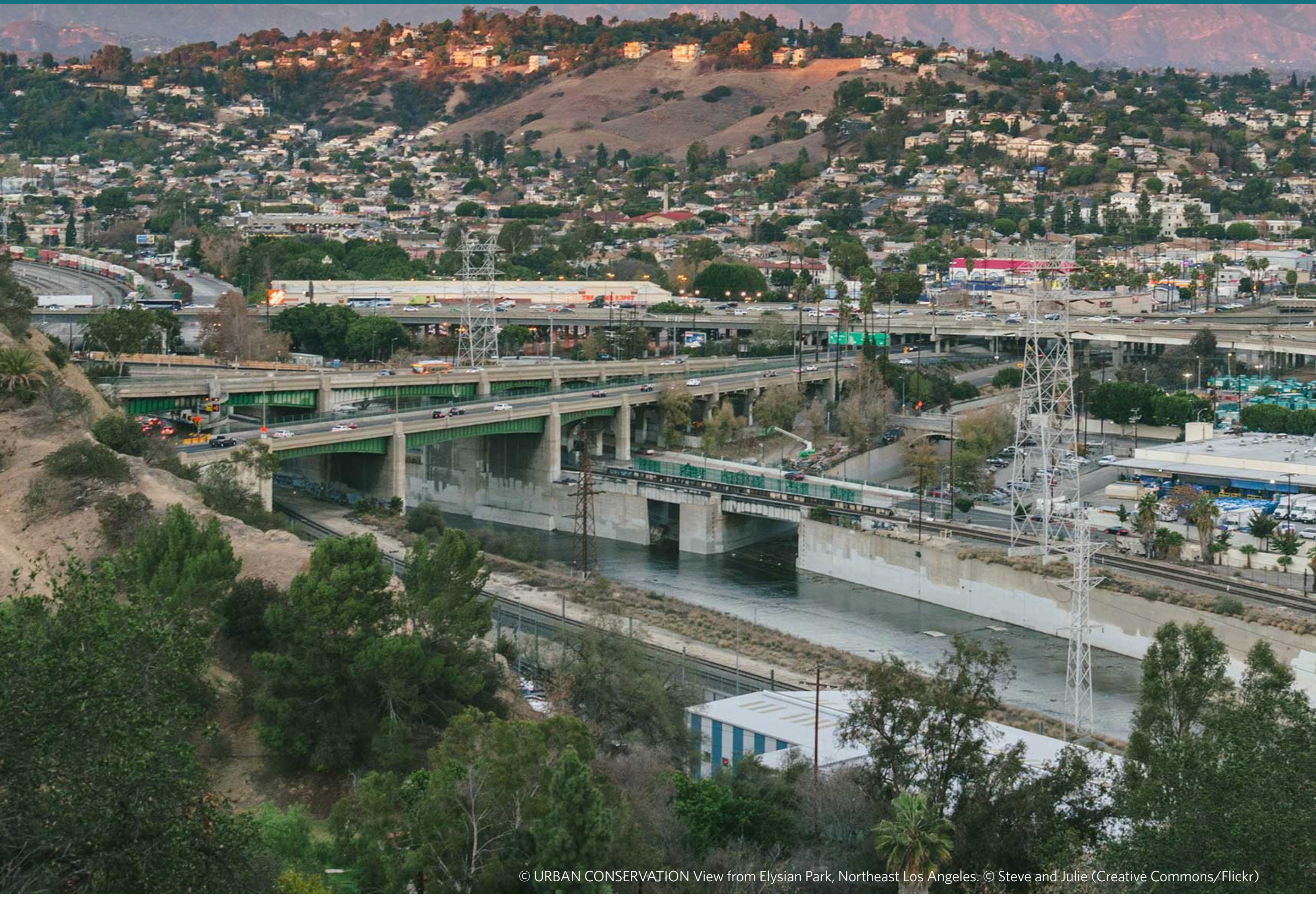
Bonnie Richardson, Tempe Transportation Center
Victoria Pino Rojas, Communal Government of the San Joaquin Municipality
Jared Romero, Albuquerque Metropolitan Arroyo Flood Control Authority

Introduction



© URBAN CONSERVATION View from Elysian Park, Northeast Los Angeles. © Steve and Julie (Creative Commons/Flickr)

Climate change impacts such as urban heat, water shortages, and floods are affecting cities across Southern California. In addition, environmental pollution and the loss of natural green space further diminish the quality of life for the most vulnerable communities and impair people's physical and mental health. Fortunately, new strategies to address urban runoff management with nature-based approaches offer promising solutions to many of these concerns.

Vegetated nature-based solutions (NBS) not only have the potential to restore natural landscapes, recharge groundwater, provide clean water and air, and reduce fire, drought, and flood hazards, but can also offer long-lasting and cost-effective alternatives to gray infrastructure. NBS use vegetated natural drainage features to slow, clean, infiltrate, and capture urban runoff and to reduce water pollution, recharge aquifers, and increase water reuse in urban areas.

The Nature Conservancy's (TNC) Urban Conservation Program in Los Angeles created a series of international and U.S. case studies on NBS for urban stormwater management to showcase the multiple benefits and examples of best practices for NBS to address urban runoff in climate conditions similar to Southern California. The following factsheets unveil processes involved in project implementation as well lessons learned to provide useful information and to encourage policymakers to drive deployment of NBS broadly across Greater Los Angeles and Southern California.

Key Terms

Nature-Based Solutions

In the context of urban stormwater management, NBS are practices that use natural systems and processes to treat and manage stormwater runoff. Processes include soil filtration and/or infiltration or physical and biological treatment with vegetation. Either or both may be used. As such, NBS can be vegetated or non-vegetated. TNC encourages the use of vegetated NBS as it is vegetation that typically provides co-benefits.

Green Infrastructure

More recently, the terms Green Infrastructure or Green Stormwater Infrastructure (GSI) have been adapted to refer to approaches to manage stormwater using stormwater best management practices, often but not always nature-based practices, rather than discharging directly into storm sewers or combined sewer systems (a.k.a. "traditional" or "gray infrastructure").

Best Management Practices

Best Management Practices (BMPs) are a broadly applicable term referring to measures taken to mitigate stormwater impacts caused by changes in land use. BMPs may address point and non-point pollution and/or volume and flow issues. Stormwater BMPs are typically classified as "structural," devices installed or constructed on a site, or "non-structural," procedures or activities, such as modified landscaping practices, pollutant control activities, soil disturbing activity scheduling, or street sweeping. NBS are a subset of structural BMPs.

Green Roofs (Vegetated NBS)

A green roof is a planted roof designed to collect, store, retain, and/or detain stormwater runoff generated by the roof and connected areas. The rooftop vegetation and soil capture rainwater allowing evaporation and root uptake to reduce the amount and peak flow rate of runoff entering stormwater systems. When the amount of rain exceeds the capacity of the soil and plants, excess water is conveyed to a roof drain.

Gray Infrastructure

Gray infrastructure typically refers to the human-engineered infrastructure to collect and convey stormwater from impervious surfaces, such as roads, parking lots, and roof tops, into a series of conveyance structures that ultimately discharge untreated stormwater into a local water body.[1]

Permeable Pavement (Non-Vegetated NBS)

Permeable pavement is an alternative to conventional pavement types like asphalt and concrete. It provides the structural support of conventional pavement used for parking, sidewalks, and patios, while reducing runoff from impervious areas. Permeable pavement is designed to allow stormwater to infiltrate through the pavement surface typically into a gravel storage layer and into the surrounding soils. Permeable paving may be designed with or without underdrains depending on subsurface soil conditions. Synthetic turf in athletic fields with permeable surfaces can also be used to collect, store, retain, and/or detain stormwater runoff generated by the turf area and potentially adjacent impervious areas.

Constructed Stormwater Wetlands (Vegetated NBS)

Constructed stormwater wetlands are systems designed to remove pollutants from stormwater runoff through settling and both uptake and filtering by vegetation. Constructed stormwater wetlands temporarily store runoff in relatively shallow pools that support conditions suitable for the growth of wetland plants. They use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to improve water quality and provide native wildlife habitat and aesthetic features. Constructed stormwater wetlands can be implemented as new facilities or retrofits of existing dry stormwater management ponds.

1 EPA, https://www.epa.gov/G3/why-you-should-consider-green-stormwater-infrastructure-your-community

Case Study

SAN MATEO BAY MEADOWS STORMWATER POND, CALIFORNIA, USA

© Rowan Roderick-Jones

Background

The Bay Meadows Stormwater Pond was implemented in 2012 by the Bay Meadows Land Company in San Mateo California, located about 10 miles south of San Francisco. The Bay Meadows development project is situated on the former site of the Bay Meadows Racetrack, the longest continually operating thoroughbred racetrack in California. In 2012, the site was redeveloped as a transit-oriented, mixed-use community including residential and commercial land uses. The development includes extensive open space with playing fields, pocket parks, stormwater planters and the "stormwater pond", which is as much community amenity as functional asset.

The site is close to sea level and discharges to a channelized tidal slough, the 19th Avenue Channel, which in-turn discharges to the San Francisco Bay. In addition to numerous water quality impairments in the Bay, the 19th Avenue Channel is prone to flooding during large storm events. Mitigating water quality and flooding impacts of the redevelopment project was therefore a primary driver for the project

DRIVERS AND INCENTIVES:

MS4 Permit (water quality and flood control)

Post Construction Stormwater Ordinance

Local fire-water requirements

PROJECT COLLABORATORS AND CONTRIBUTORS:

Bay Meadows Land Company: Project Owner
Wilson Meany: Development Manager
Arup: Lead Civil Engineer
CMG: Landscape Architecture
Cooper Robertson & Partners: Architecture and Urban Design

Project Objectives

1. **Meet local stormwater management ordinance requirements for water quality and flood control**
2. **Contribute to urban greening and neighborhood aesthetics**
3. **Provide water storage for fire response for the development.**
4. **Create a public passive recreation amenity**
5. **Create new freshwater and transitional habitats**

Design Features

The stormwater management system includes three components constituting a treatment train from the building parcels, streets, and terminating at a single outfall to the existing municipal storm drain.

- Each building parcel has rain gardens, biofiltration planters, and swales implemented to the maximum extent practicable.
- There are approximately 50 upstream pretreatment flow-through planter boxes within sidewalks along 28th Ave and South Delaware St and 31st Ave. Each planter system occupies about 45 square feet of sidewalk area.
- Storm drains from the parcels and roadways then discharge to a downstream 5.38-acre detention storage system including a 1-acre wet pond (includes 0.15-acre forebay, 0.18-acre recirculating wetland, and 0.6-acre permanent pool), 0.45 acre of dry storage over transitional wetland/upland habitat and 4 acres of additional shallow overflow dry storage over playing fields and public park landscape.

Within the wet pond, an aeration and recirculation system pumps water back to the forebay to help maintain good water quality during the dry season. The entire system is lined with reconstituted bay mud obtained from the site. Dry weather flows are sufficient to maintain water levels during dry season. During larger storms (>2-year return event) the system is designed to flood (through subsurface drains) into adjacent recreational and sports fields. The playing fields are only flooded in events greater than the ~2-year return storm. The total design capture volume is 4.4 acre-feet.

DESIGN VOLUME

Pre-treatment: 1-year 24-hour event

Flood Control: 100-year event – 4.4 acre-feet

Stormwater Features

- Pre-treatment: Parcel level rain gardens and swales and street level flow through planters
- Flood control: Downstream wet and dry detention basins

STORMWATER CATCHMENT AREA

The capture area for the stormwater features totals 83 acres including 61.2 impervious acres and 17.8 pervious acres, of which the majority is made up of public parks including the stormwater pond area.

Planting Strategy

A gradational approach to planting was based on time and duration of inundation. Wetland planting at the fringes of the wet pond and recirculating wetland included a broad native species palette of rushes and sedge. Native flood resistant planting in overflow and transitional areas include willow and oak and an assortment of wildflowers and shrubs.

Environmental Benefits

- 1.38 acres of habitat created including open water, wetland, and upland areas, providing habitat for a broad range of native species
- The wet pond system is lined with reconstituted bay mud sourced from the site, eliminating the need for installing a manufactured plastic liner.
- Improved water quality and reduced flood risk as compared to the pre-development condition
- Monitoring results generally indicate achieved removal of Total Suspended Solids, Biochemical Oxygen Demand, and Fecal Coliform in the 80% + range.

Social Benefits

- Recreational and aesthetic benefit to the new community
- Running trails with adjacent shade trees surround the pond and benched seating for viewing the pond

Technological and Cost Benefits

Extensive coordination with the fire department allowed for the wet pond to provide 600,000 gallons of community fire water storage - a first for the area and a decision, which eliminated the costly need for an additional subsurface storage tank.

Community Engagement Process

Several community stakeholder meetings (Community Advisory Committee, Public Works Commission/Planning Commission study sessions and hearings) were held to generate feedback on the proposed design. While the community was generally supportive of a nature-based stormwater system, the parks department had some concerns regarding flooding in the playing fields. This was overcome through iterative design and communication.

Challenges

- There were concerns about field playability and maintainability after storm events, which has the potential to make them unusable and fouled with debris and vegetation.
- While there was evidence of metals removal, concentrations were so low in the influent that it was difficult to quantify.

SOURCE OF INFORMATION: Interviews with Arup staff in August, 2020

Lessons Learned

- As the design and implementation progressed, it became apparent that the stormwater pond would be a major amenity for the development. Images of the pond system have been used in marketing material for home sales.
- The final design has the low points of the playing fields planted with transitional wetland plantings. The dry storage area only used on average every 2 years and is designed to drain down within 24 hours after rainfall ceases. This was acceptable from a playability and maintenance perspective and became the final design.
- Despite initial approval, the fire department has some remaining concerns about the ability to use pond water for firefighting due to potential sprinkler clogging. Additional forms of filtration should be evaluated when considering this approach in the future.
- Planting tall emergent vegetation along the pond edges has created a maintenance cost for clearing viewing corridors to the pond. Lower emergent vegetation would be preferred.

Case Study

OPEN CHARTER MAGNET ELEMENTARY SCHOOL WESTCHESTER, CALIFORNIA

Background

The Open Charter Magnet Elementary School demonstration project was implemented by TreePeople in 2005 as part of its T.R.E.E.S. (Transagency Resources for Environmental and Economic Sustainability) Project, which promotes the integrated and sustainable management of urban watersheds.

The project site forms part of the Ballona Creek watershed and is located about two miles from Los Angeles International Airport (LAX). Before the project began, most of the 6.75-acre campus was paved with asphalt. This increased urban heat, produced runoff pollution into the Ballona Creek watershed and Santa Monica Bay beaches, and inhibited stormwater retention overburdening the city's existing stormwater infrastructure.

PROJECT COLLABORATORS AND CONTRIBUTORS:

TreePeople
City and County of Los Angeles
City Bureau of Sanitation
Los Angeles County Regional Park and Open Space District
Santa Monica Bay Restoration Commission
Los Angeles Unified School District (LAUSD)
Los Angeles Department of Water & Power (DWP)
Montgomery Watson Harza (MWH)
Mia Lehrer + Associates
Open Charter students, parents, administration, faculty, and school board.
Doty Brothers Equipment Co. (contractor)

DRIVERS AND INCENTIVES:

$500,000 awarded from Proposition A

LAUSD provided $88,000 in matching funds through Proposition BB (school bond)

Project Objectives

1. **Provide a functioning demonstration of new approaches for nature-based urban stormwater management while mitigating negative environmental impacts on quality of life**
2. **Collect, treat, and store stormwater falling on campus**
3. **Make stored stormwater available for irrigation**
4. **Reduce polluted runoff from the campus to Ballona Creek and Santa Monica Bay**
5. **Provide shade for play areas with trees to reduce urban heat**
6. **Create outdoor ecosystem learning and recreation spaces to support the school's environmental curriculum**

OPEN CHARTER MAGNET ELEMENTARY SCHOOL WESTCHESTER (CONTINUED)

Design Features

The project was implemented in two phases: 1) Significant landscaping completed with DWP's Cool Schools program funding, and 2) installation of stormwater capture, treatment, and storage systems, funded through a local ballot measure.

- More than 30% of the asphalt was removed.
- A system of swales, trees, and shrubs was implemented to retain runoff.
- A sedimentation basin was installed to remove pollutants from water collected on campus.
- A 110,000-gallon underground cistern was integrated to store treated rainwater and feed the irrigation system.

CONSTRUCTION COSTS

Construction Costs
= $553,396

Engineering & Administration Costs
= $120,529

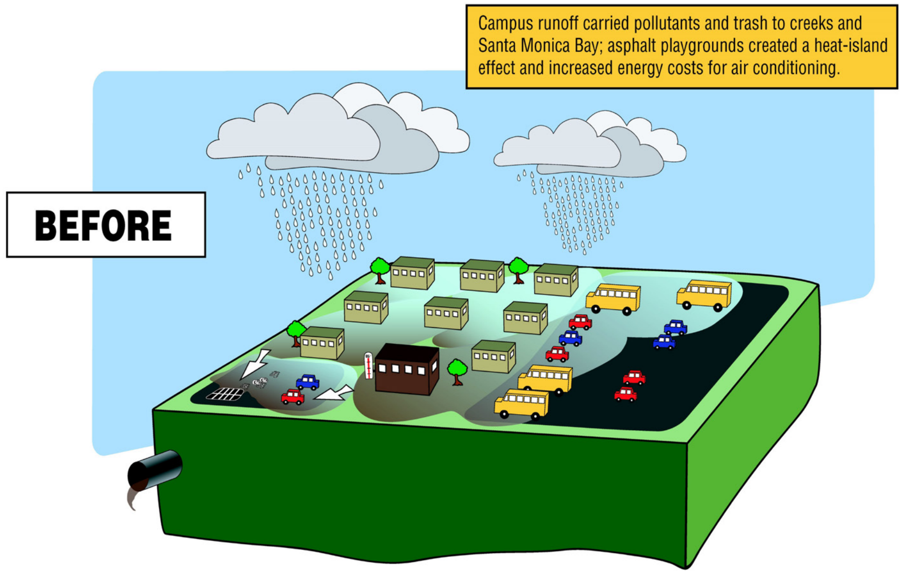
Total Project Costs
= $673,925

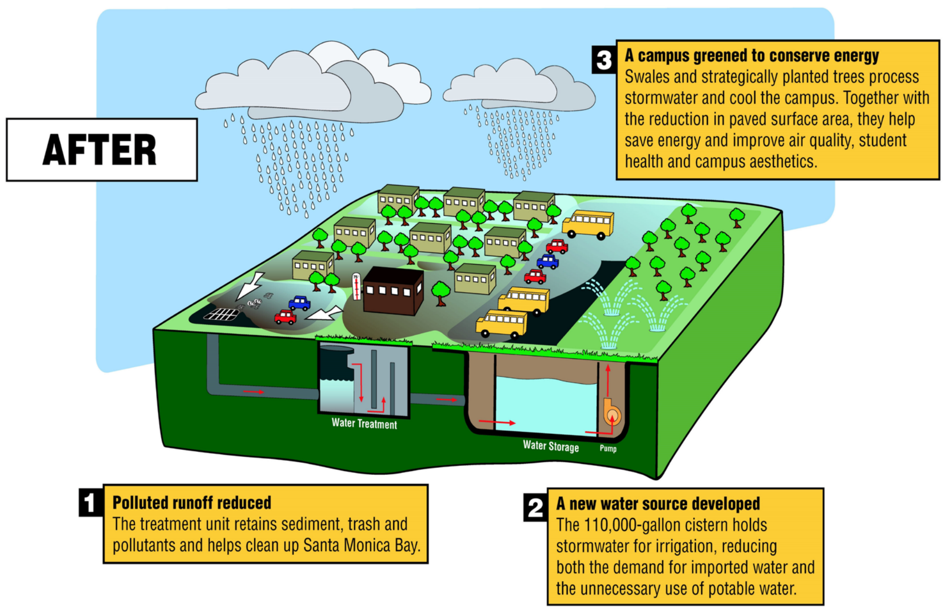
Operation Costs
= $3,869.47 Per Year

Maintenance Costs
= $6,350.61per Year

Inspection Costs
= $1,370.00 P.a. (+Contingency 20%)

Total O&M Costs
= $13,920 Per Year





© TreePeople/ The Open Charter Stormwater Project modeling.

"All stormwater on the site is either percolated in the tree wells and swales; collected, treated in a sedimentation basin and stored in an underground cistern for later use; or treated and released to the storm drain system when the cistern is full. Water that enters the sedimentation basin is treated with chlorine tablets to prevent bacterial growth and discourage mosquito breeding after being stored"

— Rainwater as a Resource report (2007).

Case Study

OPEN CHARTER MAGNET ELEMENTARY SCHOOL WESTCHESTER (CONTINUED)

Planting Strategy

About one-third of the pavement was replaced with a system of 150 planted trees, vegetation, and mulched swales, which represent the diverse landscapes of California. Canopy cover increased from 9 to 16 percent.

Planted Species

Coast live oak (Quercusagrifolia), Sweet Gum (Liquidambar styraciflua), London plane (Platanusacerifolia), and coast redwood (Sequoiasempervirens), among other species.

Water-Related Environmental Benefits from Capturing, Treating, and Storing Stormwater

- Improves water quality
- Reduces stormwater runoff from the campus
- Mitigates flooding and erosion downstream
- Reduces water imports

Environmental benefits from planting trees, plants, and grass yields

- Shading air conditioning units reduces energy use.
- Vegetation prevents erosion and promotes runoff capture.
- Shading for play areas improves student health and safety.
- Canopy and ground cover reduces urban heat.
- Using green waste onsite as mulch decreases landfill waste.

© TreePeople

Social Benefits

A healthy physical play school environment provides much-needed recreation space and offers a learning opportunity about California's native vegetation for school children.

Community Engagement Process

TreePeople raised awareness about the importance of green spaces and trees. Parents, teachers, and the school administration showed strong initiative in the school greening process, tree care, and oversight of site conditions.

Challenges

- Project implementation took six years – longer than anticipated – due to liability issues.
- The long project timeline led to increase of costs for materials and services.
- Multi-agency projects may suffer staff-turnovers and loss of institutional and project relevant knowledge.
- The school district experienced challenges providing care to the treatment system and landscaping, leading to malfunction of the cistern and loss of several trees.
- Some species from other climate zones required extra care and less permeable soils can reduce the effectiveness of porous pavement.

Lessons Learned

- Plan at least twice the time for multi-agency projects.
- Start with the agreement process when starting design.
- Spend extra time allocating responsibility for liabilities including budget issues, construction and operation and maintenance agreements.
- Develop written maintenance contracts and clear instructions; get general agreement from all partners before project completion.
- Plan for budget increases and assess the local construction cost inflation rate and international demand for materials such as plastic, steel or concrete.
- Set protocol for crediting all partners to ensure credit is shared equally both during positive and negative media attention. Document the process in detail.

SOURCE OF INFORMATION: Ben-Horin et al. (2007): Rainwater as a Resource: A Report on Three Sites Demonstrating Sustainable Stormwater Management. Tree People, Open Charter Magnet School: Operation, Maintenance & Inspection Costs, (2007), TreePeople.

Case Study

TEMPE TRANSPORTATION CENTER, ARIZONA, USA

© archdaily.com: Tempe Transportation Center

Background

The Tempe Transportation Center was built in 2008 as a strategic hub for METRO light rail, bus and bike transportation. This award-winning transportation project combines many innovative approaches including the first desert green roof on a city-owned/commercial building in the southwest, solar energy, recycled stormwater and graywater, rainwater harvesting, and a full-service bicycle center. The call for creating a 40,000 sq ft three-story mixed-use LEED Platinum certified building with a shaded exterior courtyard came along with the need to reduce urban heat islands in Arizona's already hot and dry climate.

PROJECT COLLABORATORS AND CONTRIBUTORS:

City of Tempe Public Works and Transportation Division
Contractor: Adolfson & Peterson Construction
Architect: Architekton

DRIVERS AND INCENTIVES:

In 1996, Tempe voters approved a one-half percent sales tax for transit projects, making Tempe the first city in the East Valley to provide dedicated funding for public transit and construction of an innovative Transportation Center.

COSTS $21.8M

Project Objectives

1. **Reduce runoff volume and stormwater pollutant loading from the project site**
2. **Encourage other buildings and future development along the Salt River to consider nature-based stormwater management solutions**

Design Features

The building houses the City's Transportation Offices, Traffic Management Center, Community Room and Transit Store, commercial office, and ground floor retail, as well as Arizona's first bike facility, which offers parking for 114 bikes, showers, lockers, repair, and bike rentals.

- The green roof garden insulates the roof structure and space below, reducing heat gain from direct sun exposure and reducing cooling needs. It also filters and collects rainwater, keeping the plants healthy while directing excess stormwater from the roof and the plaza to an underground cistern.
- Stormwater from the roof, garden, adjacent police station, and from routine power washing of the bus lane and plaza is collected, filtered, and stored in a 12,000-gallon underground cistern. Collected water is used for drip irrigation on site.
- Graywater is collected from sinks and showers, filtered, and reused to fill low-flow toilets. A water conditioning system maximizes reuse of water in the building's cooling system.

Case Study

TEMPE TRANSPORTATION CENTER, ARIZONA, USA (CONTINUED)

Stormwater Features

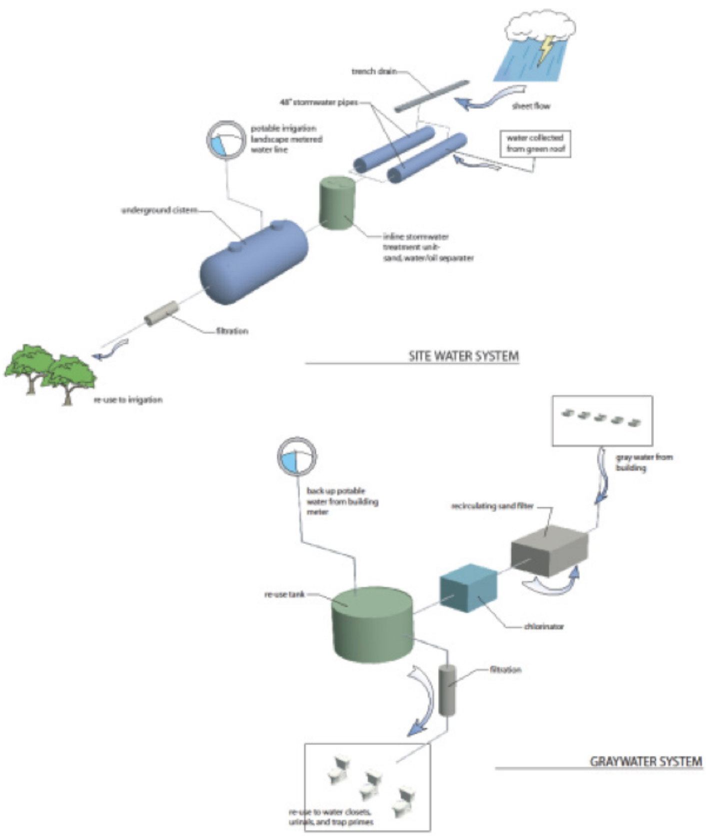
- Stormwater detention provided in two 270-ft x 48 in pipes; total capacity of 6,233 cubic feet
- 12,000-gallon fiberglass reinforced underground cistern for stormwater reuse
- Filtration system to treat water prior to reuse

Graywater Features

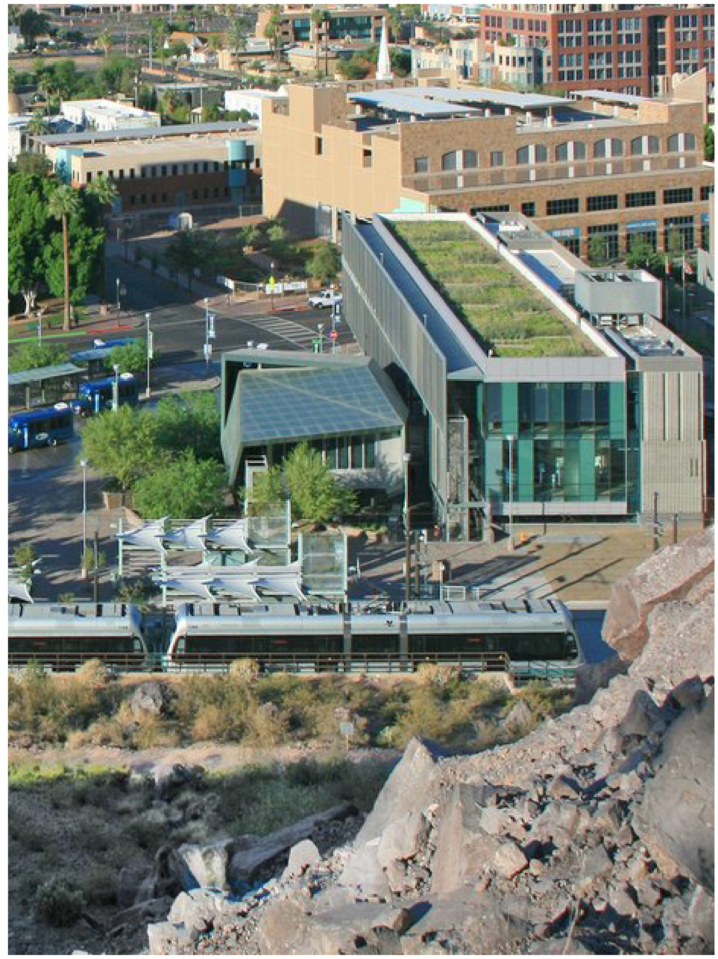
- Sand filter
- Chlorination
- 14,000-gallon reuse tank
- Filtration system

Planting Strategy

Low maintenance desert plants such as Pedilanthus macrocarpus, Hesperaloe parviflora, Malephora lutea, and Nolina microcarpa were planted over the 12″ soil mix. Over the years, Rosemary and yellow species of Hesper aloe have been added to the roof garden. Low-water-use trees and plants were planted at the plaza to provide shade and cooling.

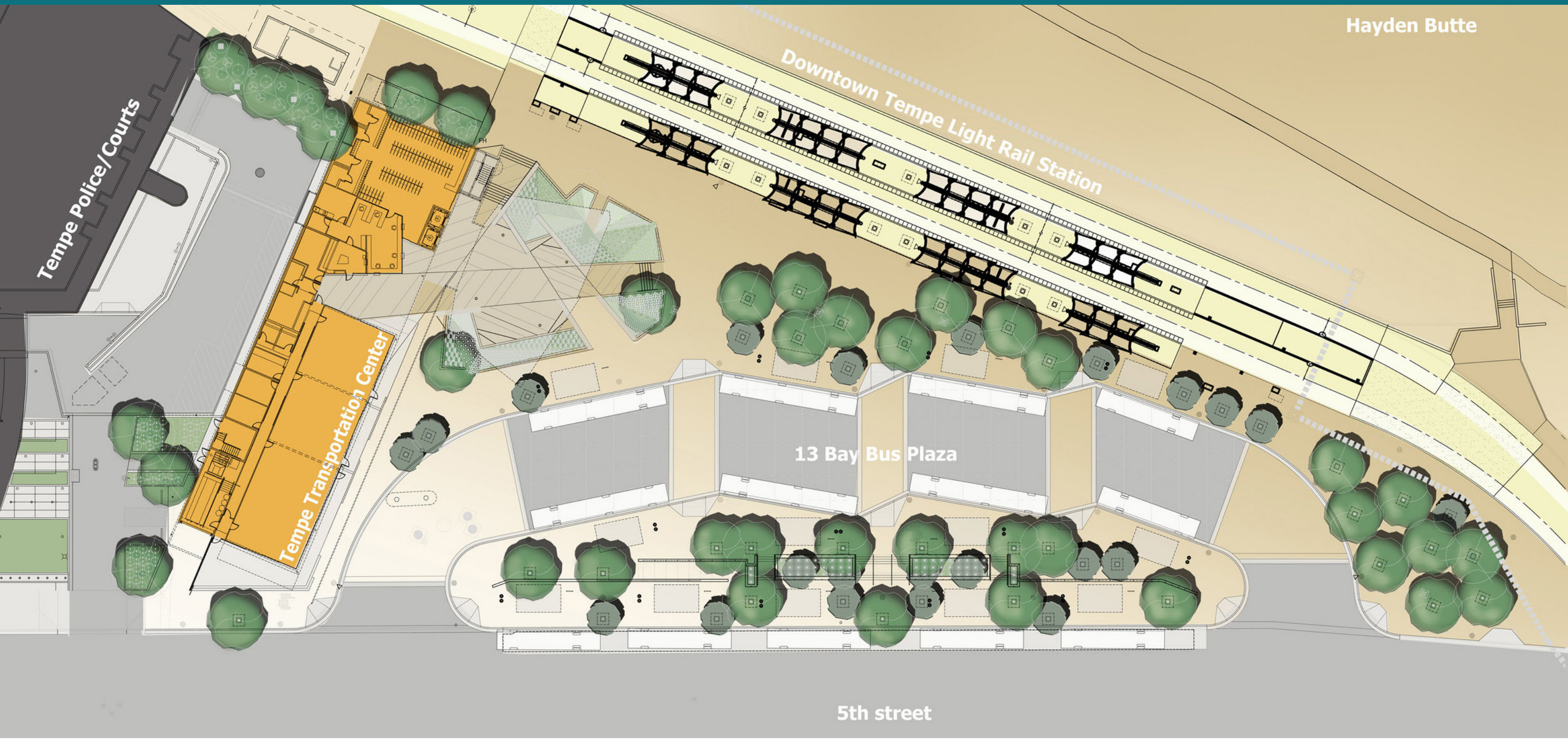


City of Tempe: Stormwater System Blueprint



Green Roof Environmental Benefits

- Stabilizes the temperature of the structure, helps reduce energy use and urban heat
- Reduces noise from adjacent vehicular traffic and overhead air traffic
- About 90% of the water that falls on the green roof surface can be retained.
- Preserves the roof membrane, filters rainwater, and reduces runoff temperature
- Helps improve air quality by filtering air, absorbs CO2 and binds dust particles (1,000 sq. foot of green roof can remove 41 lbs of airborne particles per year)
- Creates habitat for native birds, bees, and butterflies
- Broad, drought tolerant shade trees at the plaza retain water, cool the pavement, and provide relief from the sun while reducing urban heat and potable water usage



Technological and Cost Benefits

The green roof and shading strategies reduce the building's energy footprint by approximately 52%, providing operational savings.

Social Benefits

- Healthy, comfortable environment for employees working at the mixed-use building
- Successful demonstration of the use of sustainable water and stormwater management strategies at an urban bus and rail transportation hub

Challenges

- County and city regulations prohibit use of gray water in irrigation systems in publicly accessible areas, including the vegetated roof.
- Per local codes, stormwater retention must be fully drained from site within 36 hours and cannot be stored for later irrigation purposes.
- Use of pervious pavers presents challenges due to clogging from fine particulates.
- Management of the graywater system requires special expertise, making it difficult to maintain.
- Water saving dry toilets were replaced by conventional toilets due to odor complaints. Installing improved dry toilet design and better maintenance, would have resolved odors.
- The cost of drinking water is not high enough to make water recycling economically feasible.

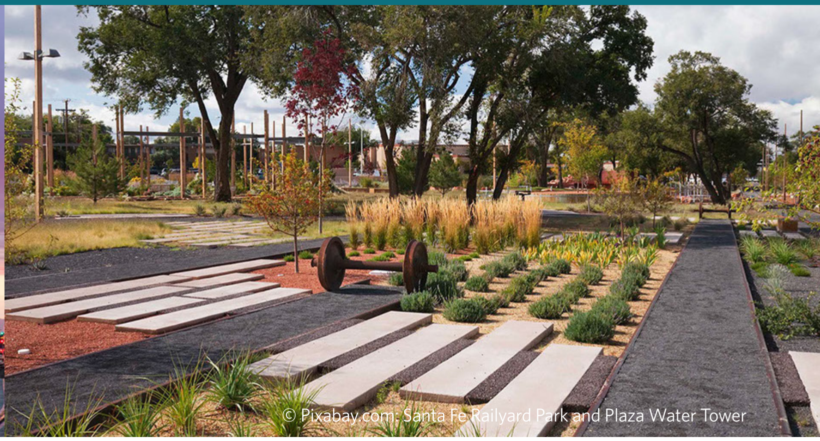
Lessons Learned

- Regulations need to be adjusted to better address water needs of the region. This requires extensive education of key decision makers and departments on different legislative levels.
- It is crucial to develop guidelines for operation and maintenance of water recycling and other equipment and to train maintenance personnel and manage operations to ensure long-term functionality.
- If stormwater collection and reuse are not possible due to regulations, graywater reuse for toilet flushing could be a feasible option.

SOURCE OF INFORMATION: ARCHITEKTON (2008): Tempe Transportation Center American Society of Landscape Architects (n.d.): Green Infrastructure & Stormwater management. Case Study. Tempe Transportation Center. Interview with Bonnie Richardson, Urban Planner/Architect with the City of Tempe Transportation Department, Project Manager for the Tempe Transportation Center on August 28, 2020

Case Study

SANTA FE RAILYARD PARK AND PLAZA, SANTA FE, NEW MEXICO, USA



© Pixabay.com; Santa Fe Railyard Park and Plaza Water Tower

Background

The Railyard Park and Plaza is situated in downtown Santa Fe alongside the Acequia Madre channel, one of the oldest irrigation canals in the U.S. In the 1880s, the former agricultural area became a railyard and, consequently, a center of community life, but experienced a decline after suspension of passenger services after World War II. The city's former redevelopment attempts have failed because of the site's past industrial contamination with lead, other metals, and petroleum products.

The most recent redevelopment project was launched in 1995, when the city and the Trust for Public Land (TPL) initiated the purchase of the Santa Fe Railyard and placed 13 of the site's 50 acres under a permanent conservation easement. Seven years later, Santa Fe City Council approved the Railyard Master Plan and organized the Santa Fe Railyard Community Corporation to oversee mixed-use development for 37 acres of the site. Finally, environmental contamination was cleaned up setting the stage for development. By 2008, Santa Fe Railyard Park and Plaza was converted from an abandoned railyard into a flourishing community activity center incorporating an innovative stormwater-harvesting system that is compatible with water rights restrictions and irrigates a 10-acre landscape.

PROJECT TEAM:

Owner: The City of Santa Fe
Developer: The Trust for Public Land
Engineering: URS
Architect: Fredric Schwartz
Landscape architect: Ken Smith
Landscape artist: Mary Miss
Landscape design: Edith Katz

Project Objectives

1. **Develop a contaminated railyard site and preserve historic places tied to the city's identity**
2. **Create a large open space that serves city residents and helps protect the environment**
3. **Harvest stormwater for irrigation to contribute to water conservation in the arid New Mexico climate**
4. **Restore a part of the Acequia Madre irrigation channel that runs through the railyard site**

DRIVERS AND INCENTIVES:

The city's landscape and site design standards required water harvesting and encouraged use of alternative sources for irrigation.

Design Features

- 10-acre park
- 1-acre plaza
- 1.5-acre pedestrian walkway
- Stormwater harvesting system that stores 110,000 gallons of stormwater from impervious surfaces on the property

Case Study

SANTA FE RAILYARD PARK AND PLAZA, SANTA FE, NEW MEXICO, USA (CONTINUED)

Water Harvesting System Features

- Swales and stormwater detention facilities help reduce runoff rates and slow erosion.
- Runoff is collected from approximately 3.7 acres of railyard buildings and impervious surfaces.
- Collected stormwater is stored in five 15,000-gallon underground tanks and in a 35,000-gallon water tower and is used for irrigation of the park.
- Flow sensors track the amount of collected and used rainwater, and detect if additional water is needed from the city. They also provide monthly, annual, and historical data to the public.

Planting Strategy

Native and drought-resistant plantings were incorporated into the landscape and included the following features:

- Shady riparian area
- Dry gulch that fills seasonally with rain
- Ornamental gardens adapted for dry conditions
- Bird and butterfly gardens

Environmental Benefits from Water Harvesting

- Reduce runoff and help slow erosion
- Capture stormwater runoff to irrigate more than 300 new trees and thousands of drought resistant and native plants
- Contribute to water conservation in New Mexico's arid high-desert climate

CONSTRUCTION COSTS

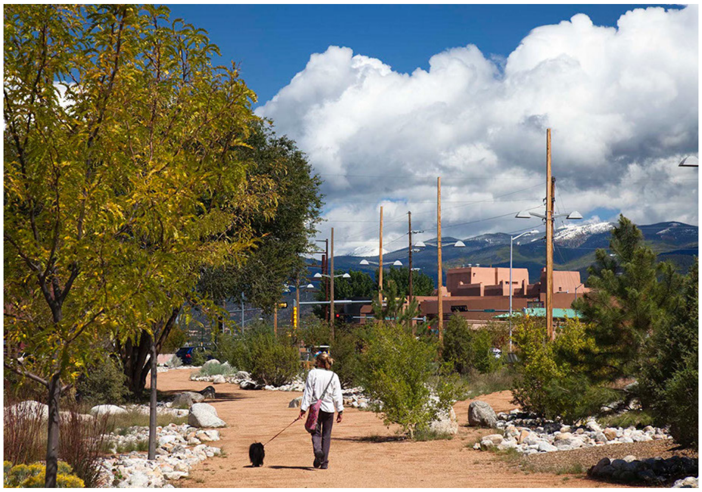
Cost of the park, plaza, and walking paths: $13 million
Planning costs: $400,000
Design and Engineering: $1.1 million
Construction: $1.1 million
Stormwater costs: $2 million
TOTAL PROJECT COSTS: $137 million

Social Benefits

- The irrigation system, signage, and outdoor classrooms at the community gardens help the public to understand the link between historical agriculture practices and the need for water conservation in a region with limited water resources.
- Flourishing community activity center that creates recreational space and stimulates social togetherness
- The redevelopment project led to millions of dollars in private investment and boosted local economy.

Community Engagement Process

Before the project began, citizen activists strongly pushed for pedestrian-oriented areas with public open space and local businesses, reestablishment of rail service, and preservation of the character of surrounding neighborhoods. During the planning process, more than 6,000 residents provided input into the railyard's redevelopment.



Challenges

- New Mexico's commitment under the Rio Grande Compact prohibits passive water harvesting, which means that it is prohibited to detain water and let it infiltrate into the soil to maximize yield to downstream users. This regulation impedes runoff reduction and requires pumping the collected stormwater into the drainage system instead of letting it infiltrate.
- Regulations allow active water harvesting, which allows for stormwater collection from the 50-acre site in a storage container for later use. However, stormwater from surrounding streets is not allowed to be collected.
- The city did not approve construction of a decentralized wastewater treatment plant from which treated effluent could be used for irrigation.

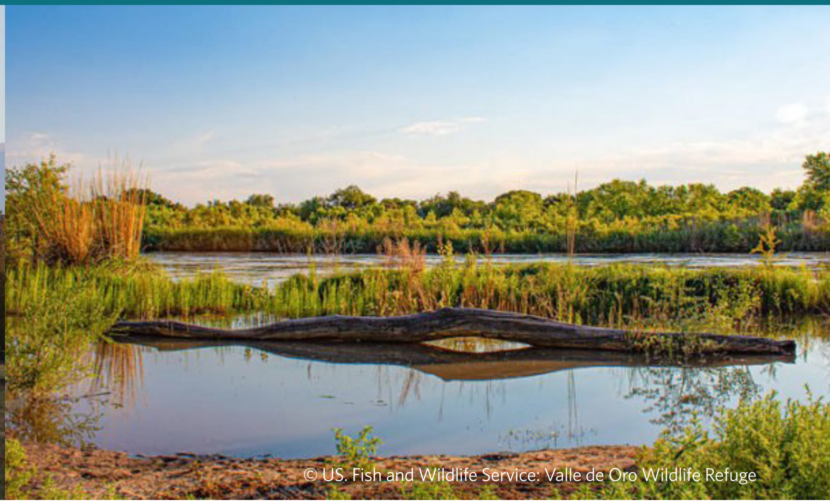
Lessons Learned

- Nature-based solutions can help achieve water conservation goals in arid climates by storing stormwater for irrigation and can be incorporated into development projects even in areas that are subject to water rights laws.
- The city had to reduce the originally planned development density on the site in exchange for the community desire to preserving historic places, which in return, brought more investment and community support for the project.

SOURCE OF INFORMATION: Hair, L., Kramer, M. (2016): City Green: Innovative Green Infrastructure Solutions for Downtowns and Infill Locations. EPA United States Environmental Agency. EPA 230R16001

Case Study

VALLE DE ORO NATIONAL WILDLIFE REFUGE, ALBUQUERQUE, NEW MEXICO



© US. Fish and Wildlife Service: Valle de Oro Wildlife Refuge

Background

The 570-acre Valle de Oro National Wildlife Refuge was developed under the US Fish and Wildlife Service Urban Wildlife Conservation Program to serve as an essential ecological, educational, and recreational resource for the greater Albuquerque metropolitan area. The Refuge, which is the first urban wildlife refuge in the Southwest, is located only seven miles from downtown Albuquerque on a former dairy farm in a heavily industrialized, largely minority community. Historically, the Rio Grande flowed through what is now the Refuge, leaving natural shallow depressions which form "playa wetlands". After the river was channelized, these natural drainage features that slowed storm run-off and reduced sediment loading to the river disappeared. The restoration of natural hydrology started with the first constructed playa wetland in 2018. In July 2020, the first construction phase of an outlet (designed as a meadow/ swale) from Valle de Oro to the Rio Grande was completed. A total of five seasonal playa wetlands on 120 acres is planned to convert and restore the Refuge.

SUPPORT OF THE PROJECT:

Federal funds
Partner funding and support

COSTS

- Design, permitting, and survey: $800,000 Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA)
- Construction costs as of 2020: $5.5 Million (AMAFCA)
- AMAFCA projects to spend approx. $6 Million on the rest of the facility build out, however costs will depend on design estimates and bids at the time of construction

Project Objectives

1. **Restore native habitats**
2. **Buffer for surrounding urban and suburban development that produce increased runoff and pollutant loading**
3. **Provide flood risk management**

PROJECT COLLABORATORS AND CONTRIBUTORS:

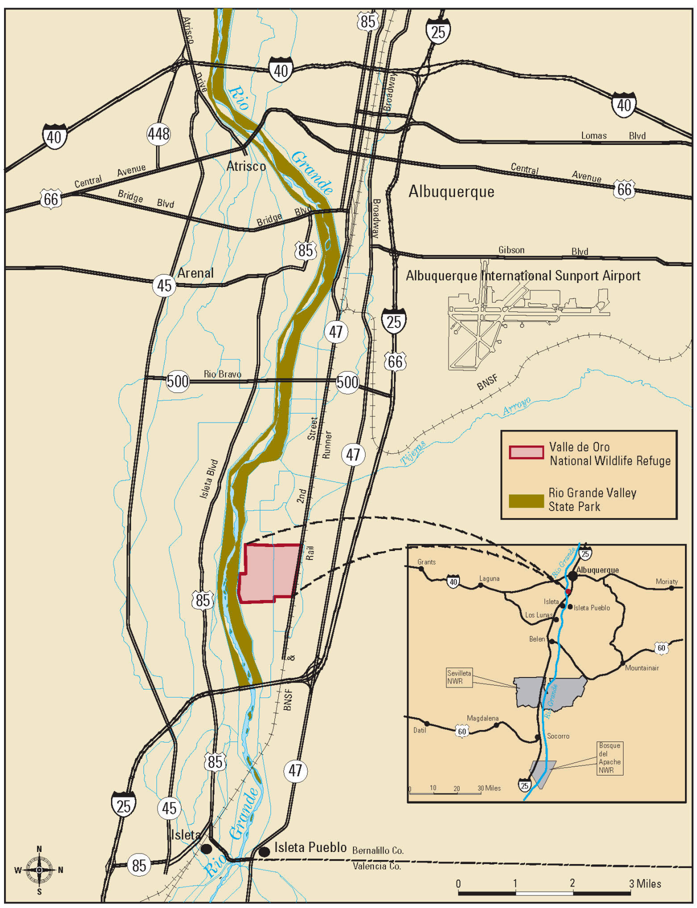
The Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA)
Bernalillo County
Bureau of Land Management
Friends of Valle de Oro National Wildlife Refuge
Middle Rio Grande Conservancy District (MRGCD)
Mid-Region Council of Governments (MRCOG)
National Park Service
New Mexico State Parks
The State of New Mexico
Trust for Public Land
U.S. Army Corps of Engineers (USACE)
U.S. Bureau of Reclamation
U.S. Fish and Wildlife Service (USFWS)

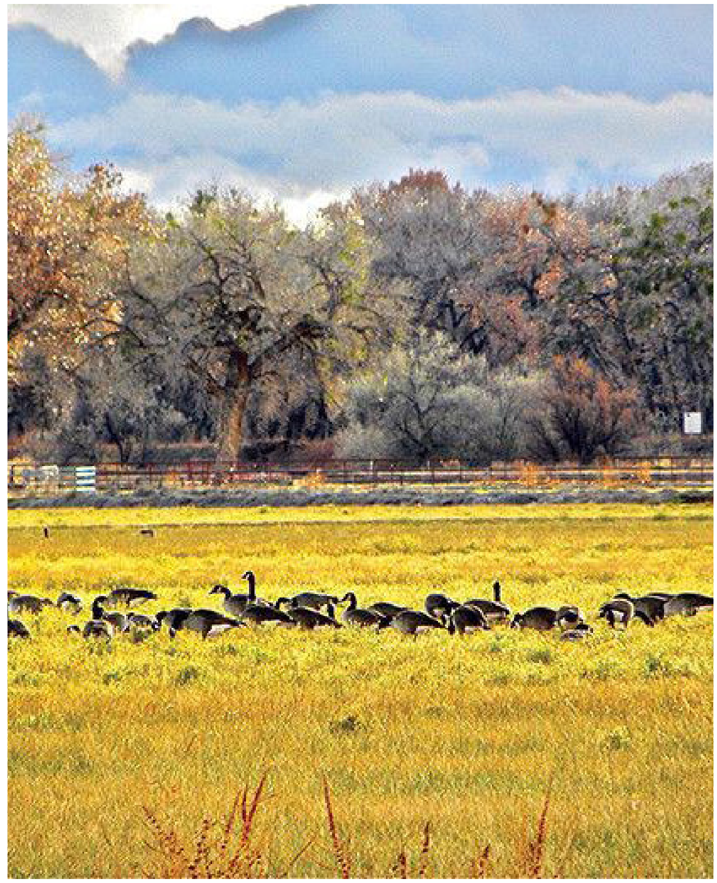
Flood Control & Stormwater Management Features

- Stormwater travels through the Refuge's vegetated swale and is naturally treated by plants and soil before returning to the Rio Grande.
- The large playa wetland and meadow/swale outlet safely conveys stormwater, protecting the surrounding communities from flooding.
- Stormwater provides additional water to the site for the restoration of a diverse riparian habitat.

Stormwater Catchment Area Description

At full build-out, the catchment area of the Valle de Oro Drainage Facility is planned to be 5.6 sq. miles of the far Southeast Valley. Planned land uses include rural residential, single family residential (2-4 and 8 DU/Ac), commercial, commercial-light industrial, light-industrial, and open space.





Planting Strategy

The restored habitat includes riparian forest, wetlands, and open meadows that occurred historically. Before endemic species could be planted, alfalfa, that was planted for agricultural purposes in the past, needed to be removed.

Environmental Benefits

- Enhances habitat and existing biodiversity
- Provides an important waypoint for migratory birds such as Sandhill cranes, Arctic geese, and varied duck species, fish, and mammals along the Rio Grande
- Conserves a rare ecosystem in a metropolitan region with increasing suburban development
- Provides the community with flood relief
- Improves water quality before stormwater is returned to Rio Grande
- Provides additional water for restoration of diverse natural habitat

Social Benefits

- Provides the community with recreational open space located within a thirty-minute drive of 50% of New Mexico's population
- Serves as a place for the community to connect with nature and learn about important natural resources through outdoor recreation, education, and interpretive programs
- Fosters environmental awareness, a sense of civic responsibility, and pride for the regional landscape
- Engages urban, rural, and tribal communities in conservation

Community Engagement Process

From the beginning, community input was used to determine the development and features of the Refuge. Community members continue to be involved in each stage of development and restoration.

SOURCE OF INFORMATION: United States Fish and Wildlife Service (n.d.): Valle de Oro NWR Upland and Playa Restoration Collaborative. A Valle de Oro NWR Story, AMAFCA (2020): Valle de Oro Outlet Structure. Valle de Oro National Wildlife Refuge Environmental and Economic Justice Strategic Plan 2017-2020. United States Fish and Wildlife Service (n.d.): Innovative Stormwater Management. Valle de Oro National Wildlife Refuge. Email interview with Jared Romero, Engineer I at the Albuquerque Metropolitan Arroyo Flood Control Authority on January 20, 2021.

Challenges

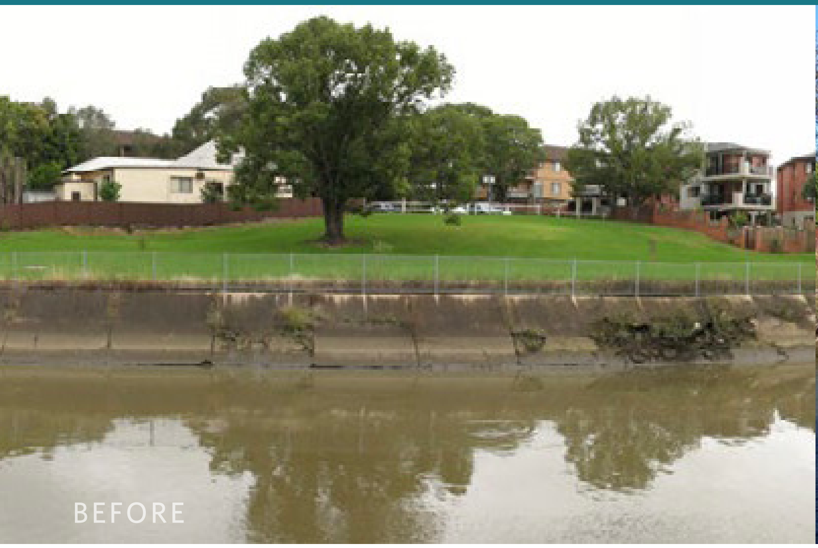
- Understanding that the Refuge's stormwater features are one aspect of the Refuge, and being able to work towards AMAFCA's mission of protecting life and property from flooding while also working with partners to serve the constituents of the Refuge
- Communicating to constituents that the Refuge's stormwater features are not a single solution for stormwater and flood issues and that more projects are necessary to achieve more robust flood protection in the area

Lessons Learned

- Do what you can when you can – the Refuge is a collaborative effort between all of the partners to facilitate the design and construction of stormwater improvements within the confines of funding and other governmental priorities
- Stay focused on the overarching objective of the Refuge – the stormwater features are AMAFCA's focus, but there must also be flexibility to accommodate partner goals and needs
- There are several right answers to most problems.

Case Study

SYDNEY WATER BANK NATURALIZATION, SYDNEY, NEW SOUTH WALES, AUSTRALIA



© Water Sensitive Cities: Sydney Water Bank

Background

The Cooks River flows for 14.3 miles through the inner South West of Sydney before discharging into Botany Bay in the Tasman Sea. In the 1930's, authorities began to channelize the river to reduce flooding, wash away pollutants, and facilitate urban development. In the early 2000s, the concrete lining started to deteriorate causing ecological degradation and risk to people and adjacent assets. Instead of proceeding with a new concrete embankment, the city's water and sanitation company, Sydney Water decided to explore alternative methods and incorporate natural bank features with sandstone and native plants to remediate 0.7 miles of the deteriorated canal. In collaboration with eight councils, Sydney Water developed a flood study, a masterplan, and a partnership model for the naturalization project.

The Cooks River revitalization planning phase took place between 2007 and 2011. In 2010, 0.6 acres of constructed wetland was added to treat stormwater and provide habitat. The failing concrete riverbanks were replaced with gently sloped banks in 2014 and 2015 and adding open spaces and cycleways to the adjacent neighborhoods.

DRIVERS AND INCENTIVES

Failing embankments required remediation
Federal Government grant

COSTS

AUD $8.6 million total budget
(USD $6.6 million as of January 2021)

Project Objectives

1. **Repair the deteriorated canal, maintaining the stability of riverbanks and flood water capacity**
2. **Increase the natural character of the Cooks River**
3. **Create riparian habitat along the canal**

Design Features

Preliminary concept designs were developed for three sites where bank naturalization was possible.

To ensure dry conditions for the sandstone bank construction, riverbanks needed to be isolated from the waterway using vertical walls running parallel to the bank. Bank slopes were reduced from 1:1 to 1:4 to allow space for natural features and improving aesthetics. Natural features were integrated along with other improvements such as pathways, viewing areas, interpretive signage, and seating.

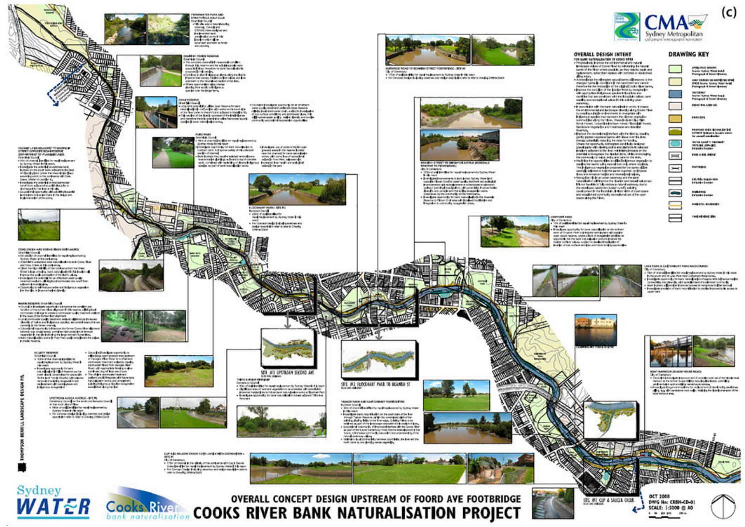
Prior to remediation of the riverbanks, an off-channel wetland in the Cup and Saucer Creek catchment, one of the tributaries of the Cooks River, was constructed under a separate design and construction contract. A diversion structure was built to redirect water via an underground pipe into the two existing wetland cells.

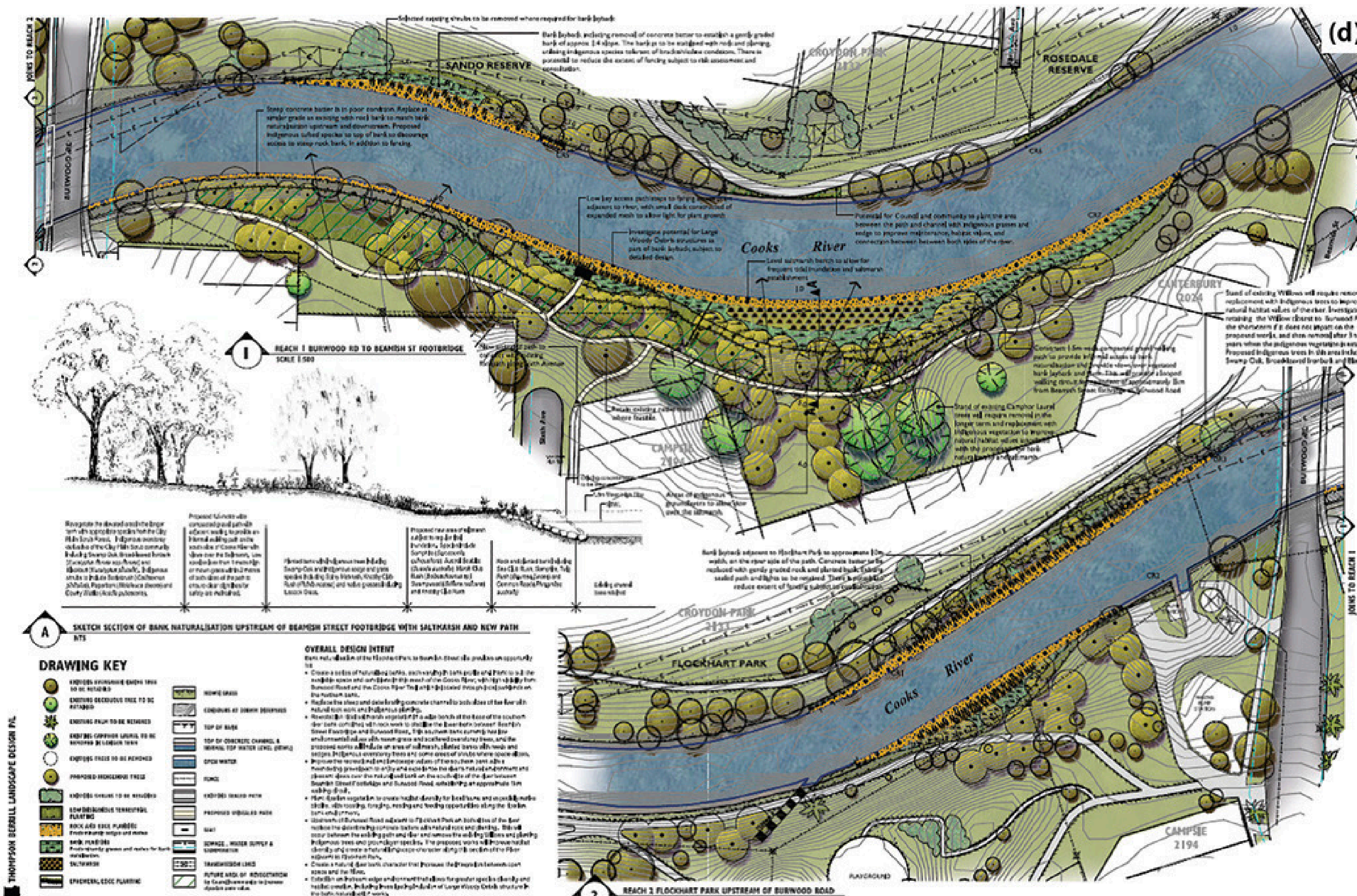
Case Study

SYDNEY WATER BANK NATURALIZATION, SYDNEY, NEW SOUTH WALES, AUSTRALIA (CONTINUED)

PROJECT COLLABORATORS AND CONTRIBUTORS:

Canterbury City Council (now City of Canterbury Bankstown)
Sydney Water
State agencies
Local Residents
Parsons Brinckerhoff - Flood study, flood impact assessments and hydraulic design
Thompson Berrill Landscape Design - Naturalization master planning, concept design, detailed concept design and construction supervision
Total Earth Care - Cup and Saucer Wetland construction
Josa Constructions - Riverbank construction
Toolijooa - Vegetation planting and establishment





© Sydney Water: Sydney Water plans extensive work for the Cooks River

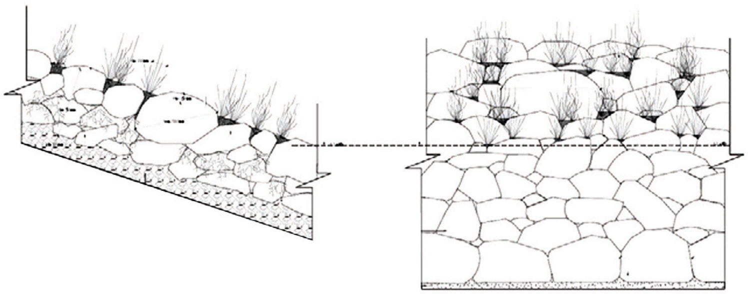
SYDNEY WATER BANK NATURALIZATION, SYDNEY, NEW SOUTH WALES, AUSTRALIA (CONTINUED)

Planting Strategy

- Over 100,000 local native plants were planted along the embankment, within the wetland, and to create habitat in adjacent terrestrial areas.
- Plants were chosen to mimic local ecological communities.
- Over 28,000 square meters of new native vegetation was created.
- Endangered salt-marsh vegetation was incorporated into newly naturalized banks.

Environmental Benefits

- Improved river health
- Increased diversity of native riparian habitat for birds and aquatic life
- Improved connectivity for flora and fauna between reaches of the river
- Creation of about 7 acres of new native vegetation
- Created about 0.6 acres of freshwater wetland providing stormwater treatment and aquatic habitat



Social Benefits

- The local community developed a sense of pride in the project by providing feedback into the planning and design process.
- Improved aesthetics of the naturalized river section
- Opportunity for locals to enjoy nearly a kilometer of new public pathways along the river
- Improved property value along the restored waterfront

Technological and Cost Benefits

- Improved cost effectiveness due to the longer asset life of the naturalized river embankment compared to concrete alternatives
- Costs of flood study were shared by Sydney Water, local councils, and other agencies. The study results can be used for local floodplain management in the future.

Community Engagement Process

Concept designs were developed by Sydney Water in consultation with local councils, state agencies, and community groups along the Cooks River. Key concepts along with a survey to determine the level of support for naturalization were distributed to over 5,000 residents along the river and got support from over 96% of respondents.

A separate communication campaign consisting of a mailbox drop with information about the upcoming construction and updates on the progress was designed for residents near the Cup and Saucer Creek Wetland. Meetings to understand concerns and preferences of residents as well as an opening event were held for residents of the adjacent communities.

Challenges

- A multitude of agencies with management responsibility (13 local councils and several state government agencies) along the Cooks River and throughout the catchment made effective coordination and management challenging.
- The initial scope for restoration work needed to be broadened in order to be economically feasible and to take advantage of economies of scale.

Lessons Learned

- Naturalization is feasible where there is adjacent open space available and where works would not affect underground and overhead services and flooding potential.
- Completing work on the embankment in small sections at a time resulted in reduced risk of failure and reduced risk to ecosystems.
- Collaboration and integrated planning provide better value for communities.

SOURCE OF INFORMATION: Cooperative Research Centre for Water Sensitive Cities (2018): Sydney Water Bank Naturalisation. Case Study — Prepared by Cooperative Research Centre for Water Sensitive Cities, September 2018. Cunningham, D. (2017): Cooks River naturalization. Sydney Water. State of New South Wales through the Department of Industry 2017. Cunningham, D. (2010): Contemporary Riverbank Renewal. Restoring the Banks of The Cooks River, Sydney. STORMWATER 2010 National Conference of the Stormwater Industry Association. Sydney Water (2009): Cooks River Bank Naturalisation Project. Water Service Association of Australia (2013): Cooks River bank naturalization. Case study 13.

Case Study

ORANGE STORMWATER HARVESTING SCHEME, NEW SOUTH WALES, AUSTRALIA

Background

The City of Orange is located about 155 miles west of Sydney in New South Wales, Australia. Despite relatively high annual rainfall compared to surrounding areas, Orange periodically experiences water supply challenges due to its location in the upper Macquarie River Catchment and the lack of a substantial river system or groundwater supplies. The city lies within two local creek catchments, Blackmans Swamp Creek and Ploughmans Creek. Fresh water for about 40,000 people is sourced from two dams, which are fed by a network of local creeks. In 2008, due to continuous dry conditions, the city's main supply storages dropped to less than 25% and left Orange with about one year's supply. The City Council investigated structural initiatives and determined stormwater harvesting as a viable option. In 2008 Orange began the construction of Australia's first Stormwater to Potable Harvesting Scheme in the Blackmans Swamp catchment.

PROJECT COLLABORATORS AND CONTRIBUTORS:

Orange City Council: construction, and community engagement

GEOLYSE (now called Premise): planning and design

Department of Industry Water: State Regulator, responsible for surface water and groundwater resources management in NSW

NSW Health: advisor on water quality risk assessment

Project Objectives

1. **Diversify water supply cost effectively**
2. **Harvest urban stormwater for potable uses by taking advantage of the runoff from hard surfaces that existed in the urban environment**
3. **Introducing a purple pipe system, reduce consumption of drinking water by 40% by using treated stormwater to irrigate gardens and flush toilets**

Design Features

The Orange Stormwater Harvesting Scheme was built in two phases:

- First Phase: In 2009, the Blackmans Swamp Harvesting Scheme (BSHS) was constructed under drought emergency conditions with emergency funds to boost the city's water needs. Through the BSHS, water from the Blackmans Swamp Creek is harvested and transferred to a holding dam. Then it is treated in batch ponds and piped into the Suma Park Dam whereupon it is subsequently treated for potable supply. The first transfer of treated stormwater to Suma Park Dam was in April 2009, following a 6-month construction phase.

ORANGE STORMWATER HARVESTING SCHEME, NEW SOUTH WALES, AUSTRALIA (CONTINUED)

- Second Phase: Due to the success of the First Phase, an additional harvesting scheme from the Ploughman's Creek was developed in 2011, adding a system of four constructed wetlands that naturally treat and transfer runoff to the holding dam and then the same process used for the BSHS.
- The City Council has also introduced a dual pipe plumbing system, which uses treated stormwater from the holding dam for toilet flushing and garden irrigation. The dual pipe systems have been introduced in houses built after 2005 to the north and west of the City.

Strategy

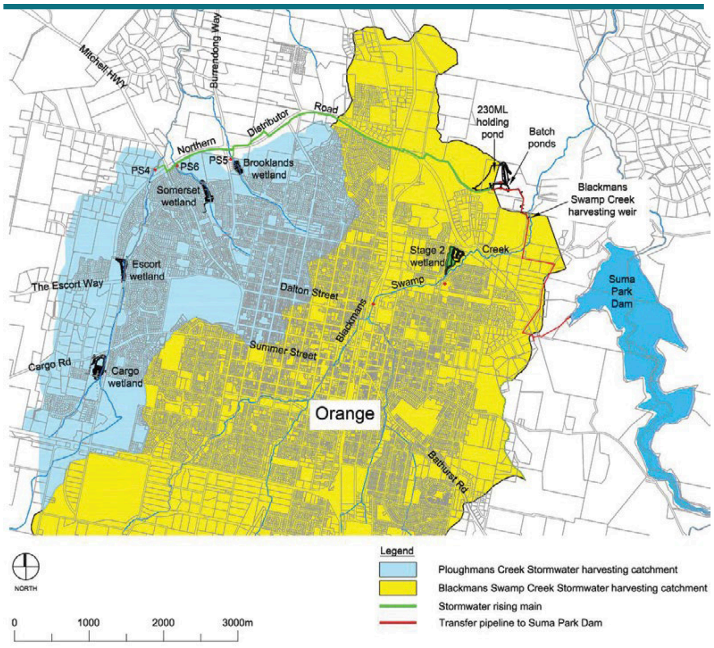
Vegetation for the constructed wetland was selected considering the climatic conditions at the top of the catchment: At an altitude of 3,150 feet above sea level, it snows two to three times a year.

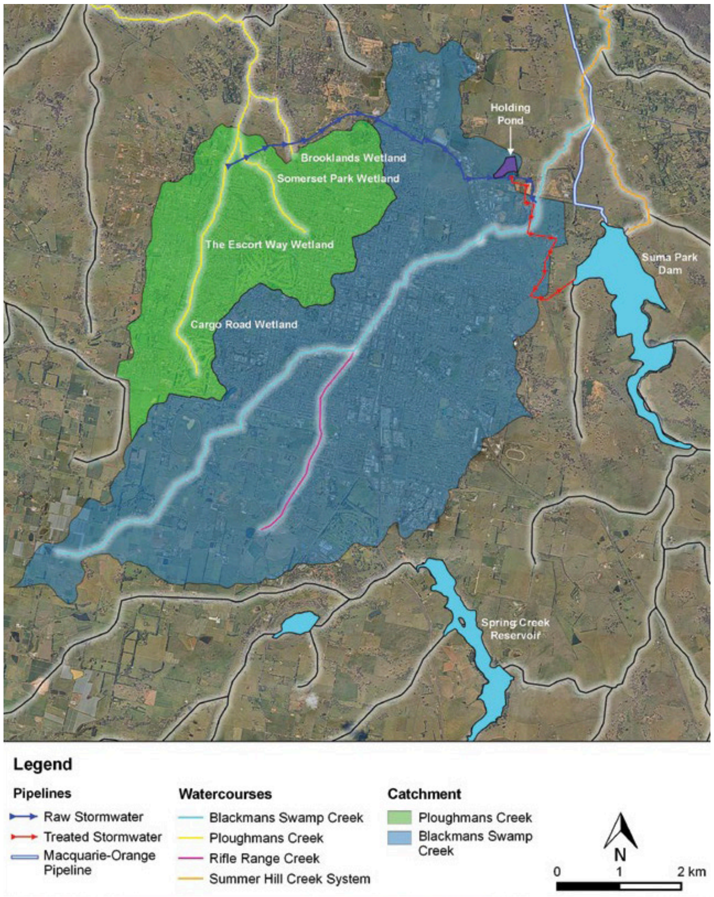
CONSTRUCTION COSTS

The Blackmans Swamp Creek SWHS:
US $3,569,500

The Ploughmans Creek SWHS:
US $2,927.000

Dual Water Scheme: US $1,070,850
(treatment system, pipes, connections, and audit cost)





Benefits from Harvesting and Treating Stormwater

- Additional 1,350ML/year, covering 25% of the city's water needs
- Wetlands slow and treat stormwater flows, reduce erosion and pollution, and contribute to ecosystem health while providing important urban habitat

Benefits from the Dual Pipe System, Using Stormwater for Irrigation and Toilet Flushing

- Reduces potable water consumption by up to 29%
- Reduces stormwater pollutants and volumes from entering waterways

Social Benefits

- Community education program for stormwater harvesting scheme and the audit of homes with the dual water system increased community engagement and public confidence in the scheme
- Extensive engagement with residents with dual water systems has built an understanding of the fit-for-purpose use of stormwater and drinking water in homes

Challenges

- Lack of regulations and guidelines for harvesting and use of stormwater for potable uses in Australia
- Lack of relevant established data for typical stormwater runoff contaminants
- Resourcing and management of new infrastructure
- Wetlands bring obligations for resourcing and collaboration with other city departments for maintenance which may prove challenging
- Drowning risk for children accessing the wetlands
- Mosquito risk due to extended inundation of stormwater wetlands
- Negative social media feedback was caused by slightly discolored treated stormwater used for toilet flushing from dual pipe system. The discoloring was evoked from oxidation of manganese by chlorine, the latter of which is added to the water to kill pathogens.

Lessons Learned

- To overcome the lack of data and guidance, the Australian Drinking Water Guidelines were used in a conservative hierarchy for treatment quality targets
- Strong leadership within Council during the drought created an environment which fostered innovation and empowerment
- The development of Review of Environmental Factors (REF) for the SWHS was important in getting stakeholder agreement and approval for harvesting and using stormwater for potable uses
- To prevent drowning risks, vegetation barriers were planted around the wetlands to make access difficult
- To reduce mosquito risk, wetlands need to be well maintained to prevent standing water
- Discoloring of the treated stormwater is a small technical issue but can lead to consumer concerns on water aesthetics if not communicated effectively

SOURCE OF INFORMATION: GEOLYSE, Orange City Council (2018): Orange Stormwater to Potable: Building urban water supply diversity. Case Study. Orange City Council (2018): Operation Environmental Management Plan Orange Raw Water Supply System. Interview with Jonathan Francis, Water Treatment Manager at Orange City Council on September 11, 2020

Case Study

FLOOD PARK ZANJÓN DE LA AGUADA, CITY OF SANTIAGO, CHILE

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Background

Since urbanization spurred development in the natural floodplain of Zanjón de la Aguada, flooding has been an issue in this part of the City of Santiago, Chile's capital. The 16.8-mile channel crosses the city from east to west, running through nine municipalities before discharging into the Pacific Ocean. Over 50 years ago, the natural drainage system was channelized in an attempt to create a more efficient conveyance system. However, the system has insufficient capacity to manage heavy winter rains, and the combined flows from twenty-one bordering and upstream municipalities, including municipal wastewater, has been flooding downstream neighborhoods. Additionally, the channelized river became a place of violence and crime. Authorities had planned to increase the channel's capacity to address the flood risk. However, given a relatively short rain season, a lower-cost solution to add an off-channel "flood park" to detain peak flows during winter periods was ultimately selected.

The 0.4 miles long flood park Zanjón de la Aguada (later named Victor Jara Park) opened to the public in 2018 and is part of a larger reconstruction framework called the Inner Ring Master Plan of Santiago. The plan aims to recover the land belonging to the former railway belt, which marked the limits of the city until the beginning of the 20th century. The deteriorated and obsolescent land linked to the railway belt was a great opportunity space to drive urban development and revitalization in one of the poorest areas of the city.

Project Objectives

1. **Control the overflows in the Zanjón de la Aguada to prevent streets and homes from flooding**
2. **Revitalize urban spaces by providing new recreational space for the south-central area of Santiago**
3. **Improve equity by providing public amenities to communities in outlying neighborhoods where there has been historic disinvestment**

PROJECT COLLABORATORS AND CONTRIBUTORS:
Ministry of Public Works
Municipal Works Directorates

DRIVERS AND INCENTIVES

The project is part of the "Bicentennial Work" (Obra Bicentenario) that is a State development initiative, which obliges successional governments to continue with the project development stages and to cover more than one communal territory in a legislative period.

COSTS: Approx. $61M

FLOOD PARK ZANJÓN DE LA AGUADA, CITY OF SANTIAGO, CHILE (CONTINUED)

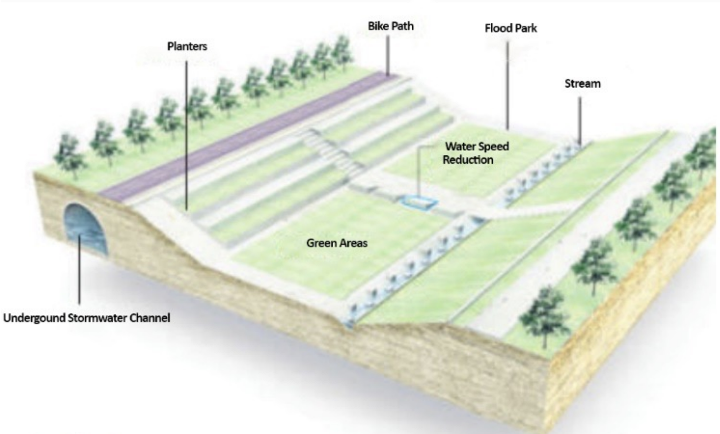
Design Features

The flood park Zanjón de la Aguada/ Victor Jara Park is an open hydraulic system that seasonally manages high peak flows to reduce flood risk in the surrounding neighborhoods. The park begins to flood in a controlled manner when the artificial stormwater channel exceeds its ability to convey high flows. Surplus flows are diverted into the flood park where runoff is detained and gradually returned to the channel, avoiding flooding. There is no natural infiltration inside the flood park and all stormwater from the channel is treated in the municipal wastewater treatment plant. The park design includes vegetated open space areas, a permanent lagoon, a children's playground, sports areas, more than 2.8 miles of bike lanes, and walkways. To date, the park has not been flooded as the improved hydraulic capacity of the channel has been sufficient to manage peak flows during heavy rains.

Stormwater Features

Detention capacity: 1,589,160 cubic feet

- Open and underground channels
- Vaults
- Permanent lagoon



© DISEÑOARQUITECTURA.CL: Zanjón de la Aguada Flood Park in section view.

© DISEÑOARQUITECTURA.CL: Left: Underground stormwater channel with low water level. Right: After heavy rain when the maximum vault capacity is exceeded, and the water floods the park.

Planting Strategy

- 487 trees, 1 acre of ground cover, 1.2 acres of shrubs and 2 acres of grass were planted inside the park.
- Planted species: "quillayes" and "vilcas" (native plants), palms, Jacaranda trees, European carob, Judea trees, and banana plants

Environmental Benefits

- Improves a deteriorated neighborhood by creating new green space and park amenities
- Contributes to ecosystem health by reducing pollutant loading to the channel, which discharges to the Pacific Ocean
- Establishes habitat that attracts insects and beneficial fauna (butterflies, bees, sparrows, thrushes, etc.) that had largely disappeared due to urbanization and pollution
- Helps to restore one of the city's main ecological corridors

Social Benefits

- Prevents future damage by floods for 6,200 homes, 4,700 commercial properties, 286 industrial properties, streets, avenues, highways, and metro lines
- Improved hydraulic infrastructure and green space transforms the reputation of the neighborhood as a place of crime and violence into a public good or community asset
- Created an urban space that can be actively used for sports and recreation for the four most deteriorated municipalities of the Santiago inner ring
- Increased market value for housing around the park

Green vs. Gray Benefits

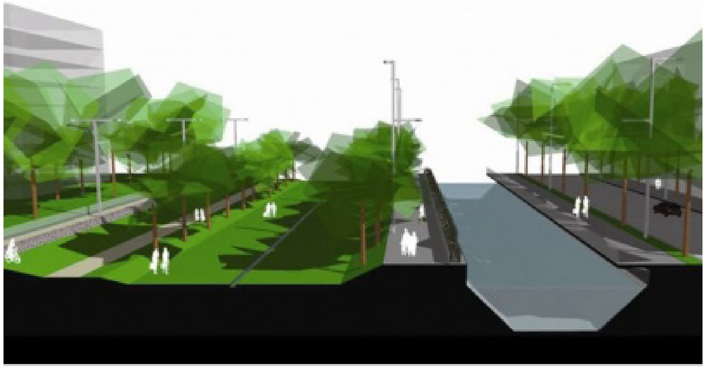
The Ministry of Public Works originally planned to build an expensive second overflow channel to cope with the stormwater discharge from heavy winter rains. However, the second channel would have only functioned a few days per year, been hard to maintain, had a higher construction cost, and added more gray infrastructure to the city.

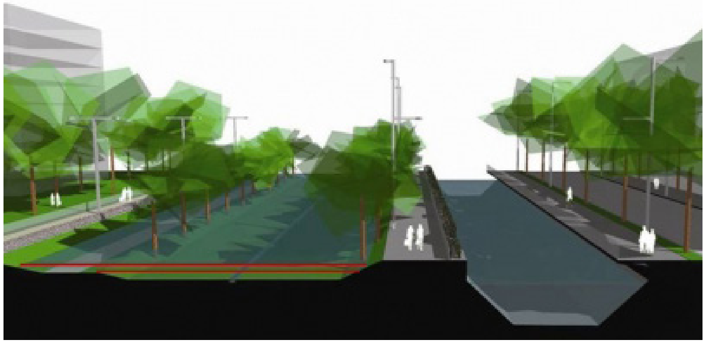
Community Engagement process

The Ministry of Public Works coordinated and led the construction work. Initially, authorities from the four municipalities bordering the park were included in the planning process but were not involved during construction. Consequently, the Ministry of Public Works completed construction leaving out most of the green infrastructure features envisioned in the master plan. Municipalities, backed by environmental committees, politicians, design professionals, and community members, launched a participatory process to procure new funding and make the necessary adjustments and improvements to the already finished construction.

Challenges

- During the design stage, the project became overly complex in terms of the proposed architecture, engineering, landscaping, and regulatory framework. The Ministry of Public Works removed several natural infrastructure components such as greening of the park, natural stormwater treatment features, and irrigation channels without further consultation with the adjacent municipalities.
- The project had a low profile and lacked strong political representation for many years. During construction and proposed flood park improvements, governance changed four times. This impeded the progress and continuity of the project.
- The main technical challenge was to integrate hydraulic and landscape improvements into the project. The park is a major intervention (2.8 miles long) in the middle of the City of Santiago. Construction involved modifying many basic services, making traffic detours, and interfering with other infrastructure projects, such as pavements, public transport corridors, Metro lines, and urban highways.





Lessons Learned

- Through a year-long participative management process led by local governments, environmental committees, and neighborhood councils, it was possible to re-envision the project as a park and community asset.
- Due to friction between the Ministry of Public Works and local governments, the Ministry was pushed to consider voices from civil society more seriously.

SOURCE OF INFORMATION: DISEÑOARQUITECTURA.CL: Parque Inundable De La Aguada. Municipalidad de San Joaquín: Cuenta Pública de Gestión 2019. Fernández, I (n.d.): Dossier Parque Inundable "Zanjón" De La Aguada. Universidad de la República. Interview with Victoria Pino Rojas, Architect at the San Joaquin municipality, responsible for flood park construction management from 2013 on, September 15, 2020

Case Study

URBAN FLOOD PARK "LA MARJAL", ALICANTE, VALENCIA, SPAIN

© Alicante City Council: Urban Flood Park La Marjal.

Background

Alicante is the second largest Valencian community on the southeastern coast of Spain with a population of about 330,000. The Mediterranean region has historically experienced "cold drops", heavy rain occurring in the fall and causing flooding, damage to assets, and loss of life. In 2019, "cold drops" caused evacuation of 3,500 people, serious economic damage, and seven deaths in the Valencian Community. To address the flood issues, Aguas de Alicante, the city's water and sanitation utility, evaluated the feasibility of an urban flood park that could absorb and filter excess stormwater. In 2015, a 9-acre urban flood park functioning as a detention basin during heavy rain events was built. The green areas in the park are fed with harvested water for the creation of artificial ponds and irrigation. The urban park "La Marjal" developed on former marshes forms part of a larger urban green belt near the coast. Despite the 2013 EU-wide strategy providing investments in green infrastructure, Aguas de Alicante covered the expenses to build the park with water utility fees.

PROJECT COLLABORATORS AND CONTRIBUTORS:

Aguas de Alicante is a public-private water and sanitation utility, formed the municipality of Alicante and Grupo SUEZ, a multinational water, energy, and waste management corporation. Aguas de Alicante is responsible for the entire urban hydraulic infrastructure and water and sanitation services

Alicante City Council provides for management of the municipal area

Project Objectives

1. **Protect biodiversity and improve aesthetics**
2. **Reduce flood risk in urban areas**
3. **Create nature-based leisure and recreation activities**
4. **Promote environmental education**

Design Features

The flood park was designed to detain urban stormwater runoff that the municipal sewer system cannot handle effectively. The built system captures and conveys the excess stormwater towards two lagoons inside the park using remotely controlled valves. The collected stormwater is either stored in the lagoons for later use within the park, or gradually returned to the city's sanitary sewer system for treatment. In the unlikely event of exceeding the park's capacity, the overflow can be conveyed to the sea.

The treated stormwater from the flood park meets quality standards for water reuse and can be also used for irrigation, farming, and street cleaning in the municipal dual pipe plumbing system.

DRIVERS AND INCENTIVES

National regulations allow reuse of reclaimed stormwater for irrigation, farming, street cleaning, etc.

Municipal infrastructure such as a dual pipe plumbing system favors the reuse of treated stormwater

Cost advantage of nature-based solution compared to gray infrastructure: the cost of the urban flood park was four times less than an alternative canal to convey untreated stormwater to the sea

Stormwater Features

- Detention capacity: 1,589,160 cubic feet
- Two ornamental water ponds of 3,638.2 sq ft and 71,838 sq ft
- The larger pond has a system of pipes and pumps that convey the water to the small pond, where it rushes through a 13 feet cascade.
- Aerators to oxygenate the lagoons
- Submerged ultrasonic algae control
- Recirculation pumps
- Flood gates and remotely controlled valves
- Alarm system to warn park visitors an impending flood event

Planting Strategy

There are four types of native Mediterranean vegetation inside the urban flood park: riverside vegetation, Mediterranean crops, Mediterranean forest, and marshy aquatic vegetation. Landscape design, planting and care for park vegetation is carried out by the Alicante City Council.

Environmental Benefits

- The formerly arid area was converted into a vibrant, vegetated park landscape.
- Reclaimed water is used for park irrigation and maintaining water levels in the lagoons.
- The park mimics the natural function of marshes, creating natural habitat for nesting birds, and other aquatic and marsh species.
- More than 100 bird species have been identified since the opening the park. Many migratory birds use the coastal park to rest.

Social Benefits

- Recreational space for the community
- Promotes mental and physical health through physical activity
- Stimulates social cohesion through community events
- An ornithological center inside the park educates the public about birds
- Reduces exposure to air pollutants, noise, and excessive heat
- Increases property value and tourism opportunity value of the city

Green vs. Grey Benefits

- Cost-benefit: The nature-based park infrastructure cost about USD $4 million, whereas a gray infrastructure project would have cost about USD $18 million.
- Gray infrastructure would convey polluted stormwater directly to the sea while the flood park allows treatment and reuse.

Community Engagement Process

The City Council evaluated the project and authorized construction because of general knowledge regarding community acceptance of the project.

Operations and Maintenance

Operations and maintenance responsibility is shared between the Alicante City Council and Aguas de Alicante.

- City Council is responsible for gardening, irrigation systems, landscape design, park cleaning, security, and social activities
- Aguas de Alicante is responsible for water quality, algae control, pumps, rainwater inlet control from the lagoons, and ornithological center.

Challenges

- In hot climates, legionella, which is a water born bacteria that can spread in standing waters through aerosols, is a potential risk.
- Algae growth in the lagoons
- Mosquito prevention

SOURCE OF INFORMATION: iagua (2015): Alicante inaugura el parque urbano inundable 'La Marjal', una infraestructura antirriadas. EUROPA PRESS article from 03/30/2015. Interview with Amelia Navarro Arcas, Director of Sustainable Development and Equity, and Manager of Management Systems at Aguas de Alicante on August 26, 2020.

Lessons Learned

- To reduce legionella risk, the cascade originally designed to aerate reclaimed water was removed and alternative aeration systems were introduced within the lagoons.
- To fight algae, a Venturi system, aeration pumps, and a subsurface ultrasonic system were introduced to the lagoons. Aeration can also help to reduce odor.
- Water should be exchanged gradually within the lagoons as it was found that rapid water exchange caused a quick deterioration in water quality.
- Mosquito eating fish and birds were introduced to the park to fight mosquitos.

Lessons Learned

To better understand the benefits and co-benefits of NBS and to advance their use in urban areas, we evaluated nine case studies where nature-based approaches were successfully implemented to address pressing environmental needs. The case studies emphasize the use of vegetated nature-based stormwater management solutions as a sustainable way to contribute to urban resilience and mitigate climate change impacts. We selected four countries and four states in the U.S. that have arid and semi-arid climate conditions to show that nature-based solutions have the potential to address water stress in Mediterranean-like climates by infiltrating and storing water for immediate or later use and to be incorporated into urban development projects. Additionally, the selected examples highlight potential barriers and identify the multiple benefits of NBS in the urban water cycle such as adaptability into green spaces, cost-effectiveness, multifunctionality, and significant social and health benefits, especially for underserved communities.

Although the list of benefits and co-benefits from nature-based solutions is long, NBS can have limitations. However, our case studies have shown that risks such as safety and water quality can be successfully addressed with simple and low-cost solutions and that risk assessment, planning, and maintenance can minimize risks and uplift the benefits of NBS providing cooling, recreational space, fresh air, and improved mental health to the surrounding communities. Unlike NBS, gray infrastructure does not provide community co-benefits. Plus, while gray infrastructure can serve an important water management role, it often has many unintended consequences, such as increasing urban heat islands, increasing runoff due to additional impervious surfaces, and creating waste products.

It is important to highlight that educational programs and extensive engagement with communities and residents are crucial to understanding the purpose and the benefits of NBS and to increase public confidence in the implemented solutions. Input from thoughtful community engagement activities should be incorporated in every stage of project development. It ensures that residents' needs are being met by design features and project elements.

The selected cases show that shifts in environmental and climatic conditions have created a need to adjust water use patterns to adapt to new volatile water conditions. To adjust existing outdated regulations and prepare for climate change impacts, policy makers and regulators at various legislative levels need to be aware of the issue and adapt relevant laws and policies to future climate scenarios. For example, the successful adoption of integrated water cycle practices as a business-as-usual approach in Australia helped to significantly extend alternative water supply and water reuse. Policies providing continuous investment in green infrastructure helped boost economic growth, create sustainable jobs, and reduce resource consumption by lowering energy use and increasing available water supply in the European Union.[2] Infrastructure projects can no longer serve a single purpose. With increasingly limited resources, urban areas need multi-benefit projects to address a variety of challenges. Vegetated nature-based solutions provide those multiple benefits while investing in a climate resilient future for communities.

2 Compare: European Commission (2020): Investing in green infrastructure https://ec.europa.eu/environment/nature/ecosystems/investing/index_en.htm

The Nature Conservancy

Thank you!

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