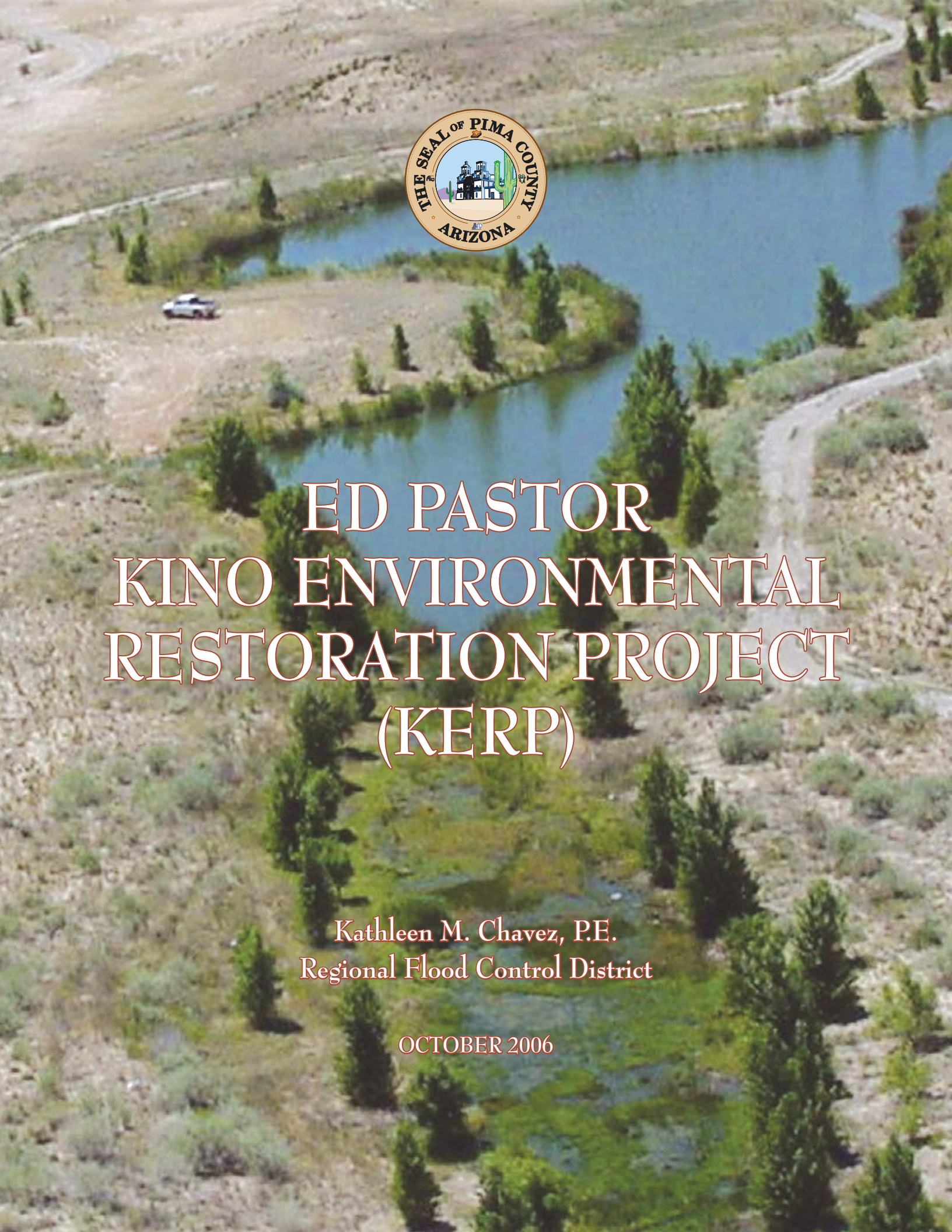

ED PASTOR KINO ENVIRONMENTAL RESTORATION PROJECT (KERP)

Kathleen M. Chavez, P.E.
Regional Flood Control District

OCTOBER 2006


ED PASTOR
KINO ENVIRONMENTAL
RESTORATION PROJECT
(KERP)

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Introduction

In the mid 1990s, the U.S. Army Corps of Engineers, Pima County and the Pima County Flood Control District entered into a cooperative agreement to create the Ed Pastor Kino Environmental Restoration Project (KERP). This project was the result of the agencies' desire to redevelop an existing unlined storm water detention basin—Tucson (Ajo) Detention Basin—into a detention basin that was more environmentally sensitive and aesthetically pleasing to the community. The multifaceted KERP facility was designed to meet three primary purposes—create native ecosystems, harvest urban storm water and control flooding.

The primary purpose was to establish or reestablish ecosystems representing Arizona's southwest riparian environment throughout the detention basin.

Secondly, the basin was developed to detain and store storm water and reclaimed water to reduce groundwater usage, particularly at Kino Hospital and the Kino Sports Complex.

The third purpose was to preserve the basin's functionality as a flood control facility by controlling drain flow in the basin to minimize flood impacts downstream.

This report documents the urban storm water harvesting benefits of the Ed Pastor Kino Environmental Restoration Project and the diverse benefits provided to the environment and community.

"This is truly an exceptional project. It takes an existing mud flat in an arid area and creates aesthetic landscapes, recreation features, flood control, and is a prototype for water harvesting. It is technically sophisticated while appearing natural. It has proved sustainable over the recent drought years."

Project History

The Tucson (Ajo) Detention Basin was constructed by the U.S. Army Corps of Engineers in 1966 to retain storm water that drained from a 17.7 square mile watershed. Located within an urban area of Tucson, the Ajo Detention Basin is surrounded by residential neighborhoods to the north; Davis-Monthan Air Force Base, a railroad yard and industrial complexes to the east; I-10, Kino Hospital and the Kino Sports Complex to the south, as well as mixed-use commercial and residential developments to the west.

Ajo Detention Basin

In 1999, the United States Congress authorized construction of the Ajo Detention Basin Environmental Restoration Project to develop watercourses, marshes and riparian habitat under Section 1135 of the Water Resources Development Act.

This project was one of the first projects to be constructed by the Los Angeles District of the U.S. Army Corps of Engineers, under the provisions of Section 1135.

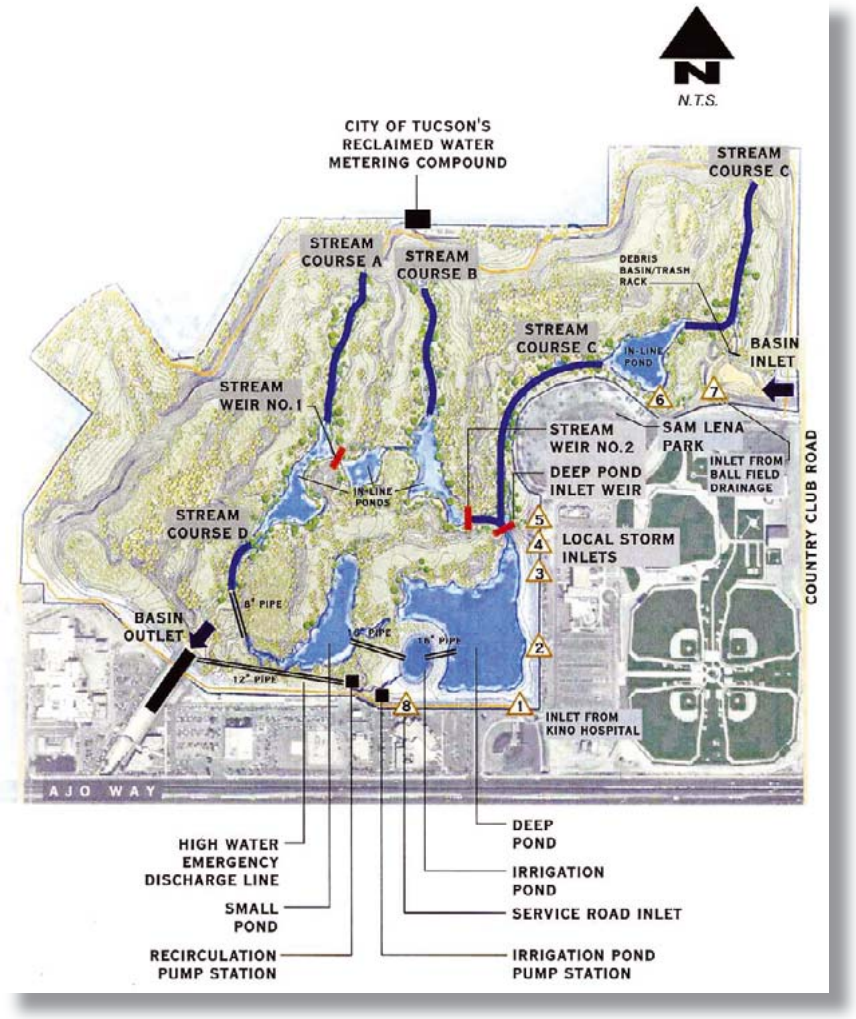
The project, completed in November 2001, was dedicated and renamed the Ed Pastor Kino Environmental Restoration Project on May 29, 2002. The project is now commonly known as KERP.

KERP (outlined in purple) and Surrounding Neighborhoods—2002 Aerial View

Project Description

The original focus of KERP was to create 50 acres of a native ecosystem and wildlife habitat in the Ajo Detention Basin. The basin's 9-acre area had a flat bottom with scrub trees and grasses growing along the edges. The restoration project design consisted of grading the detention basin to create 4.5 acres of marshland, 15 acres of riparian habitat, 8 acres of upland or higher ground and 10 acres of grassland—all fed by water retained in a 7-acre, 50 foot deep lake created in the basin.

The final footprint of the new KERP facility covers 125 acres, with the 50-foot deep lake covering 7 acres, 20 acres of watercourses and hills and mounds topping out at an elevation of 2,520 feet. Areas have been planted with native species to create marsh habitats, mesquite bosques, grasslands and an open water environment that will support wildlife and birds.

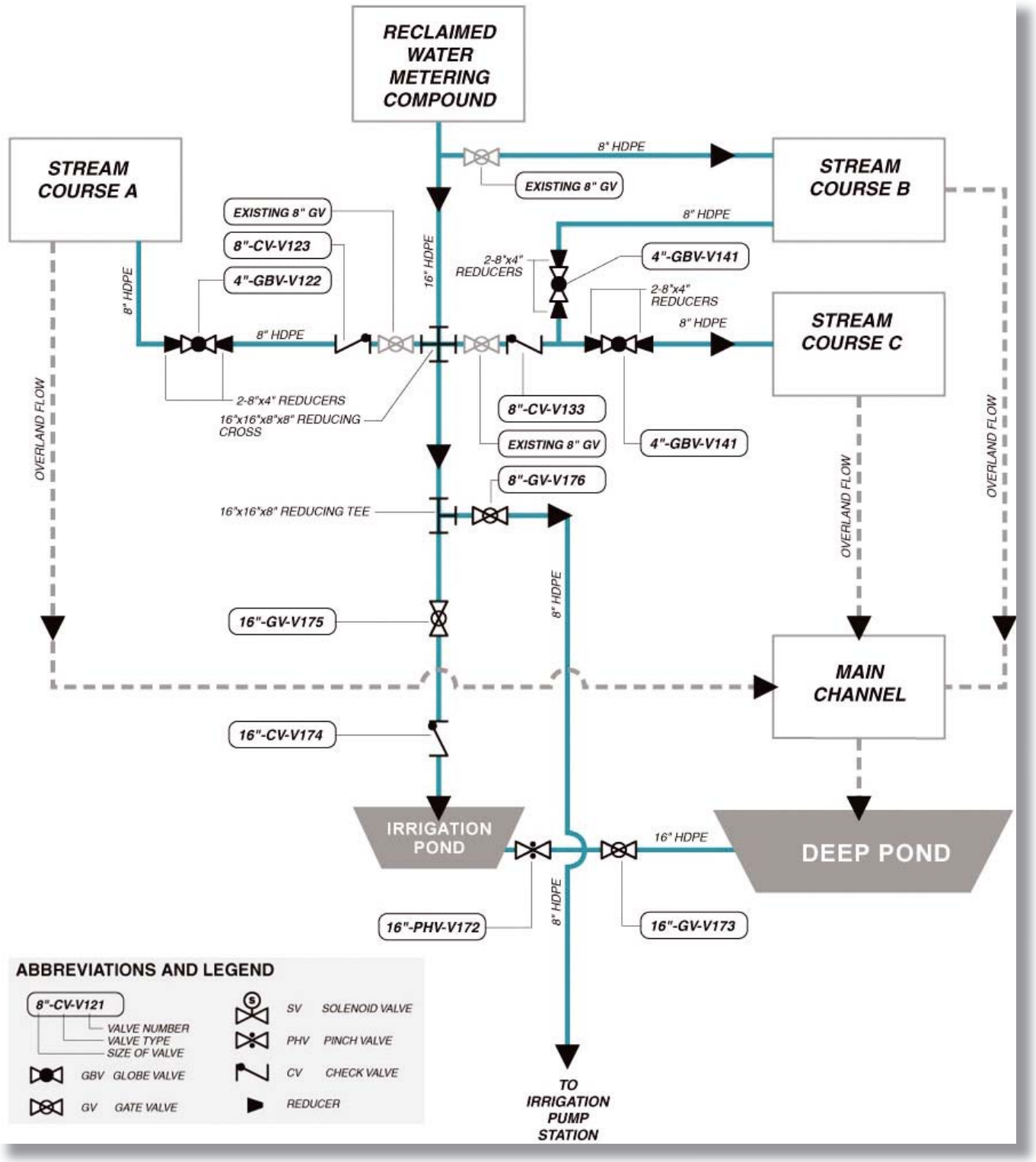


Overview of KERP Design

The environmental restoration project maintains the flood storage capacity and capabilities of the original basin, while permitting water harvesting from storm flows.

KERP was designed to reduce an incoming peak, 100-year storm flow of 15,300 cubic feet per second (cfs) to an outflow of 9,300 cfs, by detaining and storing approximately 1,880 AF (acre-feet) of storm water. [1]

The project is also designed to harvest storm water for use on vegetation within the project limits and the adjacent Kino Sports Complex athletic fields while continuing to support the basin's original purpose of detaining storm water.

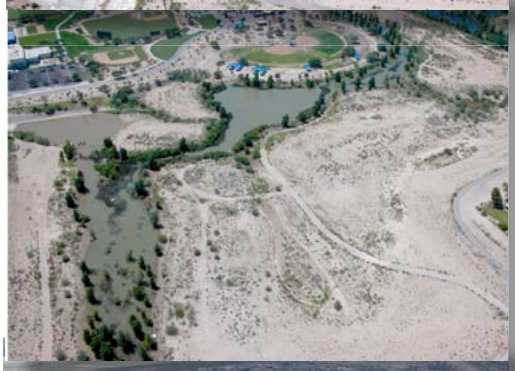

RECLAIMED WATER METERING COMPOUND
STREAM COURSE A
STREAM COURSE B
STREAM COURSE C
MAIN CHANNEL
IRRIGATION POND
DEEP POND
8" HDPE
EXISTING 8" GV
8"-CV-V123
4"-GBV-V122
16" HDPE
2-8"x4" REDUCERS
4"-GBV-V141
8"-CV-V133
16"x16"x8"x8" REDUCING CROSS
8"-GV-V176
16"x16"x8" REDUCING TEE
16"-GV-V175
16"-CV-V174
16"-PHV-V172
16"-GV-V173
OVERLAND FLOW
TO IRRIGATION PUMP STATION
ABBREVIATIONS AND LEGEND
8"-CV-V121
VALVE NUMBER
VALVE TYPE
SIZE OF VALVE
GBV GLOBE VALVE
GV GATE VALVE
SV SOLENOID VALVE
PHV PINCH VALVE
CV CHECK VALVE
REDUCER

The project also includes an extensive pumping and valve system designed to circulate and mix reclaimed and storm water within the basin.

Operational Aspects

The basin operates by taking in storm water from the highly urbanized watershed around the Davis-Monthan Air Force Base. A sediment basin and trash rack immediately below the inlet provides for the initial removal of debris and sediment coming from the Tucson Diversion channel during runoff events.

Sediment Basin and Trash Rack



Storm water then passes into the storage ponds lined with a geosynthetic fabric to retain optimum amounts of runoff water by preventing seepage into the aquifer. Water levels are maintained within the in-line ponds by means of two small weirs and a weir gate into the deep lake. Pumps recirculate the water within the basin to feed three stream courses. Recirculating water develops the stream course within the tall cottonwood/willow riparian areas and drains back into the ponds.

As in nature, the water level in the ponds will fluctuate depending on the availability of storm water. An unexpected benefit has been the resilience of some plant species to sustained inundation during flood events. Some portions of the wetlands have been naturally colonized by seepwillow, which is tolerant of saturated soil conditions, but even more surprising is that mesquite and cottonwood have not "drowned" during sustained ponding.[2]

When a period of extended dryness occurs, reclaimed water, purchased from Tucson Water, can be used to insure the continuation of the open water and marsh habitats by maintaining minimum pond and lake elevations.[3]

Water Harvesting

Newly planted KERP Channel—August 2001 • Same view 2005

Storm water from the detention basin is "harvested" and used to irrigate the basin's reestablished vegetation, Kino Hospital grounds and the Kino Sports Complex ballpark and practice fields.

Harvested storm water provides a low cost alternative to purchasing and using groundwater or reclaimed water as well as the beneficial use of storm water that would otherwise have evaporated or infiltrated into the original Ajo Detention Basin.

To maximize the available water from each runoff event, storm water is transferred through weir gates into the deep lake and then into the small pond to increase the capacity of the in-line storage ponds to receive the next storm's runoff. Cycling storm runoff from the in-line ponds into the deep lake allows the basin to collect the maximum volume of runoff from a series of small storms. The deep lake can be filled up to a 2,499-foot elevation, storing 30 million gallons of water.[4]

When irrigation water is needed for plants within the restoration area and on the adjacent Kino Sports Complex athletic fields, the storm water is moved into the irrigation pond from the deep lake or the small pond through an underground piping system. The water is then pumped from the irrigation pond to the athletic fields. During dry periods when storm water is not available for harvesting, irrigation is supplemented by reclaimed water to irrigate the plants.

Reclaimed water is treated wastewater (effluent) that has undergone additional filtration to remove impurities at the metropolitan treatment facilities (Roger and Randolph) before being wheeled (distributed) by the City of Tucson's reclaimed water system. In 2005, the new Randolph Park facility produced enough reclaimed water to provide wheeled reclaimed water to KERP. A 16-inch reclaimed water pipeline "wheels" the treated wastewater that supplies the basin and the Kino Sports Complex.

The pipeline feeds into the irrigation pond and the deep lake. Three 8-inch pipelines are also available to provide reclaimed water directly to the marsh and open water areas in the basin during periods of drought when there is insufficient storm water.

Water Demands

One of KERP's objectives is to use harvested storm water supplemented with purchased reclaimed water for vegetation and irrigation of the athletic fields' turf, as well as landscaping on the roadway median and hospital grounds. Approximately 84.5 acres are irrigated with water from KERP.[5] By maximizing the use of harvested storm water, costs to purchase reclaimed water or ground water are minimized. Due to contractual obligations with Major League Baseball, Tucson Electric Park does use some groundwater (30.54 AF in 2004).[6]

Water needed to irrigate the sports complex ball fields, medians and the hospital landscaping was estimated at 410 AF a year and 172 AF a year to irrigate the vegetation within the environmental restoration basin.[7] The spray irrigation, initially used in KERP, was discontinued in 2006 due to the successful establishment of the plants. The water sources for 2004 and 2005 were:

Acre Feet	**2004**	**2005**
Reclaimed Water	330	180
Harvested Storm Water	252	402
TOTAL SUPPLY	**582**	**582**

The increase in harvested storm water was due to a productive rain season in September 2004 and that meant storm water could be stored during the winter months and used during the Spring of 2005. Storage ponds within the project can store up to 132 AF of water.

Value

The 1998 Project Design Report estimated water demand at 574 AF per year and water costs at $265,000 annually, based on an assumed cost of $462 per AF.[8] However, in 2005, the cost basis to purchase reclaimed water from the City of Tucson was $610/AF.[9]

Based on the water demand in 2004 and 2005 of 582 AF each year, the cost to purchase reclaimed water exclusively would have been $355,020. However, because of water harvesting practices, only 330 AF and 180 AF of reclaimed water were purchased in 2004 and 2005, respectively.

The reclaimed water costs, based on the City of Tucson's reclaimed water rate of $610/AF, would have been $201,300 in 2004 and $109,800 in 2005. A savings of $153,720 in 2004 and $245, 220 in 2005 was realized because harvested storm water was used in place of reclaimed water.

Additional savings have been achieved due to intergovernmental agreements approved between Pima County and the City of Tucson. These agreements establish the basis to wheel county treated effluent in the city's reclaimed system for delivery to county facilities.

The *environmental* rate of $260.92/AF[10] applied to secondary-treated effluent from metro plants in 2004, but in 2005, with the reactivation of the Randolph Park Water Reclamation Facility, the *operating* rate of $60.38/AF applied to the Class A water produced by the County. The environmental rate applies to effluent that has been treated and delivered by Tucson Water. The less costly operating rate applies to effluent that is delivered through Tucson Water's reclaimed lines but treated by Pima County.

The combined savings of harvesting water and favorable reclaimed water rates are $613,068 over the two years the KERP facility has been at full operational levels. The costs saved by harvesting water combined with the intergovernmental rates are summarized in the table below:

	2004	**2005**
Water Demand (acre feet)	582	582
Value[11]	$355,020	$355,020
Reclaimed Water Purchased (acre feet)	330	180
Value[12]	$201,300	$109,800
Savings	$153,720	$245,220
Based on IGA Rates		
Value[13, 14]	$86,104	$10,868
TOTAL SAVINGS	**$268,916**	**$344,152**

Due to the rainy 2004 summer, storm water was stored, harvested and used through the Spring of 2005, resulting in the purchase of only 180 AF of reclaimed water, primarily during the summer months. Had the project been entirely dependent on reclaimed water for all irrigation needs, the cost to purchase reclaimed water would have been approximately $355,020.

Using harvested water and a smaller amount of reclaimed water, the costs to irrigate the KERP and Kino Sports Complex was just under $11,000 in 2005. In other words, storm water harvesting and reduced reclaimed water rates resulted in a 76 percent saving in water costs in 2004 and a 97 percent saving in 2005.

KERP Riparian Area

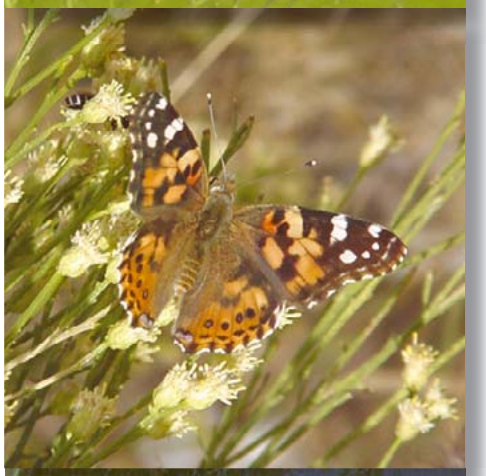
Environmental Benefits

KERP uses storm water, thereby contributing to groundwater conservation goals and improving aquifer water quality.

As further urban growth occurs in this already heavily urbanized area, the restoration component of KERP provides a managed watercourse environment and increases wildlife habitat for Tucson's metropolitan area. The project provides valuable habitat for resident and migratory waterfowl, shore birds, riparian obligate[15] bird species and upland bird species. Due to Tucson's location along the Pacific Flyway, there is a need for wetland habitat to provide important resting and foraging areas for migratory bird species.[16] It also provides additional habitat for reptiles, amphibians, small mammals and invertebrates.

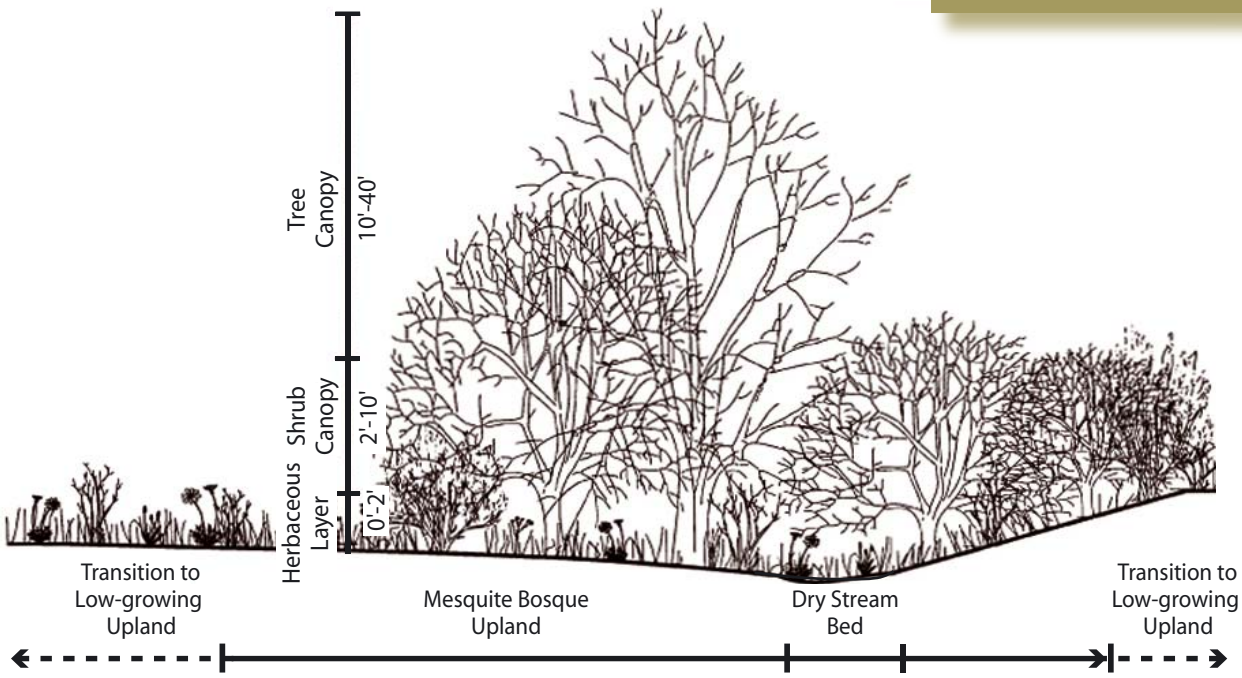
The ponds are now used by a wide variety of waterfowl, as the basin is located within a national waterfowl migration corridor. Development of open water, emergent freshwater marsh and upland cover provides habitat for waterfowl such as black-bellied whistling duck, northern shoveler, mallards and the American widgeon.

Development of mudflats and shorelines in the basin provides habitat for shorebirds and associated species, such as black-neck stilt, greater yellowlegs, long-billed dowitcher, western sandpiper and least sandpiper. The project's riparian habitat provides areas for riparian obligate bird species such as yellow warbler, song sparrows, rufous-sided towhee and blue grosbeak.

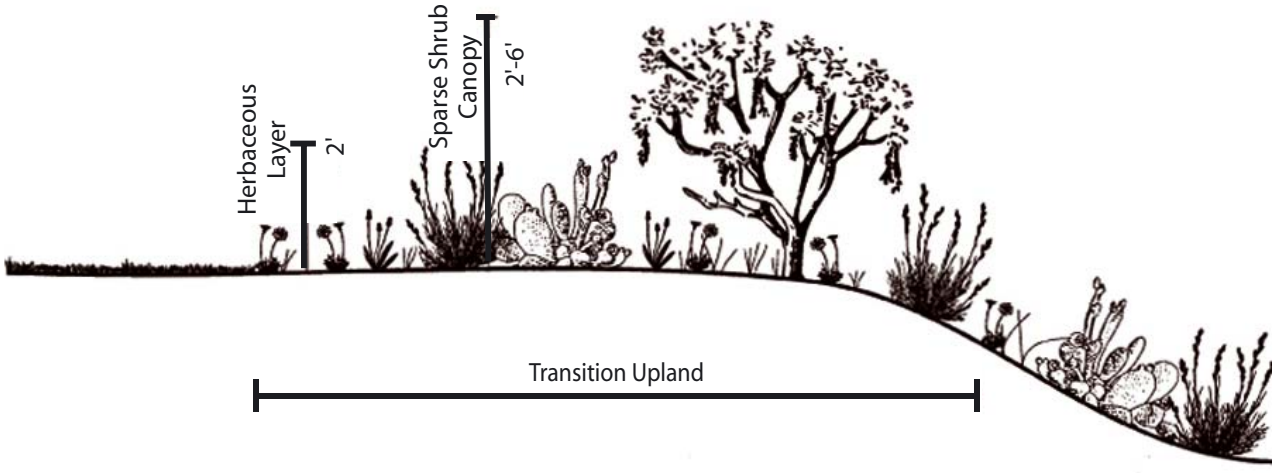


Waterfowl attracted to KERP mudflats and shoreline

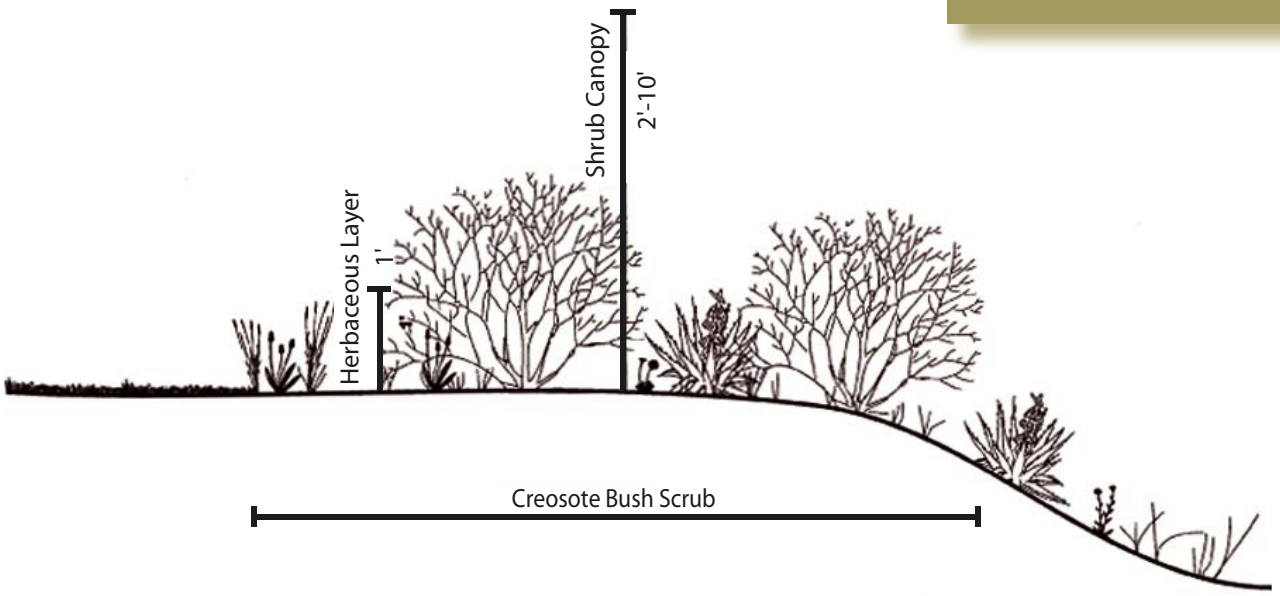
Cross Section of Mesquite Bosque Habitat



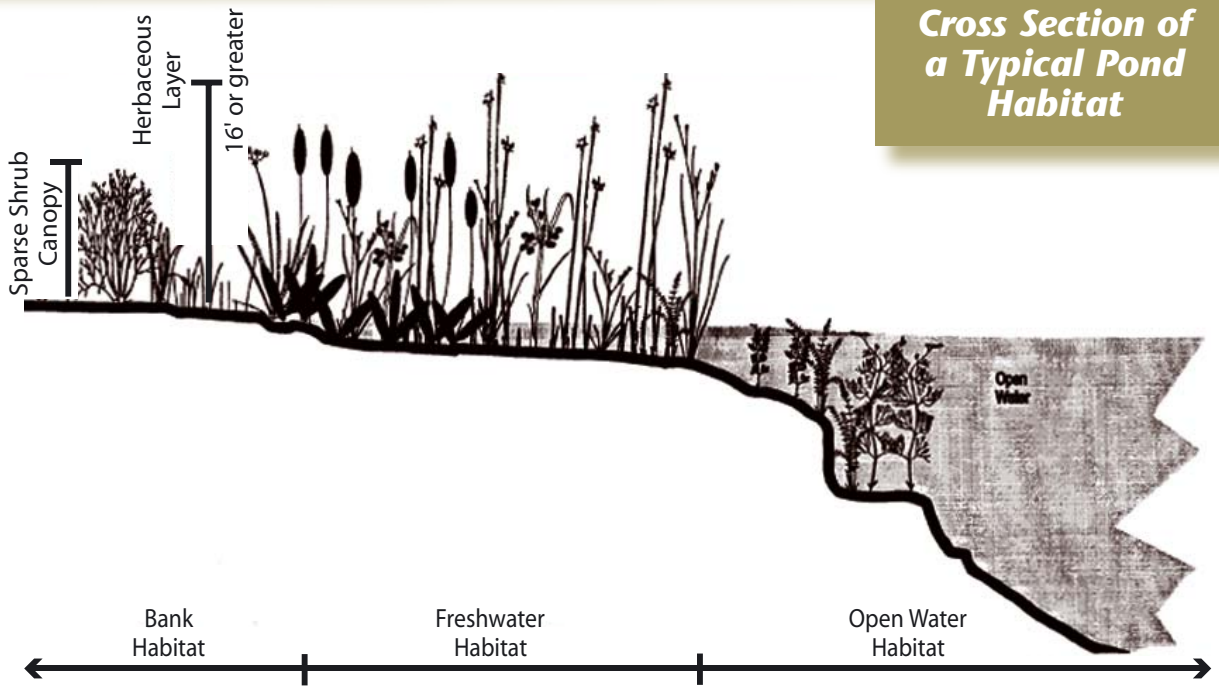
Cross Section of Transition Upland



Cross Section of Creosote Bush Scrub Habitat



Cross Section of a Typical Pond Habitat



Burrowing Owl Habitat

The KERP basin has become an ideal site for habitat restoration and relocation for the burrowing owl. The burrowing owl, a rare bird in Pima County, is listed as a migratory bird under the Migratory Bird Treaty Act and is a priority vulnerable species under the draft Pima County Multi-Species Conservation Plan (MSCP). The species is declining as a result of habitat disturbance and loss of nesting sites.

A number of community groups are involved in restoration efforts. A burrowing owl relocation program in the basin is run by Wild At Heart, a non-profit organization dedicated to the conservation and preservation of Arizona's native wildlife.[17]

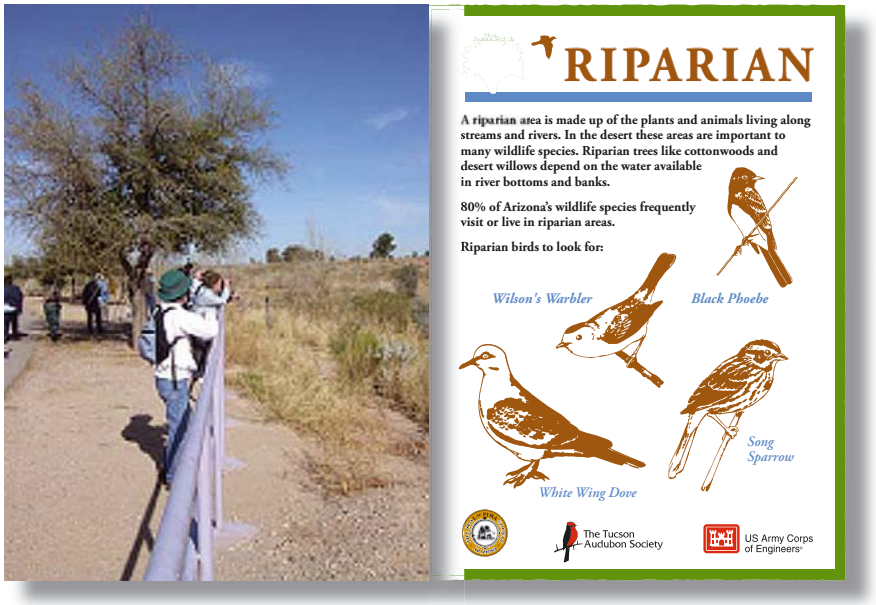
The Arizona Game and Fish Department oversees burrowing owl relocation and education. The Pima Vocational High School assists in installing burrows for the owl.[18]

Relocated Burrowing Owl

Some of the challenges in the basin have been controlling feral dogs that prey on wildlife, including the owls. Control strategies include assistance from Pima County Animal Control to remove feral dogs as well as planting prickly pear and cholla cactus in key areas to provide refuge for the owls.

Community Benefits

> "This is one of the best birding locations in Tucson, and one of the least known. As the native vegetation planted their matures, the birding will only get better."



KERP Bird Habitat Education Program

KERP supports various recreational features and community facilities, including Tucson Electric Park, Sam Lena Park, Kino Hospital, the Kino Community Recreation Center, Juvenile Court Center and James Thomas Park.

Additionally, the University of Arizona conducts research in the basin.

A two-mile pedestrian and bicycle trail system along the basin's perimeter continues downstream (west) along the Tucson Diversion Channel. Additionally, ramadas have been installed for use by visitors to KERP.

In addition, the Tucson Audubon Society monitors bird populations and conducts weekly bird walks for the public. These walks are wheelchair accessible. Binoculars and Spanish language bird guides are also provided.

The Tucson Audubon Society designed the interpretive signs.

The Tucson Audubon Society says, "This is one of the best birding locations in Tucson, and one of the least known. As the native vegetation planted there matures, the birding will only get better."[19]

Five environments exist within KERP; these environments include Arizona uplands, open water, riparian communities, wetlands and a mesquite bosque.

The Tucson Audubon Society has developed interpretive signs to post along the pedestrian walkway to inform and educate the public of the value of the habitat and wildlife that they are observing.

Vector Control

A number of natural approaches have been integrated into the environmental restoration project to reduce mosquitoes. Several types of birds and wildlife that will inhabit the restoration site are predators to the mosquito, as are various insects such as dragonflies.[20]

The project is designed to circulate water along three stream courses that drain into the in-line ponds. The 50-foot deep lake provides cooler water that is pumped from the bottom of the deep lake to the top of the stream courses. Both these measures, circulating water and cooler water, reduce mosquito-breeding areas.

Another feature to reduce a potential mosquito problem was to build a steep bank near the edge of the ponds, thereby reducing the shallow water habitat required by mosquitoes for breeding.[21]

Funding and Costs

Planning, design and construction costs for this project totaled $11,283,000. The two funding participants were the U.S. Army Corps of Engineers, who contributed a $5 million federal share, and Pima County. The local share match included $5 million in 1997 Sewer System Revenue Bonds and $1,282,459 in other funding from the Wastewater Management Department and the Pima County Flood Control District.[22]

Operating and Maintenance Costs

Although KERP provides many community, environmental and water resources benefits, operating and maintenance costs have been minimal. The FY06-07 budget is approximately $280,000 with an estimated $179,598 in personnel costs.[23] Kino Sports Complex operators, in conjunction with other departments, have been learning how to work with the natural floods to minimize the need for artificial irrigation. They are operating the wetlands to be as self-sustaining as possible.

KERP is in the process of adding personnel to work at the site to help with management and compliance issues. The basin is currently operated using 4.1 full time equivalent employees, some who share their time between KERP and the Sports Complex. Their operational knowledge regarding KERP is valuable and should be retained and transferred as employees change.[24]

Review of Environmental Objectives

As one of the first environmental restoration projects constructed by the Los Angeles District of the Army Corps of Engineers, KERP was conceived to meet several environmental objectives—establish or reestablish native ecosystems, reduce groundwater usage and preserve the functionality as a flood control facility.

Pima County Regional Flood Control District conducted a review of these objectives[25] and the study shows that this multifaceted facility has definitely met the outlined environmental objectives.

- Several native ecosystems that represent Arizona's southwest riparian environment have been established or reestablished throughout the KERP basin
- Five environments now exist within KERP—Arizona Uplands, Open Water, Riparian Communities, Wetlands and a Mesquite Bosque
- The restored wetlands are ecologically resilient and self-sustaining
- The potential for sediment and organic matter accumulation in restored wetlands has been minimized
- Vector control in the wetlands has been provided
- Stormwater is detained during flood events
- Incidental recreational values have been created and promoted

Ongoing research and evaluation will determine if these other environmental objectives are being met:

- Restore habitats for target/beneficial fish and wildlife species
- Achieve an optimal mix of habitats that supports the greatest diversity of species
- Maximize the acreage of functional wetland habitat within limits of the design area
- Protect restored wetlands from feral predation
- Enhance water quality of the reclaimed water source

Evaluation of Benefits

The detention and retention of storm water and the use of reclaimed water means that the project operates independent of ground water to meet its objectives. This storm water/reclaimed water harvesting system is successful at irrigating the vegetation of KERP, Kino Hospital and the Kino Sports Complex.

Additionally, KERP benefits a myriad of migratory birds, songbirds and local wildlife, as well as benefiting the surrounding neighborhoods with native riparian habitats.

Finally, it retains the functionality as a flood control facility in minimizing flood impacts downstream by detaining flow in the basin.[26]

This project received a "Chief of Engineers Award of Excellence." The selection jury commented,

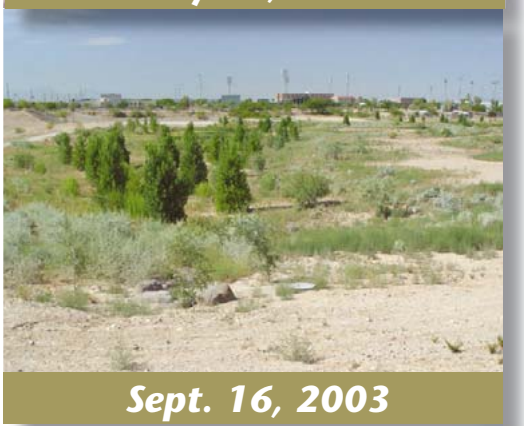
"This is truly an exceptional project. It takes an existing mud flat in an arid area and creates aesthetic landscapes, recreation features, flood control, and is a prototype for water harvesting. It is technically sophisticated while appearing natural. It has proved sustainable over the recent drought years."[27]

KERP has demonstrated the benefits of storm water harvesting: water conservation, economical, environmental, educational and recreational.

This project substantially improved the environmental quality of a mudflat basin, while maintaining the original function of detaining and storing flood waters. This report authenticates that environmental restoration can be successfully implemented in urban settings and with demonstrated cost effectiveness. This project is an excellent example of effective integration of water, land and habitat elements in an urban environment.

Aug. 21, 2001

May 29, 2002



Sept. 16, 2003

Oct. 21, 2004

References

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3 Ed Pastor Kino Environmental Restoration Project Informational Sheet, Robison, L., page 2

4 Ed Pastor Kino Environmental Restoration Project Informational Sheet, Robinson, L., PC Dot and FCD, December 5, 2002, page 2

5 Ball Fields (turf) = 53 acres; Kino Sports Complex (other than turf) = 17 acres; Ajo medians = 4.5 acres; Kino Hospital = 10 acres, (Total 84.5 acres), Dave Wise, Kino Sports Complex, email August 4, 2006

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11 Based on City of Tucson Reclaimed Water commodity rate of $610 per acre-foot

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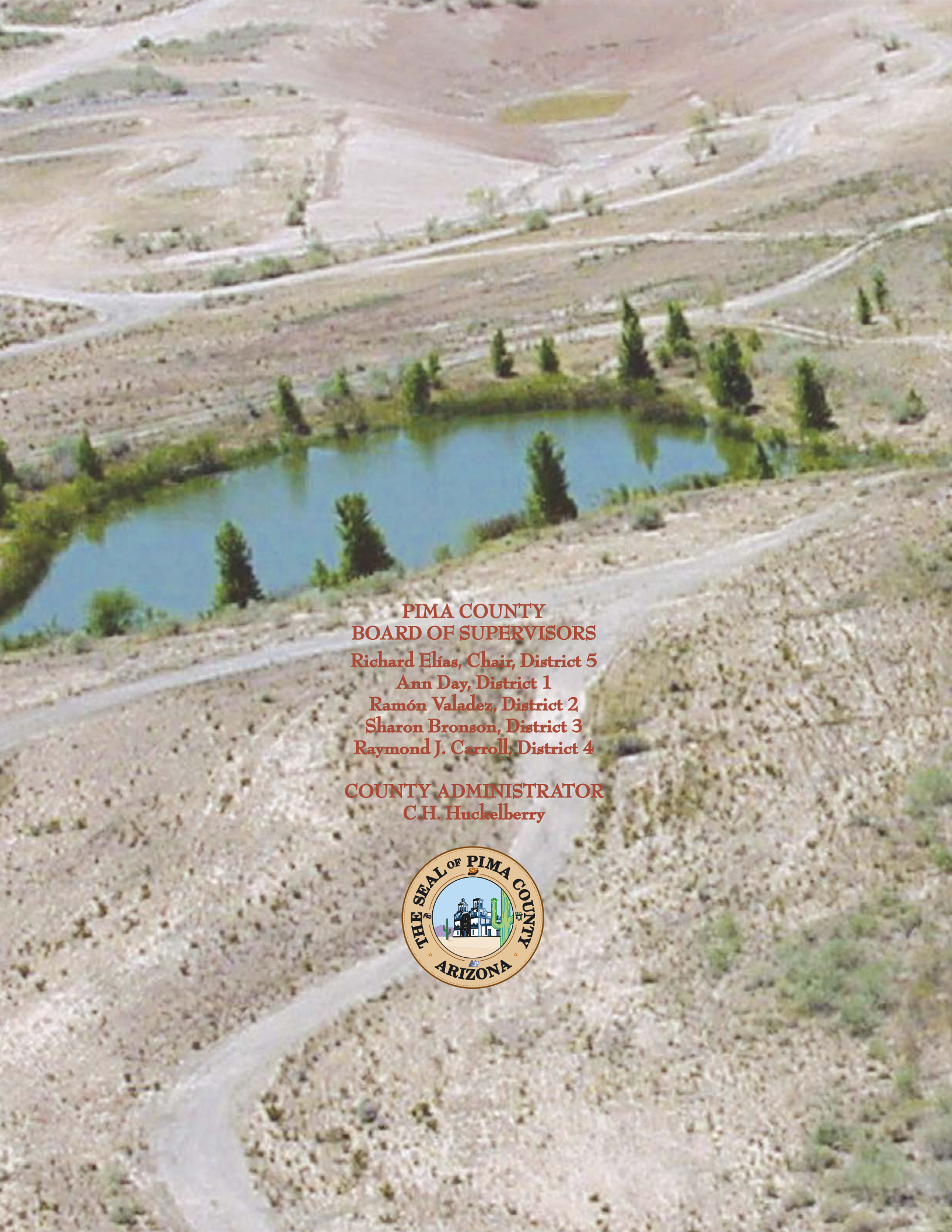

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