Riparian Restoration Efforts in the Santa Cruz River Basin

Description of the projects, analysis of the stakeholder issues and cooperation

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Preface

The following report presents a general picture of riparian restoration in the Santa Cruz river basin, analysing how and why various restoration projects were undertaken. It is also a first step towards an answer to the question of how to bring together the stakeholders of the different projects in order to build a common vision of the river and a restoration plan.
This report is built upon a previous study published in April 2006 by the Water Resources Research Center: *Projects to Enhance Arizona's Environment: An Examination of Their Functions, Water Requirements and Public Benefits*, a compilation of information concerning environmental restoration projects in Arizona. The project descriptions in Appendix A were taken from this study. A few projects that were not in the original report were added (Martin Farm, Cochie Spring, Arroyo Chico, El Rio Medio, Avra Riparian Restoration, Big Wash, Cortaro Mesquite Bosque). For the other projects, the original report was the primary source of information; each project was updated with information from the internet and/or interviews and visits on site. Some projects were hardly modified (El Rio Antiguo, Santa Fe Ranch, San Xavier) as very few information was found. In other cases more modifications were made in order to insert the updated information.

The updates and interviews for this report were carried out between November 2008 and March 2009, as a part of our internship at the University of Arizona.
We would like to thank all those who helped us in this project, the sponsors of the restoration projects who took time to answer our questions, Sharon Megdal who advised us and guided us during our work, as well as Joanna Bate for her help with editing the report.
We would also like to thank Graciela Shneier Madanes, Robert Varady and the members of the UMI CNRS/University of Arizona « Water Environment and Public Policy », who made it possible for us to come at the University of Arizona, and who supported us during our Internship, and once again Sharon Megdal and the WRRC staff, who welcomed us at the Water Resources Research Center during our stay at the University of Arizona.

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Introduction

The Santa Cruz River is a river in southern Arizona, which flows southward into Mexico, then turns westward before it re-enters the United States just to the east of Nogales, and then flows north. The Santa Cruz River is usually a dry riverbed through most of the year; the only water in the river comes from effluent discharged from wastewater treatment plants and storm water runoff. Riparian ecosystems have been heavily degraded along the Santa Cruz River. Combined effects from groundwater pumping, flood control measures, water diversions and other human activities have damaged or destroyed many of the cottonwood and willow trees that used to thrive along portions of this river. Riparian areas provide many benefits: they provide critical habitat for many wildlife species, and they also enhance groundwater recharge, improve water quality by filtering runoff and offer opportunities for hiking, birding and other recreational activities. Given these many benefits to both humans and animals, we can understand why more and more environmental restoration projects are undertaken along the Santa-Cruz River to protect this unique and precious resource.

Over the past fifteen years, approximately twenty riparian restoration projects have been undertaken on the Santa Cruz river basin, demonstrating the growing interest in protecting the river, its tributaries and aquifers, especially in urbanized areas. An environmental restoration project on this river basin is never undertaken by only one entity. There are always at least three different stakeholders, federal, local, or NGO, who each have specific interests in taking part in a restoration project. Most of the projects are undertaken independently from one another. Even if some sponsors are involved in several projects, it does not seem that there is a real comprehensive plan for riparian restoration in the entire river basin. Each project seems to be led according to the goals and interests of the engaged sponsors and only within its designated area along the river without taking into account the rest of the basin.

This report draws a general picture of riparian restoration in the Santa Cruz river basin, and explores the possibility for a sustainable rehabilitation strategy for the Santa Cruz River basin as a whole by characterizing the current state of organization and dialogue between stakeholders.

Methodology

This study is built upon a previous study published in April 2006 by the Water Resources Research Center: *Projects to Enhance Arizona's Environment: An Examination of Their Functions, Water Requirements and Public Benefits.* Eleven of the projects analyzed in this study were reviewed in the *Projects to Enhance Arizona's Environment* study, and seven others were added in an effort to develop a thorough overview of riparian restoration projects in the Santa Cruz river basin. Project information was gathered and updated through on-line resources and, if possible, interviews and site visits.

The first goal of this study is to describe the ongoing and completed riparian restoration projects, utilizing the questionnaire set up for *Projects to Enhance Arizona's Environment*. The information gathered on each project is synthesized into a standardized project summary, which includes information on the location, sponsors, history, phases, planning objectives, planning, maintenance, funding, water demand and sources, land ownership, public outreach and challenges/lessons learned.

The second part of the study aims to characterize the different types of stakeholders, their interests and goals, and the existing cooperation between them. Key actors in riparian restoration projects were interviewed in order to define opportunities and conditions for cooperation.

I- Project summaries and summary analysis

Nine project sponsors were interviewed, covering fourteen of the studied projects. For four of the projects (Cortaro Mesquite Bosque, San Xavier Reservation, Big Wash Restoration and Santa Fe Ranch) updates were conducted with information available online, therefore some information may be incomplete. Three projects were visited: Ed Pastor Kino, Sweetwater Wetland and Esperanza Ranch.

Project	**Contact**	**Meeting date**
North Simpson Farm	Kendall Kroesen (TAS)	Interview, Jan.13
Martin Farm	Kendall Kroesen (TAS)	Interview, Jan.13
Esperanza Ranch	Kendall Kroesen (TAS)	Interview, Jan.13
Cochie Spring	Kendall Kroesen (TAS)	Interview, Jan.13
Swan Wetland	Andrew J. Wigg (PCRFCD)	Interview, Jan.30
KERP	Lawrence E. Robison (PCRFCD	Interview, Jan.30
Arroyo Chico	Lawrence E. Robison (PCRFCD)	Interview, Jan.30
Tres Rios del Norte	Ann Audrey (City of Tucson) Jennifer Becker (PCRFCD)	Interview, Jan.15 email
Paseo de las Iglesias	Jennifer Becker (PCRFCD)	email
El Rio Medio	Ann Audrey (City of Tucson)	Interview, Jan.15
El Rio Antiguo	Franck Postillion (PCRFCD)	email
Sweetwater Wetland	Joaquim Delgado (Tucson Water) Bruce Prior (Tucson Water)	Interview, Feb.13
Avra Riparian Restoration	Franck Postillion (PCRFCD)	Interview, Jan.27
Marana High Plains	Franck Postillion (PCRFCD)	Interview, Jan.27
Santa Fe Ranch		*no answer*
Big Wash Rehabilitation		*no contact found*
San Xavier		*possible phone contact*
Cortaro Mesquite Bosque		*no answer (no time)*

Figure 1: Sponsors interviewed regarding each project

This first part of the study is an analysis of the information found on the projects. It focuses specifically on project locations, main objectives, the different phases of the projects, and their source of water. A typology of the projects was built with the results of this analysis.

The summaries of the projects can be found in Appendix A.

a) Location

The eighteen projects are located on the Santa Cruz river basin, and occur between the Mexican border in the south to north of the Town of Marana. Ten projects are located directly on the Santa Cruz River; the others are either along a tributary of the Santa Cruz River or around detention basins inside Tucson. Eight projects are within the City of Tucson, which, interestingly, shows that many of these environmental restoration projects take place in urbanized areas.

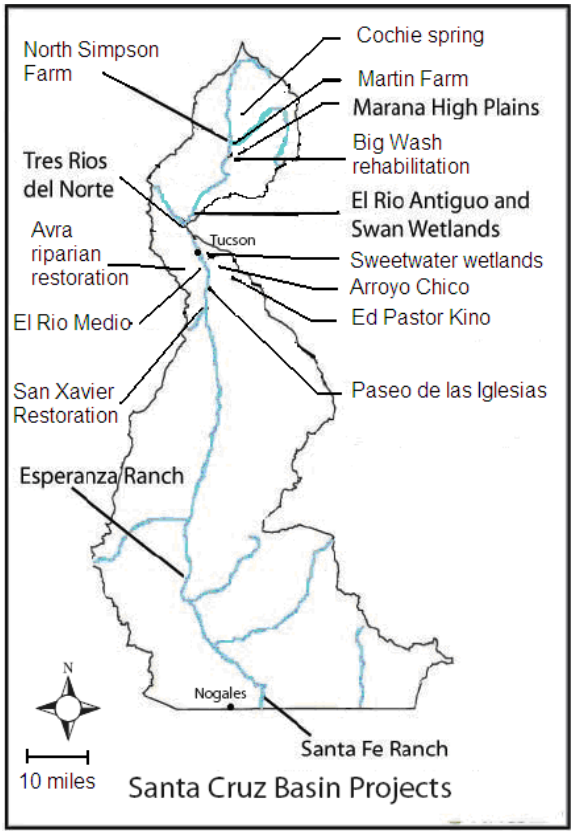


Figure 2: Map of the location of the projects

Within the City of Tucson (8)		**Outside the City of Tucson (8)**			
On the Santa Cruz	Not on the Santa Cruz	On the Santa Cruz	On the Rillito River	Oro Valley	Tortolita Mountains
4 projects	4 projects	6 projects	2 projects	1 project	1 project

Figure 3: Table of the location of the projects

b) Phases

Each riparian restoration project goes through three different phases:
- Planning phase: feasibility studies, design of a plan
- Restoration work in the field
- Monitoring and maintenance

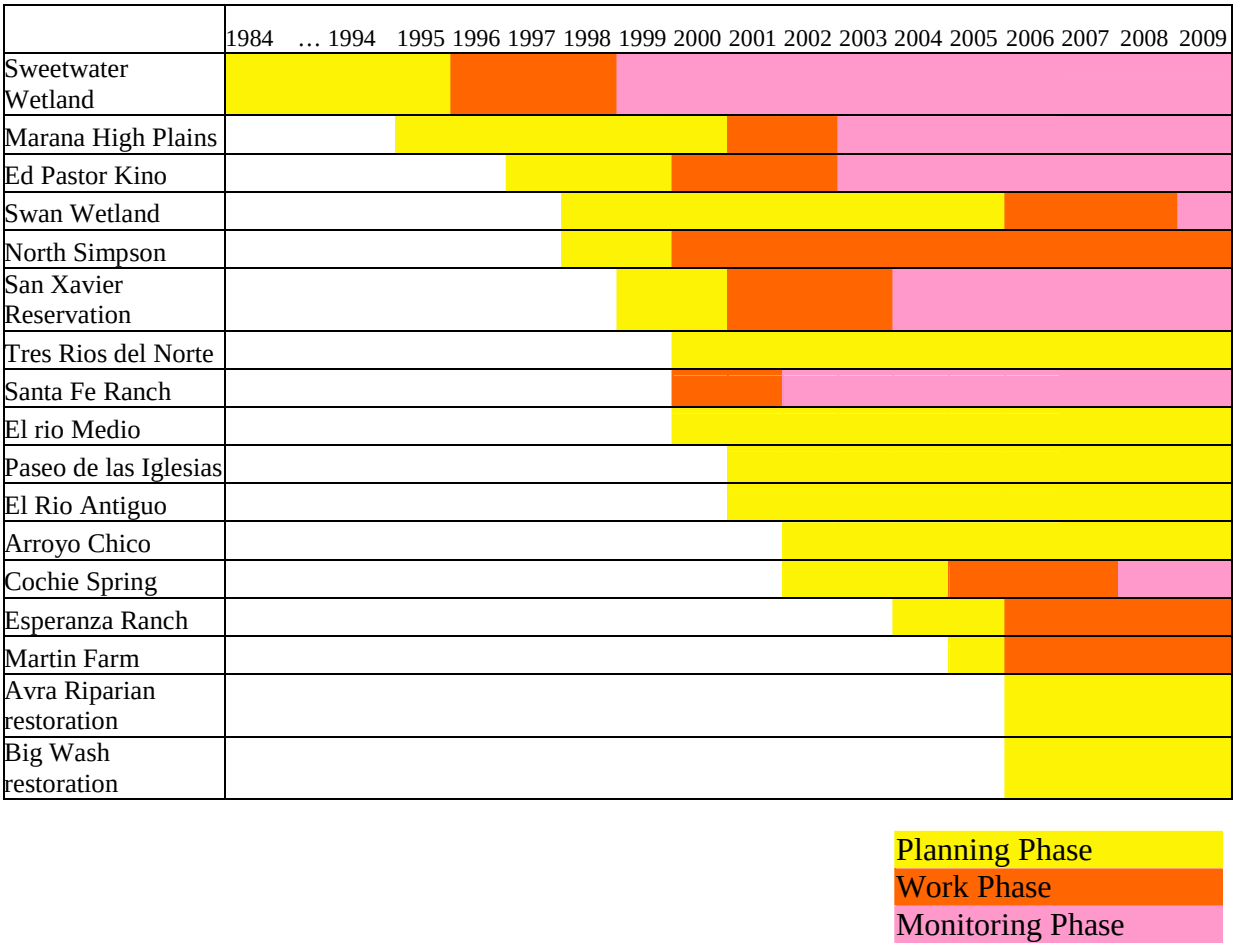


Figure 4: Project phases

Figure 4 shows that the length of these phases can vary a lot from one project to another. In the studied projects, the planning phase lasted five years on average. However, for the seven projects that are still in the planning phase, in some cases there is no final plan yet (Tres Rios del Norte – started in 2000), others have been put on hold (El Rio Medio, El Rio Antiguo), and still others have a final plan but cannot start work because of a lack of funding (Arroyo Chico). Among studied projects, the working phase of the projects has lasted on average 3.7 years. In the last one or two years of the working phase, there is usually little actual restoration work being done, as projects at this phase usually only require temporary irrigation for the establishment of plantings.

Seven of the projects analysed have been completed, and monitoring and maintenance on the sites are ongoing. The intensity of this last phase varies according to the objectives of the projects: for Marana High Plains, where research is an important component, monitoring is very active, whereas for some projects, like Cochie Spring, maintenance is minimal once the restoration is done.

New projects have been initiated regularly since 1995, indicating that there has not been a downturn in interest for riparian restoration in this area.

c) Planning objectives

The studied riparian restoration projects are rarely undertaken with the only goal to enhance riparian habitat: one can note an average of three different planning objectives per project. Figure 5 shows the ten different planning objectives of the projects and how many projects quoted each one of them.

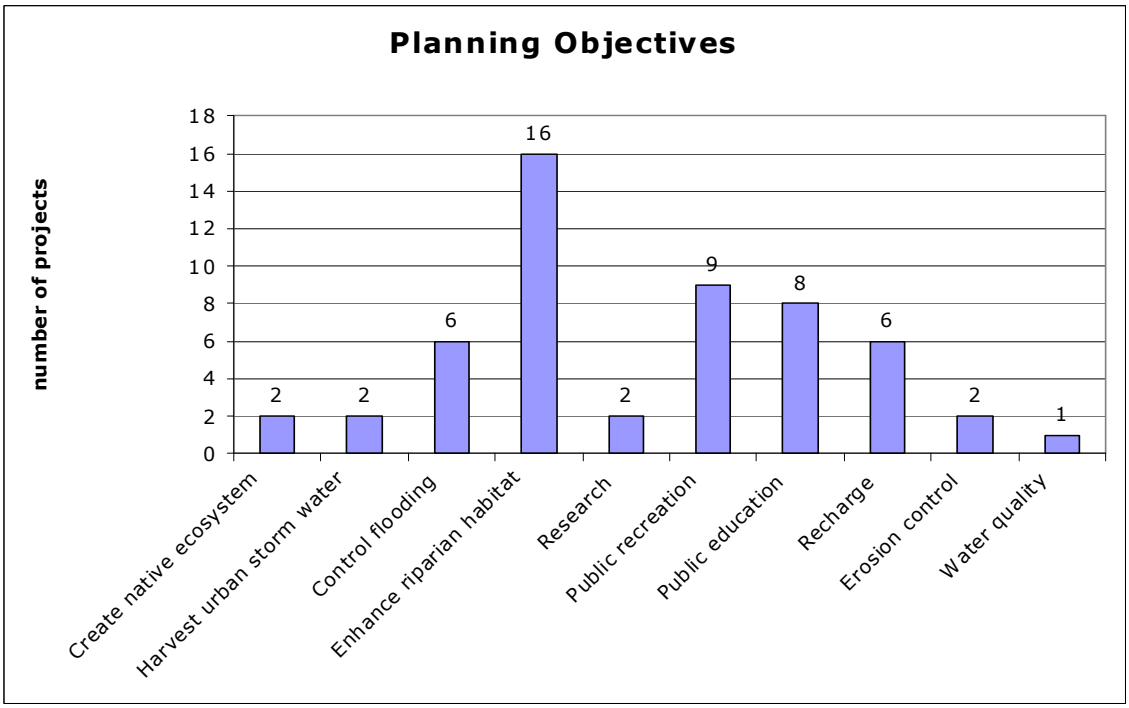


Figure 5: Project objectives

The environmental aspect, present in every case, can be linked with a more technical aspect (aquifer recharge, flood control) and/or with public involvement. Most projects are multipurpose projects, with up to five different objectives for a single project. This can be linked to the variety of sponsors involved in one project and their different reasons to take part in a project. Multiple objective projects may also be more likely to obtain grants.

d) Water sources

The projects make use of six different sources of water. Eight of them rely on effluent, but none of these have a contract that secures this source by guaranteeing allocation of effluent for the project. The projects take advantage of the water released by the treatment plant which flows in the river or is recharged to enhance habitat. Storm water is used in six projects, either because the project is located near a wash where water flows when there is a flood event, or because the project is linked to a storm water detention basin. Reclaimed water and groundwater are used, but only for temporary irrigation for the establishment of the plantings (generally for the first two or three years). CAP water is only used at the San Xavier restoration project. Rainwater harvesting is a very popular water source and is used in eight projects. It is never the sole source of water to a project, but when new vegetation is planted it is often in a rainwater harvesting basin.

	Storm Water (6) Flows in the wash or detention basin	**Reclaimed Water (5)** Only for temporary irrigation	**Effluent Water (8)** Not a secured source	**Ground water (4)** Only for temporary irrigation	**CAP Water (1)**	**Rain water harvesting (8)** Not a sole source
North Simpson (3)						
El Rio Antiguo (3)						
Esperanza Ranch (2)						
Marana High Plains (2)						
Paseo de las Iglesias (2)						
Swan Wetland (2)						
Ed Pastor Kino (2)						
Tres Rios del Norte (2)						
Arroyo Chico (2)						
Cochie Spring (2)						
Big Wash restoration (2)						
Sweetwater Wetland (1)						
San Xavier Reservation (1)						
Avra Riparian restoration (1)						
Santa Fe Ranch (1)						
Cortaro Mesquite (1)						
El Rio Medio (?)						
Martin Farm (1)						

Figure 6: Water sources for each project

e) Typology

Using information discussed above, projects were classified into six categories (or types) according to their water sources, drivers and goals.

Type	**Number of projects**	**Projects**
A : Effluent flow for riparian enhancement	4	Esperanza Ranch, Martin Farm, Cortaro Mesquite Bosque, North Simpson Farm
B : Effluent recharge for riparian enhancement	3	Sweetwater Wetland, Avra Riparian Restoration, Maran High Plains
C : Multi purpose flood control facility for riparian enhancement	4	Arroyo Chico, Swan Wetland, Ed Pastor Kino, El Rio Antiguo
D : Habitat restoration	3	San Xavier Restoration, Big Wash, Cochie Spring
E : Erosion control and riparian restoration	1	Santa Fe Ranch
F : Feasibility studies along the Santa Cruz for urban riparian restoration	3	El Rio Medio, Tres Rios del Norte, Paseo de las Iglesias

Figure 7: Typology of the projects

A: Four projects take place along a river (the Santa Cruz or one of its tributaries) where effluent water is flowing. These projects take advantage of this water source to restore riparian habitat.

B: For three projects, effluent water is recharged at a facility surrounded by riparian habitat.

C: Four projects are located at flood control facilities such as detention basins or channelization of a river, where environmental restoration is linked to flood protection purposes.

D: Three projects were created for habitat restoration (without any other « technical » aspect) and do not rely on effluent water. They are located near washes where water flows only during flood events.

E: One project aims both to control erosion and enhance riparian habitat (however little information was available for this particular project).

F: Three projects are still in the planning process; they will rely on effluent water, with or without a recharge component. All three projects are part of an effort to restore riparian areas in an urban context.

This review of riparian restoration projects raises a host of water issues specific to Arizona. First of all, the rule of prior appropriation states that water right seniority is determined by the time at which a given amount of water was put to beneficial use. When the water flowing in the Santa Cruz was appropriated, no water was allocated to the river and the environment. Instream appropriation rights were confirmed as a valid beneficial use in the 1976 McClellan v. Jantzen case. Rights for instream flows can be obtained through new appropriation, but these rights require collection of flow data for a certain number of years (one year for a temporary permit, four additional years for the instream flow right to be issued). While water rights can generally be transferred between users, no transfers for instream flows have been attempted, although the law states that water rights may be" transferred for use for… wildlife purposes, including fish". Several temporary leases of stored water have been secured to augment stream flows. These instream flow rights have junior priority and have not been used widely for riparian restoration.

Secondly, the groundwater in the Tucson area was mined to the extent that water tables fell too low to support a perennial flow in the river. The groundwater likely will not return to its original level through natural recharge, and, because of water quality concerns, local water managers do not want the water table to reach landfills dug in along the river.

These restoration projects are taking place in a river basin whose main river, the Santa Cruz, does not flow perennially anymore. Project managers do not seek to restore the water flow but to take advantage of the water that is available. Projects seek all kinds of « alternative » sources of water, such as effluent, which has gone from being considered waste to being a precious resource and rainwater harvesting techniques. Riparian restoration can also be linked to recharge projects, which are found throughout the state. Some projects are also linked to flood control facilities, because of the flood events occurring in Arizona.

II- Stakeholder issues and cooperation

a) Sponsors interviewed

The 18 projects included in this study had a total of 19 different sponsors, with an average of 4 sponsors per project. There are many different types of sponsors: federal agencies, state entities, county departments and districts, cities and towns, NGOs, tribal government entities, and private entities. The different sponsors are listed in the figure below.

Federal (5)	State (2)	County (5)	City (2)	NGO (1)	Tribal (1)	Private entities (2)
US Fish and Wildlife Services US Army Corps of Engineers Natural Resources Conservation Services Bureau of Reclamation Environmental protection agency	Arizona Water Protection Funds Arizona Department of Environmental Quality	Pima County Regional Flood Control District Pima county Pima County Natural Resources, Parks and Recreation Department Pima County Waste Water Management Pima County Regional Reclamation Department	City of Tucson Town of Marana	Tucson Audubon Society	San Xavier District Community	Devon Energy Private

Figure 8: Project sponsors

The following bar chart shows the number of times each category of sponsors was cited in the projects: federal agencies and services were involved 19 times (single projects may have more than one federal sponsor).

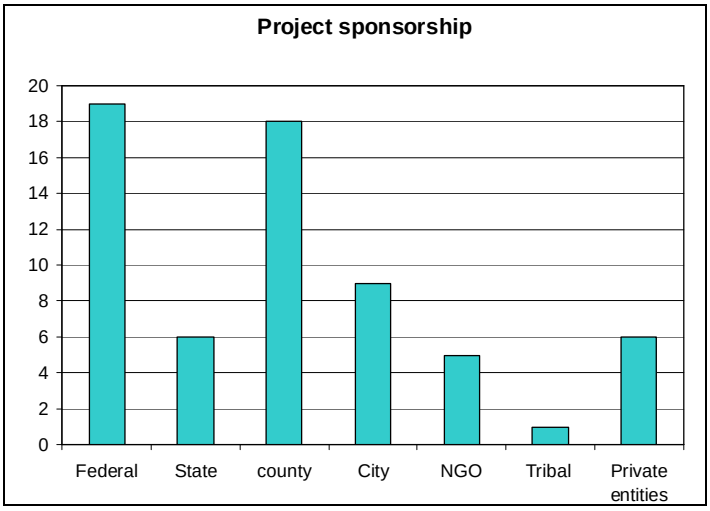


Figure 9: Project sponsorship by category

Interviews were conducted with representatives from 5 of the sponsor categories, with 9 people interviewed in total:
- **1** at the Bureau of Reclamation
- **4** at Pima County Regional Flood Control District
- **2** at Tucson Water
- **1** at the City of Tucson
- **1** at Tucson Audubon Society.

Interviews were conducted with representatives from the federal, county, city, and NGO categories. Unfortunately, the U.S. Army Corps of Engineers is not included in this list, so their perspective may not be well-represented. For each sponsor, the following questions were discussed: their goals and interests in the projects, the reasons for which they were involved, and the challenges they saw in completing riparian restoration in the Santa Cruz river basin and in undertaking stakeholder cooperation.

b) Goals and interests

Each sponsor is involved in riparian restoration for different reasons. Most of the entities' missions lead them to participate in environmental restoration projects, but their primary goals and interests vary considerably:

- Tucson Water is a water provider. Their primary goal is to guarantee a secure, clean water supply to their service area and to secure a future supply to meet the growing demand. This entity got involved in riparian restoration when a water quality issue led them to build the Sweetwater Wetlands.

- The Pima County Regional Flood Control District builds flood control facilities such as detention basins, drainage channels for storm water, etc. These flood control facilities concentrate water in a given area, and the District conducts habitat enhancement projects around some of these areas.

- The U.S. Army Corps of Engineers is involved in riparian restoration through the Water Resources Development Act of 1986. The Corps' mission is to provide public engineering services. The Water Resources Development Act authorizes the agency to participate in restoration projects that attempt to repair environmental damage done by previous Corps projects. The USACE also oversees Clean Water Act section 404 in-lieu mitigation projects.

- The U.S. Bureau of Reclamation (BOR) is responsible for the Reclamation projects built during the 20th century to enhance Arizona's surface water supply. They are involved in restoration in the Santa Cruz river basin because of two different issues: the Santa Cruz River is a potential recharge site to serve the Town of Marana its allocation of CAP water, and the BOR owns 28,000 acre feet of effluent from Tucson on behalf of the Tohono O'Odham Nation.

- The Tucson Audubon Society is a non-profit organization whose primary goal is to protect avian diversity. Their involvement in riparian restoration projects is directed by their interest in improving the quality of the environment and maintaining ecosystems for birds.

- The Arizona Water Protection Fund distributes funds for environmental projects and sets conditions for project management such as levels of public involvement.

Riparian restoration is rarely the main goal of the sponsors in the projects, and the goals and interests involved in one project can be very different. Therefore cooperation can be difficult, because agreement on objectives and plans for restoration can take a very long time to be reached for each project.

c) Issues brought up

During the interviews, the main issues (points of agreement and disagreement) that were brought up by the sponsors were:

- The cost and scale of projects

Some stakeholders think that it would be better to focus efforts on work that can be done now with the little money available (for example remove invasive species, a very threatening and urgent problem). To them, some projects seemed over-scaled and poorly adapted to the actual problems of the area. The money and time put into planning large project sites can be a point of disagreement. For example, the planning phase for the Paseo de las Iglesias, Tres Rios del Norte and El Rio Medio projects began in 2001, has already cost millions of dollars and no plan has been finalized. The areas studied for these projects are greater than 2500 acres, which is much bigger that the average size of all other projects. Restoration work is never undertaken on the whole area studied in feasibility studies, but all areas included in the project study area are environmentally protected. Considering the number of different sponsors with different interests involved in each project, a long planning stage may be necessary to bring all the actors to common goals and objectives. It is also sometimes argued that extensive planning and expensive work may avoid high maintenance costs in the future.

- Insecure water: problems with effluent, reliance on groundwater

Effluent flowing in the riverbed is not a secure water supply. Projects must not rely on it too much; it cannot be taken for granted that effluent will always be flowing in the river. Many project managers underline the need to consider the uncertain nature of this water supply when designing projects, for example by planting vegetation that is not too water-demanding (xero-meso riparian) and that will survive even if the flow of effluent is interrupted (see project descriptions, Appendix A). But this would involve planting vegetation that may not be as valuable for habitat as some more water-demanding trees (like cottonwood and willow). In the Army Corps cost/benefit analysis, water demanding plants such as cottonwood and willow earn more points. Some interview respondents disagree with this valuation because of the possibility of the effluent being put to another use, in which case the trees would die or require permanent irrigation.

Many stakeholders insist on the need for restoration projects to be sustainable. Sustainable projects do not rely on ground water for long term irrigation and must be resilient enough so that the wildlife and bird habitat will survive if the effluent present on-site goes to another use. Prioritizing projects that are sustainable may involve giving up very valuable areas for habitat.

The future of effluent flow in the Santa Cruz River is crucial to riparian restoration. Although the environmental value of effluent is recognized by all interview respondents, the need for future water supplies to support human uses and aquifer recharge may overpower environmental needs. The two main owners of effluent in the Santa Cruz (Bureau of Reclamation and Tucson Water) will have key roles in determining this future. They must deal with many questions, such as making the choice of interrupting effluent flow in the river or leaving a certain volume in the river bed, which will involve weighing their responsibility for the environmental state of the river while fulfilling their primary goals as water management agencies.

- Local vs. Federal

Many projects involve a partnership between local and federal sponsors. In some cases, funding is provided by federal sources with local entities leading projects; in many cases, a cost sharing agreement divides funding between federal and local sponsors (75%-25% (Swan Wetlands), 65%-35% (Arroyo Chico), etc. depending on the projects). Sometimes the restoration work is performed and funded by federal agencies, with monitoring and mitigation under the responsibility of the local sponsors. Long and expensive work usually leaves less mitigation to be done, whereas if the federal sponsors spend less money and time on the project, more work is left to the local sponsors.

Among the five categories of project sponsors, the federal sponsors are quite different from the local sponsors, which constitute the largest category. The relationship between federal and local sponsors can sometimes be contentious, mostly due to differing views on the scale and timing of projects. Federal agencies tend to plan large-scale projects with longer planning phases, which can be a source of tension with local sponsors who prefer to see restoration done at a smaller scale, with visible progress and more continuity. Another issue between federal and local sponsors is that local problems specific to Arizona's environment are sometimes not perceived by sponsors at the federal level. Finally, the physical distance between the sponsors can cause communication problems.

However, stakeholder issues on riparian restoration are not limited to local vs. federal disagreements; there are also many points of disagreement between the local sponsors, particularly when they have different reasons for taking part in the restoration project.

- The perception of the river

In certain areas (particularly highly urbanized areas) the Santa Cruz River is no longer perceived as a potentially enjoyable place for recreation. Development has not taken place around the river, and the river bed is often littered. Many landfills were placed along the river, and the effluent that flows in it may be perceived as wastewater. Interest in restoring the original riparian habitat in these areas is generally not as strong as it is for stretches of the river that have been more accessible to the public and are still used for recreational purposes (as is more common in Santa Cruz County).

- Public involvement

Projects must gain strong public support: the Agua Caliente project was abandoned for lack of public support. Public outreach is often a requirement for AWPF grants. In some cases, when the project site is on private property or noted no trespassing (Esperanza Ranch for example), public outreach is done by organizing volunteer work days or birding days. Some sites offer guided tours, and public involvement also includes public lectures and community participation off-site (which is the case for many Tucson Audubon projects). At multi-purpose facilities, sites include walking and/or biking trails where possible; however, it can be difficult to include such features at sites with limited access or in fragile areas that may be subject to degradation by the public.

Also, public meetings and neighborhood involvement are an important component of the planning process but must be managed with caution: in the case of very long planning phases

as for Tres Rios del Norte or Paseo de las Iglesias, public meetings were held a number of years ago, and the public is frustrated with the projects since they cannot see any advancement in the restoration work.

d) Opportunities and barriers to a plan for riparian restoration

All the project sponsors interviewed during this study agreed that having a common vision and a plan for the Santa Cruz river basin as one environmental entity would be very useful and helpful. However such a plan would most likely be extremely time-consuming to develop and would need a force behind it in order to succeed, such as a leader in power with an interest in the river.

To date there is no global vision for the river basin and no unifying goal. Some efforts were started in that direction:
- the Santa Cruz River Alliance started early 2000 and faded away after some time.
- the Friends of the Santa Cruz River in Santa Cruz County have regular communication with the County and have mapped the vegetation along the river in their area.
- the Sonoran Desert Conservation Plan could be a good starting point for a plan but is not specific to the Santa Cruz River.
- The Sonoran Institute, who do not currently sponsor any restoration projects, is however trying to develop an overarching vision for river conservation and are interested in crediting the EPA with recognizing the Santa Cruz as an important resource and providing two fairly substantial grants for conservation. Indeed the EPA has recognized the Santa Cruz River as an important resource and has devoted recent funds to support restoration and conservation activities. EPA grants include a Wetlands Grant for riparian mapping in Santa Cruz County and a Targeted Watersheds Grant to support monitoring, restoration, water harvesting, and conservation policy for the river.

These efforts and some others not listed here show the interest in ramping up restoration efforts at a larger scale.

A plan would include a set of strategies and values and perhaps a way to prioritise sites for restoration. Of course, the plan would have to address the question of water supplies for restoration projects and bring the sponsors to agreement on this crucial question.

There are different ways to prioritise sites for restoration, including:
- **According to ecological needs**: for example, enhance an important migration corridor or selected washes that are connected to natural open spaces. Even if the focus is only on ecological needs, a decision needs to be made whether it is more important to first put efforts on trying to maintain one part of the river where the habitat is in jeopardy (mainly because of the proliferation of invasive species) or to first focus on areas adjacent to the river that have very low to no current habitat value.
- **According to the level of the water table**, particularly in the Tucson area: efforts could be concentrated in areas with particularly low water tables.
- **According public needs** for parks and recreation.
- **Select places where a multi-purpose project is possible** (recharge, storm water harvesting) to guarantee sustainability.

There are many different landowners along the river; it can be an issue to tie up land for restoration projects. The County buys flood-prone land and some local sponsors own land

(City of Tucson, Town of Marana), but a large part of the land is owned by different private entities.

The USACE and Pima County have a history of working collaboratively with one another. When working with the USACE, federal funds contribute to local project planning and/or construction. Also, USACE oversees submission of applications for some permits, easing that burden for local sponsors. This type of collaboration could be an important part of the restoration plan.

The Tres Rios del Norte project demonstrates one stakeholder cooperation problem: 2% of the project area is located within the city of Tucson, but 90% of the water belongs to the city. Tucson Water might want the ability to recover the water they send to the county and to Marana.

The answers to the questions: « What environmental state of the river do we want ? How to reach this goal? What water will be used ? Where should our efforts be focused? » are far from being obvious or agreed-on by everyone. The multiplicity of sponsors involved makes the time to reach agreement on each project very long, and if the river were considered as one environmental entity and the different sponsors agreed on common goals, this time could be considerably reduced.

According to the interviews that were conducted, some driver that is common to all the sponsors for an agreement on a restoration plan for the river as a whole would be necessary to incent them to participate in a planning process. As the goals and interests of the sponsors vary widely, this common necessity is not obvious, and no urgent problem has brought all the stakeholders together on the subject of the environmental state of the Santa Cruz River and its tributaries.

Conclusion

What future for the Santa Cruz River?

The restoration situation today seems to be better than a few years ago but remains very fragile. When people involved in riparian restoration are asked how they see the future of the Santa Cruz River, answers vary considerably. For some people interviewed, the picture is quite dark: they think that we keep losing ground (due to development and invasive species) because nothing is really being done. To them, the river that has been the heart of human settlement and a main wildlife corridor in the region is dying. However, most of the sponsors point out the fact that the situation is better now than few years ago; interest in riparian restoration seems to be growing, which is a cause for optimism. More restoration work is being done, and even if those initiatives need to be strengthened, there is hope for improved environmental quality of the Santa Cruz in the coming years.

Although some people have a very pessimistic vision of the future of the river, many sponsors have new project sites in mind, and all knew about upcoming projects. This shows the interest is not dying off and a better environmental situation on the Santa Cruz river basin is possible.

Places with good opportunities for riparian restoration, mentioned by some sponsors as possible sites to start new projects include:

- projects along the Rillito, within feasibility (PCRFCD)
- Tanque Verde Valley, with very good habitat on Tanque Verde Wash (TAS, City of Tucson)
- Cienega Creek (City of Tucson)
- Canada del Oro (west side of the Santa Cruz), Orange Grove road (PCRFCD, TAS)
- Agua Caliente (City of Tucson)

PCRFCD is looking for multi-purpose sites with storm water harvesting or recharge possibilities. Rio Nuevo has also brought some attention to possible project sites: this project for “Downtown redevelopment” in Tucson could involve some riparian enhancement along the Santa Cruz.

One of the main concerns regarding the Santa Cruz River is whether or not effluent will be available in the future for riparian restoration, given the fact that it is a precious resource for municipalities facing growing demand. However, we notice that the entities that own the effluent (City of Tucson, BOR) seem more and more morally involved in environmental matters, they recognize that they have played a role in the deterioration of the river, and that they should be part of the restoration of the Santa Cruz and keeping water in ecosystems.

Appendices

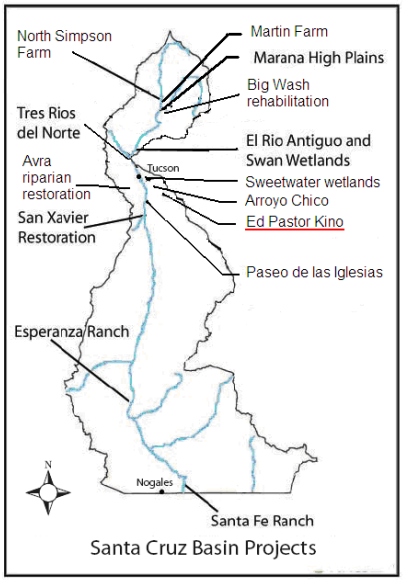
Appendix A: Project descriptions

This report is built upon a previous study published in April 2006 by the Water Resources Research Center: *Projects to Enhance Arizona's Environment: An Examination of Their Functions, Water Requirements and Public Benefits*, a compilation of information concerning environmental restoration projects in Arizona.

The project descriptions in Appendix A were taken from this study. A few projects that were not in the original report were added (Martin Farm, Cochie Spring, Arroyo Chico, El Rio Medio, Avra Riparian Restoration, Big Wash, Cortaro Mesquite Bosque). For the other projects, the original report was the primary source of information; each project was updated with information from the internet and/or interviews and visits on site. Some projects were hardly modified (El Rio Antiguo, Santa Fe Ranch, San Xavier) as very few information was found. In other cases more modifications were made in order to insert the updated information.

ED PASTOR KINO ENVIRONMENTAL RESTORATION PROJECT (KERP)

Multi purpose flood control facility with riparian enhancement



Location and Size:

Within an urban area of Tucson north of Ajo Way and west of Country Club Road, along the Tucson Diversion Channel. This project includes:

- 28 acres of riparian and open water
- 21 acres of grassland, mesquite bosque
- a 120 acre area with marsh.

Sponsors:

- Pima County Regional Flood Control District (PCRFCD)
- United States Army Corps of Engineers (USACE)
- Pima County
- Pima County Wastewater Management

History:

The Tucson (Ajo) Detention Basin was constructed in 1966 along with the Tucson Diversion Channel by the USACE. The basin was built as a flood control element, which intercepted and reduced peak flows from the Tucson Arroyo and Railroad Wash drainage areas. The basin had a flat earthen bottom and levee with scrub trees and grasses along the edges. In 1981, the USACE and Pima County developed a master plan for the diversion channel called The Tucson Diversion Channel Recreation Development Program. The plan called for improving the recreational opportunities on the land. With the exception of the construction on Sam Lena Park in 1986, little progress was made on the master plan between 1981 and 1995.

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 Resource development Act.

Chris Bartos, MLB Complex Manager, Pima County Stadium District reports that the Army Corps of Engineers awarded the 2006 Chief of Engineers Award of Excellence to the Pima County Stadium District. This Environmental Category award cited the Ed Pastor Kino Environmental Restoration Project as an exceptional project. Judges summarized the project saying, “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 (also) has proved sustainable over the recent drought years.”

Planning Objectives:

Turn the Ajo Detention Basin into a detention basin that was more environmentally sensitive and aesthetically pleasing to the community while maintaining its existing flood protection capacity:

- create native ecosystems (representing Arizona’s southwest riparian environment)
- detain and store urban storm water and reclaimed water to reduce groundwater use
- preserve the basin’s functionality as a flood control facility by controlling drain flow in the basin to minimize flood impact downstream.

Phases:
Early 1997: The Corps initiated a Preliminary Restoration Plan (PRP) to determine the feasibility of modifying the basin features for restoration of riparian habitat.
April 1998: An Ecosystem Restoration Report (ERR) was approved.
June 1998: Plans and Specifications were initiated.
1999: The United States Congress authorized construction of the Ajo Detention Basin Environmental restoration project under section 1135 of the Water Resource Development Act.
July 2000: Construction was awarded.
2002: Modifications were completed.

Current Phase and Future Plans:
Operation and maintenance, construction was complete in 2002.

Recommended or Implemented Plan:
The new KERP facility covers 125 acres, with a 50-foot deep lake covering 7 acres, 20 acres of water courses and hills. Areas have been planted with native species to create marsh habitats, mesquite bosques, grasslands and open water environment that will support wildlife and bird habitat.
The project also includes an extensive pumping and valve system designed to circulate and mix reclaimed and storm water within the basin.
A recharge element was originally considered, but was rejected due to issues with obtaining permits; since a large amount of runoff was derived from industrial areas, water quality became an issue.

Monitoring/Management:
Pima County is responsible for the operation and maintenance of the site.
The site is managed to achieve a series of objectives including:
- maintain the flood control capacity of the basin
- maintain an ecosystem habitat
- maximize the use of harvested storm water
- minimize the use of reclaimed water
- minimize the mosquito population
- maintain water quality.

Audubon Society is monitoring bird life. Arizona Game and Fish is monitoring the establishment of a Burrowing Owl population.

Funding and Cost:
Funding and authorization for this project came from the USACE Section 1135 of the Water Resource Development Act of 1986.
- Project Modification for Improvement of the Environment Total cost of this project was approximately $12 million (planning, design and construction costs). The two funding participants were USACE, 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 funds from the wastewater Management Department and the PCRFCD.
- Total construction award cost: approximately $8,215,444.
- Operation and maintenance cost: $280,000 in FY 06-07, including approximately $180,000 in personnel costs.

- Water cost is estimated to be $265,000 a year.

Land Ownership:
The Basin is owned by Pima County.
A small parcel adjacent is owned by Pima County Regional Flood Control District.

Water:
From February 2003 to March 2004 the complex used 88,406,718 gallons of reclaimed water. During the same time, KERP harvested 28,313,282 gallons of storm water. With 1.35 inches of rain in February 2005, approximately 18,246,424 gallons of water were harvested. The entire complex was irrigated with that water until the end of May.

Total water demand is estimated to be 574 acre-feet per year.
The project provides the ability to harvest and store storm water as well as reclaimed water. Storm water is harvested from the highly urbanized watershed around the Davis-Monthan Air Force Base. KERP was designed to retain and store approximately 1,800 acre-feet of storm water.
The water is stored and circulated through the basin and then is moved into the irrigation ponds to be used to irrigate the basin's re-established vegetation, Kino Hospital grounds and the Kino Sports Complex ballpark and practice fields; approximately 84.5 acres are irrigated with water from KERP.

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.
During the dry seasons, the harvested water is used until it is gone. The habitat is kept alive with the use of reclaimed water, purchased from Tucson Water, until more water can be harvested.
Due to intergovernmental agreements between Pima County and the City of Tucson, the less costly operating rates apply to the effluent that is delivered through Tucson Water's reclaimed lines but treated by Pima County.
Strom water harvesting combined with reduced reclaimed water rates resulted in a 76% saving in water cost in 2004 and 97% in 2005.

Public Outreach:
A school program was developed at a local elementary school, where students created a model to present to the community. Audubon has provided outreach, as has Pima County Natural Resources, Parks, and Recreation.
Public access to the site is limited; however, teachers are allowed to take classes into the riparian areas. The site is also being used by Tucson Audubon for Saturday morning bird walks, and a jogging trail that goes around the basin is open to the public.

Lessons Learned/Challenges:
One challenge of this project was working through the regulatory issues surrounding the commingling of reclaimed water with storm water. At the present time changes in regulatory approaches to this issue continue. In addition the use of a "Waters of the U.S." posed challenging regulatory hurdles.

Several permits were required for activity within the basin, including:
- Arizona Pollutant Discharge Elimination System (AZPDES) permit (including a

Management Plan as well as current testing requirements)
- An Arizona Aquifer Protection Permit (APP) (including an Emergency Response Plan that necessitated training of personnel within several city and county agencies)
- A 401/404 permit for upkeep and reconstruction of the basin after flood events
- An Arizona Reclaimed Water Reuse permit for areas needing irrigation outside the basin
- A Pima County Industrial Wastewater Permit for any wet well sediment disposed of within the wastewater conveyance system
- Arizona Water Rights appropriation (for storm water harvesting and use)
- Fifra and TSCA regulations on the application of pesticides within "a Waters of the U.S."
- Meeting the retention of FEMA 100-year flood events.

Mosquito monitoring and management is still needed, but one of the lessons learned is that design can reduce the problem.
Vandalism of irrigation devices and of the Burrowing Owl nests has also been a problem in this urban environment.

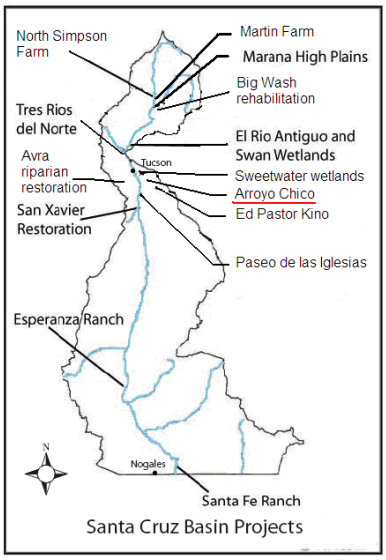
Drivers:
Create native ecosystems, harvest urban storm water and control flooding.

Sources:
http://rfcd.pima.gov/projects/kerp/

Contact:
Lawrence Robison (PCRFCD)

Photos: January 2009.

ARROYO CHICO MULTI-USE PROJECT
(TUCSON DRAINAGE AREA)
Multi-purpose flood control facility with riparian enhancement



Location and Size:
This project runs along 6 miles of the Arroyo Chico wash (also known as Tucson Arroyo) from Alvernon Way to its confluence with the Santa Cruz River near St. Mary's Road.

Sponsors:
- Pima County Regional Flood Control District (PCRFCD)
- US Army Corps of Engineers (USACE)
- The City of Tucson

History:
Arroyo Chico is an ephemeral watercourse that drains about 11 square miles of Urban and Suburban Tucson. Summer thunderstorms cause frequent flash floods. Plans for reducing flood damage for thousands of residential and commercial properties along Arroyo Chico are being undertaken in a two phase project.
A segment of the lower watershed main channel is conveyed through an underground two-barrel, 10 feet wide by 8 feet high concrete box culvert for approximately 1.7 miles that was originally constructed in the 1920's. Because of the increased runoffs due to urbanization of the contributing watersheds, the capacities of the open channel/culvert sections are generally inadequate to convey the peak flows caused by intense thunderstorm events, resulting in frequent and severe flooding of residential, commercial and industrial areas along the entire length of the arroyo.
Flood damages to both private properties and public infrastructures are estimated by the Corps of Engineers at $5.3 million annually, resulting in a benefit-cost ratio of 1.4.

Planning Objectives:
- Flood control
- Environmental restoration
- Recreation project

Phases:
(Phase 1: Randolph South Detention Basin which was completed in April 1996 by the Pima County Flood Control District and the City of Tucson)
Phase 2: The Park Avenue Detention Basin Complex, constructed by the Corps of Engineers beginning in the summer of 2007 and expected completion in four years.

Current Phase and Future Plans:
Phase II under construction.
The project now has a Phase IIB, which is the actual riparian restoration phase. This phase has been blocked due to a lack of funding.

Recommended or Implemented Plan:

(Only the second part of the project deals with riparian restoration.)

Phase 1: Randolph South detention basin complex constitutes the Phase 1 of the overall Arroyo Chico Project. It was designed and constructed by the Pima County Flood Control District and the City of Tucson, and represents the local sponsor's contribution to the overall project under Section 104 Credit Agreement with the U.S. Army Corps of Engineers.
The basin complex consists of six interconnected detention basins that were constructed within the existing Del Urich Municipal Golf Course (formerly the Randolph South Golf Course). It intercepts flood flows from a 3.5 square mile drainage area of the upstream reach of Arroyo Chico and its tributaries. The basins are interconnected by weirs and reinforced concrete pipes, having a total storage capacity of 530 acre-feet. The basin complex reduces the without-project 100-year discharge of 3400 cfs to 269 cfs. The outflow (269 cfs) from the basin is conveyed through a concrete box culvert under Randolph Way and discharges into the existing channel of the Arroyo Chico. The Randolph South basins have worked successfully during flood events since its construction was completed in April 1996, eliminating flood damages in the downstream areas of Colonia Solana, Broadway Village, Broadmoor, and Parkway Vista.

Phase 2: The Park Avenue Basins complex and the associated channel/culvert improvements constitute Phase 2 of the overall project. The Phase 2 project includes the following elements:

- Three in-line detention basins, called Basins 1, 2, and 3, located along Arroyo Chico between Cherry Avenue and Park Avenue.
- An offline basin, called TUSD Basin, located within TUSD's Cherry Field between Campbell Avenue and Cherry Avenue.
- Realignment of High School Wash box culvert (underground) along 3rd Avenue and 8th Street.
- Modified confluence of Railroad Wash and Arroyo Chico.
- Larger concrete box culverts under Campbell Avenue.
- Improved channel along Arroyo Chico between Campbell Avenue and Parkway Terrace, with culverts at existing dip sections.

The Park Avenue Basins 1, 2, and 3 will provide the opportunity for environmental restoration of degraded riparian ecosystem, preservation of acceptable existing native habitats, and recreational improvements for the adjacent neighbourhood. Currently the basin areas are vacant with mostly grass.
The inlet to the basin complex is located at the Arroyo Chico confluence with Railroad Wash, followed by Basin 3, Basin 2, and Basin 1 in the downstream direction. The basins are interconnected with concrete arch culverts. The depth of the basins below the adjacent streets varies between 16 and 18 feet, with the bottom approximately at the same depth as the existing arroyo channel invert or bottom. Flows are conveyed from inlet to the offline TUSD Basin through a side weir on the north bank at the Arroyo Chico-Railroad Wash confluence. The side weir is designed such that flow enters TUSD Basin only for inflows larger than 18-year events. During the receding phase, flows out of TUSD Basin are conveyed back to the confluence through a low-flow drain to Basin 3. During a 100-year flood (or smaller flows), storage within the four basins reduces the flood peak to a level that can be contained within the existing Tucson Arroyo underground concrete box culverts and open channel segments. The maximum time to drain the four basins completely is 30 hours during a 100-year flow event, or shorter during smaller flow events.

Approximately 1,048 residential, commercial, and industrial structures will be removed from the 100-year floodplain by the second phase, compared with 241 removed by the first phase.

The project would provide environmental restoration of degraded desert habitat and riparian ecosystem within the Park Avenue Basins. Environmental impacts would include preservation of 2.85 acres of existing riparian habitat, restoration of 12.95 acres of riparian environment, and 5.55 acres of riparian mitigation. Revegetation of Basins 1, 2, and 3 includes a combination of native riparian and upland species, as well as turf areas for use by residents of the local neighbourhoods.

Monitoring/Management:
PCRFCD will be responsible for monitoring.

Funding and Cost:
- The total estimated cost (Phases 1 and 2) of the project is $68 million; 35% of the funding is provided by PCRFCD, most of this contribution has been made on Randolph golf course.
- Cost of phase IIB amounts to $22 million. Only $5 million are currently available.

Land Ownership:
The land is owned by the City of Tucson and Pima County.

Water:
During establishment, plants will be irrigated with reclaimed water bought from Tucson Water.

Public Outreach:
The City of Tucson Citizens Advisory Committee (CAC) provided eighteen points that were adopted in April 1998 by the Mayor and Council for the development of the Park Avenue Basins. These recommendations have been used as guidelines for the design of the Park Avenue Basins with final construction plans and specifications completed in March 2005.
The public will be aloud on the site on a bike path, with posts and cables discouraging from entering the restored area.

Lessons Learned/Challenges:
None noted at this time.

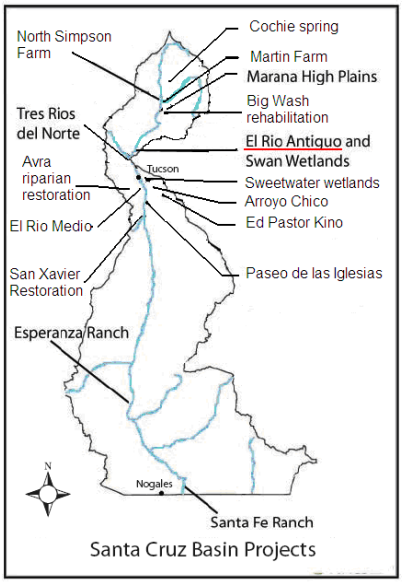
Drivers:
Create native ecosystems, harvest urban storm water and control flooding.

Sources:
http://rfcd.pima.gov/projects/arroyochico/

Contact:
Lawrence Robison (PCRFCD)

EL RIO ANTIGUO

Multi-purpose flood control facility with riparian enhancement



Location and Size :
On the Rillito River, Pima County, Craycroft Road downstream to Campbell Avenue. The study area for the project is 1,066 acres of land and 4.8 mile of the Rillito River. The project area will actually cover 284 acres of the study area.

Primary Sponsor(s):
- Pima County Regional Flood Control District (PCRFCD)
- United States Army Corps of Engineers (USACE).

History:
In the past, the Rillito River flowed perennially, meandering and supporting dense vegetation of cottonwood, willows, mesquite bosques, numerous beaver dams, and wetlands. Flows supported agriculture along the river. With growing agriculture in the 1930's, Finger Rock Wash was cut off from the Rillito River, and riparian vegetation was removed. Urbanization, along with agriculture, increased and contributed to a loss in surface water flow and lowering of the water table. Today much of the riparian habitat is degraded.

Planning Objectives:
- Restore riparian vegetative communities within the river corridor to a more natural state
- Increase the acreage of functional seasonal wetland habitat within the study area
- Provide incidental flood control through ecosystem restoration to the extent that it does not adversely impact the restoration objective
- Increase recreation and environmental education opportunities within the study area.

Phases:
September 2001: Reconnaissance Report completed
October 2003 and May 2004: Draft Feasibility Report Study published
November 2003: Draft EIS

Current Phase:
The project has been shelved for now.

Recommended or Implemented Plan:
A set of terraces would be constructed in the area known as the "Bend". Cottonwood, willow, mesquite, shrub and grasses would be planted in the channel, tributary mouths, and in rainwater harvesting basins along the tributaries.
Soil cement will be used to stabilize the stream bank with a culvert and pipeline from upstream to allow water to flow behind the soil cement during severe storm water events (larger then 2 year events).

The plan also includes a high and low-flow channel created to support a mesquite community and connect the Finger Rock Wash to the Rillito River.

Rainwater harvesting basins at each upstream tributary mouth will collect and detain storm water.
An effluent distribution system would also be installed to support the establishment of planted vegetation during dry periods.
A linear park will be constructed on both the north and south banks of the river

Monitoring/Maintenance:
Project is still in the planning phase. No monitoring or maintenance plan exists at the present time.

Funding and Cost:
The project is funded and authorized through USACE's General Investigation, Ecosystem Restoration. Total First Costs are $66,657,000.

It is estimated that annual operation and maintenance costs will be $1.26 million.
This project is funded through a cost share agreement between the USACE and PCRFCD, with the USACE covering 65% of the cost.

Water:
Current annual water cost to non-Federal sponsor is approximately $852,000.
The recommended plan requires a total irrigation need of 1,490 acre-feet of water per year.

Irrigation for the establishment and maintenance of new vegetation is provided by effluent, rainwater harvesting, and surface water diversions from tributaries of the Rio Antiguo.

Public Outreach:
- El Rio Antiguo Work Group, facilitated by Novak Inc. and initiated on May 8, 2002, included seven months of field trips and meetings.
- The final Corps public meeting for the feasibility stage was held on January 28, 2004.

Lessons Learned/Challenges:
Project is in early stages, none at this time.

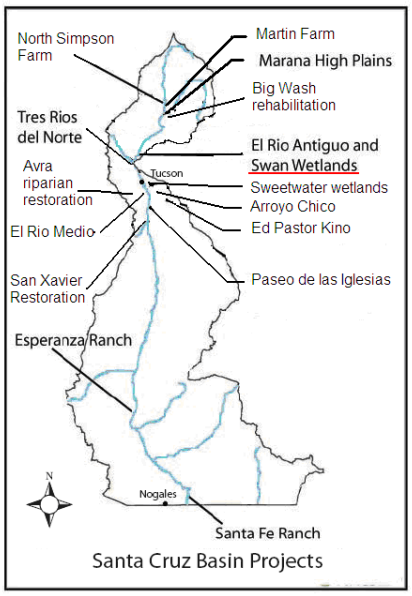
Drivers:
Habitat restoration, returning an area to its pre-World War II beauty.

Sources:
http://rfcd.pima.gov/projects/rillitoalvernon/

Contact:
Frank Postillion, Chief Hydrologist, Water Resources Division, Pima County Regional Flood Control District.

RILLITO RIVER RIPARIAN AREA (SWAN WETLANDS)

Multi purpose flood control facility with riparian enhancement



Location and Size:
This project encompasses 60.7 acres and 1.5 mile of the Rillito River, with a total of 36 acres of planting.
The site is located on the south Bank of Rillito River, between Craycroft Road (at the confluence of Tanque Verde Creek with Pantano Wash) and Columbus Boulevard.

Sponsors:
- Pima County Regional Flood Control District (PCRFCD)
- United States Army Corps of Engineers (USACE)

History:
In the past, the Rillito River flowed perennially, meandering and supporting dense vegetation of cottonwood, willows, mesquite bosques, numerous beaver dams, and wetlands. Flows supported agriculture along the river.
With growing agriculture in the 1930's, Finger Rock Wash was cut off from the Rillito River and riparian vegetation was removed. Urbanization also increased and contributed to a loss in surface water flow and a decrease in the water table.
Today much of the riparian habitat is degraded due to reduced water supply.

Planning Objectives:
- Restore riparian vegetative communities within the river corridor to a more natural state
- Increase the acreage of functional seasonal wetland habitat within the study area
- Minimize the potential for sediment and organic matter accumulation in restored areas
- Increase recreation and environmental education opportunities within the study area.

Phases:
June 1999: The preliminary Restoration Plan was approved.
November 2003: Environmental Restoration Report and Environmental Assessment (ERR/EA) were completed
February 15, 2005: A contract between the USACE and Pima County was signed
September to December, 2006: Construction in Area 1 and design of the second phase, Areas 2 and 3 (by USACE)
May, 2007 to January, 2008: Construction of the second phase with Area 3
December, 2007 to April, 2008: Construction in Area 2

Current Phase and Future Plans:
October 17, 2008: The Pima County Regional Flood Control District held a dedication ceremony for the Rillito River/Swan Wetlands Ecosystem Restoration Project.
Currently the site is in the one year warranty period, during which the contractor is still responsible for monitoring and maintenance.

Recommended or Implemented Plan:

The project plan consisted of land recontouring to enhance passive water harvesting and planting of native vegetation. Passive water harvesting is expected to occur during storm events in small, created basins and along drainage channels. A mix of plant species, grading from mesoriparian (i.e. Mesquite type) to upland species (i.e. Mesquite/Palo Verde type) was planted. After planting, each area was hydroseeded with a seed mix of local native plants. Supplemental irrigation with reclaimed water was provided to vegetation during the establishment period (five years).
For planning purposes, the project area was divided into four areas.

- Area 1: small water harvesting basins were created, near Craycroft Road north of the Hill Farm subdivision. Non-native plants and some invasive plants were removed to allow planted native species to become established. The entire area was hydroseeded with a native seed mix. Restoration of plant species is expected to increase habitat value. During construction, a biologist was on site to direct construction equipment so as to avoid damaging existing vegetation.

- Area 2: a small basin adjacent to Alamo Wash, minor surface recontouring of the basin will result in small water harvesting basins. Native vegetation was planted in the basin and irrigation with reclaimed water will be provided during the establishment period. The area was hydroseeded with a native seed mix after planting was completed.

- Area 3: at the north end of Columbus Boulevard, cement lining in the existing drainage channels was removed and the channels were recontoured to create a more sinuous alignment. This is expected to decrease the water velocity, which will allow more time for the water to move into the banks increasing soil water available to vegetation. The channel bank slopes were flattened and native vegetation was planted along the newly constructed channels. The channels were designed to convey the same amount of water as before construction. In the area away from the channels, small water harvesting basins were created to capture rain water and native vegetation will be planted. The area was hydroseeded with a native seed mix after planting was completed. Irrigation with reclaimed water will be provided during the establishment period. The Work Plan and drawings of the new channel alignments can be found under the subheading Reports and Brochures on the web page.

- Area 4: The current maintenance path along the bank protection, will receive additional vegetation plantings as part of a separate river park project that will be completed by Pima County Parks and Recreation Department.

Monitoring/Management:
The PCRFCD will take over monitoring and management activities when the warranty period ends.

Funding and Cost:
The project was funded and authorized through Section 1135 of WRDA - Modification of existing USACE projects for Ecosystem Restoration.
The Rillito River Bank Protection Project was completed in 1996 by USACE and PCRFCD.

- Project cost amounted to a little over $4 million. This type of ecosystem restoration project utilizes a cost sharing of local sponsor (Pima County) 25% and U.S. Army Corps of Engineers 75%. Pima County expects to pay for their portion of the costs through Flood Control District Tax Levy receipts.
- Under the recommended plan, the project requires 349 acre-feet of water per year, at

approximately $230 per acre-foot the total cost of water will be approximately $81,000 per year. The volume of water needed may have been overestimated.

Land Ownership:
Pima County

Water:
- Reclaimed water from the City of Tucson's Roger Road Wastewater Treatment Plant is used for temporary irrigation (five years).
- Water will also come from harvesting storm water runoff from Alamo Wash and other local tributaries.

Total annual water use for the project was estimated at 349 acre-feet. This use seems to have been overestimated, this year the project site used 35 acre-feet, with a good rainfall. The current estimate is approximately 100 acre-feet/year.

Public Outreach:
Jan 6, 2000: a public workshop.
March 21, 2003 - April 21, 2003: the Draft of ERR/EA was released for public comment.
April 17, 2003 and May 2004: PCRFCD held two open houses.

Lessons Learned/Challenges:
None at this time.

Drivers:
Habitat restoration, there are no public use elements in this plan.

Sources:
2003 U.S. Army Corps of Engineers Rillito River draft feasibility study, restoration report and environmental assessment
http://rfcd.pima.gov/projects/rillitoswan/

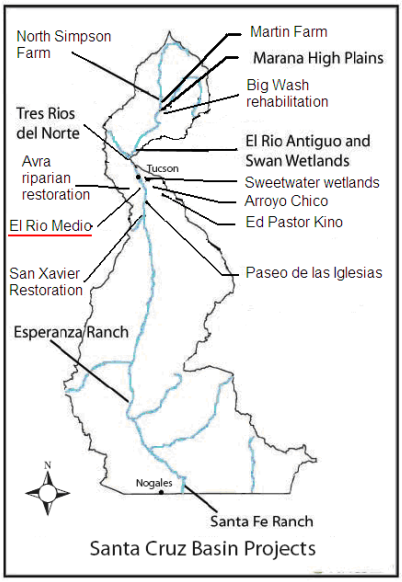
Contact:
Andrew Wigg (PCRFCD)

View of the site before restoration

View after restoration

EL RIO MEDIO ENVIRONMENTAL RESTORATION

Feasibility studies along the Santa Cruz River for urban riparian restoration



Location and Size:

The project site is located along the Santa Cruz River, within the City of Tucson, from West Congress Street downstream (South) to Prince Road (North), between Silverbell Road and Interstate Highway 10.

This project encompasses 2,675 acres of land and 4.5 miles of the river.

Sponsors:

- Pima County Regional Flood Control District (PCRFCD)
- U.S. Army Corps of Engineers (USACE)
- City of Tucson (officially joined the study as an additional local sponsor in September of 2005)

History:

Prior to degradation, the Santa Cruz River flowed year round past San Xavier del Bac to downtown Tucson, ten miles north. At that time, the Santa Cruz River was a shallow stream with a wide flood plain containing cottonwoods, willows, and mesquite bosques.

Today, a riparian habitat nourished by natural perennial river flows no longer occurs along the river within the project area.

Due to past agriculture and current municipal use, groundwater levels today are approximately 100 to 250 feet below the surface contributing to reduced river flows.

In addition, sand and gravel mining, which began in the 1970s and ‘80s near Ina and Cortaro roads and continues today, has further altered the characteristics of the river course.

Critical riparian and cienega habitats have been lost in the region due to water resource changes in Pima County.

Congress authorized the US Army Corps of Engineers (USACE) to evaluate environmental restoration potentials along the Santa Cruz River, from the north boundary of the Tohono O’Odham Nation, north to Sanders Road, in Marana.

The USACE has divided this evaluation of the river into three separate feasibility studies: Tres Rios del Norte, Paseo de las Iglesias, El Rio Medio.

Planning Objectives:

- Ecosystem restoration
- Water resources improvements : water supply recharge for later recovery and municipal use
- Flood damage reduction
- Groundwater recharge and recovery
- Recreational opportunities

Phases:

August 2000: The reconnaissance phase of the study was initiated

January 2001: Results indicated interest in continuing the study into the feasibility phase, so the Pima County Flood Control District, as the non-Federal sponsor, and the U.S. Army Corps of Engineers initiated the feasibility phase of the study.
December, 2005: The City of Tucson formally joined the study as a second non-Federal sponsor.
2005: An Existing Conditions Report was completed. (El Rio Medio study inventories the character of the river and tributary washes, notes land uses, summarizes habitat quantity and quality, reviews recreational demand, and evaluates cultural, archaeological and historical resources.)
January 2006: The Plan Formulation Phase started with a public Plan Formulation Kick-Off meeting hosted by the City and the District.
April 2006: Local sponsors, other stakeholders, and USACE utilized the public input contributed during a Plan Formulation Workshop.

The draft feasibility report for public review is expected in 2009.

Current Phase and Future Plans:
The study team is currently analyzing an array of 14 single purpose ecosystem restoration (ER) alternatives, and a separate array of five single purpose water supply recharge (WSR) alternatives. The best ER and WSR alternatives will be selected and combined into a final recommended plan using a tradeoffs analysis.
The recommended plan will be presented to the public for comment as the study progresses.
The project is pending for diverse reasons including lack of funding and stakeholder issues.

Recommended or Implemented Plan:
Twenty seven alternatives were created for consideration. Through various USACE screening and cost-benefit analysis, a final array of three ecosystem restoration alternatives has been determined. These alternatives are currently undergoing additional internal review.

Funding and Cost:
The total cost of the feasibility phase is $3,427,000, which is being shared equally between the Corps and the local sponsors.

Land Ownership:
Multiple public and private owners.

Public Outreach:
For the past two years the Study team used the public input to create a matrix of alternatives for both ecosystem restoration and water supply-recharge.

Lessons Learned/Challenges:
None noted. Project is in early stages.

Sources:
Feasibility Studies Along the Santa Cruz River, January 2006 (pdf)
http://www.tucsonaz.gov/planning/prog_proj/projects/elrio/

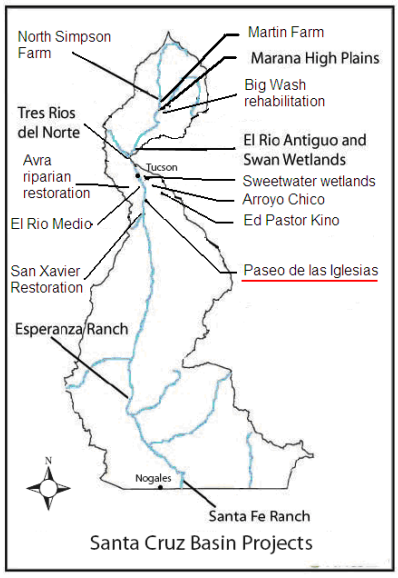
Contact:
Michael Wyneken (City of Tucson) (*El Rio Medio Feasibility Study)*
www.tucsonaz.gov/planning

Ann Audrey (City of Tucson, Office of Conservation and Sustainable Development)


Feasibility Studies Along
the Santa Cruz River
January 2006

PASEO DE LAS IGLESIAS

Feasibility studies along the Santa Cruz River for urban riparian restoration



Location and size:
Santa Cruz River and West Branch, within the City of Tucson, from West Congress Street upstream to the San Xavier District. "Paseo de las Iglesias" means the "Path of the Churches". The referenced churches include Kino's San Xavier Mission, and Mission San Augustín del Tucson. The project encompasses 5,005 acres in area and 7.5 miles of the river.

Primary Sponsor(s):
- Pima County Flood Control District (PCRFCD)
- U.S. Army Corps of Engineers (USACE)
- City of Tucson

History:
Prior to degradation, the Santa Cruz River flowed year round past San Xavier del Bac to downtown Tucson, ten miles north. At that time, the Santa Cruz River was a shallow stream with a wide flood plain containing cottonwoods, willows, and mesquite bosques.

Today, a riparian habitat nourished by natural perennial river flows no longer occurs along the river within the project area. Due to past agriculture and current municipal use, groundwater levels today are approximately 100 to 250 feet below the surface contributing to reduced river flows. In addition, sand and gravel mining, which began in the 1970s and '80s near Ina and Cortaro roads and continues today, has further altered the characteristics of the river course.

Critical riparian and cienega habitats have been lost in the region due to water resource changes in Pima County. Congress authorized the US Army Corps of Engineers (USACE) to evaluate environmental restoration potentials along the Santa Cruz River, from the north boundary of the Tohono O'Odham Nation, north to Sanders Road, in Marana.
The USACE has divided this evaluation of the river into three separate feasibility studies: Tres Rios del Norte, Paseo de las Iglesias, El Rio Medio.

Planning Objectives:
- Ecosystem restoration : Increase wildlife habitat diversity by providing a mix of riparian habitats
- Flood control improvements
- Reduced bank erosion and sedimentation
- Improved surface water quality
- Recreational opportunities (river park trail development)

Phases:
2001: The Feasibility Study process began with a 2-day public meeting
July 2005: Final Feasibility Report (evaluating : ecosystem restoration/ flood control improvements/ river park trail development along a 7-mile reach of the Santa Cruz River from Congress Street upstream 7 miles).

2007: The study was authorized by the House and Senate as part of the Water Resources Development Act, enabling future federal fund appropriations for design and construction of the project.

At the numerous meetings, citizens and experts have provided ideas regarding desired plant communities, visions of what the river banks could look like, options for irrigation and water harvesting, and recreation needs. These ideas were combined in various ways to form "alternatives". The alternatives were screened based on environmental and cost-benefit analysis, and the Corps suggested several "best buys" alternatives.

Current Phase:
A recommended plan has been selected from an initial array of 47 alternatives based on the USACE's analysis and public input. Restoration work has not started yet.

Recommended or Implemented Plan:
- The Recommended Plan includes 1,100 acres of mesquite bosques on river terraces and floodplain, bordered by palo verde woodland and desert shrubs on both banks.
- A land re-contouring to enhance passive water harvesting.
- Supplemental irrigation will be provided to support establishment and as needed to maintain healthy plant communities. Irrigation is planned for mesquite and riparian shrub on terraces above the low flow channel and in the historic floodplain.
- Flood control improvements include erosion protection that will be limited to at-risk areas.
- Recreation elements will include trail linkages to complete the Santa Cruz River park trail throughout the study area. Trails will also link to the existing Julian Wash Trail. It was important to develop a passive recreation plan that would encourage enjoyment of the environment while recognizing the history of the area. The recreation elements will provide better access to the area for hiking, wildlife viewing, biking, and equestrian use. The plan includes construction of a portion of the 1,200 mile Juan Bautista de Anza National Historic Trail that is planned to eventually connect Nogales to San Francisco.

The plan features are consistent with the desires expressed by public involvement work groups.
Implementation of the plan is supported by : the U.S. Fish and Wildlife Service, Arizona Game and Fish Department, Center for Biological Diversity, Santa Cruz River Alliance, Tucson Herpetological Society, and others.

Monitoring/Maintenance:
The local sponsors are responsible for monitoring and maintenance, which will consist of periodic channel clearance, control of invasive plant species, pumps and irrigation maintenance, and periodic replanting of habitat areas damaged by flood.

Funding and Cost:
The feasibility study was funded by the USACE and Pima County through the USACE's General Investigation, Ecosystem Restoration funds.

Total project construction first cost: $92,058,546.
Total operation and maintenance costs excluding water: $807,046.
The Federal share of the recommended plan is $59,666,768 (65%) and the local cost share is $32,391,778 (35%). Of the $32 million non-federal share, $26 million is accounted for by the sponsor's land contributions, leaving $6 million as the local sponsor's cash commitment.

Existing local funds include $14 million in dedicated 2004 bonds.

Recreation elements are a 50/50 cost share.
100 percent of the costs of providing water will be paid by the non-Federal sponsor (Pima County). These costs are currently estimated at $1,099,175 annually based on the use of reclaimed water from Tucson Water.

Land Ownership:
City of Tucson, Pima County, State of Arizona and various private owners.

Water:
Rainwater harvesting and reclaimed water were the two sources of water looked at for the feasibility study; however, the local sponsor (PCRFCD) can use any water source(s) deemed most practical if the project is approved.
At this time no water source has been determined for the project.
The annual water budget for the tentatively recommended plan is estimated at 1,925 acre-feet per year. As the local sponsor, Pima County is responsible for providing the irrigation water.
As part of the cost analysis, the Corp's used a known water source with a known cost. They used the current market rate for reclaimed water from Tucson Water. Pima County is in no way obligated to use this particular water source. In fact, there are significantly less costly irrigation water sources including storm water harvesting, use of other secondary or tertiary effluent, leasing other water, or the use of groundwater, although that is not a preferred source.

Even though the region is in an eight-year drought, successful storm water harvesting has already been accomplished at the County's Kino Environmental Restoration Project near Tucson Electric Park.
The Paseo project could include a facility like this at the location of the retired S&G pit south of Valencia Road if that private property can be acquired. At this site water could be harvested from both the Santa Cruz River, and adjacent tributaries.

Public Outreach:
There have been a series of workshops and public meetings to solicit input regarding restoration measures and desired outputs, plus numerous stakeholders meeting to gather technical information and determine planning constraints.

April 2001: Notice of Intent.
March 30 and 31, 2001: Public Scoping Meetings.
April 1, 2001: tour of site.
March 21, 2002 and April 9, 2003: two smaller workshops were held.
January 22, 2004: open house by PCRFCD.
October 26, 2004: public meeting to present the feasibility study results and recommended plan overview.

Because of the public interest shown during the initial meeting, further meetings were scheduled to establish a process for development of public involvement in planning for restoration of the Santa Cruz River in the study area. Public concerns included loss of habitat & wildlife, water issues, invasive plants, stream bank erosion, other destructive influences, and inclusion of recreation elements in the final plan.

Lessons Learned/ Challenges:
Project is in early stages, none noted at this time.

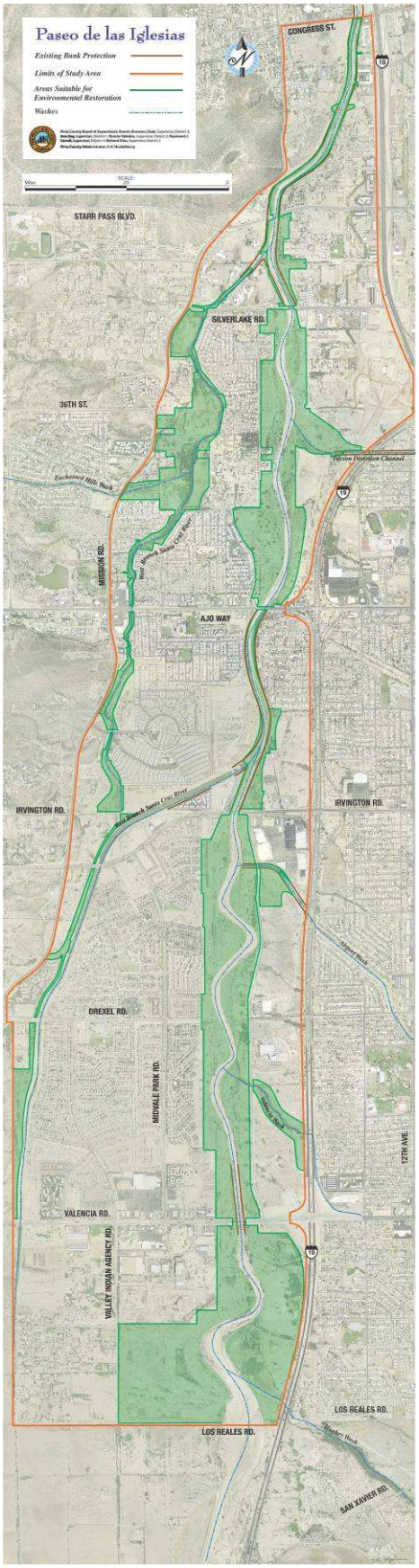
Drivers:
Reversing the perception of the Santa Cruz River as a dumping ground, restoring both the cultural and ecological heritage of the area.

Sources:

- ***Feasibility Studies Along the Santa Cruz River*, January 2006**
- http://rfcd.pima.gov/largefiles/pdli2/index.htm
- http://rfcd.pima.gov/projects/paseoiglesias/
- http://rfcd.pima.gov/projects/paseoiglesias/outreach.htm

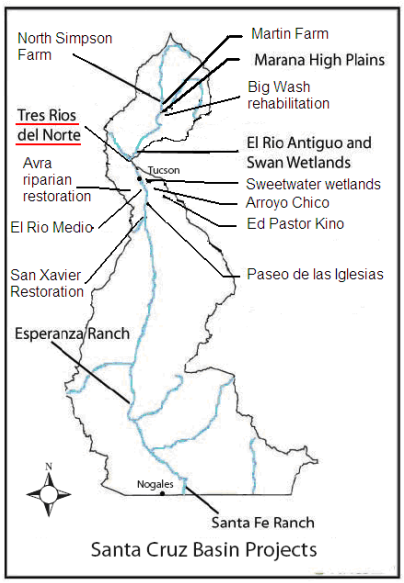
Contact:
Jennifer Becker, Principal Hydrologist, Pima County Regional Flood Control District


MARANA
ORO VALLEY
SAGUARO NATIONAL PARK WEST
TUCSON MOUNTAIN PARK
TOHONO O'ODHAM NATION
SOUTH TUCSON
PASCUA YAQUI NATION
TOHONO O'ODHAM NATION
SAN XAVIER DISTRICT
Tres Ríos del Norte
El Río Medio
Paseo de las Iglesias
Feasibility Studies Along the Santa Cruz River
January 2006


Paseo de las Iglesias
Existing Bank Protection
Limits of Study Area
Areas Suitable for Environmental Restoration
Washes
CONGRESS ST.
STARR PASS BLVD.
SILVERLAKE RD.
36TH ST.
AJO WAY
IRVINGTON RD.
DREXEL RD.
VALENCIA RD.
LOS REALES RD.
SAN XAVIER RD.

TRES RIOS DEL NORTE

Feasibility studies along the Santa Cruz River for urban riparian restoration



Location and size :
Santa Cruz River, within the City of Tucson, from Prince Road (South) to Sanders Road (North), West Moore Road, and West Avra Valley Road.
The project encompasses approximately 3,000 acres of land and 19 miles of the river.

Primary Sponsor(s):
- Pima County Regional Flood Control District (PCRFCD)
- U.S. Army Corps of Engineers (USACE)
- City of Tucson
- Town of Marana

History:
Prior to degradation, the Santa Cruz River flowed year round past San Xavier del Bac to downtown Tucson, ten miles north. At that time, the Santa Cruz River was a shallow stream with a wide flood plain containing cottonwoods, willows, and mesquite bosques.

Today, a riparian habitat nourished by natural perennial river flows no longer occurs along the river within the project area. Due to past agriculture and current municipal use, groundwater levels today are approximately 100 to 250 feet below the surface contributing to reduced river flows. In addition, sand and gravel mining, which began in the 1970s and '80s near Ina and Cortaro roads and continues today, has further altered the characteristics of the river course.

Critical riparian and cienega habitats have been lost in the region due to water resource changes in Pima County. Congress authorized the US Army Corps of Engineers (USACE) to evaluate environmental restoration potentials along the Santa Cruz River, from the north boundary of the Tohono O'Odham Nation, north to Sanders Road, in Marana. The USACE has divided this evaluation of the river into three separate feasibility studies: Tres Rios del Norte, Paseo de las Iglesias, El Rio Medio.

Planning Objectives:
- Enhance riparian habitat for native species
- Minimizing the potential for sediment and organic matter accumulation in restored wetlands
- Recharging and recovering municipal groundwater supplies that also will facilitate vegetation restoration
- Flood damage reduction
- Recreation and protection of cultural resources

Phases:
February-December 2000: Reconnaissance Report (Sec 6 of Flood Control Act of 1938)
An array of alternatives describing different levels of restoration was prepared and evaluated

by the local jurisdictions. Several of these alternatives were being reformulated to better conform to current conditions and economic realities.
January 2004: Feasibility F4A Milestone (AFB)
Summer 2006: Draft feasibility report. Once the reformulation of alternatives was completed, they were passed through a series of screenings, including a cost-benefit analysis, which resulted in a final array of "best buy" alternatives. These best buy alternatives, along with the detailed technical analyses of how everything was evaluated and the recommended plan is presented in the Draft Feasibility Report and its companion Draft Environmental Impact Statement.

The TRDN planning process and timeframe are determined by the requirements of the National Environmental Policy Act (NEPA), the Water Resources Development Act (WRDA).

Current Phase:
Planning phase, no final plan yet. The project is pending for diverse reasons including lack of funding and stakeholder issues.

Recommended or Implemented Plan:
The Recommended Plan will likely be a combination of enhancements that provide for ecosystem restoration, water supply (recharge and recovery), and recreation.
Restoration goals are to improve mesquite, cottonwood-willow, and emergent wetland habitats to a condition supportive of wildlife, and for the benefit of residents and visitors to the area.
Additionally several new alternatives are being drafted including an alternative that reflects the possibility that all of the effluent currently discharged into the Santa Cruz River will be diverted from the channel for municipal water needs.

Monitoring/Maintenance:
Operations and maintenance will consist of:
- Regular monitoring of restoration performance
- Invasive species control
- Maintenance of water delivery system
- Replacement of non-surviving vegetation

The annual monitoring is estimated at $60 per acre with control of invasive species costing an additional $60 per acre.

Land ownership:
City of Tucson, State of Arizona, Pima County, Town of Marana, and private.

Funding and Cost:
Funding and authorization for this project is from the USACE General Investigation, Ecosystem Restoration.
Construction cost: approximately $292 million; Federal share of construction is currently estimated at approximately $170 million, and the non-Federal share at $117 million.
The annual cost of water is estimated to be $13,209,560.

Water:
The tentative plan includes piped delivery of tertiary reclaimed water and in-channel effluent

flows from the Roger and Ina Road Wastewater Treatment Plants. These flows of approximately 44,000 acre-feet per year would be used to sustain vegetated areas. Site work would include micro-grading for individual tree basins, flood irrigation, bubblers, drip irrigation, and implementation of micro- and macro-scale storm water-harvesting features. The revegetated area will include over 3,000 acres of watered and storm water-nourished habitat.

Public Outreach:
Public involvement activities are an important aspect of the TRDN study and have been part of this restoration project from the beginning**.**
2001: One public meeting to determine the extent and type of work to be done.
2003: Two public meetings to obtain formal public input and feedback on proposed restoration elements of the project.
February 2006: Public Open House, to show the relationship of all of the ongoing USACE studies along the Santa-Cruz River : El Rio Medio, Paseo de las Iglesias and Tres Rios del Norte.

Planned for 2009: The Corps is also working on preparing a "Community Report" which will be a more user-friendly document for the public, with sufficient discussion of the alternatives and planning process to better explain how values for water use and costs were determined. The report will also highlight groundwater recharge benefits associated with the project so that the water use is put in correct context.

Public comments to date demonstrate strong support for riparian restoration along the TRDN stretch of the Santa Cruz River.

Challenges/Lessons Learned:
Project is in initial stages, none at this time.

Drivers:
Provide mitigation for lost riparian habitat.

Sources:
- http://www.marana.com/index.asp?NID=358
- http://rfcd.pima.gov/projects/tresrios/
- *Feasibility Studies Along the Santa Cruz River*, January 2006 (pdf)

Contact:
- Jennifer Becker, Principal Hydrologist, Pima County Regional Flood Control District
- Ann Audrey, Office of Conservation and Sustainable Development, City of Tucson


Feasibility Studies Along
the Santa Cruz River
January 2006
MARANA
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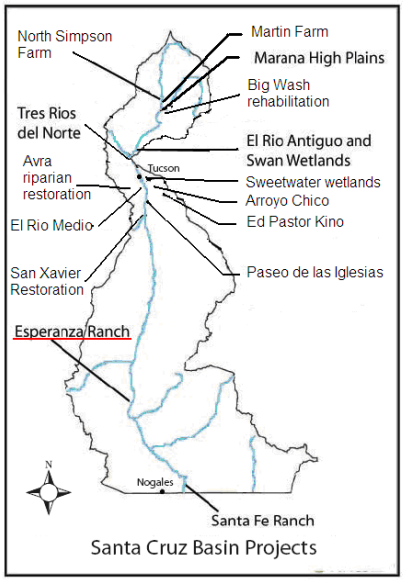
SOUTH TUCSON
Tres Rios del Norte
El Rio Medio
Paseo de las Iglesias

ESPERANZA RANCH

Effluent flow and riparian enhancement



Location and Size:

Situated in northern Santa Cruz County, between Amado and Tubac off the I-19 at Agua Linda Road, the project encompasses 300 acres of land and both sides of the Santa Cruz River for 1 mile, and the land of the west side of the channel for another mile, ½ mile of the Chivas wash and a 10-acre pond area.

Sponsors:

- Tucson Audubon Society (TAS)
- Devon Energy Corporation
- partnership with the Sonoran Institute to get an EPA grant

History:

The land is adjacent to the Santa Cruz River. It is a migratory corridor that has been heavily disturbed through decades of development and ranching activity, which caused erosion and allowed invasive plants to thrive.

Devon Energy Corporation, the original owner, sold the 800 acres of land at Esperanza Ranch to local land owner Mr. Olson requiring, as a condition of the sale, to put 300 acres in a conservation easement, managed by TAS. Tucson Audubon is undertaking habitat restoration, monitoring and maintenance on the site.

US Representative Raul Grijalva applauded this innovative agreement saying "This type of partnership, where the private sector voluntarily bears the burden of conservation, is what will be necessary to achieve conservation goals in the next four years. I applaud the parties to this agreement for their leadership and foresight in this area."

The Esperanza Ranch Conservation Easement project is one of many environmental enhancement efforts Devon has undertaken. "We recognize this as a property with tremendous environmental potential. It's one of several non-producing properties Devon possesses that could benefit wildlife," said David Templet, manager of Devon's Environmental Health and Safety Department. "We are grateful for the Tucson Audubon Society's willingness to team up with us to see this project through…Tucson Audubon's commitment and dedication will fulfill Devon's primary objective, the preservation of this important wildlife habitat," Templet said.

The program has gained notice in several ways, most recently helping Tucson Audubon be a finalist for an Achievement Award from the Community Foundation for Southern Arizona. Ann Phillips accepted a plaque and a cash award on behalf of Tucson Audubon in recognition of having been a finalist in the foundation's "innovation" category.

The flow of the Santa Cruz River is intermittent through the reach that is being restored. Most of the year the flow comes from effluent released from the Nogales International Wastewater Treatment Plant about 20 miles upstream.

A pond in the restoration area was created by sand and gravel removal during construction of

Interstate 19 and has cottonwood and willow already growing on its banks.

Planning Objectives:

- Increase the diversity, density and sustainability of riparian habitat for the benefit of birds and other wildlife
- Stabilize erosion prone areas
- Engage the local and regional community in site activities and develop a long-range strategy for stewardship of the site as well as an endowment to carry out the plan.

Phases:

December 2004: beginning of the project, planning stage.
Spring of 2006: Restoration began, once the ungulate proof fencing was completed.
The project was scheduled to be completed in 2008, but the strategy was changed due to high plant mortality and high competition with non-native species.

Current Phase and Future Plans:

Restoration work is ongoing. About 20 more years should be needed to complete the work.

Mr. Olson, the new owner of the Esperanza Ranch, plans to construct a very low density residential development on the 500 acres of the Esperanza Ranch located adjacent to the easement. In conceptualizing his development, Mr. Olson worked closely with Tucson Audubon to ensure that his plans were compatible with the easement's conservation goals. His goal is to attract conservation-conscious residents to the land.
The joint transaction comprises 800 acres about 40 miles south of Tucson. About 500 acres will be developed as a low-density residential area bordering the 300-acre wildlife easement.

Recommended or Implemented Plan:

- The global plan for the site is to have a cottonwood and willow area along the river, a mesquite bosque-type area (xeroriparian species) higher up, and native grassland farther up along the west of the site. A mesquite forest should run along Chivas Wash.

- The first stage of work on this project was the installation of fencing around the 27,226 foot perimeter of the lands designated under the conservation easement, to exclude cattle.

- Once the fence was in place new vegetation was planted by seeding and planting around the river channel, in the ponds, along Chivas Wash, and in the broad floodplain west of the river. Planting techniques included pole planting of cottonwood and willow, seedling planting of riparian and uplands species, and seeding of the broad landscape. All plants were placed in water harvesting basins and swales to concentrate rainwater around them until they can access nearby elevated soil moisture.

- Non-native species are removed and suppressed by cutting and applying herbicides.

- Erosion around the pond perimeter and east end of Chivas Wash will be addressed through a combination of water harvesting and planting up gradient of erosion, and soil stabilization at the erosion points.

- Establishing both a plan for long-term stewardship and an endowment with contributions from the property owner and Tucson Audubon Society to fund long-term management of the site.

Monitoring/Management:

- Observing : seedling survivorship, wildlife and avian use (bird watching 9 times/year)
- Photo monitoring is used to document conditions before, during, and after restoration efforts.
- Online real-time data from stream gages and rainfall data are collected on the US Geological Survey website. USGS has a stream gage at Tubac and one at Amado (upstream and downstream of the site). Depth to groundwater (currently 20-35 feet deep) is also monitored in three locations: two in the easement, and one in a well at Agua Linda farm.
- The fencing will be monitored monthly throughout the project period, within 24 hours of significant river flows that could take out river crossing fencing, and within 24 hours of seeing vehicles, cows, or unauthorized people within the conservation. The agreement with the AWPF indicates that the project sponsors must maintain the fence for 15 years after installation and operate and maintain the site of revegetation for a minimum of 20 years.
- A conservation easement has been established on the property to protect the riparian area from development and encroachment in perpetuity.

Funding and Cost:

- $135,000 from Devon Energy Corporation (to establish an endowment for long-term stewardship, not for restoration work), in addition to the land
- $279,411 from AWPF
- $6,500 in-kind contributions from Stewart Loew and the Sky Island Alliance
- $151,270 matching and in-kind contributions from the Tucson Audubon Society
- $60 000 grant from Environmental Protection Agency (EPA) through the Sonoran Institute

Land Ownership:

Devon Energy Corporation, an Oklahoma City-based oil and natural gas producer, acquired the property through its acquisition of PennzEnergy Co. in 1999. At the time of the grant application, Devon Energy owned the Esperanza Ranch.
The 800-acre Esperanza Ranch property, including the 300-acre conservation easement portion, is now owned by Mr. James Olson of Green Valley, Arizona.

Water:

- The project takes advantage of intermittent effluent flows coming from the Nogales International Wastewater Treatment Plant. There is no contract or agreement in place which secures these flows and guarantees that they will continue to be delivered. The project is designed to be resilient and dynamic so that if the effluent flows are removed from the ecosystem, the vegetation will shift to more meso-riparian species but will survive with altered characteristics.

- No water will be pumped from groundwater wells nor diverted from surface water supplies at the Esperanza Ranch site to use in restoration activities due to an agreement entered into by previous owners that restricts pumping here (the FICO Agreement).

Public Outreach:

Esperanza Ranch is an area of sensitive habitat and its access is governed by a conservation easement agreement between Tucson Audubon and the landowner. Access to the conservation easement is strictly controlled and requires escort by a Tucson Audubon staff member. However there are opportunities to join Tucson Audubon staff members on birding trips, site

tours and volunteer work days. Public involvement also includes public lectures and community participation off-site.

Lessons Learned/Challenges:
The first plan had been done at a large scale, and turned out to be too ambitious. After seeding and planting over 3000 plants, a high mortality rate was observed. This plan did not allow native species to compete with non-native species.
A new strategy has been implemented, working on small, intensive areas, one area at a time.
The main obstacles to completing restoration work were the lack of funding and competition with non-native species.

Drivers:
Increase and restore habitat, then protect the area in perpetuity.

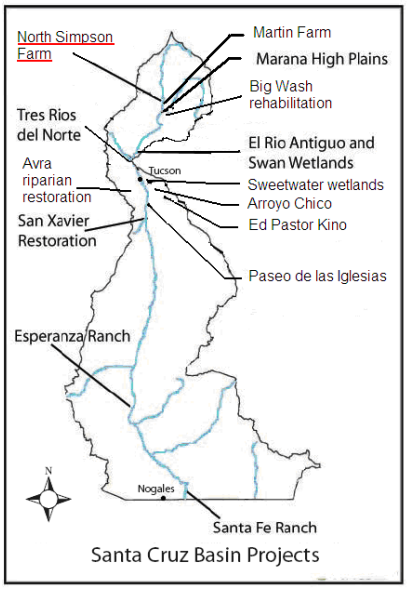
Sources:
www.tucsonaudubon.org/restoration/espintro.htm
http://www.tucsonaz.gov/ocsd/community/nature/OCSD%20CommOppsNatureFood2.

Contact:
Kendal Kroesen (TAS)

Photos: December 2008

NORTH SIMPSON SITE RIPARIAN RESTORATION

Effluent flow and riparian enhancement



Location and Size:

This site consists of retired farmland with a riparian area along the lower Santa Cruz River in Avra Valley northwest of the City of Tucson and west of the Town of Marana.

The project encompasses a total of 1,700 acres with restoration concentrated to date in the northeast portion of the site:

- 150 acres of seeding funded through in-lieu mitigation fees for Clean Water Act Section 404 permits managed by the U.S. Army Corps of Engineers (USACE)
- 20 acres of restoration completed through an Arizona Water Protection Fund (AWPF) grant
- 25 acres funded through a Phase 2 AWPF grant
- 6 acres funded through U.S. Fish and Wildlife Service (USFWS)
- 51 acres of intensive planting and erosion control.

Sponsors:

- Tucson Audubon Society
- City of Tucson
- Arizona Water Protection Funds (AWPF)
- US Fish and Wildlife Services (USFWS)
- US Army Corps of Engineers (USACE)

History:

Historically, the Santa Cruz River at the North Simpson site was ephemeral, flowing only during flood events.

Since the 1970s, however, this area has had a near constant flow of treated effluent released from regional wastewater treatment plants.

The North Simpson Riparian Restoration project does not attempt to recreate the historically-present ephemeral riparian habitat at the site; rather, it attempts to take advantage of the effluent flow to expand the cottonwood and willow habitat (hyporiparian habitat) that is developing at the site and to increase the diversity of mesoriparian, xeroriparian, and upland habitat to offset habitat losses in other areas.

The North Simpson Site is part of a total of 23,000 acres of Avra Vally farmland purchased by the City of Tucson during the 1970s and 1980s to obtain associated groundwater rights.

In 2001, the City of Tucson entered into 99-year right-of-entry agreement allowing Tucson Audubon Society to undertake restoration within the 1,700 acres of former farmland. Restoration work had been concentrated to date in the northeast portion of this 1,700-are area. TAS also holds a right to 10 acre feet/year from either groundwater or effluent in the river.

The first 150 acres of restoration were funded by mitigation fees provided by the US Army Corps of Engineers, TAS then applied for the AWPF grant for more restoration.

Tucson Audubon's habitat restoration program is now a regional force for the improvement of wildlife habitat in the Santa Cruz Valley. The program has gained notice in several ways, most recently helping Tucson Audubon be a finalist for an Achievement Award from the

Community Foundation for Southern Arizona. Ann Phillips accepted a plaque and a cash award on behalf of Tucson Audubon in recognition of having been a finalist in the foundation's "innovation" category.

Planning Objectives:
The goals and objectives stated in the original AWPF grant application submitted by Tucson Audubon Society were:

- Assess the site to identify favorable areas for AWPF habitat recovery efforts
- Enhance the wildlife habitat along one stretch of the lower Santa Cruz River and restore native vegetation to adjacent abandoned farm fields
- Control erosion
- Engage local and regional members of the public and governmental bodies in learning and recovery activities at the site to promote a sense of stewardship
- Educate and act as a model for other habitat recovery efforts.

Phases:
1998-1999: Planning phase
2001: 99-year right-of-entry agreement with the City of Tucson allowing Tucson Audubon Society to undertake restoration.
2001-2005: AWPF Phase 1 work
2000-2003: USFW-funded seeding on 6 acres.
In-lieu mitigation work commenced in 2000 and is ongoing.
2004-2007: AWPF Phase 2 work

Current Phase and Future Plans:
AWPF and USFWS work is completed.
In-lieu mitigation work is ongoing: TAS has a right of entry on approximately 25 more acres. Restoration work should take two to three more years, adding a few years of irrigation.

Recommended or Implemented Plan:

- Cattle fenced out in 2001.
- One of the major strategies of the restoration design was the use of rainwater harvesting to catch rainwater and focus it around plantings. Part of the project plan was to integrate the riparian habitat around the river corridor with adjacent xeroriparian and upland areas to provide an integrate habitat.
- Installation of a drip irrigation system to deliver groundwater to plantings for the first two years after establishment.
- Some eradication has been done to control invasive species.

However, because cooperative agreements for control are not in place on adjacent properties and upstream on the river, there is a constant influx of seeds which make it nearly impossible to fully eradicate the non-natives.

- The area was planted with native species and has quickly turned into a dense riparian habitat. The work started on the east side; usually work is done on 2 to 5 acres at a time.
- Each area is irrigated for two to three years, some are still being irrigated.
- Another water source on the property has facilitated creation of a second mesoriparian area in addition to that found on the corridor around the river. On the north side of the site, irrigation tail water released from adjacent agricultural fields flowed into a ditch along the north property boundary.

The water was initially a nuisance, creating dense colonies of tumbleweed. In order to take

advantage of the water source, a 1000-foot long meandering trench was dug to pull this water south into an otherwise barren part of the site. Small “chicken foot” branches were constructed periodically along this trench to extend flow out from the main channel.

Monitoring/Management:

- Photo monitoring is generally performed annually during the same month each year. Additional rounds of photo monitoring are performed early in grant-funded projects to document restoration implementation and early plant growth.
- Vegetation monitoring is conducted to determine the survival and growth of introduced plants and to document the changes to habitat quality resulting form restoration efforts.

Survival and growth monitoring at AWPF -funded areas is conducted monthly at first to track initial plant growth, then reduced to quarterly, then finally to annual measurements. Vegetation monitoring for habitat conditions is conducted at the beginning and end of AWPF projects to document changes in habitat due to restoration efforts and natural system changes.

- Avian monitoring has been conducted quarterly since 2001 at multiple locations of the site and will continue indefinitely into the future. Bird surveys have shown increases in the diversity of bird species at the site. An article in the March Vermilion Flycatcher described work that led to the relocation of twenty four Burrowing Owls to the Simpson Site.
- Erosion monitoring was preformed initially in September 2002 and will be repeated following flow events of 3,000 cubic feet per second or more during the duration of the AWPF grants.
- Collection of stream gage data and rainfall data are conducted by downloading internet data from the US Geological Survey website and the Arizona Meteorological Network website.

Maintenance of grant-supported work will continue for 20 years as required under the AWPF and USFW agreements.

Funding and Cost:

As of December 2003, total funding amounted to $550,000.

- In-lieu mitigation fees for section 404 of the Clean Water Act
- grants from the Arizona Water Protection Fund
- U.S. Fish and Wildlife Service Partners for Wildlife grant.

Land Ownership:

The North Simpson Site is part of a total of 23,000 acres of Avra Valley farmland purchased by the City of Tucson during the 1970s and 1980s.

In 2001, the City of Tucson and TAS entered into a 99-year right-of-entry agreement allowing Tucson Audubon Society to undertake restoration within the 1,700 acres of former farmland.

Water:

- Effluent released into the Santa Cruz River from regional wastewater treatment plants in Tucson. The average daily effluent flows through the site are generally less than 40 cubic feet per second and are usually present, except during the hot season when water evaporates prior to arriving at the site, and during flood events when the river bottom is scoured and an increase in infiltration rates allows the effluent to infiltrate prior to arriving at the site. There is no agreement or contract currently in place to guarantee that effluent flows will continue indefinitely at the site.

There is also a small water treatment plant close to the site, which treats water for Marana. The plant is currently run by the County and releases small amounts of water. However the

Town of Marana is currently in lawsuit to take over the treatment plant, which might mean less effluent would flow through the site if it were to be used by Marana.

- Pumped groundwater: supplemental water is used to nourish plantings during their first two years after establishment. It is provided by the City of Tucson through their groundwater wells on site. Groundwater use has consistently been less than the 10 acre feet/year allotment, with an average of 5 acre feet per year.
- Rainwater harvesting was also used extensively on the site to capture and focus rainwater around plantings.

Public Outreach:

- Semi-annual articles in the Vermillion Flycatcher, the Tucson Audubon Society's newsletter
- Volunteer workdays; restoration workshops for adults; educational programs with area schools; site tours and birding field trips; off-site lectures and slide shows.

Lessons Learned/Challenges:

One important lesson learned from the North Simpson Site Restoration project, according to the Tucson Audubon Society, was the value of having a partner like the City of Tucson involved in the project. The city provided fencing, heavy equipment and operators when needed as well as enforcement against illegal uses of the property. The city was able to deploy resources that insured the success of the project, and the TAS was able to concentrate on restoration activities.

Another lesson learned is that periodic safety meetings with the crew were well worth the time and expense. They brought the crew together to discuss safety issues as well as other topics. They also gave the staff a chance to discuss response procedures. This was especially important because of the large number of volunteers on the site during volunteer days.

Vehicle access to the site proved to be extremely valuable. The site is long and narrow. A narrow dirt road snakes through the site allowing deliveries of irrigation pipes, plants, tools and other materials to be brought very close to where they would be used.

Installation of irrigation piping for over 2000 plants elicited several lessons learned. Pipe expansion and contraction caused many problems. Temperatures on the site fluctuated almost 100 degrees over the four years from 2000-2004. Pipes installed at either side of the temperature spectrum tended to experience separation at glued joints. It was found that installing pipes when the temperature was between 60 and 80 degrees produced the best results as temperatures changed.

In addition, installing expansion couplings every 1000 feet for above-ground pipes and every 2000 feet for below-ground pipes increased their ability to withstand temperature fluctuations.

Flushing and draining the irrigation lines was also an issue. Drain valves were initially installed at the end of each pipe run, but it was found that additional drain valve needed to be installed at low spots and at the end of each branch line. The team also found that flushing the lines to remove scale and ants was required monthly to keep the system functioning properly.

No mechanical timers were used in the irrigation system so that human oversight would be present whenever the system was on. This turned out to be a very effective strategy for detecting leaks and reducing erosion from pipe breaks.

The water from the river clogged the drip irrigation system, which led to the exclusive use of groundwater for drip irrigation.

Use of pole planting was a simple cost-effective method of facilitating colonization by some species. The restoration team noticed that cottonwoods and willows along the river corridor

naturally oriented themselves in lines parallel to the river banks. The most upstream tree growing in this stringer pattern takes the brunt of the flood impact, reducing impact to downstream trees from detritus and high flows. Pole plantings were placed in this same pattern. Trees planted too low got damaged by floods, as well as the irrigation system.

Drivers:
Restoration of a portion of the Santa Cruz River to provide riparian habitat in an area where much of the historic habitat is degraded or has disappeared entirely.

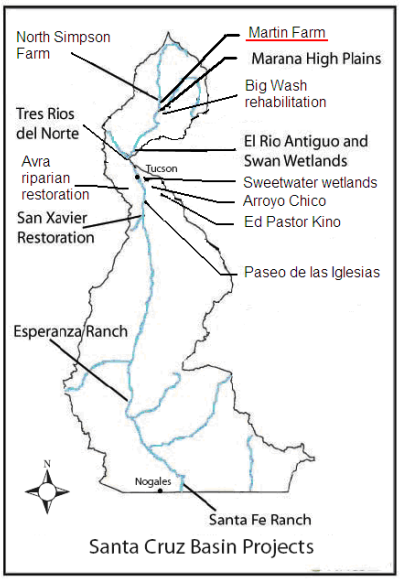
Sources:
http://www.tucsonaudubon.org/restoration/scriver.htm

Contact:
Kendal Kroesen (TAS)

Santa Cruz River through the project site

MARTIN FARM

Effluent flow and riparian enhancement



Location and size:
Along the east side of the lower Santa Cruz River northwest of Tucson and Marana, just upstream from the Simpson site (northern Pima County).
The project encompasses 30 acres of land and 0.5 miles of river.

Sponsors:
- Tucson Audubon Society (TAS)
- City of Tucson
- U.S. Army Corps of Engineers (USACE)

History:
The TAS received in-lieu mitigation checks from the USACE while they were working on the North Simpson site. TAS chose the nearby Martin Farm site for enhancement of riparian habitat.

Planning Objectives:
Enhance wildlife habitat along the lower Santa Cruz River in northern Pima County.

Phases:
2005: Agreements signed with the City of Tucson (for land and water).
Fall 2006: Beginning of the work.

Current phase:
Planting is completed, only 3 acres are still under irrigation.

Recommended or implemented plan:
- Removal of invasive species
- Seeding and planting of native species, not too many trees were planted because at the site the flood plain is very wide and trees planted get torn out by floods (lesson learned at the North Simpson site). Most planting is xeroriparian. The vision for the site is a thick mesquite forest with a lot of plant diversity.
- Construction of erosion control features.

Monitoring/ Management:
Regular monitoring surveys are now being conducted at the restoration site. Avian surveys already show a good number of southern Arizona bird species are utilizing the site.

In addition to bird surveys, plant monitoring at Martin Farm is showing great early success. Plants put in by the restoration crew hardly one year ago have a 74% survival rate and a 74% growth rate. Growth in the former "bosque" area (where a good number of medium sized velvet mesquites were already present) is particularly encouraging.
In a few years, this area should provide excellent bird habitat containing a greater diversity of plant, shrub and grass species.

Funding and Cost:
In-lieu mitigation checks managed by the USACE.

Water:
The water flowing at the site is effluent from Tucson.
There is a drip irrigation system using effluent water, groundwater is cleaner and doesn't clog the system, but there is no other choice than using effluent water here since there is no well at the site.

Land ownership:
City of Tucson

Public Outreach:
This site is posted no trespassing, and can be accessed only during official Tucson Audubon events led by Tucson Audubon staff members.

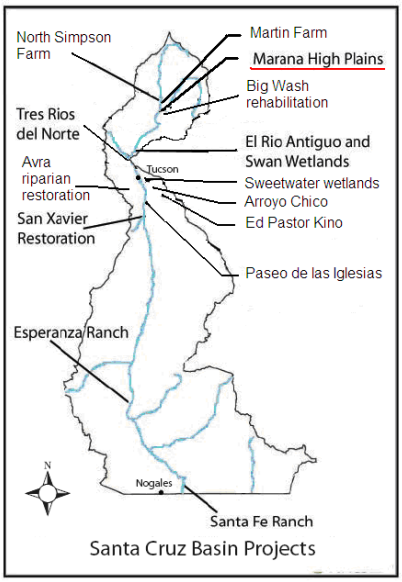
Challenges/Lessons Learned:
None at this time.

Source:
www.tucsonaudubon.org

Contact:
Kendal Kroesen, Tucson Audubon Society

MARANA HIGH PLAINS EFFLUENT RECHARGE PROJECT

Effluent recharge with riparian enhancement



Location and size:

Near the Santa Cruz River in the town of Marana, off of Moore and Sanders Road in Pima County. The project encompasses 18 acres of created riparian habitat along 1.2 miles of an oxbow channel of the Santa Cruz River.

Sponsors :

- Pima County Regional Flood Control District (PCRFCD)
- Bureau of Reclamation (BOR)
- Town of Marana
- Cortaro-Marana Irrigation District
- Mr. Robert Honea
- Arizona Water Protection Fund (AWPF)

History:

The Marana High Plains Effluent project area historically had an ephemeral flow, and it is estimated that groundwater depth was never sufficient to support extensive stands of riparian vegetation. Records from a well near the High Plains site indicate groundwater depth of over 180 feet below the surface in 1939. Extensive livestock grazing in this area is also a contributing factor to the historical lack of vegetation.

The Marana High Plains Recharge project began in 1995. It is the Pima County Flood Control District's first recharge project.

The Bureau of Reclamation had secured funding for what was originally a two-year pilot project to investigate the feasibility of using treated effluent to enhance riparian habitat while recharging the underlying ground water aquifer. Originally, the Rillito River Recharge project had been selected as the demonstration project site. However, the project failed to gain political support and was never undertaken.

Planning Objectives:

The first goal of the project was to evaluate and compare infiltration rates between basins having side slopes vegetated with riparian vegetation, basins fully vegetated with native grasses and bare basins.

But the Marana High Plains project is a multipurpose effort, it includes other objectives such as:

- Characterize wildlife, aquatic macro-invertebrates, and vegetative resources associated with an important effluent-dominated stream.
- Revegetate the area outside recharge basins with plants that will improve wildlife habitat value and could survive if recharge activities cease.
- Provide trails, descriptive literature, and interpretive signs that describe the pilot project.

Phases:
1995: Beginning of the project.
2000: Project initiation. Although the grant for the Marana High Plains project was provided in 1996, problems with staffing and permitting delayed the initiation.
July 2000: Development of a facility concept design; preparation of construction plans, vegetation plans, and a monitoring plan.
Dec 2001: Revegetation of the area and development of an educational interpretive displays and final trail design plans.
March 2001- May 2002: Construction of the recharge basins.
Sept 2002-March 2005: Pilot phase.

Current phase:
The results are still being monitored, and the PCRFCD keeps trying to improve the facility. A new permit was recently granted to operate the facility for 20 more years.

Recommended or Implemented Plan:
As constructed, the facility consists of one settling basin and four spreading basins covering a total of 4.2 acres, which were designed to recharge up to 600 acre-feet of water per year.
The discharged effluent flows about 10 to 15 miles before reaching a pre-existing berm constructed of streambed materials that diverts a portion of it into the "oxbow" channel, a remnant channel of the Santa Cruz River from when the riverbed was less incised and the channel meandered back and forth across the floodplain.
The effluent then flows about one mile down the oxbow channel before reaching a constructed wetwell from which two non-clogging submersible pumps convey it into an equalization basin. The equalization basin is used to provide a more constant source of effluent for recharge and to help serve as a settling basin for removing particulate materials that could clog the recharge cells. From the equalization basin, the effluent passes through an isolation valve into the main distribution line, which feeds into four recharge cells through motorized valves.
Deliveries to the facility are impacted by storm water events in the Santa Cruz River, that demolish the earthen diversion structure used to divert flows into the oxbow channel. The diversion structure must be rebuilt in order to resume the flows to the project. On the other hand, the vegetation along the channel is maintained by the relatively stable influx of surface water that is diverted into the channel, and is protected from large erosive flows that tend to wash out vegetation along the main channel of the Santa Cruz River in this area.

Some basins have side slopes vegetated with emergent plants and riparian trees, and others are fully vegetated with native shrubs and grasses tolerant of periodic inundation. The area outside the recharge basins was revegetated with plants (1.5-2 acres) to improve wildlife habitat value and which, once established, could survive if recharge activities cease. The effluent flowing down the Oxbow channel adds a considerable expanse of lush riparian habitat, including willow, cottonwood and mesquite trees.
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Monitoring/Management:
- Daily inflows into the project and into each of the individual recharge cells are monitored to determine the number of recharge credits available through the facility's Water Storage and Recovery Well Permits, as well as to comply with the facility's Underground Storage Facility Permit.

- Monthly water quality sampling is performed to comply with the facility's Aquifer Protection Permit and to study the cleansing effects of soil and vegetation.
- In addition, biological studies are being performed to monitor the diversity of vegetation species and increased canopy cover of vegetation at the recharge site. Biological studies are also attempting to determine the project's impact on surrounding terrestrial and aquatic wildlife.

In November 2002 a contract was entered into with BKW Farms, Inc. to perform the weekly operation and maintenance at the recharge facility, however, PCRFCD still performs the major repairs on site and is responsible for vegetation maintenance.

Results have indicated that there is no significant difference between treatments for infiltration rates. In conclusion: you can vegetate basins on side slope without impacting infiltration rates.

Funding and Cost:
- $600,000 from BOR for recharge aspect
- $149,973 from AWPF grant for riparian restoration.

Operation costs over the 2003 calendar year were approximately $28,000.

Land Ownership:
State of Arizona. The PCRFCD has a lease for the land through May 2, 2011.

Water:
Effluent water is discharged from Roger Road and Ina Road wastewater treatment plants into the Santa Cruz; a berm is then used to divert some of the effluent from the main channel of the Santa Cruz to the site. The effluent flows down the Oxbow channel about 1.2 miles before reaching the recharge site. The effluent creates one of the densest riparian habitats on the Santa Cruz River as it flows to the recharge basin.

The project is permited by Arizona Department of Water Resources (ADWR) to recharge up to 600 acre-feet per year. Right now the facility recharges 350 acre-feet per year, some improvement will be made to increase the infiltration rate, however the 600 acres of the first plan were a little over estimated. The current infiltration rate in the basins is 2.3 – 3 feet per day at best; the rates start at 3-4 feet/day for one or two weeks after drying of the basins, then go down.

A drip irrigation system was installed for the three first years, rainwater harvesting is now the only irrigation used.

Public Outreach:
The educational element was included in this project according to PCRFCD policy. As part of the project, trails were built around the area and a series of interpretive signs describing the recharge process, a history of the Santa Cruz River area, and riparian vegetation were installed.

The site is not currently open to the general public; however, a number of tours have been

conducted. At this time the site gates are locked in order to prevent vandalism. The Flood Control District would like to develop outreach by having more visitors on the site.

Challenges/Lessons Learned:
The Marana High Plains project faced a number of challenges associated with getting the water from the main channel of the Santa Cruz River to the project site.

The permits for recharge activities were difficult to obtain because of the nearby Tangerine Landfill. A "worst case model" was used to show that the water table would not reach the landfill.

The berm, used to divert water from the Santa Cruz River to the remnant channel as currently designed, cannot withstand flows of more than 500 cubic feet per second and is frequently washed out from flooding. Once the berm is washed out the PCRFCD must wait for the area to dry before they can rebuild it. During the monsoon and winter storms the PCRFCD is unable to repair the berm for months at a time because of successive storms.

Another problem that has been encountered at the Marana High Plains site is the effectiveness of the pumps installed to move water from the channel into the recharge basins. Frequently these pumps cannot keep up with the volume of water coming into the system and therefore hinder the amount of water that can be recharged. Gravity-fed canals and weirs were initially considered; however, it was decided not to use this method because it would have been necessary to remove a large portion of riparian vegetation to construct the canals and weirs, and it was initially more expensive than the pumps.

The project also faced the dual challenge of staff turnover and sufficient staffing to devote the time necessary to the project. These problems made it difficult to move forward because every time a new person came onto the project they had to learn anew about how best to proceed. The situation was further complicated by the fact that this was PCRFCD's first recharge project and therefore there was no expertise in the agency for this type of work.

Another institutional issue has been securing consultants to do the work on the site. The process for obtaining outside consultants can take months and so, because of staff time constraints, all of the work done on site was through existing contracts through Pima County. This has caused problems because the consultants used are not directly accountable to the project and often are not the best suited for the job. For example, the project has experienced a number of electrical problems and the electricians sent out by the County are not necessarily experienced in repairs of the type of equipment that is on the Marana High Plains site.

Drivers:
Multi-purpose/multi-function project, intended to improve habitat for rare species in the area and to be used as a recreational and educational public facility. Funding was available for an artificial recharge project to compensate for depletion due to groundwater pumping in the Tucson area. Additionally, PCRFCD was interested in investigating whether a constructed recharge facility could create riparian benefits.

Contact:
Frank Postillion, Chief Hydrologist, Water Resources Division, Pima County Regional Flood Control District.

Sources :

- *Marana High Plains effluent Recharge Project, Preliminary Evaluation of a Multi-purpose Pilot Recharge Facility*, september 2004
- *Multipurpose Recharge facilities boon or bane,* June 2005
- http://rfcd.pima.gov/projects/maranahighplains/pdfs/maranahpfacts.pdf

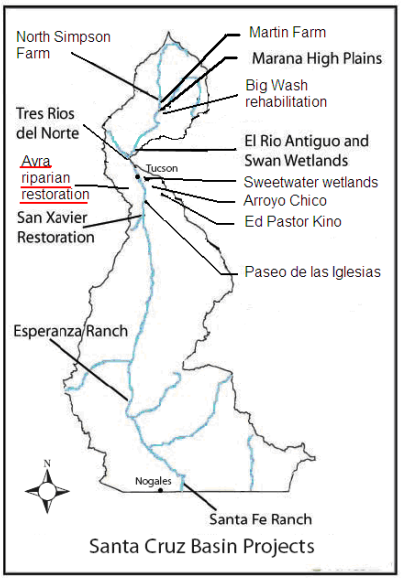
Marana High Plains oxbow channel, March 2004.

Saltbush planted north of Recharge Cell 2, April 2004

Aerial Photograph of Oxbow Basin

AVRA RIPARIAN RESTORATION AND GROUNDWATER REPLENISHMENT PROJECT

Effluent recharge with riparian enhancement



Location and Size:
The Pima County Avra Valley Wastewater Treatment Facility (AVWWTF) is located 20 miles southwest of Tucson in southern Avra Valley.
The project encompasses approximately 50 acres of ponds with riparian vegetation on the edge.

Sponsors:
- Pima County
- Pima County Regional Flood Control District (PCRFCD)
- Pima County Regional Reclamation Department (PCRRD)

Members of the Natural Resources Parks and Recreation, U.S. Fish and Wildlife and the TAS met to develop project goals and objectives.

History:
The Pima County Avra Valley Wastewater Treatment Facility (AVWWTF) site currently produces 1.2 million gallons per day (mgd) of wastewater.
Most of the effluent produced is released into several percolation ponds. At times, water cannons are used to dispose of excess water to nearby cottonwood trees or to the Black Wash. The availability of water has made the treatment facility a haven for migratory birds. As a result, birders have made Avra Valley Wastewater Treatment Facility a well-know destination for observing migratory birds and the site is listed in "Finding Birds in Southeast Arizona," a Tucson Audubon Society (TAS) publication.

The Avra Valley/Black Wash area of Pima County has exceptional environmental values, and is undergoing rapid population growth and corresponding needs for wastewater infrastructure expansion. The current Avra Valley facility capacity must be expanded to meet projected increases in flow. The opportunities to support and further enhance habitat values on PCRFCD lands adjacent to the treatment plant, would be significantly increased by utilizing this water available from the treatment plant.

Planning Objectives:
- Recharge effluent water in the aquifer
- Enhance riparian habitat
- Create recreational and wildlife viewing opportunities
- Establish the area as an educational site for the sustainable use of water resources, habitat conservation and restoration consistent with the Sonoran Desert Conservation Plan

Phases:

2007: The 4.0 mgd expansion of the Avra Valley Wastewater Treatment Facility was approved by the Pima County Board of Supervisors as part of the Department's Capital Improvement Program.
May 2008: Ecosystem Evaluation and Restoration feasibility Study done by RECON Environmental for PCRFCD to evaluate existing conditions of Pima County properties in the vicinity of the AVWWTF.

Current phase and Future Plans:
Planning phase, but stakeholders haven't met in the last two years.

Recommended or Implemented Plan:
- Expand the current 1.2 mgd wastewater treatment facility to 4 mgd capacity to meet Arizona Water-Quality Standards.
- Create riparian and aquatic habitat.
- Recharge the maximum amount of reclaimed effluent to ponds and Black Wash, while maintaining the planned wildlife and riparian habitat restoration and protection.

Monitoring/Management:
Not determined yet.

Funding and Cost:
The 2004 Revenue Bond Authorization for Pima County has been amended to allocate $25 million to the expansion of the Avra Valley Wastewater Treatment Facility. House Bill 1503 may fund up to $14M. These project bonds will be sold as needed to finance the expansion.
PCRFCD estimates $3 million will be needed from bonds and Riparian Mitigation Funds for off-site restoration.

Land Ownership:
The AVWWTF is owned and operated by Pima County Regional Wastewater Reclamation department. Parcels to the west, northwest and southwest of the AVWWTF are owned and controlled by PCRFCD.

Water:
Water used for the project is class A+ effluent from the treatment plant. The plant currently treats approximately 1,300 acre-feet per year and recharges approximately 1,100 acre-feet per year. PCRFCD is requesting 10% of the total effluent produced for riparian restoration on its land to the west. At full capacity, the Facility will treat 4,500 acre-feet per year and will recharge approximately 4,000 acre-feet per year. 200-400 acre-feet per year will go to riparian restoration on PCRFCD lands to the west, southwest and northwest.

Public Outreach:
The plan will include environmental education and other outdoor recreational activities such as wildlife watching.

Lessons learned/Challenges:
The project actually faces many political and stakeholder issues.
Discharge of effluent into the Black Wash was an issue during planning; Tucson Water agreed to the use effluent for riparian restoration on land downstream of AVWWTF, provided it would not reach their land farther west.

Muti-purpose facilities also face the challenge of acquiring all the necessary permits for recharge facilities, and have to support the high cost of testing before recharging.

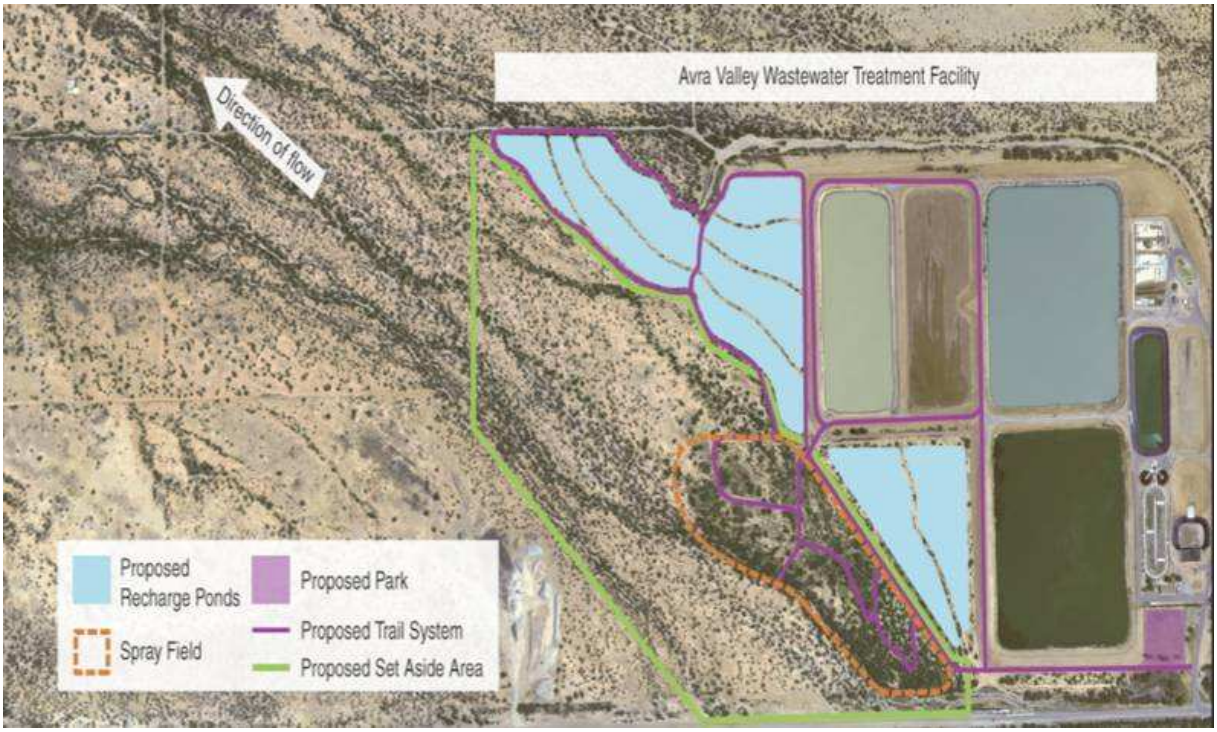
Drivers:
A unique opportunity to incorporate environmental restoration and enhancement with the expansion of a rural wastewater treatment facility.

Sources:
- *Avra Riparian Restoration and Groundwater Replenishment Project* (pdf available on the PCRFCD web site)
- *Avra Valley–Black Wash Ecosystem Evaluation and Restoration Feasibility Study*, by RECON Environmental, Inc.
- Responses to Questions from The House Committee on Natural Resources Subcommittee on Water and Power Testimony Given on May 17, 2007 by Michael Gritzuk, P.E., Director of Pima County Wastewater Management Department, Tucson, Arizona

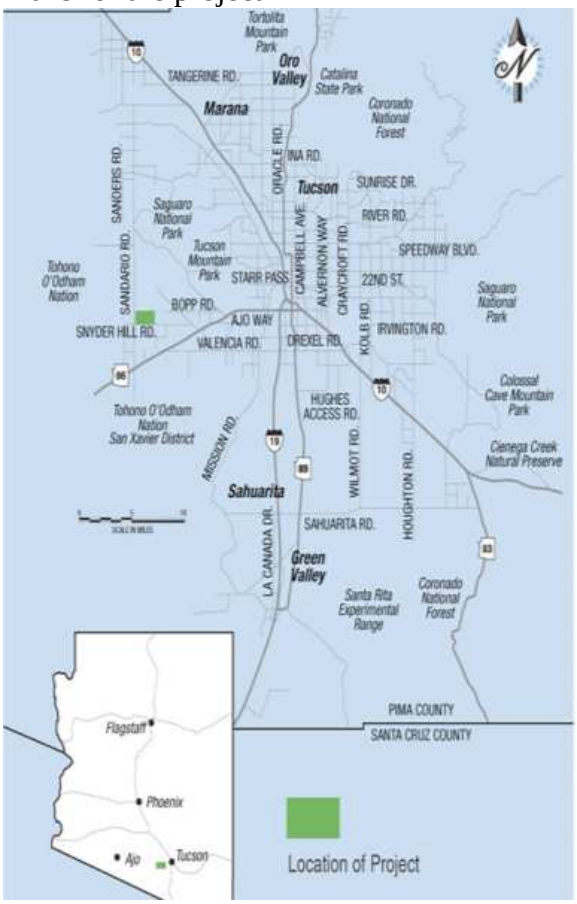
Contact:
Frank Postillion, Chief Hydrologist, Water Resources Division, Pima County Regional Flood Control District.


Percolation pond, with Tucson mountains in the background


Permeable channel on the Black Wash

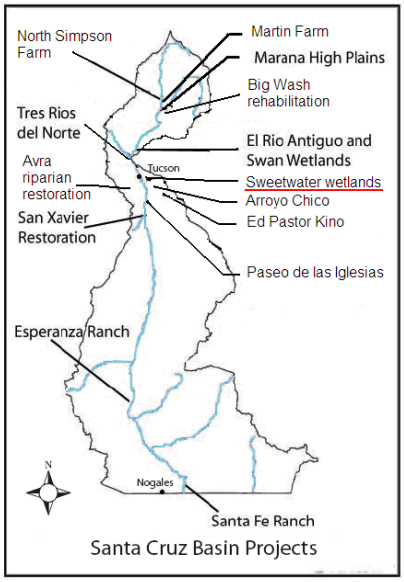


Plans for the project



SWEETWATER WETLANDS

Wastewater treatment and effluent recharge with riparian enhancement



Location and Size:
The project encompasses 109 acres with 17.3 acres of constructed wetlands in Tucson, east of the Santa Cruz River.

Sponsors:
- City of Tucson

History:
In November 1993, the Arizona Department of Environmental Quality (ADEQ) issued the City of Tucson a letter of warning citing 24 violations of state drinking water laws and rules. ADEQ then filed suit in May 1994 and Tucson, which did not admit to any wrongdoing, settled in July 1994. As part of the settlement, Tucson agreed to pay between $300,000 and $400,000 to create a wetland utilizing backwash water used to clean filters at the Tucson Reclaimed Water Treatment Plant.
Construction began on the Sweetwater Wetlands in June 1996 and the facility was opened to the public two years later in March 1998.

Planning Objectives:
The consent agreement signed with ADEQ required 3 principal actions:
- Address the backwash issue
- Create wildlife habitat
- Provide public education.

Phases:
1984-1989: Demonstration phase, to determine the hydrologic feasibility of aquifer recharge and recovery, and the impacts of recharge on aquifer water quality and water levels. Construction of a group of 4 recharge basins.
1989-1997: Development phase, after the success of the first phase and granting of the necessary permits. As a condition of a judicial consent order issued by ADEQ, Tucson Water agreed to construct a wetland facility at the Sweetwater Recharge Facility. The wetlands were conceptualized to provide broad community benefits in addition to their core purpose of treating backwash water. In 1996, construction began on the wetlands as well as on four additional recharge basins (East bank).
1997-today: Full-Scale phase
The wetlands were completed and opened to the public in March 1998.

Current Phase and Future Plans:
Monitoring and maintenance. Recently, work was done for mosquito control.
Tucson Water evaluated operational changes to develop more recharge capacity out of the existing facility. By increasing the wet-cycle flooding depth, increasing basin delivery flow rates, and increasing the frequency of basin bottom ripping, a 35% increase in annual recharge capacity is projected.

A project to expand recharge facilities was also presented; it has been suspended for lack of funding.

Recommended or Implemented Plan:
The backwash water is filtered by cattail and bulrush colonies throughout the wetland. By design, the settling basins and wetland ponds are situated over a natural clay layer that minimizes infiltration during wetland treatment. However, recharge basins are placed on more permeable soils where infiltration rates are higher.
The various wetland components rely on gravity flow to convey water from one point to another along the various flow paths.

Monitoring/Management:
The principal focus of monitoring and management of Sweetwater Wetlands revolves around containment and control of the mosquito population. Mosquito management is conducted through the application of larvacide to the vegetated areas on a weekly basis for about 36 weeks per year. The larvacide used is rotated periodically to prevent the mosquitoes from developing a resistance. Adulticide is used only when the number of mosquitoes rises above a certain threshold. Mosquito counts are conducted regularly.

Vegetation management at the wetlands consists of controlling bulrush and cattail overgrowth. After a few seasons, both species will die out, causing a dense thatch to form in the wetland ponds which affects the wetland's ability to filter water. To remove the thatches of bulrush and cattail, Tucson Water has instituted a controlled burn program with a strategy of burning a third of the wetlands every third year. This strategy retains a balance between providing habitat for migratory birds and the maintenance of the system.

Water quality is measured at eight sampling points throughout the wetlands as well as at the source of water for the wetlands.

Funding and Cost:
- Project cost amounted to approximately $1.6 million which was paid for by bonds approved by the voters in the City of Tucson.
- Annual maintenance cost for the wetlands is $72,000.

Water:
The wetlands process approximately 1.2 million gallons per day of secondary effluent and filtered backwash water.
The adjoining recharge facility recharged about 57,000 acre-feet between October 1986 and May 2005. The recharge rate is approximately 1.5 feet/day. 8-10 percent is water from the wetlands. The remaining water used for recharge is secondary treated effluent.

Public Outreach:
The community was involved in the planning and designing of this project through the Citizens' Wetlands/Recharge Advisory Committee, with members appointed by the Mayor and Council of Tucson.
A Wetlands/Recharge Educational Outreach Program was established that produced an official wetlands logo designed by local students.

Lessons Learned/Challenges:
- Removal of the overgrown cattail and bulrush:

The maintenance team first tried to remove the vegetation using mechanical means. This process was problematic, however, because in order to get the equipment into the areas that needed to be thinned, the wetland area had to be completely dried out. Once the machines were in the area and had removed the vegetation, it was then necessary to remove and dispose of the material. Tucson Water found that it was much more efficient to burn about one-third of the wetlands each year to control overgrowth. Burning the vegetation eliminates the need for drying the ponds as well as hauling away debris. These burns do not require a permit from the Arizona Department of Environmental Quality and are used as wildland fire training for the Tucson Fire Department.

- Mosquito control:
Three different technologies have been employed to apply granular larvicide: using a land-based, truck-mounted hydro-seeder, a tracked, aquatic water craft with a seed spreader, and a remote controlled helicopter.
Tucson Water staff found that the truck-mounted hydro seeder was unable to broadcast the larvacide beyond 100 feet from the edge, and the wetlands were up to 400 feet across in some areas. The tracked aquatic water craft could traverse the cattail and bulrush but could only disperse the granular larvacide in a 30-foot swath. The best solution was a remote controlled helicopter that was able to cover the entire wetland area in less than two hours but it was removed by the Department of Homeland Security.

- Designing the ponds so that some of the pools can be drained while leaving others full has proved to be a valuable element of the design. For example, during an outbreak of avian botulism, operation crews contained the epidemic by draining the ponds in the areas most affected by the disease. At the same time, other ponds remained full in adjacent areas providing undisrupted habitat.

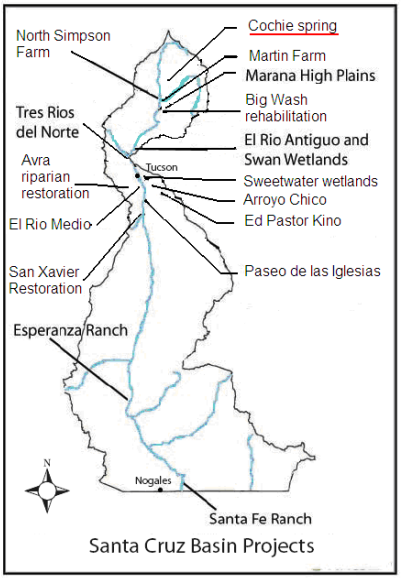
Drivers:
Multiple use wetland-treatment facility, research, public education, and passive recreation.
Initial funding and minimum project requirements for a wetlands project were established through a settlement between the City of Tucson and the Arizona Department of Environmental Quality over alleged drinking water quality violations.

Sources:
www.watereuse.org/files/images/Sweetwaterat20.pdf
http://www.ci.tucson.az.us/water/sweetwater.htm

Contact:
Joaquim Delgado (Tucson Water)
Bruce Prior (Tucson Water)

COCHIE SPRING

Habitat restoration



Location and size:
Homestead site in the Tortolita Mountains, around spring and wash. The project encompasses approximately 10 acres.

Sponsors:
- Tucson Audubon Society (TAS)
- Pima County
- U.S Army Corps of Engineers (USACE)

Under an agreement with Pima County, Tucson Audubon has done the restoration work.
USACE is providing funding.

History:
This site is a historic homestead owned by Pima County, which was degraded by trash and cattle grazing. USACE gave TAS mitigation checks from 404 permits (Clean Water Act). The first check came from the Phoenix USACE office, from a development in Pinal County. The money had to be spent in Pinal County, this site is right at the border between Pinal and Pima County.

Planning Objectives:
Habitat restoration and enhancement.

Phases:
Early 2002: agreement and planning phase
2004-2007: restoration work and irrigation

Current Phase and Future Plans:
The project is completed, monitoring is ongoing and there is still a little clean up work left.

Recommended or Implemented Plan:
- Cattle were fenced out, TAS worked with the county to have it fenced. The fence was a success and prevented cattle from eating young native plants.
- TAS cooperated in trash cleanup with county personnel
- Appropriate plants were planted along the wash and irrigated for the first two years.

.
Monitoring/ Management :
- Photo Monitoring
- Bird counts

Funding and Cost:
The USACE gave TAS three mitigation checks
Money for fencing was given by the US Fish and Wildlife Service

Land Ownership:

Pima County

Water:
Mostly storm water which comes down the wash.
Groundwater from a rancher's well was used during the first three years.

Public Outreach:
This site is posted no trespassing, and can be accessed only during official Tucson Audubon events led by Tucson Audubon staff members.
At the beginning of the project, some interviews were led with the locals to better understand the history of the site.

Lessons Learned/Challenges:
The tamarisk trees growing along the river could not be removed because they are associated with the historic homestead.

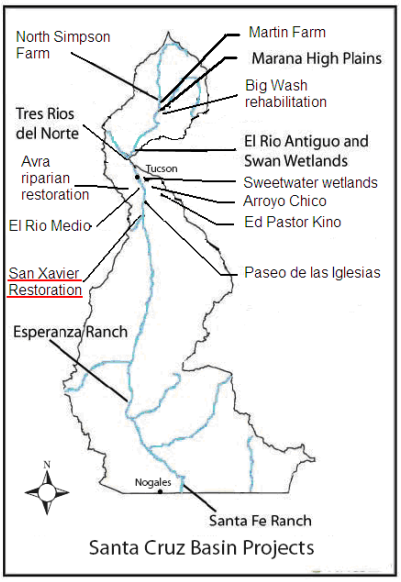
Drivers:
Increase and restore habitat.

Sources:
http://www.tucsonaz.gov/ocsd/community/nature/OCSD%20CommOppsNatureFood2
www.tucsonaudubon.org

Contact:
Kendal Kroesen, Tucson Audubon Society

SAN XAVIER INDIAN RESERVATION RIPARIAN RESTORATION

Habitat restoration



Location and Size:

- Site 1: 12.5 acres, located on the west side of the Santa Cruz River, approximately 0.57 miles southeast of the intersection of San Xavier Road and the I-19 bridge in Pima County.
- Site 2: 5 acres, located 1.5 miles upstream from site one.

Sponsors:

- San Xavier District community
- Arizona Water Protection Fund (AWPF)
- Natural Resource Conservation Service (NRCS)
- Bureau of Reclamation (BOR)
- Sonoran Joint Venture
- U.S. Fish and Wildlife Service (USFWS)

History:

At the turn of the century, the Santa Cruz River flowed perennially through the restoration area, making it unique amongst the restoration projects studied on the Santa Cruz.
At this time, the water table was only 10-15 feet below the surface, and two springs flowed year round creating marshy areas. The vicinity supported a 3,200 acre mesquite bosque, cottonwood-willow groves, and other riparian vegetation.
Groundwater pumping began in earnest in the 1940s and over time has lowered the water table over 100 feet, killing mesquites and riparian vegetation.
In an effort to address growth and environmental concerns in their region, the San Xavier Reservation community adopted a Vision document in 1990 and Land Use Plan in 1992 that developed a long-term plan for riparian restoration on the reservation.
In the two restoration areas, the predominant prior land use was farming by the San Xavier Cooperative Farm.

Planning Objectives:

The overall objectives for riparian restoration on the San Xavier Reservation are:

- Develop an ecosystem approach to resource management for the Reservation and surrounding regions
- Conduct a feasibility study on riparian restoration possibilities on the Reservation
- Enhance and restore riparian vegetation along two arroyos on the Reservation
- Establish a grazing management plan to enhance and restore riparian vegetation

Restoration of the first site began with the process of selecting eligible sites. Objectives for the site selection process included: evaluate and compare the current ecological conditions of the five proposed sites; discuss the ecological changes that had occurred at the sites in recent years and the reasons for these changes; propose a preliminary plan to restore or at lease improve ecological conditions for each of the five sites; develop a budget for each of the proposed restoration plans; and provide a ranking of the five sites proposed for restoration activities.

Objectives for the restoration itself were:

- site 1:
    - Develop a resource management guide that identifies specific appropriate riparian restoration strategies and implement the selected strategies.
- site 2:
    - Re-establish a mesquite bosque plant community;
    - Establish a biologically significant area where tribal members can actively participate in the restoration and management of a desert riparian system;
    - Improve understanding of what restoration strategies can be most effective in bringing back bottomland habitat throughout the Santa Cruz River reach within the San Xavier District.

Phases:

Restoration of site 1, the Wa:k Hikdañ site, was conduced in four phases:
Spring 1999-Winter 2000: technical and community assessment and site selection between five potential bottomland restoration sites
Winter 2000-Summer 2002: pre-implementation phase
Summer 2002-Spring 2003: project implementation phase
The final phase is monitoring and maintenance (ongoing)

Site 2 will follow the same four phases with the exception of phase 1 which was completed at the time of Wa:k Hikdañ's restoration.

Current Phase and Future Plans:

Site 1: Restoration activities have been completed and monitoring and maintenance of is ongoing.
Site 2: Restoration is underway.

Recommended or Implemented Plan:

Five sites were reviewed and ranked according to nine ecological and three non-ecological parameters on a scale of 1 to 3 (three highest) with the parameter of meets restoration objective receiving twice as much weight as any other parameter. Examples of other parameters include: depth of saturated soils, livestock impacts, undesirable vegetation, restoration potential, distance to Central Arizona Project (CAP) line, community access, and budget.

Site 1:

- Pre-implementation phase :
    - Selection of the site
    - A thorough ecological assessment that included an assessment of channel morphology, hydrology, vegetation, and land use.
    - Sponsors installed 2,900 feet of cattle exclusion fence, as well as a rock revetment approximately 938 feet long along the eastern edge of the project site for bank stabilization.
    - Construction of a pipeline link from the main CAP pipeline to the project. The original plan was for a six inch diameter pipe; however in the spring of 2002, the San Xavier Cooperative Farm approached the AWPF about using the project pipe to convey water to their fields as well. They offered funding and technical assistance from the Bureau of Reclamation in return for increasing the size of the pipeline to make this possible.

- Implementation phase
    - Removal of undesirable plants (focusing predominantly on the non native tamarisk and tumbleweed)
    - Delineation of the areas to be revegetated according to riparian, mesquite bosque, and wetland zones
    - Installation of irrigation systems
    - Construction of the wetland and revegetation.

Site 2:

- Site preparation : Removal or treatment with herbicide of non-native, invasive vegetation, as well as cutting a small trench along the center portion of the floodplain for irrigation water and plant sites for riparian species
- Irrigation design and installation : irrigation will consist of a main delivery pipeline bringing water from the CAP pipeline to a drip irrigation system at the site similar to the Wa:k Hikdañ site
- Planting the vegetation: revegetation is divided into two zones for design purposes: terrace surfaces and floodplain surfaces. Terrace surfaces will be planted with mesic species such as mesquite, netleaf hackberry, and desert willow, which are plants that can survive in drier environments where depth to saturated soils can be considerable. Floodplain surfaces will be planted with riparian plants that are capable of withstanding frequent high flow events.

Monitoring/Management:

According to the AWPF agreement for both sites, grantee shall:

- develop monitoring and project site maintenance plans
- monitor the operation of the irrigation system for as long as it is in use
- monitor plant performance for at least five years

“The intensity of monitoring efforts will decrease over time until the fifth year after revegetation. The grantee shall fund monitoring and maintenance work conducted after the termination of this agreement.”

Funding and Cost:

Site 1:

Funded by AWPF, NRCS, BOR, and the San Xavier District.

- The total cost of the site selection phase was $184, 260.
- Restoration of site 1 cost $413,432.

Site 2:

- $32,688 from AWPF and
- $37,555 matching funds which came from the San Xavier District Community, the U.S. Fish and Wildlife Service, and Sonoran Joint Venture.

Land Ownership:

The restoration sites are both located on reservation allotted land with a lease administered by the Bureau of Indian Affairs.

Before restoration could begin, permission had to be obtained from all of the allottees. No compensation was initially provided to landowners.

All but two allottees agreed without payment, and these two landowners were provided a one time payment of $500, an amount derived from an appraisal of an adjacent allotment.

Water:
Supplemental water for the project is provided by a diversion of CAP water. The CAP diversion is part of the Southern Arizona Water Right Settlement Act of 1983. The water flows through a created stream and wetland area, nourishing the riparian species and seeping into the aquifer.
The primary use of supplemental water is to recharge a perched aquifer under the site. Exploratory drilling during the feasibility phase showed that the perched aquifer was about 47 feet below the surface and extended to the area under both project sites. It is believed that recharge from the stream and wetland areas will create a mound within several years of implementation. It is feasible that this mound will eventually reach sufficient size to support the riparian plant community with scaled-back irrigation.

Under the agreement with the AWPF, supplemental irrigation and maintenance of the irrigation system is the responsibility of the San Xavier Reservation community.

Despite the long-term water requirement for the wetlands, the majority of the project was designed to survive without irrigation (after initial establishment). "A significant portion of the site is occupied by deciduous riparian and mesquite bosques plant communities, which will hopefully be able to survive with out long-term inputs of artificial water."

This project was the first to use CAP water in the Tucson basin for riparian restoration and laid the groundwork for the use of as much as 50,000 acre-feet of CAP water for restoration purposes on the Reservation in the years following project.

Public Outreach:
Quarterly project updates were published in the Wa:k Community newsletter as well as an annual project newsletter for the San Xavier District community members. "In the case of the San Xavier revegetation effort, the restoration project is considered critical to not only meeting documented goals, but also of tantamount importance to many elders and other community members who would like to see a semblance of how the Santa Cruz River used to be before it was affected by human impacts." "The [Citizen's Steering] Committee was particularly effective in obtaining information from community elders on past site conditions, the plant and water conditions that they saw along the Santa Cruz River in Wa:k Hikdañ, their youth, and their ideas as to how the Wa:k Hikdañ should look when completed."

Lessons Learned/Challenges:
- Formation of a citizen steering committee to guide the project's implementation was critical to its success. Initially, they encountered problems with attendance and achieving quorum for monthly meetings. This problem was remedied in part by providing stipends and dinner to attendees.

- When developing restoration efforts on allottee land, a considerable amount of time should be allocated to the pre-implementation phase to obtain the necessary signatures and permission from land allottees, many of whom no longer live near the Wa:k Hikdañ restoration site.

- Additional water provided for restoration attracted both desirable and undesirable animals.

- The significant time and money invested in the construction of the fence proved critical in realizing restoration objectives.

- Be careful to include everything from the official plan in the bid plans. The restoration team ran into problems when the final pipeline design did not include several design features that were included in the Standards and Specs, but not drawn on the pipeline plans, and the contractor did not include them in his bid.

- Planting during the hot months of June through September can cause the black plant containers to heat up to significant temperatures in the mid-day sun, potentially cooking the roots of the plants and killing the plant before it is put in the ground. They found that plant containers of one-gallon and five-gallon sizes were not as vulnerable to this threat as were seedlings grown in long and narrow tubex tubes that encourage the development of long tap roots, and skinny seedlings. Trees grown with the tubes in the nursery had a high rate of survival when planted in the ground; however, they will not survive if they are subject to extreme heat or sun prior to planting.

- Removing non-natives from the site is critical to overall project success, yet it is one of the most tedious and difficult activities to perform. Several strategies were useful in improving the effectiveness of weeding as well as maintaining the energy of maintenance staff. Examples of these strategies are: developing a schedule where groundskeepers focus on only one particular part of the restoration site during any given day, which helped to concentrate the work and maintain the focus of the groundskeepers; focus weeding only in planted areas with the goal of reducing competition, giving planted vegetation more of a chance to survive the critical first year following planting; and bringing in temporary laborers to assist groundskeepers in weeding parts of the site where weeds are particularly problematic.

- Another challenge faced was the large turnover of maintenance staff. To combat this problem, the restoration team has implemented several strategies designed to maintain the interest and energy of the groundskeeper team including field trips, training activities, and participation of other staff and technical consultants in various aspects of the work.
Conducting 'weeding days' where consultants and staff help groundskeepers to remove undesirable vegetation has been particularly helpful in maintaining a team spirit and interest of the groundskeepers.

- Finally, the project ran into problems when in June 2003, the controllers on the irrigation system all failed within a matter of days of each other. The irrigation system was down for several days before the problem was discovered, and close to 10% of the trees in the affected areas died. As a result, the irrigation maintenance schedule was altered to include performance checks of all irrigation programs and weekly tests of the controllers. The restoration team notes that providing additional training in irrigation maintenance after revegetation was finished may have prevented the irrigation system's failure from significantly affecting plantings.

- The restoration team also noted the importance of post-implementation maintenance, monitoring, and evaluation activities. They assert that the project would not have succeeded without diligent weeding, replacement of dead plants, and irrigation system maintenance. Mark Briggs of Briggs Restoration recommends that 20% of the entire budget of project be

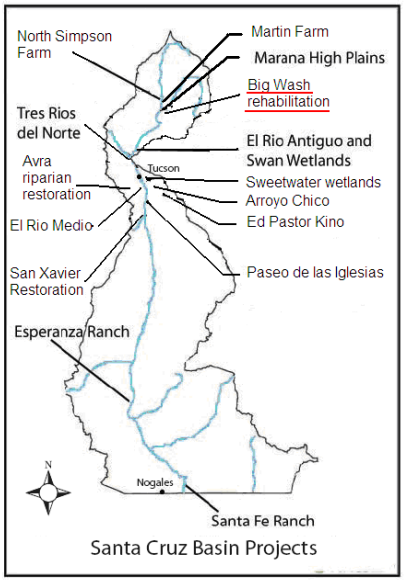
devoted to these post- implementation activities.

Drivers:
San Xavier Community created a visioning document where one of the primary objectives was riparian restoration. "One of the other principal reasons for implementing this project [aside from restoration of habitat] was the San Xavier community's desire to create an area for residents to visit for low intensity recreational uses, such as walking, contemplation, and observing wildlife."

Sources:
1996 San Xavier Indian Reservation grant application to Arizona Water Protection Fund

THE BIG WASH REHABILITATION PROJECT

Habitat restoration



Location and Size:

The proposed Oro Valley Marketplace and adjacent rehabilitation site are located in the Town of Oro Valley, at the southwest corner of Oracle Road (Highway 77) and Tangerine Road.

The site is located in the Big Wash floodplain, just upstream of the Cañada del Oro Wash. Land use in the surrounding area consists of residential development to the west, a hospital to the north, and Catalina State Park and residential to the east.

Sponsors:

- Pima County
- Vestar corporation

History:

Oro Valley voters recently approved a proposal to build an 800,000 sq. ft. commercial development that will include a retail center and a movie theater. As part of a previous agreement, unrelated to the commercial development, the Vestar Corporation is required to restore a former farm field that is owned by Pima County.

Currently, the rehabilitation site is primarily retired agricultural land and degraded mesquite woodland. The farm field contains annual grasses and forbs. In the recent past, much of the site has been bladed or disked to reduce the fire risk the dried annuals present.

Planning Objectives:

The goal of the rehabilitation project is to replace the low diversity vegetation with a diverse mix of native vegetation based on characteristics of near-by natural reference sites.

The project proposes to create a self sustaining ecological system that will be similar in hydrology, topography and vegetation to what is found in the undeveloped portions of the Big Wash floodplain.

Phases:

No information available.

Current Phase and Future Plans:

Pending project

Recommended or Implemented Plan:

Transects across sections of Big Wash were used as reference plots to guide what might be appropriate vegetation and site contours for the rehabilitation area.

Plant species used in the project will be similar to the species found in the reference sites. Planted and preserved-in-place trees will include velvet mesquite, whitethorn acacia, palo verde, cat claw acacia, and others. A mix of mid and understory species will be used to create a diverse xeroriparian community.

Funding and Cost:

No information available

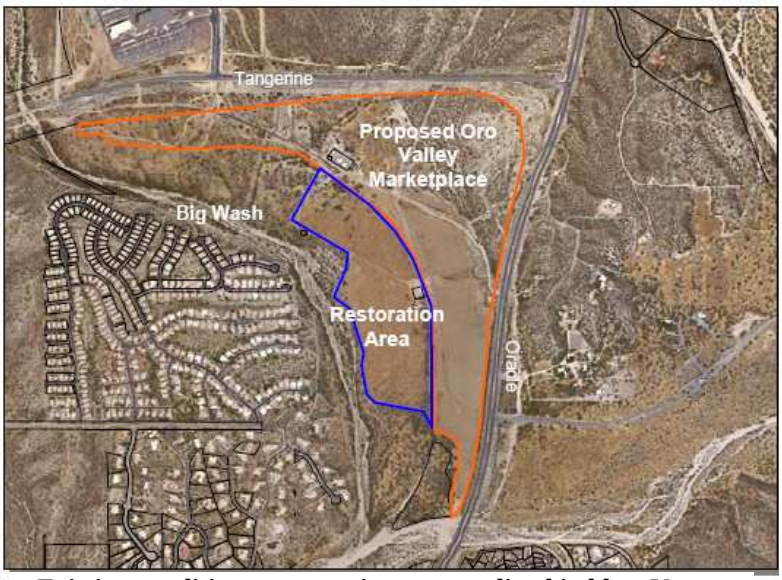
Land Ownership:
Pima County

Water:
- The project will contour the site to capture water from several small tributaries and from storm water runoff generated from the impervious surfaces of Oro Valley Marketplace. The water will flow through a network of streambed channels intended to encourage the establishment of similar topography naturally occurring in the reference sites.
- Initially, the vegetation will be irrigated; as the vegetation matures and is established, supplemental irrigation will no longer be necessary.

Lessons Learned/Challenges:
The Vestar Corporation plans on constructing a retail center adjacent to the rehabilitation site. As part of the commercial development, Vestar is allowed to remove some fill material from the site. The removal of material would allow more frequent inundation of the rehabilitation site by Big Wash. Plans have not been finalized for the fill removal, and the rehabilitation plans are on hold until the details are worked out.

Drivers:
Create a self sustainable native ecological system and enhance riparian habitat.

Sources:
PCRFCD projects: *« Sonoran DesertConservation Plan »Bigwash* pdf



Existing conditions: restoration area outlined in blue, Vestar development outlined in red.

View of retired agricultural field targeted for rehabilitation

View looking upstream of Big Wash

CORTARO MESQUITE BOSQUE

Habitat restoration

Location and size:
80-acre in northwest Tucson located along the west side of the Santa Cruz River near Continental Ranch (near the north end of the Tucson Mountains).

Sponsors:
Pima County Regional Flood Control District

History:
The river here has an effluent dependent strip of riparian vegetation, and the adjacent project area has the potential to widen existing habitat.

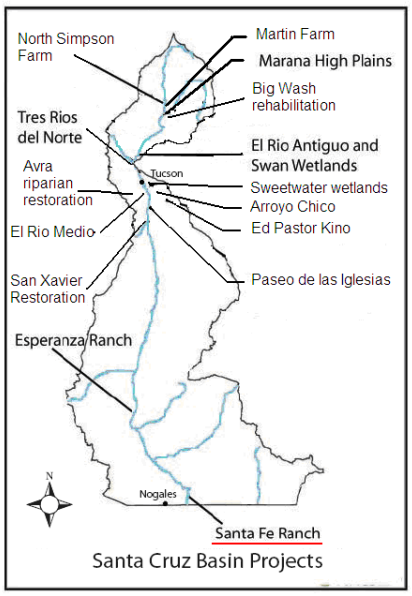
Planning Objectives:
The goal of the project is to increase vegetation structure and biological diversity of the floodplain and provide wildlife habitat, for- age, and nesting area for birds.

Phases:
No information available.

Recommended or implemented plan:
The plan involves islands of five planting zones of vegetation, separated by areas planted primarily in native grasses. The grassland areas separating the planting zones provide extended edge habitat preferred by many neo-tropical migrants and endemic birds. The planting zones consist of vegetation communities of cottonwood/willow, riparian mesquite bosque, riparian grassland/willow, xeroriparian mesquite bosque, and upland/grassland areas. Plant material is being grown for the project by the Pima County Native Plant Nursery from local seed sources.

SANTA FE RANCH RIPARIAN RESTORATION

Erosion control and riparian restoration from flood damage



Location and Size:
The project is located five miles north of Nogales in Santa Cruz County and encompasses 1,200 feet of river, through a 10-acre project area.

Sponsors

- Coronado Resource Conservation and Development Area, Inc.
- Arizona Water Protection Fund (AWPF)
- Arizona Department of Environmental Quality (ADEQ)
- Natural Resources Conservation Service (NRCS)

History:
In 1967 a flood destroyed mature cottonwoods and other riparian vegetation in the Santa Fe Ranch section of the Santa Cruz River. The storm left timber and large rocks piled in the river channel, causing storm water to flood out onto adjacent pasture, eroding tons of topsoil and removing vegetation from those areas that served as buffers and habitat. The project area continued along a downward trend in condition until the initiation of this restoration project.

Planning Objectives:
The goal of the Santa Fe Ranch Riparian Restoration project is to re-establish a corridor of historic vegetation on a segment of the Santa Cruz River that will create diverse habitat and reduce stream bank erosion.
The three objectives are:

- Erosion control
- Revegetation of the area
- Increased public awareness of riparian systems and values.

Phases:
2000: grant from ADEQ to install Kellner Jacks205 (Jetty Jacks) to stop further erosion and trap sediment.
March 2004: revegetation of the area through use of pole plantings.
Sept 2002 – Sept. 2005: monitoring, outreach and education to provide information to local schools and land users about the value of riparian areas and options in restoration and techniques for monitoring of such projects.

Current Phase:
Monitoring and outreach activities continue on the site.
The final project report for the AWPF was completed in September of 2005.

Recommended or Implemented Plan:
The fencing plan, implemented in October of 2001 included installing fencing between irrigated pasture and the revegetated bank stabilization area to exclude livestock access.

The project also implemented an irrigation plan to provide supplemental irrigation to approximately one acre of the site to establish riparian vegetation. The system was used during establishment of trees, shrubs forbs and grasses in a 60 feet wide 700 feet long area. The irrigation schedule during peak use (May and June) is to operate the system for 24 hours every 2.5 days.
The revegetation plan designated three planting zones: the floodplain, the scarp (which is the transition zone between upland area and floodplain), and the upland area.

Monitoring/Management:
Monitoring activities are focused on determining survivability of pole planting used for revegetation on severely eroded area and to determine the overall benefits of restoring riparian corridors. In order to determine this, the sponsors established a database of baseline conditions using survey and photographic methods. This database included information on plant counts, corresponding well data, and gauging station data from the Arizona Department of Water Resources and United States Geological Survey.

After revegetation, the project site was inspected at least on a weekly basis by Santa Fe Ranch personnel. Weekly inspections included: inspecting fencing for breaks or gaps, inspecting the irrigation system for breaks or malfunctions, and observations of plant materials for overall vigor and health.

Monitoring also included replacement of dead trees or shrubs and control of invasive species until the revegetated site was decided to be in fully functional condition.
According to the May 2005 report to AWPF, the survival rate of willow is 57% and mesquite 63% (35 plantings for each species were conducted originally).
Under the agreement with the AWPF, the operation and maintenance period for grant-assisted fencing construction is 15 years following completion of the structure; for all other grant-assisted structures, the operation and maintenance period is 20 years.

Funding and Cost:
-$49,008 from AWPF
-$13,996 from NRCS
-$5,063 in matching funds
-The project also received funding from an ADEQ 319(h) grant to install the Kellner Jacks and erosion control structures.

Land Ownership:
Private (Sedgewick family)

Water:
Competing land interests such as a County road on the west side and irrigated pastures on the east side of the river forced NRCS to propose a stream corridor that is less than ideal.
The ideal corridor would contain the stream, its banks, the floodplain, and the valley slopes. The proposed corridor will create a pattern of habitat that crosses the stream area and flood plain, connecting the riparian areas to the upland areas. The proposed corridor will also function to trap sediment and provide hydraulic storage during floods and will trap organic matter necessary for the health function of the stream system.

Irrigation of riparian plantings comes from a well that is currently being used to irrigate pasture adjacent to the site. Water table levels have not been conducive to pole planting

success at this site.
According to the irrigation plan, the estimated peak irrigation need for 70 trees, 130 shrubs, 1,800 grasses and forbs is 19,950 gallons per day.

Public Outreach:
The project included an Outreach Plan that outlined steps that the restoration team would take to reach individuals in the community. Examples of items in the plan are: a teachers guide to riparian education in desert ecosystems to be used in grades 3 – 8, technical team work with the Nogales High School science class to use the plant nursery at the high school to propagate plants for the project, fact sheets on riparian systems, a power point presentation, and an informational tour for the public and partner agencies of the project site.

Challenges/Lessons Learned:
In a later survey of plantings, other vegetation had grown up around plantings, making it difficult to find/identify them. It was suggested that in the future, all plantings be clearly flagged so that their survival rate could be more easily determined.
The number of cottonwood plantings was reduced during the project because of survival concerns caused by the drought and a lowering of the water table.
At the beginning of the project, the water table was 10- 15 feet below the surface and during the project dropped to 24 feet.

Drivers:
Previous flood events had decimated the system, the primary goal in restoration was to stabilize bank erosion and re-establish a riparian corridor in order to improve water quality.

Appendix B: Sponsor descriptions

The United States Army Corps of Engineers (USACE)

Legal status:
The United States Army Corps of Engineers is part of the U.S. Department of Defense.

Staff/work force:
Approximately 34,600 civilian and 650 military engineers, scientists and other specialists (geologists, hydrologists, natural resource managers), who work hand in hand as leaders in engineering and environmental matters.

Creation date:
The Army established the Corps of Engineers as a separate, permanent branch in 1802.
In the 20th century, the Corps became the lead federal flood control agency and significantly expanded its civil works activities. In the late 1960s, the Corps became an environmental preservation and restoration agency.

Scope/scale of action:
Ecosystem restoration is a relatively new focus for the Corps. The purpose of ecosystem restoration is to re- establish the attributes of a natural, functioning and self- regulating system. The Corps pursues projects involving environmental restoration under multiple congressional authorities.

All projects, regardless of their cost, require a local sponsor.
USACE has both the ability to fund projects and the human resources to implement them and is authorized to provide assistance to States, Tribes, local governments, and non-profit groups for watershed and ecosystem planning and for the design and implementation of restoration projects.
The USACE brings 18 years of experience in ecosystem restoration.

Main activities (in general):
The Corps's mission is to provide public engineering services. Their role in civil works has changed as the needs of the country have changed. Their activities in different areas include:

- Planning, designing, building and operating water resources and other civil works projects (Navigation, Flood Control, Environmental Protection, Disaster Response, etc.)
- Designing and managing the construction of military facilities for the Army and Air Force. (Military Construction)
- Providing design and construction management support for other Defense and federal agencies. (Interagency and International Services).

Goals and interests:
The USACE, working with county flood districts and other local agencies, has been the key federal partner in construction flood control structures to limit property damage due to flooding.
The Water Resources Development Act of 1986 authorizes the agency to participate in

restoration projects that attempt to repair environmental damage done by previous Corps projects.

Projects:

- Tres Rios del Norte
- El Rio Medio
- Paseo de las Iglesias
- North Simpson
- Cochie spring
- Martin Farm
- Ed Pastor Kino Environmental Restoration Project
- Arroyo Chico
- Swan Wetland
- El Rio Antiguo

Funding:

Environmental restoration projects may be undertaken through Sections 1135 and 206 of the Water Resources Development Act (WRDA). The Section 1135 and Section 206 programs each have an annual program limit nationally of $25 million, and each project under either of these sections is limited to a federal contribution of $5 million.
Through its General Investigations (GI) efforts, the Corps participates in individually authorized programs. The investments associated with GI efforts are not so limited, and the federal government typically funds 65 percent of the construction costs.

Funding for the Civil Works programs is authorized through the annual federal Energy and Water budget.

Sources:

http://www.usace.army.mil/Pages/Default.aspx
Arroyo winter 2008-12-02
Environmental restoration in Urban Arizona, *Sharon Megdal July 2005*

BUREAU OF RECLAMATION

Legal status:
Part of the US Department of Interior

Staff/work force:
Federal government paid staff.

Creation date:
The Bureau of Reclamation was established in 1902.

Scope/scale of action:
The Bureau is a federal agency that manages water in the 17 western states.

Main activities (in general):
The Bureau of Reclamation is best known for the dams, power plants, and canals it constructed in the 17 western states. Reclamation has constructed more than 600 dams and reservoirs including Hoover Dam on the Colorado River and Grand Coulee on the Columbia River. The phoenix metropolitan area has benefited from the construction of series of dams and reservoirs that make up the Salt River Project, one of the first projects built by the United States Bureau of Reclamation.
The Central Arizona Project, which brings Colorado River water to the Phoenix and Tucson region, was also built by the BOR.
Today, they are the largest wholesaler of water in the country. They bring water to more than 31 million people, and provide one out of five Western farmers (140,000) with irrigation water for 10 million acres of farmland that produce 60% of the nation's vegetables and 25% of its fruits and nuts.
Reclamation is also the second largest producer of hydroelectric power in the western United States.

Goals and interests:
Reclamation is a contemporary water management agency with numerous programs, initiatives and activities that will help the Western States, Native American Tribes and others meet new water needs and balance the multitude of competing uses of water in the West.

Projects:
- Marana High Plains
- San Xavier Reservation Riparian Restoration

Money:
Federal

Contact:
Carol Erwin

Sources:
http://www.usbr.gov

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT

Legal status :
Pima County Flood Control District is a regional agency

Staff/work force : The District is governed by the Pima County Board of Supervisors, who are designated as the Flood Control District's Board of Directors.

Creation date : PCRFCD was formed as a result of Arizona State legislation passed in 1978. Spurred by a disastrous flood event on the Salt River in the Phoenix metropolitan area, the 1978 legislation mandated that flood control districts be established in all Arizona counties.

Scope/scale of action :
As a regional authority, their projects cross jurisdictional boundaries and occur within the City of Tucson, the Town of Oro Valley, the Town of Marana, and the Town of Sahuarita.

Main objectives :
Provide flood protection and floodplain management services within Pima County.

Main activities :
- Structural Flood Control Facilities : bank stabilization, levees, regional detention basins, bridges and various other drainage facilities.
- Floodprone Land Acquisition : To date, the District has purchased over 7,000 acres of floodprone land, primarily through its Floodprone Land Acquisition Program (FLAP). Land acquisition is undertaken mainly as a means of removing buildings and residents from potential flood hazards. The District has also used this approach to preserve natural floodplain characteristics in upstream areas and to discourage development from taking place in vulnerable locations.
- Floodplain Management
- Flood ALERT System and Emergency Response
-Wherever feasible, Pima County supports riparian restoration in river corridors and floodplains. Several areas now owned by the District have outstanding wildlife habitat values, and are managed specifically to protect ecological values.

Money :
PCRFCD uses bond monies in conjunction with state and federal funding sources to build flood control facilities and to acquire floodprone land

Projects:
- Arroyo Chico Multi-Use Project
- Avra Riparian Restoration and Groundwater Replenishment
- Project Big Wash Rehabilitation
- El Rio Antiguo
- El Rio Medio
- Paseo de las Iglesias
- Tres Rios del Norte

- Cortaro Mesquite Bosque Construction Project
- Kino Environmental Restoration Project (KERP)
- Rillito River/Swan Wetlands Ecosystem Restoration Project
- Marana High Plains Effluent Recharge Project

Source :
http://rfcd.pima.gov/district/funding.htm

CITY OF TUCSON

Legal status:
Public office

Staff/work force:
Paid staff. Office of Conservation and Sustainable Development.

Scope/scale of action:
Local sponsor in a lot of projects. Owns most of the effluent.
The City of Tucson is working with the United States Fish and Wildlife Service to create two Habitat Conservation Plans (HCPs). HCPs help municipalities comply with the Endangered Species Act (ESA) through documenting the occurrence of endangered, threatened, and vulnerable species while also describing conservation strategies to mitigate possible future negative impacts to those species.

Main activities (in general):
Protect and manage city land and resources.
The Office of Conservation and Sustainable Development promotes environmental vision and leadership in the City toward strong environmental protection and sustainable practices. The office oversees development of habitat conservation, ecosystem restoration, and green infrastructure plans that identify how resource protection, sustainability, and quality of life goals will be achieved. It also provides guidance for private developments on environmentally-sensitive and sustainable design while offering a streamlined and clear review process.

Goals and interests:
- Interest of the citizens of Tucson
- Sustainable development in Tucson
- Land and effluent owner

Projects:
- Tres Rios Del Norte
- Paseo de la Iglesias
- El Rio Medio
- North Simpson
- Martin Farm
- Arroyo Chico

Contact:
Ann Audrey (Office of Conservation and Sustainable Development)
ann.audery@tucsonaz.gov

Sources:
www.tucsonaz.gov
www.tucsonaz.gov/ocsd

U.S. FISH AND WILDLIFE SERVICE

Legal status:
Federal Government Agency

Staff/work force:
The USFWS utilizes 8,704 Fill Time Equivalent Employees at facilities across the country including headquarters office in Virginia, 8 regional offices and nearly 700 field offices.

The Service also works with close to 38,000 volunteers contributing in excess of 1.4 million hours. Volunteer opportunities include conducting fish and wildlife population surveys, leading tours and providing information to school groups and other visitors, assisting with laboratory research, improving habitat such as re-establishing native plants along a riverbank, photographing a variety of natural and cultural resources, and other activities.

Creation date:
The Service's origins date back to 1871 when Congress established the U.S. Fish Commission to study the decrease of the nation's food fishes and recommend ways to reverse the decline.

Scope/scale of action:
The U.S. Fish and Wildlife Service is the premier government agency dedicated to the conservation, protection, and enhancement of fish, wildlife and plants, and their habitats. It is the only agency in the federal government whose primary responsibility is management of these important natural resources for the American public. The Service also helps ensure a healthy environment for people through its work benefiting wildlife, and by providing opportunities for Americans to enjoy the outdoors and our shared natural heritage.

Main activities:
The Service is responsible for implementing and enforcing important environmental laws, such as the Endangered Species Act, Migratory Bird Treaty Act, Marine Mammal Protection Act, North American Wetlands Conservation Act, and Lacey Act. The diverse activities and programs aim to:

- protect and recover threatened and endangered species
- monitor and manage migratory birds
- restore nationally significant fisheries
- enforce federal wildlife laws and regulate international wildlife trade
- conserve and restore wildlife habitat such as wetlands
- help foreign governments conserve wildlife through international conservation efforts
- distribute funds to States, territories and tribes for fish and wildlife conservation projects.

The Service also manages the 96 million acre National Wildlife Refuge System. Within the Fisheries program, the Serve operates 70 National Fish Hatcheries.

Goals and interests:
Conserve, protect and enhance fish and wildlife and their habitat for the continuing benefit of the American people.

Projects:

- Avra Riparian Restoration and Groundwater Replenishment Project
- North Simpson Site Riparian Restoration
- San Xavier Indian Reservation Riparian Restoration
- Cochie Spring

Money:
The Fish and Wildlife Service manages funding from 27 distinct Treasury appropriations that total$3.4 billion. This funding is divided between three types of funding: discretionary, permanent and allocations from other agencies.
The Service's fiscal year 2009 budget request was $2.2 billion, which included over $800 million in permanent appropriations apportioned to the states and territories.

Contact:

Sources:
www.fws.gov
http://www.fws.gov/fwsataglance.html

NATURAL RESOURCES CONSERVATION SERVICES

Legal status:
Federal agency: the Natural Resources Conservation Services (NRCS) is a technical Agency of the United States Department of Agriculture.

Staff/work force:
NRCS employees provide technical. Participation in the conservation programs is voluntary. 12,000 employees in nearly 2,900 field offices across the Nation.

Creation date:
NRCS was established in 1935 as the Soil Conservation Service (SCS) to carry out a continuing program of soil and water conservation. The Secretary of Agriculture organized NRCS in 1994. NRCS combines the authorities of the former SCS as well as additional programs that provide financial assistance for natural resource conservation.

Scope/scale of action:
The Conservation Technical Assistance (CTA) program provides voluntary conservation technical assistance to land-users, communities, units of state and local government, and other Federal agencies in planning and implementing conservation systems.

Main activities (in general):
- Manage natural resource conservation programs that provide environmental, societal, financial, and technical benefits.
- Provide technical expertise in such areas as animal husbandry and clean water, ecological sciences, engineering, resource economics, and social sciences.
- Provide technical assistance to foreign governments, and participate in international scientific and technical exchanges.

Goals and interests:
- Assess the resources on the land, the conservation problems and opportunities.
- Draw on various sciences and disciplines and integrate all their contributions into a plan for the whole property.
- Work closely with land users so that the plans for conservation mesh with their objectives.
- Through implementing conservation on individual properties, contribute to the overall quality of the life in the watershed or region.

Projects:
- San Xavier Indian Reservation Riparian Restoration
- Santa Fe Ranch Riparian Restoration

Funds:
Federal

Sources:
http://www.nrcs.usda.gov/

ENVIRONMENTAL PROTECTION AGENCY

Legal status:
Federal Agency

Staff/work force:
EPA employs 17,000 people across the country, including their headquarters offices in Washington, DC, 10 regional offices, and more than a dozen labs. More than half of the staff are engineers, scientists, and policy analysts.

Creation date:
In 1970, the White House and Congress worked together to establish the EPA in response to the growing public demand for cleaner water, air and land. Prior to the establishment of the EPA, the federal government was not structured to make a coordinated attack on the pollutants that harm human health and degrade the environment.

Scope/scale of action:
Nation wide.

Main activities (in general):
-Develop and Enforce Regulation
-Give Grants: half of their budget goes into grants to state environmental programs, non-profits, educational institutions and others.
-Study environmental issues
-Sponsor partnership
-Public information

Goals and interests:
EPA leads the nation's environmental science, research, education and assessment efforts. The mission of the Environmental Protection Agency is to protect human health and the environment. Since 1970, EPA has been working for a cleaner, healthier environment for the American people.

Money:
Federal Money

Project:
Esperanza Ranch

Sources:
http://www.epa.gov/epahome/aboutepa.htm

ARIZONA WATER PROTECTION FUND

Legal status:
AWPF is an administrative agency that does not implement projects.

Staff/work force:
This state run program is administered by a 15-member Commission. Appointments to the Commission are made by the Governor, the president of the Senate and the speaker of the House.

Creation date:
Created in 1994 by the Arizona legislature.

Scope/scale of action:
The program supports the protection and restoration of riparian areas throughout Arizona.

Main activities (in general):
The AWPF is an annual source of monies for the development and implementation of measures to protect water of sufficient quality and quantity to maintain, enhance, and restore rivers and streams and associated riparian habitat.

Goals and interests:
This policy is designed to allow the people of this state to prosper while protecting and restoring this state's rivers and streams and associate

Money:
Monies for Fund use are obtained from three sources. The primary source of funding is from the Arizona State Legislature. Another source of funding is fees collected by the Central Arizona Project (CAP) for each acre-foot of water sold to out-of-state CAP water lessees and purchasers. The third source is private gifts, grants or donations. By statute, the Fund is to receive $5 million annually from the Arizona State legislature.

Projects:
- Esperanza Ranch
- Marana High Plains
- North Simpson Farm
- San Xavier Reservation
- Santa Fe Ranch

Sources:
http://www.awpf.state.az.us/

SAN XAVIER DISTRICT COMUNITY

Legal status:
The San Xavier District (SXD) is one of eleven political subdivisions of the Tohono O'odham Nation. It lies approximately 10 miles south of downtown Tucson, AZ and contains nearly 72,000 acres of Sonoran desert, including a stretch of the ephemeral Santa Cruz River. Its population is approximately 1800.

Staff/work force:
Over the past twenty years, the District government has grown to 80 employees in fourteen departments providing services such as education, health and wellness, elder care, protection of natural and cultural resources, and many others. 69% of staff members are registered members of SXD, an additional 9% are Tohono O'odham from other Districts, 9 % are from other tribes, and only 13% are non-Indian.

Creation date:
The SXD government was formally established in 1937, shortly after the U.S. Congress passed the Indian Reorganization Act (IRA).

Scope/scale of action:
Under the 1968 Indian Self-Determination Act tribes can petition to take over a service or program provided by a federal agency. If the request is approved, the money for the contracted program goes directly to the tribe, bypassing the federal agency. This allows the tribe to provide the program or service directly to its people, rather than relying on the federal agency.

Main activities:
SXD meets many societal needs, including housing, education, environmental and cultural resource protection, law enforcement, health and wellness, and elder care. Clients for all of these services are the enrolled tribal members of the San Xavier community. With fourteen departments, there are many priorities. These can be divided into the clusters of land and natural resources, community and economic development, human resources, and governance. Priority areas for water resources include developing a water management plan and researching large-scale groundwater recharge within the District.

Goals and interests:
The mission of SXD is to promote self-determination and provide a legacy for future generations by guiding, leading, and supporting the community in the protection and preservation of the land, water, air, culture, traditions, knowledge, language, and vitality of community.

Projects:
- San Xavier Indian Reservation Riparian Restoration

Sources:
http://www.waknet.org/history.asp

TUCSON WATER

Legal status:
Tucson Water is a department of the City of Tucson, Arizona and operates as a Public Water Utility serving residential, commercial and industrial customers both within and outside of the City's boundaries. As a public water provider, Tucson Water is regulated under the Safe Drinking Water Act, and all drinking water must meet standards set by the U. S. EPA, the Arizona Department of Environmental Quality, and local ordinance.

Creation date:
Tucson Water has been the City's municipal water utility since 1900.

Scope/scale of action:
Tucson Water serves approximately 775,000 people in a 350-square-mile service area.

Main activities (in general):
Tucson Water has a potable system which mainly delivers water to residential customers.
In 2007, approximately 50% of the potable water delivered by Tucson Water came from the Clearwater Renewable Resource Facility. At this facility, Colorado River water from the Central Arizona Project (CAP water) is delivered to constructed basins on City-owned property in Avra Valley. The water is recharged and mixes with the native groundwater beneath the facility. Production wells recover the blended water, which is delivered to customers in Tucson Water's main system.
Since the mid-1980s, Tucson Water has also operated a separate Reclaimed Water production, storage and delivery system.

Goals and interests:
Water provider.

Money:
Tucson Water is an enterprise fund of the City of Tucson. The utility operates in a manner similar to a private business, covering all costs of doing business with revenues from operations and other water-related funding sources (bonds, property sales, etc). Tucson Water's Fiscal Year (FY) 2008 annual budget was $125 million.

Projects:
Sweetwater Wetland

Sources:
http://www.tucsonaz.gov/water/

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Original ADEQ seal

Legal status:
The ADEQ is an administrative state agency that does not implement projects.

Staff/work force:
The department has more than 700 people, who support a wide range of environmental programs that protect the quality of our air, water and land in Arizona.

Creation date:
The ADEQ was established by the Arizona Legislature in 1986 in response to growing concerns about groundwater quality

Scope/scale of action:
The ADEQ's mission is to protect and enhance public health, welfare and the environment in Arizona.

Main activities (in general):
The ADEQ administers a variety of environmental protection programs. The department has created the rules and regulations necessary to administer state environmental protections laws and a number of federally-delegated programs, such as the Clean Air Act program, the Safe Drinking Water Act program, the National Pollutant Discharge Elimination System program, and the Resource Conservation and Recovery Act program.

Goals and interests:
Improve the health and welfare of citizens and ensure the quality of Arizona's air, land and water resources meets healthful, regulatory standards

Money:
State Fund

Projects:
Santa Fe Ranch

Sources:
http://www.azdeq.gov/function/laws/index.html