

Riparian Areas

Restoration & Management In Eastern Pima County

***Watershed Forum
December 3, 2003***

Report Prepared by
Pima Association of Governments

Based on the Meeting Minutes



Pima Association of Governments

March 2004

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Riparian Areas Restoration and Management in Eastern Pima County

1.0 Introduction and Summary

Pima Association of Governments (PAG) facilitates information sharing about water and environmental issues through the Watershed Forums. At these forums a panel of speakers is invited to present information about a particular topic. An effort is made to include presentations by speakers with a range of perspectives on the topic, so that complex issues can be portrayed with a depth not otherwise possible.

In addition, PAG publicizes the Watershed Forums to a wide audience: PAG committee members, local consulting firms, environmental groups, and others that might be interested. These forums are unique opportunities to get the community together to discuss particular issues of concern. In order to document the forums, summary reports are written. Although these reports are reviewed by the speakers before publication, they are only intended to represent the presentations and discussions held at the meetings. PAG staff would like to thank the speakers and attendees for their valued participation at the meeting.

On December 3, 2003, Pima Association of Governments hosted a Watershed Forum focusing on riparian areas in eastern Pima County. The meeting was titled *Riparian Areas: Restoration and Management in Eastern Pima County*. Speakers were asked to describe their riparian restoration sites, and to relate some of the lessons they learned as they managed and/or restored the sites. The following seven riparian management sites were discussed by the speakers:

- Agua Caliente, north of Tanque Verde Road, near Soldier Trail
- Cienega Creek, east of Vail, tributary to Pantano Wash
- Bingham Cienega, San Pedro River, northeast of the Santa Catalina Mountains
- Lower Santa Cruz River, just south of the Pima/Pinal County line
- Martinez Hill, Santa Cruz River on the Tohono O'Odham Reservation
- West Branch of the Santa Cruz River, abandoned channel near Mission and Drexel Roads
- Effluent Dependent reach of the Santa Cruz River, from Roger Road through Marana

Our region has made significant strides in the arena of riparian awareness, management, and restoration over the last ten years. Although some of the riparian properties discussed were acquired by management agencies during the late 1980's early 1990's, all of them have progressed significantly in the last eight years.

Each of the presenters spoke about the importance of community support for their projects. The community clearly has a vested interest and their identity is linked with the health of the riparian environments. In the cases of Agua Caliente, the West Branch of the Santa Cruz, and Martinez Hill, citizens have showed a compelling interest in the projects and have devoted their time and energy to help direct their outcomes.

The importance of financial support through agency involvement and government grants is also abundantly clear. Agencies devoting resources to the projects discussed in this forum include Pima County, Audubon Society, Tucson Nature Conservancy, Arizona Open Land Trust, Fish and Wildlife, Bureau of Reclamation, U.S Geological Survey, and Arizona Game and Fish. Five of the riparian projects described at the meeting have entered the capital improvement phase and none of them would have proceeded at the same level without grant funding. Of these projects, two have received money from mitigation funds, three have received grants from the State of Arizona's Water Protection Fund, and two have received Fish and Wildlife Partners for Wildlife grants.

Each of the speakers was asked to provide an overview of the lessons they learned through implementation of the projects. Several of the main issues are summarized below.

Project Management

- A useful first step is to modify the existing management of the resource instead of developing an entirely new management program.
- Clearly defined project objectives are important. Managers should know what they are restoring and who they are restoring it for.
- A slow and amenable public process allows time for the affected community to become invested in the project and help to drive the project.
- Project timing can affect acceptance by the community. For example, if the community sees that a drought is causing decline of riparian areas, they might be more inclined to work towards getting a long term water resource to the sites.
- Ideally, the project planning team should be interdisciplinary, should include project implementation staff, and staff should be involved throughout the implementation process.
- Project planning should include a rigorous cost analysis and should establish milestones that must be completed prior to moving to the next task.
- Post-implementation monitoring and maintenance needs to be included in the cost analysis and should be fully funded.
- To adequately evaluate project success, the sites must be monitored for a long time (greater than 10 years), especially during drought conditions.

Project Implementation

- Weed control is one of the most important elements in restoration projects and should be considered a primary goal of the project.
- The tall pot planting method is very effective for deep rooted plants such as mesquite and its use is probably more critical to plant survival than irrigation. For Sacaton grass plantings, 3 x 1½ paper pots are recommended.
- Non degradable plant flagging is beneficial for long term monitoring of individual plants.
- Planting larger plants increases survival rate and these plants show more growth and greater increases in biomass
- Plant cages were not beneficial, they did not discourage herbivory, they made it difficult to remove weeds around plants, which adversely affected plant growth, and plants were often damaged when the cages were removed.

- Observing the natural environment and using observed elements in the restoration project design decreased the need for irrigation and increased survival rates. Examples include: not planting in bare soil, since it is bare for a reason; building catchments to increase soil moisture in planting areas; judging depth to water by the type of existing vegetation; and planting appropriately for south and north facing slopes.
- Mulching tends to benefit exotic species and was not cost effective for large areas.
- Irrigation installation should be done when temperatures are moderate to minimize swelling and shrinking due to temperature changes.

Consequences

- Mosquitoes are an issue with any water restoration project and should be addressed early in the project.
- Security issues may arise when densely vegetated areas are created in the urban context.
- A structurally diverse native plant base (herbs, subshrubs, shrubs, vines, and trees) is necessary to support highly diverse animal populations.
- The habitat created through restoration can be further expanded in urban areas if residents integrate their yards with the restoration effort. For example, they can landscape using native vegetation, suitable vegetation structure, and minimize the use of pesticides.

2.0 Attendees

The December 3, 2003 Watershed Forum was very well attended, attracting nearly 60 people, including representatives from local, state, and federal government agencies, environmental groups, consultants and citizens.

Tucson Area Cities and Towns

Lynne Hubbard	City of Tucson, Ward 2 Council Office
Jean Melillo	Tucson Water
Ries Lindley	Tucson Water
Bruce Prior	Tucson Water
Jane Duarte	City of Tucson, Department of Transportation, Stormwater Section
Catesby Willis	City of Tucson, Dept. of Transportation, Stormwater Section
Frank Sousa	City of Tucson, Dept. of Transportation, Stormwater Section
Leslie Liberti	Town of Marana

Pima County and Maricopa County

Jennifer Becker	Pima County Flood Control District
Elizabeth Hill	Pima County Flood Control District
Tom Helfrich	Pima County Flood Control District
Frank Postillion	Pima County Flood Control District
Steve Dolan	Pima County Flood Control District
David Scalero	Pima County Flood Control District
Julia Fonseca	Pima County Flood Control District
Marc Herman	Pima County Department of Environmental Quality
Prakash Rao	Pima County Wastewater Management Department
Tom Berry	Pima County Wastewater Management Department
Shaun Haley	Pima County Wastewater Management Department
Theresa Pinto	Flood Control District of Maricopa County

State of Arizona

Bill Knight	Arizona Dept. of Transportation (ADOT)
Melissa Maiefski	Arizona Dept. of Transportation (ADOT)
Dean Foster	Arizona Game and Fish Department
Annalaura Averill-Murray	Arizona Game and Fish Department
Elissa Ostergaard	Arizona Game and Fish Department
Gerald Wright	Arizona Game and Fish Department
Kathryn Mauz	University of Arizona
Philip Rosen	University of Arizona
Robert Emanuel	University of Arizona, Cooperative Extension
Robert Glennon	University of Arizona, College of Law
Jackie Moxley	University of Arizona, Water Resources Research Center
Kristine Uhlman	University of Arizona, NEMO

Federal Agencies

Mike Fink	US Army Corp of Engineers, Env. Restoration Information System
Doug Duncan	U.S. Fish and Wildlife Service

Cecil Schwalbe	U.S. Geological Survey
Diane Laush	U.S. Bureau of Reclamation
Kris Randall	U.S. Fish and Wildlife Service
Bill Steinkampf	U.S. Geological Survey

Tribes

Elizabeth Ridgely	Gila River Indian Community
Scott Rogers	San Xavier District

Other Agencies and Water Districts

Greg Hess	Pima Association of Governments (PAG)
Matt Matthewson	Pima Association of Governments (PAG)
Claire Zucker	Pima Association of Governments (PAG)
Staffan Schorr	Pima Association of Governments (PAG)

Environmental and Environmental Advocacy Groups

Diane Freshwater	Arizona Open Land Trust
Kendall Kroesen	Tucson Audubon Society
James MacAdam	Plant Ecologist- Tucson
Ann Phillips	Tucson Audubon Society
Greta Anderson	Botanist
Jeanmarie Haney	Nature Conservancy

Consultants and Businesses

Scott Altherr	Castro Engineering Corp.
E. Linwood Smith	EPG, Inc.
Bob Pape	EPG, Inc.
Kevin Barnes	Westland Resources
Brian Lindenlamb	Westland Resources
Laura Davis	Haley & Aldrich
Priscilla Titus	SWCA
Ken Kingsley	SWCA
Kathy Meadows	Stantec
Angela Barclay	Entranco
Crystal Hines	Entranco
Jonathan Mobry	Desert Archeology, Inc.

Private Citizens

Lynn Almer
Meron Kidane
Susan Hess

3.0 Presentations

Agua Caliente Park

Presenter: Julia Fonseca, Pima County Flood Control District

(Substituting for Lori Woods, Recon Consultants)

Phil Rosen, commented

Ken Kingsley, commented

Agua Caliente Park is located along Agua Caliente Wash on the northwest side of the Rincon Mountains in the eastern part of the Tucson basin. This County park measures approximately 100 acres in extent. The County found through previous investigations that many native wetland plants and animals had been dying off at the park, although they were still present in nearby privately managed wetlands. The Pima County Flood Control District invited the Corps of Engineers to study the County's proposal to modify the operation of Agua Caliente Park to create appropriate habitat conditions for native wetland plants and animals. The proposal also addressed the specific habitat needs of plants and animals, in particular native fish and frogs. The proposal also included measures to manage against non-natives species, such as bull frogs.

Using the Corps' process, several alternatives were developed. These included: 1) using the existing ponds as a native fishery; 2) modifying two of the lower ponds into cienega wetland environments for use by native aquatic species, but leaving the first pond intact; and 3) modifying all three ponds into Cienega habitats. Over a one-year period, there was a great deal of public debate, but even after all the public discussion the project remained very divisive. The County eventually withdrew their request to have the Corps of Engineers review the project.

Lessons learned:

One of the basic principles of restoration is to begin by modifying the existing management of the resource. Unfortunately, this step was not taken at Agua Caliente Park because the County Parks Department did not commit to implementing the native fish component of their existing management plan, which was adopted in 1994. The Parks management priority has been to maintain water levels in all the ponds. Unfortunately, this course of action is causing the remnant cienegas to desiccate because of lack of dispersed flow in the areas between the ponds. In addition, the native riparian communities that had existed at the site are no longer replacing themselves because there is a lack of recruitment in the cottonwood willow community.

The Agua Caliente project would have benefited from a much slower and a much more amenable public process. The Corps process was a year long effort and at the end of that time the community had to approve one of the alternatives. This process timeline was much too quick for the affected community.

The timing of the project did not encourage acceptance by the community. One idea that was expressed by park users was "if it ain't broke, don't fix it". During the time of the project proposal, Agua Caliente Park was very beautiful and the biological losses were not very visible. However, in the subsequent summer, low streamflows caused the lower two ponds to dry up. It would have been better to initiate restoration in response to the public's concern about the

drying ponds rather than taking on the project when the existing system was unstressed in the public's eye.

The Agua Caliente proposal was very unusual because it focused on the habitat needs of several priority vulnerable species in the Sonoran Desert Conservation Plan. Most projects don't address their needs. Perhaps the natural inheritor of the concepts at Agua Caliente is the West Branch of the Santa Cruz River, where area residents have a strong desire to see conservation of the native wetlands environment. The future of Agua Caliente Park is undetermined. It might be increasingly managed for recreation at the expense of some of the natural features, or the environmental education and restoration component might grow.

Comment by Phil Rosen

The Agua Caliente project would have greatly benefited from early assessments of the community's concerns and wants. The proliferation of bullfrogs at the park makes it especially difficult to manage because lakes are excellent bullfrog habitat. One beneficial outcome of the project is that additional research is being conducted on the dynamics of ecosystems and their effects on bullfrogs: specifically how replacement of exotic fish by native fish might increase bullfrog populations, and how naturally occurring invertebrates might limit bullfrog populations in the absence of large insectivorous fish.

Comment by Ken Kingsley

The mosquito issue was raised at several of the public meetings. Investigations of mosquitoes at the site indicate that there are as many types of mosquitoes found at Agua Caliente Park as there are at any other locality in Pima County or southern Arizona that had been investigated. Mosquitoes are an issue with any water restoration project and these issues must be addressed early in the project.

Cienega Creek

Presenter: David Scalero, Pima County Flood Control District

The Cienega Creek Natural Preserve, located southeast of Tucson, is an important riparian corridor with dense willow/cottonwood forests and mesquite bosques that support wildlife movement and migration through the area. The County's 1994 management plan for the Preserve defined their major management goals: 1) to maintain and preserve the streamflow; 2) to protect the riparian corridor associated with the stream habitat; and 3) to accommodate public use including low impact recreation through the use of permits, research, and public education.

Since the late 1990s, Pima County has been conducting revegetation projects on a 60 acre parcel of abandoned farmland located within the eastern part of the Preserve. This parcel was cultivated for a few years in the early 1970's, after which it became pasture land that was grazed until the District purchased the parcel in 1988. Before cultivation, the parcel was predominantly mesquite woodland with some remnant stands of sacaton grass lands, which had been the dominant species of this, and other areas, in the late 1800s and early 1900s.

Comparison of photographs from 1975 and 1994 showed that the area was slow to naturally recover. Even after the District removed cattle from the majority of the preserve, this area continued to be grazed by the caretaker's horses.

Two revegetation projects were conducted in the area. The revegetation projects benefited from the fact that water and electricity were available nearby, that soils were stable and had not been eroded by flooding, and the caretakers were on site to provide project oversight. The first project was conducted as a Section 404 mitigation project, developed by the County. The second project was conducted with support from the U.S Fish and Wildlife Services Partners for Wildlife (PFW) and AZ Game and Fish. The 404 mitigation project required an 80% survival rate of the plants for a five-year period. The PFW project sought to accelerate mesquite re-establishment in the area and to increase the structural diversity, by re-establishing a variety of plants.

As a first step for both projects, a plant list was developed through onsite field observations so that the most suitable plants could be used for the projects. The plant list included mesquite, cat-claw acacia, hackberry, desert willow, little-leaf sumac, gray-thorn, salt-bush, wolfberry, sacaton, and Mexican elderberry. Approximately 80 trees and 80 shrubs per acre were planted for both projects. For the PFW project, seed collection by the Native Plants Society was conducted in conjunction with the project, so that a truly native seed source could be used.

An archeological survey, which involved digging several three-foot deep trenches in both project areas, showed that some Hohokam pithouses had existed on the southern area. The District did not plant any woody species in this area so that their root systems didn't threaten to disturb the artifacts. Sacaton species have a shallower root system and were planted on this part of the site.

Several nurseries were used to propagate the plants used for revegetation for both projects. Game and Fish Department provided mesquite trees used for the PFW project and a drip irrigation system was constructed at the site to provide supplemental water to the plants.

In July 1997, the County proceeded with revegetation of the Section 404 mitigation site. Unfortunately, the irrigation system, which had just been installed, had not been completely

tested for leaks. Although the woody species that died were replaced, the sacaton grasses all died because of insufficient water supply and they were not replaced. This 404 project included 800 woody plants (288 were mesquite), and 900 sacaton seedlings.

In August 1997, the County moved forward with the Partners for Wildlife (PFW) project. Some of the sacaton seedlings were planted in 4 inch containers, while others were planted in 1 ½ inch containers. Volunteer staff did the planting, and some of the seedlings were planted in swales, while others were planted on mounds. Ample irrigation was provided and the monsoon rainfall also helped get the grasses started. Tall pots were used on some species to encourage tap root develop. About half of the Mesquites were not irrigated in order to test the importance of irrigation to survival. All other species were planted in 1 to 2 gallon containers. Maintenance included two years of watering, with decreased watering in the last six months so that the plants could adjust to natural water supplies. Landscapers weeded around the plants, removing some Bermuda grass and tumble weed.

In January 1999, the Section 404 mitigation project was monitored using three transects. Approximately 100 plants were located within the three plots. Plant status, plant stress, tree height, degree of cover and the number of survived and volunteer plants were among the features measured. Monitoring showed that 91.5% of the planted plants survived. Also there was a substantial amount of ground cover on the site, but the majority of this cover consisted of non-native noxious weeds. Woody species covered 10.4% of the project area, but most of these were salt bush. Volunteer plants had grown to be large, but they were not abundant at the site.

At the PFW site, monitoring measured plant survival, growth and biomass. There was a 74% survival rate for sacaton plantings, with 60% of the smaller container plants surviving, and 80% of the larger 4" plants surviving. The larger plants also had greater biomass and greater growth. The majority of the plants are showing signs of water stress, especially the hackberry species. Although most plants are healthy, there has not been a lot of growth or recruitment, probably because of water stress.

The Cienega Preserve revegetation projects have overall resulted in an increased number of plant species for this area. However, there has been very little recruitment of the mesquite species, probably because of the affect of current drought, which was exacerbated by the weed proliferation competing for water and nutrient resources.

Lessons Learned:

One of the lessons learned was that the tall pot method worked well. Mesquites planted in tall pots had more growth than the other mesquites, even though the others might have been watered. The use of the tall pot method appears to be more crucial to survival than having irrigation.

Bingham Cienega

Presenter: Jeanmarie Haney, Tucson Nature Conservancy

The Bingham Cienega Natural Preserve is a 285 acre site located on the San Pedro River on the east side of the Santa Catalina Mountains. The site is located along the middle section of the San Pedro, and forms an important corridor between the Catalina/Rincon complex and the Galiuro Mountains. This region has very low population density and it is a nearly unfragmented landscape. In 1989, Pima County Flood Control District purchased the Bingham Cienega Natural Preserve and entered into a 25-year management agreement with the Tucson Nature Conservancy. The Conservancy manages or owns several other properties in the area, but Bingham is the earliest restoration site they have worked on. An Arizona Water Protection Fund grant was obtained to provide partial funding for restoration at the site.

Bingham Cienega is a spring fed marsh supporting extensive stands of cattail, bulrush and other wetland plants. The site also hosts a mesquite bosque, a wooded swamp, a cottonwood/willow riparian forest, and some persistent stands of sacaton grass along the forest edges. The site occurs on the pre-entrenchment floodplain of the San Pedro River, which now lies approximately four meters below the elevation of the spring. Shallow bedrock in this area forces the water to the surface. Studies by PAG indicate that the source is a mixture of San Pedro subflow and water from the tributary canyons.

The agricultural fields in the Bingham Cienega area were last cultivated in 1987. When Pima County acquired the land, they breached the dam allowing the wetlands to re-establish, and the wetlands are now approximately 28 acres in size. The restoration goals were to establish a diverse riparian habitat in the old agricultural fields, which would support a greater number of species, and also be self-maintaining on a long term basis. Site conditions such as depth to groundwater, groundwater/plant associations, soil moisture, and soil type were carefully studied when preparing the restoration plan.

Restoration habitat types were selected based on depth to water. The deciduous riparian woodland planting area was located close to the wetlands where depth to groundwater was approximately 3 feet. Sacaton grasses were restored in areas with 6-9 foot depths to water, and mesquite woodland were planted where depths to water exceeded 9 feet. The project emphasized sacaton riparian grasslands restoration. This was because the region has lost so many of these types of grasslands over the last century, due to clearing for agriculture, overgrazing, fire suppression, and declining water tables. Also, mesquite trees have high water use and project managers were concerned that if they were planted, their water consumption might adversely affect the spring flow.

Restoration began in the summer of 1998 with the planting of sacaton grass seedlings. Deciduous tree saplings were planted in fall of 1988, mesquites were planted in 1999, native grasses were planted in 2001, and cottonwood/willow poles were planted in 2000/2001. Many of the cottonwoods and willows died because of fire damage and because they were uprooted by frost heave during the winter after they were planted. In three years, a total of ~62,000 sacaton seedlings were transplanted into the 13 acre restoration area.

Monitoring and site maintenance was conducted throughout the project. Monitoring included hydrologic monitoring, vegetation monitoring on plots and transects, photo point monitoring, and a three-year bird monitoring study. Hydrographs show that water levels have been steadily

declining since October 2000. Water levels are about six feet lower now than in January 1997, causing the wetlands to be dry with no standing water on the surface. Weed control has been a very big issue at the site. Exotic species of grass especially Johnson grass, bermuda, yellow star thistle, bind weed, and wild oats have been a problem.

The final report for the AZ Water Protection Fund was produced in 2001. Survivorship of trees ranges from about 60% to 83% for tree plantings. Planting of sacaton grass seedlings in 3 x 1½ paper pots are recommended based on survival and costs per plant (10 cents/plant). Cages were not very successful: plants in cages were less robust and taking the cages off took a lot of time and caused damage to the plants. Irrigation was used prior to and immediately after planting, but supplemental watering favored exotic species over native species because native plants are well adapted to natural conditions.

Lessons learned:

An interdisciplinary team including soil scientists, plant ecologists, hydrologists, administrators, and the project implementation staff is really important for project planning. All the team members need to understand the project design and their roles in that design. Continuity of personnel is also extremely important so that the lessons learned are applied throughout the project. Project planning should include a rigorous cost analysis taking into consideration creeping cost escalations and false economies. For example, if project managers for Bingham had known all the costs of irrigation lines, they would have seen that it would have been cheaper to drill a well adjacent to the fields rather than depending on the existing well at the house site.

When implementing a project, it is really important to establish milestones that must be completed prior to moving to the next task. For example, the planting at Bingham was conducted prior to completion of irrigation lines. This placed an enormous amount of pressure on personnel. Installing a well near the fields would have reduced irrigation start up costs by 50%.

Weed control is paramount and when conducting restoration it should be considered one of the primary project goals, not a secondary goal. Field preparation can greatly assist weed control. Field preparation that includes deep ripping the fields to completely remove mesquite saplings, but does not overly disturb soils is recommended. Invasive species thrive on disturbances, so field preparation should minimize disturbance. Also, irrigation can favor exotic species over native species that are better adapted to dry conditions. None of the weed control methods used adequately managed the weed infestation at Bingham. Management included mowing, herbicide, mulching, tilling, furrow maintenance, and re-plowing. Mulching was not cost effective on a large scale and it seemed to favor Bermuda grass propagation. Herbicide application required very careful attention to surfactants and concentrations. The most successful method was frequent mowing, which created natural mulch and prevented weeds from going to seed, substantially reducing their density over time.

The Nature Conservancy is planning to minimize soil disturbance during ongoing and future restoration projects. The current practice is to mow the weeds and to use a seed drill to plant the native seeds. This is followed up by continued mowing but no disking or plowing. Supplemental irrigation is being limited and natural precipitation cycles are being relied on for water. Additionally, planting in areas of bare soil is not recommended because the soil is bare for a reason. Thinning and pruning of mesquite trees has had beneficial affect on growth rates and where Bermuda grass cover exceeded 40% of the ground cover around mesquites, mesquite growth rates were reduced.

The Bingham restoration project used volunteers on many activities. However, it was more cost effective to use a small paid crew and a tractor pulling a plug planter for installing the seedlings.

Overarching recommendations include:

- Delineate site hydrologic and soil conditions and design planting zones accordingly;
- Conduct realistic and robust cost estimates;
- Make weed management a primary objective for the restoration project;
- Assist weed control efforts by conducting soil preparations for years prior to restoration;
- Build flexibility into project planning to adjust for climatic conditions and seasonality; and
- Project time-line must be prolonged (10 years) in order to demonstrate success, especially during drought conditions.

Lower Santa Cruz River

Presenter: Ann Phillips, Tucson Audubon Society

The Audubon Society manages a restoration project along the Santa Cruz River just upstream (south) from the Pima/Pinal County line. The restoration site consists of 1,700 acres of land owned by the City of Tucson. It was part of 23,000 acres of farmland purchased by the City in the 1970s and 1980s in order to get the groundwater rights for the land and at that time the land was retired from agricultural use. Before 1993, the river channel at the restoration site had some long-standing meanders. After the 1993 flood wiped out vegetation and caused sediment to fill the channel, this sediment was bladed out of the channel to create loose sandy flood control berms on either side. In the course of re-creating the channel, the natural meanders of the river were cut off. Today, meanders are starting to reform, but this portion of the river is generally still a straight channel. Water in the channel is predominantly effluent from Tucson's wastewater treatment plants, which travels approximately 18 miles in 10 hours to get to the site. The water retains its effluent character; it is darkly colored and suds can sometimes be seen in the water. Since 1993, abundant vegetation has volunteered along the river. The river also has periodic natural flows of stormwater.

Current funding levels of \$550,000 were obtained through in-lieu mitigation fees from developers with Clean Water Act Section 404 permits from the US Army Corps of Engineers, and a large grant from the Arizona Water Protection Fund. The overall goals of the project are enhancement of the vegetative cover by increasing diversity and resiliency, and working with the interaction between the riparian corridor and the adjacent farmland within the natural climatic conditions of the region. Over the years, the City's property, which was abandoned farmland, was used for hunting, off-road vehicle driving, dumping, open-range grazing, and other activities. The City has now fenced the property, though there was some resistance to this from the local community. Efforts to work with the local citizens are being made as site use is developed.

A moderate stormwater flow in October 2000, scoured the river removing the algal mat in the sandy river bottom at and upstream of the site. As a result, the effluent releases infiltrated upstream and no longer extended into the restoration area for a period of time. The flood also removed vegetation from the streambed and there was some aggradation of sediment in the river channel. If any irrigation or planting had been done in the river bed, it would have been affected by the flood and probably lost. One decision made as a result of observing this, was that the primary restoration work would be done adjacent to, rather than in, the river channel area. Work done in the channel area needed to be carefully adapted to the conditions there to avoid loss of effort and investment. Initially, the 2-year planning period was criticized as being too long; however, a lot of good information was learned during this part of the project. Observation of animals and plants provided a basis for decision making. At various times, advice was received to drill piezometer wells to assess groundwater depths. However, observations about where the willow and cottonwoods naturally thrived provided a good indication of where subsurface water was available. The practice of concentrating hydro riparian restoration in these areas has saved the project a lot of money.

Permaculture techniques have been used at the site. Solar orientations were analyzed and micro-climate analyses were done. Graphics were created to differentiate hot and dry areas, such as southwest facing slopes, from those that were moist and cool. This type of information was used for plant selection. Drainage patterns were also studied. Darker plant patterns were

noted on aerial photos in areas that were probably remnant recessional drainages, formed as the flood waters receded. The rainwater collected and the tumbleweeds grew more thickly in these areas because soil moisture was available. These areas were preferentially planted. Sustainable techniques were emphasized, such as rainwater harvesting, using native plants, and growing seedlings in tall pots so that their roots are well formed.

The techniques used at this restoration site are providing examples for what might be done on other City-owned lands in Avra Valley. Much has been learned about how to plant seeds on a broad scale and about how to control tumbleweeds, the predominant weed in the area.

After creating the site design, native seeds were collected or purchased. Outreach included getting high school classes to help grow seedlings in tall tubes. The plants could be left in the tubes for up to a couple of years. The planting procedure included auguring or hand-digging out a hole, loosening the seeding within the tube, setting the tube and plant in the hole, then alternately backfilling the hole and pulling the tube off via the top of the plant. This procedure allowed the root structure to remain undisturbed during planting. Much of the native seed was purchased from a local vendor, because it was not possible to collect enough seed on site.

Seed pelletization techniques were used to plant seeds in small areas. The seed pellet mixture, consisting of two parts native clay, one part water, and one part seed mix, is mixed then, can be rolled into very small balls or extruded through hardware cloth to make pellets. The dried clay obscures the seeds helping protect them from rodents and other animals. This has been a very popular public outreach effort especially with children.

Other seeding methods were used for larger areas. For some areas, a cyclone feeder was used to distribute the seeds, which was followed by compaction of the soils using an imprinting device. Imprinting creates a corrugated pattern in the ground, and establishes localized water catchments with areas of compressed soil that induce capillary rise of the soil moisture up to the seeds. The imprints last four or five years. One drawback of using seeding in revegetation projects is that rainfall is unpredictable, so you have to be patient when waiting for results.

For nursery plantings, the ground was contoured to create rainwater harvesting catchments. Water harvesting basins, measuring about 10 feet across, were constructed on the loose sandy flood control berms at the site. After a good monsoon, rainwater penetration was about 4 inches on the slopes without basins, whereas the center of the basins showed 20 inches of penetration. Also, a 2000 foot long swale was dug by hand at the site. It was constructed with minor internal divisions, so that it served as a whole string of micro basins. Vegetation was planted in imitation of the natural patterns observed. For example, staff noted a river escarpment that had been covered by tumbleweeds, buffering it from erosion. As part of the restoration effort, an irrigation line was run along the escarpment and saltbushes were planted every five feet. The saltbushes were planted so that they could train over the sides of the escarpment to reduce erosion as the tumbleweeds had done, while providing native habitat.

Less mulch was used than expected for the project. Trees planted on degraded farmland had more success in unmulched areas than in mulched areas. There was a 70% mortality of trees in the mulched swales, versus 40% mortality in unmulched swales that were side by side. It is possible that the mulch encouraged weed growth and fungus in the degraded, fine-grained former farm fields. Although mulch seemed to help on the well drained sandy flood control berms, native plants did not seem to need it. Straw mulch might be better than the composted black mulch, but many of the trees seem to be doing just fine without it.

Irrigation installation would be done differently next time. Miles of irrigation were installed on the site. However, irrigation was installed in the summer and shrinkage during winter months caused many of the joints to crack. Installation during moderate temperatures is recommended.

Plant monitoring was conducted as part of the project, but one challenge was to find the plants repeatedly over time. Plants within the river corridor were sometimes difficult to find the next time they were checked. Over a period of a year, flagging tape would dry up and break apart in the desert heat and sun, so rebar and brightly painted fence posts were more appropriate marking devices, especially on a large site with thousands of plants involved.

Lots of volunteers worked on the site. They were provided with safety orientations and they signed liability waivers before volunteering. These people tended to be very motivated and they were incredibly fast and hard workers. It was sometimes difficult to keep ahead of them and to supply them with adequate work. Rocks for use as inorganic mulch or to create reptile habitat were generally not used at the site because much of the site was inaccessible by equipment necessary to move them.

Tumbleweed proliferation on former degraded farmfields were addressed by using a large disking machine to break the soil surface, and then followed by seeding with native seed. An unforeseen result of this cultivation was that all the tumbleweed in the field germinated at the same time, immediately after the seeding. Because all the tumbleweed sprouted at the same time, they competed with each other and died off because of competition and because of dry, hot weather. In other places, the tumbleweeds were crushed and mulched in place causing all the seeds to germinate in one big crop. Again the sprouts competed and died. A few years using this technique should take care of some of the weed problem.

Martinez Hill

Presenter: Greta Anderson, Consultant to Mark Briggs

The twelve acre Martinez Hill restoration site located along the Santa Cruz River within the San Xavier District of the Tohono O'odham Nation is about sixteen kilometers southwest of Tucson. In 1996, the San Xavier District received a grant from Arizona Water Protection Fund to enhance the condition of the District lands along the Santa Cruz River. The District formed an oversight committee of technical and non-technical consultants to assess community needs and wants. They chose five areas as priority restoration sites. The Sonoran Institute was hired to do an ecological evaluation of the five sites including the probability of restoration success at each of the potential sites. The Martinez Hill site was eventually selected for the project, and Mark Briggs, a restoration ecologist in Tucson, was hired to design and implement the project.

After the site was selected, a more thorough ecological evaluation was conducted. Historically the area near the Santa Cruz River at Martinez Hill was composed of extensive mesquite bosques, deciduous riparian gallery forests, and some cienegas. Soils, water availability, depth to the water table, existing vegetation and other factors were evaluated. The design for the site incorporated elements of the pre-scouring flood conditions, while also reflecting the community's needs and wants. For example, the community really wanted wetland areas. Two wetland areas connected by an open waterway channel were constructed at the site. Mesquite bosque was planned for the central part of the area and riparian zones were planned for the perimeter. Open water was scaled back to about one-quarter acre of total open water space. The water is supplied through the Nation's CAP agricultural allotment.

Construction of the restoration area began in spring 2002. First, a berm was constructed along the Santa Cruz so that the river would remain in the channel if it were to flood again. Next, tamarisks were removed from the site and a fence was constructed around the perimeter. The wetland areas were dug with berms around them to raise them in relation to the surrounding landscape. Aspen fiber was incorporated into the wetland banks to create a stable bank structure for the wetland planting. This allowed the banks to be very steep, reducing the extent of shallow water areas in order to minimize mosquito problems.

A total of 3,500 plants of 10 species were planted in wetland areas. Sedges, rushes, Monkey flowers, and various wetland emergent species were planted, some of which had cultural significance for the Nation. Piezometers were installed when the irrigation system was put in. Project staff had hoped that the groundwater levels might rise as water was applied to the surface; however, this has not happened. Nation/District staff continues to monitor groundwater levels on a monthly basis. As soon as water was introduced to the wetland areas, the wildlife started to come to the site.

Once the irrigation system was installed, the riparian and mesquite zones were planted with 1,200 plants of 15 species. Most were greenhouse grown, but some species, such as the cottonwood and willow, were pole plantings. Species included velvet mesquite, cottonwoods, desert willow, hackberry and sacaton, and the plant distribution throughout the site was based on water availability. Planting was fairly dense, with between 250 and 260 plants planted per hectare. Protective baskets were used on some of the plants, but the baskets ended up having a somewhat detrimental effect, because they did not prevent herbivory, they hindered weeding around the plants, and plants were often damaged during basket removal.

Vegetation monitoring began as soon as planting began. Twenty five percent of the plants were tagged and monitored for height and width on a monthly basis for the first two years of the project. When plants were monitored, they were also checked for herbivory and weed infestation, and the irrigation system was checked. Long term monitoring was also conducted in 12 plots and associated transects in the riparian and mesquite zones, and 17 transects in the wetland area. In general, cover, density and diversity at all of the samples sites, for both native and non-native species, increased. There has been a significant weed issue on the site, mostly with tumbleweed, bermuda grass, and canary grass. Photo point monitoring was also conducted.

One of the goals of the project was to encourage community visitation, and this element has been successful. There are interpretive signs, picnic areas, and trails located around the wetlands, so that the community can watch wildlife, picnic and enjoy being in nature. There has been increased community visitation at the site over time. In order for non-Nation residents to visit the site, permission must first be granted by the San Xavier District.

The Martinez Hill restoration site was heavily irrigated for the first two summers, but irrigation will be reduced next summer and some of the irrigation will be turned off after next summer. The irrigation system will be left on site so that it can be turned on in case of extreme drought. The site currently uses 12-14 acre feet of water per year. The wetlands will continue to receive water indefinitely. The water is introduced to the site through two inflows, and after it circulates through the system it is discharged. Water is not being re-circulated in the system.

For the future, long term monitoring of plant cover and density will hopefully be continued. In addition, avian and herpetological monitoring will be conducted to determine animal diversity. A site specific plant identification manual has been created and training of District staff in plant monitoring and in the identification of bullfrogs, should they show up at the site, are project goals. Currently, the site has lots of native toads and small frogs, and the possibility of introducing native animal species into the wetlands has been discussed.

Lessons Learned:

It is important to clearly define project objectives – to know what you're restoring to and who you are restoring for. The current ecological condition, why the situation has changed, and what needs restoring should be well understood. Post implementation activities including monitoring and evaluation of the site should be emphasized and appropriately funded.

West Branch of the Santa Cruz River

Presenter: Diana Freshwater, AZ Open Land Trust

Historically, the west branch of the Santa Cruz River was a lush valley with abundant wildlife and plant life. In 1915, a water control project diverted water from the West Branch over to the main channel of the Santa Cruz River to protect agricultural land along the West Branch from potential flooding. After the diversion, the West Branch was largely ignored, which actually turned out to be beneficial for the West Branch in many ways as development interests focused elsewhere.

The Arizona Open Land Trust got involved with this project in 2000, because the neighbors were concerned about the County's plans to put a bus barn in the neighborhood. The bus barn site was very close to the West Branch channel and the neighbors were concerned about the potential of pollutants contaminating the channel. With funding being scarce for land protection efforts, preservation options such as acquisition were not feasible. Other avenues were considered including an assessment of the resource with an eye toward attracting habitat protection funds possibly from state and federal agencies. The neighborhood called Phil Rosen and requested that he conduct a natural resource inventory of the West Branch area. About that time, the County acquired some land in the area to mitigate for a project with the Army Corps of Engineers. At the same time, Southern Arizona was experiencing a four-year drought, and neighbors were noticing that the trees were becoming water stressed and losing their leaves.

People in the West Branch neighborhood realized that a plan was needed and a vision statement process was conducted to identify goals for the area. The neighborhood wanted to share this place with others and to incorporate it into a larger framework of cultural resources within the community. The planning process identified objectives including protecting cultural resources, exploring the agrarian culture, and connecting with the modern urban lifestyle with particular consideration for the Rio Nuevo Project.

One of the first steps for developing a land-use plan was to look at existing land use, planned land use, park areas that are already protected, and the river resources. One notable feature of the area was the Enchanted Hills Wash, which is tributary to the West Branch. It has a well developed distributary floodplain because the channel has not been incised. There are about six land owners in the area that are interested in conservation, are actively working on the planning document, and are applying to Fish and Wildlife to do their own backyard restoration projects. One Partners Grant has already been obtained from the Fish and Wildlife Service for a small restoration project to begin during the winter of 2003/2004.

In October 2003, a public meeting was held, with about 45 people in attendance. People were asked to contribute their individual memories which were merged to create a group memory. Four topics were focused on at the meeting: 1) land protection methods, 2) neighborhood leadership in the planning process 3) plan adaptation over time, and 4) influencing the outcomes of regional projects, which the neighborhood might otherwise not be able to influence.

Presenter: Phil Rosen, University of Arizona

Several small restoration projects have been discussed for implementation along the West Branch of the Santa Cruz River. Water is the key ingredient to many of the possible restoration

projects. Eventually, installing a well, re-establishing the recently ended irrigation district, or hooking up to the reclaimed system might provide the water resource. However, this would best be done in conjunction with the County or some other jurisdiction because of the cost. An economical and immediately possible alternative would be to capture water on the floodplains, using the distributary floodplain of Enchanted Hills Wash as a model, and thus bring it into the system. Natural irrigation would occur where side washes flow over floodplains instead of funneling through entrenched channels and out into the Santa Cruz arroyo. Some of the richest vegetation exists on floodplains where storm flows along side channels frequently irrigate. Reactivating the irrigation district to deliver water to the West Branch area is another large scale and inexpensive possibility, but it is unprecedented.

Returning the Church Wash to its distributary floodplain is one project of special interest to the West Branch neighborhood. This is a County/City/neighborhood project, which would serve to irrigate several properties in the area. Discussions with USGS hydrologists indicate that if water were returned to the distributary floodplain, it would not significantly decrease contributions to the West Branch channel. The amount of water that would be absorbed on the floodplain in the distributaries would be significant, but the loss to the main channel would be minor, since most floodwater runs off the site anyway.

In 1983, the drainage area of the West Branch was decreased because the Midvail diversion was built (at Irvington Road) to divert West Branch water flowing off Black Mountain and the San Xavier District over to the Santa Cruz River. This diversion was built to protect development along the West Branch from possible flooding caused by newly developed, impervious residential areas on the floodplain. However, the result of the diversion was that the West Branch has been further starved of water. The hope of the West Branch neighborhood is that a low-flow diversion structure can be created, so that low flows are returned to the West Branch, but larger floodwaters are still diverted to the main branch Santa Cruz, so that flood damage is still averted. The final decision is up to the various governments involved.

Down cutting in the West Branch drainage system, caused by sediment-starved floodwater, has become a problem for the area. Floodwaters need to have enough sediment load to have deposition balance erosion and thus maintain the river bottom elevation and to prevent severe downcutting and entrenchment. The natural pattern is for scour to occur at the beginning of each flood, while the tail of the flood drops sediment. One solution is to use gabions to retain sediment load during flooding. The Enchanted Hills drainage system is key to bringing a healthy sediment load into the West Branch. A lot of this drainage system could still be developed, but if low-density development is maintained, the sediment load would be preserved. If paving and high-density development were built, the channel would lose its sediment source.

Herpetology and bird studies indicate that the West Branch has a great diversity of animal life. This is largely because the area has high structural diversity in vegetation (herbs, subshrubs, shrubs, vines, and trees), which attracts and supports the animals. In addition, the West Branch retains some vestiges of the original biodiversity of the Santa Cruz, which suggests that unique elements will eventually be lost if there is not substantial ecological restoration. Park planners need to be encouraged to think in these broad terms. Another consideration for planners is the potential security issue that may arise when an area of dense vegetation is created or maintained in an urban area. If the people in the neighborhood feel a sense of ownership and responsibility, they will help insure that the area is safe and secure.

One of the first steps to enhancing the natural environment is to encourage people to interface their yards with the natural area. In the West Branch area people are living within the natural environment and in some cases the best habitat is on private property. Neighborhoods, not just

open space, could be incorporated into the wildlife and plant population dynamics, if residents develop their vegetation, plantings, and yards with elements that fit into the broader landscape and the natural setting. In this way, a critical mass of habitat could be built up within the yards so that desirable species are sustained.

Just Add Water

Presenter: Ken Kingsley, SWCA Environmental Consultants

What happens if you don't have a planned project, but you just add water to a desert river environment? Historically, most of the Santa Cruz River, which is approximately 222 miles long, was dry for much of the year. During really big flood years, water might flow downstream to the Gila River, but most of the time, flow dissipated just north of Tucson. Today, portions of the river flow year round because effluent is discharged into the river from wastewater treatment plants in Tucson and Nogales. This talk was limited to the Tucson area effluent stream. The flowing part of the river generally extends for 20 to 30 miles. Shortly after a flood, when the impermeable layer has been scoured from the riverbed, water infiltrates more quickly and flow may extend as little as four miles downstream. Almost all of the currently flowing part of the river was dry before effluent was first discharged in the 1970s. Approximately 50,000 to 60,000 acre feet of effluent is released to the river each year: ~41 million gpd released from the Roger Road Treatment Plant, and ~ 25 million gpd from the Ina Road Wastewater Facility

Significant differences in water quality can be found between the released effluent and that of natural streams. When comparing the effluent dominant Santa Cruz river to water in the San Pedro and Salt rivers, the effluent shows low dissolved oxygen, high concentrations of ammonia, lots of sand, and various other chemical differences.

Since discharge began, an incipient and thriving riparian community has developed along the river. Native and non-native plant and animal species have returned to the area or become established even though they were historically absent. Conditions vary along the river and any given point along the river is different from any other. Also, the area is subject to frequent channel changes due to flood scour and fluctuating flow rates. Fremont Cottonwood has become established in areas where it was previously absent. Goodding's Willow is also present. Non-native species, including tamarisk, Bermuda grass, buffelgrass, and castorbean, sometimes form a dense carpet of mostly invasive non-native weeds, which is a potential problem in some areas.

Daily volume changes in the river create tidal flow patterns. A double peaked daily cycle causes water depth to vary dramatically. Also, annual patterns of higher flows during winter months when visitors come to the Tucson area and lower summer flows are evident. In addition, channel changes caused by flooding sometimes occur, with the channel being diverted from well developed riparian zones causing them to decline, and new riparian zones to develop. Once water is introduced to a new channel the vegetation grows very quickly and is abundant.

As water became dependable and riparian vegetation became established, birds started to come to the area. A bird survey conducted over a course of a year showed that abundant wading birds, shore birds and waterfowl were present in the area even though these types of birds were not historically present because there was no habitat for them. Breeding birds, wintering birds, migrating birds, riparian obligate species (species that must nest in riparian areas), preferential riparian species, birds that are just moving through the area, and desert species from neighboring lands were all found during the surveys. Considerable variation in bird species and numbers was found at five different sites along the river. Even though the sites were very diverse, all had a large component of aquatic and riparian birds.

Only brief investigations of invertebrate species have been conducted. Although very little data have been collected, there appear to be serious habitat limitations for aquatic and riparian invertebrates in the effluent dominant portion of the river. The substrate consists of sand or fine muck, with very few larger grained materials such as cobbles and boulders. The daily fluctuations make it difficult for aquatic invertebrates to thrive and many aquatic invertebrates found on the site are fly-ins from adjacent areas. Diversity increases down stream as the water quality improves. When studied, the part of the Santa Cruz River near Cortaro was not populated by mayflies, stone flies and caddis flies, which are all prevalent on the San Pedro River at Charleston and other native watercourses. Aquatic worms and midges that are adapted to life in very low oxygen situations were the predominant types of invertebrates found at Cortaro. These types of invertebrates do not provide a very dependable food source for birds and other animals. An apparent paucity of small aerial insectivorous birds, such as flycatchers, may be a result of insufficient diversity and biomass of aquatic insects. A study by URS indicated that aquatic invertebrates generally lack diversity but are abundant near the outfalls, and that their numbers decrease as their diversity increases downstream. Portions of the river do provide important feeding (primarily wintering and migration stopover) areas for shorebirds and waterfowl.

Other types of animals have only been casually observed along the stream, so there is very little data on their abundance. A few species of mammals including coyotes, raccoons, wood rats, cotton rats, house cats, dogs, and cattle have been sited. No systematic search for amphibians has been done. Bull frogs are in the river, which would inhibit a lot of other species. Some reptiles have been noted including some spiny soft-shelled turtles, and Sonoran mud turtles. Sonoran mud turtles are thriving in the Sweetwater wetlands. The Arizona Game and Fish Department has recorded a few fish, including mosquitofish, black bullhead and green sunfish at the downstream edge of the flow area. These are introduced species. No native fish are known to be present.

We have unintentionally created a dynamic, ever changing riparian and aquatic community that is entirely dependent upon our wastewater. We are only beginning to understand some of the biological consequences of just adding water.