



MEMORANDUM

Date: July 20, 1999

To: The Honorable Chair and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator 

Re: **Attached Discussion Paper -- *Water Resources and the Sonoran Desert Conservation Plan***

I. Background

The attached paper entitled *Water Resources and the Sonoran Desert Conservation Plan* describes a comprehensive regional policy direction to achieve meaningful riparian restoration necessary for endangered species compliance. The basic relation of water policy to conservation planning is that:

- (1) Continued groundwater mining has caused substantial damage to riparian environments, with an estimated loss of 85 to 95% of quality riparian habitat during the last century.
- (2) An estimated 85% of wildlife depends on this riparian habitat for some part of its life cycle, including a long list of endangered, extirpated and imperiled species.
- (3) The ongoing implementation of water programs which undermine the purpose of the Endangered Species Act and significantly impact habitat, might preclude implementation of meaningful conservation under the Sonoran Desert Conservation Plan.
- (4) Given that two decades of plans administered under the State's Groundwater Code have failed to bring the Tucson Active Management Area on track with the goal of balancing groundwater withdrawal with recharge (safe yield), perhaps the Conservation Plan can assist where other actions have fallen short.

The County has made a commitment to pursue a high conservation standard, however, under any standard that seeks to comply with the Endangered Species Act, the Sonoran Desert Conservation Plan will have to include significant riparian restoration in order to prevent the decline and extinction of some of our imperiled riparian-dependent species, given the largely decimated status of the riparian ecosystem. There is an over-representation of riparian-dependent endangered, extirpated and imperiled species, which we have lost along with most of our perennial streams and the associated ground-water dependent riparian habitat.

Given the status of the riparian ecosystem, the jurisdictions throughout the region face the realistic prospect that a level of restoration will be a condition of the Section 10 permit issued under the Endangered Species Act. Such restoration will require improvement and some changes in the direction of current regional water policy with regard to groundwater mining and underutilization of sources such as effluent.

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II. Report

This report describes five water resource problems that have particular significance to the viability of the conservation plan. These include the problems of:

- (1) the administration of a system of rights for surface water and groundwater that does not reflect their hydrologic interconnection, or account for the environmental impact of streamflow and groundwater depletion;
- (2) the continuation of groundwater mining in the face of a seriously overdrafted aquifer;
- (3) the substantial damage that past practices have done to the riparian ecosystem;
- (4) the impact of this damage to the species; and
- (5) the continued strategies within the community to defer reconciliation of water use with water availability.

After discussion of these problems, five proposals are described in the context of the Sonoran Desert Conservation Plan. These include acceptance of a regional water policy that:

- (1) anticipates various types of water uses (including conservation uses) that will make calls on future resources, respects Indian water rights and other federal purposes, and recognizes hydrologic and environmental realities;
- (2) achieves safe yield within the Tucson Active Management Area;
- (3) implements recovery strategies for riparian systems;
- (4) adapts multi-species conservation and recovery programs to riparian restoration plans;
- (5) integrates effluent, recharge and reclamation water programs into the regional conservation program so that the best use of renewable resources is made for the community.

The Sonoran Desert Conservation Plan offers the community the opportunity to consider water resource policy from a comprehensive, integrated, regional perspective, rather than a narrow or interest based perspective. As the lead local entity overseeing the development of the Plan, Pima County will support and promote regional water policy which moves toward an ecosystem baseline that requires our basin to be in balance, and eventually results in some level of recovery of natural functions within riverine systems. Also, by acknowledging federal purposes, the Sonoran Desert Conservation Plan anticipates that simply to comply with federal law, we will have to find ways to accommodate more than just the traditional consumptive users of water. As a practical matter, the region must begin to make the right choices now with regard to water resource policy in order to accommodate current and future users.

III. Applicability -- The Gridlock of Local Water Decisionmaking has been Overcome by Protection of Federal Purposes

Public confidence in the direction of water resource policy has eroded to such a point that options offered at the local level are viewed with great skepticism and often destined to fail. Significantly, the major water policy decisions that have succeeded in overriding local concerns, entrenched interests, and the credibility problems created by our history of utilizing the resource within an artificial legal and administrative construct, share certain important characteristics. They are all **regional** and **comprehensive** in nature, and involve a **federal** connection. The most profound interruption to the rules of the local water decisionmaking process has involved the federal government's protection of federal purposes.

(1) Indian Water Rights: During this century, federal purposes have been protected through litigation and settlement attempts which make room within the community's water budget for the reserved right of water for Native American Tribes or Nations. The 1908 United States Supreme Court decision of *Winters v. United States* held that "the Government of the United States has the power to reserve waters of a river flowing through a Territory and exempt them from appropriation under the laws of the State which that Territory afterwards becomes." Pima County would like to see an end to the long negotiation of claims of the Tohono O'odham Nation, and a settlement which benefits the Nation and the natural resource base of the region.

(2) Federal Purposes Will Increasingly Include Wildlife Protection on Land Under the Jurisdiction of the United States: In 1964, the Supreme Court made it clear that federal purposes includes protection of wildlife on land under the jurisdiction of the United States. In *Arizona v. California*, which predates enactment of the Endangered Species Act, the Court upheld a reserve right in water sufficient to protect wildlife on federally designated land. In another case thirteen years later, the Supreme Court applied the *Winters* doctrine to stop groundwater pumping which interfered with the habitat needs of a "unique species of desert fish," the Devil's Hole Pupfish. *Cappaert v. United States* held: "since the implied-reservation-of-water rights doctrine is based on the necessity of water for the purpose of the federal reservation, we hold that the United States can protect its water from subsequent diversion, whether the diversion is of surface or ground water." Next century, protection of federal purposes such as wildlife and related habitat protection will require accommodation within water resource policy. Federal purposes, when established, override local laws and policies which have depleted water and natural resources by ignoring hydrologic reality and environmental impacts. In light of the current state of the riparian ecosystem, new proposals for groundwater pumping will face credible challenges from those who assert claims to protect federally listed species and their habitats, as such species are threatened or endangered by the proposed water use. A June 8, 1999 speech by the Secretary of the Interior entitled *From Reclamation to Restoration* encourages Western communities to elevate water policy discussions and deliberations to the level which envisions "a river [as] a living resource, entitled to at least parity with consumptive uses." The Sonoran Desert Conservation Plan will carry forward the protection of federally listed species and their habitats and in doing so, propose a regional and comprehensive approach to water resource utilization, inspired by natural resource protection goals outlined in federal law.

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IV. Conclusion

Pima County's participation in water resource management issues is critical to the region's future. Some time ago, it appeared that Tucson Water, along with the smaller water providers, could develop a coherent water strategy for the metropolitan portion of the county. Today, the lack of a coherent water management strategy for the region makes it imperative that each jurisdiction carefully monitor and participate in the development and implementation of a regional water policy.

Furthermore, Pima County is not simply interested in the metropolitan area -- water resources are everywhere precious, no less in rural areas than urban ones. Water supply is not the only issue involved, either. Flood control, wastewater treatment, upland watershed management, land use planning, exotic species, and many other issues must be considered together in formulating regional water policy. These issues have been treated only peripherally in the past.

The Sonoran Desert Conservation Plan provides an effective process for the community to begin more nearly at the beginning with water resource issues.

Last century a conservation ethic expressed itself in Arizona's first policy statements about the scarcity of water, and publicly owned nature of the resource. Next century, beneficial use will have to recognize hydrologic principles and environmental realities in addition to consumptive uses.

The measure of our success will be quantifiable to the degree we reach a positive bottom line with our water budget, and meet the needs of various users.

In a civic sense, we will succeed when rational water policy is the creation of local cooperative efforts, and not always the result of enforcement of federal purposes. The Sonoran Desert Conservation Plan, because it is keyed to the Section 10 process which requires a regional, comprehensive, inclusive and collaborative process, will allow us to make that showing of leadership at the local level.



Water Resources and the Sonoran Desert Conservation Plan

A Discussion Paper on the Regional Policy
Necessary to Achieve Meaningful Riparian Restoration

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I. Introduction - Meaningful Riparian Restoration within the Sonoran Desert Conservation Plan

1. Origins of the Sonoran Desert Conservation Plan

On October 27, 1998, the Pima County Board of Supervisors launched a major conservation planning effort -- the Sonoran Desert Conservation Plan -- that will: (1) define urban form and prevent urban sprawl through the protection of natural and cultural resources; (2) provide the basis of a natural resource protection and environmental element of the Comprehensive Plan; (3) lead to the recovery of the endangered cactus ferruginous pygmy-owl and stabilize the ecosystem and plant communities which support multiple species and thereby prevent future listings; and (4) lead to issuance of a Section 10 permit under the Endangered Species Act for a regional multi-species conservation plan that is one of the largest in the United States.

Pima County's Sonoran Desert Conservation Plan will address and meet, for multiple species, the federal compliance standards spelled out in the Endangered Species Act, its regulations, and guidelines.

In exchange for a long term conservation commitment, the business interests within the region will receive greater economic certainty and ability to plan, a streamlined regulatory process, and relief from the threat of potential criminal and civil liability under Section 9 of the Endangered Species Act for the "take" of an endangered animal.

2. Role of Water Resources in the Sonoran Desert Conservation Plan

The County has made a commitment to pursue a high conservation standard since the reach of the Sonoran Desert Conservation Plan is extensive. However, under any standard that seeks to comply with the Endangered Species Act, the Plan will have to include significant riparian restoration in order to prevent the decline and extinction of some of our imperiled riparian-dependent species, given the largely decimated status of the riparian ecosystem.

Because there is an over-representation of riparian-dependent extirpated and imperiled species, which we have lost along with most of our perennial streams and the associated ground-water dependent riparian habitat, some significant amount of riparian restoration will be required if the Plan is to be meaningful.

An inventory of some of the results of water resource utilization during the past one hundred years includes: (1) the loss of most perennial stream flow in Pima County; (2) the dramatic decline in the water table due to ground water pumping and the continued overdraft of this resource; and (3) the loss of 85 to 95% of quality riparian habitat during the last century, which negatively impacts the 85% of Arizona's wildlife population that depends on riparian habitat during some part of its life cycle.

Given the status of the riparian ecosystem, the jurisdictions throughout the region face the realistic prospect that some level of restoration is likely to be a condition of the Section 10 permit issued under the Endangered Species Act.

3. Purpose of this Discussion Paper

This discussion paper will introduce water resource policy perspectives within the context of the Sonoran Desert Conservation Plan and suggest a comprehensive regional policy direction to achieve meaningful riparian restoration necessary for endangered species compliance. Stated in greater detail, the basic relation of water policy to conservation planning is that continued groundwater mining in the context of local legal and administrative systems that have historically treated surface water and groundwater as though they are not hydrologically related, has caused substantial damage to riparian environments, upon which 85% of wildlife depends for some part of its life cycle, and the ongoing implementation of water programs which undermine the purpose of the Endangered Species Act and significantly impact habitat, might preclude implementation of meaningful conservation under the Sonoran Desert Conservation Plan. Given that two decades of plans administered under the Groundwater Code have failed to bring the Tucson Active Management Area on track with the goal of balancing groundwater withdrawal with recharge (safe yield), perhaps the Conservation Plan can assist where other actions have fallen short.

Five water resource problems have particular significance to the viability of the conservation plan. These include the problems of (1) the bifurcated system of legal rights for surface water and groundwater that does not reflect their hydrologic interconnection, or account for the environmental impact of streamflow and groundwater depletion; (2) the continuation of groundwater mining in the face of a seriously overdrafted aquifer; (3) the substantial damage that past practices have done to the riparian ecosystem; (4) the impact of this damage to the species; and (5) the continued strategies within the community to defer reconciliation of water use with water availability.

After discussion of these problems, five solutions are proposed in the context of the Sonoran Desert Conservation Plan. These include acceptance of a regional water policy that (1) anticipates various types of water uses (including conservation uses) that will make calls on future resources, respects Indian water rights and other federal purposes, and recognizes hydrologic and environmental realities; (2) achieves safe yield within the Tucson Active Management Area; (3) implements recovery strategies for riparian systems; (4) adapts multi-species conservation and recovery programs to riparian restoration plans; and (5) integrates effluent, recharge and reclaimed water programs into the regional conservation program so that the best use of renewable resources is made for the community.

The Sonoran Desert Conservation Plan offers the community the opportunity to consider water resource policy from a comprehensive, integrated, regional perspective, rather than a narrow or interest based perspective. As the lead local entity overseeing the development of the Plan, Pima County will support and promote regional water policy which moves toward an ecosystem baseline that requires our basin to be in balance, and eventually results in some level of recovery of natural functions within riverine systems. Also, by acknowledging federal purposes, the Sonoran Desert Conservation Plan anticipates that simply to comply with federal law, we will have to find ways to accommodate more than just the traditional consumptive users of water. As a practical matter, the region must begin to make the right choices now with regard to water resource policy in order to accommodate current and future users.

II. Five Water Resource Problems in Light of the Sonoran Desert Conservation Plan

1. Problem of Having Separate Systems of Water Rights for Surface Water and Groundwater That Do Not Reflect Hydrologic Reality or Environmental Impacts

A. How Did Separate Water Rights Systems Evolve? Arizona water law established categories of rights based on a mistaken understanding of the principles of hydrology. Early decisions had the effect of creating a bifurcated set of legal water rights that did not match hydro-geologic reality, and did not mitigate for environmental impacts. "The beliefs of early philosophers (and, unfortunately, some not-so-early legislators) that there are two kinds of water, surface and underground, has led to what, for lack of a better term, we will call the hydrologic bicycle."¹

Reformation of the faulty system of legal categories has proven to be difficult, even though more complete hydrologic information is available. Administering water resources within an artificial construct of rights has not only served as a limitation on the ability of principles of hydrology to inform policy decisions, it also limited the ability of policy makers to incorporate principles of environmental protection into water policy.

1) Original Policy Recognized Water Scarcity, but had a Limited View of Beneficial Use. It is interesting to note that from the beginning, Arizona case law dealing with water recognized the scarcity of the resource. The first cases distinguished water concerns in the "arid portions of the earth" from water concerns in those areas "precipitated with lavish profusion." "The problem there to be solved," according to an 1888 decision, "was how best to drain the water off the land ... ; not how to save it."

Based on a concern for making the best use of available surface water, the early Arizona courts rejected the traditional doctrine of riparian rights, which vests water rights with the landowner. Instead, with regard to surface water, the court adopted a rule of prior appropriation, which vests water use rights with the first user to put the water to a beneficial use. In fact the 1888 case of *Clough v. Wing* states that "A person has no right to water he does not use for some beneficial purpose."

Mining practices, viewed as beneficial, gave rise to the "first in time, first in right" doctrine, which was later extended to irrigation. Language in the 1888 case of *Hill v. Lenormand* explains:

"Among the earliest apprehensions of the people was the paramount importance of water. Among the miners the custom early grew of according to him the best right who was first in time. The privileges of irrigation soon became gauged by the same rule; so that now this doctrine is thoroughly interwoven into the jurisprudence of the coast, and may not be questioned."

¹ *Basic Groundwater Problems*, 14 Rocky Mountain Mineral Law Institute, Moses, 501, 503 (1968).

Today mining and agriculture still use significant amounts of water, but following the loss of most stream flow in Pima County the impact is now on the groundwater supply. Data from 1997 indicates that the municipal use demand on the groundwater aquifer was 145,300 acre feet, while the agricultural demand was 104,700 acre feet, the mining demand was 37,700 acre feet, and industrial demand was 20,800 acre feet.² Allocations for Colorado River water to be delivered through the Central Arizona Project (CAP) also equate such traditional consumptive uses with beneficial uses.

Despite that compliance with federal endangered species law will require protection and a degree of restoration of riparian habitat, there is no regional strategy being pursued by regulating entities or the public holders of major water rights to manage water resources so that they have a meaningful and effective benefit to riparian habitat.

2) Statutory Law of the Territory and Early Statehood Focused on Surface Water Rights while Groundwater Rights were Developed by the Courts. Surface water was recognized in the 1864 Arizona territorial constitution which stated that: "All streams, lakes, and ponds of water capable of being used for the purposes of navigation or irrigation, are hereby declared to be public property; and no individual or corporation shall have the right to appropriate them exclusively to their own private use."

Though groundwater found its way into the language of 1904 case law, the State Constitution avoided dealing with it by defining water rights in two short sentences of Article XVII: "SECTION 1. The common law doctrine of riparian water rights shall not obtain or be of any force or effect in the State; SECTION 2. All existing rights to the use of any of the water in the State for all useful or beneficial purposes are hereby recognized and confirmed."

The opportunity lost in the State Constitution to bring ground water and surface water under a single system of rights left in place the 1904 rationale from *Howard v. Perrin*.³ Subsequent Arizona water policy has developed under the influence of these words in *Howard v. Perrin* : "The distinction is made between all waters running in distinct channels, whether upon the surface or subterranean, and those oozing or percolating through the soil in varying quantities and uncertain direction."

While this distinction, despite many attempts to refine groundwater legal terminology so as to distinguish it from surface water, has not stood the test of time, it had -- and continues to have -- a very real impact on the rights of landowners.

In a departure from the rule of prior appropriation, groundwater, when it was recognized in the courts, essentially became the right of the overlying landowner, subject to reasonable use.

² Water in the Tucson Area, Seeking Sustainability, 1999.

³ 8 Ariz. 347, 76 Pac. 460 (1904).

3) Economies Vested Around the Laws of "Separate" Hydrologic Systems. The exhaustion of surface water resources, the nexus created in law between groundwater rights and overlying landownership, and the ability to use new technology to retrieve groundwater had the effect of removing water resource administration from a domain which recognized the public nature of surface water, to the narrower sphere of interests defined by landowners. In addition to dis-integrating water resource administration, these forces created a market dynamic that led to the unrestrained mining of Arizona's aquifers during the half century which preceded adoption of the Arizona Groundwater Code.⁴ The economies built around this incentive system still are responsible for the overdraft of water resources. Perhaps one of the most lasting effects has been the abandonment of the conservation ethic that was at least faintly evident in early case law, despite the narrow view of beneficial purposes.

The weight of the economic forces dependent on groundwater rules is felt in the 1936 case of *Southwest Cotton*⁵ where the court acknowledged that this "case is one of the most important which has ever come before the court, involving ... not only property interests of value of many millions of dollars, but also a declaration of legal principles which will in all probability determine and govern to a great extent the course of future agricultural development within the arid regions." The Court tried to put an end to the somewhat mystical descriptions that were being offered for surface and groundwater. But this end was confounded by introducing new subcategories of groundwater into legal discourse, and by perpetuating the legal standard that breaks the connection between surface water from groundwater in the eyes of the law, and assigns different rights that arise from very different schools of legal thought.

An oddly dramatic turn of events further illustrates the pressure that exists on policy makers to protect the interests of those holding groundwater rights. In 1952, the Arizona Supreme Court in the case of *Bristor v. Cheatham* actually held that "percolating" groundwater rights, previously linked to landownership, were public property rights -- like surface water. The firestorm which followed led to a rehearing, and a reversal.

While the courts strained to make sense of precedent in the face of scientific facts and economic pressures, the state legislature, for the most part facilitated a fifty year binge of groundwater mining by refusing to effectively regulate use. In 1980, the Groundwater Code tried to throw the brakes on this trend, and within the Tucson Active Management Area, established a forty-five year plan to achieve "safe yield" -- i.e., a balance point under which groundwater withdrawals will equal natural and artificial recharge.

⁴ "During the 1930's, groundwater pumping began to increase rapidly, as a result of increased pump efficiency, lower electricity costs, rural electrification, and higher cotton prices. Pumping exceeded one million acre-feet (MAF) state-wide for the first time in 1934. It exceeded two MAF in 1945, three MAF in 1948, four MAF in 1953, and 5 MAF in 1961." Leshy & Belanger, *Arizona Law Where Ground and Surface Water Meet*, 20 Arizona Water Law 657, 691.

⁵ *Maricopa County Mun. Water Conservation Dist. v. Southwest Cotton Co.*, 39 Ariz. 65, 4 P.2d 369 (1931).

The difficulty in staying on track with the safe yield goal, and the unresolved tension in the law today between groundwater and surface water rights, are legacies of a legal and administrative system that essentially is not in tune with hydrologic reality.

Perhaps more importantly, this system is not in tune with environmental impacts or federal endangered species compliance issues, which will play a major role in future policy considerations.

The consumption ethic which threatened the resource base has not been replaced with a conservation ethic. We are in many ways farther away today from honoring the public value of certain limited resources than the miners of the Arizona territory were in the 1800s when they worked out a practice among themselves to sustain their very limited surface water resource base for purposes deemed beneficial to the public welfare at that time.

- B. **The Gridlock of Local Water Decisionmaking has been Overcome by Protection of Federal Purposes.** Public confidence in the direction of water resource policy has eroded to such a point that options offered at the local level are viewed with great skepticism and often destined to fail. Significantly, the major water policy decisions that have succeeded in overriding local concerns, entrenched interests, and the credibility problems created by our history of utilizing the resource within an artificial legal and administrative construct, share certain important characteristics.

They are all regional and comprehensive in nature, and involve a federal connection. The most profound interruption to the rules of the local water decisionmaking process has involved the federal government's protection of federal purposes.

1) Indian Water Rights: During this century, such protection has been defined through litigation and settlement attempts which make room within the community's water budget for the reserved right of water for Native American Tribes or Nations. The 1908 United States Supreme Court decision of *Winters v. United States*⁶ upheld the lower federal court's finding that "the Government of the United States has the power to reserve waters of a river flowing through a Territory and exempt them from appropriation under the laws of the State which that Territory afterwards becomes."

2) Federal Purposes Include Wildlife Protection on Land Under the Jurisdiction of the United States: In 1964, the Supreme Court made it clear that federal purposes includes protection of wildlife on land under the jurisdiction of the United States. In *Arizona v. California*,⁷ which predates enactment of the Endangered Species Act, the Court upheld a reserve right in water sufficient to protect wildlife on federally designated land.

⁶ 207 U.S. 564 (1908).

⁷ 373 U.S. 546 (1963).

In another case thirteen years later, which still did not rely on the Endangered Species Act, the Supreme Court applied the *Winters* doctrine to stop groundwater pumping which interfered with the habitat needs of a "unique species of desert fish," the Devil's Hole Pupfish. In *Cappaert v. United States*,⁸ the court held:

"since the implied-reservation-of-water rights doctrine is based on the necessity of water for the purpose of the federal reservation, we hold that the United States can protect its water from subsequent diversion, whether the diversion is of surface or ground water."

It is clear from this line of cases, that next century, protection of federal purposes such as wildlife and related habitat protection will require accommodation within water resource policy. Federal purposes, when established, override local laws and policies which have ignored hydrologic reality and depleted water resources.

In light of the current state of the riparian ecosystem, new proposals for groundwater pumping will face credible challenges from those who assert claims to protect federally listed species and their habitats, as such species are threatened or endangered by the proposed water use.

A June 8, 1999 speech by the Secretary of the Interior entitled *From Reclamation to Restoration* encourages Western communities to elevate water policy discussions and deliberations to the level which envisions "a river [as] a living resource, entitled to at least parity with consumptive uses."

The Sonoran Desert Conservation Plan will carry forward the protection of federally listed species and their habitats and in doing so, propose a regional and comprehensive approach to water resource utilization, inspired by natural resource protection goals outlined in federal law.

To date, we have not dealt with the serious indicators of our community's resource depletions, except in a disintegrated and insufficient way. As we continue to exhaust the original resources which once defined Tucson, we continue to lose our identity. Perhaps the distance from fundamental causes and the lack of authenticity which results, explains our inability this century to break through to seemingly new solutions in the areas of water resources in the absence of a federal override.

What is called for is the redirection of water resource policy which will demonstrate that our community can come to terms with the past century of our practice of borrowing from, but not retaining or restoring the original resources that have drawn people here in steady or increasing numbers over time. This can be accomplished at the local level, but only if a regional, comprehensive and cooperative approach is adopted, consistent with the direction of the Sonoran Desert Conservation Plan.

⁸ 426 U.S. 128 (1976).

2. Problem of Groundwater Mining -- Continuous Decline of the Basin

A. Groundwater --The First Escape from the Reality of Constraints. During the few decades that fell on either side of 1900, while the issue of groundwater was being avoided by the legislature and surface water was being zealously appropriated for agricultural uses, a relief valve opened with the discovery and increased use of groundwater. Case law and other records from the time reveal that mining of groundwater was increasingly aggressive. The 1926 *Pima Farms* case involved a farmer who dropped a well 45 feet in 1916 and by 1923 had to install additional equipment to reach the water table, which was now 67 feet below ground.⁹ By 1980, when the Groundwater Code was adopted, the State had an annual groundwater overdraft of millions of acre feet. Fifteen years after adoption of the Code, Tucson was still 95% dependent on groundwater for municipal purposes, 98% dependent for agricultural purposes, and 99% groundwater dependent in the area of industry.¹⁰ The groundwater cycle can be described in the following terms:

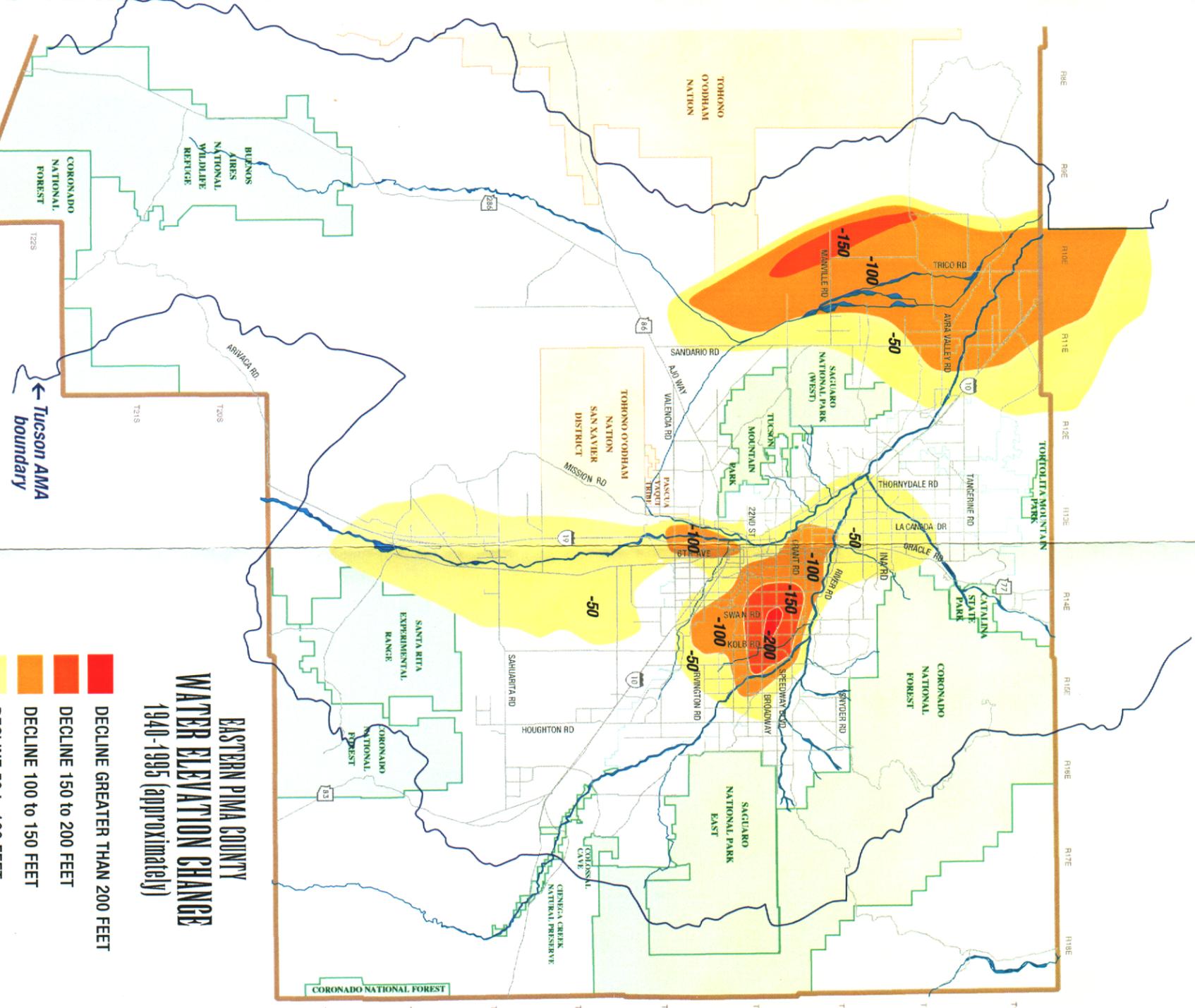
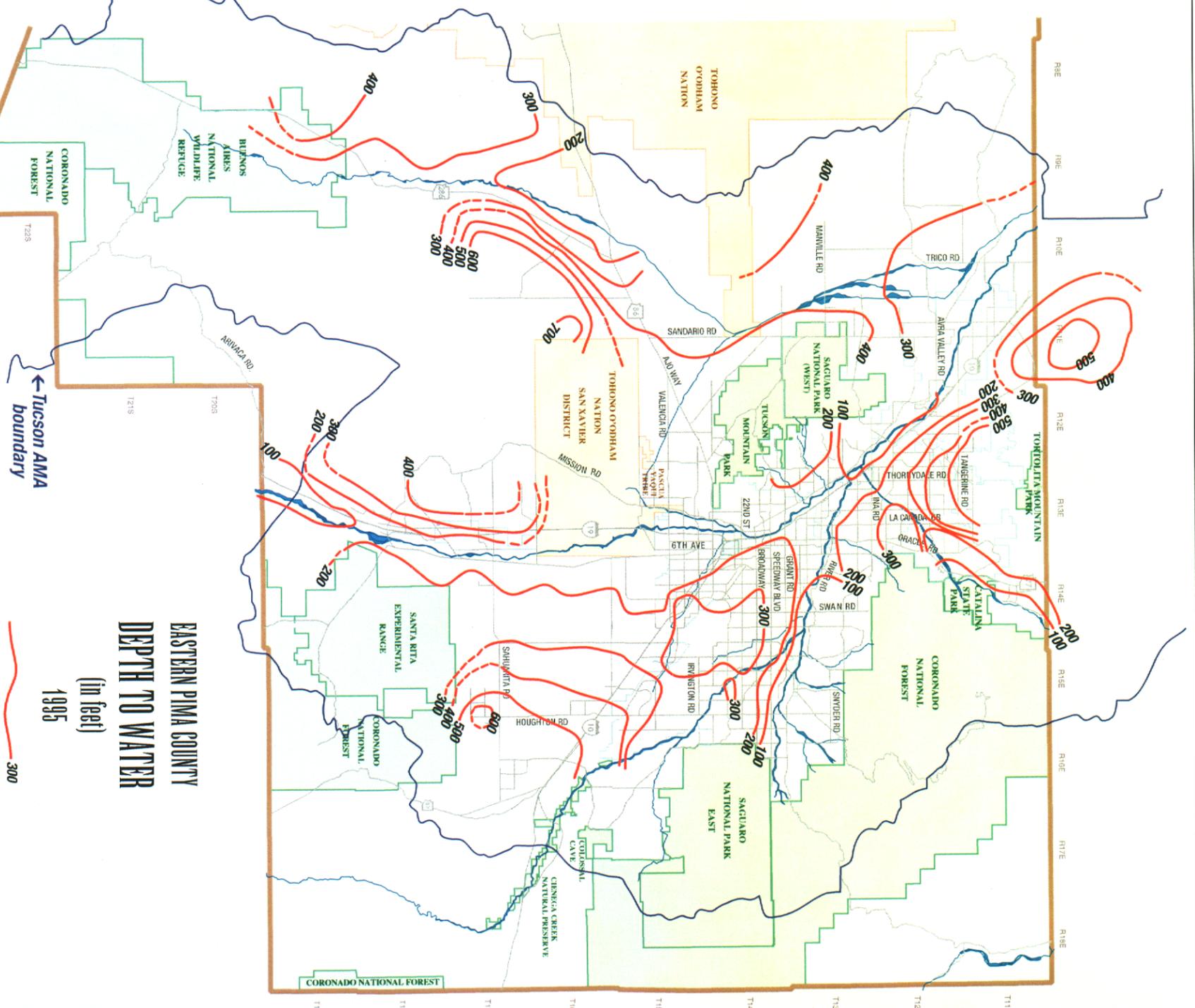
In deserts evaporation rates greatly exceed precipitation. Although most rainfall evaporates, a small fraction of that water goes into storage underground perhaps to fall again in another place and time. Water stored underground is less susceptible to evaporation. If the water goes into storage in the soil, it is available to plants for their growth during periods where no rain falls. Water in the first ten feet or so of soil and rock will be used by plants and any excess will be available to pass deeper. Water that passes into deeper strata has a good chance to go into longer-term storage, and ultimately, into the aquifer. In a healthy water cycle, rainfall is absorbed by soil, and evaporation and runoff losses are minimized. The soil, in effect, helps to buffer the landscape against both flood and drought.

Water which reaches the aquifer is said to be "recharged". The opposite phenomenon is "discharge"--and this slow release of water from our aquifer is what sustained year-round flow along the Santa Cruz, Rillito, Tanque Verde, and Pantano watercourses. In a natural state, long-term recharge to the aquifer would be balanced by discharge to springs and rivers. Thousands of years ago, people learned how to use this water to irrigate crops. Streamflow diversions used the water table's discharge to produce food for people during times when water would otherwise be unavailable for farming. Necessarily, this method could only sustain a population that was regulated by the discharge rate, and the technology available at the time.

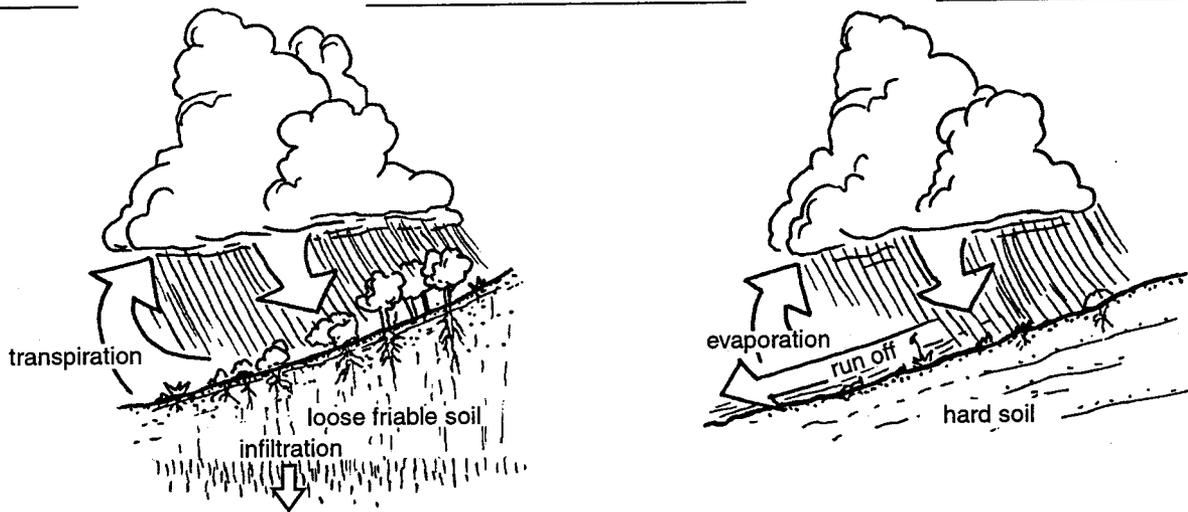
The invention of fuel-driven pumps allowed people in the desert to take water faster than natural discharge would allow, and the lack of surface water motivated them to do so. In the Tucson Basin, pumped water began to be used extensively around the turn of the century. The pumps were installed in shallow wells near the river and began to deplete stream flow and lower the water table. By 1940, most of the Tucson Basin's flow was depleted. Population growth was increasing and has continued throughout the century.

⁹ In 1915, approximately 123,000 acre-feet of water was pumped statewide; in 1923 over 500,000 acre-feet of water was pumped, and withdrawal exceeded recharge for the first time.

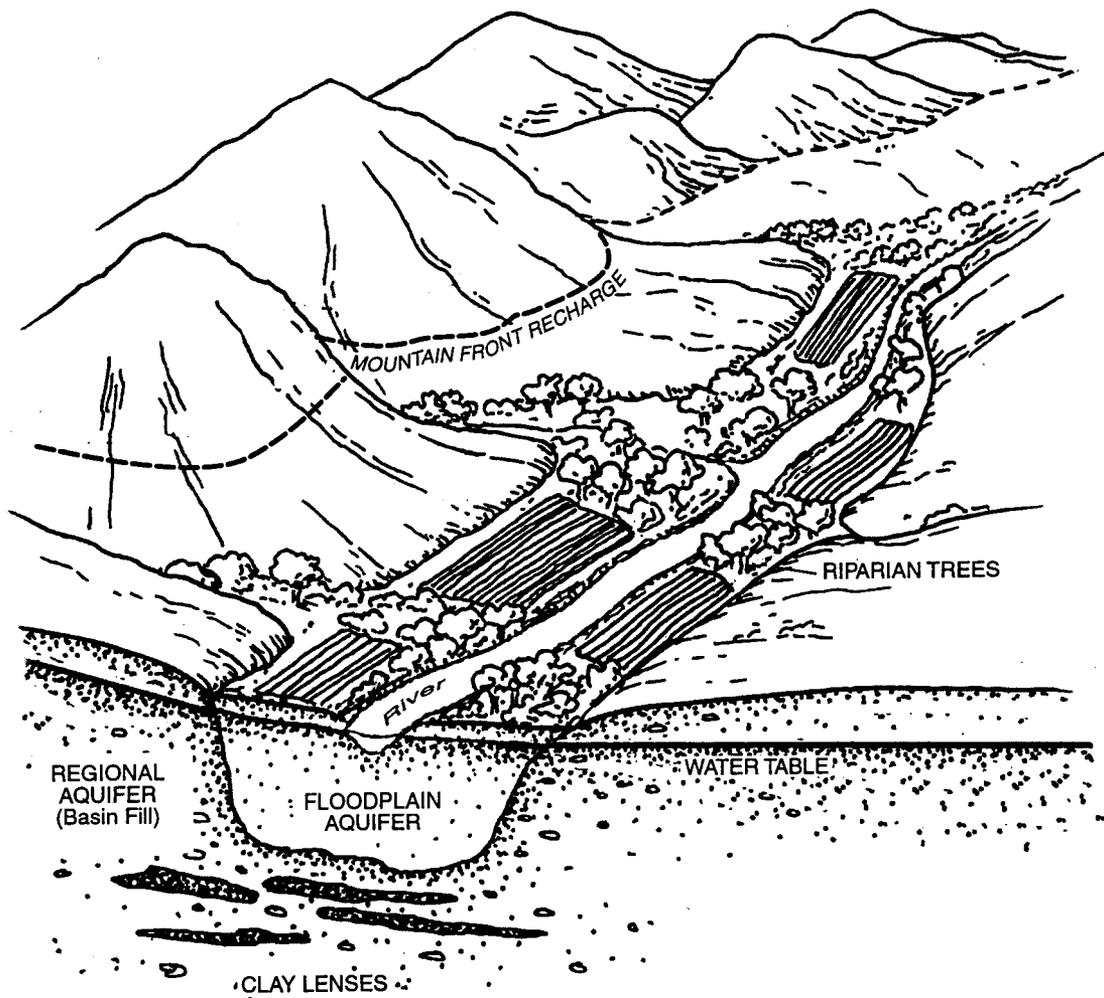
¹⁰ April 1999 Auditor General's Report of the Arizona Department of Water Resources, citing the Tucson Active Management Areas' Draft Third Management Plan.



DEPTH TO WATER 1995
 WATER ELEVATION CHANGE 1940-1995
 Figure 1



How soil conditions affect the water cycle



Schematic showing recharge and discharge processes along a perennial stream

B. Accommodations for Population Growth and Growing Ambitions for Water Use.

Given the highly technical nature of groundwater depletion data, it is easy to lose perspective on the scope of the problem. As described earlier in the text, courts were aware of the scarcity issue. But when public declarations about water availability from newspapers dating back to 1880 are reviewed, it becomes apparent that as a community we badly misjudged the long term ability of this resource to sustain municipal and agricultural purposes.

In 1880, for example, the City of Tucson ran advertisements to sell off lots to meet the demands of population growth, reported to have doubled in the six months previous. These parcels were promoted as "the most eligibly located in Tucson" for reasons including that "an inexhaustible supply of well water may be obtained at a depth of about forty feet."

In the late 1880s, the Arizona Star published a number of articles or advertisements which made claims to water resources which have since not materialized, including the following:

"There is sufficient water in the Cienega at Pantano to irrigate fifty thousand acres of land. This water can be parlayed on the mesa lands east and south of Tucson at no great outlay of money."¹¹

"The water questions in Pima County is practically determined. The Santa Cruz, the Cienega, the Rillito, the Sonoita, all discharge sufficient water to irrigate all the lands tributary to these streams. The great stretches of mesa land in western Pima can all be brought under cultivation, as there is abundant water at all depths which can be raised by pumping machinery and at no greater expense to the agriculturalist than the present canal system. Pima county will during the next ten years, prove to be a wonderful agricultural region."¹²

"What Pima County Will Produce? It would be easier to tell you what will not grow than to tell of all which will grow and grow exuberantly, as well. ... First there is no crop which will return so good a profit as alfalfa. Six and seven crops per year is the rule, averaging two tons of cured hay to each cutting per acre. Once well started, nothing is required of it save an occasional irrigation. ... The water of the river holds in solution certain salts which keep the land in a high state of fertility. Barley and wheat give abut 30 bushels to the acre and corn a little more. Beans from three to four thousand pounds to the acre. ... We have vegetables of all kinds during every month in the year. Our ponds and lakes are filled with carp, whose rapid growth is wonderful, reaching five pounds and more in three years." (1888)

¹¹ Arizona Weekly Star, July 28, 1887, Ted Knipe Collection.

¹² Arizona Weekly Star, June 14, 1888, Ted Knipe Collection.

The City of Tucson and Pima County, Arizona.

many opportunities in Arizona for the honest, temperate and industrious of all c
 there are thousands of acres of land upon which crops of an, hundred fold can be
 Farmers, mechanics and laborers can work in the open air every day in the year if they choose, as there are no snow storms or hillside winds to hinder. It takes little fuel in winter or costly over-crowding to protect one from cold in winter. It does not require the work of the summer and fall to supply the labor for the winter. There is not a single industry which is over-crowded, hence opportunities are necessarily good.

Tucson is the second oldest City in the United States. It was located and settled by the early Christian Fathers about the same time that Saint Augustine, Florida.

All its surroundings, the pure atmosphere, the altitude; the agricultural and mineral resources no doubt led the Fathers to believe that this location was a natural commercial point, as well as remarkable for its preserving climate.

Its altitude above sea level, is 2,403 feet. The climate is dry and pleasant during the entire year. During the months of June, July and August the average temperature is about 95 degrees, but there is so little humidity in the atmosphere, that little or no inconvenience is experienced. The heat is not oppressive, and during these months it is much more pleasant than in the Atlantic seaboard cities.

This pleasing semi-tropical atmosphere is probably owing much to the physical conditions which are prominent. The Santa Catalina, the Rincon and the Santa Rita mountains, form a circle of high mountains curving three-quarters around this immense valley to the west of which stands another range, all of which prove a complete barrier to storms which maintain the equilibrium of the climate of this great sub-tropical basin, and which contains an area of thirty miles square.

While three of the summer months are warm during the day, the nights are always cool. This is on account of the rarified condition of the atmosphere which becomes instantly cool after setting of the sun.

The Fall, Winter and Spring months can be compared with the Italian climate, little or no frost. Flowers bloom during the entire Winter months; grass is green and much of the shrubbery retains its foliage.

It is plainly to be seen that such a climate must be health restoring. It is a fact worthy of note that every hundred of people who come here to the mountains of pulmonary troubles recover in a few weeks they are enabled to engage in business. Many of the most prosperous, pushing and wealthy business men of our Western States, their northern homes, have been rendered infirm invalids, with the hope of being cured. They are now in robust health and prosperity. As compared with the climate of Florida or Arizona, Tucson and its surroundings are far superior in every respect and much the better of all invalids who have seen both climates as equal trial.

BUSINESS INDUSTRIES.

Tucson has four wholesale establishments, two of which are grocery houses; about sixty retail grocery stores; three dry goods houses; two drug stores; two large tin manufacturing establishments which carry all kinds of stoves, hardware etc.; book and stationery store; five good hotels; ten lodging houses and a tannery. A large machinery depot and machine shop, and the Southern Pacific shops and headquarters of the Gila and El Paso Division of the Southern Pacific Railroad.

An ice manufactory which supplies its products to the citizens of Tucson, and all local settlements within a radius of one hundred miles of the place.

Two photographing establishments, sampling works, reduction works, a fine City Library which is well patronized, and the most magnificent Court House and School Building in Arizona.

There are fifteen practicing lawyers in Tucson, six physicians and surgeons, two dentists, two Methodist preachers, one Congregational, two Baptist and several Roman Catholic priests. The public schools employ from ten to twelve teachers at salaries ranging from \$65 to \$125 per month. A school month is twenty days of six hours each.

There are three flouring mills, two lumber yards, three wagon-making establishments connected with machine and blacksmith shops.

WHAT WILL PAY IN TUCSON.

A woolen factory, for wool is produced largely in Arizona and Sonora.
 A soap and candle factory, for the consump-

tion of these articles is very large.
 A shoe manufactory, as leather is manufactured here at lowest prices.

It is the County Seat, the location of the Surveyor-General's office, also the United States Land Office and the Territorial University, which is about to be erected; also the Indian Educational Institution which is now being built.

St. Joseph's Academy and the Parochial School are two popular Catholic institutions and are well patronized. They employ ten teachers.

There are four churches well supported.
 There are within the City two large public parks.

The City is supplied with water from the Santa Cruz, and gas is furnished by an incorporated company.

There are two daily and three weekly journals well supported.

All industries are represented in Tucson, such as an enterprising frontier City of 10,000 inhabitants must necessarily contain.

It is the center of a series of large mining districts, the Rincon and the Santa Rita, and a most magnificent agricultural region, which is awaiting the coming of the eastern farmer to utilize it.

There is no point between Galveston and Los Angeles with so bright a future as Tucson. All the conditions point to the fact that this will be the commercial center of Arizona.

WHAT PIMA COUNTY WILL PRODUCE.

It would be easier to tell what will not grow than to tell of all which will grow and grow exuberantly, as well.

The actual experience of several gentlemen, any of whom will give information on the subject, has demonstrated that the Santa Cruz Valley has an untold world of wealth awaiting those who have the pluck and energy to put their hands to the plow.

First there is no crop which will return so good a profit as alfalfa. Six and seven crops per year is the rule, averaging two tons of cured hay to each cutting per acre. Once well started nothing is required of it save an occasional irrigation. The farmers in the valley sow their barley and wheat in November, harvesting the same in May and June of the following year, then plant this same land in corn, beans or potatoes, and get a second crop each year off the same land.

The water of the river holds in solution certain salts which keep the land in a high state of fertility. Barley and wheat give about 30 bushels to the acre and corn a little more. Beans from three to four thousand pounds to the acre. Sugar cane and sweet potatoes grow thrifflly and pay a handsome return to the grower. Upland rice has been tried by some and yielded large returns of good quality.

The lands on the mesas are admirably adapted to fruit—peaches, pears, plums, apricots and nectarines do exceptionally well, producing as finely flavored fruit as is known in any part of the United States.

The small fruits, such as strawberries, blackberries etc., do well. We have seen Nelson seedling strawberries grown in the open air in March. All fruits ripen some weeks in advance of California.

We have vegetables of all kinds during every month in the year. Our ponds and lakes are filled with carp, whose rapid growth is wonderful, reaching five pounds and more in three years.

TUCSON A MINING CENTER.

Tucson is surrounded by a wonderful mining country. To the north of us but a few miles is the Santa Catalina range of mountains with gold, silver and copper veins, many of which are being developed. The Tortillas to the west of the Santa Catalinas, has many promising silver and copper mines, some of which are giving a steady out-put of bullion.

The Silver Bell District, some thirty miles west, is noted for its wonderful copper ledges as well as some rich silver mines. The rise in the price of copper will make this a most important wealth producing district in Pima county.

To the west and south of the Silver Bell is the Gunsight and the Quipasa districts with miles of silver and gold ledges, some of which are being worked and others under development.

The Tucson range, immediately west and south of the valley is threaded with silver veins, and copper deposits are very numerous. The Olive Camp, twenty miles south, is the richest chloriding camp in the Territory, from which many thousand dollars worth of ore is extracted and shipped monthly. The Sierra district, south and west of the Olive district, is rich in silver veins. Cababi district, fifty miles south of Tucson, has some fabulously rich silver mines, gold quartz veins and placers, also large, but low grade copper veins.

Arivaca and Oro Blanco districts are covered with most promising silver and gold veins, many of which are being worked on the chloriding principle.

The Santa Rita mountain range, from twenty to forty miles south of Tucson has for many years been known to be one of the most promising mineral fields of Arizona in both gold and silver. A large amount of work has been done on the mines in several districts in this mountain range and many promising mines are opened. The gold placers in the vicinity of Gatesville, on the south side of the mountains, produce annually many thousands of dollars in gold dust.

The Patagonia range of mountains contains two important mining districts—the Harshaw and Washington. Large quantities of bullion have been produced from the mines of these districts and at present chloriding is being carried on extensively. The district is noted for its mammoth lead veins, which will ultimately make it famous.

In the Empire district, some thirty miles southeast of Tucson, are a number of good mines which have been well developed. There is some profitable chloriding being carried on in the Empire district. There are many other districts in Pima county and in them many promising mineral prospects, all that is necessary is well directed capital to make the mines of these districts profitable by making them bullion producing. Pima county is a wonderful mineral region in silver, copper and gold. Her mountains all contain some of the metals in profusion.

INQUIRIES ANSWERED.

We have received numerous enquiries as to cost of living, wages and general opportunities or working people in Arizona. As a rule labor of all kinds is well paid. All kinds of mechanics receive from \$2.50 up to \$5.00 per day. Millers from \$2.50 to \$3.50. Stone masons, carpenters, plasterers, paper hangers from \$3 to \$4.50. Farm hands from \$50 to \$40 per month and board. Domestic from \$10 to \$15 per month. Ordinary laborers from \$7 to \$12.50 per day. Salesmen from \$30 to \$100 per month. Bookkeepers from \$50 to \$75. School teachers from \$50 to \$700 per school month of twenty days. Lawyers, doctors and ministers receive a liberal support. Cost of living is just about one-third more than in the east. Lodging in private houses from \$5 to \$15 per month; in hotels from \$15 to \$30 per month. Furnished rooms rent from \$6 to \$20 per month according to location and furniture of rooms. Clothing, and dry goods generally are 10 per cent higher than in the thickly populated States. Groceries of all kinds about 20 per cent higher.

The professions, including the political, are pretty well filled.

To all and any who contemplate coming to this land of sunshine and comfort, we would say: If you are willing to work and be thoroughly honest and as economical as in the eastern States, you will find fortune, comfort and contentment. But if you expect to fall into fortune through sheer luck, without any business qualifications, without a willingness to pull off your coat and go to work and save the earnings of your toil, we would say, stay where you are as we have no alms-houses in Arizona, neither have we any lottery schemes, for here fortune only favors the brave and industrious.

No Industrious man or woman need wait long for steady employment and for such there is a comfortable little fortune to be made in Arizona if the ordinary rules of economy are observed. The principal industries at present are farming, mining and stock raising, but the opportunities for all other kinds of unskilled and skilled labor are good. Good agricultural lands can be had with irrefragable privileges and good titles, from \$25 to \$250 per acre. As a rule with well directed industry, these lands will pay the purchaser money in from three to four years, this includes the cost of labor for cultivating the land. There are a number of business where the product of the land has given a profit in a single year greater than the purchase price. (See Send five cents in stamps for a copy of the Arizona State for Laws concerning Public Lands and other information.)

D. **CAP -- The Second Escape from the Reality of Constraints.** In sober contrast from the newspaper coverage of water availability during the century preceding adoption of the Groundwater Code, in 1980 the Legislature declared: "that the people of Arizona are dependent in whole or in part upon groundwater basins for their water supply and that in many basins and sub-basins withdrawal of groundwater is greatly in excess of the safe annual yield and that this is threatening to destroy the economy of certain areas of this state and is threatening to do substantial injury to the general economy and welfare of this state and its citizens. The legislature further finds that it is in the best interest of the general economy and welfare of this state and its citizens that the legislature evoke its police power to prescribe which uses of groundwater are most beneficial and economically effective."

The State was able to articulate this perspective and begin to regulate some uses of groundwater only after it appeared that the federal government was going to pull the plug on Arizona's Colorado River allocation by withdrawing support for the construction of the Central Arizona Project. Today, water from the Colorado River slated for delivery through the Central Arizona Project is considered a major water resource in central and southern Arizona. Most descriptions of water sources in Arizona are similar to this one found in the 1997 Town Hall report entitled Ensuring Arizona's Water Quantity and Quality into the 21st Century: "Arizona has four primary sources of water: (1) surface water captured from in-state rivers and streams; (2) water drawn from the Colorado River that is either diverted to adjacent farmlands or is distributed through the Central Arizona Project (CAP); (3) groundwater mined from ancient underground aquifers; and (4) effluent or reclaimed water. Arizona currently consumes approximately 6.8 million acre-feet of water, with 1.5 million acre-feet supplied by surface sources and 2.8 million acre-feet supplied by the Colorado River. The balance of our water needs are filled by pumping groundwater, a finite and diminishing resource, and reusing effluent, a small but growing water resource."¹³

Colorado River water allocated through the Central Arizona Project created a second escape hatch from the reality of water constraints -- referred to by one leading scholar as "Arizona's last waterhole."¹⁴ Though not a resource fully utilized within Pima County, the Central Arizona Project dates back to the Colorado River Compact of 1922 when the states within the Basin divided up the river.

Related landmarks since 1922 include: (1) 1944: Twenty-two years after the Colorado River Compact, Arizona contracted with the Secretary of the Interior for delivery of 2.8 million acre-feet per year of Colorado River water; (2) 1964: Within another two decades, the Supreme Court decided the case of *Arizona v. California*, which cleared the way for Congress to construct the aqueduct to carry Colorado River water to central and southern Arizona; (3) 1980: In 1980, the Groundwater Management Act was passed in Arizona

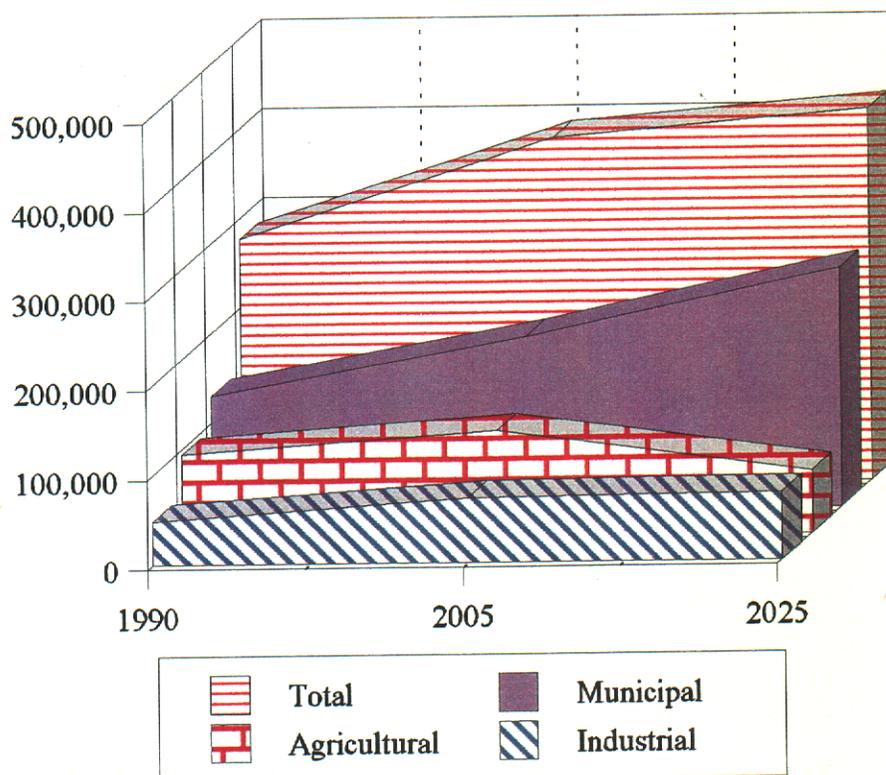
¹³ Wright, *Managing Water in Arizona: Making Tough Choices*.

¹⁴ Leshy, *The Nexus Between Groundwater and Surface Water in Arizona* (1989).

when Congressional funding support for CAP water availability was in jeopardy; (4) 1982: In 1982, the Southern Arizona Water Rights Settlement Act obligated Interior to deliver 66,000 acre-feet of water per year to the San Xavier and Schuk Toak Districts of the Tohono O'odham Nation. A total of 37,800 acre-feet is CAP water suitable for agricultural purposes while 28,200 acre feet is effluent which the Secretary will use to secure other water sources.

CAP and other water facts include: (1) The total CAP allocation for the Tucson Active Management Area (including Native American allocations) is 215,463 acre-feet per year, of which 138,920 is allocated to Tucson Water. (2) In the mid-1990s, 64,000 acre-feet of effluent was produced in the Tucson AMA annually, but only 11,000 acre-feet was put to direct use; (3) In the event of a water shortage in the Colorado River, Arizona will receive less than its allocation because Arizona has lower priority than other states; (4) According to the Third Management Plan, if 1995 conditions continue, then in the year 2025, municipal consumption alone in the Tucson Active Management Area is projected to be 267,100 acre-feet, while industrial use is projected to require 75,900 acre feet and agriculture is projected to require 70,000 acre-feet of water.

**Tucson Active Management Area
Projected Water Demand in Acre-Feet***



E. **The Unmet Promise of the Groundwater Code.** In 1910, the hydrologist G.E.P. Smith offered these insights which took seven decades to be codified and still are not in force almost 90 years after publication: "It may be questioned whether it is right to draw more heavily from the groundwater supply than is reasonably certain of renewal each year. ... [What is needed is a] systematic cooperative effort on the part of the landowners of the valley. In no other way can all of the valley land or even a considerable part of it be irrigated. In no other way can the petty annoyances due to underpumping of private wells be obviated. The welfare of the community as a whole demands that the development of the groundwater shall be along broad and comprehensive lines rather than dependent on conflicting individual interests."¹⁵

A 1960 refrain to Smith's insight is found in an article by Dean Mann in the Arizona Law Review entitled *Law and Politics of Groundwater in Arizona*, which concludes: "In spite of the adage, 'When the well is dry, they know the worth of water,' it does not appear that Arizonans have yet fully realized their dependence on this vital commodity. Many assert the need for planning and adoption of practices needed to conserve the limited supply of water but there has been little initiative in planning. It appears that economic forces will dictate the utilization of water ... [but it is] questionable that decisions concerning the very basis of the economy -- the water supply -- should be made solely on that basis. It would appear necessary to adopt a policy which would subordinate short-run economic interests to the long-run future of the State's economy. Such a policy should provide for the most efficient utilization of the existing water supply and whatever adjustments might be required."

Best Laid Plans: In 1980, the State adopted the Groundwater Code in order to retain federal support for the Central Arizona Project. At least on paper, the Code offers the promise to fulfill Smith's 1910 prescription for addressing groundwater conservation within a comprehensive framework. In overly simplified terms, the conservation goals for groundwater are implemented in the following way:

- 1) The Groundwater Code establishes Active Management Areas (AMA).
- 2) The Tucson Active Management Area has a goal of "safe yield" by the year 2025, which would mean that groundwater withdrawals are not in excess of recharge of an aquifer (by artificial or natural means).
- 3) To assist in reaching the safe yield goal of the of the Tucson AMA, the laws, along with rules promulgated in 1995, require that subdivisions of land must demonstrate an assured water supply for 100 years.
- 4) In effect, development based on groundwater should not be possible in the Tucson AMA because the rules require that:

¹⁵ Groundwater Supply and Irrigation in the Rillito Valley, 1910. (Pp. 195-196)

- (a) the assured water supply be physically, continuously and legally available to the applicant; and
- (b) groundwater will not be considered "physically available" if the applicant's pumping along with other withdrawal activity in the area causes the groundwater level to drop below 1000 feet after 100 years.

Continuation of Groundwater Depletion and the Illusion of Safe Yield

In 1996 the Board received a memorandum from County staff which advised that Pima County participate in water management issues since "successful implementation of a program to steer the region to safe yield, as mandated by the 1980 Groundwater Management Act, is stalled [and] the lack of a coherent water management strategy for the region makes it imperative that each jurisdiction carefully monitor and participate in the development and implementation of regional water policy."¹⁶

Three years later the State of Arizona Office of the Auditor General confirmed the perspective that the Tucson AMA was not on track to achieve safe yield, after completing an audit of the Arizona Department of Water Resources. The report makes the following findings:

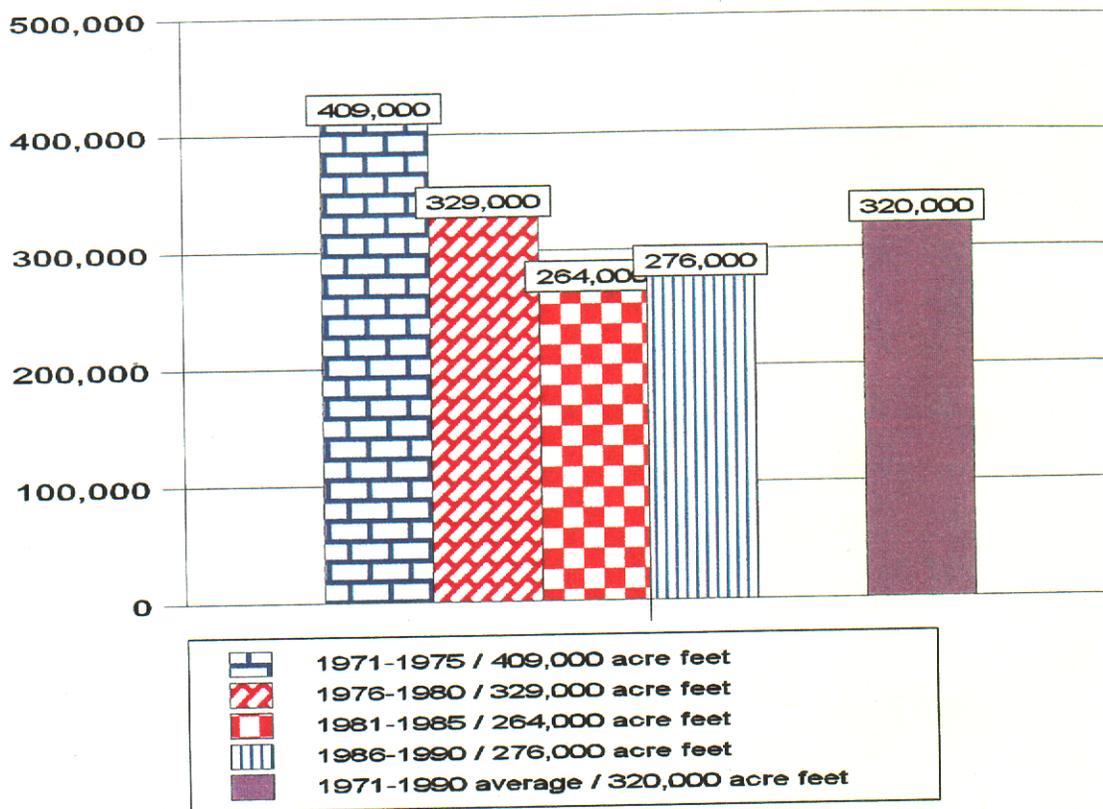
- 1) "Under the current regulatory structure, the statutory goal of 'safe yield' will not likely be achieved by 2025 for the ... Tucson area."
- 2) "[E]ven if the ... Tucson AMA meet[s] all requirements of the Management Plan currently being developed, [it] will not achieve this safe yield by 2025 because the Groundwater Code contains a number of statutory restrictions and exemptions that limit the AMA's ability to achieve safe yield. These include the following:
 - (a) The Code created grandfathered rights, mainly for agricultural and industrial users.
 - (b) Agricultural users with grandfathered rights can accrue credits for unused groundwater and carry credits over for future use. These credits have created a lien against the groundwater supply that, if used, could increase groundwater depletion In 1997, credits in the Prescott, Phoenix, and Tucson AMAs totaled more than 6 times the total groundwater consumption of all users in these AMAs in 1995."

The Arizona Department of Water Resources stated in the Third Management Plan that:

"Groundwater use in the Tucson AMA currently exceeds the rate of natural and incidental recharge by a factor of two. The water budgets ... illustrate that based on current projections of water use, the Tucson AMA may not achieve safe-yield by 2025 unless additional management efforts are undertaken. Attainment of safe-yield will require optimal use of Central Arizona Project (CAP) water and effluent currently available to all municipal users in the AMA in place of groundwater."

¹⁶ February 13, 1996 Memorandum to the Board of Supervisors.

AVERAGE ANNUAL GROUNDWATER WITHDRAWALS



Other indicators of the difficulty of implementing a safe yield program exist. After an initial reduction in groundwater withdrawals within the Tucson AMA following passage of the Code, levels have been on the rise once again as the chart above shows.¹⁷

More recently, 1994 data indicates that of the 314,000 acre-feet of water used in the Tucson AMA, 279,000 came from groundwater; 24,000 acre-feet came from CAP water; and 11,000 acre-feet came from effluent, although almost 6 times that amount effluent was available.

¹⁷ Geography of Water Availability, DeKok (1997)

3. Problem of Damage to Riparian Systems

A. Current Riparian Status and the Implications for Conservation Planning. The water law and policy that developed over the past century failed to describe physical conditions, and failed to prescribe a long term resource protection policy. As the map on the next page shows, we have -- since 1890 -- completely eliminated the presence of cienegas and riverine marshes, and largely eliminated perennial flows from the Santa Cruz Valley in Eastern Pima County. In the space of 100 years, we have lost most of our aquatic and semiaquatic habitats. This section places the rapid change of the last century in the context of on-going change within the ecosystem. Pima County's landscape is constantly changing in response to climate and ongoing evolutionary processes. The plant and animal communities we see today have been shaped by several profound events, namely: (1) the end of the glacial period; (2) the advent of people to the New World; and (3) the dramatic increase in human population and technology during the last 100 years or so. These changes are discussed below.

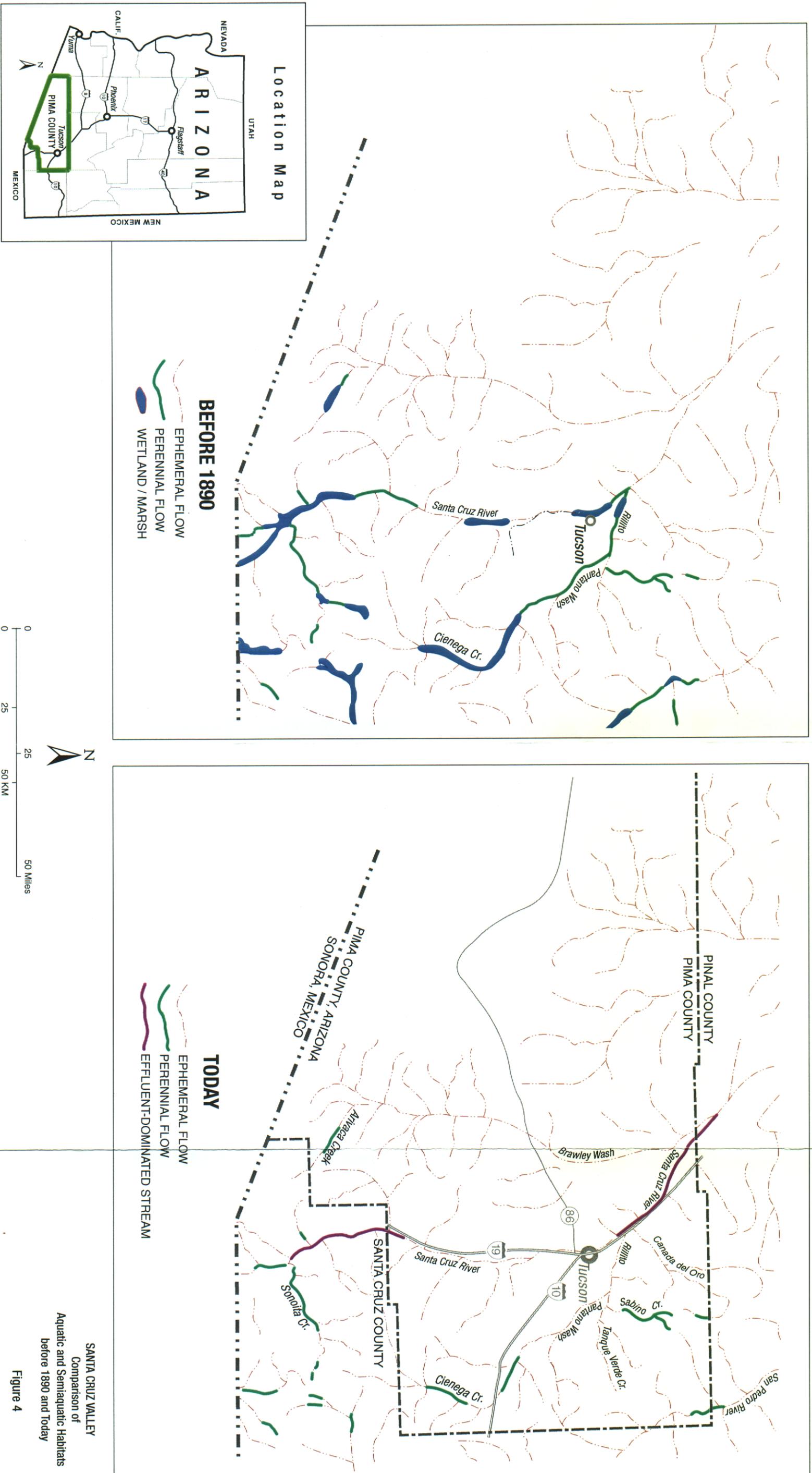
Historical Backdrop: We live in what is known as an interglacial period. Our modern climate is the driest, warmest period during the last 32,000 years (Van Devender et al., 1991). Pinyon pine, juniper, and oak trees grew on the slopes of the Waterman and Ajo Mountains 10,000 to 20,000 years ago; douglas fir and ponderosa pine grew on Pontatoc Ridge at the base of the Catalina Mountains (Van Devender, 1990). Saguaro cacti and palo verde trees arrived in Pima County beginning approximately 8,900 years ago, when the climate warmed (Anderson and Van Devender, 1991). Interglacial periods are short relative to glacial periods (10,000 vs. 100,000 years), heightening the significance of conserving biological diversity during our time.

The plant communities 8,900 to 4,000 years ago differed from today. For instance, plants now typical of riparian areas such as catclaw acacia (Acacia greggii), blue palo verde (Cercidium floridum), and velvet mesquite (Prosopis velutina) grew on exposed slopes. As more modern-looking desert scrub communities formed around 4,000 years ago, the species discussed above retreated to the riparian zones and subtropical species moved northward from Sonora, Mexico. Until approximately 13,000 years ago, southern Arizona hosted a much wider array of herbivores and carnivores, including bison, mammoth, horse, camel, lion, tapir and dire wolf (Martin, 1999). Some have argued that the advent of people to the New World not only coincided with the demise of these species, but that prehistoric hunters were responsible for the abrupt extinction of these and other large mammals (Martin, Klein, 1984). More recently, Pima County residents have witnessed profound changes, particularly in grasslands and riparian areas during the period 1870 to 1960. Many areas of native grassland became covered with creosote bush and mesquite scrub, non-native grasses increased, the incidence of wildfires decreased, and several grassland predators and herbivores were eliminated (Bahre, 1995). Widespread livestock grazing reduced the grassland cover after 1880, which provided fine fuels for fires, nearly eliminating fire as a disturbance process (McPherson, 1995). Beginning in 1880, many of the major watercourses began to incise their floodplains, and massive soil erosion ensued.

SANTA CRUZ VALLEYS AND SAN PEDRO RIVER, ARIZONA

Comparison of Aquatic and Semi-aquatic Habitats before 1890 and Today

(after Hendrickson and Minckley, 1984)



After passage of the Taylor Grazing Act in 1934, the federal government began livestock programs aimed at maintaining production of forage for cattle, while reducing soil erosion. Techniques included contour plowing, fencing, burning fire suppression, herbicides, construction of check dams, predator and rodent control, and bulldozing of woody shrubs, such as mesquite (Bahre, 1995).

They also introduced non-native grasses for forage and soil erosion control, such as Lehmann's lovegrass, Bermuda grass, and johnson grass. The 200 hectares of Lehmann's lovegrass seeded on the Santa Rita Experimental Range has spread to 90% of the Range (Anable et al., 1992). The Soil Conservation Service seeded over 70,000 acres of the Avra-Altar watershed with Lehmann's lovegrass, and it remains the dominant perennial grass for over 60,000 acres today (Robinett, unpublished manuscript).

Changes in the desert and forest areas outside the urban and riparian areas have been less obvious. The changes include losses of saltbush communities to agriculture (Turner, 1974), and loss of saltbush and galleta grass stands by grazing (Rutman, 1998).

The spread of the invasive buffel grass may alter the composition of desert scrub by promoting a regime of recurrent fires to which palo verde-saguaro plant communities are not adapted (Burgess et al., 1991). A good example of this ongoing conversion of desert scrub to an exotic grassland can be seen at Sentinel Peak, where the slopes are turning tawny with the advance of the buffel. Hunting and sheep grazing contributed to the demise of bighorn sheep populations in the Tucson Mountains, and the population in the Catalina Mountains has also been recently lost.¹⁸

¹⁸Sources: (1) Anderson, R. S. and T. R. Van Devender, 1991. Comparison of pollen and macrofossils in packrat (*Neotoma*) middens: A Chronological sequence from the Waterman Mountains of Southern Arizona, USA: *Review of Paleobotany and Palynology* 68: 1-28. Amsterdam: Elsevier Science Publishers; (2) Bahre, C. J., 1995. Human impacts on the grasslands of southeastern Arizona; (3) Burgess, T. L., J. E. Bowers and R. M. Turner, 1991. Exotic Plants at the Desert Laboratory, Tucson, Arizona. *Madroño* 38: 96-114; (4) Clemensen, A.B., 1987. Cattle, copper and cactus: the history of Saguaro National Monument, Arizona. Historic Resource Study, National Park Service, Denver. 271 pp.; (5) Martin, P.S., 1999. Deep history and a wilder West. *Ecology of Plants and Plant Communities in the Sonoran Desert*. University of Arizona Press, Tucson; (6) Martin, P.S. and R.G. Klein (editors), 1984. Quaternary Extinctions: A Prehistoric Revolution. University of Arizona Press, Tucson; (7) McPherson, Guy, 1995. The role of fire in the desert grasslands in *The Desert Grassland*, M. P. McClaran and T. R. Van Devender. Tucson: University of Arizona Press, pages 130-145; (8) Robinett, D., no date. *The History, Soil and Plant Resources of the Altar Valley*. Unpublished manuscript, USDA Soil Conservation Service, Tucson; (9) Rutman, S. 1996. An Assessment of accelerated erosion and its management at Organ Pipe Cactus National Monument. Intern report for Harold Smith, Superintendent; (10) Turner, R. M., 1974. Map showing vegetation in the Phoenix area of Arizona. Map I, 845-1. Miscellaneous Investigation Series, 1: 250,000. U.S. Geological Survey, Reston, Virginia, U.S.A; (11) Van Devender, T. R., 1990. Late Quaternary vegetation and climate of the Sonoran Desert, United States and Mexico in Packrat Middens: *The Last 40,000 Years of Biotic Change*.

B. **Decline of the Santa Cruz River.** Historical accounts of Tucson indicate that the Santa Cruz River flowed year-round at San Xavier del Bac and near downtown Tucson.

Near present-day Silverlake Road, there was a natural cienega/wetlands that was impounded for irrigation and later more fully developed into Warner's Lake in 1883 which covered some 50 acres. The river flow was carried downstream in series of acequias dating from the Spanish period to irrigate farmfields.

The Santa Cruz River was broad and shallow until floods in 1887 caused the river to incise Sam Hughes' water diversion channel. The ensuing incision of the floodplain caused a lowering of the water table and serious channel bank erosion. Even then, the river flowed, until it finally disappeared due to groundwater pumping in the late 1930's and 1940's.

Groundwater pumping, floodplain development, wood-cutting and habitat loss due to erosion have significantly altered the biologically rich Santa Cruz River. For example, the river lost at least six species of native fish, including the federally endangered Gila topminnow and desert pupfish. The endangered Huachuca water umbel, which grew at the base of Sentinel Peak, was also lost. The mesquite bosque (Spanish for a closed-canopy woodland) at Martinez Hill died when the water table dropped due to municipal groundwater pumping.

The bosque harbored great number of white-winged doves and other birds, and was described in these terms:

"The bottom lands on either side are covered, miles in extent, with a thick growth of giant mesquite trees, literally giants, for a person accustomed to the scrubby bush that grows everywhere in the desert regions of the southwest, can hardly believe that these trees, many of them sixty feet high and over, really belong to the same species. This magnificent grove is included in the Papago Indian reservation, which is the only reason for the trees surviving as long as they have, since elsewhere every mesquite large enough to be used as firewood has been ruthlessly cut down, to grow up again as a straggly bush."¹⁹

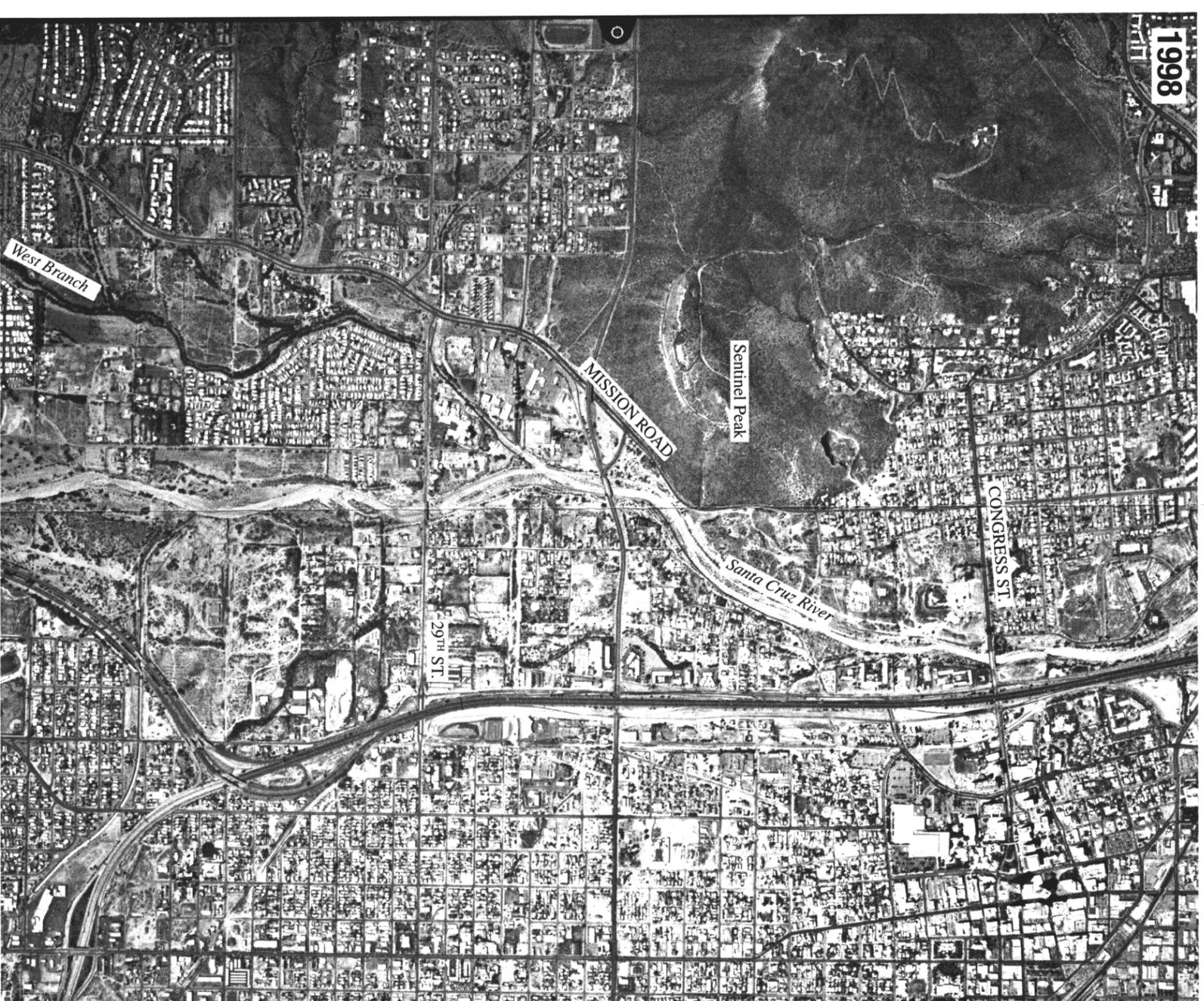
More recently, the riparian vegetation along the West Branch Santa Cruz River has been diminished through urban development and channelization. Sand and gravel operators removed huge quantities of sediment, and garbage was dumped into the pits. Many of the incised channel banks are now lined with soil-cement bank stabilization to prevent erosion.

¹⁹ Swarth, H.S. 1905. Summer birds of the Papago Indian Reservation and of the Santa Rita Mountains, Arizona. Condor 7:22-28.



Santa Cruz River at Sentinel Peak, 1941.

By this time the river was dry and most of the floodplain was under cultivation, or in the process of being urbanized.



Santa Cruz River at Sentinel Peak, 1998.

The river and its tributaries have been channelized, and most of the agricultural land has been urbanized. The West Branch is notable as one of the tributaries which has retained its natural character.

C. Decline of the Rillito River and Tanque Verde Creek. Hydrologist G.E.P. Smith (1910) provides the following account of changes in a portion of the Tucson Basin in a report entitled, *Ground Water Supply and Irrigation in the Rillito Valley*:

The oldest known effort at settlement in the Rillito Valley was that of an Arkansas pioneer who cleared a small area of bottom land just east of Fort Lowell in 1858. The entire valley was at that time unbroken forest, principally of mesquite, with a good growth of grama and other grasses between the trees. The river course was indefinite, a continuous grove of tall cottonwood, ash, willow, and walnut trees with underbrush and sacaton and galleta grass, and it was further obstructed by beaver dams.

In the fall of 1872, the U.S. Army post was moved from the military plaza in Tucson to the junction of Pantano Wash and the Rillito. There was a great demand for hay and the grass was cutoff with hoes to supply the post on large contracts. A few years of such cropping sufficed to kill it. Cattle were brought into the country during the seventies and roamed the valley and hills, destroying the root grasses and wearing trails which later became rivulets in time of rain, increasing the runoff of water to the river.

New and unusual flood cut out a wide channel, washed the big cottonwoods away, and exposed the white sand. The amount of total runoff from the land must have increased very greatly, and yet meanwhile the permanency of the small surface flow in the river was decreased. The general affect [sic] of settlement was to increase the magnitude and severity of the floods and, also, the length of the totally dry seasons. In the Pantano, the first real flood to reach the Rillito occurred in 1881, but it was much spread out over the valley and not until in the 90s was the present deep broad wash with vertical banks eroded.

Since Smith's 1910 remarks, the Rillito (Spanish for "creek") has become an ephemeral stream, the stream channel has widened considerably, and urbanization has encroached the floodplain. While the Rillito was once home to pygmy-owls, this is no longer the case.

Pima County and the U.S. Army Corps of Engineers have constructed soil-cement embankment along the channel to reduce erosion damages to private property and bridges, sewers and other infrastructure.

The Rillito Recharge Project (RRP) examined the effectiveness of natural and artificial ground water recharge in a formerly perennial stream. Under current conditions, the Rillito flows only in response to storm flows or persistent snowmelt. Near the confluence of Tanque Verde Creek and Pantano Wash, the water table can rise to the surface following large natural recharge events, such as the 1993 flood.

Feasibility studies, research and monitoring were funded by the Bureau of Reclamation, Pima County Flood Control District, Arizona Department of Water Resources, City of Tucson, and U. S. Geological Survey.

The availability, water quality and potential impacts of three sources of recharge water (CAP water, reclaimed water, and surface water from Alamo Wash and Rillito Creek) were evaluated for a project reach located between Swan and Craycroft Roads. However, Tucson Water's expressed lack of interest in recharging CAP water or reclaimed water at the site meant that the project design would be restricted to surface-water recharge only. In 1995, the District decided not to construct the stormwater recharge component of the project.

Near-surface sediments were tested using ring infiltrometers, and were found to have favorable infiltration rates. Analytical models of ground-water mounding indicated the project area would provide limited capacity for CAP recharge, if surface flows and reclaimed water were concurrently recharged.

Gravity methods were used to estimate ground-water storage change caused by natural flow events, including the January 1993 flood. The distribution of gravity changes indicated recharged water moved toward Tucson's central wellfield in the west part of the study area (Pool and Schmidt, 1997).

In the area east of Swan Road, flow away from highly transmissive stream deposits appeared to be inhibited by lower permeability sediments to the south, resulting in ground water mounding to the surface. In all, 10,900 acre-feet naturally infiltrated in the floodplain reach between Craycroft Road and Dodge Boulevard between December 1992 and March 1993 (Pool and Schmidt, 1997).

Recharge in this area is needed to increase groundwater levels upstream along Tanque Verde Creek and lower Pantano Wash, restoring the aquifer and allowing riparian vegetation to re-establish. Recharge of the central well field is also a pressing need.

On November 5, 1995 City of Tucson voters approved the Water Consumer Protection Act, which sets forth certain standards for CAP water, should it be delivered to customers for drinking purposes. The Act encourages basin and streambed recharge of CAP water and requires recharge of all ground water withdrawals from the central well field during a five-year period.

Nearly four years later, groundwater continues to be pumped from the Rillito and Tanque Verde valleys.

D. **Decline of the San Pedro River.** The San Pedro River is one of Arizona's most precious streams. Portions of the river upstream of Pima County have been designated a Riparian National Conservation Area in recognition of the significance of the river to wildlife.

The portion of the San Pedro River in Pima County contains habitat for the Southwestern Willow Flycatcher and is also potential critical habitat for the cactus ferruginous pygmy-owl.

One of the most striking changes along the San Pedro River in Pima County since 1879 is the elimination of the sacaton (Sporotolus wrightii) grassland plant community (Fonseca, 1999).

Sacaton grasslands used to occupy millions of acres of floodplains in the southwestern United States; today they cover less than 5% of their former distribution (Humphrey 1960).

In Pima County, sacaton has been replaced by mesquite, exotic grasses such as Bermuda grass (Cynodon dactylon), brome (Bromus carinatus and B. rubens) and wild oats (Avena fatua), and woody riparian plants such as tamarisk and Goodding willow.

Approximately four miles of the San Pedro River within the township have ceased to flow reliably (Fonseca, 1999).

That the river was shallow and stable enough to permit irrigated agriculture is consistent with late 19th century descriptions for the San Pedro River.

Speaking of his ranch, which encompassed the study area, C.H. Bayless (1900) said:

"About twelve years ago the San Pedro Valley consisted of a narrow strip of subirrigated and very fertile lands. Beaver dams checked the flow of water and prevented the cutting of a channel. Trappers exterminated the beavers, and less grass on the hillsides permitted greater erosion, so that within four or five years a channel varying in depth from 3 to 20 feet was cut almost the whole length of the river.

Every year freshets are carrying away new portions of the bottom lands. At present this valley is a sandy waste from bluff to bluff, while the few fields remaining are protected from the river at large and continuous expense. Thus, in addition to curtailing the area of good land, the deep channel has drained the bottoms, leaving the native grass no chance to recover from the effects of close pasturing. It also makes it more difficult to get irrigating water onto the surface of the land."

E. **Decline of Cienega Creek and Pantano Wash.** Cienega Creek originates southeast of Tucson and becomes Pantano Wash as it enters the Tucson Basin.

The Spanish words "cienega" and "pantano" both refer to the historically marshy conditions that prevailed along the length of this stream.

Arroyo-cutting along Cienega Creek began in the 1880's resulting in a channel incised 10 to 25 feet into the former floodplain. The incision led to a lowering of the water table, as indicated by the elevation of present-day groundwater discharges compared to former cienega and stream locations shown in early surveys and the disappearance of discharging springs that were noted by historic accounts (Potter, 1902).

Topographic surveys indicate that the channel had assumed dimensions similar to the modern channel geometry by 1936.

Over an arroyo-cutting period no longer than 56 years, a minimum of 4 million tons of sediment was removed from the Preserve. The deep arroyo desiccated marshlands and sacaton bottomlands.

By 1936, Soil Conservation Service maps show that erosion had widened and deepened the arroyo to dimensions similar to the present, and closed-canopy mesquite woodlands began establishing in the former floodplain.

Surface flows continued, despite the incision, because of the lack of groundwater pumping in the area and the presence of bedrock outcrops. During the late 1970's and 1980's, cottonwood and tamarisk trees became established within the channel.

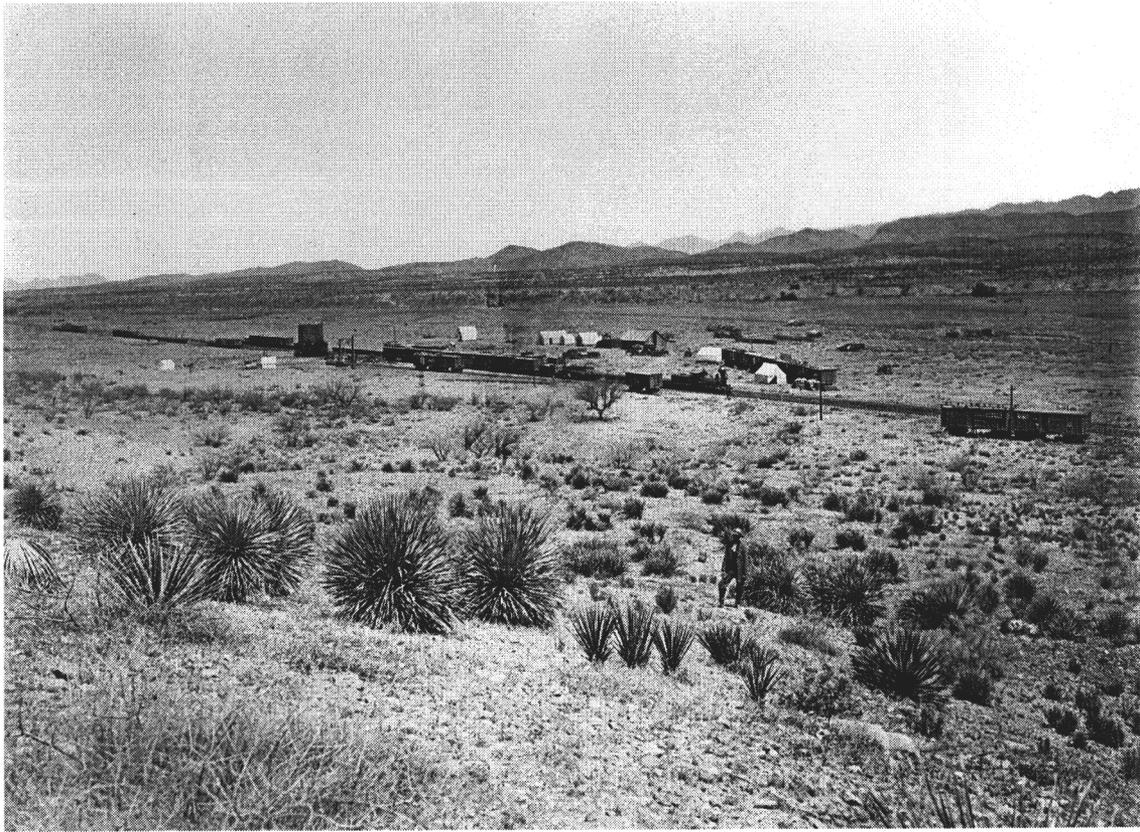
The draining of the cienegas and incision of the former floodplain has probably had profound effects upon flood hydrographs along the stream. A large amount of natural flood storage capacity was lost when the floodplain was narrowed by incision, resulting in flashier storm discharges and higher flood peaks.

Today the only perennial reaches along Cienega Creek are within the Preserve and at "the Narrows."

Perennial flow ends just downstream of a dam located in Section 14, Township 16 South, Range 16 East. An at-grade concrete arch dam extending 65 feet down to bedrock was constructed in 1911 at this location to divert subflow into a ditch to irrigate areas downstream. Today this water right is held by Estes for the development of the Vail Valley golf course.



Two boys play in Pantano Wash near Tanque Verde Road, 1934. (Photo from Ed Petrie)



Cienega Creek floodplain prior to incision, 1880. (Photo from Myrick's Railroads of Arizona)



Cienega Creek after several arroyo-cutting floods, 1887. The railroad track formerly ran around the left side of the canyon.
(Photo courtesy of the Arizona Historical Society.)

F. **Decline of Rincon Creek.** Cattle ranching and farming expanded in the Rincon Valley in the 1880s following the subjugation of the Apaches and the opening of the Southern Pacific railroad. Quicklime production in the 1900-1920 depleted palo verde (*Cercidium floridum* and *C. microphyllum*) and mesquite (*Prosopis* spp.) trees, which were being cut down to fuel the kilns (Simpson and Wells 1984; Rasmussen 1995).

Walnut trees along Rincon Creek were cut down in the 1950s for furniture-making (Briggs, personal communication). Where grazing still occurs along the more natural upper Rincon Creek, understory species are nearly absent and cattle trails across the creek have caused some bank erosion and undermining of the trees that line the channel (Rasmussen 1995; Randy Gimblett, personal observation).

G. **Decline of Brawley Wash.** When George Roskrige first surveyed the valley in 1886, he found no evidence of gullies in the valley floor (Cooke and Reeves, 1976). The Brawley Wash, an ephemeral stream, was unincised; its broad floodplain was covered with tall grass. By 1900, Johnson grass [an exotic] was well established in the valley, where it was cut for hay cut from the flooded fields of the Brawley (Robinett, no date). The road from Robles Ranch to Altar, Sonora followed the valley bottom, and may have focused the erosive power of floods to form the first arroyo.

By 1923, the arroyo varied from two to six feet deep from Pozo Nuevo almost to Anvil Ranch.

By 1937, it was up to 20 feet deep and in places 600 feet wide (Cooke and Reeves, 1976).

Presently, the depth is still 20 feet, but in places it is over 1400 feet wide.

During the course of a soil survey, Robinett (no date) found an area of 3000 acres of upland soils on the Garcia Strip which were buried by recent deposits of silt one to two and half feet thick. The volume of material eroded from the Brawley arroyo has been deposited on these ancient soils downstream.

H. **Decline of Arivaca Creek.** Arivaca Creek is a tributary draining 87 square miles of desert grassland before entering Brawley Wash. Portions of the Creek and its remaining cienega have been acquired by the U. S. Fish and Wildlife Service to add to the Buenos Aires National Wildlife Refuge. However, the town and areas to the east of Arivaca - a wildcat subdivision known as "The Forties", are also growing rapidly.

There are over 300 registered wells in the basin, with more being drilled every year. The long-term impact on the aquifer is unknown at this time, but natural recharge occurs rapidly in the basin and Arivaca Creek continues to flow perennially, indicating overdraft of the aquifer is not yet a major problem.

Most of the Arivaca watershed has been grazed continuously for the last century, and some native vegetation has been displaced by a variety of introduced plants intended to improve grazing - Johnson grass, filaree, and Bermuda grass, to name a few. Native fauna such as the Chiricahua leopard frog has also been reduced by the introduction of the exotic bullfrog.²⁰

I. **Decline of Canada del Oro Wash.** Canada del Oro Wash originates as a perennial stream in the Santa Catalina Mountains, but historically its lower reaches have always been ephemeral.

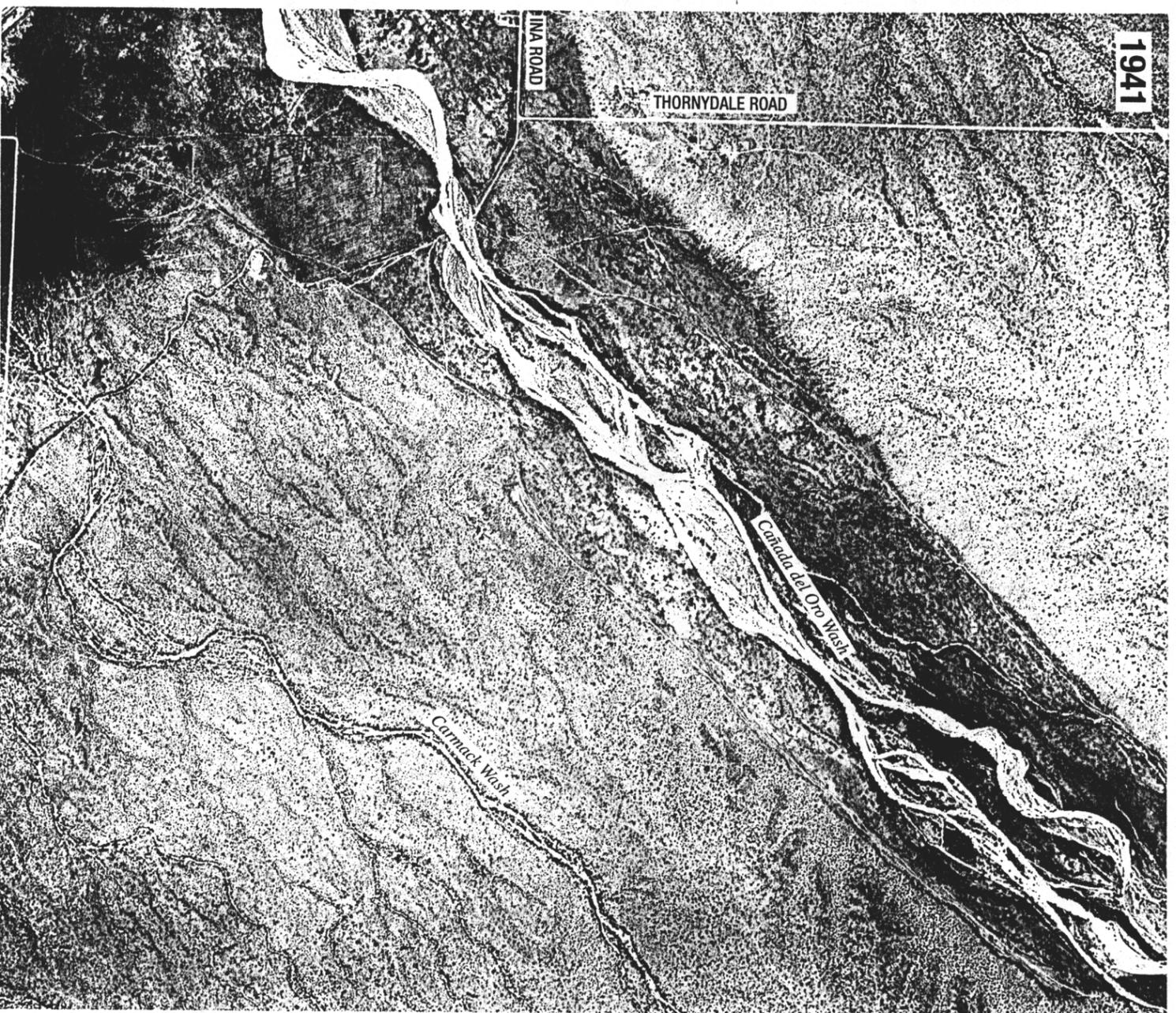
The Canada del Oro Wash is a broad floodplain offering mesquite thickets, some of which are preserved in Catalina State Park, where they are sustained by mountain front and streambed recharge.

As Tucson expanded into the lower reaches of the Canada del Oro Wash, the channel was excavated for fill, earthen dikes were constructed, and homes constructed in the floodplain.

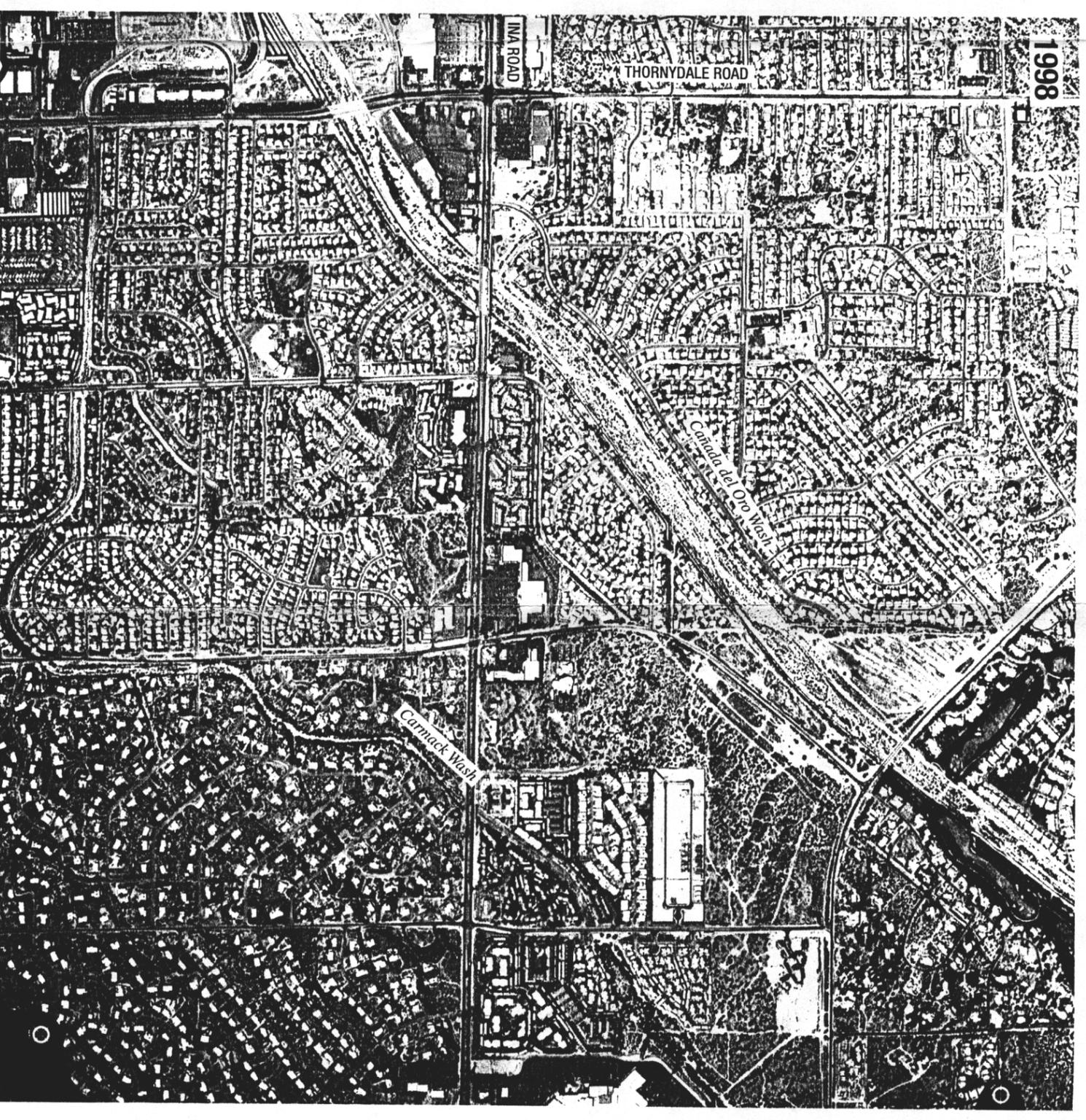
Following the 1983 flood, Pima County constructed a levee to protect Oro Valley, and a grade-control structure at Magee Road to stem channel down-cutting.

A principal tributary of the Canada del Oro Wash known as Big Wash today still retains many natural characteristics, however its floodplain continues to be encroached by homes and roadways, as the maps from 1941 and 1998 on the next page reflect.

²⁰ Sources: (1) Bayless, C.H., 1900, letter to David Griffith, December 14, 1900. Letterbook 1899-1906, 1914-19, Box 3, Bayless Family Papers, MS AZ228. Special Collections, University of Arizona Library; (2) Cooke, R. U. and Richard W. Reeves, 1976. Arroyos and Environmental Change in the American Southwest. Clarendon Press, Oxford, Great Britain; (3) Fonseca, J., 1998. Vegetation changes at Bingham Cienega, the San Pedro River Valley, Pima County, Arizona, since 1879. Journal of the Arizona-Nevada Academy of Science, Issue 2; (4) Gimblett, H. R., no date. Monitoring riparian ecosystems: An Inventory of Riparian Habitat Along Rincon Creek, Near Tucson, Arizona. Website; (5) Humphrey, R.R., 1960. Forage Production on Arizona Ranges: V. Pima, Pinal and Santa Cruz Counties. University of Arizona Agricultural Experiment Station Bulletin 302; (6) Rasmussen, B. 1995. Rincon Valley: landscape history. Unpublished manuscript, University of Arizona, Tucson. 27 pp; (7) Robinett, D., no date. The history, soil and plant resources of the Altar Valley. Unpublished manuscript, U. S. Department of Agriculture, Soil Conservation Service, Tucson; (8) Simpson, Kay and Susan Wells. 1984. Archaeological survey in the eastern Tucson Basin, Saguaro National Monument, Rincon Mountain Unit, Tanque Verde Ridge, Rincon Creek and Mica Mountain Areas in Western Archaeological and Conservation Center, Publications in Anthropology 22, Volumes I and III. U.S. National Park Service; (9) Smith, G.E.P. 1910.



Cañada del Oro Wash, 1941.
 This historically ephemeral stream had a braided channel within a broader floodplain.



Cañada del Oro Wash, 1998.
 The stream has been channelized and nearly all of the floodplain has been urbanized. The potential for large flood flows originating in this watershed to dissipate energy has been greatly reduced by the loss of the braided channel pattern and natural overbank storage areas.

4. Problem of Impact to Species

A. Decline of Species and the Interface of the Endangered Species Act. Arizona's water law and water policy direction of the past 100 years has resulted in: (1) the loss of most perennial stream flow; (2) the dramatic decline in the water table due to ground water pumping and the continued overdraft of this resource; and (3) the loss of 85 to 95% of quality riparian habitat during the last century, which negatively impacts the 85% of Arizona's wildlife population that depends on riparian habitat during some part of its life cycle. Groundwater pumping, floodplain development, and habitat loss due to erosion have significantly altered the biologically rich and diverse riparian corridors of Eastern Pima County. The losses are profound, but there are still many opportunities to recreate our watercourses as a gathering place for people and wildlife. This will be a major task of the Sonoran Desert Conservation Plan.

Within Pima County, the federal government recognizes eighteen species as threatened or endangered. Of these, at least five have been endangered by depletion of the water tables in Pima County: (1) Desert Pupfish; (2) Gila Topminnow; (3) Huachuca Water Umbel; (4) Cactus Ferruginous Pygmy-Owl; and (5) Southwestern Willow Flycatcher. Other species dependent on riparian areas that might be listed as endangered soon include (1) the Western Yellow-billed Cuckoo, (2) the Sonoyta Mud Turtle, (3) the Chiracahua Leopard Frog, and (4) the Gila Chub.

Beyond federally protected species, the April 1999 report entitled *Determining Species of Concern in Pima County* identified 49 more species of concern, and described aquatic habitat and wetlands as a target habitat for conservation under the Sonoran Desert Conservation Plan. On page 5-1, the discussion paper states: "Aquatic habitats, wetlands and riparian woodlands are considered to be a high priority for conservation planning based on discussions during the interviews [with experts from the local science community]. These ecosystems are rapidly disappearing throughout the United States, including Pima County. Diversion of water and desiccation of these habitats has caused extirpation of at least five fish species in Pima County. A large number of species listed within this report either live in aquatic or riparian habitats, or utilize them in some way. Primary threats include groundwater pumping, which has reduced water tables needed to sustain these ecosystem, and the establishment of exotics or "invader species" which inhibit growth of native species."

The federal Endangered Species Act of 1973 is discussed in greater detail in the next section. For purposes of assessing the impact of the loss of water resources and riparian habitat, it is sufficient to say that once a riparian/aquatic dependent animal is listed as endangered, the prohibition on "take"²¹ of the listed animal under Section 9 of the Endangered Species Act, if enforced, will prevent water utilization practices which can hurt, harm or harass the animal, or significantly alter its habitat.

²¹ "Take" is a term from the Endangered Species Act which means harass, harm, pursue, hunt, shoot, wound, kill, trap, collect or attempt to do any of these acts in relation to a listed species. Under the Endangered Species Act, "take" is a violation of federal law.

B. **Impact to the Pygmy-Owl.** Depletion of water tables and the loss of riparian habitat has impacted cactus ferruginous pygmy-owl habitat. Most of the major documents describing the pygmy-owl connect it to its riparian habitat based origins.

On March 10, 1997, the pygmy-owl was listed as endangered. There were only 12 known individuals, making the listing one of the most difficult in the United States. The Federal Register states that the "pygmy-owl occurs in a variety of subtropical, scrub, and woodland communities, including riverbottom woodlands."

Following the listing, Russell Duncan and Lisa Harris conducted a study of *The Ferruginous Pygmy-owl in Arizona: Historical Context, 1972-1998*. Citing Roy Johnson et al, the study found in part that "the range contraction [of the pygmy-owl in Arizona] is the result of numerous direct and indirect human-related impacts including dam construction for diversion and flood control purposes beginning in the early 1900s; conversion of both riparian and upland (non-riparian) desertscrub habitats to croplands; urban development; lowering of groundwater tables for urban and agricultural uses; and other causes."

Confirming that water is a necessary component of owl habitat is an 1898 article by George Breninger (following page). The article states that "among the growth of cottonwood that fringes the Gila and Salt rivers of Arizona this Owl is of common occurrence." As water resources were extended from the rivers through irrigation canals, the owls followed the water, or in the words of the author, "this Owl has gradually worked its way from the natural growth of timber bordering the rivers to that bordering the banks of irrigating canals."

One hundred years later in advising local landowners about survey protocol and take guidance, the United States Fish and Wildlife Service included riparian vegetation such as cottonwoods, willows, and mesquites growing along watercourses within the scope of the guidelines.

In 1999, 731,712 acres of riverine habitat and upland habitat across Pima, Pinal, Maricopa and Cochise Counties were designated as critical habitat for the pygmy-owl.

Critical habitat is defined in the U.S. Code as: "the specific areas within a geographic area occupied by the species at the time of listing ... on which are found physical or biological features essential to the conservation of the species and which may require special management considerations or protection; and specific areas outside the geographic area occupied by the species at the time it is listed ... upon a determination of the Secretary that such areas are essential for the conservation of the species."

In addressing pygmy-owl conservation and recovery initiatives, the Sonoran Desert Conservation Plan will have to prescribe a riparian protection and restoration strategy. Pygmy-owl compliance issues make such strategies a more immediate matter for the community, but the same can be said for conservation and recovery initiatives of all listed and imperiled animals in Pima County which are dependent on riparian habitat.

of the cock had been clustered directly about the nest, which fact, taken in connection with the late date and fresh condition of the eggs in the nest, makes it a fair inference that the first brood had, upon hatching, been promptly turned over to the cock while the female proceeded to deposit and incubate a second set. This accords with the testimony cited by Bendire in his 'Life Histories,' to the effect that this species occasionally raises two broods in a season.

I must not omit mention of a Mallard nesting fifteen

feet up in a tree at the water's edge, making use of a veritable Hawk's nest, possibly abandoned, but at any rate containing, among the comparatively-fresh dozen Duck's eggs, a genuine egg of the Swainson's Hawk on the point of hatching. My informant, who is well posted and thoroughly reliable, climbed to the nest while the duck was setting, but knows nothing of the manner in which the young ducks were transported to the water, nor what was the ultimate fate of the occupant of the hawk's egg.

THE FERRUGINOUS PYGMY OWL

GEO. F. BRENNINGER.

THE Ferruginous Pygmy Owl is one of the smallest of North American Owls, and while its discovery dates back many years yet up to the present time very little is known of this diminutive species. Its habitat is tropical North America, extending up to Southern Arizona and Texas. Although small in body it is by no means small in fighting capacity, often attacking and bringing to the ground birds whose weight would equal and often exceed that of the Owl. Unlike other members of the Owl family this species feeds largely during the daytime. I have had them pounce down upon and carry away wounded birds as large as robins.

Among the growth of cottonwood that fringes the Gila and Salt rivers of Arizona this Owl is of common occurrence. They can be seen perched out on some exposed situation surveying the ground beneath, and nothing seems to pass unnoticed. With eyes that never sleep and pluck that never diminishes until death, it is a formidable foe even to the large rodents that burrow in the sands and alluvial deposits of the river bottoms.

Not long since I came upon a single individual seated upon a leafless limb of a cottonwood tree. Being prompted to learn how close an approach the owl would allow without seeking other quarters, I came within a few feet of being directly beneath the bird when a quail flew up near my feet. With a hunter's instinct my gun came to my shoulder and the quail

fell some thirty or forty yards off. The shot did not disturb the owl in the least. After securing the game I threw it beneath the owl; its eyes were at once turned groundward, and its gaze upon the lifeless form of the quail was so intent that I succeeded in climbing to within five feet of the bird before its eyes were turned toward me; then, with a few erratic jarks of its tail, it flew to another tree where it soon called up its mate.

Its nest is usually an abandoned woodpecker's hole, which is used from year to year. No lining is used, and the three or four white spherical eggs are laid upon the bottom of the cavity, without any material being added either for the comfort of the setting bird or for the fledglings.

Nidification in this valley usually takes place about the 20th of April. During the winter months as well as early spring the tawny coloring of

the tail and upper parts is very prominent; but with the approach of summer the entire plumage becomes worn and bleached.

In more recent years, and since trees planted by man have become large enough to afford nesting sites for woodpeckers, this Owl has gradually worked its way from the natural growth of timber bordering the rivers to that bordering the banks of irrigating canals, until now it can be found in places ten miles from the rivers. I have never known it to use holes in giant cacti as does the little Elf Owl.



FERRUGINOUS PYGMY OWL.
PHOTOGRAPH FROM LIFE. BY GEO. F. BRENNINGER.



Photo: Arizona Game and Fish Department

Cactus Ferruginous Pygmy Owl



Photo: Arizona Game and Fish Department

**Cactus Ferruginous Pygmy Owl (Juvenile)
(note red leg band)**



Photo: Arizona Game and Fish Department

**Cactus Ferruginous Pygmy Owl
(notice transmitter antenna)**



Photo: Arizona Game and Fish Department

Cactus Ferruginous Pygmy Owl
(actual size)

C. **Impact on Listed Species and Species of Concern.** There are 24 plants and animals in Pima County that are listed or under consideration for federal protection. Another 49 species are in decline, according to the scientists interviewed for the *Species of Concern* report drafted for the Sonoran Desert Conservation Plan Science Technical Advisory Team. The charts below describe the status of obligate riparian species and aquatic habitat species.

OBLIGATE RIPARIAN SPECIES

SCIENTIFIC NAME	COMMON NAME	STATUS IN PIMA COUNTY (Federal or SDCP)*
<i>Empidonax trailii extimus</i>	Southwestern Willow Flycatcher	Endangered
<i>Coccyzus americanus occidentalis</i>	Western Yellow-billed Cuckoo	Petitioned Endangered
<i>Dalea tentaculoides</i>	Gentry Indigobush	Extirpated
<i>Pipilo aberti</i>	Abert's Towhee	Status 1
<i>Melospiza melodia</i>	Songsparrow (subspecies)	Status 1
<i>Sorex arizonae</i>	Arizona Shrew	Status 2
<i>Peromyscus merriami</i>	Merriam's Mouse (Mesquite Mouse)	Status 2
<i>Lasiurus borealis</i>	Red Bat	Status 2
<i>Cnemidophorus burti stictogrammus</i>	Giant Spotted Whiptail Lizard	Status 2
<i>Thamnophis eques</i>	Mexican Garter Snake	Status 2
<i>Choeronycteris mexicana</i>	Mexican Long-tongued Bat	Status 3
<i>Buteo nitidus</i>	Grey Hawk	Status 3
<i>Buteo albonotatus</i>	Zone-tailed Hawk	Status 3
<i>Caprimulgus ridgewayi</i>	Buff-collared Nightjar	Status 3
Trogon	Trogon	Status 3
<i>Senticolis triaspis</i>	Green Rat Snake	Status 3
<i>Capsicum annuum</i> var. <i>Glabriusculum</i>	Chiltepin	Status 4

***Legend**

- Proposed or Candidate; Petitioned (Species petitioned to be federally listed)
- Extirpated Species believed to have been extirpated from Pima County
- Status 1 Species in jeopardy in Pima County and for whom habitat in Pima County is critical for their existence
- Status 2 Species in jeopardy in Pima County and whose numbers are generally declining throughout their range
- Status 3 Species in jeopardy in Pima County, but are not at risk overall
- Status 4 Species not at risk in Pima County, but are considered for conservation because of their ecological or social importance to the community

AQUATIC HABITAT SPECIES

SCIENTIFIC NAME	COMMON NAME	STATUS IN PIMA COUNTY (Federal or SDCP)*
<i>Kinosternon sonoriense longifemorale</i>	Sonoyta Mud Turtle	Candidate
<i>Rana chiricahuensis</i>	Chiricahua Leopard Frog	Candidate
<i>Cyprinodon macularius</i>	Desert Pupfish	Endangered
<i>Poeciliopsis occidentalis occidentalis</i>	Gila Topminnow	Endangered
<i>Gila intermedia</i>	Gila Chub	Candidate
<i>Lilaeopsis schaffneriana</i> spp. <i>recurva</i>	Huachuca Water Umbel	Endangered
<i>Castor canadensis</i>	Beaver	Extirpated
<i>Ondatra zibethicus</i>	Muskrat	Extirpated
<i>Rana tarahumarae</i>	Tarahumara Frog	Extirpated
<i>Catostomus insignis</i>	Sonoran Sucker	Extirpated
<i>Catostomus clarki</i>	Desert Sucker	Extirpated
<i>Rhinichthys oculus</i>	Speckled Dace	Extirpated
<i>Speyeria nokomus caeruleus</i>	Blue Silverspot Butterfly	Extirpated
<i>Anodonta californensis</i>	California Floater (clam)	Extirpated
<i>Tryonia protea</i>	Desert Tryonia	Extirpated
<i>Tryonia quitobaquitae</i>	Quitobaquito Tryonia	Status 1
<i>Zaitzevia parvula</i>	Santa Rita Water Beetle	Status 1
<i>Argia sabino</i>	Sabino Creek Damselfly	Status 1
<i>Rana yavapaiensis</i>	Lowland Leopard Frog	Status 2

*Legend

Petitioned	Species petitioned to be federally listed
Extirpated	Species believed to have been extirpated from Pima County
Status 1	Species in jeopardy in Pima County and for whom habitat in Pima County is critical for their existence
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D. Impact on Extirpated Species. A dozen species that are not federally listed have been extirpated in Pima County. A disproportionate number of these missing natives to the area were dependent on aquatic habitat that is now lost.

These species formerly occurred in the Tucson Basin and have been lost due to the decline of the water table along the Santa Cruz and its tributaries, which eliminated perennial flow and habitat for these species and others. The progressive demise of native fish in the Santa Cruz is reflected in the table below, which is based on the 1986 Site Specific Water Quality Criteria Study for the Santa Cruz River²²

DECLINE OF NATIVE FISH

NATIVE FISH	1851-1854	1874	1893	1904	1937-1939	1950-1970	1985
Agosia chrysogaster (Dace)	O	O	O	O	O	E	E
Cyprinodon macularius	PO	PO	PO	E	E	E	E
Catostomus clarkii (Sucker)	O	PO	O	O	E	E	E
Catostomus insignis (Sucker)	O	PO	O	O	E	E	E
Gila robusta (Chub)	O	PO	O	O	E	E	E
Poeciliopsis occidentalis (Topminnow)	O	O	O	O	E	E	E

²² "O" = occurrence; "PO" = probable occurrence; E = extirpated.

5. Problem of Continued Strategy of Deferring Reconciliation

A. **Managed Recharge Proposal.** Despite the trends in resource depletion, habitat destruction, and pending species compliance issues, a managed recharge program by the City has been tentatively permitted by the Arizona Department of Water Resources (subject to appeal by four governmental entities). This program provides credits for effluent that is currently recharged into the Santa Cruz River channel in a way that does not facilitate groundwater conservation throughout the Tucson basin, nor does it promote regional riparian restoration. These paper credits can be used to draw down more groundwater from an already seriously overdrafted aquifer. The County is objecting to this, and proposing a more efficient use of effluent (described later in the text). Because water use decisions become institutionalized as economies vest around the administrative practice, it is particularly important to avoid making decisions which perpetuate groundwater pumping and the related harm to habitat and species.

B. **Undermining the Basic Purpose of the Endangered Species Act.** The findings and purposes sections of the Endangered Species Act demonstrate Congressional intent to incorporate a conservation ethic into economic growth and development. The findings state in part: "The Congress finds and declares that: (1) various species of fish, wildlife, and plants in the United States have been rendered extinct as a consequence of economic growth and development untempered by adequate concern and conservation; (2) other species of fish, wildlife, and plants have been so depleted in numbers that they are in danger of or threatened with extinction; (3) these species of fish, wildlife, and plants are of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people."

The purposes of the Endangered Species Act, which Pima County adopted in Resolution 1998-250 signed on December 3, 1998 with the Secretary of the Interior, states in part that: "The purposes of this Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved [and] to provide a program for the conservation of such endangered species and threatened species...."

Local water resource decisions have in the past, and can continue to undermine the basic purposes of the Endangered Species Act.

C. **Role of the Prohibition on Significant Impact on Habitat.** Section 9 of the Endangered Species Act describes prohibited acts. It states in part that: "with respect to any endangered species or fish or wildlife ... it is unlawful for any person subject to the jurisdiction of the United States to ... take any such species within the United States or the territorial sea of the United States." Take is a term from the Endangered Species Act which means harass, harm, pursue, hunt, shoot, wound, kill, trap, collect or attempt to do any of these acts in relation to a listed species. Supreme Court case law has extended the definition of take to apply to acts which significantly alter the habitat of a listed animal.

Like land use decisions that have a level of impact on habitat, local water resource decisions, given the state of the riparian ecosystems and the status of species dependent on systems that are so highly degraded, could face challenges going forward based on violation of the prohibition of take under the Endangered Species Act and its case law.

D. **Meaningful Restoration under the Sonoran Desert Conservation Plan.** Section 10 of the Endangered Species Act allows the Secretary of the Interior to permit take that is prohibited under Section 9, if it is incidental to otherwise lawful activity, and if "the applicant ... submits to the Secretary a conservation plan that specifies -- (i) the impact which will likely result from such taking; (ii) what steps the applicant will take to minimize and mitigate such impacts, and the funding that will be available to implement such steps; (iii) what alternative actions to such taking the applicant considered and the reasons why such alternatives are not being utilized; and (iv) such other measures that the Secretary may require as being necessary or appropriate for purposes of the plan."

Again, similar to the situation which applies to land use decisions that have a level of impact on habitat, certain local water resource decisions, given the state of the riparian ecosystems and the status of species dependent on systems that are so highly degraded, will need to be permitted under Section 10 of the Endangered Species Act, and therefore will need to be defined under the terms of a habitat conservation plan.

III. **Five Solutions in the Context of the Sonoran Desert Conservation Plan** The previous pages outlined five water resource problems facing the region. These include:

(1) the bifurcated system of legal rights for surface water and groundwater that does not reflect their hydrologic interconnection, or account for the environmental impact of streamflow and groundwater depletion; (2) the continuation of groundwater mining in the face of a seriously overdrafted aquifer; (3) the substantial damage that past practices have done to the riparian ecosystem; (4) the impact of this damage to the species; and (5) the continued strategies within the community to defer reconciliation of water use with water availability, despite the potential to run afoul of federal species protection laws.

The next pages outline five regional, comprehensive, integrated water resource strategies in the context of the Sonoran Desert Conservation Plan. These include acceptance of a regional water policy that:

(1) anticipates various types of water uses (including conservation uses) that will make calls on future resources, respects Indian water rights and other federal purposes, and recognizes hydrologic and environmental realities; (2) achieves safe yield within the Tucson Active Management Area; (3) implements recovery strategies for riparian systems; (4) adapts multi-species conservation and recovery programs to riparian restoration plans; (5) integrates effluent, recharge and reclamation programs into the regional conservation program so that the best use of renewable resources is made for the community.

The Sonoran Desert Conservation Plan promotes regional water policy which moves toward an ecosystem baseline that requires our basin to be in balance, and eventually results in some level of recovery of natural functions within riverine systems. Also, by acknowledging federal purposes, the Sonoran Desert Conservation Plan anticipates that simply to comply with federal law, we will have to find ways to accommodate more than just the traditional consumptive users of water. As a practical matter, the region must begin to make the right choices now with regard to water resource policy in order to accommodate current and future users.

1. **Accept a Regional Water Policy that Recognizes Indian Water Rights, Federal Purposes, Hydrologic and Environmental Realities.** The Sonoran Desert Conservation Plans offers the community the opportunity to consider water resource policy from a comprehensive, integrated, regional perspective, rather than a narrow or interest based perspective. Two decades ago, the Groundwater Management Act introduced the concept of balance into the relationship between development and resource utilization. Now, the Sonoran Desert Conservation Plan extends this idea of balance to include water, riparian habitat, wildlife preservation and growth accommodation.

The primary issue that concerns Pima County is that the most important promise of the Groundwater Management Act of 1980 may not be achieved to the extent that groundwater pumping continues. Pima County also supports federal purposes that are consistent with meaningful regional habitat conservation and land use planning.

Another general principle that must be foremost for the success of future Western water policy is the will to see an end to the long conflict over the reserved right of water for Native Americans.

Pima County has offered to purchase effluent which is available to Secretary of the Interior under Southern Arizona Water Rights Settlement Act for the benefit of the Tohono O'odham Nation, and construct and operate an effluent distribution system on the northwest side that would redistribute the differential between the amount of effluent used for turf irrigation, and the amount of effluent available, throughout the urban area, and discharge excess effluent at multiple points within the major river system to help establish riparian areas and contribute to recharge for the whole Tucson AMA, not just Avra Valley sub-basin.

This would create a benefit to the Tohono O'odham Nation in at least the following ways: The San Xavier District and other areas experiencing subsidence would benefit from groundwater rebound; and the Tohono O'odham Nation would benefit by receiving value for effluent that has been wastefully discharged to the Santa Cruz for a period of 17 years since enactment of SAWRSA (during that period, the Nation has received no value for discharged effluent).

As discussed in greater detail below, Pima County would like the Department of Interior to consider the practical issue of SAWRSA effluent use in the context of achieving multiple federal purposes and facilitating meaningful regional habitat conservation planning.

The only way for the community to anticipate and meet various types of water uses, including conservation uses that will make calls on future resources, to respect Indian water rights in spirit and within the letter of the law, to honor other federal purposes, and recognize hydrologic and environmental realities, is to begin now to examine and plan for all waters resources, including effluent uses, so that the right source of water is matched with the most appropriate use.

2. Adopt Strategies to Achieve or Improve on the Goal of Safe Yield

Policy direction outlined by the Secretary of the Interior within the text of a June 8, 1999 speech entitled *From Reclamation to Restoration* invites Western communities to elevate water policy discussions and deliberations so that we begin to achieve the goal that we must achieve, if we are to survive as communities. The speech states the new federal policy direction this way:

“in every watershed we should work toward a baseline necessary to maintain a healthy, natural system, below which water depletions should not take place.”

In Arizona, this goal is embodied in the Groundwater Code, also the creation of the Secretary of the Interior when, 20 years ago, he served as Governor of Arizona.

Options available to address the problems caused by continuation of ground water pumping include restoring the aquifers through substitution of renewable resources, and retiring groundwater uses. The valleys along perennial or intermittent streams should be managed as a critical area where not only water volumes, but water levels, are managed. Greater limitations on groundwater pumping for golf course and cemetery irrigation should also be considered, and reporting should be required for exempt wells in these areas. A prime example of the opportunity to restore a river by restoring the aquifer would be along the Santa Cruz River in the vicinity of Martinez Hill, where recharge of CAP water could elevate the water table, if groundwater withdrawals by Tucson Water were limited. This area once had the Tucson Basin's largest mesquite bosque, as well as a cottonwood gallery forest. Pima County support efforts of the San Xavier District of the Tohono O'odham to restore the Santa Cruz River.

On one level, these are statements of the obvious, but as a community we have been unable to get on track with the goal of safe yield.

What is worse is the possibility that safe-yield and CAP water are insufficient to restore balance. The imbalance of population, technology, and water resource use has only grown since 1940, demanding greater efforts to secure a sustainable future. Wells have been deepened and water is being “mined” from portions of the aquifer that were last recharged thousands of years ago. Because the productivity of the aquifer generally declines with depth, more wells have been drilled to maintain the same production rate. Colorado River water has been imported and conservation efforts imposed in an attempt to bring population and cultural practices into balance. However, even these efforts will not be adequate to stop groundwater depletion, according to Arizona Department of Water Resources (ADWR).

The region's current approach to water management has been successful in preventing the costs of excessive growth from being visited upon the majority of citizens. The fact that energy costs for fossil fuels have not increased also works in our favor.

Most people realize, however, that we are not yet creating a community that is in balance with our natural resource base, and that there are many problems and opportunities that are not being addressed.

CAP water is considered a renewable supply of water because the ultimate supply is derived from snow melt in the Colorado River watershed. For eastern Pima County, it represents a supply of water that will not "run out" over hundreds or thousands of years, so long as the delivery infrastructure can be maintained. However, CAP in the short-term sense, is less reliable than ground water because droughts will periodically reduce Colorado River flows, and Arizona's full allocation will not be available during those times.

Furthermore, the delivery system that brings water to eastern Pima County was built without duplicate pumps, so the supply will be interrupted by mechanical failure. Finally, the CAP water leaving the municipal water treatment facility passes through a single pipeline, which, as a recent event demonstrated, is also vulnerable.

For these reasons, using CAP water makes the region more vulnerable to drought and mechanical failure, while at the same time, offering a solution to groundwater mining that requires minimal social change. This vulnerability can be addressed through redundant delivery systems, including subsidiary pumps and pipelines and storage of vast quantities of CAP water for use during time of drought. CAP recharge for use during a drought is a necessity, and several recharge projects are now in operation. Those projects, however, are not sufficient for drought insurance--their primary purpose is to assist water suppliers to meet the "safe-yield" requirements of the Tucson Active Management Area (AMA).

Safe-yield means using no more groundwater than is annually recharged in the area over the long term. Recharged CAP water can be now used to offset additional groundwater pumping elsewhere in the Tucson Basin, while maintaining a balance "on paper".

A basin-wide paper balance between supply and demand for groundwater does not address concerns about ongoing depletions in some areas (e.g., the Tanque Verde and the Santa Cruz valleys). Safe yield in fact, can result in depletion of perennial streams, for if all net annual recharge continues to be pumped away, there is no excess for discharge or restoring aquifer levels.

In the face of how difficult it will be to balance water budgets in the future it will be surprising for many to learn that the major water resource governmental entities are still endeavoring to find ways to extend the ability to pump ground water rather than make direct use of existing effluent.

Going forward into the next century, then, at a minimum, strategies can and should include the basic principles of putting a stop to practices contributing to groundwater pumping, and making a start in the direction of direct use of effluent -- which is the only growing water resource within the total water budget.

3. Adopt a Regional Long Term Recovery Plan for Riparian Systems and a Strategy for Project-by-Project Implementation. In 1974 the Board of Supervisors adopted the first Floodplain Management Ordinance. Amended several times since, the ordinance was amended in 1994 to protect riparian vegetation as defined and mapped. Concurrently, the zoning code was modified to allow changes to development standards in exchange for protection of riparian areas. In July of 1998, the Board extended protection of riparian habitat to land potentially affected by individual building permits and to lot splits. The Sonoran Desert Conservation Plan will likely be the next major extension of riparian habitat protection. It will address and meet the federal compliance standards spelled out in Endangered Species Act, its regulations, and guidelines. The County has made a commitment to pursue a high conservation standard since the reach of our Plan is extensive. However, under any standard that seeks to comply with the Endangered Species Act, the Plan will have to include significant riparian restoration in order to prevent the extinction of some of our imperiled riparian dependent species, given the largely decimated status of the riparian ecosystem.

As has been stated elsewhere in this report, the loss of 85 to 95% of quality riparian habitat during the last century has negatively impacted the 85% of Arizona's wildlife population that depends on riparian habitat during some part of its life cycle. There is an over-representation of riparian dependent extirpated species, which we have lost along with most of our perennial streams and the associated ground-water dependent riparian habitat. Therefore, some significant amount of riparian restoration will be required if the Plan is to be meaningful. In order to move toward federal compliance for species protection, the Sonoran Desert Conservation Plan includes a Riparian Restoration element. The Plan is divided into planning units based on watershed boundaries. As the lead local entity overseeing the development of the Plan, Pima County will support and promote regional water policy which moves toward an ecosystem baseline that requires our basin to be in balance, and eventually some level of recovery of natural functions within riverine systems.

The projects below reflect the County's longstanding interest in riparian restoration. With the development and implementation of the Sonoran Desert Conservation Plan, an even more comprehensive and strategic riparian habitat recovery plan will be formulated.

A. Pima County - Selected Past Projects

1. River Parks
2. Cienega Creek Natural Preserve
3. "Pantano Jungle" Restoration
4. Bingham Cienega Natural Preserve

7. Cienega Creek Streamflow Restoration
8. Riparian Corridor Protection

B. Pima County's Present Projects

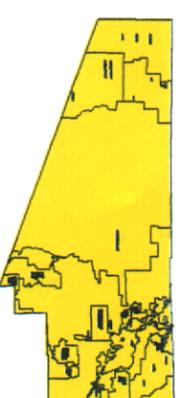
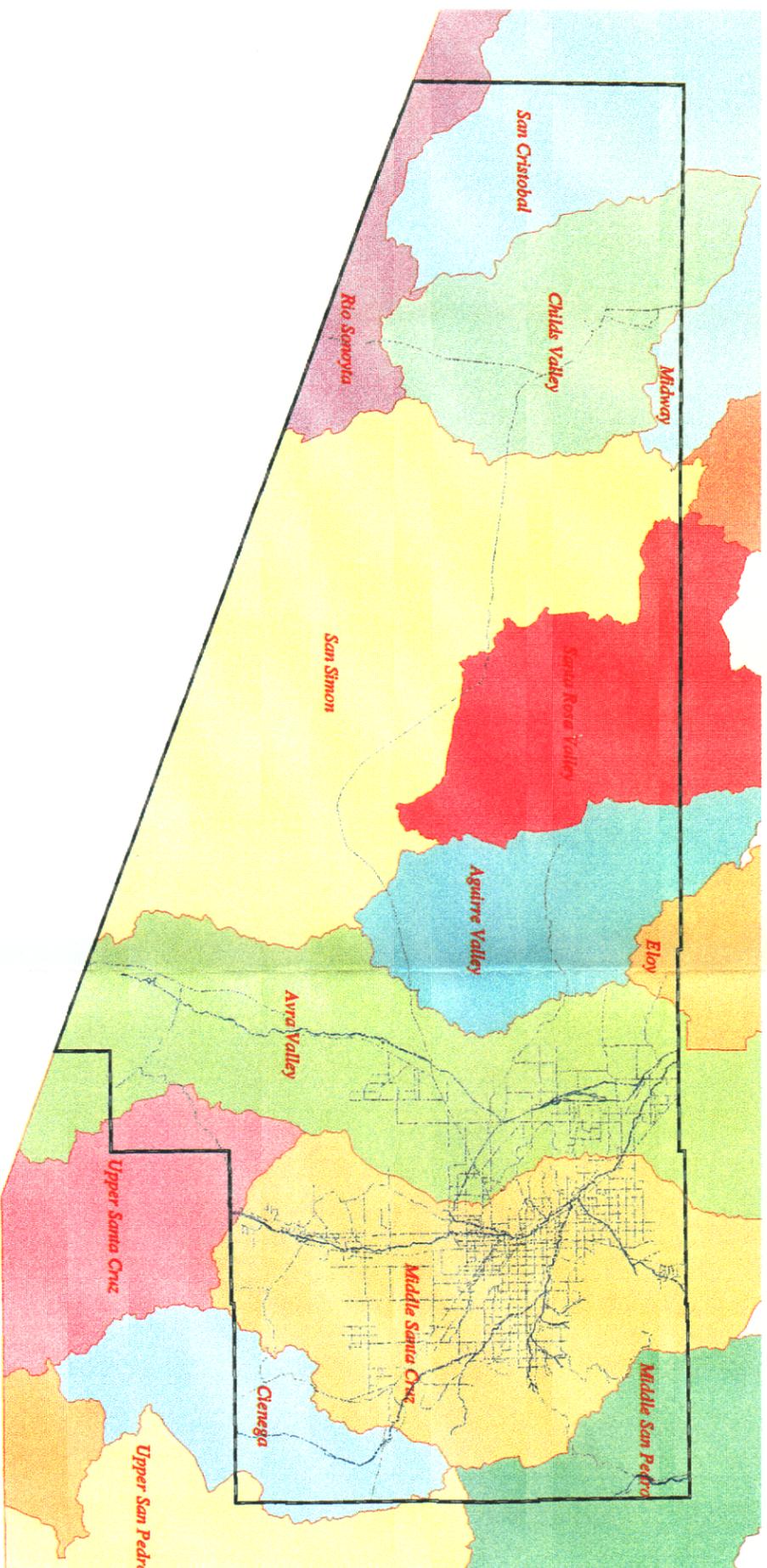
1. Paseo de las Iglesias
2. Rillito Recharge & Habitat Restoration
3. Tucson/Ajo Detention Basin Environmental Restoration
4. Bingham Riparian Restoration
5. Marana High Plains Effluent Recharge
6. Park Avenue Detention Basins Habitat Restoration and Recreation

C. Pima County's Future Projects

1. Cañada Del Oro (CDO) Recharge
2. River Parks
3. Rincon Creek Restoration
4. Martinez Hill Riparian Restoration Project
5. Canoa Overbank Storage
6. Santa Cruz Effluent Riparian Investigations
7. Cortaro Mesquite Bosque Restoration Demonstration

Watersheds of Pima County

-  Sub-Basin Boundaries
-  Major Streets
-  Major Washes
-  County Limits



Index Map Scale: 1:1,500,000

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Scale 1: 100,000



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Santa Cruz Effluent Riparian Restoration - Surplus effluent, which is now discharged to the Santa Cruz and projected to be 95,800 acre feet by 2025, could be more beneficially utilized by reestablishing riparian zones along barren river corridors. This naturally improves the water quality of the effluent. The effluent will percolate through the ground to replace the over-drafted groundwater table in the Tucson Basin. Pima County will pursue this restoration project under the Sonoran Desert Conservation Plan.

Ina Road Santa Cruz Environmental Restoration - Studies indicate that it would be financially viable to construct and operate an effluent distribution system on the northwest side. This would create at least these benefits: (1) the region would benefit through more direct reuse of effluent in lieu of groundwater for turf irrigation; (2) the water table and the riparian habitat would benefit because Pima County proposes to redistribute the differential between the amount of effluent used for turf irrigation and the amount of points within the major river system to help establish riparian areas and contribute to recharge for the whole Tucson Basin; (3) endangered and imperiled species that are dependent on riparian ecosystems would benefit from the recovery of the special water-based habitat; and (4) areas experiencing subsidence, including the San Xavier District, would benefit from groundwater rebound.

Tucson/Ajo Detention Basin Environmental Restoration - The Tucson/Ajo Detention Basin Project will restore 27 acres of wetlands and riparian habitat to a 120-acre flood control basin. The project will also extend the Tucson Diversion Channel, or Julian Wash River Park. In the final phase, the wetlands will be surrounded by an 18-hole golf course. The Tucson/Ajo Detention Basin is located just north of Ajo Way and west of County Club Road. The basin partially surrounds San Lena Park. The Kino Sports Complex has been developed to the south and is the winter home of the Arizona Diamondbacks and the Chicago White Sox. A state-of-the-art stadium, Tucson Electric Park, opened earlier last year. Now Pima County, in cooperation with the United States Army Corps of Engineers, is bringing another phase of this project to fruition with the restoration of the Tucson/Ajo Detention Basin. The project will capture normally lost urban stormwater within the project water features and will use this water for turf irrigation, thereby becoming an important water conservation project.

Paseo de las Iglesias - Paseo de las Iglesias (Walk of the Churches) is the name given to the recent plan to restore the Santa Cruz River between the San Xavier Mission, the San Agustín Mission, and the Convento site at the base of Sentinel Peak. The project provides potential recharge opportunities for CAP water, native farming restoration opportunities on the Tohono O'odham Reservation, preservation of an area rich in history and culture, and completion of missing trail links along the Santa Cruz River Park. The Juan Bautista de Anza National Trail, along the traditional route of the Camino Real, closely follows the western edge of the river. Paseo de las Iglesias will provide low-flow bank protection for erosion-threatened neighborhoods along the Santa Cruz River. The implementation of this type of flood control will allow the restoration of the riparian habitat that once existed along the river.

Martinez Hill Riparian Restoration - The San Xavier District is examining alternatives for riparian restoration and recreational features using Arizona Water Protection funding. The alternatives include studying the feasibility of projects at various locations within the District, including the Santa Cruz River arroyo near Martinez Hill. San Xavier District's staff will be presenting the restoration alternatives to tribal members within the next year for feedback. The selected project will proceed to design and construction.

Cienega Creek Streamflow Restoration - One to five miles of streamflow could be restored by acquiring a one-acre inholding within the Cienega Creek Natural Preserve, transforming what is now an ephemeral stream into a lush riparian area similar to other reaches within the Preserve. The inholding contains two key features, a surface-water diversion dam and a well, as well as a streamflow gauging station used by the United States Geological Survey and Pima County Flood Control District. By acquiring the inholding and the associated water right, the stream can be made whole again. To do this, the Vail Water Company will need a replacement source of water for its development, either groundwater pumped from outside the Preserve, effluent, or CAP.

Canada Del Oro (CDO) Recharge - A pipeline to deliver raw CAP Canal turnout near Moore Road could be constructed to release water into Big Wash. The release of water into recharge basins and the low-flow channel downstream of the basins is expected to provide benefits such as direct recharge to the regional aquifer, and trail, equestrian and bird-watching enhancements.

Bingham Cienega Natural Preserve - In 1989, the Pima County Flood Control District acquired lands along the San Pedro River to preserve a natural spring-fed marsh known as Bingham Cienega. Because of the site's remote location and sensitive environment, the District entered into a long-term agreement with The Nature Conservancy to manage the property. Conservancy volunteers fenced out livestock and, once vegetation began to fill in drainage channels, the marsh began to spread. The District has installed a small check dam that has successfully arrested erosion that threatened the marsh.

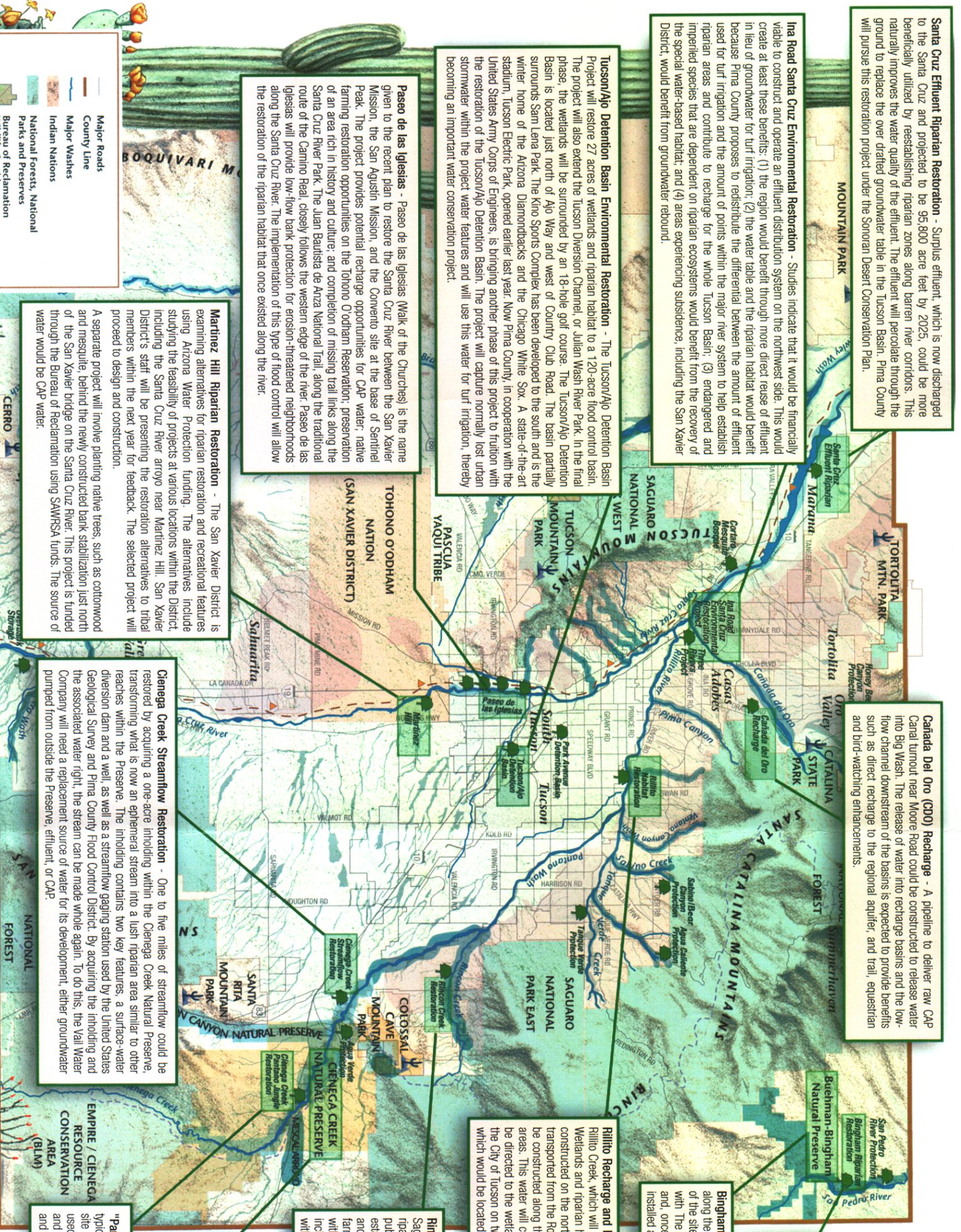
Bingham Riparian Restoration - In the summer of 1998, Pima County and The Nature Conservancy began a three-year project to restore sycamore grasslands, willow forests and mesquite woodland at Bingham Cienega Natural Preserve. With help from volunteers and a wide variety of State, Federal and private funders, 50 acres of former farm fields have been or will be returned to native vegetation.

Fillito Recharge and Habitat Restoration - The proposed project will help restore a higher water table along the Fillito Creek, which will benefit existing riparian areas along the Fillito, Tanque Verde Creek, and lower Pantano Wash. Wetlands and riparian habitat will be restored along the south bank of the Fillito west of Swan Road. A park will be constructed on the north bank of the River. Water supply for the project will consist of reclaimed treated wastewater transported from the Roger Road Treatment Plant. The water will be obtained from a reclaimed water pipeline that will be constructed along the Alamo Wash from the City of Tucson's reclaimed water distribution system to the wetland areas. This water will cycle through wetlands before being recharged in the riverbed. On-site stormwater runoff will be directed to the wetlands as well as to vegetated areas around them. In addition, Pima County is cooperating with the City of Tucson on two other projects just upstream: a pilot recharge project and a wildlife habitat project, both of which would be located on County land east of Swan Road.

Rincon Creek Restoration - The Rincon Creek Restoration Project is located south of Saguaro National Park's Rincon Mountain unit. This project will restore a 600-foot wide riparian-woodland corridor along two miles of the creek using a combination of private and public funding. A non-profit organization known as the Rincon Institute has been established to assist the developer in preparing a restoration plan. Most of the native trees and shrubs have been removed and the stream channel has been destabilized due to farming and grazing. The developer's plan will control flood water and related erosion without the use of visually or physically intrusive structures. Other restoration components include planting, groundwater monitoring, and removing livestock. A multi-use trail system within the restored floodplain will provide access to Saguaro National Park.

Cienega Creek Restoration - Nearly 4,000 acres along a 12-mile reach of the Cienega Creek have been acquired to preserve one of the region's few remaining perennial streams. Establishment of the Preserve in 1986 marked Pima County's first major flood control effort that included riparian habitat preservation. In response to eliminating grazing and off-road vehicle activity, the density of cottonwoods, willows and other trees and shrubs along the stream has increased dramatically and channel erosion has decreased.

"Pantano Jungle" Restoration - This newly completed project re-establishes vegetation typical of mesquite woodland and riparian grassland. Formerly known as the "Jungle," the site was cleared in 1974 for pasture. Plantings of native trees and grasses are now being used to improve the nature of land for wildlife use. Volunteers have installed check dams and other measures to reduce erosion. The project is funded by the United States Fish and Wildlife Service and the Arizona Game and Fish Department.



Pima County Graphic Design 7/99 BS & MCH

Figure 22

Pima County -- Selected Past Projects

1) River Parks - Over 23 miles of river parks have been constructed along the Santa Cruz River, Rillito Creek and Tucson Diversion Channel within the present urban area. These parks are used by thousands of people each week to relax and exercise. The channel bottoms offer one of the few locations for horse use in a growing urban area. Riparian vegetation is allowed to regrow in the channel bottom, making the watercourse an important future biological corridor linking open space and public lands.

2) Cienega Creek Natural Preserve - Nearly 4,000 acres along a 12 mile reach of the Cienega Creek have been acquired to preserve one of the region's few remaining perennial streams. Establishment of the Preserve in 1986 marked Pima County's first major flood control effort that included riparian habitat preservation. In response to eliminating grazing and off-road vehicle activity, the density of cottonwoods, willows, grasses and shrubs along the stream has increased dramatically, even in areas where the arroyo walls are quite high and narrow. Channel erosion has decreased in response to increased channel vegetation, which decreases flow velocities. Pima County Flood Control District has acquired one of the few in-stream flow water rights in the state, however, the State's disjunct management of groundwater and surface water does not assure protection of this valuable stream.

3) "Pantano Jungle" Restoration - This newly completed project re-establishes vegetation typical of mesquite woodland and riparian grassland. Formerly known as the "Jungle," the site was cleared in 1974 for pasture. Plantings of native trees and grasses are now being used to improve the nature of land for wildlife use. Volunteers have installed check dams and other measures to reduce erosion. The project is funded by the United States Fish and Wildlife Service and the Arizona Game and Fish Department.

4) Bingham Cienega Natural Preserve - In 1989, the Pima County Flood Control District acquired lands along the San Pedro River to preserve a natural spring-fed marsh known as Bingham Cienega. Because of the site's remote location and sensitive environment, the District entered into a long-term agreement with The Nature Conservancy to manage the property. Conservancy volunteers fenced out livestock and, once vegetation began to fill in drainage channels, the marsh began to spread. The District has installed a small check dam that has successfully arrested erosion that threatened the marsh.

Present Projects

1) Paseo de las Iglesias - Paseo de las Iglesias (Walk of the Churches) is the name given to the recent plan to restore the Santa Cruz River between the San Xavier Mission, the San Agustín Mission, and the Convento site at the base of Sentinel Peak. The project provides potential recharge opportunities for CAP water, native farming restoration opportunities on the Tohono O'odham Reservation, preservation of an area rich in history and culture, and completion of missing trail links along the Santa Cruz River Park. The Juan Bautista de Anza National Trail, along the traditional route of the Camino Real, closely follows the western edge of the river. Paseo de las Iglesias will provide low-flow

bank protection for erosion threatened neighborhoods along the Santa Cruz River. The implementation of this type of flood control will allow for the restoration of the riparian habitat that once existed along the river.

2) Rillito Recharge and Habitat Restoration - The proposed project helps restore a higher water table along the Rillito Creek, which will benefit existing riparian areas along the Rillito River, Tanque Verde Creek, and lower Pantano Wash. Wetlands and riparian habitat will be restored along the south bank of the Rillito River near Swan Road. A park will be constructed on the north bank of the River. Water supply for the project will consist of reclaimed treated wastewater transported from the Roger Road Treatment Plant. The water will be obtained from a reclaimed water pipeline that will be constructed along the Alamo Wash from the City of Tucson's reclaimed water distribution system to the wetland areas. This water will cycle through wetlands before being recharged in the riverbed. On-site stormwater runoff will be directed to the wetlands as well as vegetated areas around them. In addition, Pima County is cooperating with the City of Tucson on a wildlife habitat project just upstream which would be located on County land east of Swan Road.

3) Tucson/Ajo Detention Basin Environmental Restoration - The Tucson/Ajo Detention Basin Project will create 27 acres of wetlands and riparian habitat within a 120-acre flood control basin. The project will also extend the Tucson Diversion Channel, or Julian Wash River Park. In the final phase, the wetlands will be surrounded by an 18-hole golf course. The Tucson/Ajo Detention Basin is located just north of Ajo Way and west of Country Club Road. The basin partially surrounds Sam Lena Park. The Kino Sports Complex has been developed to the south and is the winter home of the Arizona Diamondbacks and the Chicago White Sox. A state-of-the-art stadium, Tucson Electric Park, opened earlier this year. Now, Pima County, in cooperation with the United States Army Corps of Engineers, is bringing another phase of this project to fruition with the restoration of the Tucson/Ajo Detention Basin. The project will capture normally lost urban stormwater within the project water features and will use this water for turf irrigation, thereby becoming an important water conservation project.

4) Bingham Riparian Restoration - Upon acquisition of a 289 acre tract along the San Pedro River, Pima County began the passive restoration of a cienega by allowing vegetation to fill in drainage ditches and restore flow paths. In 1991, the District constructed a small check dam to stem erosion. In the summer of 1998, Pima County and The Nature Conservancy began a three-year project to restore sacaton grasslands, willow forests and mesquite woodland at Bingham Cienega Natural Preserve. With help from volunteers and a wide variety of State, Federal and private funders, 50 acres of former farm fields will be returned to native vegetation.

5) Marana High Plains Effluent Recharge - This project is located along the Santa Cruz River, approximately one-quarter mile upstream of the Sanders Road bridge in Marana. The project will protect and enhance an existing riparian area via operation of a groundwater recharge facility utilizing treated wastewater from the Santa Cruz River. Additional benefits include education through descriptive literature and interpretive

signage and development of a pedestrian trail system. The project is funded by the United States Bureau of Reclamation and Arizona Water Protection Fund.

6) Park Avenue Detention Basins - The existing Arroyo Chico alignment is one of the few urban wildlife sanctuaries in the metropolitan area. The portion of Arroyo Chico with the highest resource value is an artificial channel, constructed in the late 1920's as part of the Colonia Solana development. The design of the channel provided for overbank flooding in a zone located between entry roads to the subdivision, and where a "cactus garden" was planted. Over time, the channel itself became vegetated with native riparian trees and shrubs such as mesquite, wolfberry, grayhorn and cat-claw acacia. Urbanization has benefited the stream in that increased impervious areas cast runoff into the zone with a higher frequency than would be the case. However, the same factors have increased the size of the 100-year flood to the point of threatening downstream subdivisions with flooding.

Use of this alignment to convey the 100-year storm could require significant modifications to the Arroyo Chico if standard bank protection and channelization measures were used. To maintain the Arroyo's environmental resource value, flood control detention basins were constructed in the Del Urich Golf Course to the east. Additional detention would be needed to alleviate flooding in the vicinity of Park Avenue and Broadway Boulevards. The Park Avenue Detention Basins and Habitat Restoration Project will reduce flood damage while retaining the watercourse's natural alignment. Vegetation associated with downstream reaches of Arroyo Chico will be restored after construction. A key to this will be detaining the volume of peak flow from large storm flows by means of side-channel weirs, which allow the low flows important to vegetation to pass unimpeded down the channel. Cooperators include Pima County, the City of Tucson, the United States Army Corps of Engineers, and the Tucson Unified School District.

7) Cienega Creek Streamflow Restoration - One to five miles of streamflow could be restored by acquiring a one-acre inholding within the Cienega Creek Natural Preserve, transforming what is now an ephemeral stream into a lush riparian area similar to other reaches within the Preserve. The inholding contains two key features, a surface-water diversion dam and a well, as well as a streamflow gaging station used by the United States Geological Survey and Pima County Flood Control District. By acquiring the inholding and the associated water right, the stream can be made whole again. To do this, the Vail Water Company will need a replacement source of water for its development, either groundwater pumped from outside the Preserve, effluent, or CAP.

8) Riparian Corridor Protection - Most of the previous projects dealt with restoring previous riparian areas. A number of classic riparian areas need protection so that their environmental benefits can be maintained. In the long run it is much more costly to restore riparian areas rather than protect them. Below are listed riparian areas that should be protected through acquisition or other means.

Land Area Acquisitions (Acres)

<u>Riparian Corridors</u>	<u>State</u>	<u>Federal</u>	<u>Private</u>
Cienega Creek Natural Preserve	6,767	160	366
Davidson Canyon Natural Preserve	3,343	3	2,845
Buehman-Bingham Natural Preserve	2,478	7	5,004
Peñitas Wash	2,947	0	246
Mescal Arroyo	<u>1,795</u>	<u>0</u>	<u>61</u>
Total	17,330	170	8,522

Pima County will work with landowners to protect riparian areas from future development through conservation easements and acquisitions. Using bonds approved by voters in 1997, lands along the Sabino Creek, Honey Bee Wash, Bear Canyon, Tanque Verde Wash, San Pedro River, and Agua Caliente Wash will be preserved. Pima County will encourage the State Land Department to set aside State Trust land along significant corridors such as Cienega Creek, Mescal Arroyo, Davidson Canyon, and Peñitas Wash, among others.

Future Projects

1) Cañada Del Oro (CDO) Recharge - A pipeline to deliver raw CAP water from a CAP Canal turnout near Moore Road could be constructed to release water into Big Wash. The release of water into recharge basins and the low-flow channel downstream of the basins is expected to provide benefits such as direct recharge to the regional aquifer, environmental enhancement of the existing riparian corridors of Big Wash and CDO Wash, and recreational opportunities associated with trail and equestrian development and bird watching.

2) River Parks - New river parks are planned along the east bank of Pantano Wash between Tanque Verde and Golf Links Roads, Rillito Creek from Campbell Avenue to Craycroft Road and west from La Cholla Boulevard, Tanque Verde Creek between Sabino Canyon and Tanque Verde Roads, Santa Cruz River from Irvington to Valencia Roads, and Cañada del Oro Wash between Thornydale and Magee Roads.

3) Rincon Creek Restoration - The Rincon Creek Restoration Project is located south of Saguaro National Park's Rincon Mountain unit. This project will restore a 600-foot wide riparian-woodland corridor along two miles of the creek using a combination of private and public funding. A non-profit organization known as the Rincon Institute has been established to assist the developer in preparing a restoration plan. Most of the native trees and shrubs have been removed and the stream channel has been destabilized due to farming and grazing. The developer's plan will control flood water and related erosion without the use of visually or physically intrusive structures. Other restoration components include planting, groundwater monitoring, and removing livestock. A multi-use trail system within the restored floodplain will provide access to Saguaro National Park.

4) Martinez Hill Riparian Restoration Project - The San Xavier District is examining alternatives for riparian restoration and recreational features using Arizona Water Protection funding. The alternatives include studying the feasibility of projects at various locations within the District, including within the Santa Cruz River channel near Martinez Hill. San Xavier District's staff will be presenting the restoration alternatives to tribal members within the next year for feedback. The selected project may proceed to design and construction, depending on the alternative selected.

A separate project will involve planting native trees such as cottonwood and mesquite behind the newly constructed bank stabilization just north of the San Xavier Road bridge on the Santa Cruz River. This project is funded through Bureau of Reclamation using SAWRSA funds. The source of water would be CAP water.

5) Canoa Overbank Storage - Floodplain conditions along the Santa Cruz River from Canoa Ranch north to the San Xavier District shape the duration and magnitude of large, regional floods that affect the Santa Cruz River in Tucson. The restricted dimensions of bridges and bank protection in downtown Tucson require that great care be taken in permitting any land uses upstream which involves reducing the amount of natural flood storage in the channel or its overbank floodplain. Channel straightening and floodplain encroachment are already negatively affecting the Santa Cruz River upstream of Tucson--these activities are currently authorized through various planning and regulatory documents. A uniform policy prohibiting such for the Santa Cruz River south of the San Xavier is appropriate. This would require cooperation between the Sahuarita Town Council and the Pima County Board of Supervisors and acquisition of property rights. Where possible, increasing the amount of vegetation in the channel and overbank floodplain will have the effect of reducing peak flood velocities and discharges downstream, and locally increasing the height to which floodwaters will reach. For this reason, land uses in the overbank floodplain should be compatible with occasional inundation, or are exempted by state statutes from regulation.

6) Santa Cruz Effluent Riparian Investigations - Effluent discharges from wastewater treatment facilities have augmented riparian ecosystems along the Santa Cruz River downstream of Roger Road. These discharges often flow as far north as the County line, and provide habitat for wildlife that would not otherwise be present. As Tucson grows, there will be increasing demand for alternative uses of the effluent now discharged to the stream. U. S. Bureau of Reclamation and local jurisdictions are currently studying the biological significance of the effluent discharges and the potential alternative uses of treated effluent in the "Regional Effluent Planning Partnership". Pima County is participating in these discussions both from the perspective of being the operator of two wastewater treatment facilities and from the perspective of the Sonoran Desert Conservation Plan. Some amount of effluent needs to be reserved for environmental benefits. Legally, all of the effluent presently released to the Santa Cruz River could be diverted and used for other purposes. At present, the infrastructure is not available to utilize the effluent for other purposes.

7) Cortaro Mesquite Bosque Restoration Demonstration. This project would be constructed on the floodplain terraces along the Santa Cruz River downstream of Cortaro Farms Road and upstream of Avra Valley Road within the bank-protected reach. Project length is about two miles.

Approximately 124 acres of riparian habitat and marsh is being proposed. This project would substantially increase the amount of mesquite woodland along the river, and broaden the width of the riparian corridor beyond what the existing effluent-dominated stream currently offers. With time, the project might also serve to improve habitat quality for the cactus ferruginous pygmy owl.

Planting areas would consist of mesquite and understory riparian vegetation. A smaller area planted with marsh/wetland vegetation combined with a cottonwood-willow forest would complement the bosque. Open water areas would be limited. The planting areas would be flood irrigated with effluent pumped directly out of the river. The marsh/cottonwood-willow forest area would receive water from the river in the same manner.

The water source, secondary effluent, generated from the metropolitan sewage treatment facilities at Roger Road and Ina Road must meet ADEQ reuse standards, currently the effluent in the river meets PBC standards (partial body contact). Irrigation schedules would be adjusted to avoid pedestrian contact. The marsh area design would be mostly subsurface flow, limiting the amount of open water to avoid human contact and reduce evaporation.

A combination of planting schemes would be proposed. A mixture of tree sizes and seeding would be utilized during multiple planting events to reduce plant mortality due to insect/predator presence, and adverse weather conditions. Compost mix for planting and mulching would be available from Pima County Solid Waste Department.

This proposed project would complement/tie-into a planned future river park system for Continental Ranch Development, planned Marana trail system and parks, the Los Morteros archaeological site, and the Anza Trail, providing passive recreational opportunities for area residents and visitors. Although this proposed project would complement the above mentioned projects, it is not dependent upon them.

If Pima County Wastewater Management's proposed rubber-dam recharge project is not built, the restoration project could be expanded. The restoration project would require an estimated 440-450 ac-ft of effluent per year. The approximate 109 acres of mesquite bosque and riparian vegetation would require approximately 380 ac-ft and the 15 acres of marsh/cottonwood-willow forest would require approximately 60-70 ac-ft per year to maintain. The existing salt bush community requires no supplemental irrigation. The anticipated life of the project is 150 years. Design and construction of the entire project is estimated between 9-12 months.

4. **Adopt a Regional Multi-Species Conservation Plan with an Adaptive Management Plan Keyed to Riparian Habitat Restoration Plan.** The Sonoran Desert Conservation Plan will work on three levels at the same time: (A) It will address issues related to the listing of the cactus ferruginous pygmy-owl; (B) it will include other listed species and species of concern; and © it will protect riparian habitat and other target habitats of concern.

A. **Pygmy-owl Protection under the Sonoran Desert Conservation Plan.** Pima County's most immediately felt environmental dilemma is related to the listing of the pygmy-owl in March of 1997. Pima County has 18 plants and animals listed under the Endangered Species Act, but no listing has caught the attention of the community like the pygmy-owl. Considered one of the most difficult listings in the United States, the pygmy-owl listing is a vexing dilemma for a number of reasons, including:

(1) The numbers are extremely low, and very little is known about this tiny, secretive bird. At the time of the listing there were only 12 known individuals. After the 1998 survey season there were around 32 known owls, and during the 1999 survey season 78 owls were identified, although some fledglings were lost. The survey season will bring us more information about the owl population, its genetic make up, and its tolerance for urban occurrences in part because Pima County has poured \$300,000 into study efforts. Yet we are a long way from delisting, downlisting, or even understanding how to protect the pygmy-owl based on its habitat needs and tolerances.

(2) Many of the known individuals are located in the fastest growing areas of Tucson, which places their habitat in conflict with large and intensive development projects.

(3) This development is occurring at the urban/rural interface and so is embroiled within divided community sentiment about whether urban or rural land uses should prevail. Our first round of pygmy-owl litigation has asked the community to choose between building a new high school or preserving owl habitat. Confounding this debate is the fact that owl habitat in this area includes an ancient forest of Ironwood trees -- a species that can live to be 1,200 years old.

In a regulatory sense, Pima County's environmental dilemma turns on the issue of potential liability under Section 9 of the Endangered Species Act, which prohibits the "take" -- hurt, harm, harass, or significant alteration of habitat -- of a pygmy-owl. The County is exposed to criminal or civil liability under Section 9 for activities as various as carrying out our \$1.1 billion dollars worth of bond projects or conducting our daily road maintenance activities, in the event of "take."

Section 9 of the Endangered Species Act can be summarized in one word -- "no." The prohibition on take is a surprising and draconian provision in the law -- sometimes called the pit bull of environmental rules. What it means in action is that if one individual endangered animal is in conflict with any land use that leads to take, that individual trumps the land use. The presence of 2 ½ ounce pygmy-owls living in a county park has caused the Pima County Board of Supervisors to abandon plans to allow building of a community college and a YMCA on that land. The passage of dispersing baby owls over

roadways in Northwest Tucson has delayed plans to widen these roads.

Section 9, by itself, can significantly alter land use, and therefore the economic expectations tied to that land use. However, its neighboring provision in the text of the Endangered Species Act, Section 10, provides a mechanism for balancing protection of listed species with other land use.

The Sonoran Desert Conservation Plan, which is keyed to Section 10, will define the level of conservation measures needed for the species, and in doing so, provide allowance for other land uses, and assurances that these uses will not be subject to Section 9 liability.

B. Multi-Species Protection Under the Sonoran Desert Conservation Plan. While the pygmy-owl is our most famous listed animal, it is by no means the only concern of the Plan. The Sonoran Desert Conservation Plan will be designed to protect and lead to the recovery of the pygmy-owl population and other species currently listed within Pima County or determined by our Science Advisory Team to be sensitive and in need of protection to avoid future listing. The first report to the Science Team, entitled *Determining Species of Concern*, identified 74 plants and animals which might be included within the plan.

There are 25 animals and plants within Pima County that are federally recognized as listed, proposed, candidates, or petitioned for threatened or endangered status.

An additional 49 species have been identified by local scientists as species of concern. Of these,

-12 species are considered to be in jeopardy in Pima County, and are species for whom habitat in Pima County is critical for their overall existence;

-18 species are considered to be in jeopardy in Pima County, and are generally declining throughout their range;

-13 species are believed to be in jeopardy in Pima County, but are not considered to be at risk overall;

- 6 species are not believed to be at risk in Pima County, but should be considered because of their ecological or social importance.

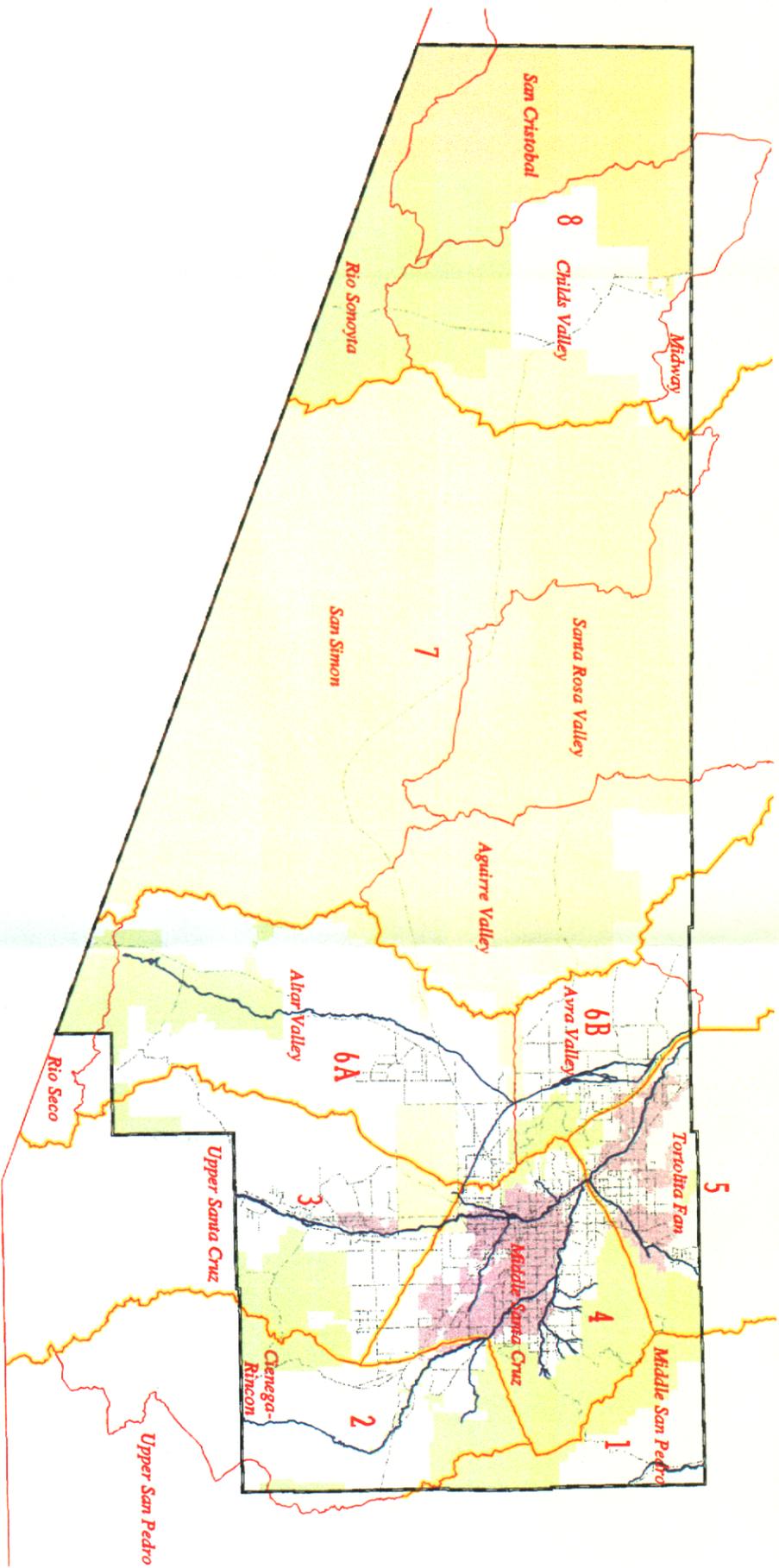
C. Riparian Habitat Protection Under the Sonoran Desert Conservation Plan. The Sonoran Desert Conservation Plan covers over 9,000 square miles of land -- nearly 6 million acres -- the rough equivalent of Connecticut, Delaware and two Rhode Islands, which makes it one of the largest regional conservation plans in the United States. The elements of the Plan are numerous but interrelated, including: (1) Ranch Conservation; (2) Riparian Restoration; (3) Cultural and Historic Preservation; (4) Mountain Park Expansion; (5) Protection of Biological Corridors; and (6) Conservation of Critical and Sensitive Habitat.

Past comprehensive plans have divided the community into subareas for planning purposes based on boundaries that were not defined by natural features. The Sonoran Desert Conservation Plan will be divided into subareas based on watershed and riparian features. Initial proposals for subareas in Eastern Pima County include:

1. The San Pedro planning unit, which includes Buehman Canyon and the San Pedro River in the vicinity of Redington.
2. The Cienega-Rincon watershed planning unit, which includes the Empire-Cienega Ranch and proposed National Conservation Area, as well as the Vail and Rocking K communities.
3. The Upper Santa Cruz planning unit, which extends north from the Santa Cruz county line to Martinez Hill. It includes Green Valley, Sahuarita, Amado and the Santa Rita Experimental Ranch.
4. The Middle Santa Cruz planning unit, which encompasses the Santa Cruz River from Martinez Hill north to the confluence of the Canada del Oro Wash. The unit includes the foothills of the Tucson and Catalina Mountains, and the Tanque Verde Creek.
5. The Tortolita Fan planning unit, which includes all the watersheds that drain the Tortolitas, as well as the communities of Tortolita, Catalina, Oro Valley and portions of Marana along the Santa Cruz River.
6. The Avra-Altar planning unit, which includes all of the Avra or Brawley Wash, as well as portions of north-ward flowing watersheds near the Silverbell Mountains, and southward-flowing watersheds near Sasabe. This planning unit will be broken into two subunits, recognizing that the Altar Valley ranches have organized their own watershed association.
7. The Tohono O'odham planning unit, which includes the Aguirre and Santa Rosa Valleys, and the San Simon watershed.
8. Western Pima County's planning unit, which includes four separate watersheds: the Midway, Childs Valley, San Cristobal and Rio Sonoyta.

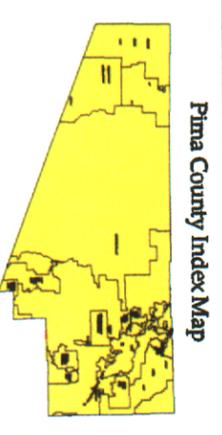
The watershed / riparian link to subareas enhances the ecosystem basis of the conservation plan. It is also clear, as elements of the Plan are studied, that the riparian connection is among the most critical. In the recently issued report on *Determining Species of Concern*, a number of sensitive species and a disproportionate number of extirpated native species were found to be dependent on aquatic habitat which is now lost. Likewise, the technical report issued on *Preserving Cultural and Historic Resources* found a strong correlation between existing cultural sites and riparian areas. Each subarea will be drafted in concept form, and redrafted after the biological, cultural and economic assessments are completed. These plans, when viewed together, will provide preserve alternatives that will constitute Eastern Pima County's conservation plan.

Watershed Planning Units of Pima County



- Watershed Boundaries
- Major Streets
- Major Washes
- County Limits
- Planning Unit Boundaries
- Tribal Lands
- Incorporated Cities
- National Parks / Monuments
- Military Range

- Planning Units**
1. Middle San Pedro
 2. Cienega-Rincon
 3. Upper Santa Cruz
 4. Middle Santa Cruz
 5. Tortolita Fan
 6. Avra-Altar
 - A. Altar valley
 - B. Avra Valley
 7. Tohono O'odham
 8. Western Pima County



Scale: Map Scale: 1:1,000,000

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Scale 1: 100,000

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5. **Adopt an Integrated Regional Effluent, Recharge and Reclamation Plan that Maximizes Use of Renewable Resources.**

The Sonoran Desert Conservation Plan will address the regions failure to effectively utilize effluent with multiple benefits, and propose an integrated comprehensive water resource and recharge program as part of the Section 10 permit.

Approximately 69,400 acre-feet per year (af/yr) of wastewater is currently treated by the two metropolitan treatment plants owned and operated by Pima County. Almost 2% of this secondary effluent is directly used on turf while 4% is delivered to agricultural users. Another 13% is further treated and used in various ways as reclaimed water, which is used for landscape irrigation.

The remainder, approximately 50,000 acre-feet of secondary effluent per year, is discharged into the Santa Cruz River, creating a perennial stream that extends at times beyond the Pinal County line, supporting a variety of important wildlife habitats and replenishing the groundwater aquifer along the way. The Arizona Department of Water Resources estimates about 90% of the discharge recharges the aquifer before it leaves the Tucson Active Management Area. This is counted as incidental recharge in the AMA water budget.

One problem is that recent changes to state law allow 50% of the effluent that recharged naturally to be used for storage credits. These storage credits can be assigned, sold or pumped, and enable the pumping of groundwater at sites other than the location of the recharge. It has been suggested that credits be granted for 100% of the effluent. If storage credits are used to allow pumping outside the area of incidental recharge along the river, groundwater declines in other areas of the Tucson Basin will be exacerbated.

Riparian vegetation along the effluent-dominated Santa Cruz River is influenced by variation in effluent flows and periodic scouring by floods. Other important factors influencing the extent and maturity of vegetation are the river's lack of direct connection to an aquifer and variations in soil texture and sediment transport. Under present conditions, the riparian communities will remain limited to a narrow strip along the channel.

The City of Tucson has proposed a managed recharge program which is tentatively permitted by the Arizona Department of Water Resources, pending appeal by four entities. This program in essence provides credits for effluent which is currently recharged into the Santa Cruz River channel in a way that conflicts with groundwater conservation throughout the Tucson basin, and does not promote regional riparian restoration, and these credits can be used to draw down more groundwater from an already seriously overdrafted aquifer. The County has raised objections to the Managed Recharge Program because of the danger of institutionalizing this less efficient use of effluent which benefits only a small reach of the Santa Cruz River and the Avra Valley aquifer. An immediate concern for Pima County is that the most important promise of the Groundwater Management Act of 1980 may not be achieved to the extent that groundwater pumping continues

As an alternative to supporting effluent use which leads to the discharge of this resource in a limited area of the Santa Cruz River, and to the continued mining of groundwater in exchange for credits, Pima County supports effluent uses in the following priority order:

- (1) directly replacing groundwater use for turf irrigation;
- (2) restoring riparian habitat and thus protecting endangered and imperiled species;
- (3) restoring groundwater levels at multiple points across the basin within the major river system and recharging the aquifer;
- (4) protecting and buffering the San Xavier District from continued groundwater mining which leads to further subsidence and depletion-related problems.

Studies indicate that it is possible to construct an effluent distribution system so that Pima County could bring effluent to the Canada del Oro basin. Much of the distribution system is now constructed to deliver effluent to multiple points along the Rillito and Santa Cruz Rivers, as the figure on page 75 shows. Therefore it is possible to create multi-benefits for all of the major urban river basins in at least the following ways:

- ▶ The region would benefit through more direct reuse of effluent in lieu of groundwater for turf irrigation across the northwest side, as well as throughout the urban area where the effluent distribution system exists.
- ▶ If the City of Tucson would agree, the differential between the amount of effluent used for turf irrigation, and the amount of effluent available, now discharged entirely to the Santa Cruz River, could be redistributed throughout the urban area river system.

This discharge of excess effluent at multiple points through artificially constructed natural wetlands within the major river system would help establish riparian areas and contribute to recharge for the whole Tucson Basin, not just Avra Valley.

- ▶ Endangered and imperiled species that are dependent on riparian ecosystems would benefit from the recovery of the special water based habitat;

Pima County strongly believes there are alternate uses of effluent that can promote federal purposes that are consistent with meaningful regional habitat conservation.

More generally, areas of critical groundwater decline should be identified and efforts made to require use of reclaimed water in place of groundwater for landscape irrigation. More of the water now discharged to the river could be directed to these areas to reduce groundwater pumping. Candidates would include the Tanque Verde Valley, Big Wash, Canada del Oro Wash, and upper Rillito Creek, where shallow water tables support riparian habitat.

At the same time, care must be taken to avoid damaging the riparian areas along the effluent-dominated Santa Cruz River.

Fortunately, effluent production at the two metropolitan plants is expected to increase more than 20,000 af/yr by the year 2010. Some portion of present effluent flows could be reserved for wildlife purposes.

At present, none of the flows are allocated for wildlife purposes, so in theory, all of the flows of the river could be diverted. The existing value of the effluent-dependent riparian habitat and its relationship to flow rates in the Santa Cruz River must be better understood.

The Bureau of Reclamation has recently begun riparian assessments to understand the baseline flows and the implications of changes in effluent flows in the Santa Cruz River on riparian vegetation, wildlife, and other river processes.

R10E

R11E

R12E

R13E

R14E

R15E

R16E

DRAFT

Reclaimed Water System Tucson, Arizona

-  CITY OF TUCSON RECLAIMED WATER LINE
-  PIMA COUNTY WASTEWATER MANAGEMENT RECLAIMED WATER LINE

-  RECLAIMED STORAGE FACILITY
-  GOLF COURSE USING RECLAIMED IRRIGATION
-  GOLF COURSE NOT USING RECLAIMED IRRIGATION
-  PIMA COUNTY WASTEWATER TREATMENT FACILITY

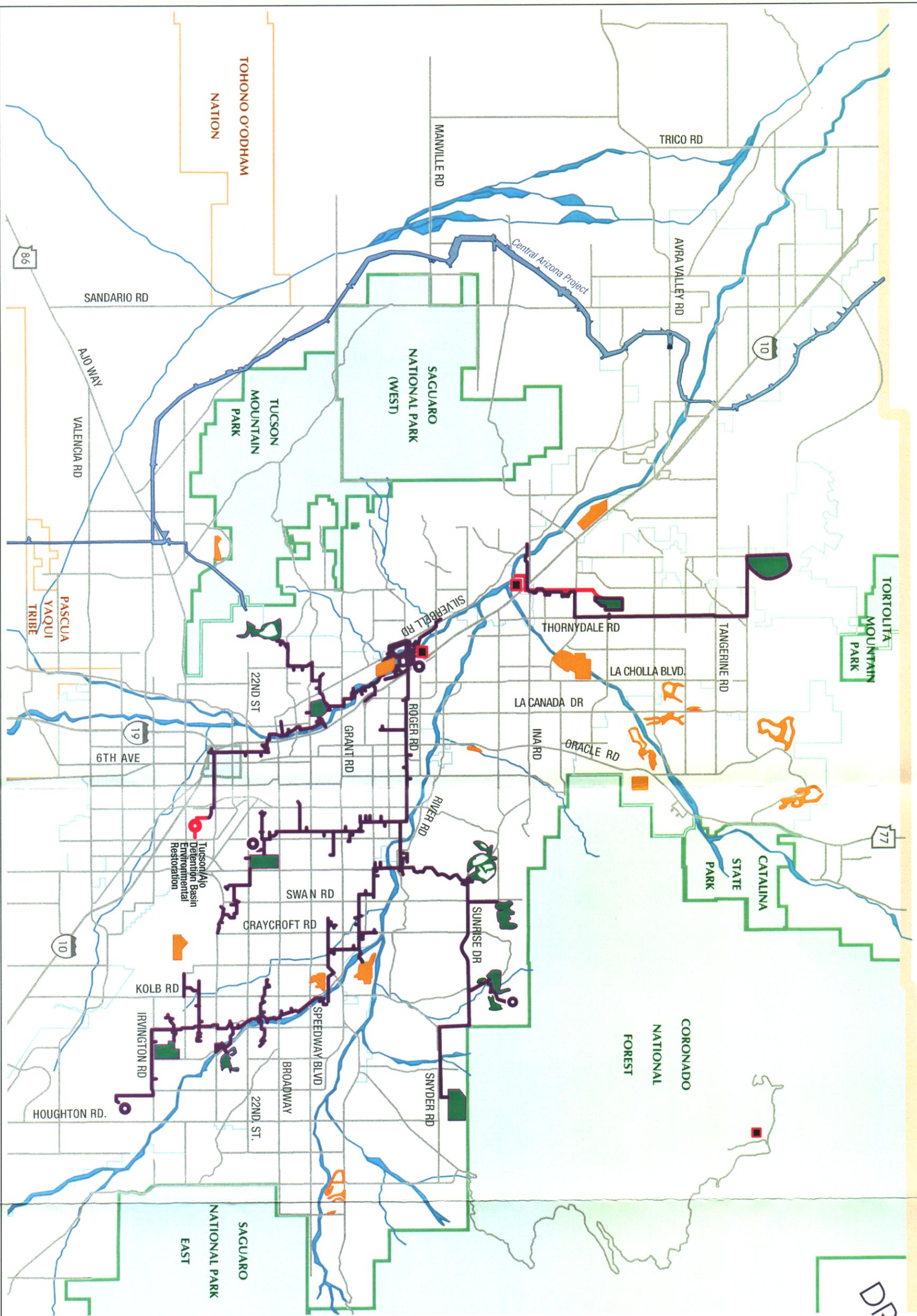
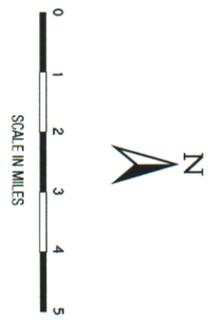


Figure 28

IV. Conclusion

Pima County's participation in water resource management issues is critical to the region's future. Some time ago, it appeared that Tucson Water, along with the smaller water providers, could develop a coherent water strategy for the metropolitan portion of the county. Today, the lack of a coherent water management strategy for the region makes it imperative that each jurisdiction carefully monitor and participate in the development and implementation of a regional water policy.

Furthermore, Pima County is not simply interested in the metropolitan area--water resources are everywhere precious, no less in rural areas than urban ones. Water supply is not the only issue involved, either. Flood control, wastewater treatment, upland watershed management, land use planning, exotic species, and many other issues must be considered together in formulating regional water policy. These issues have been treated only peripherally in the past.

The Sonoran Desert Conservation Plan provides an effective process for the community to begin more nearly at the beginning with water resource issues. The original conservation ethic that expressed itself in Arizona's first policy statements about the scarcity of water, and publicly owned nature of the resource, should be revisited. But next century, beneficial use will have to recognize hydrologic principles and environmental realities in addition to consumptive uses.

The measure of our success will be quantifiable to the degree we reach a positive bottom line with our water budget, and meet the needs of various users.

In a civic sense, we will succeed when rational water policy is the creation of local cooperative efforts, and not always the result of enforcement of federal purposes. The Sonoran Desert Conservation Plan, because it is keyed to the Section 10 process which requires a regional, comprehensive, inclusive and collaborative process, will allow us to make that showing of leadership at the local level.