MEMORANDUM

Date: January 30, 2018

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

From: C.H. Huckelberry
County Administrator

Re: **Lower Santa Cruz River: Identifying the Recreational and Economic Benefits of Access and Trails along the Santa Cruz River**

The attached draft report titled Identifying the Recreational and Economic Benefits of Access and Trails along the Santa Cruz River, provides an historic account of the Santa Cruz River in Southern Arizona, and analyzes the benefits of physically accessing the Lower Santa Cruz River within the jurisdictions of unincorporated Pima County, Town of Marana, and City of Tucson.

The release of this report is timely and coincides with the receipt of the 2018 National Environmental Achievement Award from the National Association of Clean Water Agencies (NACWA) given to the Living River Project. The National Environmental Achievement Award Program recognizes individuals and NACWA member agencies that have outstanding contributions to environmental protection and the clean water community. The Living River Project and its collaborative partners – Regional Wastewater Reclamation Department, Regional Flood Control District, Natural Resources, Parks and Recreation, Office of Sustainability and Conservation, and the US Environmental Protection Agency, will be honored with this award at its annual conference in Napa, California, February 6-9, 2018.

This report acknowledges the success of the Living River Project and makes recommendations to improve access to the Santa Cruz River.

1. It identifies there is a lack of access to natural open space in urban areas and proposes a methodology to address the problem;
2. Describes existing conditions and identifies several regional achievements in providing open space;
3. Describes the benefits of planning comprehensively along the Lower Santa Cruz River;
4. Utilizes a planning exercise to analyze strengths, weaknesses, opportunities, and threats;
5. Makes recommendations for physical access to the Santa Cruz River and associated infrastructure and amenities.

I. Introduction

The Santa Cruz River at the end of the Pleistocene attracted people to this area more than 12,000 years ago when the region was inhabited by ground sloths, bison, camels, horses, and mammoths, and the banks of the river had lush vegetation of towering cottonwood and sycamore trees, and marshy areas. Through the millennia, the region became warmer and drier, but the river continued to flow providing Native people and early Spanish and Mexican settlers a rich environment to farm and build communities. However, during the American period, John Wesley Powell's caution that only a fraction of the West was irrigable went largely ignored; and the river became 'ever a dwindling stream' as a result of ever-increasing use by an ever-growing population, until the river stopped flowing. In recent years, however, environmental conservation efforts including release of cleaned effluent and recharge to the aquifer have begun to bring life back into segments of the Santa Cruz River, highlighting its remarkable resilience.

II. Existing Conditions

A segment of the Lower Santa Cruz River from approximately Grant Road north to Sanders Road was mapped with a two-mile buffer area to perform a landscape-level assessment of current conditions, including current land use, zoning, recreation and open space amenities, infrastructure improvements, economic development, education, and health and general welfare conditions, among others. Land use is primarily residential housing, with a mix of commercial, industrial, recreational and agricultural uses that accommodates approximately 77,000 residents. There is also areas of vacant private land for future growth within the jurisdiction of Pima County, Town of Marana, and City of Tucson. This presents an opportunity for seamless land-development in the urban and urbanizing areas where the river can function as an open space amenity that links the built and natural environments.

III. Regional Achievements

Over the past few decades. the following projects within this reach of the Santa Cruz River have contributed to the economic, environmental, and social improvement of the area:

- Tres Rios and Agua Nueva Regional Wastewater and Reclamation projects
- Environmental restoration projects
- The Living River Project and Sweetwater Wetlands projects
- Juan Bautista de Anza National Historic Trail;
- The Loop—a 131-mile pathway system for recreational pursuits;
- Tourism/eco-tourism parks, trails, birding, etc.
- Heritage experiences of the Anza Trail and Los Morteros Archeological Preserve
- Education/healthy lifestyle projects
- The 2006 Regional Transportation Plan
- Proposed economic development and major employment centers

IV. Planning for the Santa Cruz River

Planning is the key to ensure benefits of public and private open space in urban and urbanizing areas. These benefits include recreation, clean air, health and well-being, aesthetics and view sheds, serenity, relief from congestion, ecosystem management and wildlife preservation, and storm-water management, among others. In eastern Pima County—the Santa Cruz River is a public resource and a gift of immeasurable value.

Pima County has adopted a number of notable goals in Pima Prospers and in other plans that are consistent with public use and access to the Santa Cruz River.

- Water resources that integrate trails, transportation modes, economic development, land use and principles of healthy communities;
- Infrastructure improvements, including the construction of two metropolitan wastewater reclamation facilities (WRF);
- Multimodal transportation and mobility for users and goods through County transportation planning and the 2006 Regional Transportation Plan;
- A range of open space/recreation parks and infrastructure (e.g., The Loop and Anza Trail) and opportunities to reduce obesity and incidents of chronic disease;
- The improvement of general health and welfare by connecting residents to the natural environment for improvements in mental health, interpersonal relationships, health literacy, access to care, and healthy lifestyles;
- Economic development, as described in the Pima County Economic Development Plan,
- Promoting tourism (2015 Pima County statistics: $2.77 billion travel industry; $674 million in earnings; $197.3 million in government revenues; and 24,060 travel-related jobs).

V. Analysis of Strengths, Weaknesses, Opportunities, and Threats (SWOT)

The Lower Santa Cruz River SWOT analysis focused on minimizing weaknesses and threats while enhancing strengths and opportunities to favor recreation, the environment, finance/funding, planning/education, archaeology/culture, water/effluent, and economic development and tourism. Weaknesses and threats identified in the categories of recreation, planning/education, and finance/funding, all of which will require attention and careful planning to ameliorate and eventually overcome.

In spite of certain pitfalls, jurisdictions continue to plan for open space, trails, and other recreational amenities. Examples include the City of Tucson and Town of Marana's Parks and Recreation Master Plan updates. The citizen surveys associated with these plans received numerous responses from residents who voiced support for the preservation of open space and the natural environment. However, respondents

also expressed frustration over a shortage of such facilities in the region and their willingness to fund new paths, greenways, trails, and open space. The Lower Santa Cruz River provides an excellent opportunity to meet and possibly exceed these shortfalls and access to recreational amenities.

VI. Physical Access to the Lower Santa Cruz River

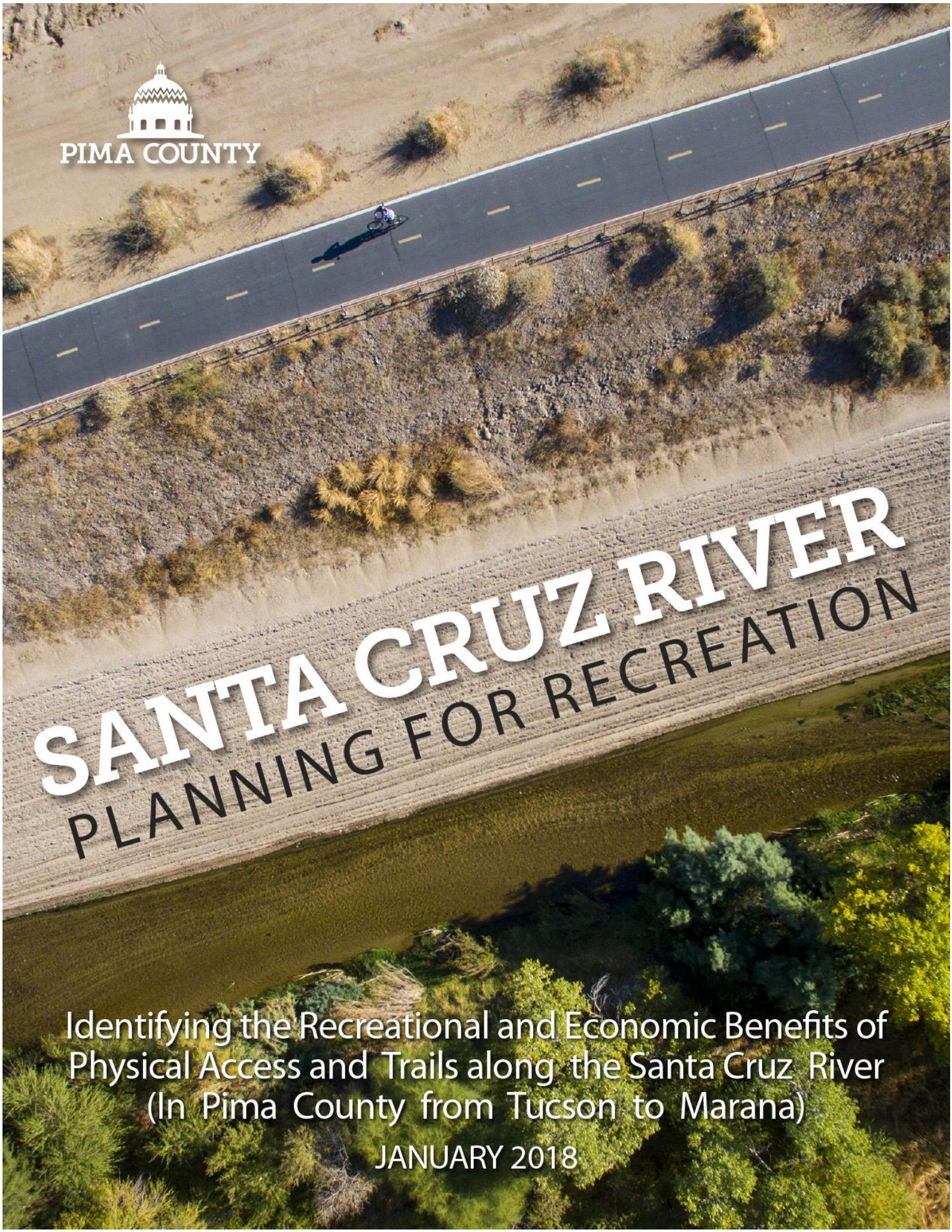
Based on existing conditions and planned improvements, potential locations to physically access the Lower Santa Cruz River have been identified at Sweetwater Wetlands, Columbus Park, Ina Road Trailhead, Crossroads Park, Wade McLean Park, Cortaro Mesquite Bosque, El Rio Park, Frisbee Park, Avra Valley Road Trailhead, Gladden Farms Park, and Marana Heritage Park. The current infrastructure and amenities at these locations vary greatly. However, the existing parks, ball fields, and other uses make the potential physical access locations compelling, since those land uses adjacent to the river are already accessible albeit at varying degrees of convenience.

VII. Conclusion and Recommendations

Over the years, areas adjacent to the river have been transformed by recreational, physical infrastructure, economic development, tourism, and environmental projects and achievements. These achievements justify the health and welfare, economic, recreational, cultural, environmental and educational benefits of funding facilities and amenities—such as parking, shade and picnic structures, restrooms, trash disposal, signage, and landscaping—in the physical locations identified along the Lower Santa Cruz River. This report provides information and an opportunity to fulfill the goals of improving our community and its recreational needs.

CHH/lab

Attachment



PIMA COUNTY

SANTA CRUZ RIVER
PLANNING FOR RECREATION

Identifying the Recreational and Economic Benefits of Physical Access and Trails along the Santa Cruz River (In Pima County from Tucson to Marana)

JANUARY 2018

Lower Santa Cruz River:
Identifying the Recreational and Economic Benefits of Physical Access and Trails along the Santa Cruz River (In Pima County from Tucson to Marana)

January 2018

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I. Purpose

To identify benefits of physical access to the Lower Santa Cruz River, which may be at or in proximity of existing recreational facilities and eco-tourism attractions along the river.

II. Problem Statement

Open space has been infrequently utilized as an element of urban design and an essential component of the built environment within private development in post-World War II U.S. cities. In Pima County, the Santa Cruz River is a prized public open space asset. However, the river that was once a focus of activities was relegated to a "back alley" status over 100 years ago and continues today.[1]

Over the past couple of decades, residential, commercial and recreational development in proximity of the Lower Santa Cruz River have been complemented by infrastructure improvements in water reclamation, transportation, and parks and recreation, funded by revenue bonds and other sources.

The Pima County jurisdictions have an opportunity to take advantage of these developments and improvements to avail the river and reverse its "back alley" status. Such an effort has the potential to:

1. utilize recent and future transportation improvements;
2. serve recreational needs;
3. promote education programs: environment/nature, culture, and recreation;
4. add health and general welfare value for residents;
5. avail benefits of economic development; and,
6. promote tourism.

III. Methodology

The report has two components.

1. A background and historical account of the Santa Cruz River in southern Arizona.
2. A benefits analysis of physically accessing the Lower Santa Cruz River—from north of Prince Road to south of West Moore Road—located within Marana, Tucson and unincorporated Pima County.

A 2015 field survey identified viable locations for physical access to the Lower Santa Cruz River (more details are provided in the "Lower Santa Cruz River Physical Access" chapter of this report). A key finding was the deterrents to accessing the river, which include (a) distance from the nearest inhabited areas that may discourage foot travel; (b) steep embankments resulting from arroyo cutting and soil cement embankment, among other factors; and (c) a lack of visibility in large stretches.

This report includes:

1. maps, illustrations, and aerial photographs of existing conditions for reference and orientation;
2. citations from studies, reports, and projects (completed, on-going, and future) to elicit the challenges of planning for the river in a comprehensive manner;
3. an assessment of strengths, weaknesses, opportunities, and threats (SWOT) to build on the strengths and opportunities that may ameliorate, if not eliminate, weaknesses and threats; and,

4. proposed recommendations favoring river-access that may shape policies for implementation and provide adequate funding.

IV. Introduction

The river, as it exists today, can only be partially restored "to some previous state of perennial naturalness."[2] This challenge is compounded by the river's stretches lying within multiple local jurisdictions with differing plans and policies; however, this aspect also presents opportunities for regional planning and the funding of a wide range of projects and improvements.[3]

"[F]ew heeded John Wesley Powell's caution that only a fraction of the West was irrigable,"[4] and despite human exploitation, the Santa Cruz River has maintained a unique identity in our community and shown remarkable resilience. Late-twentieth and early-21st century conservation efforts have breathed life into segments of the river, such as the Lower Santa Cruz where creating parks, trailheads and other attractions have facilitated physical access to the river.

Today, the river's success as a recreational amenity begins with "what environmental and social features of rivers are important to people."[5] Many Pima County residents view water, vegetation, fish and wildlife as key ecological features but consider the river's surface-water as stagnant and prone to vector-borne diseases, thus, rendering the river undesirable.[6] This dichotomy presents an opportunity to assess the river's potentials and pitfalls through a SWOT analysis.

Additionally, archaeological, transportation, recreational, and wastewater projects within- and in close proximity of the river provide impetus for comprehensive planning.

V. Brief History and Background

Called "ever a dwindling stream"[7] more than 100 years ago, the Santa Cruz River's current state—in most of its entire 205-mile stretch—is either intermittent or ephemeral.[8] The river, molded by weather and environmental conditions over many millennia,[9] has had a profound impact on the physical landscape[10] of Pima County and the region at large, through which it flows.

It enticed human settlement more than 12,000 years ago,[11] when the region was inhabited by Pleistocene fauna, such as ground sloths, bison, camels, horses, and mammoths that have since become extinct in North America. The river and its wetter, cooler climate had typically very lush vegetation, with towering cottonwood and sycamore trees, as well as marshy areas with willow, elderberries, ash, walnut, hackberry, and catclaw, which persisted along stretches until relatively recent historic times.

To understand the human impacts on ecology over several millennia, "it is convenient to divide the known span of human occupation into several phases or periods each characterized by cultural attributes distinct from those of the other periods."[12] These phases/periods are: (a) hunting big game; (b) gathering food (while limited hunting continues); (c) initial agriculture (hunting and gathering continues); and (d) developed agriculture.

Over roughly 12,000 years of environmental, climatic, and human-induced events, the Santa Cruz River has transformed greatly from a braided, flowing stream—with the beginning of a new floodplain, cienega development, floodplain aggradation, and formation of different arroyos—to reach where it is today (See ***Appendix A*** for a chronology of events).

The Santa Cruz River possesses a great wealth of environmental and archaeological information dating back to the late-Pleistocene era. This warrants the development of an education component that explains the river's (a) historic background;[13] (b) physical environment from a bygone era;[14] (c) fate in the modern era of the 1900s,[15] resulting in its current state; [16]; and (d) role and significance in the new millennium.[17]

Furthermore, it is evident that (a) certain restoration efforts have succeeded in recent decades;[18] (b) the river warrants more attention from a seemingly disaffected population;[19] and (c) additional opportunities and means are available to restore sections of the river for public use and enjoyment.[20]

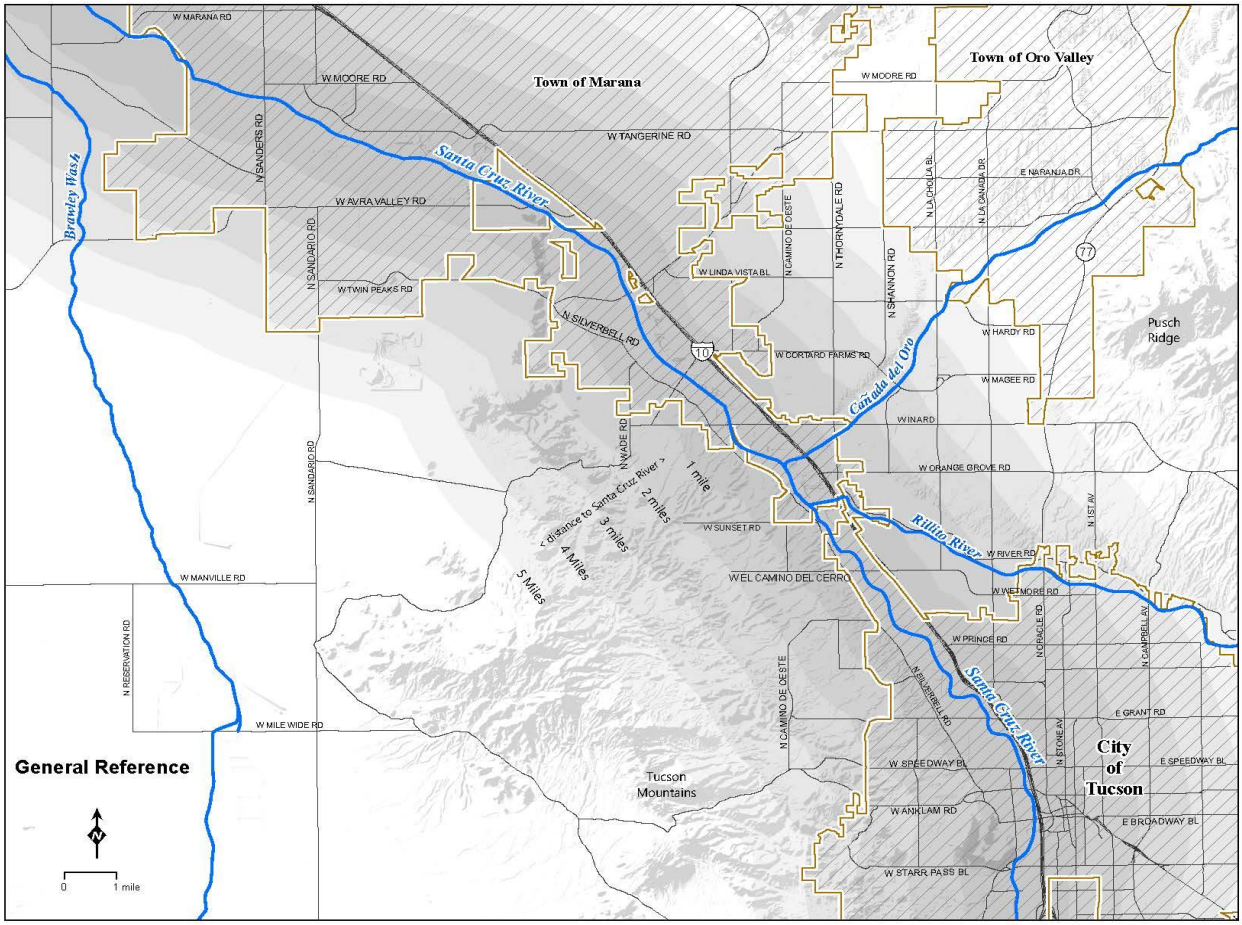
More recently, there have been discussion of discharging effluent water into a section of the river—under the Agua Dulce project—to breathe life into downtown Tucson and areas in its proximity.

VI. Existing Conditions

General Layout

Map 1 shows buffers centered on the riverbed at one-mile intervals up to five miles out.

Map 1 - General Reference



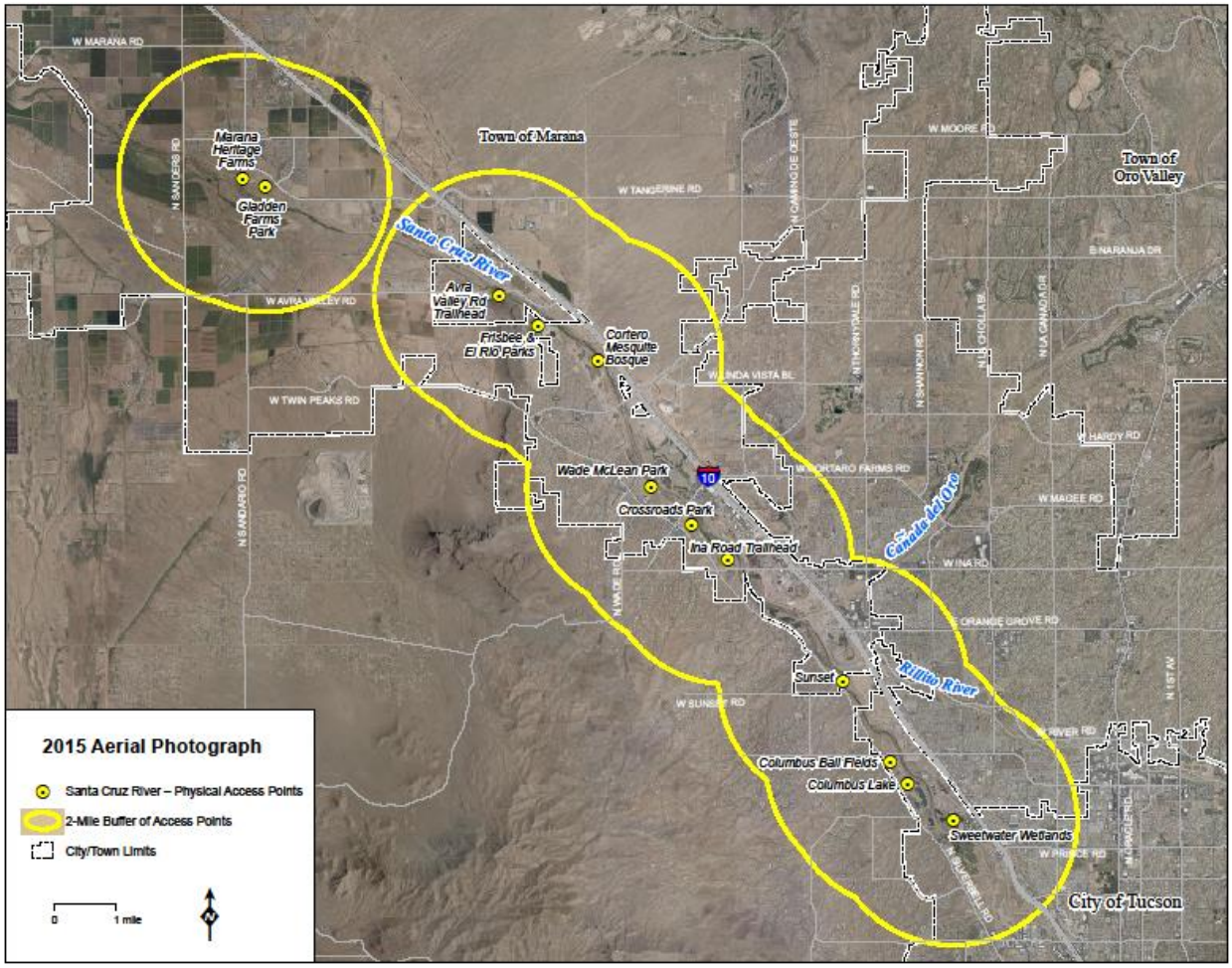
The purpose of setting these buffers was to obtain a landscape-level idea of current conditions, including land use, zoning, recreation and open space provisions, infrastructure improvements,

economic development, education, and health and general welfare matters, among others. The two-mile buffer revealed a good sample of land use and demographics to help determine economic, recreational, and educational benefits of accessing the river.

Aerial Photograph

Map 2 shows the built environment and land available for urban development, sandwiched between the Tucson Mountains (to the south and southwest) and the Coronado National Forest (to the north-northeast).

Map 2 - Aerial Photograph



Land Use

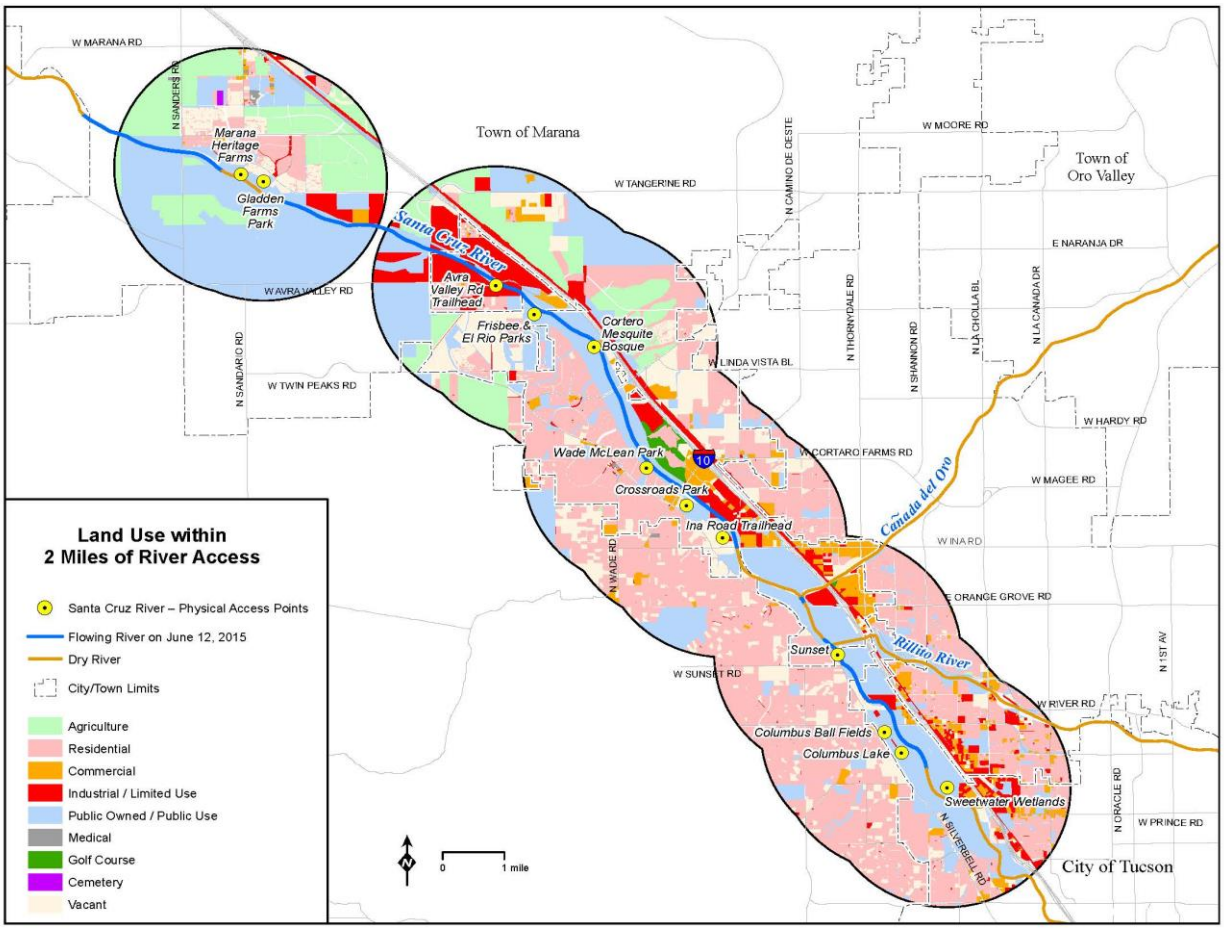
The buffer area's land use is predominantly residential (*Map 3 - Land Use*)—at varying allowable densities of development—including single family, multifamily, duplexes, and multiplexes. Additionally, a mix of agricultural, commercial, industrial, recreational, and open space, among other land use designations occur at varying footprints and acreages.

The area accommodates a population of over 77,000 people who need adequate physical infrastructure for mobility, recreation, amusement, and health and general welfare, among others.

Furthermore, the Lower Santa Cruz River is a draw for residents and visitors, compounding the case for needed amenities where river access is planned.

While each jurisdiction—Town of Marana, City of Tucson, and unincorporated Pima County—will carry out land development and disturbance based on its needs, the Lower Santa Cruz River may have the potential to forge cross-jurisdictional policies that promote and develop a uniform pattern of construction and development to compliment this natural resource. Smart growth, green infrastructure, water resources management, and complete streets can and should be utilized to build sustainable communities.

Map 3 - Land Use

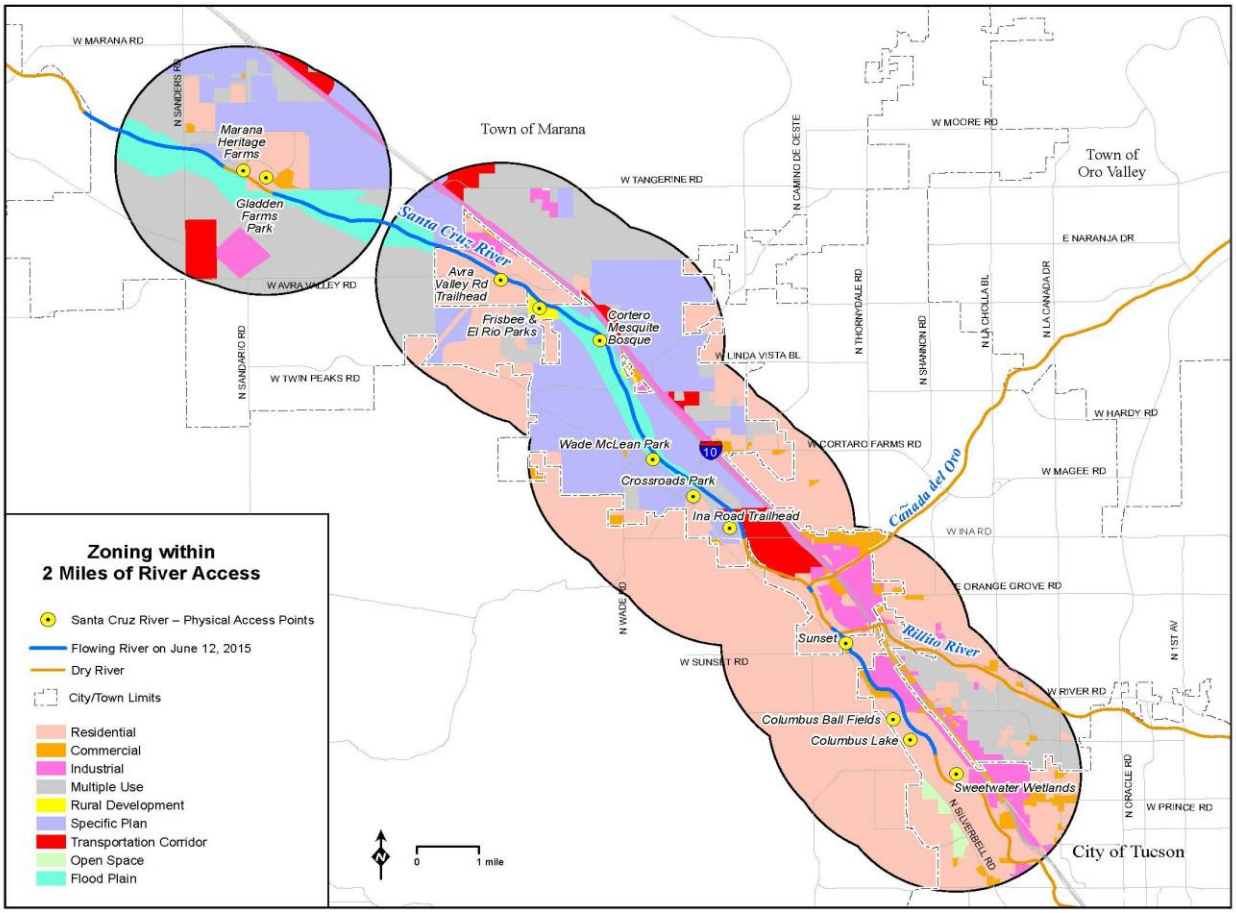


Zoning

Largely, the zoning categories (*Map 4 - Zoning*) reflect the land use map designations (*Map 3 - Land Use*), with certain variations based on each jurisdiction's zoning code requirements (Town of Marana, City of Tucson, and unincorporated Pima County).

As with land use, there may be a unifying role for the river to play in ensuring seamless development patterns across political jurisdictions. Such may occur through inter-governmental agreements on the best way to develop and promote a regional open space resource, given the nexus between wastewater reclamation, effluent ownership, land planning, and eco-tourism.

Map 4 - Zoning

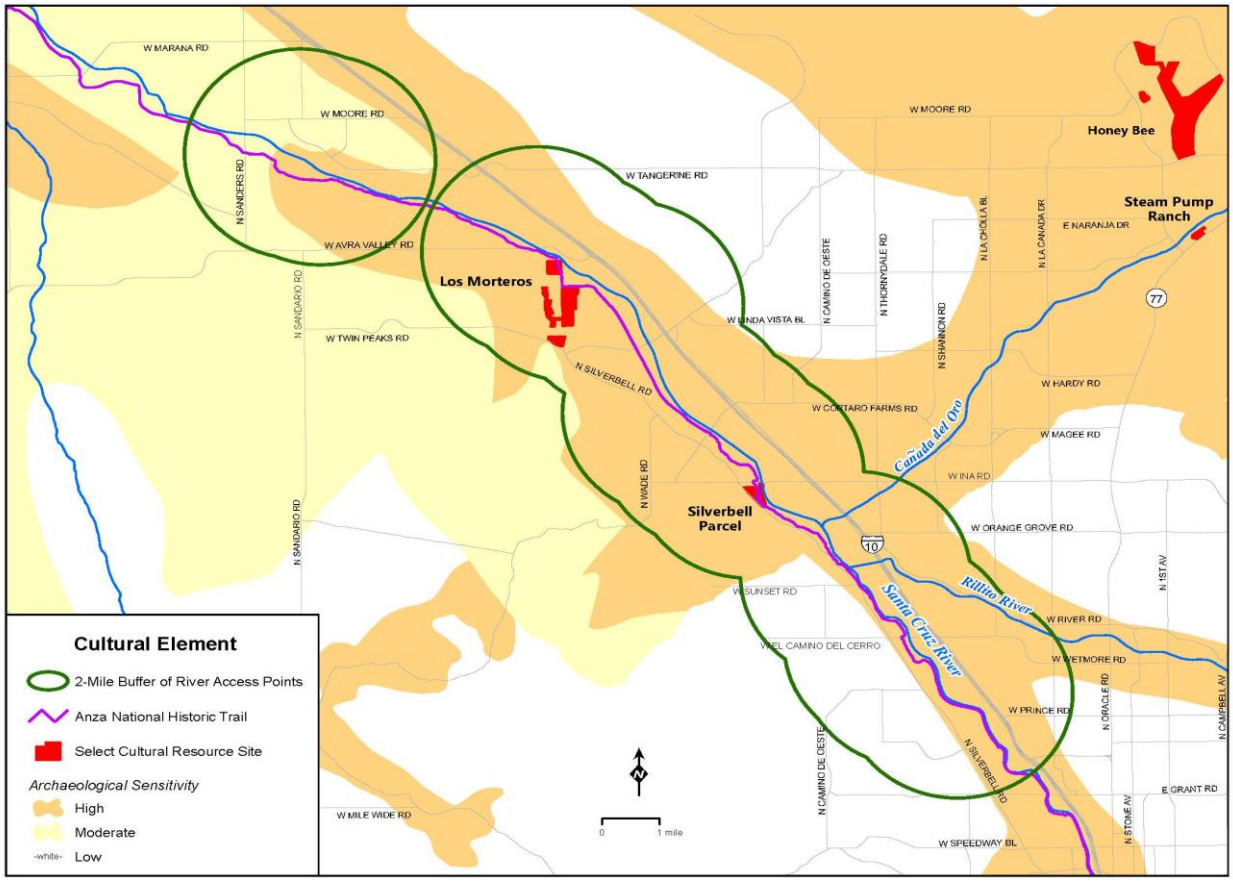


VII. Regional Achievements

Over the past few decades, a number of projects have been developed, others are in progress, and yet more are planned for positive impacts on awareness, visibility, access, and utilization of the Santa Cruz River, which include the following (See ***Appendix D*** for details).

1. 2006 Regional Transportation Plan (RTP) projects near the river.
2. Juan Bautista de Anza National Historic Trail—the land route of de Anza's Portolá expedition—a segment of which plies along the Santa Cruz River, stretching across four Pima County jurisdictions and notable for its archaeological, historic and educational significance. *Map 5 - Archaeological and Cultural Resources* shows the historic national trail and the extent of cultural resources in the Lower Santa Cruz River area.
3. The Loop—a 131-mile multi-modal paved and unpaved pathway system for walking, bicycling, skating, and horseback riding—with more than 80 percent of the project completed.
4. Environmental Restoration projects, such as Tres Rios del Norte and Paseo de Las Iglesias that promote eco-tourism, recreation, and activities that engender better health and general welfare of the County's residents.

Map 5 - Archaeological and Cultural Resources



5. Wetlands and river-monitoring projects like *The Living River* that bring public understanding of the values of wetlands, while promoting environmental education and eco-tourism.

6. Infrastructure projects like the Regional Optimization Master Plan (ROMP) that facilitate the County's metropolitan water reclamation facilities (WRF) to produce high quality effluent responsible for supporting the Lower Santa Cruz River flora and fauna habitat.

7. Economic development projects, such as the proposal for utilizing Pima County Regional Flood Control District (PCRFCD) lands northwest of Interstate 10 and Sunset Road that will generate jobs and revenue while highlighting the river.

8. Projects that promote tourism and environmental education, such as the Sweetwater Wetlands, which is a venue for birding enthusiasts from all over the world.

9. Education, recreation, and healthy lifestyle projects, such as (a) El Corazon, which contains a trail system along the river; (b) Las Milpitas Community Farm (a part of Paseo de Las Iglesias); and, (c) Sweetwater Wetlands with walking and hiking opportunities.[21]

10. Several studies and reports generated by Pima County jurisdictions on or related to the river.

These projects—at varying levels—also fulfill recreational, educational, economic development, tourism and health/welfare needs mentioned in the report's Purpose statement.

VIII. Planning for the Lower Santa Cruz River

The value of open space in urban areas cannot be underestimated. In a little over 100 years, the population has transformed from living in small towns and rural areas in the late 1800s to roughly 85 percent of the population residing in cities and metropolitan areas in the new millennium. The anticipation of 19th Century American visionaries like Frederick Law Olmstead—that a rural to urban migration trend was occurring—resulted in the creation of New York's Central Park, San Francisco's Golden Gate Park, and other parks, which were designed and built as necessities, and not amenities.[22]

The benefits of open space in urban and urbanizing areas are manifold: recreation, clean air, health and well-being, aesthetics and viewsheds, serenity, relief from congestion, ecosystem management and wildlife preservation, and storm-water management, among others. "Both publicly held and privately held lands can provide open space benefits, but because people who do not directly own the land still enjoy the benefits, open space is likely to be underprovided by the private sector."[23] This highlights the value of the Lower Santa Cruz River as a public open space amenity that serves the needs of the public and private sectors.

The value of the Lower Santa Cruz River in Pima County rises with the decline in public open space across cities and communities in the US. The United States Forest Service states that

> [E]ach day, an estimated 6,000 acres of open space are converted to other uses. Expanding urban and suburban areas often result in a loss of forests, grasslands, and other natural areas. This loss is significant, as open spaces provide many benefits and ecosystem services. From clean water and natural flood control to wildlife habitat and biodiversity to recreation opportunities, there are many diverse benefits derived from open space that we must consider and manage sustainably.[24]

Economic, social, and environmental benefits can be attained by building communities that have

> [W]alkable neighborhoods, parks and open spaces also are believed to generate economic benefits to local governments, home owners [*sic*] and businesses through higher property values and correspondingly higher tax assessments. The economic benefits of open, walkable spaces can play an important role in policy-makers' decisions about zoning, restrictions on land-uses, government purchase of lands for parks and similar initiatives.[25]

The underestimation of open space value often results from the exclusion of nonmarket benefits associated with passive uses from typical land speculation plans and methods.[26]

There are economic, recreational, environmental, health and welfare, and aesthetic benefits of open space that are located near urban areas.[27] The high urban development densities place a premium on open space, the significance of which is enunciated in studies that have found considerably diminished economic premiums for open space located near rural areas.[28]

There are instances when "open space can reduce nearby property values, an outcome sometimes called 'the nuisance effect,'"[29] because these spaces are poorly maintained, located in declining neighborhoods, or, are over-crowded. The Lower Santa Cruz River does not possess any such danger, as Pima County has succeeded in converting the terrible disaster of 1983 into region-wide assets like its river parks and the Loop.[30]

Basically, "recreation areas and parks located in metropolitan areas provide economic benefits to residents, municipal governments and private real estate developers."[31]

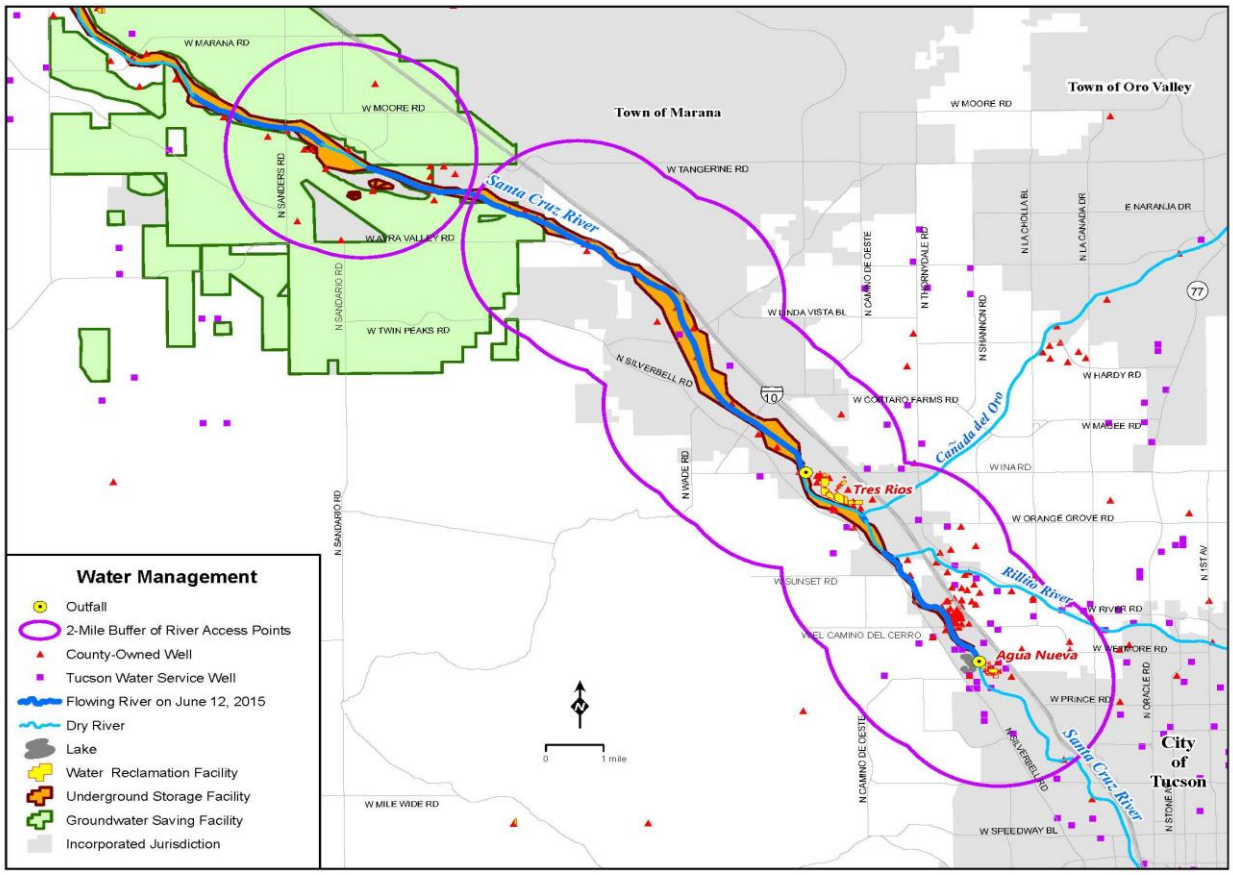
Water Resources

Water resources form a key element of green infrastructure, which has a proven track record of social, economic, and environmental benefits.

> States can benefit in multiple ways by aligning open space, habitat and water resource programs to serve, where effective, as green infrastructure. First, green infrastructure allows the integration of inter-related programs such as natural resources management, mapping, parks conservation, floodplain management and planning. Second, it requires an assessment of the full range of economic value and costs related to land conservation. By presenting a comprehensive picture of costs and benefits, including costs avoided, natural resource and environment departments can serve as stewards of the environment and the state budget at the same time.[32]

Water resources in proximity to the Lower Santa Cruz River include wells, underground storage facilities, recharge facilities, lakes, and water reclamation facilities, responsible for flowing water in most of this section of the river (*Map 6 - Water Resources*). Preventing pollution from stormwater runoff in the area has been addressed by implementing Pima County and City of Tucson's green infrastructure program, among other efforts.[33]

Map 6 - Water Resources



Pima County also has goals to integrate its "trails system, transportation modes, economic development and land use patterns with healthy community principles."[34] Furthermore, the County strives to "continue to require development to conform to adopted Pima County code provisions that integrate watercourse, riparian and upland habitat, land use, recreation and drainage."[35]

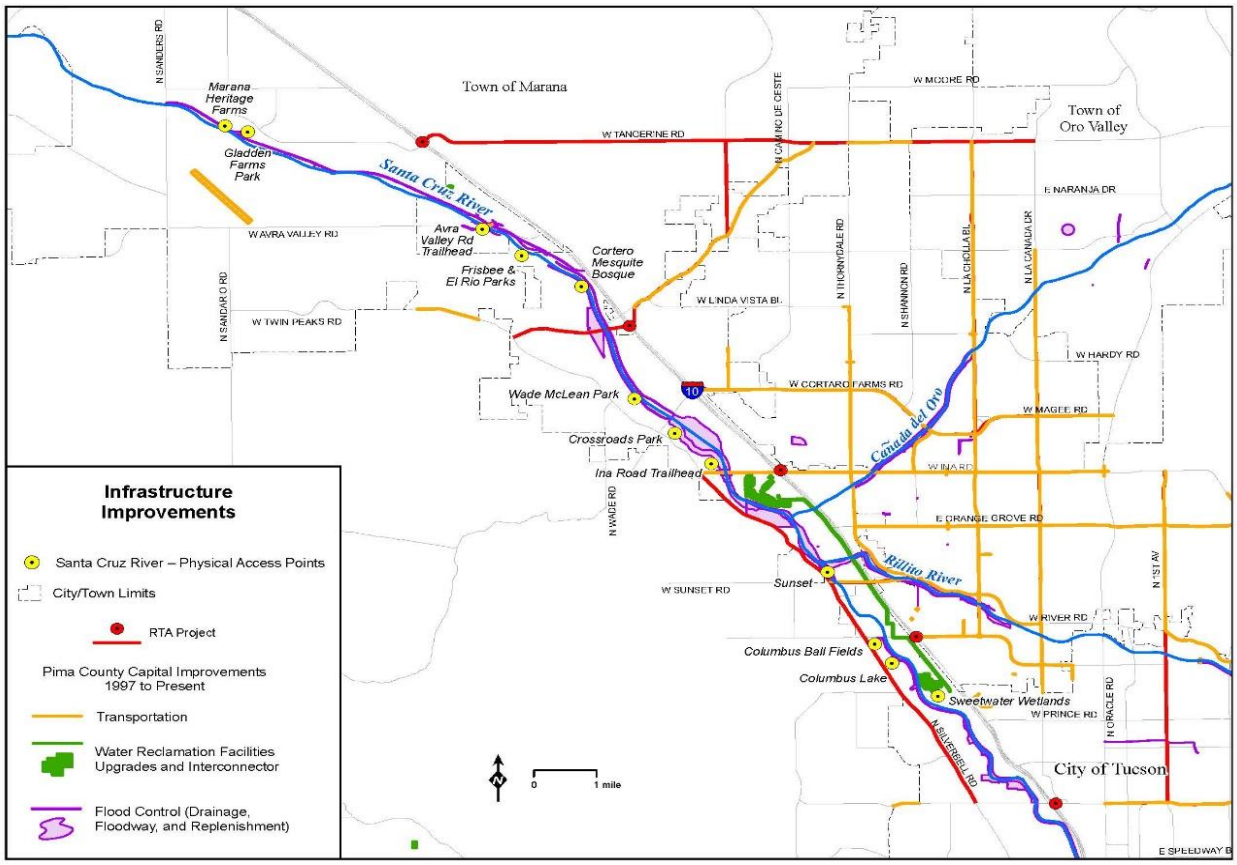
Infrastructure Improvements

The comprehensive infrastructure improvement in the Lower Santa Cruz River area includes the two metropolitan water reclamation facilities (Agua Nueva and Tres Rios), a number of flood control and drainage facilities, and a network of roads and highways that have been built over the past several decades (*Map 7 - Infrastructure Improvements*).

In the future, maintaining a balance between urban development, water resources, recreation, floodplain management, and pollution control will become key to sustaining the Lower Santa Cruz River's natural characteristics; and, the plans that Pima County and Tucson have made will need community wide support.

> The Pima County Regional Flood Control District and the City of Tucson are implementing a joint outreach and education program to promote the planning, design, and implementation concepts outlined in their manual. Integrating green infrastructure practices into new development and redevelopment projects in southern Arizona will largely depend on adoption of the concepts by professionals involved in design, engineering, architecture, landscaping, and other specialties. Some basic level of support also will be required from property owners, managers, and lending institutions.[36]

Map 7 - Infrastructure Improvements



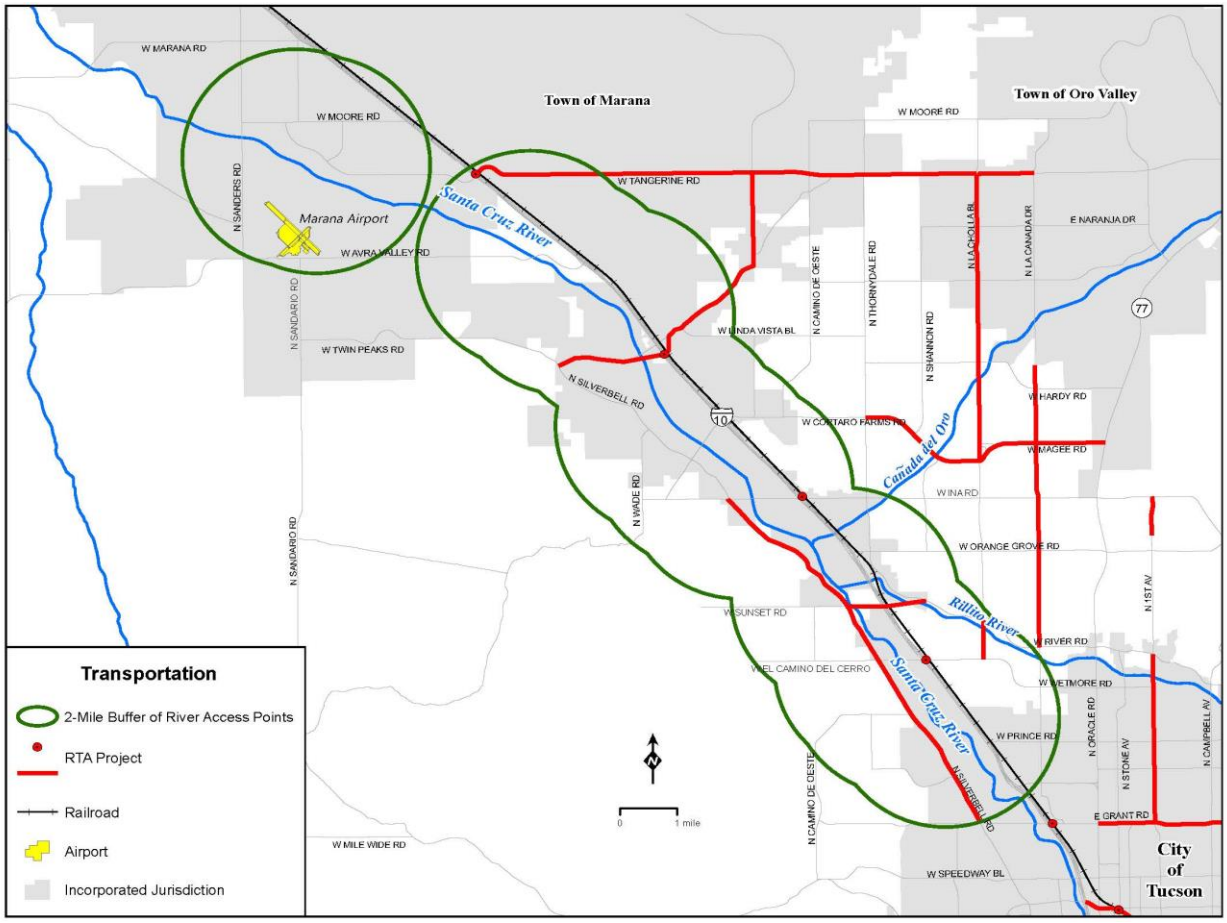
Transportation Improvements

Over the years, transportation infrastructure projects in the river's vicinity have been funded by a variety of sources, including the 2006 Regional Transportation Act (RTA) bond funds. Some of

these projects have either provided or improved access to the river (*Map 8 - Transportation Improvements*). In the new millennium, neo-traditional transportation projects, like the Loop, demonstrate their far-reaching economic, social, environmental, recreational, and health and welfare benefits.

> Transportation was once the heart of a city's prosperity. Sitting on the right freeway exit ramp or rail line was enough to guarantee generations of successful businesses. Globalization has ended that guarantee. Now, the natural resources that keep cities competitive are residents with know-how. Cities and businesses prosper by attracting and retaining people with talent and skills that fit the specialized niches the global economy needs. And this talent pool wants more than a fast freeway.
>
> In fact, for a rising generation of workers who've grown up amid urban rebounds such as what we're experiencing here in Southern Arizona, traffic jams and office complexes are the last places they want to spend time. That's why companies that rely on young talent are increasingly seeking to locate in regions with good biking and walking facilities. These appealing transportation options give workers the commutes they prefer.[37]

Map 8 - Transportation Improvements



One of Pima County's goals is to "continue to work with PAG [Pima Association of Governments] in the implementation of the most recent long-range transportation plan, the 2040 regional Transportation Plan Update (RTP)."[38]

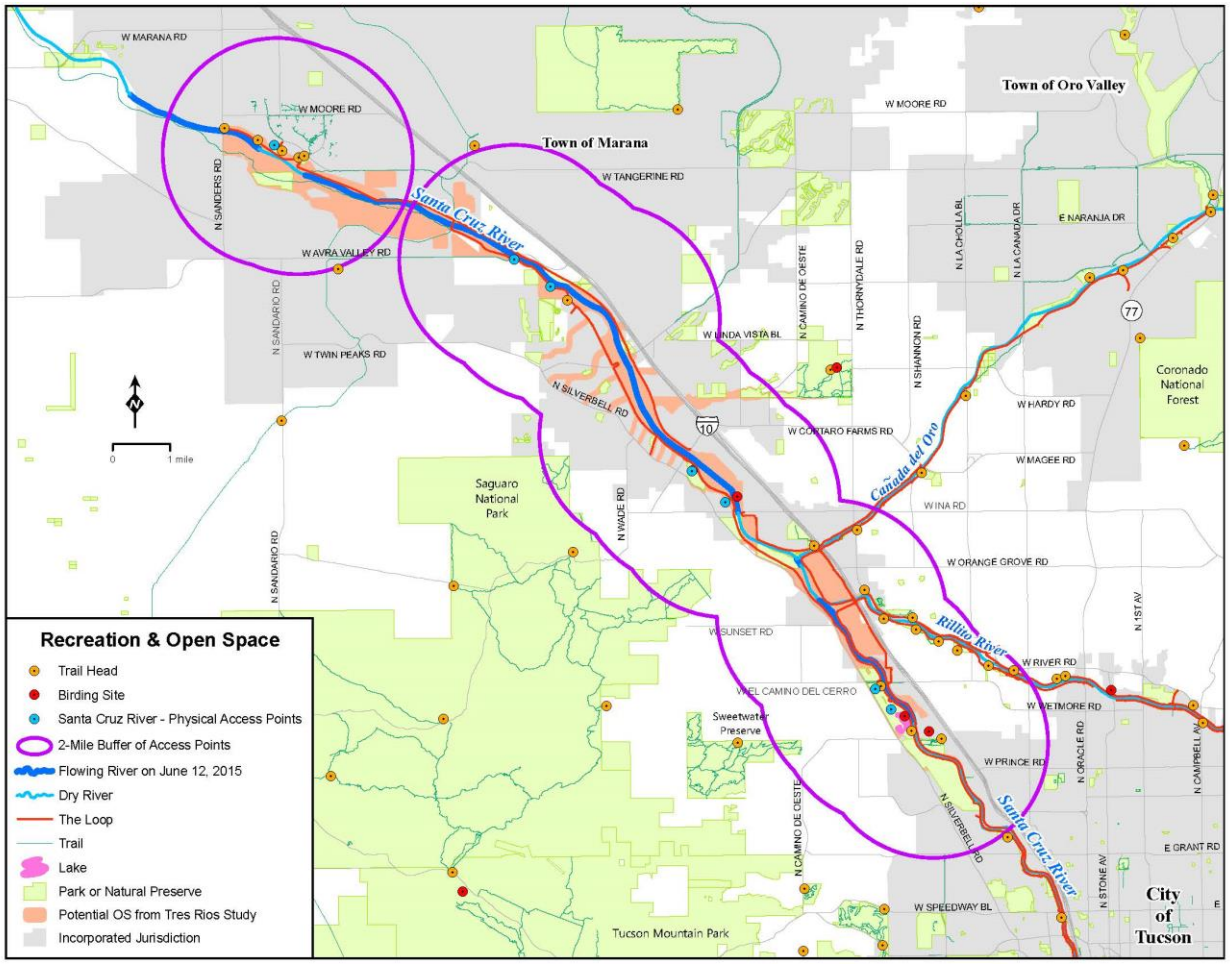
"Transportation is a critical element of the recreation experience"[39] and reflects Pima County's 'complete streets' planning goal to "provide a cost-effective comprehensive and multi-modal transportation system [*emphasis added*] while providing mobility for all users and goods, and all modes of travel including automobile, transit, bicycling and walking."[40]

Recreation

Pima County and southern Arizona promote recreation and tourism nationally and internationally. Given the region's natural environment (one of the most bio-diverse on the planet[41]), rich history (stretching back 10,000 years[42]), good weather (Arizona is considered "America's sunniest state"[43]), and a general absence of natural hazards, among other attributes, heritage and nature tourism play a vital role in our region's economic viability.

A range of recreation and open space resources available for access within the Lower Santa Cruz River are shown in *Map 9*.

Map 9 - Recreation and Open Space



Over the decades, recreation has transformed from an activity to a management strategy that "incorporates a range of recreation-related factors that, in alternative combinations define a standardized system of recreation opportunities."[44] This management strategy, known as Recreation Opportunity Spectrum (ROS), is based on "experience-based setting management"

which "theorizes that experiences are derived from recreation activities, and that these activities are linked to the settings in which they occur."[45]

Recreation Opportunity Spectrum is widely applied by federal land managing agencies including the U.S. Forest Service (USFS), U.S. Bureau of Land Management (BLM), and U.S. Bureau of Reclamation (BOR). The United States Forest Service states that ROS "was designed for, and is best suited to, the large tracts of public lands in the western U.S."[46]

Over the years, "ROS has been extended to other professional and specialized areas, including wilderness, tourism and ecotourism, water resources, land use patterns and ownership, and roads."[47] "Recreation can be understood within a "behavioral" approach or model. This model's basic structure postulates that recreationists participate in selected activities in specific settings to fulfill motivations that in turn lead to benefits."[48] **Table 1** illustrates four levels of outdoor recreation demand.

Table 1

Levels or Hierarchies of Demand for Outdoor Recreation

Level		Example 1	Example 2
1.	Activities	Wilderness hiking	Family picnicking
2.	Settings A. Environmental setting B. Social Setting C. Managerial Setting	 Rugged terrain Few people No restrictions	 Grass fields No boisterous teenagers Picnic tables
3.	Motivations	Risk taking Challenge Physical exercise	In-group affiliation Change of pace
4.	Benefits A. Personal B. Social C. Economic D. Environmental E.	 Enhanced self-esteem Lower crime rate Lower health care costs Increased conservation commitment	 Enhanced personal health Family solidarity Increased work production Higher quality environment

Adapted from Haas et al., 1980

The management strategies of ROS are applicable to the Lower Santa Cruz River—a large and diverse resource with multiple uses within Pima County's urban environment—which has supported historical, cultural, archaeological, environmental, social, and recreational activities over millennia. The Loop shares a large tract of open space and epitomizes the multiple use ethos.

> It [the Loop] helps attract and retain high-wage employers, improves the value of adjacent lands, enhances the quality of life and health for our community, generates revenue and improves the tax base, providing a growing source of income for the entire region. And it brings us all together, connecting residents of Pima County to the places where we live, work, shop, learn and play.[49]

As an active open space, the Loop offers opportunities of return on investment for all parties in a community.[50]

Pima County has a goal to "increase opportunities to incorporate green space as a part of the urban environment,"[51] intended as a means to establish a nexus between the built and natural landscapes,

which can be realized by planning and building infrastructure and amenities at physical access locations on the Lower Santa Cruz River.

Education

Education of the natural environment is a means to develop values.[52] The Tbilisi Declaration (1977) "noted the unanimous accord in the important role of environmental education is the preservation and improvement of the world's environment, as well as in the sound and balanced development of the world's communities."[53] It also provides "the framework, principles, and guidelines for environmental education at all levels—local, national, regional, and international—and for all age groups both inside and outside the formal school system."[54]

Outdoor classrooms, workshops, seminars, and field trips add to an individual's inclination and motivation to attain the benefits of recreational activities. For example, placing displays and exhibits in the Sweetwater Wetlands area and conducting workshops can increase an individual's knowledge of birds and their environment, and the enthusiasm for birding. A sightseer is also likely to spread the word of a memorable experience, which can promote the site. As interest in such recreation sites increase, so do revenues from boarding, lodging, food and souvenirs—thereby demonstrating the interconnectedness with economic development and tourism.

Providing educational opportunities at the river's physical access points serve as gateways to a greater personal experience in the pursuit of recreation, healthy lifestyles and general wellness.

Health and General Welfare

Table 1 refers to enhancing personal health and self-esteem, physical exercise, lowering of health care costs, and increased work production, inexorably tying recreation to health and welfare.

"The human relationship with nature, and the idea that this might be a component of good health, have a long history in philosophy, art, and popular culture, from ancient Greece to the New England transcendentalists."[55] Originating with E. O. Wilson's hypothesis, contact with nature is said to enhance health, the evidence of which can be found in four aspects of the natural world-animals, plants, landscapes, and wilderness experience.[56] Henry David Thoreau's "tonic of the wilderness"[57] and a component of Japan's national public health program called "tree bathing"[58] have demonstrated the value of nature on human health.[59]

Physical activity is not merely a matter of personal choice or decision; "community design and the availability of open spaces and recreation areas strongly influence how active people are."[60] This places onus on the public and private sectors to design communities with adequate open space, especially, with children and adolescents in mind.[61]

In Pima County, connecting with nature is rife with opportunities owing to an extensive trails system, which "consists of 853 miles of existing and proposed trails, paths, greenways, river parks, bicycle boulevards, and enhanced corridors that connect regional destinations, parks, schools, and preserve areas. In addition, there are 1,422 miles of single-track level trails."[62] Many of these trails link with the Santa Cruz River.

With half of the world's population residing in cities, "the livability of urban areas and the quality of life afforded their citizens" is of paramount importance, especially, as it relates to "access to

urban nature and investments in green infrastructure."[63] Decades of research and studies reveal that access to nature is scientifically linked to human wellness.[64]

While there are benefits to urbanization,

> it also is associated with increased levels of stress and mental illness, including depression. It has been suggested that decreased nature experience may help to explain the link between urbanization and mental illness. This suggestion is supported by a growing body of correlational and experimental evidence, which raises a further question: what mechanism(s) link decreased nature experience to the development of mental illness?[65]

There is an opportunity for Pima County residents and visitors to utilize the Santa Cruz River as a valuable resource for better health and general well-being, given decades of research revealing the positive impacts of greenspace on well-being.[66] The Pima County Natural Resources, Parks and Recreation Department has goals to "help reduce obesity and incidence of chronic disease by providing opportunities for rigorous physical activity in a variety of forms" and "provide a connection to nature which studies demonstrate relieves stress levels, tightens interpersonal relationships, and improves mental health."[67]

The Pima County Community Health Improvement Plan (CHIP), 2010-2013, was created "to examine the challenges and opportunities facing the health of Pima County residents."[68] Its priorities are: (a) healthy lifestyles; (b) health literacy; (c) access to care; and (d) health disparities.[69] These goals also have a nexus to the 2015 Pima County Comprehensive Plan update (Pima Prospers) which features policies to (a) increase access to resources to improve physical health, behavioral health, and wellness; (b) provide green infrastructure; and, (c) create programs for wellness and healthy lifestyles.[70]

Economic Development

In a world of economic uncertainty, since the economic downturn of 2008, every community in the U.S. is employing innovative ideas and strategies for financial, fiscal and economic stability.

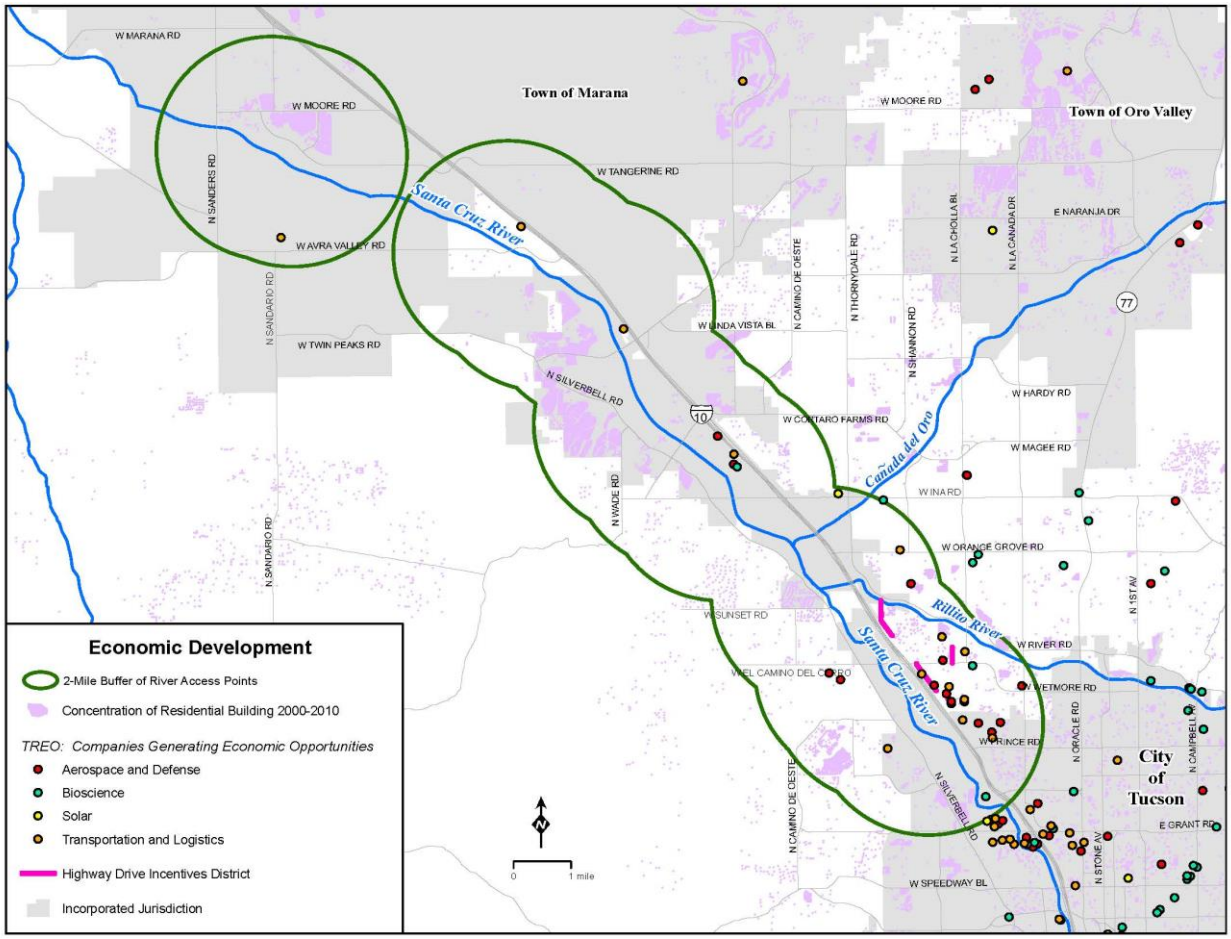
Economic Development[71] features prominently in Pima County, with business development and job-creation initiatives at the forefront. The following is a list of the County's economic development plans and projects.

1. Pima County Economic Development Plan - 2012 to 2014 (http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Economic%20Development%20and%20Tourism/121017PC%20ED%20Action%20Plan%202012-10-17.pdf);
2. Pima County Economic Development Plan - 2015 to 2017 (http://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=183160);
3. The Sonoran Corridor – A Regional Economic Catalyst;
4. Economic Development – Business Attraction and Expansion;
5. Economic Development – Attractions & Tourism; and,
6. 2016 Third Quarter Update.

Major economic development projects have located south of Camino de Oeste (*Map 10 - Economic Development Projects*); however, future projects near the Lower Santa Cruz River stand to benefit

from the river's recreational opportunities. As these plans materialize, the existing residential areas warrant physical access improvements for recreational purposes.

Map 10 - Economic Development



The County has identified goals and policies[72] to:

1. "support and promote natural resource-based trail system as a regional attraction promoting healthy lifestyles, economic development, and connectivity to a variety of destinations;"
2. "integrate trail system, transportation modes, economic development and land use patterns with healthy community principles;" and,
3. "identify funds and design a program for the provision of recreational and cultural programs and activities appropriate for parks and recreation facilities along the Juan Bautista de Anza National Historic Trail and the Loop."

The nexus between economic development and health is best established through the adoption of smart growth and sustainable development practices; because, well-designed communities generate more revenues that can be utilized toward health and general welfare programs, activities, events, and infrastructure.[73]

Tourism

The 2015 Pima County Comprehensive Plan update[74] has the goal to "revitalize the tourism industry" by implementing a number of policies.

As one of the five biggest industries in Arizona, tourism, with a $21 billion-dollar total travel spending (2015), "out-of-state travelers generate more than three-fourths of the visitor impacts in Arizona. Visitors from other states are the largest segment (more than 60 percent of spending)."[75]

Travel industry gross domestic product (GDP), in concept, "is equal to gross output (sales or receipts) minus intermediate inputs (the goods and services purchased from other industries). Gross Domestic Product is always smaller than output or sales because GDP measures only the 'value added' component of an industry and does not include the cost of the inputs that are also necessary to produce a good or service."[76] Arizona's travel industry GDP for 2015 was $6.8 billion.

"The analysis of travel impacts at the county level provides a valuable overview of how the economic benefits of travel and tourism are distributed throughout the state."[77]

In Pima County, the 2015 travel impact projections[78] for total direct travel spending were as follows:

1. $2.77 billion in travel spending (destination spending = $2.24 billion + other travel spending = $53 million);
2. $674 million in earnings;
3. 24,060 travel-generated jobs;
4. $197.3 million in government revenue (local government = $81.9 million + State government = $115.4 million).

Revenue-generation is a catalyst for more tourism-oriented attractions and activities in Pima County, and the Lower Santa Cruz River will serve as a prime location.

Agua Dulce

Agua Dulce is a conceptual project devised by the City of Tucson to introduce "reclaimed water north of 29th Street and north of Cushing Street." The City states that the (a) use of reclaimed water has levelled off; (b) water conservation measures include more use of rainwater and storm water; and, (c) current potable water use is comparable to levels experienced in 1985. These factors give the *Agua Dulce* project a high rate of feasibility.

The project plans to add approximately 2,500 AFY [Acre Feet per Year] in each location,"[79] and envisions using the City's Conservation Effluent Pool (CEP) resources of approximately 7,000 AFY, which includes 500 to 1,000 AFY to maintain and enhance riparian habitat.

There is a network of existing infrastructure in the area, which will account for most of the project, dramatically reducing infrastructure costs. Official approvals from state agencies will be required,[80] and a number of public and private partners and collaborators have already been identified. The project anticipates reaping a number of benefits.[81]

IX. Analysis of Strengths, Weaknesses, Opportunities, and Threats (SWOT)

Assessing the strengths, weaknesses, opportunities and threats to planning in- and for the Lower Santa Cruz River is a preamble to ameliorating—if not eliminating—the weaknesses and threats (negative), while enhancing/increasing the strengths and opportunities (positive). See ***Appendix C***, **Table 3** for the four SWOT categories.

The strengths and opportunities have been grouped against weaknesses and threats, across seven key categories: (a) recreation, (b) environment, (c) finance/funding, (d) planning/education, (e) culture/ archaeology, (f) water/effluent, and (g) economic development/tourism (see ***Appendix C***, **Table 4**). This approach provides an opportunity to determine which areas require the maximum attention to lessen the negative and augment the positive.

The analysis reveals three categories that must overcome weaknesses and threats: (a) Planning/ Education, (b) Recreation, and (c) Finance/ Funding.

While the Loop, existing ballparks, and trails/trailheads/pathways, score well in favor of recreation, there must be changes to improve their value. These include:

1. facilitate river-access;
2. add or build new infrastructure and amenities in areas key to accessing the river;
3. minimize obstruction to recreational pursuits resulting from routine bank-protection repairs;
4. ameliorate conflicting land uses that may generate NIMBYism or other social ill-constructs;
5. prevent issues of safety that may result from a low turnout at areas demarcated for access to the river; and,
6. publicize recreation in the river.

Furthermore, in recent years, the State legislature has placed greater financial responsibilities on counties and municipalities by transferring State costs to local jurisdictions.[82]

Against this backdrop of additional financial burden, completion of the Loop and the Juan Bautista de Anza National Historic Trail (the segment within Pima County) will stand as testaments to Pima County jurisdictions' foresight, planning, and follow-through on voter expectations that can catalyze successful future bond elections to fund local needs projects, including Santa Cruz River amenities.

The City of Tucson Mayor and Council adopted the *City of Tucson Parks and Recreation System Master Plan* (Master Plan) in October 2016.[83] A very significant component of the Master Plan is the survey/questionnaire, which generated 685 responses from city residents who "submitted 443 questionnaires, 67 comment cards, and 110 email comments"[84] on matters such as:

1. their frequent use of trails, greenways, walking/biking paths, and natural areas;
2. the utilization of ramadas, shelters, picnic areas, and park amenities;
3. the need for more natural resource parks, trails, greenways, park amenities and facilities, etc.;
4. the inadequacy of walking/biking paths, picnic areas, ramadas and other park amenities, and natural resource areas, where only 50 percent of their current needs are met;

5. the need to preserve open space and the environment; and,
6. residents' willingness to support funding for new paths, greenways, trails, and open space.

Tucson residents' overwhelming support for natural areas, parks, trails, infrastructure and amenities, reinforces the validity of taking the Santa Cruz River from 'back door' to 'front door' status.

In October 2016, the Marana Mayor and Council adopted the *Town of Marana Parks, Recreation, Trails and Open Space 5 Year Update and Strategic Plan*. The six Marana parks in proximity of the Santa Cruz River – referenced in this report – have varying levels of adequate infrastructure in areas that can be used to access the river.

While recreation planning continues largely at the jurisdictional level—which has been identified as a weakness in the SWOT analysis—there are uniting elements such as the river itself, Juan Bautista de Anza National Historic Trail, the Loop, and river parks, among others, to foster regional parks, recreation and open space planning.

Over the next few years, parks, recreation, and open space improvements within Marana, Tucson and unincorporated Pima County could generate impetus for regional recreation planning in and along the Lower Santa Cruz River. Goodwill generated by such regional planning endeavors, coupled with cross-jurisdictional recreation programs, education, and publicity/marketing has the potential to garner public-private partnerships that have the potential to increase funding for recreation planning, especially in the wake of dwindling State funds. A successful model generated from this endeavor is expected to help restore other segments of the river—nationally and internationally.

X. Lower Santa Cruz River Physical Access

In 2015, a field study was performed to assess river access locations.

Map 11 - Potential River Access Location

Map 11 - Potential River Access Location shows the potential areas/ location to access the Lower Santa Cruz River.

The pros and cons of accessing the Lower Santa Cruz riverbed became apparent in this survey. For instance, existing parks and natural areas sustained by modern day effluent discharge from water reclamation facilities ranked well for river access.

Generations of engineered manipulation and modifications rendered large segments of the river inaccessible, compounded by some less than favorable land use decisions over the past few decades. Furthermore, large segments of the river are at considerable distances from built areas and considered adverse to accessibility. Visibility is a significant factor in determining the success of open space; "increasing the visibility and accessibility of parks can help maximize their value to the surrounding community."[85]

However, the counter argument of encroachment upon a public amenity is equally valid. Collectively, these conditions have influenced the listing of the potential river access points.

Table 2 lists existing parks, trailheads and other attractions with varying levels of amenities, such as parking, seating, restrooms, etc. (See ***Appendix B*** and *Map 11 - Recreation and Open Space Map* for detailed information).

Table 2

Locations for Physical Access to the Lower Santa Cruz River

Location	Parking	Access to River	Amenities (restrooms, etc.)	Other
Marana Heritage Park	Yes	Yes, ramp down soil cement	Some	Hike to river; water not visible from river path
Gladden Farms Park	Yes	No	Yes	A long walk, not ideal
Avra Valley Road Trailhead	Some	Yes	None	
Frisbee Park	Yes	No	None	Long walk to river
El Rio Park	No	No	Ramada	Neighborhood park access issues.
Cortaro Mesquite Bosque	No	Yes	None	No parking, access from river path
Wade McLean Park	Yes	No, soil cement	Yes	River path to riverbed: no access.
Crossroads Park	Yes	No, soil cement embankment	Yes	River is visible from river park
Ina Road Trailhead	Yes, some	Yes	Bench	Waterfall
Columbus - North	Yes	Yes	Yes	
Columbus (main park)	Yes	Yes	Yes	South parking lot - no water in river.
Sweetwater Wetlands	Yes	No, soil cement	Yes	Effluent outflow: ½ mile to the north

XI. Conclusion and Recommendations

The following conclusions can be drawn from this study.

1. Research and studies have repeatedly shown the benefit of natural open space to physical and mental health, and to general wellbeing.

2. Economic development planning in Pima County has generated several significant projects over the past few years.

3. In Pima County, travel spending in 2015 accounted for $2.77 billion, to yield $674 million dollars in earnings, 24,060 jobs, and $81.9 million dollars in local tax receipts.

4. Economic development and tourism—as revenue generators—have a role in the future funding of natural resources, parks and recreation facilities and amenities.

5. A City of Tucson survey revealed that its residents:

   a. frequently use trails, greenways, walking/biking paths, and natural areas;

   b. utilize ramadas, shelters, picnic areas, and park amenities;

   c. feel they need more natural resource parks, trails, greenways, park amenities and facilities, picnic areas, etc.;

   d. feel the inadequacy of walking/biking paths, picnic areas, ramadas and other park amenities, and natural resource areas, where only 50 percent of their current needs are met;

   e. feel the need to preserve open space and the natural environment; and,

   f. are willing to support funding for new paths, greenways, trails, and open space.

   The survey results reveal the need to fund more facilities and Lower Santa Cruz River is promising.

6. Many transportation infrastructure improvements have occurred adjacent to or in close proximity of the river, improving and facilitating river access.

7. The Pima County ROMP now produces cleaner effluent for discharge in the Lower Santa Cruz River, creating habitat for local flora and fauna.

8. The Juan Bautista de Anza National Historic Trail Master Plan has inspired the construction of trails along the Lower Santa Cruz River to generate cultural and historic education and interest.

9. The SWOT analysis in this report asserts overcoming threats and weaknesses to (a) Recreation, (b) Planning/ Education, and (c) Finance/ Funding. Together with tourism and economic development, the strengths of the SWOT analysis present opportunities for new recreational projects and solutions to improving existing projects.

10. Environmental education, eco-tourism, and the pursuit of outdoor recreation help to develop values for the prudent use of natural resources.

These achievements—past, current, and on-going—justify the health and welfare, economic, recreational, cultural, environmental, and educational benefits of providing facilities and amenities in the physical locations identified along the Lower Santa Cruz River.

For these physical access locations to become successful, they must be considered functional and usable by the public, which means they must be accessible, safe, and attractive (image and awareness), and possess some redeemable value.

The success of physically accessing the riverbed can be facilitated through

1. transportation infrastructure improvements such as the RTA projects on Silverbell Road that allow access to the Ina Road Trailhead and Columbus Park and on to the river;
2. recreational infrastructure improvements such as The Loop and the riverparks that are contiguous to the river; and,
3. economic development projects such as the one planned in the northwest corner of W. Sunset Road and Interstate 10, which is in proximity of the river access point planned on W. Sunset Road.

These physical access locations can become attractive if adequate amenities such as parking, shade structures/ramadas, restrooms, trash disposal, signage, landscaping, etc. are provided. Additionally, there may even be opportunities for food and beverage services in the future.

The physical access locations can possess redeemable value if there are opportunities for:

1. nature and culture education with displays, exhibits, and outdoor infrastructure for workshops, classes and show-and-tell programs about the river's history, biology, and archaeology.
2. outdoor experiences that have physical and mental health benefits.
3. recreational opportunities that supplement The Loop, ballparks, and urban pocket parks.

This composite plan to build on the (a) strategic strengths and opportunities (SWOT), (b) existing and planned infrastructure, (c) legacy of the river, and, (d) the demand of Pima County residents for more natural open space, trails, and nature parks, as documented in parks and recreation surveys performed by the City of Tucson and Marana, presents a very viable justification to invest funds toward making these physical access locations functional, usable and attractive to residents and tourists alike.

Appendix A

List of Historic Events

The following events describe the extent of climate change and other impacts on the Santa Cruz River.[86]

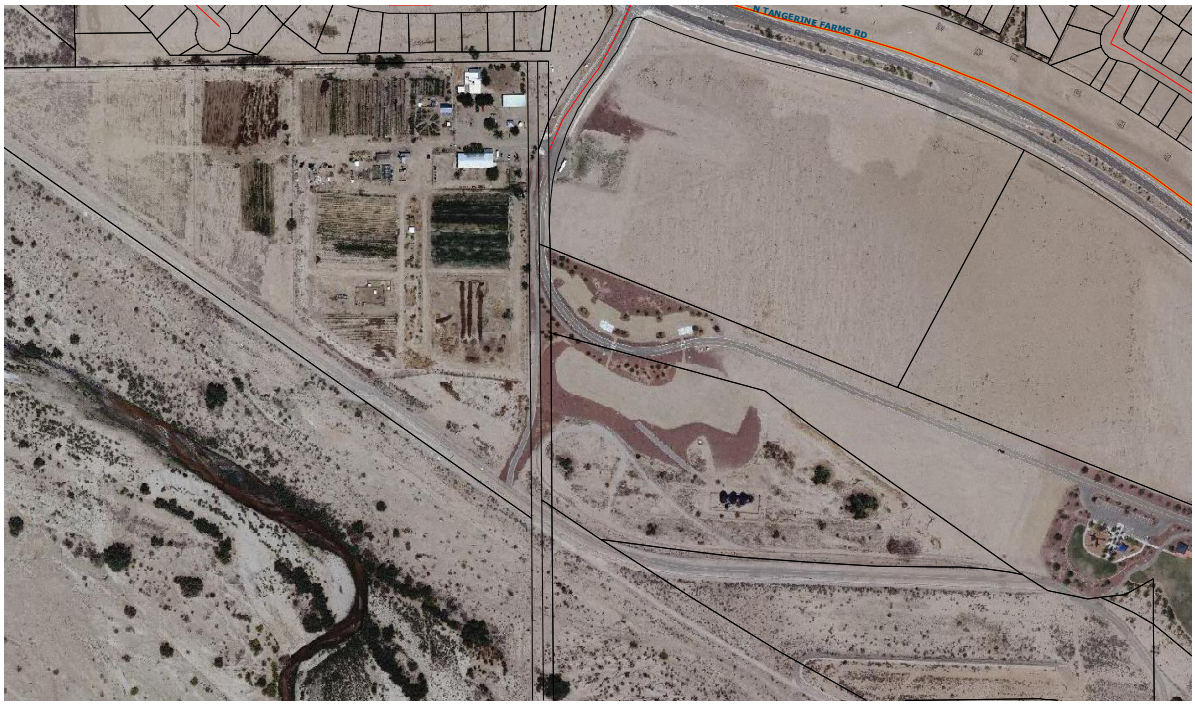
~11,500 years:	Human occupation of southeastern Arizona[87]
+9,000 years:	A braided stream at the beginning of the Holocene Period[88]
9,000-6,400:	Holocene alluvium removed; beginning of new floodplain[89]
4,500-2,500:	Cienega development[90]
2,000 years:	Alluvial stratigraphy, floodplain aggradation, and channel downcutting[91]
1,150-500:	Aggradation, discontinuous and tributary arroyos, paleoarroyos, and cienegas [92]
500-300:	Major cut-and-fill cycle[93]
1840s-1850s:	Introduction of Anglo-Americans' concepts and technology to the arid American Southwest from more mesic eastern landscapes
1849:	Existence of short entrenched reaches upstream of Tucson[94]
1868-1890:	Unusually heavy summer rainfall; except for 1890, all the other El Niño years (1868, 1871, 1874, 1878, 1880, 1884, 1887, 1889) registered three days of greater than one inch of rainfall
1872-1882:	A discontinuous arroyo deepened ten feet in the San Xavier District[95]
1887:	New arroyo entered the cienega from downstream, eroded by floods[96]
1890:	La Niña year; major floods initiated headcut migration starting at the unprotected heading of an intercept ditch[97]
1900s:	Loss of the Great Mesquite Forest Bosque's towering old-growth trees[98]
1904-1905:	Arroyo extended upstream into the San Xavier reach during winter floods
1905:	Floods caused the greatest channel changes on the river (El Niño episode)[99]
1914-1915:	Arroyo extended upstream into the San Xavier reach during winter floods[100]
1915:	Floods caused the greatest channel changes on the river (El Niño episode)[101]
1925-1926:	Largest number of annual El Niño tropical storms occurred[102]
1939:	Largest number of annual El Niño tropical storms occurred[103]
1940s:	Continued woodcutting forever altered the Great Mesquite Forest[104]
1950s-1960s:	Documentation of the Great Mesquite Forest[105]
1957-1958:	Largest number of annual El Niño tropical storms occurred[106]
1965-1970:	Number of annual tropical cyclones = 13.7[107]
1970s:	Groundwater levels plunged below the limit for obligate riparian species[108]
1973:	Congress passes Flood Disaster Protection Act.[109]
1976-1977:	Largest number of annual El Niño tropical storms occurred[110]
1977:	Floods caused the greatest channel changes on the river (El Niño episode)[111]
1980s:	The Great Mesquite Forest was displaced[112]
1982-1983:	Largest number of annual El Niño tropical storms occurred[113]
1983:	Floods caused the greatest channel changes on the river (El Niño episode)[114]
1983-1988:	Average annual tropical cyclones increased from 13.7 (1965-1970) to 16.4[115]
1989-2011:	Average annual tropical cyclones decreased from 16.4 (1983-1988) to 15.5[116]

Appendix B

Lower Santa Cruz River Access Locations

The following locations are suitable to access the Lower Santa Cruz River but need new infrastructure and amenities or improvements to what currently exists, to entice outdoor recreation enthusiasts.

1. Marana Heritage Park



Parking: A parking lot is accessible from Tangerine Farms Road and Heritage Park Drive.

Access to Santa Cruz River: There is access to the river-path and a ramp to the riverbed, a hike across which leads to the river flow. This location does not provide a good view of the river but it has suitable public space for large meetings in the Marana area.

Facilities: Ramadas, drinking fountains, and restrooms are available.

Noise Level: Low.

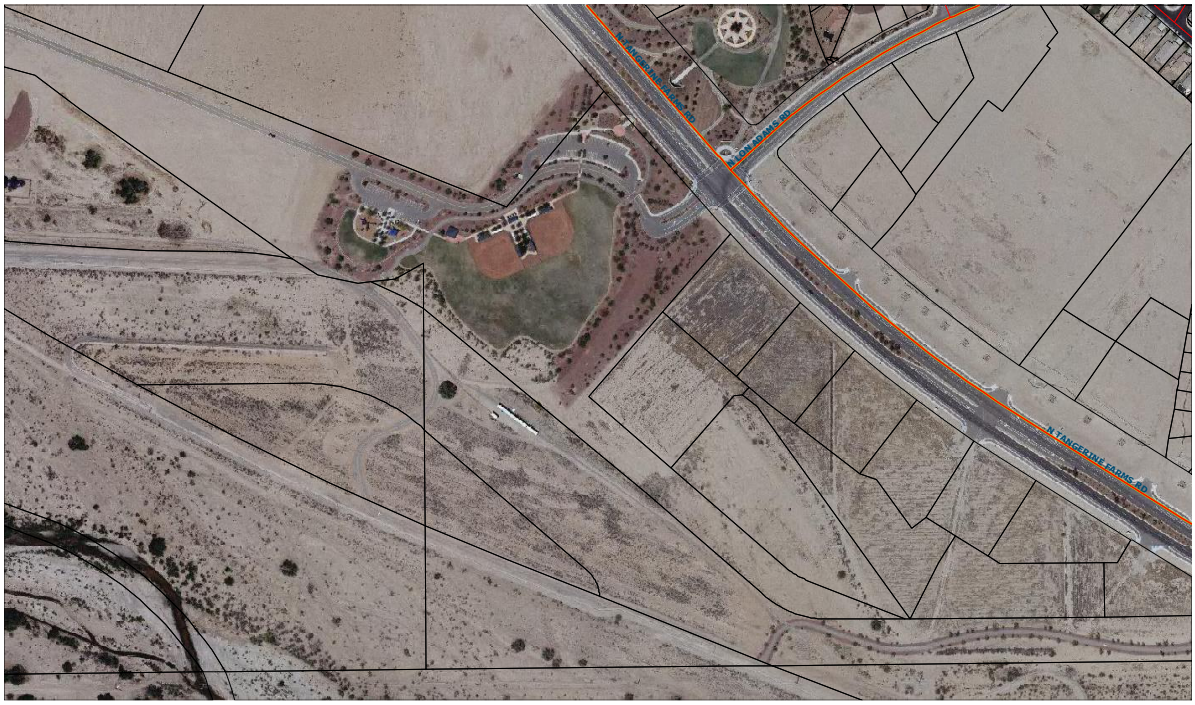
Odor: No odor.

Safety: No safety concerns noted.

View from river path: The river is not visible from the river path; there are riparian trees in the distance.

Riparian vegetation in riverbed at Marana Heritage Farms site.

2. *Gladden Farms Park*



Parking: There is a parking lot off Tangerine Farms Road.

Access to Santa Cruz River: This is not an ideal location to view and access the river. There are no ramps nearby to access the riverbed. A long walk on the river path from the children's park leads to the riverbed. The river flow is across a long stretch of riverbed, and is not visible from the river path.

Facilities: Ramadas, drinking fountains, and restrooms are available.

Noise Level: Low.

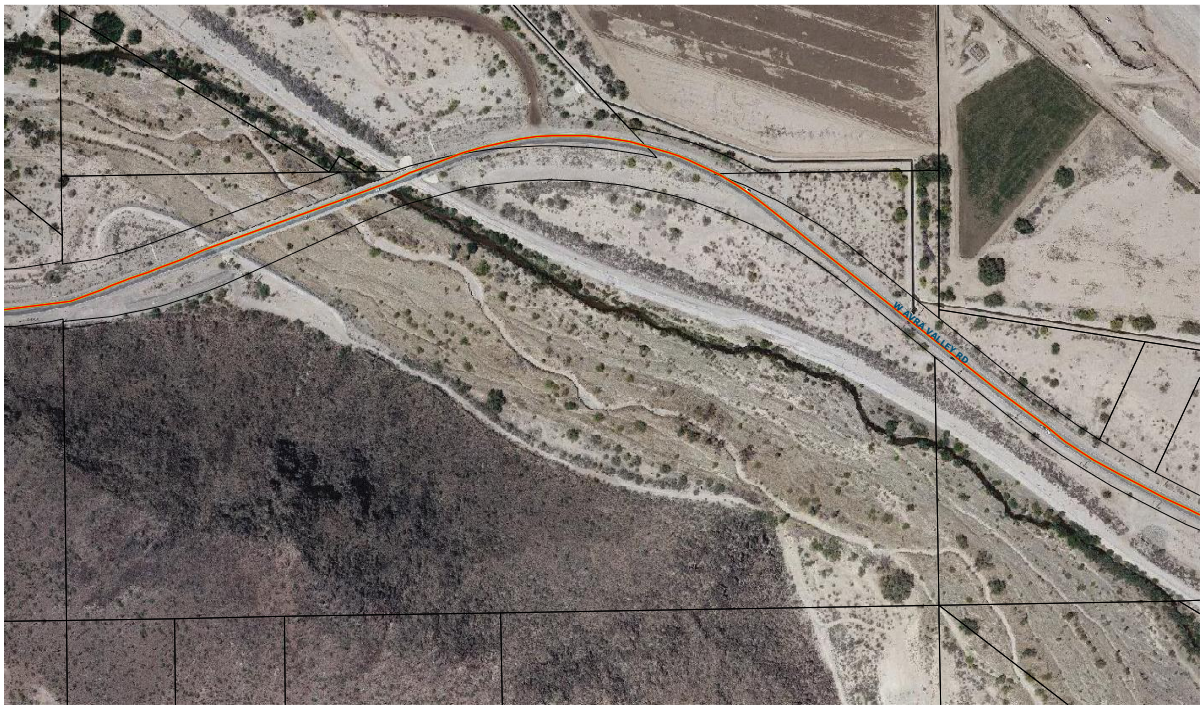
Odor: No odor.

Safety: No safety concerns noted.

View from river path: Riverbed and distant riparian trees.

View of the river from The Loop near Gladden Farms Park.

3. Avra Valley Road



Parking: A parking lot, with limited vehicle parking, is accessible from Avra Valley Road.

Access to Santa Cruz River: There is access to the river path at two points from Avra Valley Road (one before the bridge, one after). The river flow and trees are visible from the river path at the first access point, which is a pull-off from Avra Valley Road where there is limited vehicle parking. At this location, the soil cement is steep without any ramp to the riverbed. At the second access point, the riverbed is accessible and the river flow—not quite visible—is a short walk away. Vehicle parking is limited.

Facilities: None.

Noise Level: Medium traffic noise from Avra Valley Road. The first access point has running water.

Odor: No odor.

Safety: No safety concerns noted.

View from river path: Flowing water, riparian trees, bridge, and riverbed.

Santa Cruz riverbed from parking area off Avra Valley Road.

4. ***El Rio Neighborhood Park and 1775 Anza Campsite of "Puerto del Azotado" and Anza Trailhead.***

Parking: The Anza Trailhead has a dirt road accessible from Coachline Blvd. and the parking area.

Access to Santa Cruz River: There is access to the Anza Trail and river path via El Rio Park. The river flow is across a long stretch of riverbed. El Rio is not an ideal location to directly view and access the river, but it may serve well for other riparian tours.

Facilities: No facilities; ramadas at El Rio.

Noise Level: Low.

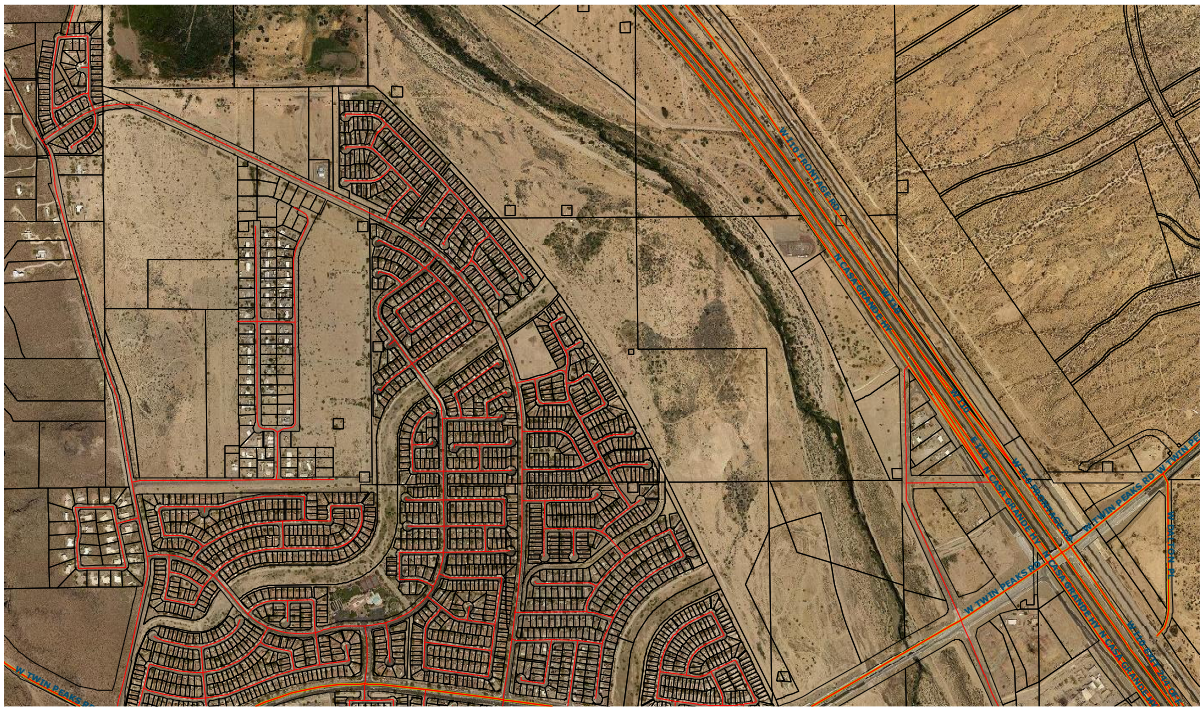
Odor: No odor.

Safety: No safety concerns noted.

View from river path: Riverbed, distant riparian trees and interesting views.

View looking into El Rio Park.

5. Cortaro Mesquite Bosque



Parking: There is no vehicle parking in the Cortaro Mesquite Bosque area.

Access to Santa Cruz River: There is access to the Cortaro Mesquite Bosque from the river path and El Rio Neighborhood Park. The river flow is across a long stretch of the riverbed. This is not an ideal location to view and access the river, though it does present an opportunity to visit a riparian restoration project.

Facilities: Ramada at El Rio Park.

Noise Level: Low.

Odor: No odor.

Safety: No safety concerns noted.

View from river path: Riverbed and distant riparian trees.

6. Wade McLean Park

Parking: There is a parking lot accessible from Silverbell Road.

Access to Santa Cruz River: There is access to the river path via a path from Coyote Crossroads Elementary School. The river flow is across a long stretch of riverbed. This is not an ideal location to view and access the river.

Facilities: Ramadas, drinking fountains, and restrooms are available.

Noise Level: Low.

Odor: No odor.

Safety: No safety concerns noted.

View from river path: Riverbed and distant riparian trees. No water is visible from this site.

View of the river from Wade McLean Park

7. Crossroads Park

Parking: There is a parking lot accessible from Cortaro and Silverbell Roads.

Access to Santa Cruz River: The river can be viewed from the river path, which is accessible through Crossroads Park. The soil cement embankment to the riverbed is negotiable only by able-bodied individuals. Access to flowing river involves a short walk through the riverbed.

Facilities: Ramadas, drinking water fountains, and restrooms are available.

Noise Level: Traffic noise from Cortaro Road is moderate.

Odor: Low odor.

Safety: No safety concerns noted.

View from river path: Riverbed, riparian trees, water, Cortaro Road, Crossroads Park, and river path.

View from Crossroads Park.

8. Ina Road Trailhead

Parking: There is an unpaved parking lot accessible from Ina Road (with space for about 20 cars), but no signage. According to Geographic Information Systems (GIS) records, a private company owns the access road and most of the parking area.

Access to Santa Cruz River: The river park is easily reachable and possibly has wheelchair access. There is a ramp down to the riverbed, but access to the flowing river involves a short walk through heavy vegetation.

Facilities: There is a bench near the river path and parking lot, but there are no bathrooms or water.

Noise Level: Traffic noise from Ina Road is moderate. A waterfall can be heard from the river path. An outdoor presentation to a small group (±20 persons) will be audible.

Odor: Low odor.

Safety: No safety concerns noted.

View from river path: Water, trees, roadway, cleared area, and a small glimpse of the waterfall. River is hidden from the river path by lush vegetation and mature trees.

View from the Loop looking toward Ina Road (waterfall)

9. Christopher Columbus Park – Ball Fields (north end)

Parking: There is a paved parking lot accessible from El Camino del Cerro.

Access to Santa Cruz River: There is easy access to the river park, which may be wheelchair accessible to the river path. There is a ramp/path down to the riverbed. Access to the flowing river involves a short hike through silty sand and heavy vegetation.

Facilities: There are restrooms, a water fountain, benches, and ramadas (one near the Loop).

Noise Level: Traffic noise from El Camino del Cerro is moderate. The sound of water in the river is inaudible.

Odor: No odor.

Safety: No safety concerns noted.

View from river path: From the river path, river water is not visible due to mature trees and lush vegetation; but, the roadway, cleared areas, and the park are visible.

Santa Cruz River at the Christopher Columbus Park ball fields

10. Christopher Columbus Park

Parking: There is a paved parking lot accessible from Silverbell Road.

Access to Santa Cruz River: From the south parking lot, there is access to the river path; a quarter-mile walk on a paved path followed by a short hike over the riverbed leads to an outlet. From the north parking lot, the walk to the river path is not paved.

Facilities: There are restrooms, benches, a water fountain, and ramadas (one near The Loop).

Noise Level: Low noise.

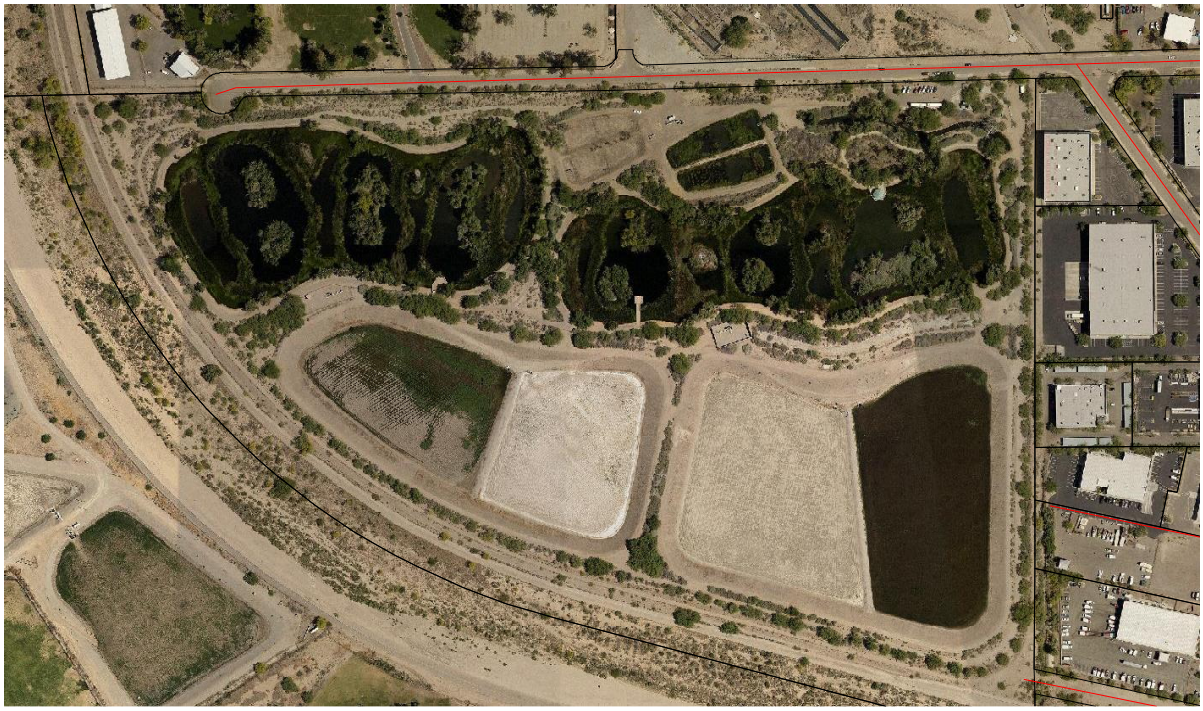
Odor: Slight odor.

Safety: The park is heavily utilized by recreationists, dog-walkers, etc.

View from river path: The dry riverbed leads to the outfall where there is water. The river runs along the west bank and is not visible from the river path.

Santa Cruz River bed near the effluent outfall

11. Sweetwater Wetlands



Parking: There are paved parking lots off West Sweetwater Drive.

Access to Santa Cruz River: Vehicle parking at the dead end on West Sweetwater Drive leads directly to the Loop. On the west side of the wetlands, a gate leads out to the Loop.

Facilities: Within the wetlands preserve, there are ramadas, drinking fountains, and restrooms. Off the Loop, there are benches and shaded areas.

Noise Level: Low noise level, some originating from Interstate 10.

Odor: Slight odor.

Safety: No safety concerns noted.

View from river path: There is no water flow in this section of the river; the outflow point is about half a mile north on the Loop.

Gate and seating area from Sweetwater Wetlands to the Loop

Appendix C

Analysis of Strengths, Weaknesses, Opportunities, and Threats

Table 3

STRENGTHS	**WEAKNESSES**
• The Loop • Cultural and Archaeological richness • Nexus to Gem Show (tourism, economic development, etc.) • County Economic Development planning • A few access points to the river channel • History of river as a recreational amenity • Existing recreational activities • Existing parks and paths along the river • River park trail system, trailheads • *The Living River* project outreach • Year round water in part of the river • Continued investment by local governments • Sports fields/ball parks (proximity) • Housing and schools next to the river • Odor from WRF greatly lessened • Vegetation in and along river banks	• Lack of river channel access in some key areas • Lack of visibility • Lack of infrastructure at access points • Riverbed overlooked as recreational area • Land use conflicts • Funding issues • Piecemeal planning (by jurisdictions) • Inadequate inter-governmental cooperation • Lack of robust public-private partnerships • Disproportionate water allocation (SAWRSA) • Trash in the river • Perceptions of safety may be low due to low user density • Recreational amenities are deficient • Temporary impairment to recreation may occur due to bank protection repairs • River not used as 'front door'
OPPORTUNITIES	**THREATS**
• The Loop (expansion) • Nexus to Gem Show (tourism, economic development, etc.) • A few access points to the river channel • Existing recreational activities • Existing parks and paths along the river • River park trail system (expansion) • *The Living River* project • Conservation Effluent Pool-CEP (WRF) • Continued investment: local governments • Plans/Master Plans (jurisdictions, FICO,) • Open Space goals (Comprehensive Plan) • Year-round water in part of the river • Mature vegetation, bosques (proximity) • 25 miles of river in Pima County • de Anza Trail: ROW, signs (west bank) • El Corazon de los Tres Rios (RFCD-ACOE) • Sports fields/ball parks (expansion) • Tourism/Economic Development • Research (University of Arizona, etc.) • 'Recreational Overlay District' • Federal, local water recharge projects	• Land use conflicts • Funding issues • Wildcat dumping (potential) • Loss of identity as regional amenity • Future effluent demands elsewhere may further reduce river flows • Dwindling State funds for conservation and recreation • Loss of heritage-related features • Lack of inter-jurisdictional cooperation • Lack of regional planning for the river

Table 4

	STRENGTHS/OPPORTUNITIES	WEAKNESSES/THREATS
Recreation	• The Loop • Sports fields/ball parks (proximity/ expansion) • History of river as recreational amenity • Existing recreational activities • Existing parks and paths along the river • River park trails/trail heads (expansion) • Open space goals (Pima Prospers)	• Lack of access to river channel (in key areas) • Lack of visibility • Lack of infrastructure at access points • Dwindling State funds for recreation • Riverbed overlooked as recreational area • Temporary impairment to recreation may occur due to bank protection repairs • River not used as 'front door' • Recreational amenities are deficient • Land use conflicts • Perceptions of safety may be low due to low user density • Lack of publicity as recreational amenity
Environment	• Year-round water in part of river • Vegetation in and along river banks • Mature vegetation/bosques • 25 miles of river within Pima County • El Corazon de los Tres Rios (RFCD-COE) • Open space goals (Comprehensive Plan) • A few access points to the river channel	• Lack of inter-jurisdictional cooperation • Wildcat dumping/trash in river
Finances/ Funding	Continued investments by local governments	• Funding issues • Dwindling State funds for conservation • Lack of robust public-private partnerships
Planning/ Education	• Plans/Master Plans (local jurisdictions, FICO, etc.) • Housing and schools next to the river • 'Recreational Overlay District' (potential) • Research opportunities (UA, etc.)	• Land use conflicts • Lack of regional planning for the river • Loss of identity as regional amenity • Piecemeal planning (local jurisdictions) • Lack of inter-jurisdictional cooperation • Lack of publicity, educational opportunities
Archaeo - logy	• Cultural and archaeological richness • Juan Bautista de Anza trail: ROW	Loss of heritage-related features
Water/ Effluent	• *The Living River* project • Conservation Effluent Pool-CEP (WRF) • Federal and local water recharge projects	• Disproportionate water allocation (SAWRSA) • Future effluent demands elsewhere may further reduce river flows
Econ. Dev./ Tourism	• County Economic Development planning • Tourism • Nexus of 'Gem and Mineral Show' to river (tourism, Econ. Dev., etc.)	• Lack of inter-jurisdictional cooperation • River as economic development catalyst – not fully explored

Appendix D

Projects and Studies

The following are descriptions of projects and studies that have contributed to recreational, educational, economic, tourism-related, and health/general welfare needs of Pima County residents.

Juan Bautista de Anza National Historic Trail

Spain began to build frontier posts of empire and church in California with the 1767 expulsion of Jesuits from all Spanish colonies; and, in Mexico, they were replaced with the Franciscan Order as missionaries in Baja California, headed by Junipero Serra.[117] In 1773, Serra convinced the powers in Mexico City to support these missions financially and militarily, and "urged Mexican officials to establish an overland route to Alta California"[118] – the Portolá Expedition.

Two years later, on October 23rd, 1775, Lieutenant Juan Bautista de Anza "and his column of soldiers, vaqueros, muleteers, aids, servants and pioneers took to the saddle, ready to commence Spain's first major expedition to settle California."[119] The entourage and their livestock travelled out of San Ignacio de Tubac presidio—which, at the time, was the northern frontier of Spain's kingdom in the new world—to traverse 1,200 miles through Arizona and California before reaching the San Francisco bay area about five and a half months later.

"This journey had its meager beginnings in the Mexican towns of Culiacán and [San Miguel de] Horcasitas, where tradesmen and their families joined the company."[120] By the time they arrived in San Francisco, it had become "an expedition of more than 2,700 miles, with most of the company mounted on horseback and other pack animals."[121]

The 1,200-mile stretch within the US, from Nogales, Arizona – approximately 24 miles south of Tubac – to San Francisco, California, was designated the Juan Bautista de Anza National Historic Trail by the U.S. Congress in 1990; and, it is administered by the National Park Service.[122]

The trail's planning and development, within southern Arizona, is described later in this report under *Master Plan for Pima County, Arizona Juan Bautista de Anza National Historic Trail*.

The Loop and Access from Interstate 10

The Loop—Pima County's 131-mile multi-modal paved and unpaved pathway system, created through partnerships with the jurisdictions of Marana, Oro Valley, South Tucson and Tucson—connects "parks, trailheads, bus and bike routes, workplaces, restaurants, schools, hotels and motels, shopping areas, and entertainment venues,"[123] which can be enjoyed on foot, bicycles, skates/rollerblades, and horseback.

Originating as an infrastructure project,[124] the pathway system connects "the Rillito, Santa Cruz, and Pantano Riverparks with the Julian Wash and Harrison Road Greenways."[125] Additional pathways have also been constructed along tributaries such as the Tanque Verde and Cañada del Oro washes.

As of 2017, more than 120 miles of the pathway have been constructed, with an impressive return on investments in economic development, business and employment, tourism, housing, alternative transportation, health benefits, and the environment, among others.[126]

Planning for recreation along the Santa Cruz River has materialized with the Loop, which plies along several stretches of the river and the linear river parks to provide a comprehensive recreational, environmental, and cultural experience for Pima County residents.

Use of Pima County-owned Lands

The use of Pima County-owned land that may be in proximity of the Santa Cruz River, to locate infrastructure and amenities, will minimize land use and eminent domain pitfalls associated with private lands, specifically, Arizona's Proposition 207 (2006) whose restrictive partial regulatory takings measures "call for compensation for any reduction in [property] value [Miller & Amrhein]. First, by requiring payments of compensation that most local governments simply cannot afford"[127] making it impossible for local governments to apply land use regulations toward public good.

Plans and Studies

The following plans and studies are either Santa Cruz River-centered or enunciate the environmental, archaeological/cultural, recreational, and land use impacts on the river, showcasing collaborative efforts that are essential to good planning and fiscal responsibility.

Master Plan for Pima County, Arizona Segment Juan Bautista de Anza National Historic Trail

In 2002, the *Master Plan for Pima County, Arizona Segment Juan Bautista de Anza National Historic Trail* (Master Plan) "was prepared to facilitate the acquisition of rights-of-way and easements and to provide standards for the construction of the Pima County segment of the Juan Bautista de Anza National Historic Trail."[128] The Master Plan was funded by a 1997 Pima County voter-approved bond (CH-30).

The following is a chronology of planned, completed, and on-going activities, as of 2017.

1. Trailhead built at Elephant Head Road, west of Santa Cruz River.
2. From Elephant Head Road to north of Canoa (5 miles): there is a Constructed Trail.
3. From south of Continental Road/Abrego Trailhead to north of Canoa: the trail is marked usable but remains to be improved.
4. Easements: from Abrego Trailhead to Haven golf course, and on to the north end of Country Club of Green Valley golf course: three or four easements remain to be finalized; then, unimproved trail will be marked.
5. From north of Country Club of Green Valley golf course (roughly southern end of the Town of Sahuarita) to north of Sahuarita Road: an unimproved trail is scheduled to be marked by the end of 2018.
   a) Robson properties: questionable!! Under discussion;
   b) FICO property will provide and donate easement;
   c) Castillo Drive: plan is to place trailhead (within Town of Sahuarita) on ± 2 acres of FICO property to be donated by FICO.
6. From north of Castillo Drive trailhead location to "North Santa Cruz Park" in the Town of Sahuarita: there is a constructed trail.
7. From North Santa Cruz Park to Valencia Road: the proposed trail section will likely go northward immediately east of the San Xavier District; officials of the San Xavier District have chosen to have the trail located outside its district boundary.
8. From Valencia Road to Camino del Cerro: the trail has been situated and built on the west side of Santa Cruz River as part of the Loop.

9. Trailhead at the south end of Columbus Park along the constructed trail: it has been built by Pima County on City of Tucson property.
10. From Camino del Cerro to Ina Road:
    a) No trail has been planned for the west side of the river, yet
    b) The Loop plies on the east side of the river, follows the water reclamation facilities' Plant Interconnect, all the way to Ina Road.
11. From Ina Road travelling north to El Rio Park in Marana: the Anza Trail is on the west side of the river; Arizona Department of Transportation (ADOT) will be rebuilding the Interstate-10/Ina Road interchange all the way west to Silverbell Road; this will affect the Anza Trail's continuity until late-2018/early-2019.
12. Yuma Wash Park (Marana): the park has access to the Anza Trail and Santa Cruz River.
13. Pima County and Town of Marana: Pima County plans to construct a trailhead immediately north of Coachline Blvd. at Los Morteros, and Marana plans on constructing a trail from El Rio Park to Avra Valley Road.

Living River Project

The *Living River Project* was made possible through "a Wetland Grant from the Environmental Protection Agency (EPA), Region IX, Charting the Wetland Health of the Lower Santa Cruz River (EPA Grant 00T83301)."[129] The project aimed at tracking wetland ecosystems along the Lower Santa Cruz River. It has "increased [the] understanding of wetland conditions, and improved public understanding of the value of wetlands."[130]

Effluent from the metropolitan water reclamation facilities ensures that the Lower Santa Cruz River flows year-round and allows the principal wetland habitat in Pima County to thrive. Completing the $600 million Regional Optimization Master Plan (ROMP) public works project in 2013 has improved the quality of that effluent.

Three *Living River Project* status reports have been produced after tracking changes in the river environment, since the completion of ROMP (2013, 2014, 2015, and 2016).[131]

El Corazon – Regional Flood Control District

El Corazon includes building a trail system along the west bank of the Santa Cruz River—incorporating the Juan Bautista de Anza National Historic Trail—to provide passive recreation opportunities in the Tucson Mountains area on land purchased with Pima County Regional Flood Control District (PCRFCD) funds. It is a good example of comprehensive planning that combines environmental restoration, flood control, regional recreation, and archaeology.

The project scope is to link existing river parks located at the confluence of Cañada del Oro and the Rillito River along both banks of the Santa Cruz River between El Camino del Cerro and Ina Road, which will result in expanding the County's current bike path and trails system.

El Corazon consists of design and construction projects for environmental restoration, flood control and regional recreation, with an estimated cost of $7 million. It is part of the *Tres Rios del Norte Ecosystem Restoration Feasibility Study* for habitat restoration along the Santa Cruz River from Prince Road to Sanders Road, involving the Army Corps of Engineers, Pima County, Town of Marana, and City of Tucson.

The project has three key phases. Phase 1 is planned for funding from PCRFCD; phases two and three look to future Pima County bond funds. Additionally, the "proposed Regional Transportation Authority (RTA) improvements for Silverbell Road and Sunset Road will enhance project viability and public access to recreational facilities."[132]

Paseo de las Iglesias

Authorized by and funded through the 2004 bond election, the $14 million *Paseo de las Iglesias* project along the Santa Cruz River stretches between Ajo Way and Silverlake Road.[133] A goal of the project is to provide signage for the *Juan Bautista de Anza National Historic Trail*.

The environmental restoration and river park project includes riverbank protection, habitat restoration, flood control installations, recreational amenities, and cultural education opportunities reflecting goals of the Sonoran Desert Conservation Plan (SDCP). The project is a component of the Loop and began with a feasibility study in 2005 that partnered Pima County with the Army Corps of Engineers. In 2008, a subsequent study expanded ecosystem restoration and erosion control measures. *Paseo de las Iglesias* was completed in 2015 and won an award in 2016 (American Public Works Association, Arizona Chapter - Environment category).

The project also includes the "seven-acre Las Milpitas Community Farm, a food-production and education project of Pima County, the Community Food Bank of Southern Arizona and City High School."[134]

City of Tucson Recreation Planning

The 1976 *Santa Cruz Riverpark Master Plan* called for turning a 13-mile stretch of the river channel into a "visual and recreational amenity," setting forth broad land use proposals for land adjacent to the proposed riverpark and exploring water resources to create a greenbelt in the desert. The City acquired much of the land for the riverpark, and designed and implemented major components of the master plan.

The 1982 update stated that "[T]he purpose of the Santa Cruz Riverpark Masterplan Update is to define and recommend site-specific opportunities for the Santa Cruz Riverpark to the degree of detail that can be achieved in a masterplanning [*sic*] process,"[135] including specific riverpark goals.[136]

The Mayor and Council adopted the *City of Tucson Parks and Recreation System Master Plan* (Master Plan) on October 5, 2016. The purpose of the Master Plan is to "deliver high-quality recreation facilities, programs, and services to the Tucson area,"[137] that: (a) guides decision-making, (b) provides insights to changing community needs and perspectives, (c) addresses levels of service provisions for the community, (d) evaluates resources toward making strategic investments, (e) develops a prioritized action plan, (f) reinforces Plan Tucson and (g) supports CAPRA accreditation.[138] The Master Plan will feature a Needs Assessment Prioritized Action Plan.[139]

The Master Plan includes a 2015 survey of city residents in public open houses[140] including questionnaires, comment cards and input through e-mails.[141]

The survey contains several questions pertaining to trails, greenways, walking/biking paths;[142] ramadas, picnic areas, and shelters;[143] natural resource areas/parks;[144] and other park amenities.

There are also statistics on park usage, ranking of facilities, park needs, program needs, etc. The survey ranks (a) trails, greenways, walking and biking paths; (b) natural resources areas/ parks; and, (c) ramadas, picnic areas, and shelters, very favorably. The survey statistics are a favorable harbinger for the Santa Cruz River recreational planning effort in terms of key recreational needs, public support, and funding validation. A summary of the referenced survey can be found in **Appendix E** of this report.

The support for natural open space, parks, and related amenities in the Master Plan is complemented by the immense and continued public support for Pima County's Sonoran Desert Conservation Plan (SDCP); and, the 2016 Multi-Species Conservation Plan that paved the path for Pima County's 30-year Section 10 Permit.

Town of Marana Recreation Planning

On October 4, 2016, the Mayor and Council adopted (Resolution No. 2016-104), *Town of Marana Parks, Recreation, Trails and Open Space 5 Year Update and Strategic Plan* (Plan), the purpose of which is "to provide an update and strategic vision for implementation of the 2010 Parks, Recreation, Trails and Open Space Master Plan.[145] The Plan has seven goals and "in conjunction with the 2010 Parks, Recreation, Trails, and Open Space Master Plan is provided as a working document."[146]

Emphasizing that "the Town needs input from its citizens—whether you use Town of Marana Parks and Recreation services or not,"[147] the feedback survey for the Plan was closed in March 2016.

Within the Town of Marana, there are six parks in relative proximity of the Santa Cruz River.[148] These parks vary in their amenities, such as parking, restrooms, etc.[149]

Marana's parks have the potential to expand the river's cultural, environmental and social validity by (a) providing educational and programmatic opportunities; (b) facilitating access to the river; and, (c) adding amenities that make the river a focus of interest for residents and tourists.

The town maintains a detailed inventory of its parks' amenities and infrastructure, and a subset of the information—pertaining to the six parks referenced above—features in **Appendix F** of this report.

Sahuarita Farms Plan - Farmers Investment Company (FICO)

The Farmers Investment Company (FICO) owns roughly 5,645 acres of land in the Town of Sahuarita and about 1,355 acres in unincorporated Pima County. Since 2008, FICO has been "preparing a comprehensive, long-term plan to guide the future of its 7,000 acres and its 12 miles of Santa Cruz riverfront."[150] The Sahuarita Farms Plan (SFP)—incorporating five guiding principles, namely, land use planning, employment opportunities, four community villages, river enhancements, and extensive open space and trails—is comprised of the: (a) Sahuarita Farms Specific Plan (Town of Sahuarita);[151] (b) Sahuarita Farms River Master Plan (Town of Sahuarita);[152] and, (c) Continental Farms Specific Plan (unincorporated Pima County).[153] In the future, SFP will have a considerable impact on the environmental, recreational, and archaeological aspects of the Santa Cruz River.

Preliminary biological and cultural resources evaluations are included in the Sahuarita Farms Plan River Master Plan (RMP).[154]

The sparse native riparian vegetation reflects the decades-long agricultural pursuits;[155] however, there appears to be a commitment from the project proponent to comply with "the conservation principals of the Pima County Conservation Lands System."[156]

The Resource Management Plan envisions a "programmatic agreement" for cultural resources to include various jurisdictions and agencies.[157] In 2009, a Class I Archaeological Records Search was conducted on a roughly 10,300-acre Area of Potential Effects (APE) "centered on the Santa Cruz River between the San Xavier Indian Reservation to the north and the San Ignacio de la Canoa historical land grant to the south."[158]

2015 Pima County Comprehensive Plan Update: Pima Prospers

The Open Space Element of the Comprehensive Plan Update (Update) references the County's responsibility to fulfill tasks assigned by the "community through voter approved bond funds to conserve this region's most prized natural and cultural resources"[159] and alludes to open space for geo-tourism and economic considerations 'where appropriate.'[160] Establishing a link between the annual Gem and Mineral Show with recreational components of the Santa Cruz River is one effort that could fulfill this goal.

The Update references the Pima County Regional Trail system, stating that it "will expand on the existing and planned river park systems, and is intended to include natural tributary washes and upland segments, and road and utility rights-of-way that together will form an interconnected system linking urbanized areas with surrounding public preserves." This effort has the potential to promote recreation in areas along the Santa Cruz River.[161]

The Update acknowledges that the County trail system provides "connectivity from neighborhoods to diverse land uses, recreation areas and open space."[162]

The Parks and Recreation Element of the Update seeks to provide "adequate and varied facilities that meet the community's needs and coordinating recreation and parks with economic development."[163]

The Update's Economic Development Element (Tourism as an Economic Engine chapter) states the need (a) for 'good first impressions;' (b) to 'revitalize the tourism industry;' and, (c) to 'develop geo-tourism opportunities.'[164]

Economic Development and Tourism Opportunities

The Loop and the river park system are catalysts to eco-tourism and highlight cycling as a tourism destination event in Pima County.[165]

In 2011, Pima County, the University of Arizona, and several nature-based attractions "began a strategic initiative to showcase the assets of Pima County in a different non-commercial way"[166] that raised the profile of geo-tourism.

Tucson Audubon Society recognizes southern Arizona as a birder's paradise, with more than 300 species found each year in Pima County's Sweetwater Wetlands alone,[167] which is adjacent to the Santa Cruz River. Another site along the river is Silverbell Lake.

The Tucson Gem and Mineral Show has its origins with the Tucson Gem and Mineral Society, which was established in 1946 "as a small group interested in the hobby of mineral collecting and lapidary."[168] It is "[T]he largest, oldest and most prestigious gem and mineral show in the world. The "Tucson Gem and Mineral Show® has enjoyed international stature since the 1970s, and was the first gem and mineral show to bring hobby enthusiasts, the public, and curators/professionals together for discovery and discussion."[169] Many venues for this annual event are set up close to the Santa Cruz River, which presents an opportunity to connect tourists pursuing commercial interests in the Gem and Mineral Show with the recreational opportunities available on- and near the Santa Cruz River.

Reclaimed Water for River Restoration

Pima County generates reclaimed water[170]—also referred to as 'recycled water' and 'effluent'[171]—from its 10 water reclamation facilities (WRF); but, bulk of the effluent is produced at Tres Rios and Agua Nueva WRFs – the County's metropolitan WRFs that were rebuilt under the Regional Optimization Master Plan (ROMP) to achieve compliance with State regulatory requirements.

In 2015, Tres Rios and Agua Nueva produced 61,356 acre feet (AF) of effluent, which was allocated to various jurisdictions/agencies[172] under the 1979 Southern Arizona Water Rights Settlement Act (SAWRSA) and a series of other agreements.[173]

As authorized by the Arizona Pollution Discharge Elimination System (AZPDES), the "Tres Rios facility discharges into the Santa Cruz River."[174] The Agua Nueva WRF replaced the now decommissioned Roger Road WRF; it discharges Class B+ effluent into the Santa Cruz River.[175] In a 2015 wheeling agreement with the City of Tucson, approximately 2.6 AF of Class A effluent was delivered to the Santa Cruz River West Branch Bosques – a small wetland area managed by the Pima County Regional Flood Control District (PCRFCD).[176]

Climate change, drought, and legally binding agreements such as SAWRSA have the potential to short-change any availability of effluent for environmental restoration and riparian enhancement projects; this features as a 'threat' in the strategic planning analysis of this report.

Producing more effluent from the six sub-regional WRFs, with increases in treatment capacity over time, will increase Pima County's total effluent supply without the binding requirements of SAWRSA and other agreements that govern Tres Rios and Agua Nueva. Two of these WRFs—Green Valley and Arivaca Junction—could potentially contribute to environmental restoration and riparian enhancement projects located in proximity to the Santa Cruz River.

Regional Planning: Inter-governmental Cooperation

The Santa Cruz River, Juan Bautista de Anza National Historic Trail, portions of the Loop multi-use pathway, and segments of Interstates 10 and 19, are unifying elements and shared resources of history, culture, archaeology, the natural environment, infrastructure, and recreation across the jurisdictions of Pima County, Marana, Tucson and Sahuarita. Inter-governmental cooperation and regional planning are rendered inevitable in order to attain the maximum benefit from pooled resources and prudent use of taxpayer funds.

Appendix E

City of Tucson Parks and Recreation Master Plan Update

Citizen Survey - 2016

1. Facilities Tucson households have used in the City of Tucson Parks and Recreation System over the past 12 months (Q1).
   a. Trails, greenways, walking and biking paths = 55% (rank 3rd)
   b. Ramadas, Picnic areas, and Shelters = 51% (rank 4th)
   c. Natural resource parks and areas = 24% (10th)

2. Facilities households use the most often
   a. Trails, greenways, walking and biking paths = 39% (rank 2nd)
   b. Ramadas, Picnic areas, and Shelters = 18% (rank 5th)
   c. Natural resource parks and areas = 8% (12th)

3. Households who indicated a need for parks and recreation facilities
   a. Ramadas, Picnic areas, and Shelters = 55% (rank 2nd)
   b. Natural resource parks and areas = 35% (8th)

4. Estimated number of households in the City of Tucson that have a need for parks and recreation facilities
   a. Outdoor walking and biking paths = 138,022 (rank 1st)
   b. Ramadas, Picnic areas, and Shelters = 112,965 (rank 3rd)
   c. Outdoor restroom facilities = 112,759 (4th)
   d. Natural resource parks and areas = 72,708 (8th)

5. Estimated number of households in the City of Tucson whose needs for parks and recreation facilities are only being 50% met or less
   a. Outdoor walking and biking paths = 38,094 (rank 2nd)
   b. Ramadas, Picnic areas, and Shelters = 30,048 (rank 6th)
   c. Natural resource parks and areas = 25,520 (rank 9th)

6. Parks and recreation facilities that are most important to households
   a. Outdoor walking and biking paths = 47% (1st)
   b. Ramadas, Picnic areas, and Shelters = 19% (4th)
   c. Outdoor restroom facilities = 18% (6th)
   d. Natural resource parks and areas = 12% (10th)

7. How important it is for the City of Tucson to provide high quality parks, trails, and recreation facilities
   a. Very important = 81%
   b. Not important = 2%

8. Respondent households level of agreement with benefits received from parks, trails, recreation facilities and services
   a. Preserve open space and environment (3rd) = 86% agree / 3% disagree
   b. Protect historical attributes of City (6th) = 73% agree / 4% disagree
   c. Promotes cultural interaction = (8th) = 71% agree / 5% disagree
   d. Promote tourism in City (9th) = 70% agree / 6% disagree

9. Benefits of parks, trails, and recreation facilities and services that most households consider important
    a. Preserve open space and environment = 32% (4th)
    b. Promotes cultural interaction = 12% (7th)
    c. Protect historical attributes of City = 11% (8th)
    d. Promote tourism in City = 6% 10th)

10. Funding for parks and recreation that households would support most
    a. Development of new paths, trails and greenways to connect existing parks = 47% (2nd)
    b. Acquisition of new park land and open space = 23% (5th)

11. Programs, facilities, and services that households would allocate $100 toward

    Historical/cultural programs-operation of Tucson's historic Spanish walled presidio = $7 (6th)

Appendix F

Town of Marana Parks and Recreation Master Plan Update

Santa Cruz Multi-Use Path – Infrastructure and Amenities

Santa Cruz Multi-Use Path (South)

From El Rio Park to Ina Road

- 5.25 miles of paved pathway
- 13 Pet disposal stations
- 9 trash cans
- 10 Benches
- 3 Map/information holders
- 7 Wildlife signs
- 20 Neighborhood access points
- 1 Bike repair station (with air pump and tools)
- 5 Bike racks
- 2 Rest areas
- 3 Access points to parks
- 2 Restrooms
- 3 Juan Bautista de Anza National Historic Trail interpretive signs (presented by the Marana Heritage Conservancy): The route traversed present day Marana 16 miles south to north along the Santa Cruz River.

Santa Cruz Multi-Use Path (North)

From Sanders Rd. to Approximately ½ Mile past Gladden Farms Park

- 1.5 miles of paved path
- 2 Pet disposal stations
- 8 Benches
- 3 Trash cans
- 1 Map/information holders
- 4 Neighborhood access points
- 2 Access points to parks

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Endnotes

[1] http://arizona.openrepository.com/arizona/bitstream/10150/326060/3/Arizona%27s_Changing_Rivers_March+1997.pdf
"The Santa Cruz once was a series of marshy areas alternating with flow for much of its length through the Tucson area. Groundwater pumping has mostly dewatered the stream north of the Mexican border, except for effluent flow." (*Arizona's Changing Rivers: How People Have Affected the Rivers*, Tellman, Yarde, Wallace et al., *March 1997*, page 4)

"The Indians were alarmed because the Padres pastured so many cattle that the watering places were drying up." Father Kino, 1691 (*Arizona's Changing Rivers: How People Have Affected the Rivers*, page 18)

"By the middle of the twentieth century, open-pit copper mining became a major land use south of the Tucson area, with smaller mines to the northwest. During the mining peak of the 1960s to the 1980s, groundwater pumping by the mines affected the water table from the San Xavier District to Tubac. In 1994, mining activity declined, annual pumping by these mines just over 30,000 a.f. [acre feet], down from more than 50,000 a.f. earlier. Mining operations have led to pollution problems, especially on the San Xavier District of the Tohono O'odham Nation, and contributed to lowering of the water table and dewatering of the river." (*Arizona's Changing Rivers: How People Have Affected the Rivers*, page 19)

"Large number of livestock were grazing in the Santa Cruz Valley when severe weather patterns affected the area about 1885. A series of very dry summers and very wet falls, coupled with the overgrazing of livestock, left the valley in a precarious state. In the spring of 1890, the heaviest rains then recorded fell on the valley, washing away dams and other diversion structures along with ranches. Rather than encourage new growth on the damaged range, the heavy fall rains washed away topsoil. The damage to the grasslands was extensive. Within a year, the livestock industry in the Santa Cruz Valley began to decline. Some of the grasslands never recovered. Today most ranchers practice conservative grazing management." (*Arizona's Changing Rivers: How People Have Affected the Rivers*, page 20)

"After efficient pumps made it economical to bring groundwater into otherwise dry lands, water-intensive crops were planted up and down the valley. Wheat, alfalfa, cotton, fruits and vegetables have been grown in the valley for decades. Green Valley's 7,000 acres of pecan trees use 30,000 acre-feet of water per year today. The Marana-Avra Valley area has been heavily farmed since 1930s. When the City of Tucson bought some 10,000 acres of Avra Valley land in the 1960s and 1970s, farming declined but pumping continued to serve municipal demands." (*Arizona's Changing Rivers: How People Have Affected the Rivers*, page 21)

"Urban development affected the river in many ways. Woodcutting for fuelwood deforested areas near the river. People who built homes and businesses near the river demanded flood control structures to protect their investments. Today, most of the Santa Cruz and Rillito rivers through the Tucson urban area are soil-cemented to prevent erosion. Streets, parking lots and buildings increased paved areas, causing less water to soak into the ground. Instead, flowing water rushes rapidly to the watercourses, often causing flooding problems and eroding streambanks." (*Arizona's Changing Rivers: How People Have Affected the Rivers*, page 22)

[2] "[A]ridlands geomorphic processes also took place in the valley as Tucson grew from mud-walled village to modern metropolis, with one exception: historical water development and channel changes proceeded hand in glove, each taking turns reacting to the other, eventually lowering the water table and killing a unique habitat that can no longer recover or be restored." (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, Webb, Betancourt, et al.)

[3] "The Sweetwater Wetlands, albeit an off-channel cienega, and the establishment of native riparian trees downstream from the wastewater treatment plants without clearing to maintain channel conveyance are a good start to developing multipurpose channels in the Tucson Basin. These are a pale shadow of what once was, but they are an improvement over barren flood conduits." (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 181)

[4] *Requiem for the Santa Cruz: An Environmental History of an Arizona River*, Webb, Betancourt, et al., Page 3

[5] New research highlights human perceptions of a flowing Santa Cruz River; February 2016; Fonseca and Powell

[6] "To most inhabitants of the river valley today, water is something that comes from a faucet, is delivered in bottles to the doorstep, or is purchased in six-packs at the grocery store. The river is a dry wash that sometimes floods during the monsoon or tropical storms, but the muddy, swift water that courses down the channel on those spectacular occasions is certainly not the same water that comes from the kitchen tap. This perception has much to do with the assumptions that go far beyond the realm of intellectual awareness." (*The Lessening Stream*, Logan, page 9)

[7] "IN 1910, G.E.P. SMITH, the eminent University of Arizona hydrologist, described the Santa Cruz River in the Tucson Basin as "ever a dwindling stream." He was studying the water sources in the basin and had come to the conclusion that the river had diminished to a such an extent—a "brook" he called it—that its tributary, Rillito Creek, was by far the more promising source for water in the basin." (*The Lessening Stream*, page 3)

[8] "The Santa Cruz River Watershed is located in south-central Arizona and Northern Sonora, Mexico. Within the U.S. the watershed encompasses >8,000 square miles. The river flows in a north direction. There are very few perennial reaches remaining in the drainage: portions of the mainstream Santa Cruz River in the San Rafael Valley, an 11 mi reach downstream of the Nogales Sewage Treatment Plan (effluent dominant segment), and portions of Cienega, Sabino, and Sonoita Creeks. All other reaches in the watershed are either intermittent (flowing seasonally) or ephemeral (flowing in response to precipitation events) and are characterized by broad, flat bottoms with deep sand substrate." (Chapter 10 Santa Cruz River Watershed, USFWS, Arizona Game and Fish, 2011, page 10-4)

[9] "Most scholars agree that semiarid conditions in the region have prevailed for the last 6,000 to 8,000 years. Earlier climate patterns were probably wetter, with heavier winter precipitation resulting in more woodland trees and shrubs, such as pinyon pine and juniper. The debate centers around when this pattern changed to dryer circumstances. No doubt the river changed as a consequence of the changing weather patterns, the wetter conditions 10,000 years ago probably created a broad, shallow, meandering or braided stream that must have been quite alluring to the first human arrivals." (*The Lessening Stream*, page 21)

[10] "The valley through which the river flows is an alluvial plain, its relatively flat surface made up of sands, clays, and gravels brought down from surrounding ranges of mountains and deposited there in geologic times. Throughout its long history the river has meandered. It has flowed on the surface; it has carved deep fissures into the soils; it has widened; it has narrowed; it has filled." (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page xi)

[11] "With the transition to a dryer climate at the end of the Pleistocene, the changing pattern of slow meander, cienega, dry stretches, and periodic flooding and arroyoization took hold in the valley. Into this setting the Clovis people emerged, and the narrative of human presence in the valley intensified." (*The Lessening Stream*, page 26)

[12] "The following remarks to not represent final conclusions on the complicated subject of interrelationships between man and his environment in the arid Southwest, but rather are speculative and programmatic." (*Pre-Spanish Human Ecology in the Southwestern Deserts*, Woodbury, page 1)

"[H]uman ecology is fundamentally different from plant or animal ecology because of the important fact that man can change his behavior systems rapidly and profoundly through changes in his culture—the infinitely adaptable learned patterns of action that distinguish human activities from those of all other organisms. Therefore, human behavior is not a near-constant in its relation to a given environment, but can change radically and almost instantaneously." (*Pre-Spanish Human Ecology in the Southwestern Deserts*, page 1)

"[I]t is fortunate that subsistence techniques comprise an aspect of human activity that archeologists are usually able to define in some detail, since they also are basic to understanding man's relationship with his environment. For convenience, the following four large time periods can be defined for the Southwest.

1. Period of hunting big game from the time of man's first arrival in the area more than ten to twelve thousand years ago to about 6000 B.C.
2. Period of gathering food from wild plants (with hunting continuing on a limited scale), from about 6000 B.C. to about 2000 B.C.
3. Period of initial agriculture (with hunting and gathering both continued), from about 2000 B.C. to about A.D. 500.
4. Period of developed agriculture (with hunting and gathering continuing), from about A.D. 500 to the present."

"Since the changes in subsistence patterns were gradual, with older techniques persisting together with the new, these periods merge at the boundaries. Also, agriculture could never be practiced as widely as could the gathering of wild foods, so that the third and fourth periods also involve a smaller area, with older techniques persisting in marginal areas." (*Pre-Spanish Human Ecology in the Southwestern Deserts*, page 1)

[13] "[M]any species of large grazing mammals—ground sloths, bison, camels, horses, and mammoths—ignorant of human predators, grazed on the thick and bountiful grass, making the area a prime hunting ground." (*The Lessening Stream*, page 22)

[14] "The higher older mountain peaks, covered with snow through most of the year, shimmered blue in the distance with thick stands of spruce, fir, and mountain juniper. Pinyon and juniper descended the slopes of the mountains onto the hill lining the valley." (*The Lessening Stream*, page 22)

"Cottonwood and sycamore towered over the river, and interspersed among the trees in several marshy areas were thick stands of willow, elderberries, ash, walnut, hackberry, and catclaw." (*The Lessening Stream*, page 23)

"Conifer forests spread far down the sides of the mountains, and lined the river, juniper trees spilled onto the foothills. Further up the valley as terraces lined the river, juniper and pinyon pine found footholds closer to the river, restricting the grass to the flatter mesas and plains." (*The Lessening Stream*, page 24)

[15] "[T]he modern perception depends on a more complete view of the hydrological system that creates the surface flow of the river, and as such is generally accompanied by a faith and reliance on technological expertise in the management and exploitation of the water resource. Not without spirituality, this perception embodies the culture of the early 1900s, when science came to challenge religion in the hearts of many Americans. The modern temper held that the salvation of human society would come from science and technology, not from religion." (*The Lessening Stream*, page 8)

[16] "Eventually, a culture appeared on the banks of the river that surpassed cattle and rivaled even climate in its influence on the river: the industrial society that arrived in the Tucson Basin with the Southern Pacific Railroad in 1880. With the steam locomotive came the prospect and soon the reality of the widespread use of steam-powered pumps to lift groundwater from the Santa Cruz River's shallow aquifer. The railroad also brought the prospect of wider markets for the region's products. Cattle and copper became linked to national and international markets. The river continued to be the center of life in the valley, but it now coursed through a much larger world. This second formulation of the river—underground and vast—is recent and current, and diverges widely in its influences on human cultures from the earlier, aboveground, slowly meandering river." (*The Lessening Stream*, page 6)

[17] "[N]o matter what the political outcomes, the river will be central to valley residents. Without the river and its aquifer there would be no human society to wrangle over water politics in the Santa Cruz Valley." (*The Lessening Stream*, page 248)

[18] "[E]xample of a riparian area [Patagonia-Sonoita Creek Preserve] preserved by environmental groups serves as a good indication of the continuing relevance of the archaic perception of the river….. [I]t merely requires that a respect and reverence be directed toward the flowing stream." (*The Lessening Stream*, page 207)

[19] "If politics determine the fate of the river and its aquifer, and if the river and its aquifer are central to the survival of human society in the valley, then how is it that so many valley residents, at least in Tucson, can be so disassociated from the political process?" (*The Lessening Stream*, page 247)

[20] "Although one might take exception that the flows of treated effluent are "artificial" and thus should not be considered part of the historic river, such a judgment would clearly emanate from a distinct perception of the river, and would not be shared by residents of the valley approaching the river with a different vision." (*The Lessening Stream*, page 228)

[21]http://tucsonaudubon.org/go-birding/get-started-with-birding/great-places-to-bird/sweetwater-wetlands/

"Sweetwater Wetland is a constructed wetland located in Tucson between I-10 and the Santa Cruz River, near Prince Road. Built in 1996, it helps treat secondary effluent and backwash from the reclaimed water treatment system at

adjacent Roger Road Wastewater Treatment Plant. Sweetwater serves as an environmental education facility and habitat for a wide variety of wildlife.

"Rarities seen here over the years include Groove-billed Ani, Least Grebe, Chestnut-sided Warbler, and many others. Sweetwater Wetland consists of several ponds surrounded by cattails, willows, and cottonwoods. Ducks visit the ponds while Red-winged, Yellow-headed, and Brewer's blackbirds frequent the cattails. Thick stands of saltbush provide cover to Song Sparrows, Abert's Towhees, wrens, and many other species.

"Paths, both paved and unpaved, visit all the ponds and give a view to the large detention basins to the south which, when containing water, attract wading birds and shore birds."

[22] *Why America Needs More City Parks and Open Space*, 2003, The Trust for Public Land (www.tpl.org)

[23] http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-REPORT-Open%20Spaces.pdf
"The two major approaches for estimating open space value from the economics literature are the focus of this study: revealed preference methods and stated preference methods. In the first category are hedonic property value studies in which the open space value is inferred by estimating the sales price or value of a property as a function of measures of proximity to open space and other property and neighborhood characteristics. In the second are studies that use carefully designed surveys to elicit preferences or values households place on various types of open space amenities. Both contingent valuation and contingent choice studies are reviewed."

[24] United States Forest Service
https://www.fs.fed.us/science-technology/loss-of-open-space
https://www.fs.fed.us/openspace/loss_space.html

[25] http://activelivingresearch.org/sites/default/files/Synthesis_Shoup-Ewing_March2010_0.pdf: *Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design*, Active Living Research.org, page 2

[26] http://activelivingresearch.org/sites/default/files/Synthesis_Shoup-Ewing_March2010_0.pdf: *Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design*, Active Living Research.org, page 4

"The impact parks can have on property values may actually underestimate the value of open space, by excluding the nonmarket values associated with passive uses, such as just knowing that open space exists. Stated preference surveys, similar to hedonic pricing methods, attempt to value nonmarket benefits by asking respondents about their willingness to pay for an amenity. Residents in one Boulder, Colo., neighborhood were willing to pay $234 per household (in 1995 dollars) to keep a 5.5-acre parcel of undeveloped land preserved forever. Extrapolating to the whole neighborhood within a mile of the parcel, the total value was $774,000, more than the $600,000 cost of the land. Another method for calculating the recreational benefits of parks and open space estimates the travel costs associated with visiting a park in order to estimate the total benefit to all park users. A study of the Monon Trail in Indianapolis / Marion County, Ind., found that the average property price premiums for 1999 home sales could total $140.2 million, with an additional net present recreational benefit of $7.6 million."

[27] http://activelivingresearch.org/sites/default/files/Synthesis_Shoup-Ewing_March2010_0.pdf: *Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design*, Active Living Research.org, page 6

"How much economic value open space provides to surrounding property may depend on its location. For instance, the value of open space may be higher in urban areas than in suburban ones, with parks, greenways, forests and other natural areas providing greater economic benefits as population density increases. Broadly speaking, urban residents in dense neighborhoods located near downtowns place substantial value on proximity to open space, while suburban and rural residents do not appear to value open space as highly."

[28] http://activelivingresearch.org/sites/default/files/Synthesis_Shoup-Ewing_March2010_0.pdf: *Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design*, Active Living Research.org, page 6

"A study of four large, regional parks in Bastrop County, Texas confirms that open spaces in rural areas may have less of an impact on property values. In the largely rural county near Austin, Texas, the parks — both individually and as a group — had no statistically significant impact on property prices in the rural county in which they are located.

The authors cite the relatively large amount of undeveloped land (whether publicly or privately owned) in the area, as well as the rather large size of lots compared to those in the typical American city as reasons why the price premium associated with living close to a public open space in a predominantly rural area might be limited."

[29] http://activelivingresearch.org/sites/default/files/Synthesis_Shoup-Ewing_March2010_0.pdf: *Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design*, Active Living Research.org, page 4

"Some types of open space can reduce nearby property values, an outcome sometimes called 'the nuisance effect.' Studies have confirmed that parks that are excessively busy, located in highly desirable or undesirable neighborhoods, or unattractive or poorly maintained have a negative impact on home values. In these instances, parks detract from property values due to the perception that they are unsafe, unnecessary or unused."

[30] *The Loop Annual Report*, 2014, page 13
http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/The%20Loop/Annual%20Reports/1386%20-%20Loop%20Annual%20Report_web-ready.pdf

"The Tucson region's long history of flooding drove the creation of our River Park system, which became the backbone of The Loop. The worst of the floods was in 1983, when between 6 ½ to 7 ½ inches of rain fell across the Tucson basin over five days. Four people died in flood-related incidents from the 1983 event, and public infrastructure damage was estimated at $64 million. After this natural disaster, Pima County spent millions stabilizing the banks of the Rillito, Pantano and Santa Cruz rivers to protect our community.

"While nature was the driving force behind the bank stabilization that led to the River Parks, people were the driving force behind what eventually became The Loop. It took vision, tenacity, and a lot of people working hard together to bring this Southern Arizona treasure to where it is today. From planning and design to construction and maintenance, thousands have contributed to the development of this 100+ mile linear park."

[31] Active Living Research, Building Evidence to Prevent Childhood Obesity and Support Active Communities, May 2010 (http://activelivingresearch.org/economic-benefits-open-space-recreation-facilities-and-walkable-community-design), page 10

"In addition to providing opportunities for physical activity, recreation areas and parks located in metropolitan areas provide economic benefits to residents, municipal governments and private real estate developers. Parks tend to increase the value and sale price of homes and property located nearby. In addition, the amount of local tax dollars required to operate and service recreation areas may be less than for other types of land use, such as residential developments, further increasing the fiscal impacts they have on municipal governments."

[32] http://old.smartgrowthamerica.org/green_infrastructure – Smart Growth America

[33] Low impact development and green infrastructure manual: https://www.epa.gov/sites/production/files/2017-02/documents/epa-pima_county_final_report_factsheet_010517_for_508.pdf

"Stormwater runoff is a major cause of water pollution in urban areas. When rain falls in undeveloped areas, soil and plants absorb and filter the water. When rain falls on our roofs, streets, and parking lots, however, the water cannot soak into the ground. In most urban areas, stormwater is drained through engineered collection systems and discharged into nearby water bodies. The stormwater carries trash, bacteria, heavy metals, and other pollutants from the urban landscape, polluting the receiving waters. Higher flows also can cause erosion and flooding in urban streams, damaging habitat, property, and infrastructure."

[34] http://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=164638

[35] http://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=164638 – Flood Control and Drainage

[36] Low impact development and green infrastructure manual: https://www.epa.gov/sites/production/files/2017-02/documents/epa-pima_county_final_report_factsheet_010517_for_508.pdf

[37]http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/The%20Loop/Annual%20Reports/1386%20-%20Loop%20Annual%20Report_web-ready.pdf, *The Loop Annual Report*, 2014, page 15

[38] http://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=164638 – Transportation

[39] http://www.recpro.org/assets/Library/Visitor_Experience_Management/tros_lit_rev.pdf.pdf *A Review of the Recreation Opportunity Spectrum and its Potential Application to Transportation in Parks and Public Lands*, page 1

[40] http://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=164638 – Transportation

[41] https://www.fs.fed.us/rm/pubs/rmrs_p067.pdf, *Merging Science and Management in a Rapidly changing World: Biodiversity and Management of the Madrean Archipelago III*, May 1-5, 2012, Tucson, Arizona (conference)

"In 2007, Conservation International named the Madrean Pine-oak Woodlands as a global biodiversity hotspot. This was a very large area that included the Sierra Madre Oriental in eastern Mexico, the Sierra Madre Occidental (SMO) in western Mexico, and the Sky Island ranges north of them into Texas, New Mexico, and Arizona. The Sierra Madre Occidental extends in western Mexico from Zacatecas and Jalisco north to Chihuahua and Sonora. The southwestern United States is famous for its diversity of animals and plants, and in many groups diversity increases southward in Sonora into the Sierra Madre Occidental and the New World tropics.

"Species richness is enhanced in the Sky Island Region for many reasons. The western half of North America is mountainous, with topographically diverse habitats and vegetation zoned along elevational-climatic gradients. Biotic communities are concentrated in small geographic areas compared to the eastern United States where vegetation mostly changes along a north-south latitudinal gradient.

"The Madrean Archipelago is a convergence zone for five biotic provinces (fig. 1). The Rocky Mountains and Colorado Plateaus to the north have temperate climates. In the mid-continent, the grasslands of the Great Plains extend from Canada south to New Mexico, Texas, and the Mexican Plateau. In the south, a mosaic with desert grassland in the valleys and Chihuahuan desertscrub on adjacent limestone slopes extends westward into southeastern Arizona and northeastern Sonora. On the western edge of the Sky Island Region, Sonoran desertscrub surrounds Sky Island ranges. In the south, more tropical oak woodlands and pine-oak forests are in the Sierra Madre Occidental and Sky Island mountaintops. In the lowlands, foothills thornscrub (FTS) and tropical deciduous forest are present."

[42] *The Flowing Santa Cruz River: The Living River* Project
https://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Wastewater%20Reclamation/Publibations/LivingRiverProject_Brochure.pdf

"In an arid landscape, water is the essential resource for people and wildlife to survive. The Santa Cruz River has long been the lifeblood of the region, attracting the first humans over 12,000 years ago. In fact, the Santa Cruz River Valley has the longest continuous record of agriculture in the United States. Early inhabitants settled along the valley because the river supplied water year-round."

[43] https://www.washingtonpost.com/blogs/govbeat/wp/2015/04/19/arizona-is-the-best-state-in-america-for-having-and-harnessing-the-sun/?utm_term=.964ec9b90503, The Washington Post, April 19th, 2015

"None of the other contiguous states received more average daily sunlight from 1979 to 2011 (and none ranked as consistently high from month to month), according to data from the Centers for Disease Control and Prevention. That distinction also holds true based on average city-level data from all 50 states, tracked by the National Oceanic and Atmospheric Administration."

[44] http://www.recpro.org/assets/Library/Visitor_Experience_Management/tros_lit_rev.pdf.pdf *A Review of the Recreation Opportunity Spectrum and its Potential Application to Transportation in Parks and Public Lands*, page 4

[45] "ROS is conceptualized as a four-tiered framework that links activities, settings, motivations, and benefits. The basis for this system is often described as "experience-based setting management" (Manfredo et al. 1983, Floyd and Gramman 1997), and may be thought of as a type of "production process." It theorizes that experiences are derived

from recreation activities, and that these activities are linked to the settings in which they occur. Settings, in turn, are comprised of three categories of factors, resource, social, and managerial.

"Through articulating ranges and varying combinations of these factors, ROS may be used to design, plan, and allocate diverse recreation opportunities for a more comprehensive recreation system." (*A Review of the Recreation Opportunity Spectrum and its Potential Application to Transportation in Parks and Public Lands*, page 4)

[46] https://www.fs.usda.gov/treesearch-beta/pubs/19574 - "The huge population increases anticipated over the next century make the problem of identifying and conserving open space critical. While the Recreation Opportunity Spectrum is undoubtedly the most sophisticated recreation inventory system established to date, it was designed for, and is best suited to, the large tracts of public lands in the western U.S."

[47] *A Review of the Recreation Opportunity Spectrum and its Potential Application to Transportation in Parks and Public Lands*, page 1

[48] "Under this model, managers might be able to provide recreation opportunities (comprised of alternative activities and settings) designed to fulfill certain motivations and produce related benefits." (*A Review of the Recreation Opportunity Spectrum and its Potential Application to Transportation in Parks and Public Lands*, page 10)

[49]http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/The%20Loop/Annual%20Reports/1386%20-%20Loop%20Annual%20Report_web-ready.pdf, *The Loop Annual Report*, 2014, page 15

[50] https://urbanland.uli.org/planning-design/open-spaces-and-active-transportation/, *Urbanland* magazine, 20140131

"From the standpoint of infrastructure investment, active open spaces are statistically proven to deliver an excellent ROI, often supplying far more in benefits than they cost to construct. These benefits accrue to public investments as well as to private development. According to a study from the University of Texas at Arlington, the $15 million redevelopment of Houston's Buffalo Bayou Promenade led to a fourfold increase in the number of businesses in the area and boosted retail sales from $10.46 million to $57.28 million.

"The 2013 study revealed that the bayou's restoration increased outdoor activity for 88 percent of the survey respondents by providing space for cycling, jogging/running, and other activities. For 66 percent of respondents, the park creates a feeling of safety and security primarily through the lighting design, visibility, and the planting scheme.

"Research by North Carolina's department of transportation found that the state's cycling infrastructure cost only $6.7 million, but had an economic impact of $60 million. And a study of Maryland's Northern Central Railroad Trail showed that the state received $303,000 a year in trail-related tax income, compared with management and maintenance costs of just $192,000 a year.

"Contributing to this ROI is the fact that these spaces serve multiple purposes. Trail systems not only provide opportunities for recreation but also support multipurpose green infrastructure for transportation, stormwater, utility corridors, and natural habitat that enhances a project's appeal."

"A review of research and case studies, including communities, urban districts, and workplaces, provides a more robust understanding of the return on investment (ROI) for developers, city officials, planners, and designers."

[51] http://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=164639 – Parks and Recreation

[52] http://msue.anr.msu.edu/news/values_as_part_of_environmental_education

"Values play an important role within environmental education. All human values are linked to satisfying our biological needs. These basic needs of survival (food, water, shelter, clothing) all place demands on the environment. Other values exist (social, political, economic) but the primary values of survival become principle in our daily lives. Since all we have comes from what the earth provides, there is an obvious connection between our values and the environment."

[53] http://www.gdrc.org/uem/ee/tbilisi.html - Tbilisi Declaration (1977)

[54] http://www.gdrc.org/uem/ee/tbilisi.html - Tbilisi Declaration (1977)

[55] http://www.ajpmonline.org/article/S0749-3797(00)00317-2/fulltext, *American Journal of Preventive Medicine*, April 2001, Vol. 20, Issue 3, Pages 234-240, Howard Frumkin, MD, DrPH

[56] http://www.ajpmonline.org/article/S0749-3797(00)00317-2/fulltext, *American Journal of Preventive Medicine*, April 2001, Vol. 20, Issue 3, Pages 234-240, Howard Frumkin, MD, DrPH

"For the great majority of human existence, human biology has been embedded in the natural environment. Those who could smell the water, find the plants, follow the animals, and recognize the safe havens, must have enjoyed survival advantages. According to biologist E. O. Wilson, 'It would…be quite extraordinary to find that all learning rules related to that world have been erased in a few thousand years, even in the tiny minority of peoples who have existed for more than one to two generations in wholly urban environments.' Wilson hypothesized the existence of biophilia, 'the innately emotional affiliation of human beings to other living organisms.' Building on this theory, others have postulated an affinity for nature that goes beyond livings things, to include streams, ocean waves, and wind."

"Natural landscapes may have a similar effect. Returning to an evolutionary perspective, human history probably began on the African savanna, a region of open grasslands punctuated by scattered copses of trees and denser woods near rivers and lakes. If this sounds like the choicest real estate in most cities and towns, that may not be a coincidence. As E. O. Wilson points out, 'certain key features of the ancient physical habitat match the choices made by modern human beings when they have a say in the matter.'—a pattern that repeats in parks, cemeteries, golf courses, and lawns. 'It seems that whenever people are given a free choice, they move to open tree-studded land on prominences overlooking water.'"

"Wilderness experiences—entering the landscape rather than viewing it—may also be therapeutic. David Cumes has described 'wilderness rapture,' including self-awareness; feelings of awe, wonder, and humility; a sense of comfort in and connection to nature; increased appreciation of others; and a feeling of renewal and vigor."

It should, however, be noted that "much of the publicized research comes from proponents with a personal or commercial interest in wilderness experiences, such as companies that market adventures. . Much of the research refers to structured trips or summer camp programs rather than to the more general phenomenon of contact with wilderness. To the extent that such research seems to show benefits, this may be due to the vacation quality of the experience, to the psychological value of setting and achieving difficult goals, and/or to the group bonding that occurs on some such trips, rather than (or in addition to) a direct effect of wilderness contact…… Despite these limitations, many published accounts do suggest some benefit from wilderness experiences. Mental health has been more studied than somatic conditions, and short-term benefit has been demonstrated more than long-term benefit."

[57] Quartz (https://qz.com/804022/health-benefits-japanese-forest-bathing/)

"The tonic of the wilderness was Henry David Thoreau's classic prescription for civilization and its discontents, offered in the 1854 essay *Walden: Or, Life in the Woods*. Now there's scientific evidence supporting eco-therapy."

[58] Quartz (https://qz.com/804022/health-benefits-japanese-forest-bathing/)

"Now there's scientific evidence supporting eco-therapy. The Japanese practice of forest bathing is proven to lower heart rate and blood pressure, reduce stress hormone production, boost the immune system, and improve overall feelings of wellbeing.

"Forest bathing—basically just being in the presence of trees—became part of a national public health program in Japan in 1982 when the forestry ministry coined the phrase *shinrin-yoku* and promoted topiary as therapy.

"From 2004 to 2012, Japanese officials spent about $4 million dollars studying the physiological and psychological effects of forest bathing, designating 48 therapy trails based on the results. Qing Li, a professor at Nippon Medical School in Tokyo, measured the activity of human natural killer (NK) cells in the immune system before and after exposure to the woods. These cells provide rapid responses to viral-infected cells and respond to tumor formation, and

are associated with immune system health and cancer prevention. In a 2009 study Li's subjects showed significant increases in NK cell activity in the week after a forest visit, and positive effects lasted a month following each weekend in the woods.

[59] The Washington Post (https://www.washingtonpost.com/news/to-your-health/wp/2016/05/17/forest-bathing-is-latest-fitness-trend-to-hit-u-s-where-yoga-was-30-years-ago/?utm_term=.bef2fb8279b1)

"… a 2010 study using data from field experiments conducted in 24 forests across Japan found that subjects who participated in forest bathing had lower blood pressure, heart rate and concentrations of salivary cortisol — a stress hormone — when compared with those who walked through a city setting. Studies performed in other countries, such as Finland and the United States showed similar reductions in tension and anxiety.

""There have been studies comparing walking in nature with walking in an urban environment and testing people on their mood, different aspects of depression, and in some cases, brain scans," said David Yaden, a research fellow at the University of Pennsylvania's Positive Psychology Center. "In the natural setting, people are more relaxed and less stressed."

""In Japan, Shinrin-yoku trails are certified by a blood-sampling study to determine whether the natural killer cell count is raised enough for the trail to qualify," [Ben] Page said. "I should also note that in Japan and Korea, forest therapy modalities are integrated into their medical system and are covered by insurance."

[60] http://activelivingresearch.org/sites/default/files/Synthesis_Shoup-Ewing_March2010_0.pdf: *Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design*, Active Living Research.org, page 1

"Overweight and obesity rates have risen dramatically in the United States since the 1970s, and, during a similar time period, physical activity rates have declined in both children and adults. Being physically active is more than a personal decision; community design and the availability of open spaces and recreation areas strongly influence how active people are. The Guide to Community Preventive Services created by the Centers for Disease Control and Prevention identifies community designs in which residents can walk or bicycle to nearby destinations (often called compact, walkable or traditionally designed communities) as effective ways of promoting physical activity for adults, and other studies demonstrate similar findings for youth. People living in walkable neighborhoods get about 35–45 more minutes of moderate-intensity physical activity per week, and are substantially less likely to be overweight or obese, than do people of similar socio-economic status living in neighborhoods that are not walkable. Living close to parks and other recreation facilities also is consistently related to higher physical activity levels for both adults and youth."

[61] http://activelivingresearch.org/sites/default/files/Synthesis_Shoup-Ewing_March2010_0.pdf: *Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design*, Active Living Research.org, page 1

"One national study found that adolescents with easy access to multiple recreation facilities were both more physically active and less likely to be overweight and obese than were adolescents without access to such facilities. The Institute of Medicine has stated that improving the walkability of neighborhoods and increasing access to recreation facilities are essential strategies for preventing childhood obesity."

[62] *Pima Regional Trail System Master Plan*, August 9, 2010, revised May 2012, page v (https://webcms.pima.gov/UserFiles/Servers/Server_6/File/Recreation/Master%20Plans%20and%20Design%20Manuals/Pima_Regional_Trail_System_Master_Plan_May2012.pdf)

[63] https://ehp.niehs.nih.gov/1408216/, *Metro Nature, Environmental Health, and Economic Value*, Environmental Health Perspectives (EHP)

"More than 50% of the world's population now live in cities and further concentration in urban areas is forecast (United Nations Population Fund 2007). Although some city governments struggle to meet basic daily needs such as safe housing, dependable utilities, and transportation, many others have achieved reliable and affordable basic systems and services. Of interest to both governments and citizens, once basic systems are in place, is the livability of urban areas and the quality of life afforded their citizens. Residents of highly urbanized centers often expect livable environments that include access to urban nature and investments in green infrastructure."

"The public has long recognized that nature in cities and towns provides beauty and respite. There is now extensive evidence that both constructed and endemic nature elements can contribute significant ecosystem services (ES) that generate public health co-benefits."

"The term "metro nature" is used here to refer to the collective opportunities for human nature experiences that improve urban livability (Wolf 2008). The term "metro nature" is used here to refer to the collective opportunities for human nature experiences that improve urban livability (Wolf 2008). The term "metropolis," from which "metro" is derived, refers to an urbanized area made up of multiple settlements and political jurisdictions. Metro nature is a unifying concept that acknowledges cultural and ecological landscapes governed by diverse entities and landowners—both public and private—within cities. Metro nature includes endemic ecosystems, such as urban forests, greenbelts, conserved open spaces, and riparian corridors that may be patch, relic, or feral expressions of native ecological associations. It also includes culturally constructed nature such as parks, streetscapes, community gardens, pocket parks, and recreation paths. Finally, metro nature includes structural innovations that are integrated within built form to serve specific functions, such as green roofs, green walls, or green infrastructure facilities."

[64] https://ehp.niehs.nih.gov/1408216/, *Metro Nature, Environmental Health, and Economic Value*, Environmental Health Perspectives (EHP)

"Convenient and pervasive access to nearby nature includes passive views from homes and vehicles, green spaces within walkable distances, and active encounters with nature (such as gardening and tree planting); all are scientifically linked to wellness. Beneficial human responses include physical activity that can reduce incidences of chronic diseases, physiological stress moderation, and improved mental health. For instance, urban forest canopy proximate to households has been associated with higher infant birth weight (Dadvand et al. 2012) and green urban neighborhoods with reductions in elder mortality (Takano et al. 2002)."

[65] http://www.pnas.org/content/112/28/8567.full.pdf: *Nature experience reduces rumination and subgenual prefrontal cortex activation*, Bratman et al., Proceedings of the Natural Academy of Sciences, Vol. 112, No. 28

[66] http://www.pnas.org/content/112/28/8567.full.pdf: *Nature experience reduces rumination and subgenual prefrontal cortex activation*, Proceedings of the Natural Academy of Sciences, Vol. 112, No. 28

"Using a variety of methodologies, researchers have demonstrated affective and cognitive benefits of nature experience, thereby contributing to an evolving understanding of the types of psychological benefits of which humanity may be deprived as urbanization continues. Correlational findings show that growing up in rural vs. urban settings is associated with lesser stress responsivity. A recent longitudinal study, tracking the well-being and mental distress of more than 10,000 people over a period of nearly two decades demonstrates a significant positive effect of proximity to greenspace on well-being. This effect traces to living location within a same individuals as they moved closer or further from greenspace. Other correlational studies reveal that window views that include natural elements (compared with window views that do not) are associated with superior memory, attention, and i9mpulse inhibition, as well as greater feelings of subjective well-being. These correlational findings are buttressed by experimental findings showing, for example, that nature experience (usually in urban greenspace) can improve memory and attention and increase positive mood. Experimenters also have used psychophysiological methods to characterize the ways in which images and sounds of the natural environment lead to decreased stress and negative emotion after participants have been subjected to stressful stimuli. Taken together, these and numerous other studies provide compelling evidence that nature experience may confer real psychological benefits."

[67] http://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=164639 – Parks and Recreation

[68]https://webcms.pima.gov/UserFiles/Servers/Server_6/File/Health/Health%20Data,%20Statistics%20and%20Reports/CHIP_Report_April30-2013_Final.pdf

[69] http://healthypima.org/ourstory.html

[70] http://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=164639

[71] Pima County: Economic Development (http://webcms.pima.gov/government/county_administrator/)

[72] http://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=164638 – Trails

[73]http://americas.uli.org/wp-content/uploads/sites/125/ULI-Documents/Intersections-Health-and-the-Built-Environment.pdf - *Interactions: Health and the Built Environment*, Urban Land Institute, 2013, pages 26-27

"A growing body of research suggests that evidence-based architectural and urban design strategies are building a foundation for healthier lives. Community design patterns and urban design elements that promote healthy living follow many of the principles of smart growth and sustainable development, as well as concepts related to design for active living.

"Smart growth means building compact communities with housing and transportation choices near jobs, services, and schools to support local economies and to protect the environment. A vibrant local economy, a balance between jobs and housing that reduces the need for long commutes, and diversity in housing sizes, types, and costs, including adequate affordable housing, are all important to healthy and sustainable communities.

"Smart growth development costs one third less for upfront infrastructure, such as roads, sewers, and water lines. It saves an average of 10 percent on ongoing delivery of police, fire, and ambulance services and generates ten times more tax revenue per acre than conventional suburban development [*emphasis added*], according to a Smart Growth America survey of 17 studies of development scenarios."

[74] http://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=164640 – 2015 Pima County Comprehensive Plan Update, Chapter 6.2 Tourism as an Economic Engine

[75] *Arizona Travel Impacts 1998-2015p*, Dean Runyan Associates, page 10

[76] *Arizona Travel Impacts 1998-2015p*, Dean Runyan Associates, page 11

[77] *Arizona Travel Impacts 1998-2015p*, Dean Runyan Associates, page 36

[78] *Arizona Travel Impacts 1998-2015p*, Dean Runyan Associates, page 54

"DIRECT IMPACTS: Travel impacts consist of estimates of travel spending and the employment, earnings, and state and local taxes generated by this spending. These estimates are also broken out by type of traveler accommodation and by the type of business in which the expenditures occur." (page 60)

"GROUND TRANSPORTATION ESTIMATES: County and regional level estimates of destination or visitor spending include only a portion of the ground transportation expenditures for travel that occur in the county. The remaining portion is included in "other travel" as it represents transportation costs for travel to another destination within Arizona. State level estimates of visitor spending include all of these expenditures for ground transportation." (page 60)

"INDIRECT IMPACTS: Indirect impacts represent the purchases of goods and services from other firms by businesses that directly receive expenditures from travelers. Hotels, for example, purchase maintenance services from independent contractors." (page 60)

"INDUCED IMPACTS: Induced impacts represent the purchase of goods and services by employees whose earnings are in part derived from travel expenditures." (page 60)

[79] 2017 Santa Cruz River Research Days (SCRRD) Conference presentation "Agua Dulce Overview – Water Reliability" (City of Tucson)

[80] Agua Dulce Overview – Water Reliability presentation at 2017 SCRRD:

Permits	Issuing Agency
Arizona Pollutant Discharge Elimination System (AzPDES)	ADEQ
Aquifer Protection (APP)	ADEQ
Underground Storage Facility (USF)	ADWR
Water Storage (WS)	ADWR

[81] Agua Dulce project benefits:

- Virtually all of the City's reclaimed water put to beneficial use.
- Increased river flows and riparian habitat in the City.
- Potential economic development driver.
- Lower cost than potable reuse. Maximizes use of existing infrastructure.
- Supports historical and cultural community projects.
- Improves water management efficiency.

[82]https://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Administration/CHHmemosFor%20Web/June%202015/June%208,%202015%20-%20State%20Cost%20Shifts%20Have%20a%20Disproportionate%20Impact%20on%20Pima%20County%20Taxpayers.pdf

[83] https://www.tucsonaz.gov/files/parks/masterplan/Tucson_Parks_and_Recreation_System_Master_Plan_10_5_16.PDF

[84] https://www.tucsonaz.gov/files/parks/masterplan/Tucson_Parks_and_Recreation_System_Master_Plan_10_5_16.PDF, page iv

[85] http://activelivingresearch.org/sites/default/files/Synthesis_Shoup-Ewing_March2010_0.pdf: *Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design*, Active Living Research.org, page 6

[86] Source: *Requiem for the Santa Cruz: An Environmental History of an Arizona River*, Webb, Betancourt, et al.

[87] "Human occupation of southeastern Arizona began around 11,500 years ago with the Clovis culture, which is best preserved in the San Pedro River valley east of Tucson. This is a good reason to assume that these peoples, and several groups that followed, would have also occupied the Santa Cruz River valley in the Tucson Basin, given later aboriginal uses. However, channel erosion evidently has removed all the geologic and cultural evidence of early people in the vicinity of Tucson. The earliest evidence of human occupation in the vicinity of Tucson in in the late Archaic period, 4,500 to 2,000 years ago" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 14).

[88] "Little is known about the channel form of the Santa Cruz River through the Tucson Basin at the end of the last Ice Age and the beginning of the Holocene approximately 12,000 years ago. Before 9,000 years ago (calendric age, not radiocarbon age), the Santa Cruz was a braided stream flowing across bottomlands about 20-30 feet below the land surface adjacent to the present-day river" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 12).

[89] "The early Holocene alluvium was removed by downcutting and channel widening between 9,000 and 6,400 years ago, during the middle Holocene or so-called Altithermal, which thus left little depositional evidence. Deposition of a new floodplain began before 6,400 years ago, and alternating braided streams, high water tables, and arroyo downcutting occurred at least five times afterward, including initiation of the late nineteenth-century arroyo" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 13).

[90] "Cienega development, reflecting high groundwater levels, characterized the period between 4,500 and 2,500 years ago. The Santa Cruz River generally follows the regional framework of downcutting and filling over the past 4,000 years. Two paleoarroyos of comparable width and depth to the modern arroyo and following a similar course were incised into the floodplain around 2,000 and 500 years ago" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 13).

[91] "Correlation of stratigraphy in various reaches [Tucson Basin] suggests that cienegas developed near the end of deposition of stratigraphic packages; in other words, groundwater rise follows alluviation, and groundwater drop follows arroyo downcutting" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 14).

[92] "The peak of Hohokam activity corresponded with periods of net aggradation and cienega development; for example, aggradation occurred during the Rillito and early Rincon phases between 850 and 1,150 years ago. The location of several village sites shifted during the middle Rincon phase (90-1,000 years ago) to the fans of newly formed discontinuous arroyos. As these paleoarroyos filled and cienegas developed during the Tanque Verde phase (700-850 years ago), the number of villages increased, particularly in the eastern sector of the floodplain, which remained unincised. The paleoarroyos that developed about 500 years ago may account for abrupt abandonment of the area. As this paloearroyo filled between 500 and 300 years ago, prehistoric farmers known as the Sobaipuri occupied the Tucson Basin" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 14).

"Between 1020 and 1160, two tributary arroyos on the western side of the valley were discontinuous and became shallower as they approached the floodplain of the Santa Cruz River. At the time that these arroyos were present, sand transported downwind from their channels accumulated to form low dunes that now outcrop near the historical source of the Spring Branch or Agua de la Misión" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 13).

[93] "The Santa Cruz River experienced a complex alluvial history culminating in a major cut-and-fill cycle between 500 and 300 years ago, with renewed downcutting historically." (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 166).

[94] "Short entrenched reaches existed six to twelve miles upstream of Tucson as early as 1849, suggesting that the Santa Cruz River was a discontinuous arroyo through the Tucson Basin. In most reaches, particularly near present-day downtown Tucson, the stream flowed at or near the valley surface over a broad floodplain. Perennial reaches were present upstream from present-day Continental, near San Xavier, at Tucson, and, less certainly, near the confluence of the Santa Cruz and Rillito Rivers" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 166).

[95] *Requiem for the Santa Cruz: An Environmental History of an Arizona River*, Web, Betancourt, et al., page 166

[96] *Ibid*.

[97] *Ibid*.

[98] "Woodcutting in the early 1900s resulted in the loss of the bosque's towering old-growth trees, some of them more than four feet in diameter and more than sixty-five feet high. By 1917, 2,500 cords of mesquite were being cut and removed annually, and a few years later, it was noted that "woodchoppers had been cutting down the larger trees all over it and making a network of cart roads all through it." Most of the mesquite had been cut to sustain Tucson's power needs. The forest resprouted from the stumps, creating a shorter-stature woodland still dependent on high groundwater levels" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 108).

"While the gigantic mesquites of the Tucson Basin were being destroyed during the late 1800s and early 1900s, a new plant was introduced into the Southwest. A group of shrubs—eight species of saltcedar (tamarisk)—was imported from eastern Europe and the southern Mediterranean area and planted as ornamentals, as windbreaks, and for stream-bank stabilization. Saltcedar soon escaped from cultivation and the erosion-control sites, and by the 1920s, at least 10,000 acres of riparian habitat in the southwestern United States consisted of various species of the genus. By 1970 this had increased to 1.3 million acres" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 177).

[99] *Requiem for the Santa Cruz: An Environmental History of an Arizona River*, Web, Betancourt, et al., page 167

[100] "The winter rains of 1914-1915 generated the largest flood to date on the Santa Cruz River, where 55,150 acre-feet of flow passed the Congress Street gaging station in December alone. A peak discharge of 15,000ft3/s occurred on 23 December" (*Requiem for the Santa Cruz*, Web, Betancourt, et al., page 86).

[101] *Requiem for the Santa Cruz: An Environmental History of an Arizona River*, Web, Betancourt, et al., page 167

[102] *Requiem for the Santa Cruz: An Environmental History of an Arizona River*, Web, Betancourt, et al., page 168

[103] *Ibid*.

[104] "By the 1940s, perennial flow had ceased in the Santa Cruz River, and the velvet mesquites that once were sixty to seventy feet tall and with diameters of four feet and more had been cut for fireweed and replaced by secondary growth and resprouting of mesquites that attained, at best, "a height of some twenty or twenty-five feet."" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 127).

[105] "its [The Great Mesquite Forest] destruction was documented by ornithologists who conducted research in the bosque in the 1950s and 1960s. Woodcutting and groundwater pumping had decimated the larger mesquites. These tenacious mesquites clung to life as the groundwater literally dropped away from their roots, and the bird populations remained only as long as there were habitat and food offered by the bosque. By the 1960s, the Great Mesquite Forest had been reduced to a fraction of its original size by agricultural fields" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 127).

[106] *Requiem for the Santa Cruz: An Environmental History of an Arizona River*, Web, Betancourt, et al., page 168.

[107] *Ibid*.

[108] "During the 1970s, construction of Interstate 19 bisected the remains of what had been the most celebrated mesquite bosque in the American Southwest" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 127).

"The ground water levels had dropped well below the rooting depths of riparian areas by 1967 and reached a depth of 80 feet. In the vicinity, large pumps were installed to irrigate adjacent fields around 1959-1960, as the last remnants of a cotton-willow forest began withering. By 1971, the construction of Interstate 19 had been completed, by which point damage to the Great Mesquite Forest had been done, and during the early 1970s, these biotic communities had gone past the tipping point beyond which, their recovery was impossible. Ornithologists R. Roy Johnson and Steven W. Carothers wrote an obituary for the Great Mesquite Forest in 1982 (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 128).

[109] "Communities not participating in the National Flood Insurance Program became ineligible for federal disaster relief. Federally insured lenders had to require borrowers to purchase flood insurance for loans secured by floodplain property. The Federal Emergency Management Agency (FEMA) was formed to administer the federal flood insurance programs and oversee floodplain insurance studies by each community" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 131).

[110] *Requiem for the Santa Cruz: An Environmental History of an Arizona River*, Web, Betancourt, et al., page 168.

[111] "The floodwaters reached the Gila River, with a peak discharge of around 2,000ft3/s arriving on 13 October, making the 1977 flood one of the few historic events to flow continuously from headwaters to terminus at Laveen" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 133).

[112] "In the mid-1980s, all that remained of the Great Mesquite Forest were stumps of what once had been large trees, which were replaced by xerophytic mesquite, desert shrubs, and, in some areas, nonnative Athel tamarisk" (*Requiem for the Santa Cruz: An Environmental History of an Arizona River*, page 172-174).

[113] *Requiem for the Santa Cruz: An Environmental History of an Arizona River*, Web, Betancourt, et al., page 168.

[114] *Requiem for the Santa Cruz: An Environmental History of an Arizona River*, Web, Betancourt, et al., page 168.

[115] *Requiem for the Santa Cruz: An Environmental History of an Arizona River*, Web, Betancourt, et al., page 168.

[116] *Ibid.*

[117] http://www.pbs.org/weta/thewest/people/s_z/serra.htm: "In 1767 the Spanish emperor's expulsion of the Jesuits from Spain's colonies led the government to ask the Franciscan Order to replace them as missionaries in Baja (lower) California. Serra was appointed head of these missions. The next year the Spanish governor decided to explore and found missions in Alta (upper) California, the area that is now the state of California. This project was intended both to Christianize the extensive Indian populations and to serve Spain's strategic interest by preventing Russian explorations and possible claims to North America's Pacific coast."

[118] http://www.pbs.org/weta/thewest/people/s_z/serra.htm: "Serra argued with the Spanish Army over the proper authority of the Franciscans in Alta California, which he thought should subsume that of military commanders. In 1773 he convinced the authorities in Mexico City to increase financial and military support for expansion of his missions, and to expand the authority of the Franciscans over both the army and the baptized mission Indians. He also urged Mexican officials to establish an overland route to Alta California, a suggestion which led to colonizing expeditions from New Mexico which established civilian settlements at San Francisco in 1776 and at Los Angeles in 1781."

[119] http://www.desertusa.com/desert-trails/anza-trail.html

[120] http://www.blm.gov/az/st/en/prog/blm_special_areas/hist_trails/anza.html

[121] *Ibid.*

[122] http://www.blm.gov/az/st/en/prog/blm_special_areas/hist_trails/anza.html: "The National Park Service (NPS) administers the trail, but works in partnership with federal, state, and local government agencies, as well as private landowners who manage or own lands along the trail route."

[123] The Loop Pathway System Map, July 2015 (www.pima.gov/TheLoop)

[124]http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/The%20Loop/2.LOOPeconomicbooklet2013PROOF13_20130329103152.pdf: "The Loop, a 131-mile shared-use path, began as an infrastructure project to protect the community from potential flooding during the torrential rains of the summer monsoon. During the past 40 years, Pima County invested over $70 million toward improvements along the Loop."

[125] *Ibid.*

[126] The Loop return on investment (cost-benefit analysis) has been calculated at approximately $940 million ($103 million 'Benefit to Government' and $837 million 'Benefit to Pima County Residents'); thus, every dollar spent on The Loop yields over nine dollars in economic benefits to Pima County residents.

The breakdown shows that 'Benefit to Government' includes $5.4 million in jobs created, $57.6 million in regional sales tax, $40 million in property tax revenue; and, 'Benefit to Pima County Residents' includes $72 million in outdoor recreation, $300 million in value to homes, $465 million in averted healthcare costs. Jobs created per $1 million spent on infrastructure projects include 11.4 'Bicycle Only Project' jobs, 10 'Pedestrian Only Project' jobs, 9.6 'Multi-use Project' jobs, and 7.8 'Road Project' jobs.

[127] http://www.arizonalawreview.org/pdf/51-1/51arizlrev211.pdf, page 211-213

In November 2006, Arizona voters approved Proposition 207: The Private Property Rights Protection Act. This state-level ballot initiative was part of a larger regulatory takings movement motivated largely in response to the U.S. Supreme Court's 2005 decision in Kelo v. City of New London. In that decision, the Court held that the use of eminent domain in furtherance of an economic development plan is a constitutionally valid "public purpose." Private property advocates viewed Kelo as an attack on private property rights via an expansion of the government's power of eminent domain. Though that case dealt exclusively with eminent domain--the right of the government to take private property in exchange for reasonable compensation and turn it over to public use--property rights advocates used public sentiment against the ruling to support laws requiring compensation for partial regulatory takings: the idea that property owners should also be compensated for any reduction in property value resulting from land use regulation.

Arizona's Prop 207 narrows the definition of what constitutes a public purpose for eminent domain actions, and requires state and local governments to compensate landowners whenever land use regulations diminish property values. As an alternative to paying compensation, the new law allows the governmental entity imposing a regulation to exempt a landowner from enforcement of the value-reducing regulation. The proposition also allows governments and landowners to come to agreements whereby a landowner agrees to waive the right to sue for compensation regarding a particular regulation. Finally, Prop 207 also includes exceptions for land use regulations concerning public health and safety, public nuisances, and other subjects.

For several reasons, scholars have criticized the more restrictive partial regulatory takings measures, such as Arizona's Prop 207, that call for compensation for any reduction in value. First, by requiring payments of compensation that most local governments simply cannot afford, these laws interfere with the ability of governments to regulate land use for the public good. Second, such laws tip the balance between private property and the public good in favor of private property to the public's detriment. Finally, partial regulatory takings laws take an oversimplified view of the relationship between property value and land use regulation. Public debate concerning the measures largely ignored these criticisms and instead focused on perceived abuses of government power.

[128] *Master Plan for Pima County Arizona Segment Juan Bautista de Anza National Historic Trail*, 2002, page 2-1

[129] http://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=65418: Historical Conditions Report, Chapter 1 - Introduction, page 1-2

[130] *Ibid.*, Project Overview

[131] http://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=65418

https://sonoraninstitute.org/files/pdf/living-river-charting-wetland-conditions-of-the-lower-santa-cruz-river-2013-water-year-09292014.pdf: A Living River: Charting Wetland Conditions of the Lower Santa Cruz River, 2013

[132] 431.1 El Corazon – Santa Cruz River: Rillito & CDO Confluence (Appendix)

[133] https://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=68818

[134] https://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=60292

https://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Flood%20Control/Projects/Paseo%20de%20las%20Iglesias%20Phase%201/phase1-masterplan.pdf

[135] http://dot.pima.gov/urbanloop/pdfs/Santa%20Cruz%20River%20Park%20Masterplan.pdf

[136] Goals established in the Santa Cruz Riverpark Master Plan Update:

- The overall goal of the Santa Cruz Riverpark is to return integrity to the Santa Cruz River. The Riverpark will have a profound impact on its immediate area, serving as prime recreational resource for nearby residents and workers. Amenities provided by the park will include attractions to serve and entertain the highway traveler and Tucson visitor.

- The Riverpark will respond to its historic roots, incorporating and emphasizing the role of the river in the historic continuum of Tucson's development.

- The Riverpark will be a visual attraction, preserving open space and providing green oasis areas. Physical and psychological comfort will be achieved through grassy fields, ponds with vegetated edges and an overhead green canopy. The park will serve as a model for wildlife habitat enhancement without tapping groundwater supplies.

- The Riverpark will be an identity element for Tucson, a park in the heart of the community, strongly tied to the Central Business District. It will have regional context due to its proximity to interstate highways. It will create an interconnected system of major nodes and destination points, which provide a diversity of recreation experiences. Most of all, it will offer a 13-mile linear park experience for the pedestrian, the bicyclist, and the horseback rider.

[137] https://www.tucsonaz.gov/parks/masterplan

[138] https://www.tucsonaz.gov/files/parks/masterplan/Tucson_Parks_and_Recreation_System_Master_Plan_10_5_16.PDF

[139] https://www.tucsonaz.gov/files/parks/masterplan/150714-COT_PR_MP_Info_Board_8.5x11.pdf:
Needs Assessment Prioritized Action Plan: (a) improvements to existing parks, etc.; (b) identification of additional parks and facilities; (c) connectivity improvements; (d) administration initiatives; (e) budget; (f) sustainability priorities; (g) O&M; (h) funding; (i) identify 'champions'; and (j) Five-year Action Plan.

[140] https://www.tucsonaz.gov/files/parks/masterplan/Tucson_Parks_and_Recreation_System_Master_Plan_10_5_16.PDF, page 69

[141] https://www.tucsonaz.gov/files/parks/masterplan/Tucson_Parks_and_Recreation_System_Master_Plan_10_5_16.PDF, page iv

[142] Fifty-five percent (ranked 3rd) of surveyed residents said they had used trails, greenways, walking and biking paths in the previous 12 months; 39 percent (ranked 2nd) said they use trails, greenways, walking and biking paths the most; 47 percent (ranked 1st) said walking and biking paths were the most important all parks and recreation amenities; 138,022 residents (ranked 1st) said they have a need for outdoor walking and biking path; and, 38,094 residents (ranked 2nd) said that only 50 percent of their outdoor walking and biking path needs are being met.

[143] Fifty-five percent (ranked 2nd) of surveyed residents said they had a need for ramadas, picnic areas, and shelters; 51 percent (ranked 4th) of residents said they had used ramadas, picnic areas, and shelters within the previous 12 months; 112,965 residents (ranked 3rd) said they have a need for ramadas, picnic areas, and shelters; and, 30,048 residents (ranked 6th) said that only 50 percent of their needs for ramadas, picnic areas, and shelters are being met.

[144] Twenty-four percent (ranked 10th) of surveyed residents said they had used natural resource parks/areas; 72,708 residents (ranked 8th) said they have a need for natural resource parks/areas; and, 25,520 residents (ranked 9th) said that only 50 percent of their natural resource parks/areas needs are being met.

[145] This 2016 Update and Strategic Plan is intended to act as an advisory document to guide growth of the green infrastructure network (open space, parks, and trails) within the Town of Marana over the next five years, until the next Master Plan Update (to be completed in 2020). Policy objectives on programs, special events, facilities maintenance and financing/ plan implementation are also included.

https://static1.squarespace.com/static/54cc191ce4b0f886f4762582/t/5821f84ee6f2e191dc6ec9e4/1478621284707/Marana_PRTOS_Strategic_Update_2016_LOWRES_WEB.pdf

[146] http://www.maranaaz.gov/yourparks

[147] Community survey, January – March 2016 (http://www.maranaaz.gov/yourparks)

[148] Town of Marana parks near the Santa Cruz River: Marana Heritage Farms, Gladden Farms, Frisbee, El Rio, Wade McLean, and Crossroads (*See Map below*).

[149] Town of Marana Parks in proximity of the Santa Cruz River: Amenities (*See Tables below*).

Maintenance Properties	Park Acreage	Parking Spaces	ADA Spaces	Trail/Path Miles	Tables	Benches	Ramadas/Pavilions			
							Small	Large	Group	Pavilion
Crossroads District Park	48.9	305	18	0.71	32	7	0	6	1	0
Disc Golf Course	40	0	0	0	0	0	0	0	0	0
El Rio Park	1.3	8	1	0.09	1	1	1	0	0	0
Gladden Farms Community Park	12.5	62	6	0.26	14	6	1	1	0	0
Heritage Park	163	8	1	0	0	0	2	0	0	1
Wade McLean Park	4.9	0	0	0	0	0	1	0	0	0
TOTAL	270.6	383	26	1.06	47	14	5	7	1	1

Maintenance Properties	Cans for Disposal		Grills	Water Fountains			Restrooms			Bike Racks
	Trash	Recycle		Wall	For dogs	No dogs	Toilets	Urinals	ADA	
Crossroads District Park	39	4	8	4	0	0	9	6	6	0
Disc Golf Course	0	0	0	0	0	0	0	0	0	0
El Rio Park	3	0	0	0	1	0	0	0	0	0
Gladden Farms Community Park	8	0	3	0	0	3	3	1	4	3
Heritage Park	0	0	0	0	0	0	3	1	2	0
Wade McLean Park	0	0	0	0	0	0	0	0	0	0
TOTAL	50	4	11	4	1	3	15	8	12	3

[150] http://www.sahuaritafarms.com/vision/: "A major component of FICO's vision is to enhance portions of the Santa Cruz River, which will allow for access to and beautification of the river, a route for the Anza Trail, more open space and recreational opportunities, improved flood control, public safety, and rehabilitation of some of the native habitat within the river corridor. The Sahuarita Farms Land/River Master Plan follows a number of adopted planning studies that have been conducted over the last 30 years."

[151]http://www.sahuaritafarms.com/wp-content/uploads/2011/05/Final-Sahuarita-Farms-Specific-Plan-October-2015.pdf: "The Specific Plan follows and complements previous and ongoing planning efforts conducted by the Town. The plans adopted by the Town include the 2002 Town of Sahuarita General Plan, the Town of Sahuarita Parks, Recreation, Trails and Open Space Master Plan, and the Sahuarita Town Center and Santa Cruz River Corridor Subarea Plan. These documents represent the vision and goals of the citizens of the Town for the future of the community and the river. The Specific Plan embraces, expands and enhances this vision."

[152]http://www.sahuaritafarms.com/wp-content/uploads/2012/11/APPENDIX-F-RIVER-MASTER-PLAN-10-2012-submittal.pdf: "The Santa Cruz River is the geographic heart of both the Town of Sahuarita and the FICO property. For many decades, the residents of this region have envisioned opportunities to transform the river corridor into a recreational and natural asset that benefits both existing and future generations. Previous planning studies by the Town of Sahuarita and Pima County reflect a comprehensive roadmap for a river-centered community. Growth pressures, exerted from current and future development projects adjacent to the FICO property, require thoughtful and farsighted long-range planning of land use, infrastructure and regional flood control. This River Master Plan (RMP) creates a long-term management strategy for the Santa Cruz River corridor that complements the Town's current land use and infrastructure plans."

[153]http://www.sahuaritafarms.com/wp-content/uploads/2014/05/Final_Adopted_Continental_Farms_Specific_Plan_March_2014.pdf: "FICO is embarking on the next phase of a long-term planning process for its land within both Pima County and the Town of Sahuarita. This planning process is consistent with, and a continuation of, previous planning studies that have been ongoing over the past 30-years [*sic*], beginning with the Sahuarita Farms and Continental Farms Community Plans adopted by the Pima County Board of Supervisors in the early 1980s, and revisited in the early 1990s. These plans identified the FICO property as a primary growth area within the region with a variety of residential and commercial land uses within and adjacent to the property. The planning efforts over the past 30-years also contemplated improvements to the Santa Cruz River corridor to address flood control, public safety, and regional recreational amenities for Town of Sahuarita and Pima County residents."

[154] http://www.sahuaritafarms.com/wp-content/uploads/2012/11/APPENDIX-F-RIVER-MASTER-PLAN-10-2012-submittal.pdf, Appendix D, page 48: "During the preparation of this RMP, preliminary evaluations of the biological and cultural resources within the project area have been completed. A Class I Archaeological Records Search and an Environmental Overview have been prepared."

[155] http://www.sahuaritafarms.com/wp-content/uploads/2012/11/APPENDIX-F-RIVER-MASTER-PLAN-10-2012-submittal.pdf, Appendix D, page 48: "The Santa Cruz River and its floodplain in the vicinity of the project area historically supported more riparian vegetation: mesquite bosques, dense sacaton (Sporobolus airoides), and likely scattered cottonwood (Populus fremontii) and possibly willow (Salix spp.). Beyond the historic and modern alteration of the surrounding landscape, changes in the morphology of the river and the depth of the ground water table within the valley have also altered the vegetation within the channel itself. Presently, only the margins of the constrained active floodplain possess at least some limited mature, woody vegetation characteristic of xeroriparian habitat.

"The majority of the project area is currently pecan groves, actively maintained and harvested by FICO. The pecan tree (Carya illinoinensis) is, by far, the most prominent plant species within the project area. Some relatively undisturbed lands on the fringes of the project area do possess more common, non-cultivar vegetation including foothill paloverde (Cercidium microphyllum), velvet mesquite (Prosopis velutina), creosote bush (Larrea tridentata), sotol (Dasylirion wheeleri), four-wing saltbush (Atriplex canescens), staghorn cholla (Opuntia versicolor), cane cholla (Opuntia spinosior), and Engelmann prickly pear (Opuntia engelmannii). Non-native disturbance species such as Russian thistle (Salsola spp.) and bermudagrass (Cynodon dactylon) were also observed."

[156] http://www.sahuaritafarms.com/wp-content/uploads/2012/11/APPENDIX-F-RIVER-MASTER-PLAN-10-2012-submittal.pdf , Appendix D, page 48: "Within the land and river master plan area there are: 1) 665 acres of Important Riparian Area, 2) 431 Acres of Biological Core Management Area, 3) 354 acres of Multiple Use Management Area, and 4) 2,322 acres of Agricultural In-holdings. The bulk of these CLS designations are for lands that will be managed in accordance with the RMP."

[157] http://www.sahuaritafarms.com/wp-content/uploads/2012/11/APPENDIX-F-RIVER-MASTER-PLAN-10-2012-submittal.pdf, Appendix D, page 48: "Cultural resources are protected by a variety of local, state, and federal regulation. For the majority of the Sahuarita Farms project area, including those actions to be governed by this RMP, the principal controlling regulation will be the National Historic Preservation Act (See Section 1.1). Considering the time frames that are likely involved with the development of the property and the features associated with implementation of the RMP, it may be most appropriate from a resource management and regulatory perspective to prepare a programmatic agreement that would include the Corps, SHPO, Pima County, Sahuarita, and interested Native American groups. This agreement would guide cultural resource compliance requirements through the life of the project."

[158] http://www.sahuaritafarms.com/wp-content/uploads/2012/11/APPENDIX-F-RIVER-MASTER-PLAN-10-2012-submittal.pdf, Appendix D, page 48: "A Class I Archaeological Records Search was completed by Desert Archaeology, Inc. (DAI) in February 2009."

"The search included records in the AZSITE cultural resources database at the Arizona State Museum (ASM) for all previously recorded archaeological sites and completed cultural resources investigations located both within and in a 1-mile radius around the APE.

"The records search identified 35 previously completed cultural resources investigations within the APE. An additional 99 were completed within the 1-mile buffer. The majority of the APE, and consequently the current Analysis Area, has not previously been surveyed for cultural resources. Additionally, most of the survey occurring within the APE was performed more than 10 years ago and by standard practice and agency policy may have to be redone.

"The Class I Archaeological Records Search identified a total of 27 previously recorded archaeological sites within the APE and an additional 185 sites within the 1-mile buffer. Sites within the APE represent a wide spectrum of ages, but with clusters dating to the Hohokam Sequence (A.D. 500 -1450) and the American Period (1856 to Present). Of the 27 sites in the APE, eight were considered eligible for inclusion on the National Register of Historic Places (NRHP) by the recording archaeologist, and 13 were not evaluated for NRHP eligibility. The State Historic Preservation Office (SFPO) has not made an official determination of eligibility for any of the sites within the APE."

[159] Pima Prospers Comprehensive Plan Initiative, Open Space Element.

[160] Pima Prospers Comprehensive Plan Initiative, Open Space Element, "Goal 4: Consider open space lands for geo-tourism or other economic considerations where appropriate; Policy 1: Identify appropriate opportunities and types of uses suitable for open space lands to support geo-tourism or other economic considerations where such do not conflict with cultural or natural resource conservation or open space management objectives."

[161] Pima Prospers Comprehensive Plan Initiative, Trails Element, "Goal 1: Continue to support the development of high quality, integrated and multi-use countywide trail system. Policy 8: Promote vehicular access to trail heads at public preserve boundaries based on a determination by the Natural Resources, Parks and Recreation Department. Policy 9: Dedicate public road rights-of way and associated parking and multi-use trail staging areas as a condition of rezoning or specific plan approval in those cases where road access to public land trailheads is deemed critical by the Natural Resources, Parks and Recreation Department."

[162] Pima Prospers Comprehensive Plan Initiative, Trails Element, "Goal 2: Integrate trail system, transportation modes, economic development and land use patterns with healthy community principles. Policy 1: Support and promote The Loop as a regional attraction promoting healthy lifestyles, economic development and connectivity to a variety of destinations. Policy 2: Support and promote our natural resource-based trail system (the trails in Pima Regional Trail System Master Plan, including the Arizona National Scenic Trail, the Juan Bautista de Anza National Historic Trail, and the CAP Trail) as a regional attraction promoting healthy lifestyles, economic development, and connectivity to a variety of destinations."

[163] Pima Prospers Comprehensive Plan Initiative, Parks and Recreation Element, "Goal 1: Support healthy lifestyles through the provision of parks and recreation. Policy 3: Continue to provide a diverse range of park types, functions, recreational opportunities to meet the physical and social needs of county residents. Policy 6: Continue to develop and maintain a comprehensive network of multi-use trails that enhance bicycle, equestrian and pedestrian connectivity throughout the region."

[164] Pima Prospers Comprehensive Plan Initiative, Tourism as an Economic Engine, "Goal 1: Revitalize the tourism industry. Policy 1(b): Create more natural attractions that serve as destinations. Policy 2(f): Take advantage of our geography, topography, and natural environment to develop Geo-Tourism opportunities. Policy 3(f): Support, maintain, and expand the Pima County regional trail system."

[165] http://www.pima.gov/administration/documents/pdfs/PC_ED_Action_Plan_2012-10-17.pdf, Pima County Economic Development Plan – 2012 to 2014, page 15: Making Cycling a Tourism Destination Event - "Pima County's sunny weather, ample bike paths, mountain biking opportunities and established cycling culture make the region one of the world's top cycling destinations. Area cycling recognitions include Tucson being listed as one of the top 10 best cycling towns by 10Best and USA Today. Fox News Travel lists Pima County's The Loop trail as America's third-best city bike path. USA Today named Tucson as one of the nation's top 10 mountain biking areas, and Outside magazine listed Tucson as the best road biking city.

"The County has already completed more than 100 miles of the Loop trail around metro Tucson."

[166] www.pima.gov/economicdevelopemntplan2015, Pima County Economic Development Plan, 2015 through 2017, chapter 6, page 3: "Utilizing the community program generated by the Tucson Advertising Federation, more than $300,000 of media value began to introduce the concept of geo-tourism and how can it benefit Pima County. Geo-tourism adds to sustainability principles by building upon a destination's character and its "sense of place" to emphasize the distinctiveness of its locale and benefits to visitors and residents, Pima County is located in one of the world's most diverse eco-regions."

[167] Tucson Audubon Society:

https://sites.google.com/site/sweetwaterwetlands/checklist
http://tucsonaudubon.org/go-birding/get-started-with-birding/great-places-to-bird/sweetwater-wetlands/

[168] Tucson Gem and Mineral Society (http://www.tgms.org/what-we-do)

[169] Tucson Gem and Mineral Show (http://www.tgms.org/show)

[170] http://www.azleg.state.az.us/ars/49/00201.htm: "Reclaimed Water" means water that has been treated or processed by a wastewater treatment plant or an on-site wastewater treatment facility.

[171]http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Wastewater%20Reclamation/Treatment/Effluent_gen_2014.pdf , page 5 "In 1989, the Arizona Supreme Court refused to characterize effluent as either surface water or groundwater, choosing instead to characterize it as "nothing more than sewerage effluent." This decision kept this part of the water supply from being regulated in the same manner as waters of the state. The court held that local governments do now "own" the effluent, but have the right to put it to a beneficial use."

[172]http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Wastewater%20Reclamation/Treatment/Effluent_gen_2015.pdf, page 26:

Entitlement Calculations	Effluent Total (AF)
Total Effluent	61,356.3
SAWRSA	28,200.0
Total Less SAWRSA*	33,156.3
Water Providers Share	0.9
Pima County Share	0.1
Entities Share 2015	
- Water Providers (90%)	29,840.6
- Pima County (10%)	3,315.6

[173]http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Wastewater%20Reclamation/Treatment/Effluent_gen_2015.pdf, page 3: "In 2015, the effluent allocation formula designated the fixed amount of 28,200 AF [acre feet] for the Bureau of Reclamation to manage under Southern Arizona Water Rights Settlement Act (SAWRSA). No effluent was used for the Conservation Effluent Pool. Of the remaining portion, 29,840 AF were accorded to the City of Tucson and other water providers, while Pima County retained 3,316 AF."

[174]http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Wastewater%20Reclamation/Treatment/Effluent_gen_2015.pdf, page 6: "Capacity at this facility [Tres Rios WRF] was increased in 2006 with the addition of a 12.5 MGD, Biological Nutrient Removal Activated Sludge process, thereby increasing the overall combined plant capacity of 37.5 MGD. Completion of RWRD's Regional Optimization Master Plan allowed an increase in capacity to 50 MGD. A new plant interconnect pipeline between Agua Nueva WRF and Tres Rios WRF allows additional sewage flow to be diverted to the Tres Rios Facility."

"The addition of the Bardenpho process achieves compliance with regulatory requirements to reduce total nitrogen concentrations to 8 mg/L or less."

"Effluent discharged into the Santa Cruz River flows into the Lower Santa Cruz Managed Recharge Project (LSCMRP) which extends along the river channel from Cortaro Road to Trico Road. Groundwater storage credits are issued from the Arizona Department of Water Resources (ADWR) for half of the effluent that reaches the water table. Credits are apportioned among participants in the LSCMRP in accordance with IGAs that recognize each party's entitlement."

[175]http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Wastewater%20Reclamation/Treatment/Effluent_gen_2015.pdf, page 7: "The effluent produced [in the Agua Nueva WRF] is currently classified as Class B+ reclaimed water utilizing chlorination for disinfection. After dechlorination, it also meets AZPDES permit standards for the Santa Cruz River, as well as numeric Aquifer Water Quality Standards (AWQS). An average of nearly 17 MGD [million gallons per day] of the total effluent produced was sent to the City of Tucson Reclaimed Water System in 2015. A small percentage of treated effluent is reused for irrigation onsite, at the adjacent Pima County laboratory, and to maintain wildlife ponds at the former Roger Road facility. The remaining portion of the effluent is discharged to the same outfall previously used by the Roger Rd WRF in the Santa Cruz River at an average rate of approximately 8 MGD."

[176][176]http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Wastewater%20Reclamation/Treatment/Effluent_gen_2015.pdf, page 23: "Reclaimed water [was] used for vegetation establishment in water harvesting basins adjacent to existing mesquite bosque along West Branch of Santa Cruz River. Previously (2005-2011) [effluent] provided drought relief for mature bosque vegetation."

PIMA COUNTY

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