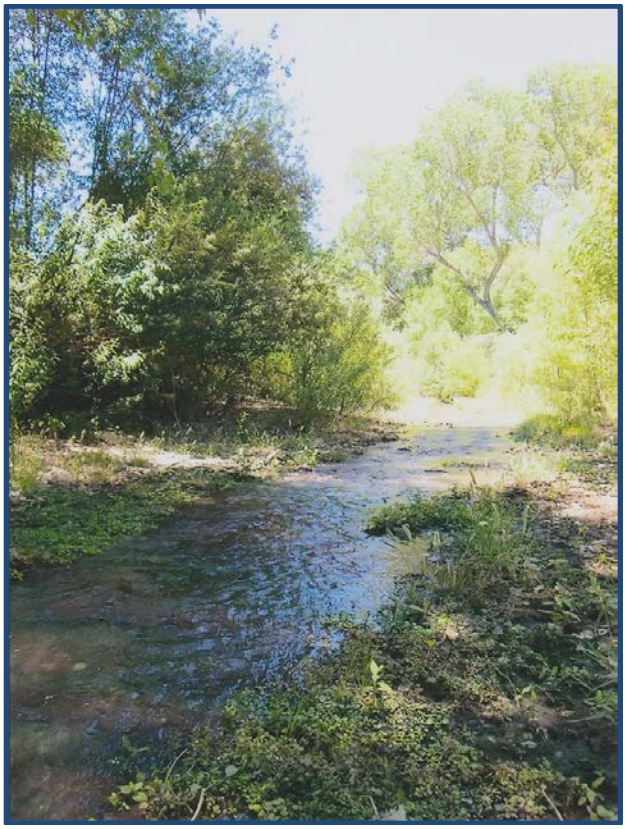
Sonoita Creek Watershed

Final

Sonoita Creek Watershed Management Plan

Phase 1

May 12, 2017



Prepared for:

The Town of Patagonia, Arizona

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Sonoita Creek Watershed Management Plan

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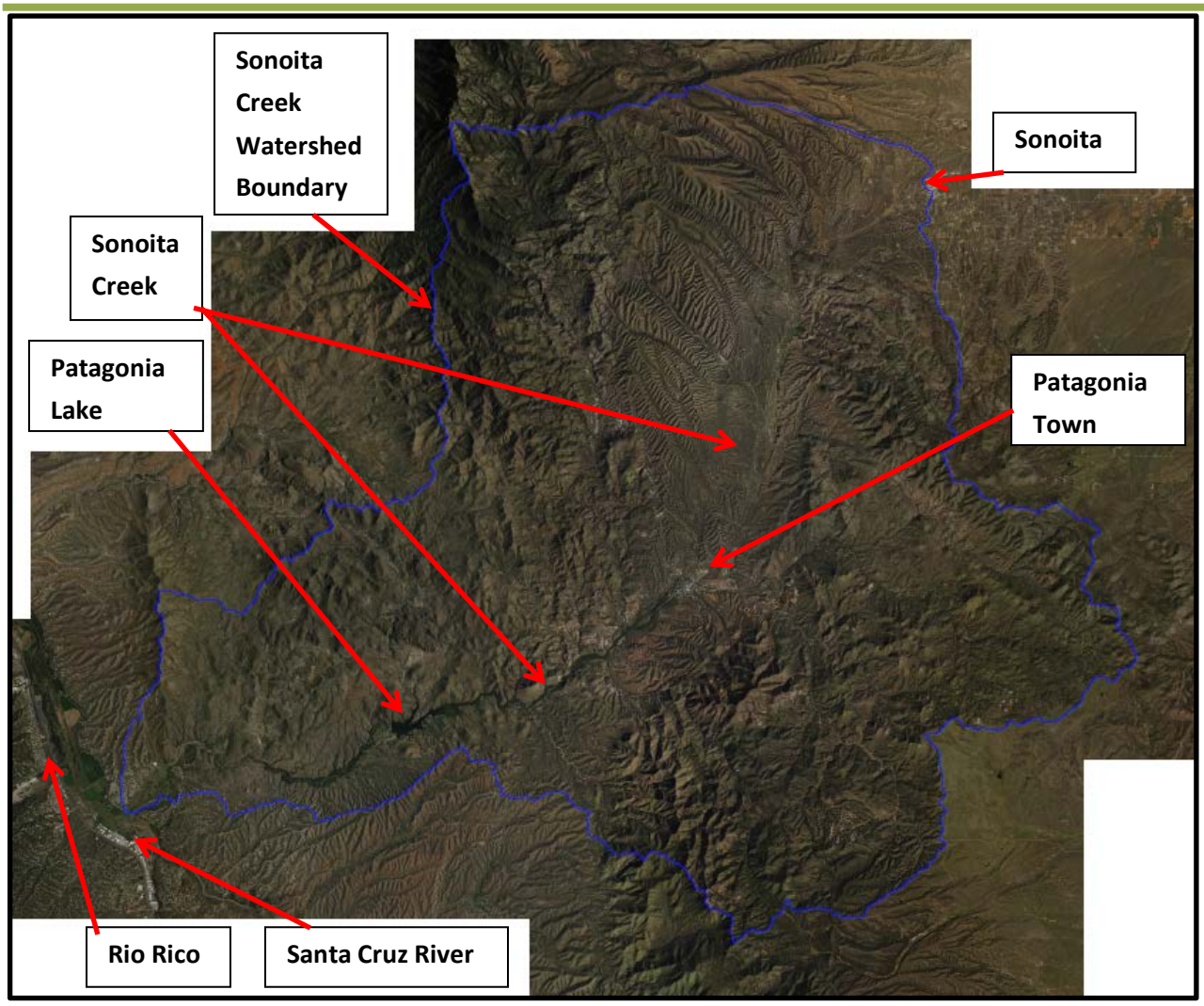


Sonoita Creek Watershed (Bing Aerial Imagery 2016)

1.1 Introduction

1.1.1 Watersheds and Watershed Management

Watersheds are basins that "catch" rain and snow and drain into a central waterbody. Every area of land is part of a watershed; as each person's location. Each watershed is separated from the next by ridges between mountain peaks. Watersheds come in all shapes and sizes, and usually contain smaller "subwatersheds."

The Patagonia and Santa Rita mountain ranges form the boundaries of the Sonoita Creek watershed; and all the watershed's tributaries ultimately drain to the Sonoita Creek and on to the Santa Cruz River near Rio Rico, Arizona. The origin of the name Sonoita is the local Indian name *Ṣon 'Oidag*, which may be best translated as "spring field".

There are complex interrelationships among the streams, aquifers, lakes, habitats, people and economies that make up a watershed system, such that changes or impacts to one part of a watershed can ripple through and affect other parts. Pollutants that enter the stream network can affect a variety of water resources. Modifications to stream channels upstream can cause changes downstream. The water available to each groundwater pumper can depend upon activity at neighboring wells. A structure erected to address a water supply concern can deprive the downstream riverbed of sand. The interrelationships go on and on.

The web of interconnected processes that permeate watersheds do not correspond to the fragmented patchwork of community, land and water regulatory jurisdictions. The recognition of these interrelationships is the essence of watershed-level planning. Collaborating across jurisdictional boundaries, sharing the wider watershed perspective, can increase the effectiveness and efficiency of managing water supplies, keeping water clean, managing flood flows, and maintaining habitat for sensitive species.

Sonoita Creek at Salero Road (Old Pueblo 2014)

There is no one agency responsible for watershed management planning. The watershed plans are sometimes initiated, lead and funded by citizens, sometimes by local governments, resource conservation districts, or watershed councils.

When the plan development process is inclusive of the broad base of stakeholders, watershed plans are a rare example of a planning effort that places considerable emphasis on what the stakeholders care about. Each watershed management plan offers a unique vision for a specific watershed that is rooted in the local community.

1.1.2 Plan Organization

This document is called the Phase 1 Watershed Management Plan (WMP), meaning that this is a start, Phase 1, and other Phases may develop with time. This document is meant to describe the current condition of the watershed, and the current plans for projects and programs that affect water and natural resources.

Part 1. About this Plan

Part 1 (herein) starts with this introductory plan overview chapter, followed by a description of the Watershed Stakeholders, and details the development process for this WMP.

Part 2. Plan Framework - Goals, Projects, and Programs

Part 2 contains the product of the Stakeholder's consensus:
Plan Framework – Goals describes the purpose and stakeholder goals that guided the development of the watershed plan. All the projects and programs are related to the stakeholder goals.
Existing and Proposed Projects, Programs, and Recent Accomplishments are listed and summarized
Priorities for implementation are discussed.

Part 3. Watershed Characterization

Part 3—the Watershed Characterization— summary of the watershed's physical features, followed by more detailed characterization sections which describe and illustrate the watershed's physical features, geology and climate, surface water and groundwater hydrology, flooding, water supplies and demands, water quality, habitat and species and related issues, opportunities for access to nature, and demographics and local regulations. Characterization sections contain topic history, relevant statistical data, and assessment of current conditions.

Part 4. References and Supporting Material

Part 4 provides a listing of the source documents used to develop this plan, and several appendices that provide data and information that expand on that provided in the body of the plan.

1.1.3 Acknowledgements

This Sonoita Creek Watershed Management Plan was produced over the course of months and represents the combined effort of numerous people and organizations. Many, many individuals contribute to the understanding and stewardship of the watershed. Many also contribute professional and volunteer effort to the sources of data and studies that were used to become parts of this plan.

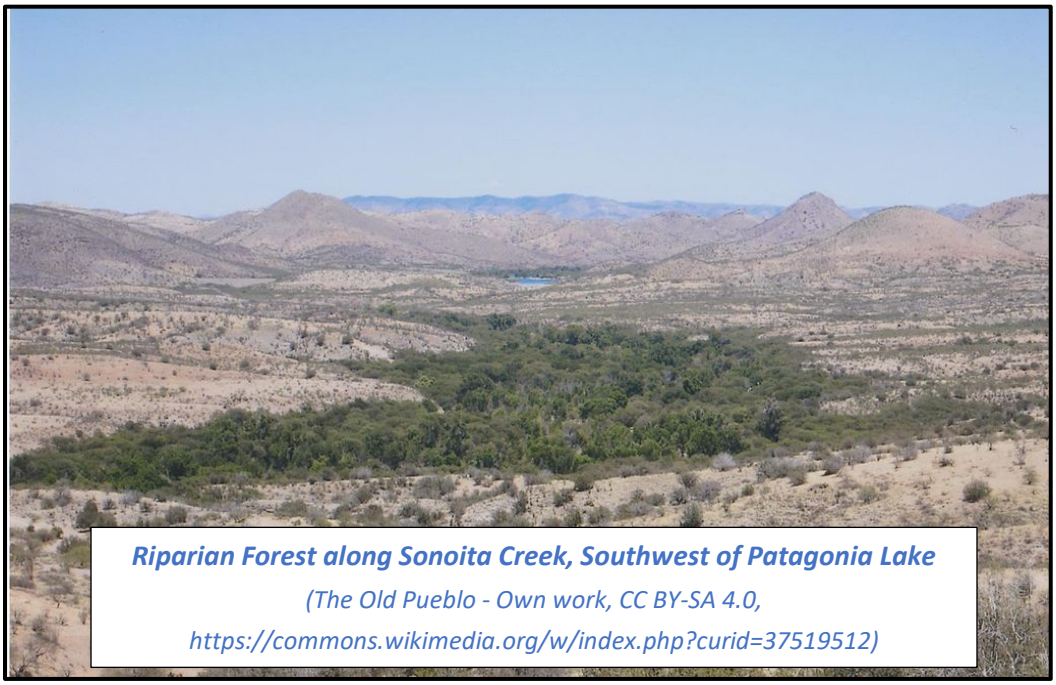
1.2 Watershed Stakeholders

The Watershed Stakeholders are an unofficial volunteer group for watershed planning in the Sonoita Creek watershed. It is not a regulatory entity. It is initially formed as a special independent group that schedules meetings with the Town of Patagonia through its Flood and Flow Committee organization. The first broad stakeholder gathering and presentation was held on March 9, 2017. The Town of Patagonia's Flood and Flow Committee commenced the process of drafting a watershed management plan and invited all stakeholders in the watershed to a gathering and presentation on March 9, 2017 at the Patagonia council chambers.

The stakeholders' meetings were formed to provide a framework for enhancing communication and collaboration among diverse stakeholders to better address the watershed's many complex and cross-jurisdictional issues.

1.2.1 Participants

The Watershed Stakeholders is an open group for those who live and work within the watershed boundary, with active participation by local, state, and federal government agencies, water and sanitation entities, environmental and educational nonprofits, agricultural organizations, community volunteer groups, as well as engineers, biologists, businesses, students, and other private citizens. The participants are listed and introduced in Section 1.2.3.



Riparian Forest along Sonoita Creek, Southwest of Patagonia Lake

(The Old Pueblo - Own work, CC BY-SA 4.0,
https://commons.wikimedia.org/w/index.php?curid=37519512)

1.2.2 Stakeholders Mission and Structure

A general mission statement and strategy is provided guidance for future phases of the WMP. This may be updated and refined by the stakeholders as the WMP progresses.

Mission

The mission of the Watershed Stakeholders is to facilitate and support efforts by individuals, agencies, and organizations to maintain and improve the health and sustainability of the Sonoita Creek Watershed for the benefit of the people and ecosystems that depend upon it.

Strategies

The stakeholders use the following and other strategies to accomplish their mission:

- Collaborate on the development of a comprehensive, integrated watershed management plan to guide priorities and implementation strategies.
- Facilitate communication between public, private, and nonprofit stakeholders.
- Provide a forum for collecting, sharing, and analyzing information about, and creatively responding to, watershed issues.
- Refine understanding—among stakeholders, decision-makers, and the public—of the watershed's conditions, processes, interrelationships, and challenges from a variety of perspectives, including scientific, cultural, economic, and regulatory.
- Identify opportunities for members to leverage resources and work together toward common goals.
- Promote the priorities and projects of the watershed management plan to local, state, and federal officials.
- Seek funding and other support to implement priority watershed management projects.
- Monitor the effectiveness of, and regularly update, the watershed management plan.
- Facilitate coordination of watershed education activities.

Governance

Currently this stakeholder's volunteer group is formed for providing information for the Watershed Management Plan and constructive criticism and feed back to guide its development. The stakeholders are a voluntary organization that has no powers or authorities other than those already possessed by its member agencies. The agencies, organizations, and interests represented are not obligated to adopt or carry out the recommendations of the WMP, but give due consideration to the recommendations and take actions they consider appropriate.

1.2.3 Local Entities and Designations

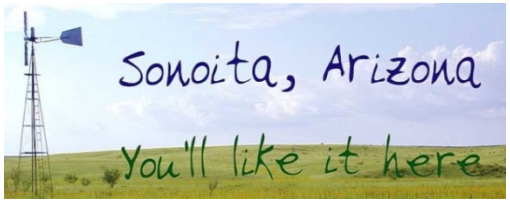
Patagonia Town Hall

Town of Patagonia
Address: 310 McKeown Ave. or P.O. Box 767
Patagonia, Arizona 85624, Phone: (520) 394-2229

The Town of Patagonia is located approximately 15 miles north of the United States-Mexico International Border in the southern part of Arizona. It lies near the center of Santa Cruz County, on State Highway 82, approximately 19 miles northeast of the City of

Nogales, Arizona. In 2006, the Town of Patagonia had a population of 926. Subdivision development has occurred south and east of the town corporate limits.

The Town of Patagonia is appropriately proud of its history and distinctive character. The community is quirky and likes it that way. Visitors tell that Patagonia's unique spirit is easily perceived and is their reason to stay or to return. Situated at over 4,000 feet elevation between the Santa Rita Mountains and the Patagonia Mountains in the riparian corridor of Sonoita Creek, Patagonia is spectacularly rich in both natural and human assets. The distinguishing vision of the community is to protect and build sustainably upon these assets and town character.



Sonoita is a census-designated place (CDP) in Santa Cruz County, Arizona. The population is 818 (2010). Sonoita is located at the crossroads of US Highways 82 and 83, surrounded by rolling, grass-covered hills and wonderful blue skies and wide-open spaces. Sonoita lies in a wide valley surrounded by mountains. Oak and pine forests are found in the higher elevations. The arroyos found across the cienega (wetlands) may have occasional flash floods during the monsoon season. **Local information about Sonoita can be obtained at: http://sonoitaaz.com/index.html**

Santa Cruz County

2150 N. Congress Drive, Nogales, AZ 85621, 520-375-7800
Public Works: 275 Rio Rico Drive, Rio Rico, AZ 85648, 520-375-7830

Santa Cruz County is located the southernmost central part of Arizona, bordering Mexico and serving as the gateway to one of North America's important port of entry, Nogales, Sonora, Mexico. While one of the state's smallest counties, Santa Cruz County is also one of Arizona's most diverse and interesting destinations, offering an eclectic blend of history, culture, art, recreation, shopping, cuisine and entertainment in a beautiful and relaxing setting. From the artist colony of Tubac, to the historic national monuments at Tumacacori, to the twin border towns of Nogales, Arizona and Mexico, to the mountain and birding town of Patagonia, and on to Arizona's wine country in Sonoita and Elgin. The history of the region dates to the cultures of the Apache, Yaqui and Hohokam peoples who built their communities along the Santa Cruz River, Sonoita Creek and Harshaw Creek, whose waters flowed year-round and provided ideal sites for agriculture and ranching.

Circle Z Ranch
Patagonia, Arizona

At **Circle Z Ranch** guests come to enjoy the traditions and beauty of their historic property. They create unique, all-inclusive dude ranch vacations for guests of all ages and horseback riding abilities. Nestled in the heart of Southern Arizona's Sky Islands, they have thousands of acres of the most scenic horseback riding trails in Arizona. Guided by expert wranglers, guests will experience unspoiled landscapes rich in scenery; grasslands, canyons, and mountain ranges rising suddenly and

dramatically out of the desert lowlands. Distinct to the ranch property is the protected and ever-flowing Sonoita Creek, creating a lush riparian oasis.

Town of Patagonia Flood and Flow Committee The watershed is a vital component of this community's well-being. The Flood and Flow Committee make recommendations to the Patagonia Town Council with respect to best practices within its jurisdiction to manage erosion, to enhance water flow, to create optimal flood mitigation and to promote the long-term health of the riparian corridor, look at the entire watershed area to influence upstream conditions and to optimize downstream consequences, and educate the public.

The **Arizona Game and Fish Department** establishes policy for the management, preservation, and harvest of wildlife in Arizona. They makes rules and regulations for managing, conserving, and protecting wildlife and fisheries resources, and safe regulated watercraft and off-highway vehicle operations for the benefit of the citizens of Arizona.

The **Patagonia Area Resource Alliance (PARA)** is a grassroots, non-profit community alliance committed to preserving and protecting the Patagonia, Arizona area. They are a citizen watchdog organization that monitors the activities of mining and development companies, as well as ensures government agencies' due diligence, to make sure their actions have long-term, sustainable benefits to public lands, water, and the town of Patagonia. PARA recognizes that the health and economic prosperity of the community are tied deeply to the well-being of the Patagonia Mountains and the watershed - the source of drinking water, clean air and the biological wealth that drives our local economy.

Patagonia Area Resource Alliance

Hudbay is committed to producing strong investor returns and creating better futures for communities and employees by finding, building, and operating successful mines.

Borderlands Restoration Leadership Institute The mission is to foster ecological and cultural place-based learning and leadership which cultivates a restoration economy in the US-Mexico borderlands. As a world-class restoration training institute, we provide project and program offerings, first-rate education, research facilities, work experience opportunities and project management training in the field of ecological, cultural, and economic restoration.

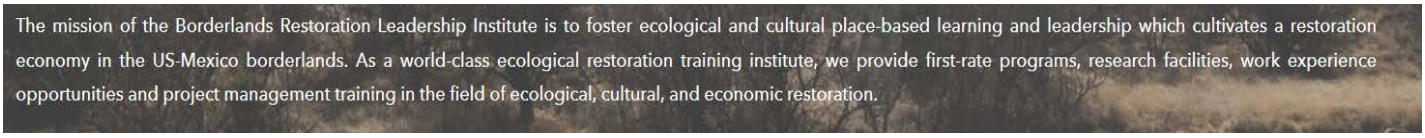
Deep Dirt Farm Institute (DDFI) makes a significant contribution as a learning center that cultivates understanding about, and knowledge of, local food production. Kate Tirion, Founder and Director of the Deep Dirt Farm Institute was raised on an Amish-style farming (pre-industrial) world in West Wales, where every day was an opportunity to learn.

Friends of Sonoita Creek is an educational non-profit organization dedicated to the protection of southern Arizona's Sonoita Creek and its watershed.

The Nature Conservancy's Patagonia-Sonoita Creek Preserve (TNC-PSCP) protects Earth's natural resources and beauty. It is renowned for its outstanding scenic beauty and the diversity of its plant and animal life. It is the site for native plant research, materials collection, and restoration.

The mission of **Borderlands Restoration** is to reconnect wildlife, land, and people in Arizona/Sonora Borderland region by involving people in restoring the ecosystem on which we depend.

Borderlands Restoration Leadership Institute (BRLI)



The BRLI has initial projects that include a multi-year watershed effort to understand the issues facing the water security of the town and offer solutions to issues that are identified**.**

Tucson Audubon Society inspires people to enjoy and protect birds through restoration and the environment upon which we all depend. We work for a future in which the people of southeast Arizona are connected to their natural world through birds, and they protect and use our natural resources in a responsible and sustainable manner.

The Paton Center, managed by the Tucson Audubon Society, is a place to explore and experience the special birds of southeast Arizona. It is dedicated to the celebration and conservation of hummingbirds—*and all of southeast Arizona's astounding biodiversity*—through recreation, education, and sustainable living. 213 bird species have been reported for this cozy home lot on the outskirts of Patagonia.

Biophilia Foundation supports the efforts of protecting, restoring, enhancing, and preserving wildlife habitat for all species of native plants and animals. Biophilia funded native plant propagation efforts. It is instrumental in supporting early baseline work on pollinator/plant/climate interactions and earthworks on three sites in Patagonia.

Sky Islands Tourism Association's mission is to grow regional tourism in the Elgin, Sonoita, and Patagonia, Arizona region.

US Geological Survey is a governmental science organization that provides impartial information on the health of our ecosystem, the natural hazards that threaten natural resources. It provides a science system that provide timely, and useable information that researches the ground water recharge, sediment detention, soil moisture, and vegetation change. Using advance technologies, USGS is pushing the boundaries of knowledge for hydrological restoration techniques in the arid Southwest.

US Forest Service's mission is captured by the phrase, "Caring for the Land and Serving People." The mission is set forth by law, in which is to achieve quality land management under the sustainable multiple-use management concept to meet the diverse needs of people. Coronado National Forest contains land that within the Sonoita Creek watershed.

Arizona Mining Inc. (an Augusta Group Company) is a Canadian mineral exploration and development company focused on the exploration and development of its projects located in Santa Cruz County, Arizona.

Patagonia Lake State Park Tucked away in the rolling hills of southeastern Arizona is a hidden treasure. Patagonia Lake State Park was established in 1975 as a state park and is an ideal place to find whitetail deer, roaming the hills and great blue herons, walking the shoreline. The park offers a campground, beach, picnic area with ramadas, tables, and grills; along with a creek trail, boat ramps, and a Marina. The nearby Lakeside Market offers boat rentals and supplies. The campground overlooks the lake where anglers catch crappie, bass, bluegill, catfish, and trout. The park is popular for water skiing, fishing, camping, picnicking, and hiking. And the tracks of the New Mexico/Arizona railroad lie beneath the lake and remnants of the old historic line, may be found at the Nature Conservancy in Patagonia. Hikers can stroll along the creek trail and see birds such as the canyon towhee, Inca dove, vermilion flycatcher, black vulture, and several species of hummingbirds.

The communities of **Sonoita and Elgin** were established in 1882 along the newly developed Santa Fe railroad running the length of Sonoita Creek and extending between the towns of Benson and Nogales. The area was first settled almost a half century earlier due to the vast cattle ranching and mining potential. The Sonoita/Elgin communities were preceded by the establishment of Fort Buchanan and Fort Crittenden. These

short-lived forts were founded to protect settlers in the newly occupied region, but were soon abandoned: Fort Buchanan in 1861 due to the outbreak of the civil war and Fort Crittenden in 1873, near the close of the Apache Wars.

The Santa Fe Ranch Foundation is dedicated to the conservation and preservation of the land and its non-renewable resources; to agriculture and its role in our daily lives; and to science, social studies, physical and health education.

Patagonia Public Schools is a caring community; nurturing and empowering both academic and individual excellence. The schools serve rural eastern Santa Cruz County and the communities or Patagonia, Sonoita, and Elgin. Go Lobos.

Native Seeds/SEARCH seeks to find, protect, and preserve the seeds of the people of the Greater Southwest so that these arid adapted crops may benefit all peoples and nourish a changing world.

The mission of the **Resource Conservation District of Santa Cruz County** is to help people protect, conserve, and restore natural resources through information, education, and technical assistance programs.

On February 24, 1863, by an Act of Congress, the Territory of Arizona was established. The Congressional Act reserved Sections 16 and 36 of each township for the benefit of the common schools. The State Enabling Act, passed June 20, 1910, allowed the Territory of Arizona to prepare for statehood. In addition to the previously designated Sections 16 and 36, the Enabling Act assigned Section 2 and 32 of each township to be held in Trust for the common schools. The need of other public institutions was also considered by Congress, and through the Enabling Act, more than 2 million additional acres were allocated to be held in Trust for the benefit of the identified public restrictions.

The goal of **High Spirits Flutes** is to provide everything needed to make the learning experience fun and enjoyable.

The Arizona Trail Association mission is to protect, maintain, enhance, promote, and sustain the Arizona Trail as a unique encounter with the land.

Nestled in the oak-studded foothills of the Santa Rita Mountains, **Casas Arroyo** has been home since 1972, to individuals who value the unique natural setting and share the common values of preserving the landscape and living in harmony with neighbor and nature.

1.2.4 Watershed Management Plan Funding

Since 2015, the beginnings of a Watershed Management Plan have been stewarded by volunteers representing various organizations (non-profits, civic, governmental, private) currently working in the community on watershed issues. In addition, the members include representatives from various segments of the community such as ranching, construction, business, etc. The Town of Patagonia received an anonymous donation to fund Phase 1 of the Watershed Management Plan.

1.3 The Planning Process

The Watershed stakeholder's process for developing the WMP was, by design, very broad, inclusive, and transparent. One of the most important outcomes of the watershed planning effort is the sharing of information with and among stakeholders.

The stakeholders have started with rough ideas of what a WMP is and could do, and agreed to a Phase 1 WMP (this document). The WMP will evolve as stakeholder input is received, as the stakeholders grow in understanding their watershed, and as the specific projects and programs takes shape. Once the Phase 1 WMP is finalized, it can be used directly for planning or project development.

1.3.1 Stakeholder Goals

The writing of the watershed management plan began with summarizing stakeholder goals and objectives that would guide the development and implementation of the plan. Surveys were

distributed to the stakeholders from February through March of 2017. Over 20 responses were obtained. These are described in Part 2 of this WMP.

1.3.2 Implementation Strategy

Perhaps the most challenging part of developing the watershed management plan was crafting an approach for a loose group of separate organizations—which all report to their own boards/members and are governed by their own budgets/priorities—to agree to some level of collective action and implementation.

Initially, the stakeholders may try to develop a "Short-Term Action Plan" strategy that would prioritize projects and programs that might realistically be completed or worked on within a three-year time frame. This approach will be used for the Phase 1 WMP. A longer-term strategy, focused around "campaigns" *or a similar title*, could be crafted instead of focusing on separate individual priority projects or programs. The campaigns widen the perspective and can be focused on priority regional issues that may have more funding options.

Future steps in this WMP process after the Phase 1 WMP is completed may involve:

- **Stakeholder Meetings.** The stakeholders may publicize and hold several topic-focused meetings to attract a wider variety of potential stakeholders. Meetings can include specific project planning or a focus area for the next phases of the WMP.
- **Project Lists and Recommendations:** The stakeholders may use the WMP Phase 1 to seek funding and local support for water and natural resources projects. Material from the WMP can be freely used in grant applications.

Sonoita Creek Watershed Management Plan

PART 2 Plan Framework - Goals, Projects and Programs

2.1 Plan Framework - Goals 1

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2.1 Plan Framework - Goals

The Watershed Management Plan (WMP) begins with the goals of the stakeholders. Goals are the answer to the question, "What do we want this watershed to be like for us and the next generation?". This framework of goals holds all the projects and programs that are to fulfill these goals. The goals and associated projects with the highest degree of consensus will rise to the top priority for implementation. These have the best chance for funding where community support is considered. The goals:

- serve as a reference or touchstone to guide future projects and programs,
- imply a wide perspective and a long view, and
- address a primary watershed threat or need.

The stakeholders were surveyed and asked about the goals they have for the watershed. Over 40 goals were received. These goals were then condensed and summarized and are presented below.

1. Sustainable Local Water Supplies: to reliably support ecosystem and human water supply needs through wise water management and maintained infrastructure. Infrastructure includes recharge areas, wells, pipelines, storage tanks, plumbing, and water conservation fixtures. This goal includes water use efficiency and water conservation education.

2. Clean Water: Have water of sufficient quality to safeguard public and ecosystem health and to meet regulatory requirements. This includes water treatment and waste water treatment infrastructure able to meet these goals.

3. Integrated Flood Management: to reduce flood risk and insurance costs, restore natural Creek processes and ecosystems, increase water infiltration and storage, and deal with erosion and sediment concerns.

4. Healthy Ecosystems: To conserve aquatic and terrestrial ecosystem structures, functions, and processes that support a diversity of world famous native habitats, and threatened, endangered, and sensitive species (over 100 species). Maintain perennial flow reaches and riparian forest area.

5. Access to Nature: To have ample and appropriate opportunities for the public and researchers to enjoy natural areas and open spaces, and to provide educational site visit opportunities (including recreation and water conservation).

6. Responsible Land and Resource Management: that supports economic use of the land, considers ranching, mining, residential, commercial, and is compatible with healthy ecosystem goals and with environmental mitigated impacts of land use (includes traffic).

7. **Coordinated Watershed Planning:** Stakeholder coordination that objectively represents all interests in the watershed; collaborates on developing an integrated watershed management plan and projects, and maximizes funding opportunities

Patagonia Lake, Arizona

2.2 Projects and Programs

A number of projects and programs that improve or affect the watershed are underway, and others are in the creative thinking or design stage. These project and program lists are not exhaustive and were developed from conversations at public meetings and from the stakeholder surveys. There are a number of agencies, entities, and community organizations involved in these projects and programs. They are listed and described in the Stakeholders list in Part 1, Section 1.2.3.

2.2.1 Existing Projects

- **Upper Watershed Gabions** – DDFI with BRLI –testing land use management options and installing rock gabions in upper watershed. Purpose is to slow down the runoff, allow increased infiltration and improve habitat formation. USGS (Laura Norman) research on the impacts of the gabions on hydrology, groundwater recharge, and sediment.
- **In-stream Monitoring** - US Forest Service (CNF) – setting gauges in 2 places in Harshaw Creek to monitor stream flows and flood evnts.
- **Stream flow monitoring and Groundwater Monitoring** (The Nature Conservancy)
- **Mining**: Exploratory drilling and geophysics being done near Red Mountain.
- **Maintenance of Sonoita Creek channel** – gravel excavation as needed to maintain clearance at Hwy 82 Bridge.

2.2.2 Existing Programs

- **Groundwater Investigations** USGS Groundwater investigations for much of the watershed
    - **Santa Cruz Area Management Area** (only lower portion of watershed from Patagonia Lake to Rio Rico). Continued studies and water management to sustain safe yield of Santa Cruz River. Misc. data collection
- **Patagonia Town Drought Planning** Review of groundwater pumping and thresholds for water supply cutbacks (in process with the Town Council)
- **Ranching** –
    - Land use and permaculture with DDFI and BRLI
    - NRCS grants, U of A Extension
    - Johnson Grass Abeyance and Sacaton re-introduction (The Nature Conservancy)
- **General Watershed Education** – there are many ongoing education programs that involve aspects of Watershed Management: Town of Patagonia Flood and Flow Committee, BRLI, Friends of Sonoita Creek, and the Town Council meetings
- **Research** – BRLI with DDFI, the USGS, and University of Arizona have research projects. The BRLI program includes workshops and courses, Earth Care Youth internships, Field School for Ecological Restoration and applied Restoration Economy Internships and Fellowships. http://www.borderlandsinstitute.org/the-institute.html
- **Water Quality Education** – ADWR monitoring and reporting, including TMDLs, USGS monitoring and studies, PARA water quality reporting
- **Rapid Stream Riparian Assessments RSRA** (Friends of SC)
- **Water Well Monitoring** (Friends of SC, Borderlands) To improve knowledge of groundwater supplies and reduce potential for contamination at well head.
- **Fencing Survey** (Friends of SC, Az Game and Fish, Az State Parks) with goal for maintaining fences for livestock range control and to keep livestock out of the creeks.

2.2.3 Proposed Projects

Public Projects

- **New Stream gage at Hwy 82 Bridge –** this is needed for bridge maintenance and potential flood mitigation projects.
- **Reinstate a stream gage near Circle Z Ranch –** To obtain basic flow and peak flow data, can be new technology at the old Circle Z site. County Flood Control, USGS, or ADWR may be partner. A goal is to create a long-term composite record for water budgets and designs.
- **Reduce flood risk (other than recharge/detention basin) -** look at flood management options, earthwork, erosion protection, berms, raising and floodproofing buildings. Expand the DDFI with BRLI land use management options and installing rock gabions in upper watershed to slow down the runoff, allow increased infiltration and improve habitat formation. Continue and expand USGS (Laura Norman) research on the impacts of the gabions on hydrology, groundwater recharge, and sediment.
- **Stop head cutting near inlet to Lake Patagonia -** the head cutting erosion of Sonoita Creek Channel is working it way upstream toward the TNC land near Patagonia. This is decreasing the pristine riparian habitat and bringing more sediment into the lake. Friends of Sonoita Creek are the proponents for this project.
- **Multipurpose recharge/detention basin** at confluence of Harshaw and Sonoita Creeks for flood peak mitigation, groundwater recharge, habitat enhancement, recreation/education.
- **Rehabilitate Patagonia Sewer system** to mitigate leaks and improve water quality released (on-going)
- **Upgrade Patagonia water supply system** to reduce leaks, get lines into public Right of Way, and reduce dead ends (on-going)

Public /Private Projects

Some projects will need an active link between private and public entities to succeed.

- **Water Quality Assessment and Mitigation** – comprehensive summary of water quality monitoring results from many independent programs, pollution treatment and mitigation strategies for current and legacy pollutants. Proponents will likely include mines, Santa Cruz County Az, PARA, and the Town of Patagonia.

Private Projects

- **AMI Mine Development with Required Mitigations** – A May 1, 2017 press release discusses the potential for zinc-lead-silver mine at one deposit and silver at another on land owned by the mining company. (https://www.arizonamining.com/news/details/index.php?content_id=412). The magnitude of the project and impacts on the watershed goals requires stakeholders' consideration.

Private projects can include land management, restoration of old mine sites, resources use and infrastructure development. If project proponents want public support, their projects should be

included in the WMP. The WMP lists of projects or programs are voluntary for project proponents. However, the WMP will include the collection of available public information.

Private projects have their own public review and permitting process. These may include study of water budgets, water quality, aesthetics, vegetation, fate and transport of contaminants, traffic concerns, etc.

2.2.4 Proposed Programs

- Development of BRLI educational programs, accreditation
- Rationalize Monitoring Network – this requires coordination with many entities that do some water resource monitoring, but a little coordination can give a comprehensive monitoring plan without duplication of effort and funds.
- Water conservation incentive programs – low flow toilets and other fixtures, fixing leaks
- Conservation land use education – BRLI, DDFI, NRCS
- Ranches Land Management – private ranches work with NRCS to form partnerships to complete protection from erosion, soil or water conservation, or vegetation projects. The NRCS works confidentially with land owners.
- Promote Patagonia Bird Watching internationally – from education about Hummingbirds to international bird watching must see sites. The Paton Center, TAS and TNC are already actively involved with promoting this. This has an economic tourist impact on the area.

2.3 Priorities for Implementation

One of the most helpful aspects of a watershed management plan is have a list of screened projects and programs to help stakeholders prioritize what is implemented. Projects are specific actions or construction. Programs for the WMP are educational, financial, or imply the coordination of multiple related projects. This listing gives guidance to decision makers and project proponents. Priorities may be determined by cost, number of benefits, funding opportunities, or a number of other methods.

Table 2.1 shows which goals are impacted by each project, and which projects achieve or impact multiple goals. Some projects will require mitigation measures, and the net impact of the project, with mitigation, should advance one or more watershed goals. These projects do not have available cost/benefit data or other data for weighting their priority. As noted on the table, there are reasons that a project may get the go ahead for other than how many goals it achieves. Some health or data collection projects may only benefit a few goals. This is a working table, where other projects can be added and the relative numbers of watershed goals met is discussed. These projects may be also weighed by other criteria requested by the stakeholders.

A table of programs, **Table 2-2**, shows programs in the Sonoita Creek Watershed with the number of watershed goals accomplished. This also is a working table for discussion and to aid in consideration of comprehensive programs.

Table 2.1 Comparison of Proposed Projects and Watershed Goals Impacted

05/12/17

Proposed Project	Funding	Project Proponent	Goals for Watershed Impacted							# Goals Impacted	Action stage	Notes - Reason for Project
			Water Supply	Clean Water	Integrated Flood Management	Healthy Ecosystems	Access to Nature	Responsible Land and Resource Mgmnt	Coordinated Watershed Planning'			
Stream Gaging Station - at Hwy 82	USGS, County, ADWR (AWP)	Patagonia	X		X			X	X	**4**	Seek Funding	Need basic data
Stream Gaging Station - at old site at Circle Z Ranch	USGS, County, ADWR (AWP)	Circle Z, County	X		X			X	X	**4**	Seek Funding	Need basic data
Reduce Flood Risk (sub-watershed projects, gabion or rock pools, not large recharge/detention basin)	ADWR, FEMA	Patagonia, County, FEMA, BRLI, DDFI	X		X	X	X	X	X	**6**	Seek Funding	Affects Most Goals
Stop Headcutting at Inlet to Lake Patagonia	ADWR, TNC,	Friends of Sonoita Creek			X	X		X	X	**4**	Seek Funding	Channel erosion
Multi-purpose large recharge, detention basin	ADWR, FEMA	Patagonia, County, FEMA, TNC + habitat and education interests	X		X	X	X	X	X	**6**	Seek Funding	Affects Most Goals
Rehabilitate Patagonia Sewer system	Patagonia, ADEQ	Patagonia		X		X			X	**3**	Getting bids	Health
Upgrade Patagonia water supply system	Patagonia, ADEQ	Patagonia	X	X					X	**3**	Getting bids	Health
Water Quality Assessment	ADEQ, Private	Mines, PARA, Patagonia	X	X	X	X		X	X	**6**	Seek Funding	Affects Most Goals
AMI Mine Development with Required Mitigations	Private	AMI	X	X	X	X		X	X	**6**	Geo Investigations	Affects Most Goals, Magnitude of impacts

Table 2.2 Comparison of Proposed Programs and Watershed Goals Impacted

05/12/17

Proposed Program	Funding	Program Proponent	Goals for Watershed Impacted							# Goals Impacted	Action stage	Notes - Reason for Project
			Water Supply	Clean Water	Integrated Flood Management	Healthy Ecosystems	Access to Nature	Responsible Land and Resource Mgmnt	Coordinated Watershed Planning'			
Develop Borderlands Institute Training	ADWR, USGS, University, Private	BRLI, DDFI	X	X	X	X	X	X	X	7	Planning	Affects all goals
Rationalize Monitoring Network - rain gauges, stream gauges, water quality of surface and groundwater, and well water levels.	USGS, USFS, National Park Service, USBR, Bat Conservation Int., Cuenca Los Ojos, BRLI, Sky Island Alliance	Sky Islands Watershed Assessment and Resource Restoration Partnership	X	X	X	X		X	X	6	Planning	Check quantity and quality of water resources
Water conservation incentives	ADWR	Patagonia	X						X	2	TBD	Costs of water system
Conservation land use	US Forest Service, USDA	BRLI, DDFI	X	X	X	X			X	5	TBD	Affects Most Goals
Ranches - Land Management (if public support is needed)	Private, NRCS	Private		X		X		X	X	4	TBD	Depends what Public Support is needed
Promoting Bird Watching Education		TNC, BRLI, Paton Center, Friends of Sonoita Creek				X	X		X	3	Planning	Economic boost to area

Sonoita Creek Watershed Management Plan

PART 3 Watershed Characterization

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3.1 Overview and Quick Facts

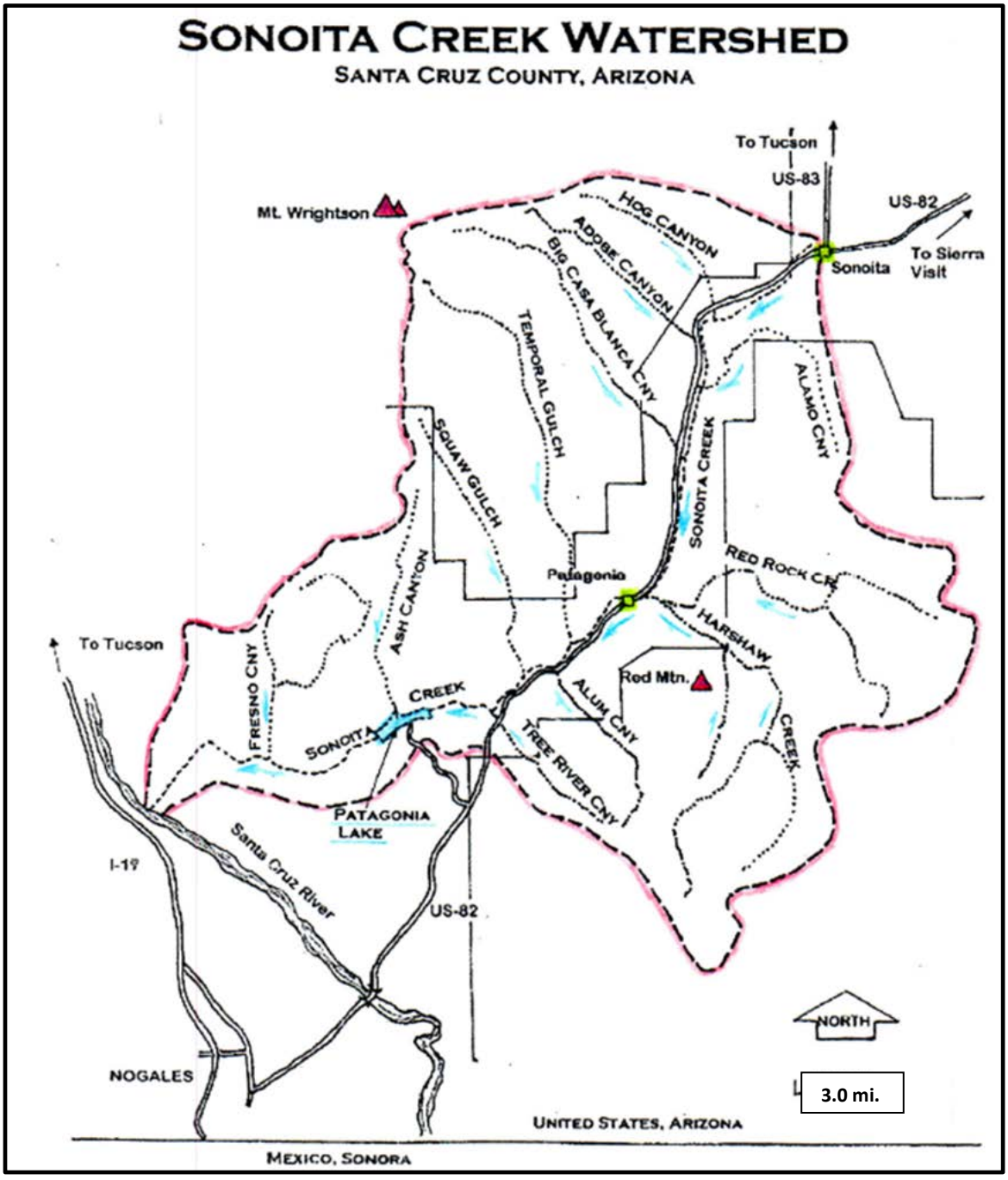
The Watershed Management Plan (WMP) seeks to give an accurate snapshot of the Sonoita Creek watershed. Sonoita Creek is about 80 miles southwest of Tucson, Arizona. It is part of what is called the geological feature called Cienega Basin, with a flow divide where Sonoita Creek flows southwest and Cienega Creek flowing north toward Tucson. The watershed divide is at Sonoita.

3.1.1 Quick Facts for Sonoita Creek Watershed

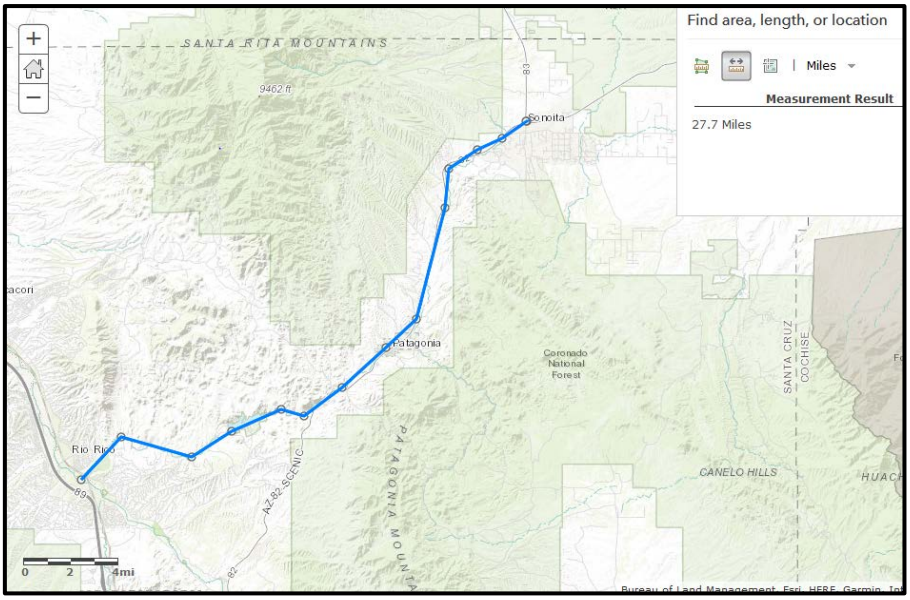
Length = 27.7 miles from its most upstream divide at the intersection of Highway 82 and Highway 83 near Sonoita, to the confluence with the Santa Cruz River near Rio Rico, Arizona.

Watershed Area = 258 square miles to Rio Rico, 246 sq. mi. to outlet of Lake Patagonia; and to the Town of Patagonia the Municipal Watershed is 89,000 ac = 139 sq. mi.

Sonoita = is the local Indian name *Ṣon ʼOidag*, which may be best translated as "spring field" (Wikipedia).
Mountains = Sonoita Creek is bounded by the Santa Rita Mountains on the north and the Patagonia Mountains on the east and the south.
Perennial flow reaches = the rock narrows at the Nature Preserve at the south edge of the Town of Patagonia, keeping the flow near the surface, then downstream to Lake Patagonia, about 7 miles. From the Lake downstream toward Rio Rico, the perennial flow reach is approximately 5 miles. Coal Mine Canyon, Fresno Canyon, Temporal Gulch, Harshaw Canyon, Red Rock Canyon, Ash Canyon, Cottonwood Spring and Cott Tank Drainage all contain small perennial flow sections.



Sonoita Creek Watershed (Jim Davidson)

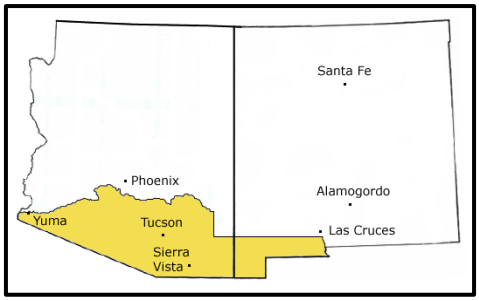


Sonoita Creek Plan View
(From http://www.arcgis.com/home/webmap/viewer.html)

3.1.2 Demographics and History

The Patagonia Mountains have likely been inhabited for about 10,000 years. There is archeological evidence of inhabitants during the Archaic period (7000 - 1 B.C.E.). The Hohokam thrived in this area from about 1050 CE to 1450 CE. The Patagonia Mountains were part of Mexico until annexed to the United States through the 1853 Gadsden Purchase. The communities now known as Patagonia, Sonoita and Elgin were united by the railroad from 1882 to 1962.

Gadsden Purchase - The purchased lands were initially appended to the existing New Mexico Territory. To help control the new land, the US Army established Fort Buchanan on Sonoita Creek in present-day southern Arizona on November 17, 1856. The difficulty of governing the new areas from the territorial capital at Santa Fe led to efforts as early as 1856, to organize a new territory out of the southern portion.



Area of Gadsden Purchase 1854
(https://commons.wikimedia.org/wiki/File:Gadsden_Purchase_Cities.png)

Both the Treaty of Guadalupe Hidalgo in 1848 and the Gadsden Purchase in 1854 resulted in the transfer of ownership of large parts of the Southwest from Mexico to the United States. Both of these agreements recognized the rights of existing landowners under the Spanish legal system, which differs from the English based system of law of the United States. Spanish law, prior to 1854, still has legal standing in these regions, leading to litigation at times.

The two current census areas in the watershed are the Town of Patagonia and the designated area of Sonoita.

Patagonia, Arizona is a town in Santa Cruz County. As of the 2010 census, the population was 913.
Sonoita, Arizona is also in Santa Cruz County. In 2010, the population was estimated at 818.

3.1.3 Regulations in the Riparian Area

Regulations for development in the water course of the Sonoita Creek are determined on a case by case basis but usually include the ADEQ (Clean Water Act 401 permit), floodplain permit with the Santa Cruz County Flood Control District, and US Army Corps of Engineers, Section 404 permit. Each of these permits requires a professionally prepared application with supporting studies.

In August 2013, the Patagonia Town Council adopted a Watershed Amendment to their General plan. The adopted language says that the US Forest Service officially defines water from the Sonoita Creek and the Harshaw Creek drainages which encompass 89,000 acres (139 sq. mi), as the Municipal Watershed of the Town of Patagonia. One of the eight Planning Principles set forth in The Town Plan specifically states that the Town must, "Closely study and reject mining (resource extraction) proposals, which pose a threat to the environmental, economic or cultural resources of the Patagonia area." The Town should work with the US Forest Service to ensure that there is a comprehensive ground water study conducted before any industrial activity that's going to use water from our watershed commences.

Water Rights are determined by ADWR and are described in Section 3.4. Most of the Sonoita Creek Watershed is outside the Santa Cruz River Active Management Area (AMA), where much more intense resource monitoring, water management studies and decisions are made. The AMA starts at Lake Patagonia and includes that downstream reach of Sonoita Creek to Rio Rico.

3.1.4 Land Use

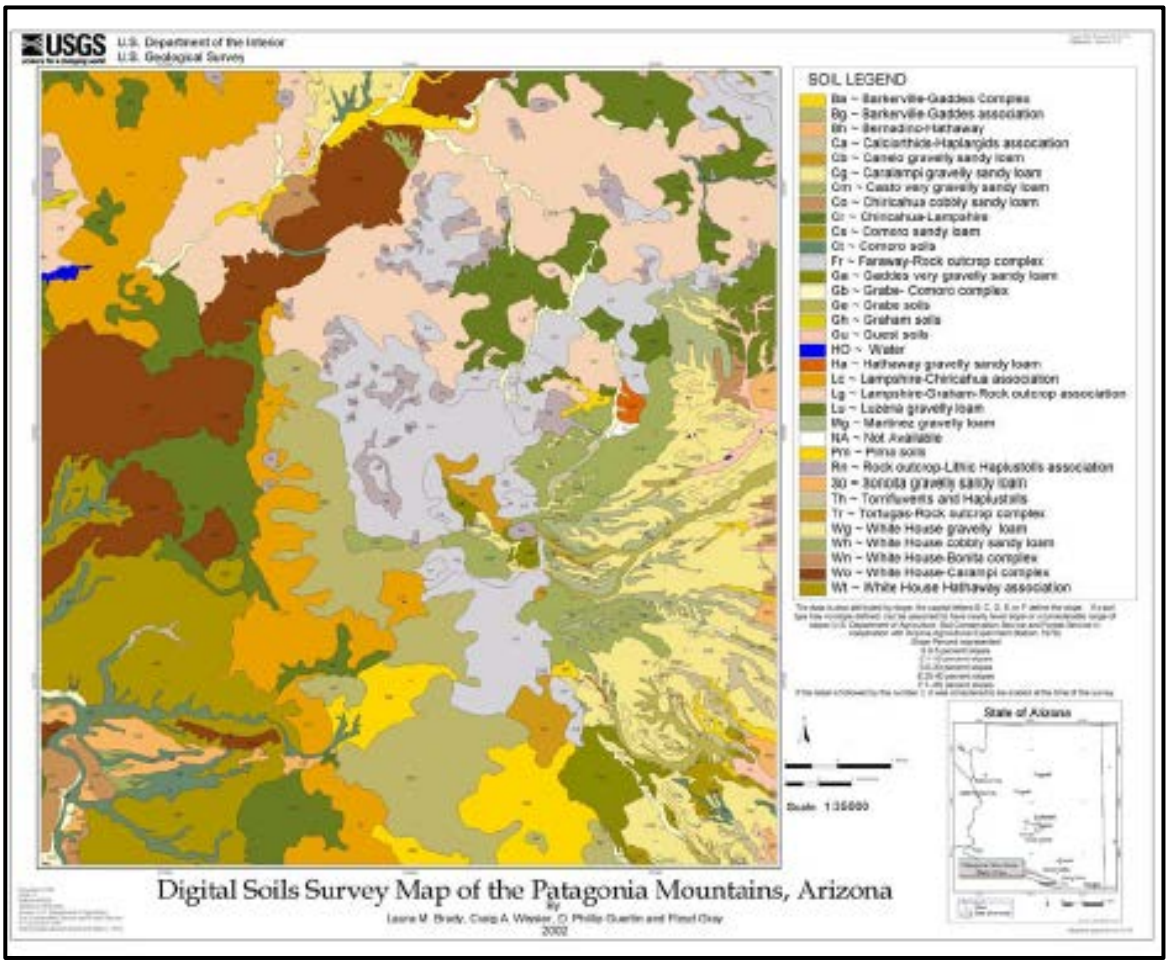
Increasing human settlement by settlers moving west beginning in the 1800s, has altered the watercourse with diversions, agricultural irrigation, and livestock and municipal water use. The watershed historically included ranching, mining and commercial land uses.

3.2 Geology and Soils

The USGS has developed geological maps and groundwater models for much of the Sonoita Creek Watershed. There has been intense research in the Santa Cruz River area that includes the Sonoita Creek reach from Lake Patagonia to Rio Rico.

The Patagonia and southern Santa Rita Mountains area was mined intermittently from the 1600's to the mid-1960's, primarily for silver, lead, copper, and zinc. The USGS, with the U.S. Forest Service, is making assessment of these mining sites in the Sonoita Creek watershed. There is current interest in mining by AMI who are investigating a site in the Harshaw Creek drainage. A May 1, 2017 press release discusses the potential for zinc-lead-silver mine at one deposit and silver at another on land owned by the mining company. (https://www.arizonamining.com/news/details/index.php?content_id=412)
Graybeal (USGS, 2015) and others published a geology map and GIS data: for the Sonoita Creek area: https://pubs.usgs.gov/of/2015/1023/

The USGS (2002) updated their analog soils data to create a high resolution digital soils survey map of the Patagonia Mountains, Arizona. The most accurate soil information for the area was available as 1:20,000 scale maps in the "Soil Survey of Santa Cruz and Parts of Cochise and Pima Counties, Arizona" (USDA, SCS & FS, 1979), a product of the US Department of Agriculture's Soil Conservation Service and Forest Service in cooperation with the Arizona Agricultural Experiment Station. The 1979, soil maps were automated to incorporate into the hydrologic modeling within a GIS. The Soil Survey map is shown below:



The largest most impacting earthquake to affect the Sonoita Creek Watershed was the **1887 Sonora earthquake** that occurred at 22:13 UCT on 3 May 1887 in the Teras mountain range of northwestern Mexico. It was widely felt, with some damage being recorded up to 200 kilometres (120 mi) from the epicenter in both Mexico and the United States. The earthquake had an estimated magnitude of 7.6 and caused 42 casualties in the town of Bavispe and 51 overall. It was the only historical earthquake to cause considerable damage in Arizona. The 1887 Tombstone Arizona newspapers mentioned lesser quakes (aftershocks) on August 27, 1887, and November 11, 1887. https://en.wikipedia.org/wiki/1887_Sonora_earthquake). This earthquake likely affected Sonoita Creek and set the geologic structure of the watershed that is seen today.

3.3 Surface Water and Groundwater Hydrology

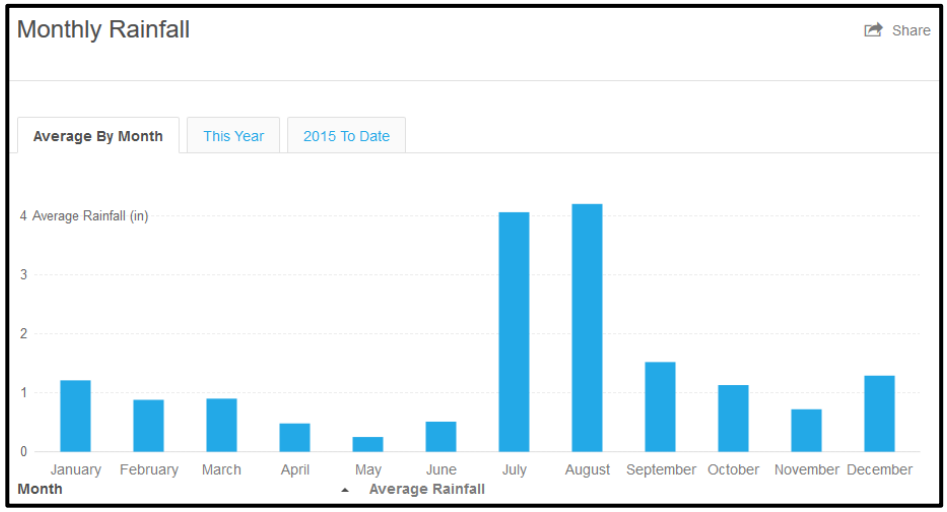
Much of the input of water to the Sonoita Creek Watershed is in the form of rainfall. There are occasionally snow events that have created unusually long periods of flow in the creeks. Water from springs contribute to the watershed. A spring is any natural situation where water flows from an aquifer to the Earth's surface. It is recharged by seepage into the earth's surface from rainfall.

Hydrology tells us how much water is involved. The water budget involves estimates of inflow (rainfall, snow, or stream flow), outflow (evaporation and/or stream flow), and change in storage (amount of water in the lake or groundwater basin)

3.3.1 Rainfall

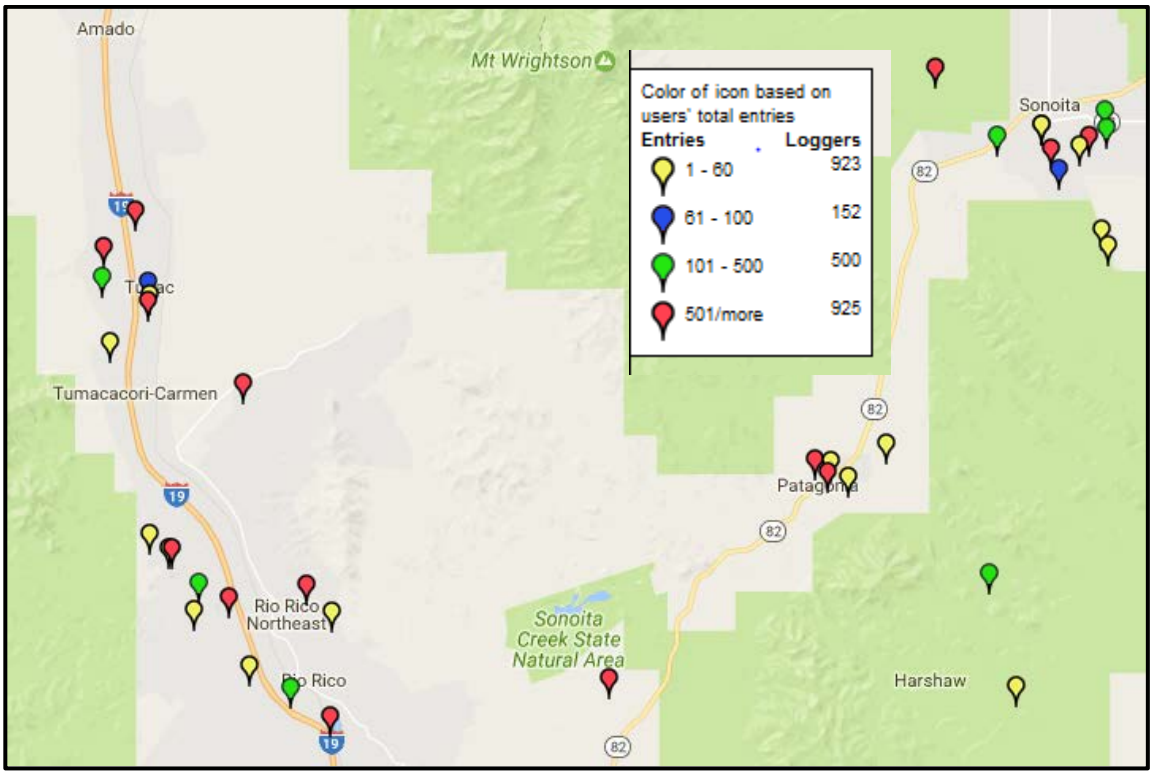
Rainfall occurs from three general types of storms. Winter storms are the result of frontal activity and usually cover large areas. Winter precipitation is generally less intense but is longer in duration than summer precipitation. The "summer monsoons" precipitation in July, August, and September, is high intensity and short duration, and it is usually the result of thunderstorms that cover a small area. Occasionally, tropical storms moving inland, generally in September, contribute large amounts of precipitation. It is from these tropical storms that extreme flood events occur (such as in 1983) on the larger drainage areas. Summer thunderstorm activity is the usual cause of major flooding on the smaller tributary streams.

The maximum rainfall recorded at Patagonia for one day is 4.3 inches on August 7, 1929. The average annual rainfall is 17.15 in/yr with most rainfall in the monsoon season of July and August.



Climate changes are in evidence according to the State Climatologist (personal communication Dec. 2016) with a general decrease in the winter rains and an increase in the summer monsoon rains.

Rainfall networks include the US National Weather Service and the voluntary Rain.Org (see map of stations below) A rain gauge has been operating in Patagonia Town since 1921 with NOAA data readily available at https://daily-weather.weatherdb.com/d/a/Patagonia%2C-AZ



Rainlog.Org Rain Gauge Network

http://rainlog.org/usprn/html/main/PublicActions?action=map_users

3.3.2 Evaporation

The State Monthly Pan Evaporation for the nearest station is at Nogales. The total evaporation far exceeds the rainfall at 91.2 inches per year. This is only achieved if there is water to evaporate, so only applies to the water balance for Lake Patagonia and the short term and location where there is ponded or flowing water.

ARIZONA

MONTHLY AVERAGE PAN EVAPORATION (INCHES)

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
BARTLETT DAM	1939-2005	3.92	4.92	7.10	10.02	13.77	16.21	15.56	13.95	12.10	9.66	5.86	4.47	117.54
BLACK RIVER PUMPS	1948-2005	0.00	0.00	0.00	6.93	8.83	10.12	7.99	7.02	5.70	3.94	0.00	0.00	50.53
DAVIS DAM # 2	1958-1977	7.49	7.46	9.75	12.78	16.71	19.48	19.87	17.91	14.64	12.03	8.40	7.80	154.32
DAVIS DAM	1948-1961	3.54	5.13	7.60	9.30	11.33	13.33	13.14	12.15	9.51	7.24	5.38	3.88	101.53
DOUGLAS	1948-2005	0.00	0.00	0.00	11.34	13.19	13.55	10.66	10.27	8.18	6.44	0.00	0.00	73.63
FORT VALLEY	1909-2005	0.00	0.00	0.00	0.00	5.86	7.37	6.03	4.91	3.35	0.00	0.00	0.00	27.52
GRAND CANYON NATL PARK	1957-1977	0.00	0.00	0.00	0.00	6.94	10.45	8.79	8.12	6.83	4.91	0.00	0.00	46.04
GRAND CANYON N P 2	1976-2005	0.00	0.00	0.00	0.00	7.46	9.80	8.94	7.29	6.10	4.45	0.00	0.00	44.04
HAWLEY LAKE	1967-1988	0.00	0.00	0.00	0.00	7.57	8.55	6.89	5.48	4.68	0.00	0.00	0.00	33.17
MANY FARMS SCHOOL	1951-1975	0.00	3.66	5.45	9.18	12.23	15.14	12.87	10.88	9.40	6.54	3.26	2.16	90.77
MC NARY 2 N	1933-2005	0.00	0.00	0.00	0.00	7.86	8.25	6.60	5.98	4.90	3.97	0.00	0.00	37.56
MESA	1896-2005	3.03	4.02	6.11	8.64	11.33	12.67	13.10	11.87	9.69	6.81	4.15	2.96	94.38
NOGALES 6 N	1952-2005	3.59	4.46	7.01	9.35	11.91	13.31	10.00	8.28	8.06	7.17	4.49	3.57	91.20

Monthly Pan Evaporation (http://www.wrcc.dri.edu/htmlfiles/westevap.final.html)

3.3.3 Stream flow

Most of the streams in the watershed are ephemeral and are dry for long periods of time. The streambeds of the Santa Cruz River and its major tributaries (such as Sonoita Creek) are extremely permeable, and considerable water is lost to the subsurface as flow moves downstream. Thus, as one moves down stream, the flood volume diminishes, with an accompanying decrease in peak discharge.

The US Forest Service has a program to stream gauge a number of tributaries in the watershed to monitor "instream flow for fish, wildlife, or recreational purposes" and have selected 16 sites. Only preliminary data from one site is available at the time of this report.

As part of an Arizona Water Protection (AWP) grant, the TNC has been monitoring flows near its property south of Patagonia town. Their data has not been published.

A gage on Sonoita Creek near Patagonia (USGS Gage 09481500) has records for 1930-72, 1978 and 1984. The estimate for 1-percent-annual-chance peak discharge is 15,100 cfs. This gage was located at the Circle Z Ranch and was washed out in the 1984 flood event. It has not been replaced. https://waterdata.usgs.gov/nwis/inventory/?site_no=09481500&agency_cd=USGS:

DESCRIPTION:

Latitude 31°29'59", Longitude 110°49'03" NAD27
Santa Cruz County, Arizona, Hydrologic Unit 15050301
Drainage area: 209.00 square miles
Datum of gage: 3,818.09 feet above NGVD29.

AVAILABLE DATA:

Data Type	Begin Date	End Date	Count
Daily Data			
Discharge, cubic feet per second	1930-06-01	1972-09-30	14917
Daily Statistics			
Discharge, cubic feet per second	1930-06-01	1972-09-30	14917
Monthly Statistics			
Discharge, cubic feet per second	1930-06	1972-09	
Annual Statistics			
Discharge, cubic feet per second	1930	1972	
Peak streamflow	1930-08-07	1983-10-02	45
Field measurements	1948-08-10	1971-08-27	8

OPERATION:

Record for this site is maintained by the USGS Arizona Water Science Center

The FEMA Flood Insurance Study (2011) estimates flows in Sonoita Creek as follows:

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10%-Annual Chance	2%-Annual Chance	1%-Annual Chance	.2%-Annual Chance
Santa Cruz River (continued)					
Highway 82 Bridge	574.00	11,380	23,400	32,500	78,000
International Border	532.00	11,200	23,040	32,000	76,800
Sonoita Creek					
At Confluence with Santa Cruz River	258.30	6,705	15,389	20,514	34,477
Downstream Patagonia Lake (Cross Section BI)[1]	246.20	6,701	15,373	20,451	34,309
Sonoita Creek (continued)					
Confluence with Harshaw Creek	137.80	5,374	12,879	17,253	27,660
Sonoita Tributary A					
At Confluence with Sonoita Creek	2.01	461	710	821	1,080

3.3.4 Groundwater Hydrology

The principal water-bearing deposits in southeast Arizona basins are moderately thick sediments deposited prior to the formation of the Basin and Range structure and an overlying layer of lower basin fill that can reach over 1,000 feet thick, derived from the subsequent partial erosion of the ranges. Lower basin fill sediments are composed of fined-grained to moderately fine-grained materials. Upper basin fill deposits average 300 feet thick and are generally composed of sands gravels, silts, clay and some limestones. Aquifers in this region often consist of two or more water-bearing units separated by a fine-grained unit that forms a leaky confining layer over the lower basin fill. Thin layers of sand and gravel along major streams make up the stream alluvium.

The major groundwater inflow components are mountain front recharge and stream infiltration with some underflow from adjacent up-gradient basins. Outflow consists of evapotranspiration, pumpage, discharge to streams as baseflow and some underflow to down-gradient basins, including into Mexico.

The Cienega Creek basin consists of a narrow northeast trending alluvial valley, drained by Cienega and Sonoita creeks, and surrounded by fault-block mountains. There is a surface water divide southwest of Sonoita, with Cienega Creek flowing northeast and Sonoita Creek flowing to the south and west. Hydrogeologic conditions in the basin are complex. The basin has been divided into three subareas based on the presence of a distinctive aquifer or set of aquifers: upper Cienega Creek, lower Cienega Creek, and Sonoita Creek.

The southwestern part of the basin is the Sonoita Creek subarea where the main aquifer is the stream alluvium that forms the floodplain of Sonoita Creek and its tributaries and may be up to 90-feet thick. Wells drilled in the basin fill are generally low yielding. Groundwater recharge comes from mountain front recharge and streambed infiltration along Cienega and Sonoita creeks and their tributaries.

Groundwater recharge estimates vary from 8,500 to 25,500 AFA for the combined Sonoita Creek and Cienega Creek. For this same area, estimates of groundwater in storage range from 5.1 to 11 million acre

feet (maf) (Arizona Water Atlas, 2009). Recharge and storage for only the Sonoita Creek Watershed were not estimated. Water level trends are generally stable with some declines noted near Patagonia and east of Sonoita.

3.4 Water Rights

Early in its history, Arizona adopted the doctrine of prior appropriation to govern the use of surface water. This doctrine is based on the tenet of "first in time, first in right" which means that the person who first puts the water to a beneficial use acquires a right that is better than later appropriators of the water. Prior to June 12, 1919, a person could acquire a surface water right simply by applying the water to a beneficial use and posting a notice of the appropriation at the point of diversion. On June 12, 1919, the Arizona surface water code was enacted. Now known as the Public Water Code, this law provides that a person must apply for and obtain a permit in order to appropriate surface water (Arizona Revised Statutes § 45).

The Town of Patagonia has a municipal water right (Registry #33-96392) approved by ADWR for 205,000,000 gallons per year or 629 AF/Yr. This is originally dated October 17, 1994. After discussion with The Nature Conservancy and Rio Rico, the application was re-submitted August28, 2002.

Groundwater use is now subject to the Groundwater Management Act (GMA) of 1980. Most of the Sonoita Creek Watershed is outside the GMA zone that is called the Santa Cruz River Active Management Area (AMA), where much more intense resource monitoring, groundwater levels, groundwater recharge, water management studies and decisions are made. The AMA boundary includes Lake Patagonia and coverage goes downstream to Rio Rico and joins the broader Santa Cruz River AMA .

The Sonoita Creek Watershed has areas that are part of Spanish land and water rights, so in the watershed there are both the Arizona appropriative rights and Spanish land grant rights that are at times subject to conflict and litigation.

The following information is taken from a local newspaper report about a presentation by Michael M. Brescia, Associate Curator of Ethnohistory at the Arizona State Museum and associate professor of history at the University of Arizona. He addressed the Patagonia Town council on Aug. 12, 2015 about the history of water usage laws in the state, and described the complications that have arisen in such regions that have been subject to both Spanish and English (Arizona) laws.

> Both the Treaty of Guadalupe Hidalgo in 1848 and the Gadsden Purchase in 1854 resulted in the transfer of ownership of large parts of the Southwest from Mexico to the United States. Both of these agreements recognized the rights of existing landowners under the Spanish legal system, which differs from the English based system of law of the United States. Spanish law, prior to 1854, still has legal standing in these regions. Differences between these two systems have led to litigation. Under Spanish law, a landowner does not have absolute right to surface water, unless

stated in the original grant. Locally, the Babocomari Land Grant is one of the few that was granted absolute water rights, Brescia said.

Brescia discussed the San Jose de Sonoita grant of 1825, which included the Patagonia area. He said that this area was originally part of a satellite mission established by Father Eusebio Kino. In 1821, Leon Herreras, a rancher in Tubac, successfully petitioned the Spanish government for a land grant of approximately 5,000 acres to graze his cattle. In 1892, title to the land was rejected by the U.S. court, but this decision was reversed by the Supreme Court in 1898, an example of the complications for U.S. judges forced to apply Spanish property law.

Brescia stressed the difference under Spanish law between surface and ground water. "Upstream users don't have absolute right to [surface] water," he said, but he cautioned that Spanish law often favored mining activities, because of the revenue that they generated.

http://www.nogalesinternational.com/the_bulletin/news/council-learns-about-spanish-influence-on-water-rights/article_6f8b707a-4697-11e5-9975-ef8905219b9b.html

3.5 Flooding

In 2011, FEMA updated the floodplain maps for Santa Cruz County and wrote a Flood Insurance Study (FIS) describing the flood issues. The FIS describes the following:

The town of Patagonia, which was established in 1896, and incorporated in 1948, lies in a narrow valley, with hills rising steeply on either side. The town lies at an elevation of 4,044 feet and is surrounded by mountainous terrain, with the Santa Rita Mountains rising to over 9,400 feet on the north and the Patagonia range rising to over 6,400 feet on the south.

The main streams affecting the town are Harshaw Creek, Redrock Creek, and Sonoita Creek. These intermittent streams are dry, a large portion of the year. The smaller tributary streams affecting the town are ephemeral in nature and enter the major streams at various points along their reaches through the town. Highway 82 is approximately parallel to Sonoita Creek within the valley. The town development has evolved following the old railroad and highway along the Sonoita Creek flood plain. This pattern of development makes Sonoita Creek the main flood hazard to the town.

Low-lying areas in Santa Cruz County are subject to periodic flooding caused by overflow of the Santa Cruz River and its many tributaries. One of the most severe floods occurred on December 20, 1967, resulting from heavy rain or snow. Should this flood occur again, the town will experience even greater flood depths and damages due to increased development in the floodplain and increased vegetative growth in the river channel.

Other major floods occurred on the Santa Cruz River in 1914, 1929, 1935, 1942, 1946, 1952, 1954, 1955, 1962, 1964, 1974, 1975, 1977, 1983, and 2016. Minor flooding occurred in 1990, 1993, and 2000.

Specific Patagonia flood history is lacking because there is neither a long-term stream flow gauging station nor any local newspaper containing a record of flooding. Interviews indicate that flood damage is neither frequent nor serious. The floods of July 1930, July 1948, July 1953, July 1958, and October 1983 have been described as ranking among the highest. The October 1983 flood is shown in Figures 3-5 below.

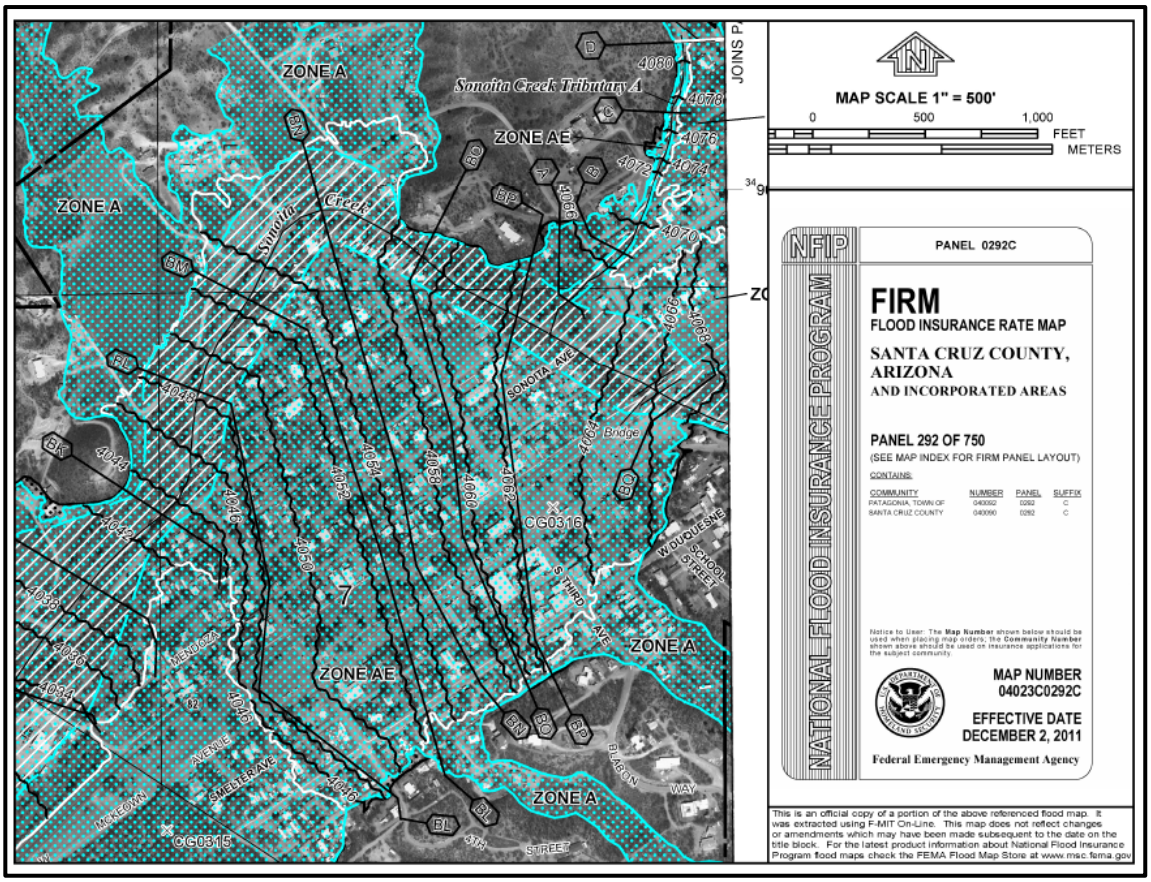
Figure 3 – Highway 82, Sonoita Creek, Oct 1983

Figure 4 – Patagonia, Oct 1983

Figure 5 – Patagonia, Oct 1983

In August 2016, floods forced evacuations in Patagonia. Rains related to Tropical Storm Javier caused the evacuation of 22 homes. The town received close to 3.75 in of rain in less than an hour, causing the creek to spill over its banks and have an emergency response by County crews. (The Weekly Bulletin, 2016).

The FEMA floodplain map (Flood Insurance Rate Map) shows most of the town in the 100-year floodplain. Shown here is the downtown area of Patagonia:



3.4.1 Flood Protection Measures

Current floodplain management measures taken to reduce flood potential consist of Floodplain Regulations and Flood Damage Prevention Requirements as adopted by the Santa Cruz County Board of Supervisors. The regulations define a regulatory flood and give requirements for floodplain encroachment and provisions for the development of a floodway. Also, defined in the regulations are methods to be used to analyze flood hazards and permissible land uses within special flood hazard areas.

The State Highway 82 Bridge over Sonoita Creek is the major constriction, and poses the most serious threat of aggravating the flood problems in the town area. The bridge over Harshaw Creek located outside the southeast corner of town is another major constriction to floodwaters.

Projects to mitigate or reduce flood damage include floodproofing structures and infrastructure, and detention basins at various scales upstream of the town. Flood mitigation is also improved by the coordination of Town and County Emergency Management Plans and the first responders.

3.6 Water Supply and Waste Water Treatment

Most of the ranches and residences on large lots use their own wells for water supply and have septic systems for waste water. Wells and springs are the only reliable source of water in Patagonia.

The Town of Patagonia is situated in a dry grassland environment. The town's source of surface water is from the Sonoita Creek and Harshaw Creek drainages. The Town of Patagonia relies solely on groundwater to serve its residents. Two wells, operated alternately and equipped with submersible pumps, are located within the center of town and supply water directly into the distribution system and to an upper storage reservoir. The static water levels of the wells vary from 15 to 45 feet below the land surface, depending on demands and time of year. The two recently-overhauled 30 hp submersible pumps are controlled by telemetered signals from reservoir water-level sensors. The pumps operate daily, for up to six hours, at a rate of 325 gallons per minute (gpm).

Treated drinking water is conveyed either from the storage tanks via gravity or by direct well pumping to the service area, which has 414 connections. The pressure in the uppermost portion of town is 65 psi and rises to 95 psi in the lower portion. Pressure reducing valves are used to regulate the pressure. Water from storage is conveyed to the service area utilizing the same pipe (8-inch main) that is used to transport it to the reservoir

The town's wastewater is conveyed to the plant via gravity and received at an average rate of approximately 420,000 gpd. During peak season, the flow rate increases to nearly 520,000 gpd. The system works efficiently and there have been no significant maintenance issues. The installed collection piping is a combination of concrete, vitreous day, and PVC types.

3.7 Water Budget

A water budget is like a check book that tracks the inflow and outflow of water in the Watershed, and the corresponding change in water storage, the check book balance. This general resource equation Inflow minus Outflow Change in Storage and can be used for the duration of the available data. Water budget depend on how extensive and detailed are the basic water resources data available.

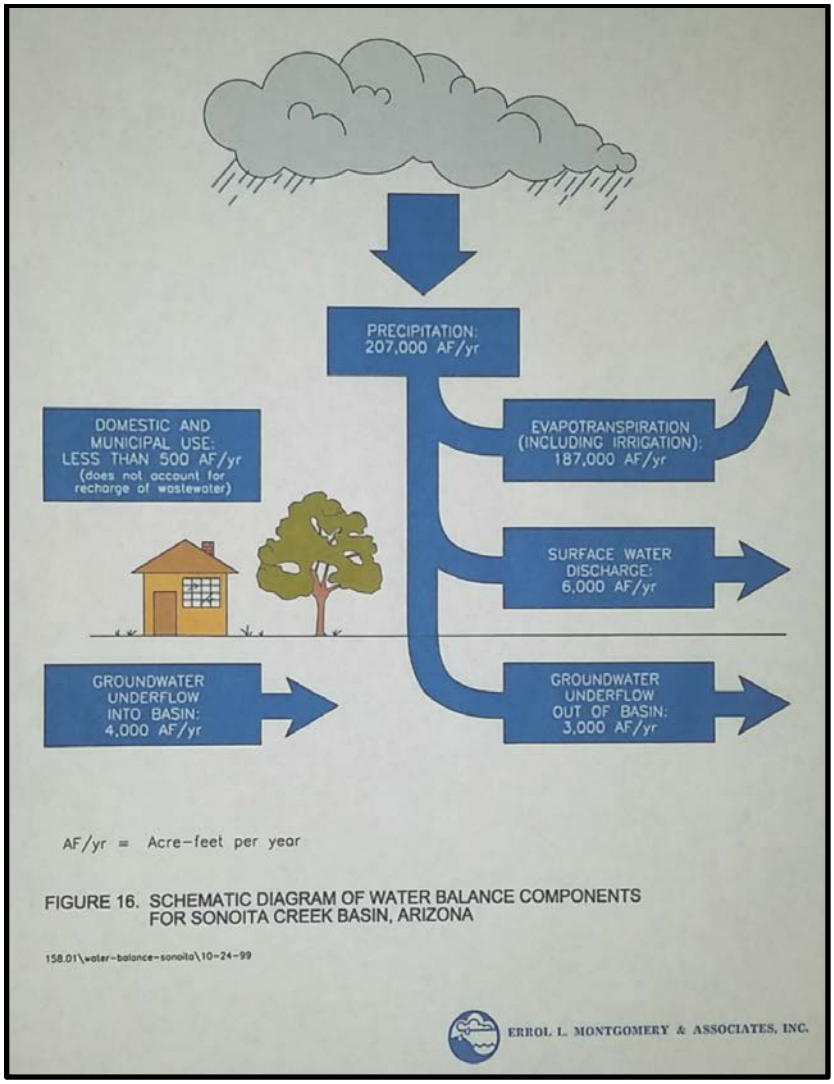
Components of the water budget include:
Inflow: Rainfall, snow melt, streamflow, spring flow, return flow from users, wastewater discharges, sub-surface (groundwater) inflow, enhanced recharge (recharge basins)
Outflow: Evaporation from open water surfaces, diversions of stream or lake to user, groundwater pumping, sub-surface outflow
Storage: Surface water ponds, basins, and lakes; water tanks, groundwater aquafers

Monthly and annual data for many of the components has been collected but not put together for an annual (or more frequent) water budget.

Patagonia Town water pumping and water levels has a reliable monthly record from 2008 to date. For January 2008 through August 2016 this record shows an average annual groundwater pumpage of 39.8 Million Gallons per year or 122 AF/Yr. This includes bulk water sales of 0.9 million gallons per year or 2.7 AF/Yr.

To see how the water budget works over time, an annual or monthly analysis shows the limits of the storage (the bank balance) over dry and wet rainfall years and over seasons of the year. In the absence of detailed water data, an average water budget is often made to see the overall size of the water (bank) account.

An average water budget was prepared by Errol Montgomery and Associates in 1999 for the Sonoita Creek Watershed (see diagram below). They had to use rough assumptions for many of the water budget components, but they were able to provide a “ball park” average rainfall year water balance that others, with more data can improve upon.



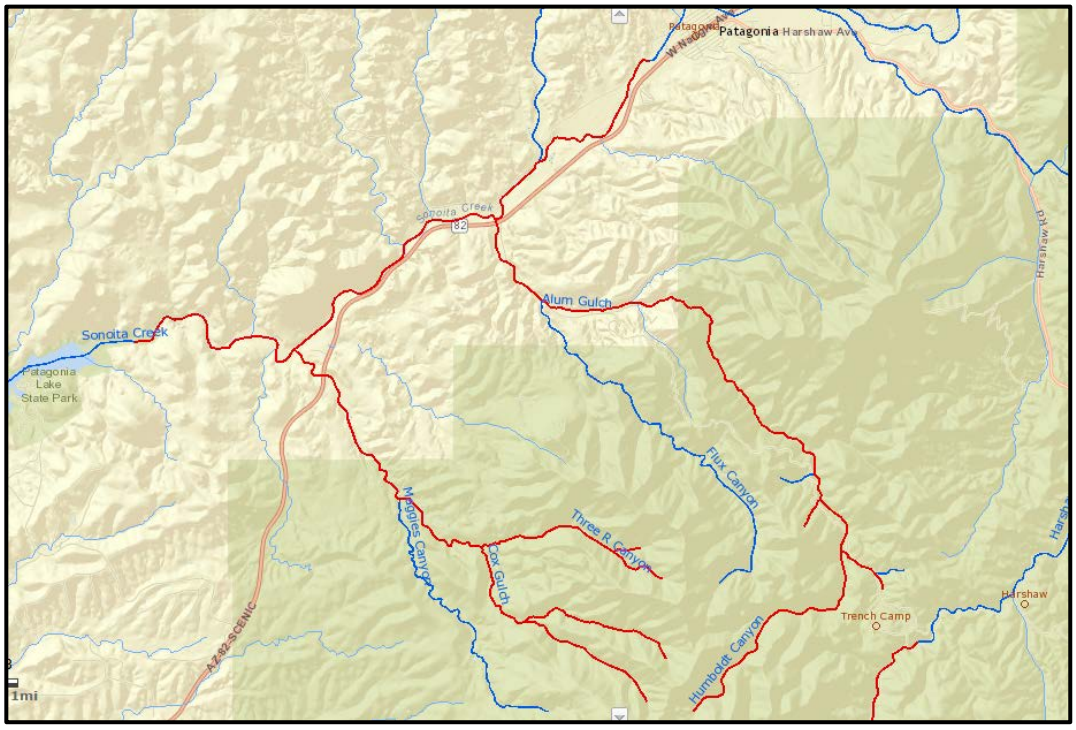
Sonoita Creek Basin Water Budget by E.L. Montgomery and Associates (1999)

3.8 Water Quality

A recent ADEQ study (Nov. 2012) concluded that in general the water quality of groundwater in Sonoita Creek meets or exceeds drinking water standards and is suitable for domestic, stock, municipal, and irrigation purposes. A few groundwater exceedances appear to be the result of natural chemical reactions, although sulfate, TDS, and gross alpha can be further mobilized by human activities such as mining. (ADEQ Factsheet, Ambient Groundwater Quality of the Cienega Creek Basin A 2000-1 Baseline Study – Nov. 2012)

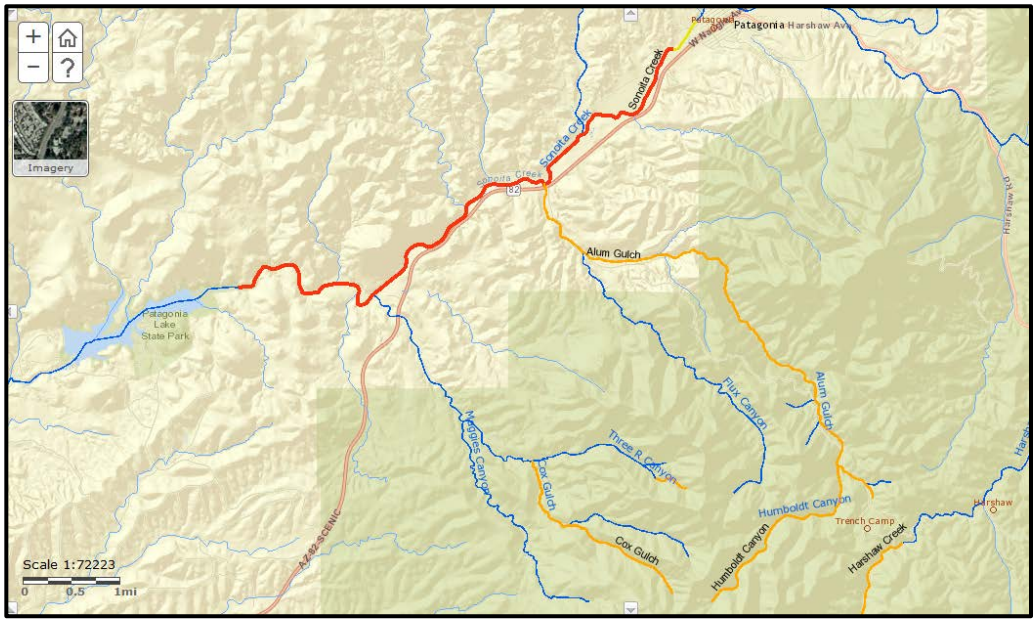
However, within this watershed, there are waters that the state has categorized under the Total Maximum Daily Load program as “impaired”. At Harshaw Creek, ADEQ called this impaired for copper and low pH (acidity). Alum Gulch is listed for total cadmium, copper, and zinc concentrations as well as pH that exceed standards. The 3R Canyon is listed for beryllium, copper, zinc, and low pH (acidity).

The 2012-14 ADEQ system shows most of the impaired streams enter the Sonoita Creek downstream of the town of Patagonia, but all flow to Lake Patagonia. Only upper Harshaw is impaired on streams that eventually go upstream of Patagonia Town, but the lower reaches of Harshaw creek are not impaired.



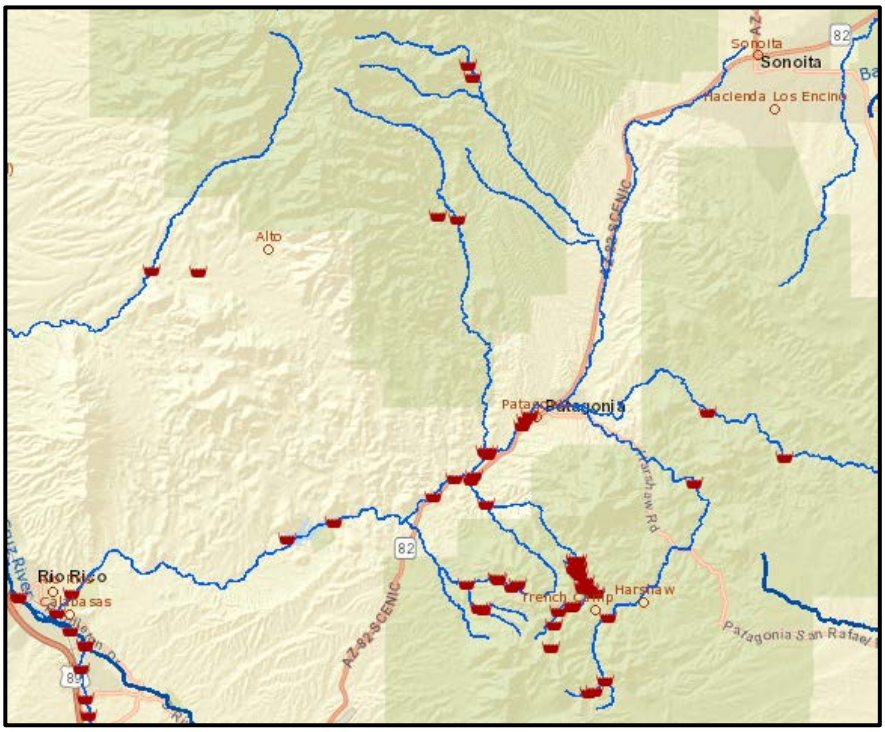
2012-14 ADEQ Impaired Streams (red) in the Sonoita Creek Watershed (http://gisweb.azdeq.gov/arcgis/emaps/?topic=impaired)

Further work by ADEQ in 2016 shows that the main stem of Sonoita Creek is impaired while the tributaries were assessed but not considered impaired. This 2016 study is still called draft.



2016 Draft ADEQ Impaired Streams (red) in the Sonoita Creek Watershed
Assessed streams are in orange (http://gisweb.azdeq.gov/arcgis/emaps/?topic=impaired)

The ADEQ water quality monitoring sites are shown below. There are approximately 37 sites in the watershed.



ADEQ Water Quality Sampling Sites in the Sonoita Creek Watershed
(http://gisweb.azdeq.gov/arcgis/emaps/?topic=impaired)

3.9 Habitat and Species

Upstream of Patagonia Lake are isolated islands of riparian habitat along the creek. This perennial section above Patagonia Lake is approximately 7 miles in length flowing from the town of Patagonia to the confluence with Patagonia Lake. During the warmer summer months this perennial section typically dries up before reaching the lake. Below the dam Sonoita Creek is perennial for about 5 miles, supporting continuous ribbons of lush vegetation along the floodplain terraces in the lower reaches. Sonoita Creek contains perennial reaches scattered throughout its length. Perennial portions of Sonoita Creek do not connect with the Santa Cruz River and typically ceases to be perennial approximately 3 miles upstream of the confluence with the Santa Cruz River (Santa Cruz Watershed Bio-Opinion, 2011).

Additionally, there are several perennial tributaries located in the upper reaches of Sonoita Creek. Water released from the dam passes through Arizona State Trust Land, then flows through the Sonoita Creek State Natural Area. The riparian area also contains wetlands, or ciénegas—some of the most endangered habitats in Arizona. Coal Mine Canyon, Fresno Canyon, Temporal Gulch, Harshaw Canyon, Red Rock Canyon, Ash Canyon, Cottonwood Spring and Cott Tank Drainage all contain small perennial sections

Near the town of Patagonia, The Nature Conservancy's Patagonia-Sonoita Creek Preserve is internationally recognized for its diversity of species. Some of the tallest and oldest Fremont cottonwood trees in the country—over 100 feet and as much as 130 years old—are found along the drainage. Black walnut, velvet mesquite, velvet ash, netleaf hackberry and several willows also grow here, along with rare and sensitive plants such as the Huachuca water umbel, Santa Cruz striped agave and the Santa Cruz beehive cactus. At just under 4,000 feet elevation, this habitat draws more than 300 species of birds, including green kingfisher, thick-billed kingbird, gray hawk, vermilion flycatcher, violet-crowned hummingbird, black-bellied whistling duck, and rose-throated becard. Northern beardless-tyrannulets are said to be common in the mesquite thickets, and zone-tailed hawk frequent the area in spring and summer, and white-throated sparrows visit in the winter. Over 20 species of flycatchers have been recorded on the preserve, as well as 130 species of butterflies.

The creek supports four native fish, including Sonoran sucker, desert sucker and endangered Gila topminnow. All of the perennial sections mentioned above are free of nonnatives with the exception of Redrock Canyon and Cott Tank drainage. Also the section of Sonoita Creek above Patagonia Lake is free from nonnatives.

Non-native species such as large-mouth bass and catfish prey upon native species, or compete with them for food. The creek and its surrounding drainage provides important habitat for desert tortoises, rattlesnakes, toads, and frogs. Mammals include bobcat, javelina, white-tail deer, coatimundi, coyote, and the rare mountain lion. Sightings of Mountain lions can be rare but the species is not considered rare by AZGFD.

This watershed is part of the Madrean Pine Oak Woodlands, a global biodiversity hotspot.
Retrieved from http://www.azheritagewaters.nau.edu/loc_sonoita.html on March 2, 2017

3.10 Access to Nature

There are several significant land areas set aside for preservation and access by the public:

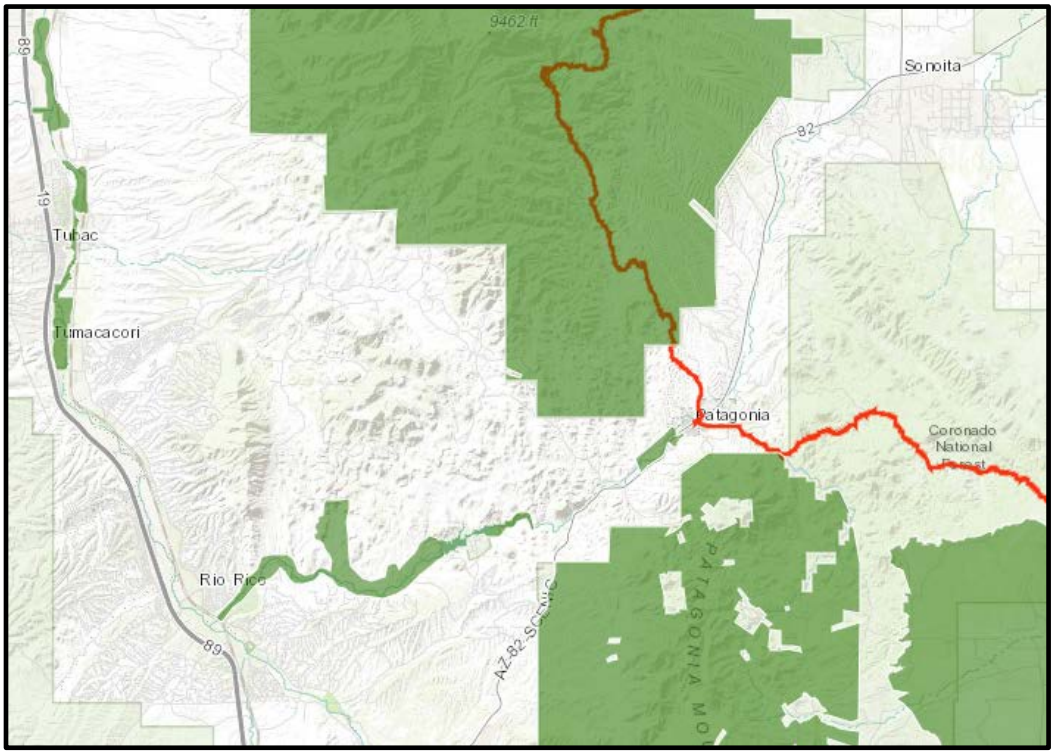
- Lake Patagonia State Park
- Sonoita Creek State Natural Area
- Patagonia – Sonoita Preserve (TNC)
- Coronado National Forest
- Audubon Birding Areas
- Paton Center for Hummingbirds (Tucson Audubon Society)

There is an eco-tourism industry in the Sonoita Creek Watershed that includes visitors from Arizona and the world that have an economic impact of recreation at these locations. This can then be tied back to the need to maintain a healthy watershed and how this effort can maintain if not increase economic viability of the

area. As an example AZGFD recently completed a creel survey at Patagonia Lake and that report shows that the lake supports nearly 8,000 angler days and over 41,000 angler hours annually. A 2001 study by AZGFD showed that fishing recreation provided $11.2 million of economic impact to Santa Cruz County. These numbers combined with the visitation of bird watching, etc makes a strong case for healthy watershed.

In addition, the Arizona Trail passes through Patagonia Town as it traverses from the Mexican Border to the Grand Canyon and on to Utah.

A portion of the upper watershed is within the first project of The Nature Conservancy in Arizona, the Patagonia-Sonoita Creek Preserve. It is partially sustained by waters released from the Wastewater Treatment plant at the Town of Patagonia. This 740-acre preserve protects a rare riparian forest of Fremont cottonwood and Gooding willow—a once common forest type that is now quite rare.



Arizona Trail (red) and Audubon Important Birding Areas (green)

(http://aztrail.maps.arcgis.com/apps/View/index.html?appid=452a5037e5ba4199bb2c1446fcf0e154)

Lake Patagonia (250 ac) was formed in the 1960's and officially became a State park in 1975. Tucked away in the rolling hills of southeastern Arizona is a hidden treasure. Patagonia Lake State Park was established in 1975 as a state park and is an ideal place to find whitetail deer roaming the hills and great blue herons walking the shoreline. The park offers a campground, beach, picnic area with ramadas, tables & grills, a creek trail, boat ramps, and a Marina. (See https://azstateparks.com/patagonia-lake/explore/park-history)

The Arizona State Parks Board purchased most the land for the **State Natural Area** in 1993, just south of Lake Patagonia and acquired several smaller adjacent parcels over the next several years. In 1994, the Trust for Public Land and the Arizona Game and Fish Department acquired 874 acres of ranchland in Coal Mine Canyon, a tributary of Sonoita Creek. The property, in the foothills of the Santa Rita Mountains, was part of the historic 20,000-acre Salero Ranch, that was subdivided and sold as 40-acre ranchettes. This area is managed to protect critical habitat for threatened and endangered species. Spring-fed pools in this side canyon are home to the largest known population of the Gila topminnow. This parcel was added to the Sonoita Creek State Natural Area. The protected area, managed by Arizona State Parks, now spans nearly 9,000 acres and includes several miles of Sonoita Creek. Access to the State Natural Area for birding, wildlife watching, hiking, and equestrian activities is limited and requires a permit.

The Coronado National Forest land is part of the watershed, administered by the US Forest Service https://www.fs.usda.gov/coronado/

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Sonoita Creek Watershed Management Plan

PART 4 References and Supporting Material

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4.2 Glossary

1% Annual Exceedance Probability Flood: A flood that has a 1 in 100 chance of being equaled or exceeded in any 1 year, and has an average recurrence interval of 100 years. 1% AEP is the current way of referring to what used to called a "100- year flood." AEP describes the probability of specific flood flows occurring, rather suggesting the length of time (years) between floods of specific flows.

50-year Flood: A flood whose flow has a 2%, of being exceeded in any given year. Has smaller peak flows than a 100-year flood.

100-Year Flood (also Base Flood): A flood whose flow has a 1% chance of being exceeded in any given year. A misleading term that does *not* mean a flood that will occur once every 100 years. The preferred term is currently "1% Annual Exceedance Probability Flood."

303(d) List: Section 303(d) of the Clean Water Act requires states to identify waters that do not meet water quality standards and to classify them by category. States must submit their lists to the USEPA for review and approval. These state-developed lists are known as Section 303(d) lists of impaired waterbodies (stream/river segments, lakes).

A

Acre-foot: The amount of water necessary to cover an acre (43,560 sq. feet) to a depth of one foot, or 43,560 cubic feet, which is equivalent to 325,828 gallons.

Adjudication: With regard to water rights, a legal decision that allocates water to parties in proceedings and is overseen by a court-appointed Watermaster.

Alluvial: Pertaining to material or processes associated with transportation and/or deposition by running water.

Alluvial Deposits: Loose, unconsolidated sediments that have been transported by and deposited from running water.

Alluvial Fan: Cone-shaped fans of rock and sediment that have built up by stream deposition at the mouths of mountain and foothill canyons.

Alluvial Fan Flood: Flooding occurring on the surface of an alluvial fan or similar landform characterized by high-velocity flows; active processes of erosion, sediment transport, and deposition; and unpredictable flowpaths.

Alluvium: Soil, sand, gravel, and other material that has been transported and deposited by flowing water, as in a riverbed.

Annual Exceedance Probability: The Annual Exceedance Probability (AEP) values indicate the chance that specific flood flows will occur in any one year. A 1% AEP means there is a 1 in 100 chance that a flood will occur in any one year.

Anticline: In structural geology, anticline refers to a fold, generally convex upward, in which each half of the fold dips away from the crest and whose core contains the older rocks.

Aquifer: Refers to subsurface deposits and geologic formations that are capable of yielding usable quantities of water to a well or spring, whereas a confining layer (or confining bed) refers to a low-permeability deposit or geologic formation that restricts the movement of groundwater. An aquifer can refer to a single geologic layer (or unit), a complete geologic formation, or groups of geologic formations.

Artesian: Pertaning to groundwater under sufficient hydrostatic pressure to rise above the aquifer containing it.

Atmospheric Deposition: Gases and particulates released to the atmosphere from combustion sources such as motor vehicle emissions, slash burning, and industrial sources, contain nitrogen, sulphur, and metal compounds, which eventually settle to the ground as dust or fall to the earth in rain and snow.

Average (or Mean): In statistics, the sum of all the numbers in a set divided by the number of numbers in the set.

B

Base Flow: The flow of water in streams that remains well after storms have passed. Also referred to as groundwater flow, or dry-weather flow.

Bed Load: Sediment particles resting on or near the channel bottom that are pushed or rolled along by the flow of water.

Bedrock: A general term for the solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Beneficial Uses: The resources, services, and qualities of aquatic systems that water quality regulations aim to preserve or improve. Beneficial uses include recreation; water supply; navigation; and the preservation and enhancement of fish, wildlife, and other aquatic resources. Beneficial uses can be existing, potential, or intermittent uses.

Benthic: Of, relating to, or occurring at the bottom of a body of water.

Best Management Practice (BMP): With regard to water quality, methods that have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources.

Biodiversity: Refers to the variety and variability among living organisms and the ecological complexes in which they occur. A measure of the variety of organisms present in ecosystems.

Blackwater: Household wastewater from toilets.

Braided Stream: A channel or stream with multiple channels that interweave as a result of repeated bifurcation and convergence of flow around inter-channel bars, resembling the strands of a complex braid. Braiding
is generally confined to broad, shallow streams of low sinuosity, high bed load, non-cohesive bank material, and a steep gradient.

C

Channel: An open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. Natural channels may be single or braided.

Channelization: Artificial straightening, stabilizing, or diverting of stream channels, resulting in a straighter and deeper channel.

Coastline Armoring: The building of protection structures such as seawalls and riprap, intended to prevent coastal erosion.

Cobble: A rock fragment larger than a pebble and smaller than a boulder, rounded or otherwise abraded in the course of aqueous, eolian, or glacial transport.

Conductivity: Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge).

Confined Aquifer: An aquifer bounded above and below by impermeable beds, or by beds of distinctly lower permeability than that of the aquifer itself; an aquifer containing confined groundwater.

Confluence: The point where two streams meet.

Conglomerate: Consolidated (sedimentary) stone composed primarily of large, gravel-sized particles.

D

Debris Basins: A flood control feature in areas where streams carry high sediment loads. Debris basins are typically placed at canyon mouths, debris basins capture the sediment, gravel, boulders, and vegetation that are washed out of canyons during storms. The basins capture the material and allow the water to flow into downstream drainage channels.

Delta: The nearly flat alluvial tract of land at the mouth of a river, commonly forming a triangular or fan shaped plain resembling the Greek letter "delta." It is crossed by many distributaries, and results from the accumulation of
sediment supplied by the river. Most deltas are partly above and below water.

Detention Basins: Engineered basins that temporarily store stormwater runoff, thereby reducing the peak rate of runoff to a stream or storm sewer. They help to prevent localized flooding and, if designed to do so, provide some water quality benefits and reduce streambank erosion downstream.

Discharge: In the context of water quality regulations, "discharge" means the release of waste to surface water or to the ground.

Distributary Channel: A channel that flows away from the main channel, characteristic of a delta.

Diversion: Control or removal of water from its natural course or location by ditch, pipe or other conduit.

E

Ecosystem: The interacting system of a biological community and its non-living environmental surroundings.

Effluent: An outward movement of water, as a stream from a lake or purified discharge from a wastewater treatment plant.

Electrofishing: A common fish population monitoring technique that uses electricity to stun fish before they are caught and counted.

El Nino/La Nina: El Niño is characterized by unusually warm ocean temperatures in the Equatorial Pacific, as opposed to La Niña, which characterized by unusually cold ocean temperatures in the Equatorial Pacific. El Niño is an oscillation of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe.

Endangered Species: Animals, birds, fish, plants, or other living organisms threatened with extinction by anthropogenic (man-caused) or other natural changes in their environment. Requirements for declaring a species endangered are contained in the Endangered Species Act.

Environmental Water: Defined by the state of California as "water serving environmental purposes, including instream fishery flow needs, wild and scenic river flows, water needs of fresh-water wetlands, and Bay-Delta requirements."

Ephemeral Stream: A stream that flows in direct response to and only during and shortly after precipitation events. Ephemeral streams may or may not have a well-defined channel. Their beds are always above the elevation of the water table, and stormwater runoff is their primary source of water. Ephemeral streams include normally dry arid or semi- arid region desert washes.

Erosion: The wearing away of the land surface by running water, waves, or moving ice and wind, or by such processes as mass wasting and corrosion (solution and other chemical processes).

Eutrophication. The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears. During the later stages of eutrophication
the water body is choked by abundant plant life due to higher levels of nutritive compounds such as nitrogen and phosphorus. Human activities can accelerate the process.

Eutrophic Conditions: Occur in a body of water that is highly productive of aquatic plants or algae due to the input of large quantities of nutrients.

Evapotranspiration: That portion of precipitation returned to the air through evaporation and plant transpiration.

F

Fault: In geologic terms, a fracture or fracture zone along which there has been displacement of the sides relative to one another parallel to the fracture.

Flash Floods: Floods that occur very quickly after rain.

Flood or Flooding: A general and temporary condition of partial or complete inundation of normally dry land areas from:

l) The overflow of inland waters and/or

2) The unusual and rapid accumulation of runoff of surface waters from any source.

3) The collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature, such as flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event which results in flooding as defined in this definition.

Floodplain: The area adjacent to a watercourse or other body of water that is naturally subject to recurring floods.

Floodplain Terrace: One, or a series of flat-topped landforms in a stream valley that flank and are parallel to the stream channel, originally formed by a previous stream level, and representing remnants of an

abandoned flood plain, stream bed, or valley floor produced during a past state of fluvial erosion or deposition (i.e., currently very rarely or never flooded; inactive cut and fill and/or scour and fill processes). Remnants of constructional valley floors thickly mantled with alluvium are called alluvial terraces.

Floodway: The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot above the elevation of the water surface prior to encroachment into the floodplain.

Fluvial: Of or pertaining to rivers or streams; produced by stream or river action.

Fluvial Deposits: Sedimentary deposits produced by stream or river action.

G

Gaining Reach: A stream or reach of a stream whose flow is being increased by inflow of groundwater.

Geomorphic Province: Naturally defined geologic regions that display a distinct landscape or landform. Earth scientists recognize eleven provinces in California. Each region displays unique, defining features based on geology, faults, topographic relief and climate.

Geomorphology: The geographical study of the form of the earth. Geomorphic means of or pertaining to the shape of the earth or its topographic features.

Graywater: Water drained from household sinks, washing machines, tubs, and showers; that is, all water not coming from toilets. All household water except blackwater.

Groundwater Basin: An aquifer or system of aquifers that has reasonably well defined boundaries and more or less definite areas of recharge and discharge.

Groundwater Recharge: The movement, usually downward, of surface water or precipitation into subsurface soil and groundwater basins.

H

Habitat: The place where a population (e.g., human, animal, plant, microorganism) lives, along with its surroundings, both living and non-living.

Headwaters: The source of a river or stream.

Hydraulic Continuity: the interconnection between groundwater (aquifers) and surface water sources.

Hydrology: The properties, distribution, and circulation of water.

I

Impervious Surface (or Impermeable): A surface that does not allow the passage of water and thus potentially facilitates the generation of runoff.

Infiltration: The process by which water moves downward through the earth's surface, replenishing soil moisture and groundwater basins.

Influent: An inward movement of water, as a stream that flows into another stream or flows entering a wastewater treatment system.

Intermittent Stream: A stream that flows only at certain times of the year when it receives water from springs, groundwater, rainfall, or surface sources such as melting snow. Includes intermittently dry desert washes in arid or semi-arid regions.

L

Levee: An artificial embankment along a watercourse or an arm of the sea, to protect land from flooding.

Liquefaction: A process by which water-saturated sediment temporarily loses strength and acts as a fluid, like when you wiggle your toes in the wet sand near the water at the beach. This effect can be caused by earthquake shaking.

Losing Reach: A stream or reach of a stream in which water flows from the stream bed into the ground.

M

Maximum Contaminant Level (MCL): Enforceable drinking water quality standards.

Median: The mid-number in a set of numbers, such that half the numbers are above the median and half are below. To be distinguished from "average."

N

Nitrate: A compound containing nitrogen that can exist in the atmosphere or as a dissolved gas in water and which can have harmful effects on waterbodies, humans and animals. A plant nutrient and inorganic fertilizer.

Nitrogen: A colourless, odourless, tasteless gas that is the most plentiful element in Earth's atmosphere and is a constituent of all living matter.

Nonpoint Source: Nonpoint source pollution comes from a variety of diffuse sources: fertilizers, herbicides, and insecticides from agricultural and residential areas that do not drain to an MS4; oil, grease, and toxic chemicals from industrial and urbanized areas; sediment from improperly managed construction sites, crop and forest lands, eroding streambanks, and naturally occurring, erosive landscapes; salt from irrigation; bacteria and nutrients from horses, livestock, pet waste, and septic systems; atmospheric deposition; and stream channel modification.

NPDES Permit: As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States.

O

Orographic Lift: The forced rising of moist air up the slopes of hills and mountains.

P

Pathogen: Anything that can produce disease.

Peak Flow: The maximum instantaneous discharge of a stream or river at a given location.

Perennial Stream: A stream that flows continuously during a year of normal rainfall.

Point Source: Any discernible, confined, and discrete conveyance, (e.g., a pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft) from which pollutants are or may be discharged. This does not include agricultural stormwater discharges and return flows from irrigated agriculture, but does include discharges from municipal separate storm sewer systems (MS4s). (Clean Water Act, Section 502(14))

R

Reach: A continuous part of a stream between two specified points.

Riffle: Shallow water area with rapid current and with flow broken by a substrate of gravel or rubble.

Riparian Habitats: Water-dependent habitats adjacent to streams or other water bodies. Includes both wetland and upland zones.

River Terrace: Floodplain Terrace.

S

Safe Yield: In the context of water reservoirs, safe yield, or "firm yield" is defined as "…a quantity of water from a project or program that is projected to be available on a reliable basis, given a specified level of risk, during a
critically dry period." (Public Law 108-361). In the context of groundwater basins, safe yield has commonly been defined as "the maximum quantity of water that can be continuously withdrawn from a groundwater basin without adverse effect" (CDWR 2003).

Scour: The powerful and concentrated clearing and digging action of flowing air, water, or ice, especially the downward erosion by stream water in sweeping away mud and silt on the outside curve of a bend, or during the time of a flood; a process.

Scour and Fill: A process of alternate excavation and refilling of a channel, as by a stream or the tides; especially such a process occurring in time of flood, when the discharge and velocity of an aggrading stream are suddenly increased, causing the digging of new channels that become filled with sediment when the flood subsides.

Secondary Maximum Contaminant Level (SMCL): Non- mandatory water quality standards related to esthetic factors, such as taste, staining, and color.

Sediment: Material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by water, wind, ice or mass-wasting and
has come to rest on the earth's surface either above or below sea level.

Sedimentary Rocks: A layered rock resulting from the consolidation of sediment, e.g. a clastic rock such as sandstone, a chemical rock such as rock salt, or an organic rock such as coal. Some authors include pyroclastic rocks, such as tuff.

Sediment Load: The amount of sediment carried in a stream
Semi-Confined Aquifer: An aquifer that is partially confined and partially unconfined.

Septic Tank Leachate: The liquid that remains after wastewater drains through septic solids.

Sheet Erosion: The removal of thin layers of surface material more or less evenly from an extensive area of gently sloping land, by broad continuous sheets of running water rather than by streams; rain wash.
Stormwater Runoff: Rainfall or snowmelt that runs off over the land surface, potentially carrying pollutants to streams, lakes, or reservoirs.

Sub-watershed: A smaller watershed that is part of a larger watershed.

Surface water: All water naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.).

Suspended Load: The part of the total stream load that is carried for a considerably period of time in suspension, free from contact with the stream bed; it consists mainly of clay, silt, and sand.

T

Tertiary: The first period of the Cenozoic era thought to have covered the span of time between 65 million and 2 million years ago.

Total Dissolved Solids: The total amount of mobile charged ions, including minerals, salts or metals dissolved in a given volume of water, expressed in units of mg per unit volume of water (mg/L), also referred to as parts per million (ppm).

Total Maximum Daily Load (TMDL): A regulatory term in the federal Clean Water Act describing the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.

Tributary: Any stream that contributes water to another stream.

Turbidity: Cloudiness or muddiness of water or ocean, resulting from suspended or stirred up particles.

U

Unconfined Aquifer: Groundwater that has a free water table, i.e. is not confined under pressure beneath relatively impermeable rocks.

Unconsolidated: Soil material that is in a loosely aggregated form.

Unincorporated Area: Land area that is outside of city limits and in the jurisdiction of the county

W

Wastewater: Includes any combination of water, soap, food scraps, and human excrement that is flushed down toilets, sinks, and shower drains. Wastewater can contain a wide variety of constituents known to affect water quality, including pathogens, bacteria, nutrients, pharmaceuticals, perfumes, and toxic chemicals. Wastewater includes both "blackwater" (wastewater from toilets) and "graywater" (all used household water except blackwater).

Water Quality Objectives: Defined by the Water Code as "the allowable limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area." (RWQCB-LA 1994)

Watershed: A geographic region within which water drains into a particular river, stream, or other waterbody. Also called catchment, drainage, or basin. Every area of land is part of a watershed, each

one separated from the next by the ridges between elevation peaks. There are complex interrelationships among the streams, aquifers, lakes, habitats, people and economies that make up a watershed system, such that changes or impacts to one part of a watershed can ripple through and affect other parts.

Water Table: The top of the saturated zone of a groundwater basin, the level below which the ground is saturated with water.

Water Year: A "water year" or "rain year" is defined as October 1 of the previous year through September 30. For example water year 2003 is from October 1, 2002, through September 30, 2003.

Wetland: Lands transitional between obviously upland and aquatic environments.

4.3 Supporting Material

Climate

The Sonoita Creek State Natural Area is located at an elevation of 3,500 feet, southwest of Patagonia Lake. The skies are mostly always clear. From December to February, it is very rainy in this area. There are occasionally heavy rainstorms during the summer time which occur from July to August. The humidity is under 20% throughout most of the year. (Sonoita Creek State Natural Area)

MONTH	HIGH	LOW	PRECIPITATION
January	64° F	27° F	1.31"
February	67°	30°	1.09"
March	71°	34°	1.00"
April	78°	38°	0.49"
May	86°	45°	0.32"
June	96°	54°	0.54"
July	94°	64°	4.27"
August	92°	63°	4.24"
September	90°	56°	1.68"
October	82°	44°	1.84"
November	72°	33°	0.78"
December	64°	28°	1.47"

Table 4.1: The weather of Sonoita Natural Area
(high and low temperatures, amount of rainfall during each month (Annual Weather)).