

FIVE-YEAR REVIEW & ANNUAL REPORT 2020

INSIDE

Who is the CCRN?
How the CCRN works
5-Year Road Map
Accomplishments
CCRN Sites and Projects
Lessons Learned
Monitoring Program



FIVE-YEAR REVIEW & 2020 ANNUAL REPORT

June 11, 2021

CONTENTS

WHO WE ARE	1
HOW WE WORK.....	2
Charting the Path: CCRN 5-Year Road Map	4
Groundwater Modeling: Looking to the Future	6
WHAT WE'VE ACCOMPLISHED	7
Water Benefits	8
Lessons Learned in Water Management	9
CCRN SITES AND PROJECTS	11
HYDROLOGIC MONITORING PROGRAM	28
2020 ANNUAL ACCOMPLISHMENTS	29
ACRONYMS & ABBREVIATIONS.....	30
REFERENCES	30

BACKGROUND

In 1988, Congress designated the San Pedro Riparian National Conservation Area, or SPRNCA, as the nation’s first Riparian National Conservation Area to protect this area’s unique natural and cultural resources. Spanning 43 miles along the river and managed by the U.S. Bureau of Land Management (BLM), the SPRNCA is located in Cochise County near the City of Sierra Vista and the U.S. Army post Fort Huachuca.

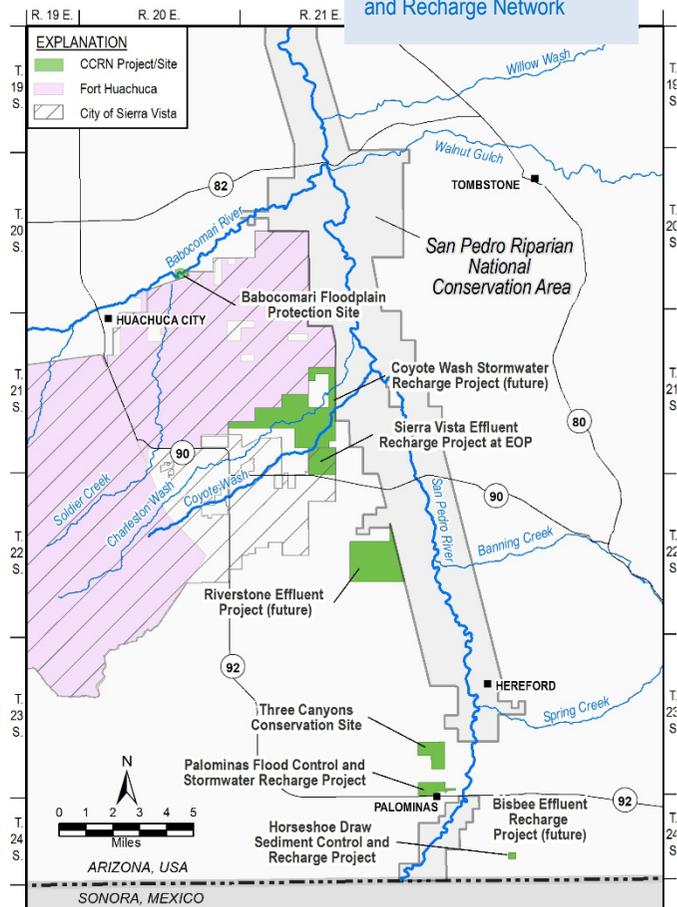
The groundwater that Fort Huachuca and local communities use for homes, businesses, and agriculture is the same water source that keeps the San Pedro River flowing and sustains the riparian area. Local and federal partners of the Cochise Conservation and Recharge Network have joined forces to develop innovative projects for a resilient water supply for both people and nature along the San Pedro River.

WHO WE ARE

The Cochise Conservation and Recharge Network (CCRN) was formed in 2015 to implement projects that could meet the area’s water needs. Collaboration, innovation, and science-based decision making are the CCRN’s guiding principles. The projects are designed to increase groundwater recharge and protect groundwater resources in the most strategic places, thereby helping to ensure both the health of the riparian corridor and water security for communities. As of 2020, the CCRN consists of 8 project sites totaling more than 6,000 acres along 25 miles of the San Pedro River, as shown on Figure 1. The sites benefit the aquifer and river through a combination of managed aquifer recharge, retiring historical pumping, and precluding future pumping.

Each of the 8 CCRN sites is summarized in the CCRN Sites and Projects section of this report.

Figure 1. Sites and projects in the Cochise Conservation and Recharge Network



To accomplish its goals, the CCRN not only designs and builds projects, but also supports a long-term monitoring network, and conducts hydrologic modeling and engineering studies. When the network is complete, the CCRN's science-based approach and innovative water management projects will help sustain the aquifer and the river long into the future.

This 5-Year Review summarizes the CCRN purpose, projects, and accomplishments during its first 5 years. The CCRN intends to release annual reports beginning in 2021. For additional information visit CCRNSanPedro.org.



The CCRN was originally formed by the City of Sierra Vista, Cochise County, Hereford Natural Resource Conservation District, and The Nature Conservancy (TNC). The City of Bisbee joined in 2016 and Fort Huachuca joined in 2021. CCRN projects are successful because its members collaborate on common goals and effectively leverage their resources.

The mission of the CCRN compliments other collaborative conservation efforts in the region. CCRN members also participate in the Upper San Pedro Partnership (USPP) and Fort Huachuca's Sentinel Landscape Program (FHSLP). The USPP is a group of 21 agencies and organizations that has provided a forum for collaborative development of the hydrologic science for the region, including predictive hydrologic models, research, and monitoring programs, which have been used in developing CCRN projects. The FHSLP is a forum for additional collaboration in the region on restoration, conserving working lands, and funding initiatives. The FHSLP is a joint effort of the U.S. Departments of Agriculture, Defense, and the Interior and is dedicated to promoting natural resource sustainability in areas surrounding military installations, in this case, Fort Huachuca, the U.S. Army post in Sierra Vista.

CCRN MISSION

To implement a regional network of land and water management projects that result in a healthy watershed, flowing San Pedro River, conservation of water resources, and a vibrant local economy.



HOW WE WORK

The CCRN's water management approach focuses on ways to ensure the right amount of water is available in the right locations at the right times.

Aquifer recharge is a process for storing water underground. In the case of the San Pedro River, recharge projects increase groundwater levels in key locations, where it is needed the most. Figure 2A illustrates how groundwater is connected to streamflow in the river.

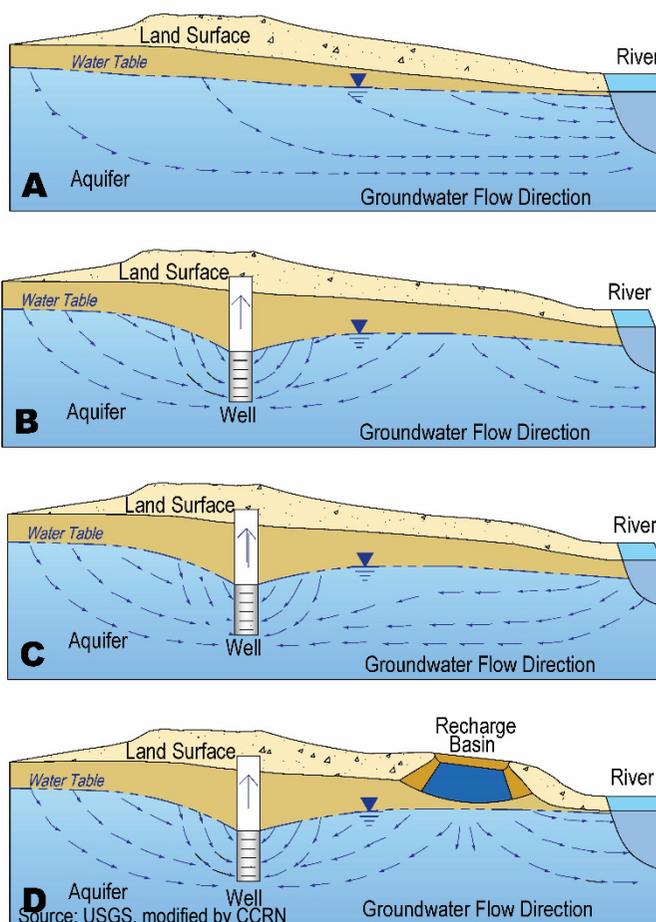
Figure 2B shows that groundwater pumping creates a "cone of depression" in the water table, increasing the depth to groundwater around large pumping centers. A cone of depression can initially reduce streamflow by intercepting groundwater that is flowing toward the river.

Over time, Figure 2C shows as the cone of depression expands toward the river, it can reverse water flow direction and "capture" or take water out of the river.

Figure 2D demonstrates how recharging water into the ground in key areas between a cone(s) of depression and the river, recharge basins can stabilize or even increase groundwater levels, minimizing pumping impacts on the river.

The CCRN recharge projects are helping nature replenish groundwater by storing high quality effluent and accelerated stormwater runoff underground in these key locations where they can most benefit the flows of the river and the regional groundwater aquifer.

Figure 2. Conceptual representation of groundwater-surface water connection and groundwater recharge project



The CCRN also focuses on protecting groundwater through conservation easements that permanently restrict high volume pumping and large-scale developments on key parcels of land.

CCRN Project Criteria



Benefits to the river or aquifer are measurable and consistent with CCRN goals.



Volumes of local water for recharge (stormwater or effluent) are measurable and used efficiently.



Recharge facilities are monitored for groundwater level changes and other responses.



Project complies with applicable laws and regulations.



A CCRN member entity has ownership or authority of the site and/or site activities.



Charting the Path: CCRN 5-Year Road Map

The [CCRN Road Map](#) lists CCRN priorities and specific goals and objectives for developing and maintaining projects. The Road Map covers a 5-year period and is reviewed annually as a group to create project-specific work plans for the coming year. The

initial CCRN Road Map covered 2015-2020; however, the main goals were largely accomplished by 2019, so a new 5-year Road Map was adopted by the group in 2020. The Goals and Objectives in the current 2020-2024 Road Map are listed below.

GOAL 1 Groundwater Recharge

Ensure continued operation of all network sites and begin implementation of 3 new recharge projects using local water supplies to sustain groundwater levels that preserve flows and habitats of the San Pedro River

- **Objective 1.1** Design and/or construct 3 additional recharge infrastructure projects: Coyote Wash Urban Enhanced Runoff, Riverstone Effluent, and Bisbee Effluent.
- **Objective 1.2** Continue the operation, maintenance, and hydrologic monitoring of all existing network sites, to quantify and continuously improve the design and effectiveness of projects, and to address legal and regulatory compliance.

GOAL 2 Water Conservation

Protect local sources of water while supporting the local economy

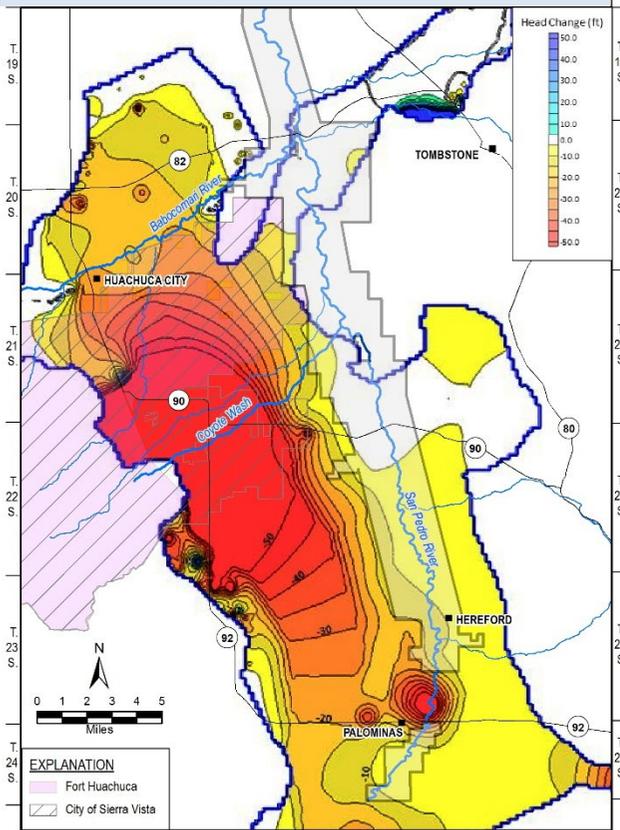
- **Objective 2.1** Implement conservation and watershed health projects that are most effective at maintaining groundwater levels to support flow in the San Pedro River.
- **Objective 2.2** Implement projects that maintain groundwater levels in the regional aquifer.
- **Objective 2.3** Continue to use the groundwater model and other tools to evaluate the combined effects of recharge, water conservation, and watershed health projects to maximize the effectiveness of CCRN efforts.

Groundwater Modeling: Looking to the Future

Groundwater modeling is a tool the CCRN uses to project water level changes under various future water demand and management scenarios. A groundwater model for the region was originally developed by the U.S. Geological Survey based on data available through 2003 (Pool and Dickinson, 2006). The model was later updated by the CCRN and is now being used to design the CCRN's groundwater protection and recharge projects.

The CCRN has used groundwater modeling to guide the location and amount of recharge water needed to achieve the desired groundwater levels that support stream flows and riparian health. These modeling scenarios project that operation of the full network of proposed CCRN projects would maintain groundwater levels in the alluvial aquifer and baseflow in the San Pedro River at or above the 2003 calibration period levels from the original USGS report through 2075.

Figure 3. Regional decline in groundwater levels projected by 2075, under status quo conditions



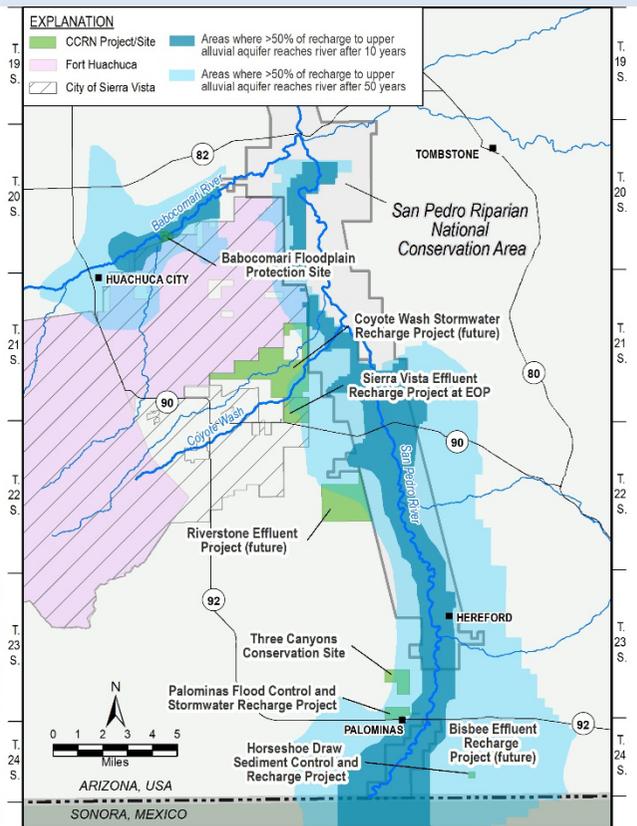
Source: L. Lacher, groundwater modeling presentation to CCRN, December 2018

Figure 3 shows the change in the depth to groundwater projected in the year 2075 compared to the baseline year of 1902 if no additional water management measures were to be implemented. The orange and red areas depict where groundwater levels are predicted to decline the most.

While groundwater model projections can be used to define future water management challenges, they also can help to select the best management alternatives.

Groundwater modeling also predicts how much streamflow is “captured” or “intercepted” by groundwater pumping in a specific location, which helps identify the best locations for recharge projects. Recharge projects along the river in the alluvial aquifer will most directly benefit the adjacent river.

Figure 4. Area where groundwater pumping will capture 50% or more of the groundwater moving toward the river in 10 and 50 years



Sources: USGS capture map; data modified by CCRN Leake, et al., 2008

The blue area on Figure 4 shows the zone where projects can most effectively recharge and/or protect the aquifer to help the river and riparian corridor. The blue areas indicate areas where 50% or more of water that is recharged is expected to benefit the river within 10 and 50 years, respectively. The same can be said for water that is no longer pumped in this area; 50% of the water saved by retiring pumping will be made available to the river again within that same timeframe. Recharge projects outside of those areas will take longer, and in some locations much longer, to benefit the river (Leake, *et al.*, 2008).

CCRN groundwater modeling shows that operation of the full network of proposed projects would maintain groundwater levels in the alluvial aquifer and baseflows in the San Pedro River at or above 2003 levels through 2075.

WHAT WE'VE ACCOMPLISHED

To date, CCRN project benefits total 40,846 acre-feet (AF)* with 17,179 AF of recharge, 15,528 AF of retired pumping, and 8,139 AF of precluded pumping.

*since 2015

CCRN Total Water Benefits (in acre-feet)

	Recharge	Retired Ag Pumping	Precluded Pumping	Total Benefits
2015	2,872	2,588	1,352	6,812
2016	2,696	2,588	1,352	6,636
2017	2,725	2,588	1,352	6,665
2018	2,942	2,588	1,361	6,891
2019	3,000	2,588	1,361	6,949
2020	2,945	2,588	1,361	6,893

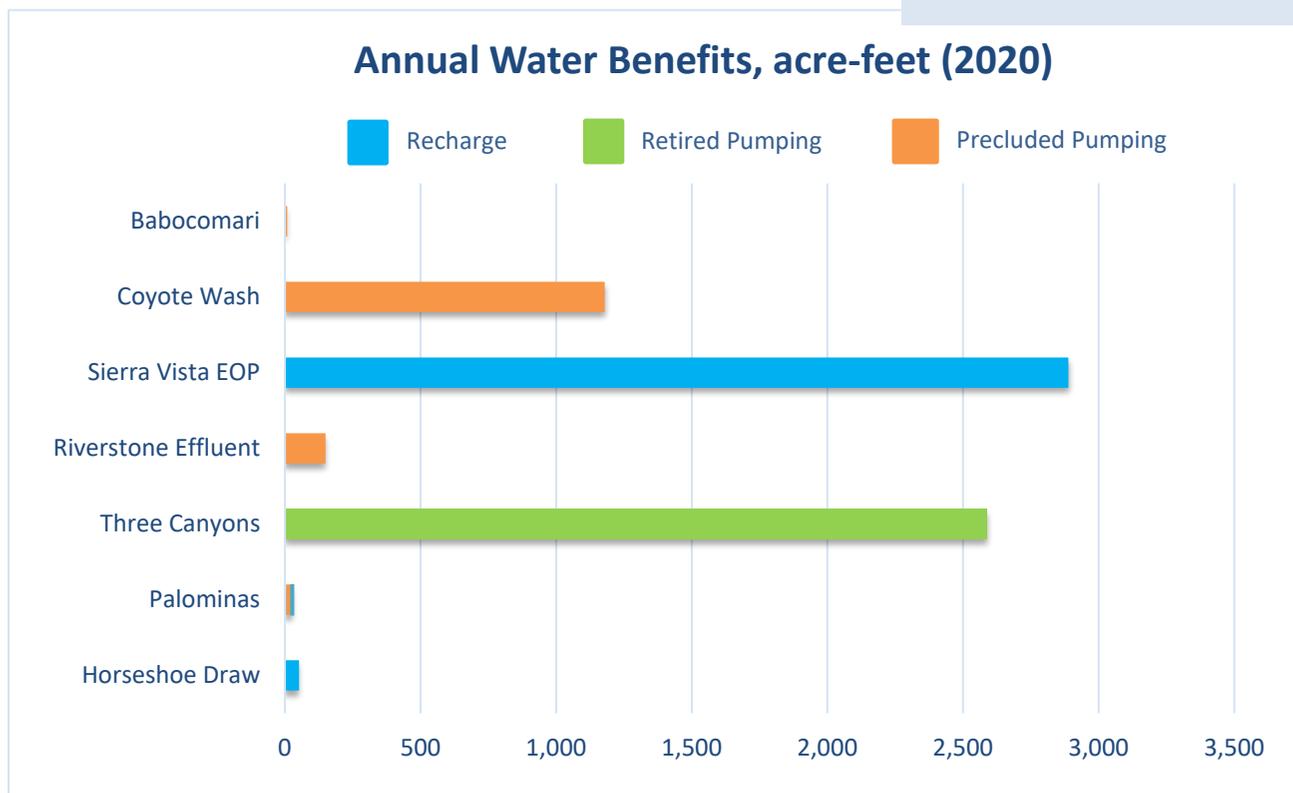


Water Benefits

CCRN tracks the water benefits by year at each site. The benefits are a combination of reported recharge and calculated water savings. Water savings are calculated as how much pumping in the future is prevented or precluded and, where applicable, the retirement of historical pumping. Future pumping is prevented through permanent conservation easements placed on land that legally restrict use of groundwater. Several sites where pumping has been retired and/or precluded also serve as current or future recharge projects. The CCRN methodology for calculating the quantity of precluded pumping is generally consistent with the 2014 Biological Opinion for Fort Huachuca (Fort Huachuca, 2014). This calculation is based on the zoning density of the parcel with an average of 2.5 people per household, at a per capita usage of 118 gallons.

The Benefits of the current CCRN projects are shown on Figure 5. There are other projects being pursued by individual members that are not reflected on this list. CCRN projects provided more than 6,000 AF of water benefits to the San Pedro River in 2020, and more than 40,000 AF since the formation of the CCRN in 2015. Two of the projects, the Sierra Vista Effluent Recharge project at EOP and Three Canyons Conservation Site, are responsible for nearly 80% of the calculated water benefits accrued by the network.

Figure 5. Annual water benefits in 2020



Lessons Learned in Water Management

The hydrologic monitoring and modeling associated with these projects, as well as their engineering, design, construction, and maintenance has provided us with the following findings and insights.

- **Infiltration of stormwater runoff in ephemeral stream channels and large flood flows along the San Pedro and Babocomari Rivers result in significant amounts of natural recharge.** Ensuring that natural channels and floodplains remain unobstructed and able to convey floodwaters is important to ensure their proper function and the benefits of natural recharge. In addition, natural systems can be incorporated into more traditional, managed aquifer recharge facilities to increase their effectiveness.



- ◆ **In response to a natural flood event along the Babocomari River** in 2019, the natural recharge of flood flows during the monsoon season raised groundwater levels near the river more than 7 feet in one month, and the water table remained 2 feet higher several months later. In 2020 the recharge of flood waters again raised the water table more than 5 feet in one month. In contrast, regional groundwater levels are generally declining by about 0.6 foot per year in this part of the watershed.
- ◆ **Monitoring results from the Horseshoe Draw Sediment Control and Recharge Project** show that 25 to 50% of the recharge from the project is due to infiltration of stormwater within the ephemeral channel downstream of the constructed detention basin. Infiltration rates are relatively high in these channels. Other CCRN projects, such as Coyote Wash, are also being designed to utilize the “natural infrastructure” associated with ephemeral channels to take advantage of these relatively high infiltration rates and to minimize capital construction costs and future maintenance and operation expenses.

- **Given the relatively large and consistent annual yield of projects that utilize treated effluent for recharge, it is important to prioritize where these projects can be most beneficial, using predictive groundwater models. In some cases, multiple recharge locations may be required to optimize where the effluent produced at a given wastewater treatment plant can most effectively be used to maintain groundwater levels along a river or stream.** Treated effluent is a key resource for groundwater recharge not only because of its steady supply, but also the yield of these projects increases if future indoor water demands also increase.
- **Even during a long-term drought, infrequent storm events can produce significant volumes of runoff for use in groundwater recharge facilities when storms do occur. The use of stormwater for recharge, as a compliment to other recharge facilities with steady supplies of water, such as treated effluent, can significantly increase groundwater storage over the long term.** However, given the year-to-year variability in precipitation patterns, relying on stormwater alone as a source of water for aquifer recharge will likely not be adequate in the short term to maintain or replenish regional groundwater supplies.

Precipitation monitoring occurs at 4 locations in the network to improve estimates of stormwater runoff and better understand the relationship between rainfall, runoff, and recharge. The annual and seasonal

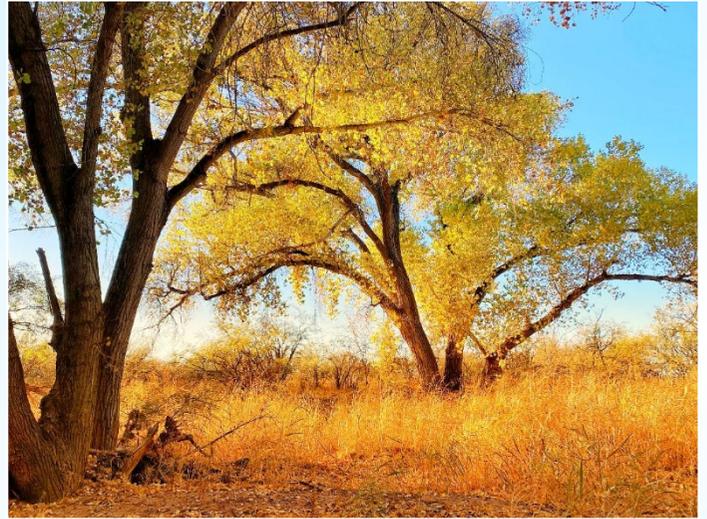
precipitation at each site is compared to the historical average precipitation for the San Pedro River Basin. Overall, 2020 was generally drier than average during all seasons, at all locations.

Table 1. Precipitation monitoring results

		2017	2018	2019	2020
Horseshoe Draw	Annual	Dry	Average	Average	Dry
	Monsoon (July-Sept)	Dry	Average	Dry	Dry
	Non-Monsoon	Dry	Average	Wet	Average
Palominas	Annual	Average	Wet	Wet	Average
	Monsoon (July-Sept)	Average	Average	Average	Dry
	Non-Monsoon	Average	Average	Wet	Average
Riverstone	Annual	Dry	Average	Average	Dry
	Monsoon (July-Sept)	Average	Average	Average	Dry
	Non-Monsoon	Dry	Average	Average	Average
Coyote Wash	Annual	Dry	Average	Average	Dry
	Monsoon (July-Sept)	Dry	Average	Average	Dry
	Non-Monsoon	Dry	Average	Average	Dry

Note: Precipitation is highly variable year-to-year and across project sites in a given year.

Source: J.E. Fuller, 2021



CCRN SITES AND PROJECTS



Horseshoe Draw Sediment Control and Stormwater Recharge Project

Project Description

Horseshoe Draw is an ephemeral tributary to the Upper San Pedro River. The Horseshoe Draw Sediment Control and Stormwater Recharge Project receives accelerated runoff that originates in the San Jose Mountains in Mexico. Before the project was constructed, a large head-cut had been steadily eroding Horseshoe Draw upstream of its confluence with the San Pedro River. Pictured below, the recharge project consists of an 8-acre detention basin that collects and slows the runoff, enhances infiltration to the aquifer, and improves downstream water quality.

The Horseshoe Draw Project is located on the San Jose Ranch, on the east side of the San Pedro River. The project is managed by Cochise County, but situated on a private cattle ranch. Project studies and planning were conducted in 2015-2016, with design and construction completed in 2017. Infiltration monitoring began in 2019.



AT A GLANCE

Project Partners:

San Jose Ranch, Hereford Natural Resource Conservation District (NRC), Cochise County

Site Size:

40 acres

Type:

Recharge of accelerated runoff in an ephemeral channel

Status:

Completed in 2017

Funding Sources:

ADEQ, Howard Buffett Foundation, Cochise County, Hereford NRC

Water Benefits

*219 AF since 2019
52 AF in 2020*

Significant Features and Lessons Learned

Multiple Benefits

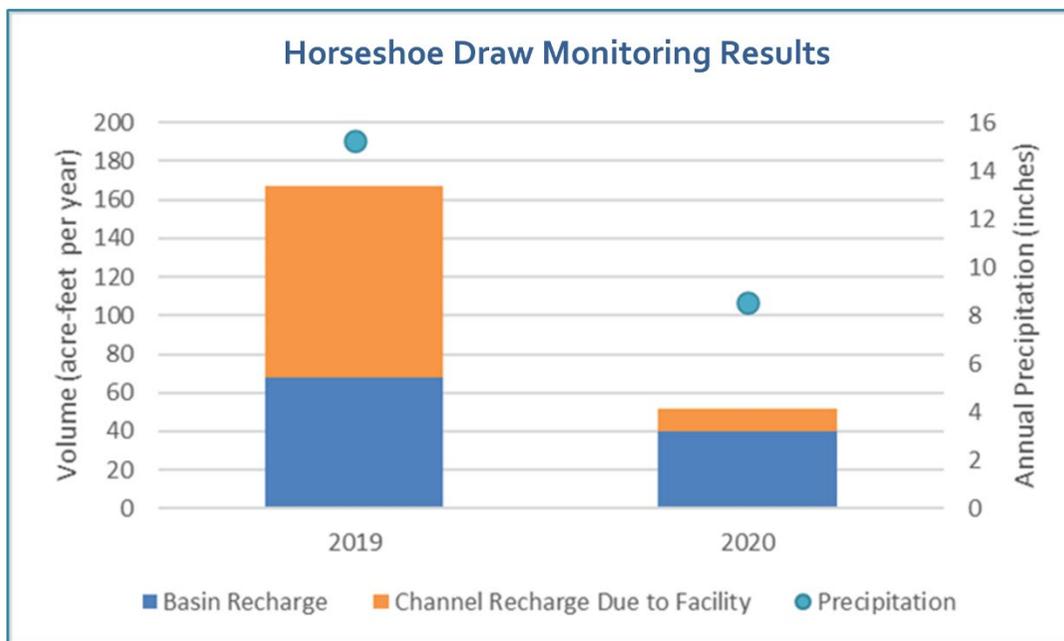
The project prevents further erosion of a sacaton grassland, controls runoff of sediment and E. coli into the San Pedro River and enhances groundwater supplies by recharging stormwater underground into the aquifer.

Precipitation Patterns

Because the watershed is relatively large (more than 10,000 acres), storms in the upper portion of the watershed in Mexico can result in channel runoff despite little to no rainfall at or near the site. This highlights the importance of precipitation monitoring both in the larger watershed and on site. With 2 years of monitoring data, shown below, more precipitation results in more recharge.

Ephemeral Channels

This project demonstrates the importance of ephemeral stream channels in recharging groundwater. Monitoring results show that the detention basin slows and extends the time of release of the stormwater into the channel downstream of the basin, allowing additional time for both infiltration and recharge. It appears that this benefit to natural channel recharge may be particularly important during wetter years with larger and/or more frequent events, as was observed in 2019.



Source: J.E. Fuller, 2021

Bisbee Effluent Recharge Project (future)

Project Description

The Bisbee Effluent Recharge Project will be located between the international border and Highway 92 in Palominas at a near-stream location to be determined east of the San Pedro River. This area is where streamflows have declined most significantly in SPRNCA, based on 20 years of monitoring. The facility will be designed to recharge a minimum of 200 AF/year of effluent transported via a 13-mile pipeline from the City of Bisbee's San Jose Wastewater Treatment Plant. Cochise County and the City of Bisbee signed a five-year Option Agreement in the summer of 2019 that gives the County the option to purchase a minimum of 200 AF/yr of treated effluent for use in near stream recharge for 25 years.

CCRN partners are working on establishing the right of way for the pipeline in cooperation with federal agencies along the international border. The location of the project will be determined by the pipeline route, land acquisition, and hydrogeologic investigations and groundwater modeling that demonstrate the most benefit to the river. Funding is required from outside partners to ensure the success of this project before the option agreement expires in 2024.



AT A GLANCE

Project Partners:

City of Bisbee, Cochise County, TNC

Size:

TBD

Type:

Effluent recharge project

Status:

Option to purchase effluent expires in 2024

Funding Sources:

Cochise County, TNC

Water Benefits:

Minimum 200 AF/year, once constructed

Significant Features and Lessons Learned

Critical Location

The results of 20 years of “wet-dry mapping” each June indicate this reach of the river is where pre-monsoon flows have most significantly declined during the hot, dry summer months. The cause for this decline, at least in part, is likely pumping in Mexico, where similar declines in the Mexican river reaches have also been observed. Groundwater modeling shows that further declines will continue without a significant volume of recharge in this area. The continued decline of stream flows and the water table would impact the health of the streamside forest that provides an important habitat for millions of birds each year, and many other species of wildlife.

Funding Needed

The Option Agreement was funded by the County (\$25,000) and TNC (\$10,000). The pipeline is estimated to cost between \$5.4M-\$7.9M. Additional project costs are design and engineering of the recharge facility, land and right-of-way acquisition, construction of recharge facilities to receive the effluent, and long-term operation and maintenance costs. Finally, an additional payment of \$150,000 to Bisbee will be required to exercise the 25-year agreement, and Bisbee will also receive \$60/AF of effluent that is delivered each year, up to 200 AF, and \$90 per acre-foot for additional water.



Palominas Flood Control and Stormwater Recharge Project

Project Description

The Palominas Flood Control and Stormwater Recharge Project is located along Palominas Road, just north of the Highway 92 intersection, on the west side of the San Pedro River, and is managed and owned by Cochise County. A conservation easement is held by The Nature Conservancy on the 285-acre parcel on the west side of Palominas Road. The facility is designed to recharge up to 98 acre-feet/year via its large detention basin and 13 recharge cells that together form a constructed channel. Natural sheet flow runoff from surrounding areas is conveyed to the channel, and the cells are designed to test and compare the effectiveness of various types of infiltration structures in terms of how much they enhance the storage of stormwater into the ground. The quicker stormwater can infiltrate into the soil, the more the aquifer is replenished, and evaporative losses are minimized.



AT A GLANCE

Project Partners:

Cochise County, TNC

Size:

285 acres

Type:

Stormwater (sheet flow) recharge project

Status:

Completed in 2014

Funding Sources:

WFF, Wingate Foundation, Fort Huachuca ACUB, TNC, Cochise County

Water Benefits:

Recharged: 93 AF since 2015; 4.9 AF in 2020

Precluded Pumping: 141 AF since 2015; 24 AF in 2020

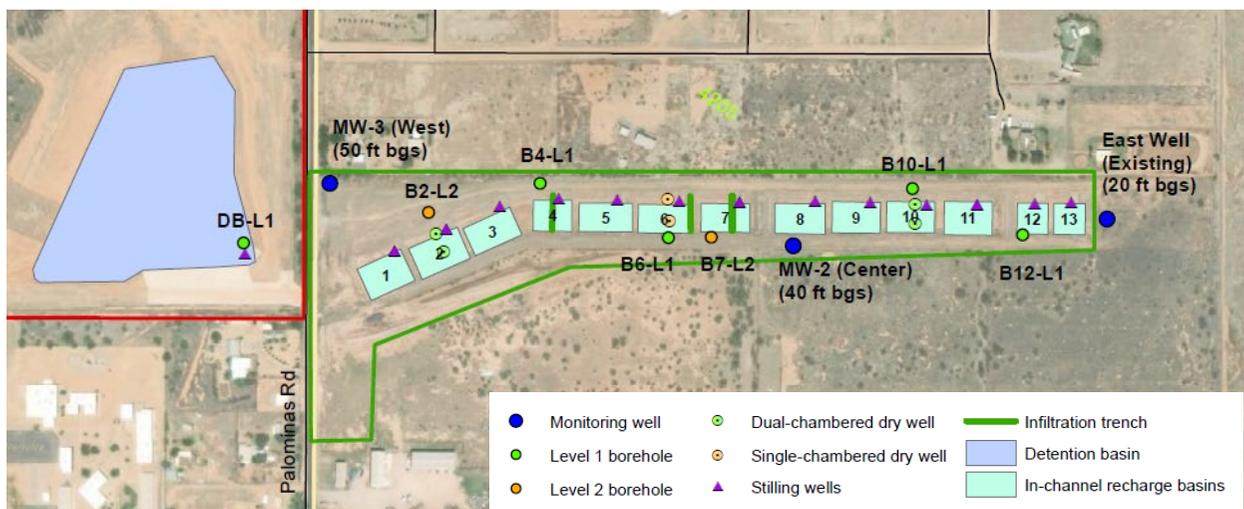
Significant Features and Lessons Learned

Multiple Benefits

This project has multiple benefits, including mitigation of flooding at a nearby school and homes. With more rapid infiltration, the project also enhances recharge and reduces evaporative water losses.

Test Site

The project is used to evaluate the most effective infrastructure and methods (dry wells, trenches, basins) for infiltrating stormwater into the ground. Results guide and inform the design of other CCRN recharge projects. Dry wells and trenches are both effective at capturing stormwater runoff, but thus far, infiltration galleries have recharged more water than dry wells due to their larger size. However, some clogging has occurred in the infiltration galleries, which can reduce infiltration rates. More data from larger storm events are needed to evaluate the relative performance of the different recharge enhancement features at the test site.

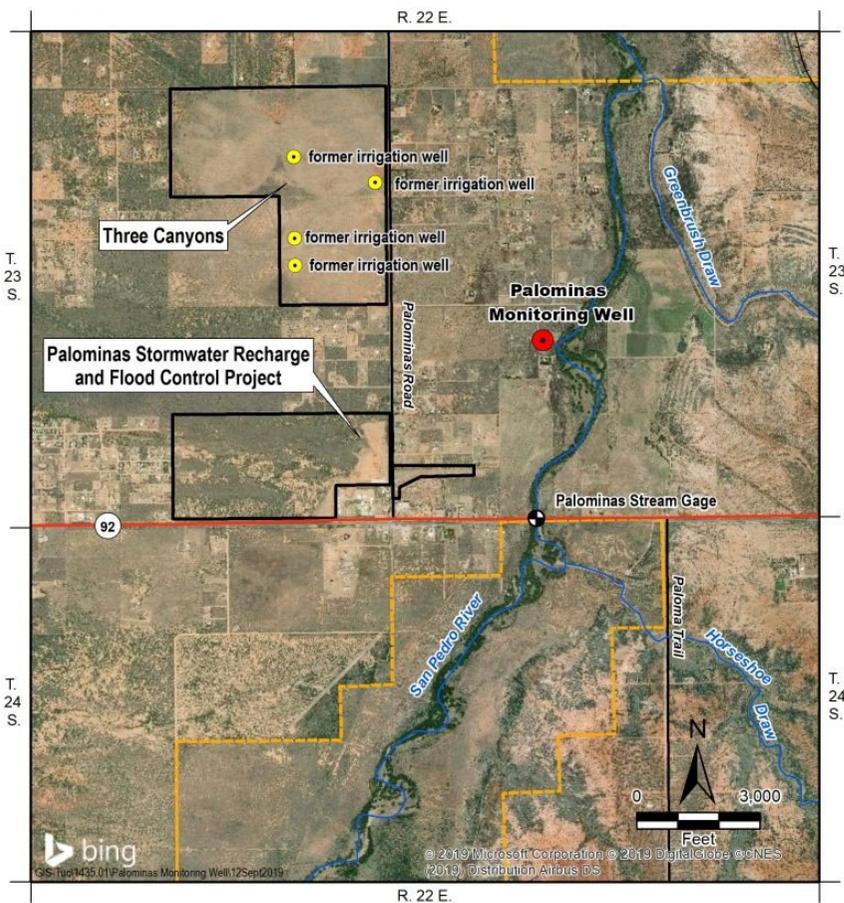


Recharge test features at the Palominas project (J.E. Fuller, 2021)

Three Canyons Conservation Site

Project Description

The Three Canyons Conservation Site is owned and managed by Cochise County. The City of Sierra Vista holds a conservation easement on this parcel that will permanently limit future groundwater pumping and development. The purchase of the property was originally funded by the U.S. Army and Fort Huachuca. Historically, large capacity irrigation wells on the property pumped approximately 2,500 acre-feet of water each year.



Three Canyons Conservation Site and Palominas Monitoring Well adjacent to the San Pedro River

AT A GLANCE

Project Partners:

*Cochise County,
City of Sierra Vista*

Size:

480 acres

Type:

*Retired high-volume
irrigation pumping*

Status:

Acquired in 2013

Funding Sources:

*Fort Huachuca, Cochise
County*

Water Benefits:

*Retired Pumping:
15,528 AF since 2015;
2,588 AF in 2020*

Significant Features and Lessons Learned

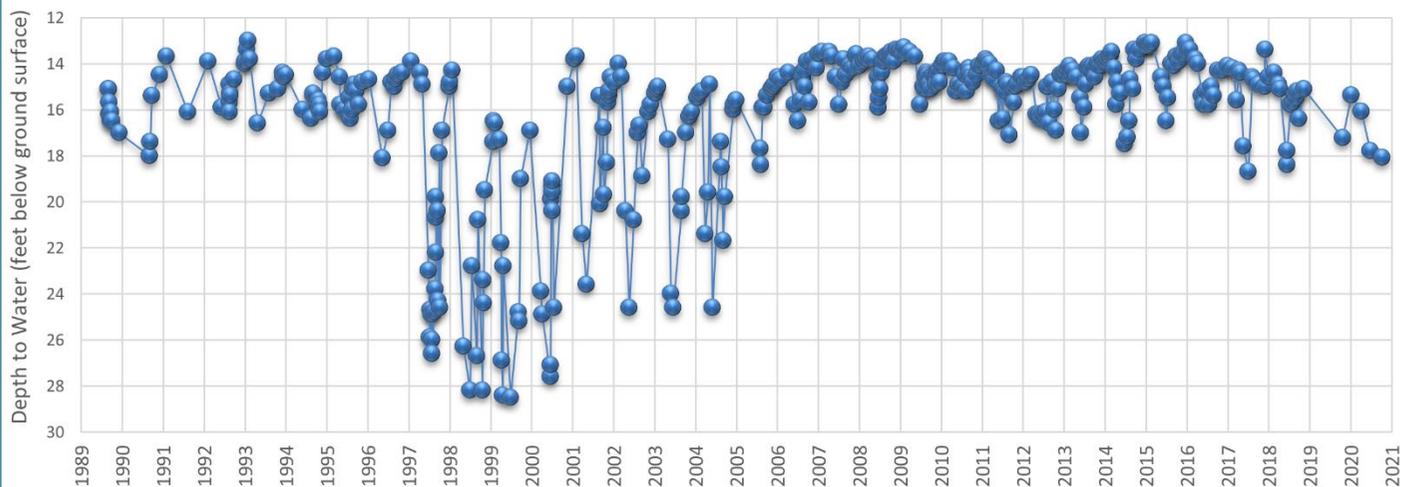
Protection of Local Wells

This project showcases how retiring high-volume pumping in strategic locations benefits not only the river, but also nearby Palominas property owners. The graph below is from a local residential well (the Palominas Monitoring Well, shown on the aerial photo). After the significant pumping for irrigation on this site was permanently retired in 2005, the groundwater levels rebounded over 20 feet to approximately pre-pumping water levels. All well owners in the area share the benefit when water levels rise.

Some Pumping Matters More

Not all pumping is created equally when it comes to saving a flowing river. This project shows that retirement of high-volume pumping in wells located close to the river presents the largest opportunity to protect flows in the river. Location and volume of pumping are the factors that matter the most when it comes to pumping impacts.

Palominas Monitoring Well Water Levels, 1989-2019



Riverstone Effluent Project (future)

Project Description

The future Riverstone Effluent Project is located on an 1,800-acre parcel adjacent to SPRNCA on the west side of the San Pedro River. The land was acquired in 2012 with funding from the ACUB program. The conservation easement precludes future development and associated groundwater pumping. The site is downstream of both developed and undeveloped areas of the City of Sierra Vista. Several ephemeral stream channels on the parcel drain into the San Pedro River.

The goal for the site is to construct an effluent recharge project that will raise near stream groundwater levels and increase downstream baseflow in the river. Initial project studies were completed in 2014, and groundwater and surface water monitoring began in 2016. Additional recharge feasibility studies are underway in 2021. Planning and design are expected in 2022 and construction is anticipated in 2023.



Historical erosion control structures on this property built many decades ago continue to slow accelerated stormwater runoff, trap sediment, and increase infiltration.

AT A GLANCE

Project Partners:

*TNC, Cochise County,
City of Sierra Vista*

Size:

1,811 acres

Type:

*Recharge of high-quality
effluent from City of
Sierra Vista*

Status:

*Acquired in 2012;
currently in design phase*

Funding Sources:

*Fort Huachuca ACUB,
WFF, TNC, Cochise
County, City of Sierra
Vista*

Water Benefits:

*Precluded pumping:
898 AF since 2015
150 AF in 2020*

Significant Features and Lessons Learned

Strategic Partnership

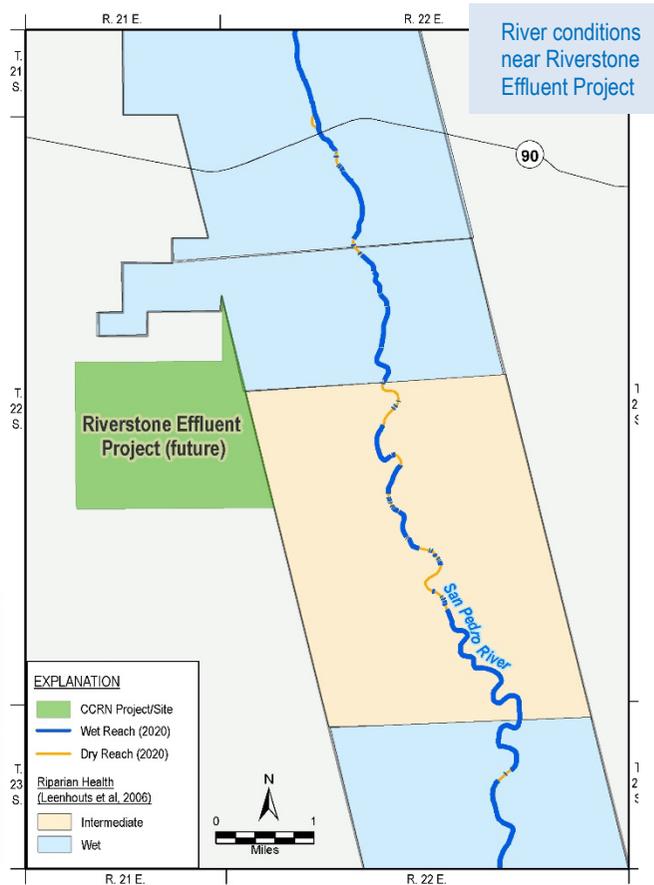
The purchase of this large property was the result of the strategic partnership between The Nature Conservancy, Fort Huachuca, and the U.S. Army's Compatible Use Program (ACUB). This land had previously been slated for development and now the lands and waters are permanently protected. Cochise County has subsequently assumed ownership and management of the property and is now working with Sierra Vista to design and develop effluent recharge facilities on it.

Joint Funding

The initial engineering for the recharge project in 2021 is jointly funded per an agreement between The Nature Conservancy, Cochise County, and the City of Sierra Vista. Additional funding is needed to construct the effluent recharge project.

Location

The location of Riverstone Effluent Project represents a unique opportunity to enhance flows in a critical stretch of river. Nearly 2 decades of wet-dry mapping show that this site is at the start of the longest perennial reach of the river (see figure to right). Groundwater modeling suggests that effluent recharge at the site will not only raise groundwater levels but may increase downstream baseflow in about 15 miles of the San Pedro River and connect sections of the river that no longer flow year-round.



Sources: Leenhouts, *et al.*, 2006
The Nature Conservancy wet-dry mapping, 2020

City of Sierra Vista Effluent Recharge at the Environmental Operations Park

Project Description

The Sierra Vista Effluent Recharge Project at Environmental Operations Park (EOP) is located on Highway 90 on the west side of the San Pedro River. The project recharges the city's "Class A" quality treated effluent and is raising groundwater levels in a critical area that is supporting San Pedro River flows by protecting the river from the main municipal groundwater pumping center.

Project operation began in 2002, with groundwater monitoring beginning that same year. Through the EOP's 11 recharge basins, an average of 2,000 AF is recharged annually, plus another 700 AF of incidental recharge that occurs in the adjacent EOP wetlands.



AT A GLANCE

Project Partner:

City of Sierra Vista

Size:

640 acres

Type:

Effluent recharge project

Status:

In operation since 2002

Funding Sources:

City of Sierra Vista

Water Benefits:

16,868 AF since 2015

2,888 AF in 2020

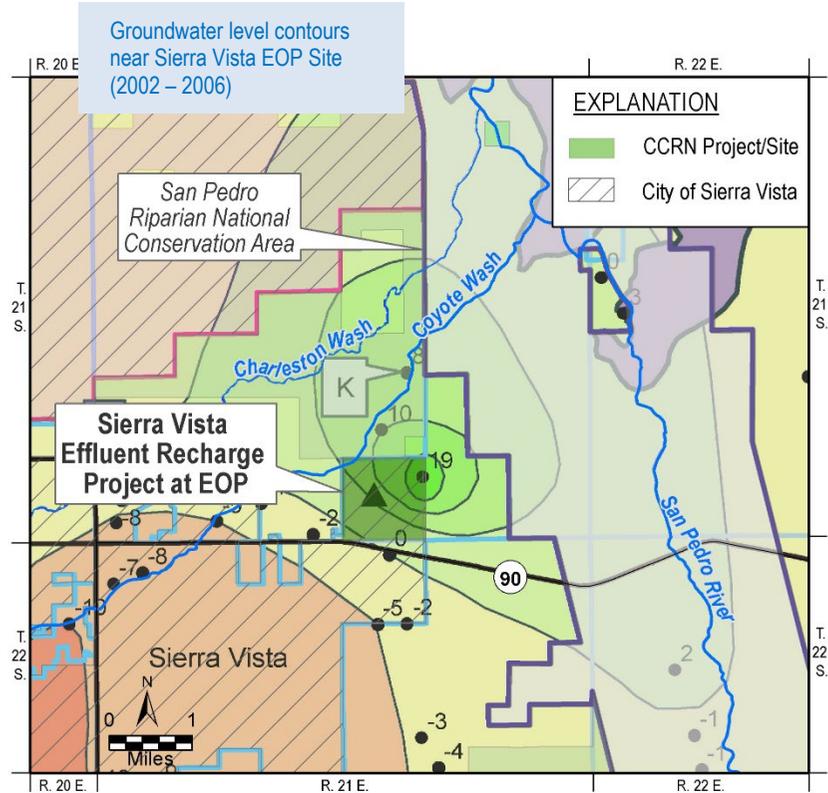
Significant Features and Lessons Learned

Groundwater Mounding Shows Success

Long-term, consistent recharge in this strategic location directly benefits groundwater levels and baseflows in the river. The “proof of concept” recharge project causes groundwater levels to rise, forming a “mound” in a critical area that is both supporting San Pedro River flows and helping to stabilize municipal pumping centers. Groundwater level contours prepared by the Arizona Department of Water Resources (ADWR) depict this mounding below, shown as concentric circles (ADWR, 2009). The numbers indicate the water level change observed in the wells after only 5 years of operation of the facility. The mound of water stored underground had increased water levels by 19 feet in its center, and extended over 5 miles, including areas under the San Pedro River.

Birds and Recreation

Constructed wetlands are part of the wastewater treatment facility at the EOP and provide habitat for birds and recreation for bird watchers at a public observation area, as well as increase groundwater recharge.



Coyote Wash Stormwater Recharge Project (future)

Project Description

The future Coyote Wash Stormwater Recharge Project, shown on the figure on the next page, will be located adjacent to and in an ephemeral stream channel that lies just downstream of the City of Sierra Vista and flows into the San Pedro River. The urbanized areas upstream produce additional stormwater runoff from streets, parking lots, and roof tops. Compared to undeveloped areas, these relatively impervious surfaces reduce the ability of rainfall to infiltrate into the ground as illustrated by the rainfall hydrograph on the next page. The future Coyote Wash Stormwater Recharge Project will capture some of this additional Urban Enhanced Runoff (UER) to recharge the underground aquifer. The recharge project is being designed to retain a portion of this flow while also allowing natural runoff to continue downstream. The goal of the project is to raise groundwater levels in a critical area that supports river baseflows and protects the river from municipal groundwater pumping centers. By reducing runoff and erosion, the project will reduce E. coli, other contaminants, and sedimentation downstream, improving the water quality in the San Pedro River.

The Coyote Wash Stormwater Recharge Project will be located on the Bella Vista Ranch parcel, which encompasses nearly 3,000 acres. The land was acquired in 2013 with funding from the ACUB program. The parcel is owned and managed by Cochise County. Initial project assessments began in 2015, and final engineering and design work is currently underway.



AT A GLANCE

Project Partners:

*Cochise County,
City of Sierra Vista, TNC*

Size:

2,984 acres

Type:

*Stormwater recharge
project*

Status:

*Acquired in 2013;
currently in design phase*

Funding Sources:

*Fort Huachuca ACUB,
WFF, Cochise County,
TNC, NRCS*

Water Benefits:

*7,075 AF since 2015
1,179 AF in 2020*

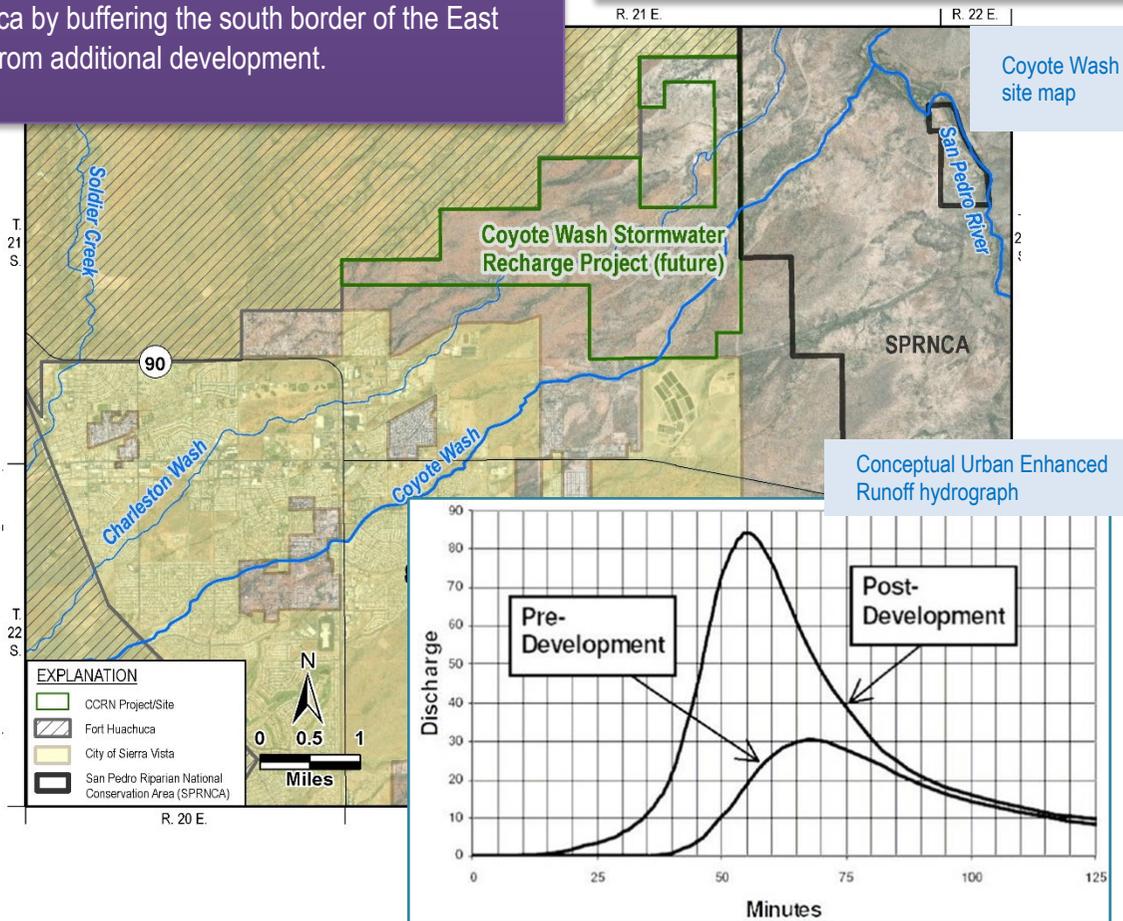
Significant Features and Lessons Learned

Strategic Partnership

Similar to the Riverstone project, the purchase of this large property was the result of the strategic partnership between The Nature Conservancy, Fort Huachuca, and ACUB. The property had previously been slated for development, for up to 3,500 homes but was instead purchased for conservation and water protection. Subsequently, Cochise County has assumed ownership and management of the property and is now working with Sierra Vista to develop urban enhanced runoff stormwater recharge facilities. This site not only conserves groundwater near the San Pedro River, but also protects Fort Huachuca by buffering the south border of the East Range from additional development.

First in Arizona

This innovative project to capture and recharge urban enhanced runoff to benefit a flowing river that depends on groundwater to keep flowing is the first of its kind in Arizona. The project uses problematic runoff from downtown areas as a source of water for an aquifer replenishment project that will help protect the river over time. Additional funding will need to be secured to construct the project, including a detention basin and diversion structure.



Post-development “urban enhanced” runoff is generated from streets, parking lots, and roof tops, and is greater than pre-development runoff. This extra runoff is being harnessed as a source of water for recharge and as a result, will reduce problematic flooding and erosion. Recharging in key areas will also provide benefits to the San Pedro River. Results of groundwater modeling indicate the Coyote Wash project location is one of these key areas.

Babocomari Floodplain Protection Site

Project Description

The Babocomari Floodplain Protection site is located just downstream of Huachuca City, on the largest tributary to the Upper San Pedro River. The site consists of 3 parcels with conservation easements that collectively protect 488 acres of Babocomari riverfront and floodplain, as well as a 104-acre parcel now owned and managed by Cochise County. The site also buffers the north border of Fort Huachuca's East Range from additional development. An estimated 9 acre-feet/year of groundwater will not be pumped due to precluded development on a 104-acre parcel. While no recharge infrastructure project is currently planned at the site; initial studies suggest a future project at this location may raise groundwater levels and increase flows of the Babocomari River, connecting sections of the river that do not flow year-round.



AT A GLANCE

Project Partners:

Cochise County, TNC

Size:

488 acres

Type:

Precludes future pumping

Status:

Acquired in 2018

Funding Sources:

Fort Huachuca ACUB, TNC, Cochise County

Water Benefits (2020):

*26 AF since 2018
8.6 AF in 2020*

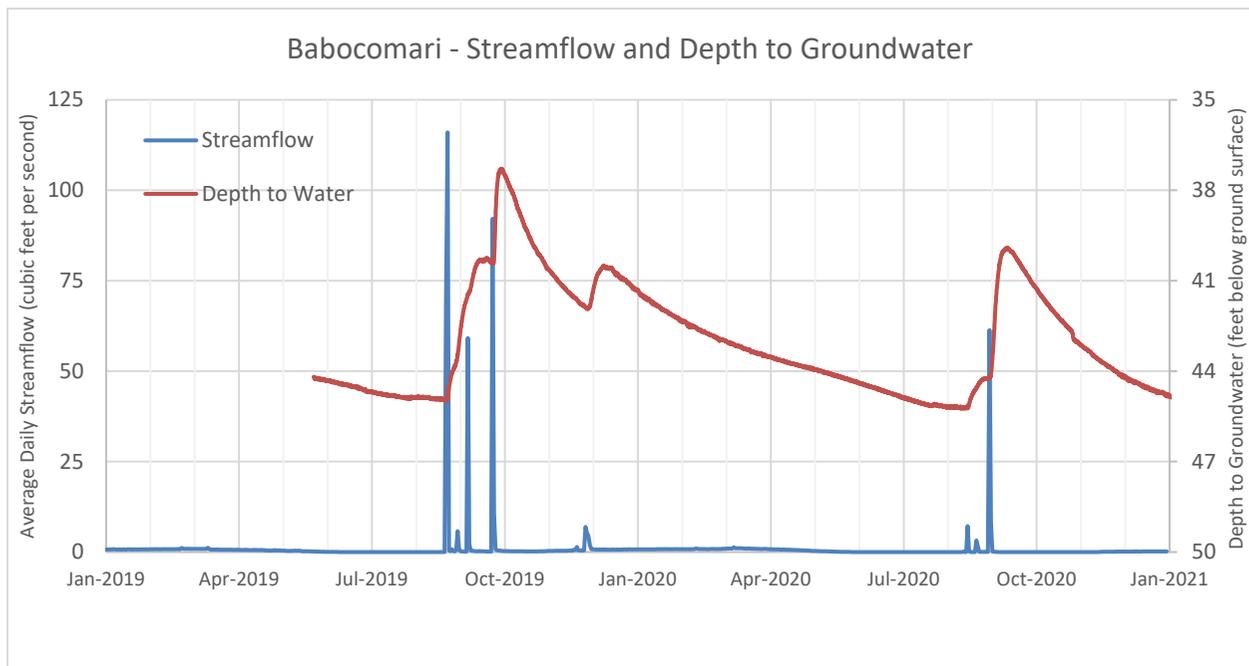
Significant Features and Lessons Learned

Benefits

Natural flood flows are important for recharging streams by storing water in floodplains. The benefits of natural recharge within floodplains were evident in 2019 at the Babocomari River project site. Flood flows during the monsoon season raised groundwater levels over 7 feet in one month, and the water table remained 2 feet higher several months later. A similar pattern was repeated in 2020, as shown on the graph below. Regional groundwater levels are declining by about 0.6 foot per year.

Ongoing Monitoring

Ongoing monitoring here shows how natural floodplain recharge increases water availability for the Babocomari River, supporting lush streamside forests and marshlands. Not only does this project conserve groundwater that will not be pumped due to precluded development, but it also buffers the northern border of Fort Huachuca's East Range from additional development.



Data from J.E. Fuller, 2021, Appendix H Groundwater Monitoring Digital Data

HYDROLOGIC MONITORING PROGRAM

Hydrologic monitoring is ongoing at all CCRN project sites. The objectives of the CCRN's Hydrologic Monitoring Program are to quantify the effectiveness of stormwater capture and groundwater recharge projects, aid in the improvement of the project designs, and address legal and regulatory compliance. The results for 5 Cochise County sites (Babocomari Floodplain Protection Site, Coyote Wash Stormwater Recharge Project, Riverstone Effluent Project, Palominas Flood Control and Stormwater Recharge Project, and Horseshoe Draw Sediment Control and

Recharge Project) are provided in the Annual Monitoring Reports (J.E. Fuller, 2020, 2021). Cochise County monitors the Three Canyons Conservation Site separately, and the City of Sierra Vista provides the data on the EOP effluent recharge project. The data collection at each site is tailored to the site features and project goals to support design, improve operation, and track results. Monitoring data includes precipitation, surface water runoff, and groundwater levels. The general types of monitoring data, equipment, and purpose are summarized below.

Table 2. Types of hydrologic monitoring in the CCRN

Type of Data	Type of Equipment	Purpose	Type of Project
Precipitation / barometric pressure	Rain gage Barometric pressure transducer	Monitor precipitation events to analyze rainfall/runoff characteristics and estimate recharge	Stormwater recharge
Surface water runoff (ephemeral streamflow monitoring or ESM)	Pressure transducer Flow photo monitoring (paired camera and stream gage) Weir	Estimate the stormwater flow into basins and in ephemeral channels Estimate the average annual urban enhanced runoff available for capture and aquifer recharge Estimate the natural flood flow regime Estimate amount of stormwater infiltrated onsite	Stormwater recharge
Soil moisture	Soil moisture sensor	Assess movement of water in vadose zone	Stormwater Recharge
Groundwater level	Pressure transducer (automated) Sonder (manual)	Track trends of local groundwater elevation in vicinity of project	Stormwater and Effluent Recharge Retired pumping

2020 ANNUAL ACCOMPLISHMENTS

Projects & Monitoring

- Developed new 5-year road map
- Total water benefits (recharged, retired pumping, and preclude pumping) 6,893 AF
- Recharged 11 billion gallons of treated effluent at Sierra Vista EOP since 2002
- Completed third year of operation at Horseshoe Draw Sediment Control and Recharge Project
- Palominas operated for sixth year, opened new parking area for trail system, and designed future trail system
- Continued conceptual design for Coyote Wash
- Surface water and groundwater monitoring continues

Funding

- City of Sierra Vista and Cochise County continue to fund the hydrologic monitoring program
- Prepared federal agency funding requests to assist with regional hydrologic monitoring
- Cochise County and TNC funded development of an RFP for the hydrologic assessment and conceptual effluent recharge project design for Riverstone Effluent Project
- Cochise County submitted a pre-proposal to the DOD to fund construction of Coyote Wash Stormwater Recharge Project

Outreach

- CCRNSanPedro.org website has been expanded
- A CCRN Fact Sheet on 2019 hydrologic monitoring was developed and posted on the website
- CCRN members continued to participate in the Sentinal Landscape Restoration Partnership
- Worked with staff from Fort Huachuca to develop a presentation about the efforts of CCRN, USPP, Fort Huachuca's Senital Landscape, and 20 years of water management
- *Military Engineer* featured CCRN recharge projects
- CCRN members made several virtual presentations, plus 2 in-person presentations that pre-dated COVID-19 travel restrictions

ACRONYMS & ABBREVIATIONS

ACUB.....	Army Compatible Use Buffer
ADEQ.....	Arizona Department of Environmental Quality
AF	acre-feet
BLM.....	Bureau of Land Management
CCRN.....	Cochise Conservation and Recharge Network
DOD	Department of Defense
EOP	Environmental Operations Park
FHSLP	Fort Huachuca Sentinel Landscape Partnership
NRCD.....	Natural Resource Conservation District
SPRNCA	San Pedro Riparian National Conservation Area
TNC.....	The Nature Conservancy
UER	Urban Enhanced Runoff
USPP	Upper San Pedro Partnership
WFF	Walton Family Foundation

References

- ADWR, 2009. Water level change map series report No. 3, Water-level conditions in the Upper San Pedro Basin, Arizona, 2006
- Barlow, P.M., and Leake, S.A., 2012, Streamflow depletion by wells—Understanding and managing the effects of groundwater pumping on streamflow: U.S. Geological Survey Circular 1376, 84 p. (Also available at <https://pubs.usgs.gov/circ/1376/>.)
- Fort Huachuca Biological Opinion, March 31, 2014, letter from U.S. Fish and Wildlife Service, corrected May 16, 2014.
- J.E. Fuller Hydrology & Geomorphology and GeoSystems Analysis, Inc., 2020. CCRN Hydrological Monitoring Program, 2019 Annual Monitoring Report. June 10, 2020.
- _____, 2021. CCRN Hydrological Monitoring Program, 2020 Annual Monitoring Report. June 3, 2021.
- Leake, S.A., Pool, D.R., and Leenhouts, J.M., 2008, Simulated effects of ground-water withdrawals and artificial recharge on discharge to streams, springs, and riparian vegetation in the Sierra Vista Subwatershed of the Upper San Pedro Basin, southeastern Arizona (ver. 1.1, April 2014): U.S. Geological Survey Scientific Investigations Report 2008-5207, 14 p., <http://pubs.usgs.gov/sir/2008/5207/>
- Leenhouts, James M., Juliet C. Stromberg, and Russell L. Scott, 2006. River Health: U.S. Geological Survey, 2006 Scientific Investigations Report 2005-5163, Hydrologic Requirements of and Consumptive Ground-Water Use by Riparian Vegetation along the San Pedro River, Arizona.
- Pool, D.R. and Jesse E. Dickinson, 2006. Ground-Water Flow Model of the Sierra Vista Subwatershed and Sonoran Portions of the Upper San Pedro Basin, Southeastern Arizona, United States, and Northern Sonora, Mexico. Scientific Investigations Report 2006-5228 Prepared in cooperation with the Upper San Pedro Partnership and Bureau of Land Management. <https://doi.org/10.3133/sir20065228>
- The Nature Conservancy Arizona, Results of June 2020 Wet-Dry Mapping in the SPRNCA



Prepared by The Nature Conservancy and Montgomery & Associates in cooperation with the CCRN
Funding provided by the Walton Family Foundation