MEMORANDUM

Date: June 2, 2015

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

From: C.H. Huckelberry
County Administrator

Re: Second Annual Living River Project Report Release – Charting Wetland Conditions of the Lower Santa Cruz River 2014 Water Year

Introduction

Data emerging from the Living River Project shows that important changes are taking place in the Lower Santa Cruz River. The attached Second annual Living River Report provides the first look at a host of river conditions before and after the completion of upgrades to Pima County's wastewater treatment facilities in December 2013. The new report and attached fact sheet document recent changes in the effluent-dependent Santa Cruz River; including water quality, aquatic life, water clarity, and infiltration during the 2014 water year (October 1, 2013 to September 30, 2014).

This is the second of three annual reports for which funding has been provided by the United States Environmental Protection Agency, Pima County Regional Wastewater Reclamation Department, Regional Flood Control District, and community individuals.

Findings

Highlights of the changes, compared to the 2013 water year, include:

- 27 percent greater floodwater volume in the river, primarily from runoff during the late monsoon;
- 12,000 acre-feet more effluent recharge via the riverbed, reflecting increased infiltration rates likely due to cleaner water;
- Decreased effluent releases from the Agua Nueva Treatment Facility;
- Decreased flow extent in both the upper and lower reaches;
- Improved water clarity and less muck covering the riverbed during normal, non-flooding conditions;
- Fewer odor complaints;
- Significant reduction in ammonia, improving conditions for aquatic wildlife; and
- Loss of some aquatic habitat due to a reduction in flow extent.

Public Outreach

This year, the Living River Project brought young people to the river for science-based classroom activities and field trips via Pima County's Environmental Education Program. This was the first opportunity for some students to experience a flowing river. During their visits to the river, students worked with local artists to create poetry and visual arts such as drawing and photography. The 2015 Living River of Words Art and Poetry Contest received over 900 submissions from 21 schools.

You are invited to see the traveling exhibit of art and poetry at the upcoming Living River celebration at Agua Caliente Park Ranch House Visitor Center and Art Gallery at 12325 E. Roger Road, on June 19, 2015 from 5 PM to 7 PM. This release party coincides with the popular Bugs and Bats Program later in the evening, an event hosted by Pima County and the Arizona Game and Fish Department. If you are planning to attend, please register at www.tiny.cc/LRCelebration.

CHH/mjk

Attachments

c: Robin Brigode, Clerk of the Board of Supervisors
John Bernal, Deputy County Administrator for Public Works
Suzanne Shields, Director, Regional Flood Control District
Jackson Jenkins, Director, Regional Wastewater Reclamation
Chris Cawein, Director, Natural Resources, Parks and Recreation
Linda Mayro, Director, Office of Sustainability and Conservation
James DuBois, Principal Hydrologist, Regional Wastewater Reclamation

living river celebration

AGUA CALIENTE PARK, RANCH HOUSE - 12325 EAST ROGER ROAD

June 19, 2015 5 to 7 pm

Join us for a casual evening to celebrate the Lower Santa Cruz River and other important regional water resources that support wildlife and maintain our rich heritage.

We hope you can make it!

ACTIVITIES

MEET OTHER WATER LOVERS WHILE ENJOYING LIGHT REFRESHMENTS

GET THE NEW *LIVING RIVER* REPORT WHICH SHOWS INITIAL EFFECTS OF BETTER WATER QUALITY

VIEW THE *LIVING RIVER OF WORDS* YOUTH POETRY AND ART EXHIBIT

CONNECT WITH ORGANIZATIONS WORKING ON RELATED ISSUES

STAY FOR "NATURE NIGHT - BATS AND BUGS" AT 7 PM

25 SONORAN INSTITUTE

PIMA COUNTY

2ND ANNUAL LIVING RIVER PROJECT REPORT

WHAT WE ARE LEARNING ABOUT THE LOWER SANTA CRUZ RIVER

Changes in Water Quality, Aquatic and Wetland Conditions

- **Ammonia no longer limiting life:** New data shows appreciably reduced ammonia levels; and nitrate, at low levels, is now the prevalent nitrogen form.
- **Oxygen availability not a stressor:** Biochemical Oxygen Demand (BOD) is now at nearly non-detectable levels. Dissolved oxygen essential for aquatic life has remained at steady levels, well above the problem conditions of past years.
- **Water clarity much improved:** Elevated levels of suspended solids can increase water temperature and rob water of dissolved oxygen. Suspended solids in the effluent flows have greatly decreased yielding a much clearer flow.
- **More diverse life:** Fish, turtles, and a greater diversity of pollution-sensitive macroinvertebrates are being seen in the river.
- **Vegetation changes will be a longer term:** No significant change observed.
- **Urban stormwater shows elevated metals:** The Pima County Regional Wastewater Reclamation Department (RWRD) sampled two monsoon events to document the difference in pollutant load between high-quality effluent and urban storm flow on the river. Besides high suspended solids, pollutants in upstream stormwater include elevated organic nitrogen, copper and selenium.

Physical Characteristic Changes

- **Increased infiltration rates and groundwater recharge:** Aquifer recharge on the study reach of the river in 2014 has more than doubled over the last year, which is a likely result of less fine-grained sediment (muck) in the riverbed. A bank to bank flood in September 2014 scoured the bed and further improved infiltration rates. Increased infiltration means that less water is lost downstream and more recharge credit is accrued.
- **Decreased flow extent:** At certain times in the fore-summer and fall corresponding with the highest reclaimed water demand, the river goes dry upstream of Ina Road and upstream of Trico Road. There were 94 dry days at the Trico Road gage, and the USGS reports lower than average flows.
- **Farmland runoff occurs:** Aerial surveys revealed farmland runoff as a material component of flow in the river north of our study area. There may be some farmland runoff into the river within the Marana Flats area.

Education/Public Perception

- **Public knowledge about the river is limited:** Environmental Protection Agency researcher Matt Weber found that while many people in Tucson know the Santa Cruz River was once perennial there is very little awareness that the river has flowing water today.
- **Public access to the river is limited:** A Pima County survey found that although the Loop trail and many parks are proximal to the river, actual physical access to the river bed and easy visual access to river views is limited.
- **Many kids have never been to a river:** The Living River of Words outreach effort provided the first contact with a flowing stream for numerous Tucson students. The Santa Cruz River habitat and flowing water created meaningful inspiration for both art and writing experience.
- **Reduced odor:** Extent and intensity of odors from treatment facilities have diminished with the completion of upgrades. Complaints have decreased significantly and RWRD continues to be vigilant about any transitory odor issues.

Living River of Words

Youth Poetry and Art Contest

Agave

Mario Reynoso, age 16

Amphitheater High School • Mrs. Hollman

Grand Prize–Art–Category 4

This book is dedicated to 2015 Living River of Words
Teacher of the Year, Carrie Hollman
from Amphitheater High School and all the teachers and parents or guardians that promote the integration of science and the arts while creating opportunities for children to connect with nature.

Living River of Words 2015 – 2016 Traveling Exhibit Schedule

April 4 – April 17, 2015
Wheeler Taft Abbett Sr. Branch Library • 7800 N. Schisler Dr.

April 20 – May 29, 2015
Joel Valdez Main Library • 101 N. Stone Ave.

June 6 – July 1, 2015
Agua Caliente Park – Ranch House Art Gallery • 12325 E. Roger Rd.

July 4 – August 2, 2015
Dusenberry-River Branch Library • 5605 E. River Rd., # 105

August 5 – September 7, 2015
Murphy-Wilmot Library • 530 N. Wilmot Rd.

September 10 – September 29, 2015
Pima County Juvenile Court • 2225 E. Ajo Way

October Oct 1 – November 2, 2015
Sam Lena-South Tucson Library • 1607 S. Sixth Ave.

November 5, 2015 – January 3, 2016
Martha Cooper Branch Library • 1377 N. Catalina Ave.

January 6 – February 8, 2016
Quincie Douglas Branch Library • 1585 E. 36th St.

February 10 – March 1, 2016
Valencia Branch Library • 202 W. Valencia Rd.

Living River of Words: Youth Arts and Science

Within these pages we celebrate the award winning works of poetry and art by local youth artists. Formally known as Tucson's River of Words, *Living River of Words* introduces children to watersheds and wetland habitats through a multi-disciplinary series of science investigations and the practice of poetry and visual arts.

Living River of Words encourages young people to explore how water moves through the landscape and the connections that plants, animals, and people have to water. After exploring these topics, children ages 5–19 have the opportunity to share their impressions with entries of poetry and/or visual art to *Living River of Words: Youth Poetry and Art Contest*.

The Living River Project

Since it began attracting people to the region more than 12,000 years ago, the Santa Cruz River has undergone a series of dramatic changes. Initially a flowing life force teeming with fish, frogs, and other wildlife, the river all but dried up over the last century as groundwater pumping increased along with the human population and its ever-growing demand for water.

Photo: Taelyn Johnson

Today, however, thanks to the release of effluent — or highly treated wastewater — into the river, certain sections of the Santa Cruz River again flow year-round. This practice is not only re-creating our flowing river heritage, but is also supporting important wildlife habitat and building a valued community amenity. As effluent helped create a thriving river ecosystem along this corridor, the community responded by building numerous river parks and The Loop recreational trail (www.pima.gov/TheLoop) to provide easier access to this river bounty.

Effluent in the Lower Santa Cruz River is not new; two wastewater treatment plants have been operating on this section of the river since the 1970s. What has changed is the quality of the effluent being released. In its largest public works project ever, Pima County recently completed the upgrade of the two wastewater treatment plants. The upgrade significantly improved the quality of water released into the river, a key ingredient for a healthier river. The river now attracts walkers and bikers and is a popular birding destination from the Sweetwater Wetlands to the Marana Flats.

The Living River Project aims to gauge conditions of this valuable ecosystem and track the impacts of our community investment. All Living River reports and associated documents for the Lower Santa Cruz River are available for download on the Sonoran Institute website at www.tiny.cc/lscr.

In 2014, EPA grant funding for the Living River Project allowed for student field trips to the flowing portions of the lower Santa Cruz River. This partnership made possible the expansion of the environmental science, poetry, and art residencies for students to prepare entries to the *Living River of Words: Youth Poetry and Art Contest*.

Photo: Wendy Burroughs

For Tucson area students a morning spent in the shade of mature willow trees on the banks of a flowing river is a very rare and special experience. While at the river, students conducted water quality tests and surveyed wildlife and riparian vegetation, using methods that mirrored the Living River Project indicator assessments. A visiting poet or artist spent time with the students by the river to guide their journaling and drawing in preparation for poetry writing and artwork back in the classroom.

Living River of Words Honors Youth Poets and Artists

This is the 14th year for this community celebration of water in the desert as part of the national River of Words. Many dedicated teachers brought their classes and individual students on outdoor excursions to learn about watersheds and wetlands habitats close to their schoolyards and neighborhoods. In these pages you will see the award winning youth poetry and art works that are the result of these field trips and school residencies.

Living River of Words (formally Tucson's River of Words) is a regional coordinator providing local support for River of Words. River of Words is a Project of The Center for Environmental Literacy at Saint Mary's College of California. River of Words is its own watershed: a linked network of people throughout the United States and the world who are committed to teaching the art and poetry of place to young people.

Thank You!

Many thanks to the community partners, school administrators, teachers, science, poetry and art instructors, judges, and graphic designers that worked diligently to bring Living River of Words through the 2015 cycle of activities.

Yajaira Gray, Wendy Burroughs, Jeffery Babson, Gavin Troy, Kimi Eisele, Josh Schachter, Carolyn King, Mariana Caballero, Morgana Wallace, Doris Evans, Rebecca Seiferle, David E. Dickerson, Brian Powell, Edie Price, Helen Wilson, Joy Mehulka, and NRPR interns Josue Romero, Arturo Valdenegro, Esperanza Zepeda, and David Veloz.

The Tortoise

The rough brown desert tortoise
Is eating the pink and purple
Flowers before the rain.
He hears thunder…BOOM!
It's sprinkling on the tortoise's shell.
The sprinkling stops and the tortoise
Walks to a puddle.

Shaylyn Pope, age 6
Bloom Elementary • Mrs. Martin
Grand Prize–Poetry–Category 1

Rain Is

Rain is wet and lovely
Rain is cold and blue
Rain is a peaceful treat

Jillian Marsalek, age 7
Mesquite Elementary • Mrs. Collins

Rain in the Desert

Gives both energy and rest.
great tapping refreshing
rest.
As tears drop from the clouds
a voice booms across the desert sky
permitting life to replenish itself
in this aquifer in the air.
Soft, cool,
rest.
An oasis of energy and life.

Maximillian Kassel, age 10
Sam Hughes Elementary • Ms. Chuc

The River

I saw a river it was green and white.
It was cleaning cans and it was bubbling bubbles.
I heard orange footed ducks and black and gray birds.
I felt rough trees, soft sand and the cold river.
That was the coldest thing I ever touched in my whole life.

Natalia Solis, age 9
Ochoa Community Magnet School • Mrs. Selden

Snowy Desert

It is a snowy night in the desert.
The bees buzz on A Mountain
while in Sabino Canyon the coyote drinks from the waterhole
while a Gila monster hunts in the snow that is as white as paper.

The desert tortoise's shell is a rock with a pattern.
A big black bat makes his wings go flap, flap, flap
over the aloe vera that looks as if it is trying to run away.

Near the Grand Canyon a roadrunner runs as fast
as a rattlesnake slithers away from Sedona Creek.

As dawn approaches the anxious animals scurry to their dens.
All the diurnal animals jump up like jackrabbits.

The prairie dog jumps out of his hole and goes to a creek.
The prairie dog gets as wet as a raincoat.

As the snow melts scorpions sulk.
Soon it will be hot and dry again.

Joshua Linneman, age 10
Erickson Elementary • Mrs. Martin

Dark Evening Clouds

Clouds white, the river swift,
sound of walking.
When years of the valley
look clay-brown,
Dark evening clouds
make a river.

Josiah Santamour, age 7
Agua Caliente Elementary • Mrs. Robinson
Grand Prize–Poetry–Category 2

The Dry Canyon

When I went to Sabino Canyon
There were rocks, pebbles, stones and boulders everywhere!
There were many lizards crawling all over the boulders.
They scampered quickly over all sorts of plants!
Cactuses of all kinds, prickly or smooth.
There was a roaring waterfall,
but beside that the rest was very dry.
The waterfall formed a shimmering lake
with little fishes swimming about.
At the top the view was beautiful!
There was a lot of tan, with many greens,
light and dark greens with a bit of blue
that was the waterfall that flowed into the pond.
As I walked toward a cactus, I saw a bird.
The bird was a woodpecker using its beak
to tunnel its way through the saguaro.
Peck, peck, peck…

Abigail Denton, age 9
Bloom Elementary • Mrs. Martin

Bees buzz around cactus flowers,
Butterflies look for water drops,
Rain clouds start to come,
Insects wait for a shower.

Sebastian Alvarez, age 6
Hudlow Elementary • Mrs. Winter

The Perspective of the Santa Cruz River

I come from a long line of rivers from many years ago.
I did not have much of a family
I lived with my Mother the Colorado River.
I got my color from the many different types of rain
And soil I passed through.
When there is a monsoon, I turn darker,
But when it sprinkles, I am lighter.
I have been taking care of nature since
I was trickle of rain run-off.
I have a story for you that tells how I came to be.
I will stop working once I have completed my job,
Bringing water to all living things around me.
One hundred years ago,
My life was part of a different water cycle,
So I gave water for different uses to the people back then.
I love my job and will never stop doing it
Until my bed gets dried up and all sandy.
Then hopefully I will still come back here
To the desert where water is so important.
Take care of me as I take care of you,
My friends…all living beings.

Zaxarie Silva, age 9
Ochoa Community Magnet School • Mrs. Elvick-Mejia

A River's Journey

Where have you been, River?
I came from the sky…
I fell into the mountain.
I dripped down. I got trapped.
I became a watershed.
Somehow, I escaped.
I kept searching for my family – the ocean.
Then, one day it was time to evaporate.
I floated up and turned into a white, fluffy cloud.
I couldn't hold on; let go of the sky.
I fell and hit the ground HARD!
I was everywhere…
Awhile later, I found my brother.
He also went through what I had.
In an instant, he began his ascent
Up into the sky as water vapor he went.
I haven't seen him since.
I ended up here, in this river.
Still searching for my family
An endless journey.
Hopefully, I will find them…
Maybe soon!

Jose Licea, age10
Ochoa Community Magnet School • Mrs. Elvick-Mejia
Grand Prize–Poetry–Category 3

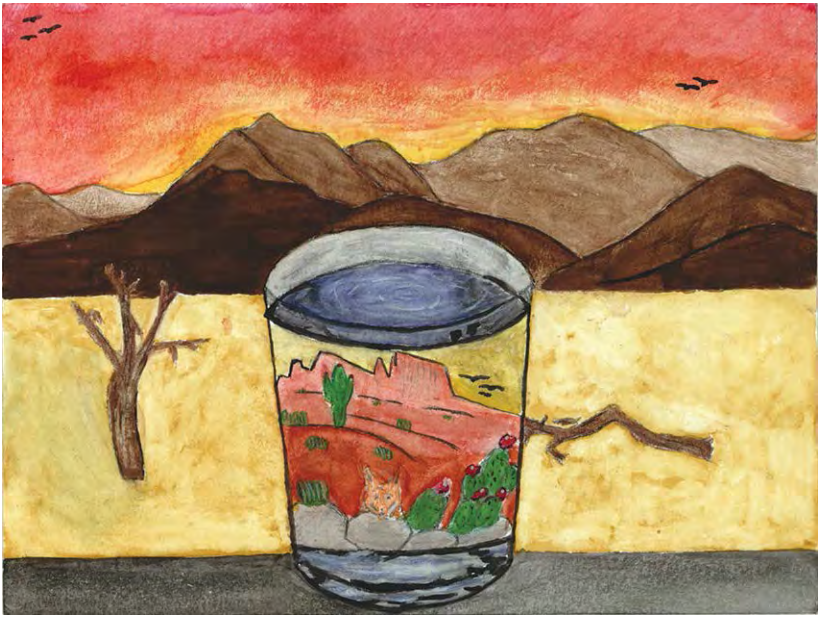
Giving

The lake
gives a cool drink
to an owl
on a moonlit night in the
canyon.

Kyla Boxley, age 6
Mesquite Elementary • Mrs. Collins

Desert Rain

Marina Vujassinović, age 7
Sam Hughes Elementary • Ms. Chuc
Grand Prize–Art–Category 1



The View with Water

Jesus Landy, age 19
Amphitheater High School • Mrs. Hollman

Bunny in the Desert
Celeste V. Padilla, age 9
Presidio School • Mrs. Cohn

Hummingbird

Clara Compton, age 10

Mesquite Elementary • Mrs. Collins

Rain in the Desert

Ayanna Ponder, age 9

Sam Hughes Elementary • Ms. Chuc

Rain from My Backyard

Abigail Trouard, age 9

Sam Hughes Elementary • Ms. Chuc

Grand Prize–Art–Category 3

The Desert

Andrew Schalk, age 8

Agua Caliente Elementary • Mrs. Robinson

Owl Wonderland

Tatiana Berley, age 8

Presidio School • Mrs. Powers

Ringtail on a Cactus
Aubriella Sherman, age 5
Sewell Elementary • Ms. Aho

Sophia Galaz, age 11
Miles ELC. • Mrs. Chapman

Stop Littering

Jacob Molina, age 10
Basis Tucson • Ms. Vonier

Kai Rendon, age 8
Miles ELC. • Ms. Chapman

Violet Silverleaf Flower

Olivia Palomino, age 9

Ochoa Community Magnet School • Mrs. Selden

The Sounds of the Rainfall

Alexia Arzate, age 10

Basis Tucson • Ms. Vonier

The Grandest of Canyon's Beauty

Kristin Jung, age 10

Basis Tucson • Ms. Vonier

Javalina

Xochitl Villanueva, age 9

Ochoa Community Magnet School • Mrs. Selden

Purple Mountain Galore!

Anna Carr, age 11

Miles ELC. • Mrs. Isaacson

Green Tree
Simone Gomez, age 11
Basis Tucson • Ms. Vonier

Lizard by the Water
Anisa Maximo-Glauner, age 8
Presidio School • Mrs. Cohn

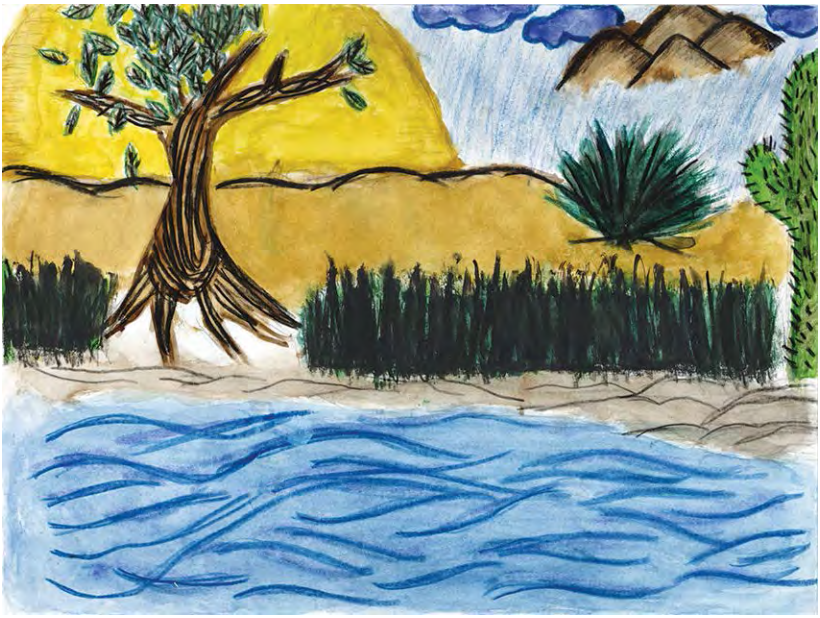
Summer Land

Carmen Reyes, age 16
Amphitheater High School • Mrs. Hollman

Rain in the Desert

Eizel Oliva, age 7
Grijalva Elementary • Ms. Chuc

Ava Hudson, age 10
Satori Charter School • Mrs. Dudas



Earth

Carolyn Germen, age 17
Amphitheater High School • Mrs. Hollman

Rainbow

Marina LaFoley, age 8
Agua Caliente Elementary • Mrs. Johnson

Desert Breakfast

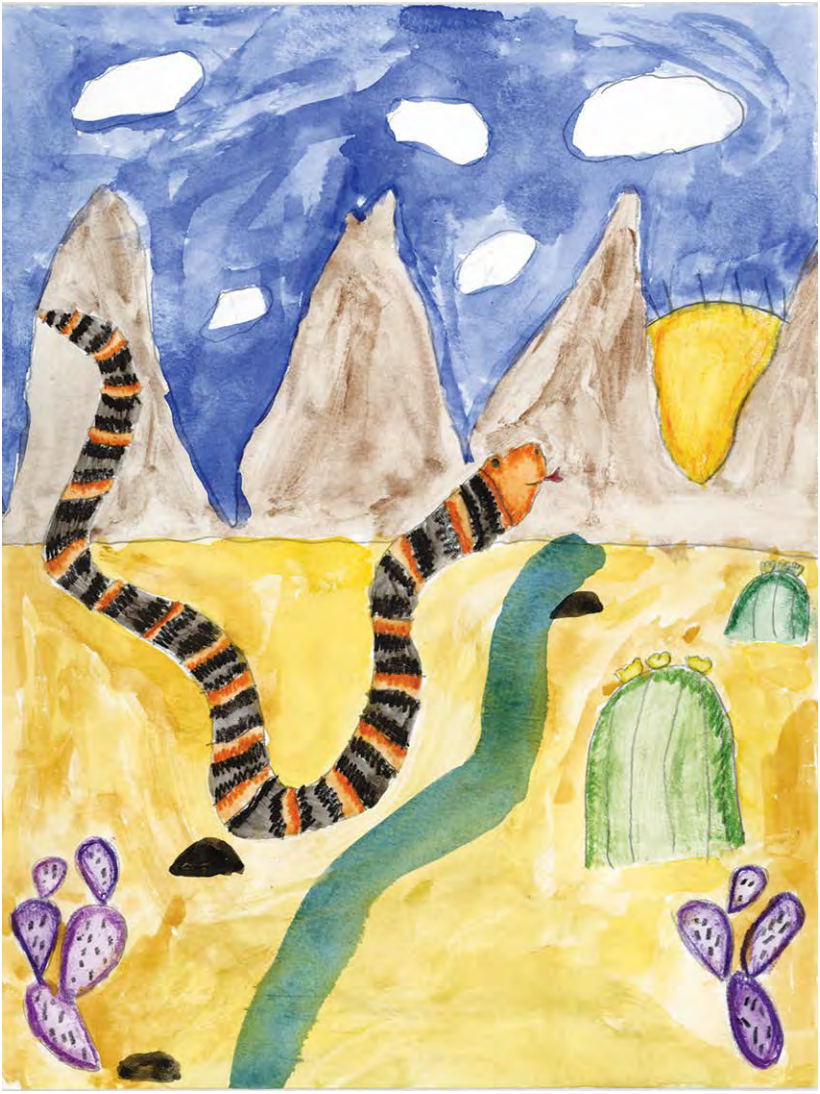
Sienna Cortez, age 8

Pima County Ellie Towne Flowing Wells Community Center • Mr. Troy

Water, Water

Sonora Cumberworth, age 10

Basis Tucson • Ms. Vonier



A Snake in the Sun

Clara Rocha, age 8

Presidio School • Mrs. Cohn

Grand Prize–Art–Category 2

Desert Night

Jack Miles, age 10

Satori Charter School • Mrs. Dudas

Taelyn Johnson, age 11
DeGrazia Elementary • Mrs. Minninger
Grand Prize–Photography–Category 3

MacKenzie Powers, age 11
DeGrazia Elementary • Mr. Mayer

Brandon Paredes, age 11
DeGrazia Elementary • Mrs. Minninger

Nature
Israel Garcia, age 12
DeGrazia Elementary • Mrs. Powers

Hayden Parson, age 12
DeGrazia Elementary • Mrs. Minninger

Rain in the Desert

Rain in the desert,
Bringing redolence of sage green creosote,
Bringing grace and beauty, rain will enhance the desert,
Pronghorns drink from the puddles of sweet desert rain,
Majestic desert rain is the core of life,
Rain, clear and blue brings showers of beauty,
It will shroud the desert with green colors of life,
Cloud burst will bring joy and happiness,
Calm emotions will come with drizzling rain,
As the world is being painted green,
Rain brings life to the desert.

George Parra, age 11
Sam Hughes Elementary • Ms. Chuc

The Hawk

So much depends upon the river.
The hawk swoops to get a drink.
The river splashes when the hawk lands.
Then he flies to a tree to look for food.
He went to get it.
He eats it.

Jesus Camacho, age 9
Ochoa Community Magnet School • Mrs. Selden

Desert Rain

Noiseless drizzles, stomping showers
Cooling, refreshing, skidding rain
In the fresh and foggy air
The peaceful birds take cover
And the playful coyotes entertain
The cactus flower blooms
With nothing in its way,
It's delicate pleasant
Rain

Madeline G. Riccitello, age 11
Sam Hughes Elementary • Ms. Chuc

Dark Universe

Lonely pool in the slow night, surfaces.
Dark universe is in the night sky.
Rain gives the desert
swift oceans of rain.

Cade Young, age 7
Agua Caliente Elementary • Mrs. Robinson

The River Flows

The wind blows at the river.
The plants dance in the wind
The clean water gives them life,
As they drink they get refreshed,
The sand on the shore soaks up the water,
Some wet some dry.
Rocks in the river are smooth,
From the water's flow
The rocks fall into the water
Clickity-clack goes the river.
All the animals depend on the
drinkable water,
The birds find shelter on the banks
of the peaceful water
While they twitter a beautiful harmony.
The river gives strength to all the animals
and plants,
We all depend on the river for hydration,
shelter and harmony.

Steven Duarte, age 10
Ochoa Community Magnet School • Mrs. Elvick-Mejia

The Soft Long Rivers

Wide streams forever spread at night.
Monsoon river dark at night.
Soft long grass wide as stream
Dark forever streams spread at night.
Years spread long rivers wide at night.
Soft long streams spread at night.

Richard Knott, age 7
Agua Caliente Elementary • Mrs. Baker

Smooth River

Look faraway between dust.
Universe time,
the wind sounds new.
Smooth river speaks
when the rain stops.

Dylan Lewis, age 8
Agua Caliente Elementary • Mrs. Baker

I Am The River

I am the river wise and old,
I have heard stories that are rarely told,
I am the river young and new,
I see even now as I talk to you,
I am the river not a water sprite,
I write and write very long into the night,
I am the river massaged by leaves and rocks,
I do not care about watches or clocks,
I am the river flowing to the ocean,
Where animals live and play in me as waves keep me in motion,
I am the river home of the animals around me,
One is a little fish who could not survive without me,
I am the river I do feel pain and sadness,
When animals hunt from me I don't feel gladness,
I am the river replenished with re-used water,
Still I am clean enough to house an otter.

Aidan Frye, age 10
Satori Charter School • Mrs. Dudas

Rain in the Desert

The rain pours down, spanning far and wide.
This is rain in the desert, feels like a miracle,
a booming voice of nature erupts,
through the sky like ripples in the water,
the rhythmic pitter-patter of raindrops
like music for a dance,
wishing this would never end,
but then
a crackle of white hot roots of light stakes its claim,
rain comes down to a drizzle and stops as if the
lightning scared the rain away,
my eyes well up as if to beckon the rain to come back,
to reality I return,
breaking my heart.

Maxwell Smith, age 11
Sam Hughes Elementary • Ms. Chuc

The Elf Owl

The speckled elf owl
gathers its food.
Then searches for
the saguaro cactus
it has made its nest in
before the rain.

Zachary Denton, age 7
Bloom Elementary • Mrs. Martin

Life in the Desert

I see red-tailed hawks, hummingbirds too,
with ducks swimming in that beautiful river.
I see that whirlpool spinning and that bamboo bending.

Aiden Gipson, age 8
Miles, ELC • Mrs. Isaacson

A New Life…

During a rainstorm at Sabino Canyon,
the clouds are dark and puffy.
The rain shoots down from the musty sky,
making the world look wet and muddy.
The barrel cactus eagerly soaks up all that it deserves.
The Gila monster slithers around trying to find
some place that will be his protection from the rain.
He tries to slide under a piece of saguaro rib,
But it drops water on his bumpy skin.
Finally, he finds a nice, big rock just the right size
for him to have a nice cozy nap.
He is better under his rock than outside.
The downpour starts flooding the canyon,
the mud is very thick.
Many creeks and streams are above the usual level.
But this is good for Arizona, and when the rain finally stops,
The world will be fresh and new,
with lots of new life that it brings.

Haeleigh Chipman, age 10
Bloom Elementary • Mrs. Martin

Rain in the Desert

Desert drizzle
Flashing rainstorm
Dripping drops
Flood
Muddy
Rain

Leo E. Ravia, age 8
Sam Hughes Elementary • Ms. Chuc

Desert Rain

Drizzles pour
Falling, soaking, freezing
cool graceful
Rain

Marina Vujasinović, age 7
Sam Hughes Elementary • Ms. Chuc

The Storm in the Desert

It was a pleasant morning
for the happy jackrabbits
who were resting joyfully
under the palo verde tree.
Out came the giant spider
in the Sonoran Desert
trying to find some food
before the terrible flood.
As the sky grew darker
above the wildflowers
splish, splash, splish, splash
the water washed away the ringtail cat.
The angry mountain lion
roared after the storm
'cause it was hungry
for a nice juicy coyote.
All the desert animals
love the sparkling drizzle
now Mount Lemmon
was covered with rain drops…

Wenli Xu, age 10
Sewell Elementary • Mrs. Martin

For more information contact: Pima County Natural Resources, Parks and Recreation Environmental Education
Phone: (520) 615-7855 • Email: eeducation@pima.gov • Website: www.pima.gov/nrpr

RIVER of WORDS
ENVIRONMENTAL POETY & ART

SAINT MARY'S COLLEGE of CALIFORNIA
KALMANOVITZ SCHOOL OF EDUCATION

SONORAN INSTITUTE
Shaping the Future of the West
www.sonoraninstitute.org

U.S. Environmental Protection Agency

Natural Resources, Parks and Recreation
Regional Flood Control District
Regional Wastewater Reclamation Department
Pima County Public Library

PIMA COUNTY

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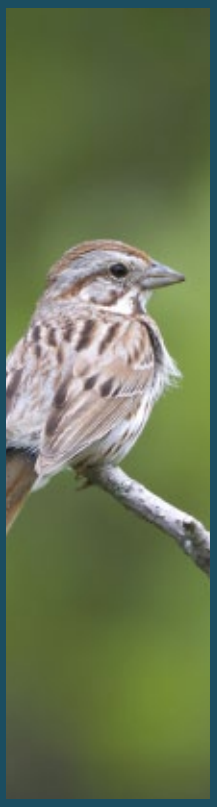
a living river

CHARTING WETLAND CONDITIONS OF THE LOWER SANTA CRUZ RIVER

2014 Water Year



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PIMA COUNTY

Arrowweed (*Pluchea sericea*)

PINAL COUNTY

PIMA COUNTY

Pinal Air Park Road

Trico Rd

Marana Rd

MARANA

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ORO VALLEY

Silverbell Rd

Tangerine Farms Rd

Sanders Rd

Sandario Rd

Avra Valley Rd

Twin Peaks Rd

CAÑADA DEL ORO WASH

Cortaro Rd

Rufous-Winged Sparrow (*Aimophila carpalis*)

Ina Rd

TRES RIOS

Silverbell Rd

RILLITO RIVER

Camino Del Cerro

AGUA NUEVA

TUCSON

SANTA CRUZ RIVER

10

19

THE SANTA CRUZ RIVER WATERSHED

REACHES OF THE RIVER

- Marana Flats
- Cortaro Narrows
- Three Rivers
- River reaches with seasonal flows
- River reaches dominated by effluent
- Direction of river flow
- Water reclamation facility (treatment plant)

0 1 2 miles

north

Fremont Cottonwood (*Populus fremontii*)

2014 NOTABLE FINDINGS FOLLOWING UPGRADES

Water clarity and quality improved

Nutrient pollution declined

Flow extent declined with higher infiltration rates

Aquatic wildlife showed signs of improvement

This is a sister series to the *Living River* reports completed for the Upper Santa Cruz River (learn more at **www.tiny.cc/uscr**).

THE LOWER SANTA CRUZ RIVER A LIVING ECOSYSTEM

Since it began attracting people to the region more than 12,000 years ago, the Santa Cruz River has undergone a series of dramatic changes. Initially a flowing life force teeming with fish, frogs, and other wildlife, the river all but dried up over the last century as groundwater pumping increased along with the human population and its ever-growing demand for water.

Today, however, thanks to the release of effluent—highly treated wastewater—into the river, certain sections of the Santa Cruz River again flow year-round. This practice is not only re-creating our flowing-river heritage, but is also supporting important wildlife habitat and building a valued community amenity. The Lower Santa Cruz River offers a great example. For decades, much of this stretch of river was hidden from view behind industrial neighborhoods along the freeway. As effluent helped create a thriving river ecosystem along this corridor, the community responded by building numerous river parks and The Loop recreational trail to provide easier access to this river bounty. The river in this area now attracts walkers and bikers and is a popular birding destination from the Sweetwater Wetlands to the Marana Flats.

Effluent in the Lower Santa Cruz River is not new; two wastewater treatment plants, or "water reclamation facilities," have been operating on this section of the river since the 1970s. What has changed is the quality of the effluent being released. In its largest public works project ever, Pima County recently invested more than $600 million to upgrade the facilities. Completed in 2013, this project significantly improved the quality of water released into the river, a key ingredient for a healthier river.

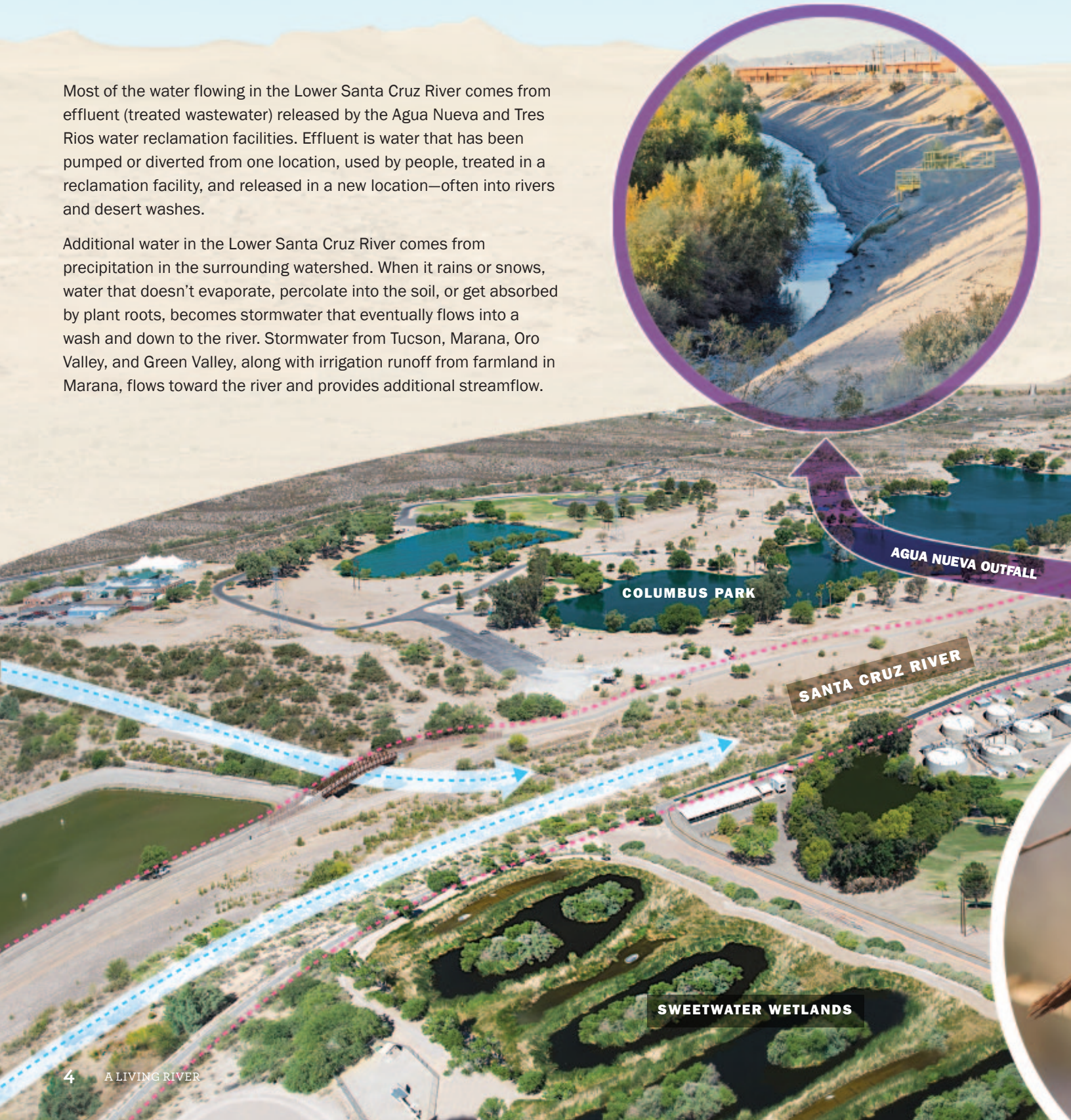
To gauge conditions of this valuable ecosystem and track the impacts of our community investment, Pima County and the Sonoran Institute have developed a *Living River* series for the Lower Santa Cruz River. Modeled on the Sonoran Institute's *Living River* report for the Upper Santa Cruz River, this report documents annual change along the Lower Santa Cruz River in order to gain insight into the river's health. Beginning with a baseline in 2013, the *Living River* series is an assessment of the wetland conditions created and affected by the effluent. This second report examines changes in indicators of river health along a 23-mile stretch of the river during the 2014 water year (October 1, 2013–September 30, 2014). The final facility upgrades were completed in December 2013. This report includes an assessment of conditions before, and any changes observed just after, the upgrade process.

All *Living River* reports and associated documents for the Lower Santa Cruz River are available for download on the Sonoran Institute website at **www.tiny.cc/lscr**.

WATER SOURCES

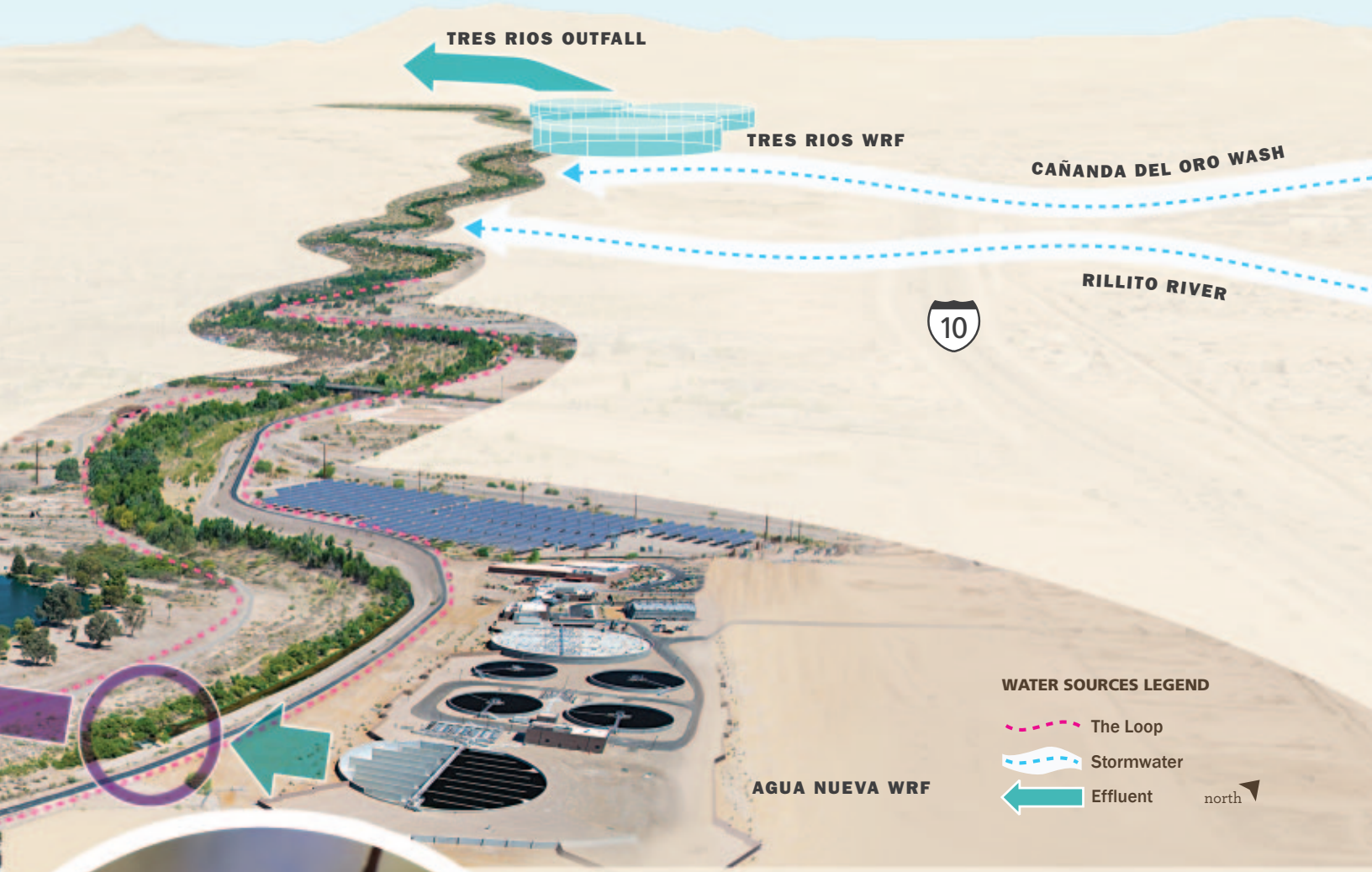
Most of the water flowing in the Lower Santa Cruz River comes from effluent (treated wastewater) released by the Agua Nueva and Tres Rios water reclamation facilities. Effluent is water that has been pumped or diverted from one location, used by people, treated in a reclamation facility, and released in a new location—often into rivers and desert washes.

Additional water in the Lower Santa Cruz River comes from precipitation in the surrounding watershed. When it rains or snows, water that doesn't evaporate, percolate into the soil, or get absorbed by plant roots, becomes stormwater that eventually flows into a wash and down to the river. Stormwater from Tucson, Marana, Oro Valley, and Green Valley, along with irrigation runoff from farmland in Marana, flows toward the river and provides additional streamflow.



The Ribbon of Green

Sections of the Santa Cruz that are dependent entirely on stormwater tend to have vegetation that is adapted to drier conditions. Add effluent to the river and suddenly we see a vivid ribbon of green snaking its way downstream (notice the green start near the Agua Nueva outfall). This green ribbon includes native willows and other riparian plants that need more water and are becoming very rare in the desert Southwest. The enhanced vegetation provides important wildlife habitat as well as a vibrant, cooling corridor for people to enjoy as they visit river parks and travel The Loop recreation path.



Sweetwater Wetlands

A portion of effluent from Agua Nueva is reused to create the Sweetwater Wetlands. While flowing through the wetlands and into adjacent recharge ponds where it percolates down through soil, effluent gets additional cleaning while replenishing the local aquifer. This water is then pumped and distributed by the reclaimed water system for reuse in Tucson's golf courses, parks, schools, ball fields, and other large turf-irrigation areas. In addition, this water-rich environment provides urban wildlife habitat for many native species that make the wetlands their full- or part-time home.

ASSESSING CONDITIONS

The *Living River* report evaluates conditions of the Lower Santa Cruz River using indicators (see diagram) organized into six categories that represent a breadth of biological, chemical, physical, and social properties of the river. The indicators relate to conditions in the river channel and in the adjacent riparian areas, the areas next to and affected by the river. Other characteristics tracked informally and discussed throughout the report include birds, amphibians and reptiles, and recreation.

The purpose of the *Living River* series is to monitor and report on wetland and riparian conditions at various intervals

CATEGORY		PURPOSE	INDICATORS
FLOW EXTENT		General measure of water flowing in and out of the system, recharge, and available aquatic habitat.	• Miles of flow in each reach • Number of “dry days” at Trico Road
WATER CLARITY		Measure of solid particles in the water and on the channel bottom, which can impact habitat and conditions for aquatic life.	• Total suspended solids • Turbidity • Percent fines
WATER QUALITY		Measure of chemical conditions necessary for sustaining the river’s animal and plant communities.	• Total dissolved solids • Ammonia • Dissolved oxygen • Biochemical oxygen demand • Metals
AQUATIC WILDLIFE		Direct measure of river’s wildlife, which integrate many factors of the surrounding environment.	• Fish • Aquatic invertebrates
RIPARIAN VEGETATION		Direct measure of river’s plant communities, which reflect changes in water quantity and quality.	• Wetland indicator status • Nitrogen affinity score • Riparian tree cover
SOCIAL IMPACTS		Measure of aesthetic factors that directly impact people living or recreating along the river.	• Odor at reclamation facilities

downstream of the effluent discharge points. As effluent flows downstream, it impacts and is impacted by the natural conditions of soils, vegetation, and the surrounding ecosystem. For the purposes of this study, the 23-mile stretch of river is divided into three sections, or reaches: Three Rivers, Cortaro Narrows, and Marana Flats. Reaches were delineated because they differ in hydrology, geology, and adjacent land use.

The following pages present the data collected in the 2014 water year (October 1, 2013–September 30, 2014). Facility upgrades at Tres Rios began in phases between fall 2012 and fall 2013. The Agua Nueva upgrades were completed in December 2013. To review all the data in more detail and see additional charts from the 2014 water year, please visit the Sonoran Institute website at **www.tiny.cc/lscr14**.

1

2

3

4

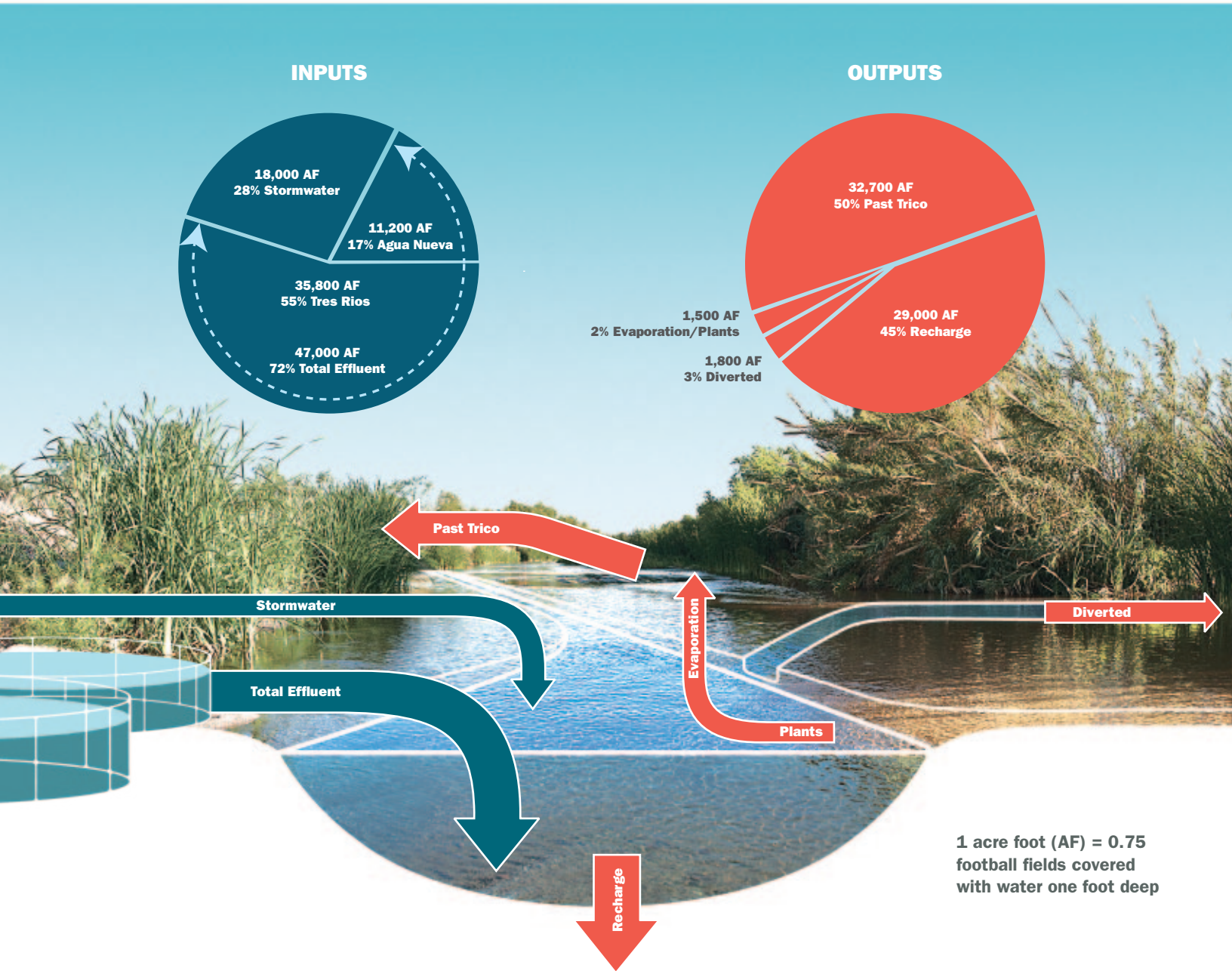
5

1. Looking southwest at floodwaters at the Agua Nueva outfall, September 2014
2. Flowing conditions near Sanders Road, October 2014
3. Dry conditions near Sanders Road, October 2014
4. The Santa Cruz River in 1902 (courtesy of Arizona Historical Society, Main Photo Collection)
5. Fish survey in the Santa Cruz River, fall 2013

STREAMFLOW, RAINFALL, AND WATER BUDGET

The amount of water flowing in the river provides an important context for the indicator results. Reclamation facilities continuously release water into the river, which accounts for the majority of streamflow. However, streamflow also includes stormwater from the watershed. The Santa Cruz River Watershed includes all of the land whose stormwater flows toward the river. Seasonal floods are important for scouring the riverbed, recharging aquifers, dispersing seeds, inducing seed germination, and clearing natural debris.

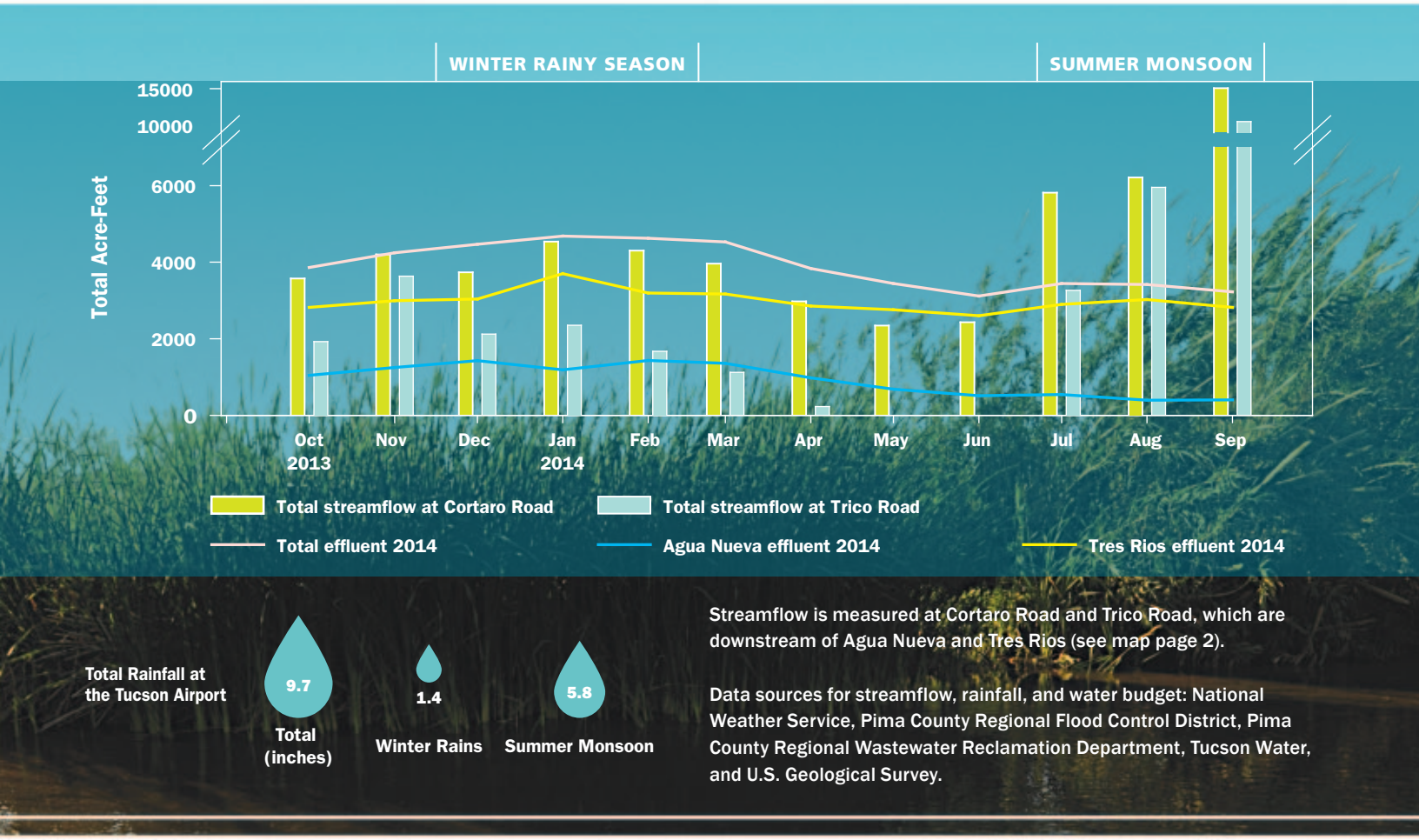
A water budget for the Lower Santa Cruz River estimates the water inputs and outputs. Inputs are effluent and stormwater, while outputs include water that does one of the following: flows past Trico Road (see map on page 2), evaporates or is used by wetland vegetation (a process called evapotranspiration), is diverted for agricultural use, or sinks into the riverbed to recharge local groundwater. Input and output volumes are totaled in acre-feet (AF), the number of acres that would be covered with water one foot deep.



1 acre foot (AF) = 0.75 football fields covered with water one foot deep

2014 WATER BUDGET

In comparison to 2013, total inputs were about 27% greater in 2014 from higher volumes of stormwater. In 2014 about 28% of the inputs came from stormwater, primarily from the summer monsoon season. In 2013, only 8% came from stormwater. Even with greater inputs, there was 12,000 AF more recharge in 2014 than in 2013, likely from increased infiltration rates in the riverbed after improved water quality (see page 15). Although the total effluent released into the river remained similar to 2014, effluent releases from Agua Nueva have decreased, for two reasons. First, the facility upgrade resulted in some wastewater being redirected to Tres Rios and thus released further downstream. Second, more water was diverted to the reclaimed water system to irrigate Tucson's large turf areas. Compared to 2013, the volume of water diverted for irrigation increased by an average of 223 AF per month from March through September.



2014 RAINFALL AND STREAMFLOW

Although there was more rain in 2014 compared to 2013, total rainfall was similar to the historical average. Much of the extra rain fell during the summer monsoon season. The extra flow from stormwater was most notable in August through September, when the total volume of streamflow at both Cortaro and Trico Roads was significantly greater than the effluent released into the river upstream. Overall, volume of streamflow at Cortaro Road was generally similar to 2013. However, at Trico Road, streamflow was lower in 2014 and recorded no flow in May and June, the driest part of the year. Learn more and view more data about streamflow, rainfall, and the water budget online at **www.tiny.cc/stream14**.

SUMMARY OF WETLAND CONDITIONS

This assessment of the 2014 water year identified initial changes to 2013 baseline conditions of the Lower Santa Cruz River following upgrades to the Agua Nueva and Tres Rios water reclamation facilities.

As anticipated, water quality improved following the completion of the upgrade, and all measures were better or remained similar to the 2013 baseline. Most notably, ammonia levels were significantly reduced, which improved conditions for fish. Reductions in ammonia likely allowed fish to expand into Three Rivers, where fish were absent in 2013. However, flow in this reach was shallow and one of the survey sites was dry. Therefore, fish habitat may be best downstream of the Tres Rios facility where there is more water.

Reduced nutrient pollution likely diminished any "clogging" layer in the riverbed and increased infiltration, the ability of water to percolate through the sediments in the riverbed. This effect likely contributed to the contraction of the extent of flow in both Three Rivers and Marana Flats. Although shorter flow extent suggests decreased availability of habitat

CATEGORY	2013 CONDITIONS	2014 CONDITIONS
FLOW EXTENT	Water was always flowing through all three reaches.	Flow extent decreased in both Three Rivers and Marana Flats (p. 12).
WATER CLARITY	High amount of particles moving through all three reaches during normal, non-flooding conditions. Materials in the water increased as the river flowed downstream.	Water clarity improved with reduced number of particles in the water column during normal, non-flooding conditions (p. 13).
WATER QUALITY	High levels of ammonia posed a health risk to aquatic life. Other measures met standards or provided a baseline for comparison in future assessments.	All water quality measures improved or remained similar to 2013. Most important were significant reductions in ammonia, improving conditions for aquatic wildlife (pp. 14–15).
AQUATIC WILDLIFE	No fish in Three Rivers, but Western Mosquitofish in Cortaro Narrows and Marana Flats. Aquatic invertebrate communities in all three reaches suggest the river is impaired or under environmental stress.	Western Mosquitofish now found in all three reaches, but Three Rivers had less habitat with one site dry. Aquatic invertebrate communities showed some signs of improvement (pp. 16–17).
RIPARIAN VEGETATION	Wetland and nitrogen-tolerant plants increased immediately downstream of the reclamation facilities. With the exception of Marana Flats, riparian trees generally declined as the river flowed downstream.	No change in wetland and nitrogen-tolerant plants (trees were not measured). Continued monitoring will determine if improved water quality and reduced flow extent will lead to changes in streamside plants (p. 18).
SOCIAL IMPACTS	Odor data unavailable at press; past efforts to reduce odor impact have resulted in significant reductions in odor levels.	Reduced odor complaints and anecdotal observations of little or no odor near the boundaries of the reclamation facilities (p. 19).

for aquatic wildlife, increased infiltration of water possibly benefited local aquifers along the river.

Materials suspended in the water decreased, and water was clear on normal non-flooding days. The percentage of the fine materials or "muck" covering the riverbed was reduced compared to the 2013 baseline. Fine materials can smother habitat and life on the riverbed if too abundant. Therefore, in addition to improved water quality, this decrease in fine materials likely contributed to improvements in the aquatic invertebrate community.

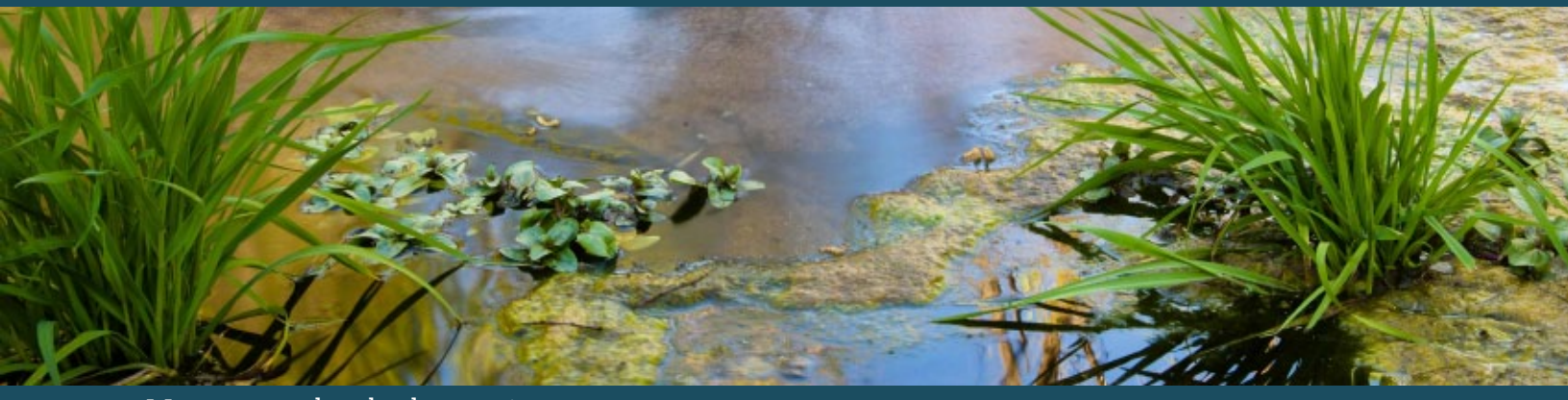
While Three Rivers was still dominated by pollution-tolerant invertebrates, overall community diversity and abundance of species sensitive to pollution increased. However, the invertebrate community still reflects impaired river conditions compared to warm-water streams in Arizona that are not dominated by effluent. More time may be needed for the invertebrate community to attain the diversity and abundance found in other streams.

Wetland and nitrogen-tolerant plants were most abundant immediately downstream of the reclamation facilities and were similar to plants found in 2013. Continued monitoring will determine if reductions in flow extent or improvements in water quality will lead to changes in the riparian vegetation community.

As demonstrated in the 2013 baseline report, both the extent and intensity of odor emanating from the reclamation facilities has diminished significantly with the upgrade process. This is further supported by the reduction in odor complaints in the 2013-2014 period and observations from people recreating in the area that odors are either gone or barely noticeable compared to past conditions.

1. Cloudy water, May 2013

2. Clear water, June 2014



3. Watercress and wetland vegetation

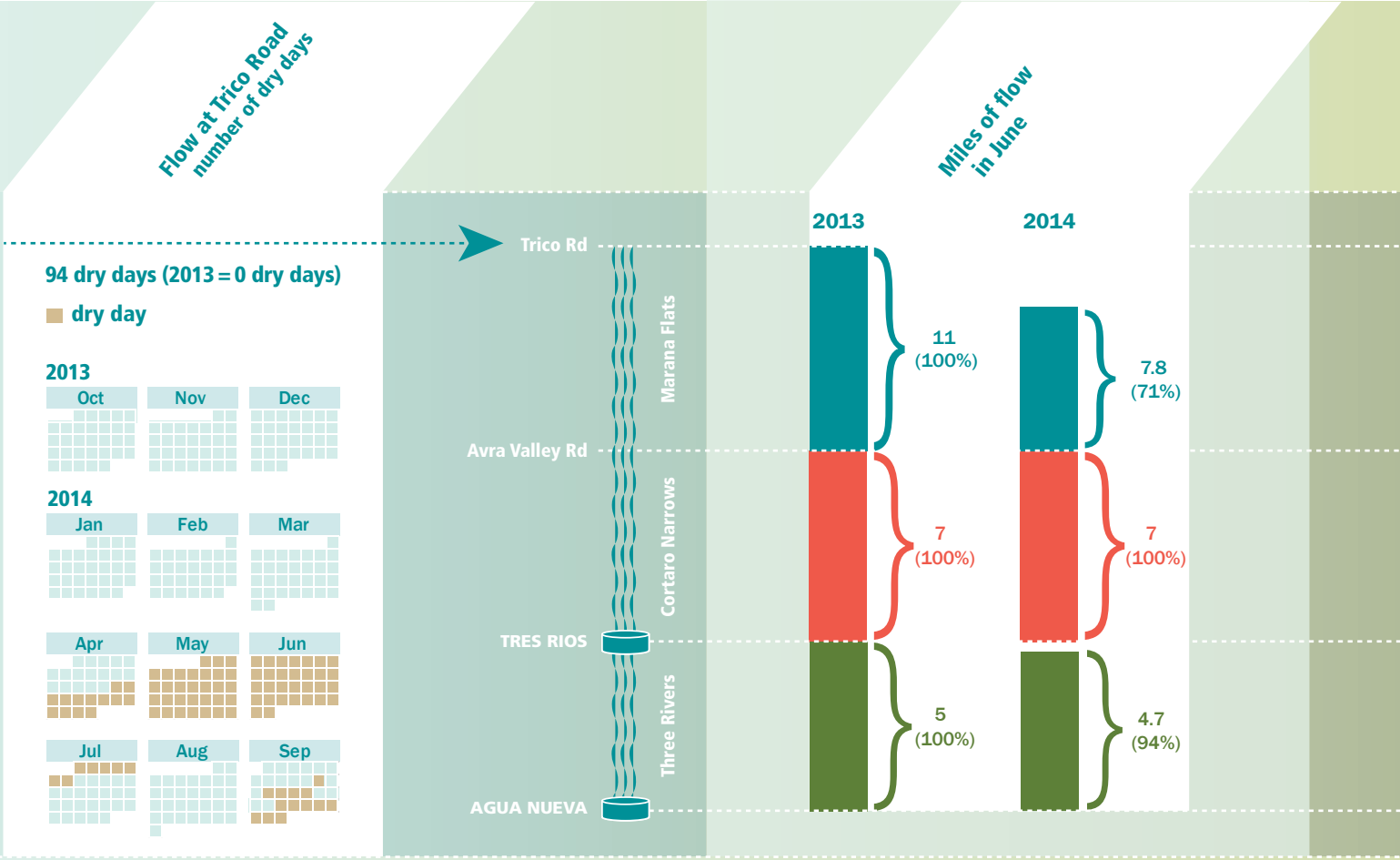
INDICATOR RESULTS

FLOW EXTENT

Measuring flow extent, or the distance the river has visible water flowing, provides a general measure of water flowing in and out of the system and the length of available aquatic habitat. Abundant flow extent may indicate high availability of habitat for aquatic life or low infiltration of water into the riverbed. Decreased flow extent could result from reduced water inputs or greater infiltration of water into the riverbed.

2014 RESULTS: Flowing stretch of river is shorter

Flow extent decreased compared to 2013. When measuring miles of flow in June prior to the start of the monsoon season, only Cortaro Narrows had flow through the entire reach. In addition, there were 94 days when the river was dry at Trico Road, thus fewer days when the flow extended to the end of the study area. Although total effluent volume released into the river was similar to 2013, increased infiltration is likely one of the factors responsible for the decreases in flow extent and the dry days at Trico Rd. Decreased release of effluent from Agua Nueva may be another factor responsible for the decrease in flow extent in Three Rivers (see water budget page 8). More monitoring will be needed to determine if increased infiltration will influence any long-term changes in flow extent. Learn more about flow extent and view all the data online at **www.tiny.cc/fe14**.



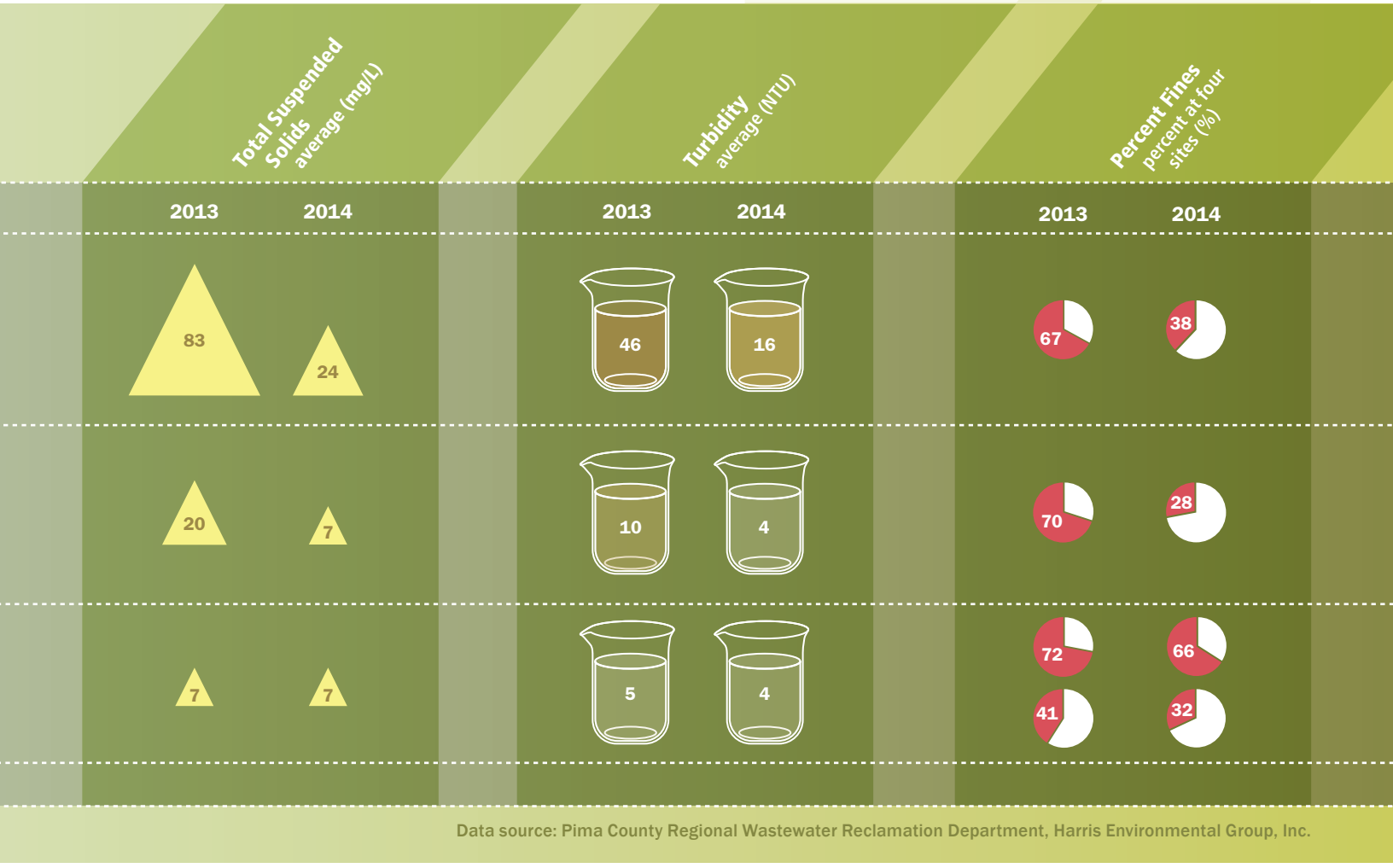
Data source: Pima County Regional Flood Control District and U.S. Geological Survey

WATER CLARITY

Rivers naturally move sediments and other particles downstream. As these materials are swept away, others are conveyed from upstream, bringing an influx of nutrients, organic matter, and sediments to the river ecosystem. Measuring the concentration of the materials in the water provides an estimate of the suspended particles or "cloudy" conditions in the water. Murky water and the associated materials that settle on the riverbed can negatively impact habitat and conditions for aquatic life.

2014 RESULTS: Water clarity increased

Water clarity was measured throughout the year at several locations during normal times when the river was not flooding (murky conditions are normal during high flows). The count of suspended particles in the water, as measured by total suspended solids, declined in 2014 relative to 2013. Turbidity describes the ease of seeing through the water, with higher scores representing cloudier water. All turbidity scores were lower in 2014, indicating improved water clarity. The percent fines, or "muck," that settles out of the water was reduced at all four sites in the spring of 2014, suggesting improved conditions for aquatic life on the riverbed. Learn more about water clarity and view all the data online at **www.tiny.cc/WC14**.



Data source: Pima County Regional Wastewater Reclamation Department, Harris Environmental Group, Inc.

WATER QUALITY

Aquatic ecosystems, such as streams, depend on particular water-quality conditions (chemical, physical, and biological properties) to sustain plant and animal communities. There are many typical measures that help track changes in water quality in the river, including the amounts of total dissolved solids, ammonia, dissolved oxygen, biochemical oxygen demand, and metals.

Nitrogen and other nutrients enter the river from air pollution, fertilizer, surface runoff, and release of effluent. While elevated nutrient levels can benefit growth of riparian plants, they can also lead to poor conditions for aquatic wildlife. High nutrient levels also can encourage an overabundance of organisms that live in the spaces between the sand and gravel in the streambed. These organisms can become so numerous that they "clog" the streambed and reduce the ability for water to soak into the riverbed and recharge aquifers.

Sonoran Desert Toad
(*Bufo alvarius*)

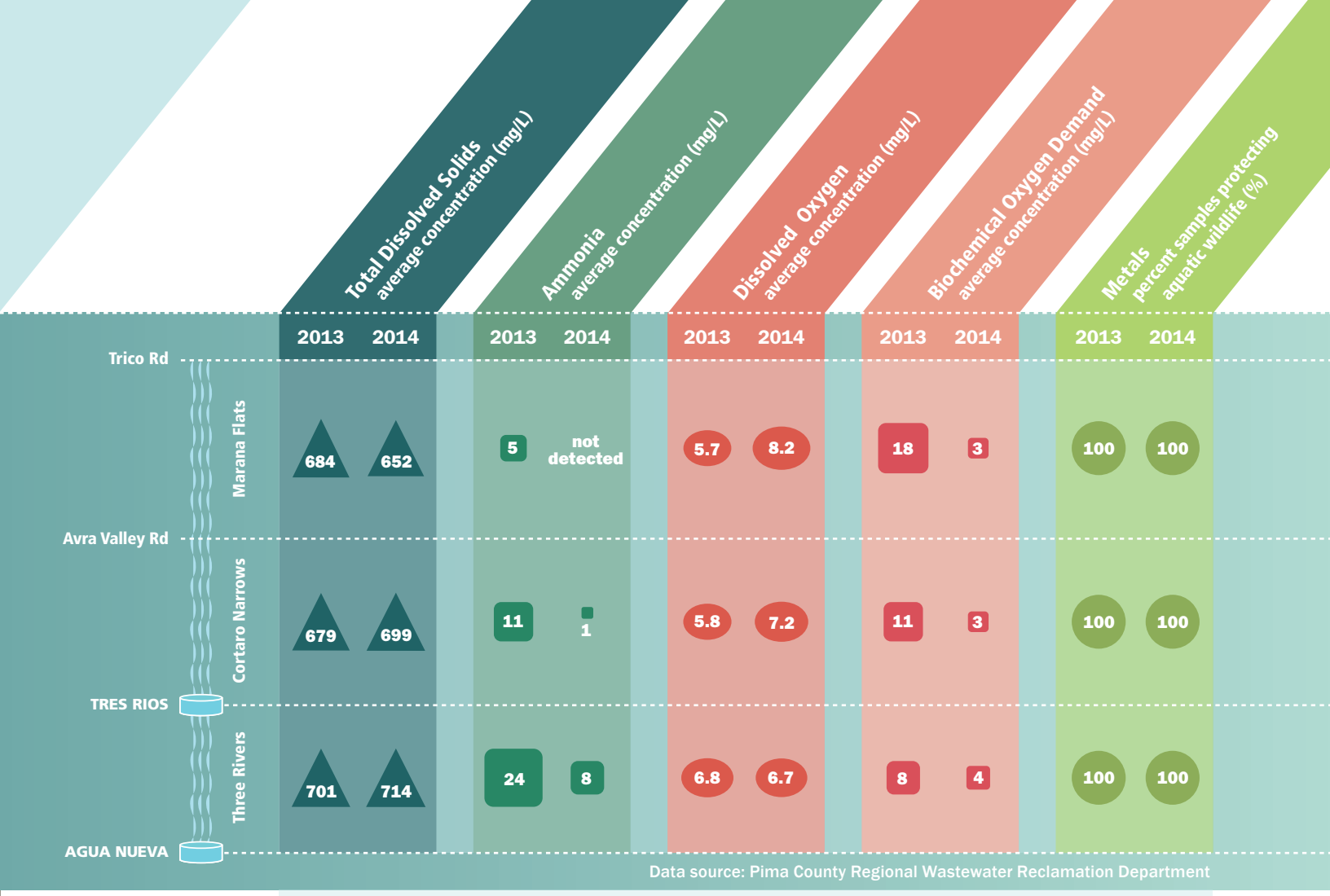
Giant Spotted Whiptail Lizard
(*Cnemidophorus burti stictogrammus*)

Leopard Frog
(*Rana yavapaiensis*)

Amphibians and Reptiles

Riparian areas are critical habitat for numerous amphibian and reptile species. Historically, the Santa Cruz River was home to a community of species commonly found along rivers and desert washes in southeastern Arizona. Now the effluent stretch of the Lower Santa Cruz River provides some of the only flowing water habitat for these species in the Tucson area. Though no formal surveys were conducted, Sonora mud turtles were observed along the river in Cortaro Narrows. One observation may have been of a very young turtle, but more data is needed to determine if the mud turtles are breeding along the river. American bullfrogs and spiny softshell turtles are two non-native species that are present and breeding in the river.

Sonora mud turtle (*Kinosternon sonoriense*)



2014 RESULTS: Improved water quality from reductions in nitrogen

Measures of water quality were taken at several locations throughout the year. Measuring total dissolved solids is a common way to test for salts in the water. Total dissolved solids have been higher with the community's rising use of water from the Colorado River since 1993. However, these levels did not change between 2013 and 2014.

Ammonia (NH_3) is one form of nitrogen that can be toxic to fish and is more common in rivers dominated by effluent. In 2014, average concentrations of ammonia significantly declined. Since the upgrade at Agua Nueva was only complete in December in 2013, levels of ammonia are expected to further decline in Three Rivers in the future. These lower concentrations of ammonia and other nutrients may be a factor in the reduced clogging effect in the riverbed, which in turn resulted in increased recharge (page 8) and reduced flow extent (page 12).

Fish and other aquatic animals need dissolved oxygen to survive. Levels of dissolved oxygen remained high enough for fish and tended to be higher in Cortaro Narrows and Marana Flats in comparison to 2013. Biochemical oxygen demand estimates pollutant levels by measuring how much dissolved oxygen is being used. For example, microorganisms breaking down organic materials use a lot of oxygen and deprive other animals of their supply. Compared to the 2013 baseline, biochemical oxygen demand declined along the river. This may be due to several factors such as reduced ammonia levels from improved water treatment.

Metals in high concentrations can endanger wildlife in aquatic ecosystems. As in 2013, all the samples tested for arsenic, cadmium, chromium, copper, lead, mercury, selenium, and zinc were low enough to protect conditions for aquatic wildlife in the river.

Learn more about water quality and view all the data online at **www.tiny.cc/wq14**.

AQUATIC WILDLIFE

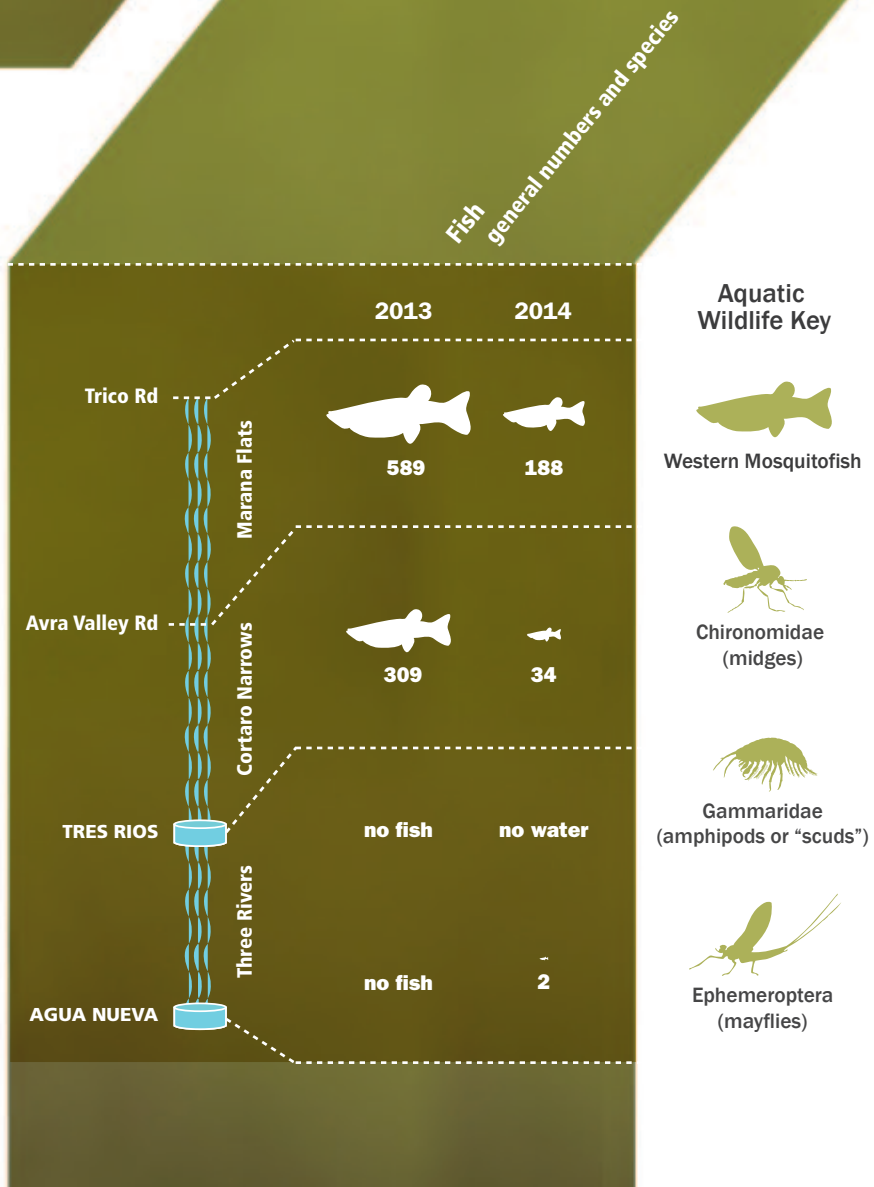
Water is essential for aquatic wildlife to survive in our arid landscape. With natural waters becoming increasingly rare throughout the Southwest, releases of effluent into the Lower Santa Cruz River are providing critical habitat for aquatic wildlife in the Tucson region. Furthermore, wildlife can be good indicators of river health because they integrate and reflect conditions of multiple factors in the surrounding environment, such as water quality and availability of habitat.

Aquatic Invertebrates

For many invertebrates life starts in the river with a larval stage. After the required development time, they emerge and live out of the water as adults. Emerging adults like this adult mayfly become an important food source for birds.

2014 RESULTS: Aquatic wildlife show some improvement

A spring 2014 survey of the aquatic invertebrate community was conducted at four locations along the river. In Three Rivers, the invertebrate community was still dominated by pollution-tolerant midges from the family Chironomidae. This lack of diversity, with more than 50% of a community dominated by a single group, suggests the river is impaired. However, the dominant groups in Cortaro Narrows and Marana Flats were pollution-sensitive mayflies from the Ephemeroptera family, and both comprised less than 50% of the community. Overall, pollution-sensitive Ephemeroptera increased in all reaches. While this increased diversity is supported by an increase in the biological index scores, the scores remain below 39 and suggest that river life is impaired. Increased community diversity and presence of mayflies likely results from improved water quality conditions and possibly from the reduction in percent fines on the riverbed. As the survey occurred only four months after the completion of the water reclamation facility upgrades, continued monitoring is needed to confirm improvements.



Birds

The birds of the Santa Cruz Valley support the local economy by attracting thousands of visitors each year. In the 2014 water year, 434 volunteers collected more than 44,000 bird observations along the Lower Santa Cruz River as part of a citizen-science program managed by Cornell Lab of Ornithology, www.ebird.org. Though bird watchers made observations all along the three reaches, more than 38,000 of the observations were from the Sweetwater Wetlands and Columbus Park. Overall, there were 215 unique species observed along the Lower Santa Cruz, including several migrating warbler species who stop and rest on their journey.

Data source: eBird Basic Dataset. Version: EBD_relNov-2014. Cornell Lab of Ornithology, Ithaca, New York. November 2014.

Abert's Towhee (*Pipilo aberti*)

Bell's Vireo (*Vireo bellii*)

Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

Dominant Species percent of invertebrate community (%)		Pollution-Sensitive Species percent of invertebrate community (%)		AZ Biological Integrity Index > 50 meets standard < 39 impaired	
2013	2014	2013	2014	2013	2014
90%	42%	2%	42%	10	28
40% 41%	40%	7%	40%	18	35
86%	61%	6%	8%	13	14
63%	67%	3%	14%	19	19

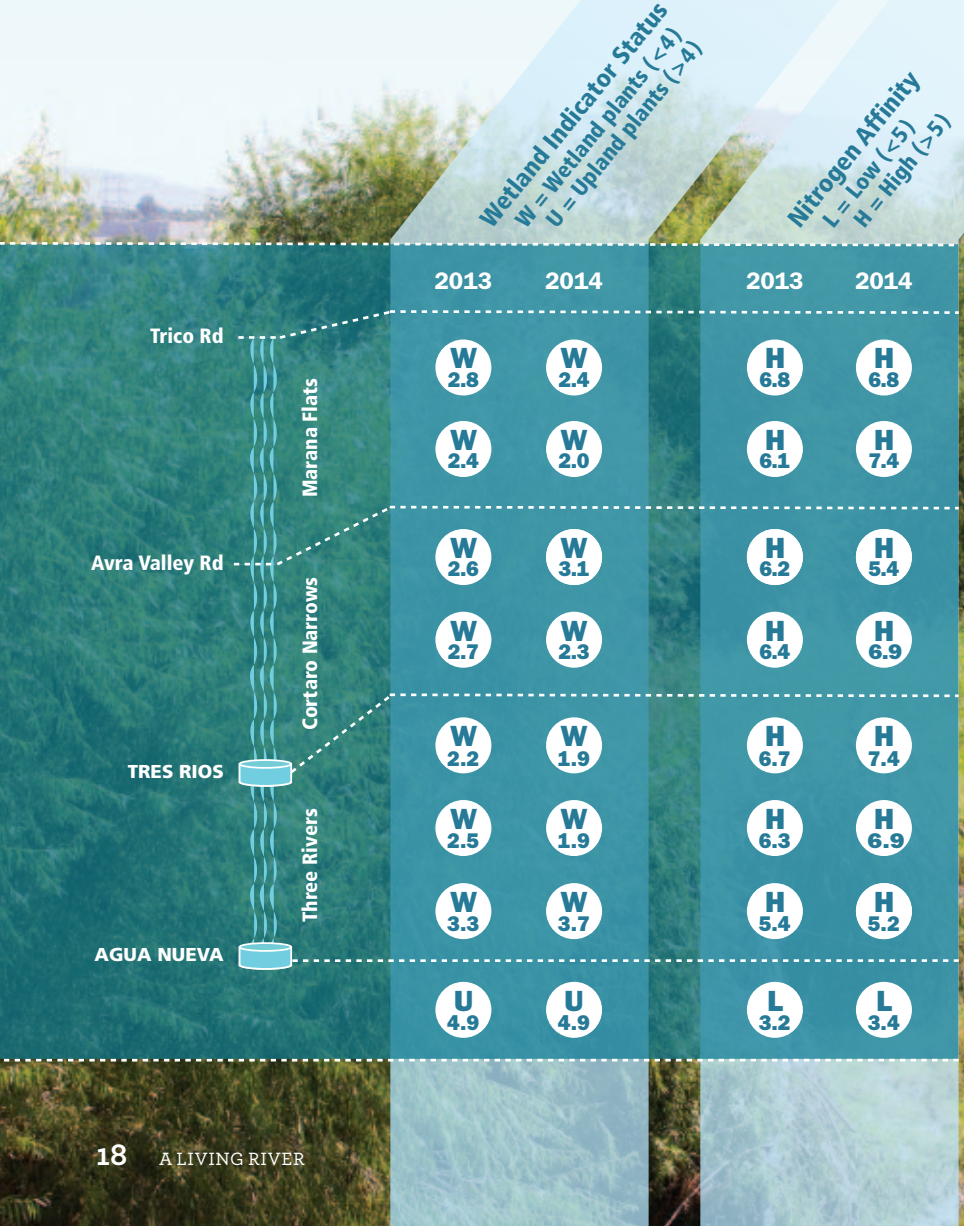
Data source: Arizona Game and Fish Department, Pima County, Sonoran Institute, U.S. Fish and Wildlife Service

A fall 2014 fish survey was conducted at the same four locations to detect species and general fish numbers. As in 2013, surveys found only non-native Western Mosquitofish. While several large non-native fish, including catfish, were observed during the spring invertebrate survey, these were not seen in the fall. Many fish may have succumbed or been washed past Trico Road in the large floods of September 2014. This is one possible explanation why general fish numbers were lower than in 2013. However, Three Rivers had more fish than last year, suggesting a possible expansion of fish upstream. Flows were very shallow during the survey and one site was dry. Thus, continued monitoring will help us understand if Three Rivers can provide habitat for fish.

Learn more about aquatic wildlife and view all the data online at **www.tiny.cc/aw14**.

RIPARIAN VEGETATION

Just as water is essential for aquatic wildlife, many plants grow only in areas with more water, such as wetlands and riparian areas next to rivers and desert washes. Thus, effluent released into the river is also supporting numerous plants that add to the ecosystem diversity along the Lower Santa Cruz River. Although riparian vegetation represents only a small percentage of the land cover in the Santa Cruz River Watershed, it provides important benefits to the region, such as slowing flood flows, increasing groundwater recharge, reducing erosion potential along stream banks, maintaining habitat for wildlife, and providing recreational and spiritual enjoyment.



2014 RESULTS: Effluent supports wetland species; little change in streamside vegetation

Measures of riparian vegetation were taken in the spring at one site in the dry part of the river upstream of Agua Nueva and at seven sites along the river. Only streamside plants, no trees, were surveyed this year.

Riparian vegetation varied among sites, but was similar to the 2013 baseline. Overall, the abundance of wetland plants increased immediately downstream of the reclamation facilities, as compared to the site upstream of Agua Nueva where upland species of plants were more common. Streamside plants that grow well in high-nitrogen environments were most common immediately downstream of the reclamation facilities. The survey occurred only four months after the upgrades were completed and prior to the reduced flow extent in both Three Rivers and Marana Flats. Therefore, monitoring in subsequent years will determine if changes in water availability and nitrogen levels will reduce abundance of wetland or nitrogen-tolerant plants.

Learn more about riparian vegetation and view all the data online at **www.tiny.cc/rv14**.

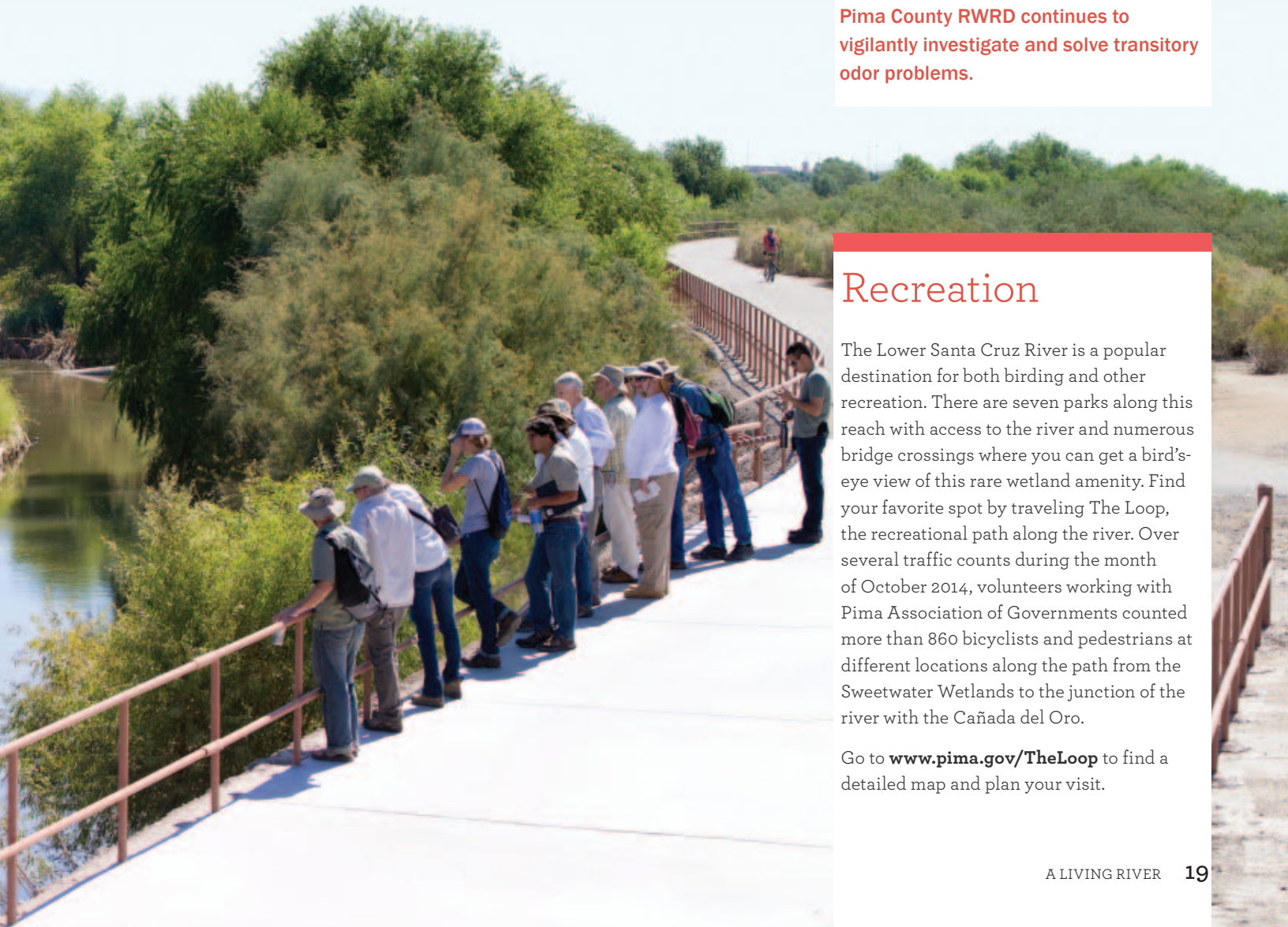
Several plant species were misclassified in 2013, resulting in incorrect wetland and nitrogen affinity scores. The corrected values are shown here. Data source: Pima County, Harris Environmental Group, Inc.

SOCIAL IMPACTS

With the release of effluent into the river, reclamation facilities are supporting important wetland habitats and heightening the recreation experience for those enjoying our river parks or walking and biking along The Loop trail adjacent to the river. Even so, unpleasant odors often associated with the reclamation process can lead to negative perceptions of the river. The most common offender is hydrogen sulfide, or the "rotten egg" smell. Minimizing both the extent and intensity of disagreeable odors coming from the facilities was one of the goals of the reclamation facility upgrades.

2014 RESULTS: Significant reductions in odor

As demonstrated in the 2013 baseline report, both the extent and intensity of odor emanating from the reclamation facilities have diminished significantly since the completion of upgrades. Recent anecdotal data from people recreating in the area indicate that odors are either gone or barely noticeable compared to past conditions. Odor complaints received and investigated by Pima County Regional Wastewater Reclamation Department (RWRD) have decreased in the 2013-2014 period, reflecting a system-wide effort by the department to reduce odor incidents. Pima County RWRD continues to vigilantly investigate and solve transitory odor problems.



Recreation

The Lower Santa Cruz River is a popular destination for both birding and other recreation. There are seven parks along this reach with access to the river and numerous bridge crossings where you can get a bird's-eye view of this rare wetland amenity. Find your favorite spot by traveling The Loop, the recreational path along the river. Over several traffic counts during the month of October 2014, volunteers working with Pima Association of Governments counted more than 860 bicyclists and pedestrians at different locations along the path from the Sweetwater Wetlands to the junction of the river with the Cañada del Oro.

Go to **www.pima.gov/TheLoop** to find a detailed map and plan your visit.

LIVING RIVER OF WORDS YOUTH POETRY AND ART CONTEST

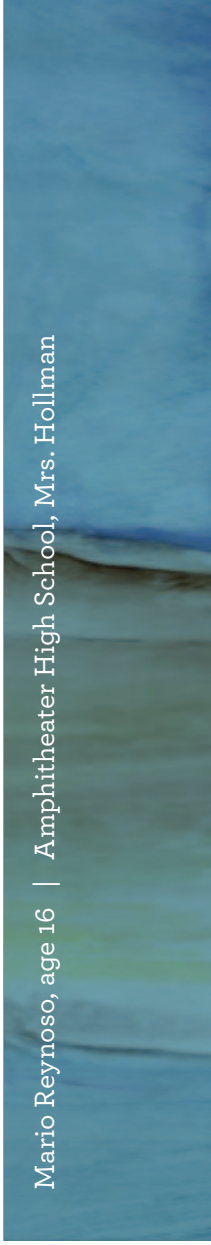
In 2015 Sonoran Institute and Pima County expanded the Living River Project goals to include sponsorship of a unique youth education program run by Pima County Natural Resources, Parks and Recreation. The Living River of Words, formerly known as Tucson's River of Words, offers local schools the opportunity to participate in a program that encourages young people to explore how water moves through the landscape and the connections that plants, animals, and people have to water.

The *Living River* reports help guide the science-based classroom activities and field trips to the river. These field trips are a key element of the program as they often represent the first opportunity students have to experience and visit a flowing river. In the second half of the program, students work with local artists to take what they have learned and create poetry or art entries for the contest. The contest is open to all youth who are 5 to 19 years old.

The 2015 Living River of Words Youth Poetry and Art contest received more than 900 submissions from 21 schools and included several independent entries. Included here, and on other pages, are some of the final poetry, art, and photography selections featured in the traveling exhibit. Learn more about the program at: **www.pima.gov/nrpr**.

GET INVOLVED

- Have your child enter the 2016 Living River of Words Youth Poetry and Art Contest. **www.pima.gov/nrpr**
- Take a water harvesting class sponsored by Tucson Water. Water harvesting is a great way to improve the resilience of our community by using water more efficiently. Find out how to harvest water and get a rebate on your water harvesting system. **www.tucsonaz.gov/water/rwh-rebate**
- Double your water harvesting efforts and join Tucson's Conserve 2 Enhance (C2E). C2E connects conservation with community action. Your donations, based on water savings, provide funding to enhance Tucson's rivers and urban washes which ultimately flow into the Lower Santa Cruz River. **www.conserve2enhance.org/Tucson**
- Count birds for the Tucson Bird Count and help document which birds are found along the Lower Santa Cruz River. **www.tucsonbirds.org**
- Visit the river for yourself! There are many places to see the river. One easy spot is from the Crossroads and Silverbell District Park. You can walk out to The Loop which passes behind the Wheeler Taft Abbett Library and easily watch the river flow by. If you're lucky you might even see a native Sonora mud turtle!



Mario Reynoso, age 16 | Amphitheater High School, Mrs. Hollman

Jesus Landy, age 19
Amphitheater High School, Mrs. Hollman

Aidan Frye, age 10
Satori Charter School, Mrs. Dudas

I Am The River

I am the river wise and old,
I have heard stories that are rarely told,
I am the river young and new,
I see even now as I talk to you,
I am the river not a water sprite,
I write and write very long into the night,
I am the river massaged by leaves and rocks,
I do not care about watches or clocks,
I am the river flowing to the ocean,
Where animals live and play in me as waves keep me in motion,
I am the river home of the animals around me,
One is a little fish who could not survive without me,
I am the river I do feel pain and sadness,
When animals hunt from me I don't feel gladness,
I am the river replenished with re-used water,
Still I am clean enough to house an otter.

LIVING RIVER PROJECT TEAM

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Image Credits: cover left: **Harris Environmental Group, Inc.**; right: *Lake in an Old Gravel Pit by the Santa Cruz River* **(Arizona Historical Society, Western Ways Photograph Collection—MS 1255, F143/S)**. 2–3, 14, 17: wildlife illustrations by **Bill Singleton** (Pima County). 4–5 photo montage by **Terry Moody** created with aerial photos by **Brian F. Powell** and **Google Earth**; left photo: outfall at Agua Nueva by **Watershed Management Group**. 7: image 1 by **James Dubois**; image 2 and 3 by **Ricardo Garcia** (Tucson Water); image 4 **(Arizona Historical Society)**; image 5 by **Brian F. Powell**. 8–9: **Terry Moody**. 11: image 1 and 2 by **Jennifer Duan**; image 3 by **Brian F. Powell**. 14: Sonora Mud Turtle by **Timothy R. Burkhardt**. 18–19: The Loop near Crossroads at Silverbell District Park by **Dean Knuth** (Pima County). Back cover top left: *Santa Cruz River* **(Arizona Historical Society, Main Photo Collection, 1902)**; bottom left: *Tucson and Santa Cruz Valley* **(Arizona Historical Society 101859)**; bottom right: *View of Tucson and the Santa Cruz River from the south side of A Mountain*, 1904 **(Arizona Historical Society 24868)**

Brandon Paredes, age 11 | DeGrazia Elementary, Mrs. Minninger

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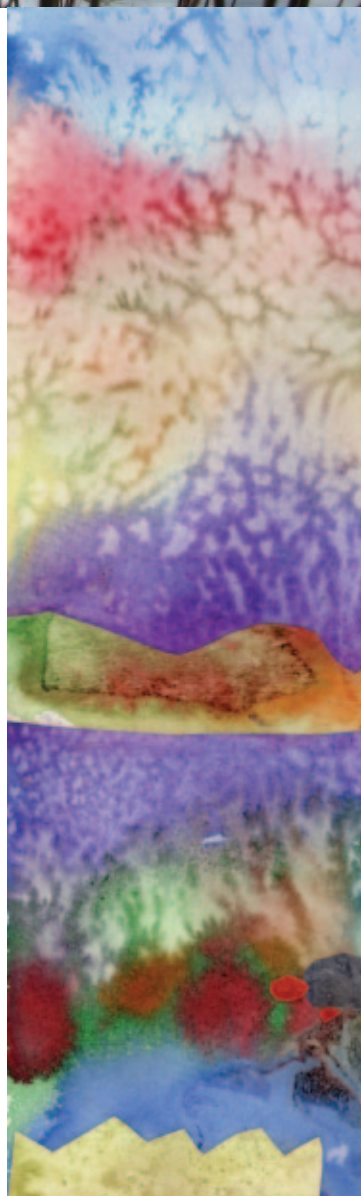
The Sonoran Institute convened a Living River Technical Committee of ecology, hydrology, and wildlife experts to bring the best available science to bear on the development of the Living River health assessments. The Technical Committee provided guidance by selecting and aggregating indicators of river health, identifying reference values or standards for evaluating and tracking changes in river conditions, and reviewing this report. The information presented in this report grew out of discussions involving these experts and represents the product of a collective effort; it does not reflect the opinions or viewpoints of any individual member of the technical team. The viewpoints and opinions expressed in the discussions of the group and captured in this report also do not reflect the opinions or viewpoints of the agencies, institutions, or organizations with whom the technical team members and external reviewers are associated or employed. Any errors or omissions contained herein are solely those of the Sonoran Institute.



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LEARN MORE

Request a presentation about the Living River Project. More information at **www.tiny.cc/lscr.**

SONORAN INSTITUTE

With 25 years of experience, the Sonoran Institute inspires and enables community decisions and public policies that respect the land and people of western North America. Facing rapid change, communities in the West value their natural and cultural resources, which support resilient environmental and economic systems.

Founded in 1990, the Sonoran Institute helps communities conserve and restore those resources and manage growth and change through collaboration, civil dialogue, sound information, practical solutions and big-picture thinking.

The Sonoran Institute is a nonprofit organization with offices in Tucson and Phoenix, Arizona; Bozeman, Montana; Glenwood Springs, Colorado; and Mexicali, Baja California, Mexico. Join us in celebrating our 25th Anniversary; visit our website to learn more www.sonoraninstitute.org.

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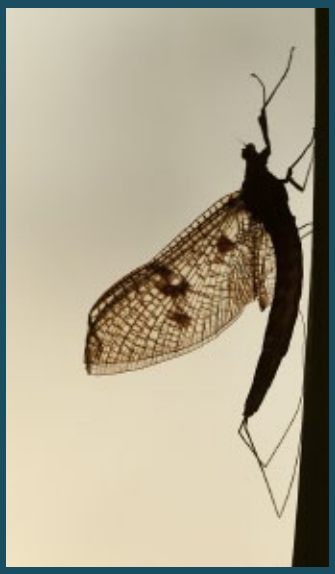

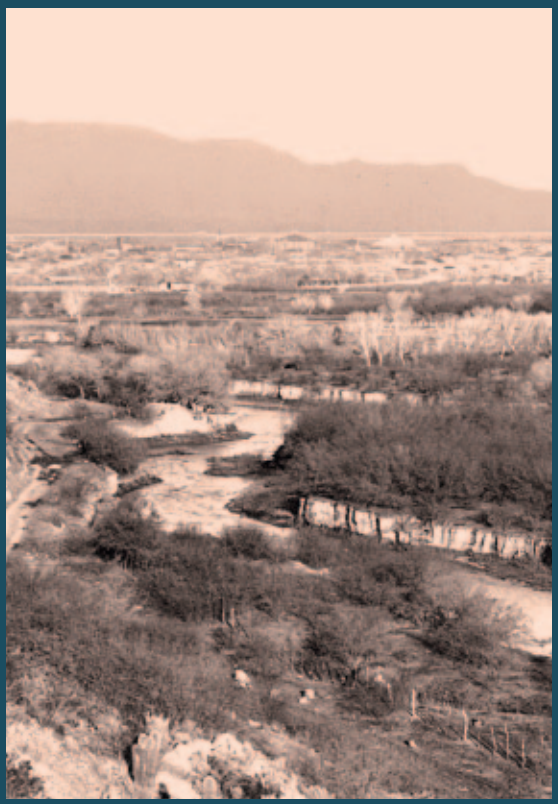

PIMA COUNTY

Pima County Regional Flood Control District
www.pima.gov/floodcontrol

Pima County Wastewater Reclamation Department
www.pima.gov/wastewaterreclamation

Pima County Office of Sustainability and Conservation
www.pima.gov/government/sustainability_and_conservation

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