Reclaimed Water in Arizona: History of Use and Current Issues

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Topics For Today

Some reclaimed water history

Arizona's current program

Into the future: Trends and challenges

ADEQ
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Of Arizona's 100 largest sewage treatment plants, what percentage distribute treated wastewater for beneficial reuse?

ADEQ
Arizona Department of Environmental Quality

10 %

20 %

30 %

40 %

50 %

60 %

70 %

80 %

90 %

Categories of Water (Under the Law)

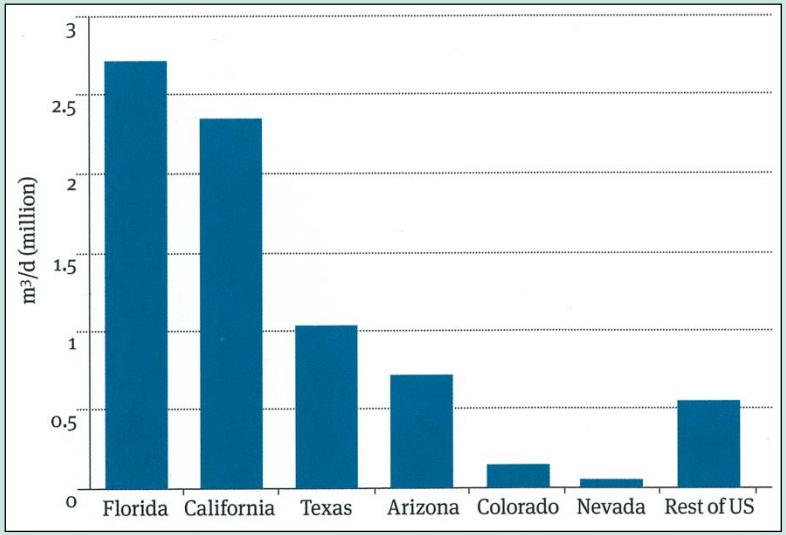
- Drinking Water
- Surface Water
- Groundwater
- Reclaimed Water
  - Treated wastewater
  - Gray water

Reclaimed Water Use

82% of reuse occurs in just four states, Arizona being one

Map: Western Water, July/August 2008

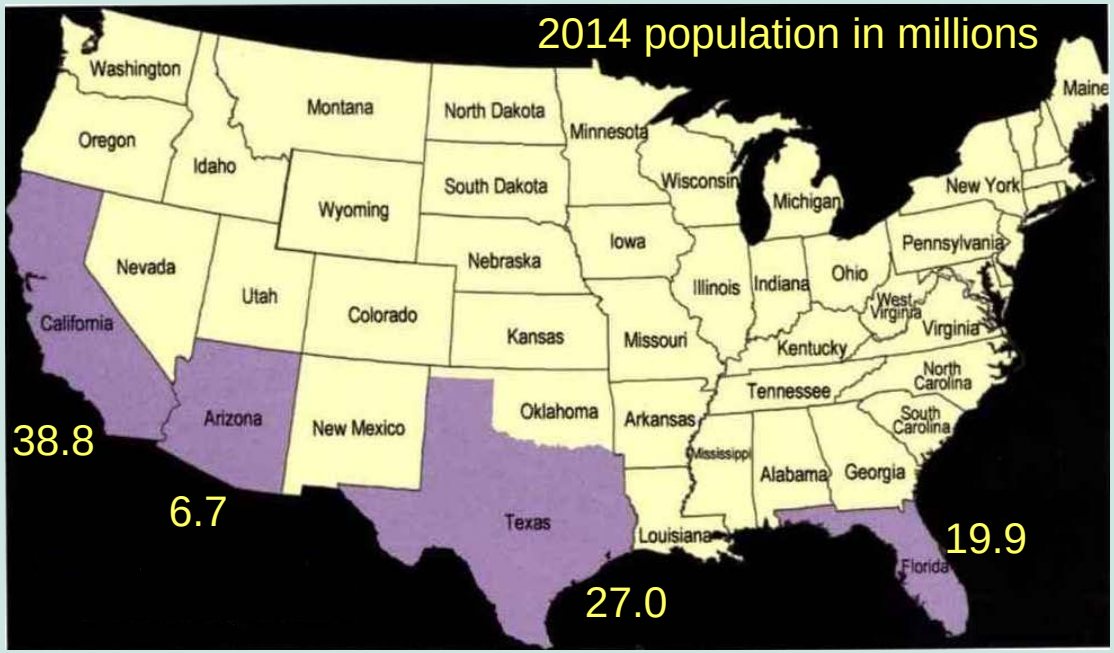
Reused Wastewater Flows, 2014



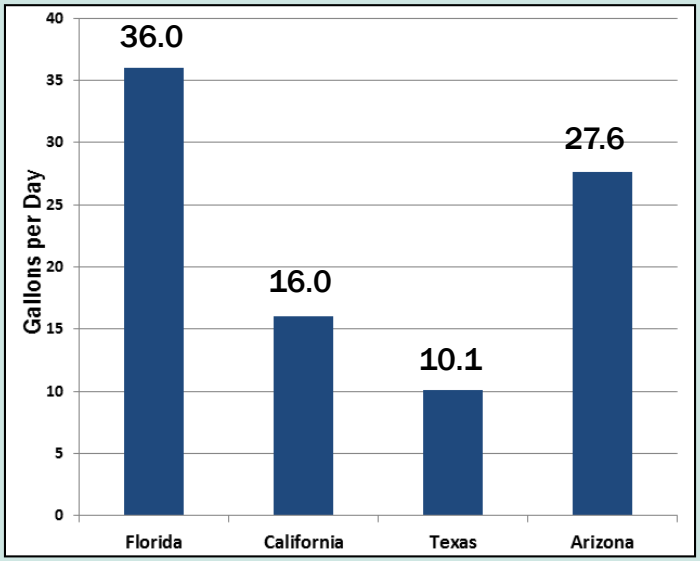
Source: Bluefield Research

Reclaimed Water Use

Arizona is 2nd highest nationally in per capita reuse



Reuse Per Person, 2014



Reclaimed Water Use

	Water Reuse Capacity (AF/yr)	Reclaimed Water as % of Total Water Supply
Israel	510,000	20%
Singapore	80,783	30%
United States	3,400,000	3%
Florida	955,000	4%
California	807,000	2%
Texas	482,000	3%
Arizona	504,000	7%

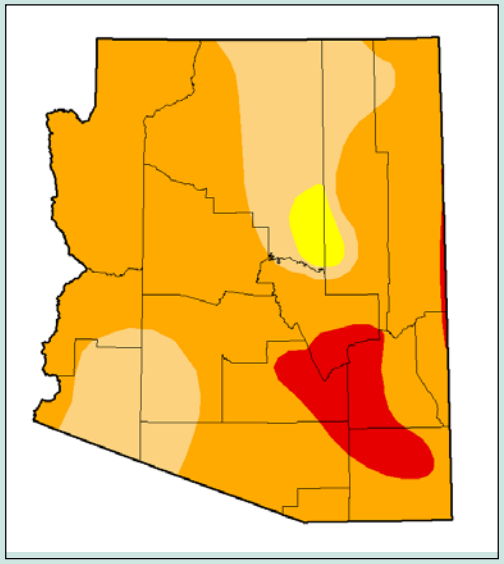
Source:
Bluefield Research

...but #1 at integrating reuse into the water supply portfolio

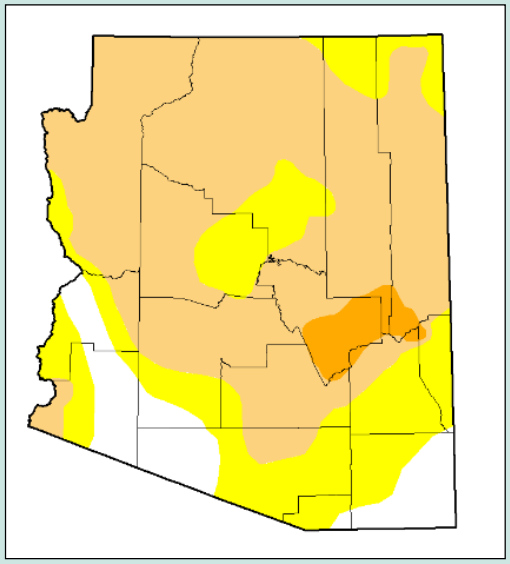
Q: Why Arizona?

A_1: Driven by need

- We're an arid state!
- We have droughts!



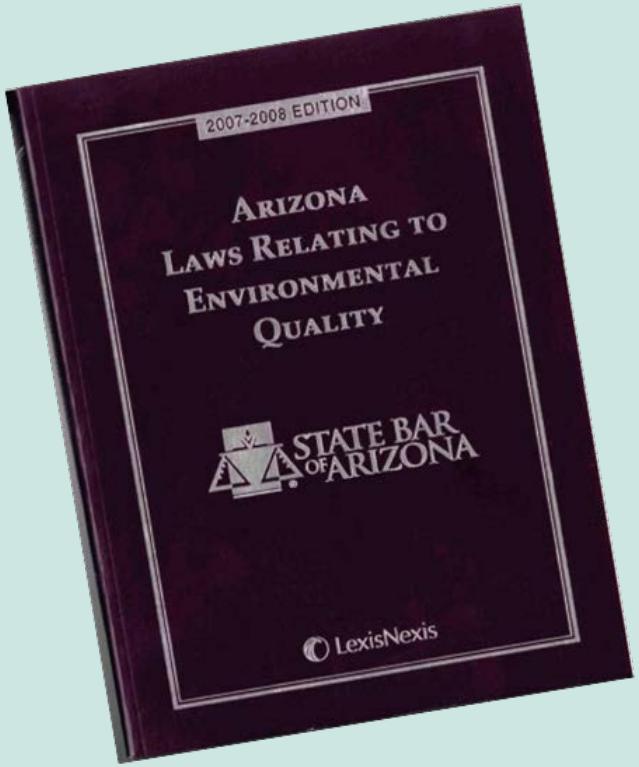
Drought map – June 2014



Drought map – Current

Q: Why Arizona?

A_2: We have a comprehensive legal framework



Before Wastewater Infrastructure

- *"Old Bisbee was raucous, crowded, noisy, smoky and vastly overpopulated. Raw sewage ran down the streets."*

Raw sewage in Brewery Gulch, Bisbee, 1906
Source: Bisbee Mining & Historical Museum

- Hundreds die from typhoid fever in Bisbee, 1888-90
- 800 cases in one 10-week period in 1891
- Water system (1904) and sewage system (1908) eliminated the problem

Reuse Driven by Need

AZ – one of first states to reuse treated wastewater

- Grand Canyon Village – 1926

Reuse Driven by Need

Grand Canyon – first WWTP in US built specifically to allow reuse (0.13 mgd capacity)

- Toilet flushing
- Boiler feed for power generation
- Water for steam locomotives

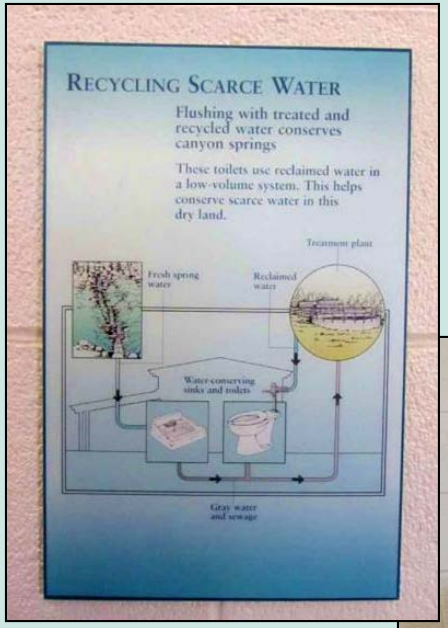
Reuse Driven by Need

Grand Canyon Village—

still water-short,

still using reclaimed water!

- Toilet flushing
- Landscape irrigation



Restroom at Visitor Center, Grand Canyon National Park, 2013

Early Reuse

1932 – irrigated agriculture receives reclaimed water from new Phoenix 23rd Avenue WWTP

- To this day, Phoenix WWTPs supply reclaimed water for irrigated agriculture

Sewage Farming: A Trip Back in Time

Irrigation with raw sewage

- Popular in arid west due to limited water supplies
- Reached peak in CA in 1923
- Over 70 cities had sewage farms for growing food crops

Sewer farm near Salt Lake City, Utah

Source: Utah Historical Society, ca. 1908

Tucson Sewage Farming: Local Trip Back in Time

Irrigation with raw sewage in Tucson

1900 – Sewers installed.
Open ditch from end of sewer to small farm NW of city center.

1914 – New 30” main irrigates 120 acre farm 4.5 mi. NW of city center

1923 – Farm expands to 750 acres (0.5 x 3 mi.)

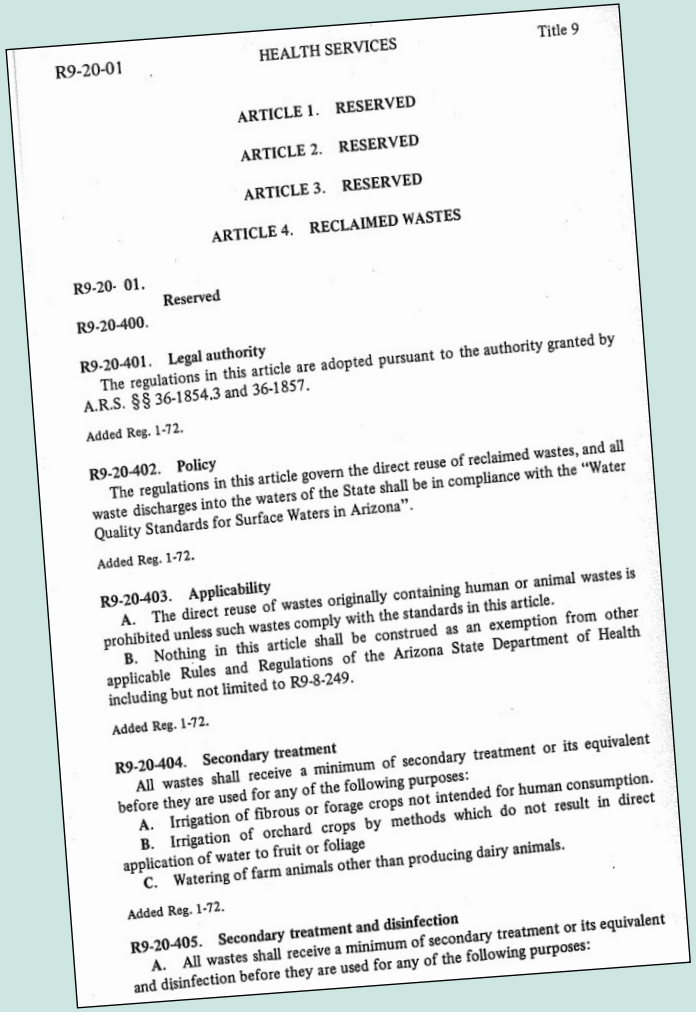
1928 – Odor complaints and threats of lawsuits prompt construction of first WWTP

Plan of Sewerage for Tucson, 1900
Source: sewerhistory.org

Ahead of the Times

- Jan 1972 – 1st reclaimed water rules

1974—Reclaimed water reuse begins at Fountain Hills



R9-20-01 HEALTH SERVICES Title 9

ARTICLE 1. RESERVED

ARTICLE 2. RESERVED

ARTICLE 3. RESERVED

ARTICLE 4. RECLAIMED WASTES

R9-20- 01. Reserved

R9-20-400.

R9-20-401. Legal authority
The regulations in this article are adopted pursuant to the authority granted by A.R.S. §§ 36-1854.3 and 36-1857.

Added Reg. 1-72.

R9-20-402. Policy
The regulations in this article govern the direct reuse of reclaimed wastes, and all waste discharges into the waters of the State shall be in compliance with the "Water Quality Standards for Surface Waters in Arizona".

Added Reg. 1-72.

R9-20-403. Applicability
A. The direct reuse of wastes originally containing human or animal wastes is prohibited unless such wastes comply with the standards in this article.
B. Nothing in this article shall be construed as an exemption from other applicable Rules and Regulations of the Arizona State Department of Health including but not limited to R9-8-249.

Added Reg. 1-72.

R9-20-404. Secondary treatment
All wastes shall receive a minimum of secondary treatment or its equivalent before they are used for any of the following purposes:
A. Irrigation of fibrous or forage crops not intended for human consumption.
B. Irrigation of orchard crops by methods which do not result in direct application of water to fruit or foliage
C. Watering of farm animals other than producing dairy animals.

Added Reg. 1-72.

R9-20-405. Secondary treatment and disinfection
A. All wastes shall receive a minimum of secondary treatment or its equivalent and disinfection before they are used for any of the following purposes:

Reclaimed Water for Power Generation

1983 – Phx 91st Ave WWTP delivers treated wastewater to Palo Verde NGS

- Largest nuclear power plant in US
- Unique in world: 100%-cooled by reclaimed water

Phoenix 91st Ave WWTP

Reclaimed Water for Power Generation

1983 – Reclaimed water to Palo Verde NGS

- 36 mi. long pipeline
  - 6½' to 9½' diameter
- Delivers 60 mgd
  - 45% of WWTP flow
- 3% of entire US reuse!

Palo Verde Nuclear Generating Station

Comprehensive Rule Framework

2001 – New rules transform program

- Foster reuse while protecting WQ & human health

Reclaimed water pipeline, City of Chandler

Stringent Treatment Standards

1. WWTPs must employ Best Available Demonstrated Control Technology (BADCT)

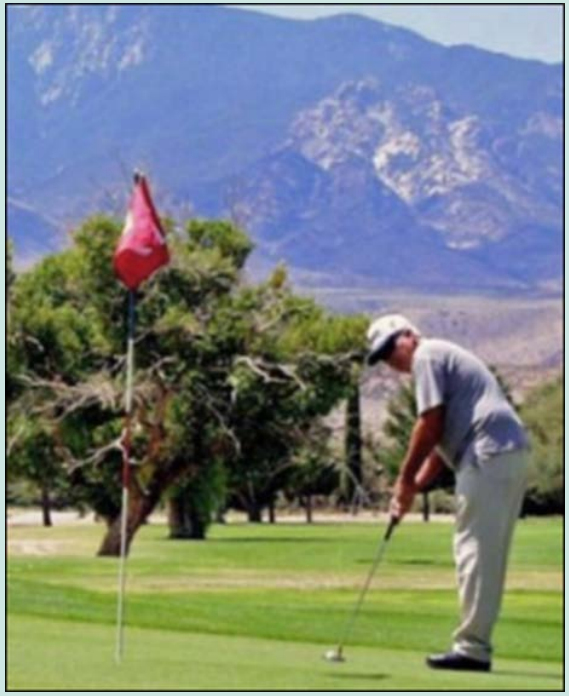
- Pathogen-free effluent
  - No *E. coli*, 4 of 7 daily samples
  - *E. coli* never over 15 cfu/100 ml
- Nitrogen removal, l.t. 10 mg/l
- Odor control

Nogales International Wastewater Treatment Plant, upgraded 2009

Water Quality Provisions

2. Five reclaimed water quality classes (A+, A, B+, B, C)

- with corresponding allowed end uses



Class A+ water irrigates Safford golf course

Photo: Mt. Graham Golf Course

Reclaimed Water Quality

Class A+, A → open access uses

- pathogen-free
- denitrified (A+)

} BADCT

- filtration to meet turbidity <2 NTU

Turf irrigation with Class A+ water, Northern Arizona University, Flagstaff

Some Class A+ and A Allowable Uses

- irrigation of food crops
- recreational impoundments
- residential/schoolyard irrigation
- toilet & urinal flushing
- fire protection systems
- snowmaking
- and more

Reclaimed Water Fire Hydrant

Viticulture with reclaimed water, Cottonwood
(Yavapai College photo)

How Good is A, A+ Reclaimed Water?

- Compare with SRP canal water
  - Delivers water from 6 Salt and Verde River reservoirs
  - Irrigation of yards, parks & school grounds in greater Phoenix area since 1928

SRP Residential Irrigation, Phoenix

Bacterial Quality

- 61 Fecal Coliform samples collected by SRP throughout canal system
  - Highest > 16,000 (cfu/100 ml)
  - Mean = 2360
  - Median = 500
  - Lowest = 17
- Compare to RWQS
  - Class A+/A = 0

Photo: Dartmouth Univ.

But…
There Are Prohibitions

- Evaporative cooling, misting
- Full-immersion water activities w/potential for ingestion
  - swimming, windsurfing, water skiing, etc.
- ***Direct reuse for human consumption***

Eye-opening Statistics

Arizona's 98 largest WWTPs

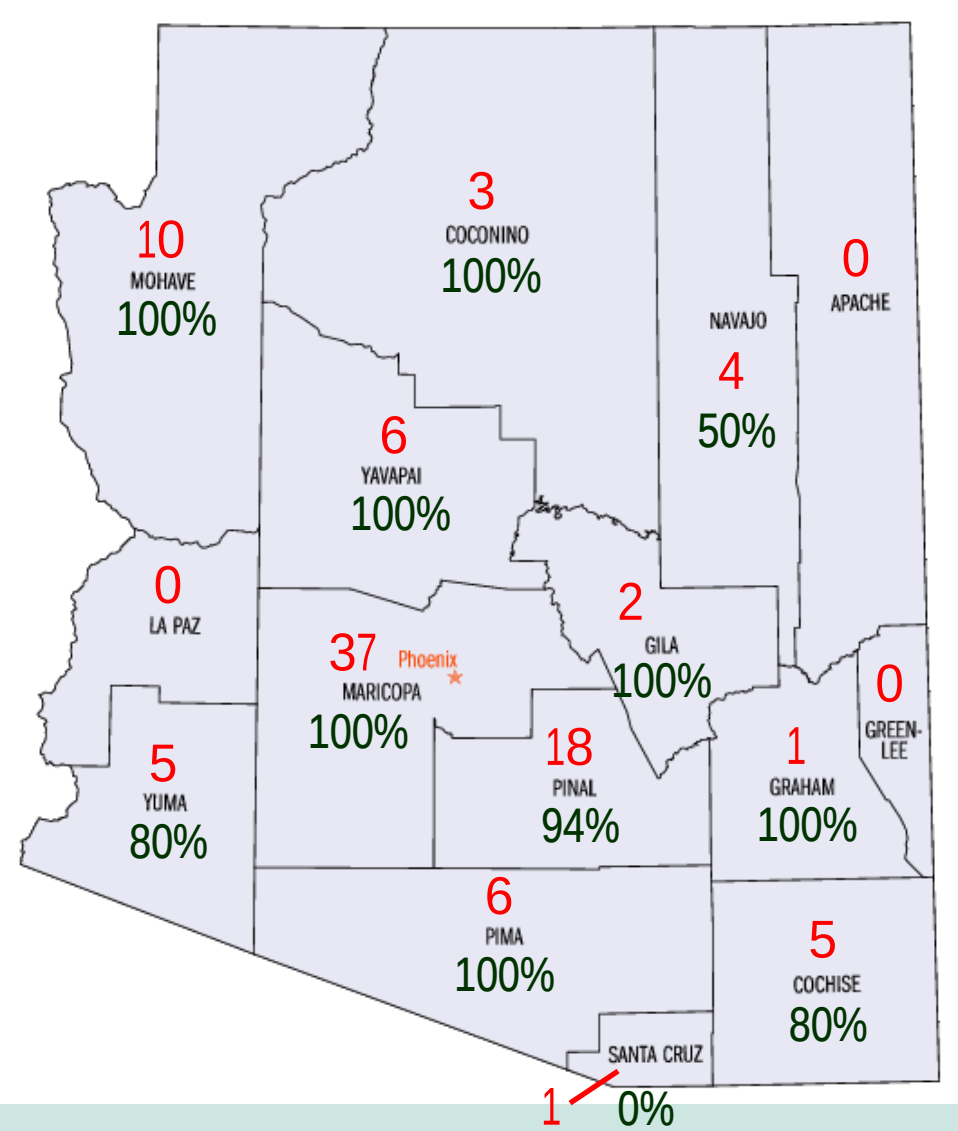
- Comprise 1/3 of total, yet treat 95% of AZ sewer flows
- 93% distribute at least some reclaimed water for reuse!

Landscape impoundment,
Freestone Park,
Gilbert, AZ

Reuse is Everywhere—Metro & Rural!

WWTPs, design flow ≥ 1 mgd

RED, 98 total



Reuse or recharge for credit

GREEN, percentage

Another Surprising Statistic

Of Arizona's 98 largest WWTPs (≥ 1 mgd)

- 56% distribute Class A+ water

Mesa Northwest Water Reclamation Plant

Reuse is Pervasive

More than 82% of treated wastewater generated in the Phoenix metro area is reused

- represents wastewater from 60% of AZ population

Reuse in the Greater Phoenix Area

- Disposition of treated wastewater

- Power	22%
- Agriculture	22%
- Recharge	21%
- Environmental (i.e., Tres Rios)	11%
- Landscape, turf irrigation	6%
SUBTOTAL THAT IS REUSED	82%
- Discharged (uncommitted)	18%
TOTAL	100%

Source: "Water Reuse in Central Arizona," ASU Decision Center for a Desert City, 2013

Largest Permitted Reclaimed System in AZ

City of Tucson

- Serves 1000s of residential, M & I, and agricultural users

  160 miles of purple pipe
  18 golf courses
  50 parks
  65 schools (incl. Univ. of Arizona)
  >700 single family homes

Irrigating athletic field with reclaimed water, University of Arizona

Substantial Recharge

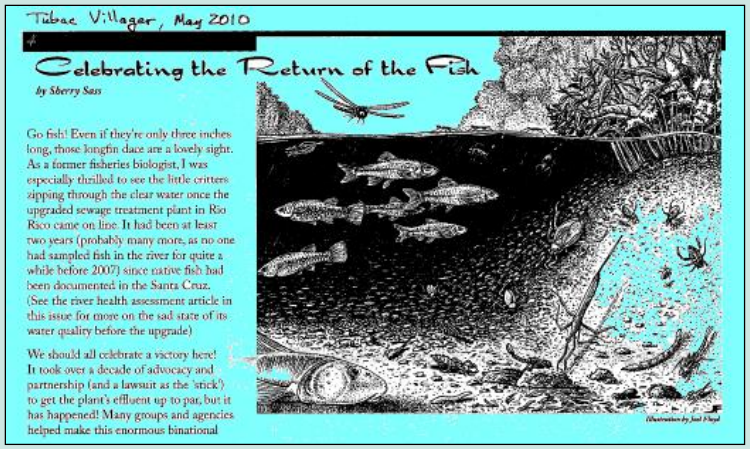
- 56 groundwater recharge facilities recharge reclaimed water under permit
- Permitted recharge is 160,000 af/yr (143 mgd)
  - 16% of permitted design flow of all WWTPs

Recharging Class A+ reclaimed water, Gilbert Riparian Preserve

Photo: arizonensis.org

How has it worked?

- Standards for new/expanding WWTPs has dramatically improved many formerly poor-quality discharges
  - Nutrients
  - Clarity
  - Health risk



Tubac Villager, May 2010

Celebrating the Return of the Fish

by Sherry Sass

Go fish! Even if they're only three inches long, those longfin dace are a lovely sight. As a former fisheries biologist, I was especially thrilled to see the little critters zipping through the clear water once the upgraded sewage treatment plant in Rio Rico came on line. It had been at least two years (probably many more, as no one had sampled fish in the river for quite a while before 2007) since native fish had been documented in the Santa Cruz. (See the river health assessment article in this issue for more on the sad state of its water quality before the upgrade)

We should all celebrate a victory here! It took over a decade of advocacy and partnership (and a lawsuit as the 'stick') to get the plant's effluent up to par, but it has happened! Many groups and agencies helped make this enormous binational

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Endangered fish reappear in the Santa Cruz River

Recommend 0 | Tweet | G+1 0 | Share | Print | Email

Respond: Write a letter to the editor | Write a guest opinion

Bruce Taubert

Scientists say that improved water quality in the Santa Cruz River may be the reason behind the topminnow sightings.

Santa Cruz River below the upgraded Nogales International WWTP comes back to life

Program Accomplishments

Large majority of WWTPs now produce high-quality treated wastewater suitable for reuse

- Has turned a waste "to be gotten rid of" into a resource with value

Wheeling reclaimed water around, Gilbert Riparian Preserve

Future Trends?

Increased off-season utilization

More ski areas?

Alternatives other than golf courses?

DC Ranch, Scottsdale
Photo: Cronkite News Service

Biggest Developing Off-season Trend?

More recharge projects to bank groundwater?

Existing facilities recharging Class A+ reclaimed water

City of Surprise
Source: American Academy of Environmental Engineers and Scientists

Town of Prescott Valley

Payson Green Valley Lake

Future Trend?

Transition to higher-valued end uses

More industrial reuse?

Existing high-value end uses

SCA Tissues, Flagstaff
Recycled paper production

Intel Ocotillo Campus, Chandler
Semiconductor fabrication

Higher Value End Use: Craft Beers, Too?

Photo: Milwaukee Journal Sentinel

"a little bit of me,
a little bit of you"

SALON NEWS POLITICS ENTERTAINMENT LIFE TECH BUSINESS SUS

WEDNESDAY, JAN 28, 2015 03:17 PM MST

Craft beer made from recycled sewage water is coming soon to Portland

A toast, to water conservation!

LINDSAY ABRAMS Follow

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TOPICS: WATER WASTE, PORTLAND, SEWAGE, CRAFT BEER, FOOD, INNOVATION NEWS, SUSTAINABILITY NEWS, NEWS

(Credit: Igor Kilmov/Shutterstock)

A Developing Trend

More multi-purpose & community enrichment projects

Kino Environmental Restoration Project (combined reclaimed/ stormwater)
Credit: Pima County

Town of Payson Green Valley Lake

Anthem Community Park
Credit: MCM Group

Birdwatching blind, Veterans Oasis Park, Chandler
Credit: Buck-Fever

Unintended Consequences?

Is reclaimed water becoming so valuable that riparian areas dependent on it are becoming threatened?

Photo: Channing Turner, Cronkite News

Santa Cruz River below Nogales International WWTP

ADEQ is Revising its Rules: Why?

1. Keep up with the rapidly moving reclaimed/reuse field

2. Sustainable water supplies are becoming increasingly important

Gathering Input

Three listening session workshops held

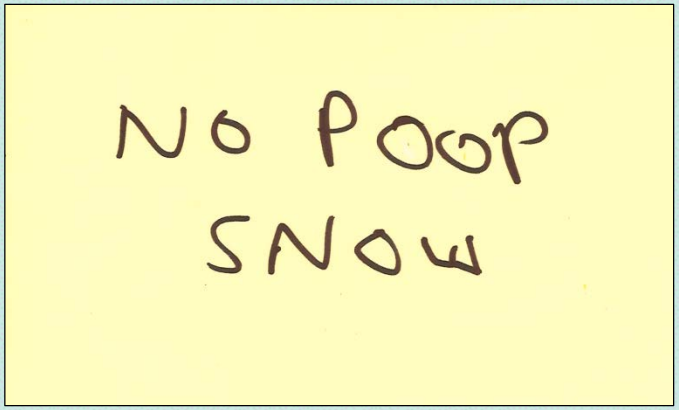
Feb 12 Tucson

Mar 10 Phoenix

May 5 Flagstaff

Listening Session Workshops

- 40 - 70 people attended each workshop
- More than 300 comments received



- Compiled into Issues Matrix

http://www.azdeq.gov/reclaimed-water-rulemaking

Selected Issues from Stakeholders

Allow easier integrated use of reclaimed water with other waters (stormwater, canal water, etc.)

Review reclaimed water quality standards

Address emerging contaminants

Allow new end uses
- including riparian restoration/enhancement

Remove prohibition for reuse of reclaimed water for human consumption

Kino Environmental Restoration Project (combined reclaimed/ stormwater)
Credit: Pima County

Gray Water Issues From Stakeholders

Continue allowing household gray water use without having to get a permit or pay a fee

Develop streamlined permits for large-scale, non-residential use of gray water

Large-scale gray water reuse, Barrett Honors College, ASU

Process Going Forward

- Establish expert workgroups
  - Technology
  - Reclaimed water quality standards
- Adopt first rule package by end of 2016?
- Adopt second rule package by end of 2017?

ADEQ
Arizona Department of Environmental Quality

To be on listserv for rule revision:

Send e-mail to: reuserulemaking@azdeq.gov

Or e-mail me at: cgg@azdeq.gov

Rule revision info & Issue Matrix:

http://www.azdeq.gov/reclaimed-water-rulemaking

Town of Payson
Green Valley Lake