

Survey of Solutions

Presented by the Citizens Water Advocacy Group:

Gary Beverly, PhD

Science Team: Peter Kroopnick, Ed Wolfe, Gary Beverly, and others

Takeaway

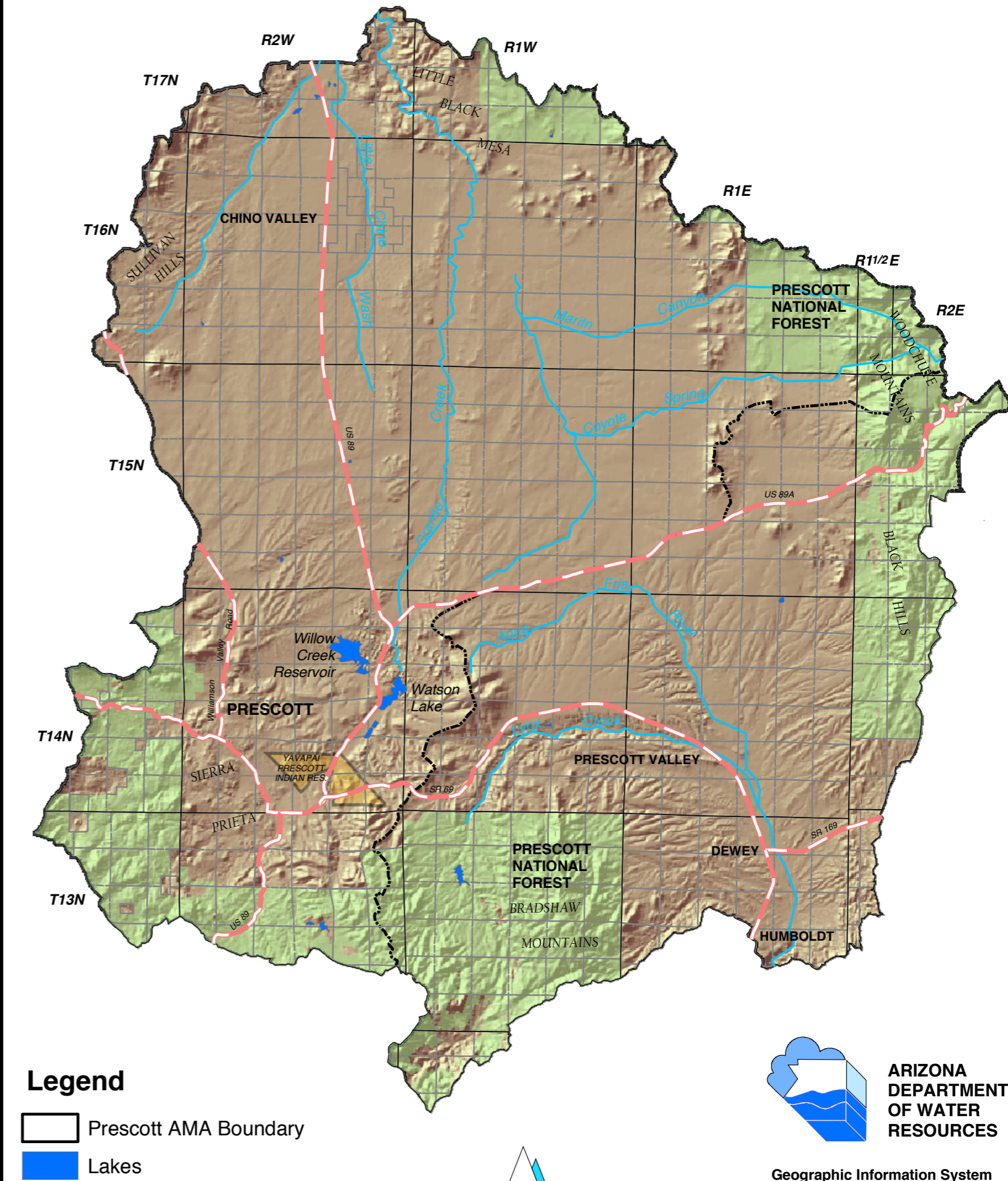
- The Problem is growing.
- Solutions exist.
- Conservation is important, but not a complete solution.
- Augmentation is needed.
- Regional planning is essential.

The Problem

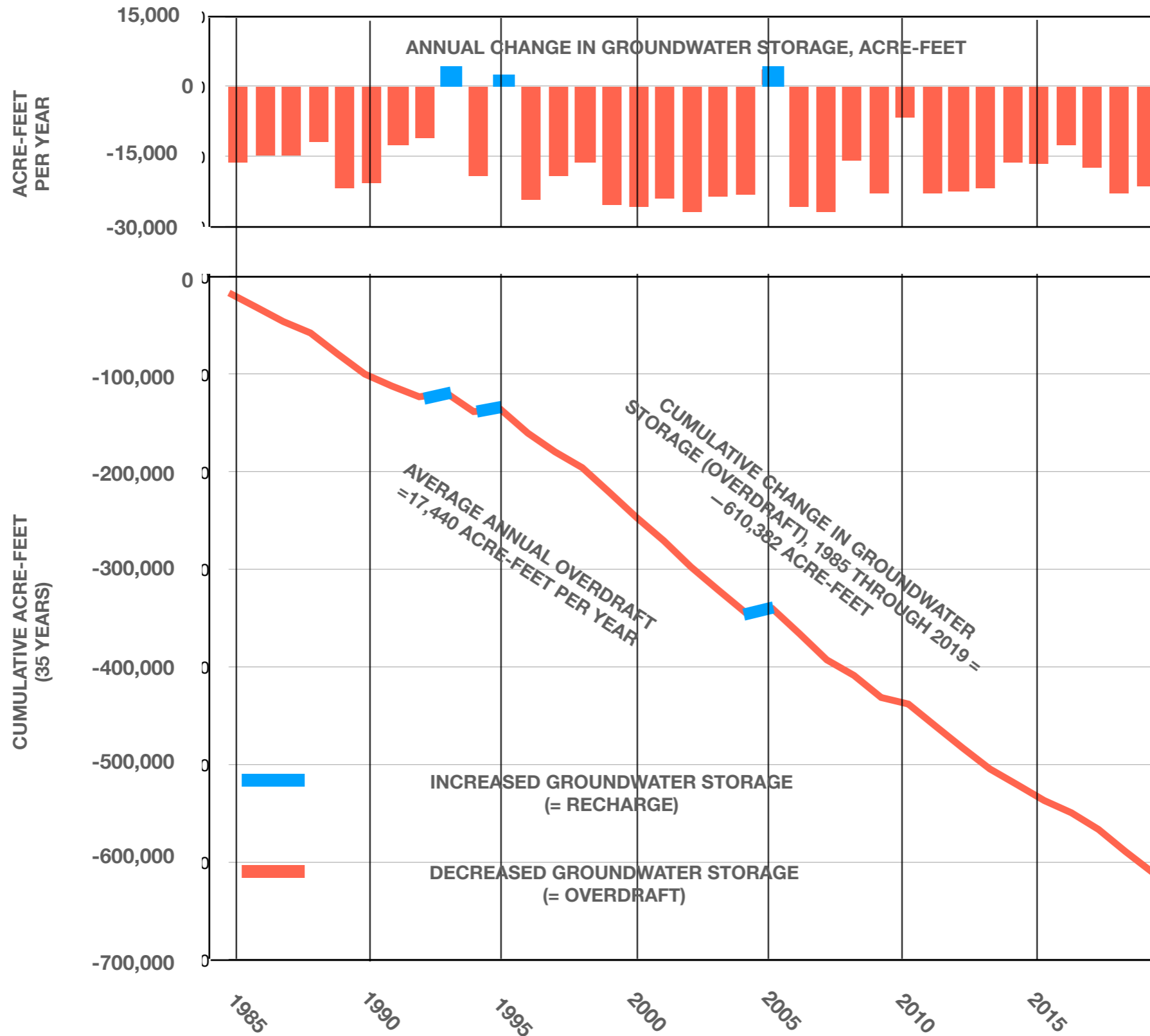
- Housing demand: every new home consumes groundwater.
- Groundwater continues to be depleted.
- Overdraft has grown to >21,000 afy in 2019.
- Growing demand for water to support future growth.
- Lack of planning and cooperation: Cities compete for water.

AMA Management Goal by 2025: **Safe Yield**

- No penalty.
- No incentives.
- ADWR provides data but no assistance.
- Responsibility of region, not ADWR.
- No regional plan exists.
- No discussions are planned.



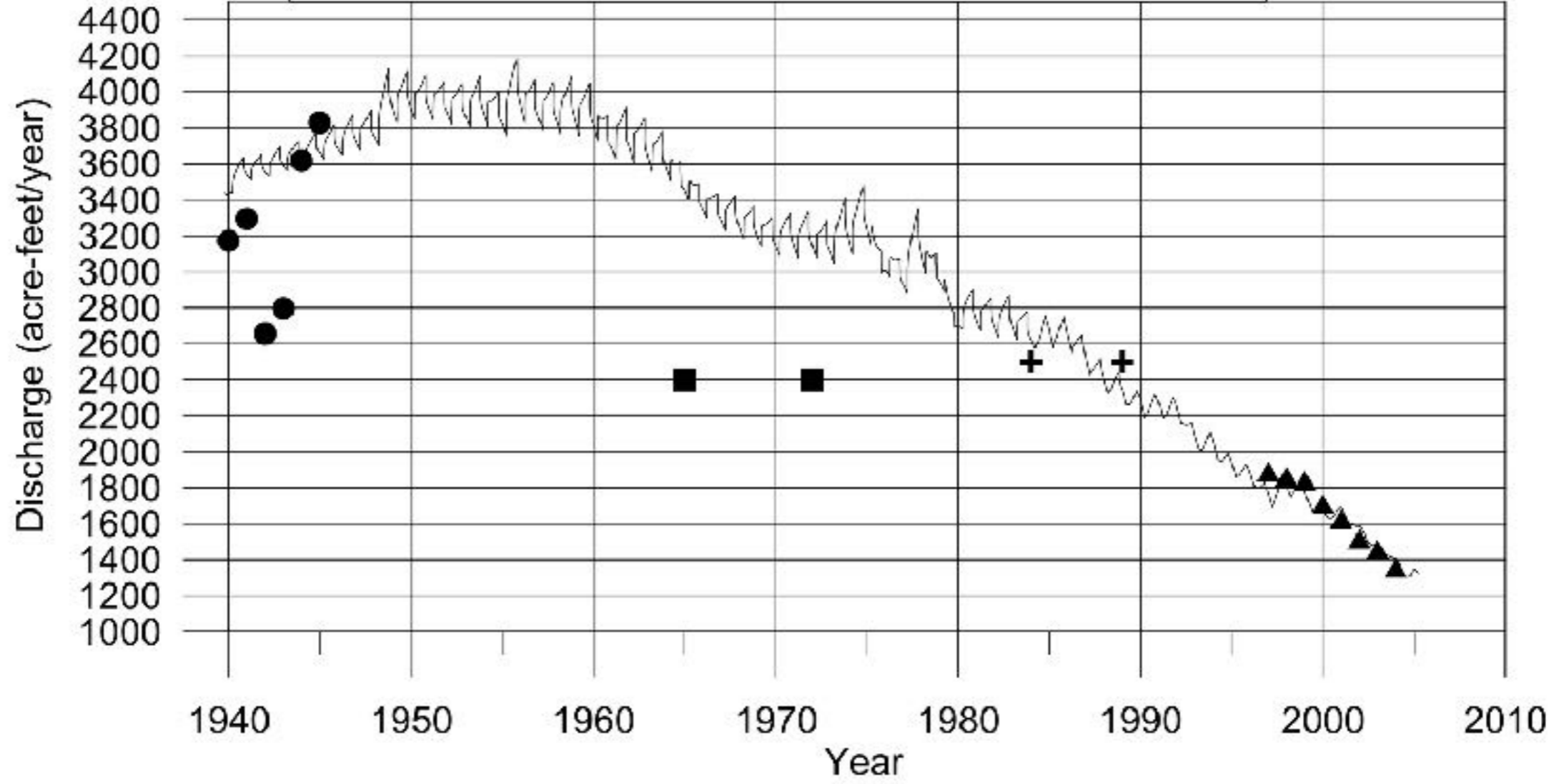
**PrAMA ANNUAL AND CUMULATIVE CHANGE
IN GROUNDWATER STORAGE, ACRE-FEET
1985 THROUGH 2019**



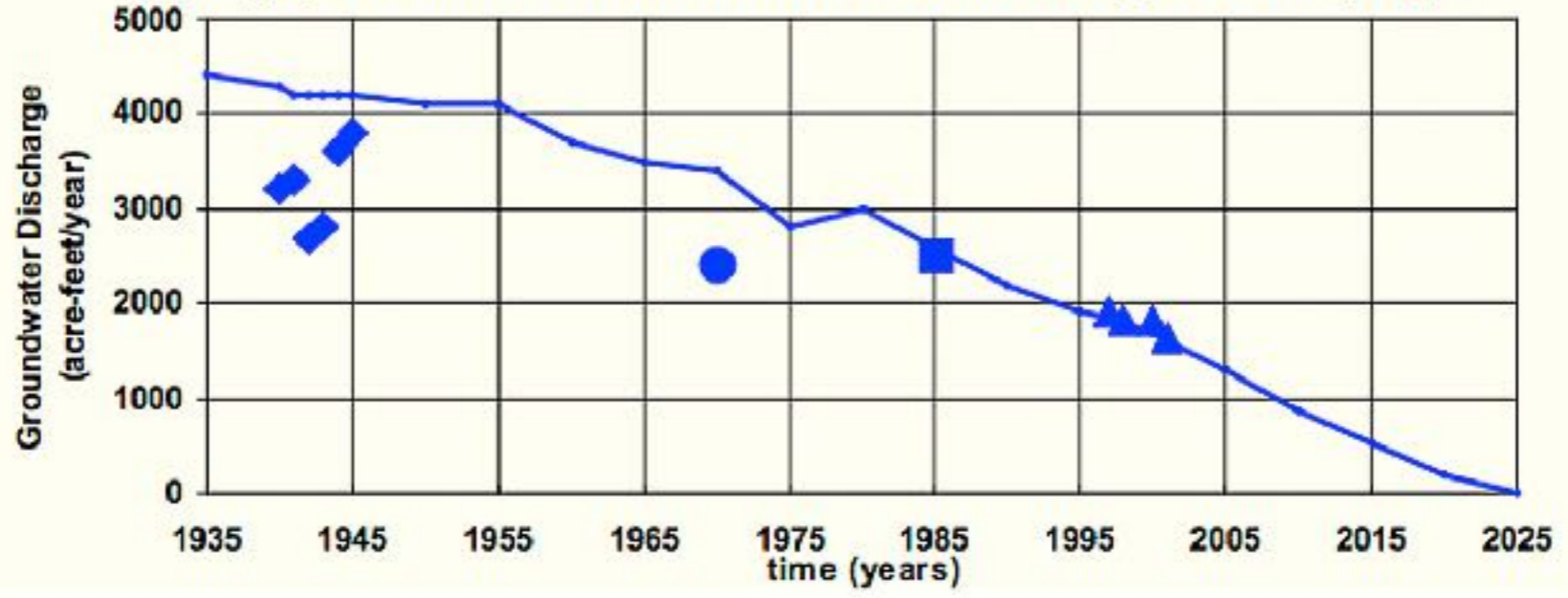
**Overdraft causes aquifer
water levels to fall**

**Overdraft causes Del Rio
Springs to dry up**

Hydrograph 19
 Prescott AMA: Groundwater Discharge at Del Rio Springs

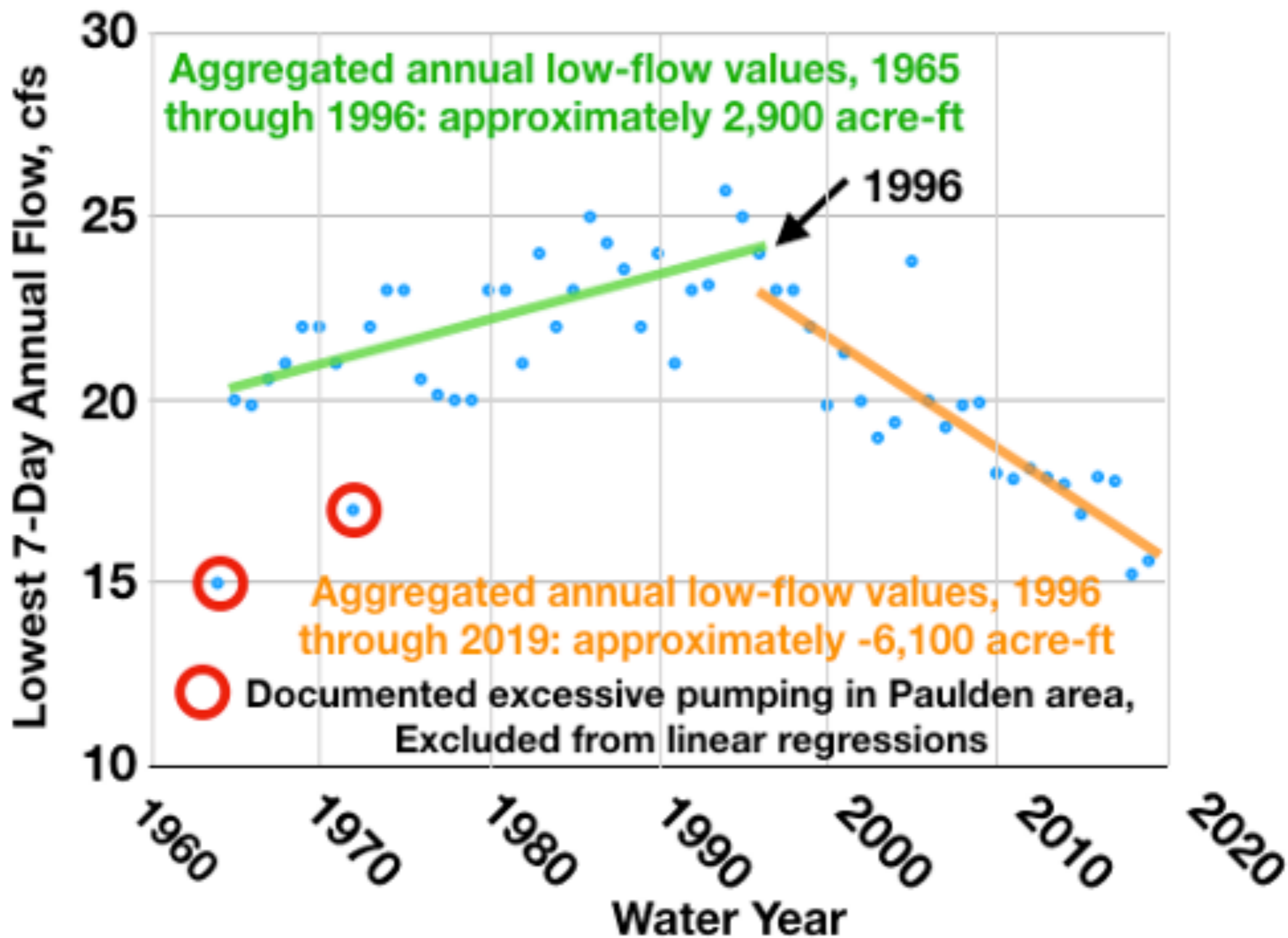


Hydrograph 7: Simulated and Observed Groundwater Discharge at Del Rio Springs



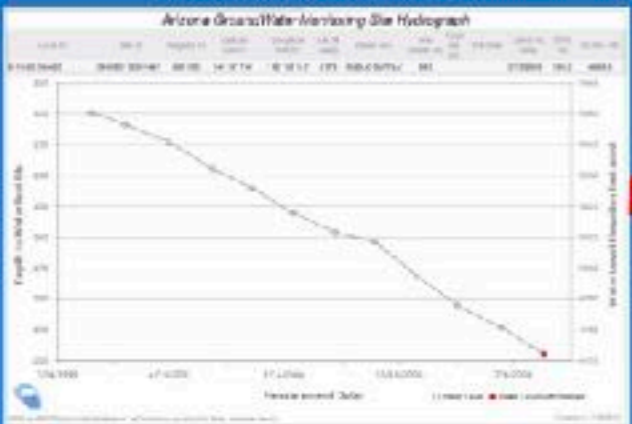
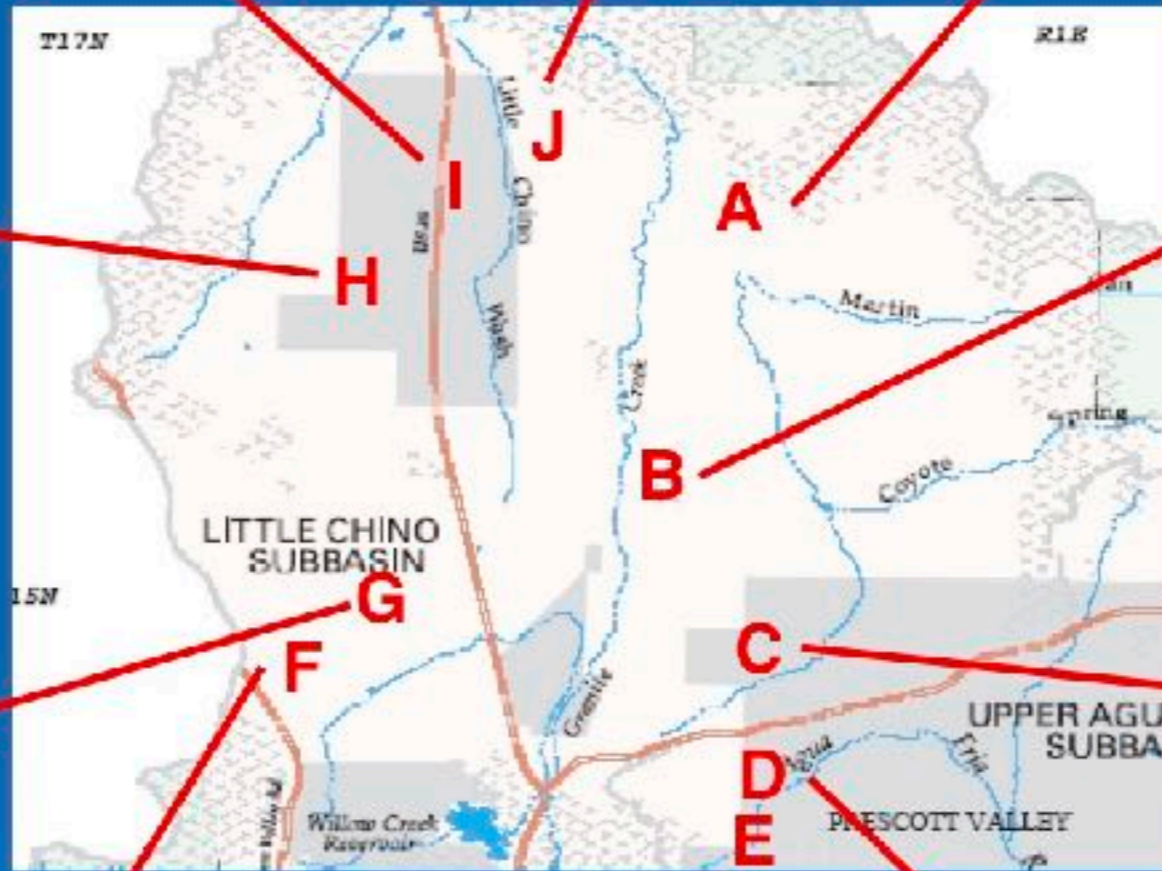
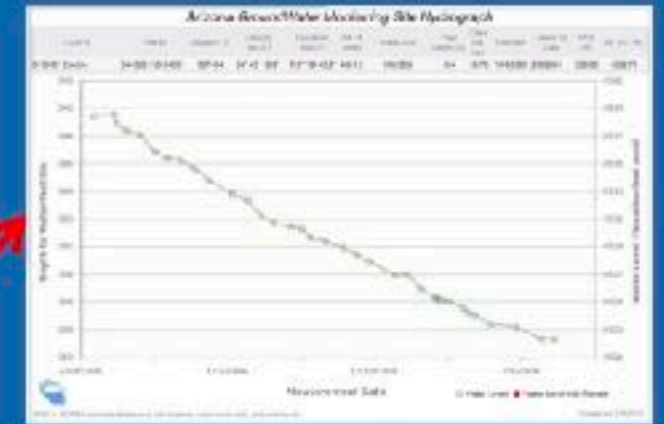
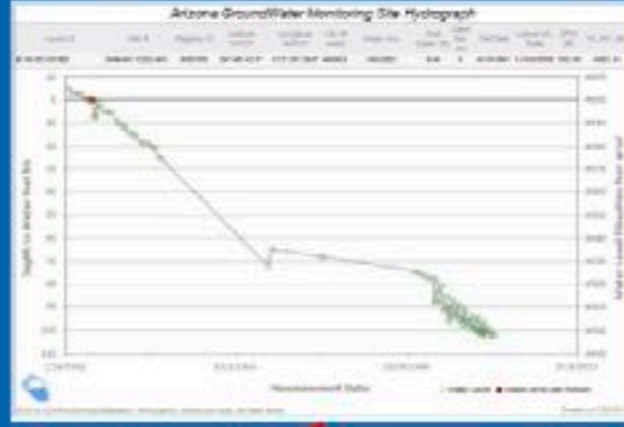
**Overdraft & increasing
temperatures reduce the
flow of the Verde River**

PAULDEN GAGE, LOWEST 7-DAY ANNUAL FLOW

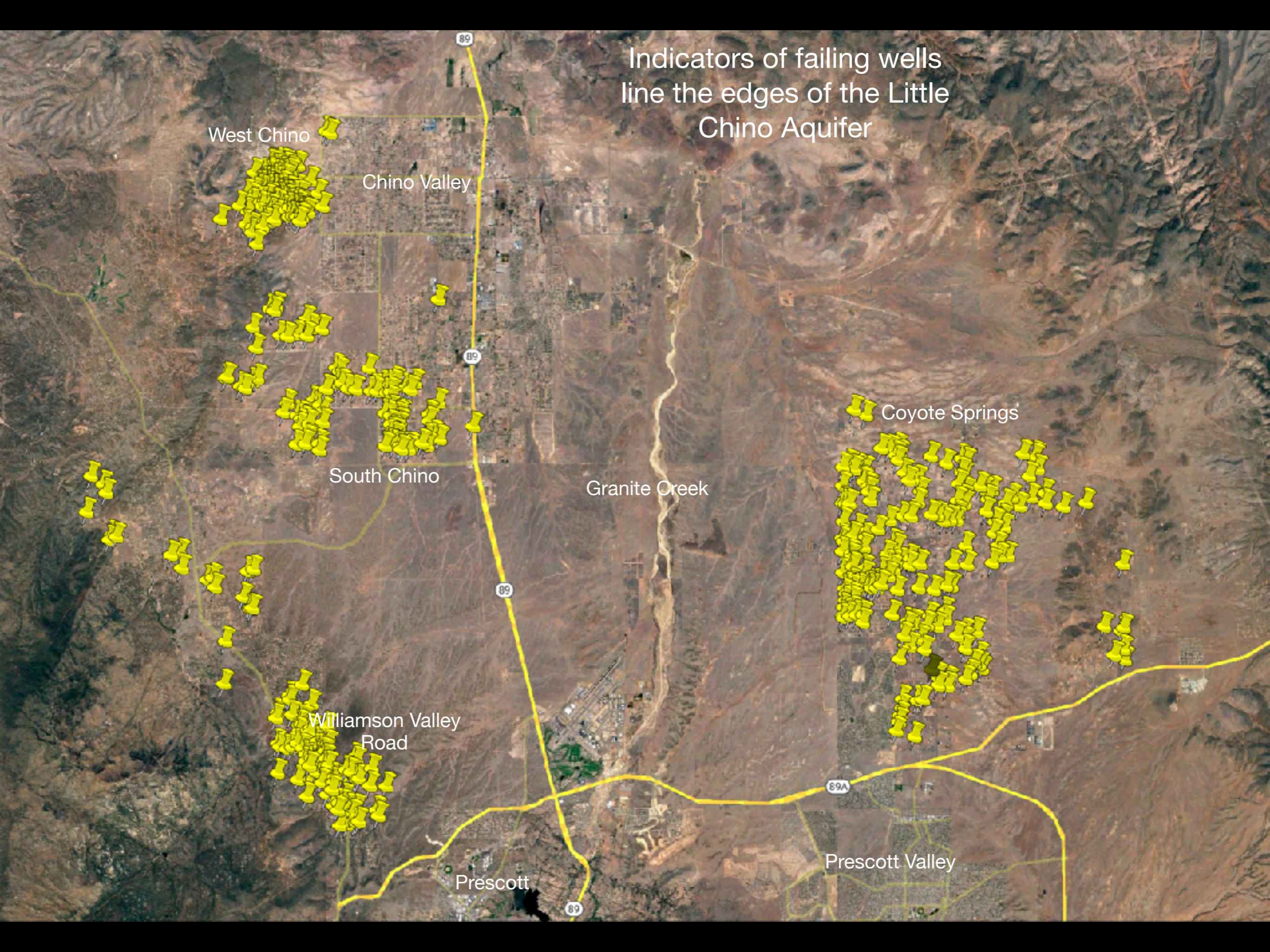


Overdraft reduces water levels in wells throughout the AMA.

Prescott AMA Groundwater Hydrographs



Indicators of failing wells
line the edges of the Little
Chino Aquifer



West Chino

Chino Valley

South Chino

Williamson Valley
Road

Prescott

Granite Creek

Coyote Springs

Prescott Valley



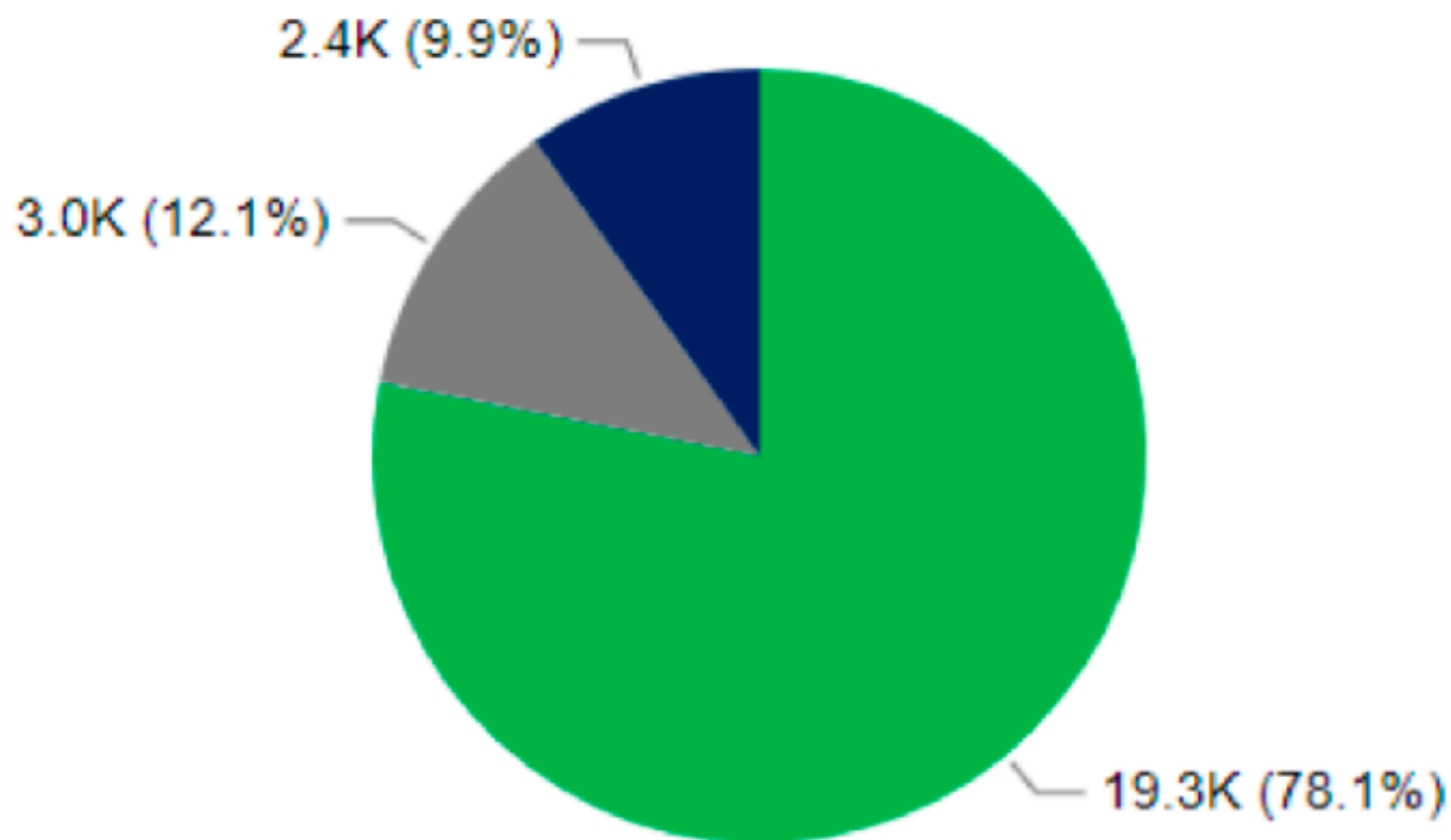
Some Solutions

- No single solution!
- Reduce demand
- Increase water reuse
- Minimize growth impact: Water Neutral Development
- State of Arizona?
- Augmentation: Import water from somewhere else.

Conservation

- Regarded as the fastest and cheapest strategy.
- Behavioral vs Device based conservation
- Voluntary vs Incentive vs Mandatory
- Reducing demand facilitates other solutions.

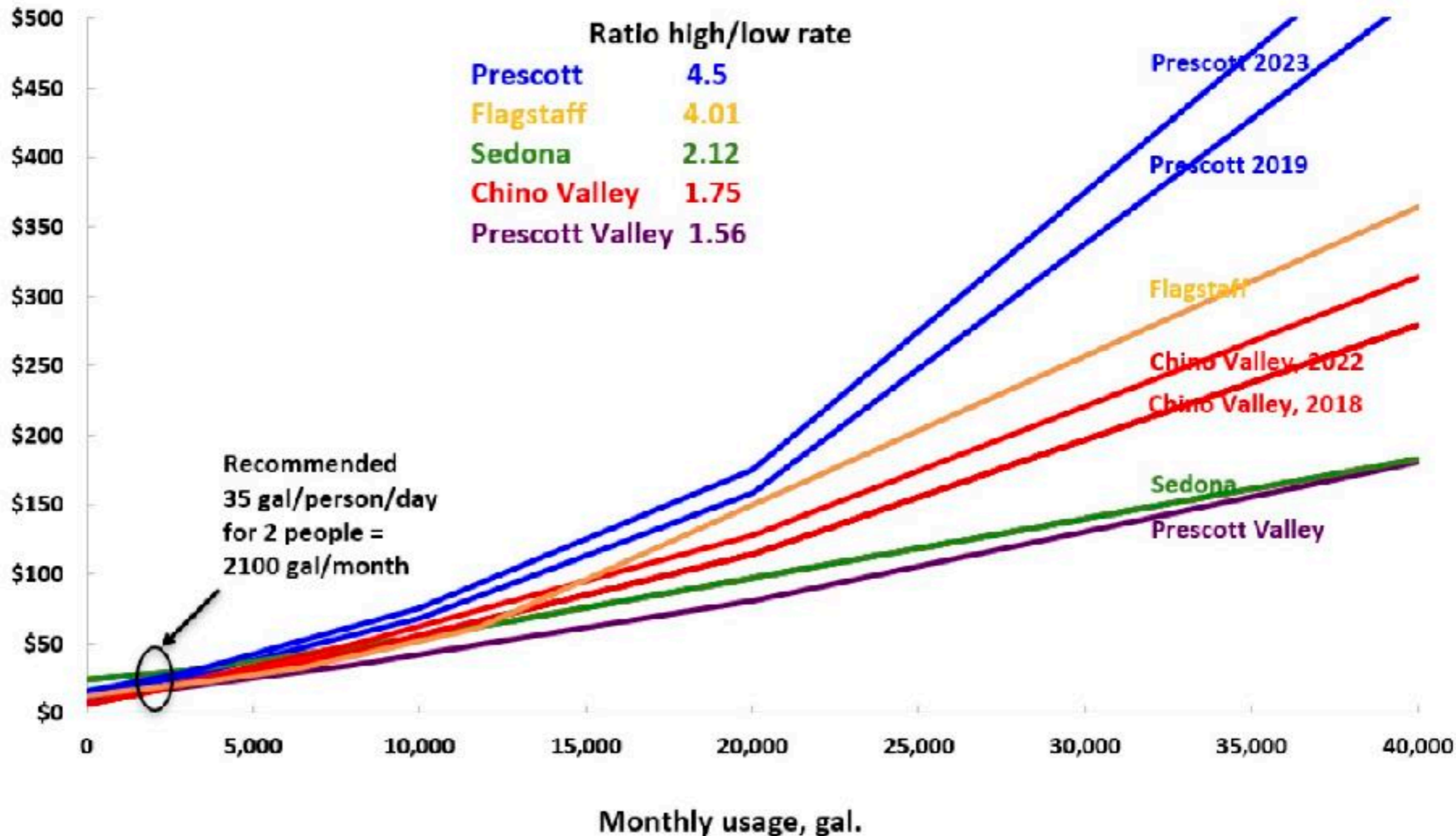
Figure 2-2 Prescott AMA Water Demand by Sector, 2019 (AF)



Sector ● Municipal ● Industrial ● Agricultural

Regional Incentive Rates

Water Charges in N. AZ Cities

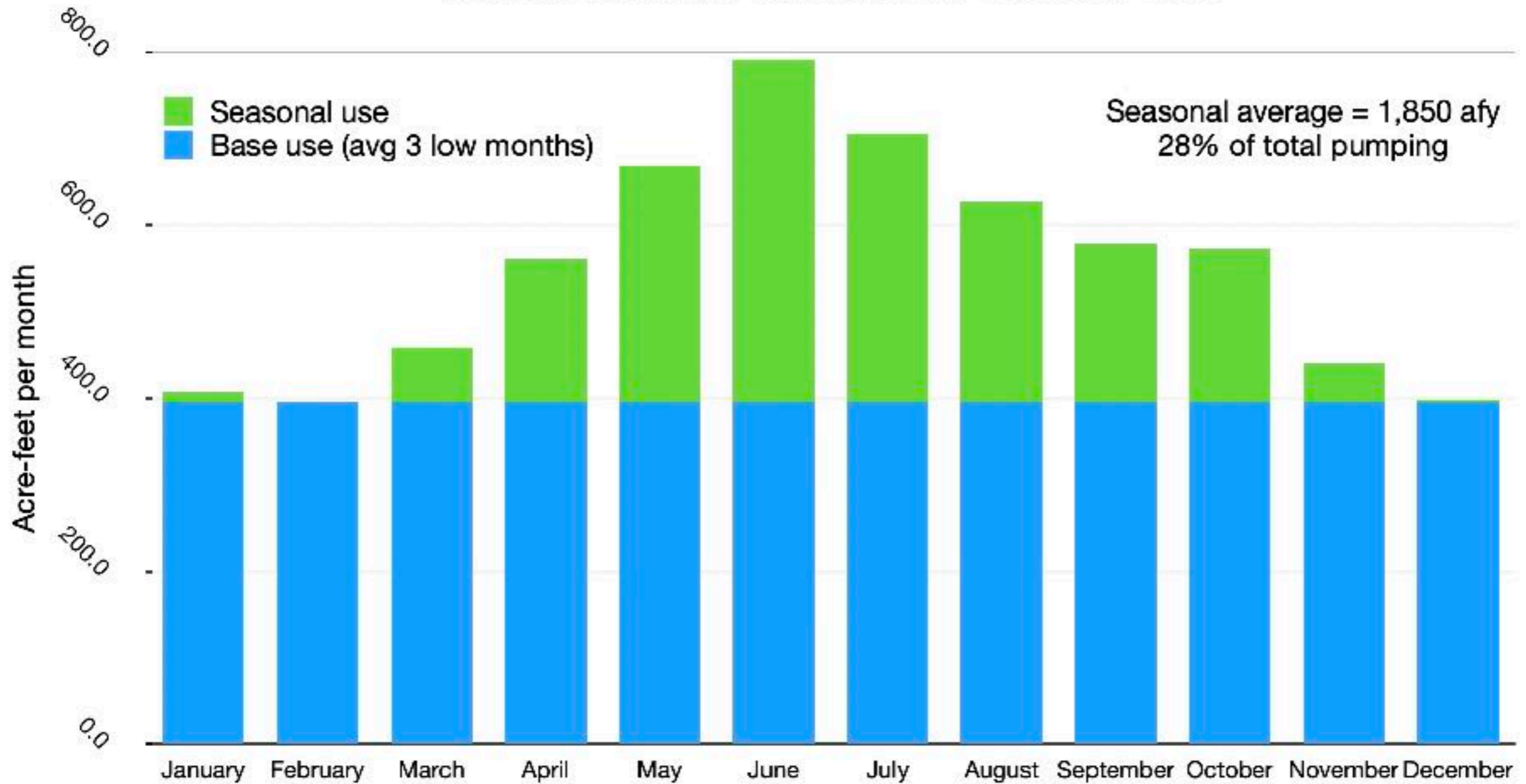


Regional Conservation Policies

Interior Conservation Policy				
Conservation Policy	Prescott	Prescott Valley	Chino Valley	Yavapai County
Potable GPCD	118 (2018)	98 (2015)	?	?
Conservation Plan	None	None	None	None
Educational Messaging	Yes - strong	Regional - WaterSmart	Regional - WaterSmart	Regional - WaterSmart
Residential Water audits	No	No	No	No
Commercial water audits	No	No	No	No
Retrofit on Resale	No	No	No	No
Tiered Rates	Strong	Weak	Weak	None
Conservation Plumbing Code	Yes	Yes	Yes	Yes
HE Toilet Incentive	\$100 for 1.28 gall dual flush	No	No	No
HE Toilet Incentive - Septic	Additional \$50	No	No	No
HE Laundry	\$200	No	No	No
HE Laundry - Septic	Additional \$50	No	No	No
Hot Water Recirculation	No	No	No	No
Waterless Urinal Replacement	\$50	No	No	No
High water use notices	Yes	Yes	No	No
Offset Program	No	No	No	No

Landscape Water

Average Monthly Prescott Water Use 2012-2016



Exterior Water Conservation Policy

Landscape Policy	Prescott	Prescott Valley	Chino Valley	Yavapai County
Seasonal Water Use	~28%	37%	?	?
Conservation Plan	None	None	None	None
Educational messages for Landscape Water Use	Yes - extensive web info Regional - WaterSmart	Regional - WaterSmart	Regional - WaterSmart	Regional - WaterSmart
Landscaping Site Plan Required	Yes	No	No	No
Landscaping Species Requirement	Drought-tolerant plants only	No	No	No
Turf Restriction	Yes	No	No	No
Turf removal incentive	\$0.50/sq ft	No	No	No
Irrigation with Recycled Water	Yes - three golf courses	Yes - golf courses	No	No
Time of Day restriction	April-Nov days	No	No	No
Active Rainwater Harvesting	Incentive: \$.50/gall (\$500 max)	No	No	No
Passive Rainwater Harvesting	\$3/sq ft (\$500 max)	No	No	No
Water Sense Irrigation Timer	\$75	No	No	No
Outdoor use of Potable Water Prohibited	No	No	No	No
Graywater Use	Prohibited unless on septic	Permitted	Permitted	Permitted
Stormwater Collection & Recharge	No	No	No	No

Residential GPCD

City	Total GPCD	Total Res'l GPCD	Single-family GPCD	Multifamily GPCD
Prescott (2019)	107	74	82	47
Prescott Valley (2019)	94	65	71	42
Albuquerque (2020)	131	80	99	54
Tucson (2020)	119	82		
California indoor target 2020			55	
AMA Safe Yield*	~35??			
Overdraft (2019)	135			

* Estimate

Conservation Potential

Prescott 2020 Population	Prescott 2020 Net Pumping	*2020 Prescott Population @ 55 GPCD	*Prescott 2020 Pumping @ 55 GPCD
44,439	4,154	~60,000	~3,100
Prescott Valley 2020 Population	Prescott Valley 2020 Net Pumping	*2020 PV Population @ 55 GPCD	*2020 PV Pumping @ 55 GPCD
46,785	6,634	~55,700	~5,600

* Alternative policy choices by municipal government

Population Estimates

minimum values for legally authorized water @ 0.20 afy/home*

	Population 2020	Legal Paper Water afy	Legal Population w/o Big Chino	Big Chino Water, afy	Max. Legal Population w. Big Chino
Prescott	44,439	5,592	100,359	4,356	143,919
Prescott Valley	46,785	300	49,785	3,711	86,895
Chino Valley	13,020	708	20,100	500	25,100
Available Credits HIA + E.C.		11,400	114,000		114,000
Total	104,244	18,000	284,244	8,567	369,914

Estimate

*Does not count indirect reuse of treated effluent.

Conservation Conclusions

- Residential Conservation is not a total solution
- Potential for Conservation:
 - Generally: deserves serious additional effort.
 - Exactly: Unknown! (Exceeds CWAG's capacity)
 - Extend throughout AMA, reduce landscape water use.
 - Improve Reuse
- NEEDS PLANNING AND ENGINEERING STUDIES.
- NEEDS REGIONAL COOPERATION AND FUNDING

Conservation Planning

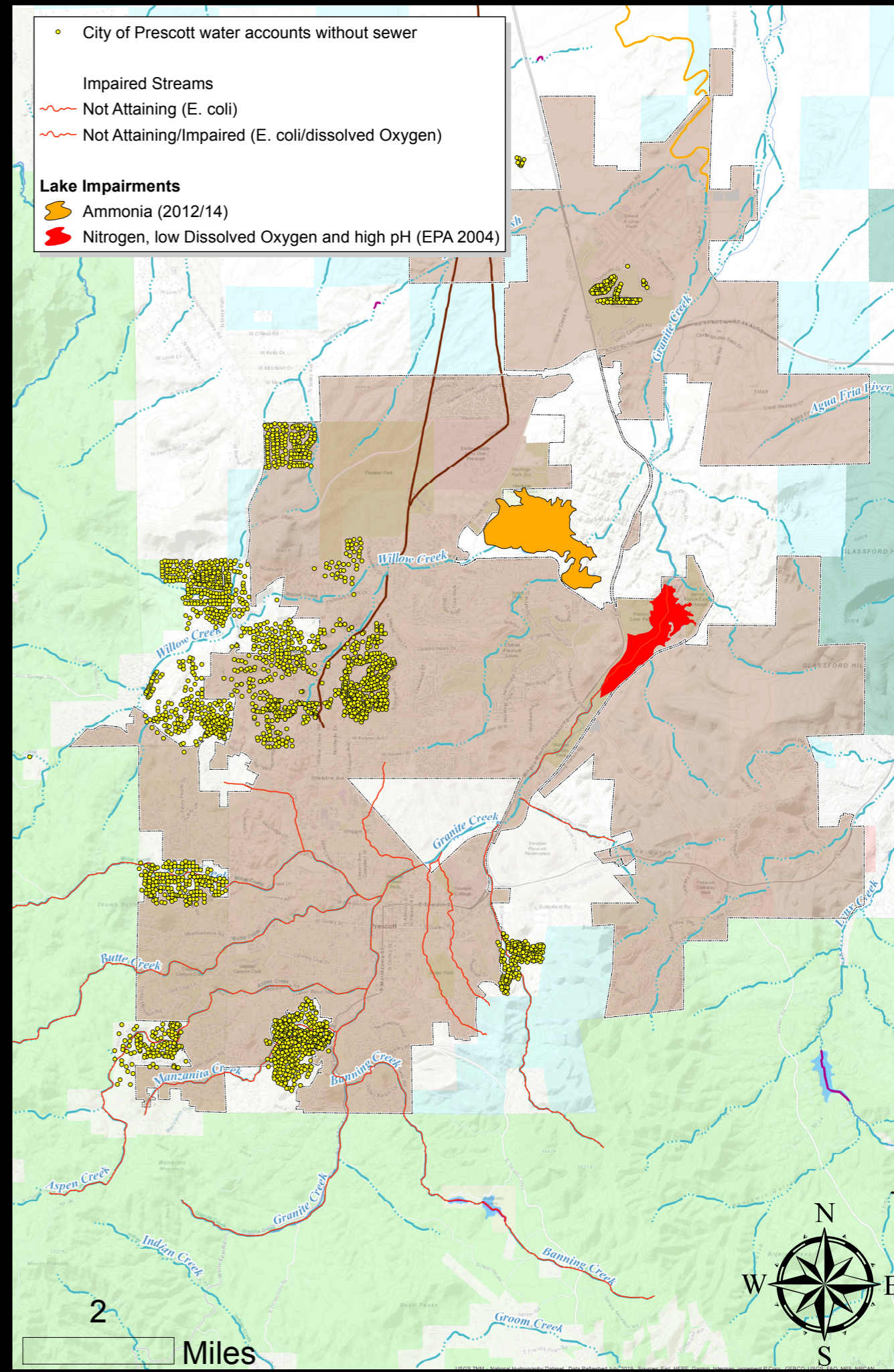
- **GOAL: Regional cooperation to manage a shared water resource to assure long-term quality of life for all current and future citizens.**
 - Comprehensive evaluation of social, economic, and environmental effects for all alternative solutions.
 - Assesses supply, demand, growth.
 - Adequate funding.
 - Minimum 10 year forward-looking plan with scheduled assessments.
 - Adaptive management with milestones.
 - Broad stakeholder/citizen participation.

Wastewater Collection, Treatment, & Reuse

- **Direct reuse of treated effluent:**
 - Industrial uses.
 - “Purple Pipe” for irrigation of homes & golf courses.
- **Indirect Potable Reuse**
 - Treated effluent is recharged to aquifer
 - Recharge credits permit immediate recovery and distribution. CHEAP!
- **Direct Potable Reuse**
 - Advanced purification of treated effluent for potable use.

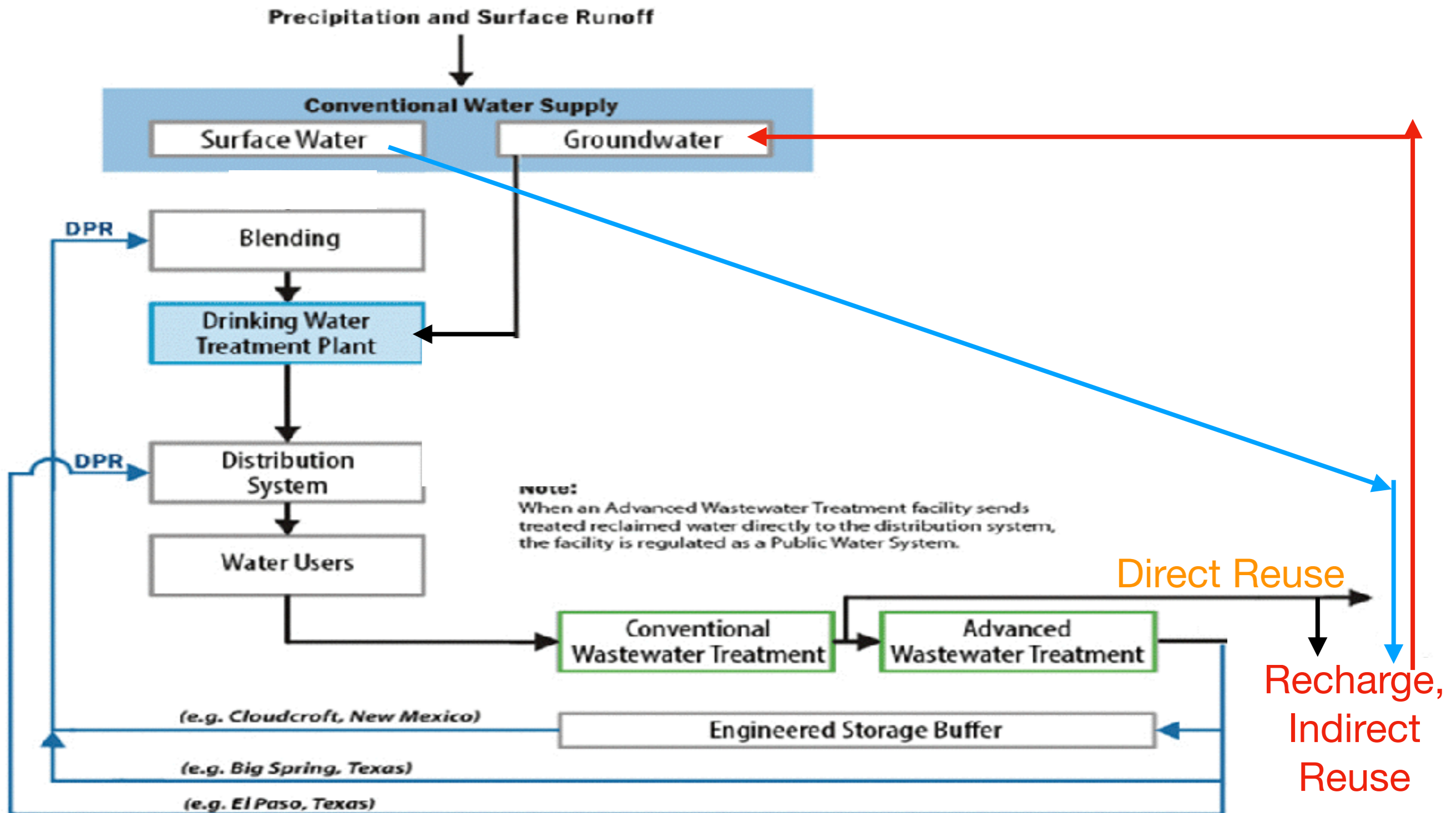
Increase Volume: Connect Septic Systems to Sewer

- Aquifer recharge from septic tanks is small and variable.
- Cost depends on geography.
- Improves water quality in lakes.
- Prescott Study:
 - 3895 parcels
 - ~405 afy recovery
 - \$86,000,000 total cost



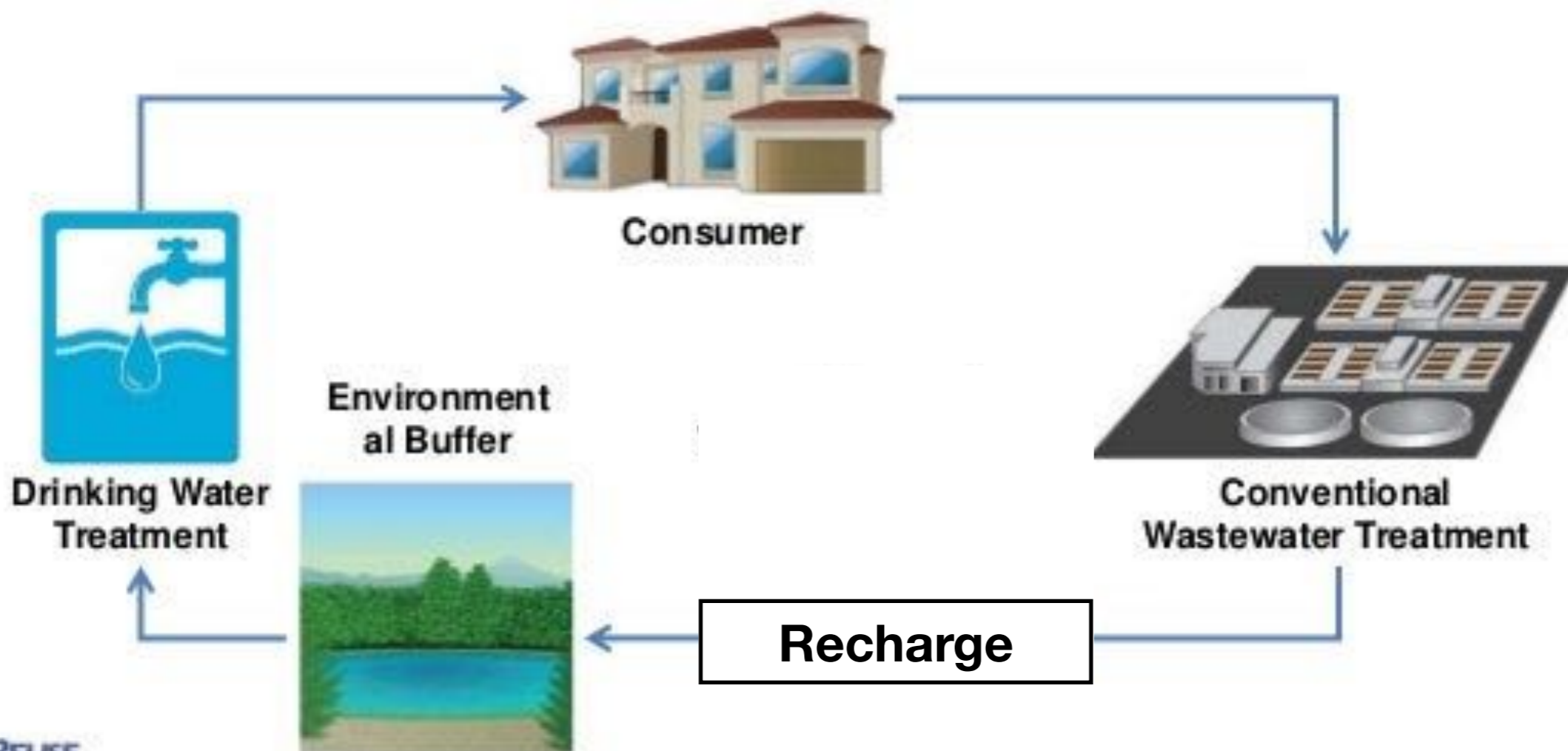
Water Reuse Systems

Collect and treat wastewater



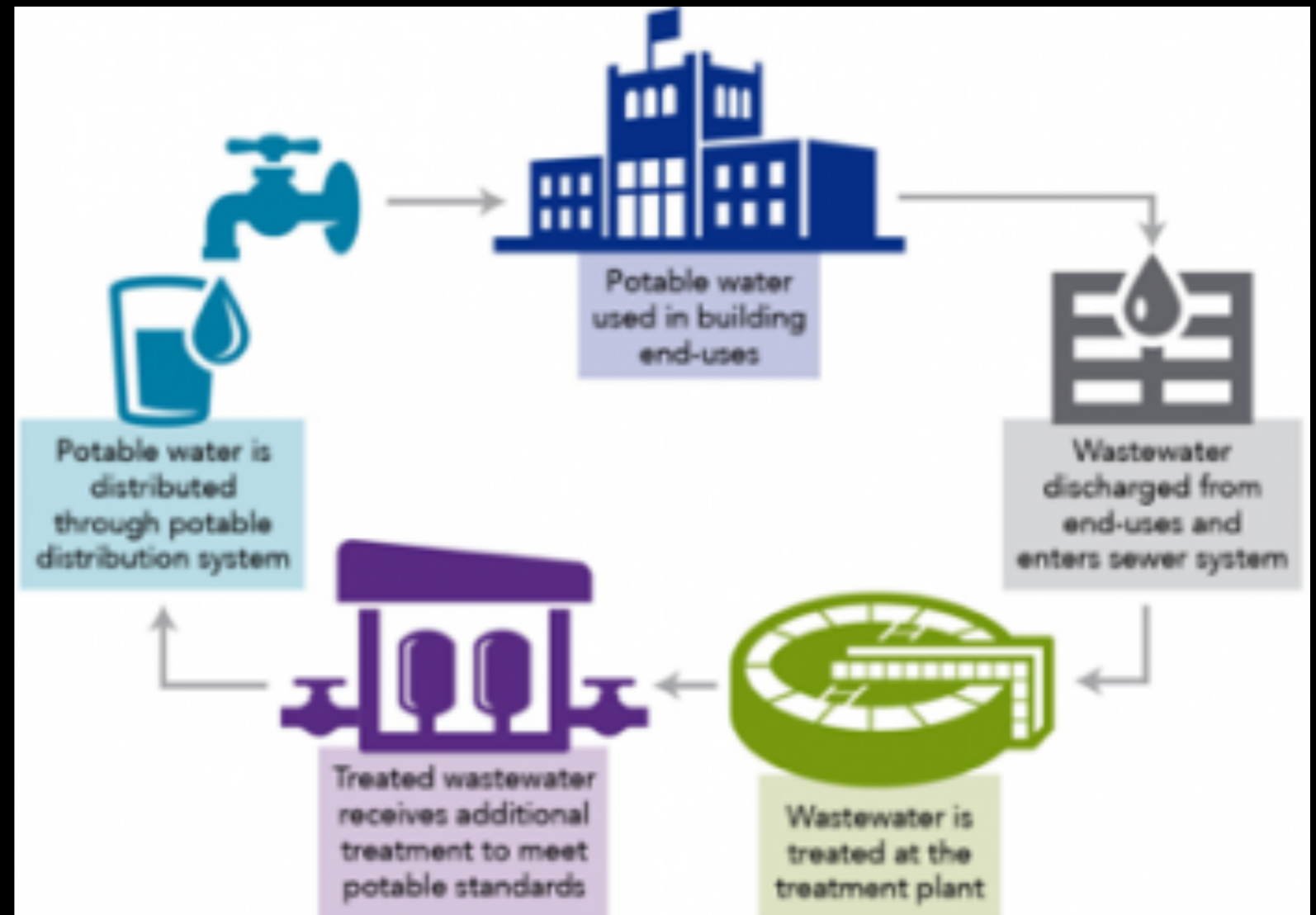
Current Practice: Recharged wastewater is recovered and used to supply new development

Indirect Potable Reuse



Direct Potable Reuse

- Legal in AZ: ADEQ rulemaking in progress.
- Obstacle: Arizona Water Law creates economic disincentive.
- CWAG Video Archive: 2015-05-09 - *“Can Local Communities Make Better Use of Wastewater?”*



Examples: Scottsdale demo system, Texas, Colorado, California, Florida

Water Neutral Development

A Win-Win Proposal

Growth vs Water

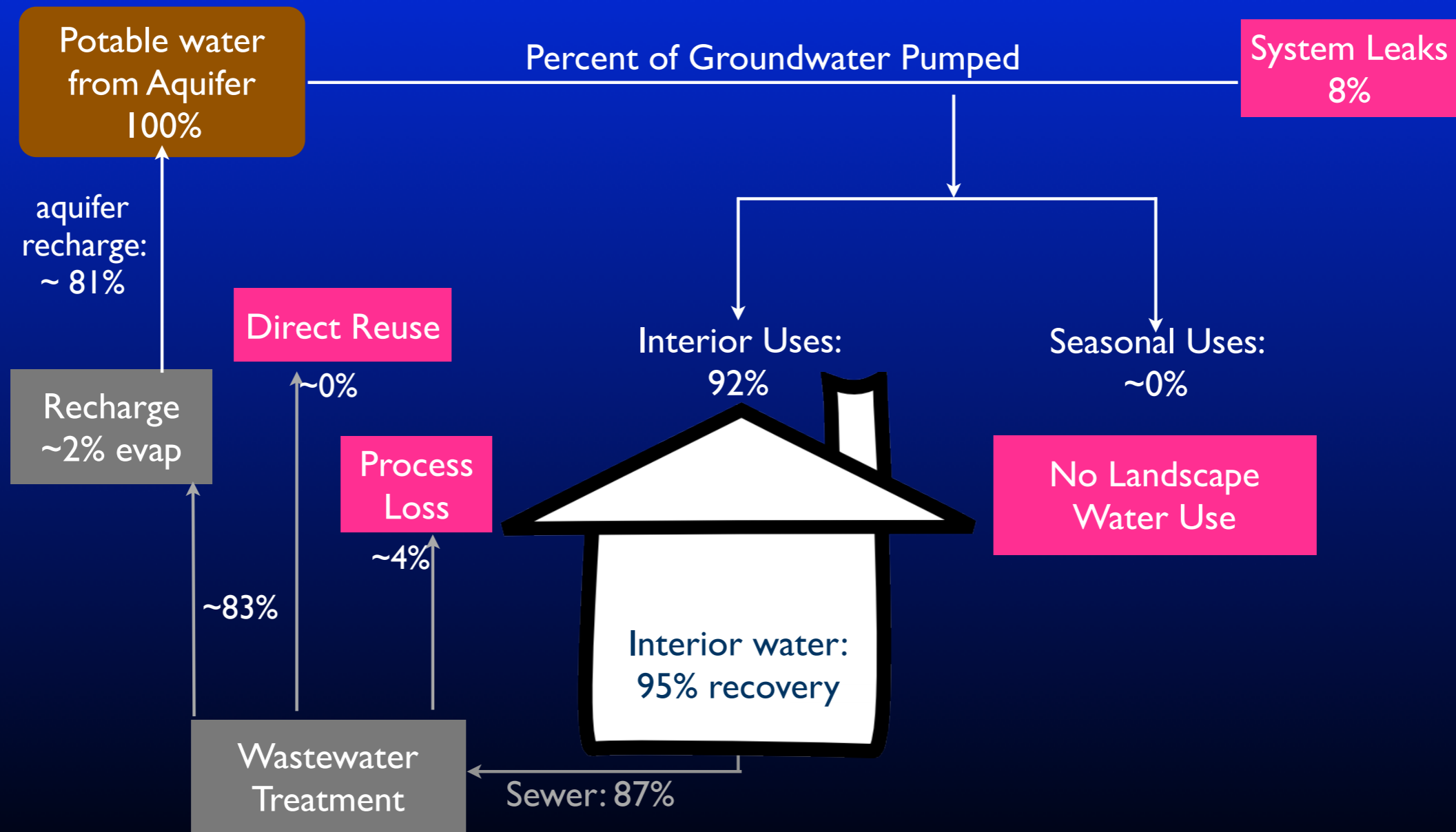
- Water Neutral Development:
 - Decouples growth from water use.
 - Halts growth in overdraft from new developments.
- WND targets subdivisions & commercial developments:
 - Use aggressive water conservation.
 - Designed to collect stormwater for recharge.
- Goal: stormwater recharge exceeds groundwater consumption

Currently...

- Every new home consumes groundwater.
- Recharge rules do not benefit the aquifer.
- Recharge practices support additional development.
- Growth harms the aquifer, even in best case conservation.
- How much stormwater is required?

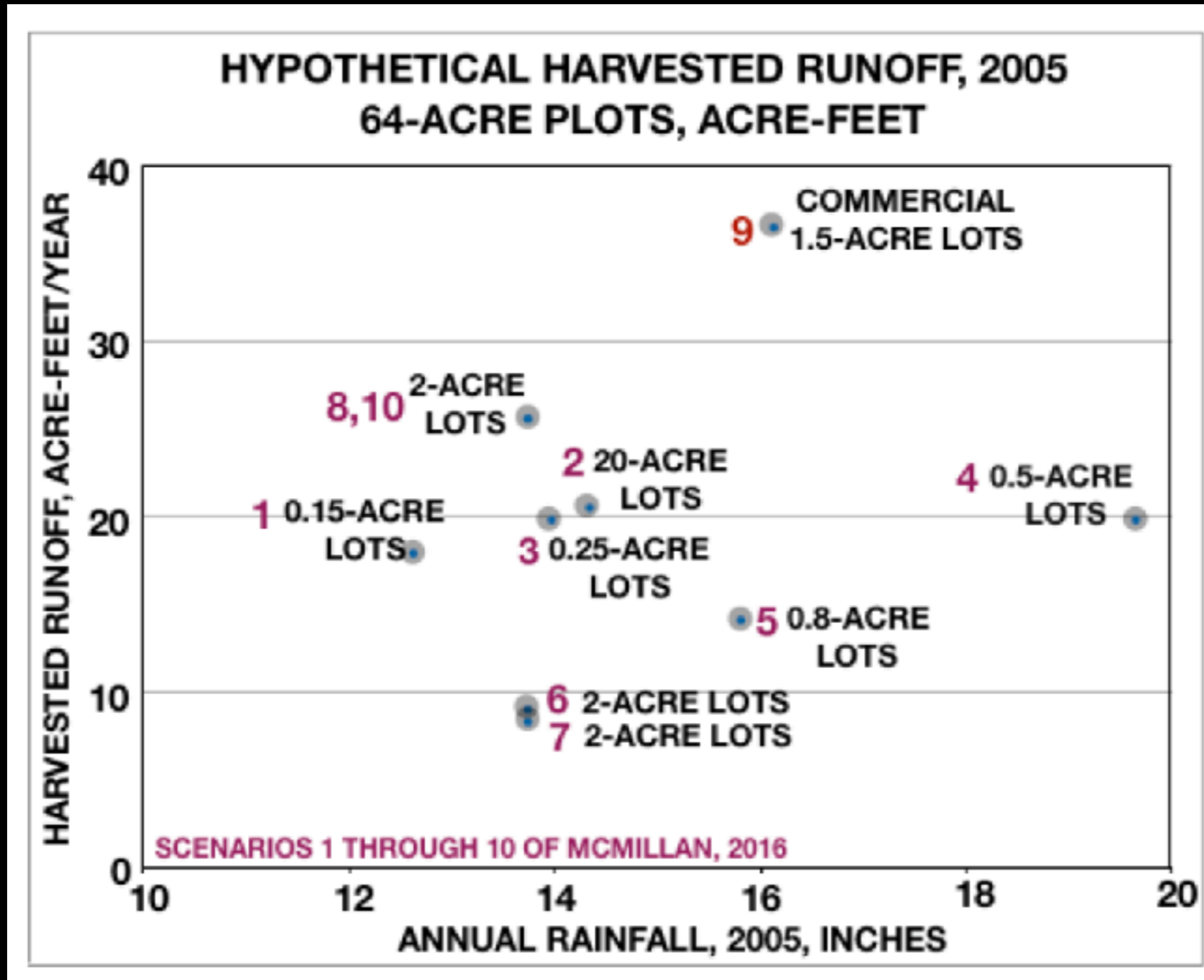
Post-2020 Prescott Home: Municipal Water & Sewer

Enhanced Rules: (no additional direct reuse, no groundwater on landscape)



BOR: CYHWRMS Study

Ten Scenarios Analyzed for Stormwater Harvest



Stormwater Capture for 12 Homes (12-19" ppt)

Case #	Post-2020 Prescott Code	lots/ acre	Capture afy	Capture, gallons/ home	Interior demand, gall/home @ 0.12 afy	Recharge deficit 20%	Annual Surplus: gall/ home	Comment
1	Chino Valley	6	0.56	15,206	39,102	35,192	-19,985	Usually septic, assume only 10% recharge
2	Prescott Valley	5	0.82	22,266	39,102	7,820	14,446	Assume best case Prescott post-2020 water policy.
3	Prescott Valley	4	1.04	28,240	39,102	7,820	20,420	Assume best case Prescott post-2020 water policy.
4	Prescott	2	2.02	54,851	39,102	7,820	47,031	Assume best case Prescott post-2020 water policy.

WND Requires:

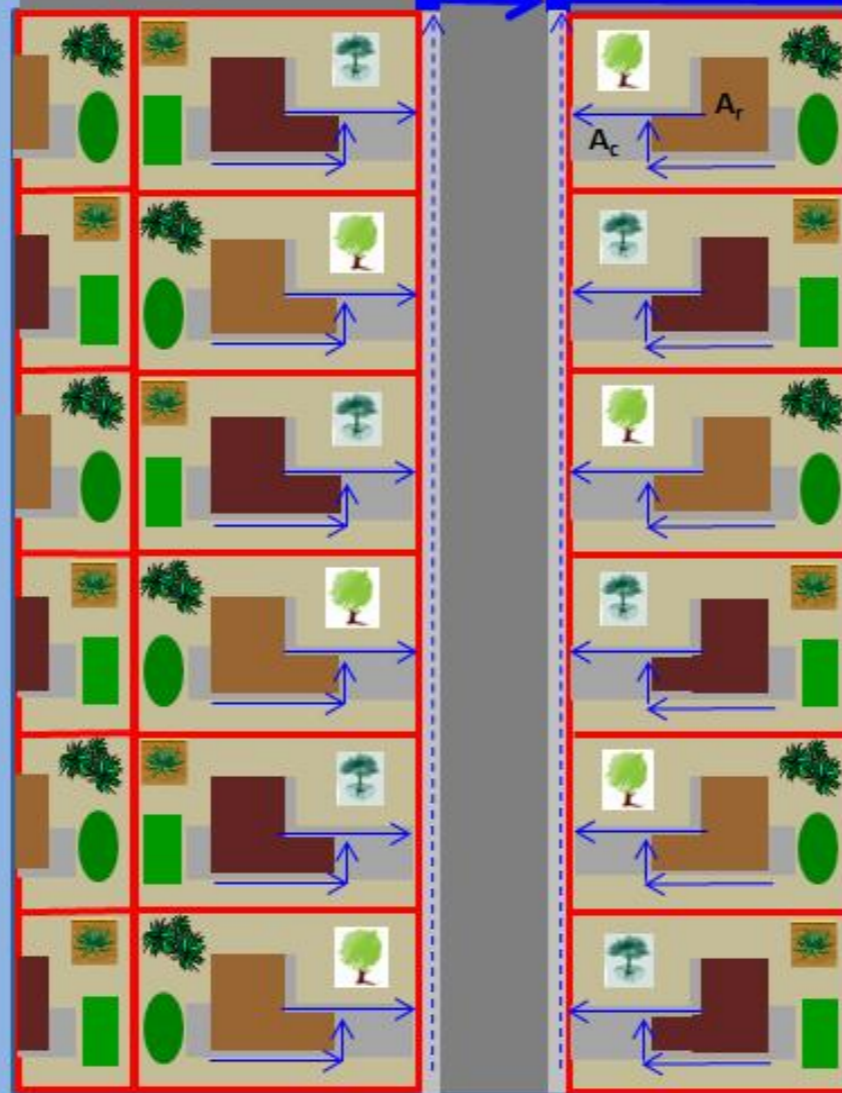
- No septic tanks - all waste water recovered.
- No groundwater applied to landscapes.
- All treated wastewater recharged to benefit aquifer - permanent recharge.
- Stormwater runoff is collected and recharged.
- Compliance with regulations.
- Compliance with Wastewater Treatment Plant Operations

Direct Aquifer Recharge



Evaporation

Existing Earthen Drainage Channel



Recharge to:
Granite Creek or
Passive Drywells or
Injection Wells

Existing Subdivision With Paved Streets, Concrete Gutters and Storm Drainage Collection Facilities

Direct Aquifer Recharge Water Quality

- Water quality regulator:
Environmental Protection
Agency
 - Passive drywells
 - Injection wells



Granite Creek Between
Highway 89A and Perkinsville Road

Controlled Recharge Into Sewer



Evaporation

Existing Earthen Drainage Channel

Detention Pond

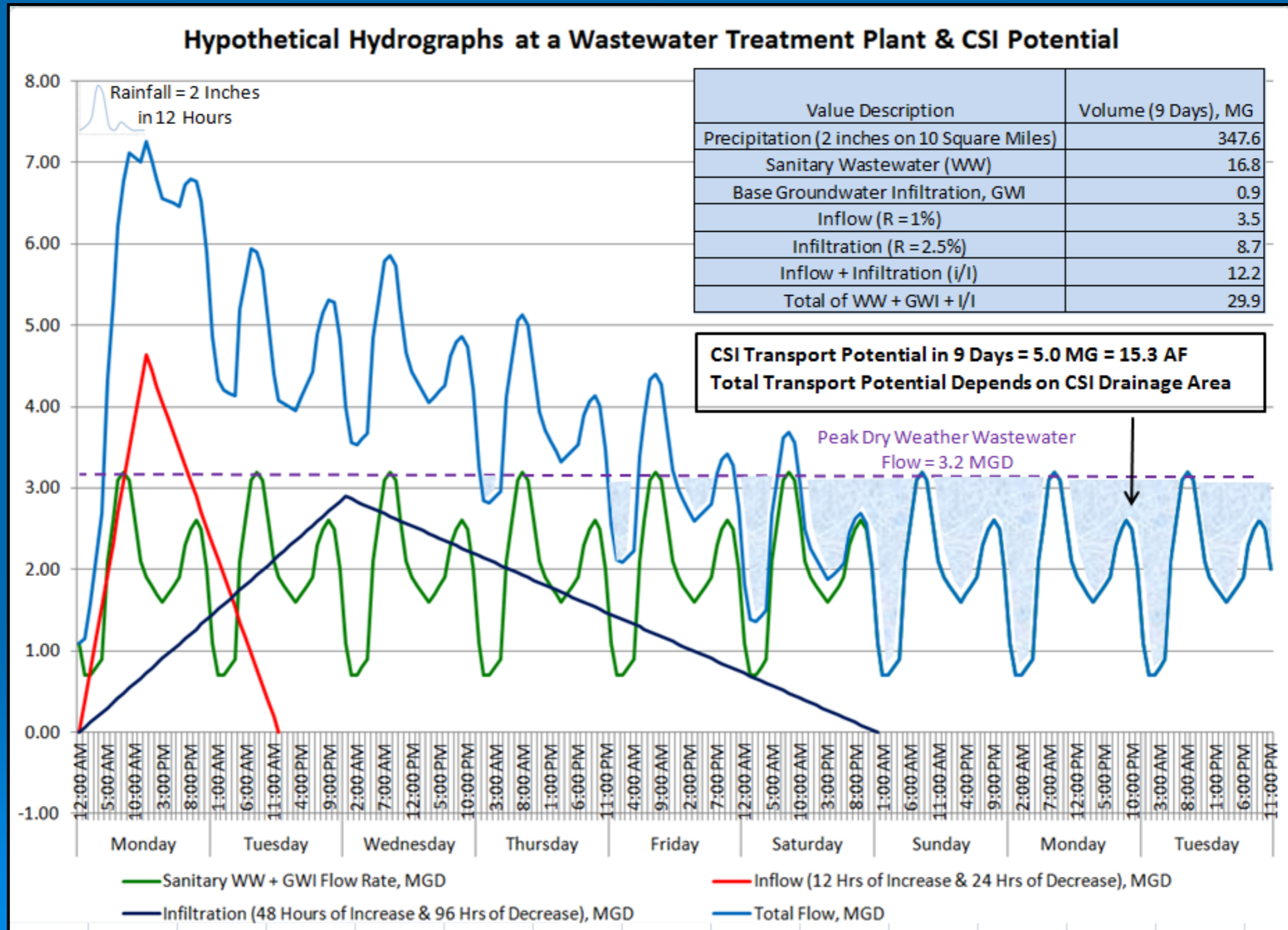


Existing Subdivision With Paved Streets, Concrete Gutters and Storm Drainage Collection Facilities

Controlled pumping to local sewer

Controlled Recharge Into Sewer

Hydrograph of Wet Weather Wastewater Flows With CSI Opportunities



Regulations

- Arizona Water Law:
 - Stormwater runoff is captured before reaching a natural channel.
 - WND is not appropriable.
- Prescott:
 - Water quality and quantity controls
 - Currently, developers use detention and evaporation.
 - Costs are now incorporated into project designs.

WND Requires Cooperation From Prescott

- **Prescott: a Designated Assured Water Supplier.**
 - Prescott determines the water allocation.
- WND extends existing water allocation to supply development.

WND Requires Cooperation From ADWR

- **Prescott Valley and unincorporated Yavapai County:**
 - Developer must obtain Certificate of Assured Water Supply (CAWS)
 - Developer uses ADWR spreadsheet to justify WND demand.
 - ADWR determines the required water allocation considering WND.
 - Developer acquires the needed remaining water credits.
- Developer investment in water is reduced.

WND Conclusions:

- Homes with well/septic systems consume more groundwater than the amount of stormwater that can be potentially collected.
- We need other solutions for rural homes, realizing that it is economically unrealistic to extend municipal water/sewer to large-lot rural homes.

WND Conclusions:

- Subdivisions constructed under Prescott's pre-2020 water codes consume more groundwater than the amount of stormwater that can be potentially collected due to high landscape water use and to direct reuse of treated wastewater for golf courses.

WND Conclusions:

- New subdivisions constructed under Prescott's post-2020 water codes, with the added assumption of zero landscape water use, consume less groundwater than the amount of stormwater that can be collected and actually contribute a surplus to the aquifer.
- Stormwater surplus yield: up to 1 afy for 256 homes on 64 acres!

WND Conclusions:

- Even if WND programs cannot supply 100% of a subdivision's groundwater consumption, a partial offset is helpful and successful.
- The preliminary estimates are promising enough to warrant further investigation.
- Professional engineering studies are needed.

Modernize Water Law

- Historically, inaction and lack of political will.
 - Irrigation Non-expansion Area.
 - Rural Management Authority.
 - Plug leaks and loopholes.
 - Etc etc etc...
- We're On Our Own

Augmentation Schemes

- Improbable, unacceptable, unworkable, grandiose, or unreliable.
- Desalination
- Big Chino Valley

Improbable Scheme: Cloud Seeding

- Utah, Colorado attempted, controversial results.
- Wyoming study: Seeding produces more runoff 5-15% increase @ \$25/af
- But it doesn't necessarily rain where you want it.
- Downwind concerns: cause flooding or drought.

Unworkable Scheme: Vegetation Management

- CHYWRMS: 4FRI thinning of Ponderosa Pine (>7000') yields ~2,000 af @ average cost \$2,200/af ; 7 year renewal cycle, no benefit for PrAMA.
- Piñon-Juniper clearing:
 - Proposed by Upper Verde River Watershed Protection Coalition for the Big Chino.
 - Does not benefit aquifer.
 - Subsidy to ranchers: forage production.

Unacceptable Scheme: Large Scale Landscape Water Collection

- Enormous landscape areas needed (e.g. Australia)
- 20 sections (12,800 acres) yields up to 10,000 afy.
- Scrape, Shape, Coat, Fence, Transport.
- Large storage reservoir needed.
- Obstacles: Cost. Appropriable water rules. Enormous environmental impact.

Grandiose Scheme

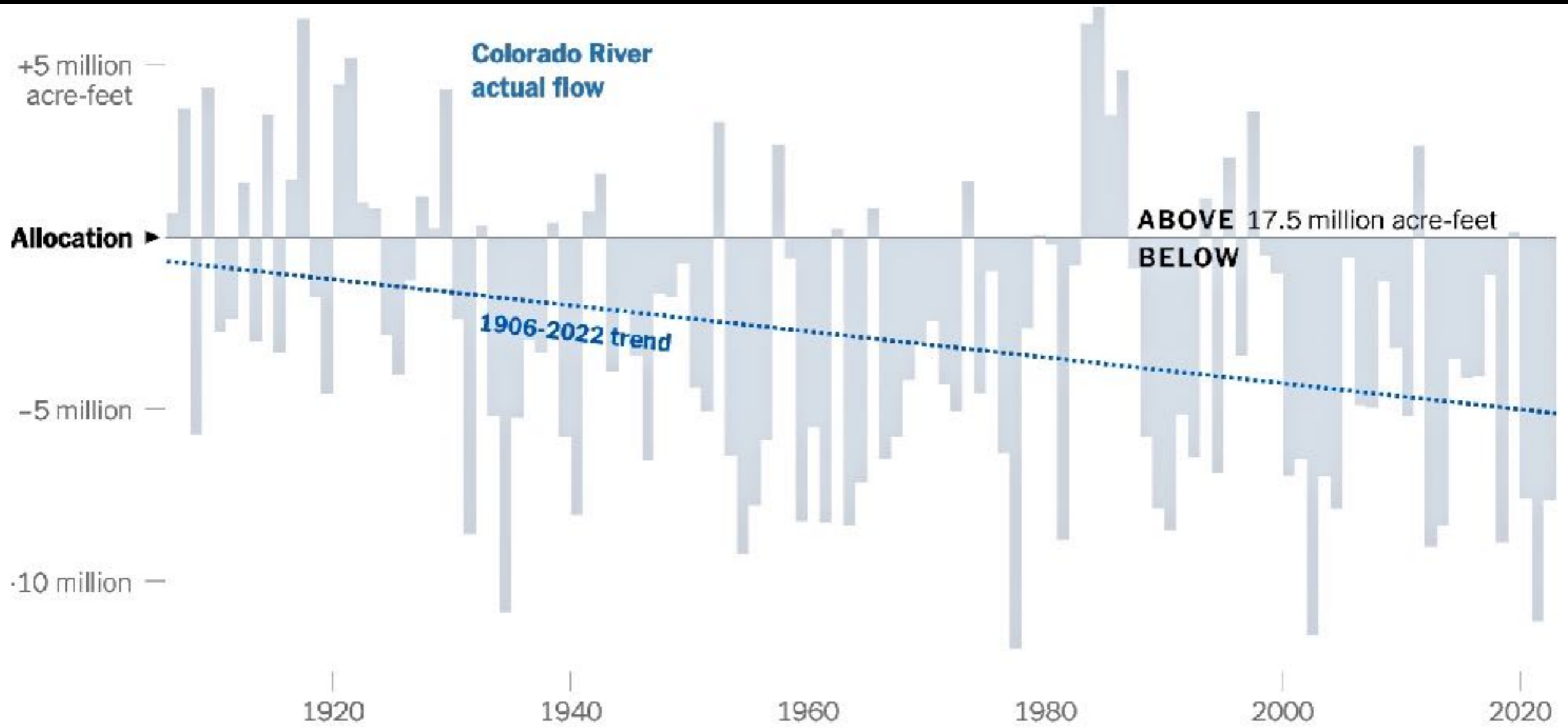
- Tow icebergs to Los Angeles
- North American Water and Power Alliance (1950-2010)
 - Divert rivers in Alaska and Canada to fill the Rocky Mt Trench. 500 dams. Pipeline to southwest.
 - Re-plumb North America!



Improbable CAP Scheme: Import from Missouri River

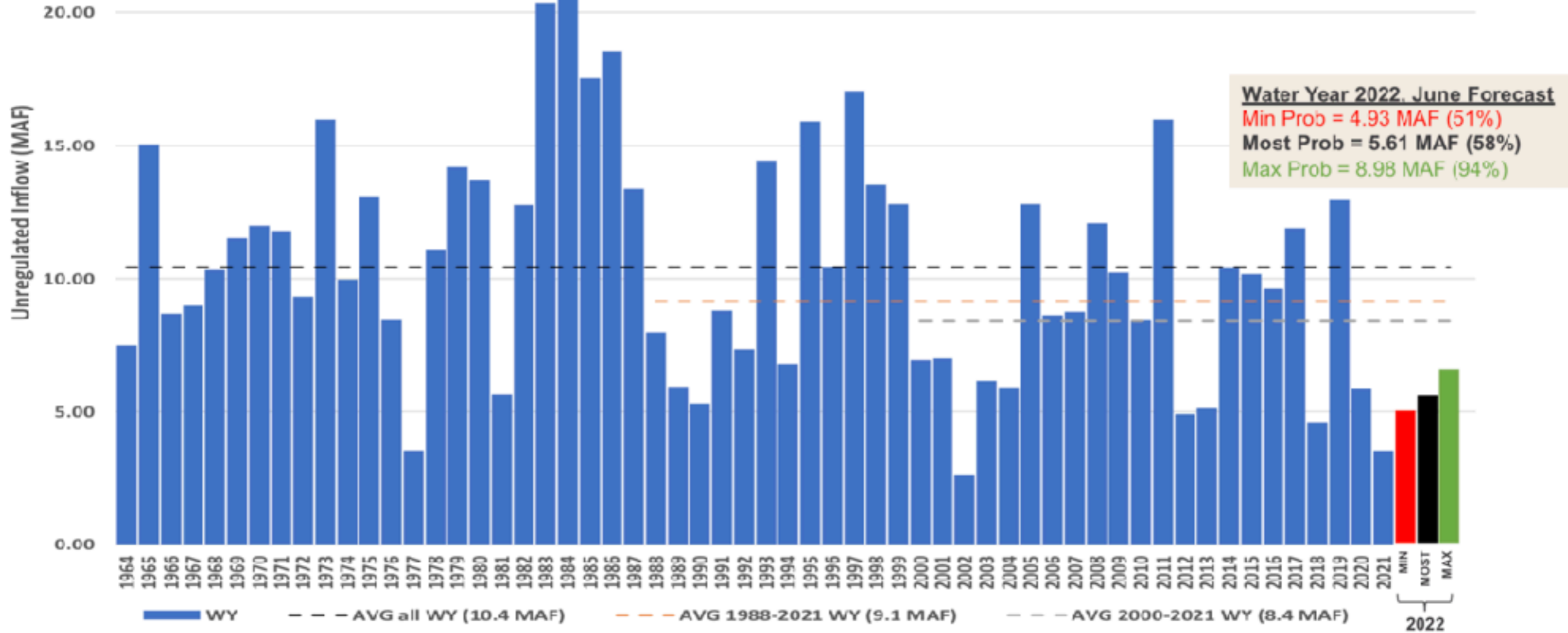
- Pump water from Kansas to Denver (5000' uphill)
- Denver exchanges Colorado River water, yields it to CAP
- Planned 200,000 afy, \$2,200 af
- Problems: Mississippi River too shallow for barges!

Unreliable Scheme: Import from Colorado River



Note: Colorado River natural flows are estimated from measurements at Lee's Ferry, Ariz. Values for 2021 and 2022 are provisional. • Source: U.S. Bureau of Reclamation

Lake Powell Inflows



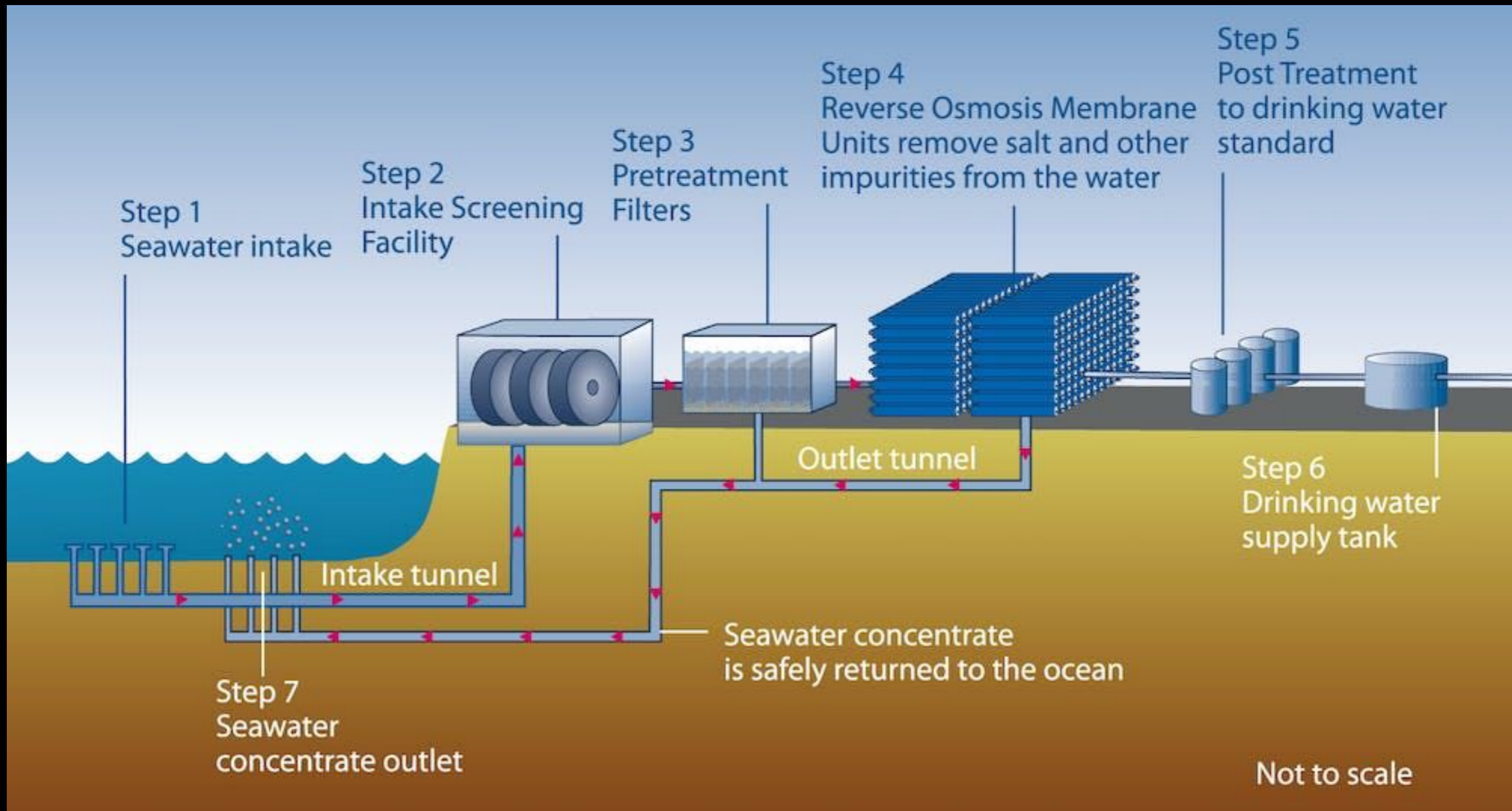
Arizona Water Infrastructure Finance Authority

- Augmentation: \$1B over 3 years for importing water from out of state
 - Grants and low interest loans.
 - Potentially can be used to finance Big Chino Pipeline!
- \$200M - 1 year - for conservation
 - No mandatory conservation
 - No conservation easements

Current Hope: Desalination



Desalination



WIFA Is Considering Desalination

- IDE Technologies proposes \$5.5 Billion desalination plant.
- 1,000,000 afy piped to Lake Pleasant, then CAP distribution to central/southern AZ.
 - Enough to serve 3 million homes, more than double current AZ housing.
 - WIFA purchase @ est \$3,000/af; adds ~\$5-600/yr to home water bill.
- World's largest desalination plant: Saudi Arabia, 414,564 afy.

Desalination Issues

- Increased water conservation and efficiency remain the most cost-effective approaches. Generally considered a last resort after water conservation.
- Environmental problems: brine disposal, energy use.
- Energy is most of process cost: 3 kWh/m³ in 2018, 20-30 kWh/m³ in 1970.
- N. AZ pays taxes, gets no water?
- Mexico wants some benefits...

Carlsbad, CA Ocean Desalination

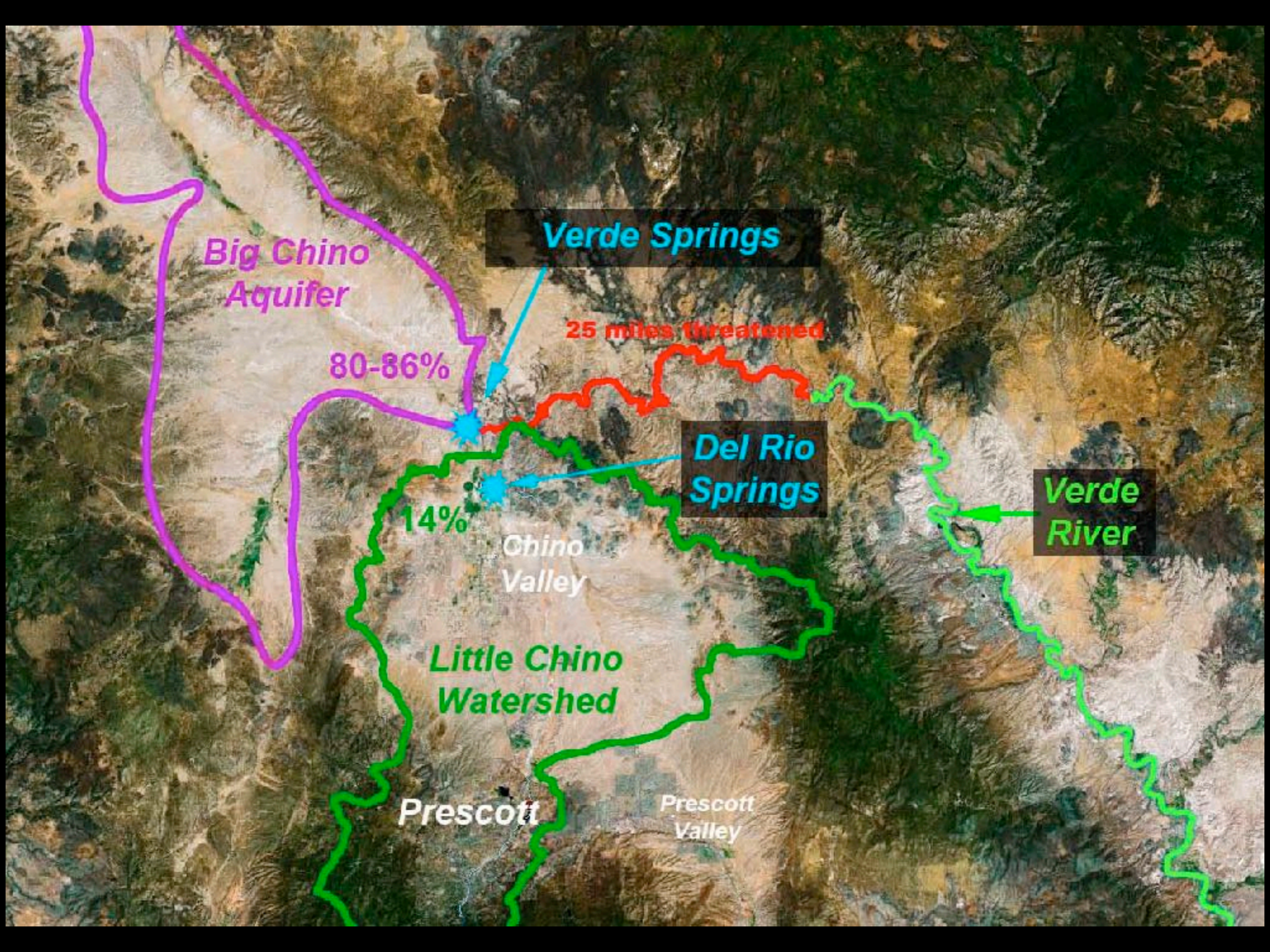
- ~41,000 afy
- > 15 years in approval & permitting
- Extraordinary public concern.



Big Chino Groundwater Import Plan



- Exemption in water law: Prescott allowed to import, can share with PV
 - Prescott: 54%; Prescott Valley 46%
- COP/PV/SRP legal settlement 2010: COP/PV agreed to mitigate pumping impacts to protect Verde River.
- Monitoring & Modeling project underway, shared cost >\$5M, complete in 2021 2022 2023 2024??
- Prop 401 requires Prescott citizen approval for financing.



Big Chino
Aquifer

Verde Springs

25 miles threatened

80-86%

Del Rio
Springs

14%

Chino
Valley

Verde
River

Little Chino
Watershed

Prescott

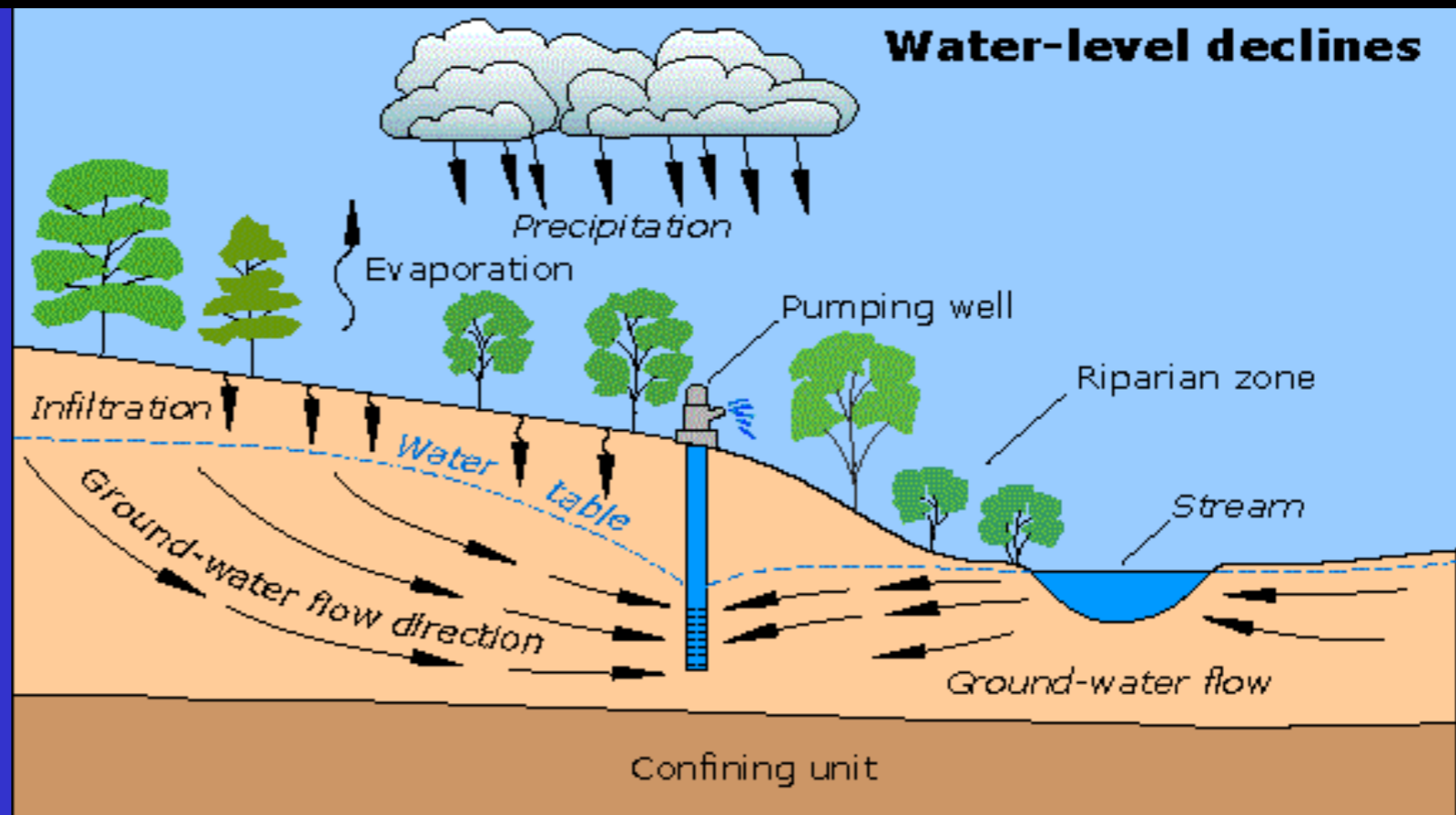
Prescott
Valley

Groundwater Pumping Captures Streamflow

- Lowers aquifer levels, diminishes base flow
- Due to geology, Verde Springs is especially sensitive
- Pumping for agriculture, development, or export will dry the river!

Ground-water flow Pumping conditions:

1. Capture
2. Induced Flow
3. Loss of storage



Threat : Groundwater Exports

Current base flow: ~ 11,000 afy

Potential legal export: ~18,000 afy

Pipeline design: ~12,000 afy

Responsibility: Prescott, Prescott Valley, AZ Legislature

**Big Chino
Aquifer**

Paulden

Williamson
Valley

Chino
Valley

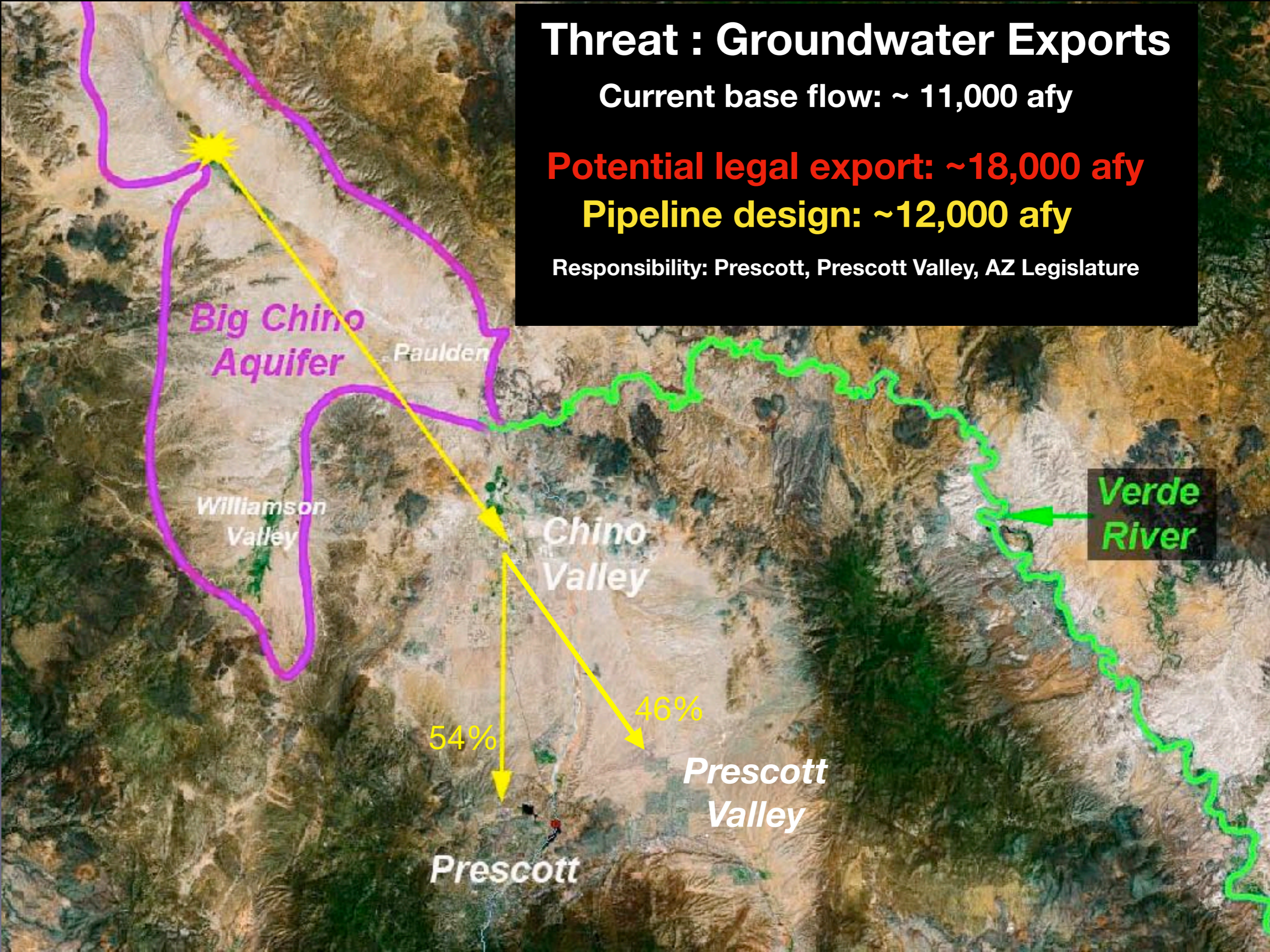
**Verde
River**

54%

46%

Prescott
Valley

Prescott



Scientific Agreement: BC Pumping Harms Verde Flow

- US Geological Survey (several studies)
- Bureau of Reclamation
- Arizona Department of Water Resources (several)
- Arizona Game and Fish Department
- Salt River Project
- Prescott's hydrology consultant
- Many Environmental NGO's
- Summary on CWAG web site

Big Chino \neq Safe Yield

- The Big Chino Water Ranch legally authorized to import 8-12,000 afy, **which exceeds the current flow of the Verde River.**
- **Unmitigated BC water imports will dry the upper Verde River. Mitigation strategies unknown.**
- The 2019 overdraft is >21,000 afy, **75% more than the pipeline capacity.**
- PV plans to use Big Chino water for **growth, not safe yield.**

Upper Verde Watershed Conservation Easements

- Willing sale of development and water rights to trusted conservation group (eg Central Arizona Land Trust).
- Rocky Mountain Elk Foundation: ~3,000 acres at confluence of Verde & Granite Creek.
- SRP and TNC beginning efforts in Big Chino Valley.

www.cwagaz.org



The screenshot shows the homepage of the Citizens Water Advocacy Group (CWAG). At the top is a banner image of a river in a natural setting with a small logo on the left. Below the banner is a navigation menu with links: HOME, OUR WATER SUPPLY, VERDE RIVER, CONSERVATION, FAQ, RESOURCES, ABOUT CWAG, and CONTACT. A search bar is located below the navigation. On the left side, there is a 'JOIN US ON FACEBOOK' button and a 'NEXT MEETING' section for Saturday, August 13, from 10:00 AM to 12:00 PM, featuring Bruce Babbitt. Below that is a 'QUICK LINKS' section with buttons for 'INTRODUCTORY WATER INFO', 'JOIN - KREW - DONATE', 'INFO BY EMAIL - SUBSCRIBE', 'VIDEO ARCHIVE', 'EVENTS CALENDAR', 'SPEAKERS BUREAU', and 'WHAT YOU CAN DO'. The main content area on the right has a 'Home' heading, followed by a 'WELCOME TO CITIZENS WATER ADVOCACY GROUP' section. This section includes a paragraph about the group's mission and two bullet points: 'Our water supply is dependent on groundwater; we are depleting our groundwater reserves because we are pumping too much.' and 'Excessive groundwater pumping and climate change are reducing the flow of the upper Verde River.' Below this is a 'FOR FIRST TIME VISITORS' section with three bullet points: 'Issues of water sustainability are discussed in the section "Our Water Supply".', 'The challenges facing the upper Verde River are discussed in the section "Verde River".', and '"Introductory Water Info" will connect you to some basic and important topics.' At the bottom of the main content area is a 'QUESTION OF THE MONTH' section with the text 'WATER FOR THOUSANDS OF NEW HOMES?' and a link 'HOW LONG WILL OUR WATER LAST?'.

Email questions are welcome:
info@cwagaz.org

Discussion and Questions

Governmental Actions for a Sustainable Water Future

- Arizona Water Law needs to be modernized to protect aquifers and rivers - a political problem.
- It is up to us. Current state law harms and does not protect the aquifer. Unlikely to change.
- Regional cooperation and new approaches are needed.
 - Engineering studies for water conservation, safe yield planning, and Water-neutral development.