CLIMATE ADAPTATION
RESEARCH SYMPOSIUM

MEASURING & REDUCING SOCIETAL IMPACTS

Quantifying and Minimizing Water Quality Impacts

Thanks for joining us!
The session will begin shortly.

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Allison Lassiter
University of Pennsylvania

Ryan Sinclair
Loma Linda University

Nate Jones
University of Alabama

CLIMATE ADAPTATION
RESEARCH SYMPOSIUM
MEASURING & REDUCING SOCIETAL IMPACTS

UCLA Luskin Center for Innovation

Allison Lassiter

Assistant Professor, University of Pennsylvania,

@allisonlassiter

Managing Salinization in a Coastal Watershed: Critical Infrastructure and Partnerships for Climate Adaptation

Managing salinization in a coastal watershed: critical infrastructure and partnerships for climate adaptation

Allison Lassiter, Scott Moore, and Zoe Covello

Presented by:
Allison Lassiter
Assistant Professor
City and Regional Planning
University of Pennsylvania Weitzman School of Design
alass@design.upenn.edu

1. Motivation + research questions
2. The case of Santa Ana Watershed Project Authority
   - Trends in Total Dissolved Solids
   - How interviewees define successful projects and partnerships
3. The problem of chloride
4. Conclusions and next steps

Motivation and research questions

Challenge: Increasing salinity in freshwater sources

- "Freshwater salinization syndrome"
  - Anthropogenic (fertilizers, road de-icers, contributions from wastewater)
  - Geologic
  - Often measured in aggregate as Total Dissolved Solids (TDS)

- Sea level rise bringing ocean salts inland
  - Captured in TDS measurements, but best isolated through chloride measurements

- Converging challenge in cities and towns around the globe, with vulnerability depending on: location of water sources, type of water source (surface or groundwater), land use, geology, and local climate shifts (timing and quantity of precipitation).

What will we do about widespread salinization?

Desalination will not work everywhere

- High-cost (scales with concentration of salt)
- Necessitates a good energy source
- Typically requires large land area
- Does not provide large volumes of water
- Waste brine disposal can present challenges

Is watershed-based salinity management a viable alternative?

- In the United States, two watershed-based, regional management organizations have salinity as a management target
  - Santa Ana Watershed Project Authority (SAWPA), located in Southern California
  - Delaware River Basin Commission (DRBC), located in the mid-Atlantic region

- What are the possibilities of regionalization as a salinity management tool? This research first focuses on SAWPA

Research Questions and Methods

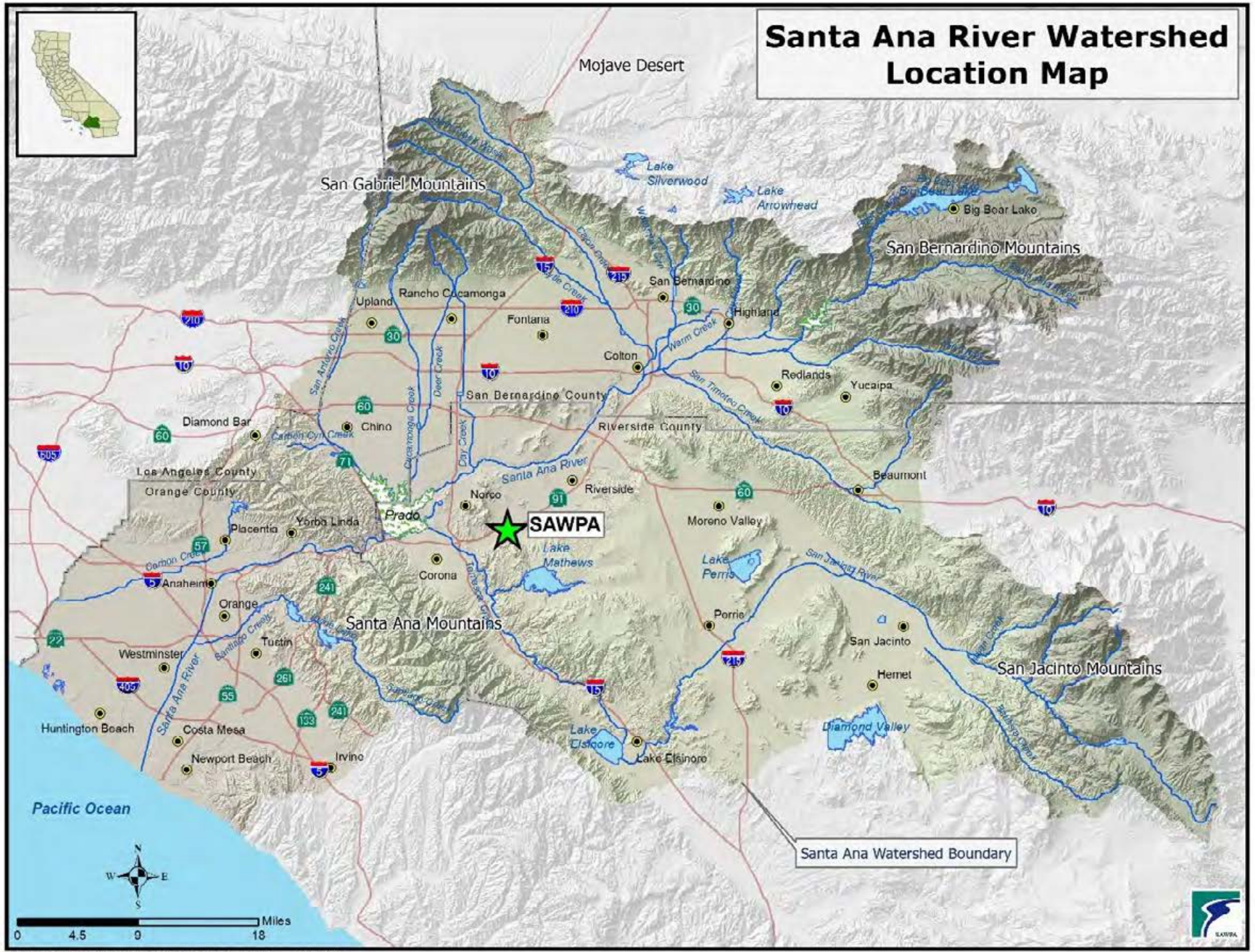
- What are SAWPA's most successful salinity management strategies?
  - Can we observe these through salinity monitoring data?
  - How would water managers define successful projects and partnerships?

- Evaluate Total Dissolved Solids (TDS), the primary management target in SAWPA, in the Santa Ana River over time

- Interview people from:
  - SAWPA
  - SAWPA member agencies
  - Regional Water Quality Board (Santa Ana, Central Valley)
  - SAWPA Mediator
  - SAWPA-adjacent agencies (Bureau of Reclamation, Metropolitan Water)

The case of the Santa Ana Watershed Project Authority (SAWPA)

SAWPA


Santa Ana River Watershed
Location Map
Mojave Desert
San Gabriel Mountains
Lake Silverwood
Lake Arrowhead
Big Bear Lake
San Bernardino Mountains
San Bernardino
Rancho Cucamonga
Upland
Fontana
Highland
Colton
Redlands
Yucaipa
San Bernardino County
Riverside County
Diamond Bar
Chino
Los Angeles County
Orange County
Santa Ana River
Norco
Riverside
Beaumont
Prado
SAWPA
Placentia
Yorba Linda
Moreno Valley
Lake Mathews
Lake Perris
Corona
Anaheim
Orange
Santa Ana Mountains
Porrie
San Jacinto
Westminster
Tustin
Hemet
San Jacinto Mountains
Huntington Beach
Costa Mesa
Newport Beach
Irvine
Diamond Valley
Lake Elsinore
Pacific Ocean
Santa Ana Watershed Boundary
Miles
0
4.5
9
18

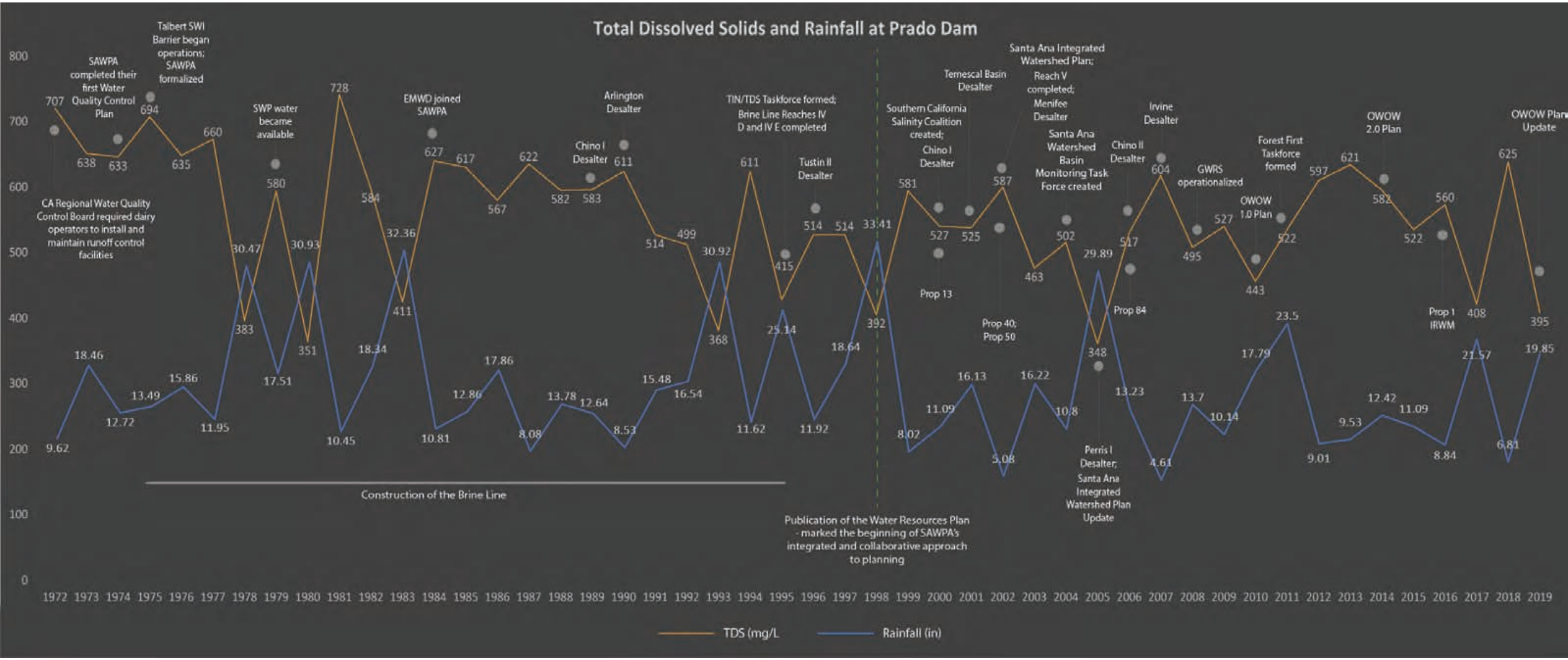
SAWPA as a case of water management regionalization

- 4 member agencies:
  - Orange County Water District (OCWD)
  - Eastern Municipal Water District (EMWD)
  - Western Municipal Water District (WMWD)
  - San Bernardino Valley Municipal Water District (SBVMWD)
  - Inland Empire Utilities Agency (IEUA)

- Spans 4 counties: Riverside, San Bernardino, Orange, and a portion of Los Angeles County

Trends in TDS

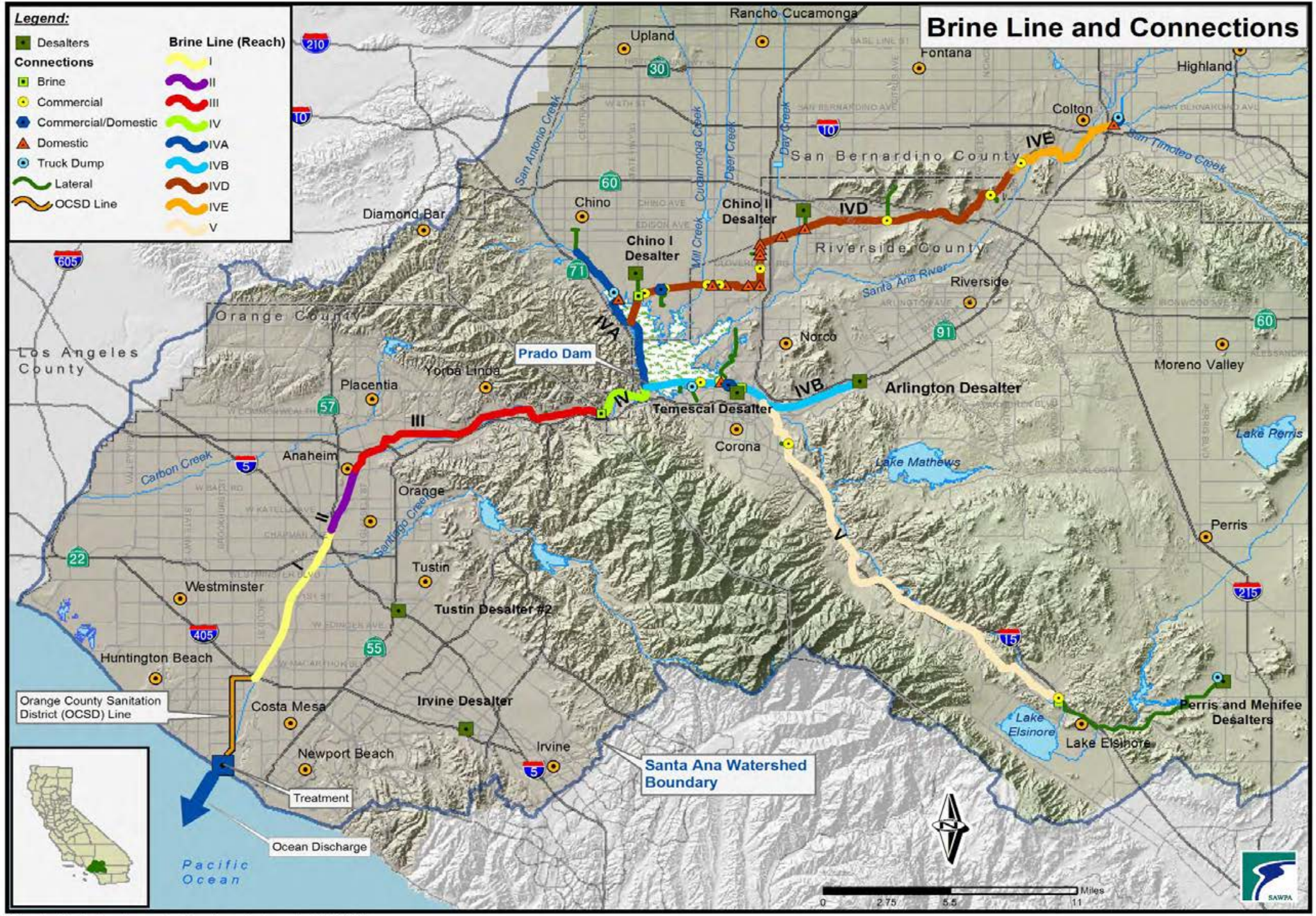
Tracking TDS (orange) and Rainfall (blue) at Prado Dam



Interviewees' perceptions of success

What is the most successful project?

The Brine Line



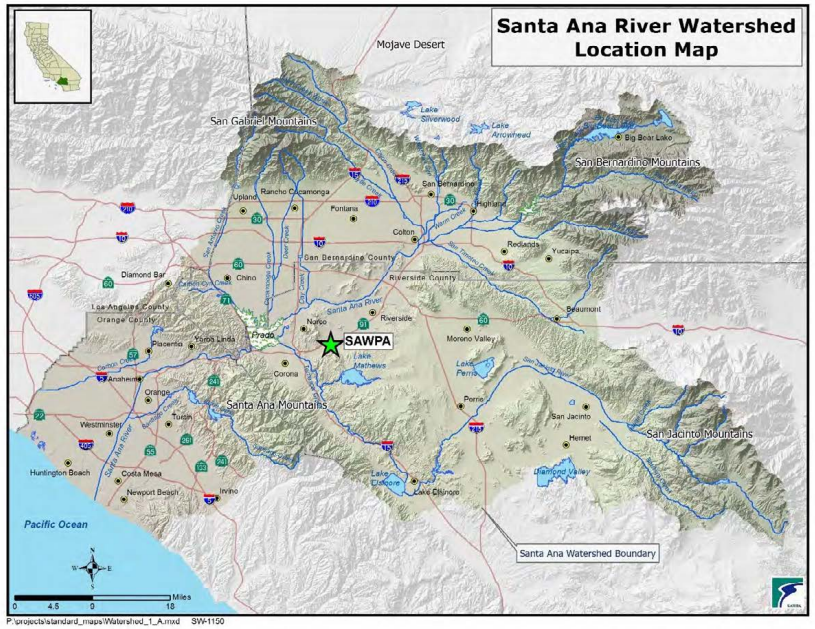
P:\projects\standard_maps\esri_system_1_A.mxd SW 1154

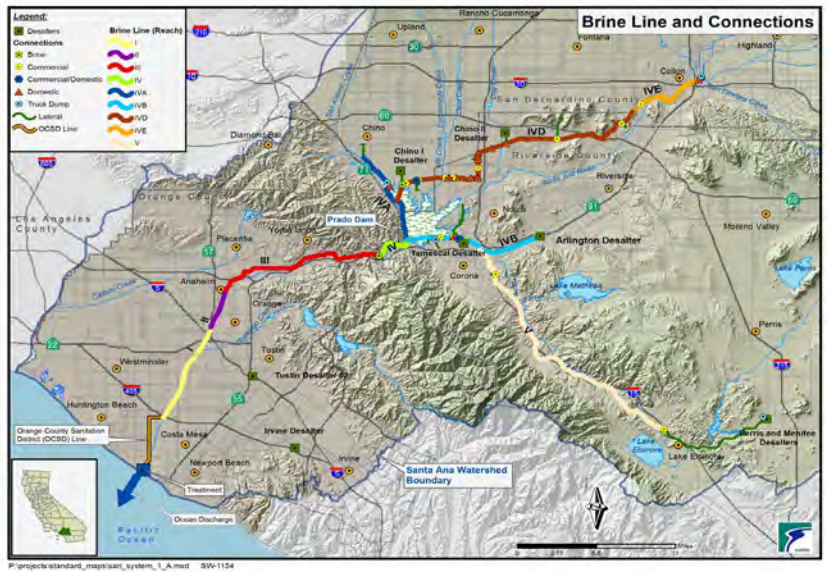
What is the most successful partnership?

- SAWPA itself and its five members → lack of litigation
- Relationship with the local regulator → cooperation while working to meet management targets
- Relationships with state and federal senators → bringing funding into SAWPA

The problem of chloride

Seawater intrusion in Orange County's groundwater, a source of drinking water





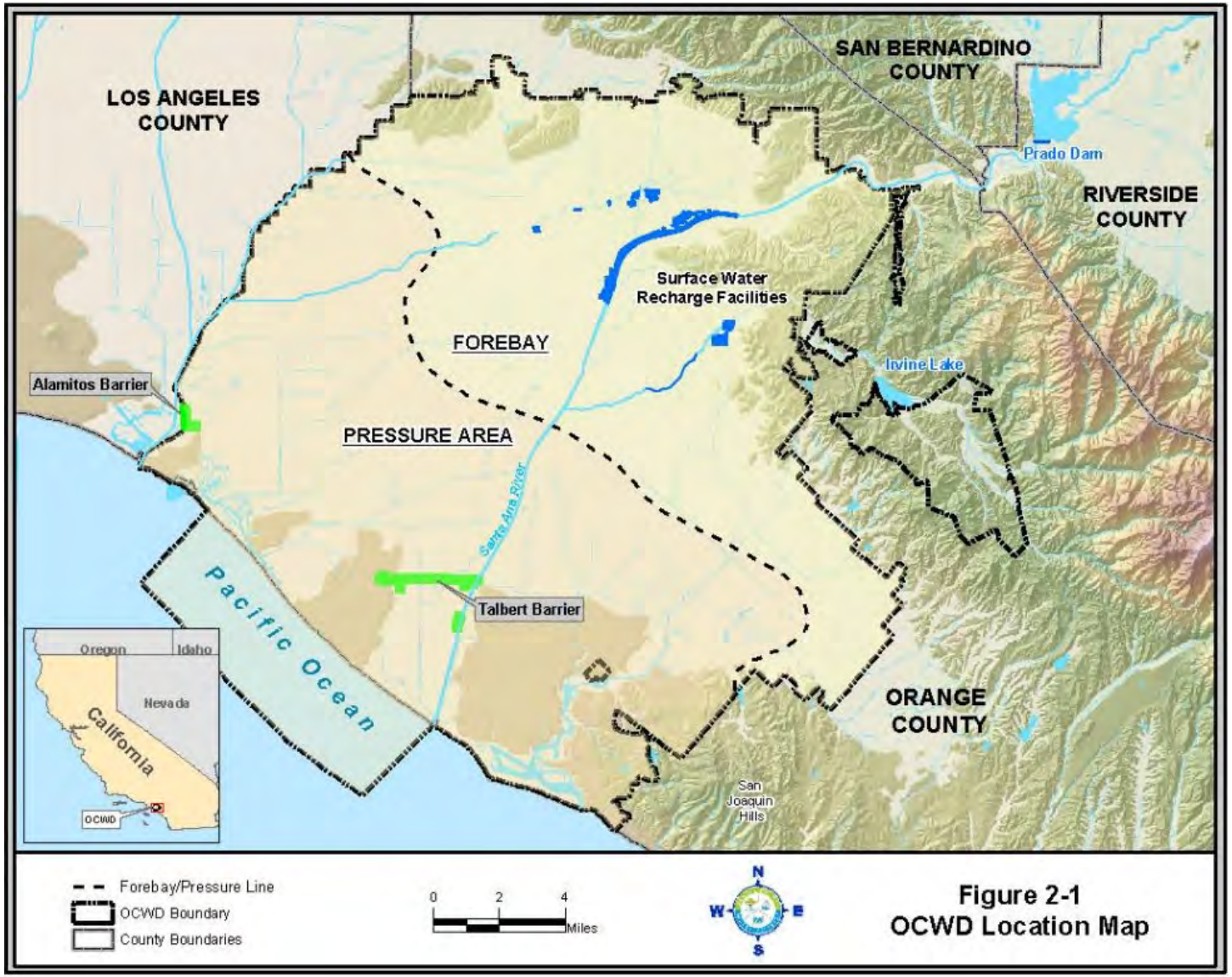


Figure 2-1
OCWD Location Map

Orange County's seawater intrusion barriers

- Groundwater Replenishment System (GWRS): create highly treated, low-salinity wastewater
- Inject low-salinity wastewater at interface with ocean, protecting fresh drinking water
- Historically attempted to do this with Colorado River water, which proved to be too saline

- GWRS Funding Sources:
  - State Water Bond ($37M)
  - CA Department of Water Resources ($30M)
  - State Water Resources Control Board ($5M)
  - US Bureau of Reclamation's Title XVI program ($20M)
  - California Energy Commission ($300k)
  - EPA ($500k).
  - The remainder of the costs are shared between OCWD and OCSD

Conclusions and next steps

Will ongoing challenges push limit of cooperation?

- External environmental stresses likely to worsen
  - High salinity in Colorado river water
  - Variability in State Water Project deliveries
- Upstream-downstream misalignment on importance of chloride
- Will brine disposal become a challenge?
  - More saline brine
  - Consequences of increasing brine disposal along the cost
  - Relationship with sewage management entities

Takeaways and Conclusions

- Regionalization is a good management strategy and can promote cooperation, but it is difficult to capture all relevant scales and actors in salinity management

- Regionalization is perhaps most effective in securing funding and resources to support collaborations

- Coastal salinization imposes political and institutional challenges that have yet to be addressed either by SAWPA or elsewhere

Next steps: Comparison with the Delaware River Basin Commission

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Associate Professor, Loma Linda University

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Arsenic Contaminated Ground Water Prompts a Community to Buy Water From Poorly Maintained Drinking Water Vending Machines

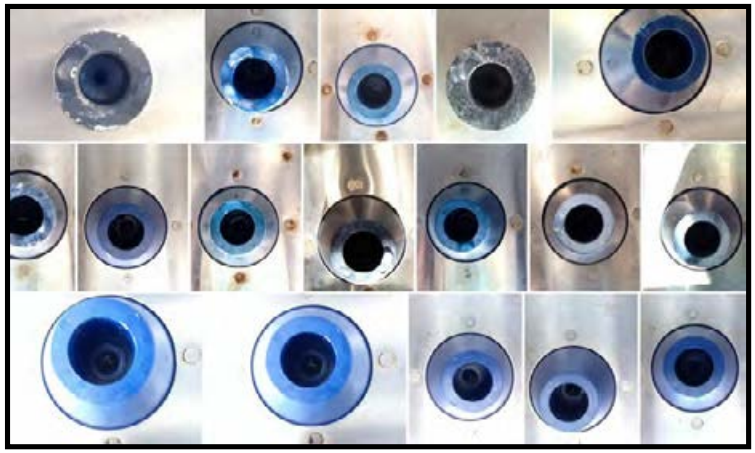
Arsenic contaminated ground water prompts a community to buy water from poorly maintained drinking water vending machines.

Ryan Sinclair PhD MPH, Nataly Escobedo Garcia MA, Thomas Hile MA

LEADERSHIP COUNSEL FOR JUSTICE & ACCOUNTABILITY

LOMA LINDA UNIVERSITY
School of Public Health

Oasis Mobile Home Park – Case Study



- Oasis Mobile Home Park – Case Study
  - ~ Many environmental health issues
  - ~ Water testing and federal agencies
- Drinking water vending machines
  - ~ An EJ compromise
  - ~ What is needed to improve this H_2O quality?
- Arsenic and Drought
  - ~ Did drought increase concentrations of arsenic in ground water?
  - ~ Water Scarcity and climate impacted communities
- Conclusions

Oasis Mobile Home Park

- 1,900 people near Salton Sea in the ECV of Southern California
- About 250 mobile homes
- Estimate MHI - $16,945
- Residents living in Oasis are majority Latino, with many Purépecha residents.
- Agriculture workers and several other occupations.
- Large family-centric households

Drinking water

- **Arsenic** Content
- Color
- Odor and residual chlorine
- Water Shutoffs
- Bacteria

Water Shut-offs

- Often more than 12 hours at a time
- Frequent water shut-offs without warning

EPA Emergency order - Arsenic

- Arsenic contamination (70-80ppb)
  - Declared Aug 2019
  - Lifted June 2020
  - Re-declared September 2020

Alternative water

- Issues with access and quality

Discolored water

- Possibly associated with super-chlorination or Fe.
- Yellow color or brown color

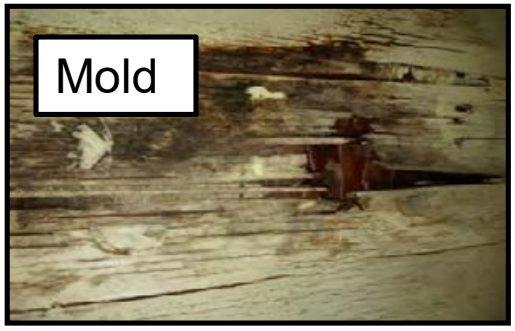
Bacteria Detected in several samples

- PVC pipes are often near surface
- Cross contamination


Frequent water leaks and shutoffs
Illegal dump sites
Demolished house debris

Habitability:

- Most are owned by residents
- Most trailers from 1960-1970s
- Mold, water leaks, insulation, dust



Electrical Infrastructure

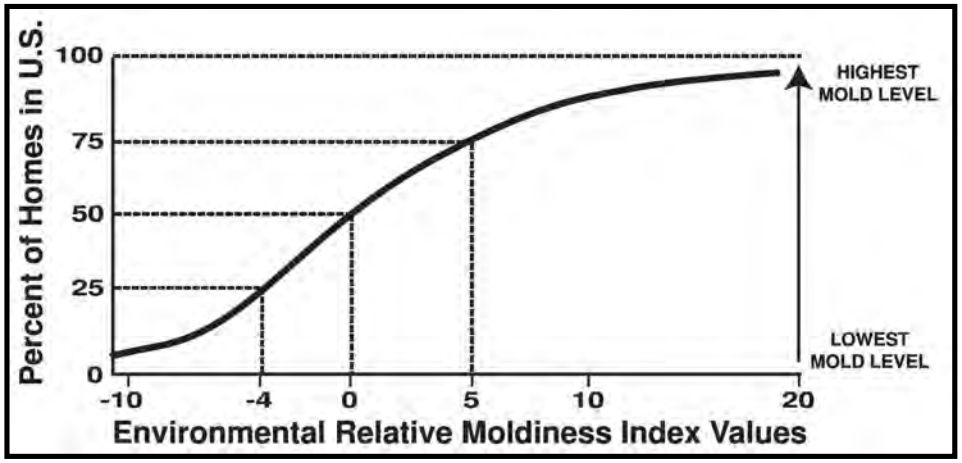
Habitability:

- Mold, water leaks, insulation, dust

Table 3: Average Environmental Relative Moldiness Index (ERMI) values in homes in the four types of housing in Mecca and Coachella City and the weighted-average ERMI values (WAEV) for all housing in each community. (n = number homes evaluated in each category).

	Mecca		Coachella City		
	n	ERMI	n	ERMI	p value
Apartment	16	7.1	17	4.9	
Modern home	18	7.8	22	6.1	
Trailer	7	17.2	18	7.0	
Mixed-use	10	15.3	3	5.9	
Total	51		60		
WAEV		10.3		6.0	<0.05

Two houses in Oasis MHP
ERMI = 14
ERMI = 17



Wastewater exposure:

- Consolidated septic systems
- PVC and ABS near surface
- Many leaks
- Some “straight pipe”

Long-term straight pipe creates shady areas - attracts children and dogs.

Timeline of events

2010 – faulty wastewater lagoon closed

2013 – nearby Los Duros closes

2014 – IRWMP helps other park water/wastewater

2014 – arsenic found in tap water

2015 - Concerned residents and LLU survey

Loose network of septic tanks used

Nearby D&D MHP USEPA action on Arsenic

LCJA contact resident advocates

Manager notified about drinking water from USEPA

#1 USEPA emergency order

USEPA declares drinking water safe

LLU finds 8x MCL arsenic in water

USEPA resistance

Manager supplies low cost drinking water

CVWD supplies treated water from truck spigots

#2 USEPA emergency order

Manager dies

Probate

BIA determines no permit for 15 years

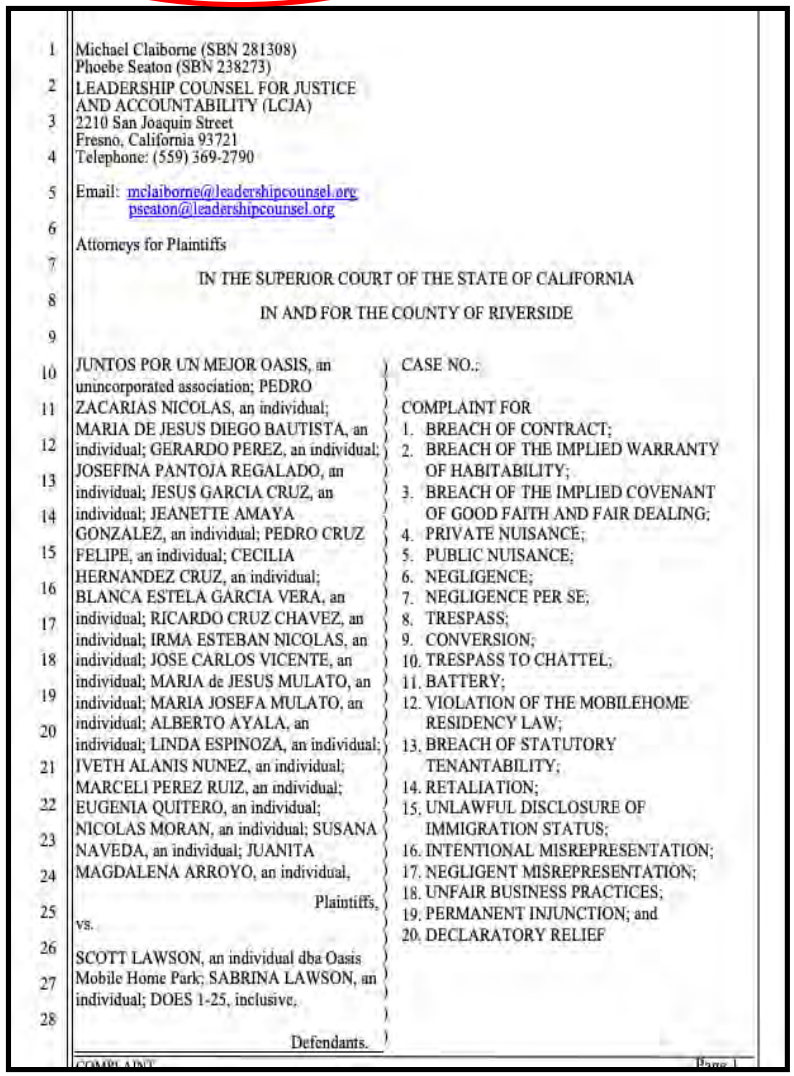
Community requests water delivery

LCJA lawsuit

2016 | 2017 | 2018 | 2019 | 2020 | 2021

LCJA action and Advocacy

- *Locally…*



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Attorneys for Plaintiffs

IN THE SUPERIOR COURT OF THE STATE OF CALIFORNIA

IN AND FOR THE COUNTY OF RIVERSIDE

JUNTOS POR UN MEJOR OASIS, an unincorporated association; PEDRO ZACARIAS NICOLAS, an individual; MARIA DE JESUS DIEGO BAUTISTA, an individual; GERARDO PEREZ, an individual; JOSEFINA PANTOJA REGALADO, an individual; JESUS GARCIA CRUZ, an individual; JEANETTE AMAYA GONZALEZ, an individual; PEDRO CRUZ FELIPE, an individual; CECILIA HERNANDEZ CRUZ, an individual; BLANCA ESTELA GARCIA VERA, an individual; RICARDO CRUZ CHAVEZ, an individual; IRMA ESTEBAN NICOLAS, an individual; JOSE CARLOS VICENTE, an individual; MARIA de JESUS MULATO, an individual; MARIA JOSEFA MULATO, an individual; ALBERTO AYALA, an individual; LINDA ESPINOZA, an individual; IVETH ALANIS NUNEZ, an individual; MARCELI PEREZ RUIZ, an individual; EUGENIA QUITERO, an individual; NICOLAS MORAN, an individual; SUSANA NAVEDA, an individual; JUANITA MAGDALENA ARROYO, an individual,

Plaintiffs,

vs.

SCOTT LAWSON, an individual dba Oasis Mobile Home Park; SABRINA LAWSON, an individual; DOES 1-25, inclusive,

Defendants.

CASE NO.:

COMPLAINT FOR
1. BREACH OF CONTRACT;
2. BREACH OF THE IMPLIED WARRANTY OF HABITABILITY;
3. BREACH OF THE IMPLIED COVENANT OF GOOD FAITH AND FAIR DEALING;
4. PRIVATE NUISANCE;
5. PUBLIC NUISANCE;
6. NEGLIGENCE;
7. NEGLIGENCE PER SE;
8. TRESPASS;
9. CONVERSION;
10. TRESPASS TO CHATTEL;
11. BATTERY;
12. VIOLATION OF THE MOBILEHOME RESIDENCY LAW;
13. BREACH OF STATUTORY TENANTABILITY;
14. RETALIATION;
15. UNLAWFUL DISCLOSURE OF IMMIGRATION STATUS;
16. INTENTIONAL MISREPRESENTATION;
17. NEGLIGENT MISREPRESENTATION;
18. UNFAIR BUSINESS PRACTICES;
19. PERMANENT INJUNCTION; and
20. DECLARATORY RELIEF

COMPLAINT Page 1

- *State policy…*
- SB 129 signed

> 3. Of the amount appropriated in Schedule (1), $30,000,000 is available to provide emergency housing, develop quality affordable housing, and construct necessary infrastructure to relocate residents of Oasis Mobile Home Park in Riverside County.

- Per USEPA
  - ~30 families at risk of eviction
- All the same issues remain +
  - Probate
  - Interim managers requiring cash rent payments

Congressman action

- *Federal…*
- BIA acknowledged
  - OMHP operated without a lease for at least fifteen years
  - Multiple deficiencies and risk factors present in the wells and water distribution systems since 2007
- BIA will not take actions to close down the park

RAUL RUIZ, M.D.
Member of Congress
36th District of California

Washington, D.C. Office:
2342 Rayburn House
Office Building
Washington, D.C. 20515
Phone: 202-225-5330

Congress of the United States
House of Representatives
Washington, DC 20515-3605

April 1, 2021

The Honorable Darryl LaCounte
Director, Bureau of Indian Affairs
Department of the Interior
1849 C St NW
Washington, DC, 20240

The Honorable Deb Haaland
Secretary
Department of the Interior
1849 C St NW
Washington, DC

Dear Secretary Haaland and Director LaCounte,

I am writing to express my extreme concern over the Bureau of Indian Affairs' (BIA) oversight of ongoing public hazards in my district. In an effort to appropriately address this issue, I am requesting a full accounting of the BIA's interactions and oversight of the Oasis Mobile Home Park (OMHP), located on Tribal land in Thermal, California.

For the past year and a half, my office and I have been working with local BIA officials in Riverside County to remedy two public health threats to my constituents. The

2016 Household Survey on water use in Oasis, Thermal, Mecca, Coachella City and North Shore.

Conducted by LLU, Alianza and the California Institute for Rural Studies

TABLE 1 HOUSEHOLD WATER USE

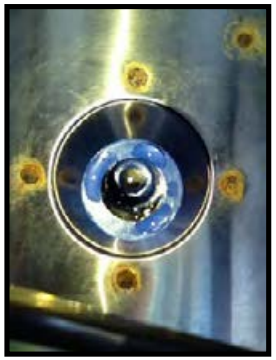
	North Shore	Mecca	Thermal	Oasis	Coachella City	ECV
Running Water at Home	96%	98%	98%	99%	98%	98%
Use Tap Water from Faucet for Cooking or Drinking	61%	78%	77%	53%	70%	70%
Tap Water from Faucet Treated before Use	35%	44%	29%	38%	71%	62%
Filter	93%	27%	30%	84%	75%	70%
Boil	9%	66%	70%	8%	18%	23%
Water Turned Off without Warning	2%	6%	8%	**30%**	3%	6%
Number of Times in Previous 12 Months	2.7	3.1	4.1	8.9	1.8	4.8
Buy Bottled Water	**82%**	**74%**	**81%**	**67%**	**50%**	**58%**
Fill Water Jugs from Vending Machine	100%	100%	100%	99%	93%	96%
Fill Water Jugs at a Market or Store	100%	100%	100%	99%	93%	96%
Buy small Bottles of Water at Store	100%	100%	100%	100 %	100%	100%

- Only 38% of people in Oasis drink from the tap
- Almost 30% of people in Oasis had water turned off.

Everyone

- Fills 5-gallon jugs at a drinking water vending machines
- Buys small disposable bottled water

LOMA LINDA UNIVERSITY SCHOOL OF PUBLIC HEALTH



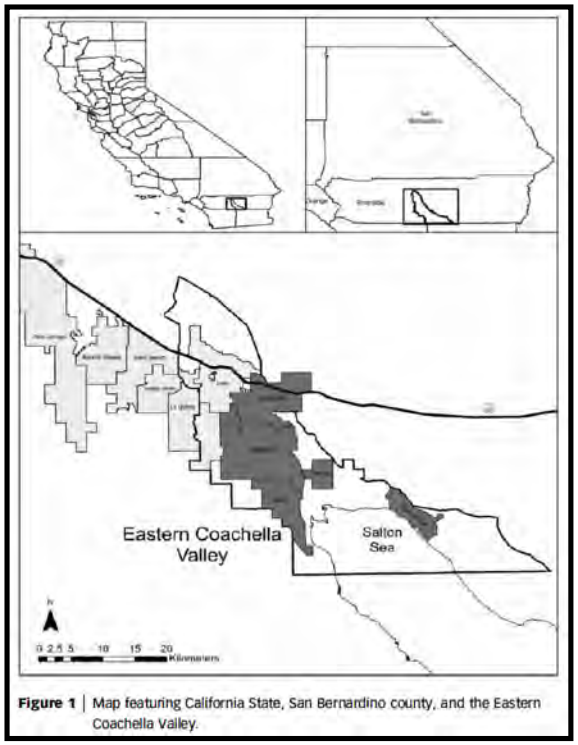


Figure 1 | Map featuring California State, San Bernardino county, and the Eastern Coachella Valley.

Findings:

- Most WVM in ECV are contaminated and neglected
- no visible record of maintenance
- Frequent occurrence of rust, biofilm, and damage
- Molecular detection of several pathogens

Recommendations to community

- Look for evidence of inspections and maintenance
    - County sticker and digital read out.
- Do not use if you see rust, biofilm, slime, mold, or broken equipment

Conclusion: Lack of maintenance represents an environmental injustice that exacerbates the already difficult drinking water situation in the ECV.

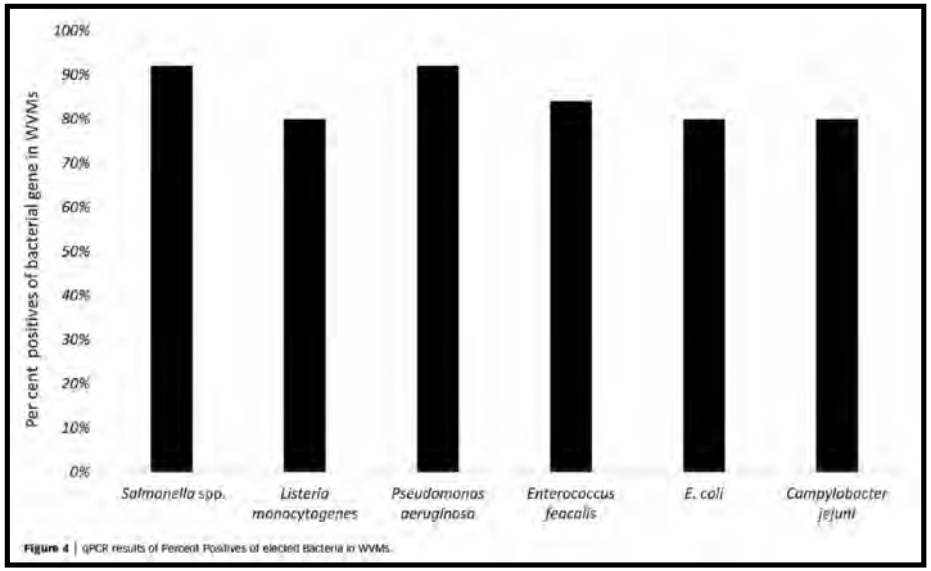


Figure 4 | qPCR results of Percent Positives of elected Bacteria in WVMs.

Conclusions

- Arsenic contamination in drinking water
  - ~ Increases water stress and water scarcity
  - ~ Motivates households to purchase other sources of water
  - ~ Motivated the USEPA to consider the Oasis MHP situation
  - ~ Motivated many others to tackle the

- Arsenic and Drought
  - ~ Did drought increase concentrations of arsenic in ground water?
    - "We don't know yet"
    - Models show a marginal increase in concentration, but not for the type of aquifer in the ECV.
  - ~ More important message: Water Scarcity is pronounced in vulnerable climate impacted communities.
    - Residents of Oasis MHP are on front lines of climate change

Nate Jones

Assistant Professor of Ecohydrology, The University of Alabama

@FloodHydrology

Microbial Contamination of Drinking Water Supplied by Private Wells After Hurricane Harvey

Microbial Contamination of Drinking Water Supplied by Private Wells after Hurricane Harvey

Nate Jones
Assistant Professor
University of Alabama

Kelsey Pieper
Assistant Professor
Northeastern University

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Article

Microbial Contamination of Drinking Water Supplied by Private Wells after Hurricane Harvey

Kelsey J. Pieper,* C. Nathan Jones, William J. Rhoads,* McNamara Rome, Drew M. Gholson, Adrienne Katner, Diane E. Boellstorff, and R. Edward Beighley

Cite This: *Environ. Sci. Technol.* 2021, 55, 8382–8392

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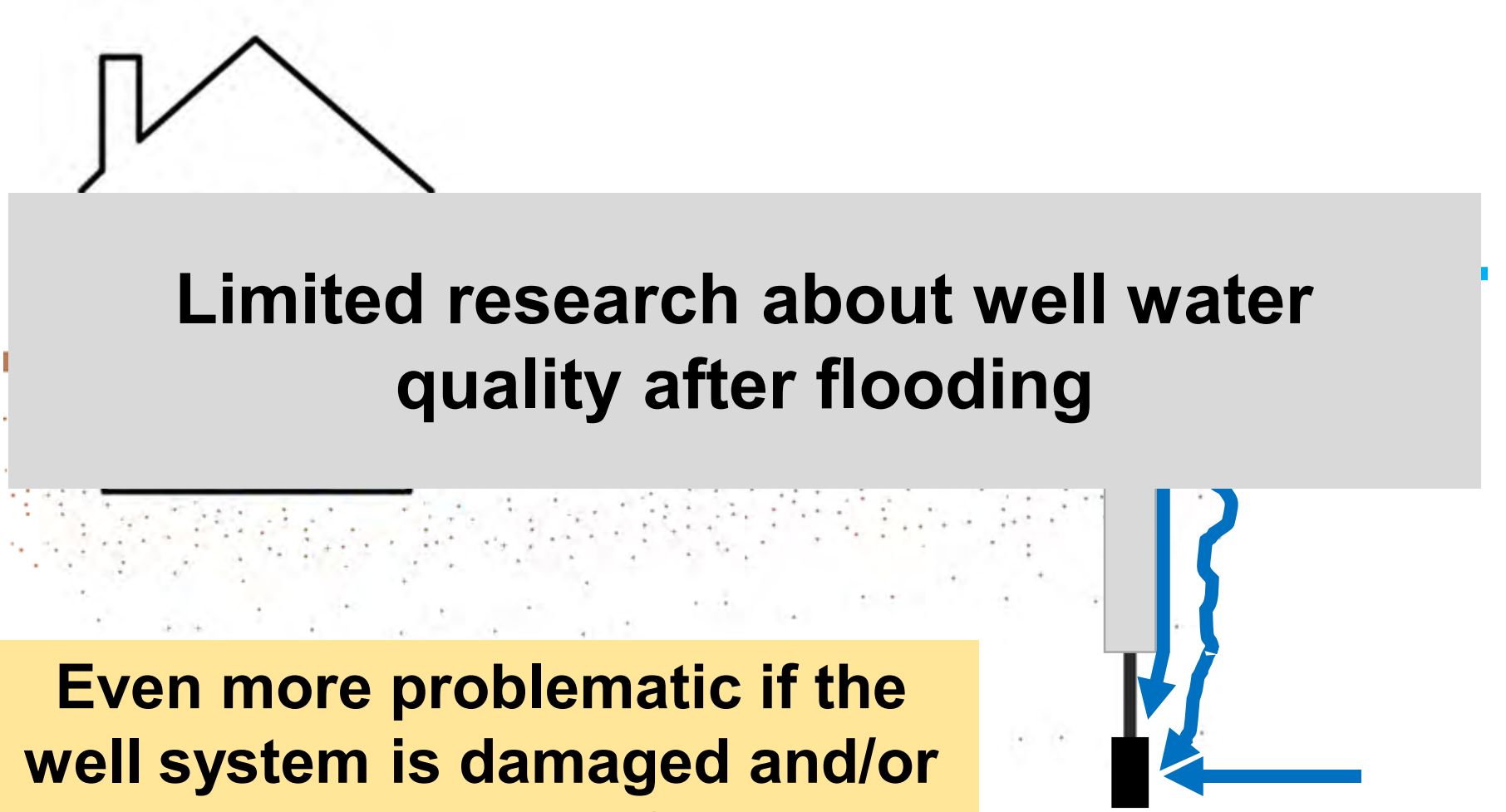
What happens to a private well during a flood?



Limited research about well water quality after flooding

Even more problematic if the well system is damaged and/or the septic system flooded

Neighboring private wells

Well water needs after a flood

"water was 7 feet over our well…under water for about a week"

Is my water safe? What do I do?

Well water quality one week following the flood

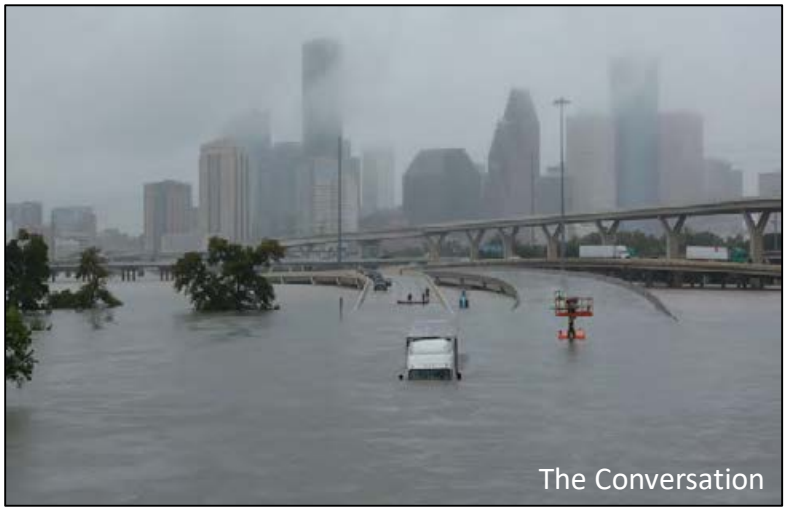
August 27, 2016 sampled five wells in Livingston Parish

Pathway(s) likely existed for surface water to influence well water during flood

- 3 wells were positive for total coliform bacteria

Beliefs that water was safe because wells are deep

Dai et al. *Environmental Science: Water Research & Technology* **2019**, 5 (8), 1464-1477. DOI: 10.1039/C9EW00109C.



Hurricane Harvey

1. Impact of flooding on private wells
2. Drivers of well water contamination
3. Well disinfection and natural attenuation

Study Objectives

paign in Texas

HOUSTON HEALTH DEPARTMENT

BRAZORIA COUNTY
WHERE TEXAS BEGAN

Bolivar Peninsula
Galveston County
Galveston Island

More free testing available for private water well owners affected by Hurricane Harvey

December 7, 2017

TWON
TEXAS
Well Owner
NETWORK

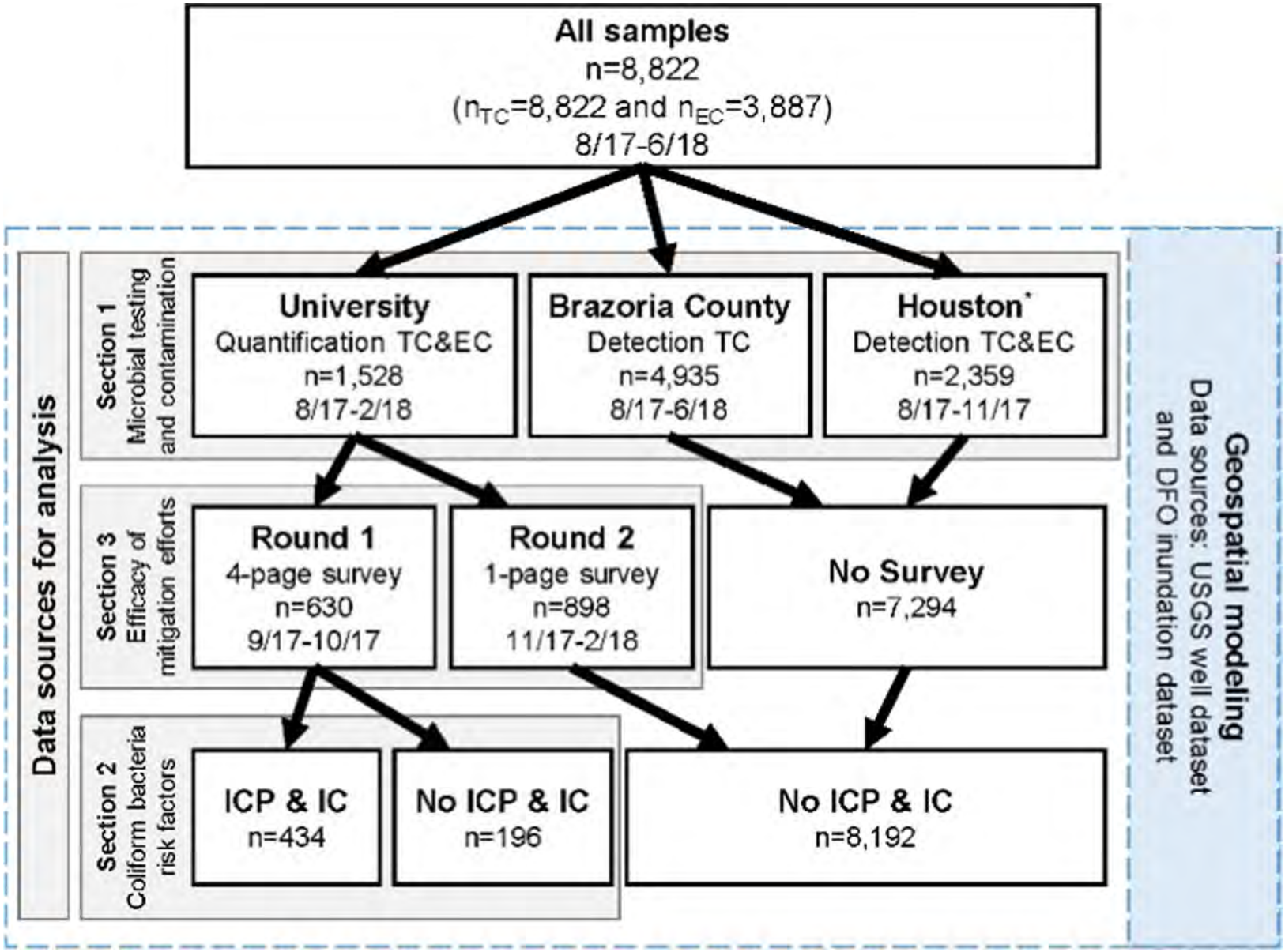
nsion Service and others are offe
well owners in areas affected by

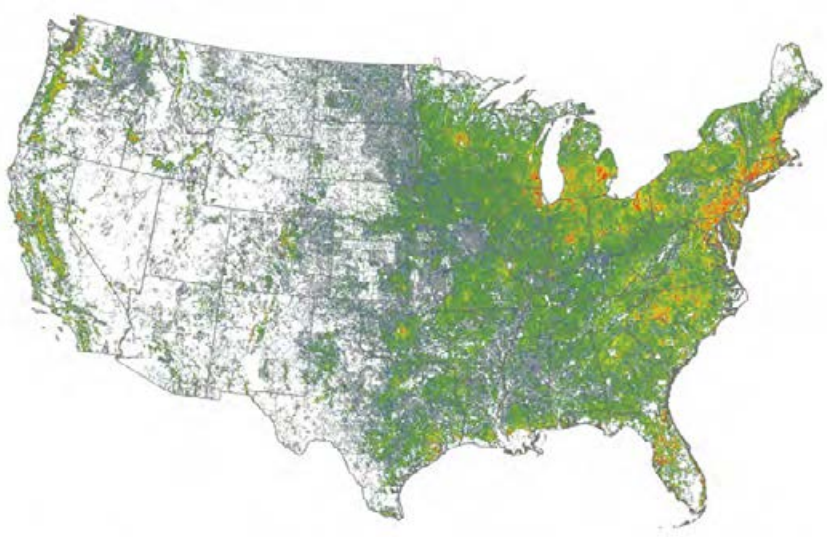
source specialist, College Statior
ot be used for drinking, cooking,
ng until tested.

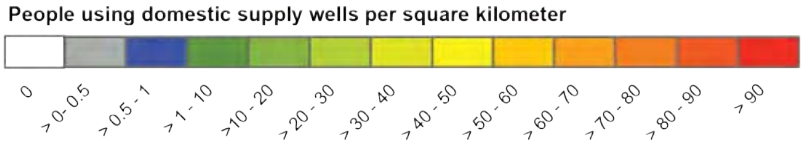
NSF

FEMA

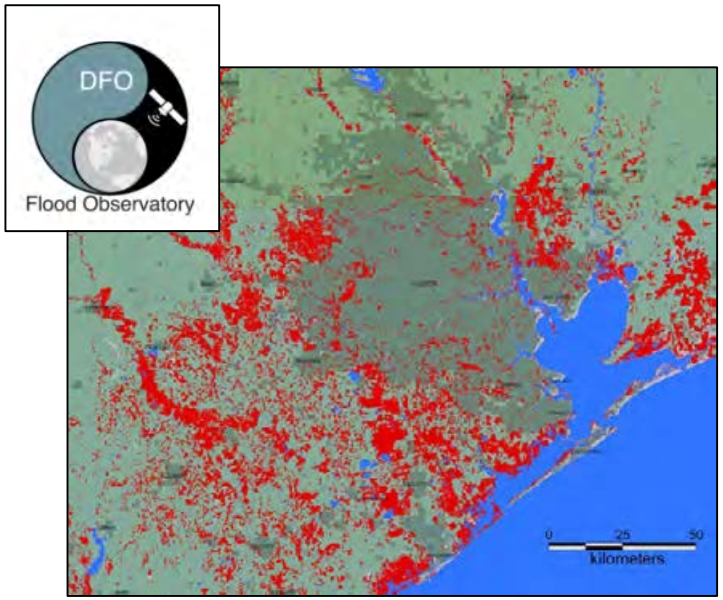
8822 total samples
1528 NSF RAPID
4935 Brazoria County
2359 City of Houston


All samples
n=8,822
(n_{TC}=8,822 and n_{EC}=3,887)
8/17-6/18
Data sources for analysis
Section 1
Microbial testing and contamination
University
Quantification TC&EC
n=1,528
8/17-2/18
Brazoria County
Detection TC
n=4,935
8/17-6/18
Houston*
Detection TC&EC
n=2,359
8/17-11/17
Section 3
Efficacy of mitigation efforts
Round 1
4-page survey
n=630
9/17-10/17
Round 2
1-page survey
n=898
11/17-2/18
No Survey
n=7,294
Section 2
Coliform bacteria risk factors
ICP & IC
n=434
No ICP & IC
n=196
No ICP & IC
n=8,192
Geospatial modeling
Data sources: USGS well dataset
and DFO inundation dataset



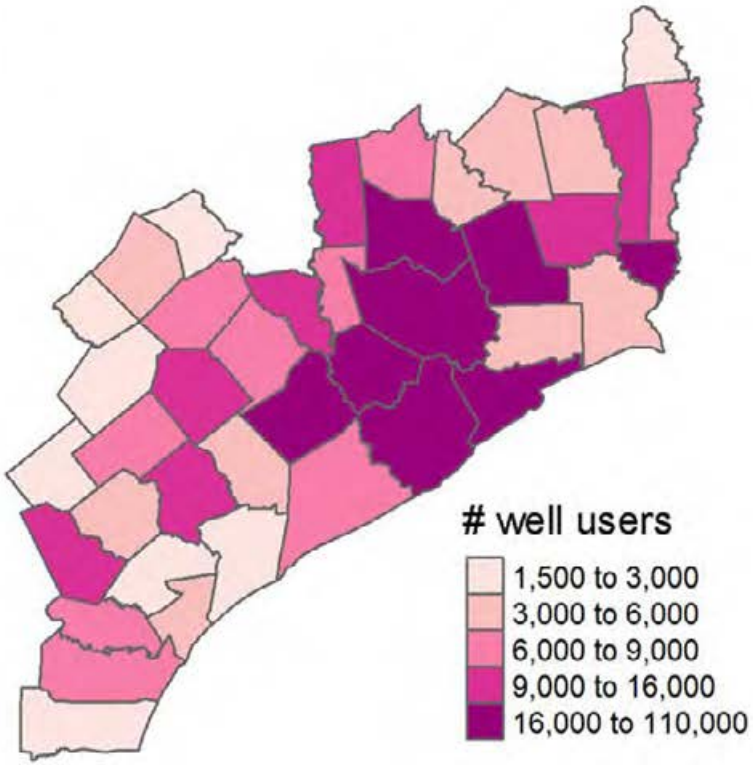


USGS Well Dataset

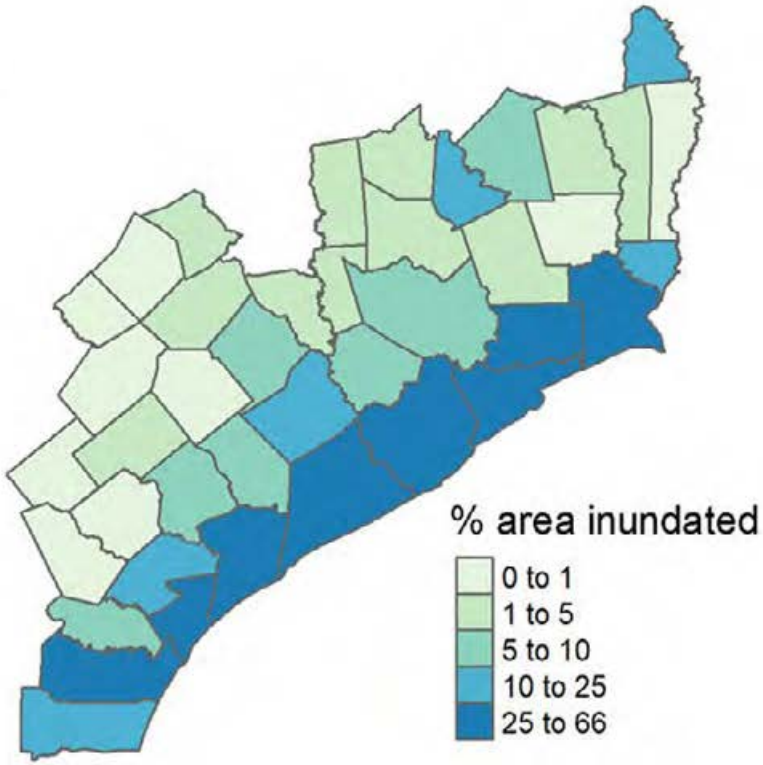


Dartmouth Flood Observatory Inundation

Geospatial Data



USGS Well Dataset



Inundation

Geospatial Data

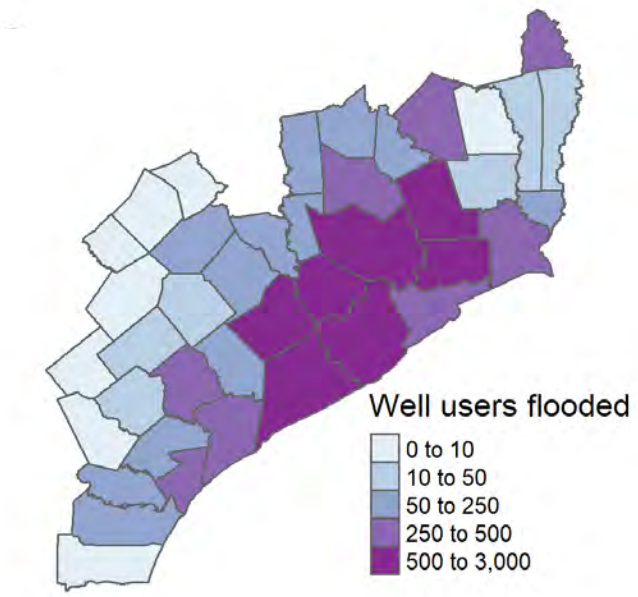
1. **Impact of flooding on private wells**
2. Drivers of well water contamination
3. Well disinfection and natural attenuation

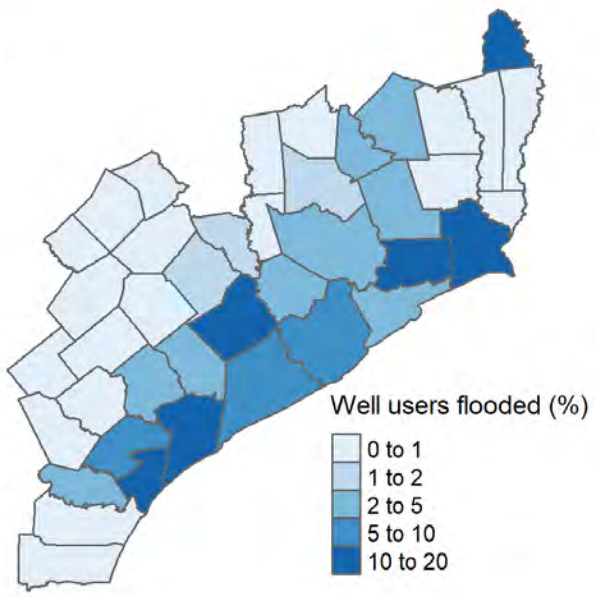
Study Objectives

Thousands of private wells were likely affected by flooding

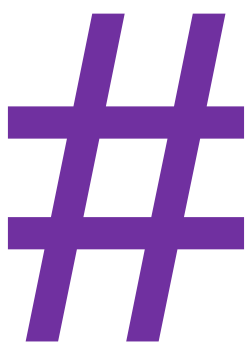
Within 41 disaster-declared counties…

- 6.1% of population was reliant on private wells
  - But still an estimated 526,000 well users
- 2.9% (15,060 users) may have been inundated





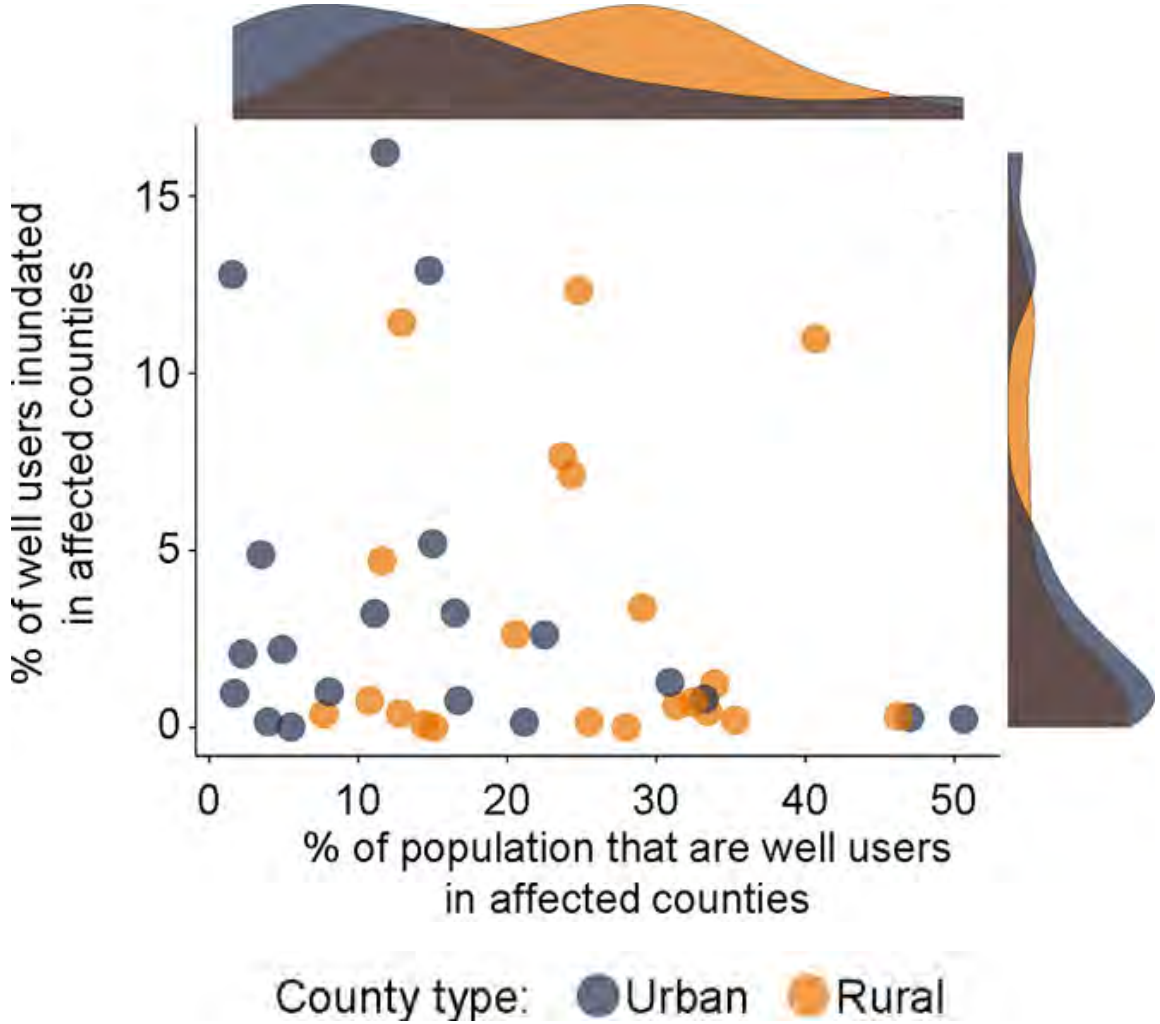
Flood impacts were not isolated to private wells in rural counties



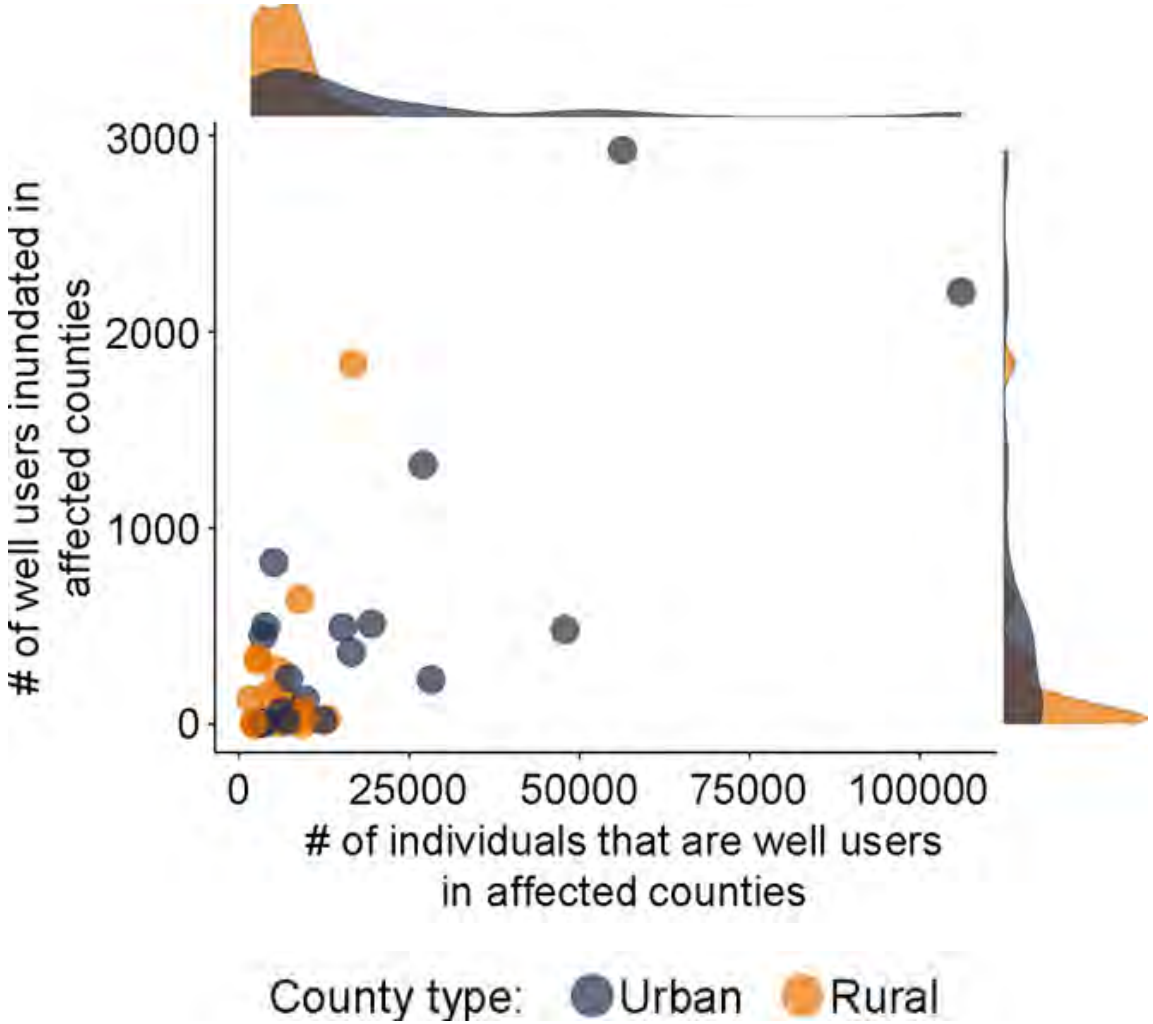
Rural > Urban

Rural < Urban

Flood impacts were not isolated to private wells in rural counties



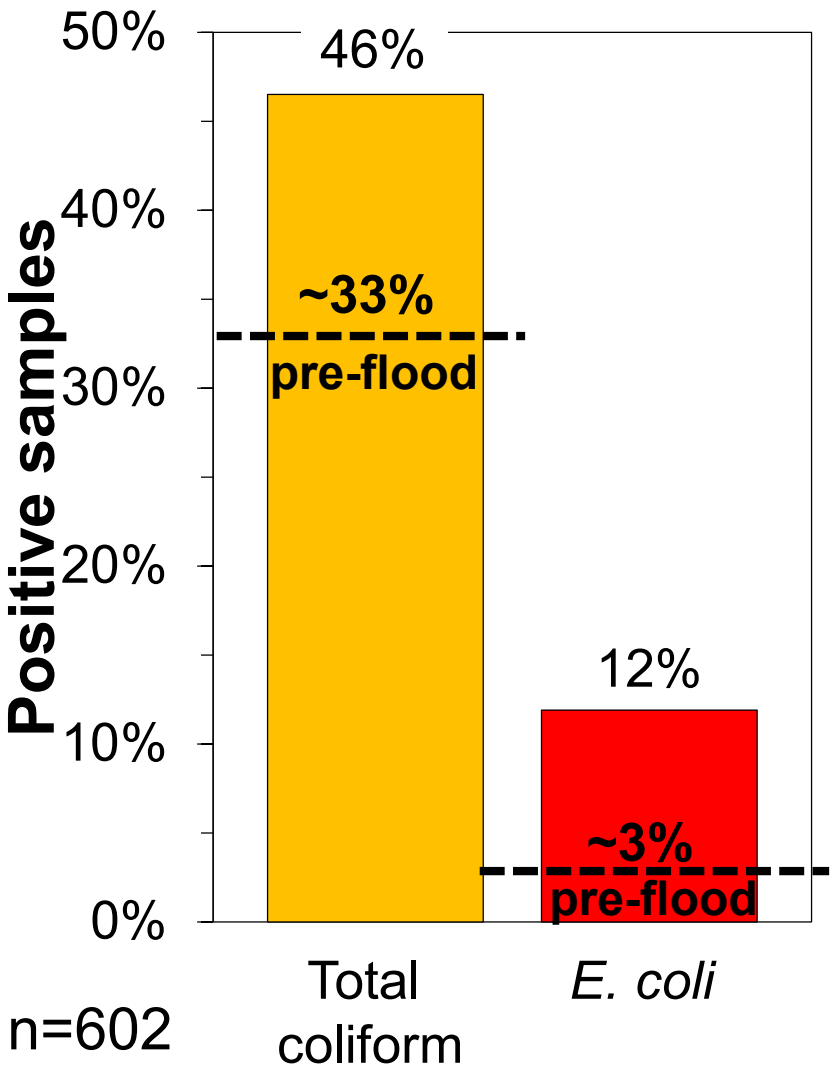
Flood impacts were not isolated to private wells in rural counties



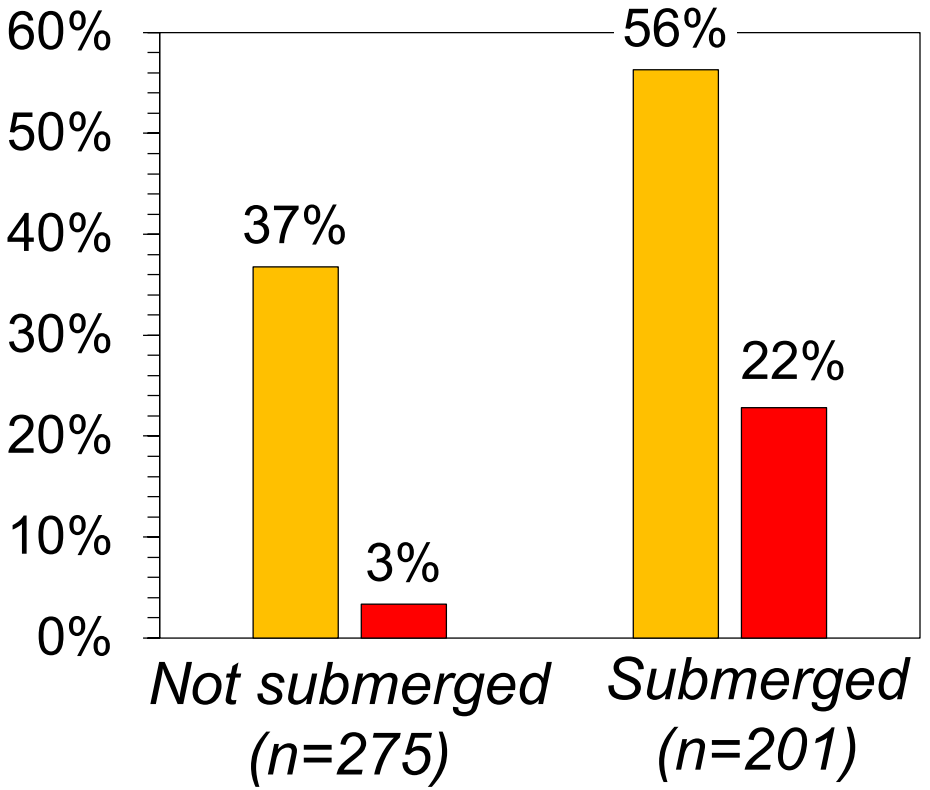
1. Impact of flooding on private wells
2. **Drivers of well water contamination**
3. Well disinfection and natural attenuation

Study Objectives

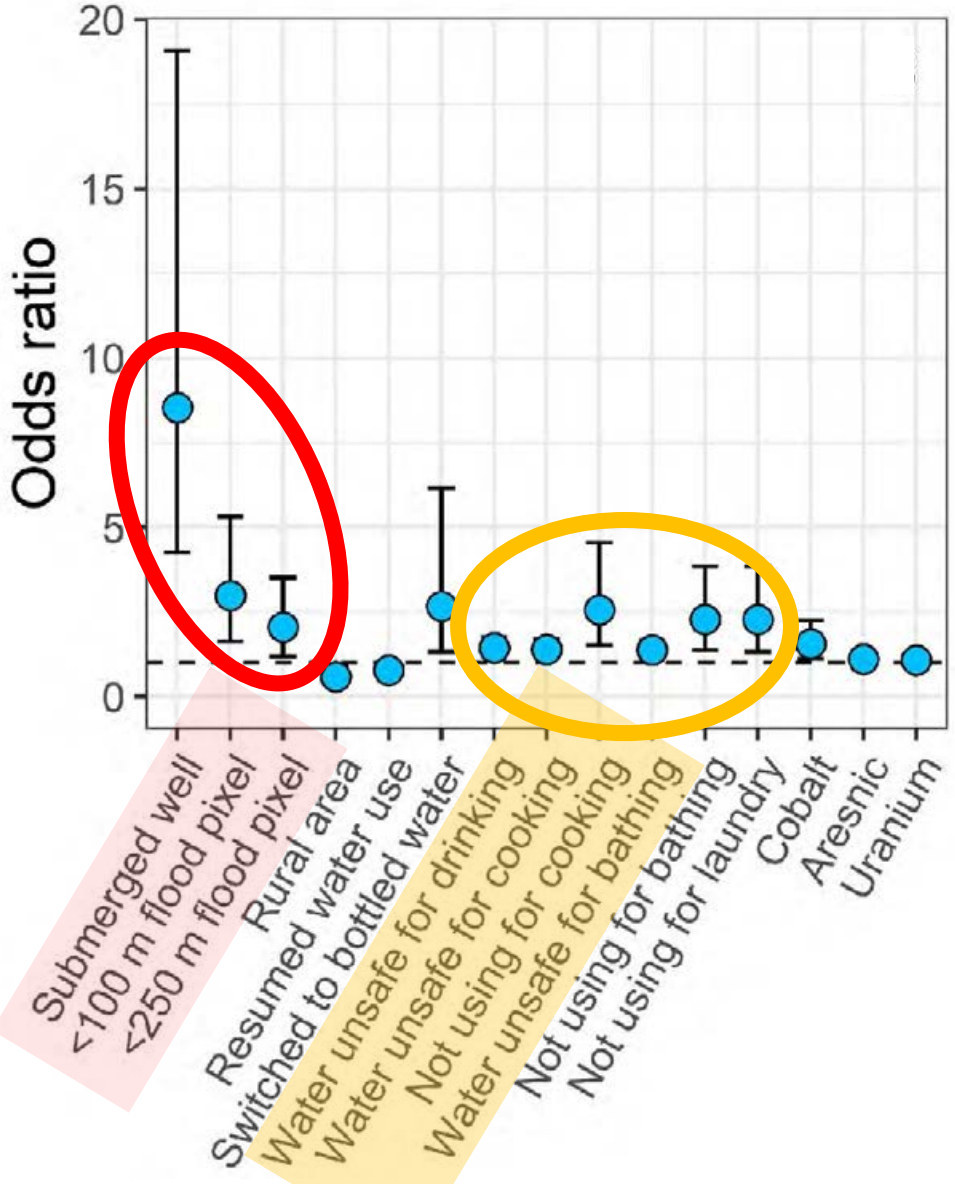
Well water was contaminated after Hurricane Harvey



Residents that reported their wellheads were…



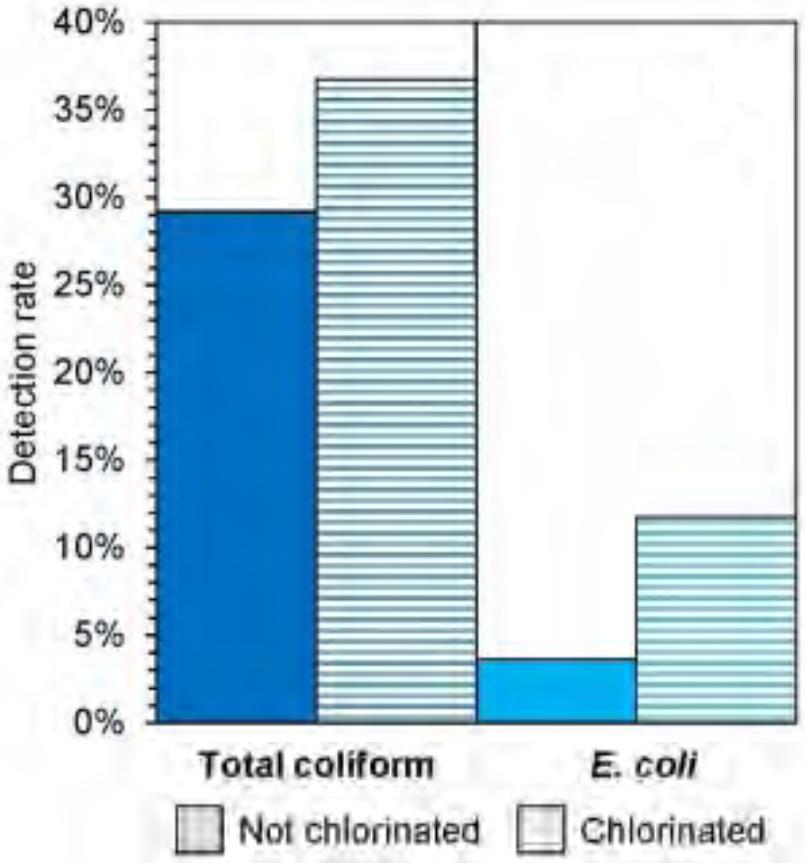
Safety concerns and flood impacts associated with *E. coli*

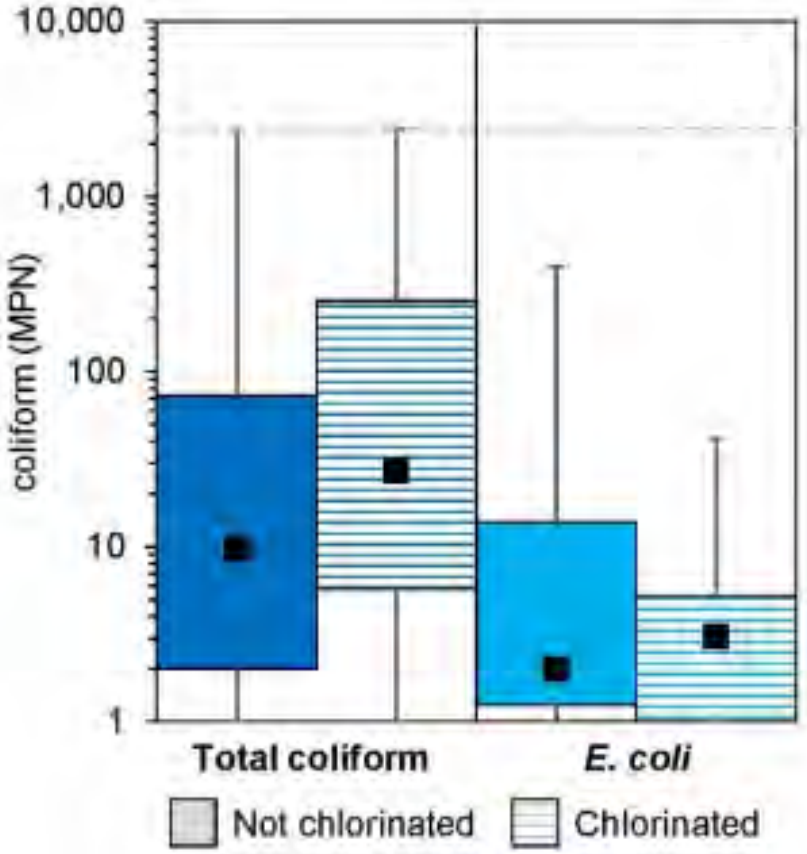


1. Impact of flooding on private wells
2. Drivers of well water contamination
3. **Well disinfection and natural attenuation**

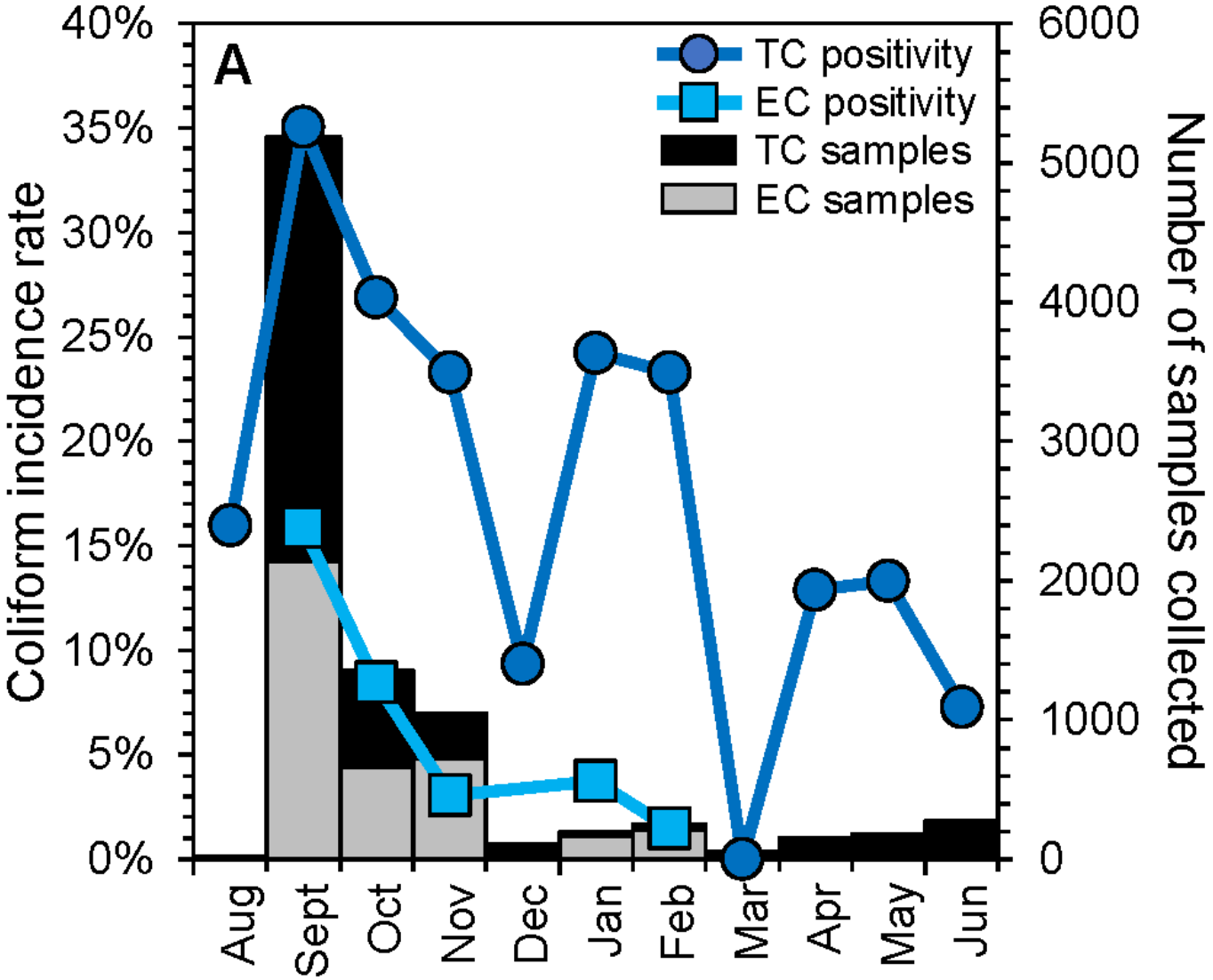
Study Objectives

Chlorination did not always eliminate contamination

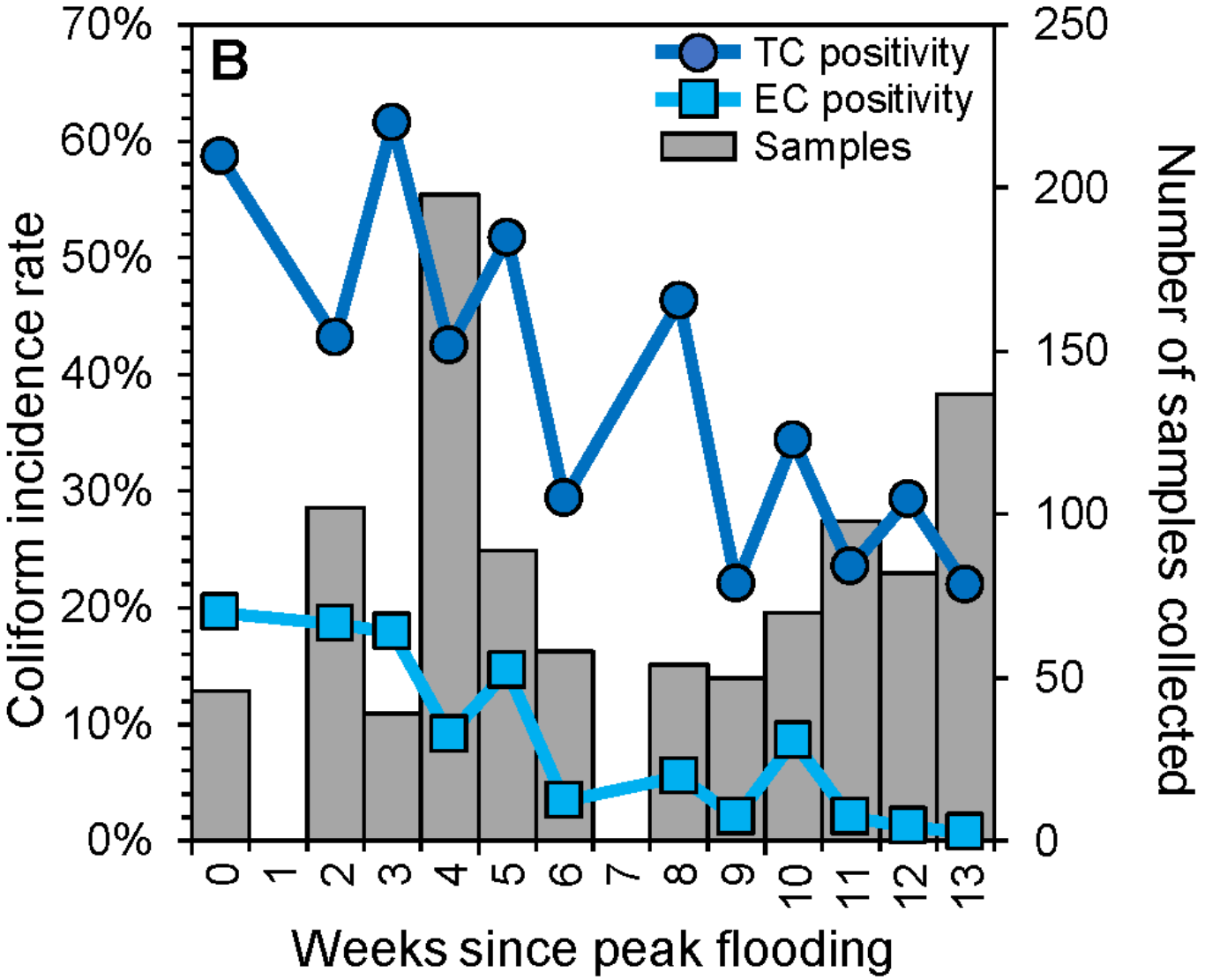




Sampling and contamination decreased over time



Contamination reduced by 1.5-2.7% each week



Take Home Points

1. Private well impacts contamination occurred in both urban and rural counties
2. Inundation (or proximity to inundation) correlated with contamination
3. Disinfection was not always effective, but we did observe natural attenuation over time

Next steps

1. Predictions of private well system locations!
2. Connectivity between floodwaters and well water
3. Physical, chemical, and biological drivers of well recovery

Thank you!

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@FloodHydrology

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USDA NIFA
United States Department of Agriculture
National Institute of Food and Agriculture

FEMA

Coming up Tomorrow!

Break-out 5 | 8:30-10am PT

SESSION 5.1

The Cumulative Costs of Climate Change

SESSION 5.2

Heat Vulnerability Affecting Workers, Healthcare, and Neighborhoods

SESSION 5.3

Innovative Toolkits for Urban Heat Adaptation

SESSION 5.4

Housing and Hazards: How Should We Protect Vulnerable Homes?

Break-out 6 | 10:15-11:45am PT

SESSION 5.1

Emerging Research on Financial Adaptations to Climate Impacts

SESSION 5.2

Wading into the Economic Impacts of Climate Change on Water

SESSION 5.3

Equitable Adaptation to Climate-Related Flood Risks: Part 2

CLIMATE ADAPTATION
RESEARCH SYMPOSIUM

MEASURING & REDUCING SOCIETAL IMPACTS

Thanks for tuning in!

UCLA Luskin Center for Innovation