PRODUCED WATER REUSE EFFORTS IN SUPPORT OF THE NATIONAL WATER REUSE ACTION PLAN

NATIONAL COORDINATION AND ASSOCIATED CHALLENGES

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NEW MEXICO PRODUCED WATER RESEARCH CONSORTIUM

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2022 WateReuse SYMPOSIUM

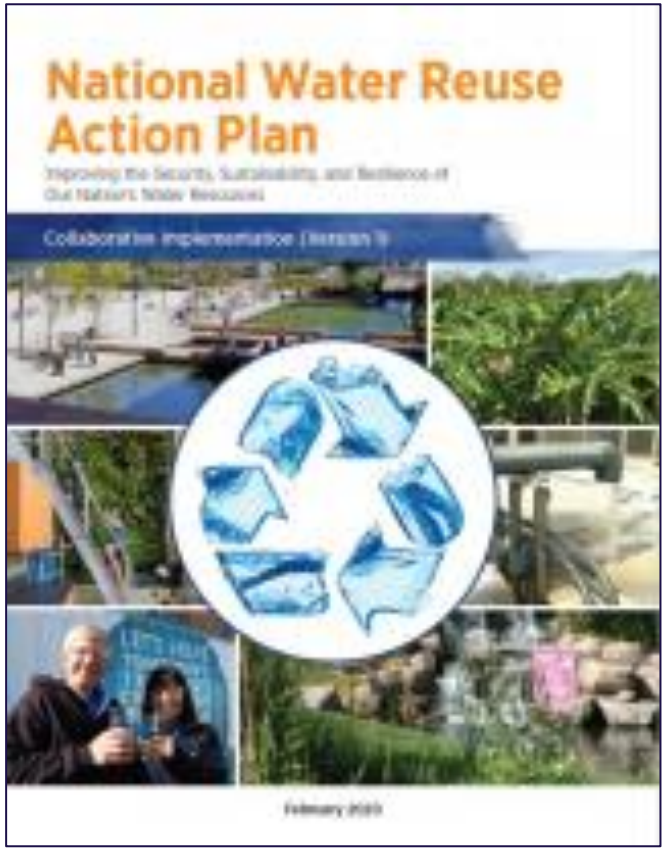
SHAPING OUR PAST &

CHARTING OUR FUTURE

Presentation Overview

- EPA's National Water Reuse Action Plan and produced water
- Overview of produced water and current practices
- The technical and health and safety challenges of the treatment and fit-for-purpose reuse of produced water
- National collaboration framework for produced water treatment and reuse
- State-of-the-science research to support the treatment and safe reuse of produced water

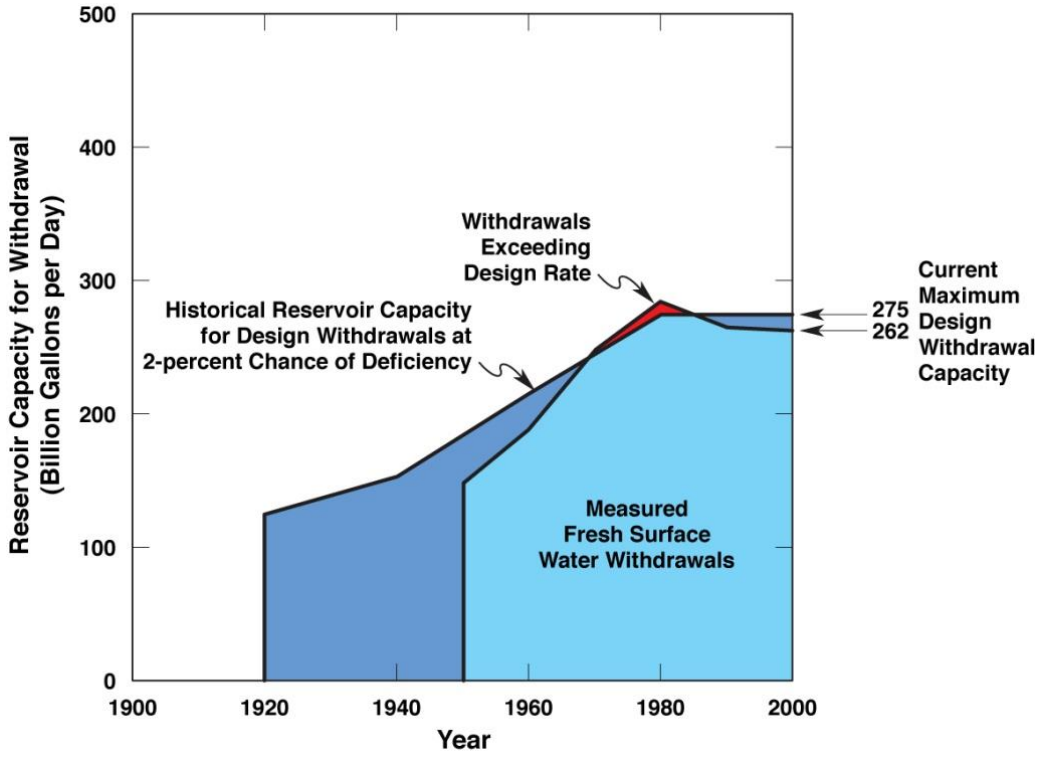
EPA National Water Reuse Action Plan



Two of the United Nations' Sustainable Development Goals identify **water reuse as key to a more sustainable future.**

- Focus on fit-for-purpose treatment and reuse of waste water
- Five major areas:
  - Thermo-electric cooling water
  - Agricultural waste water
  - Municipal waste water
  - Produced water
  - Storm water
- EPA asked the NMPWRC to lead efforts coordinating treatment and reuse of produced water outside oil and gas
- NMPWRC established a state coordinating council to improve collaboration and funding opportunities (NM, AZ, TX, WY, OK, CO, PA)

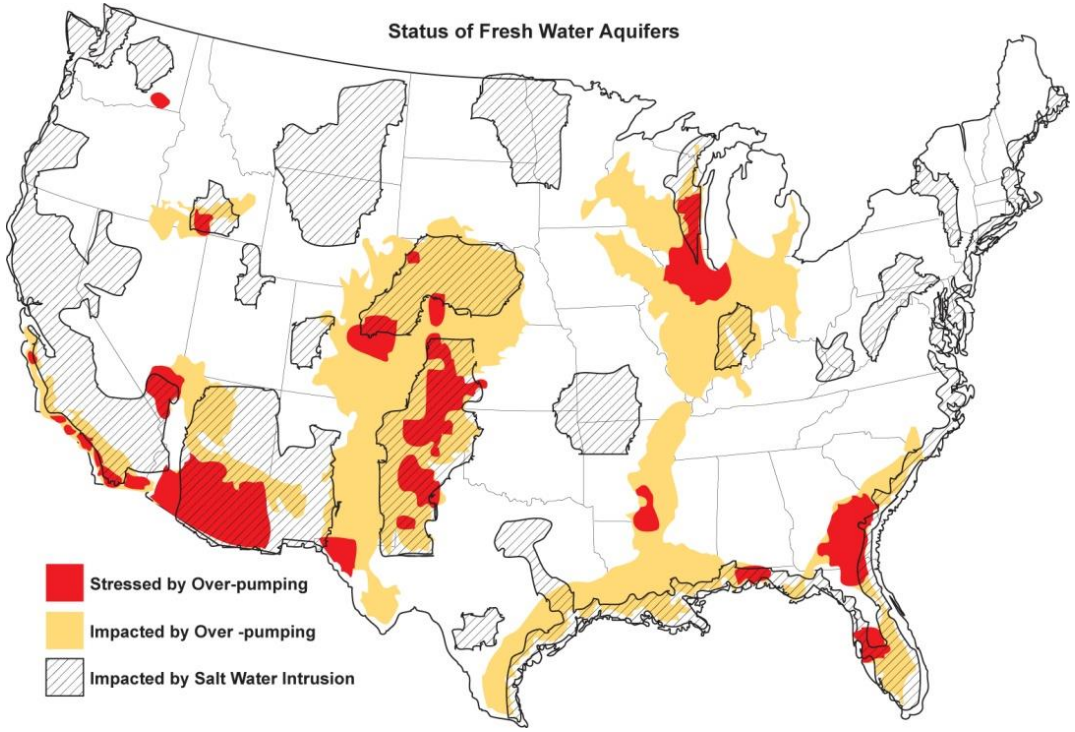
Fresh Water Issues Driving Waste Water Reuse



(Based on USGS WSP-2250 1984 and Alley 2007)

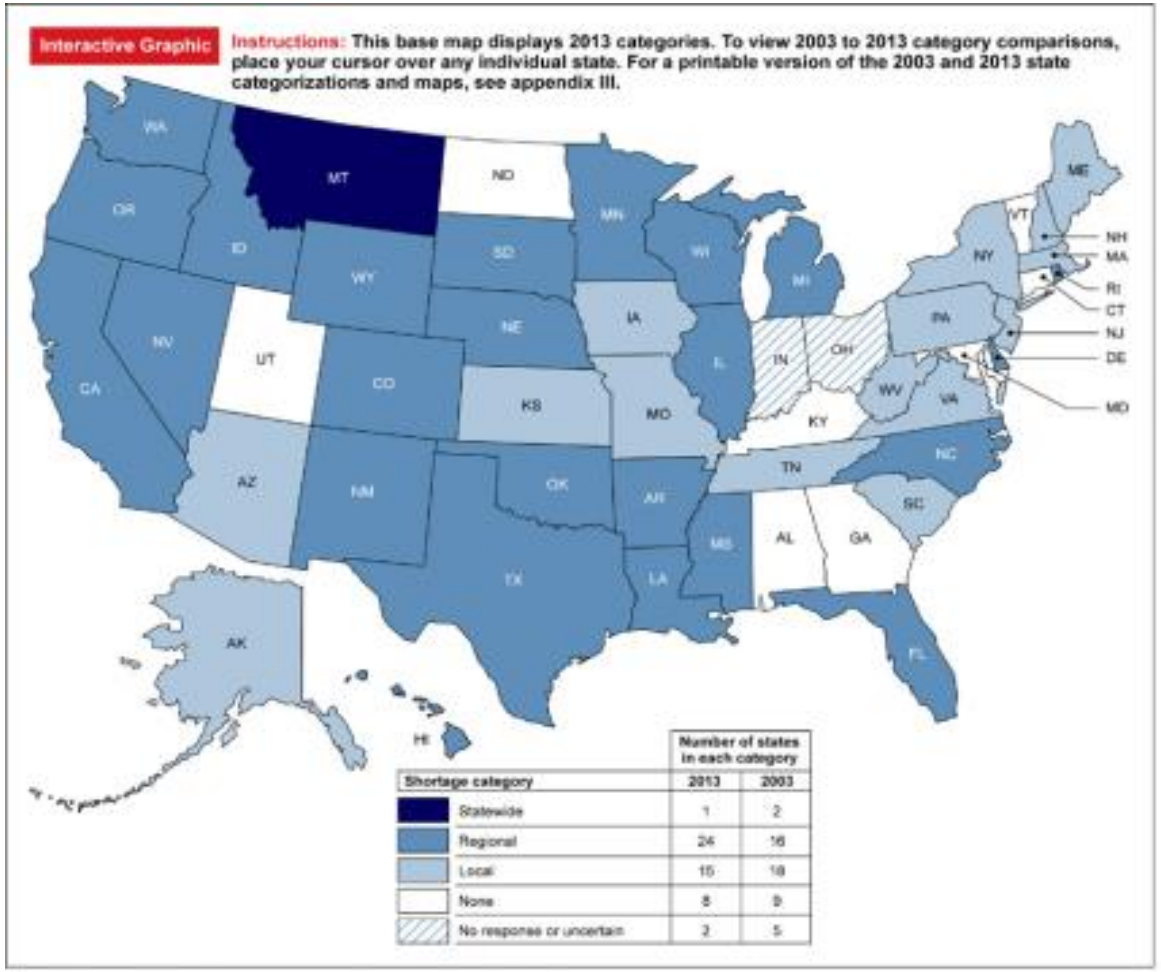
- No new surface water storage capacity since 1980

- All major groundwater aquifers overstressed

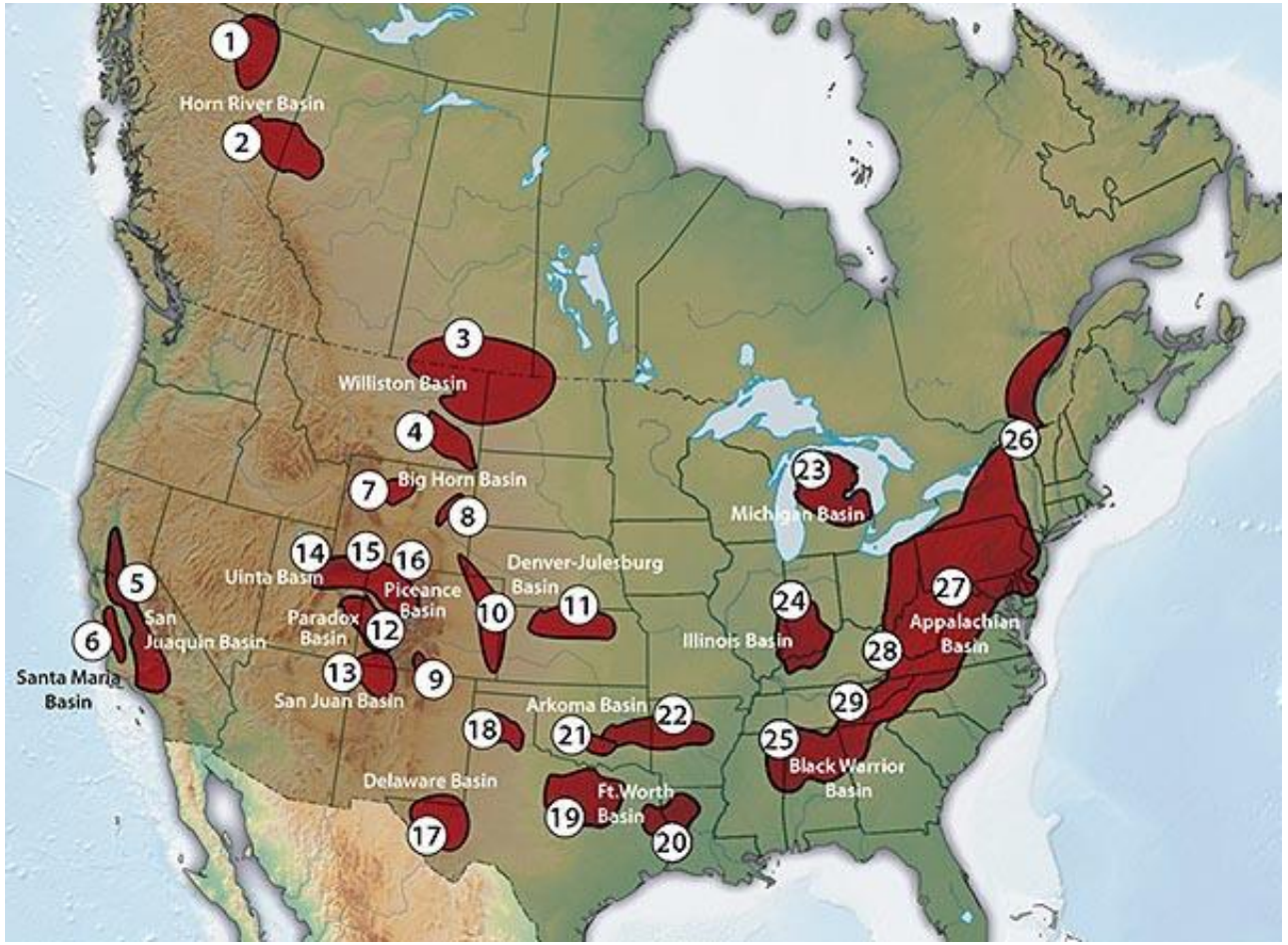


(Shannon 2007)

State Water Stress Driving Produced Water Reuse

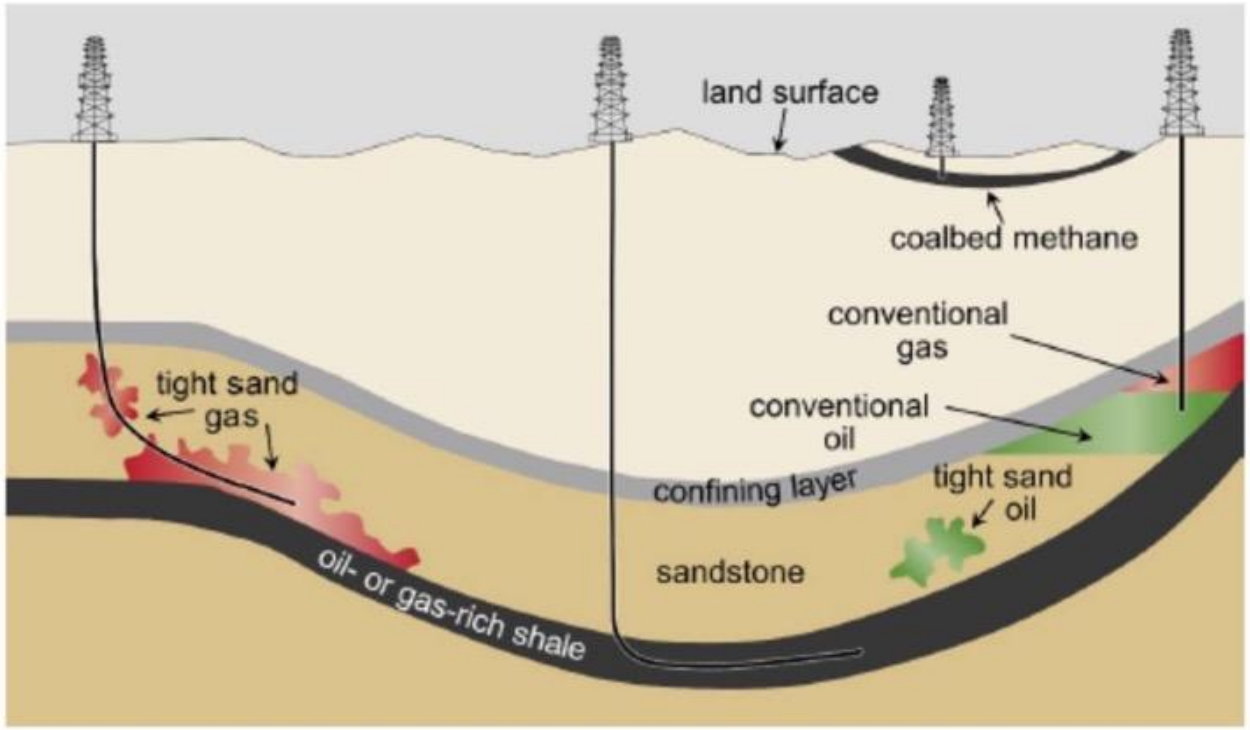


Sources: GAO analysis of state water managers' responses to GAO survey; Map Resources (map).



What is Produced Water?

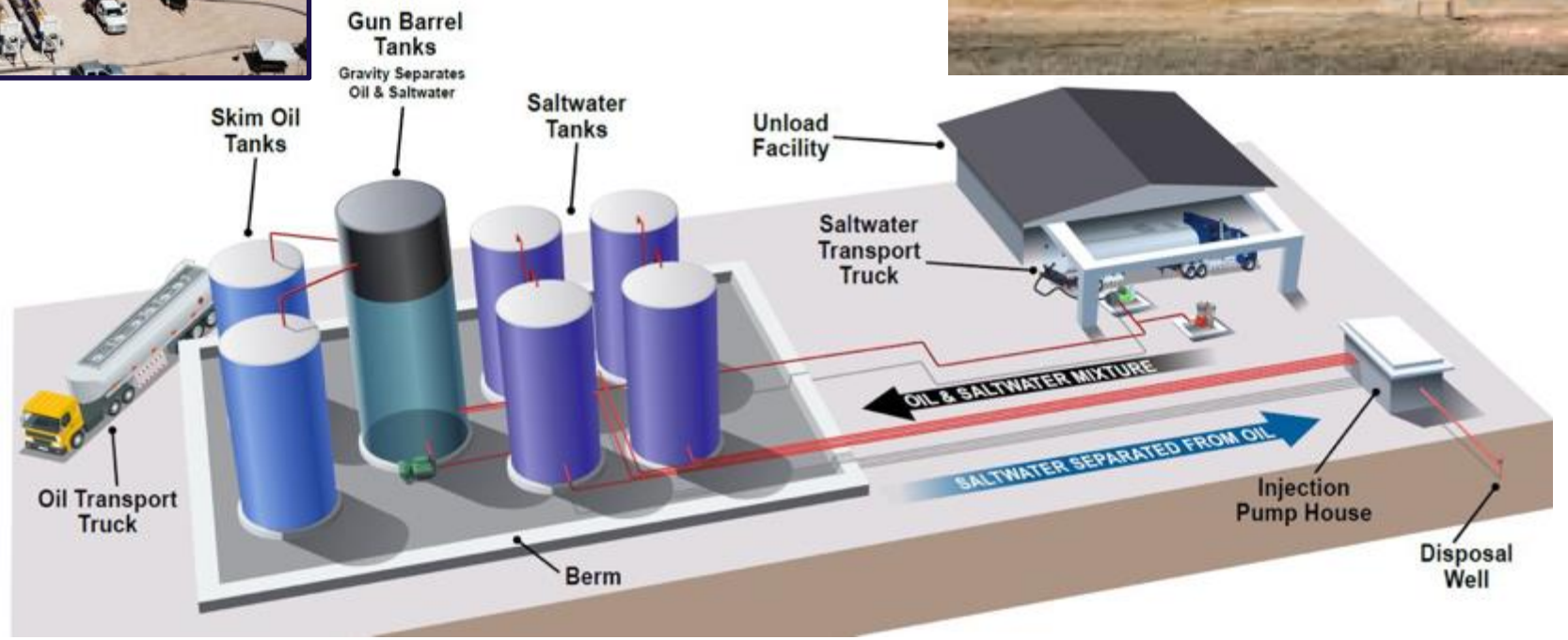
- Produced water is water produced in conjunction with oil and gas operations - drilling, development, pumping, and fracking
- Water can be 4-100 times the volume of oil produced (1 bbl oil = 4-10 bbls of water)
- Produced water can contain high levels of minerals and organic compounds from geology and hydrocarbon contact



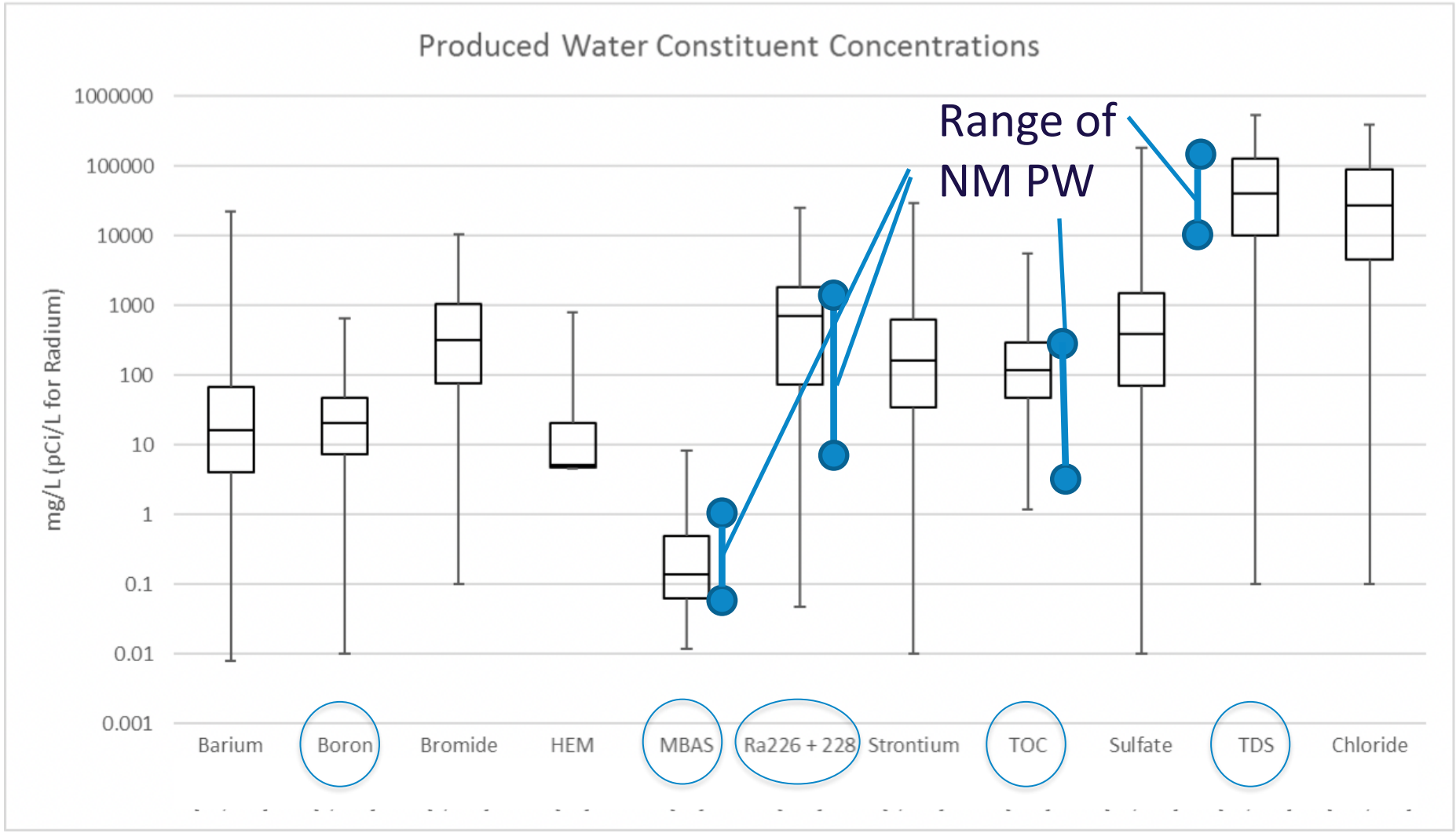
Oil and Gas Production

Oil and gas production is from ancient seas, shallow plays, or adds water

Collection, Separation, and Disposal of Produced Water

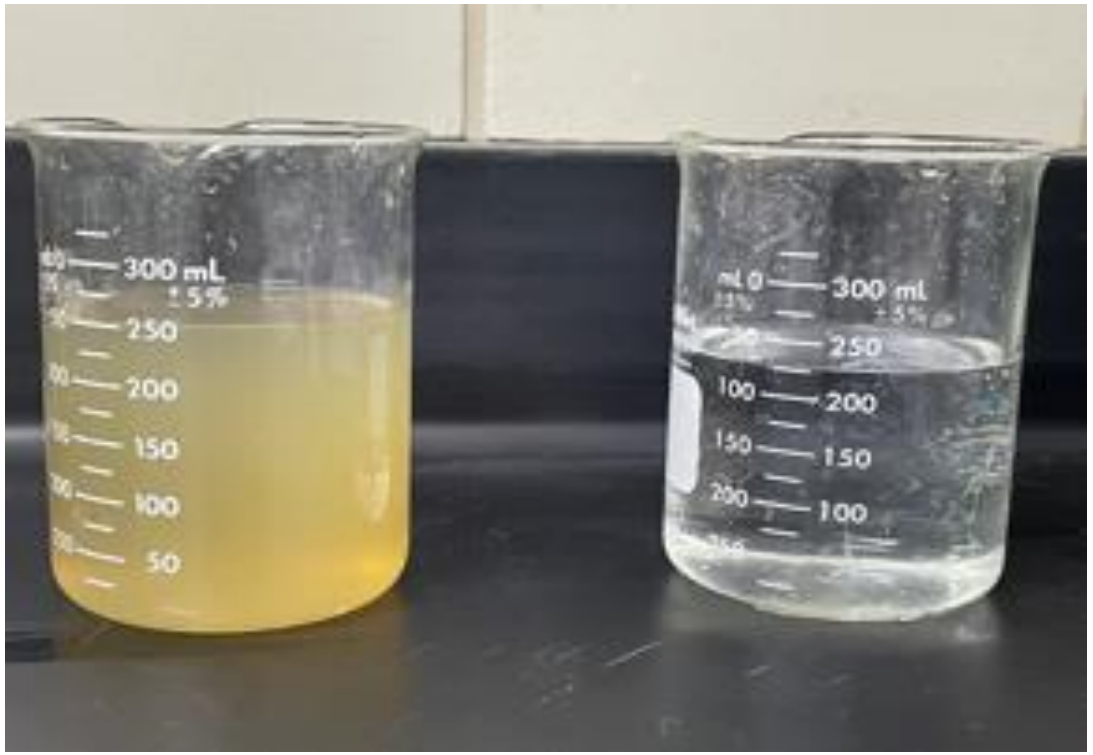


Produced Water Will Require Treatment for Reuse

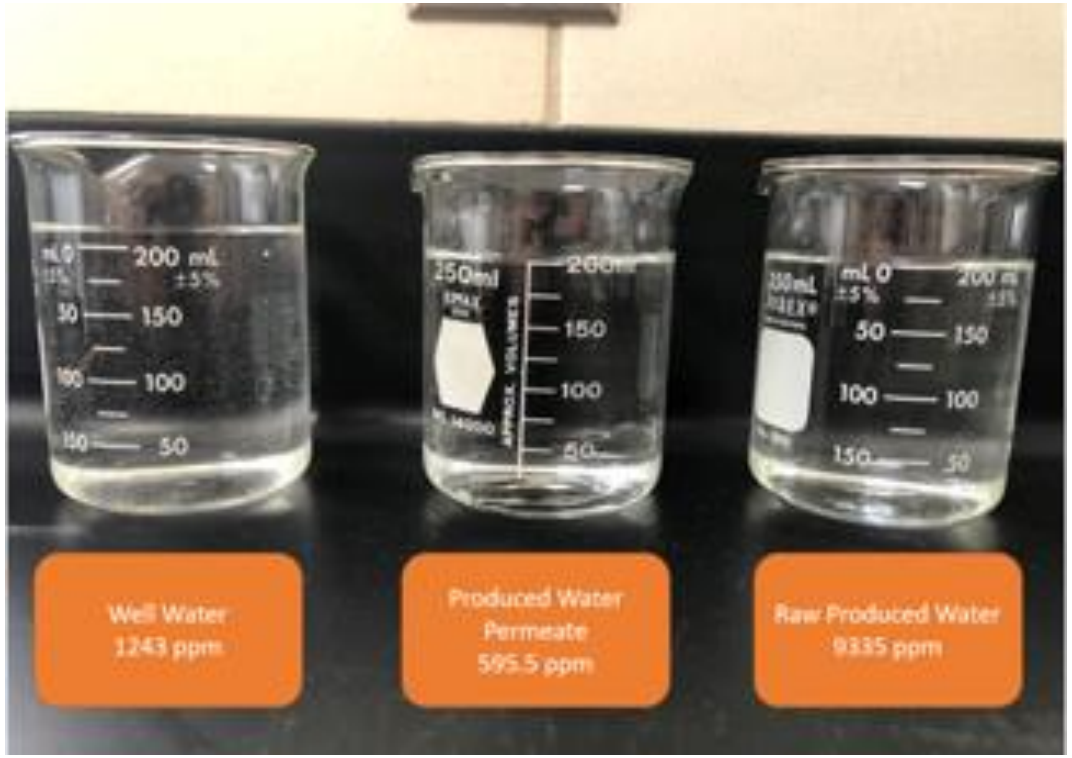


[EPA-821-S19-001]

Examples of Raw and Treated Produced Water



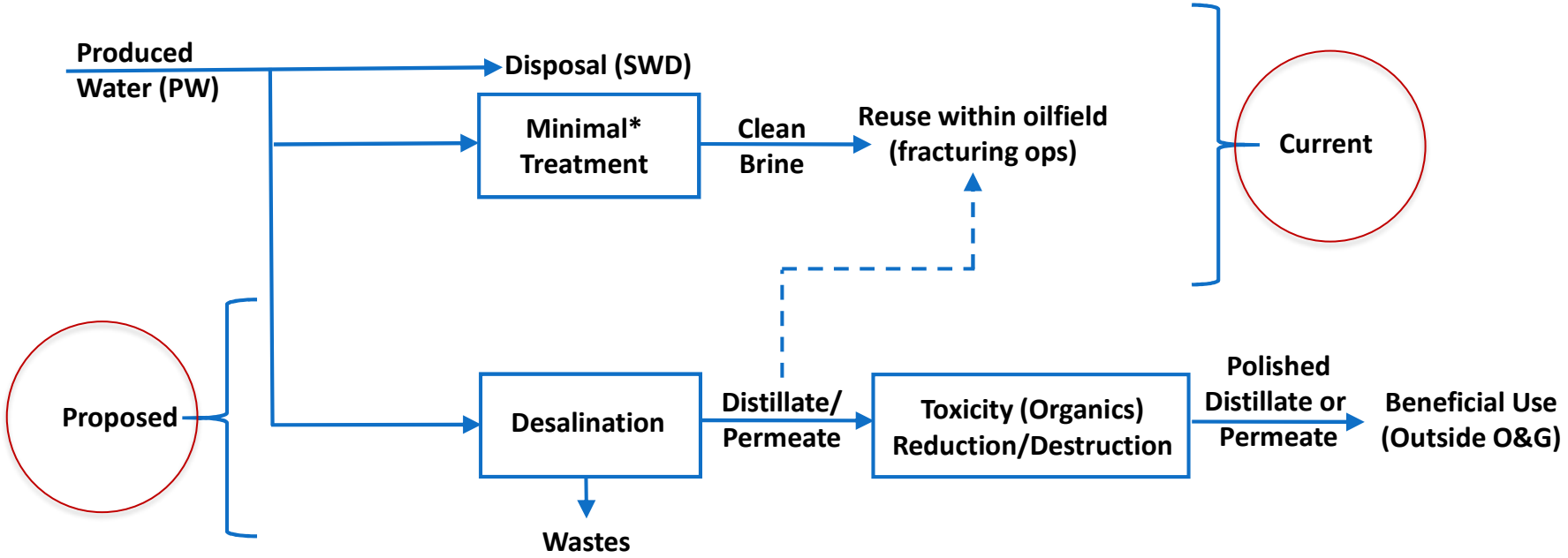
Permian Basin -100,000 TDS (left) w/pre-treatment to remove oil, grease, suspended solids (right)



San Juan Basin -10,000 TDS PW (right) w/RO treatment to remove TDS (middle)

While not universal, treatment and reuse of produced water has occurred for decades in the US

PW Treatment and Fit-for-Purpose Reuse Considerations



Enhance fresh water sustainability

Reduce fresh water use in oil and gas

Support economic development

Reduce seismicity

Assure public and environmental health and safety through state-of-the-science risk and toxicology assessment

Assure social and environmental justice

Treatment Requirements for Fit-for-Purpose Reuse

Produced Water Quality (ppm) TDS	Application	Common Water Quality Requirements (ppm) TDS
Conventional **10K to 50K** **50%<35K** **50%>35K**	Water Supply Augmentation	300-3,000
	Agriculture	Class 1 <700, <60% Na, B<0.5 Class 2 2,000, 60-75% Na, B<2.0 Class 3 >2,000, 75% Na, B~2
	Rangeland restoration	4,000 – 10,000
	Industrial applications	1,000-2,000
Unconventional **60K to 300K** **50%<100K**	Mineral Recovery	>100,000
	Road Construction	Up to 100,000
	Solution Mining (K, Li)	Up to 250,000

NM Produced Water Research Consortium

- MOU between the NMED and NMSU
  - Support NMED and state agencies in assessing produced water reuse
  - Coordinate research and development of fit-for-purpose treatment and reuse of produced water outside oil and gas
- Fill current science and technology gaps
  - **Use collaborative process - government, industry, university, and public**
  - **Assure reuse is protective of public and environmental health and safety**
- Initial 3-yr funding thru sponsorships
- Currently 80 organizations, 120 participants, 150 interested parties

20 state and federal agencies

60 industry, NGOs, associations, academia, consultants

Modeled after federal environmental technology verification programs

NEW MEXICO PRODUCED WATER RESEARCH CONSORTIUM

Our Goal – A National Framework for Produced Water Treatment and Reuse

- **Collaborative process** – inclusive of multi-state health and resource agencies
- **Common produced water data collection and portal** – public and industry access to consistent water quality and quantity data
- **Standard technology testing and evaluation approach -** consistent independent assessment of health, safety, performance, and cost data
- **Standard risk and toxicology testing and analysis** – consistent water analysis, and public and environmental health, safety, and risk analysis to support consistent, science-based, treatment and reuse regulations and policies
- **Standard socio-economic cost/benefit analysis** - quantify ESG metrics to encourage appropriate, sustainable, and safe treatment and reuse applications

Benefits Public, Regulators, Industry, Technology Vendors

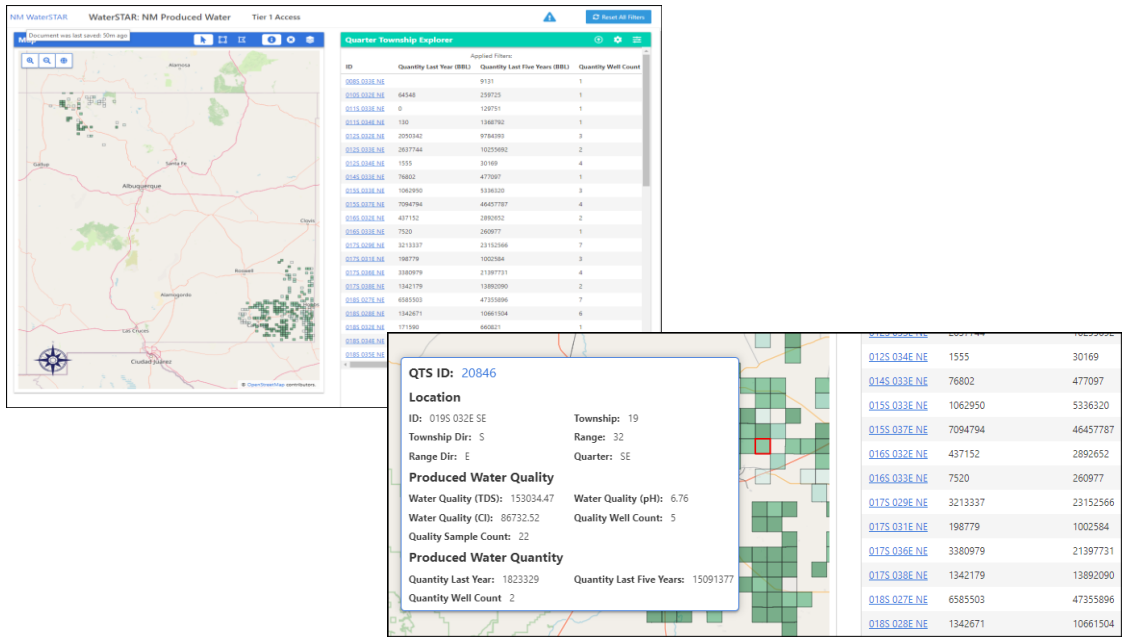
Produced Water Data Portal

New Mexico Produced Water Data Portal

WaterSTAR
An RBDMS Product

GROUNDWATER PROTECTION COUNCIL

NM STATE — NM Produced Water Research Consortium



Disposal Water Quality and Quantity data by ¼ Township.

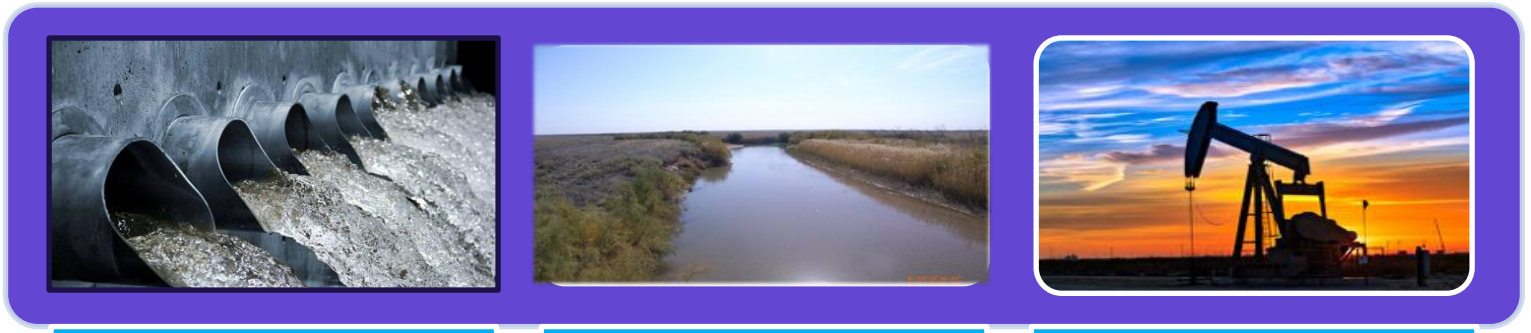
- Data from OCD, USGS, NM Tech, NMSU, NMPWRC
- Dashboard – of monthly injected and quality data

Four levels of data:

- Tier 1 - General Public
- Tier 2 – Detailed Public
- Tier 3 – Application
- Tier 4 – Regulatory (Proprietary Need to Know)

http:/nm.waterstar.org

Waste Water Treatment and Reuse is Challenging



Raw Municipal Waste Water	Raw Pecos River Water	Raw Produced Water
~60 major constituents	~70 major constituents	~90 major constituents

Produced water in most basins has nominally 100 +/- 20 constituents

NMSU found similar results for Permian produced water and Pecos River water based on nine samples each, collected in 2021 and monitored for 300 constituents

Waste Water Quality Analysis and Unknowns

Produced Water Samples		Average	Max	Min
Oil and Others				
Diesel Range Organics (C10-C20)	ug/L	45750	130000	22000
Gasoline Range Organics [C6 - C10]	ug/L	21625	46000	13000
Motor oil/lube range organics (MRO) (C20-C34)	ug/L	32444	97000	12000
Tributyl phosphate	ug/L	34.6	74	3.3
Tentatively Identified Compound	ug/L	531	1000	280

Pecos River water samples		Average	Max	Min
Oil and Others				
Gasoline Range Organics [C6 - C10]	ug/L		54	ND
Motor oil/lube range organics (MRO) (C20-C34)	ug/L	230	310	180
Tributyl phosphate	ug/L	3.6	5.7	1.7
Tentatively Identified Compound	ug/L	-	55	-

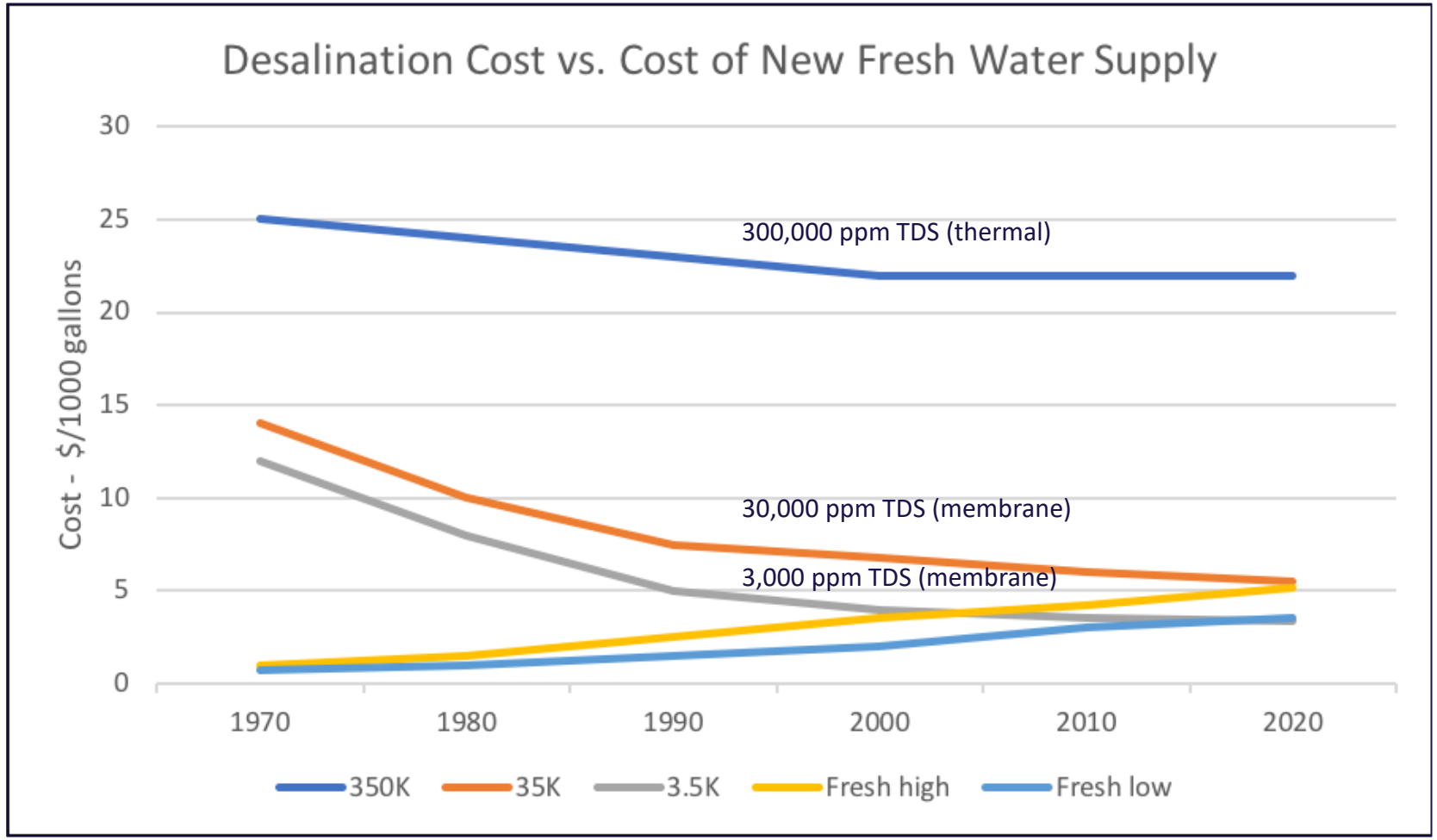
GC-MS TIC analysis is used for unknown identification in raw water

High Resolution Liquid Chromatography Mass Spectroscopy (HRLCMS) is being used to identify/quantify unknowns in treated produced water, by measuring molecular weights and comparing to data on 400,000 chemicals

Major Collaboration with EPA, Academia, and Industry on Treated Produced Water Risk and Toxicology Analysis

- Collaboration with commercial WET testing laboratories, NMSU, and EPA to:
  - Expand WET laboratory testing to more representative human and ecologically sensitive species (zebra fish, fresh water mussels)
  - Support EPA Region 6, 8, and ORD on Region Applied Research Effort (RARE) on human cell line risk analysis of produced water and treated produced water
- Plant and soil bioaccumulation and toxicity green house testing with associated universities
- University and industry collaboration in establishing more detailed Environmental Risk and Toxicity modeling tools
- Utilize treated and post treated produced water

Treatment Testing of Produced Water is Showing Good Economic and Environmental Performance

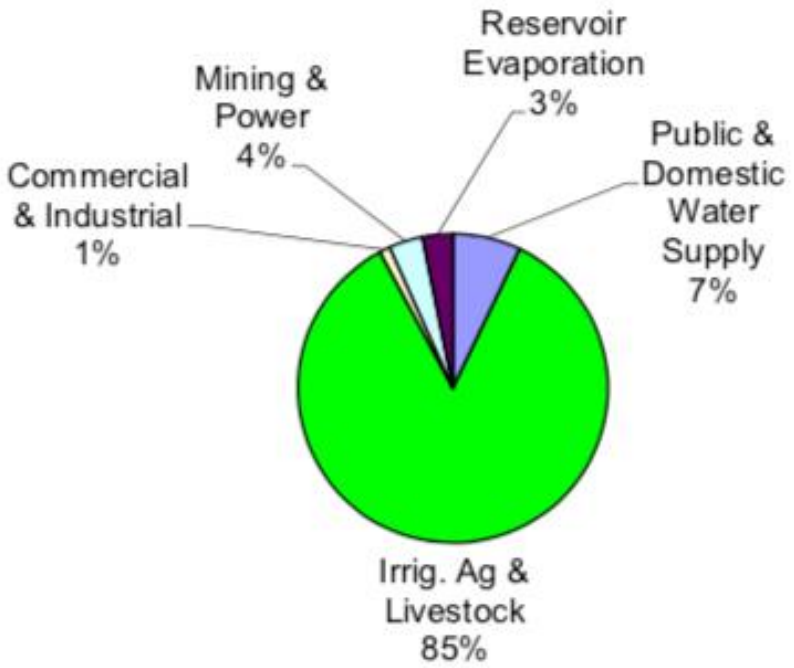


Permian Basin produced water disposal $15-30/1000 gal

Common produced water disposal $25-100/1000 gal

Desalination treatment results generally below 1000 mg/L TDS

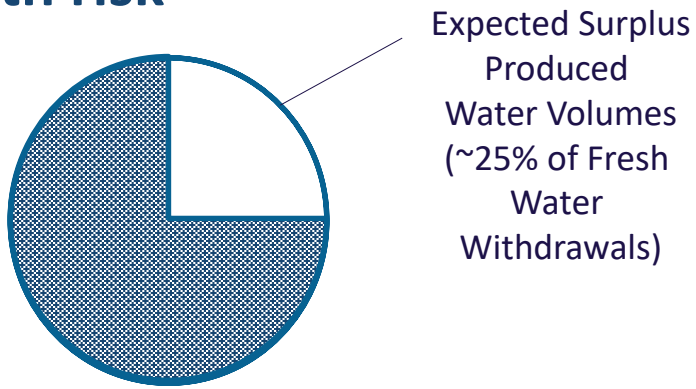
Quantitative Socio-economic Environmental Modeling of Produced Water Reuse



Annual Fresh Water Withdrawal

[Thomson 2020]

Two county impact of $2-3 B/yr in economic development opportunities for small ecologic or human health risk



Surplus expected to be ~1 B bbls/yr (40-80 MGD)

Projected Produced Water Surplus

Thanks – Questions?

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https:/nmpwrc.nmsu.edu