



Trends in Produced Water Treatment and Fit-for-Purpose Reuse

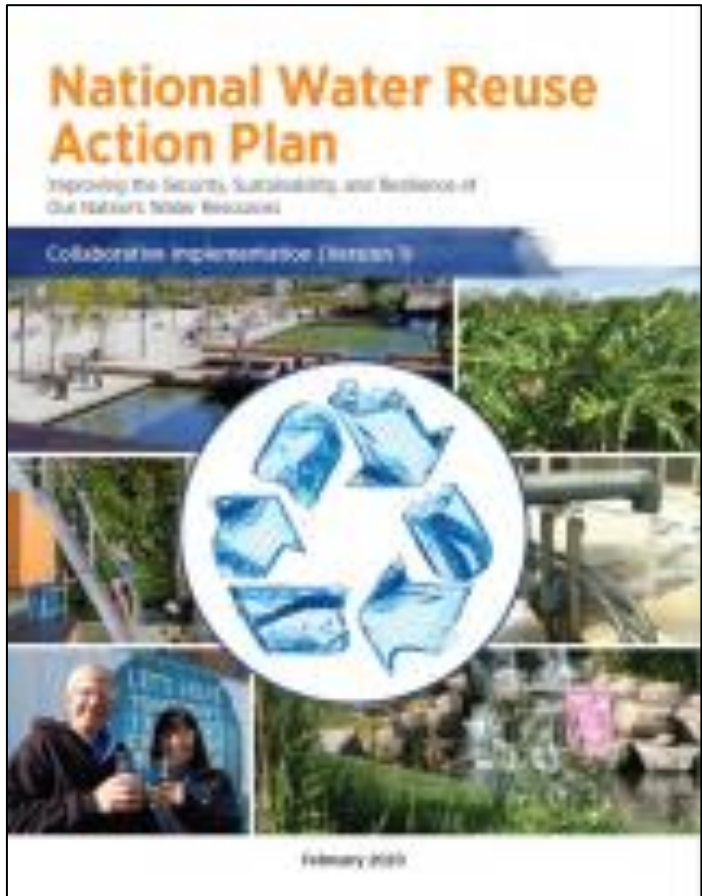
Mike Hightower P.E., Dr. Pei Xu, Deborah Dixon P.E.
New Mexico Produced Water Research Consortium

Groundwater Protection Council
June 23, 2022

Overview and Highlights of Presentation and Discussions

- Overview of EPA National Water Reuse Action Plan and produced water
- Collaborative efforts with other states on produced water R&D
- New Mexico Consortium
 - Emerging Industry Challenges and Directions
 - Trends in produced water reuse

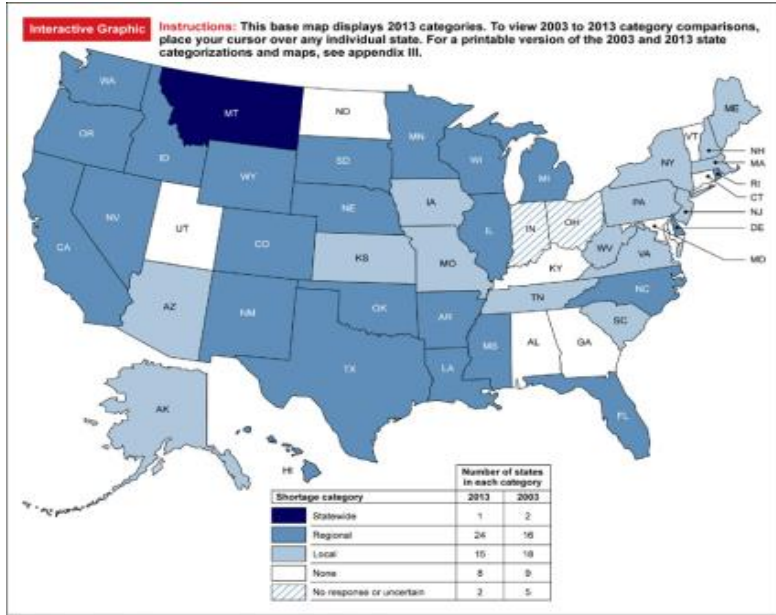
EPA National Water Reuse Action Plan – Feb 2020



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

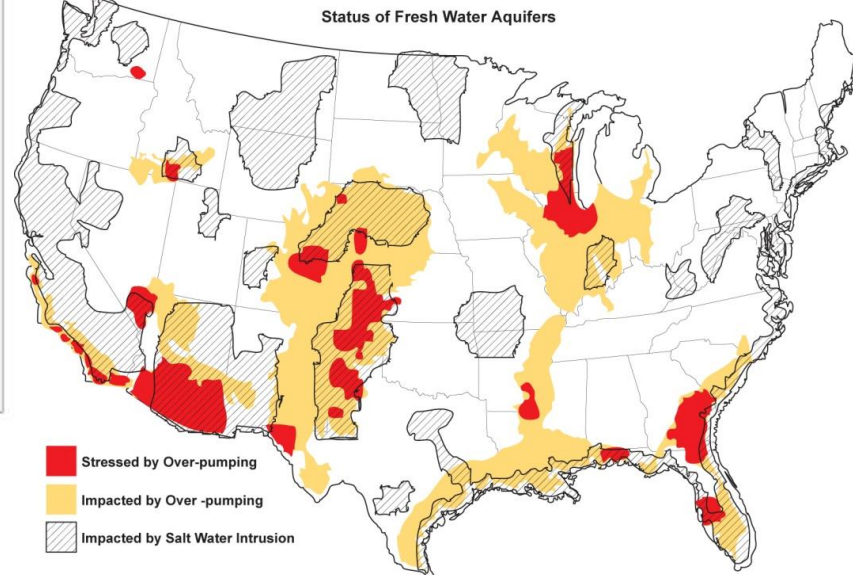
- Focus on fit-for-purpose treatment and reuse of waste water
- In five major areas:
 - Thermo-electric cooling water
 - Agricultural waste water
 - Municipal waste water
 - Produced water
 - Storm water
- EPA has asked NMPWRC to lead research efforts for the treatment and reuse of produced water
- NMPWRC has established a state coordinating council in 2022 to improve interstate collaboration and federal funding opportunities (NM, AZ, TX, WY, OK, CO, KS, PA, CA)

Why is Produced Water Even Being Considered as a New Water Alternative?

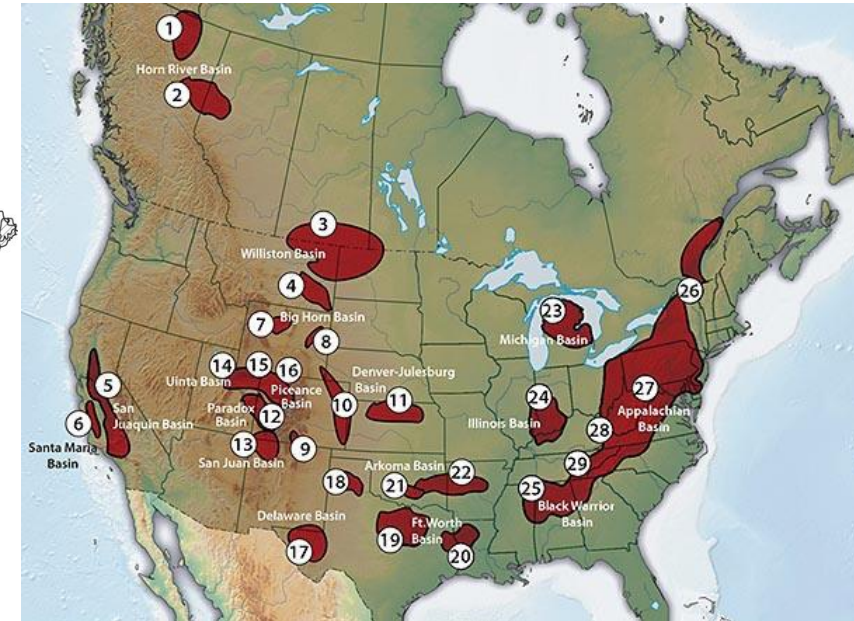


Sources: GAO analysis of state water managers' responses to GAO survey; Map Resources (Inas).

State Water Manager Identified Water Shortages by 2020

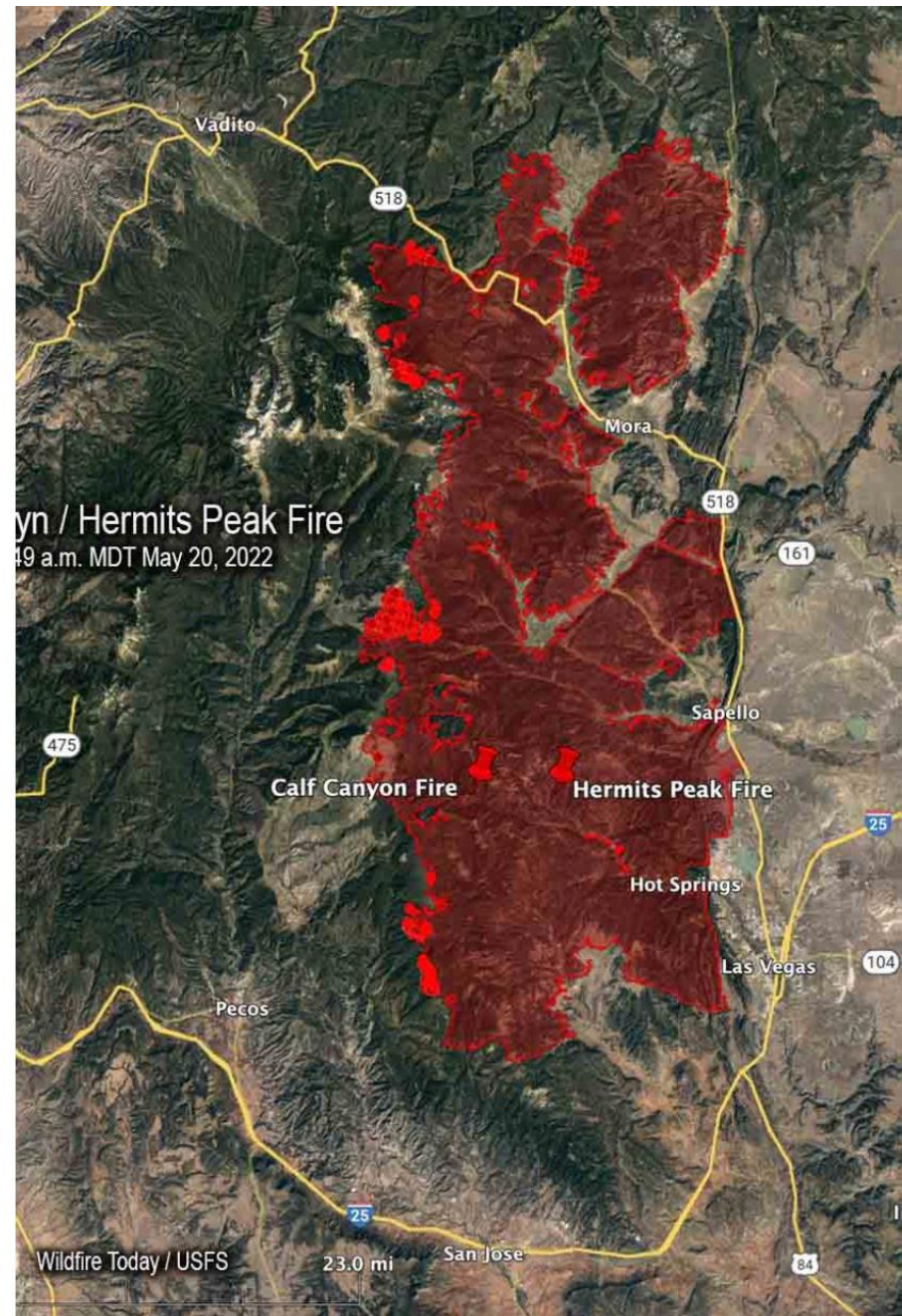
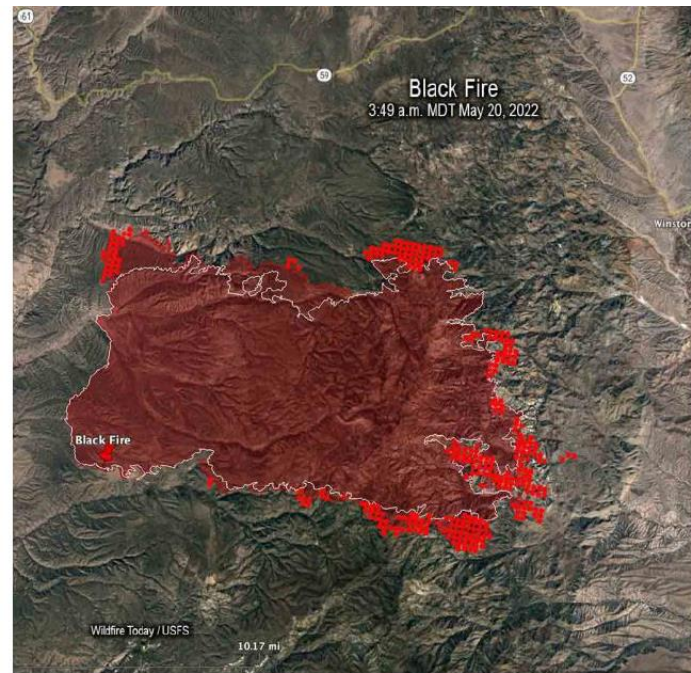


All major groundwater aquifers overstressed



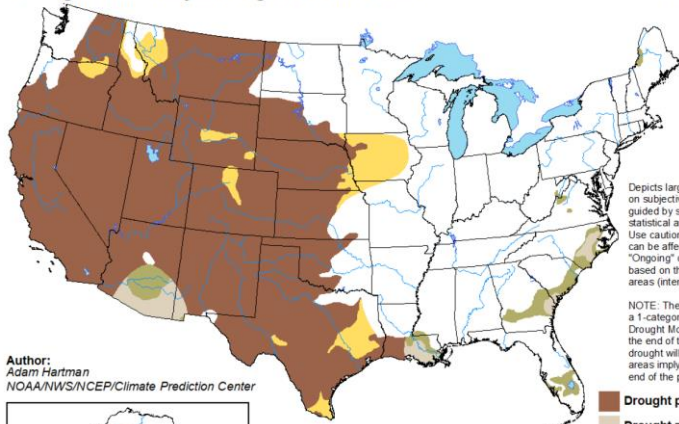
Shale/Produced Water Basins

“SEIZE THE OPPORTUNITIES”



U.S. Seasonal Drought Outlook
Drought Tendency During the Valid Period

Valid for May 19 - August 31, 2022
Released May 19



Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Use caution for applications that can be affected by short lived events. "Ongoing" drought areas are based on the U.S. Drought Monitor areas (intensities of D1 to D4).

NOTE: The tan areas imply at least a 1-category improvement in the Drought Monitor intensity levels by the end of the period, although drought will remain. The green areas imply drought removal by the end of the period (D0 or none).

- Drought persists
- Drought remains but improves
- Drought removal likely
- Drought development likely

Author:
Adam Hartman
NOAA/NWS/NCEP/Climate Prediction Center




<http://go.usa.gov/3eZ73>

“Overcoming fear requires making the unknown known”

Georgia O’Keeffe

“we oppose even entertaining the idea of using this on crops.” “Because it’s chemically altered, we believe it can never be returned to the evolutionary process as water.”

NM Desal, 2018 Produced Water Forum Protestor.

Wash Post Dec 8, 2018

“... we have been using treated waste water for 40 years, we are not afraid of it, what we want to do is protect our fresh water resources...”

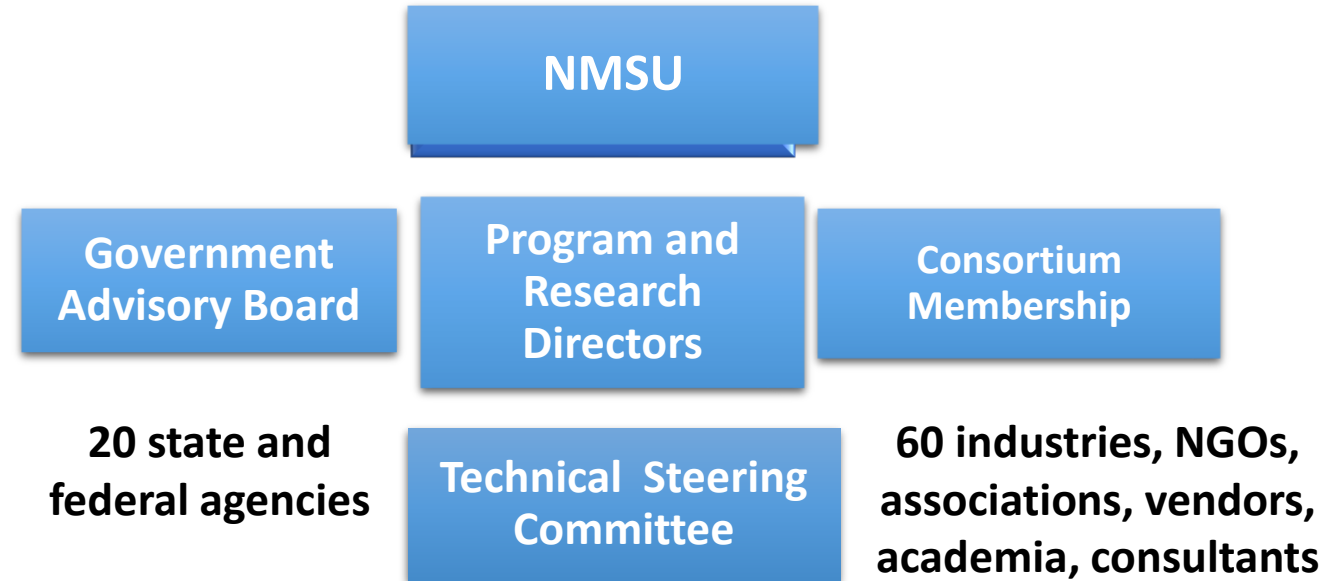
**SE NM Elected Officials Meeting,
July 2021**

“..produced water has unknown poisonous and hazardous proprietary chemicals..”

NM Public Meetings 2019

NM Produced Water Research Consortium Overview

- Formed in 2019 under an MOU between NMED and NMSU to:
 - **Coordinate collaborative research and development of fit-for-purpose treatment and reuse of produced water outside oil and gas**
 - **Fill science and technology gaps inform future rules related to treatment and reuse outside of O&G and to protect human health and the environment**
- Research Plan published January 2022 and available at <https://nmpwrc.nmsu.edu/public-information-2/>

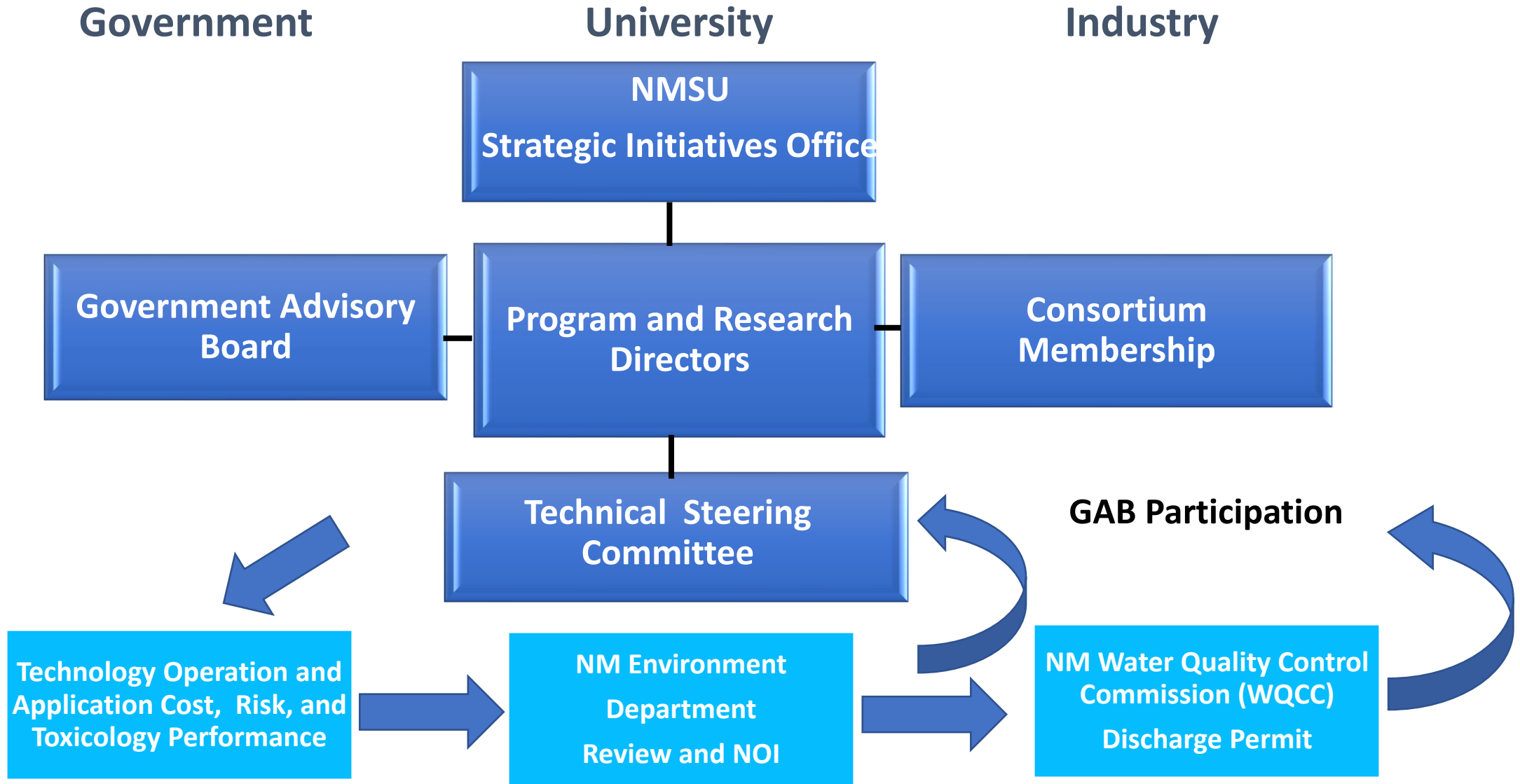


Modeled after DOE and EPA Collaborative Environmental Technology Verification Programs

Builds on Ground Water Protection Council's *Produced Water Report: Regulations, Current Practices, and Research Needs* (June 2019)

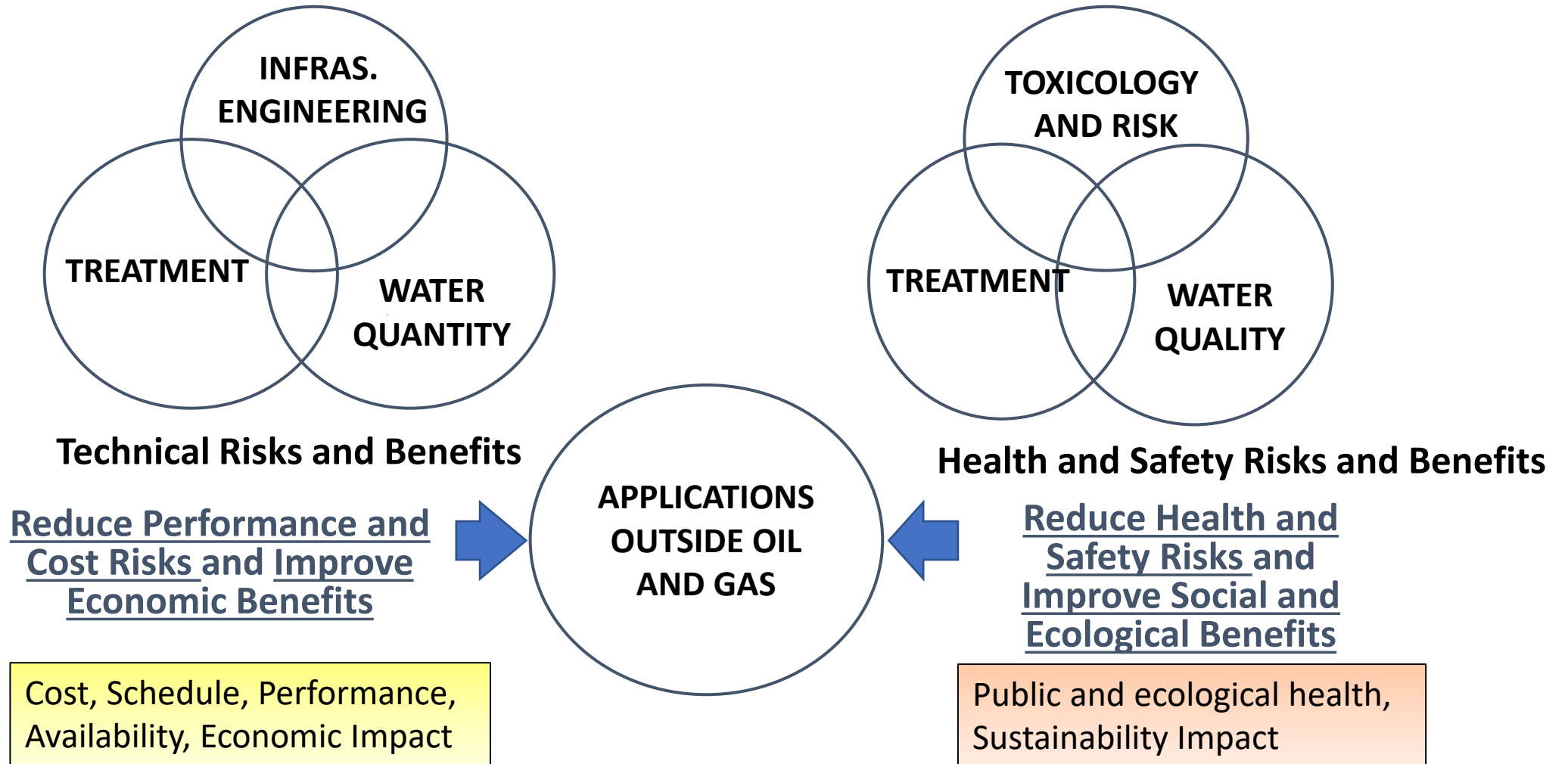
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Consortium Input on Reuse Regulations and Policies

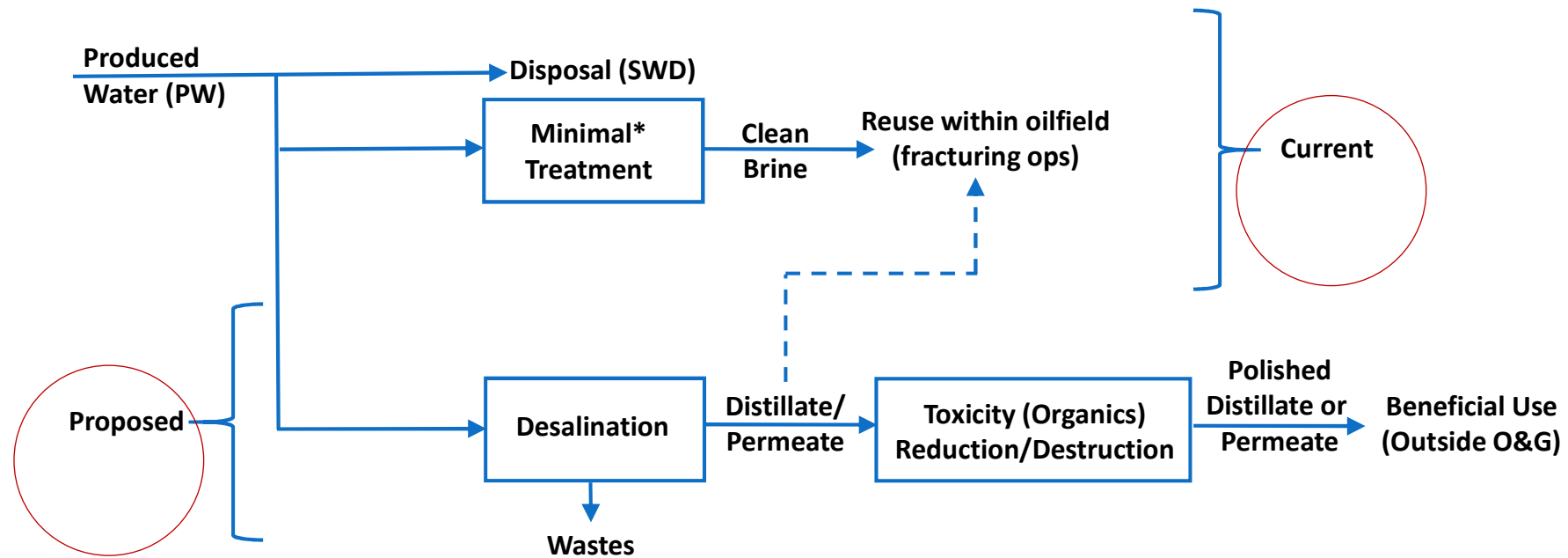


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Consortium Operation - Working Groups and Task Committees



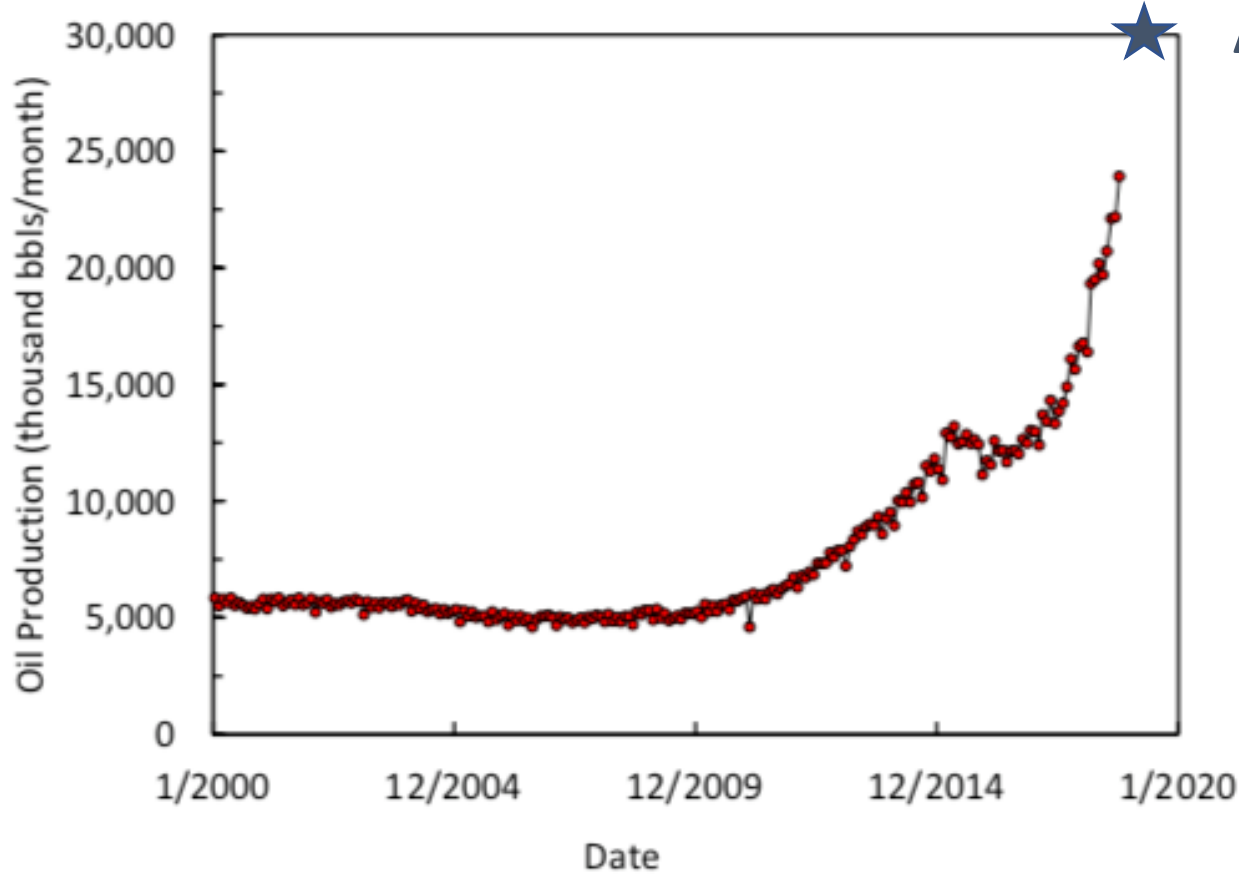
PW Treatment and Fit-for-Purpose Reuse Considerations



- 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

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How Much Produced Water is Available for Reuse in New Mexico?



[Thomson 2020]

Average 4-6 bbls of produced water/ barrel of oil
~4 million bbls produced water/day (3 ABQs)

2021: ~10% of NM PW is used for fracking
NM Fracking – 48% PW, 35% BW, 8% Saline,
10% fresh water

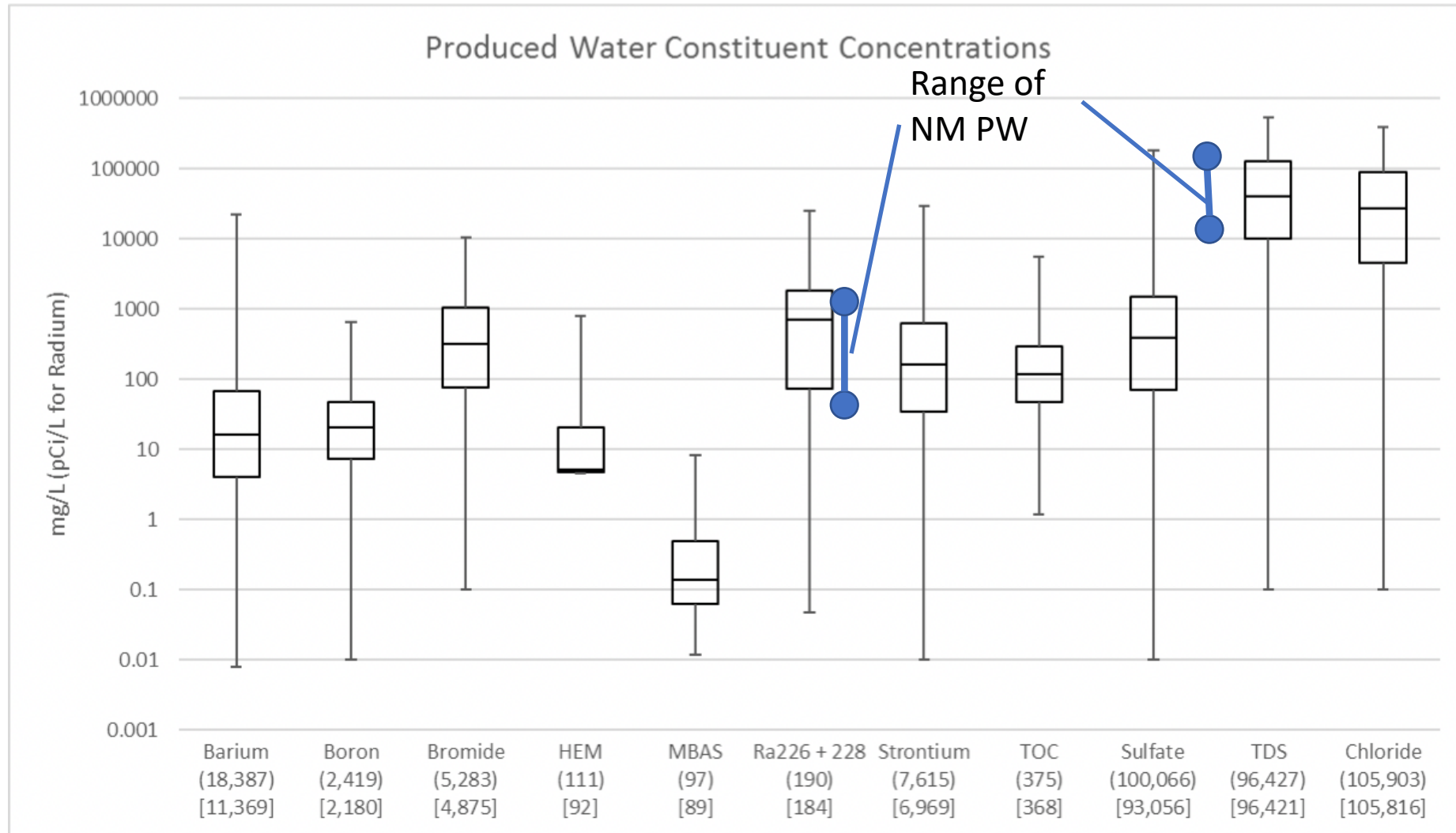
Amount of PW generated far exceeds amount
needed for fracking

Research underway to explore uses outside of
O&G to reduce deep injection disposal

Newer interests – hydrogen development, carbon
sequestration, wildlife habitat, solution mining
with high salinity brine

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Produced Water Must be Treated to Be Reused



Waste Water Treatment and Reuse is Challenging



Produced water in most basins has ~100 +/- 20 constituents
NMSU found similar trend in Permian based on water collected in 2020/2021

NMSU has identified an analytical method that can identify
over 400,000 constituents in treated produced water

NMED has accepted interim analytes to monitor

Collaboration with EPA on Treated Produced Water Risk and Toxicology Testing

- The NMPWRC is collaborating 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 at NMSU and associated universities
- Use of new and more detailed Environmental Risk and Toxicity modeling approaches
- Requires access to both treated produced water quality data and treated produced water



For NMED interim guidance in 2023 on treatment applications

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Fit-for-Purpose Water Quality Requirements for Various Uses

Produced Water Quality (ppm) TDS	Application	Common Water Quality Requirements (ppm) TDS	Typical Treatment Process
Conventional 10K to 50K 50%<35K 50%>35K	Water Supply Augmentation	300-3,000	Chemical/membrane
	Agriculture	Class 1 <700, <60% Na, B<0.5 Class 2 2000, 60-75% Na, B<2.0 Class 3 >2000, 75% Na, B~2	Membrane
	Rangeland	4,000 – 10,000	Membrane
Unconv. 60K to 300K 25%<100K	Rangeland	4,000 – 10,000	Thermal
	Surface Flow	600-2,000	Thermal
	Mineral Recovery	>100K (no discharge)	Pretreatment
	Road Construction	Up to 100,000	Pretreatment

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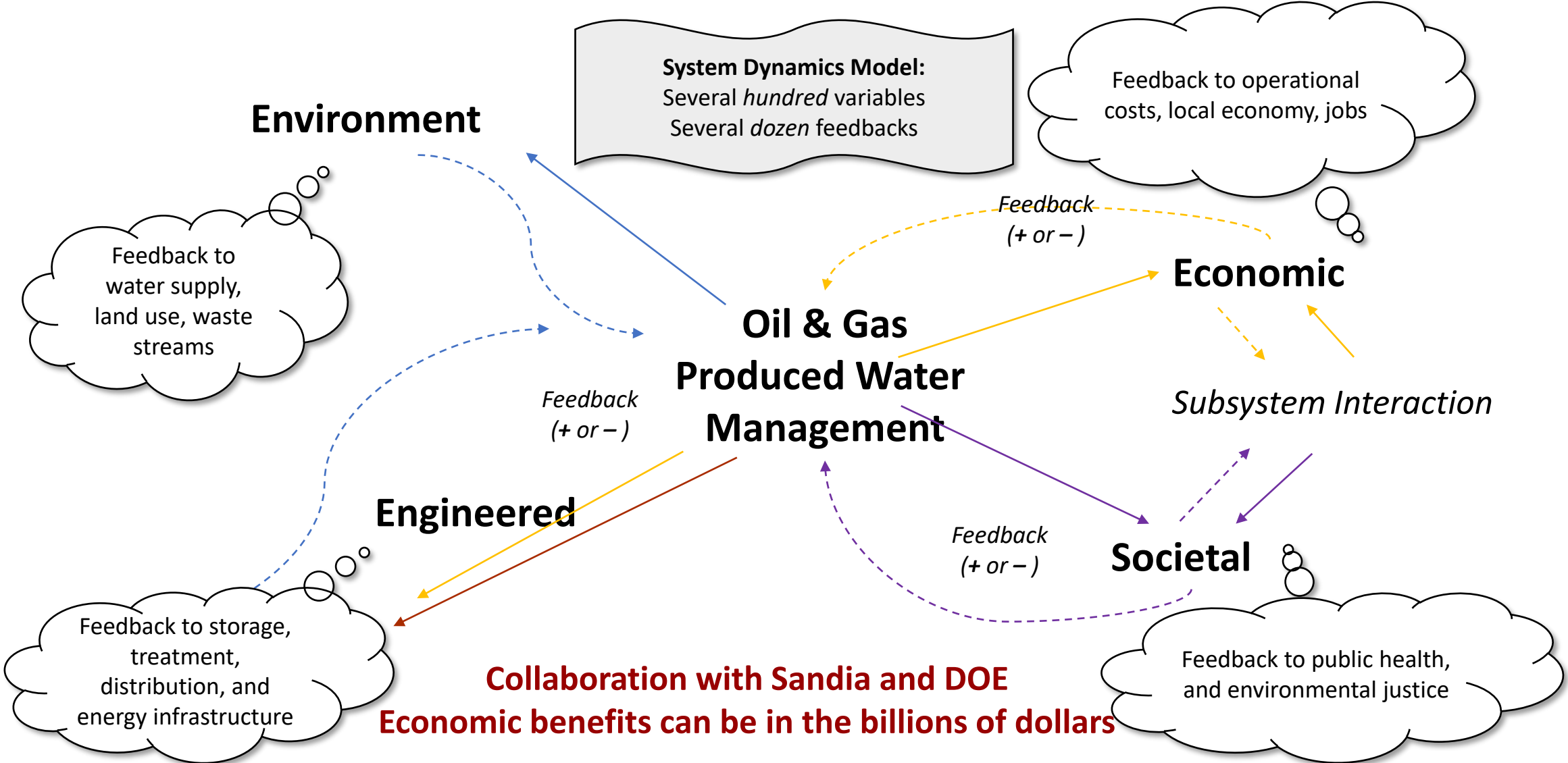
Summary of General Results to Date

- Thermal treatment technologies for Permian Basin
 - Common treatment quality of 300-800 ppm TDS
 - Some carry over of ammonia and organics – suggests post treatment needed
 - Expected full-scale costs of \$0.80-\$1.10/bbl
- Pre-treatment systems
 - Both new membranes systems tested can meet PWS ‘clean brine’ standards at < \$0.20/bbl
- Membrane treatment for San Juan
 - Treatment results obtained for both BWRO and SWRO membranes
 - Data is very encouraging – can get very high quality water
- Green house studies of treated produced water
 - Range grass growth with treated produced water very encouraging



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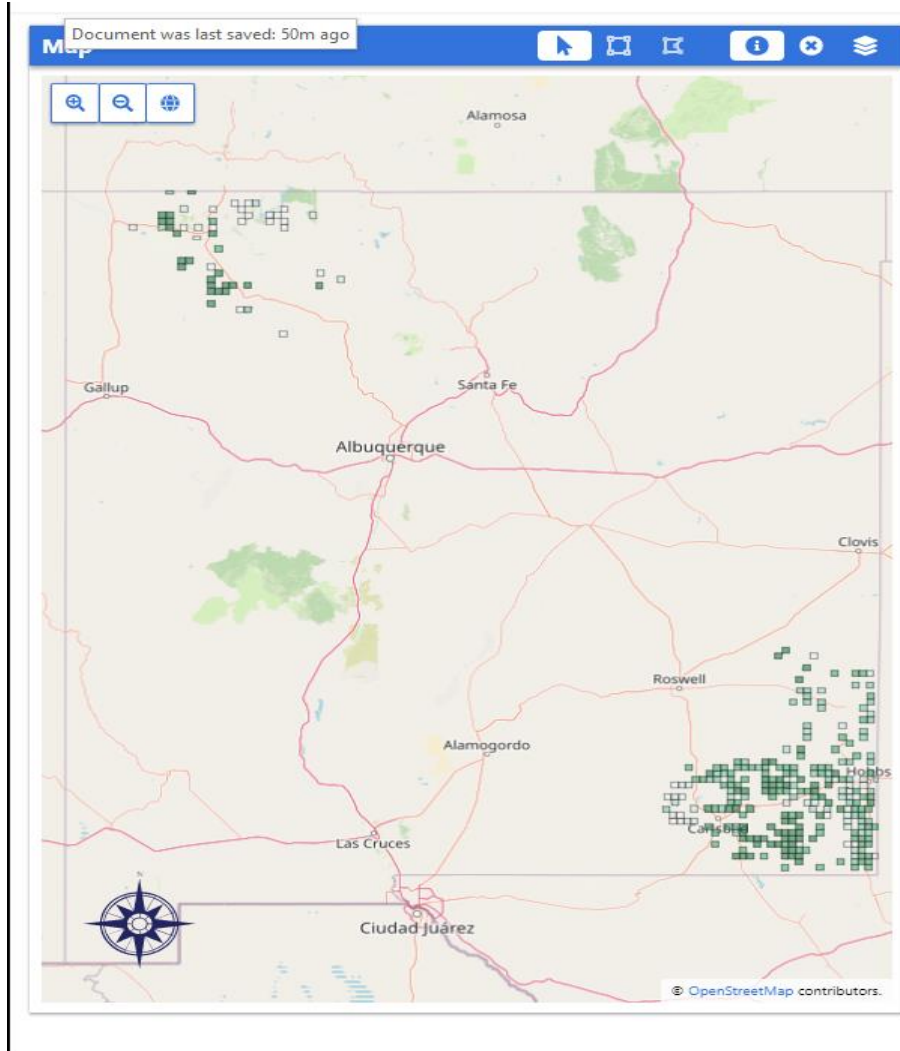
System Dynamics Modeling Approach for Quantitative ESG



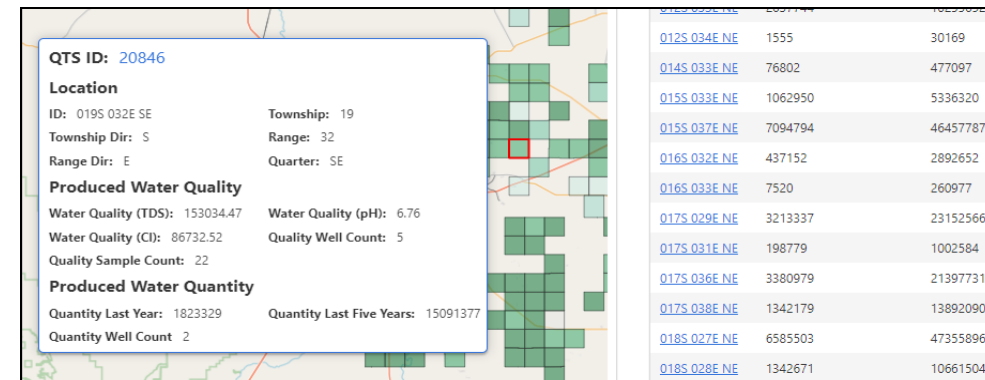
TxPWC looking to use similar model for 2022 Deliverables on CBA



NM Produced Water Data Portal



- Funded by GWPC based on Water Star RBDMS
- Designed as a national framework for produced water portals for EPA WRAP
- Produced water disposal water quality and quantity data by ¼ township.
- Collaboration with OCD, USGS, NM Tech, NMSU



<http://nm.waterstar.org>

Public Education and Outreach Efforts

- Consortium website updated with more functionality and information
- 3 pre-workshops with elected officials on public interests/concerns, appropriate approach, format, etc.
- 5 public education workshops
 - 3 in NM, 2 in TX
 - Brochures, Fact Sheets, FAQs, Posters
 - Breakout sessions presenting information and progress on each 2021 task
- Positive feedback from participants
 - Longer sessions, more detailed information
 - Come back often
 - Provide webinars/podcasts of technical information for more detail
 - Participants included – federal agencies, public, industry, economic development, NGOs, technology vendors, technology users, students



Produced Water Society – Industry Water Management Session in February 2022

- Best use of capital investment is for long/term planning
- Need discipline under higher oil prices
- Focus on increasing reuse
- Biggest hurdles
 - Seismicity
 - Disposal limitations
 - Get reuse infrastructure in place soon
 - Public perception
 - Eliminate use of fresh water so do not have to dispose or later treat

- **For More Information**

- <https://nmpwrc.nmsu.edu>
- <https://www.env.nm.gov/new-mexico-produced-water/>

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