



Research on Treatment of Produced Water for Reuse

LEGISLATIVE FINANCE COMMITTEE

WATER SUBCOMMITTEE

JUNE 11, 2024

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New Mexico Produced Water Research Consortium

<https://nmpwrc.nmsu.edu/>

- In passing the 2019 Produced Water Act (PWA), the New Mexico legislature established a legal and policy framework for reuse of produced water inside and outside of the oil and gas sector.
- The New Mexico Environment Department (NMED) and New Mexico State University (NMSU) created the New Mexico Produced Water Research Consortium (NMPWRC) to enhance freshwater sustainability and support new economic development opportunities in New Mexico, while also protecting the environment and public health.
- The objectives of the Consortium are to:
 - Fill the scientific and technical gaps associated with treatment and reuse of produced water
 - Inform future development of science-based policies and regulations
 - Coordinate a robust education, outreach, research, and development program
- Six Working Groups:
 - Risks and Toxicology; Data Management; Infrastructure; Treatment; Public Education and Outreach; State PW Coordinating Council

Updates

- Status and Progress of Produced Water Research
 - Produced Water Characterization and Toxicity Study
 - Produced Water Treatment for Closed System Fit for Purposes Uses and Resource Recovery
 - Public Education, Outreach, and Survey
- Future Research Plan

Produced Water Characterization and Toxicity Study

- Thorough understanding of raw produced water (PW) and treated PW quality for effective management, treatment, risk assessment, and fit-for-purpose reuse.
 - Developed an NPDES+ analyte list with >400 constituents
 - Used the best available analytical methods for targeted and non-targeted analyses of the constituents in PW and treated PW
 - Conducting chemical analysis of PW samples from the Permian Basin and San Juan Basin, and assessing treatment efficiency
 - Conduct bioassays and greenhouse irrigation experiments to evaluate the application of treated PW on aquatic organisms, human cell line, plants, and soil.
- Collaborate with federal and state agencies, other institutions, and stakeholders

Nontargeted Analysis Summary

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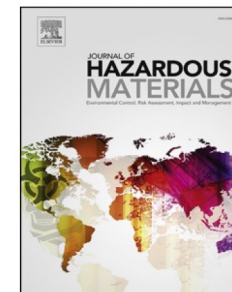


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Non-targeted analysis and toxicity prediction for evaluation of photocatalytic membrane distillation removing organic contaminants from hypersaline oil and gas field-produced water

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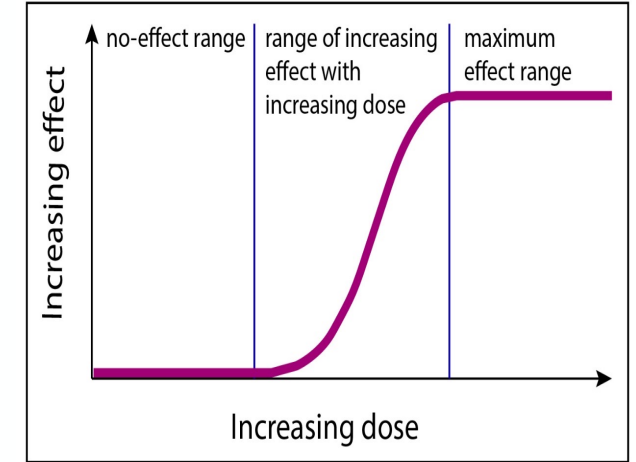
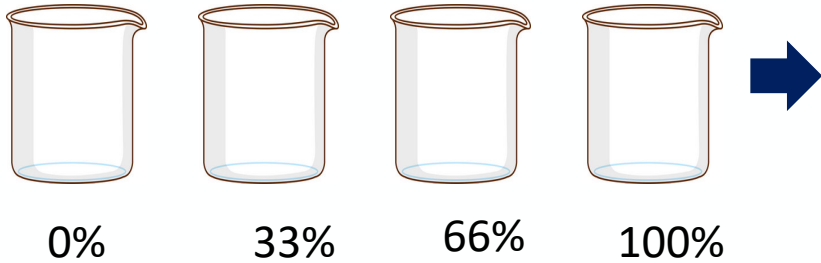
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Whole Effluent Testing (WET) – In Vivo (Environment) & In Vitro (Human Health)

Treated Produced Water Effluent (%)



Name	Description
MCF-7	a human breast cancer cell line with estrogen, progesterone, and glucocorticoid receptors
HEK 293	a specific immortalized cell line derived from an aborted fetus or human embryonic kidney cells
Caco-2	an immortalized cell line of human colorectal adenocarcinoma cells.

Thermal distillation followed by carbon and zeolite adsorption can treat PW to non-toxic level

Treatment of O&G Produced Water Generated in New Mexico for Closed System Fit for Purposes Uses

- Conducted a techno-economic analysis to evaluate the costs, benefits, challenges, and opportunities for the treatment and reuse of PW for industrial and commercial applications outside of O&G fields, such as hydrogen production, solar panel and chip manufacturing, and cooling water.
- The high salinity of the Permian Basin PW required thermal processes to meet water quality targets as well as post-treatment for polishing. The levelized cost of water from a 1 and 5 MGD facility was estimated from \$1.89 to \$2.14/bbl and \$1.12 to \$1.52/bbl, respectively.
- The lower salinities of the San Juan PW allow the use of membranes instead of thermal processes to meet water quality targets, as well as post-treatment and polishing. The levelized cost of water from a 1 and 5 MGD facility ranged from \$1.47 to \$1.59/bbl and \$0.70 to \$0.95/bbl, respectively.

Treatment of O&G Produced Water Generated in New Mexico for Closed System Fit for Purposes Uses

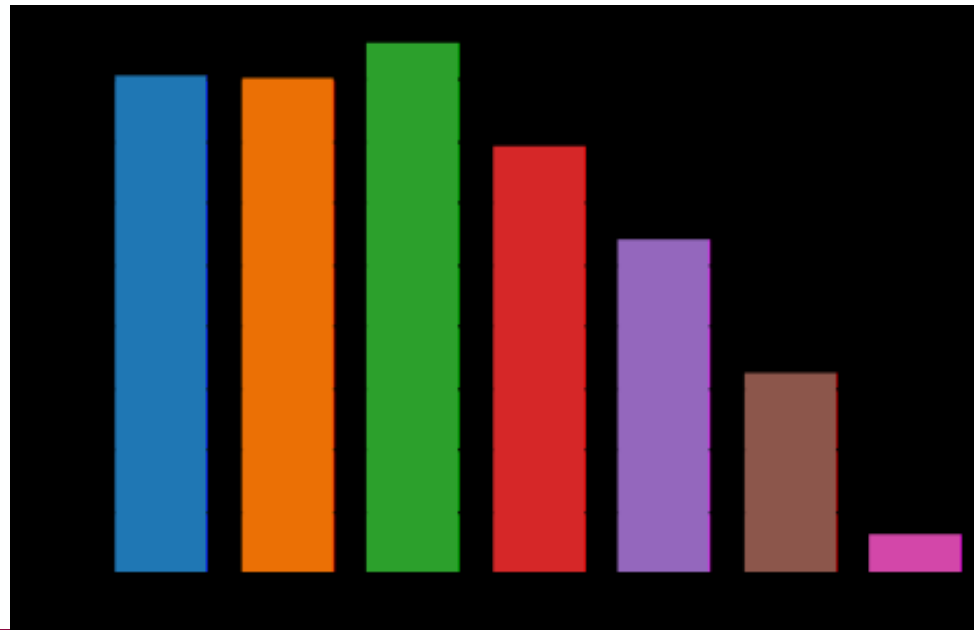
- Emerging technologies such as membrane distillation, forward osmosis, ultra-high pressure reverse osmosis, and membrane brine concentrator, have the potential to significantly lower costs but are still in the pilot testing phase and are not yet ready for full-scale PW treatment.
- The co-location and co-development of brackish water and PW facilities in the Permian, whereby brine from the brackish water facility is used to blend/dilute the produced water to enable membrane treatment, could be a method to reduce the cost of treatment to below \$1.00/bbl, using mature or near-mature technologies, which is a general cost target that would make treatment at parity with disposal.
- Valuable minerals in PW could be recovered such as lithium, ammonia, potassium, magnesium, calcium, sodium, and chloride, to reduce treatment costs.

Public Education, Outreach, and Survey

- >30 peer-reviewed publications
- 6 Podcast series
- Public meetings and presentations
- Organize conference sessions such as at the WaterReuse Annual Conference, Society of Environmental Toxicology and Chemistry Annual Meetings
- 2022-23 Questionnaire Events – 657 Valid Responses
 - 116 - NM State Fair (ABQ) September 16, 2022
 - 35 - DOE/DOI Workshop (Farmington) April 6, 2023
 - 17 - Annual Water Data Workshop (Socorro) May 4, 2023
 - 22 - Eddy County (Artesia) July 26, 2023
 - 104 - Water Dialogue Members (Online) August 29 – Sept. 14, 2023
 - 90 - NM State Fair (ABQ) September 15, 2023
 - 229 - Southern NM State Fair (Las Cruces) September 29-30, 2023
 - 43 - Southeast NM State Fair (Roswell) October 2, 2023

Public Support for Fit-for-Purpose Treatment and Reuse of Produced Water?

Identify all potential reuse applications that you would support for the use of treated produced water to conserve the use of New Mexico's freshwater supplies, if the water is treated and regulated to standards that prove it to be safe to use and protect human health and the environment?



2022 and 2023 Combined NMPWRC Survey Results

- Uses inside the oil field - such as construction, drilling and fracking, concrete mixing, and dust suppression **(61%)**
- Industrial uses outside the oil field - such as construction, power generation, manufacturing, etc. **(61%)**
- Agricultural uses, such as irrigation for non-edible crops (e.g., cotton) **(65%)**
- Multiple agricultural uses, e.g., irrigation, rangeland restoration, livestock watering, etc. **(53%)**
- Supplemental drinking water supplies **(41%)**
- I need more information to support the reuse of treated produced water **(25%)**
- No, I would not support the reuse of treated produced water for any use outside of the oil field **(5%)**

Future Research Plan

- Conduct pilot demonstration projects for treating produced water using integrated treatment trains (pretreatment, treatment/desalination, post-treatment, resource recovery)
- Collect water, plants, and soil samples for targeted and non-targeted chemical analysis
- Conduct Whole Effluent Testing (WET) – In Vivo (Environment) & In Vitro (Human Health)
- Develop a fate and transport model of contaminants in soil and groundwater
- Develop Human Health & Environmental Risk Assessment Framework to assess, minimize, and manage the risks during fit-for-purpose reuse

Future Research Plan (cont.)

- Peer-reviewed publications on targeted and non-targeted analysis, toxicity studies, treatment technologies
- Stakeholder Engagement & Practical Guidance for Implementation
 - Disseminating new knowledge via public meetings, workshops, demonstrations, video, podcasts, and publications
 - Communicating science and knowledge to regulatory agencies
 - Improving framework and research based on stakeholders' opinion and acceptance
- Workforce development – next generation of engineers

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