Update on New Mexico Produced Water Research Consortium: Risk & Toxicity

Presented by:
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New Mexico Produced Water Research Consortium

August 13th, 2025

Disclaimer

The New Mexico Produced Water Research Consortium at New Mexico State University is conducting independent, science-based research to evaluate potential environmental and health effects related to the reuse of treated produced water for fit-for-purpose applications. This work is designed to generate objective data under controlled conditions, without promoting or opposing any specific reuse practices. Our goal is to provide clear, reliable information that supports informed decision-making around the safe and responsible use of produced water in New Mexico and beyond.

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Preliminary Data Not for Distribution

Progress in R&T Space

Journal of Water Process Engineering
Volume 67, November 2024, 106146

Treatment of produced water from the Permian Basin: Chemical and toxicological characterization of the effluent from a pilot-scale low-temperature distillation system

Yeinner Tarazona [a], Mike Hightower [b], Pei Xu [a], Yanyan Zhang [a]

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- Evaluated toxicity of model organisms across 4 trophic levels (algae, bacteria, invertebrates, fish embryos).
- System removed >99% salts, 60–100% metals, ~93% ammonia and, 43–60% organics.
- Distillate still toxic and led to failed WET tests.

Go to Journal of Hazardous Materials on ScienceDirect

Journal of Hazardous Materials
Volume 478, 5 October 2024, 135549

Benchmarking produced water treatment strategies for non-toxic effluents: Integrating thermal distillation with granular activated carbon and zeolite post-treatment

Yeinner Tarazona [a], Haoyu B. Wang [b], Mike Hightower [c], Pei Xu [a], Yanyan Zhang [a]

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- Same experimental set up but added post-treatment as GAC + zeolite.
- Re-evaluated toxicity of the same model organisms across 4 trophic levels (algae, bacteria, invertebrates, fish embryos).
- Polished distillate was toxic across the board and led to passing WET tests.

Ecotoxicology and Environmental Safety
Volume 302, 1 September 2025, 118726

Comprehensive cytotoxicity assessment of treated produced water from thermal distillation using human cell lines

Senuri Wijekoon [a], Yeinner Tarazona [a], Mike Hightower [b], Huiyao Wang [a], Pei Xu [a], Yanyan Zhang [a]

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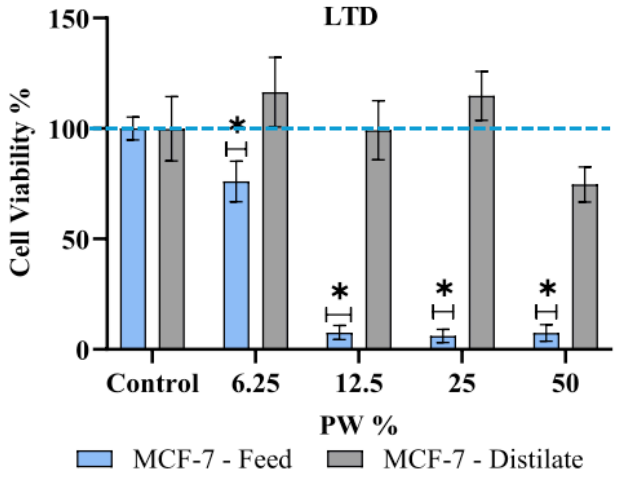
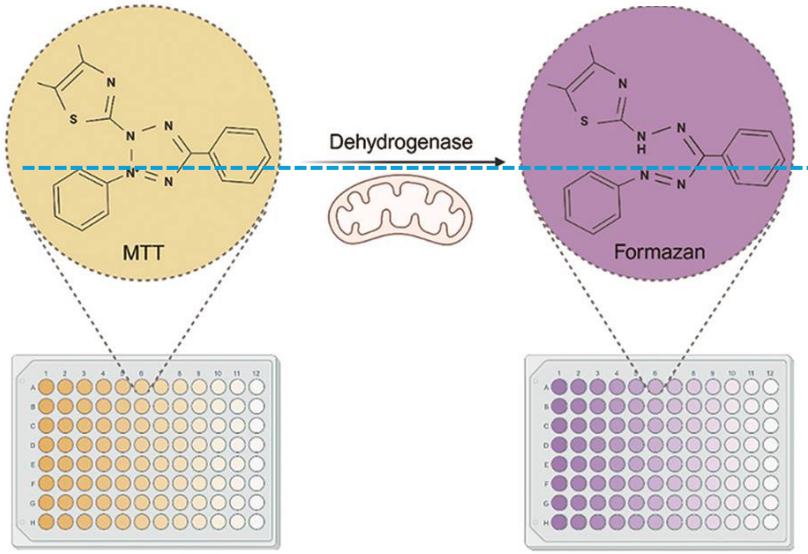
- Does polished PW have an impact on the genetic level?
- Evaluated same LTD water + MVR
  - clean brine,
  - distillate, and
  - polished PW
- 3 human cell lines
- Looked at 6 biomarkers/genes
- Results showed…

Cell Viability Assays (Mitochondrial Activity)





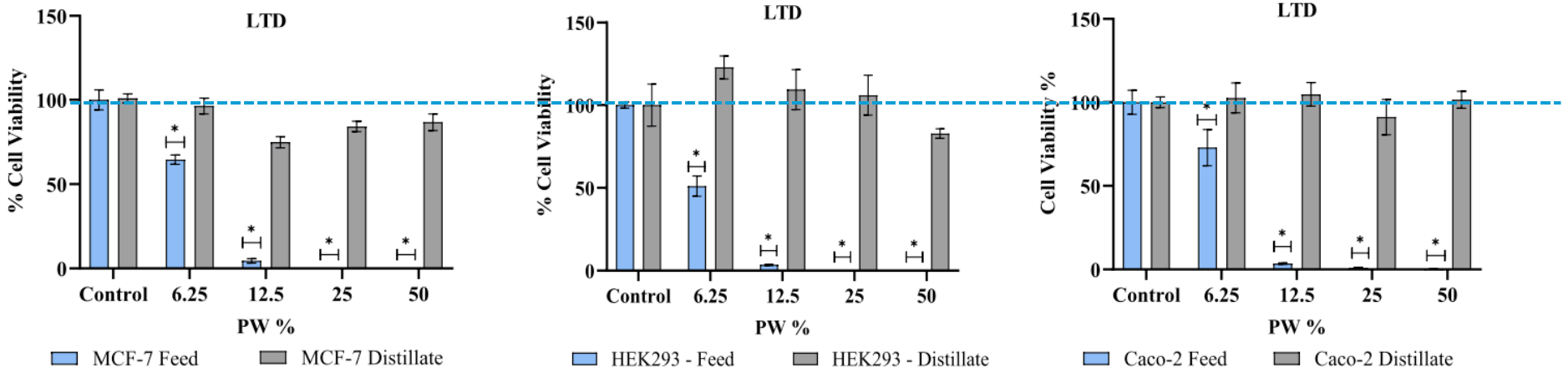
Spectraph.

Higher # = higher cell viability

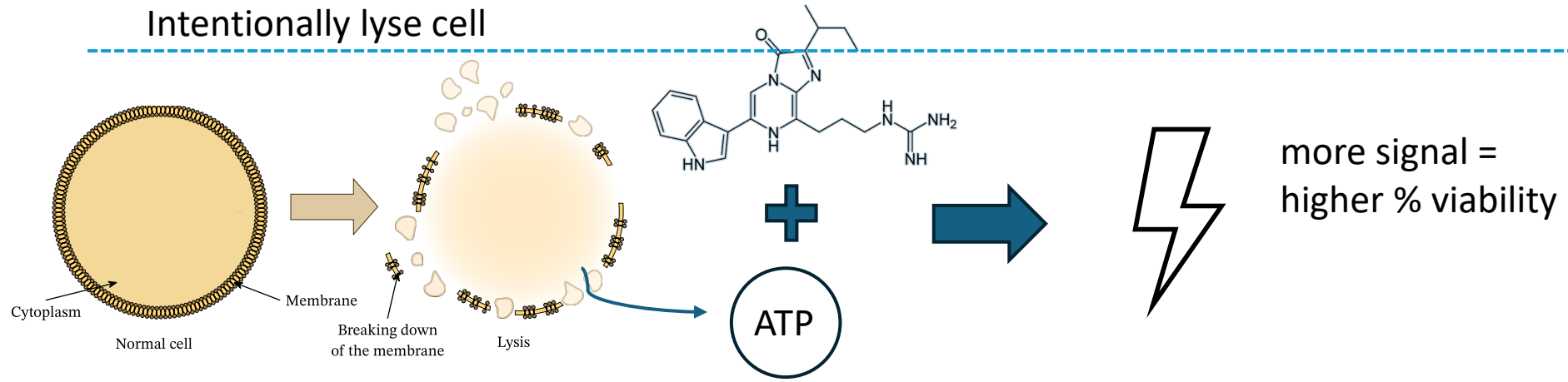
(A higher signal means more purple dye was created, have more active mtDH and therefore, more viable cells.)

https://ojs.sciltp.com/journals/ijddp/article/view/465

Cell Viability Assays (ATP-Luciferace Activity)



Intentionally lyse cell

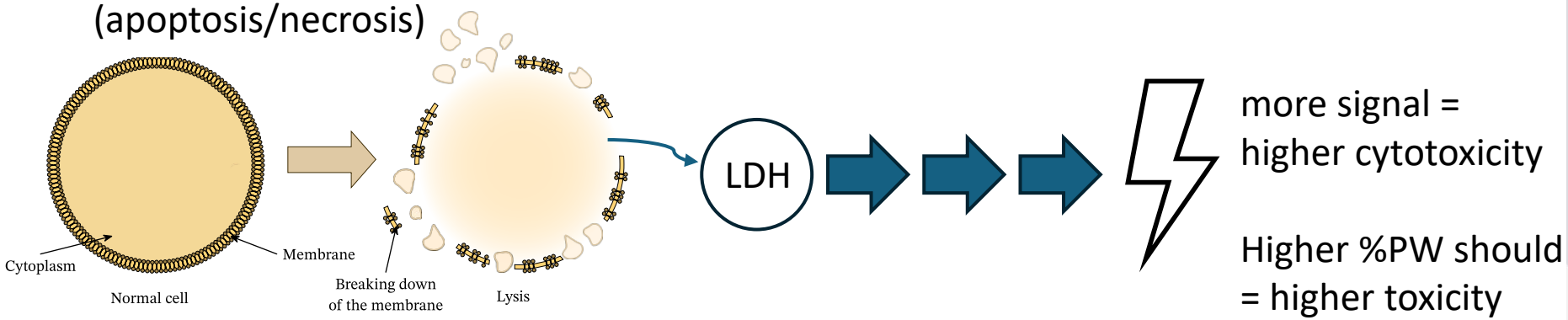


more signal =
higher % viability

https://www.nagwa.com/en/explainers/947125128689/

Cytotoxicity Assay (Lactate Dehydrogenase)

Cell lysis when dying
(apoptosis/necrosis)



more signal =
higher cytotoxicity

Higher %PW should
= higher toxicity

https://www.nagwa.com/en/explainers/947125128689/

Nitrite Assay (Oxidative Stress)

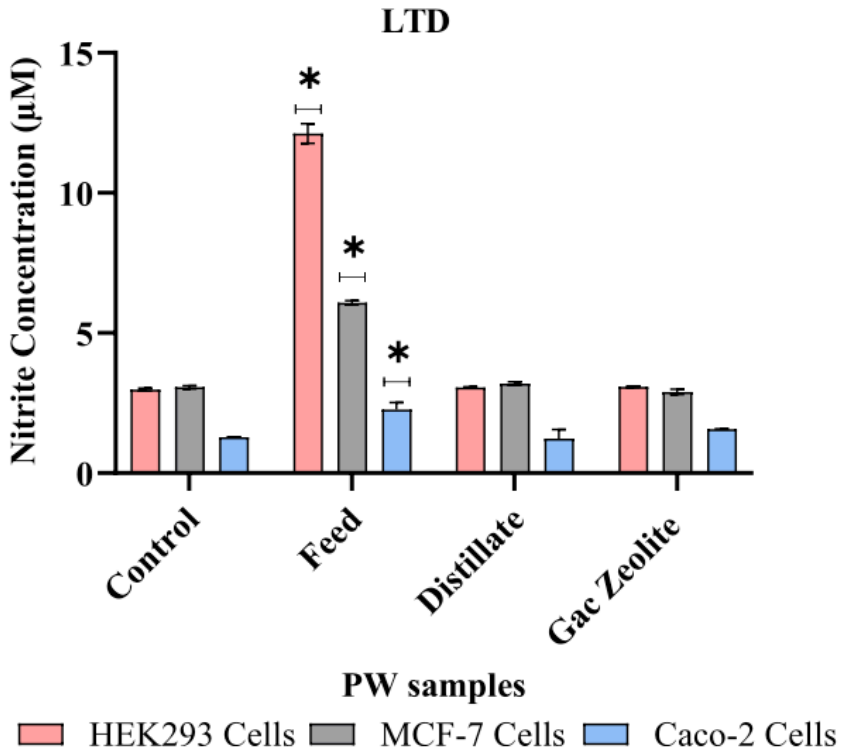


Fig. 4. Nitrite concentration was evaluated after exposure to 50 % feed, distillate, and distillate with GAC, followed by zeolite post-treatment PW. The * represents the statistical difference (P-value < 0.05) in contrast to the control.

Higher nitrite concentration = higher stress

AhR Gene Expression (Impact of PAH)

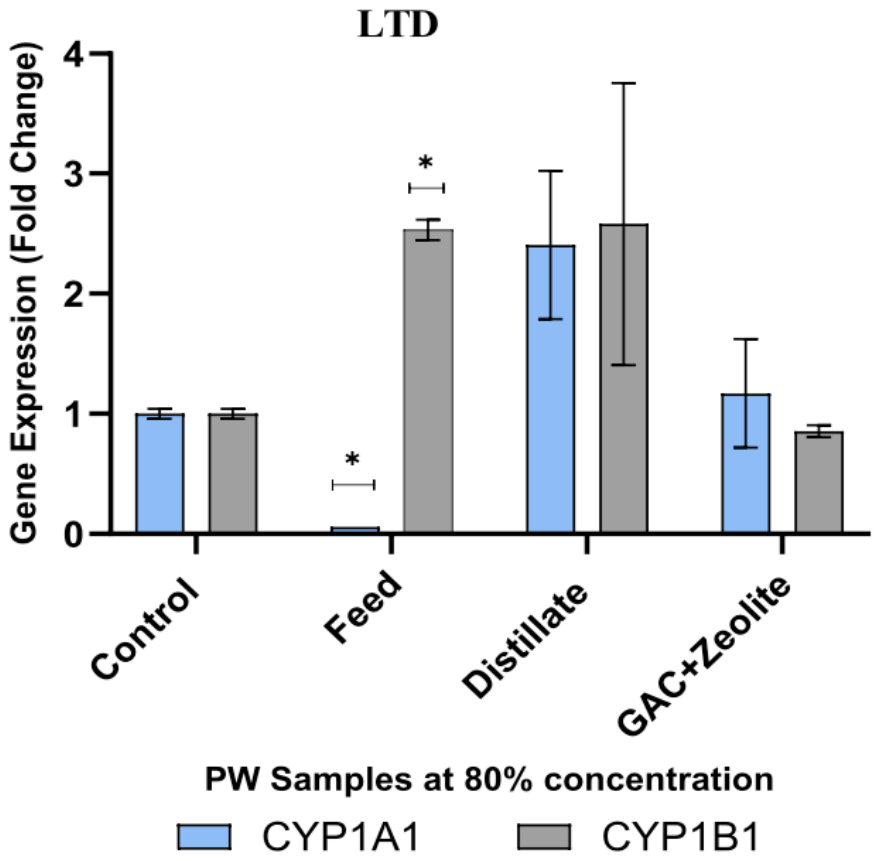


Fig. 5. Gene Expression of CYP1A1 and CYP1B1 using MCF-7 cell line after 24 h exposure to 80 % PW. The * represents the statistical difference (P_value < 0.05) in contrast to the control.

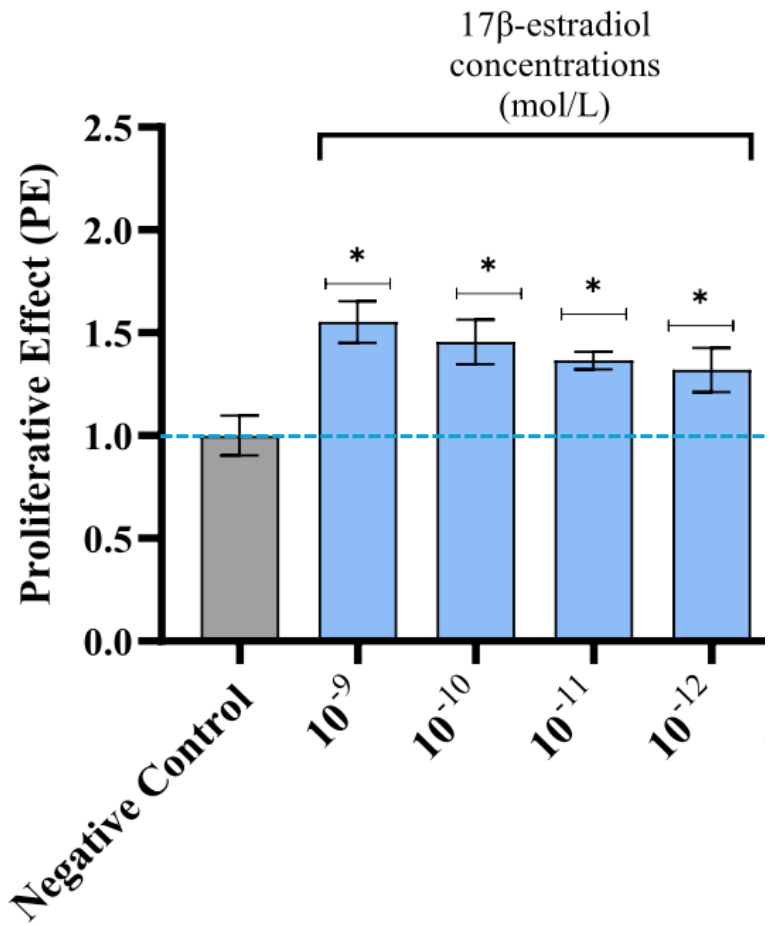


Fig. 6. The proliferative effect induced in MCF-7 cell lines by 17β-estradiol (E2), 50 % and 80 % feed, distillate, and GAC+zeolite treated PW. The * represents the statistical difference (P_value < 0.05) compared with the negative control.

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Summary

*unpublished data

Test \ PW	Feed LTD	LTD Distillate	LTD GAC + Zeolite	Feed MVR	MVR Distillate	MVR GAC + Zeolite
WET Test	Fail	Fail but not as bad	Pass	*Fail**	*Fail but not as bad**	*Pass**
MCF-7, HEK93, Caco-2 (% Cell Viability, MTT)	Low viability above 6.25% PW	High viability at or near control levels. MCF-7 some variation	Did not test	Low viability above 6.25% PW	High viability at or near control levels for all	Did not test
MCF-7, HEK93, Caco-2 (% Cell Viability, Luciferase)	Low viability above 6.25% PW	High viability at or near control levels. MCF-7 and HEK293 some variation	Did not test	Low viability above 6.25% PW	High viability at or near control levels	Did not test
MCF-7, HEK93, Caco-2 (LDH)	Increasing/dose-dependent cytotoxicity for all	No difference vs control	Did not test	Elevated cytotoxicity for all, relationship not as clear	No difference vs control	Did not test
MCF-7, HEK93, Caco-2 (Nitrite)	Elevated nitrite and increased oxidative stress except Caco-2	No difference vs control	No difference vs control	Elevated nitrite and increased oxidative stress	No difference vs control	No difference vs control
MCF-7 (AhR)	Suppressed 1A, highly upregulated 1B	Highly upregulated 1A and 1B	No difference vs control	Suppressed 1A, moderately upregulated 1B	Highly upregulated 1A, no difference vs control for 1B	No difference vs control
MCF-7 (17B-estradiol)	~ 2x higher proliferation effect	~ 1.5x higher proliferation effect	No difference vs control	Higher proliferation effect	~ 1.5x higher proliferation effect	No difference vs control

Next Steps for R&T Work

- Continue NTA (non-targeted analysis) because… most of the organics in the LTD were not identifiable.
- Longer-term testing.
- Generational studies.

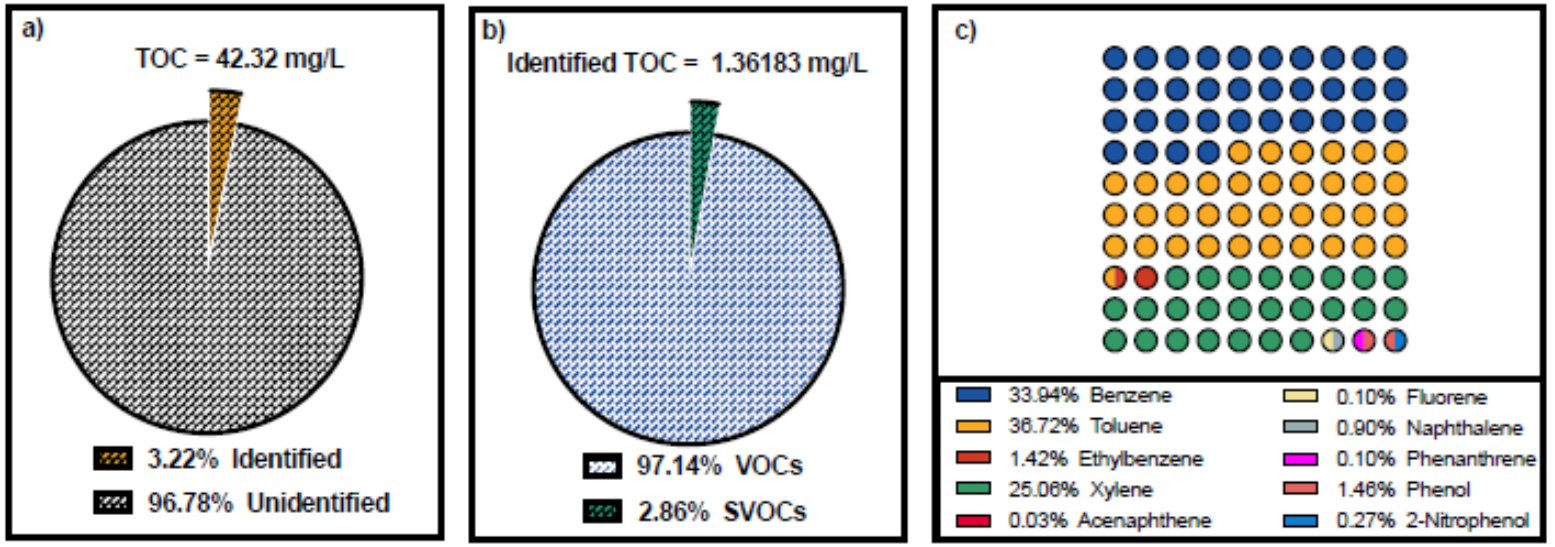

Figure 4. The composition of organics in distillate

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Senuri Wijekoon, NMSU Graduate Student

Presentation Outline

- NM PW RC FY26 R&D Priorities and Updates
- NM Risk & Toxicity – Retrospective Primer + Updates
- Summary and Next Steps

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NM PW RC FY26 R&D Priorities and Updates

PW Quality and Treatment Efficacy

Toxicological Assessments

Fate & Transport

Impact of tPW on Ag

Human/Envir. Risk Assessment

Characterize Chemical Additives