Comprehensive characterization of oil-field produced water treated by nanofiltration and reverse osmosis membranes for potential reuse in agriculture

Marin Wiltse [a1], Nohyeong Jeong [b1], Aaron Boyd [c], Tamzin Blewett [c], Corey Broeckling [d] Tiezheng Tong [b,*], Thomas Borch [a,*]

[a] Department of Soil & Crop Sciences and Department of Chemistry, Colorado State University, Fort Collins, CO, 80523, United States

[b] Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO, 80523, United States

[c] Department of Biological Sciences, University of Alberta, Edmonton, T6G 2E9, Canada

[d] Analytical Resources Core: Bioanalysis and Omics Center, Colorado State University, Fort Collins, CO 80523, USA

[1] These authors contribute equally.

Abstract. Unconventional oil and gas (UOG) produced water is formed when water that exists in shales is mixed with water that is injected by the oil and gas company into the well itself. Currently, the UOG produced water is primarily managed via deep well injection, which can cause increased seismicity and groundwater contamination. Treatment and reuse of UOG produced water has grown in interest in order to address both water scarcity and pollution caused by oil and gas production. Due to the complexity of the produced water composition, it is challenging to treat produced water for potential reuse. In order to properly understand the efficacy of treatment options like reverse osmosis (RO) and nanofiltration (NF) membranes and the possibility of reuse, we measured various inorganic and organic constituents before and after treatment using numerous analytical techniques along with measuring toxicity on *Daphnia magna* via LC50 tests for 48 hours. A comprehensive characterization of the UOG produced water is required to better understand the feasibility of treated produced water for beneficial reuse, for example, internal industry reuse, crop irrigation, and livestock irrigation. The results showed that NF membranes could not treat the UOG produced water to a level that was acceptable for irrigation. RO membranes showed a reduction in toxicity, along with other pollutants. The RO membranes were able to meet most irrigation requirement, except chloride and boron, which remained above the typical irrigation levels. Some surfactants whose molecular weights were much larger than the molecular weight cut-off of membranes were able to pass through the membrane, indicating that membranes were not able to be perfect barriers for organic constituents. The results demonstrated that thorough and comprehensive analytical techniques and tests need to be completed in order to understand feasibility and potential risks of using treated UOG produced water for beneficial reuse.