

## **PFAS, Microplastics, and Pharmaceutical and Personal Care Products (PPCP) Wastewater Treatment Technology References**

*Below is a preliminary list of resources referenced in US EPA's January 18, 2023 Clean Water State Revolving Fund (CWSRF) Emerging Contaminants Water Industry Professionals and Utility Staff Webinar, which has been recorded and is available online at: <https://www.epa.gov/dwsrf/bipartisan-infrastructure-law-srf-memorandum>.*

*EPA does not endorse any non-government websites, companies, technologies, internet applications or any policies or information expressed by third parties.*

### **PFAS**

Engineering and Analysis Division. (2022). 3rd Draft Method 1633 Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS (EPA 821-D-22-003). Environmental Protection Agency. Office of Water. Office of Science and Technology. [https://www.epa.gov/system/files/documents/2022-12/3rd%20Draft%20Method%201633%20December%202022%2012-20-22\\_508.pdf](https://www.epa.gov/system/files/documents/2022-12/3rd%20Draft%20Method%201633%20December%202022%2012-20-22_508.pdf)

National Alliance for Water Innovation. (2022). Selective Electrocatalytic Destruction of PFAS using a Reactive Electrochemical Membrane System. U.S. Department of Energy. Energy Efficiency and Renewable Energy Office. Advanced Manufacturing Office. <https://www.nawihub.org/wp-content/uploads/sites/16/2022/10/6.17-Brian-Chaplin-Selective-Electrocatalytic-Destruction-of-PFAS-using-a-Reactive-Electrochemical-Membrane-System-1.pdf>

Office of Research and Development. (2021). Potential PFAS Destruction Technology: Electrochemical Oxidation. Environmental Protection Agency. <https://www.epa.gov/chemical-research/research-brief-potential-pfas-destruction-technology-electrochemical-oxidation>

Office of Research and Development. (2021). Potential PFAS Destruction Technology: Mechanochemical Degradation. Environmental Protection Agency. <https://www.epa.gov/chemical-research/research-brief-potential-pfas-destruction-technology-mechanochemical-degradation>

Office of Research and Development. (2021). Potential PFAS Destruction Technology: Pyrolysis and Gasification. <https://www.epa.gov/chemical-research/research-brief-potential-pfas-destruction-technology-pyrolysis-and-gasification>

Office of Research and Development. (2021). Potential PFAS Destruction Technology: Supercritical Water Oxidation. Environmental Protection Agency. <https://www.epa.gov/chemical-research/research-brief-potential-pfas-destruction-technology-supercritical-water>

### **Microplastics**

Conley, K., Clum, A., Deepe, J., Lane, H., & Beckingham, B. (2019). Wastewater treatment plants as a source of microplastics to an urban estuary: Removal efficiencies and loading per capita over one year. *Water Research X*, 3. <https://doi.org/10.1016/j.wroa.2019.100030>

Kang, J., Zhou, L., Duan, X., Sun, H., Ao, Z., & Wang, S. (2019). Degradation of cosmetic microplastics via functionalized carbon nanosprings. *Matter*, 1(3), 745–758. <https://doi.org/10.1016/j.matt.2019.06.004>

- Kundu, A., Shetti, N. P., Basu, S., Raghava Reddy, K., Nadagouda, M. N., & Aminabhavi, T. M. (2021). Identification and removal of micro- and nano-plastics: Efficient and cost-effective methods. *Chemical Engineering Journal*, 421, 129816. <https://doi.org/10.1016/j.cej.2021.129816>
- Mason, S. A., Garneau, D., Sutton, R., Chu, Y., Ehmann, K., Barnes, J., Fink, P., Papazissimos, D., & Rogers, D. L. (2016). Microplastic pollution is widely detected in US municipal wastewater treatment plant effluent. *Environmental Pollution*, 218, 1045–1054. <https://doi.org/10.1016/j.envpol.2016.08.056>
- Ormaniec, P., & Mikosz, J. (2022). A review of methods for the isolation of microplastics in municipal wastewater treatment. *Technical Transactions*, 119(1), 1–12. <https://doi.org/10.37705/techtrans/e2022010>
- Özdemir, S., Akarsu, C., Acer, Ö., Fouillaud, M., Dufossé, L., & Dizge, N. (2022). Isolation of thermophilic bacteria and investigation of their microplastic degradation ability using polyethylene polymers. *Microorganisms*, 10(12). <https://doi.org/10.3390/microorganisms10122441>
- Poerio, T., Piacentini, E., & Mazzei, R. (2019). Membrane processes for microplastic removal. *Molecules*, 24(22). <https://doi.org/10.3390/molecules24224148>
- Raju, S., Carbery, M., Kuttykattil, A., Senathirajah, K., Subashchandrabose, S. R., Evans, G., & Thavamani, P. (2018). Transport and fate of microplastics in wastewater treatment plants: Implications to environmental health. *Reviews in Environmental Science and Bio/Technology*, 17, 637–653. <https://doi.org/10.1007/s11157-018-9480-3>
- Reddy, A. S., & Nair, A. T. (2022). The fate of microplastics in wastewater treatment plants: An overview of source and remediation technologies. *Environmental Technology & Innovation*, 28. <https://doi.org/10.1016/j.eti.2022.102815>
- Sun, J., Dai, X., Wang, Q., van Loosdrecht, M. C. M., & Ni, B.J. (2019). Microplastics in wastewater treatment plants: Detection, occurrence and removal. *Water Research*, 152, 21–37. <https://doi.org/10.1016/j.watres.2018.12.050>
- Werbowski, L. M., Gilbreath, A. N., Munno, K., Zhu, X., Grbic, J., Wu, T., Sutton, R., Sedlak, M. D., Deshpande, A. D., & Rochman, C. M. (2021). Urban stormwater runoff: A major pathway for anthropogenic particles, black rubbery fragments, and other types of microplastics to urban receiving waters. *ACS EST Water*, 1(6), 1420–1428. <https://doi.org/10.1021/acsestwater.1c00017>

### **PPCPs**

- Al-Baldawi, I. A., Mohammed, A. A., Mutar, Z. H., Abdullah, S. R., Jasim, S. S., Almansoori, A. F., & Ismail, N. I. (2021). Application of phytotechnology in alleviating pharmaceuticals and personal care products (PPCPs) in wastewater: Source, impacts, treatment, mechanisms, fate, and SWOT analysis. *Journal of Cleaner Production*, 319. <https://doi.org/10.1016/j.jclepro.2021.128584>
- Dhangar, K., & Kumar, M. (2020). Tricks and tracks in removal of emerging contaminants from the wastewater through hybrid treatment systems: A Review. *Science of The Total Environment*, 738. <https://doi.org/10.1016/j.scitotenv.2020.140320>
- Kumar, M., Sridharan, S., Sawarkar, A. D., Shakeel, A., Anerao, P., Mannina, G., Sharma, P., & Pandey, A. (2023). Current research trends on emerging contaminants pharmaceutical and personal care products

(PPCPs): A comprehensive review. *Science of The Total Environment*, 859.  
<https://doi.org/10.1016/j.scitotenv.2022.160031>

Madadian, E., & Simakov, D. S. A. (2022). Thermal degradation of emerging contaminants in municipal biosolids: The case of pharmaceuticals and personal care products. *Chemosphere*, 303.  
<https://doi.org/10.1016/j.chemosphere.2022.135008>

Paucar, N. E., Kim, I., Tanaka, H., & Sato, C. (2018). Ozone treatment process for the removal of pharmaceuticals and personal care products in wastewater. *Ozone: Science & Engineering*, 41(1), 3–16.  
<https://doi.org/10.1080/01919512.2018.1482456>

Snyder, S. A., Adham, S., Redding, A. M., Cannon, F. S., DeCarolis, J., Oppenheimer, J., Wert, E. C., & Yoon, Y. (2007). Role of membranes and activated carbon in the removal of endocrine disruptors and pharmaceuticals. *Desalination*, 202(1-3), 156–181. <https://doi.org/10.1016/j.desal.2005.12.052>

Suárez, S., Carballa, M., Omil, F., & Lema, J. M. (2008). How are pharmaceutical and personal care products (PPCPs) removed from urban wastewaters? *Reviews in Environmental Science and Bio/Technology*, 7, 125–138. <https://doi.org/10.1007/s11157-008-9130-2>

Sui, Q., Huang, J., Lu, S., Deng, S., Wang, B., Zhao, W., Qiu, Z., & Yu, G. (2013). Removal of pharmaceutical and personal care products by sequential ultraviolet and ozonation process in a full-scale wastewater treatment plant. *Frontiers of Environmental Science & Engineering*, 8, 62–68.  
<https://doi.org/10.1007/s11783-013-0518-z>

US EPA. (2009). Occurrence of contaminants of emerging concern in wastewater from nine publicly owned treatment works. Washington, DC: EPA-821-R-09-009.

Wang, Y., Wang, X., Li, M., Dong, J., Sun, C., & Chen, G. (2018). Removal of pharmaceutical and personal care products (PPCPs) from municipal waste water with integrated membrane systems, MBR-RO/NF. *International Journal of Environmental Research and Public Health*, 15(2), 269.  
<https://doi.org/10.3390/ijerph15020269>

Zepon Tarpani, R. R., & Azapagic, A. (2018). Life cycle environmental impacts of advanced wastewater treatment techniques for removal of pharmaceuticals and personal care products (PPCPs). *Journal of Environmental Management*, 215, 258–272. <https://doi.org/10.1016/j.jenvman.2018.03.047>