Introduction

There are no federal mandatory regulations for the removal of pharmaceuticals and personal care products (PPCPs) in wastewater. PPCPs are prevalent in wastewater and have adverse effects on the environment. Constructed wetlands allow for interaction between sunlight and dissolved organic carbon (DOC), causing photophysical reactions and formation of reactive oxygen species (ROS) which degrade PPCPs. As the wastewater undergoes wetlands treatment, DOC transforms through biological and photophysical processes. The type of DOC present affects the ROS formation potential. The objective of this project is to characterize DOC and determine the °OH formation potential within the Arcata Wastewater Treatment Facility (AWWTF).

Water Quality Methods

- Samples analyzed within 24 hour of collection
- Samples were filtered with 1.2 µm glass fiber filters and the dissolved fraction was analyzed
- Typical water quality parameters analyzed:
  - DOC - Shimadzu TOC Analyzer
  - BOD, - Standards Methods 5210B
  - pH - Standards Methods 9040C

Emission & Excitation Matrix Spectra Methods

Samples were diluted to have a maximum absorbance of 0.1 AU using Agilent UV VIS Spectrophotometer. Samples were within a pH range of 6.76-7.45. Fluorescence of the samples were analyzed using an Edinburgh FSS Spectrofluorometer with excitation wavelength from 240 nm to 458 nm using increments of 2 nm. Emission spectra began 30 nm above each excitation wavelength and ended at 704 nm in increments of 1 nm. Fluorescence data analyzed using MATLAB to create an Excitation and Emission Matrix Spectra (EEMs). Rayleigh and Raman scattering were removed by comparing with deionized water’s photon intensity. Samples were analyzed using High-Performance Liquid Chromatograph (Agilent HPLC 1100) to measure product concentration of 2HTA to quantify °OH produced by interactions of DOC and light (Fig. 4).

Results and Discussion

Water quality results show BOD5 decreased throughout the AWWTF (Fig. 5). The largest decrease was observed between TW 8-2 and EW 11, directly after chlorination. DOC concentration increased after TW 2-2 and then fluctuated by less than 1 mg/L. Fluorescence analysis showed shifting fluorescence signatures throughout the AWWTF indicating a transformation of DOC throughout the treatment process (Fig. 6). Oxidation pond effluent (OX 4-2) had a fulvic acid-like peak and a small humic acid-like region. Treatment wetland effluent (TW 8-2) had increase in fulvic acid-like peak area as well as humic acid-like peak area and photon intensity.

Conclusions

Throughout the AWWTF treatment process, the wastewater’s BOD5 has an overall reduction; however, there is minimal change in the DOC concentration. Results indicate increase in area and intensity of humic like and fulvic like peaks in TW 8-2 compared to OX-4. Humic acid-like compounds have been shown to reduce °OH formation (Sardana et al. 2019). Fulvic acid-like compounds have been shown to enhance the production of °OH. 2HTA concentrations indicate that fulvic benefit of °OH formation potential outweighs humic inhibition in the treatment wetland. Fluorescence results helped to relate composition of DOC to the ROS formation potential of constructed wetland wastewater treatment at AWWTF.

Future Work

- Investigate the characterization of DOC throughout each season
- °OH formation potential experiments on more sample locations within treatment train
- Finalize PARAFAC model to quantify EEMs results and correlate DOC to ROS formation

Acknowledgements

- We recognize the land that is the focus of our research and the institutions that housed this project are located on the present and ancestral Homeland and unceded territory of the Wiyot Tribe. Tribes and Nations in Humboldt County include Hupa, Karuk, Mattole, Tolowa, Wailaki, Wiyot. Yurok donation to the Wiyot Tribe honor tax: http://www.honoritas.org/index.html
- NSF-LSAMP (grant number HRD 1826490), NSF Naive Wises (grant number HRD 2120001), NSF Geoscience Alliance (grant number EAR 2039341).
- Yacolt Stump Fund (Cal Poly Humboldt)
- AMRI is Arcata Marsh Research Institute, City of Arcata’s Wastewater Treatment Plant, https://arcatamarsh.wordpress.com/
- Dr. Matthew Hurst: Provided training and access to Monterey Bay, Ca
- Dr. Jorge Montes: Provided training and access to the Agilent FSS Spectrofluorometer
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- Brandon Witting: Helped with the development of HPLC methodology and provided training
- Colin Welling: Provided laboratory training in both Water Quality testing and safety
- Michelle Dostal: Geological Assistance
- Schatz Energy Research Center
- Elizabeth Van Skike & Kayleigh Vincent: Welling: Provided training and assistance on Oriel Sol3ATM CLASS AAA Solar Simulator

References

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