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Investigation of Polychlorinated Biphenyls (PCBs) in Effluent Discharged from a Wastewater Treatment Plant during Dry and Rain Periods

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Background/Objectives. Polychlorinated biphenyls (PCBs) generated from industrial activities and are persistent organic pollutants, are toxic and bioaccumulative in the environment, where they due to their hydrophobicity can cause reproductive impairment and thus negatively impact the environment. A source of PCBs in the aqueous environment comes from discharged wastewater effluent. Despite the very low concentrations of total PCBs in the effluent the large volumes that are constantly being discharged can cause discharge of a large amount of PCBs. In some areas, the discharged effluent can exceed the Total Maximum Daily Load (TMDL) despite the low PCB concentrations. In this study, the concentration of total PCBs as well as the presence of individual PCB congeners were evaluated over at five year period for dry weather and storm water-effluent from a WW treatment plant. The associated toxicity of the 12 most toxic congeners (the dioxin-like PCB congeners) were evaluated. Specifically, the importance of the storm water effluent was compared to the effluent composition during normal operational conditions.

Approach/Activities. Effluent samples were collected as composite samples over 24 hours during dry and storm water-effluent periods from the main outfall and as grab samples from the bypass outfall. The main outfall discharges the fully treated WW and the bypass outfall discharges partially treated WW during rain events. All 209 PCB congeners were analyzed at a certified laboratory using EPA method 1668A. Continuous flow measurements were applied to make a mass balance for the effluent PCBs. A heat map was developed to provide information of the PCB congeners at each sampling and to improve the understanding of these complex data sets.

Results/Lessons Learned. The data showed differences in PCB congener concentrations during wet and storm water periods. It was found the storm water-effluent had a higher average chlorination level with 5.01 Cl/biphenyl versus a dry weather-effluent level of 4.22 Cl/biphenyl. Moreover, the bypass outfall had a significantly higher concentration of the very toxic 12 dioxin-like PCB congeners with an average of 39 nM in the stormwater periods and 29 nM in dry weather periods resulting in a higher total toxicity equivalent concentration of 75 pM for the storm water vs. 9 fM for dry weather effluent. On a mass level, the data showed that approximately 10% of the discharged amount of PCBs resulted from the storm water events. It should be noted that all 12 dioxin-like congeners were detected in the storm water effluent, while the congeners PCB-81, PCB-126, PCB-157 and PCB-169 congeners were never detected during in dry weather discharge. These results indicate that microbial transformation of PCBs take place during the wastewater treatment processes and the results of this study will provide the basis for a more detailed evaluation of the impact on PCB transformation during the individual treatment processes. Future research will focus on designing solutions that will bring the amounts of PCBs below the TMDL by combined chemical and microbiological approaches thus evaluating PCB transformation during the treatment processes.