OLD DOMINION UNIVERSITY
Center for Coastal Physical Oceanography

INSTITUTE FOR COASTAL ADAPTATION & RESILIENCE

# *Fall 2025 Virtual Seminar Series*

## "QUANTIFYING THE EFFICACY OF WASTEWATER ALKALINITY ENHANCEMENT ON CARBON EMISSION AND UPTAKE IN AN URBAN ESTUARY"

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**Monday, November 3, 2025**
3:30 PM EST

**ZOOM LINK**
Meeting ID: 949 7050 5459
Passcode: 348794

Abstract
Mitigating the harmful effects of global $CO_2$ increases is both a global and local problem and there is wide consensus that negative emissions technologies are required to meet global warming mitigation goals. Ocean Alkalinity Enhancement (OAE) is one of the many tools proposed to achieve negative emissions via associated marine carbon dioxide removal (mCDR). OAE using wastewater effluent as a mode of delivery of strong bases provides an opportunity for a diverse range of outcomes with potential upscaling using the global network of wastewater treatment plants (WWTPs). Benefits include marine $CO_2$ removal (mCDR) with minimum secondary precipitation, enhancement of existing wastewater processes, and mitigation of acidification. Wastewater OAE could also be used to reduce carbon emissions from WWTPs, which are a significant source of $CO_2$ (~1.7%) globally. In order to quantify the effect of WWTP OAE on both mCDR and $CO_2$ emission reduction in a WWTP, we combined field trials at a WWTP in Norfolk, Virginia, USA with a modeling framework that combines a modern activated sludge model-based WWTP simulator with an integrated hydrodynamic-biogeochemical-carbonate chemistry model of coastal oceans. In both field trials and model simulations, we evaluated the effects of both mCDR and $CO_2$ emission reduction by adding alkalinity either upstream (UpAdd) of the biological treatment stage or downstream at the discharge location (DnAdd). In a 7-day trial in October 2024, our DnAdd experiments accomplished a rapid 500 μmol/kg increase in alkalinity that led to a ~1.2 increase in pH and a 95% reduction in $pCO_2$ in the wastewater final effluent. Alkalinity in the receiving estuary increased by 60 μmol/kg during this trial. During the same trial, UpAdd experiments resulted in smaller, but more gradual pH and $pCO_2$ effects in the final effluent. These results are consistent with model experiments that displayed that carbon emissions from WWTPs decrease with increasing alkalinity dosage in UpAdd, but that carbon uptake in the surrounding oceanic water is much reduced due to elevated dissolved inorganic carbon in the discharge water. In contrast, DnAdd experiments did not affect $CO_2$ emissions from WWTPs but enhanced carbon uptake in the ocean. I will discuss how these model and field experiments have informed our understanding of scale and natural variability that will support future OAE and mCDR experiments.

Biography
Dr. Jeremy Testa earned a B.S. in Environmental and Forest Biology from the State University of New York College of Environmental Science and Forestry, a M.S. in Ecosystem Ecology from the University of Maryland, and a Ph.D. in Biological Oceanography from the University of Maryland. His research focuses on the controls on oxygen depletion, eutrophication, and ocean acidification and their ecosystem effects using a combination of numerical modeling, retrospective data analysis, and measurements of rate processes. Dr. Testa is a Professor at the Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science.

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