Executive Summary

WERF

Insights for achieving extremely low effluent total phosphorus

Phosphorus Fractionation and Removal in Wastewater Treatment – Implications for Minimizing Effluent Phosphorus (NUTR1R06l)

The Central Issue

Water resource recovery facilities (WRRFs) are increasingly challenged to investigate and evaluate tertiary treatment alternatives and to gain a better understanding of the limitations of achieving additional phosphorus (P) removal due to increasing stringent effluent concentration limits.

Context and Background

A fundamental understanding of effluent P chemical species is necessary to interpret and improve technologies for P removal to very low limits. This research sought to gain insights into the removal efficiency and mechanisms of different P fractions through various treatment technologies. Twenty processes were evaluated at 12 WRRFs.

The P composition in the influent and the secondary and tertiary effluents from the processes were characterized using standard methods, as well as methods such as sequential chemical extraction for metal-bound P analysis and molecular cut-off for distribution analysis. Wastewater characterization and fingerprinting were also performed to reveal the association of organic P with identifiable effluent organic fractions. Then, changes in P fractions along the treatment train in each WRRF were evaluated and compared to measured concentrations.

Findings and Conclusions

The results from this study suggest that advanced tertiary treatment processes can achieve low effluent total phosphorus (TP) levels. However, technologies and multi-stage treatments that target for effective elimination of fine and colloidal particulates, as well as non-reactive P fractions will be required.

There are substantial capital costs to research and implement more advanced treatment technologies to remove these P fractions. Because many watershed protection plans (e.g., TMDLs) use TP for setting limits without considering the possibility that P fractions may differ in bioavailability, and thus, differ in their potential to cause eutrophication, further comprehensive environmental and economic assessments are warranted to balance the benefits

One of the facilities selected for the study was the Noman M. Cole, Jr. Pollution Control Plant, an award-winning WRRF owned and operated by Fairfax County Government in Lorton, VA.

in potential eutrophication reduction versus the cost and other unintended co-costs (i.e., carbon footprint) of achieving low effluent TP levels.

Management and Policy Implications

Regulations on total phosphorus should take into consideration the results from this study. Removal of residual organic nutrients in highly treated effluents may be necessary for meeting very stringent nutrient removal regulations in the future, which presents challenges in the technology development and plant operation. This research provides collective and comparative information regarding the limit and variations in effluent P levels and composition that can be achieved by a range of advanced tertiary P removal processes. It also provides insight for future improvement and development of new P removal processes to achieve extremely low effluent TP.

Facilities Selected for this Study

Plant	Location
Spokane Riverside Park Water Reclamation Facility Pilot (six treatment processes included)	Spokane, WA
City of Las Vegas Water Pollution Control Facility	Las Vegas, NV
Pinery WWTP	Parker, CO
Broad Run Water Reclamation Facility, VA	Loudoun, VA
Noman M. Cole, Jr., Pollution Control Plant	Lorton, VA
Iowa Hill WWTP	Iowa Hill, CO
Hayden WWTP	Hayden, ID
Stamford WWTP	Stamford, NY
Blue Plains WWTP	Washington, DC
City of Coeur D'Alene WWTP Pilot (three treatment processes included)	Coeur D'Alene, ID
Inland Empire Paper WWTP	Millwood, WA
Concord WWTP	Concord, MA

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Related WERF Research

Project Title	Research Focus
Bioavailability and Characteristics of Dissolved Organic Nutrients in Wastewater Effluents (NUTR1R06o)	Seeks to correlate wastewater characteristics and treatment processes with bioavailable effluent dissolved organic phosphorus (DOP) to inform efforts to remove P.
Nutrient Management: Regulatory Approaches to Protect Water Quality Volume 1 – Review of Existing Practices (NUTR1R06i)	Provides a better understanding of key nutrient management issues and technical challenges that currently confront point source wastewater dischargers and regulators nationwide in setting and meeting low nutrient effluent limits.
Nutrient Management: Volume 2 – Removal Technology Performance & Reliability (NUTR1R06k)	Highlights a comprehensive two-year study of 22 real-world, full-scale nutrient removal plants designed and operated over three years to meet very low effluent total nitrogen (TN) and total phosphorus (TP) concentrations (as low as 3 mg/L TN and 0.1 mg/L TP). Provides a database for key decision makers looking for proper choices for both technologies and rationale bases for statistical permit writing.
Striking the Balance Between Nutrient Removal in Wastewater Treatment and Sustainability (NUTR1R06n)	Provides an analysis on finding the balance between nutrient removal and sustainability to determine whether a point of diminishing returns is reached where the sustainability impacts of achieving increased levels of nutrient removal outweigh the benefits of better water quality.
Mineralization Kinetics of Soluble Phosphorus and Soluble Organic Nitrogen in Advanced Nutrient Removal Effluents (NUTR1R06p)	Examines phosphorus mineralization kinetics in advanced wastewater treatment facility effluents by studying P and N species in the effluent of five WRRFs in the Spokane, WA area and five other facilities nationwide.
Nutrient Removal Workshop: How Low Can We Go & What is Stopping Us from Going Lower? (05CTS1W) **Bioavailability of Wastewater Derived Organic Nitrogen in Treatment Systems and Receiving Waters (NUTR1R06d)** **Maximizing the Dual Benefits of Advanced WWTP Processes: Reducing Nutrients and Emerging Contaminants (Chesapeake Bay STAC, MWCOG, WERF)**	Series of collaborative WERF-sponsored workshops (2006-2008) on nutrient removal, reduction, sources, bioavailability, impacts, and recalcitrance of various wastewater nitrogen species. As wastewater treatment facilities in the Chesapeake Bay implement enhanced nutrient removal and control technology strategies, they also help reduce endocrine disrupting compounds, personal care, and pharmaceutically active compounds. These workshops established what we know and do not know about the various fractions of nitrogen. Joint workshop reports are available at: http://www.chesapeake.org/stac/Pubs/eonreport.pdf http://www.chesapeake.org/stac/DONWorkshop.html#materials
Bioavailability of Phosphorus from Treated Wastewater Effluent in the Spokane River (NUTR4C09)	Uses algal growth to estimate the amount of bioavailable phosphorus in treated wastewater.

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