WEF Forum 2019: Pre-Reading List

Given the wonderful variety of topics to be covered in the technical program for the upcoming Forum, the steering committee wants to provide a pre-reading list to all registrants. The following list includes a number of published articles and online resources to give background and data on topics to be covered during our days together in Austin. Please see the citations below and seek out any which may help prepare for the in-depth facilitated discussions we expect at this event.

Opening Session

Barnard, J.L.; Dunlap, P.; Steichen, M. (2017) Rethinking the Mechanisms of Biological Phosphorus Removal. *Water Environ. Res.,* **89,** 2043-2054 (https://onlinelibrary.wiley.com/doi/10.2175/106143017X15051465919010)
(*WEF Members can access the full article for free by logging in at www.wef.org and then proceeding to bit.ly/WERonWOL and searching for the article*).

Session 1: Watershed Based Strategies for Managing Phosphorus

http://newwater.us/programs-initiatives/environmental-programs/

http://newwater.us/projects/silver-creek-project/

Water Knows No Boundaries https://www.youtube.com/watch?v=9EncDaFZfaU

A Day in the Watershed https://www.youtube.com/watch?v=V6_aoDNgxKE

Dixie Drain: https://www.livboise.org/initiatives/dixie-drain/

NPDES Permit (Section I.B.6 has info in Dixie Drain offset):
https://www.epa.gov/sites/production/files/2017-10/documents/r10-npdes-boise-west-id0023981-final-permit-mod-2016.pdf

Fact Sheet modification with info on Dixie: https://www.epa.gov/sites/production/files/2017-10/documents/r10-npdes-boise-west-id0023981-fact-sheet-mod-dixie-slough-2012.pdf

Chesapeake Bay TMDL: https://www.epa.gov/chesapeake-bay-tmdl
Fewless, K. L., S. Sharvelle, L. A. Roesner, *Source Separation and Treatment of Anthropogenic Urine*, INFR4SG09b, Water Environment Research Foundation, Alexandria, VA, 2011.

Wigginton, K., N. Love, R. Lahr, H. Goetsch, D. Aga, R. Mullen, A. Noe-Hays, K. Nace, C. Bott, A. Gagnon, J. Jimenez, Nutrient Recovery Through Urine Separation, STAR-N1R14, Water Environment & Research Foundation, Alexandria, VA, 2017.

Hilton, S., B. Zhou, G. T. Daigger, G. Keoleian, N. Love, and S. Skerlos, *Life Cycle Assessment of Urine Diversion Wastewater Treatment: Results and Software Tool*, STAR-Na1R14/4899, The Water Research Foundation, Alexandria, VA, 2018.

SFPUC summary of resources: http://uswateralliance.org//initiatives/commission/resources

Session 3: Understanding Microbial Ecology of EBPR

Fernando, E.Y., S.J. McIlroy, M. Nierychlo, F.-H. Alexander, M.C. Schmid, M. Wagner, J.L. Nielsen, and P.H. Nielsen (2018): Resolving the individual contribution of key microbial populations to enhanced biological phosphorus removal with Raman-FISH. *BioRxiv.* doi: https://doi.org/10.1101/387795.

Li Y, Cope HA, Rahman SM, Li G, Nielsen PH, Elfick APD, Gu AZ (2018): Towards better understanding of EBPR systems via linking Raman-based phenotypic profiling with phylogenetic diversity. *Environ Sci Technol*, doi:10.1021/acs.est.8b01388.

Han, G., M. Liu, J.S. Griffin, L. Xu, D. Xiang, Y.D. Scherson, W-T.Liu, and G.F. Wells (2017): Complete Nutrient Removal Coupled to Nitrous Oxide Production as a Bioenergy Source by Denitrifying Polyphosphate-Accumulating Organisms. *Environmental Science & Technology* 51: 4531-4540.

Marques R, Santos J, Nguyen H, Carvalho G, Noronha JP, Nielsen PH, Reis MAM, Oehmen A (2017): Metabolism and ecological niche of *Tetrasphaera* and *Ca*. Accumulibacter in enhanced biological phosphorus removal. *Water Res*, 122:159–171.

Stokholm-Bjerregaard, M., S.J. McIlroy, M. Nierychlo, S.M. Karst, M. Albertsen, P.H. Nielsen (2017). A critical assessment of the microorganisms proposed to be important to enhanced biological phosphorus removal in full-scale wastewater treatment systems. *Frontiers in Microbiology* 8:718. Doi: 10.3389/fmicb.2017.00718.

Law, Y, RH Kirkegaard, AA Cokro, X Liu, K Arumugam, C Xie, M Stokholm-Bjerregaard, DI Drautz-Moses, PH Nielsen, S Wuertz, RBH Williams (2016): Integrative microbial community analysis reveals full-scale enhanced biological phosphorus removal under tropical conditions. *Scientific Rep.* 6, 25719. doi:10.1038/srep25719.

Oyserman BO, Noguera DR, Del Rio TG, Tringe SG, McMahon KD (2016): Metatranscriptomic insights on gene expression and regulatory controls in *Candidatus* Accumulibacter phosphatis. *ISME J* 10:810–822.

Mao Y, Graham DW, Tamaki H, Zhang T (2015): Dominant and novel clades of *Candidatus* Accumulibacter phosphatis in 18 globally distributed full-scale wastewater treatment plants. *Sci Rep*, 5:1–10.

Skennerton CT, Barr JJ, Slater FR, Bond PL, Tyson GW (2015): Expanding our view of genomic diversity in *Candidatus* Accumulibacter clades. *Environ Microbiol*, doi:10.1111/1462-2920.12582.

Session 4: Modeling Challenges and New Thoughts

Barker, P. S., and P. L. Dold. "General model for biological nutrient removal activated-sludge systems: model presentation." *Water Environment Research* 69.5 (1997): 969-984.
Rieger, L., Koch, G., Kühni, M., Gujer, W. and Siegrist, H. (2001). The EAWAG Bio-P module for activated sludge model No. 3. *Water Res.*, 35(16), 3887-3903.

Hug, Thomas, Lorenzo Benedetti, Eric R. Hall, Bruce R. Johnson, Eberhard Morgenroth, Ingmar Nopens, Leiv Rieger, Andrew Shaw, and Peter A. Vanrolleghem. "Wastewater treatment models

in teaching and training: the mismatch between education and requirements for jobs." *Water Science and Technology* 60, no. 7 (2009): 1721-1729.

Barnard, James L., Patrick Dunlap, and Mark Steichen. "Rethinking the mechanisms of biological phosphorus removal." *Water Environment Research* 89.11 (2017): 2043-2054.

Varga, Erika, et al. "Recent advances in Bio-P modelling–a new approach verified by full-scale observations." *Water Science and Technology* (2018). doi: https://doi.org/10.2166/wst.2018.490

SANTOS, J.M.M., RIEGER, LEIV, LANHAM, A.B. & OEHMEN, A.. The META-ASM model: a novel approach for modelling EBPR systems. 6th IWA/WEF Water Resource Recovery Modelling Seminar (WRRmod2018), Québec, Canada, 10-14 March, 2018

Lanham, A.B., Oehmen, A., Saunders, A.M., Carvalho, G., Nielsen, P.H., Reis, M.A.M., 2014. Metabolic modelling of full-scale enhanced biological phosphorus removal sludge. Water Res. 66C, 283–295. doi:10.1016/j.watres.2014.08.036

Bucci, V., Majed, N., Hellweger, F. L. & Gu, A. Z. Heterogeneity of Intracellular Polymer Storage States in Enhanced Biological Phosphorus Removal (EBPR) – Observation and Modeling. Environmental Science & Technology 46, 3244-3252, doi:10.1021/es204052p (2012).

Kreft, J.-U. et al. Mighty small: Observing and modeling individual microbes becomes big science. Proceedings of the National Academy of Sciences 110, 18027, doi:10.1073/pnas.1317472110 (2013).

Schuler, A. J. et al. Is the whole the sum of its parts? Agent-based modelling of wastewater treatment systems. Water Sci. Technol. 63, 1590-1598 (2011).

Session 5: Interaction with Nitrogen Removal

Vocks, M., Adam, C., Lesjean, B., Gnirss, R., and Kraume, M. (2005) Enhanced post-denitrification without addition of an external carbon source in membrane bioreactors. Water Research, **39**(14), 3360–3368.

Rubio-Rincón, F. J., Lopez-Vazquez, C. M., Welles, L., van Loosdrecht, M. C. M., and Brdjanovic, D. (2017) Cooperation between Candidatus Competibacter and Candidatus Accumulibacter clade I, in denitrification and phosphate removal processes. Water Research, **120**, 156–164.

Camejo, P. Y., Owen, B. R., Martirano, J., Ma, J., Kapoor, V., Santo Domingo, J., McMahon, K. D., and Noguera, D. R. (2016) Candidatus Accumulibacter phosphatis clades enriched under cyclic anaerobic and microaerobic conditions simultaneously use different electron acceptors. Water Research, **102**, 125–137.

Keene, N. A., Reusser, S. R., Scarborough, M. J., Grooms, A. L., Seib, M., Santo Domingo, J., and Noguera, D. R. (2017) Pilot plant demonstration of stable and efficient high rate biological nutrient removal with low dissolved oxygen conditions. Water Research, **121**, 72–85.

Saad, S. A., Welles, L., Abbas, B., Lopez-Vazquez, C. M., van Loosdrecht, M. C. M., and Brdjanovic, D. (2016) Denitrification of nitrate and nitrite by “Candidatus Accumulibacter phosphatis” clade IC. Water Research, **105**, 97–109.

Figdore, B. A., Stensel, H. D., and Winkler, M. H. (2018) Bioaugmentation of sidestream nitrifying-denitrifying phosphorus- accumulating granules in a low-SRT activated sludge system at low temperature. Water Research, **135**, 241–250.

Figdore, B. A., Stensel, H. D., and Winkler, M. H. (2018) Bioresource Technology Comparison of different aerobic granular sludge types for activated sludge nitri fi cation bioaugmentation potential. Bioresource Technology, **251**(August 2017), 189–196.

Winkler, M. H., Bassin, J. P., Kleerebezem, R., Bruin, L. M. M. De, Brand, T. P. H. Van Den, and Loosdrecht, M. C. M. Van (2011) Selective sludge removal in a segregated aerobic granular biomass system as a strategy to control PAO e GAO competition at high temperatures. Water Research, **45**(11), 3291–3299.

Session 6: Design and Operating Practices

Barnard, J., Houweling, D., Analla, H., Steichen, M. (2012) Saving phosphorus removal at the Henderson NV plant. *Water Science and Technology*, 65(7), 1318-1322

de Haas, D.W., Wetzel, M.C., and Ekama, G.A. (2000). “The use of simultaneous chemical precipitation in modified activated sludge systems exhibiting biological excess phosphate removal. Part 1: Literature review.” *Water SA*, 26 (4), 439-452. [First of seven-part series published in Water SA across 2000 and 2001].

Le Moullec, Y., Potier, O., Gentric, C., Leclerc, J.P., 2011. Activated sludge pilot plant: comparison between experimental and predicted concentration profiles using three different modelling approaches. Water Res 45, 3085–3097. doi:10.1016/j.watres.2011.03.019

Matt Winkler, Erik R. Coats, Cynthia K. Brinkman, Advancing post-anoxic denitrification for biological nutrient removal, Water Research, Volume 45, Issue 18, 2011, Pages 6119-6130, ISSN 0043-1354, https://doi.org/10.1016/j.watres.2011.09.006. (http://www.sciencedirect.com/science/article/pii/S0043135411005252)

Session 7: Whole Plant Impacts

Mayer B, Baker L, Boyer T, Drechsel P, Gifford M, Hanjra M, Parameswaran P, Stolzfus J, Westerhoff P, Rittman B, (2016) *The Total Value of Phosphorus Recovery, Environ. Sci. Technol.*, *50* (13), pp 6606–6620

Barat R, Montoya T, Seco A, Ferrer J, (2005) The role of potassium, magnesium and calcium in the Enhanced Biological Phosphorus Removal treatment plants, Environmental Technology, Volume 26 – Issue 9

Higgins M, Bott C, Schauer P, Beightol S, (2014) Does Bio-P Impact Dewatering After Anaerobic Digestion? Yes, and Not in a Good Way, WEF Residuals and Biosolids Conference, Austin TX

Session 8: Preparing for Future Nutrient Management Strategies

Investing in SDG 6: A vital confluence of natural human, and financial resources (Dec 11, 2018) by Dr. Kala Vairavamoorthy, IWA Executive Director.

Sustainable Development Goal #6 - Clean Water and Sanitation, available online at: http://www.sdgfund.org/goal-6-clean-water-and-sanitation)

Overview of all 17 SDGs, available online at: https://www.un.org/sustainabledevelopment/sustainable-development-goals/

Dr. Art Umble's "Words on Water" interview #63 by WEF's Travis Loop, available online at: https://wordsonwaterwef.com/2018/11/14/words-on-water-63-art-umble-on-the-circular-economy/

Dana Cordell and Stuart White, Sustainable Phosphorus Measures: Strategies and Technologies for Achieving Phosphorus Security. *Agronomy* (2013) *3*, 86-116. doi:10.3390/agronomy3010086

Yi Liu, Gara Villalba, Robert U. Ayres, and Hans Schrode, Global Phosphorus Flows and Environmental Impacts from a Consumption Perspective. *Journal of Industrial Ecology* (2008) *12*, (2) 229-247.
DOI: 10.1111/j.1530-9290.2008.00025.x

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Figdore, B. A., Stensel, H. D., Neethling, J. B., and M. K. H. Winkler (2017). Aerobic Granular Sludge for Biological Nutrient Removal. Water Environment and Reuse Foundation NUTR4R14h, Alexandria, VA.