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Engineering & Scientific Consulting

Morgan Petrovich, Ph.D., P.E.

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Professional Profile

Dr. Petrovich is a Senior Engineer in Exponent's Environmental and Earth Sciences practice. She is a licensed Professional Civil Engineer with a focus on Environmental and Water Resources Engineering. She has extensive experience in water and wastewater treatment processes and characterization and remediation of contaminated sites, including Superfund sites. Dr. Petrovich has evaluated large-scale project sites contaminated with compounds including metals, PCBs, PAHs, dioxins, chlorinated solvents, and radionuclides. She has expertise in chemical forensics and historical reconstructions of contaminant releases in soil, sediment, groundwater, and surface water, as well as ecological impacts associated with contamination. Her experience includes investigations into potential environmental impacts associated with manufacturing processes, including analyses of PFAS compounds. She has also conducted environmental risk and toxicity assessments of chemical substances involved in product manufacturing. Dr. Petrovich has collaborated extensively with commercial laboratories, and has field experience collecting water, wastewater, sludge, sediment, air, and soil samples. She has worked with public utilities to analyze microbial ecology in full-scale wastewater treatment bioreactors and to investigate relationships between community composition and reactor performance using molecular methods. Dr. Petrovich is also familiar with NPDES permitting and regulations related to municipal and industrial wastewater treatment facilities.

Further, Dr. Petrovich has experience in environmental planning and landscape architecture with project experience related to ecological and landscape design. She has designed infrastructure improvements in dense urban areas to improve air quality and reduce public health impacts from diesel emissions. Dr. Petrovich has also drafted plans for living walls and green roof systems and has worked on the design and construction of composting toilets.

Academic Credentials & Professional Honors

Ph.D., Civil and Environmental Engineering, Northwestern University, 2019

M.S., Civil and Environmental Engineering, Northwestern University, 2015

B.A., University of California, Berkeley, 2011

Northwestern University Terminal Year Fellowship, 2018 – 2019

Royal E. Cabell Fellowship, 2014 – 2015

University of California, Berkeley Undergraduate High Honor Roll, 2007 – 2011

American Society of Landscape Architects Honor Award for team project “PlantLAB”, 2011

Licenses and Certifications

40-Hour Hazardous Waste Operation and Emergency Response Certification (HAZWOPER)

Prior Experience

Environmental Microbiology and Biomonitoring Intern, Metropolitan Water Reclamation District of Greater Chicago, 2017

Teaching Assistant, Northwestern University, 2016 – 2018

Ecological Design and Engineering Intern, Hyphae Design Laboratory, 2013

Publications

Petrovich, M., Zilberman, A., Kaplan, A., Eliraz, G., Wang, Y., Langenfeld, K., Duhaime, M., Wigginton, K., Poretsky, R., Avisar, D., Wells, G. (2020). “Microbial and viral communities and their antibiotic resistance genes throughout a hospital wastewater treatment system.” Frontiers in Microbiology, 153(11).

Petrovich, M., Ben Maamar, S., Hartmann, E., Murphy, B., Poretsky, R., and Wells, G. (2019). "Viral Composition and Context in Metagenomes from Biofilm and Suspended Growth Municipal Wastewater Treatment Plants." Microbial biotechnology. doi.org/10.1111/1751-7915.13464

Petrovich, M., Rosenthal, A., Griffin, J., Wells, G. (2019). "Spatially Resolved Abundances of Antibiotic Resistance Genes and intI1 in Wastewater Treatment Biofilms." Biotechnology and bioengineering, 116(3).

Petrovich, M., Chu, B., Wright, D., Griffin, J., Elfeki, M., Murphy, B., Poretsky, R., Wells, G. (2018). "Antibiotic resistance genes show enhanced mobilization through suspended and biofilm growth wastewater treatment processes." FEMS microbiology ecology, 94(5).

Chu, B., Petrovich, M., Chaudhary, A., Wright, D., Murphy, B., Wells, G., & Poretsky, R. (2017). "Metagenomic analysis reveals the impact of wastewater treatment plants on the dispersal of microorganisms and genes in aquatic sediments." Applied and environmental microbiology, 84(5).

Petrovich, M., Wu, C. Y., Rosenthal, A., Chen, K. F., Packman, A. I., & Wells, G. F. (2017). "Nitrosomonas europaea biofilm formation is enhanced by Pseudomonas aeruginosa." FEMS microbiology ecology, 93(5).

Presentations

Petrovich, M., Zilberman, A., Kaplan, A., Eliraz, G., Wang, Y., Langenfeld, K., Duhaime, M., Wigginton, K., Poretsky, R., Avisar, D., Wells, G. (August 2022) Antibiotic resistance of microbial and viral communities in a hospital wastewater treatment system. Oral presentation at the American Chemical Society (ACS) Conference, Chicago, IL.

Petrovich, M. and Brown, K. (May 2021) Genetic methods to monitor toxic Cyanobacteria blooms. Virtual presentation during 10.5 U.S. Symposium on Harmful Algae.

Petrovich, M. and Grzebyk, K. (April 2021) SARS-CoV-2 susceptibility to disinfectants. WaterWorld virtual webinar presentation.

Petrovich, M., Rosenthal, A., Griffin, J., Wells, G. (August 2018) Spatial distribution of antibiotic resistance genes and community composition in wastewater biofilms. Oral presentation at the American Chemical Society (ACS) Conference, Boston, MA.

Petrovich, M., Rosenthal, A., Griffin, J., Wells, G. (April 2018) Spatial distribution of antibiotic resistance genes and community composition in wastewater biofilms. Poster presentation at the Madison Microbiome Meeting, University of Wisconsin, Madison, WI.

Petrovich, M., Chu, B., Wright, D., Griffin, J., Elfeki, M., Murphy, B., Poretsky, R., Wells, G. (September 2017) Antibiotic resistance gene abundances, mobilization, and co-occurrences with antibiotic production genes in biofilm and suspended growth wastewater treatment bioreactors. Oral presentation for the Chicagoland Specialized Metabolite Community, University of Illinois Chicago, Chicago, IL.

Petrovich, M., Chu, B., Wright, D., Griffin, J., Elfeki, M., Murphy, B., Poretsky, R., Wells, G. (August 2017) Metagenomic analysis of composition, retention, and mobilization of antibiotic resistance and production genes in biofilm and suspended growth wastewater treatment bioreactors. Poster presentation at the 4th International Symposium on the Environmental Dimension of Antibiotic Resistance (EDAR-4) Conference, East Lansing, MI.

Petrovich, M., Chu, B., Wright, D., Griffin, J., Elfeki, M., Murphy, B., Poretsky, R., Wells, G. (June 2017) Metagenomic analysis of antibiotic resistance gene composition, mobilization, and co-occurrence with antibiotic production genes in different wastewater treatment systems. Oral presentation at the Association of Environmental Engineering and Science Professors (AEESP) Conference, Ann Arbor, MI.

Petrovich, M., Chu, B., Wright, D., Griffin, J., Elfeki, M., Murphy, B., Poretsky, R., Wells, G. (October 2016) Comparative metagenomic analysis of antibiotic resistance genes throughout attached and suspended growth wastewater treatment systems. Poster presentation at the Emerging Contaminants in Water and Wastewater Short Course, Marquette University, Milwaukee, WI.

Project Experience

Evaluated hydrologic data from a complex hydrogeologic regime in highly fractured bedrock to assess the performance of bulkheads installed in a former underground mine. Assessed hydraulic pressures behind various bulkheads and identified transport pathways for groundwater throughout a system of interconnected mines. Evaluated the performance of mine reclamation technologies and analyzed how reclamation activities influenced broader hydrogeology and water migration throughout the region.

Performed historical reconstructions, identified contaminant migration pathways, and analyzed chemical fingerprints in soil and sediment in a system of rivers impacted by industrial activities and contaminants, including metals and PCBs, to determine relative contributions of individual sites and operators.

Analyzed soil, soil vapor, and groundwater data to identify sources of chlorinated solvent contamination (TCE) and migration patterns at a former manufacturing site with multiple historical industrial uses. Evaluated concentration data in different media and quantified trends to characterize the vertical fate and transport of contaminants through the soil column. Analyzed spatial patterns of solvents in the subsurface to assess contributions to site contamination from multiple industrial operators over time. Reviewed results of engineering pre-design tests (aquifer pumping tests and dual-phase extraction tests) for purposes of designing a final groundwater cleanup strategy.

Assessed the appropriateness and feasibility of remedial designs to mitigate and reduce volatile organic compound (VOC) contamination of soil and corresponding vapor intrusion in indoor air at a combined residential/commercial development that formerly included a dry-cleaning business. The remediation activities included interim measures for treating air and improving air circulation as well as long-term plans

for redeveloping the site with a passive sub-slab venting system and liquid boot VOC barrier to minimize indoor air contamination.

Evaluated soil and sediment chemistry data to identify localized regions with elevated potential for ecological risks associated with current and former industrial operations. Analyzed contaminated sites and cleanup processes, including review of preliminary assessment reports, remedial investigations, feasibility studies, remedial action reports, five-year review reports, and other documents related to site remediation.

Performed engineering cost estimates for retiring power generation and transmission equipment based on similar historical project costs to support infrastructure updates for a major power utility. This included estimating costs for retiring processing facilities, underground holders, gas terminals, and other assets.

Managed analytical testing of wastewater effluent from a consumer product manufacturing facility to identify potential sources of PFAS in manufacturing processes.

Calculated quantities of PFAS that could be introduced into water treatment plants by stormwater runoff under specific environmental conditions.

Evaluated environmental toxicity, persistence, and bioaccumulation potential of chemical compounds proposed for use in consumer products to support sustainable and environmentally friendly ingredient choices. Performed ecological risk assessments of compounds under proposed use scenarios using EcetocTRAM and EpiSuite software.

Performed extensive literature reviews related to environmental microbiology topics, including potential risks associated with use of microorganisms as probiotics in consumer products and bioaugmentation methods for optimizing wastewater treatment processes.

Managed investigations into identification, treatment, and prevention of microbial contamination in industrial production processes in manufacturing facilities. Coordinated development of ongoing sampling and monitoring plans to prevent, identify, and address microbial contamination in multiple facilities.

Conducted research in collaboration with the Metropolitan Water Reclamation District of Greater Chicago to analyze abundances of polyphosphate-accumulating organisms (PAOs) and glycogen-accumulating organisms in enhanced biological phosphorus removal systems in two full-scale municipal wastewater treatment plants. Identified correlations between PAOs, reactor performance, and water quality parameters in the wastewater treatment plants. These approaches to quantifying PAOs and characterizing community composition make it possible to monitor temporal changes in relative abundances of key functional microorganisms and to assess how fluctuations in community structure may be related to bioreactor performance.

Quantified antibiotic resistance genes, mobile genetic elements, viruses, and microbial community composition in a biofilm reactor operated at the lab-scale and in full-scale wastewater treatment systems with attached and suspended growth bioreactor designs (including a trickling filter biofilm system and an activated sludge system) using shotgun metagenomics, 16S rRNA Amplicon sequencing, and qPCR. Conducted similar investigations into antibiotic resistance throughout a pilot-scale hospital wastewater treatment system which intends to reuse treated wastewater effluent to irrigate on-site landscaping. Analyzed associations between viruses, their predicted bacterial hosts, and bacteria harboring antibiotic resistance genes in hospital wastewater, and assessed the potential for viruses to contribute to transfer of antibiotic resistance determinants between bacteria in wastewater treatment systems.

Collaborated with an interdisciplinary team of microbiologists, chemists, and environmental engineering researchers to evaluate the impact of bacteria and antibiotic resistance genes from treated wastewater effluent on Lake Michigan using shotgun metagenomics. This included collecting water and sediment samples at various distances from wastewater effluent discharge sites and sampling as part of the U.S.

Environmental Protection Agency's Summer Survey onboard the Lake Guardian, then tracking the fate of genes potentially associated with wastewater discharge.

Identified structural parameters of wastewater treatment biofilms based on 3D microscopy and image analysis and assessed spatial stratification of genes in biofilms. The spatial organization of genes associated with resistance to antibiotics is important in the context of engineered bioprocesses that utilize biofilms, such as trickling filters for wastewater treatment, since upper portions of biofilms are more likely than deeper regions of biofilms to detach and move downstream, where they may eventually be discharged into the environment.

Cultured microorganisms relevant to wastewater treatment, including the slow-growing ammonia oxidizing bacteria Nitrosomonas europaea and the heterotrophic organism Pseudomonas aeruginosa. Operated a controlled lab-scale system to grow single-species and mixed-species biofilms with these organisms. Used optical coherence tomography, confocal laser scanning microscopy, and epifluorescent microscopy to image biofilms, then analyzed 3D images and quantified biofilm structural parameters. Enhanced retention of ammonia-oxidizing bacteria can be beneficial in the context of biofilm reactors for wastewater treatment.

Worked with the non-profit organization Urban Biofilter on a project that aimed to reduce high asthma and cancer risk associated with particulate matter. Strategized plans to add urban greenbelts, living walls, and bamboo buffers against high-density transportation networks with vehicles that emit diesel contaminants which contribute to negative public health impacts in low-income communities. Utilized ArcGIS to map out zoning constraints and opportunities as well as parcel ownership and demographic data in order to identify areas that would most benefit from remediation by urban greening. Participated in the design and construction of a trial iteration of the PPlanter with Hyphae Design Laboratory. The PPlanter is a self-contained composting public urinal system that used bamboo planters to treat gray water and urine in the Tenderloin neighborhood of San Francisco to address the issue of human waste in the streets. Also worked with Hyphae Design Laboratory on a 100-foot long living wall and roof system for the San Francisco Museum of Modern Art. This included drafting plans for roof irrigation, structural components, piping and instrumentation, and detail specifications in AutoCAD.

Software Skills

Microsoft Excel, Microsoft PowerPoint, Adobe Illustrator, Adobe Photoshop, Adobe InDesign, Adobe Acrobat, VantagePoint, AutoCAD, EcetocTRAM, EpiSuite, ArcGIS, Python, ImageJ/FIJI, Volocity