**Project Title**

Microbial ecology and fate of pathogens in constructed polishing wetlands

**Lead Supervisor Name**

Dr Jannis Wenk

**Lead Supervisor Contact Details**

j.h.wenk@bath.ac.uk

**Lead Supervisor Location/Student Home Institution**

Institution: Bath

School: Department of Chemical Engineering

**Full Project Description**

The project aims to quantify waterborne pathogens and pathogen indicators within a newly built polishing wetland and to investigate changes in the microbial community during operation of the wetland. Traditional sewage treatment plants employing primary and secondary treatment stages are able to sufficiently remove major contaminants from wastewater. However, to sustain good water quality in receiving water bodies, the amount of nutrients, trace contaminants such as pharmaceuticals and pathogens contained in wastewater effluent is still often too high. This limits the ecological, recreational and commercial value of many surface waters in the UK. With increasing public concerns and tightening regulations water utilities worldwide have been implementing advanced tertiary treatment steps to minimise biological and chemical contaminant release from wastewater effluent and to help restoring and protecting downstream ecosystems. Among various tertiary treatment options constructed polishing wetland are particularly suitable for smaller facilities and non-urban settings. Wessex Water is constructing the first wetland in England to provide tertiary treatment for phosphorus removal from a rural sewage treatment works. This is a unique site within the UK and will help to inform the water sector and regulators on what wetlands can provide in terms of substance removal and ecology, which will in turn inform both UK permitting policy and future wetland design. The treatment wetland will be built to polish the effluent of the Cromhall sewage treatment works, which has a rural catchment area, serving three villages of a population equivalent of roughly 1900. The wetland is to be constructed during 2018 and will provide the opportunity for a contained experimental system to demonstrate removal processes and mechanisms for a range of substances of concern to the water sector. For a comprehensive study three related PhD projects are envisaged investigating the fate and transport of (1) nutrients, (2) organic trace contaminants (3) and pathogens, including bacteria, viruses and potentially selected parasites. Through state-of the art microbial detection methods, the proposed project will investigate the fate of water borne pathogens and pathogen indicator organisms during wetland passage. As a working hypothesis it is expected that sedimentation, decay and predation processes greatly reduce pathogens. In addition the project will use genetic analysis and molecular techniques to understand the development of the microbial community within the wetland. Data on the microbial fauna will allow better understanding of the metabolic potential within the wetland to degrade contaminants and to assess whether wastewater polishing wetlands may serve as a vector for the spread of antimicrobial resistance genes. The student will be supervised by a highly motivated team of researchers from the University of Bath and the University of Bristol. Tasks during the project include planning of sampling schedules and strategies, regular microbial sampling at the wetland and subsequent quantification of pathogens in the lab. The PhD project requires close cooperation and coordination with the above-mentioned complementary research projects. The student should be familiar with microbial lab techniques, have interest in both field and lab work and a background in biology, microbiology, environmental science/engineering or a related discipline.

**Real Life challenges this project will address**

Create integrated solutions to manage ecosystem service sustainability for people and ecosystems. The water sector faces the challenge of providing sustainable solutions for the reduction in nutrients and emerging substances from small sewage treatment works and the provision of a wider ecosystem service benefit. This will also provide information on the ability of constructed wetlands to remove emerging substances such as pharmaceuticals, pathogens and antimicrobial resistance genes. The data produced will inform future wetland design, permitting and highlight issues surrounding wetland management and disposal of green wastes produced.

**What you should know about this project**

This PhD project is designed for a student with background in biology, microbiology, environmental science/engineering or a related discipline, with interest in both field and lab work. The project aims to quantify waterborne pathogens and pathogen indicators within a newly built polishing wetland and to investigate changes in the microbial community during operation of the wetland. The project will benefit from strong involvement of an industrial stakeholder: Wessex Water and from two related PhD projects on (1) the fate of nutrients and (2) organic trace contaminants within the wetland. The supervisory team is well-balanced representing the multidisciplinary character of this project. The team consists of Jannis Wenk (University of Bath), water science and engineering, lead-supervisor Ruth Barden, (Wessex Water), environmental management, industrial supervisor Alexander Anesio (University of Bristol), biogeochemistry and aquatic microbial ecology Patricia Sanchez-Baracaldo (University of Bristol), microbiology and phylogenetics The wider collaborators (local co-supervisors) within each institution include: Barbara Kasprzyk-Hordern, University of Bath (environmental chemistry and Jan Hofman (water engineering) Charles Tyler, University of Exeter (environmental biology), co-supervisor University of Bristol: Richard Evershed (biogeochemistry) Penny Johnes, University of Bristol (environmental science), Wessex Water: Mark Doughty and Alex Martin (wetland systems)

**What expertise you will develop**

• Detection and quantification methods of microbial pathogens in water and sludge. • Microbial fingerprinting and microbial community analysis. • Understanding of the UK water industry and regulatory systems. • How physical, chemical and biological processes in constructed wastewater polishing wetlands improve water quality. • Working in a team with scientists on related research projects.

**Why this project is novel**

This studentship will take advantage of the first full size constructed wetland in the UK to provide tertiary treatment for phosphorus from a sewage treatment works. The wetland has been included in the Wessex Water Business Plan and recognised as the solution by the Environment Agency within the National Environment Programme. The project findings will inform water industry design and Environment Agency permitting policy on the use of wetlands within the sewage treatment system. As an additional benefit, the removal of pathogens from wastewater by polishing wetlands can lead to a significant decrease of risks for waterborne illness outbreaks downstream without the need of installing any chemical effluent disinfection capacities. While information on pathogen removal by polishing wetlands is critical for decision makers on investments in upgraded wastewater treatment technologies, little quantitative data is currently available for the UK. Microbial community analysis will provide information on metabolic pathways important for nutrient removal (e.g. nitrification/ denitrification) and the effect of trace contaminants present in the wastewater (e.g. resistance genes).

**Rest of Supervisory Team:**

**Co-Supervisor 1**

Professor Alexandre Anesio

Affiliation: Bristol

a.m.anesio@bristol.ac.uk

**Co-Supervisor 2**

Dr Patricia Sanchez-Baracaldo

Affiliation: Bristol

p.sanchez-baracaldo@bristol.ac.uk

**Co-supervisor 3**

Other Barden Ruth

Affiliation: Other

ruth.barden@wessexwater.co.uk

Ruth.Barden@wessexwater.co.uk