Dynamic licensing and active control of wastewater systems
The challenges

Regulations

High standard effluent quality

- Greenhouse gas emissions
- Energy consumption
- Operational cost
Solutions for regulation related challenges

**Option 1**
Creating an efficient system using existing process units through *active control*

- Smaller capital investment
- Greenhouse gas emissions
- Energy consumption
- Operational cost

**Option 2**
Replacing existing process units with *new advanced* units

- Higher capital investment
- Still requires appropriate control systems
Automation and active control can help in creating a robust system that can cope with dynamic loads. 

Solution for load-variability related challenges
The aim of this project is to develop a systematic framework for controlling existing wastewater treatment works through the development of control strategies and testing regulation approaches in order to reduce energy use, and reduce greenhouse gas (GHG) emissions while keeping the quality of the environment.
Control Design

**Goals and objectives**
- Formulation of control problems

**Control Strategies**
- Selection of suitable control structure and design of control algorithm

**Control structure**
- Control of the wastewater hydraulic
- Control of anoxic zone and aerobic zones in activated sludge systems
- Biomass control
- Secondary settler controls

**Performance evaluation**
- Assess the performance of the system through simulation

**Application**
- Full scale application of control strategies

**Plant goals**: more specific goals to meet societal goals

**Operational objectives**: site specific

**Societal Goals**: Regulations, care for the customer, care for the environment and so on
Control Design

Goals and Objectives
- Formulation of control problems

Control Strategies
- Selection of suitable control structure and design of control algorithm

Performance Evaluation
- Assess the performance of the system through simulation

Application
- Full-scale application of control strategies

Control of the wastewater hydraulic system
- Control of anoxic zone and aerobic zones in activated sludge systems
- Control of the secondary settler

Biomass control

Societal Goals: Regulations, care for the environment, and so on

Plant Goals: More specific goals to meet societal goals

Operational specific objectives: site-specific
Performance evaluation of integrated active control strategies

Com bined sewer overflow
T reated effluent & storm overflow discharge

Tool: Effluent generator CSO simulator
Tool: BSM2

Urban Drainage System
Wastewater Treatment Work

Simulated flow & quality of river
Flow & quality of treated effluent

Spatial rainfall
CSO flow & quality

System Components

Interdependence between system components
Impact of Data Availability on Control designs

**Integrated Active Control - What Does it Need?**

A high quality model with good accuracy

**The challenges**

- Limitations within the model
- Assumptions to simplify computationally demanding processes
- Details of available data and quality of information
- Modeller experience
Assessing the impact of **Data Availability** on Control designs

- Investigate performance of a WwTP model by using different levels of datasets.

- The increase/decrease in model performance among three scenarios was assessed to investigate the benefit of using specific dataset in model setup and calibration processes.
Commonly monitored parameters like flowrates which were monitored at 15 time step at influent and effluent points, and daily average influent and final effluent quality indicators (TSS and NH$_3$-N)
- **Dataset 2**

- **Mixed liquor suspended solid** data used to match mimic SAS flow control

- **Dissolved oxygen (DO)** level in oxidation ditch used to understand the DO control structure.
Detailed process based modelling and characterisation of the influent wastewater
Final effluent TSS and NH$_3$-N accuracy in terms of $R^2$
Key findings of the Assessment of the Impact of Data availability on model predictive accuracy

- Not all measured data increase model performance at equal level

- Monitoring the influent quality on a finer time scale and fractionating the COD and the total nitrogen of the influent wastewater plays a significant role in improving model performance and therefore formulating a reliable control design.
Anticipated outcomes

- Evaluation of different control strategies using fixed standard approach and evaluation of different integrated control strategies using dynamic licensing

- A systematic framework that can be used by Scottish Water to identify suitable control strategies depending on the various goals
Thank you for your attention

Any questions?