Summarising the evidence base on the use of surface flow treatment wetlands for phosphorus removal

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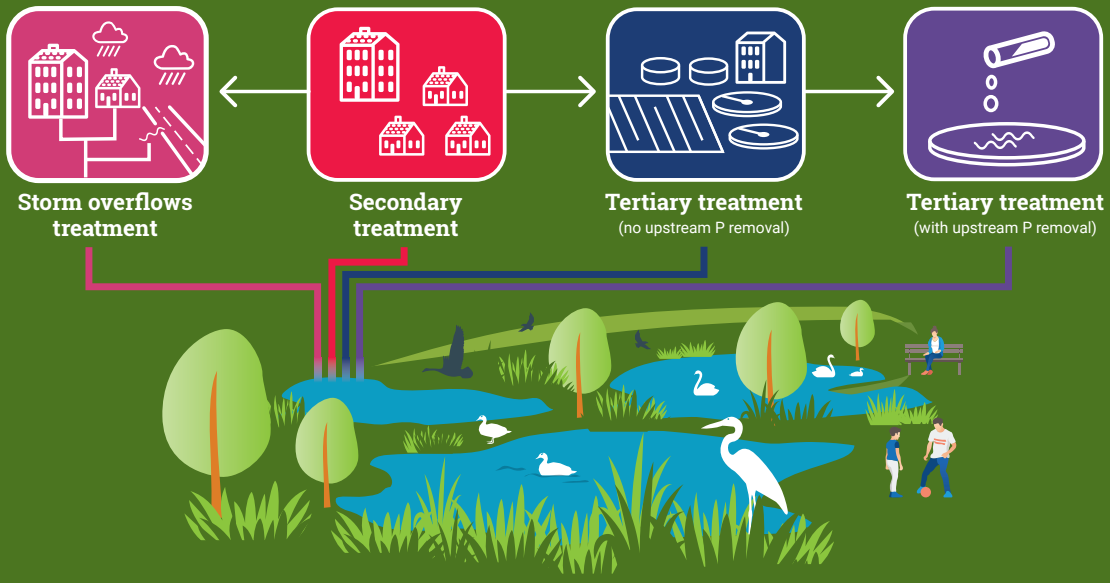
Nature-based solutions for wastewater treatment and management

Green roofs | Constructed wetland | Green urban spaces | Bioswales | Natural wetlands | Mangroves | Reforestation

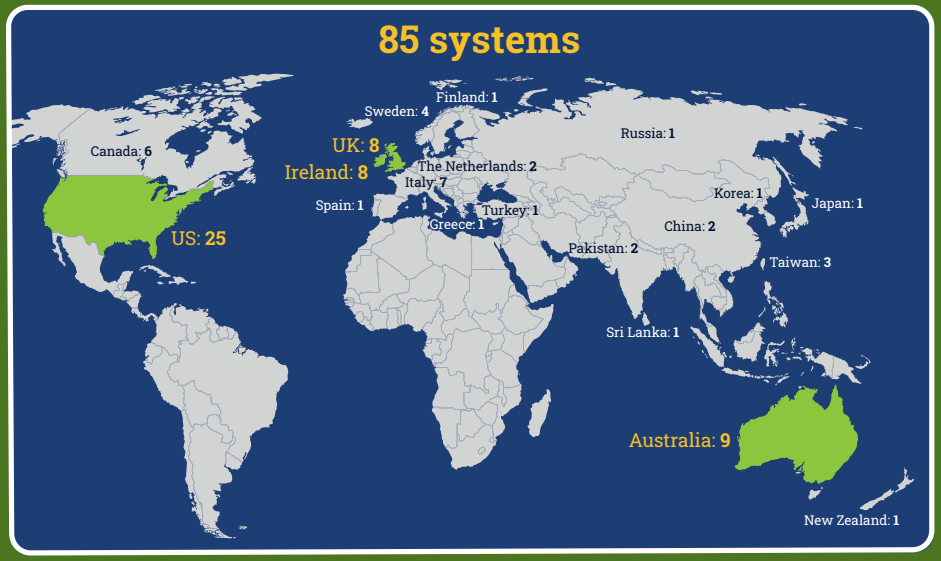
Surface flow treatment wetlands for domestic wastewater treatment

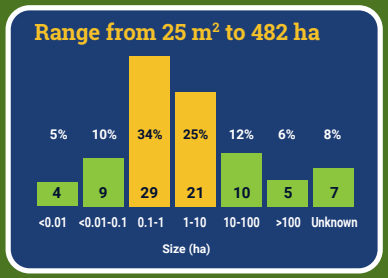
(Free water surface treatment wetlands)

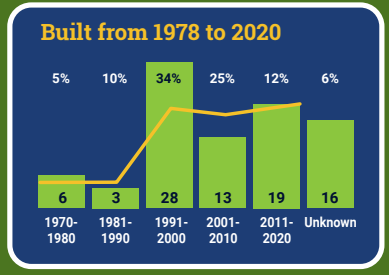


Storm overflows treatment | Secondary treatment | Tertiary treatment (no upstream P removal) | Tertiary treatment (with upstream P removal)

Case studies from around the world







Overall conclusion

There is strong evidence that surface flow wetlands can capture phosphorus from sewage but there are critical gaps in understanding the long-term storage mechanisms resulting in significant uncertainties regarding achievable effluent quality for secondary treatment applications, with a lower risk for tertiary or polishing applications.

Phosphorous removal performance

80% of the 44 tertiary treatment systems without upstream P removal produced annual average effluent TP ≤ 3 mg/L

96% of tertiary treatment systems have no start-up period

- **Annual average effluent TP < 1 mg/L** (without upstream P removal) with Influent TP < 3.2 mg/L and TP load < 28.5 mg/m²/yr
- **Annual average effluent TP < 0.35 mg/L** (with upstream P removal) with Influent TP < 0.75 mg/L

Seasonal performance:

85% of systems show no seasonality in TP effluent concentrations

Long-term performance:

95% of systems have stable annual average effluent TP over up to 30 year period

0 YEARS 30

System design

The current dataset is unable to verify the existing model and obtain key TP removal rates used for system design and effluent TP prediction

£ Cost implication of liners

Additional cost to 1-ha wetland construction 5% to 50%*

*excluded any design fees and "on costs" associated with delivery of projects

Multi-benefits:

- Improved water quality
- Flow attenuation (flood control storm buffer)
- Ecosystem services (biodiversity and wildlife)
- Recreation and tourism
- Carbon sequestration
- Education purpose and human welfare
- Reduced energy consumption
- Lower operational costs and maintenance

Research gaps

- To aid performance prediction design guidance needs to be developed based on target total phosphorus effluent quality.
- To investigate the numeric quantification of multiple benefits (e.g., carbon, biodiversity, biomass production), predicted changes in land use, and climate change.
- Other applications of surface flow treatment wetlands, including the targeting of other pollutants and further research on storm overflows treatment.

Next steps

Targeted work is needed to advance the understanding of phosphorus transformations in wetland systems. A UK and Ireland-wide co-ordinated trials effort for intensive monitoring and mechanistic research to develop inherently robust and resilient wetlands that minimise the environmental footprint of phosphorus capture from sewage is required.

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