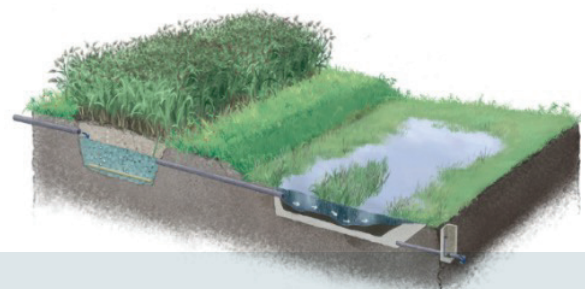


Italy – IRIDRA – Hybrid treatment wetland treating combined sewer overflows



Jaurrieta, Lide; Pueyo-Ros, Josep; Comas, Joaquim; Beral, Henry; Guillaume-Ruty, Sophie Hai Yen; Gonzalvo, Gisela, 2024, "Illustrations of nature-based solutions for urban water management", <https://doi.org/10.34810/data1745>, CORA.Repositori de Dades de Recerca, V1



DESCRIPTION

Located in Merone, Italy, Pilot 4 is a full-scale **aerated hybrid treatment wetland** aims to tackle **frequent and prolonged combined sewer overflows (CSOs)**, which can last for days and lead to untreated discharges into receiving waters, exacerbating pollution. Designed by IRIDRA in collaboration with COMO ACQUA and local stakeholders, the system integrates **aerated wetland beds** with a **surface flow wetland**, enhancing **pollutant removal efficiency** while keeping **operational costs low** compared to conventional infrastructure. Its high hydraulic flexibility allows it to adapt to intense weather events, making it a resilient solution for urban water management. Additionally, it delivers key **co-benefits**, including **cost savings, biodiversity enhancement, and educational value**.



DESIGN AND TECHNICAL DETAILS

Type of influent

CSOs with fluctuating pollutant loads.

Design

- Four aerated wetland beds covering 4,000 m².
- A 1,500 m² surface flow wetland for final polishing.
- Subsurface gravel layers and throttling valves for controlled infiltration and retention.
- Automated aeration and pumping system for optimized performance.

Cost

Up to 5x lower CAPEX & OPEX than grey infrastructure (€0.10/m³ vs. €0.46/m³).

Climatic conditions

Temperate climate with seasonal variations in rainfall affecting CSO frequency and composition.

Operational constraints



Land footprint:

Requires extensive space.



Biohazard

Pathogen risks in untreated CSOs require protective measures during maintenance.

Maintenance



Vegetation management

Periodic harvesting (1 per year).



Sludge control

Periodic removal of accumulated solids (1 every 10 years).

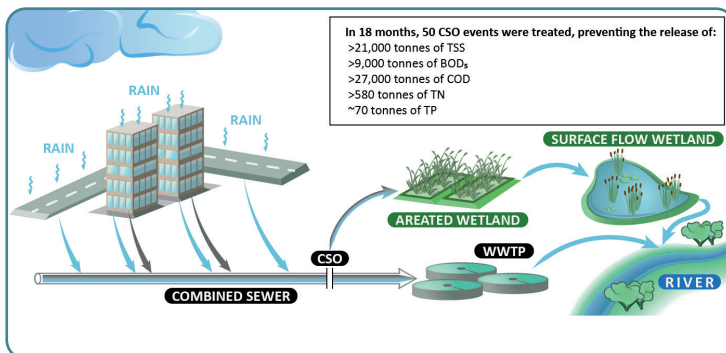


Aeration system upkeep

Regular cleaning and calibration.

TREATMENT PERFORMANCES

- **Conventional Pollutants:** High removal rates for Total Suspended Solids (TSS) (95.6%), COD (85.3%), and BOD5 (89.0%); moderate reductions in Total Nitrogen (31.9%) and Total Phosphorus (20.9%).
- **Metals:** Effective removal (70–90%) for cadmium, chromium, iron, copper, zinc, and aluminum; lower for manganese (29.9%), nickel (19.4%), and selenium (36.5%).
- **Organic Micropollutants:** Mixed performance, with high (>90%) removal for ciprofloxacin, trimethoprim, mycophenolic acid, and citalopram, while some compounds like venlafaxine and carbamazepine showed limited removal.
- **Microplastics:** Strong retention (70–90%) for PMMA, nylon, polypropylene, PVC, and polystyrene; PET (~15–20%) had lower removal.
- **Pathogens:** Moderate reduction (0.5–2 log); E. coli (0.75 log), total coliforms (1.23 log), enterococci (2.16 log); Salmonella, Rotavirus, Adenovirus, and Enterovirus were not detected



RISK ASSESSMENT

- **Pathogens:** The annual risk of infection from an eventual reuse for toilet flushing is 0.473% for Escherichia coli and 0% for Salmonella.
- **Metals & Pharmaceuticals:** The treatment achieves a moderate to high-risk reduction (median: 64.7%). Contrast agents pose no risk.
While the NBS effectively reduces risk, some effluent risk levels remain non-negligible, requiring potential further treatment.
- **Environmental Impact:** The overall risk is low, thanks to the dilution factor (medium risk for Se, As, Cd, Mn, and Zn).

CO-BENEFIT ANALYSIS

- Flood Reduction:** Reduces flood risk and prevents untreated discharges.
- Cost Savings:** Up to 5 times lower CAPEX & OPEX than conventional infrastructures.
- Biodiversity:** Enhances urban ecology, supporting bird diversity similar to semi-natural wetlands.
- Educational Value:** Over 100 visitors, including students and professionals, promoting awareness of nature-based solutions.

TAKE-HOME MESSAGES

- **High treatment capacity:** Treated 400,000 m³/year (2023–2024) with stable performance.
- **Enhanced hydraulic efficiency:** Operated at 100–150 m/year HLR, exceeding passive wetland standards.
- **Effective pollutant removal:** High reduction of TSS, COD, BOD5, N-NH₄⁺, heavy metals, and microplastics.
- **Optimized aeration potential:** Performance results indicate potential for energy savings and efficiency improvements.