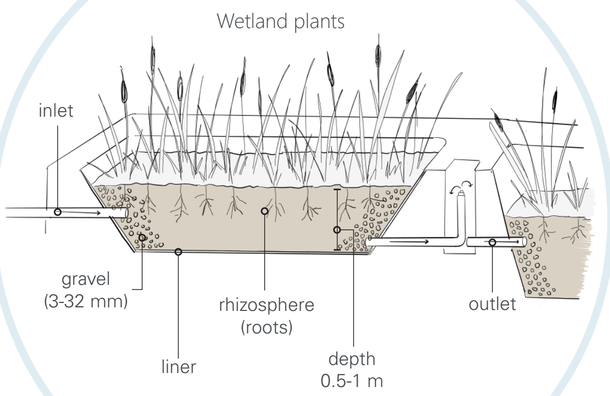
T.44 CONSTRUCTED WETLANDS

TECHNOLOGY



Horizontal, subsurface flow constructed wetland

Constructed wetlands (also referred to as artificial marshes, reed filters, or heliiophyte filters) are engineered marshes that mimic natural wetland mechanisms to improve water quality. Constructed wetlands consist of sealed basins filled with permeable filter substrate (soil, rock, gravel, sand, etc.) and planted with reeds and plants adapted to water-saturated conditions, called macrophytes. The water either flows over the surface of the wetland or through the porous substrate, horizontally or vertically. The material, colonized by microorganisms, allows for sorption and biological degradation of nutrients and contaminants; the plants serve to maintain the permeability of the filter, keep it aerated, assimilate nutrients, and provide a habitat for microorganisms. The treatment train for a constructed wetland often includes pre- and post-treatment steps.

Wetlands are low-tech, nature-based solutions that in addition to treating water, offer ecosystem services, and have recreational and aesthetic value. Wetlands can be integrated into the urban environment to support biodiversity, store water, and provide local cooling.

INPUT STREAMS

- GW Pre-treated Greywater
- MW Pre-treated Mixed Wastewater
- RW Rainwater

TARGET OUTPUT(S)

- Treated Water

SIDWELL FRIENDS MIDDLE SCHOOL

Washington DC, USA | 2007

Wetland treatment for mixed wastewater at urban school

This LEED Platinum-certified school treats mixed wastewater from toilets and sinks through a series of physical and biological technologies. The gravity-fed wetland (3600 m²) treats 11 m³ per day, circulating through the entire treatment train for 3-5 days before reuse (toilet flushing and irrigation). Pre- and post-treatment steps take place in the basement. The school has reduced their water consumption by 90%. The wetland, rain garden and biology pond are used in the school curriculum.

MW — T.42 SETTLING TANK — T.44 CONSTRUCTED WETLAND — T.45 TRICKLING FILTER — T.49 SAND FILTER — T.50 UV DISINFECTION — Treated Water

SPECIFICATIONS

INFRASTRUCTURE

Wetlands can be designed for neighborhoods, buildings or for single households. Often placed outdoors, land requirements for constructed wetlands are high and thus lend themselves for low-density areas. In high-density areas, wetlands can be integrated into city infrastructures (e.g., in courtyards, parks, and on roofs). The technology is best suited for warm climates though can withstand low-temperature conditions (with cold-resistant plants). Key design aspects of wetland types include:

Hydraulic retention time (HRT): Wetland size depends on the time it takes the water to flow through the wetland. The longer the HRT, the greater the nutrient removal.
Flow: Water can flow horizontally or vertically, and over (surface) or below (subsurface) the wetland substrate. In tidal wetlands water is filled intermittently, with flooding and draining stages.
Plants: Plants can be floating, submerged, or emergent, and should be climate-appropriate (e.g., low-temperature resistant).

OPERATION & MAINTENANCE

Constructed wetlands are considered a cost-effective and efficient nature-based solution for water treatment. These solutions typically have low construction, operation and maintenance costs, and low to no energy demands. Maintenance includes the periodic harvesting of plant biomass, and ensuring that the filter material near the inlet zone is free from solids and biofilm build-up (clogging). Removal of solids at inlet may be necessary every 10 years. Effective primary treatment (i.e., the separation of solids) also helps reduce particles entering the wetland. Nearby tree roots can damage wetland liners. Operation includes optimization of hydraulic conditions and monitoring of treatment performance.

Wetland plants remove nutrients from wastewater via assimilation into their biomass. However, they also take up and accumulate heavy metals. Potential risks should be considered when reusing plant biomass.

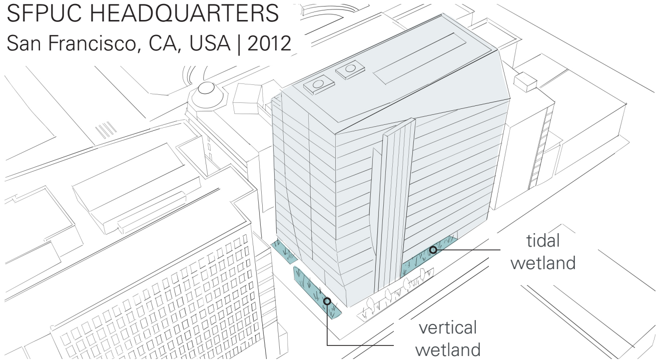
TARGET OUTPUT

Treated water from constructed wetlands can be used outdoors or infiltrated into the soil. For use indoors, further filtration and disinfection are necessary to achieve higher water qualities (see).

Wetland performance for contaminant removal is variable depending on weather conditions, influent composition and operation. Water losses through evapotranspiration occur; in wet climates rainwater enters the system.

SELECTED CASE STUDIES

SFPUC HEADQUARTERS
San Francisco, CA, USA | 2012



Wetlands integrated in urban office building and sidewalk

The San Francisco Public Utilities Commission Headquarters' "living machine" treats mixed wastewater with a series of treatment steps including tidal, subsurface flow constructed wetlands and vertical flow wetlands with a capacity of ~19,000 liters per day. The treated water is used for toilet flushing in the building, reducing consumption by 50%. The wetlands are creatively integrated into the bordering sidewalk and in the ground floor atrium of the building. The building meets all available LEED water credits and is LEED Platinum certified. The living machine and rainwater harvesting system together cost 1 million USD.

MW — T.42 SETTLING TANK — T.44 CONSTRUCTED WETLAND — T.49 MEDIA FILTER — T.50 UV DISINFECTION — T.50 CHLORINE DISINFECTION

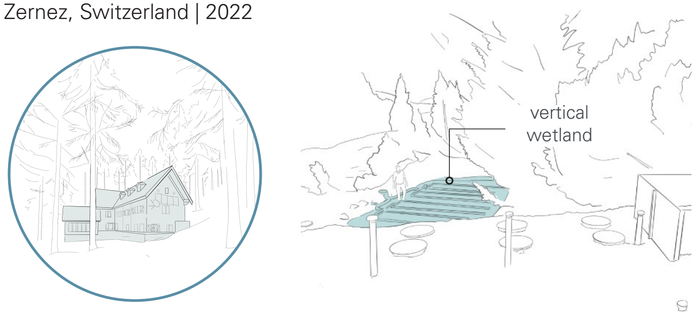
BWWB BOSCHVELD
's-Hertogenbosch, the Netherlands | 2018

Residential greywater treatment with vertical flow wetland

BWWB (Bewonersvereniging Bewust Wonen en Werken Boschveld) is a 24 household residential "eco-neighborhood" that has opted to treat their mixed wastewater (~7,000 liters per day) with a vertical constructed wetland (250m²), located in the shared garden. Pre-treatment includes two settling tanks with a five-day retention time, and a buffer tank from which the water is pumped to the wetland several times per day. The treated water is reused for toilet flushing, reducing water consumption by 40%. Excess treated water is infiltrated underground. The municipality monitors the treated water and groundwater quality regularly.

GW — T.42 SEPTIC TANK — BUFFER TANK — T.44 CONSTRUCTED WETLAND — T.41 STORAGE TANK

Chamanna Cluozza
Zernez, Switzerland | 2022



Mixed wastewater treatment at mountain lodge with wetland

Located at 1882 m in the heart of the Swiss National Park, Chamanna Cluozza offers accommodation to (~30) hikers and staff. Water used onsite is sourced from nearby springs, the wastewater is treated decentrally. Blackwater from the flush toilets and greywater flow together through a vermifilter with charcoal filter (12 m²). The effluent is then treated with a constructed wetland (40 m²), after which it is led to an infiltration area. The water is not reused. The worm compost from the vermifilter is emptied periodically and used onsite as a soil amendment.

MW — T.43 VERMIFILTER (→ vermicompost) — T.44 CONSTRUCTED WETLAND — INFILTRATION