WILLOW SYSTEMS

AUTHORS

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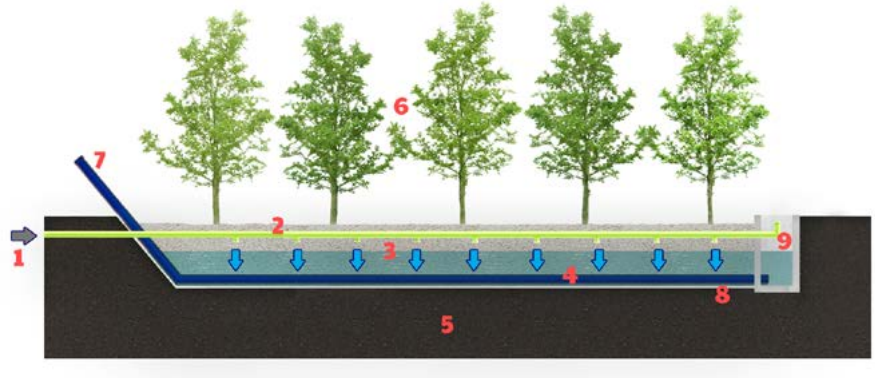

1 - Inlet
2 - Feeding system
3 - Soil
4 - Drainage system
5 - Original soil
6 - Trees
7 - Maintenance pipe
8 - Waterproof liner
9 - Inspection manhole

Description

Willow systems are treatment wetlands (TW) dominated by willows. They are used for on-site wastewater treatment and reuse by production of woody biomass. They are designed to treat all inflow water through evapotranspiration and thus there is no outflow from the system. Zero-discharge willow systems are most appropriate for the sites with strict wastewater discharge standards or where soil infiltration is not possible; however, systems with outflow or percolation are also in use. Zero-discharge willow systems produce a significant amount of biomass that can be used for energy purposes, as well as soil amendment, etc.

Advantages

- No specific hazard with mosquito breeding
- Robust against load fluctuations
- Zero emissions of pollutants to the environment
- No recipient or infiltration needed
- Woodchip production

Disadvantages

- Has to be coupled with biomass harvesting and use

Co-benefits

High	Biomass production	Carbon sequestration	Pollination		
Medium	Biodiversity (fauna)	Biodiversity (flora)	Flood mitigation	Aesthetic value	Recreation

Compatibilities with Other NBSs

Can be combined with horizontal flow and vertical flow wetlands as well as with free water surface wetlands and ponds for evapotranspiration to take place at the outflow and produce biomass or to contribute to treatment when operating as a flow-through system.

Case Studies

In publication

- Zero-discharge wastewater facilities: willow systems

Operation and Maintenance

Regular

- Control of primary treatment and plant health inspection (visual)
- 12 hours for regular maintenance per year; additional 15 minutes per 100 m^2 for machine harvesting of willows during the harvesting year
- Sludge removal from pretreatment. The emptying interval depends on the volume of the tank
- Harvesting (half or one-third of system every second or third year, respectively)

Extraordinary

- Water level inspection in the case of extraordinarily high precipitation

Troubleshooting

- Salinity increase after 20 years' or more operation: necessary to flush the system through maintenance pipe

Literature

Brix, H., Arias, C. A. (2011). Use of willows in evapotranspirative systems for onsite wastewater management – theory and experiences from Denmark. "STREPOW" International Workshop, Novi Sad, Serbia, February 2011, pp. 15-29.

Curneen, S. J., Gill, L. W. (2014). A comparison of the suitability of different willow varieties to treat on-site wastewater effluent in an Irish climate. Journal of Environmental Management, 133, 153-161.

NBS Technical Details

Type of influent

- Primary treated wastewater
- Secondary treated wastewater
- Greywater

Treatment efficiency

Zero discharge systems have no outflow, resulting in overall 100% treatment efficiency. Pollutants such as heavy metals can be stored in the system. The systems with percolation have the following treatment efficiency:

• COD	92–100%
• BOD_5	98–100%
• TN	85–100%
• NH_4-N	90–100%
• TP	~100%
• TSS	~100%
• *Escherichia coli*	< 1,000 CFU/100 mL

Requirements

- Net area requirements: based on water production use rather than on a pollutant load and is 68-171 m^2 for 100 m^3 water per year or 30–75 m^2 per capita (if water production is 120 L per capita and day)
- Electrical consumption: intermittent pumping of inflow water: 7–10 kWh per capita and year

Design criteria

- COD and TSS (pollutant load g/m^2/day): due to zero discharge willow systems are designed according to the volume of water to be used (see requirements); the COD and TSS are not design criteria
- HLR: depends on willow evapotranspiration rate at specific location

Commonly implemented configurations

- Individual system (most common)
- HF/VF/FWS - willow system

NBS Technical Details

Climatic conditions

- Suitable for both warm and cold climates; however, local species and clones of willow must be selected
- In areas with higher evapotranspiration, the surface area needed can be smaller and vice versa