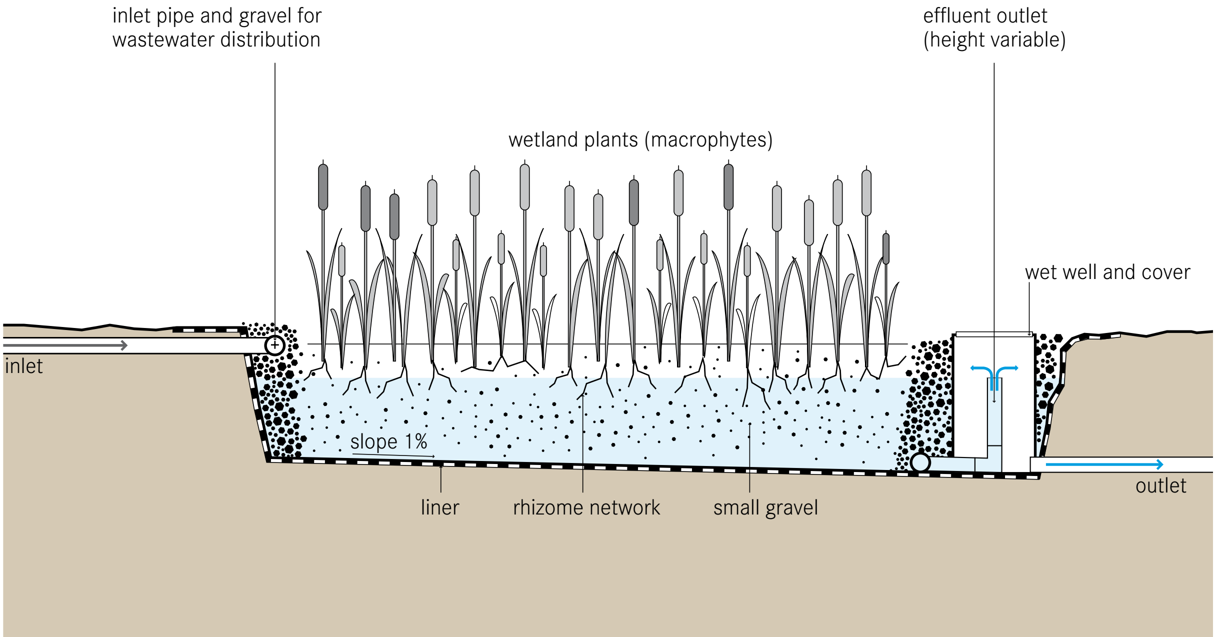
T.8

Horizontal Subsurface Flow Constructed Wetland

Applicable to:
Systems 1, 6-9

Application Level:	**Management Level:**	**Inputs:** Effluent, Blackwater, Brownwater, Greywater
★ Household	★ Household	**Outputs:** Effluent, Biomass
★★ Neighbourhood	★★ Shared	
★ City	★★ Public	



A horizontal subsurface flow constructed wetland is a large gravel and sand-filled basin that is planted with wetland vegetation. As wastewater flows horizontally through the basin, the filter material filters out particles and microorganisms degrade the organics.

The filter media acts as a filter for removing solids, a fixed surface upon which bacteria can attach, and a base for the vegetation. Although facultative and anaerobic bacteria degrade most organics, the vegetation transfers a small amount of oxygen to the root zone so that aerobic bacteria can colonize the area and degrade organics as well. The plant roots play an important role in maintaining the permeability of the filter.

Design Considerations The design of a horizontal subsurface flow constructed wetland depends on the treatment target and the amount and quality of the influent. It includes decisions about the amount of parallel flow paths and compartmentation. The removal efficiency of the wetland is a function of the surface area (length multiplied by width), while the cross-sectional area (width multiplied by depth) determines the maximum possible flow. Generally, a surface area of about 5 to 10 m^2 per person equivalent is required.
Pre- and primary treatment is essential to prevent clogging and ensure efficient treatment. The influent can be aerated by an inlet cascade to support oxygen-dependent processes, such as BOD reduction and nitrification.
The bed should be lined with an impermeable liner (clay or geotextile) to prevent leaching. It should be wide and shallow so that the flow path of the water in contact with vegetation roots is maximized. A wide inlet zone should be used to evenly distribute the flow. A well-designed inlet that allows for even distribution is important to prevent short-circuiting. The outlet should be variable so that the water surface can be adjusted to optimize treatment performance.
Small, round, evenly sized gravel (3 to 32 mm in diameter) is most commonly used to fill the bed to a depth of 0.5 to 1 m. To limit clogging, the gravel should be clean and free of fines. Sand is also acceptable, but is more prone to clogging than gravel. In recent years, alternative filter materials, such as PET, have been successfully used. The water level in the wetland is maintained at 5 to 15 cm below the surface to ensure subsurface flow.
Any native plant with deep, wide roots that can grow

in the wet, nutrient-rich environment is appropriate. *Phragmites australis* (reed) is a common choice because it forms horizontal rhizomes that penetrate the entire filter depth.

Appropriateness Clogging is a common problem and, therefore, the influent should be well settled with primary treatment before flowing into the wetland. This technology is not appropriate for untreated domestic wastewater (i.e. blackwater). It is a good treatment for communities that have primary treatment (e.g., Septic Tanks, S.9), but are looking to achieve a higher quality effluent.

The horizontal subsurface flow constructed wetland is a good option where land is cheap and available. Depending on the volume of the water and the corresponding area requirement of the wetland, it can be appropriate for small sections of urban areas, as well as for peri-urban and rural communities. It can also be designed for single households.

This technology is best suited for warm climates, but it can be designed to tolerate some freezing and periods of low biological activity. If the effluent is to be reused, the losses due to high evapotranspiration rates could be a drawback of this technology, depending on the climate.

Health Aspects/Acceptance Significant pathogen removal is accomplished by natural decay, predation by higher organisms, and filtration. As the water flows below the surface, any contact of pathogenic organisms with humans and wildlife is minimized. The risk of mosquito breeding is reduced since there is no standing water compared to the risk associated with Free-Water Surface Constructed Wetlands (T.7). The wetland is aesthetically pleasing and can be integrated into wild areas or parklands.

Operation & Maintenance During the first growing season, it is important to remove weeds that can compete with the planted wetland vegetation. With time, the gravel will become clogged with accumulated solids and bacterial film. The filter material at the inlet zone will require replacement every 10 or more years. Maintenance activities should focus on ensuring that primary treatment is effective at reducing the concentration of solids in the wastewater before it enters the wetland. Maintenance should also ensure that trees do not grow in the area as the roots can harm the liner.

Pros & Cons

+ High reduction of BOD, suspended solids and pathogens
+ Does not have the mosquito problems of the Free-Water Surface Constructed Wetland
+ No electrical energy is required
+ Low operating costs
- Requires a large land area
- Little nutrient removal
- Risk of clogging, depending on pre- and primary treatment
- Long start-up time to work at full capacity
- Requires expert design and construction

References & Further Reading

_ Crites, R. and Tchobanoglous, G. (1998). *Small and Decentralized Wastewater Management Systems.* WCB/McGraw-Hill, New York, US. pp. 599-609.
(Comprehensive summary chapter including solved problems)

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