



What are Constructed Wetlands?

Constructed wetlands are media-flow systems based on the principals of natural wetlands, but with specific media and hydrology to enhance the uptake, removal, and/or conversion of specific substances. The design dictates their capability to remove particular contaminants.

Constructed wetlands have been used throughout Canada to treat a variety of waters for the removal of nutrients, pesticides, metals, and pathogens. Typical influent waters are as varied as barnyard runoff, milkhouse washwater, municipal or domestic sanitary sewage or wastewater, landfill leachate, fruit and vegetable processing wastewater, winery effluent, and greenhouse and container nursery irrigation water runoff.

Undesirable nutrients or contaminants passing through a constructed wetland are removed by a combination of physical, biological and chemical processes: filtering through or binding to the media, plant uptake, and uptake or conversion by attached microorganisms on plant roots and on media itself. The activity of these microorganisms can influence the function and effectiveness of a constructed wetland.



Figure 1: Surface flow constructed wetland

Constructed wetlands can provide long-term

effective treatment of water with low maintenance and operational costs, and can be used in both open (water released) and closed (water recycled) systems. There are two main forms of constructed wetland: surface and subsurface flow. Surface flow wetlands (Figure 1) are usually simple, shallow systems where wastewater flows over the top of the system and infiltrates down through the media.

Subsurface flow wetlands (Figures 2, 3) direct the flow through a granular media that is typically sand or gravel. The flow can either be horizontal or vertical under saturated or unsaturated conditions depending upon the treatment objectives.



Figure 2: Mineral media cells under construction



Figure 3: Newly planted vertical subsurface flow constructed wetland (Aqua Treatment Technologies)

Vertical subsurface flow wetlands take less space and usually perform better than surface flow wetlands in colder climates (i.e. Ontario) because

the active part of the wetland is below ground. Subsurface flow wetlands stay above freezing temperatures and are more effective at filtration and microbial processes.

In both forms, vegetation can be rooted in the medium (emergent macrophytes such as sedges, cattails, reeds Figure 3), free floating (water hyacinth, duckweed), or submerged (elodea). Natural wetlands tend to be surface flow with mixed plant populations suited to the habitat.

Removal rates of particular constituents depend primarily on:

- Type of media: specific media can help with filtration, nutrient removal as well as Biological Oxygen Demand (BOD) removal
- Water and oxygen levels in the media
- Hydraulic retention time: the length of time the water to be treated spends in the wetland system
- Temperature: wetlands perform best in the summer because microbial activity increases at higher temperatures
- Season: some reversal of nutrient removal can occur in the winter because of release from organic matter as plants die-off

Multiple stage wetlands (hybrid treatment systems) provide flexibility; media in each cell can be optimized to remove specific types of contaminants. For example, using a sand/gravel first stage can remove suspended solids from the wastewater, thus enabling better performance in subsequent cells. Organic media cells such as peat or wood chips can be added to improve nitrate-nitrogen removal. Additional mineral-media cells

(e.g. slag mixtures or wollastonite) can improve the removal of phosphorus.

Who can use constructed wetlands?

- Growers with sufficient landbase depending of volumes to be treated
- Growers who want to remove multiple contaminants (e.g. undesirable nutrients, pesticides, solids and BOD)
- Growers who want to remove solids and organic matter to 'clean up' water for further treatment (e.g. UV disinfection) in closed loop systems
- Growers who want to recover some nutrients in closed loop systems
- Growers who need to rebalance a nutrient irrigation solution in closed loop systems (e.g. adjust nutrient levels, EC, or pH)
- Growers who need to meet environmental discharge standards

Consult a firm familiar with proper design and construction of these engineered wetland systems. Note that discharges to the environment require an Environmental Compliance Approval.

Further Reading

A detailed guide to constructed wetlands for the horticulture industry has been written by Sarah White at Clemson University and her co-authors: **Constructed Wetlands: A How to Guide for Nurseries**, White et al. 2011.

https://www.clemson.edu/extension/horticulture/nursery/images/cws_howtoguide_small.pdf



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