



# reed beds



*Newly planted domestic gravel reed bed system for septic tank effluent treatment prior to percolation.*

## what are they?

In a low-impact context, they're wastewater treatment systems (aka treatment wetlands, constructed wetlands or reed bed treatment systems), that use wetland plants as the active component in cleaning effluent enough to discharge back into the environment. They have the potential to be low-cost, zero energy input, low-tech, high-efficiency systems that can help protect streams and rivers from almost any source of effluent or dirty water.

### How reed beds work

Reed beds and constructed wetlands work in a very similar way to conventional treatment systems. Primary settlement takes place in a septic tank; secondary aeration is provided by the plants, which draw oxygen down to the roots via the leaves, where it becomes available for aerobic bacteria; tertiary polishing is carried out if the reed bed is built large enough, providing further removal of nitrogen and phosphorus.

The following physical, chemical and biological treatment mechanisms all come into play (see [lowimpact.org/reed-beds](http://lowimpact.org/reed-beds) for explanations): sedimentation; bacterial action; filtration; nutrient uptake; adsorption; precipitation; decomposition; volatilisation.

### Different types of reed bed system

The terms reed bed and constructed wetland are often used interchangeably, but there are a number of distinct system types within the general category of treatment wetlands. Although these different system types can be used in series on any given project, the design protocol for each type should not be used interchangeably. The different reed bed types are usually categorised as follows:

**Soil-based constructed wetlands** or free water surface (FWS) wetlands: most closely resemble a natural marsh. They consist of a lined shallow basin, backfilled to c.150mm with loam soil and planted with tall wetland plants. Effluent is treated as it moves slowly through the plant stems and leaf litter that accumulates in the shallow water of the marsh. Integrated constructed wetlands (ICW) and wetland ecosystem treatment (WET) systems both fall into the constructed wetland category.

**Horizontal flow gravel reed beds** or horizontal sub-surface flow (HSSF) systems: generally smaller in footprint area, they consist of a 6-700mm bed of limestone gravel into which common reed and other wetland plant species are planted. The effluent is treated as it flows through the gravel and plant roots.

**Vertical flow (VF) reed beds:** similar in layout to a raised sand polishing filter or stone trickling filter, they have a smaller footprint area than horizontal flow reed beds. The VF reed bed consists of c.1m of gravel, of progressively smaller particle sizes towards the bed surface. Effluent is dosed over the bed surface by pumped feed or gravity dosing mechanism and treatment occurs as it trickles down over the gravel media and plant roots. VF reed beds filled or topped with sand can be prone to blocking unless the exact aggregate grades are used and the correct degree of pretreatment is consistently achieved.

**Ponds** may also be used to provide additional storage volume. They have the advantage of offering an additional habitat – particularly towards the end of a system where the effluent is cleaner. They also offer greater penetration of UV light than marsh areas, for extra die-off of pathogens.



*Common reed (Phragmites australis) is the most common species used in constructed wetlands and reed beds. The dense growth and vigorous roots provide excellent conditions for filtering water.*



## what are the benefits?

Reed beds and constructed wetlands can offer a zero energy input way to get our sewage clean, helping to preserve the habitat integrity of our rivers, lakes and coastal waters for biodiversity.

**Soil-based constructed wetlands** work well on larger sites where a natural habitat appearance is desired. They can be a low-cost, low-resource system on clayey soils, but can also be plastic lined where needed. They provide habitat for a wide range of wildlife.

**Horizontal flow reed beds** are more suitable for sites where space is limited, or where it's desirable that the effluent is covered by a gravel surface. They need a tougher liner than soil-based wetlands, and tend to be more formal in final appearance, which can suit some garden layouts.

**Vertical flow reed beds** are generally used to pretreat effluent entering a horizontal flow reed bed, where a higher quality of effluent is needed in a small space. They can also be effective where good soil percolation characteristics exist, but where a quick burst of treatment is needed prior to discharge to ground. A pump is usually needed to distribute effluent over the reed bed surface. That said, a gravity splitter, dosing box or syphon may all be used where suitable falls are present.

## what can I do?

The more you do yourself, the lower the cost. Reed beds / constructed wetlands usually require planning permission, so you can prepare site / system drawings yourself, or go to a specialist consultancy. The excavation, lining, pipework and manhole construction all require skilled input. You can hire a mini-digger and do it yourself, or hire a groundworks contractor, landscaper or sewage treatment specialist. Planting with the right plants is the final stage (to be carried out before connecting the septic tank!). If you have a boggy field nearby with the right plants, that will be the lowest carbon footprint approach. You can also buy from specialist suppliers. The *Permaculture Guide to Reed Beds* gives guidance on all of these stages, as well as sizing.

Using a reed bed for grey water only can have advantages over treating black and grey water together. The system can be smaller because the influent is not as dirty, has fewer pathogens and may not need planning permission. With a large

wetland, you can reuse the final effluent for watering a polytunnel (use natural cleaners etc.).

Grey water from washing machines and dishwashers can be surprisingly polluted with nutrients, detergents, cleaning chemicals etc., so be sure not to undersize your system. Grey water accounts for c.60% of all household sewage volume, so you may want to build your grey water wetland or reed bed at 60% of the standard sizing recommendations. See Art Ludwig's *Oasis Design* for guidance on grey water systems.

Constructed wetlands can also be used as SUDS (Sustainable Drainage Systems) to filter runoff from yards, roofs and roads. They can be fitted with a variable flow control unit to allow flooding during heavy rainfall, then draw down slowly in drier weather to balance the flow in streams and filter water before discharging to the environment.

## resources

- see [lowimpact.org/reed-beds](http://lowimpact.org/reed-beds) for more info, courses, links & books, including:
- Feidhlim Harty, *Permaculture Guide to Reed Beds*
- Grant, Moodie & Weedon, *Sewage Solutions*
- Gary Austin & Kongjiang Yu, *Constructed Wetlands & Sustainable Development*
- [constructedwetland.co.uk](http://constructedwetland.co.uk) – Constructed Wetland Association
- [oasisdesign.net](http://oasisdesign.net) – greywater specialist
- [epa.gov/wetlands/constructed-wetlands](http://epa.gov/wetlands/constructed-wetlands) – technical documents on constructed wetlands



*Reed bed mid-construction: upper vertical flow bed followed by lower horizontal flow reed bed, then planted with Phragmites and Iris.*

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