



# Vertical Flow

Vertical flow reed beds can achieve higher Oxygen transfer rates than other passive reed bed systems reducing the required land take and enhancing treatment capabilities.

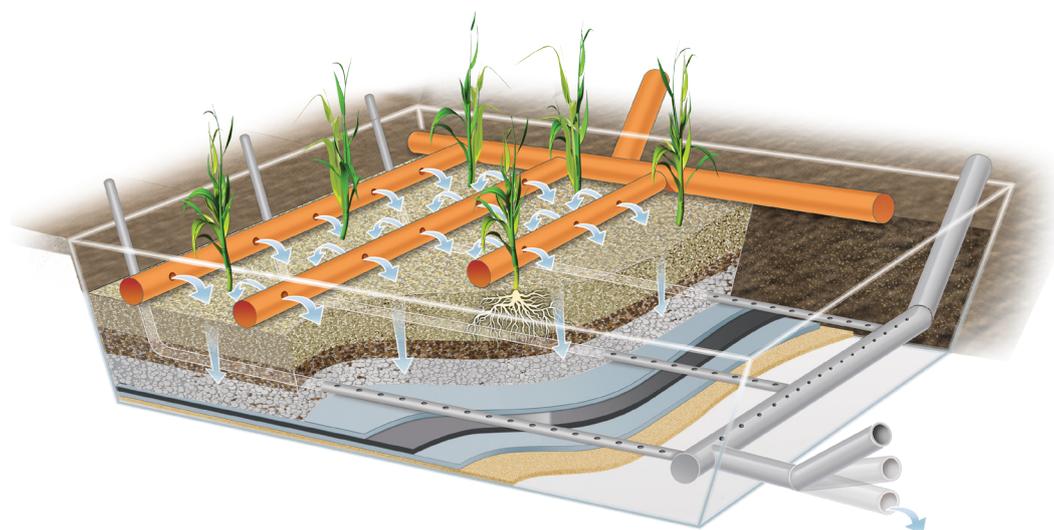


The vertical flow (VF) systems comprise a lined excavation filled with media such as sand or gravel media and unlike the horizontal flow systems, VF systems media is often graded. VF systems can have a smaller footprint than HF systems and can cope with stronger effluents. Effluent can be dosed in a variety of ways including pulse-loaded (batch), recirculating vertical flow, continuous downflow and fill-and-drain (tidal flow) wetlands. The effluent is distributed over the bed until the surface

is flooded then passes through the bed where treatment occurs. The effluent is collected in pipes positioned along the bottom of the bed and discharged through an outlet chamber.

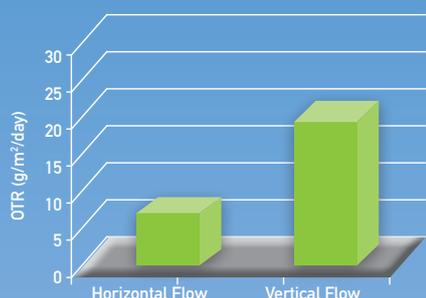
Vertical reed beds, although not as numerous in the UK as horizontal flow beds, are being used increasingly in applications with higher loads or where there is insufficient land available for a HF system.

The effluent drains down through the bed with air replacing the wastewater





Typical Oxygen Transfer Rates (OTR) for Different Reed Bed Systems



in the bed as it drains. The next dose traps the air which leads to a highly aerated system with good oxygen transfer permitting increased microbial growth and activity. VF systems are more effective than HF systems at ammonia removal due to their ability to nitrify as a result of increased oxygen levels within the beds. VF constructed wetlands typically provide a good removal of organics and suspended solids, but these systems typically provide little denitrification. Consequently, removal of total nitrogen is limited unless they are part of a multi stage or hybrid system when accompanied by a horizontal flow bed.

VF systems have many variants, these include:

#### Intermittent downflow

This option involves flood application of effluent on top of the bed for brief periods of time (e.g. Sludge Treatment Reed Beds).

#### Unsaturated downflow

This variant involves distributing effluent across the top of a granular media. Water then trickles through the media in unsaturated flow. Effluent can be recirculated through these systems.

#### Saturated flow

These systems employ continuous saturated flow of effluent through the bed. This is the system is typically used by ARM when installing Forced Bed Aeration (FBA™). The flow can be in a downward or upward fashion.

#### Tidal (fill and drain) flow

These systems employ cyclic filling and draining of a granular bed. These reactors create cycling redox conditions that contain both oxidising and reducing phases (e.g TAYA™ systems).



natural waste water treatment