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CASE STUDY
03

Open-Ditch Multistage Treatment Zone

A treatment zone for high-risk nutrient runoff - slows, settles, and filters using natural materials.

Overview

Designed for sites with high sediment and nutrient-rich runoff. This measure intercepts subsurface drainage and diverts flow through an open-ditch treatment zone. Coarse sediments settle in a trap, while willow roots and woodchip help filter nutrients (e.g. phosphorus) before water returns to the drain.

Primary Function

Reduces sediment and phosphorus loading from subsurface drainage where nutrient concentrations are high due to higher-risk farming activities.

Location Considerations

- > Best suited to areas with subsurface drainage carrying sediment- and nutrient-rich runoff from high-risk farm activities or hard standings.
- > Bank access is required for periodic sediment removal; banks should be stable to avoid erosion.

How They Work

1. Pipe Interruption and Flow Diversion

A section of the subsurface drain is removed, and water is routed into a shallow open ditch, creating a treatment zone.

2. Sediment Trap Zone

Flow velocity is reduced using control structures, allowing coarse sediments to settle out.

3. Willow-Woodchip Filter

Water passes through a willow and woodchip zone, where phosphorus is taken up by plants or bound by microbes. Woodchip supplies carbon to support denitrification.

4. Reconnection to Subsurface Drainage

Treated water flows back into the remaining downstream section of the pipe.



Figure 1: Open-ditch multistage treatment zone schematic illustrating key design principles and associated hydrological processes.

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Open-Ditch Multistage Treatment Zone



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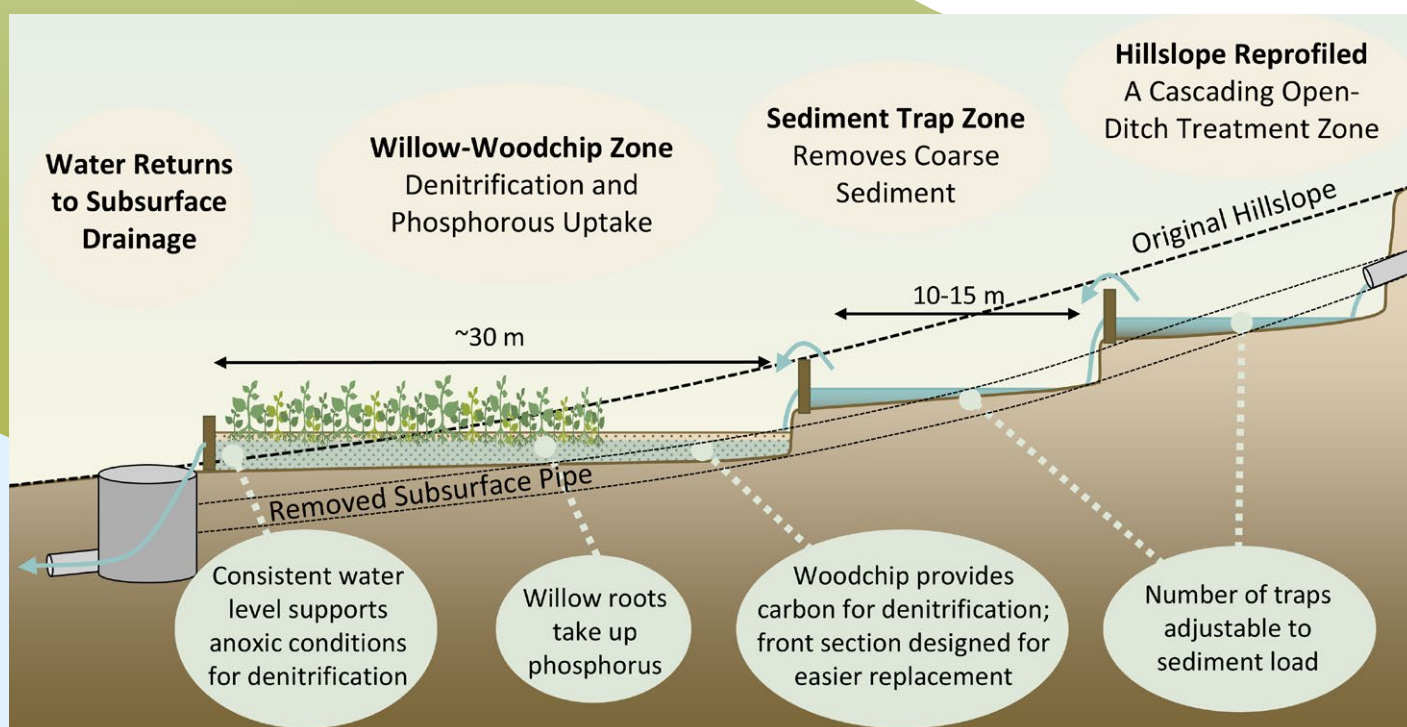


Figure 2: Open-Ditch Multistage Treatment Zone Schematic. Cascading cross-section showing the typical sequence: pipe break, sediment trap(s), willow–woodchip filter, and reconnection to subsurface drainage. Design is adaptable, but treatment stages remain consistent.

Design and Maintenance

- > An elevation drop is required to allow water to flow naturally through the treatment zone.
- > Landowner should inspect sediment traps regularly and remove sediment once ~50% full.
- > Sediment should be safely returned to land and factored into the farm nutrient budget.
- > Top up woodchip as it decomposes to maintain carbon supply for denitrification.
- > Willow should be coppiced every 3–5 years to sustain nutrient uptake and may be harvested as biomass.
- > The length of the treatment zone and number of sediment traps or willow–woodchip sections can be adapted to suit site conditions such as nutrient loading and flow.

NbS Measure Summary

Aspect	Notes
Set-up cost	Construction requires earthworks replace subsurface drainage with an open ditch.
Maintenance effort	Periodic sediment removal and need to replenish woodchip as it decomposes.
Lifespan	Long, if sediment accumulation and willow is well managed.
Flow attenuation	Minimal flow-attenuation as it is designed for water treatment not storage. ^{1,2}
Sediment retention	High for suspended solids due to sediment traps at the inlet. ²
Phosphorous (P) removal	Effective for particulate P via sedimentation. ^{2,4}
Nitrogen (N) removal	High nitrate removal when hydraulic residence time and carbon supply are adequate. ^{1,2,3,5}

Further Information

¹ USDA (2012). Denitrifying Bioreactor Guidance. (G) (PDF Link)

² Barber (2014). Sediment, nutrient and runoff management and mitigation in rural catchments (Doctoral dissertation, Newcastle University). (R)

³ Addy et al. (2016). Denitrifying bioreactors for nitrate removal: A meta-analysis. Journal of Environmental Quality, 45(3), 873-881. (R)

⁴ Carstensen et al. (2020). Efficiency of mitigation measures targeting nutrient losses from agricultural drainage systems: A review. Ambio, 49, 1820-1837. (R)

⁵ Husk et al. (2017). Reducing nitrogen contamination from agricultural subsurface drainage with denitrification bioreactors and controlled drainage. Biosystems Engineering, 153, 52-62. (R)

G = Guidance, R = Research

MATCH FUNDERS



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