Case study 4: In-line bioreactor bed Wet Tropics

Project leader and partnerships	Terrain NRM, Wet Tropics Major Integrated Project (WTMIP) collaborating with Australian Wetland Consulting (AWC)
Funding source	Department of Environment and Science (Queensland Government Reef Water Quality Program)
Project length	18 months of event-based monitoring
Region	Wet Tropics (Johnstone)
Production system	Sugarcane
Date of installation	21st September 2019
Length of installation	Three working days for installation
Bioreactor type	In-line bioreactor (above the invert/floor of the drain)
Project objective	Research trial to quantify nitrate removal performance.

Summary of the landscape

The bioreactor is at the bottom of foothills and receives both high flow from storm events and base flow from groundwater seepage from sugarcane paddocks and native vegetated hill side.

The bioreactor was placed onto the underlying clay layer at the base of a drain, occupying approximately 50% of the total drain depth. Base flow and low flow stormwater move through the bioreactor, with larger stormflows bypassing over the top.

Soil texture is a light clay (0 - 85 cm) over sandy clay loam (85 - 160 cm) over light clay (160 - 210 cm). Soil pH was acidic throughout (pH 4.9 - 5.6). The water table periodically drops to >210 cm depth during the dry season.

Average rainfall and temperature

The area is located in the Wet Tropics with maximum and minimum average annual temperatures of 28.1 °C and 19.1 °C, respectively. The mean annual rainfall is 3200 mm (long term average) (BoM, 2017).

Sizing and volume capacity

10 m long, 0.5 m deep, and 1.8 m wide. Approximately 10 m^3 (softwood woodchip).

Design features

Due to the lack of available space on the cane farm, this bioreactor was designed to be constructed within an existing drain. A collaborative design process with the farmer and local contractors resulted in a 'in-drain' bioreactor design (i.e. bioreactor built on top of the drain floor/invert) that occupied no more than 50% of the total height of the drain. This meant that base flow drainage water can move through the bioreactor (undergoing treatment), with large stormflows moving over the top. Given that the bioreactor will experience high flow rates during the wet season, a considerable amount of rock was needed to ensure a level of structural integrity (Figures 1 and 2).

Water source

Rainfall run-off and shallow groundwater, which flows most of the year.

Construction methods and materials

A large excavator was used to tidy and shape the pre-existing drain. Approximately 10 m^3 of softwood woodchip (particle size 20 mm) was placed between the inlet and outlet gabion rock baskets. The woodchip was encased with rocks that were held in place by mesh. Rocks were also used to create entry and exit 'ramps' to help secure the gabion baskets in periods of high flow.

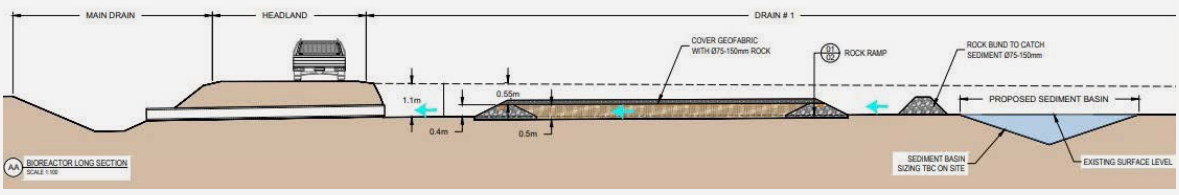

Figure 1 Cross section of in-line bioreactor bed. Source: WTMIP.

The walls of the drain were lined with geofabric.

Three 100 mm PVC piezometers were installed at the inlet, bioreactor centre and the outlet for monitoring. The piezometers were prepared by pre-drilling 5 mm perforations for a length of 30 cm at the base. The piezometers were held in place with star pickets and zip ties.

A 50 mm PVC piezometer was installed in the upslope paddock for ground water sampling.

Costs

Costs included woodchips, earth moving equipment, labour, geofabric, PVC pipe and other materials.

Performance

This system is currently being monitored and performance information is not yet publicly available.

Monitoring regime (intensity and frequency)

The bioreactor is monitored for temperature, pH, dissolved oxygen, total nitrogen, ammonia, nitrate and nitrite, total phosphorus, phosphate and redox potential.

Samples are collected as grab samples fortnightly and during other rainfall events and has been monitored since installation in September 2019. Water level monitoring is measured using a hobo diver and is collected at hourly intervals.

Troubleshooting

Wild pigs came on site during construction, causing damage and sediment loss.

The project team placed some left-over rock in the bottom of the drain to deter pigs and erected an electric fence to prevent future damage.

What would you do differently?

An important factor to consider when placing bioreactors within larger drains, is to ensure that the location (within the drain) is not on a corner, or an erosion prone area. Construction needs to be cognisant of high velocity water flow, such that it does not cut, or scour the banks around the bioreactor.

Figure 2 In-line bioreactor bed showing rock on top of woodchip zone for stability.