AGRICULTURE AND WASTEWATER

Constructed wetlands allow reuse of effluent from wineries

South African wineries are setting the example to effectively treat winery effluent with green infrastructure. Petro Kotzé reports.

All photographs courtesy Petro Kotze

The farm Vriesenhof, nestled at the food of the Stellenbosch mountains.

'***n Boer maak 'n plan*** (a farmer makes a plan), as the Afrikaans saying goes. In South Africa, artificial wetlands are allowing some famers to make cost-effective, efficient and green plans in reply to one of the biggest negative impacts associated with agriculture, namely water pollution.

In the winelands of the Western Cape, constructed wetlands are now an accepted treatment option for the large volumes of wastewater produced during the wine production process. Some farmers also use it to treat sewage (following bacterial treatment) to potable standards. Vriesenhof owner and cellar master, Jan 'Boland' Coetzee, has the proof on paper. Test reports consistently show that effluent from his farm, a combination of greywater, treated sewage and cellar water, to be of drinking water quality. His main technology of choice to achieve this is a near-40 metre strip of palmiet and reeds.

Test results show that the treated water contains faecal coliforms of 12 mpn/100 ml. ***E-coli*** readings are 3 mpn/100 ml, pH is at 5.6, conductivity at 30.3, chemical oxygen demand (COD) at 24.2, Calcium at 12 mg/L, Magnesium at 7 mg/L, Sodium at 39 and Potassium less than 0.4 (measures taken in 2016).

For Coetzee, the decision to construct the wetland was not difficult. He could see that water that initially ran through a natural reedbed emerged cleaner in the reservoir on the

other side. Building an artificial and lined system added the extra peace of mind that the water did not contaminate the environment on his farm, nestled at the foothills of the Stellenbosch Mountains.

Acceptance of this green engineering technology has come a long way in the past decade, since Dr Reckson Mulidzi wrote his dissertation on the environmental impact of winery effluent in the Western and Northern Cape provinces in 2001. The study was part of a multi-disciplinary research programme that was started as a result of a lack of information on the disposal practices of winery effluent in South Africa.

Since then, research and legislation has moved forward. Currently the research team manager at the Agricultural Research Council (ARC): Infruitec-Nietvoorbij Soil and Water Division, Mulidzi explains that they are now also investigating how far untreated and diluted winery effluent can be used to irrigate vineyards, an especially appealing option in water scares regions. However, for wineries where space and resources allow for it, the choice of artificial wetlands remains a relatively easy and affordable method to treat effluent to irrigation standards.

The wastewater from wine

Wineries produce large volumes of low-quality wastewater, particularly during the harvest period. In short, wine is produced through crushing and fermenting grapes, and then straining off the skins and seeds. The liquid is then stored, clarified and matured. This process generates a lot if liquid and solid wastes.

Liquid waste is mostly generated through cleaning, as the winery must be kept meticulous throughout the production process to avoid contamination and spoilage. The composition of the effluent varies from one winery to the other, but often contains simple organic acids, sugars and alcohols from grapes and wine as well as sulphur and potentially some fertilizers, pesticides and herbicides.

Solids include stalks, seeds and skins, sediments with pulp, tartrates, yeasts, and bentonite clay and diatomaceous earth (two soils with fine particulates) from the clarification processes.

Historically, this wastewater was mostly disposed of directly to the land in South Africa, to irrigate pastures for livestock. Of all the detrimental impacts, the biggest was due to the effluent's very high chemical oxygen demand (COD), notes Mulidzi. The decaying process of the organic matter in the wastewater consumes a lot of oxygen. Where it is discharged, oxygen is also taken out of the receiving waters. This can result in the water becoming toxic, killing off plants and aquatic life. Furthermore, the volume of wastewater that needed disposing led to soil degradation, and it could seep into groundwater and nearby streams.

Though it was already clear at the time that winery effluents posed definite pollution problems, there were few other affordable options available to farmers. Mulidzi says constructed

Most of the wastewater generated by wineries is from the cellars, and is generated during the production process.

Jan Coetzee constructed a wetland on his farm, Vriesenhof, to treat various streams of effluent generated on the property. The result is water of a potable standard.

wetlands offered a viable solution. Over and above cost savings, these structures were simple to use and open to anyone that had the required space. There is some technical knowledge necessary, he explains, especially since winery effluent is very strong and can be detrimental to some plants. For this reason, Nietvoorbij provides advisory services to farmers on the construction of wetlands, should they want to employ this technology.

About five years ago, Coetzee took up the offer, and constructed a wetland on his property on advice from Nietvoorbij. Years down the line, the structure is still performing exceptionally well, and sets a good example of the quality of treated effluent that can be achieved on a winery when wastewater of various sources is treated with an artificial wetland.

The Vriesenhof wetland

The wetland treats about 20 000 liters per day of grey and blackwater. The blackwater, or sewage, is run through a bacterial treatment process first, before being led to a central tank.

During the harvest season, a further 15 000 litres of effluent from the wine production process is added. The so-called cellar water is led to the same central tank, after the removal of solids.

From here, the cellar water, treated blackwater and greywater from the property is put through a chlorine filter. This combined water then runs down a short series of small ponds for oxidation into the wetland. From here, the water travels through the vegetation for about 40 metres (the wetland was lengthened over time) to a reservoir. At the time of ***the Water Wheel's*** visit, the reservoir was dotted with yellow-beak ducklings and, according to Coetzee, various bird species visit throughout the year. While the water is potable at this point, it is abstracted to irrigate pastures.

Maintaining the artificial wetland is not difficult, notes Coetzee, and they mostly only need to trim the vegetation every now and again. Results such as those from Vriesenhof are not unique, and constructed wetlands have proven to be effective for treating winery effluent, removing solids, lowering COD, neutralizing pH and rendering wastewater of quality sufficient for irrigation use.

Irrigation with effluent after treatment by constructed wetland

An ARC Infruitec-Nietvoorbij study found that winery wastewater treated by a constructed wetland was a viable option for irrigating cabbage. Mulidzi, who was the project leader, says the practice not only saves water, but the treated water can contribute nutrients required by the crops, leading to further cost savings on purchasing fertilizer.

For this study, a wetland of 50 m x 6 m and 1 m deep was constructed. It was filled with dolomitic gravel, and planted with the local species bulrush (***Typha latifolia***) and common reed (***Phragmitis australis***). The wetland proved to remove more than

The reservoir where all the final effluent is led to after treatment by the constructed wetland. From here, water is extracted for irrigation of pastures.

90% COD and after treatment, was used to irrigate cabbage as part of a poverty alleviation project for farm workers. The experiment entailed the application of four types of water: Clean irrigation water with fertilizer, clean irrigation water without fertilizer, and wastewater after treatment with a constructed wetland with and without fertilizer.

The results indicated that wastewater, after treatment with constructed wetland, could not only safely be used for irrigation of cash crops, but could improve the nutritional status of the soil. It was concluded that cabbage can be irrigated with the wastewater from wineries without the danger of associated diseases and that the practice can reduce the cost of fertilizer because the wastewater contained essential element such as phosphorous, potassium and nitrogen.

What a constructed wetland needs to work

Available land, funds and effective management incorporated with some creativity and flexibility are listed in reports as necessary to construct a wetland for wastewater treatment.

Recommendations include a compulsory pre-treatment system for removing solids, as these contain more than 40% of the COD load, and will otherwise clog the system. Then, rainwater should be included in the system. The wetland should be designed so that its capacity is bigger than required because once it rains, the added water will decrease the retention period of the wastewater in the system, by pushing the effluent to the outlet.

According to Mulidzi, the duration that the water stays in the wetland is the most important factor to bear in mind. At a minimum, it should be five days. Studies have shown the difference in final water quality when the retention time is shortened from 14 to 7 days to decrease from 80% to 60%, though the property owner's capacity to allow for this could depend on the space available for the wetland to be constructed.

A 10% safety factor should be incorporated into a design to allow for unknowns such as fluctuations in the composition of the effluent. The extra capacity also allows for the removal of wilted plants from parts of the wetland when necessary, without affecting its overall performance. Then, a combination of more than one type of plant is essential as various types of plants tolerate wastewater differently and their ability to remove nutrients from the effluent also differs.

The costs and benefits of treating effluent with constructed wetlands

The knock-on benefits of treating wastewater with constructed wetlands have been well documented. It can reduce the costs and energy required associated with conventional water treatment, and could reduce the cost of fertilizer if the water is used for irrigation. Where water is limited, the reuse of wastewater can lead to water savings, in turn, leading to more sustainable farming operations. Wetlands are aesthetically pleasing, and increase the biodiversity of the property.

Translating this into monetary worth is not as a simple task, according to Mulidzi, as the valuing of natural resources in economic terms is a complicated and tricky process. It's not easy to set the price for the quality of the environment as well as the aesthetic value of natural resources such as wetlands.

For Coetzee, no such questions remain. Sitting around his kitchen table on the farm, he points out the exact lay of the land, how the water flows through it from the mountaintops to the nearby Blaauwklippen River and beyond. His water readings and tests go back years, as he meticulously documents the quality of the water as it runs through his farm and beyond, and the impact that their agricultural activities have on it. For him, it is about creating a closed system, in which any contamination generated by his farming activities cannot impact the environment beyond, or below, his borders. For this, the choice of wastewater treatment system was very a simple one.

The constructed wetland on Vriesenhof, as the water runs down from the central tanks.