Winewatch: Fact Sheet 4

SUBSURFACE DISPOSAL OF WINERY WASTEWATER FOR SMALL WINERIES

Subsurface disposal of winery wastewater is used with varying degrees of success at many small wineries. A subsurface wastewater disposal system typically consists of one or two tanks followed by a leachfield. Systems for winery wastewater disposal often follow the same design as those constructed for domestic purposes. In some of the smaller wineries sanitary and winery wastewater are both disposed of through the same system.

Systems designed using domestic criteria and used for winery wastewater have been known to develop problems after only a few years. There are a number of reasons for this including:

1. Winery wastewater volumes are usually significantly higher than domestic wastewater volumes for at least part of the year. The volume of winery wastewater varies considerably throughout the year with a peak of up to 80% of the annual discharge occurring during a few months at vintage at some wineries (Chapman *et al.,* 2001). For example, a 100 tonne crush winery that produces 5 kL wastewater/tonne of grapes crushed, may produce over 33,000 litres of wastewater per week during February, March, April and/or May. Standards Australia specifications for domestic subsurface disposal systems are based on a volume of up to 14,000 litres per week (AS/NZS 1547:2000).

2. The type and concentration of organic matter likely to be found in winery wastewater differs significantly from domestic wastewater (see Table 1). Winery wastewater is much higher in organic carbon than domestic wastewater, and has a higher biological oxygen demand (BOD). The organic composition of winery wastewater is dominated by simple dissolved compounds such as organic acids, sugars and alcohols. Total dissolved solids may be particularly high during vintage. Winery wastewater is also higher in suspended solids and has a lower percentage of settleable solids at 15 to 25% compared to domestic wastewater with 70 to 80% settleable solids (Storm, 2001). Settling alone will therefore not lead to a significant reduction in the total organic material. Solids and organic matter in the wastewater will have a negative impact on soil permeability at the leachfield site.

3. Lees, bentonite and diatomaceous earth will impact on soil permeability at the leachfield site and fall into the category of winery waste products that are better removed in the winery. Bentonite is used by wineries for protein stabilisation and as a clarification aid. Bentonite particles, because of their colloidal size (generally less than 0.002 mm in diameter), tend to remain in suspension, unless natural agglomeration occurs or a cationic flocculent is added to produce the coalescence and settling of negatively charged clay particles (Storm, 2001).

4. The use of sodium hydroxide (caustic soda) for cleaning in the winery often leads to wastewater having a high sodium absorption ratio (SAR). SAR is determined by the ratio of sodium relative to calcium and magnesium. Wastewater with a high SAR may cause swelling and dispersion of clay particles and can result in reduced soil permeability at the disposal site (Chapman *et al.,* 2001).

Table 1: Typical composition of winery wastewater and untreated domestic wastewater (Source: National Water Quality Management Strategy, 1998 and Crites and Tchobanoglous, 1998)

	Winery wastewater		Untreated domestic wastewater
	Vintage	Non-vintage	
Total organic carbon (mg/L)	1000-5000	1000	80-290
Biological oxygen demand (mg/L)	1000-8000	<1000-3000	110-400
Total suspended solids (mg/L)	100-1300	100-1000	100-350
Total dissolved solids (mg/L)	<550-2200	<550-850	280-850

Winewatch is a partnership between Curtin University, Margaret River Wine Industry Association, Cape to Cape Catchments Group and GeoCatch with the Shires of Busselton and Augusta-Margaret River. This project is supported by Curtin University, through funding from the Australian Government's Caring for our Country.

Considerations for successful subsurface disposal of winery wastewater include:

Location

1. Decisions on the location of subsurface disposal systems should take into consideration soil type, distance to ground and surface water, slope and geology.

2. Adequate separation from ground and surface water are essential to minimise the risk of contamination.

3. Soils with a high phosphorus retention capacity will minimise the risk of phosphorus export and ground and surface water contamination.

Design

1. Design needs to be based on **accurate estimates** of peak and annual flow rates, the high organic load, percentage of suspended or dissolved solids, and soil permeability. Undersizing of disposal fields, inappropriate estimation of assimilative capacity and carry over of solids are three of the principal causes of system failure (Crites & Tchobanoglous, 1998).

2. A robust design would include **tank capacity** with sufficient retention time to allow settlement of solids. Unfortunately, there is limited information available on calculating suitable tank sizing for winery wastewater treatment. Kennedy/Jenks Consultants discuss tank capacity sufficient to hold 2 days of wastewater flow during the peak month of wastewater production. They state that this would allow for sufficient time for solids settling as well as time for partial treatment of the wastewater through anaerobic processes (Kennedy/Jenks Consultants, n.d.). Stefano *et al.* (2008) demonstrated that the level of suspended solids of winery wastewater retained in tanks can remain virtually unchanged after two days. They attributed the low sedimentation to the fact that for most of their experimental trial a stable hydraulic retention time (HRT) was not provided. They also demonstrated that a HRT of 5 days was effective in reducing up to 80% of the organic load. As settling alone could not account for this decrease in organic matter anaerobic biological processes must have been occurring. See boxed text for example of tank sizing.

3. Septic tank design should provide maximum opportunity for the solids to settle and this is achieved by maximizing the retention time, slowing the velocity of wastewater as much as possible and avoiding the re-suspension of settled solids. Baffles, dividers, inlet and outlet 'T's within tanks will minimise the re-suspension of solids and can all assist with the aim of minimising solids leaving the tank.

4. Given the level of uncertainty about suitable retention time, and the expense of the infrastructure necessary to retain wastewater for up to 5 days prior to disposal to a leachfield, it is highly recommended that **measures are put in place in the winery to minimise the amount of gross and fine solids entering the wastewater system**. Keeping lees out of the wastewater system cannot be recommended too highly.

5. Installation of effluent filters at the tank outlet will provide a failsafe way of preventing solids from passing into the leachfield. Although the filters will require considerable maintenance, especially during vintage, they will both encourage control of solids in the winery and significantly increase the life of leachfields. They can be used for gravity and pumped effluent arrangements and should be installed two-in-series in gravity situations so that one can be cleaned while the other continues to prevent solids from escaping to the leachfield. Effluent filters have been shown to reduce the TSS leaving a typical domestic tank by 40-60% from 40-140 mg/L to 25-55 mg/L.

6. A larger **area of leachfield** will be required for winery wastewater than for domestic wastewater. This is a result of the large peak in wastewater volume that occurs during the vintage period, as well as the high organic load. Leachfields need to be designed using peak volumes rather than annual volumes.

7. A detailed **soil profile evaluation** rather than standard percolation tests should be used to give an accurate assessment of soil permeability at the leachfield site. See boxed text below for explanation.

8. Leachfields are biological systems that rely on microbial treatment within the soil column and the bulk of the microbes are at or close to the surface. Leachfields should therefore be as shallow as legally possible (150 mm minimum below ground level AS/NZS 1547) as wastewater discharged below the upper aerobic soil layer tends to have little or no treatment which can result in discharge of high-strength winery wastewater to groundwater (Crites & Tchobanoglous, 1998).

Typical leachfield trench dimensions are 300-450 mm wide with 200-400 mm of aggregate containing 100 mm diameter perforated pipe all below 100-150 mm of topsoil. Self-supporting arch type trenches are also common and homogenous beds, as compared to individual trenches, are also feasible. Designs should be carried out by a certified engineer in accordance with AS/NZS 1547.

9. **Duplicate leachfields** should be constructed and wastewater switched between the leachfields regularly to allow resting and the breakdown of material that may result in clogging. This is highly recommended and will significantly increase the life of the leachfields.

10. Storm (2001) strongly recommends that wineries separate sanitary and winery process water. He states that the logic of separation can be readily understood if the consequences of a combined system failure are analysed from both a winery operations and a public health hazard standpoint. Failure of a combined system would require ceasing operations at the winery as a result of the public health and environmental consequences of surfacing effluent. If on the other hand, the systems were separate and the sanitary system failed, there would not be a statutory public health requirement to have the winery cease production operations and temporary arrangements could be made, such as portable chemical toilets, until the failed system was replaced or repaired.

11. **Clean stormwater** should not drain to the wastewater system unless the volume of stormwater has been included in the design of septic tanks and the leachfield. It is preferable to divert clean stormwater away from the wastewater system.

Management

1. Changing winery practices to minimise the amount of gross solids (skins, seeds, leaves, stems etc), juice, wine, lees, caustic/citric acid cleaning waste and DE filter waste entering the wastewater system will significantly reduce the risk of failure of leachfields. **Keeping lees and first rinses out of the wastewater system cannot be recommended too highly**. Screens and basket strainers can be used to capture gross solids and lees and first rinses can be drained to a portable tank and incorporated into composting operations.

2. Water efficiency measures implemented in the winery will decrease wastewater volumes and improve the effectiveness of tanks for settlement and treatment of solids and organic load.

3. Minimising the amount of caustic soda used will reduce the SAR of wastewater and minimise negative impacts on soil permeability at the disposal site. Caustic soda in solution can be reused when cleaning tanks and other equipment.

4. Septic tanks must be watertight and structurally sound, and the sludge periodically pumped out and disposed off appropriately. The accumulation of scum and sludge will reduce the available volume over time. Little data is available in regard to the sludge and scum accumulation from winery effluent and a conservative approach should be adopted unless further information is available. Annual pump out of tanks may be appropriate.

5. A formal operation and maintenance plan, including identification of staff responsibility, is recommended to minimise risks of system failure and environmental impacts. The plan should include cleaning filters, checking sludge level in tanks, removing sludge, checking for surface water spots in leachfield area and diverting wastewater regularly between two leachfields. Monitoring groundwater up and down gradient of the leachfield will enable detection of groundwater contamination and demonstrate the level of environmental impact.

Potential environmental impacts

The environmental risks associated with subsurface disposal relate both to leaching of nutrients and salts to groundwater and the possible overland flow to surface water of effluent that has surfaced as a result of leachfield failure.

The potential risk of ground and surface water contamination from subsurface disposal will depend on the size of the winery, sodicity, organic, nitrogen and phosphorus loadings, soil type, terrain, depth to groundwater and distance to surface water.

Statutory requirements

What is regulated	Statute	Regulatory office	Further information
Approval is required to construct or alter a wastewater treatment and disposal system.	Planning and Development Act 2005	Department of Planning and Infrastructure Local government authority	Contact the Environmental Health Section of your local government authority.
Wineries producing more than 350 kilolitres of wine per year (i.e. crushing over approximately 500 tonnes) are a prescribed premise and require a works approval and a licence or registration.	Environmental Protection Act Regulations 1987 (Part 5, schedule 1)	Department of Environment and Conservation	*A Guide to the Licencing System – Licences and Registration*, available www.dec.wa.gov.au, select E*nvironment>Licences>permits>forms*; then *Guidelines* or *Forms*, or phone 6364 6500.
There are constraints on the clearing of native vegetation.	*Environmental Protection (Clearing of Native Vegetation) Regulations 2004*	Department of Environment and Conservation	Refer to the brochure *Protecting Native Vegetation – New Laws for Western Australia*, available at www.dec.wa.gov.au, select *Environment>Land>Native vegetation protection*.
Development and operation of wineries in the Swan River Trust Management Area.	*Swan River Trust Act 1988*	Swan River Trust	Swan River Trust
Development in declared Waterways Management Areas.	*Waterways Conservation Act 1976*	Department of Water – regional office	The Waterways Management Areas currently declared are Albany Waterways, Avon River, Leschenault Inlet, Peel-Harvey Estuary and Wilson Inlet.

Other relevant legislation includes Environmental Harm Legislation (Amendment to Environmental Protection Act 1986), Contaminated Sites Act 2003, Environmental Protection (Unauthorised Discharges) Regulations 2004 and Environmental Protection (Controlled Waste) Regulations 2004. It is important to be aware of relevant legislation, regulations and required approvals as ignorance of the law is no defence against fines or prosecution.

References and further information

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- Winewatch (2009) *Improved industry capacity for wastewater management at small wineries in the Margaret River wine region – project report*. Unpublished report.

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Other fact sheets in this series include:
- Winewatch fact sheet 1: Winery wastewater composition and potential environmental impacts of wastewater disposal from small wineries
- Winewatch fact sheet 2: Reducing winery wastewater volumes and pollution loads from small wineries
- Winewatch fact sheet 3: Winery wastewater disposal to land from small wineries
- Winewatch fact sheet 5: Ponds for percolation/evaporation and storage of winery wastewater from small wineries
- Winewatch fact sheet 6: Disposing of winery wastewater from a small winery using irrigation

Tank sizing to allow sufficient retention to allow settlement of solids

Consider a winery that processes 300 tonne grapes/year. The maximum daily wastewater flow could lie somewhere between 1.23 and 6.16 kL/day depending on the water efficiency of the winery. Many small wineries would be at the higher end of this range. The Shire of Augusta-Margaret River winery wastewater guidelines recommend an annual wastewater design figure of 5 kL x 300 tonne = 1500 kL/year and Storm (2001) recommends a maximum daily wastewater design flow of 5.25 kL/day (300 x 0.7 x 1.5/60). A robust design would be for two to three baffled septic tanks in series with a total capacity of 12 kL (2 days x 6kL/day). A 5 day retention time would require 30 kL of septic tank capacity.

Soil permeability and determining leachfield size requirements

Historically soil permeability, or percolation, tests have been used to determine the required size of the effluent disposal area (leachfield). While this has been common practice worldwide, permeability tests, because of the nature of the test, are not related to the performance of the actual leachfield (Crites *et al,* 2006). That is, the permeability of a hole filled with freshwater a few times in 24 hours and left to drain will bear little resemblance to that of a hole filled daily with wastewater over many years. It is not uncommon practice to send out the junior engineer in the middle of summer to dig a few test holes, spend a few hours on site measuring the rate that water drains away using the old-style falling head permeability test and then go back to the office to conclude the report to the client that the site is suitable for onsite wastewater disposal requiring a minimally sized leachfield. Most authorities and the Australian Standards (AS/NZS 1547:2000) have now abandoned permeability tests and require a detailed soil profile evaluation as this is more likely to give an accurate assessment of the soils' true permeability. The soil profile evaluation is then matched to a best estimate of effluent infiltration capacity known as long term acceptance rate (LTAR) from which recommended Design Loading Rates (DLR) are assigned within each soil category. Properly measured values of LTAR are scarce in many areas and hence the need for expert advice based on local experience is required. AS/NZS 1547 requires at least three soil observation boreholes and a soil pit investigation as part of the site soil assessment and requires soil permeability to be assessed by the constant head (Talsma-Hallam method) method.

Principal site characteristics which need to be considered in the soil profile assessment include soil depth and soil type, soil permeability, site drainage, depth to rock, depth to groundwater, ground slope, lot size, proximity to water bodies (streams, wetlands), proximity to buildings/structures, vegetation and landscape.

Once the soil assessment and permeability tests have been undertaken it is possible to determine the Design Loading Rate (DLR) and trench dimensions according to:

L = Q/(DLR x w)
Where: L = leach drain length (m), DLR (mm/day), Q = design daily flow (L/day), w = leach drain width (m).

Example:
Consider a winery that processes 300 t/year and has been determined to have a soil category of #2 (sandy loam with an indicative permeability of between 1.4 – 3+ m/d). Based on primary treated effluent it may have a conservative DLR range of between 15-20 mm/day (Table 4.2A1, AS/NZS 1547).

A design based on a daily flow rate of 3.75 m^3/day with a trench width of 400 mm would require between 625 m and 470 m of leach drain length depending on the DLR used. (3,750/(15 x 0.4) > L > 3,750/(20 x 0.4) = 625 m > L > 470 m).

A design based on a daily flow rate of 2.5 m^3/day with trench width of 400 mm would require between 312 m and 417 m of leach drain length depending on the DLR used. (2,500/(15 x 0.4)) > L > 2,500/(20 x 0.4).