Model Land Capability Assessment Report

February 2006

This document was developed as part of the Victorian Government's Country Towns Water Supply and Sewerage Program. It has been prepared in accordance with EPA Victoria's Septic Tank Code of Practice and Land Capability Assessment for Onsite Domestic Wastewater Management, and the Australian New Zealand Standard 1547:2000 On-site Domestic Wastewater Management.

If there is any similarity to any real person, company, or site contained in this document, it is unintended and does not implicate them or it in any way in terms of involvement with this project.

Acknowledgements
This document has been prepared by Whitehead and Associates Environmental Consultants Pty Ltd as part of the State Government's Country Towns Water Supply and Sewerage Program Initiative

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Mr Bob Ford, Central Highlands Water
Ms Astrid Hartono, EPA
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Table of contents

List of tables

Introduction

Chapter 1

The Municipal Association of Victoria (MAV), as part of its involvement in the State Government's Country Towns Water Supply and Sewerage Program, identified a need within local government for an increased understanding of land capability assessment. This Model Report is one of three tools developed in a capacity building project to assist local government and associated stakeholders to understand, critique and assess land capability assessment (LCA) reports.

This report has been written to comply with all relevant and current Victorian legislation, guidelines, codes and standards, including Environment Protection Authority (EPA) Victoria Publication 746.1 *Land Capability Assessment for Onsite Domestic Wastewater Management*, (2003a) and EPA Publication 891 *Septic Tanks Code of Practice* (EPA, 2003b) and Australian/New Zealand Standard AS/NZ 1547:2000 *On-site domestic –wastewater management*.

It should be noted that this Model LCA Report and accompanying explanatory notes is not an EPA publication and does not replace or supersede any of the existing Victorian legalisation, guidelines, codes or standards. It is for use by local government officers as an additional source of information and should be read in conjunction with the documents mentioned above.

The Model LCA (Chapter 5) contained in this document is fictional, using some real and some contrived data for a site where on-site sewage management is proposed. The case study site has a range of site conditions to allow areas of constraint and opportunity to be presented and evaluated and a treatment and land application system to be recommended based on this evaluation. It is important to note that this model LCA is to be read as a case study, and that it is not comprehensive or representative for all Victorian situations. As outlined in the EPA Publication 746 (2003a), each local area is different and methodology, key limiting factors and high risk areas will vary between, and within, councils.

The Model LCA should be read in conjunction with the explanatory notes for each section provided in Chapter 7. These notes provide background information, such as why and when a parameter is considered, and how to measure and interpret results for a particular parameter.

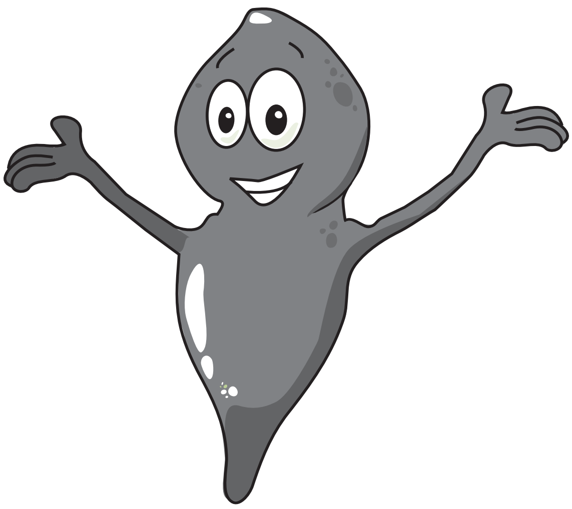
The Community Information Sheet – Land Capability Assessment and *Local Government Assessment Checklist: LCA Reports for On-site Wastewater Management* have been developed to compliment this Model Report.

When is a LCA required? Chapter 2

A LCA is required for all proposed unsewered developments, prior to the development proceeding (EPA, 2003a). The timing of the assessment may vary, for instance at rezoning or subdivision stage, or at individual lot development stage. The purpose of the LCA is to:

- Assess the capability of a site to sustainably manage wastewater within allotment boundaries; and
- Identify a management program that should be put in place to minimise the health and environmental impacts of on-site wastewater management. (EPA, 2003a).

A LCA report will identify the greatest risks to an area of land regarding domestic wastewater management. The level of detail of the LCA should reflect the identified level of risk and should demonstrate how the risk can be managed.



Consultation with LCA Assessors

Chapter 3

Land capability assessment calls on a range of professional skills from a number of disciplines. Satisfactory assessment of site suitability for wastewater application is critically dependant on both the consultant undertaking the LCA and the council officer evaluating the LCA exercising sound professional judgement. It is important that council officers assessing LCAs are both thoroughly trained and versed in assessing LCA reports and have the necessary skills and experience to confidently and competently interpret and evaluate LCA. Similarly, it is critical that LCAs received by council have been undertaken by appropriately trained, qualified and experienced assessors.

Council officers should encourage consultation with developers and LCA assessors prior to the LCA process commencing for the following reasons:

- Council will have an opportunity to explain any particular concerns regarding on-site sewage management in the area, or particular requirements regarding LCAs for that area;
- Council can pass on useful local information in regard to the site capability, performance of existing systems, or the types of systems that are suited to that environment; and
- Council can ensure the LCA assessor is appropriately qualified to undertake the work.

Meeting with the consultant or land holder first will also enable both parties to agree on the required level of detail, which will vary from site to site, before the work commences. A high level of professional skills on the part of both consultants and council officers, as well as sound communication between these parties, will go along way to reduce potential conflict later, for example at the Victorian Civil and Administrative Tribunal (VCAT).

LCA for Planning Scheme Amendments & Subdivisions

Chapter 4

The LCA process is applicable to all scales of development planning and assessment. To avoid creating adverse impacts on the environment and public health due to the installation of onsite domestic wastewater systems in the proposed development, LCAs should be undertaken at the earliest possible stage of the development. Conducting LCA at the rezoning or subdivision stage is a more strategic approach that provides a much more effective and sustainable result so that areas with higher degrees of limitation can be appropriately zoned and subdivision layouts can make best use of the physical constraints and opportunities of the land. Detailed guidance on broad scale strategic LCA is beyond the scope of this document. However, in the event that a strategic LCA does exist, the amount of additional information required in an individual site LCA report may be reduced. Again, this will need to be decided on a case-by-case basis in consultation with the LCA assessor and council.

A typical LCA for a subdivision (which may include rezoning of land) involves looking at land capability at a slightly broader scale (approximately 1:2000) for a proposed layout of allotments. In the case of a proposal of subdivision in isolation, this may simply involve determination of a minimum lot size rather than an exact lot layout. While most single site LCAs will usually involve only one soil landscape and one or two landform elements, a subdivision or rezoning can contain multiple combinations of both soil type and landform. Regardless of scale, the main objective of all LCA is the same, that is, the determination of the ability of each allotment to contain wastewater within the site boundaries, and the demonstration that the use of onsite domestic wastewater systems would not impact on surface water and groundwater. Additional considerations for strategic level LCAs, for example for Planning Scheme amendments and subdivisions, are summarised in Table 1 on page 7. The information contained in this table, along with the Model LCA and *AS/NZS 1547:2000*, provide good guidance on best practice multiple lot LCA.

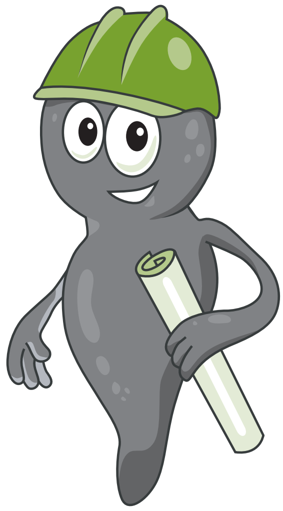


Table 1 Additional Considerations for Multiple Lot LCAs

LCA Component	Additional Considerations
Characteristics of the development	Need to consider a range of potential dwelling sizes and wastewater generation rates. Potential cumulative impacts are more significant and consideration must be given to identifying sustainable total lot numbers, minimum lot sizes and system densities.
Site assessment	There is more potential for variation in site characteristics across the development. There is a need to pay close attention to broader land capability issues (for example landform elements) when determining lot sizes and configuration.
Soil assessment	Test boreholes are required for each combination of soil landscape facet and landform element (see *AS/NZS1547:2000* for guidance on a minimum number of test boreholes). Additional chemical tests (such as phosphorus sorption capacity) may be necessary for accurate assessment.
Land capability assessment	Multiple LCAs must be undertaken for each combination of soil landscape and landform element. Land capability should be mapped and used to nominate suitable effluent management zones (preferably before lot size and configuration is determined).
Recommended management program (including system design)	Only concept wastewater system designs are necessary so minimum sizes for land application areas can be determined. Options may be left at technology types (for example primary or secondary treatment, subsurface irrigation or absorption trench). Detailed system design should be carried out at the individual lot development stage. Lot size and configuration should seek to maximise the opportunity to utilise suitable land for on-site wastewater management. A land capability map of the site can assist in this process.

The Model Land Capability Assessment

Chapter 5

Land Capability Assessment
Lot 585 Bundalaguah Road, Maffra

December 2004

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5.1 Introduction

Environmental Consultants Pty Ltd has been engaged to undertake a Land Capability Assessment (LCA) for a one hectare site at Bundalaguah Road, Maffra. The field investigation and report have been undertaken and prepared by suitably experienced staff. Environmental Consultants Pty Ltd has appropriate professional indemnity insurance for this type of work. Our professional indemnity insurance certificate is available on request.

The report will accompany an application submitted to Wellington Shire Council for a private residence with an on-site wastewater system. This document provides information about the site and soil conditions. It also provides a detailed LCA for the 10 000m^2 lot, and includes a conceptual design for a suitable onsite wastewater management system, including recommendations for monitoring and management requirements.

The site has been cleared of the original vegetation on the higher ground but there is a strip of remnant native riparian vegetation along the river. Two drainage lines intersect the site and feed into the Macalister River. The slopes range from two to five percent. The western side of the block is flood-prone with a return period of 1 in 100 years, but there is sufficient land available for sustainable onsite effluent management that maintains appropriate buffers to protect sensitive receptors.

We provide a number of options for both the treatment system and land application area (LAA). Above all, effluent should be treated to at least secondary level by an AWTS, single-pass sand filter or suitable alternative, and land application can be by sub-surface irrigation.

5.2 Description of the Development

Table 2 Site Description

Site Address:	Lot 585, Bundalaguah Road, Maffra (Figure 1)
Owner/Developer:	Mr Ebenezer Scrooge
Postal Address:	PO Box 508, Sale, Vic 3850
Contact:	Ph: 03 5142 6722
Council Area:	Wellington Shire Council
Zoning	Rural living, with a strip of land zoned Public Conservation and Resource along the Macalister River
Allotment Size:	1 ha
Domestic Water Supply:	Onsite roof water collection – no reticulated supply available or likely to be provided in the short to medium term future.
Anticipated Wastewater Load:	Assume one 4-bedroom residence, @ 6 people per residence maximum occupancy. Design wastewater load is 140L/person/day, therefore total design load = 840 L/day. This design load is sourced from AS/NZ 1547:2000, given comments in Section 4.8.3 in EPA (2003b) stating that reductions in wastewater load are allowed where roof water is the only supply.
Availability of Sewer	The area is unsewered and unlikely to be sewered in the short to medium term future

Is this example complete? What else should be included? Check the notes on page 26 and 27 to make sure.

5.3 Site Key Features

Fiona Smith and Anna Newman undertook site investigations on the 22nd of December 2004. A range of site features were assessed in terms of the degree of limitation they present for a range of onsite wastewater management systems. Reference is made to the rating scale described in Table 1 of EPA (2003a). As a guide, remedial measures should be considered whenever ratings of 3, 4, or 5 occur and this might involve land improvement works, soil amelioration or simply adoption of higher-level technologies to ensure environmental protection. Table 3 summarises the key features in relation to effluent management at the site. The site is not in a special water supply catchment area. The site experiences negligible stormwater run-on from Bundalaguah Road to the east. There is no evidence of a shallow watertable or other significant constraints and the risk of effluent transport offsite is very low.

Who are Fiona and Anna? Find out what information you should check for on page 26.

Figure 1 provides a locality plan and indicates the location of the site of the proposed development. Figure 2 provides a site plan describing the location of the proposed development works, wastewater management system components and physical site features.

Figure 1 Locality Plan

Does this map show enough detail? Check page 27 for more information.

Figure 2 Site Plan

Are there any important componenets missing from this map? What are the essential elements required? Check the notes on page 27.

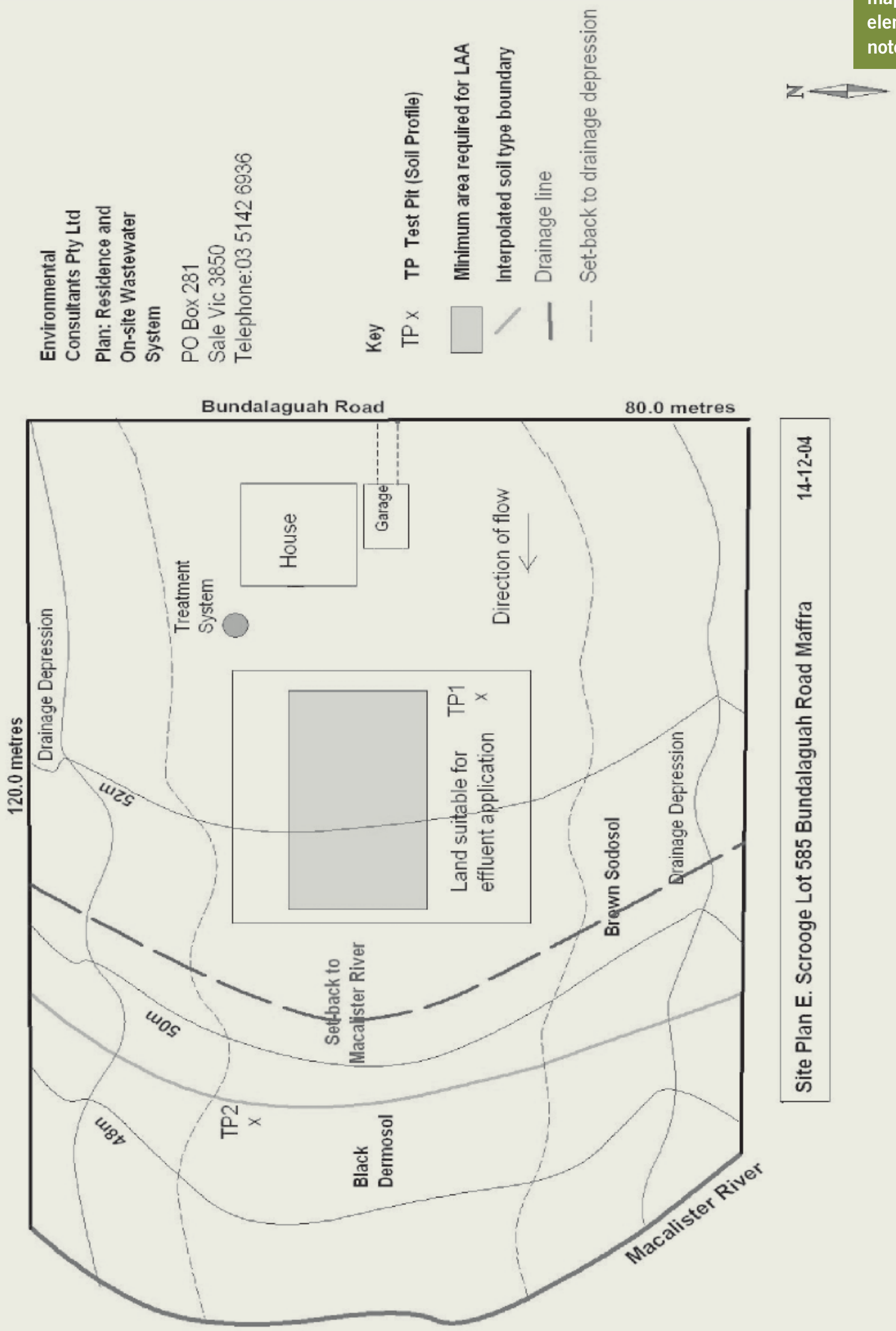


Table 3 Site Features

Feature	
Climate	The site has a Mediterranean climate with maximum temperatures and minimum rainfall in summer. Information from the Department of Primary Industries website (www.dpi.vic.gov.au, Victorian Resources Online West Gippsland Homepage) indicates that droughts are often experienced from mid-October to late April. The site experiences an average annual rainfall of 611.1 mm (Sale East Climate Station – No. 085872) and an average of 141 rain days per year. Average annual pan evaporation is taken as 1337.2 mm
Exposure	The site is completely cleared with a westerly aspect and has high sun and wind exposure.
Vegetation	The site contains a mixture of grasses, both native and exotic, with native riparian vegetation.
Landform	The site is on a lower slope leading on to a floodplain which is dissected by two deep drainage lines which join to the west of the site and feed into the Macalister River.
Slope	The proposed effluent management area is quite flat with gradients less than 5 percent, generally to the west.
Fill	Natural soil profiles were observed throughout the site. No fill was observed and no filling is proposed in the effluent management area.
Rocks and Rock Outcrops	No surface rocks or outcrop evident at the site.
Erosion Potential	No evidence of sheet or rill erosion. The erosion hazard is low.
Surface Water	The site is adjacent to the Macalister River, which ultimately flows in to the Gippsland Lakes. The site is crossed close to the northern and southern boundaries by two shallow drainage depressions, which occasionally carry water for a short period after heavy rain.
Flood Potential	Information from Wellington Shire Council indicates that the house site and area available for application of treated effluent lies above the 1:100 year flood level.
Stormwater run-on and upslope seepage	The house site and proposed effluent management area are expected to receive only minor stormwater run-on. There is no evidence of groundwater seepage, soaks or springs nearby.
Groundwater	There are no signs of shallow groundwater tables above 1.5 m depth. There is no use of groundwater for domestic purposes within 250 m of the proposed effluent management area.
Site Drainage and Subsurface Drainage	The site experiences negligible stormwater run-on and has a minor runoff hazard. There are no visible signs of surface dampness, spring activity or hydrophilic vegetation in the preferred effluent management area, or elsewhere nearby. Seasonal water logging may occur as soils display a minor amount of mottling in the deeper subsoils. This seasonal water logging could limit percolation of effluent through the soil profile.
Recommended Buffer Distances	All buffer distances recommended in Table 4.6 of EPA (2003b) are achievable and do not significantly limit siting of the LAA in this case.
Available Land Application Area	Considering all site constraints and the buffers mentioned above, the site has ample land that is suitable and available for land application of treated effluent. The preferred area is on the eastern side of the property in between the two prominent drainage lines. The land application envelope is located above the 1:100 flood level and by using a system that provides secondary treatment and pressurized sub-surface irrigation, there will be ample protection for surface and groundwater.

See page 28 for an explanation of each of these data fields.

5.4 Soil Assessment and Constraints

The site's soils have been assessed for their suitability for onsite wastewater management by a combination of soil survey and desktop review of published soil survey information as outlined below.

5.4.1 Published Soils Information

Soils of the site have been mapped and described in *Major Agricultural Soils of the Maffra Region* by Sargeant and Imhof (2000), and are described as belonging to the Stratford map unit. This unit occurs on alluvial sediments deposited in the Pleistocene period. The landform is a level plain which is an elevated weakly dissected alluvial terrace. The original vegetation was a grassy open forest of *Eucalyptus tereticornis* that has now largely been cleared. The surface soils are generally dark greyish brown loamy sands to sandy loams. They have a bleached sub-surface (typically pale brown to pale brownish grey) of similarly textured material abruptly overlying, at about 20 to 40 cm, mottled brown and yellowish brown clays. Mottled clays or sandy clays normally continue to at least 1 m often accompanied by gravel and stones. The soils are most likely to be classified as Brown or Yellow Sodosols using the Australian Soil Classification (Isbell, 1996).

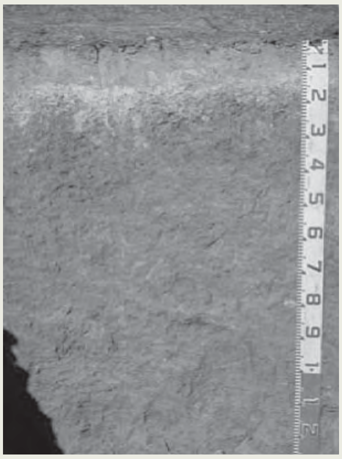
How can you check this nformation is correct? Where can you find the data? Find out on page 29.

5.4.2 Soil Survey and Analysis

A soil survey was carried out at the site to determine suitability for application of treated effluent. Subsoil investigations were conducted at two locations in the vicinity of the building envelope, as shown in Figure 2, using a hand dug test pit (TP1). An additional soil pit was dug downslope of this envelope to characterise the soils of the floodplain landscape. This was sufficient to adequately characterise the soils as only minor variation would be expected throughout the area of interest. Two soil types were encountered in these investigations. Full profile descriptions are provided in Appendix 1. Samples of all discrete soil layers for each soil type were collected for subsequent laboratory analysis of pH, electrical conductivity and Emerson Aggregate Class. Tables 4 and 5 describe the soil constraints in detail for each of the soils encountered.

Soils in the vicinity of the building envelope have fine sandy loam topsoils overlying clay, which becomes heavier with depth, from light to medium (www.dpi.vic.gov.au). The A2 horizon has a massive structure and is conspicuously bleached and mottling occurs in the subsoil, which indicates imperfect drainage. The subsoil is also strongly sodic and dispersible. This soil is classified as a Brown Sodosol (Isbell, R.F., 1996). Given the physical and chemical limitations of the subsoil, effluent application via an absorption trench is not recommended.

The soil on the floodplain was found to have a fine sandy loam topsoil with a gradual increase in texture down through the profile to a light silty clay at depth (www.dpi.vic.gov.au). The soil is moderately to strongly structured and mottles occur in the deep subsoil. This soil is classified as a Black Dermosol. Whilst this soil type is more suitable to effluent assimilation, its location some distance from the proposed building envelope and on the floodplain makes it less desirable for the LAA.



Brown Sodosol

Black Dermosol

Source: www.dpi.vic.gov.au

Table 4 Soil Features: Brown Sodosol

See Table 9 – Explanation of Soil Features, on page 27, for more information and descriptions of the methods for obtaining the data in tables 4 and 5.

Soil Feature[1]		
Soil Depth	Soil depth greater than 1200mm and no hardpans occur.	
Depth to watertable	Groundwater not encountered, hole terminated at 1.2 metres. Minor mottling in the subsoils indicates intermittent saturation.	
Coarse Fragments (%)	2% coarse fragments occur in the B1 horizon. No coarse fragments were observed throughout the remainder of the profile.	
Soil Permeability and Design Loading Rates	Soil permeability was not directly measured but can be inferred with reference to Tables 4.2A1 to 4.2A4 in AS/NZS 1547:2000, that describe conservative design loading rates (DLRs) and Design Irrigation Rates (DIRs) for various effluent application systems according to soil type. Critical soil properties are texture and structure, but depth, colour and degree of mottling are also used to infer drainage conditions. We note that the indicative loading rates below assume secondary treated effluent is being applied. Reduced loading rates would apply to primary treatment systems (septic tanks), although these are not recommended here.	
	Topsoils	**Subsoils**
Description	Massive fine sandy loam	Moderately structured medium clay
Soil Category (AS/ NZ1547:2000)	2	6
Design Irrigation Rate (DIR mm/day)	20	20
Design Loading Rate (DLR mm/day) for trenches/beds	not applicable	8
pH	The pH of 1:5 soil/water suspensions was measured using a *Hanna* hand held pH/EC meter. The soil shows a neutral reaction trend. The measured pH of the A_1 horizon is 5.4, 6.0 for the A_2, and 6.8 to 7.6 for subsoils. The present soil conditions do not appear to be restricting plant growth.	
Electrical Conductivity	Electrical conductivity of the saturated extract (ECe) was calculated by first measuring the electrical conductivity of 1:5 soil in water suspensions and using appropriate multiplier factors to convert EC (1:5) to ECe. The calculated ECe values range between 2.01 and 3.85 deciSiemens per metre and soils are slightly saline. With long-term operation of the system, it may be wise to monitor soil salinity to ensure that it does not increase significantly.	

1. Source: www.dpi.vic.gov.au, Victorian Resources Online West Gippsland Homepage

Table 5 Soil Features Black Dermosol

Soil Feature[1]		
Soil Depth	Soil depth greater than 1200mm and no hardpans occur.	
Depth to watertable	No watertables were encountered.	
Coarse Fragments (%)	No coarse fragments were observed throughout the profile.	
Soil Permeability and Design Loading Rates	Soil permeability was not directly measured but can be inferred with reference to Tables 4.2A1 to 4.2A4 in AS/NZS 1547:2000, that describe conservative design loading rates (DLRs) and Design Irrigation Rates (DIRs) for various effluent application systems according to soil type. Critical soil properties are texture and structure, but depth, colour and degree of mottling are also used to infer drainage conditions. We note that the indicative loading rates below assume secondary treated effluent is being applied. Reduced loading rates would apply to primary treatment systems (septic tanks), although these are not recommended here.	
	Topsoils	**Subsoils**
Description	Moderately structured fine sandy loam	Moderately structured light clay
Soil Category (AS/ NZ1547:2000)	2	5
Design Irrigation Rate (DIR mm/day)	20	20
Design Loading Rate (DLR mm/day) for trenches/beds	not applicable	10
pH	The pH of 1:5 soil/water suspensions was measured using a *Hanna* hand held pH/EC meter. The soil shows a neutral reaction trend. The measured pH of the A1 horizon is 5.7, and 5.9 to 6.6 for subsoils. The present soil conditions do not appear to be restricting plant growth.	
Electrical Conductivity	Electrical conductivity of the saturated extract (ECe) was calculated by first measuring the electrical conductivity of 1:5 soil in water suspensions and using appropriate multiplier factors to convert EC (1:5) to ECe. The calculated ECe values range between 2.5 in the topsoil to 0.6 deciSiemens per metre, therefore the topsoil is slightly saline, and the subsoil is non-saline.	

1. Source: www.dpi.vic.gov.au, Victorian Resources Online West Gippsland Homepage

5.5 Land Capability Assessment Matrix

The Land Capability Assessment Matrix has been developed for the whole site, but using the soils in the vicinity of the building envelope.

This is only one possible approach to determine whether domestic wastewater can be contained on-site. It is a checklist based closely on EPA Publication 746 (2003a). See the notes on page 36 for information about other methods.

Table 6 Land Capability Assessment Matrix

Land Features	Land Capability Class Rating					Site Rating
	Very Good (1)	Good (2)	Fair (3)	Poor (4)	Very Poor (5)	
General Characteristics						
Site drainage	No visible signs of dampness	Moist soil, but no standing water in soil pit		Visible signs of dampness, such as moisture-tolerant plants	Water ponding on surface	3
Runoff	None	Low	Moderate	High – need for diversionary structures	Very high – diversion not practical	2
Flood levels	Never		< 1 in 100	> 1 in 100 and < 1 in 20	< 1 in 20	3
Proximity to watercourses	> 60m				< 60m	1
Slope%	0–2	2–8	8–12	12–20	> 20	2
Landslip	No actual or potential failure		Low potential for failure	High potential for failure	Present or past failure	1
Groundwater (seasonal watertable depth (m))	> 5	5–2.5	2.5–2.0	2.0–1.5	< 1.5	4
Rock outcrop (% of land surface containing rocks >200mm	0	< 10%	10–20%	20–50%	> 50%	2
Erosion potential	No erosion potential	Minor	Moderate	High	Severe erosion potential	2
Exposure	High sun and wind exposure		Moderate	Low sun and wind exposure		1
Landform	Hill crests, convex side slopes and plains		Concave sideslopes and footslopes		Floodplains and incised channels	1
Vegetation Type	Turf or pasture				Dense forest with little understorey	1
Average Rainfall (mm/year)	< 450	450–650	650–750	750–1000	> 1000	2

Land Features	Land Capability Class Rating					Site Rating
	Very Good (1)	Good (2)	Fair (3)	Poor (4)	Very Poor (5)	
General Characteristics						
Pan Evaporation (mm/yr)	< 1500	1250–1500	1000–1250		< 1000	**2**
Fill	No fill		Fill present			**1**
Soil profile characteristics						
Soil permeability category[1]	2 and 3	4		5	1 and 6	**4**
Profile depth	> 2m	1.5m–2m	1.5–1	1–0.5m	> 0.5m	**3**
Presence of mottling	None				Extensive	**4**
Course fragments (%)	< 10	10-20	20-40		> 40	**1**
pH	6–8		4.5–6		< 4.5, > 8	**1**
Emerson Aggregate	4, 6, 8	5	7	2, 3	1	**1**
Electrical Conductivity (ECe)(dS/m)	< 0.3	0.3–0.8	0.8–2	2–4	> 4	**4**
Sodicity ESP%	< 3		6–8	8–14	> 14	**5**
Overall Site Rating			**Very Poor**			**5**

1. Source: AS/NZ1547:2000

5.6 The Management Program

This LCA has been prepared to accompany a development application to Wellington Shire Council for a private residence and associated necessary wastewater management system. As such, this report provides recommendations for treatment and land application systems that are appropriate to the land capability. The following sections provide an overview of a suitable system, with sizing and design considerations and justification for its selection. Detailed design for the system is beyond the scope of this study, but should be undertaken at the time of building application and submitted to Council.

5.6.1 Treatment System

To treat domestic wastewater and allow irrigation with the treated effluent, we recommend installing a system that provides secondary treatment with disinfection to meet Environment Protection Authority requirements for irrigation. Indicative target effluent quality is:

- BOD < 20 mg/L;
- SS < 30 mg/L;

Several suitable options are available, including aerated wastewater treatment systems (AWTS) and single pass sand filters. Either of these options is capable of achieving the desired level of performance and final selection is the responsibility of the property owner, who will forward details to Council for approval.

Aerated Wastewater Treatment systems and Sand Filters are further explained in the notes on page 34.

5.6.2 Land Application

A range of possible land application systems have been considered, such as absorption trenches, evapotranspiration/absorption (ETA) beds, surface and subsurface irrigation, and sand mounds. The preferred system is pressure compensating subsurface irrigation. In combination with the selected secondary treatment system subsurface irrigation will provide even and widespread dispersal of highly treated effluent loads within the root-zone of plants. Subsurface irrigation will provide beneficial reuse of wastewater and this will be especially desirable given that the site is not serviced by town water. It will also ensure that the risk of effluent being transported off this site will be negligible.

5.6.3 Sizing the Irrigation System

To determine the necessary size of the irrigation area water and nutrient balance modelling has been undertaken in accordance with EPA Publication 168 (1991), *Guidelines for Wastewater Irrigation*. The results show that the required irrigation area is 370 m^2, the larger of the areas calculated by the water and nutrient balance.

Additional information on water and nutrient balance calculations can be found in the notes on pages 34–37.

The calculations are summarised below, with full details in Appendix 2.

Water Balance

The water balance can be expressed by the following equation:

Precipitation + Effluent Applied = Evapotranspiration + Percolation

Data used in the water balance includes:

- Mean monthly rainfall and mean monthly pan evaporation (East Sale);
- Average daily effluent load – 840 L;
- Design irrigation rate (DIR) – 20 mm/wk;
- Crop factor – 0.7 to 0.8; and
- Retained rainfall – 100%.

The nominated area method is used to calculate the area required to balance all inputs and outputs, without the need for wet weather storage. As a result of these calculations, at least 370 m^2 of area is required to achieve zero wet weather storage.

Nutrient Balance

A nutrient balance has been undertaken to check that the LAA is of sufficient size to ensure nutrients are assimilated by the soils and vegetation. The model used here is based on a simplistic methodology, but improves on this by incorporating more variables in the respective nutrient cycles to more accurately model actual processes. It acknowledges that a proportion of nitrogen will be retained in the soil through processes such as mineralisation (the conversion of organic nitrogen to ammonia) and volatilisation (Geary and Gardner 1996). It also accounts for crop growth rates (and hence nutrient uptake rates) for a typical pasture.

Some assumptions used in the modelling follow:

- Hydraulic loading – 840 L/day;
- Nitrogen concentration in effluent – 30 mg/L[1];
- Nitrogen percentage lost to soil processes – 20%

1 Total nutrient concentrations based on typical effluent quality from a secondary treatment system.

- Phosphorus concentration in effluent – 10 mg/L[1];
- Critical nutrient loading rates – 220 kg/ha/year (60 mg/m2/day) for nitrogen and 50 kg/ha/year (14 mg/m2/day) for phosphorus [2];
- Soil phosphorus sorption capacity – 3375 kg/ha of soil [3];
- Proportion of phosphorus sorption capacity utilised – 50%; and
- Design life of system - 50 years;

The area required for nitrogen assimilation is 341 square metres, while phosphorus requires 366 square metres.

Summary and Discussion

The preferred irrigation area is based on the larger of the water and nutrient balance calculations. An area of at least 370 square metres must be provided. It is worth noting that the modelling includes several significant factors of conservatism:

- Hydraulic load (840 L/day) – this assumes 6 people will permanently occupy a 4-bedroom residence. It is likely that the actual occupancy will be less than this;
- From the nutrient balances, in the absence of site specific data very conservative estimates of crop nutrient uptake rates and total nitrogen lost to soil processes have been adopted.

Does the summary and discussion draw on the assessment? Is this section written in plain English? See the notes on page 37 for more information.

5.6.4 Siting and Configuration of the Land Application Area

It is preferable to keep the irrigation area as high on the property as possible and a maximum distance from the two intermittent waterways. The preferred area is towards the eastern boundary. Figure 2 shows an envelope of land that is suitable for effluent management, although this envelope is much larger than the minimum required. An outer envelope doubling the size of the LAA is identified to provide the necessary additional area for a reserve field, in accordance with EPA (2003b). The client is allowed flexibility in selecting the final location and configuration of the irrigation system, provided it remains within this envelope. Figure 2 shows approximately to scale the minimum area required according to the water and nutrient balance.

Whilst there is ample area for application of effluent, it is important that buffer distances to the waterways be adhered to. It is important to note that buffers are measured as the overland flow path for run-off water from the effluent irrigation area. Figure 2 shows the contours and flow path directions on the property.

The area must be subdivided into at least two separate fields (minimum 185 m^2 each) that can be watered alternately. An automatic indexing valve generically known as a 'roto-valve' can be used to allow alternation between the areas with each pump cycle.

It is recommended that the owner consult an irrigation expert familiar with wastewater irrigation equipment, to help design and install the irrigation system. The irrigation plan must ensure good, even application of effluent.

5.6.5 Irrigation System Description

A detailed irrigation system design is beyond the scope of this report, however a general description of subsurface irrigation is provided here for the information of the client and Council.

Subsurface irrigation comprises a network of drip-irrigation lines that is specially designed for use with wastewater. The pipe contains pressure compensating emitters that employ a biocide to prevent build-up of slimes and inhibit root penetration. The laterals are usually 0.6 to 1.0 m apart, roughly parallel and along the contour if possible. Installation depth is commonly 100-150 mm. It is critical that the irrigation pump be sized properly to ensure adequate pressure and delivery rate to the irrigation network.

1 Total nutrient concentrations based on typical effluent quality from a secondary treatment system.

2 Critical nutrient loading rates are based on crop uptake data available for pasture crops in Victoria (EPA Victoria 1991). The lowest uptake rates published for a typical mixed pasture have been used.

3 Soil phosphorus sorption capacity was estimated using information from Soil Landscape mapping data.

A filter is installed in the main line to remove fine particulates that could block the emitters. This must be cleaned regularly following manufacturer's instructions. Vacuum breakers should be installed at the high point/s in the system to prevent air and soil being sucked back into the drippers when the pump shuts off. Flushing valves are an important component and allow periodic flushing of the lines, which should be done at least yearly. Flush water can be either returned to the treatment system, or should be released where it will be readily absorbed.

All trenching used to install the pipes must be backfilled properly to prevent preferential subsurface flows along trench lines, particularly where trenches are not absolutely parallel to contours. Irrigation areas should not be subject to high traffic movement, especially by vehicles, otherwise compaction around emitters can lead to premature system failure.

5.6.6 Buffer Distances

Buffer distances from LAAs are required to help prevent human contact, maintain public amenity and protect sensitive environments. Council generally adopts the following nominal buffers, described in EPA Vic (2003b):

- 20 metres from potable or non-potable groundwater bores;
- 60 metres from watercourses that are non-potable; and
- 100 metres from watercourses in a potable water supply catchment.
- 6 metres if area up-gradient and 3 metres if area down-gradient of property boundaries, swimming pools and buildings.

All nominal buffers are achievable.

5.7 Monitoring, Operation and Maintenance

Maintenance is to be carried out in accordance with the certificate of approval and Council's permit conditions. The system proposed above will only function adequately if appropriately maintained. Residents will be required to carry out maintenance as discussed below.

To ensure the treatment system functions adequately, residents must:

- Have a suitably qualified maintenance contractor service the AWTS every three months, as required by Council under the approval to operate.
- Use household cleaning products sparingly and check that they are suitable for septic tanks;
- Keep as much fat and oil out of the system as possible; and
- Conserve water.

To ensure the land application system functions adequately, residents must:

- Regularly harvest (mow) vegetation within the LAA and remove this to maximise uptake of water and nutrients;
- Monitor and maintain the subsurface irrigation system following the manufacturer's recommendations, including flushing of irrigation lines;
- Regularly clean in-line filters;
- Not erect any structures over the LAA;
- Minimise vehicle access to the LAA, to prevent compaction; and
- Ensure that the LAA is kept level by filling any depressions with good quality topsoil (not clay).

Water Conservation and Improving Wastewater Quality

- Good water conservation is an important aspect in the overall management of onsite systems. It will be important for the ongoing performance of both the treatment and land application system that they are not overloaded hydraulically. AAA rated plumbing is recommended for all future water fixtures.

5.8 Stormwater Management

As mentioned above, stormwater run on is not expected to be a concern in this case. However, the construction and maintenance of diversion drains would provide an additional precaution. Roof stormwater must not be disposed in the LAA.

5.9 Conclusions

As a result of our investigations we recommend that a sustainable onsite wastewater management system can be built to meet the needs of a new four-bedroom residence at Lot 565, Bundalaguah Road, Maffra.

Specifically, we recommend the following:

- Secondary treatment of wastewater in either an Aerated Wastewater Treatment System (AWTS), or intermittently-dosed single-pass sand filter;
- Land application of wastewater in a 370 m^2 subsurface irrigation area subdivided into at least two separate fields. A water rotor will be used to dose load the two fields alternately;
- Installation of water saving devices in the new residence to reduce the effluent load for onsite disposal;
- Use of low phosphorus and low sodium (liquid) detergents to improve effluent quality and maintain soil properties;
- Operation and management of the treatment and disposal system in accordance with manufacturer's recommendations and the recommendations made in this report; and
- Construction of diversion drains on the upslope side of the LAA to divert stormwater.

Are the recommendations clearly related to the outcomes of the investigation? Is this section written in plain English?

References and Appendices

Environment Protection Authority (1991). *Guidelines for Wastewater Irrigation* Publication 168.

Environment Protection Authority (2003a). Publication 746.1 L*and Capability Assessment for Onsite Domestic Wastewater Management*.

Environment Protection Authority (2003b). Publication 891 *Septic Tanks Code of Practice*.

Geary, P. and Gardner, E. (1996). On-site Disposal of Effluent. In Proceedings from the one day conference *Innovative Approaches to the Management of Waste and Water*, Lismore 1996.

Isbell, R.F. (1996). The Australian Soil Classification. CSIRO Publishing, Melbourne.

Sargeant and Imhof (2000). *Major Agricultural Soils of the Maffra Region*. Department of Natural Resources and Environment, Victoria, Australia.

Standards Australia / Standards New Zealand (2000). AS/NZS 1547:2000 *On-site Domestic-wastewater Management*.

USEPA (2002). *Onsite Wastewater Treatment Systems Manual*. United States Environmental Protection Agency.

Appendix 1 – Soil Profiles

Soil Bore Log		Environmental Consultants Pty Ltd	
Client:	Mr Ebenezer Scrooge	Test Pit No:	TP1
Site:	Brown Sodosol	Logged by:	Fiona Smith
Location:	Lot 565, Bundalaguah Road, Maffra	Excavation type:	Shovel & crowbar
		Date:	22nd December 2004

PROFILE DESCRIPTION

Depth (m)			Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
	0.02	A1	FSL		dark brown	nil	nil	dry	
0.1	0.15	A2	FSL	massive	yellowish to pale brown	nil	nil	dry	conspicuously bleache
0.2	0.25	B1	LC	columnar to strong blocky	yellowish brown	<10% light yellow brown	<5% manganese	dry	
0.3									
0.4									
0.5									
0.6									
0.7									
0.8									
0.9	0.9	B21	MC	columnar to strong blocky	yellowish brown	<10% light yellow brown	<5% managanese seg	Moist	
	0.9+	B22	LC	Lenticular medium	light olive brown	nil	nil	moist	slickensides
1.0									
1.1									
1.2	Layer continues								

Soil Bore Log

Environmental Consultants Pty Ltd

Client:	Mr Ebenezer Scrooge	**Test Pit No:**	**TP2**
Site:	Black Dermosol	Logged by	Anna Newman
Location	Lot 565, Bundalaguah Road, Maffra	Excavation type	Shovel & crowbar
		Date	22nd December 2004

PROFILE DESCRIPTION

Depth (m)			Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1									
0.2	0.25	A11	FSL	strong polyhedral	V.dark greyish-brown	nil	nil	dry	
0.3									
0.4	0.4	A12	FSCL	strong polyhedral	V.dark greyish-brown	nil	nil	dry	
0.5									
0.6	0.6	B21	LC	weak prismatic to strong polyhedral	V.dark brown	nil	nil	dry	
0.7									
0.8									
0.9									
1.0									
1.1									
1.2	1.2	B22	LSiC	mod. Prismatic to strong polyhedral	dark brown	nil	nil	dry	

Enviromental Consultants Pty Ltd

Key to Soil Borelogs

Symbols

W	Watertable depth	?	Sample collected
X	Depth of refusal		

Moisture condition

D	Dry	VM	Very moist
SM	Slightly moist	W	Wet / saturated
M	Moist		

Graphic log and textures

S - Sand
LS - Loamy sand
CS - Clayey sand

CL - Clay loam
SCL - Sandy clay loam
SiCL - Silty clay loam

Gravel (G)

SL - Sandy loam

LC - Light clay
SC - Sandy clay

Parent material (stiff)

L - Loam
LFS - Loam fine sandy
SiL - Silty loam

MC - Medium clay
HC - Heavy clay

Parent material (weathered)

Appendix 2 – Water and Nutrient Balance

Nominated Area Water Balance & Storage Calculations

Site Address: Bundalaguah Road, Maffra

Notes: MAV Model LCA

INPUT DATA				NOTES
Design Wastewater Flow	Q	840	L/day	Based on a 4br/6 person house @ 140L/p/day, with standard fixtures (from Appendix 4.2D in AS/NZS 1547:2000)
Design DIR	DI R	20	mm/week	Assumes sand loam/loamy sand topsoils without impeded vertical drainage, DIR taken from Table 4.2A4 in AS/NZS 1547:2000
Daily DIR		2.9	mm/day	
Nominated Land Application Area	L	371	m sq	Used for iterative purposes (if desired) to determine storage requirements for nominated areas.
Crop Factor	C	0.7-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type
Retained Rainfall	Rf	1	untiless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Rainfall Data	East Sale, Station 085872 mean monthly			
Evaporation Data	East Sale, Station 085872 mean monthly			

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	**365**
Rainfall	R	\	mm/month	47.1	40.3	50.9	50.4	54.2	47.1	41.4	46.9	53.6	61.5	61.8	55.8	**611.1**
Evaporation	E	\	mm/month	198.4	165.2	136.4	84	52.7	42	46.5	65.1	90	120.9	150	186	**1337.2**
Crop Factor	C			0.80	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	159	132	109	59	37	29	33	46	63	97	120	149	**1031.73**
Percolation	B	(DIR/7)xD	mm/month	88.6	80	88.6	85.7	88.6	85.7	88.6	88.6	85.7	88.6	85.7	88.6	**1042.9**
Outputs		ET+B	mm/month	247.3	212.16	197.7	144.5	125.5	115.1	121.1	134.1	148.7	185.3	205.7	237.4	**2074.6**
INPUTS																
Retained Rainfall	RR	RxRf	mm/month	47.1	40.3	50.9	50.4	54.2	47.1	41.4	46.9	53.6	61.5	61.8	55.8	**611**
Effluent Irrigation	W	(QxD)/L	mm/month	70.2	63.4	70.2	67.9	70.2	67.9	70.2	70.2	67.9	70.2	67.9	70.2	**826.4**
Inputs		RR+W	mm/month	117.3	103.7	121.1	118.3	124.4	115.0	111.6	117.1	121.5	131.7	129.7	126.0	**1437.4**
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-130.0	-108.5	-76.6	-26.2	-1.1	-0.1	-9.5	-17.1	-27.2	-53.6	-76.0	-111.4	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage for Nominated Area	N		mm	0.00												
Total Volume of Storage	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	130	137	177	268	365	371	327	298	265	210	175	143	

MINIMUM AREA REQUIRED FOR ZERO STORAGE (m^2): 370.5 — This is based on the worst month of the year, so the balance overestimates the area/storage requirements and is hence conservative for all other months.

Nutrient Balance

Site Address: Bundalaguah Road, Maffra

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = 366 m^2

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	340	L/Day	Crop N Uptake	220	kg/ha/yr	which equals	60	$mg/m^2/day$
Effluent N Concentration	30	mg/L	Crop P Uptake	50	kg/ha/yr	which equals	14	$mg/m^2/day$
% Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal	**Phosphorus Sorption**					
Total N Loss to Soil	13.534706	$mg/m^2/day$	P-sorption result	250	mg/kg	which equals	3375	kg/ha
Annual N Loss to Soil	0.005	kg/year	Bulk Density	1.5	g/cm^2			
Effluent P Concentration	10	mg/L	Depth of Soil	0.9	m			
Design Life of System	50	yrs	% of Predicted P-sorp. [2]	0.5	Decimal			

NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer

Nitrogen	341	m^2
Phosphorus	366	m^2

Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)

Nominated LAA Size	371	m^2
Predicted N Export from LAA	-0.80	kg/year
Predicted P Export from LAA	-0.04	kg/year
Phosphorus Longevity for LAA	52	Years
Minimum Buffer Required for excess nutrient	0	m^2

PHOSPHORUS BALANCE
Using the nominated LAA Size

Nominated LAA Size	371	m^2			
Daily P Load	0.0084	kg/day	→ Phosphorus generated over life of system	153.3	kg
Daily Uptake	0.00508219	kg/day	→ Phosphorus vegetative uptake for life of system	0.250	kg/m^2
Measured p-sorption capacity	0.3375	kg/m^2			
Assumed p-sorption capacity	0.169	kg/m^2	→ Phosphorus adsorbed in 50 years	0.169	kg/m^2
Site P-sorption capacity	62.61	kg	→ Desired Annual P Application Rate	3.107	kg/year
			which equals	0.00851	kg/day
P-load to be sorbed	1.21	kg/year			

NOTES

[1]. Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise

data should be obtained from a reliable source such as,

- EPA Victoria: *Guidelines for Wastewater Irrigation*, Publication 168

- *Appropriate Peer Reviewed Papers*

- *USEPA Onsite Systems Manual.*

[2]. A multiplier, normally between 0.25 and 0.75, is used to estimate actual P-sorption under field conditions which is assumed to be less than laboratory estimates.

Explanatory Notes to the LCA

These notes explain the technical elements contained in Section 5 of this document, the Model LCA Report. They have been designed to highlight important areas of information that environmental health officers, or other council officers, should check for – and understand - when reviewing an LCA.

Section 5.1: Title and Introduction

The title page of the LCA needs to state clearly the location of the site, which should include Lot or street number, and the town. The LCA should be dated, and information regarding the name of the landowner, and name and contact details of the person/s carrying out the LCA should be provided. This information is important for the officer assessing the application so they can contact the consultant or landowner.

The introduction should provide an overview of the LCA, particularly the site features and the main constraints to on-site wastewater management.

It is desirable that any LCA performed has a strong quality assurance/quality control approach to ensure a high quality product and confidence for those that use it. The introduction section of an LCA should provide details of quality assurance processes undertaken, for example, how criteria were set, how the data was obtained, and the method used to obtain the data. EPA (2003b) Section 3.2 describes the attributes required by an LCA assessor. These necessary attributes should also be clearly stated in the introduction to enable council to have a high degree of confidence and certainty with regards to the conclusions in the report.

Section 5.2: Description of the Development

This section should provide general information about the site, such as address, ownership, Council, zoning, water supply, nearest sewer line or likelihood of sewer availability in the future (including sewer backlog programs – both urban and regional) as advised by the water authority, availability of other services (for example gas and electricity), and anticipated wastewater load. It is also important that the proposed development is described, for example a four bedroom private dwelling. Useful information can also be obtained at this point from the landholder or nearby residents. This information may relate to the soils, climate or overland flows. The sorts of questions that could be asked include:

- Can you get on this land with a vehicle (car) at all times of the year?
- If not, during which part of the winter-spring will you get bogged?
- Is the soil spewy when it is wet?
- Do you ever see any water lying on the surface for more than several days?
- Do your cattle or horses cause much pugging?
- What has the land been used for in the past? Cropping (what crops?) or grazing?

This could provide information about the condition of the land during critical times.

The wastewater load should be calculated according to the procedure provided in EPA (2003b), particularly Table 4.5 (where wastewater loads differ from those listed in Table 4.5 the consultant must demonstrate the reasons and science behind it). This allows occupancy to be calculated by the number of bedrooms plus two, multiplied by the typical daily flow allowance. Daily wastewater loads less than 200 litres per day are permissible only where roof water only is used, without supplementation (EPA 2003b).

Section 5.3: Site Key Features

The purpose of this section is to develop the appropriate LCA criteria for assessment and gather data for all the criteria developed. LCA criteria may include defining the key features of the land and soils that will define the capability of the site to assimilate on-site wastewater. Two plans should be provided in this section. The first is a Locality Plan, which shows the location of the site within the wider local context. It can be provided on a number of bases, but a topographic base will allow the reader to see the local landform and presence of land features such as watercourses. It is also important that the nearest town and names of roads and infrastructure, if applicable, has been shown on the map. The second plan that should be included in this section is the Site Plan. This plan should, as a minimum, show:

- The location of property boundaries;
- Watercourses and dams;
- Nearest road;
- A minimum of 10 metre contour interval;
- The proposed building envelope;
- The proposed LAA envelope;
- Flood levels; and
- A north point and scale.

Table 7 provides a list of key features which should be covered in a LCA, preferred parameters for these features, and the reasons why these features influence site capability.

Table 7 Site Features and their Relevance to On-site Wastewater

Site Feature	Preferred Characteristic	Outcome for on-site wastewater management
Climate	Net evaporation in excess of rainfall	Allow greater return of hydraulic load to hydrologic cycle, favours aerated soil profile.
	Net evaporation in excess of retained rainfall	Surface modified to shed higher proportion of rainfall away from LAA.
Flood potential	Above 1 in 20 year flood contour	Subsurface application preferred in flood prone area
	Above 1 in 100 year flood contour	May be capable of surface application
	Electrical and control components protected from flooding	
Water table (depth from base of LAA)	> 0.6 m for clays, 0.6 – 1.2 m for loams > 1.2 m for sands	Provides sufficient soil to attenuate hydraulic and nutrient loads and rooting depth to minimise risk of pollution of groundwater and protect beneficial uses as identified in SEPP – Groundwaters of Victoria.
Distance to surface water	Flow path, smaller or greater than buffer distance requirement, in EPA Publication 891 (2003b)	Reduced risk of impact of effluent on surface water and protection of beneficial uses as identified in SEPP – Groundwaters of Victoria.
Exposure	Northern aspect, high exposure to sun, low shade, well ventilated area	Maximise solar energy impact on evapotranspiration and provide maximum air-flow over application area
Slope	< 25%	Allows construction of application areas with minimal risk of erosion, loss of slope stability or increased runoff from application area
	> 25%	Run-on controls avoid additional hydraulic loading. Special construction conditions required, run-on and runoff controls more critical, greater likelihood of short circuiting
Landform	Shape of landscape that favours shedding of applied effluent, spreads rainfall runoff, avoids ponding or concentration of runoff	Maximises spreading of effluent and natural rainfall across the landscape, reduces potential wet spots
Landscape position	Elevated and mid-slope positions	Higher positions reduce risk of run-on and upslope seepage
	Lower positions	Run-on controls and raised LAA

Site Feature	Preferred Characteristic	Outcome for on-site wastewater management
Erosion potential	Stable slopes, well grassed surface, short flow paths	Prevention of soil erosion
Surface drainage	Well contoured landscape sheds rainfall immediately after rain	Larger proportion of rainfall contributes to runoff, greater soil moisture deficit encouraged Modifications to surface to favour better surface drainage
Subsurface drainage	Few mottles, well-drained internally	Maximises soil assimilation of effluent Cut-off drains may alleviate problem
Depth below application point to restrictive horizon	> 0.6 m for clays, 0.6 – 1.2 m for loams > 1.2 m for sands	Provides sufficient soil to adequately reduce pathogen and nutrient loads. Sufficient depth for attenuation of hydraulic load and rooting depth Note: Imported soil may increase soil depth
Imported Fill	Uniform fill with no signs of salinity or acid sulphate soil contamination. Fill material with favourable hydraulic and plant supporting qualities	Imported fill may overcome localised deficiencies in natural landscape.
Land area	Area available for assimilation of hydraulic, nutrient loads, buffer distances and living spaces	Minimises risk of off-site effects, potential addition to cumulative effects low. Additional treatment prior to soil application
Rocks and rock outcrops	< 20% of application area occupied by large rocks (over 200 mm)	Maximises soil available for effluent application and even distribution within soil profile
Geology/Regolith	Integrity of soil application area as treatment system	Provides maximum treatment with low risk of off-site effects or short –circuit to groundwater

The data provided in the key features section should be confirmed by council through a desktop review of available data as well as a site visit.

Table 8 Site Key Features Explained

Feature	
Climate	Climatic averages (rainfall) for the area should be obtained from the Bureau of Meteorology (www.bom.gov.au). The site contains a map that allows the viewer to determine the meteorological station that is closest to the site. It is desirable to use data that most reflects the site's climate. It is also desirable to use a station that has a long record and that has pan evaporation data. Rainfall and evaporation data is required to determine the water balance for the site and hence the land required to assimilate the anticipated wastewater load. The Bureau of Meteorology also provide access on their website to *Data Drill*, which is interpolated climatic data, useful for sites where there is not a representative weather station nearby.
Exposure	This parameter should be determined in the field from noting the amount of tree cover (which provides shading), and the direction that the slopes face where land application of effluent is likely to take place.
Vegetation	At the desk-top level, existing information on the vegetation of the area may be obtained (for example from www.dpi.vic.gov.au/dpi/vro), to determine the native vegetation of the area. In the field, the broad types of vegetation and their level of cover can be noted. (The level of detail collected for this feature will determined by the expertise of the assessor.)
Landform	The broad landform of the site may be determined by locating the site on a topographic map to determine its position in the overall landscape for example on a floodplain or crest, and then in the field the position of the site, particularly the proposed LAA, should be located in relation to landform elements such as midslope (and the shape of the slope). A useful reference for determining landform is the *Australian Soil and Land Survey Field Handbook* (McDonald *et al*, 1990).
Slope	The slope of the site, particularly the proposed LAA, may be measured in the field by the LCA consultant using a clinometer and reported in percent slope.
Fill	Both during the overall site survey and whilst describing the soils of the site, the assessor should observe whether soil material (which would generally look different to the site soils and may be unconsolidated or heterogeneous) has been imported to the site. Check that brief comment as to the nature of any fill encountered has been made and an estimation of its suitability and capacity for wastewater application made.
Rocks and Rock Outcrops	The nature and amount of rock (particularly bedrock – both general size and percent coverage of site) protruding from the ground that is observed over the site should be recorded in the report.

Feature	
Erosion Potential	Type and degree of erosion present, and the erosion hazard, should be recorded. For a full description of erosion types and their recognition, see McDonald *et al*, (1990).
Surface Water	A description of all watercourses, particularly their size and how often they flow, should be provided. Comment should also be made on whether rivers are in a potable water supply catchment, as declared or confirmed by the relevant authority.
Groundwater	Information on the location, depth, and quality of groundwater bores can be found at www.dpi.vic.gov.au/dpi/vro. Accessing this information may be done at the desk-top level of investigation (by checking regional groundwater maps) and followed up in a field investigation by observing the presence of any bores at the site or neighbouring properties. Also, the height of standing water in the soil survey pits or holes should be recorded.
Stormwater run-on and upslope seepage	Evidence of run-on to the proposed LAA should be noted (such as sediment dams on the surface). The presence of wet ground or seepage upslope should also be recorded.
Flood Potential	If possible, information regarding the flood recurrence levels for the site should be detailed (if Council does not already have this data, it may be available from the Catchment Management Authority). In the field, proximity to watercourses (both intermittent and permanent) should be noted, as well as position in the landscape (for example on a floodplain).
Site Drainage and subsurface drainage	From the field investigation, a record of observation and a description of the shape of the land should be provided to indicate whether water will be shed or will soak in. This gives an evaluation of the surface drainage. Subsurface drainage can be determined by the presence of mottled colours in the soil profile, which indicates waterlogging. The moisture content of the soil during dry periods also reflects the capacity for drainage.
Recommended Buffer Distances	When siting land application areas, buffer setbacks should be provided to various features as appropriate to the specific site. Guidance is provided in Table 4.6 of EPA (2003b). In the field, note the distance to relevant features from this table from both treatment systems and proposed LAAs. If the buffer distances differ from those recommended in Table 4.6 of EPA (2003b) an explanation must be provided.
Available Land Application Area	Determination of this parameter involves completion of the Land Capability Assessment Matrix to devise an overall capability based on all of the features discussed in this table (and any others deemed appropriate). Once this capability has been determined, the area most suited for land application of treated effluent can be chosen, and a decision made on the adequacy of its size, taking into account buffer setbacks.

Section 5.4 Soil Assessment and Constraints

The aim of the soil assessment is to describe, evaluate, and report on the characteristics of the soils present at the site in order to:

- Assess the capability of the soils to manage treated effluent; and
- Design a wastewater management system.

Section 5.4.1 Published Soils Information

The first step in a soil assessment is to find published soil information relevant to the area and/or site. A wealth of information is publicly available, including soil mapping, profile description (which often includes physical and chemical data), and specialised soil studies or research findings. The Victorian Government's Victorian Resources Online (www.dpi.vic.gov.au/dpi/vro) is one website that is particularly useful for this purpose. Accessing this information is a good way to check the soil survey provided in a LCA. The consultant should demonstrate that they have included research of published soil information, and cited the relevant information in the LCA. If a LCA has relied heavily on mapping data check the scale of the data used. Broadscale mapping data should be used with caution in individual or even subdivision scale LCA due to scale and field verification of this information should always be undertaken to provide detailed information for the capability assessment.

Section 5.4.2 Soil Survey and Analysis

A LCA report should include a detailed soil profile description that has been undertaken on the site and that characterises the soils in the different landform elements present (if there is more than one). This is important because soil forming processes are different in different elements for example crest to lower slope, and therefore the resulting soils can be different and so would have different capability for the assimilation of treated effluent. For guidance on the number of soil profiles an assessor should describe in the survey, refer to *AS/NZ1547:2000*. A broad overview of the recorded soil features should be provided for each soil, along with any comments on that soil's particular capability for effluent assimilation. Table 9 describes the types of data that should be presented in the LCA soil survey, as shown in the Model LCA, and how to describe and assess the parameters. Be sure when assessing a LCA the consultant has demonstrated that a satisfactory investigation (both at a desk top level and in the field) has been undertaken to obtain the results listed for each soil feature.

Table 9 Explanation of Soil Features

Soil Feature	
Soil Depth	A hole or pit should be dug, by hand or machine, to at least 2.0 metres or to refusal. The depth of the excavation should be recorded, along with the depth of each distinctive soil layer or horizon. The presence of hardened layers (hardpans) should also be recorded.
Depth to watertable	If water enters the excavation from the surrounding soil the depth to which it comes should be recorded. Groundwater maps, available from the Department of Primary Industries, can be included in the LCA, or used by council during the assessment of the LCA report.
Coarse Fragments (%)	The size and percentage of course fragments (stones and segregations) in each soil layer should be recorded.
Soil Colour	The dominant soil colour of each soil layer should be listed according to the Munsell Soil Colour Charts (2000) or similar tool. The colour code and name should be recorded, and the extent (%) and colour of any mottles (patches of different coloured soil) present should also be described.
Soil Field Texture	The LCA report should indicate the texture of each layer of soil. The consultant determines this by manipulating a small amount of moist soil (a bolus) between her/his fingers which an indication of the texture (relative amounts of sand, silt, loam and clay) of the soil sample. The technique for this procedure is described in McDonald *et al* (1990).
Soil Structure	Soil structure is the distinctness, size, and shape of the peds. A ped is a natural soil aggregate consisting of a cluster of primary particles and separated from adjoining peds by surfaces of weakness (Brewer, 1960). Soil structure should be described from a fresh vertical exposure (it cannot be taken from an augured hole). Further information on pedality may be found in McDonald et al (1990). *At the very least*, the degree (for example strong, moderate, or weak) of pedality of each layer, and the shape of the peds, should be shown in a report. Figure 4 is a photograph of a soil profile with clear pedality.
Soil Permeability and Design Loading Rates	Once a soil's textural and structural characteristics are determined a permeability category can be assigned from AS/NZ1547:2000. Six soil categories from sands to heavy clays are used to assign indicative permeability, that is the rate at which clean water percolates through the soil of that texture (see table below). If direct measurements (that is, those taken by performing a soil percolation test on site) are not applied, then worst case measurements (of the range available in AS/NZS1547:2000 must be used. Therefore, soil permeability need only be directly measured when there is some doubt as to soil texture, structure or likely permeability. In this case, the measurement can be done using a device such as a disc or Talsma permeameter, and should only de done by an experienced and qualified person. Tables 4.2A1 to 4.2A4 of AS/NZS 1547:2000, describe conservative design loading rates (DLRs) and design irrigation rates (DIRs) for various effluent application systems according to soil type. Critical soil properties are texture and structure. Depth, colour and degree of mottling are also used to infer drainage conditions. The DLR and DIR values for the most limiting layer within the uppermost part of the soil through which the treated effluent will move should be used. For instance, in a texture-contrast soil with a very shallow loamy topsoil and heavy clay subsoil, the subsoil is the limiting layer for percolation and this material should be used for the design loading rates.
pH	The pH of 1:5 soil/water suspensions is measured using a hand held pH/EC meter. Alternatively, the LCA assessor may send samples to a laboratory for the test to be performed. The assessor should test the pH trend down through the profile, for example acid, neutral, or alkaline. Acid soils (pH < 5) or alkaline soils (pH > 8) may provide an unsuitable environment for plant growth, and the assessor may recommend the use of ameliorants.
Electrical Conductivity	The electrical conductivity of the saturated extract (ECe) is calculated by first measuring the electrical conductivity of 1:5 soil in water suspensions and using appropriate multiplier factors to convert EC (1:5) to Ece. This figure infers the salinity of the soil and its potential impact on plant growth. Assessors can measure it in the field with a hand-held meter or in the laboratory.
Emerson Aggregate Class	The Emerson Aggregate Test is used to assess soil dispersibility and susceptibility to erosion and structural degradation.

Appendix 1 includes a graphic log and key for the two soil types that occur on site and within these detailed information for each soil layer is contained. This information shows, at a glance, what the soil profile is like, which can assist in clarifying and understanding the soil characteristics.

Figure 4 Soil Profile

This profile illustrates a number of the features described in the table above, such as the different colours that can be distinguished in a profile (brown to reddish-brown), and the structure, which can be clearly seen in the subsoil, where sub-angular blocky peds occur.

Photograph: Liz Shelly

Table 10 Soil Permeability Categories and Indicative Permeability

Soil Permeability Category	Soil Texture	Soil Structure	Indicative Permeability (m/d)
1	Gravels and Sands	Structureless	> 3.0
2	Sandy Loams	Weakly Structured Massive	> 3.0 1.4–3.0
3	Loams	Highly/moderately structured Weakly Structured or Massive	1.5–3.0 0.5–1.5
4	Clay Loams	Highly/moderately structured Weakly Structured Massive	0.5–1.5 0.12–0.5 0.06–0.12
5	Light Clays	Highly/moderately structured Weakly Structured Massive	0.12–0.5 0.06–0.12 < 0.06
6	Medium to Heavy Clays	Highly/moderately structured Weakly Structured Massive	0.06–0.5 < 0.06 < 0.06

Source: AS/NZS 1547:2000

Other soil parameters that can be measured that can be useful in determining land capability are discussed in Table 11.

Table 11 Additional Soil Parameters for use in LCA

Soil characteristic	Comments	Test Recommended
Sodicity (exchangeable sodium percentage –ESP)	The proportion of sodium on the cation exchange sites reported as a percentage of exchangeable cations. Levels above 6% may cause soil structural problems and reduced permeability. Refer to Technical Sheet on sodicity.	If there is evidence of dispersion, slaking, or structural decline.
Bulk density	Used to calculate the phosphorus sorption capacity of a Land Application Area when undertaking a Nutrient Balance.	When required for determining phosphorus sorption capacity.
Phosphorus sorption (mg/kg)	Used to calculate the immobilisation of phosphorus by the soil. Sandy soils are mostly low in P sorption and need not be tested. Clay soils and soils high in iron and/or aluminium often have high P-sorption. The most useful information is obtained from a multi-point test.	Sites where phosphorus is recognised as a management issue. Where the soil is intended to be used as a phosphorus removal mechanism.

Section 5.5 The Land Capability Assessment Matrix

This matrix is assembled using the data that has been presented in the previous two sections. The values for the key site and soil features are compared against the criteria in the five rating classes. This allows a rating for each parameter to be determined. The overall rating for the site is determined by the most limiting rating for a feature. In the Model LCA the most limiting rating is 5 (for sodicity), therefore the site capability overall is 5.

This is only one possible approach to determine whether the domestic wastewater can be contained onsite. In this example the table has been closely based on the checklist provided in EPA Publication 746 (2003a). However, land capability assessors may choose to use a different method, or design their own method that may be better tailored to the local conditions.

Again, it is highly advisable to consult with the land capability assessor on the proposed method prior to the assessment commencing. Using a method that is deemed unsatisfactory by the council may result in refusal of the application, or a request for further information or investigation.

Section 5.6 The Management Program

Following the completion of the assessment matrix, recommendations should be made as to the type of wastewater management system that suits the capability of the site. The proposed design and management program of the onsite wastewater system recommended must address the most limiting site and soil features, identified in the assessment and associated risks with these limiting factors. It will also need to maximise the benefits of the better site and soil features, as a basis for system sizing. Taking into account this most limiting site feature also allows the management program to incorporate improvement measures, such as use of gypsum on sodic soils to counter dispersion.

When checking the suitability of the proposed system, it is a good idea to start from the site and soil constraints and work 'backwards' through the treatment train. That is:

- Check that the nominated land application system is suited to the site and soil features;
- Check the calculations for the required effluent quality, based on the site sensitivity and land application area design; and
- Finally, check that the chosen treatment and ancillary systems proposed to achieve the effluent quality and the performance objectives for the site are adequate.

Usually, the poorer the land capability rating of the site, the higher the level of treatment required. For example, for a site with a LCA rating of 1 or 2 a primary treatment system such as a septic tank may be suitable, in conjunction with an absorption trench (providing it is not adversely impacting beneficial uses of the surface water or groundwater). Or, for a site with a LCA rating of 5 located on a site on a floodplain with high groundwater a primary or secondary treatment system combined with a Wisconsin Mound (which provides further treatment of the effluent as well as enhanced evapotranspiration) may be appropriate.

Therefore, it is important to treat every LCA individually so that the type of treatment and land application systems match the capability of the site in question and provide for the highest level of public health and environmental protection possible.

When assessing a LCA, make sure the consultant has considered the following important issues:

- The sustainability of the proposed system;
- The expectations of the future residents of the development;
- Current and future residents' ability to adequately manage the system;
- Site suitability, including environmental sensitivity;
- System reliability and the quality of service offered by the manufacturer (if any);
- The availability of service agents in the area and their quality of service;
- System cost (both capital and on-going);
- System lifespan;
- Whether on-site management is a long-term management strategy or only an interim measure before connection to a centralised sewerage system;
- The need for the proposed system to be replaced or refurbished at some later date;
- The cumulative public health and environmental impacts of present and future OSMSs within the subdivision or catchment;
- The development of contingency plans in the event of system failure; and
- The impact of the system on the amenity of the area.

If these issues have not been considered in the report, the LCA consultant can be asked to provide additional information. Again, good communication prior to commencement will reduce the risk of this happening.

Once the type of LAA system and the level of treatment are determined, based on the site's identified constraints and risks, a brief amount of information about the types of systems may be provided. For the purposes of the LCA council may not require a detailed design. However, when a detailed design is later submitted, council officers must check that it mirrors the concept design or recommendations contained in the original LCA.

Addressing the bullet points above will provide enough information as to what is proposed in the way of treatment and associated ongoing management for council to assess whether it matches the soil constraints and risks identified in the LCA. It also provides the client (landowner) with some guidance on the general type of system they would need for their site. Table 12 provides information on some commonly used LAA and treatment system combinations.

Table 12 On-site Wastewater System Options

Treatment	Device Type	Land Application System
Primary	Septic tank Greywater diversion device Waterless composting toilet Wet composting toilet Combustion toilet	Subsurface absorption systems subsurface irrigation Evapotranspiration beds Amended soil and sand mounds Burial (for compost)
Secondary	AWTS Greywater treatment Septic tank and sand filter Septic tank and peat filter	Subsurface irrigation
Tertiary (disinfection)	AWTS Greywater treatment system Septic tank and (non-aerosol) sand filter Septic tank and peat filter	Subsurface irrigation Surface irrigation (non-aerosol)
Greywater tertiary (excluding kitchen wastes)	Greywater treatment system	Subsurface irrigation Surface irrigation (non-aerosol) Toilet flushing

Section 5.6.1 Treatment Systems

Aerated Wastewater Treatment Systems (AWTS)

AWTS are pre-fabricated or pre-engineered treatment systems designed to treat small (< 2,000 L/day) wastewater flows. They are tank-based systems that typically employ the following processes:

- Settling of solids and flotation of scum in an anaerobic primary chamber;
- Oxidation and consumption of organic matter through aerobic biological processes;
- Clarification – secondary settling of solids;
- Disinfection; and
- Regular removal of sludge to maintain the process.

Good maintenance of AWTS is essential to ensure a consistently high level of performance. By law, AWTS systems are required to be serviced quarterly by an approved maintenance contractor.

Sand Filters

Sand filters provide advanced secondary treatment to water that has already undergone primary treatment in a septic tank or similar device. They contain approximately 600 mm depth of filter media (usually medium to coarse sand, but other media can be incorporated) within a lined excavation containing an underdrain system. Selection of the filter media is critical and a carefully designed distribution network is necessary. A dosing well and pump is normally used to allow periodic dosing. Depending on the desired level of treatment, sand filters can be single-pass or may incorporate partial recirculation. A subsequent disinfection system is required to allow reuse by surface irrigation. There are several proprietary sand filter systems available today and detailed sizing and design of these systems is generally undertaken by the manufacturer.

Section 5.6.3 Sizing the Irrigation System

The following section provides an overview of the fundamental principles that need to be considered when checking the proposed sizing of dispersal area or irrigation system. Further guidance on specific design parameters for on-site systems may be obtained from Part 4 of *AS/NZS 1547:2000*. Further background information may be found in USEPA On-site Treatment Systems Manual.

Both a mean monthly water balance and a nutrient balance have been used to calculate the minimum size of the land application area for the Model LCA. They can both be valuable tools for taking into account site specific variation in conditions.

Remember that mean values do not generally show the ‘spike’ or worst case scenario, and may only represent the most likely scenario. While LCA should determine the long term environmental impact of onsite wastewater, the worst case scenario may also be included. This will ensure that the LCA is conducted on a range of environmental considerations. The complex interactions between the soil, climate, topography and wastewater inputs such as hydraulic and nutrient loadings may mean that there is no ‘correct’ method or ‘right’ answers. The methods shown below have been chosen because of their relative simplicity and are examples of possible methods of calculation.

Remember also that all water and nutrient balance calculations are simply estimates. They are not exact replications of what actually happens on a land application area site. Small variations in the inputs to water and nutrient balances can lead to large differences in estimated land application area. To make sure that the performance objectives of these guidelines will be met, take a conservative approach when assessing the proposed areas.

Water Balance

A water balance can be used to estimate irrigation area requirements based on climate and wastewater production. It is expressed as:

precipitation + applied wastewater = evapotranspiration + percolation + runoff

Where:

Precipitation refers to deposits of water, either in liquid or solid form that reach the earth from the atmosphere; it can include rain, sleet, snow, hail, dew and frost.

Evapotranspiration is the removal of water from soil by evaporation and by transpiration from plants. Monthly evapotranspiration is estimated to be a percentage of the monthly evaporation. This percentage is determined for a particular vegetation type by using a 'crop factor'.

The crop factor can vary, depending on the type of plant being grown, the area of the state where the irrigation area is placed, the time of the year, and exposure of the site. A variable factor of 0.7–0.8 has been used for this balance.

Percolation is the descent of liquid through the soil profile, beneath the root zone. A design percolation rate can be taken from *AS/NZS1547:2000*. A Design Irrigation Rate (DIR) of 20 mm/week has been adopted for this design. When direct measurements from the field are not shown in the LCA, the worst case range from Table 4.2A2 of *AS/NZS1547:2000* should be adopted.

Retained Rainfall is the proportion of precipitation that is absorbed within the proposed land application area. In order to be conservative this example water balanced assumed that all rainfall was retained with no runoff.

It is important to remember that figures used in these types of equations are often a mean figure. In certain locations this may not be an appropriate value, for example, in areas experiencing markedly higher rainfall periods in a month. Care should be taken when selecting suitable data. Consistency of data type is also essential.

Formulae used in calculating the water balance are shown in the example spreadsheet in Appendix 2 of the Model LCA.

Water balance calculations demonstrate the importance of reducing the amount of wastewater produced by a household. The implementation of wastewater reduction initiatives such as composting toilets and water-saving shower heads, taps and appliances can lead to significant reductions in area and storage requirements.

If the LCA shows that sewage cannot be contained onsite, and reticulated sewerage is not available in the near future, the development should not proceed. This is one of the advantages of undertaking strategic LCA planning.

Nutrient Balance

In an effluent application area, nutrients are removed by vegetation, microorganisms, chemical precipitation, soil adsorption, volatilisation and leaching. Nutrient removal by vegetation occurs only during the active growth period of the vegetation, and varies greatly among different vegetation types. The wastewater must be available to the root zone of the vegetation for nutrient uptake to occur. Harvesting plants (which may include mowing or pruning) and removing them from the site is required to maintain the nutrient uptake rate and export the nutrients. Nutrients retained in a standing crop, detritus, or residual humus must be regarded as potential reservoirs of soluble nitrogen and phosphorus on the site, although the contribution of organic carbon may ensure their slow mineralisation.

The use of phosphorus by vegetation is only a minor removal mechanism. Adsorption onto soil particles is usually the main way that phosphorus is removed from the effluent. This mechanism is not readily renewable, and most irrigation areas (including absorption buffer areas) generally have a design life of at least 50 years before the phosphorus sorption capacity is exceeded. In the event that the design life is expected to be less than 50 years a frequent monitoring program may be put in place.

Nutrient Balance Calculations

Provided below is an explanation of the calculations used in the Model LCA to determine the most limiting area for nutrients.

Data Inputs

Nutrient concentrations in effluent can have a significant bearing on the output of a nutrient balance. Underestimating nutrient loads will reduce the validity of the results. Where possible nutrient concentrations should be obtained from monitoring data for the type of system proposed. USEPA (2002) provide indicative concentrations for nutrients in effluent from key treatment systems (it is important to note that this resource may not exactly represent Victorian scenarios).

Nitrogen lost to soil processes can be highly variable and should be conservatively estimated. Geary and Gardner (1996) suggest approximately 20% of total nitrogen will be lost through mineralization, volatilization and denitrification in the soil when applying secondary treated effluent.

Design life of the system is used to calculate the minimum area based on a phosphorus balance. A figure of 50 years has been used in the model LCA and in that situation is considered sufficiently conservative. However in certain situations, such as in a drinking water catchment, 75 years may be more appropriate.

Crop nutrient uptake rates are another highly variable input. Where site specific data is not available reference should be made to the indicative uptake rates provided in the EPA Victoria *Guidelines for Wastewater Irrigation* (1991). Conservative figures should be used.

Phosphorus sorption capacity should be determined on a site specific basis for subdivision and planning scheme amendment LCAs though soil sampling and subsequent laboratory analysis. Single lot assessments that involve a highly sensitive or limited site should also obtain site specific data. Otherwise phosphorus sorption capacity may be estimated from available published soil data for the region or the identified soil type.

Bulk density will depend on a variety of factors including soil type. It can typically be taken as 1.5 g/cm^2. This input is used along with soil depth to convert phosphorus sorption capacity from mg/kg to kg/ha.

Depth of soil can have a significant impact on the phosphorus balance and must be determined through a detailed site and soil investigation.

Actual percent of phosphorus sorption is required based on the assumption that sorption under field conditions is less than laboratory estimates. A multiplier between 0.25 and 0.75 is typically used. The figure will depend on the hydraulic conductivity of the soil among other factors.

Explanation of calculations for the Model LCA

Nitrogen (N) Balance

1 **Determine the daily N load**

Effluent concentration N – 30 mg/L
Daily hydraulic load – 840 L/day

30 x 840 = 25,200 mg/day

2 **Determine the annual N load**

25,200 mg/day x 365 days

Annual N load = 9,198,000 mg

3 **Allow 20% loss through denitrification, volatilization, microbial attack and other processes**

9,198,000 x 0.8 = 7,358,400 mg/yr

Annual N load = 7.358 kg/yr

4 **Allow for an uptake by plants (application rate) of 220 kgN/ha/yr**

(please note that where available plant uptake rate that relates specifically to the site should be utilized. This figure is suitable for a regularly maintained grass cover.)

5 **Divide the annual N load by the application rate**

7.358/220 = 0.0334 ha

multiply by 10 000 m^2

Minimum area required for N uptake = 334m^2

Using a nominated area of 371 m^2 (minimum area based on water balance) the nutrient balance spreadsheet shows a slight nitrogen deficit based on an annual balance.

Phosphorus (P) Balance based on a life of 50 years

1 **Determine the daily P load**

Effluent concentration P – 10mg/L

Daily hydraulic load – 840 L/day

10 x 840 = 8,400 mg/day

2 **Determine the annual P load**

8,400 mg/day x 365 days = 3,066,000 mg

Annual P load = 3.066 kg

3 **Allow for an uptake by plants (application rate) of 50 kg P/ha/yr (please note that where available plant uptake rate that relate specifically to the site should be utilized. This figure is suitable for a regularly maintained grass cover.)**

4 **Determine P sorption each year for 50 years**

3375 / 50 x 0.5 (actual field sorption multiplier) = 33.75 kg/ha/yr

5 **Determine total annual application rate**

Plant uptake + P sorption = 33.75 + 50

Total P application rate = 83.75 kg/ha/yr

6 **Divide the annual P load by the application rate**

3.066 / 83.75 = 0.0366 ha

multiply by 10 000 m^2

Minimum area required for P assimilation over 50 years = 366m^2

Using a nominated area of 371 m^2 (minimum area based on water balance) the nutrient balance spreadsheet shows a slightly higher phosphorus longevity (52 years).

Nutrient balance calculations demonstrate the importance of reducing both the volume of wastewater produced by a household and the concentration of nutrients within the wastewater. The implementation of wastewater and nutrient reduction initiatives such as the use of low phosphate detergents, composting toilets, and water-saving showerheads, taps and appliances, may lead to significant reductions in irrigation area requirements.

When should Water/Nutrient Balances be Undertaken?

A water balance should be undertaken for all system designs. However if site and soil characteristics, along with wider catchment sensitivities, indicate that nutrient export is not a concern, a nutrient balance may not be necessary. It is important to recognise areas within the your municipality where these calculations are required. This information can be passed on to land holders and LCA consultants in advance.

Summary and Discussion

It is important that the system is designed on the most limiting factor (water, nitrogen or phosphorus) and final sizing of the land application area is clearly nominated in this section of the LCA. An appropriate justification of the design procedure should be provided.

It is also important that the conclusion and summary discussion are written in plain English so that an audience with a marginal soil science background will be able to understand and act upon the recommendations. The relationship between the assessment and the recommended solution must also be outlined and clearly explained in this section.

Section 5.6.4 Siting and Configuration of the LAA

In this section the proposed location of the LAA should be discussed, with reference to the site plan which shows the layout. Obviously the siting will be based on the assessment results. Considerations relating to buffers, and system design should be stated here.

Section 5.7 Monitoring, Operation and Maintenance

General guidance should be provided on how to monitor, operate, and maintain all components of the on-site wastewater management system, including the treatment and land application systems. Recommendations should be in accordance with EPA Vic (2003) and the EPA approval conditions relevant to that type of system. Guidance could also be provided here on water conservation and improvement of wastewater quality.

Section 5.8 Stormwater Management

The need to provide diversion drains or other such structures to prevent stormwater running into the LAA should be described here, and the location of any such structures should be shown on the site plan.

Section 6 References

A reference list for all publications referred to in the LCA should be provided here, in alphabetical order.

References

Chapter 8

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