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Victorian Land Capability Assessment Framework

January 2014

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This document was originally developed in 2006 as part of the Victorian Government's Country Towns Water Supply and Sewerage Program. It was prepared by Whitehead & Associates Environmental Consultants Pty Ltd in accordance with EPA Victoria's Septic Tank Code of Practice Publication 891 and Land Capability Assessment for Onsite Domestic Wastewater Management Publication 746.1, and the Australian/New Zealand Standard 1547 (as amended) On-site Domestic Wastewater Management.

It has been revised by Whitehead & Associates in accordance with EPA Victoria's Code of Practice, Onsite Wastewater Management (Publication 891.3, 2013) and the Australian/New Zealand Standard AS/NZS 1547:2012 On-site domestic wastewater management.

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Disclaimer

The views expressed in this document do not necessarily represent the views of the Victorian State Government or the Municipal Association of Victoria.

Acronyms

AEP:	Annual Exceedance Probability
ARI:	Annual Recurrence Interval
AS/NZS:	Australian Standard/New Zealand Standard
BOD:	Biochemical Oxygen Demand
BoM:	Bureau of Meteorology
CA:	Certificate of Approval
CEC:	Cation Exchange Capacity
CMA:	Catchment Management Authority
DEPI:	Department of Environment and Primary Industries
DIR:	Design Irrigation Rate
DLR:	Design Loading Rate
DSE:	Department of Sustainability and Environment
EA:	Emerson Aggregate
EAC:	Emerson Aggregate Class
EC:	Electrical Conductivity
ECe:	Electrical Conductivity of a Saturated Soil Extract
EPA:	Environment Protection Authority
ESP:	Exchangeable Sodium Percentage
ET:	Evapotranspiration
FAO:	Food and Agriculture Organisation
LCA:	Land Capability Assessment
LAA:	Land Application Area
LPED:	Low Pressure Effluent Distribution
MAV:	Municipal Association of Victoria
MS:	Microsoft
RF:	Rainfall Runoff Factor
RR:	Retained Rainfall
SAR:	Sodium Absorption Ratio
SS:	Suspended Solids
TDS:	Total Dissolved Salts
TN:	Total Nitrogen
TP:	Total Phosphorus
TP(1):	Test Pit (1)
TSS:	Total Suspended Solids
USEPA:	United States Environmental Protection Agency
VCAT:	Victorian Civil and Administrative Tribunal
WATL:	(Bureau of Meteorology) Department of Water and the Land

1. Introduction

In 2004, 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 guideline and the accompanying Model Land Capability Assessment (LCA) Report have been updated to assist land capability assessment professionals in undertaking LCAs for a range of development types, as well as to provide guidance to relevant stakeholders.

This report has been written to comply with all relevant Victorian legislation, guidelines and codes including the Environment Protection Authority (EPA) Victoria Publication 891.3 Code of Practice, Onsite Wastewater Management ("the Code") (2013) and the Australian/New Zealand Standard AS/NZS 1547:2012 On-site Domestic Wastewater Management.

It should be noted that this guideline, the Victorian LCA Framework, is not an EPA publication and does not replace or supersede any existing Victorian legislation, guidelines or codes or Australian Standards. It is intended primarily for use by land capability assessors and local government officers and should be read in conjunction with the documents outlined above.

Where this Framework refers to a specific edition of a Standard, guideline, Code of Practice, policy or regulation use the most recent version of that document.

The Model LCA Report in Appendix 3 of this guideline is fictional, using some real and some contrived data for a site where onsite wastewater 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.

2. When is a Land Capability Assessment required?

An LCA is required for most unsewered developments, prior to the development proceeding (EPA, 2013). It may be also be required to determine whether an existing development can sustainably contain all treated wastewater onsite. The timing and the level of detail of the assessment may vary, for instance at rezoning or subdivision stage, or at individual lot development stage. The LCA should be undertaken as early as possible in the planning phase of the development or subdivision.

This document provides guidance on undertaking LCAs for a range of development types, but focuses on single-lot residential and small-scale commercial developments. Guidance on subdivision and broader-scale LCAs is provided in Chapter 5.

The purpose of the LCA is to:

Assess the capability of the site to sustainably utilise and manage wastewater within the allotment boundaries:

- Assess the capability of catchments to sustainably utilise and manage wastewater within sub-catchments or specific regions (broader-scale LCAs)
- Determine high risk and sensitive areas within allotments and within catchments
- Gather the relevant geographical and social information to adequately inform the process of designing the best practicable and most sustainable onsite wastewater treatment and effluent recycling / dispersal system that should protect the health of the householders and the community and protect the local environment from pollution; design the layout of the onsite wastewater treatment system and the size and location of the land application system and reserve area (where required) to minimise the health and environmental impacts of onsite wastewater management. (EPA, 2013)
- Formulate a sustainable management plan (in accordance with the Code, the conditions in the Certificate of Approval (CA) of the treatment system selected by the property owner and the local Council's permit conditions) that:
 - a) Must be adhered to by the property owner to ensure that impacts on the environment or public health do not occur or are minimised
 - b) Will ensure the beneficial reuse of the treated water, organic matter, nutrients and urine resources (where applicable).

A LCA report will identify the greatest risks to an area of land from 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, if this is possible.

It is recommended that LCAs are undertaken for all unsewered developments. However, a lot-scale LCA may not be required if Council is satisfied that the site is low risk or if there is adequate site and soil information gathered through existing investigations such as a regional, catchment or township-based land capability assessment.

LCAs must be undertaken for all unsewered properties within Special Water Supply Catchments. LCAs should also comply with any catchment management plans or strategies applicable to the site or subdivision. Assessors should liaise with Council early in the planning phase to determine what (if any) particular requirements are relevant to the site. Assessors should also refer closely to the Code and relevant Australian Standards during the planning phase and when undertaking LCAs.

3. Who should undertake a Land Capability Assessment?

Individual landowners or developers (not EPA or Councils) are responsible for engaging a suitably qualified and experienced professional to undertake a LCA for unsewered developments and subdivisions. Catchment-scale LCAs, at an appropriate level of detail, are often undertaken or commissioned by Councils, Catchment Management Authorities or state government agencies, sometimes as part of a catchment management plan or strategy. Catchment scale LCAs are generally not suitable for lot-scale assessment, however, may provide useful background information. In the case of individual lot-scale assessments, appropriate field validation should be undertaken.

Land capability assessment calls on a range of professional skills from a number of disciplines. LCA assessors should possess a tertiary-level qualification in a discipline such as hydrogeology, soil science, agricultural science, civil or geotechnical engineering, geology, environmental science, chemistry, physical geography and the like. The assessor should possess specific knowledge and practical experience of soil science, in particular soil hydrological and soil chemical processes.

In addition, LCA assessors should possess technical expertise and experience with the broader, inter-disciplinary fields of onsite wastewater management, including skills in the interpretation of site, soil and climate conditions, undertaking water and nutrient balances, selection and design of appropriate wastewater treatment and effluent disposal and reuse options, and other skills that are discussed in this guideline and the Code.

In line with the Code of Practice, councils may require written verification that Land Capability Assessors are suitably qualified, experienced, maintain appropriate professional membership and professional indemnity insurance.

Similarly, it is expected that Council officers assessing LCAs are conversant with onsite wastewater management, in order to confidently and competently interpret and evaluate LCA reports and specify conditions of development where appropriate.

Consultation with Council

Developers and LCA assessors should consult with Council officers at the planning phase of development (prior to the LCA process commencing) for the following reasons:

- Council will have an opportunity to explain any particular concerns regarding onsite wastewater 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
- Council can ensure the LCA assessor is appropriately qualified to undertake the work.

Sufficient communication should take place between the consultant and/or land holder and Council officer(s) to enable all parties to agree on the required level of detail, which will vary from site to site, before the work commences. This will assist to reduce potential conflict later, for example at the Victorian Civil and Administrative Tribunal (VCAT).

4. Undertaking Land Capability Assessments

This Chapter describes current best practice in undertaking land capability assessments for individual sites, focusing on single-lot residential and small-scale commercial developments. Guidance on multiple-lot subdivisions and broader-scale LCAs is provided in Chapter 5. An example of a Model LCA report for a single-lot residential site is provided in Appendix 3.

Both the undertaking of and reporting on land capability assessment are explained together throughout this chapter; that is, the methodologies for planning and undertaking LCAs are explained in sequential order, as well as how to interpret and describe the results of the assessments. LCA methodology and reporting are based largely on the Code as well as other relevant state and national guidelines and Standards. See the list of References for further information about undertaking LCAs and onsite wastewater management more generally.

The level of detail required in a LCA report depends on the specific requirements relating to the site and its surroundings (as discussed with the property owner, Council and other regulatory authorities, such as the water authority, if required), as well as the constraints of the site. For highly constrained sites, more detailed reporting is often required to justify approval of onsite wastewater management for new or updated developments.

Reporting styles may also differ from the general approach outlined in this guideline and the Model LCA, depending on the site constraints and the requirements of the client and Council. This guideline specifies a quantitative and qualitative matrix to assign a level of constraint rating of minor, moderate and major to each key site and soil characteristic. It is recommended that LCA assessors regularly consult with Councils and other relevant stakeholders about their requirements for land capability assessment and reporting.

Scope the Development, Consult with Stakeholders

The first stage of land capability assessment is to 'set the scene'.

Method

- Identify the location of the site, including lot and street number and the locality or town
- What is the land-owners wish-list for development (such as the number of lots, or for a single dwelling the number of bedrooms), and is this realistic for the site?
- Liaise with relevant Council staff, including Town Planners, Environmental Health Officers and Building Surveyors, to determine whether there are any special requirements for the LCA and to determine the level of detail of LCA required by Council - for example, whether the site is in a Special Water Supply Catchment, or is in close proximity to sensitive or significant environments. In some cases it may be necessary to consult with state government agencies and authorities such as Water Authorities, Department of Environment and Primary Industries (DEPI) or the Catchment Management Authority (CMA).

Reporting

The above information should be included in the introductory section of the report, clearly identifying the site and describing the proposed development.

Undertake a Desktop Assessment and Plan the LCA

Using online resources and discussing the site with the owner, you can build a comprehensive picture of the site's constraints and opportunities, and plan the LCA accordingly.

Method

Information that should be gathered, where available, includes but is not limited to:

- Land zoning, property boundaries and planning specifications (Council and DEPI)
- Topographic mapping, including position of surface waters (DEPI)
- Aerial photography (various freeware and DEPI)
- Climate data (Bureau of Meteorology)
- Geological mapping and data (DEPI)
- Soil mapping, surveys and testing data (DEPI)
- Mapping of groundwater resources, including domestic and public supply bores (Rural Water Authorities)
- Location of services such as water, sewer, gas and electricity (Council and utility service providers)
- Environmental constraints, such as flooding, bushfire, protected habitats and Special Water Supply Catchment areas (DEPI and Council)
- Any plans or strategies relating to onsite wastewater management in the area (Council)
- Current or previous land use, such as agriculture (consult with property owner)
- Incidence of site constraints such as poor drainage, high runoff, shallow soils, vegetation, rock outcrops, intended location of site structures, access, etc. (consult with property owner).

Where online information is available, the level of detail depends largely on the location of the site. There are numerous online tools (including mapping and libraries of published information)

which are located across various State department websites and these are routinely updated. Some current online resources are provided in 'References and Further Reading'.

This information allows you to plan how you will undertake the field work involved in the LCA, for example, to determine which areas of the property are likely to be the most appropriate for effluent application, and whether onsite wastewater management is likely to be constrained by factors such as proximity to surface or groundwater, poor soils and so on.

Note that broadscale mapping data should be used with caution at individual lot or even subdivision scale LCA due to limitations of scale and detail. Field verification of this information should always be undertaken to provide detailed information for the land capability assessment.

Reporting

An overview of key information relating to the development, such as planning constraints and requirements, should be included in an introductory or overview section near the beginning of the report.

A scaled locality plan identifying the site and showing key features such as site boundaries, contour lines, surface waters and so on should be included near the beginning of the report. Use of a topographic map base will allow the reader to see the local landform and presence of land features such as waterways. It is also important that the site is appropriately located on a map which includes the nearest town and names of roads and infrastructure and GPS coordinates where applicable.

Describing and interpreting site-specific data relating to the site LCA is explained in Section 3.

Field Work (Site and Soil Assessment) and Interpretation

The site and soil characteristics that will be assessed should be determined prior to undertaking the field work. Best practice LCA takes into consideration a broad range of site and soil parameters which are assessed in the field and interpreted using additional data (such as that described in Section 2). LCA assessors should have a good understanding of each of these parameters. It is helpful to have printed templates to take into the field to record notes about relevant site and soil characteristics.

Method

Site assessments should include a 'walk-over' of the entire site, or for large or difficult sites, specific areas identified by the desktop assessment should be investigated. It is a good idea to take photos and make sketches as well as notes of the site assessment.

Table 1 provides an overview of key site features and how they can be assessed and interpreted in the context of onsite wastewater management. Assessment of each feature should be recorded in the field.

Table 1: Key Site Features		
Feature	Explanation	Assessment Process
Aspect	The aspect or the direction that a slope is facing influences solar exposure.	Estimate the general direction of the slope of the land application area(s) (LAA). If there are multiple aspects, focus on the areas most suitable for LAA.
Climate	Seasonal rainfall, evaporation and temperature patterns influence potential evapotranspiration in land application areas.	Gather Bureau of Meteorology (BoM) data and determine average and maximum monthly rainfall, and average monthly evaporation.
Erosion and Landslip	Unstable areas (steep, unvegetated, dispersive soils etc.) are usually unsuitable for LAAs without mitigation.	Note any existing or potential erosion sites, as well as any past landslips or slope failures.
Fill (imported)	Capacity to assimilate effluent depends on the physical and chemical characteristics of the imported fill material(s).	Observe the extent and characteristics of any imported fill, particularly on potential LAAs.
Flooding	Requirements for siting onsite wastewater infrastructure (including LAAs) away from areas subject to flooding can vary between Councils.	Access official records where available. Note proximity of LAAs to waterways and areas subject to flooding.
Ground-water	Adequate depth of soil to protect groundwater resources largely depends on soil type and climate.	Note the presence of bores on the site or in the locality, and depth of any standing water in pits or bores.
Land Suitability	An LCA is used to determine which land is suitable and unsuitable for LAAs.	Areas that are unsuitable for LAAs should be excluded to determine available LAA on the site. A number of small and separate areas are often not suitable for LAAs.
Landform	Landform shape and the position of LAAs on slopes influence drainage and runoff characteristics both onto any potential LAAs as well as downslope of them (i.e. will runoff be evenly shed, or concentrated or dispersed flows?).	Topographic maps can be used to assess broad landform (geomorphology), and specifics such as position on slope and shape of slope should be assessed in the field, especially for any LAAs.

Feature	Explanation	Assessment Process
Rock Outcrops	Rock outcrops displace soil horizons and therefore can limit the assimilative capacity of LAAs for effluent. Outcrops can indicate shallow bedrock. Some rocks are strongly fissured and permeable and others are not.	Estimate the amount (% cover) and type of any rock protruding from the ground on the site.
Setback Distances	Determining the most appropriate position for LAAs should be prioritised over placement of building areas.	Note any constraints to required setback distances being met, e.g. lot size and shape.
Site Drainage	LAAs should be located in areas of good surface and subsurface (soil) drainage.	Determine whether rainfall will be shed (run off) or soak in, and note any waterlogged areas, which may be indicated by hydrophilic vegetation.
Stormwater Run-on and Runoff	LAAs should not be located in areas with high run-on, without mitigation such as upslope diversion structures. Downslope runoff diversion may be useful.	Note evidence of run-on to potential LAAs (such as sediment dams and wet ground) and determine likely flow path(s) of runoff from LAAs.
Slope	Land application of effluent becomes increasingly constrained with increasing slope gradient, increasing the chances of effluent runoff or subsurface seepage.	Slope can be measured in the field using a clinometer. Topographic contour lines on a site plan can also be used.
Surface Waters	Whether the setback distances specified in the Code can be achieved from LAAs.	Distance of potential LAAs from ephemeral and permanent drainage lines, creeks, rivers, lakes, dams and all other surface waters.
Vegetation	Good vegetation cover is important to prevent erosion as well as for uptake of water and nutrients from effluent.	Vegetation cover (%) and type (e.g. turf or woodland) should be determined or estimated.

Soil Assessment

Table 2 provides an overview of key soil physical and chemical features and how they can be assessed and interpreted in the context of onsite wastewater management. Assessment of each feature should be recorded in the field.

Table 2: Description of Key Chemical and Physical Soil Features		
Feature	Explanation	Assessment Process
Cation Exchange Capacity	Influences the ability of the soil to hold and exchange cations; a major controlling agent for soil structural stability, nutrient availability for plants and the soil's reaction to fertilisers and other ameliorants (refer to Hazelton & Murphy, 2007).	Recommended for soils suspected to have low fertility. This test is undertaken in a suitable soil testing laboratory and is a precursor for measuring sodicity.
Colour and Mottling	Gleyed soils indicate permanent saturation (permanent watertable), while orange, yellow and red mottles indicate seasonal saturation with intermittent periods of drying (perched or seasonal watertable).	Describe the soil, including the dominant soil colour (using Munsell soil colour chart) and the proportion and colour of any mottling or gleying (soil that is greyish, bluish or greenish) in each soil horizon. Include a photograph to illustrate.
Electrical Conductivity (EC)	EC test result infers the salinity of the soil and its potential impact on plant growth on the LAA. Refer to Hazelton & Murphy (2007) for interpretation of EC test results. Application of effluent increases salt content of soils over time.	This cheap and simple test measures the amount of dissolved salts and can be undertaken using a hand-held meter using 1:5 soil:water suspension, or in a suitable soil testing laboratory.

Feature	Explanation	Assessment Process
Emerson Aggregate Class	EAC results infer dispersibility (as ped slaking, soil dispersion or both). LAAs should not be installed in soils with moderate or high dispersibility, without adequate mitigation (e.g. addition of gypsum, use of irrigation).	The Emerson Aggregate Test (EAT) is used to assess soil dispersibility and susceptibility to erosion and degradation. Refer to Hazelton & Murphy (2007) for test methodology. The EAT should be the first test of soil structure stability; if the soil is dispersive measuring its sodicity is highly desirable and can lead to a correct gypsum dosing recommendation.
Permeability and Design Loading Rate	The rate at which water moves through the soil reflects the soil's permeability and determines the rate at which effluent is applied to land in litres per square metre per day (mm per day). The application rate for each type of land dispersal and recycling system is listed in Table 9 in the Code. Whilst the loading rate for LAA design is based on the permeability, it is less than the true permeability.	Generally, assessment of soil texture is adequate to determine soil permeability from AS/NZS1547:2012. The constant-head permeameter (AS/NSZ1547:2012) can also be used, but not if soils are waterlogged or shrink-swell cracks are present. NOTE that the falling-head percolation test is no longer considered acceptable by the EPA.
pH	Acid soils (pH <5) or alkaline soils (pH >8) may constrain plant growth and should be ameliorated by use of chemical additives (e.g. lime for acidity).	This test can be undertaken using a soil pH test kit, a calibrated hand-held meter using 1:5 soil:water suspension, or in a suitable soil testing laboratory.
Rock Fragments	Coarse rock fragments displace soil volume and therefore can limit assimilative capacity of soils.	Visually estimate the size and proportion of coarse rock fragments (pebbles etc.) in each horizon. Judge to see if rocks indicate shallow bedrock.

Feature	Explanation	Assessment Process
Sodicity [Exchangeable Sodium Percentage (ESP)]	The percentage of sodium compounds on cation exchange sites on soil particles. ESP >6% may cause damage to the soil structure. Refer to Hazelton & Murphy (2007). Effluent and greywater contain sodium.	Recommended for soils or effluent suspected to have elevated sodium levels, especially soils that disperse in water, producing turbidity. This test is undertaken in a suitable soil testing laboratory, in conjunction with testing cation exchange capacity and exchangeable cations.
Sodium Absorption Ratio (SAR)	The ratio of sodium to calcium and magnesium (beneficial elements) in the soil solution, with higher ratios potentially damaging to plants and soils.	Recommended for soils or effluent suspected to have elevated sodium levels, especially soils that disperse in water, producing turbidity. This test is undertaken in a suitable soil testing laboratory.
Soil Depth	Deeper soils generally have a greater assimilative capacity for effluent (depending on soil type).	Comment on the total soil depth, using field investigation or other sources of information such as bore logs, as well as the thickness of each soil horizon, to adequately characterise the soil beneath the LAA. The Code requires description of soil characteristic details 1.5m below the base of the LAA.
Soil Texture	Soil textures are categorised as 1. Gravels and Sands 2. Sandy Loams 3. Loams 4. Clay Loams 5. Light Clays, or 6. Medium to Heavy Clays (AS/NZS1547:2012).	Use the Code and AS/NZS1547:2012 to analyse and identify the texture of each soil horizon. Refer also to McDonald et al. (1990).
Watertable (depth to)	The required soil depth to protect groundwater depends on soil type; high permeability soils generally require a greater separation distance (soil depth).	Distinguish between temporary (seasonal) perched watertables (mottling indicates wetting and drying) and permanent watertables.

The purpose of the soil assessment is to assess the capability of the soils to sustainably assimilate the water, nutrient, salt and any pathogen content of treated effluent and to design an appropriate land application system accordingly.

Cation exchange capacity, soil sodicity, pH, salinity and dispersiveness are closely linked properties. The soil holds common cations, positively charged ions, like calcium, magnesium, sodium, potassium, hydrogen and aluminium adsorbed to the negatively charged surfaces in the soil, especially clay and organic matter. All of these adsorbed cations can be exchanged for other cations, thus when there are too many sodium ions, which affect soil structure poorly and promote dispersion, adding calcium from gypsum, CaSO_4 , and water will cause some of the sodium ions to be liberated and able to be washed down the soil profile and out of the root zone. Soil structure stability is improved, dispersion is reduced and permeability is increased. Calcium should be the dominant exchangeable cation for a “good” LAA soil. Soils with high sodicity (exchangeable sodium) often have very high pH as well so that gypsum amendment can lower the pH. Extremely acidic soils are dominated by exchangeable hydrogen and aluminium and are very stable and non-dispersive. Soils with high salinity are usually not dispersive but the salinity may inhibit good vegetative growth on the LAA. Leaching high salinity soil with very low salt irrigation water, rain water, or low salt wastewater tends to increase sodicity, dispersiveness and can produce an almost impermeable soil. The above holds for soils with significant clay content. Sands have insignificant cation exchange capacity. Sodic and dispersive subsoils are extremely common in Victoria.

Soil characteristics in the field should be assessed by undertaking soil surveys and analyses, by use of hand-dug or augered test pits to a depth of at least 1.5 metres, as well as in-situ and/or subsequent testing of collected soil samples. Deeper test pits (2.0 metres or greater) are recommended for more detailed investigations and reporting, especially on constrained sites. It is important to have a clear picture of the nature and extent of any limiting soil features within 1.2 metres below the base of the application field.

It is recommended for single-lot residential developments that at least two hand-dug or augered test pits are excavated in the proposed LAA. More would be required where the soils vary within the potential LAA. For a single-lot and sub-divisions sufficient hand-dug or augered test pits are required to adequately characterise the soils where multiple soil landscapes are mapped within the site boundaries or there are diverse landform elements present. Hand-dug or augered test pits should be excavated in areas determined to be most suitable for effluent application, following desktop investigation and walk-over of the site. AS/NZS1547:2012 provides guidance on excavating test pits and holes.

Detailed bore-logs of test pits and auger holes should be recorded, clearly communicating the key soil characteristics of each horizon (see Table 2, along with any comments on that soil's particular capability for effluent assimilation. Soil forming processes differ between landform elements, for example crest, mid-slope and lower slope. Therefore, the resulting soils can be very different and would have different capability for the assimilation of treated effluent.

Potential LAAs should be thoroughly investigated to ascertain any constraints, such as those listed in Table 2. Similarly, any beneficial aspects of short-listed areas should also be noted, to maximise the design and configuration of the effluent management system.

Reporting on site and soil characteristics is typically in tabular format.

Determine the Land Capability for Onsite Wastewater Management

The results and interpretation of the desktop and field investigations are used to determine whether effluent can be contained within the property boundaries and if onsite wastewater management is feasible.

Method

The 2006 MAV & DSE Model LCA Report and EPA Publication 746.1 Guidelines for Land Capability Assessment used a quantitative assessment matrix with specific ranges of values for most site and soil characteristics. However, it is considered more appropriate to determine the land capability of the site for onsite wastewater management using both quantitative and qualitative methodologies.

This Framework for Land Capability Assessment aims to direct the assessor to consider the totality of the site's features and draw conclusions from a logical and realistic assessment that has to be justified in the LCA report. A Land Capability Assessment must take a systems approach. The report should identify and describe the level of constraint presented by each site and soil characteristic where these present a moderate or major level of constraint. It should also describe how the proposed design adequately mitigates these constraints to the extent that the design can reasonably be expected to perform to meet appropriate public health, environmental and amenity requirements. The assessor should also explain whether or not any particular site or soil characteristic may aggravate or even compensate for another characteristic within the overall capability of the land, for example a soil with a naturally favourable permeability will cope better with high rainfall than a soil with low permeability. The assessor or Council must not assign numerical values to the levels of constraints. The impact of any actual or potential moderate or major constraint must be explained and addressed, and where possible options for amelioration proposed, in the LCA report. Not all characteristics that are listed as having the same level of constraint have the same level of impact, i.e. a major constraint in terms of exposure to sun and wind will not be as serious as a major constraint in terms of very poor drainage. The final outcome depends on the relative severity and influence of individual features on potential onsite wastewater management options and should be made in consultation with Council and other regulatory authorities, such as the relevant Water Authority, as appropriate. Management and maintenance requirements of the recommended onsite wastewater system design should be clearly detailed in the final report so landowners are aware of the commitment required to keep the system operating successfully.

Risk Assessment of Site Characteristics

An example of an LCA matrix for site characteristics is presented in Table 3 below. Note that the level of constraint can apply to the entire site or just the proposed LAA(s).

Table 3: Risk Assessment of Site Characteristics				
Characteristic	Level of Constraint			Assessed Level of Constraint for Site
	Nil or Minor	Moderate	Major	
Aspect (affects solar radiation received)	North / North-East / North-West	East / West / South-East / South-West	South	
Climate (difference between annual rainfall and pan evaporation)	Excess of evaporation over rainfall in the wettest months	Rainfall approximates to evaporation	Excess of rainfall over evaporation in the wettest months	
Erosion ¹ (or potential for erosion)	Nil or minor	Moderate	Severe	
Exposure to sun and wind	Full sun and/or high wind or minimal shading	Dappled light	Limited patches of light and little wind to heavily shaded all day	
Fill ² (imported)	No fill or minimal fill, or fill is good quality topsoil	Moderate coverage and fill is good quality	Extensive poor quality fill and variable quality fill	
Flood frequency (ARI) ³	Less than 1 in 100 years	Between 100 and 20 years	More than 1 in 20 years	
Groundwater bores ⁴	No bores onsite or on neighbouring properties	Setback distance from bore complies with requirements in EPA Code of Practice 891.3 (as amended)	Setback distance from bore does not comply with requirements in EPA Code of Practice 891.3 (as amended)	

Characteristic	Level of Constraint			Assessed Level of Constraint for Site
	Nil or Minor	Moderate	Major	
Land area available for LAA	Exceeds LAA and duplicate LAA and buffer distance requirements	Meets LAA and duplicate LAA and buffer distance requirements	Insufficient area for LAA	
Landslip (or landslip potential) ⁵	Nil	Minor to moderate	High or Severe	
Rock outcrops (% of surface)	<10%	10-20%	>20%	
Slope Form (affects water shedding ability)	Convex or divergent side-slopes	Straight side-slopes	Concave or convergent side-slopes	
Slope gradient ⁶ (%)				
(a) for absorption trenches and beds	<6%	6-15%	>15%	
(b) for surface irrigation	<6%	6-10%	>10%	
(c) for subsurface irrigation	<10%	10-30%	>30%	
Soil Drainage ⁷ (qualitative)	No visible signs or likelihood of dampness, even in wet season	Some signs or likelihood of dampness	Wet soil, moisture-loving plants, standing water in pit; water ponding on surface, soil pit fills with water	

Characteristic	Level of Constraint					Assessed Level of Constraint for Site
	Nil or Minor		Moderate	Major		
Stormwater run-on	Low likelihood of stormwater run-on			High likelihood of inundation by stormwater run-on		
Surface waters - setback distance (m)⁹	Setback distance complies with requirements in EPA Code of Practice 891.3 (as amended)			Setback distance does not comply with requirements in EPA Code of Practice 891.3 (as amended)		
Vegetation coverage over the site	Plentiful vegetation with healthy growth and good potential for nutrient uptake		Limited variety of vegetation	Sparse vegetation or no vegetation		
Characteristic	Level of Constraint					Assessed Level of Constraint for Site
	Nil or Minor		Moderate	Major		
Soil Drainage⁸ (Field Handbook definitions)	Rapidly drained. Water removed from soil rapidly in relation to supply, excess water flows downward rapidly. No horizon remains wet for more than a few hours after addition	Well drained. Water removed from the soil readily, excess flows downward. Some horizons may remain wet for several days after addition	Moderately well drained. Water removed somewhat slowly in relation to supply, some horizons may remain wet for a week or more after addition	Imperfectly drained. Water removed very slowly in relation to supply, seasonal ponding, all horizons wet for periods of several months, some mottling	Poorly/Very poorly drained. Water remains at or near the surface for most of the year, strong gleying. All horizons wet for several months	

Legend:

Nil or Minor: If all constraints are minor, conventional/standard designs are generally satisfactory.

Moderate: For each moderate constraint an appropriate design modification over and above that of a standard design, should be outlined.

Major: Any major constraint might prove an impediment to successful on-site wastewater management, or alternatively will require in-depth investigation and incorporation of sophisticated mitigation measures in the design to permit compliant onsite wastewater management.

Provide the following information in the LCA report:

- Provide basis for erosion rating
- Describe the nature of the fill and compaction
- Annual Return Interval (in years)
- Refer to setback buffers for groundwater bores in Table 5 of the EPA Code of Practice (2013)
- May require assessment by a geotechnical expert. Consider the potential for the additional water from the treatment system to impact the stability of the soil by reducing the friction forces within the soil or increasing the mass of the block of soil.
- Gentler slopes are required for higher loading rates. Steeper slopes have the potential for landslip and soil erosion.
- Provide date and weather conditions
- Use local anecdotal information
- Refer to setback buffers for specific waterway types in Table 5 the EPA Code of Practice (2013).

Risk Assessment of Soil Characteristics

The assessor should consider each parameter of the soil characteristics identified at the site or the test results obtained for the soil sample(s) and identify the level of constraint imposed. Where these present a moderate or major level of constraint, the assessor should describe how the proposed design adequately mitigates the constraint to the extent that the design can reasonably be expected to perform to meet appropriate public health, environmental and amenity requirements. The final recommendation depends on the relative severity and influence of individual features on potential onsite wastewater management options. Where possible, a solution that overcomes the constraints simply or naturally is preferred over a solution requiring high and ongoing maintenance. The final outcome should be made in consultation with Council and other regulatory authorities, such as the water authority, as appropriate.

Table 4: Risk Assessment of Soil Characteristics				
Characteristic	Level of Constraint			Assessed Level of Constraint for Site
	Nil or Minor	Moderate	Major	
Electrical Conductivity (ECe) (dS/m) as a measure of soil salinity ¹	<0.8	0.8 - 2	>2	
Emerson Aggregate Class (consider in context of sodicity)	4, 5, 6, 8	7	1, 2, 3	
Gleying ² (see Munsell Soil Colour Chart)	Nil	Some evidence of greenish grey / black or bluish grey / black soil colours	Predominant greenish grey / black, bluish grey / black colours	
Mottling (see Munsell Soil Colour Chart)	Very well to well-drained soils generally have uniform brownish or reddish colour	Moderately well to imperfectly drained soils have grey and/or yellow brown mottles and in the mottled areas occur higher in the profile the less well-drained the soil	Poorly drained soils have predominant grey colours with yellow brown or reddish brown mottles located along root channels, large pores and cracks	
pH ³ (favoured range for plants)	5.5 - 8 is the optimum range for a wide range of plants; 4.5 - 5.5 suitable for many acid-loving plants		<4.5, >8	

Characteristic	Level of Constraint			Assessed Level of Constraint for Site
	Nil or Minor	Moderate	Major	
Rock Fragments (size & volume %)	0 – 10%	10 – 20 %	>20%	
Sodicity ⁴ (ESP %)	<6%	6 – 8%	>8%	
Soil Depth to Rock or other impermeable layer (m) ⁵	>1.5 m	1.5 – 1 m	<1 m	
Soil Structure (pedality)	Highly or Moderately structured	Weakly-structured	Structureless, Massive or hardpan	
Soil Texture, ⁶ Indicative Permeability	Cat. 2b, 3a, 3b, 4a	Cat. 4b, 4c, 5a	Cat. 1, 2a, 5b, 5c, 6	
Watertable Depth (m) below the base of the LAA	>2 m	2 – 1.5 m	<1.5 m	

Legend:

Nil or Minor: If all constraints are minor, conventional/standard designs are generally satisfactory.

Moderate: For each moderate constraint an appropriate design modification over and above that of a standard design, should be outlined.

Major: Any major constraint might prove an impediment to successful on-site wastewater management, or alternatively will require in-depth investigation and incorporation of sophisticated mitigation measures in the design to permit compliant onsite wastewater management.

Footnotes

1. Refer to Stevens et al. (2008).
2. Greenish grey / black, bluish and grey / black colours are typical of prolonged periods of intermittent or continuous saturation and reducing conditions. Poorly drained soils will undergo long periods during which the soil's pores are filled with water indicating an inability of the water to leave from the site. Anaerobic conditions slow down the decomposition of organic wastewater contaminants but may increase denitrification of nitrate. Anaerobic soils often have a foul smell from rotting organic matter.
3. pH <4.5 may lead to aluminium or manganese toxicity; pH>8 may reduce availability of trace elements and phosphate and make gypsum ineffective as an amendment to lower sodicity.
4. A value of ESP = 6% is taken as the threshold between a sodic and non-sodic soil but it depends on the type of clay mineral in the soil. Soils with elevated ESP are often very dispersive and have low permeability.
5. Shallow soil depth or a high seasonal water table may result in inadequate depth of aerobic soil to adequately treat and dissipate the wastewater.
6. Refer to Soil Classification in the latest version of AS/NZS1547 and the Design Loading Rates and Design Irrigation Rates in Table 9 of the EPA Code of Practice. Indicative permeability ranges have been allotted to each texture and structure combination, but these may be need to be varied due to other soil factors such as sodicity and dispersibility. Soil permeability can be measured directly using the constant head permeability method outlined in AS/NZS 1547: 2012.

Reporting

Tabular reporting is generally the most clear and concise way of presenting the information. The LCA report should include the following:

- The assessment matrix used (such as the example given above).
- A plain-language statement drawing a conclusion from the LCA results.
- A clear explanation as to how the parameters that present moderate or major levels of constraint are adequately addressed in the design. It must be explained how the proposed design, adequately mitigates the constraint(s) and that the design can reasonably be expected to perform to meet appropriate public health, environmental and amenity requirements.
- Detailed information, such as bore logs of the test pits and/or auger holes and soil testing results, should be included as appendices to the report.

The report should consider the level of ongoing site management and maintenance required to maintain effective operation of the system. This should include a requirement to regularly check items such as cut-off drains, depth of scum and sludge in the primary tanks and removal of excess vegetation from the LAA. Appendix 3 provides an example of a model LCA report.

Design the Onsite Wastewater Management System

Following the determination of the land capability of the site (or proposed LAA(s) for large or variable sites), recommendations should be made as to the type of wastewater management systems that best suit the features and capability of the site. The proposed design and management program of the recommended onsite wastewater system must address the most limiting site and soil features identified in the assessment and the risks associated with these limiting factors. It will also need to maximise the benefits of the best location and soil features of the LAA, as a basis for system sizing. Taking into account the most limiting site features also allows the management program to incorporate improvement measures, such as run-on diversion structures, use of gypsum on sodic soils to counter dispersion, and so on.

Method

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 i.e. check that:

- The nominated land application system is suited to the site and soil features;
- The hydraulic and contaminant loads can be adequately assimilated based on the site sensitivity and land application area design; and
- The proposed treatment and effluent management systems can achieve the effluent quality and the performance objectives for the site.

It is important to assess every LCA individually so that the type of treatment and land application systems match the capability of the site and provide for the highest level of public health and environmental protection possible.

When determining the most appropriate systems for wastewater treatment and effluent dispersal or reuse, the consultant must consider the following issues in consultation with the property owners:

- The sustainability of the proposed system;
- The expectations of the owners of the development;
- Current property owners' ability to adequately manage the system;
- Site suitability, including environmental sensitivity;
- The availability of service agents in the area;
- System costs (both capital and on-going);
- The need for the proposed system to be replaced or refurbished at some later date;
- The development of contingency plans in the event of system failure; and
- The impact of the system on the amenity of the area.

Wastewater Generation

The daily wastewater flows and BOD loads must be calculated or estimated for all development types. In accordance with the Code (2013), BOD and organic material must be used as key design factors for all non-domestic developments. The organic load treatment capability must be used as the main factor in selecting the treatment system for all food catering premises (such as cafes, restaurants, function centres) and food processing factories.

In the absence of site-specific data (such as for a commercial system with metered flows and known pollutant outputs), the hydraulic and BOD loads of the wastewater must be determined using the minimum daily wastewater flow rates and organic loading rates provided in Table 4 of the EPA Code of Practice (2013) (not AS/NZS1547:2012). The Code (2013) does not make any differentiation between developments supplied with reticulated water or onsite sources (water tank or bore), as it assumes that ultimately reticulated supply will be provided, or additional water (such as by tanker supply) will be available. However, the Code (2013) allows Council to accept the reduced rates in AS/NZS1547:2012 where it is satisfied that a property not connected to reticulated supply will not have access to additional water sources.

In addition, no allowances are made for water-reduction fixtures and appliances, unless Council is satisfied that these features have been installed at the time of commissioning the wastewater treatment system, and are unlikely to be replaced by higher-usage fixtures and fittings. Note that higher water efficiency does not reduce the BOD load of the untreated wastewater stream; BOD concentration is increased while the hydraulic load may be reduced a little.

For domestic developments, the design occupancy rate is the number of bedrooms (including rooms that could be used as such) plus one.

The nutrient (nitrogen) load need only be determined if the site is located in a sensitive environment, where the soils and vegetation are suspected or observed to be limiting for nutrient assimilation, or if the development is likely to produce effluent that has higher nutrient concentrations than typical domestic developments. LCA assessors should consult with Council and other regulatory authorities to establish whether this is required. Some Certificates of Approval (CA) include expected nutrient concentrations in treated effluent (following testing). In

this absence of such data, other sources (such as the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks* 2006) should be used to estimate nutrient concentrations of effluent.

Wastewater Treatment System

Table 2 of the Code (2013) specifies the approved types of wastewater and greywater treatment systems and effluent reuse and disposal systems for both sewered and unsewered areas. Any wastewater treatment system proposed for installation in Victoria must have a current CA issued by EPA and displayed on the EPA website. There is a broad range of treatment systems* with current CAs including:

- Wet or dry composting toilets (greywater treatment system also required);
- Septic tanks;
- Aerobic biological filters (wet composting, vermiculture);
- Aerated wastewater treatment systems (AWTS);
- Ozonation;
- Textile filters;
- Sand filters;
- Tricking aerobic filters (using foam, plastic or similar media);
- Membrane filtration;
- Reed beds; and
- Sand mounds (following primary or secondary treatment).

*from Table 2 of the EPA Code of Practice (2013)

Further information (including detailed specifications) and references about wastewater treatment systems can be found on the EPA website and in the Code (2013). Note that the Code differentiates between systems that are permitted for use on sewered and unsewered sites. LCA assessors must refer to the Code (2013) when considering what potential treatment systems could be used for a given site, as well as consult with the landowner, Council and other regulatory authorities as appropriate. The CA of the treatment system specifies the hydraulic and organic loading capacity of the maximum daily wastewater load expected from the proposed development (including commercial systems, which should include a flow meter).

Usually, the higher the level of constraint of the site as determined by the land capability assessment, the higher the level of treatment required. For example, for a site with no major constraints, a primary treatment system such as a septic tank in conjunction with an adequately-sized absorption trench may be suitable. Conversely, a site with a LCA which identifies major constraints, located on a floodplain with high groundwater, will almost certainly require an EPA-accredited secondary treatment system combined with an effluent management system that can cope with the risks of flood inundation such as sub-surface irrigation. Irrigation of secondary effluent maximises the beneficial reuse of the water and nutrient resources in effluent in the biologically active topsoil.

Effluent Management System Type

The Code (2013) and the State Environment Protection Policy Waters of Victoria (2003) require all effluent to be completely contained within any lot that is not connected to sewer. Therefore, it is essential to select and design an effluent management system that will be appropriate for the land capability of each individual site. Appendix K of AS/NZS1547:2012 provides guidance on selecting land application systems that are appropriate to site conditions.

On sites where there are existing failures resulting in effluent export, the Code (2013) recommends that systems be upgraded to minimise impacts as much as possible.

Note that the following effluent management systems are no longer allowed in Victoria (EPA Code of Practice 2013):

- Boxed trenches with impervious sidewalls (AS/NZS1547:2012);
- Discharge-control trenches with impervious sidewalls (AS/NZS1547:2012); and
- Gravity flow subsurface irrigation.

Table 5: Permitted effluent management systems		
System	Conditions of Use	Reference
Subsurface drip irrigation	Secondary treated effluent or greywater only	AS/NZS1547:2012 EPA Code of Practice (2013)
Surface irrigation	Secondary treated effluent or greywater only	AS/NZS1547:2012 EPA Code of Practice (2013)
Sand (Wisconsin) mounds	Primary or secondary treated effluent or greywater	AS/NZS1547:2012 EPA Code of Practice (2013)
Evapotranspiration beds and trenches	Primary or secondary treated effluent or greywater	AS/NZS1547:2012 EPA Code of Practice (2013)
Absorption trenches	Primary or secondary treated effluent or greywater; Not for use in gravels or sands	AS/NZS1547:2012 EPA Code of Practice (2013)
Wick Trench and Bed systems	Primary or secondary treated effluent or greywater	EPA Code of Practice (2013) (Appendix E)
Low Pressure Effluent Distribution (LPED) system	Primary or secondary treated effluent or greywater	AS/NZS1547:2012 EPA Code of Practice (2013)

The DLR/DIR for secondary treated effluent for any effluent management system must not exceed the maximum in Table 9 of the Code 2013 (i.e. no reduction in the size of any land application system is permitted).

Pressure-compensating, subsurface drip irrigation is the preferred system for management of secondary treated effluent (EPA Code of Practice 2013). Sub-surface irrigation systems are more efficient at reusing the water and nutrient resources than surface irrigation. The DIR for effluent irrigation systems must be in accordance with Tables 9 of the Code (2013) not AS/NZS1547:2012.

Effluent Management System Sizing

Once the type of effluent management system has been selected, it needs to be appropriately designed for the unique site and soil characteristics. AS/NZS1547:2012 provides guidance on sizing the effluent management systems listed above, using basic calculations which generally do not include climate inputs and outputs.

Water Balance

For effluent irrigation systems a detailed water balance, using climate data for the site and the DIR specified in Table 9 of the Code (2013), is required. (A nutrient balance may also be required for sensitive sites, such as for Category 1 to 3a soils adjacent to freshwater lakes - this methodology is described later.) The water balance approach can also be used for trenches and beds, using DLRs provided in AS/NZS1547:2012 and an Excel water balance tool accompanies this LCA Framework.

The complex interactions between the soil, climate, topography and wastewater inputs may mean that there is no one 'correct' method or absolute 'right' answer. The methods shown below have been chosen because of their relative simplicity and are examples of possible methods of calculation. 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 can lead to large differences in the estimated land application area; therefore, a conservative approach should always be taken.

The water balance equation can be expressed as:

$$\text{precipitation} + \text{applied effluent} = \text{evapotranspiration} + \text{percolation} + \text{runoff}$$

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. Generally, a water balance using mean monthly rainfall is appropriate for most domestic and small commercial developments; however, a higher monthly rainfall percentile (e.g. 70%), or a more detailed daily water balance may be required for more constrained sites, or if Council (or other authority) requires this approach. Climate data is available from the Bureau of Meteorology and its subsidiary agency Water and the Land (WATL), formerly SILO.

Retained Rainfall is the proportion of precipitation that is absorbed within the proposed land application area (as opposed to the proportion that is expected to run off). Vegetation cover, soil type and slope are major factors influencing the amount of rainfall retained. In order to ensure the system is adequately sized, it is appropriate to assume 75-100% retained rainfall for the LAA:

- 75% for trenches and beds with mounded surface
- 75% for irrigation areas with upslope stormwater diversion berm on land with greater than 5% slope; and
- 100% for irrigation areas without stormwater diversion berm or on flat ground.

Fletcher et al. (2004) provides specific estimates for different regions.

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 site by multiplying the mean monthly pan evaporation (from BoM or other data) by a 'crop factor' for the particular vegetation type on the site. The crop factor can vary, depending on the type of plant being grown, the climatic zone of the State where the irrigation area is placed, the time of the year and exposure of the site. Appropriate crop factors should be selected from EPA Publication 168, Webb (2010), FAO List of crop coefficients (1998), or Dilley & Shepherd (1972).

Percolation is the rate of drainage through the soil beneath the root zone and is controlled mainly by soil permeability (dependent on texture and structure), but also in part by slope, depth to groundwater and limiting layers. The DLR/DIR for the limiting soil layer (within 600 mm of the point of application) should be selected from Table 9 in the Code (2013). These DLRs/DIRs have broadly been determined to be sustainable for the long-term application of effluent to the land in terms of clogging and salt build-up in the soils. However, it may be more prudent to use a lower DLR/DIR if soil sodicity or other factors are likely to cause problems within the LAA over time.

Formulae used in calculating water balances for irrigation systems and absorption trenches and beds systems are provided in Appendix 1. A software tool for sizing irrigation systems and trench / bed systems is included with these guidelines.

Spreadsheet templates (for example using Excel) are the most straightforward and efficient method of undertaking water and nutrient balance calculations.

Nutrient Balance

With respect to nutrients, this document gives sole consideration to nitrogen.

Within an effluent application area, nutrients are removed by vegetation, chemical precipitation, soil adsorption, volatilisation, microbial digestion and leaching. Nutrient removal by vegetation occurs only during the active growth period of the vegetation, and varies greatly among different vegetation types. The effluent must be available to the root zone of the vegetation for nutrient uptake to occur and the nutrients must be bio-available. 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 on the site, although the contribution of organic carbon may ensure their slow mineralisation.

Nutrient Balance 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. Nutrient concentrations for systems that have been tested for nutrient reduction capacities can be obtained from the relevant EPA CA. Most treatment systems have not been tested for their nutrient reduction capacity. In the absence of system-specific data in the EPA Certificate of Approval, use the conservative value of 25mg/L Total Nitrogen from EPA Publication 464.2.

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

Crop nutrient uptake rates are another highly variable input. Where site specific data are not available reference should be made to the indicative uptake rates provided in Appendix F of EPA Publication 464.2 (2003) and Publication 168 (1991). Conservative figures should be used.

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

Formulae used in calculating a nutrient (nitrogen) balance for irrigation systems are provided in Appendix 2. A software tool for sizing irrigation systems and trench / bed systems is included with these guidelines.

Sodium and other salts

The Code (2013) stresses the importance of understanding salt loads in treated wastewater and greywater and how these can build up in the soil over time. It is important to reduce the amount of salts (including but not limited to sodium) entering the wastewater stream. The most effective way to do this is to select detergents and cleaning agents that are low in salts (commonly used as fillers in powder detergents). Details of salt contents of detergents can be found on the Lanfax Laboratories website (see reference list).

However, the DLRs/DIRs for effluent management systems in Table 9 of the Code (2013) are assumed to be adequate to limit salt accumulation in the LAA soil and to allow for adequate flushing by natural rainfall and runoff percolation. It is important that the existing salinity (EC) and sodicity of the LAA soils are well understood when designing the system, as mitigation measures (such as application of gypsum or imported topsoil) may be required.

Appendix G of the Code (2013) provides guidance for LCA assessors in determining the total dissolved solids (TDS) content, including salts, of water supplied to the allotment. Household contributions to wastewater salinity may vary from 60 mg/L to 140 mg/L and TDS concentrations of more than 500 mg/L are likely to be problematic for soil structure and plant growth. The Code (2013) recommends that treated effluent and/or greywater should be tested annually for EC and Sodium Absorption Ratio (SAR). In order to prevent soil degradation, mitigation measures such as salt reduction in the wastewater stream and application of gypsum to the LAA and surrounding soils may be required.

Additional guidance on salinity and salt tolerant plants can also be found in Appendix G of EPA Publication 464.2 (2003).

Effluent Management System Configuration and Layout

The configuration and layout of the effluent management system will be based on the results of the site and soil assessment and the land capability assessment, taking into consideration optimum placement of other site improvements such as buildings. Generally, the optimum position of the LAA is determined in the field, and configured on a detailed, scaled site plan. Where possible, LAAs should be located in areas where they are least likely to be disturbed, to prevent damage to the system by human and animal access.

Specifications for effluent management systems, such as: dimensions of trenches, beds or mounds; depth of irrigation lines; proposed vegetation cover; and so on, should be determined. LAAs should be vegetated immediately following installation to prevent soil erosion, and the vegetation should be maintained. If the premises will not to be occupied immediately following construction the LAA, it may be necessary to water the LAA to maintain vegetation.

For effluent irrigation systems, it is recommended that areas larger than 400 m² are divided into equal-sized, separately dosed sub-zones using a sequencing valve, in order to ensure even distribution of effluent over the entire area. Vacuum breakers and flushing valves must be included in the system design of pressure-compensating sub-surface irrigation systems, and the pump must be adequately sized to ensure even delivery to all of the LAA.

Mitigation Measures (if Required)

This information may be required for sites or LAAs requiring specific measures to mitigate observed constraints, usually prior to or during installation/construction of the effluent management system. Examples of mitigation measures include (but are not limited to):

- Terracing for steep slopes;
- Imported topsoil fill to increase soil quality and depth;
- Application of gypsum or lime to improve soil condition;
- Construction of stormwater diversion berms or swales upslope of the LAA;
- Flood mitigation – such as installing seals, access risers and backflow prevention devices on treatment systems (in accordance with manufacturers' requirements), raising or bunding LAAs;
- Ripping of compacted or low-permeability soils (particularly for mound systems)
- Vegetation clearing over LAA; and
- Manual removal of coarse rock fragments or unsuitable fill materials.

Management of the System

Operation and maintenance requirements vary markedly between different treatment and effluent disposal/reuse systems. Proprietary treatment systems have conditions written into their CA which mandates servicing requirements (particularly frequency). Ongoing management of effluent disposal and reuse systems is usually less well-defined, and often left to the discretion of the owner. It is important that the operation, maintenance and any monitoring requirements of all aspects of the onsite wastewater systems are clearly understood and discussed with the property owner when finalising the system design.

Reporting

The LCA report should contain clear, sub-headed sections dealing with the key elements of the proposed onsite wastewater management system, such as those listed above (the wording of headings is less important than the completeness and clarity of information presented). The report should also reference information that has been used to justify the Assessor's decisions and recommendations.

Language should be concise and easy to understand, while clearly explaining all of the technical aspects of the onsite wastewater system selection, design, constraint mitigation (if required) and management. Individual styles will vary between consultants; the important thing is that reports can be clearly understood by the property owner, relevant tradespeople, Council and other authorities as required. If any items recommended in Section 3.6 of the Code (2013) are omitted, an explanation as to why those items are not considered relevant must be provided.

The report should contain specific directions for the installation, operation and maintenance of the wastewater treatment and effluent management systems (Site Operation and Management Plan), in accordance with the system design (including any mitigation measures). In addition, it should give more generic instructions common to most onsite wastewater systems; including but not limited to:

- LAA should only be installed when a constant wastewater supply is available, otherwise the vegetation cover is unlikely to survive;
- LAAs must be vegetated immediately following installation (preferably with turf); it may be necessary to water the vegetation if occupancy is not immediate;
- Vegetation within the irrigation area should be regularly cut (mown) and removed from the area to maintain nutrient budgets;
- Signs must be erected to inform householders and visitors of the proximity of the LAA and to limit their access and impact on the area;
- The LAA should be fenced or otherwise isolated (such as by landscaping), to prevent vehicle and stock access to the area;
- Stormwater run-on must be prevented from flowing over the LAA or from seeping from upslope and diverted away from the LAA;
- Other property improvements (such as paving, driveways, sheds, fences, utility trenches, play equipment) must not be built over or encroach upon the LAA;
- Details of the minimum setback distances from all features are listed in Table 5 of the Code (2013). Based on Council's local knowledge, a comprehensive LCA undertaken in accordance with this LCA Framework and a monthly water balance, Council may either:
 - increase setback distances if there is an increased risk to public health and/or the environment; or
 - reduce setback distances in non-potable water supply catchments where it considers that risk to public health and the environment is negligible;
- Details of the system servicing frequency (as per the CA) and/or requirement for a service agreement; and
- Recommended or required monitoring regimes for the treatment system or effluent management system.

The text of the report should refer to the detailed site plan which shows the layout of the proposed land application area, with features such as setback buffers and stormwater management structures clearly shown and labelled (or included in a legend). Requirements for the site plan are discussed in Section 6 below.

The report should also contain a separate Conclusion, or alternatively an Executive Summary, that summarises the key findings and recommendations of the report, for easy reference by the client, the regulator, the installer and other stakeholders. All assumptions (such as water conservation fixtures) and design requirements should be clearly identified throughout the report.

Detailed technical information, soil borelogs, test results, modelling outputs and so on should be included as appendices to the LCA report.

Prepare a Detailed Site Plan

Method

The Code (2013) specifies a list of components that could be included in the site plan, where relevant. The level of detail required in the site plan depends on the complexity of the system

design and the level of constraint of the site. As a minimum, the site plan should show the following:

- Site address;
- Lot boundaries;
- Waterways, drainage lines and dams on the site and neighbouring properties;
- Nearest road;
- Infrastructure, such as electricity, gas and telecommunications;
- Contour intervals of 1 to 10m (labelled, or slope direction shown);
- Proposed building envelope, sheds and driveways;
- Council zoning and environmentally significant overlays;
- Type of catchment i.e. potable;
- Locations of the soil test pits or auger holes;
- Groundwater bores on the site and on neighbouring properties;
- Rock outcrops or shallow bedrock, and types of vegetation cover;
- Location of any landslips, erosion potential or other potential failures;
- Presence of soil features indicative of springs and prolonged surface ponding or topsoil waterlogging;
- Direction of slope and slope analysis;
- The proposed LAA envelope or suitable area/s;
- Location and dimensions of proposed treatment system, proposed LAA and reserve LAA*;
- Required setback distances between the LAA and relevant site features;
- Stormwater diversion structures around the LAA (if applicable);
- Flood levels (1% and 5% AEP contour lines) and floodways; and
- A north arrow and scale.
- A reserve LAA is not required for surface or subsurface pressure-compensating irrigation systems where the size of the system has been calculated and designed using the Victorian LCA Framework water balance method and the DIR values listed in Table 9 of the EPA Code of Practice (2013), unless Council deems it necessary due to increased site risks.

Site features should be clearly identified by either labelling or use of a legend.

It can be useful to use a site survey plan as a base, as it usually includes many of the above features. Onsite wastewater system infrastructure can be superimposed on the survey plan using various software programs (with the permission of the plan's original author). In the absence of a survey plan, a scaled aerial photograph or topographic map can be used as a base for the detailed site plan.

Reporting

An A4 plan is usually adequate for most domestic developments; however, if the site is larger than a typical residential block, has a variable landscape and/or surrounds, or the LCA is for a commercial system, an A3 or larger plan is recommended.

The site plan can be located anywhere in the report; it does not have to be at the end. It may be useful to include the site plan near the beginning of the report, so the broader locality plan can provide some context.

5. Broad-scale Land Capability Assessments

The LCA process is applicable to all scales of development planning and assessment. To avoid or minimise adverse environmental and public health impacts from onsite wastewater systems, LCAs should be undertaken at the earliest possible stage of rezoning, subdivision or development planning. Conducting LCAs at this early stage of planning achieves a much more effective and sustainable result, because 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 within the assessed area may be reduced. This will need to be decided on a case-by-case basis in consultation with Council and the Water Authority.

A typical LCA for a subdivision (which may include rezoning of land) involves looking at land capability at a slightly broader scale (for example 1:2,000) 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 all treated effluent within the site boundaries, and the potential impact of onsite wastewater systems on local receiving environments (such as surface waters and groundwater). Additional considerations for strategic level LCAs, for example for Planning Scheme amendments and subdivisions, are summarised in the following table. The information contained in this table, along with the Code (2013) and AS/NZS1547:2012, provides good guidance on best practice multiple lot LCA.

LCA Component	Additional Considerations for Multi-Lot LCAs
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 <i>AS/NZS 1547:2012</i> for guidance on a minimum number of test boreholes). Additional chemical tests 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 areas for effluent management (preferably before lot size and configuration are determined).
Recommended management program (including system design)	Typically, only concept wastewater system designs are necessary so minimum sizes for land application areas can be determined. Options may be left at broad 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.

6. References and Further Reading

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7. Appendix 1: Water Balance Calculations

$$\text{precipitation} + \text{applied effluent} = \text{evapotranspiration} + \text{percolation} + \text{runoff}$$

The above calculation is undertaken for each month (in a monthly water balance), in a spreadsheet (such as the MS Excel spreadsheet tool provided with this guideline). The minimum area required is based on the 'worst' month of the year where the inputs are highest relative to the outputs (usually in winter). The theoretical calculation steps for each of the input and output parameters for the Model LCA water balance are provided below, along with the model spreadsheet from the Model LCA report.

Inputs:

Retained Rainfall (RR)

Usually, the mean monthly rainfall (R) from BoM data for a meteorological station closest to the site is used. Depending on Council requirements, 50th percentile (median) or other percentiles can be used. Percentiles other than 10th, 50th and 90th will need to be sourced from specialist tools (such as Data Drill) from the BoM Department of Water and the Land (WATL), formerly SILO.

In the Model LCA example, the highest mean rainfall month is 63.8 mm for November.

$$R = 63.8 \text{ mm/month}$$

Retained Rainfall (RR) is the proportion that will percolate into the soil profile. In the Model LCA example, for an irrigation area, it is assumed that all rainfall will percolate, i.e. the Rainfall Runoff Factor (RF) is 1. For trenches and beds, where the upper surface of the trench or bed can be mounded to shed some incident rainfall, the Rainfall Runoff Factor (RF) is 0.75. This represents a conservative approach for a water balance.

Hence Retained Rainfall (RR) is calculated as the product of Rainfall (R) and the Rainfall Runoff Factor (RF).

Applied Effluent (W)

$$\text{Daily flow (Q) x no. of days (D) } \div \text{ nominated land application area (L)}.$$

Note that L can be adjusted iteratively in the spreadsheet, or a value nominated if a specific area of land is available for effluent application.

In the Model LCA example, the highest effluent load is 87.1 mm/month for months with 31 days, assuming a nominated area of 267.

$$W = 87.1 \text{ mm/month.}$$

Evapotranspiration (ET)

Monthly mean pan evaporation (E), from nearby BoM station or other appropriate source x the crop factor (C) for the month.

In the Model LCA example, the lowest ET is 25 mm for June (evaporation 42 mm x 0.6 crop factor).

ET = 25 mm/month.

Percolation (B)

The design percolation rate is the daily Design Irrigation Rate (DIR), for irrigation areas or the Design Loading Rate (DLR) for trenches and beds, as specified by the EPA Code of Practice (2013) x no. of days in the month.

In the Model LCA example, the lowest B rate is 98 mm/month for February.

B = 98 mm/month.

Runoff

Runoff is the proportion of rainfall that does not percolate into the soil profile. It is reflected in the Retained Rainfall (RR) calculation step.

Required land area

This is calculated as follows:

$Q \times \text{no. days in month} \div (\text{ET} - \text{RR} + \text{B})$.

In the Model LCA example, the 'worst' month of the year is June:

$22,500 \div (25 - 45.7 + 105) = 267$.

The spreadsheet calculates the surplus effluent load for the month, in order to determine the minimum application area required, as follows:

$(\text{Retained Rainfall} + \text{Applied Effluent}) - (\text{Evapotranspiration} + \text{Percolation})$.

Victorian Land Capability Assessment Framework

Please read the attached notes before using this spreadsheet

Irrigation area sizing using Nominated Area Water Balance & Storage Calculations

Site Address: Lot 585 Bundalagwah Road, Maffra

Date: Assessor:

INPUT DATA

Design Wastewater Flow	Q	750	L/day	Based on maximum potential occupancy and derived from Table 4 in the EPA Code of Practice (2013)											
Design Irrigation Rate	DIR	3.5	mm/day	Based on soil texture class permeability and derived from Table 9 in the EPA Code of Practice (2013)											
Nominated Land Application Area	L	267	m ²												
Crop Factor	C	0.6-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type ²											
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff											
Mean Monthly Rainfall Data	East Sale Airport (085072)			BoM Station and number											
Mean Monthly Pan Evaporation Data	East Sale Airport (085072)			BoM Station and number											

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	45.4	42.5	48.9	48.2	51.7	45.7	41.4	46	51.7	58.1	63.8	54.3	597.7
Evaporation	E		mm/month	198.4	162.4	136.4	87	52.7	42	46.5	65.1	93	124	153	186	1346.5
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.60	0.60	0.60	0.60	0.70	0.80	0.80	0.80	

OUTPUTS

Evapotranspiration	ET	ExC	mm/month	159	130	95	61	32	25	28	39	65	99	122	149	1004.3
Percolation	B	DIRXD	mm/month	108.5	98	108.5	105.0	108.5	105.0	108.5	108.5	105.0	108.5	105.0	108.5	1277.5
Outputs		ET+B	mm/month	267.2	227.92	204.0	165.9	140.1	130.2	136.4	147.6	170.1	207.7	227.4	257.3	2281.8

INPUTS

Retained Rainfall	RR	RxRF	mm/month	45.4	42.5	48.9	48.2	51.7	45.7	41.4	46	51.7	58.1	63.8	54.3	597.7
Applied Effluent	W	(QxD)YL	mm/month	87.1	78.7	87.1	84.3	87.1	84.3	87.1	87.1	84.3	87.1	84.3	87.1	1025.3
Inputs		RR+W	mm/month	132.5	121.2	136.0	132.5	138.8	130.0	128.5	133.1	136.0	146.2	148.1	141.4	1623.0

STORAGE CALCULATION

Storage remaining from previous month	S	(RR+W)-(ET+B)	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	0.0
Storage for the month	M	(RR+W)-(ET+B)	mm/month	-134.7	-106.8	-68.0	-33.4	-1.3	-0.2	-7.9	-14.5	-34.1	-62.5	-79.3	-115.9	
Cumulative Storage	N		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	0.0
Maximum Storage for Nominated Area	V	NxL	L	0	0	0	0	0	0	0	0	0	0	0	0	0

LAND AREA REQUIRED FOR ZERO STORAGE: 105 m²

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 267.0 m²

CELLS

XX	Please enter data in blue cells
XX	Red cells are automatically populated by the spreadsheet
XX	Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS

NOTES

- This value should be the largest of the following: land application area required based on the most limiting nutrient balance or minimum area required for zero storage
- Values selected are suitable for pasture grass in Victoria

Appendix 2: Nutrient Balance Calculations

Nutrient balance calculations are best undertaken using a spreadsheet (such as the MS Excel tool provided with this guideline). Note the following example uses generic values and is based on the hypothetical case study in the Model LCA report in Appendix 3. Where available, site specific data should be used for nutrient balance calculations.

Hypothetical Nitrogen (N) Balance using design factors from Model LCA Report Water Balance (Appendix 3)

1. Determine the daily N load

Total Nitrogen (TN) effluent concentration: 25 mg/L (EPA Publication 464.2 cites TN range of 10-30 mg/L for secondary systems)

Daily hydraulic load: 750 L/day

Daily N load: $25 \text{ mg/L} \times 750 \text{ L/day} = 18,750 \text{ mg/day}$

2. Determine the annual N load

$18,750 \text{ mg/day} \times 365 \text{ days/year} = 6,843,750 \text{ mg/year}$

Annual N load = 6.84 kg/year

3. Allow 20% loss through denitrification, volatilization, microbial digestion and other processes

$6.84 \text{ kg/year} \times 0.8 = 5.48 \text{ kg/year}$

Annual N load = 5.48 kg/year

4. Allow for N uptake by plants of 220 kg/ha/year

Where available, plant uptake rates that relate specifically to the site should be utilized. This figure is suitable for a regularly maintained grass cover. Refer Appendix F of EPA Publication 464.2 (2003).

Divide the annual N load by the N uptake rate

$5.48 \text{ kg/year} \div 220 \text{ kg/ha/year} = 0.0249 \text{ ha}$

multiply by 10,000 m²/ha

$0.0249 \text{ ha} \times 10,000 \text{ m}^2/\text{ha} = 249 \text{ m}^2$

Minimum area required for N uptake = 249 m²

The nitrogen balance calculation steps are shown using real data for the Model LCA report site in the spreadsheet output below. Using a nominated area of 267 m² (minimum area based on water balance) the nutrient balance shows a slight nitrogen deficit based on an annual balance.

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 composting toilets, and water-saving showerheads, taps and appliances, may lead to significant reductions in irrigation area requirements.

Victorian Land Capability Assessment Framework									
Please read the attached notes before using this spreadsheet									
Nitrogen Balance									
Site Address:		Lot 585 Bundalaguah Road, Maffra							
SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE								249	m ²
INPUT DATA¹									
Wastewater Loading					Nutrient Crop Uptake				
Hydraulic Load	750	L/day	Crop N Uptake	220	kg/ha/yr	which equals	60.27	mg/m ² /day	
Effluent N Concentration	25	mg/L							
% N Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal							
Total N Loss to Soil	3750	mg/day							
Remaining N Load after soil loss	15000	mg/day							
NITROGEN BALANCE BASED ON ANNUAL CROP UPTAKE RATES									
Minimum Area required with zero buffer			Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)						
Nitrogen	249	m ²	Nominated LAA Size	267	m ²				
			Predicted N Export from LAA	-0.40	kg/year				
			Minimum Buffer Required for excess nutrient	0	m ²				
CELLS									
		Please enter data in blue cells							
	XX	Red cells are automatically populated by the spreadsheet							
	XX	Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS							
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 Guidelines for Effluent Irrigation									
- Appropriate Peer Reviewed Papers									
- Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households									
- USEPA Onsite Systems Manual									

9. Appendix 3: Model Land Capability Assessment Report

The Model Land Capability Assessment Report

**Land Capability Assessment
Lot 585 Bundalaguah Road,
Maffra**

Prepared for: Mr Ebenezer Scrooge
Prepared by: Fiona Smith, BSc
Anna Newman, BEnvSci
Environmental Consultants Pty Ltd
PO Box 281
Sale Vic 3850
Telephone: 03 5142 6936
Email: fionasmith@environmentalconsultants.com.au

DATE: February 2014

1 Introduction

THE CONSULTANTS

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 attached.

REPORT SUMMARY

This report will accompany an application for a Septic Tank Permit to Install submitted to Wellington Shire Council for an onsite wastewater management system for a private residence. This document provides information about the site and soil conditions. It also provides a detailed LCA for the 10,000 m² lot, and includes a conceptual design for a suitable onsite wastewater management system, including recommendations for monitoring and management requirements. A number of options are provided for both the treatment system and land application area (LAA). However, the wastewater should be treated to secondary level by a suitable EPA-approved treatment system and the effluent applied to land via sub-surface irrigation.

SITE OVERVIEW

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 the required buffers to protect the surface waters and the floodways.

2 Description of the Development

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 only

Anticipated Wastewater Load: A 4-bedroom residence with full water-reduction fixtures @ 5 people per max. occupancy. Wastewater generation = 150 L/person/day; total design load = **750 L/day** (source Table 4 of the EPA Code of Practice 891.3).

Availability of Sewer: The area is unsewered and highly unlikely to be sewerred within the next 10-20 years, due to low development density in the area and the considerable distance from existing wastewater services.

3 Site and Soil Assessment

Fiona Smith and Anna Newman undertook site investigations on the 22 December 2013.

SITE KEY FEATURES

Table 1 summarises the key features of the site in relation to effluent management proposed for the site.

NOTE:

- 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.

Figure 1 below 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 building envelope and other development works, wastewater management system components and physical site features.

Figure 1: Locality Plan

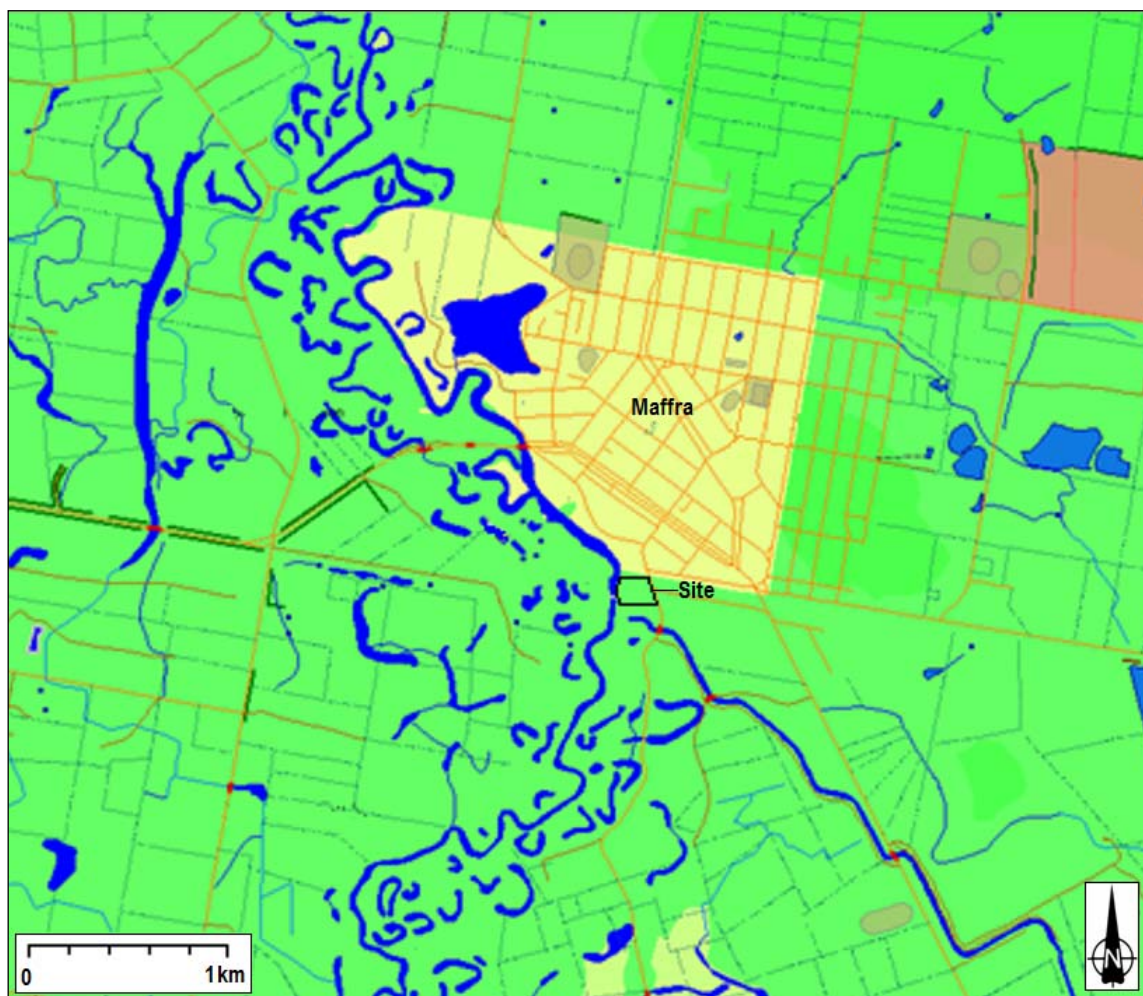


Table 1: Site Assessment

Feature	Description	Level of Constraint	Mitigation Measures
Buffer Distances	All relevant buffer distances in Table 5 of the Code (2013) are achievable from the proposed effluent management area.	Minor	NN*
Climate	Average annual rainfall 598 mm (Sale East Climate Station No. 085072), max. average 63.8 mm in November, min. average 41.4 mm in July. Average no. of rain days per year: 91.2. Average annual pan evaporation is 1350.5 mm.	Minor	NN
Drainage	No visible signs of surface dampness, spring activity or hydrophilic vegetation in the proposed effluent management area or surrounds. <10% yellow mottling was observed from 20 cm depth in TP1, indicating that seasonal water logging may occur, which could limit percolation of effluent through the soil profile in this area. No mottling was observed in TP2.	Moderate	Adopt low DIR
Erosion & Landslip	No evidence of sheet or rill erosion; the erosion hazard is low. No evidence of landslip and landslip potential is low.	Minor	NN
Exposure & Aspect	Cleared, except for riparian vegetation, with a westerly aspect and has high sun and wind exposure.	Minor	NN
Flooding	The proposed effluent management area is located above the 1:100 year flood level (source WSC).	Minor	NN
Groundwater	No signs of shallow groundwater tables to 1.5 m depth. No known groundwater bores within 250 m of the proposed effluent management area.	Minor	NN
Imported Fill	No imported fill material was observed anywhere on the site.	Nil	NN
Land Available for LAA	Considering all the constraints and buffers, the site has ample suitable land for land application of treated effluent. The preferred effluent management area is on the eastern side of the property in between the two prominent drainage lines.	Nil	NN
Landform	Lower slope leading on to a floodplain dissected by two deep drainage lines which join to the west of the site and feed into the Macalister River.	Moderate	Locate LAA with appropriate setback to floodplain and

			drainage lines
Rock Outcrops	No evidence of surface rocks or outcrops.	Nil	NN
Feature	Description	Level of Constraint	Mitigation Measures
Run-on & Runoff	Negligible stormwater run-on and minor run-off hazard.	Nil	NN
Slope	The proposed effluent management area is quite flat with gradients less than 5 percent, generally to the west.	Nil	NN
Surface Waters	Adjacent to the Macalister River which flows into the Gippsland Lakes. The northern and southern boundaries are crossed by two shallow drainage depressions, which occasionally carry water for a short period after heavy rain.	Nil	NN
Vegetation	Mixture of grasses, both native and exotic, and native riparian vegetation.	nil	NN

*NN: not needed

Site Assessment Results

Based on the most constraining site features (landform and drainage), the overall land capability of the site to sustainably manage all effluent onsite is satisfactory. The proposed effluent management area is located above the 1:100 flood level and by using secondary treatment and pressure-compensating sub-surface irrigation, there will be ample protection of surface waters and groundwater.

SOIL KEY FEATURES

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.

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).

Soil Survey and Analysis

A soil survey was carried out at the site to determine suitability for application of treated effluent. Soil investigations were conducted at two locations in the vicinity of the building envelope, as shown in Figure 2, using hand dug test pits (TP1 and TP2) to 1.5 m depth. 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 A. 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 2 and 3 describe the soil constraints in detail for each of the soils encountered.

Soils in the vicinity of the building envelope (TP1) are characterised as fine sandy loam topsoils overlying light clay, which becomes heavier with depth. The A2 horizon has a massive structure and is conspicuously bleached and mottling occurs in the subsoil (from 20 cm depth) which indicates imperfect drainage and seasonal perched watertables. 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 in this area of the site, effluent application via an absorption trench is not recommended.

The soil on the floodplain (TP2) was found to consist of a fine sandy loam topsoil with a gradual change in texture down through the profile to a light silty clay from depths of 60 cm. The soil is moderately to strongly structured and 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 make it less desirable for the effluent management area.

Tables 2 and 3 below provide an assessment of the physical and chemical characteristics of each soil type.

Table 2: Soil Assessment – TP1 Brown Sodosol

Feature	Assessment	Level of Constraint	Mitigation Measures
Cation Exchange Capacity (CEC)	The calcium/magnesium ratio is mostly lower than is generally recommended for optimal plant growth. The topsoil in the proposed effluent management area (only) should be improved by the application of gypsum (application rates not exceeding 20 kg/100 m ²).	Moderate	Soil amelioration recommended
Electrical Conductivity	EC (1:5 soil:water suspension) ranges from 2.01 (subsoil) to 3.85 deciSiemens (dS) per metre (topsoil), which is slightly saline. Long-term soil salinity monitoring is recommended.	Major	Ongoing monitoring of EC to monitor salinity recommended
Emerson Aggregate Class	Topsoil: EA Class 3 (slaking with some dispersion).	Major	Suggest soil amelioration to reduce risk of dispersion
	Subsoil: EA Class 8 (no slaking, dispersion or swelling).	Minor	NN
pH	Topsoils range from 5.4 to 6.0 which is slightly acidic; subsoils range from 6.8 to 7.6 which is neutral. Soil conditions do not appear to be affecting plant growth.	Minor	NN
Rock Fragments	2% coarse fragments in the B1 horizon (200 mm depth). No coarse fragments throughout the remainder of the profile.	Minor	NN
Sodicity (ESP)	Exchangeable Sodium concentrations are minor with a tested ESP value of 5%. Long-term soil sodicity monitoring is recommended.	Minor	NN
Sodium Absorption Ratio (SAR)	Sodium concentrations are significantly lower than Magnesium and Calcium concentrations in the tested sample; SAR is low and not expected to pose a constraint.	Minor	NN
Soil Depth	Topsoil: <200 mm	Minor	Shallow subsurface irrigation in topsoil recommended
	Subsoil: >200 mm. Total soil depth greater than 1.5 m and no hardpans occur.	Minor	NN

Feature	Assessment	Level of Constraint	Mitigation Measures
Soil Permeability & Design Loading Rates	Topsoil: Massive sandy loam: 1.4-3.0 m/day saturated conductivity (K_{sat}) (AS/NZS1547:2012); 3.5 mm/day Design Loading Rate (DLR) for irrigation system (Code, 2013).	Minor	NN
	Subsoil: Moderately structured medium clay: <0.06 m/day saturated conductivity (K_{sat}) (AS/NZS1547:2012); 2 mm/day DLR for irrigation system (Code of Practice, 2013).	Moderate	Shallow subsurface irrigation in topsoil recommended
Soil Texture & Structure	Topsoil (<200 mm): Massive fine sandy loam (Category 2)	Minor	NN
	Subsoil (>200 mm): Moderately structured medium clay (Category 6) in accordance with AS/NZS/NZS 1547:2012	Major	Shallow subsurface irrigation in topsoil recommended
Watertable Depth	Groundwater not encountered, pit terminated at 1.5 m. Minor (<10%) yellow mottling in subsoils from 200 mm depth indicates intermittent (seasonal) saturation.	Moderate	Shallow subsurface irrigation recommended

NN: not needed

Table 3: Soil Assessment – TP2 Black Dermosol

Feature	Assessment	Level of Constraint	Mitigation Measures
Electrical Conductivity	EC (1:5 soil:water suspension) range from 0.6 dS/m (subsoil), which is non-saline, to 2.5 dS/m (topsoil), which is slightly saline.	Minor - Major	Ongoing monitoring of EC to monitor salinity recommended
Emerson Aggregate Class	Topsoil: EA Class 8 (no slaking, dispersion or swelling);	Minor	NN
	Subsoils: EA Class 8 (no slaking, dispersion or swelling).	Minor	NN
pH	Topsoils range from 5.7 to 6.1 which is slightly acidic; subsoils range from 6.2 to 6.6 which is neutral. Soil conditions do not appear to be affecting plant growth.	Minor	NN
Rock Fragments	No coarse rock fragments throughout the profile to 1.5 m.	Minor	NN
Soil Depth	Topsoil <400 mm	Minor	NN
	Subsoil >400 mm. Total soil depth greater than 1.5 m and no hardpans occur.	Minor	NN
Soil Permeability & Design Loading Rates	Topsoil: Moderately structured sandy loam: >3 m/day K_{sat} (AS/NZS1547:2012); 3.5 mm/day Design Loading Rate (DLR) for irrigation system (Code of Practice 2013).	Minor	NN
	Subsoil: Moderately structured light clay: 0.06-0.12 m/day K_{sat} (AS/NZS1547); 3 mm/day DLR for irrigation system (Code of Practice 2013).	Moderate	Shallow subsurface irrigation in topsoil recommended
Soil Texture & Structure	Topsoil (<400 mm): Moderately structured fine sandy loam (Category 2) to sandy clay loam (Category 4);	Minor	NN
	Subsoil (>400 mm): Moderately structured light clay (Category 5), in accordance with AS/NZS1547:2012.	Moderate	Shallow subsurface irrigation in topsoil recommended
Watertable Depth	Groundwater not encountered, pit terminated at 1.5 m.	Moderate	Shallow subsurface irrigation recommended

Sodicity, Cation Exchange Capacity and Sodium Absorption Ratio were not tested for the Black Dermosol in TP2 as the effluent management system will not be located in this area.

For the soil in the proposed land application area (the Brown Sodosol of TP1), a number of features present moderate or major constraints, but in each case a mitigation measure is presented to address the specific constraint in such a way as to present an acceptable wastewater management solution.

OVERALL LAND CAPABILITY RATING

Based on the results of the site and soil assessment tabled above and provided in the Appendices, the overall land capability of the proposed effluent management area is constrained. However, the effluent management system will be designed, installed and maintained in ways which will mitigate these factors.

4 Wastewater Management System

The following sections provide an overview of a suitable onsite wastewater management system, with sizing and design considerations and justification for its selection. Detailed design for the system should be undertaken at the time of the building application and submitted to Council.

TREATMENT SYSTEM

The secondary effluent quality required is:

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

Refer to the EPA website for the list of approved options that are available <http://www.epa.vic.gov.au/en/your-environment/water/onsite-wastewater>. Any of the secondary treatment system options are capable of achieving the desired level of performance. The property owner has the responsibility for the final selection of the secondary treatment system and will include the details of it in the Septic Tank Permit to Install application form for Council approval.

EFFLUENT MANAGEMENT SYSTEM

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

Description of the Irrigation System

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 (drippers) that employ a biocide to prevent build-up of slimes and inhibit root penetration. The lateral pipes are usually 0.6 to 1.0 m apart, installed parallel along the contour. Installation depth is 100-150 mm in accordance with AS/NZS 1547:2012. It is critical that the irrigation pump be sized properly to ensure adequate pressure and delivery rate to the irrigation network.

A filter is installed in the main line to remove fine particulates that could block the emitters. This must be cleaned regularly (typically monthly) 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 six monthly intervals. Flush water can be either returned to the treatment system, or should be released to a small dedicated gravel-based trench.

All trenching used to install the pipes must be backfilled properly to prevent preferential subsurface flows along trench lines. Irrigation areas must not be subject to high foot traffic movement, and vehicles and livestock must not have access to the area otherwise compaction around emitters can lead to premature system failure.

Sizing the Irrigation System

To determine the necessary size of the irrigation area water balance modelling has been undertaken using the method and water balance tool in the Victorian Land Capability Assessment Framework (2013) and the EPA Code (2013). The results show that the required irrigation area is 267 m². The calculations are summarised below, with full details provided in Appendix B.

The water balance can be expressed by the following equation:

$$\text{Precipitation} + \text{Effluent Applied} = \text{Evapotranspiration} + \text{Percolation}$$

Data used in the water balance includes:

- Mean monthly rainfall and mean monthly pan evaporation (East Sale Airport);
- Average daily effluent load – 750 L (from Table 4 of the Code);
- Design irrigation rate (DIR) – 3.5 mm/day (from Table 3 of the Code);
- Crop factor – 0.6 to 0.8; and
- Retained rainfall – 100% (gently sloping site of approximately 5% gradient).

The nominated area method is used to calculate the area required to balance all inputs and outputs to the water balance. As a result of these calculations at least 267 m² of land application area is required.

Siting and Configuration of the Irrigation System

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. Final placement and configuration of the irrigation system will be determined by the client and/or system installer, provided it remains within this envelope. Figure 2 shows the minimum area required according to the water balance approximately to scale.

Whilst there is ample area for application of the effluent, it is important that appropriate buffer distances to the waterways be maintained. 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.

It is recommended that the owner consult an irrigation expert familiar with effluent irrigation equipment to design the system, and an appropriately registered plumbing/drainage practitioner to install the system. The irrigation plan must ensure even application of effluent throughout the entire irrigation area.

Buffer Distances

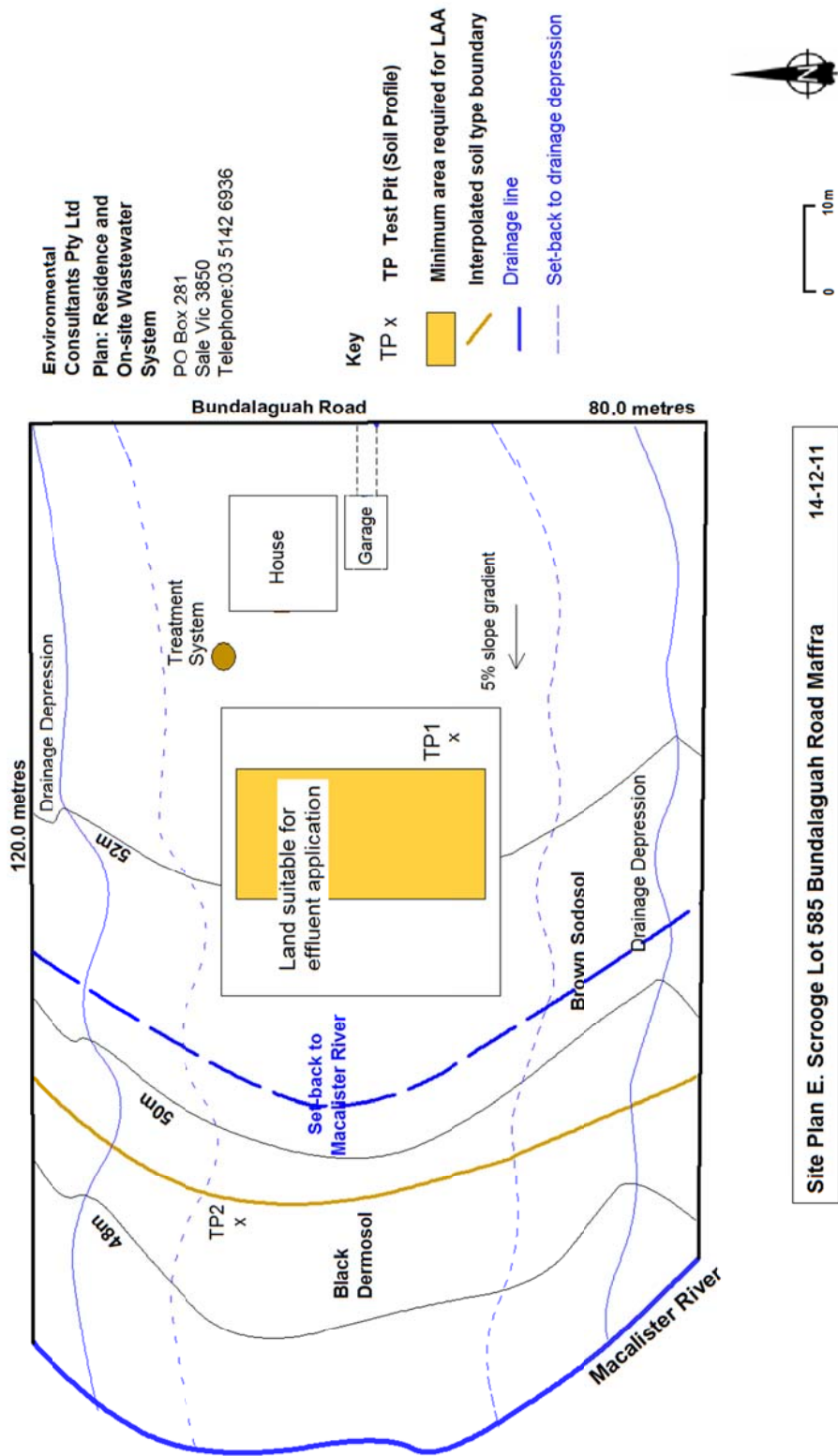
Setback buffer distances from effluent land application areas and treatment systems are required to help prevent human contact, maintain public amenity and protect sensitive environments. The relevant buffer distances for this site, taken from Table 5 of the Code (2013) are:

- 50 metres from groundwater bores in sandy soils;
- 60 metres from non-potable watercourses; and
- 6 metres if area up-gradient and 3 metres if area down-gradient of property boundaries, swimming pools and buildings (conservative values for primary effluent).

All buffer distances are achievable.

The site plan in Figure 2 shows the location of the proposed wastewater management system components and other relevant features.

Figure 2: Site Plan



Installation of the Irrigation System

Installation of the irrigation system must be carried out by a suitably qualified, licensed plumber or drainer experienced with effluent irrigation systems.

To ensure even distribution of effluent, it is essential that the pump capacity is adequate for the size and configuration of the irrigation system, taking into account head and friction losses due to changes in elevation, pipes, valves, fittings etc. An additional, optional measure to achieve even coverage is to divide the irrigation area into two or more separate sub-zones of minimum 133.5 m² each; dosed alternately using an automatic indexing or sequencing valve.

The irrigation area and surrounding area must be vegetated or revegetated immediately following installation of the system, preferably with turf. The area should be fenced or otherwise isolated (such as by landscaping), to prevent vehicle and stock access; and signs should be erected to inform householders and visitors of the extent of the effluent irrigation area and to limit their access and impact on the area.

Stormwater run-on is not expected to be a concern for the proposed irrigation area, due to the landform of the site and its relatively gentle slopes. However, upslope diversion berms or drains may be constructed if this is deemed to be necessary during installation of the system, or in the future. Stormwater from roofs and other impervious surfaces must not be disposed of into the wastewater treatment system or onto the effluent management system.

5 Monitoring, Operation and Maintenance

Maintenance is to be carried out in accordance with the EPA Certificate of Approval of the selected secondary treatment system and Council's permit conditions. The treatment system will only function adequately if appropriately and regularly maintained.

To ensure the treatment system functions adequately, residents must:

- Have a suitably qualified maintenance contractor service the secondary treatment system at the frequency required by Council under the permit to use;
- Use household cleaning products that are suitable for septic tanks;
- Keep as much fat and oil out of the system as possible; and
- Conserve water (AAA rated fixtures and appliances are recommended).

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 the irrigation lines;
- Regularly clean in-line filters;
- Not erect any structures and paths over the LAA;
- Avoid vehicle and livestock access to the LAA, to prevent compaction and damage; and
- Ensure that the LAA is kept level by filling any depressions with good quality topsoil (not clay).

6 Conclusions

As a result of our investigations we conclude that sustainable onsite wastewater management is feasible with appropriate mitigation measures, as outlined, for the proposed four-bedroom residence at Lot 565, Bundalaguah Road, Maffra.

Specifically, we recommend the following:

- Secondary treatment of wastewater by an EPA-accredited treatment system;
- Land application of treated effluent to a 267 m² (minimum) subsurface irrigation area (which may be subdivided into two or more evenly sized zones using an indexing or sequencing valve);
- Details of the irrigation design, including the filter, manifold, irrigation line location and diameter, number and length of dripper lines, number and location of vacuum breaker(s), and location of flush valve(s);
- Installation of water saving fixtures and appliances in the new residence to reduce the effluent load;
- Use of low phosphorus and low sodium (liquid) detergents to improve effluent quality and maintain soil properties for growing plants; and
- Operation and management of the treatment and disposal system in accordance with manufacturer's recommendations, the EPA Certificate of Approval, the EPA Code of Practice (2013) and the recommendations made in this report.

7 References

Environment Protection Authority (2003). *Guidelines for Environmental Management: Use of Reclaimed Water* Publication 464.2.

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

Environment Protection Authority (2013). Publication 891.3 *Code of Practice for Onsite Wastewater Management*.

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.

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

Standards Australia / Standards New Zealand (2012). AS/NZS 1547:2012 *On-site domestic-wastewater management*.

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

Appendix A: Soil Bore Logs

SOIL BORE LOG						Environmental Consultants Pty Ltd				
Client:	Mr Ebenezer Scrooge				Test Pit No:	TP1				
Site:	Lot 565, Bundalaguah Road, Maffra				Excavated/logged by:	Fiona Smith				
Date:	22 December 2013				Excavation type:	Shovel & crowbar				
Notes:	Refer site plan for positions of boreholes. Brown Sodosol.									
PROFILE DESCRIPTION										
Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1		• TP1/1	A1	SL	friable	dark brown	nil	nil	dry	high organic content
0.2		• TP1/2	A2	SL	massive	yellowish, pale brown	nil	nil	dry	conspicuously bleached
0.3		• TP1/3	B1	LC	moderate	yellowish brown	<10% light yellow	<5%	dry	
0.4										
0.5										
0.6										horizon boundary is gradual
0.7		• TP1/4	B2	MC	moderate	light olive brown	<10% light yellow	<5%	moist	
0.8										
0.9										
1.0										
1.1										
1.2										
1.3										
1.4										
1.5										layer continues

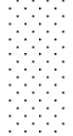




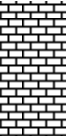
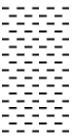


SOIL BORE LOG					Environmental Consultants Pty Ltd					
Client:	Mr Ebenezer Scrooge			Test Pit No:	TP2					
Site:	Lot 565, Bundalaguah Road, Maffra			Excavated/logged by:	Fiona Smith					
Date:	22 December 2013			Excavation type:	Shovel & crowbar					
Notes:	Refer site plan for positions of boreholes. Black Dermosol.									
PROFILE DESCRIPTION										
Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1		• TP2/1	A1	SL	moderate	very dark greyish brown	nil	nil	dry	
0.2										
0.3		• TP2/2	A2	SCL	moderate	very dark greyish brown	nil	nil	dry	
0.4										
0.5		• TP2/3	B1	LC	moderate	dark brown	nil	nil	dry	
0.6										
0.7										
0.8										
0.9										
1.0										
1.1										
1.2										
1.3										
1.4										
1.5										layer continues

Key to Soil Borelogs

Symbols

- W** Watertable depth ● Sample collected
X Depth of refusal

Graphic Log and Textures

 <p>S - Sand LS - Loamy sand CS - Clayey sand</p>	 <p>CL - Clay loam SCL - Sandy clay loam SiCL - Silty clay loam</p>	 <p>Gravel (G)</p>
 <p>SL - Sandy loam</p>	 <p>LC - Light clay SC - Sandy clay</p>	 <p>Parent material (stiff)</p>
 <p>L - Loam LFS - Loam fine sandy SiL - Silty loam</p>	 <p>MC - Medium clay HC - Heavy clay</p>	 <p>Parent material (weathered)</p>

Appendix B: Water and Nitrogen Balance Calculations

Victorian Land Capability Assessment Framework																
Please read the attached notes before using this spreadsheet																
Irrigation area sizing using Nominated Area Water Balance for Zero Storage																
Site Address: Lot 585 Bundalagwah Road, Maffra																
Date:											Assessor:					
INPUT DATA																
Design Wastewater Flow	Q	750	L/day	Based on maximum potential occupancy and derived from Table 4 in the EPA Code of Practice (2013)												
Design Irrigation Rate	DIR	3.5	mm/day	Based on soil texture class/permeability and derived from Table 9 in the EPA Code of Practice (2013)												
Nominated Land Application Area	L	267	m ²													
Crop Factor	C	0.5-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type ²												
Rainfall Runoff Factor	RF	1	unitless	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff												
Mean Monthly Rainfall Data	East Sale Airport (085072)															
Mean Monthly Pan Evaporation Data	East Sale Airport (085072)															
Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D		day/s	31	28	31	30	31	30	31	31	30	31	30	31	366
Rainfall	R		mm/month	45.4	42.5	48.9	48.2	51.7	45.7	41.4	46	51.7	58.1	63.8	54.3	697.7
Evaporation	E		mm/month	188.4	162.4	136.4	87	52.7	42	46.5	65.1	93	124	163	186	1646.6
Crop Factor	C		unitless	0.80	0.80	0.70	0.70	0.80	0.80	0.80	0.80	0.70	0.80	0.80	0.80	0.80
OUTPUTS																
Evapotranspiration	ET	E/C	mm/month	159	130	95	61	32	25	22	39	65	99	122	149	1004.3
Percapitation	B	(R-D)/L	mm/month	98	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	1277.6
Outflow	ET-B		mm/month	267.2	227.9	204.0	165.9	140.1	130.2	136.4	147.6	170.1	207.7	227.4	257.3	2281.8
Retained Rainfall	RR	(R-ET)	mm/month	45.4	42.5	48.9	48.2	51.7	45.7	41.4	46	51.7	58.1	63.8	54.3	697.7
Applied Effluent	W	(Q-D)/L	mm/month	87.1	78.7	87.1	84.3	87.1	84.3	87.1	87.1	84.3	87.1	84.3	87.1	1026.9
Inflow	RR+W		mm/month	132.5	121.2	138.0	132.5	138.8	130.0	123.5	133.1	158.0	145.2	148.1	141.4	1823.0
STORAGE CALCULATION																
Storage remaining from previous month	S	(RR+W)-ET-B	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	0.0
Storage for the month	M	(RR+W)-ET-B	mm/month	-134.7	-108.8	-88.0	-53.4	-1.3	-0.2	-7.9	-14.5	-34.1	-62.6	-79.3	-118.9	-118.9
Cumulative Storage	N		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	0.0
Maximum Storage for Nominated Area	V		mm	0.00	0											
LAND AREA REQUIRED FOR ZERO STORAGE																
			m ²	105	113	150	191	253	266	246	229	190	155	138	115	
MINIMUM AREA REQUIRED FOR ZERO STORAGE:																
			m ²	267.0												
CELLS																
Please enter data in blue cells																
Red cells are automatically populated by the spreadsheet																
Data in yellow cells is calculated by the spreadsheet. DO NOT ALTER THESE CELLS																
NOTES																
¹ This value should be the largest of the following: land application area required based on the most limiting nutrient balance or minimum area required for zero storage																
² Values selected are suitable for pasture, grass in Victoria																

Victorian Land Capability Assessment Framework										
Please read the attached notes before using this spreadsheet										
Nitrogen Balance										
Site Address:		Lot 585 Bundalaguah Road, Maffra								
SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE									249	m ²
INPUT DATA¹										
Wastewater Loading					Nutrient Crop Uptake					
Hydraulic Load	750	L/day	Crop N Uptake	220	kg/ha/yr	which equals	60.27	mg/m ² /day		
Effluent N Concentration	25	mg/L								
% N Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal								
Total N Loss to Soil	3750	mg/day								
Remaining N Load after soil loss	15000	mg/day								
NITROGEN BALANCE BASED ON ANNUAL CROP UPTAKE RATES										
Minimum Area required with zero buffer			Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)							
Nitrogen	249	m ²	Nominated LAA Size	267	m ²					
			Predicted N Export from LAA	-0.40	kg/year					
			Minimum Buffer Required for excess nutrient	0	m ²					
CELLS										
			Please enter data in blue cells							
	XX		Red cells are automatically populated by the spreadsheet							
	XX		Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS							
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 Guidelines for Effluent Irrigation										
- Appropriate Peer Reviewed Papers										
- Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households										
- USEPA Onsite Systems Manual										