Byron Shire Council

Design Guidelines for On-site Sewage Management for Single Households

Protecting the Environment and Health of Byron Shire

1 December 2004

Foreword – On-site sewage management in Byron Shire

Management of human wastes is an important issue affecting the water quality of Byron Shire, especially in the more densely inhabited catchment areas. Stricter environmental and public health requirements imposed by State and Federal government authorities, as well as rising community expectations within the shire, dictate the need to reassess and, where necessary, improve the on-site management of household wastes.

In March 1998 changes were announced to the sewage management regulations. A working group of government agencies, (including the NSW Department of Local Government, the NSW Environment Protection Authority, the NSW Department of Health, the NSW Department of Land and Water Conservation and the NSW Department of Urban Affairs and Planning) developed a set of guidelines (EHP, 1998) which requires that all major environmental and health issues are considered in on-site sewage management in NSW. Under these new regulations and guidelines, councils and landowners must ensure that:

- surface and ground water resources are protected;
- degradation of land and vegetation systems is prevented;
- public health risks are prevented;
- natural resources are reused (effluent irrigation, compost) and Ecologically Sustainable Development is promoted; and
- activities that are dependent on waterways are not adversely impacted (e.g. swimming, tourism and oyster growing).

Councils also have specific responsibility under local government legislation to:

- maintain a register of approvals granted for on-site sewage management systems; and
- prepare annual updates of State of the Environment reports for their areas showing details of polluted areas and on-site sewage management policies, performance of on-site sewage management systems and the cumulative impacts of those systems on catchments within the council's area.

Every council is now required to prepare an on-site sewage management strategy suitable for its local area. Byron Shire Council's *On-Site Sewage Management Strategy* was adopted in 2001 and is available from the Council. Council has also produced a booklet for landowners giving a plain English overview of responsibilities and options. The *Home Owners Guide to On-Site Sewage Management* is also available from the Council for a small fee or without charge from Council's website www.byron.nsw.gov.au.

Front cover photo – Sleepy Ck, Bangalow, photo by Cal MacKinnon, Lush Photographics

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1. INTRODUCTION

In situations where it is not feasible to connect to a reticulated centralised sewage treatment system (e.g. in unsewered rural areas), wastewater generated from households must be managed on-site. In other cases, even those who are connected to sewerage may wish to utilise at least some of their household wastewaters on-site. An on-site sewage management system (OSMS) generally consists of three main components: the wastewater source (household); treatment device/s; and final reuse or disposal of treated effluent via land application. This document offers guidance for applicants, owners and developers to plan the selection, design, installation, operation and maintenance of on-site sewage management systems (OSMSs) for single households in Byron Shire. In particular, it provides guidance for the appropriate selection and design of treatment system/s and the application of effluent into the land.

The NSW Environment and Health Protection Guidelines (E&HP Guidelines, 1998) referred to in the Foreword provide the statutory requirements and guidance for design of on-site sewage management systems for single households in NSW. Australian Standard AS/NZ1547 (2000) also provides important additional technical information on the subject. These **Design Guidelines for On-Site Sewage Management for Single Households (2004)** (hereon referred to as the Design Guidelines) provide local interpretations of these state and federal guidelines for Byron Shire, but do not replace or diminish their importance. System designers must be familiar with all of the above guidelines if they intend to submit an OSMS design to Byron Shire Council.

1.1. Scope and Applicability

These Design Guidelines are intended to provide guidance for those designing and installing on-site sewage management facilities for single domestic dwellings in Byron Shire. They provide information on:

- preparing an on-site sewage management report;
- the design of OSMSs in sewered and unsewered areas;
- Byron Shire Council's on-site sewage management objectives and guiding principles; and
- a glossary of technical terms used in the industry.

These Design Guidelines do not specifically apply to systems servicing more than a single household or dwelling. Package treatment plants and systems designed to cater for more than one household will be covered by separate guidelines, and until these are available will be dealt with on a case-by-case basis. Further, these Design Guidelines do not provide specific information on:

- designs for subdivision of land;
- off-site sewage management systems;
- specific advice for OSMS in urban areas;
- multiple-dwelling (combined or package) sewage management systems
- agricultural, commercial and industrial developments; or
- patented sewage treatment systems.

Nevertheless, these Design Guidelines may provide useful information when assessing the above and related issues.

The Design Guidelines rely heavily on both the NSW Environment and Health Protection Guidelines (1998) and Australian Standard AS/NZS (2000), and designers are expected to understand and follow these two documents closely. Where conflicts or ambiguities arise between the two external documents and these Design Guidelines, the advice in the Design Guidelines shall prevail.

For further advice on providing for appropriate OSMS on subdivisions, designers are required to refer to the Byron Shire Rural Settlement Strategy (BSC, 1998) – if ambiguities arise between these two documents, the Settlement Strategy takes precedence over these Design Guidelines. There are particular difficulties involved in developing on-site wastewater solutions in urban areas, and these are recognised in Council's Policy 5.59 – On-site Sewage Management Systems in Urban Areas. If a home-owner wishes to treat or utilise sewage in an urban area, these Design Guidelines should be followed in conjunction with the the above-named Policy. If ambiguities or conflicts arise between the two documents regarding an application in an urban area, the advice set out in the Policy shall take precedence.

Council has not yet developed design guidelines for larger on-site sewage management systems, e.g. for cluster dwellings, commercial, agricultural or industrial applications, etc. Until this document is prepared, these applications will need to be designed by specialists in the field in consultation with Council officers.

Finally, Byron Shire Council also offers a plain English version of on-site sewage management options called *The Home owners guide to on-site sewage management.* This is a greatly simplified version of the Design Guidelines and, if any ambiguities arise between the two documents, the advice in these Design Guidelines shall prevail.

1.2. Guiding Principles

Byron Shire Council's On-site Sewage Management Strategy aims to protect our local waterways and their capacity to assimilate and transform wastes without altering the quality of their ecosystems. The Strategy also advocates the reuse of nutrients and hydraulic loads from sewage, preferably to achieve some beneficial outcome such as the diversion of high quality potable water resources from garden watering duties. In order to achieve the aims of the Strategy, these Design Guidelines provide guidance and information to ensure sites are adequately assessed and on-site sewage systems are designed and installed in a manner that does not threaten public health or the downstream environment. The Design Guidelines adopt the precautionary principle in attempting to ensure that the long-term environmental impacts of OSMSs are minimised through the implementation of current "best practice" sewage management approaches.

The following principles underpin Council's Design Guidelines for On-site Sewage Management for Single Households:

- Selection of a treatment system and land application area begins with consideration of the health and sensitivity of the down-stream catchment and the cumulative impact to which the subject OSMS is contributing.
- Low-tech gravity-fed systems are encouraged as these tend to be cheaper and more sustainable, provided that effluent can be reliably and evenly distributed over a sufficiently broad area to enable adequate evapo-transpiration.
- Maximise the opportunity for nutrient and water re-use by vegetation uptake. Re-use by evapotranspiration is the preferred method of managing post-treatment nutrients.
- Prevent off-site movement of effluent via surface runoff, lateral subsurface seepage or percolation into ground water.
- Minimise the risk to householders and the public of contact with pathogenic microorganisms.
- Distribute effluent evenly throughout the effluent application area.
- Minimise the quantity of natural resources utilised in construction, including energy.

- Ensure that on-site sewage management systems are to be designed and installed by a suitably qualified and experienced person with demonstrated expertise in on-site sewage management issues.

Experience shows that there is no standard solution for all sites. Each site and each owner have specific requirements that must be addressed. The following step-by-step guide will assist designers and owners in selecting and designing the most suitable options for their specific sites.

1.3. NSW Health Accreditation of OSMS Facilities

Under the provisions of Division 6 (Clauses 42 and 43) Local Government (Approvals) Regulation 1999, a local council must not approve of the installation of certain sewage management facilities unless they have been accredited by the NSW Department of Health. Details of which sewage management facilities are affected by this legislative requirement and the process for gaining accreditation are provided, along with other relevant information, on NSW Health's website at http://www.health.nsw.gov.au/public-health/ehb/general/wastewater/wastewater.html.

1.4. More information

There exists in the literature a wealth of information regarding on-site sewage management. Those seeking further detail than is provided within this document are referred to the following (for example);

- *Environment and Health Protection Guidelines: On-site Sewage Management for Single Households*, 1998 available from the NSW Department of Local Government. This document can be downloaded from www.dlg.nsw.gov.au
- Australian Standard AS/NZS 1547, 2000. *On-site domestic wastewater management.* Available from Standards Australia, PO Box 1055 Strathfield NSW 2135 or www.standardsaustralia.gov.au.
- NSW Department of Local Government at www.dlg.nsw.gov.au (an overview of the Department's on-site sewage management programs to improve health and environment). A very useful document provided by DLG is the *On-site Sewage Risk Assessment System*, which is available on-line from www.dlg.nsw.gov.au/dlg/dlghome/dlg_osras.asp.
- NSW Department of Health at www.health.nsw.gov.au/public-health/ehb/general/. Information on the accreditation of sewage management facilities by NSW Health is available on www.health.nsw.gov.au/public-health/ehb/general/wastewater/wastewater.html.
- Byron Shire Council website at http://www.byron.nsw.gov.au/health_and_compliance
- Byron Shire Council's *On-Site Sewage Management Strategy, 2001*, available from Council website cited above
- Byron Shire Council's *Home owners guide to on-site sewage management, 2001.* A simplified or 'plain English' version of the design guidelines, available from Council website cited above
- BSC's *Byron Rural Settlement Strategy, 1998*.

2. STEPS REQUIRED FOR PREPARING AN OSMS DESIGN

An OSMS generally consists of three main parts: the wastewater source, treatment components, and a land application area for the final reuse or disposal of the treated effluent. These components are represented graphically in Figure 1.

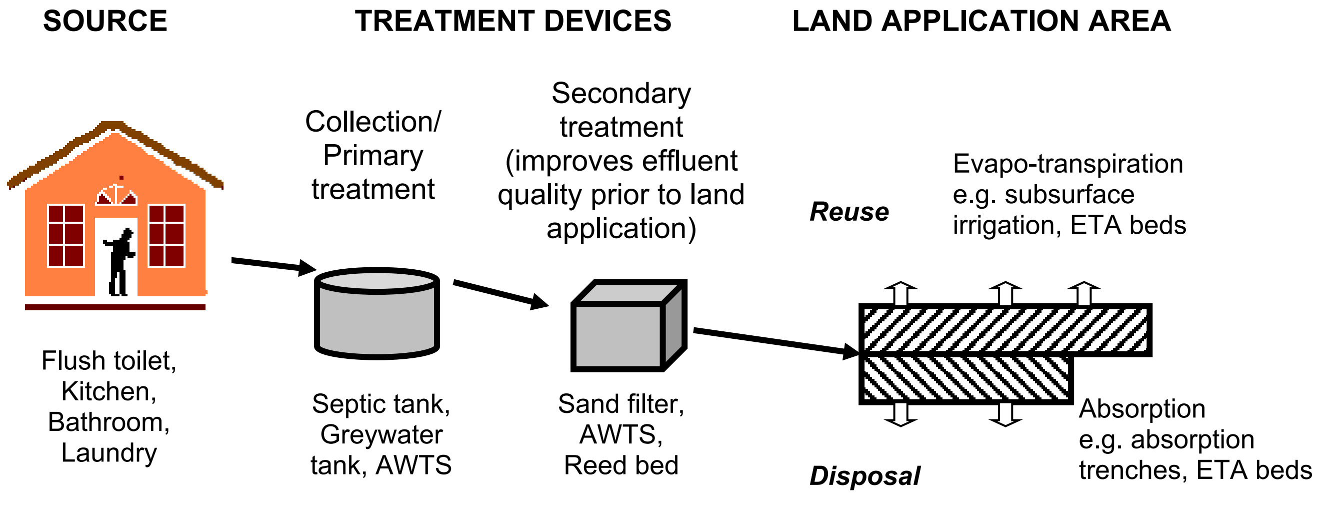


Figure 1: Major Components of On-Site Sewage Management Systems (OSMSs)

The process of designing an OSMS involves gathering, interpreting and reporting information relevant to each part of the treatment train. Thus, designing a suitable OSMS requires a good understanding of the soils and other physical variables of the site (e.g. slope, aspect and shape of the land), the wastewater generating activities of the household, and an extensive knowledge of the available treatment and land application options.

2.1. Recommended Design Steps

A number of steps are involved in successfully designing an OSMS in Byron Shire, as summarised in Table 1. Generally, once preliminary information has been gathered via desktop search, a detailed site and soil assessment is carried out to identify any potential constraints and limitations of the site for managing effluent. Once the site limitations are known, suitable treatment and land application options can be identified that will address any constraints appropriately.

Table 1 should be used as a checklist when preparing an OSMS design report for submission to Council. References to the relevant sections of the Design Guidelines are provided in Table 1 where appropriate. A computer-based model (using MS Excel) has also been developed by Byron Shire Council to assist in the design and sizing of effluent treatment and land application systems (refer Appendix C).

Note that the requirements that must be met by installers of OSMS (once an OSMS design has received Council approval) are provided in Section 10 (page 31).

Table 1: Steps required in preparation of an OSMS design report for submission to Byron Shire Council

Step	Task	Relevant section of *Design Guidelines* to refer to;
1	Undertake desktop research	Section 3.0 (page 5)
2	Identify wastewater sources and water utilising devices, and estimate hydraulic loads	Section 4.0 (page 6); Appendix C; OSMS Design Model.
3	Conduct detailed site and soil assessment to identify potential limitations of the site and soil for accepting effluent	Section 5.0 (page 8); Appendix B and H.
4	Identify suitable treatment and land application options and consult with client to determine preferred options	Section 4.5, Appendices A & B.
5	Design treatment system	Appendices A and C; OSMS Design Model.
6	Determine the most suitable method of land application system and calculate the size of the land application area.	Appendices B and C; OSMS Design Model.
7	Measure and peg out proposed land application area. Compile a diagram showing layout of proposed land application area	Section 8 (page 27)
8	Compile the above information in a detailed design report, including preparation of OSMS Management Plan for homeowners	Section 8 (page 27), Appendix G.
9	Submit 2 copies of the report to Council for approval	Section 8 (page 27)
*	Once design has been approved, requirements for installation by licensed plumber are set out in Installers Requirements	Section 10 (page 32)

3. DESKTOP RESEARCH

Desktop research must be undertaken to determine the approval status of any existing systems, Deposited Plan (DP) and Lot numbers (or BSC Parcel Numbers when known), flooding depths and frequency, risk of disturbing acid sulphate soils, geology and soils of the area (see Table 4) using, for example, *Soil Landscapes of the Lismore-Ballina 1:100,000 Sheet* by Morand (1994) and other references as necessary.

All designers are urged to come to the Byron Shire Council counter in Mullumbimby to get a copy of a selective GIS image of the subject property (ask for “OSM Layer”, small fee applies). This will show the approximate buffer distances to waterways, proximity to registered water bores and cattle tick dip sites, and slopes greater than 10 %. Approximate flood-levels are usually available but unfortunately Council’s mapping is not accurate enough to confidently predict flood levels in some areas and local information may need to be sought.

4. ESTIMATING WASTEWATER GENERATION

4.1. Predicted Hydraulic Flow

For existing dwellings fitted with a water meter, an accurate estimate of household sewage volumes can be obtained by monitoring the meter readings over a number of weeks when little or no outside watering is occurring, or examining water usage reported on previous water bills during wet periods. For new houses or where no meter readings are available, effluent generation rates should be based on the potential maximum number of people that may inhabit the dwelling at any one time. In Byron Shire, this is calculated on the basis of the number of bedrooms multiplied by 1.5 persons per bedroom, unless there is information to suggest that more people will be or are living there, in which case the higher number should be used.

Installing water efficient fittings and appliances in the household to minimise wastewater generation rates can achieve significant reductions in the size and cost of treatment and land application components of OSMS. Installing composting toilets rather than flushing toilets can achieve the greatest single reduction.

In consultation with the home-owner, the OSMS designer is required to refer to AS1547 (2000) to determine appropriate wastewater generation rates, based on what the household water source will be (e.g. tank water or reticulated supply) and whether water-saving devices are installed. Note that Council will need to confirm that any water-saving devices claimed in the design are installed when it inspects the OSMS (refer Section 10). The daily volume of household effluent that the OSMS will need to cater for is then estimated by multiplying the number of persons expected to reside there (see above) with the expected effluent generation rate from AS1547 (2000). These calculations are performed within a subroutine of the Byron OSMS Design Model (refer Appendix C).

4.2. Nutrients and Pathogens

Besides the volume of water, there are two other components of domestic sewage which need to be closely considered by the OSMS designer; nutrients (e.g. carbon, nitrogen and phosphorus) and pathogens.

4.2.1 Nutrients in Sewage

The often high levels of nutrients found in sewage can be either a potential source of pollution if they are allowed to reach surface or groundwaters, or a resource in sustaining the growth of lawns and gardens. As indicated in the Guiding Principles (Section 2.1), the challenge for the OSMS designer is to reduce the nutrient levels and spread those that remain in the effluent in such a way that they will virtually all be taken up by plants in the land application area and virtually no excess nutrients will reach the groundwaters or neighbouring surface waters.

It is expected that compliance with these Design Guidelines, in conjunction with the associated OSMS Design Model or an equivalent, will enable home-owners to be confident that they will not be causing pollution by allowing excess nutrients to leave their property boundaries or enter waterways. In most cases, this is achieved by matching the likely loads with plant uptake rates and sizing the land application area (LAA) to ensure complete reuse within that LAA. On larger blocks where the cumulative risks of OSMS are lower, Council's OSMS Design Model permits a proportional reduction of the LAA, with the expectation that the buffering capacity of the vegetated lands surround the LAA will assist in assimilating any excess nutrients (refer Appendix C).

4.2.2 Pathogens in Sewage

Pathogens are micro-organisms that can cause diseases, including bacteria, protozoa, viruses and helminths. Pathogens are found in varying concentrations in all domestic sewage, but are found in particularly high concentrations when one of more of the residents are infected with a disease.

Similarly, if pathogens are transmitted they might have no effect on a healthy adult but can be much more of a risk for small children or immunity-suppressed receptors. Another related point to note is that OSMSs servicing those who are taking strong medication, e.g. antibiotics and chemotherapy drugs, are liable to be affected and maybe disabled by these medications.

Some types of pathogens, e.g. viruses and helminths, are able to survive outside the body for months (refer for example to DLG, 2001 – OSRAS Handbook Appendix F). Although soil often performs as a very good filter for pathogens, there always remains some risk that pathogens can be transmitted from carelessly treated or inappropriately applied land application systems.

Based on available published information, Byron Council expects that adherence to these Design Guidelines will ensure that risks posed to home-owners and neighbours are kept to acceptably low levels. However, where designers have cause to reduce the recommended buffer distances (refer Section 5.1.6) or where above-ground application of effluent is proposed (refer Section 7), designers are required to provide additional written consideration to the risks of pathogenic transport and potential infection by householders, neighbours or downstream water users.

5. SITE AND SOIL ASSESSMENT

Correct and accurate site assessment is critical to developing appropriate and sustainable sewage management systems. The main aims of the site and soil assessment are to identify any constraints that may potentially limit the ability of the site to adequately deal with effluent and to determine the amount of suitable land available for land application of the treated effluent. The information gained from the site and soil assessment will ultimately be used to determine the type, size and location of the land application system, and the level of treatment required to overcome any constraints.

Different situations require different levels of assessment, especially where there are limitations to be surmounted. It is stressed that site and soils assessment are specialised disciplines and it is not possible to include in these Design Guidelines all the relevant and necessary information that professional assessors are required to understand (refer Section 1.3 for further information).

The following sections explain in detail the various parameters required for a site and soil assessment. If constraints are found during the site and soil investigations, designers should examine options for ameliorating these constraints (refer Table 6).

5.1. Site Evaluation Procedures

Most of the following information is drawn from the Australian Standard (AS/NZS1547, 2000). The information below will help you evaluate your site's capacity to manage on-site sewage (Table 9).

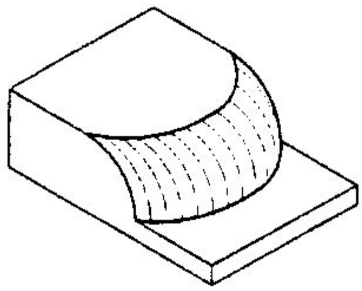
5.1.1 **Slope Angle** (Refer also AS/NZS1547, 2000)

The slope of the site, especially the proposed application area(s), should be determined in the field through the use of such instruments as an inclinometer over at least 20 m distance or through a formal survey of the site.

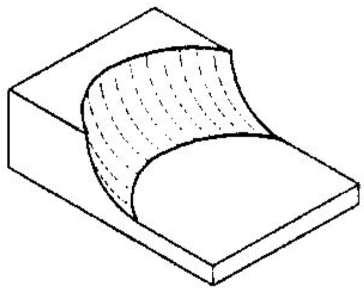
Slopes greater than 15% (8.5 degrees) are regarded as severely limiting the installation and operation of land application systems (refer Table 6).

5.1.2 Slope shape

The shape of the slope may either assist or hinder drainage as shown in the following diagrams



Best water-shedding shape (convex)



Worst water-shedding shape (concave)

(Source AS/NZS1547, 2000)

Concave-shaped slopes are much more likely to have problems with effluent dispersal than convex-shaped slopes because of the way groundwater is concentrated in them. Additional cut-off drains and diversion bunds may be used to ameliorate poor drainage conditions. The reader is referred to the Australian Standard (AS1547, 2000) for more detailed diagrams of the various types of slope shape and their implications for OSMS.

It is strongly recommended that the site be surveyed to aid landform and slope assessment. A minimum distance of 20 meters will be required to measure and determine the degree of slope, and variations in slope around relevant parts of the property should be marked on the plan.

5.1.3 Aspect

Use a compass to ascertain the dominant direction that the proposed irrigation area faces. North and northeast-facing slopes are preferred due to greater exposure to sunlight, hence higher evapo-transpiration rates. Refer to AS/NZS1547 (2000) for further advice.

5.1.4 Exposure

High exposure to sunlight and prevailing winds greatly aids the uptake of water vapour through transpiration and evaporation processes. It is worth noting that meteorological stations are invariably located in positions fully exposed to sun and wind. The daily water balance model recommended in these Design Guidelines (Appendix C and OSMS Design Model), which are based on Alstonville climate records, would not be representative of a damp shaded area. Any such areas should be marked on the site plan and avoided in the selection of the land application area. Refer to AS/NZS1547 (2000) for further advice.

5.1.5 Boulders/Floaters/Rock Outcrops

Boulders/floaters or rock outcrops may reduce the effectiveness of effluent “polishing” mechanisms in the soil. Rocks make installation more difficult and may also restrict infiltration and allow sewage to short-circuit the dispersal field and more rapidly enter waterways. (Refer also AS/NZS1547, 2000)

Proposed application areas should be traversed on foot and the presence of any boulders/floaters or rock outcrops should be recorded in the site plan. Note: The definition of a boulder is a rock whose middle dimension is at least 600mm (see Glossary).

Shallow bedrock is a significant constraint because it greatly limits the natural assimilation capacities which might otherwise be provided by clay soils, and may provide a much faster and much more poorly filtered conduit to groundwater resources. Where investigations indicate that the C-horizon (weathered bedrock) lies within 1.5m of the soil surface, the depth to bedrock should be entered into LAA calculations (e.g. in cell B14 in Byron OSMS Design Model) and amelioration measures should be considered to compensate for the constraint (refer Table 6).

5.1.6 Buffer Distances

Accurate distances to certain critical features must be recorded as described below. Appropriate setback distances are determined by the E&HP Guidelines (1998) or the Beavers and Gardner method, described in their published paper (Beavers and Gardner, 1993). It is likely that there will be difficulties in obtaining the necessary parameters (i.e. accurate estimations of soil permeability) to use the Beavers and Gardner method however, in which case the default setback distances set out below should be used.

Byron Council accepts that the following buffer distances cannot always be met. Where it is necessary, or for some reason highly desirable, to reduce the one or more of the buffer requirements, greater attention shall be paid to improving quality of the effluent or expanding the size of the land application area (Refer Table 6). Where it is proposed to place the treatment system or land application area within the following buffer distances, the designer must provide a written evaluation of the potential risks for the transfer of pathogens from the OSMS to residents or neighbours (refer Section 4.2.2) and proposed amelioration measures to be taken to reduce health and environmental risks in the reduced buffers:

1. minimum buffer distance of one hundred (100) metres from the nearest edge of permanent watercourses including rivers, creeks, wetlands, dams or lakes.

2. minimum buffer of forty (40) metres from the centre-line of ephemeral water courses (e.g. intermittent waterways, drainage channels and dry gullies).
3. minimum buffer of 250 metres to downstream or cross-gradient domestic groundwater well, and at least 50 m from upstream groundwater well.
4. minimum buffer distances between the treatment and/or land application area (LAA) **other than ETA beds** and a building or property boundary are as follows:
   (i) for sites with slopes less than 10% (5.7 degrees):
      a) three (3) meters when the building or boundary is up-gradient of the LAA; and
      b) six (6) meters when the building or boundary is down-gradient from the LAA; and
      c) 1.5 meters between adjoining subsurface application systems (e.g. ETA beds); and
      d) six (6) meters from a swimming pool, driveway, building or property boundary;
5. minimum buffer distances between the treatment and/or land application area (LAA) **for ETA beds** should be double those listed above (e.g. 6 m if building or property boundary is up-gradient of the LAA, and 12 m if it is down-gradient from the LAA)

6. effluent dispersal fields/distribution networks (i.e. pipes, gravel, etc.) should be located a minimum of 1200 millimeters above the top of the natural ground water table. This depth may need to be increased to account for highly permeable soils, low-quality effluent and/or potential sensitive environmental impacts;

6. areas of high water table (i.e. less than 1.2 m below ground surface), groundwater recharge, highly permeable soils and/or containing rock outcrops, shallow bedrock, acid sulfate, sodic or saline soils are considered major limitations to onsite effluent dispersal.

7. treatment and application systems should be kept at least 100 m from Cattle Tick Dip Sites or other known contaminated sites, unless detailed soil sampling confirms that there are no contaminated soils in the treatment or application areas.

5.1.7 Run-on and Upslope Seepage

Any known run-on or upslope seepage which might affect the application areas must be recorded on the site plan (refer AS/NZS1547, 2000). The presence of flood debris and silt deposits may assist in identifying run-on flowpaths. If stormwater cannot be reliably controlled by the construction of a catch drain, a diversionary swale or an interception trench above the dispersal field, then an alternative location must be chosen.

5.1.8 Flooding Potential

The flooding potential of the site must be determined, especially for low-lying areas and flood plains. All land application areas should be above the 1 in 20 year flood height, and treatment systems should be above the 1 in 100 year flood level. Council or the NSW Department of Public Works may be able to supply flood height records in some areas.

5.1.9 Site Drainage

The frequency and duration of seasonal shallow waterlogging should be noted. Signs of poor drainage include hard packed soils, vegetation growth characteristic of damp sites, and pooling of water. It is not recommended that land application areas be installed within sites with poor drainage. The location of channeled (concentrated) runoff on site, as well as any runoff likely to move onto neighboring properties, should be noted on the site plan (refer also AS/NZS1547, 2000) and avoided in the siting of the Land Application Area.

5.1.10 Vegetation Indicating Waterlogging

While wetland species such as bulrushes etc are obvious signs of frequent waterlogging, other less obvious species such as sedges and buffalo grass can, in this region, indicate seasonal waterlogging. The presence of these or other moisture-loving species should be noted in the site plan.

5.1.11 Surface Condition

Note cracks, hardness, previous compaction patterns, dampness and the location of seepage areas (refer also AS/NZS1547, 2000).

5.1.12 Fill

The location, depth and type of any fill should be noted on the site plan, as shown in AS/NZS1547 (2000). Clean fill consisting of soil, which has settled and is on a stable site, may be used for effluent application. However other types of fill with coarse fragments and located on steep sites, are unsuitable for land application of effluent.

5.1.13 Erosion/Mass Movement

The location and details of existing mass movement and erosion, such as gullies, slips and rills should be recorded on the site plan (refer AS/NZS1547, 2000). To protect against future erosion, adequate drainage controls must be undertaken to ensure that effluent is not concentrated within one location, and upslope runoff is diverted around the land application area.

Particular attention should be paid to ensuring that on-site systems in steep areas will not lead to slumping on slopes. If in doubt, seek suitably qualified advice.

5.2. Soil Evaluation

The relevant soil properties of each proposed land application area should be investigated and assessed in accordance with AS1547 and these Design Guidelines by a suitably skilled and qualified, independent practitioner. The assessment must contain an accurate estimation of the soil and sub-soil characteristics. The three key tests to be performed are

- the manual bolus or ribbon test to determine soil *texture*
- the visual test to determine soil *structure*
- the modified Emerson Aggregate test to determine soil *dispersiveness*

Soil evaluation needs to be focused on the proposed land application area as recommended in AS1547 (2000). At least two soil profiles should be examined in each land application area, either by boring or trenching. If significant differences are found in the first two profiles, more sampling should be undertaken in order to establish the approximate boundaries of the various soil types.

Soil profiles should be examined to a depth of at least 1.2 m, or deeper if changes in soil colour or texture are still being noted at the base of the hole. Unless there are less permeable layers found during the profiling, samples from around 0.4 m depth and around 1.0 m should be collected for detailed textural assessment, either by an independent geotechnical laboratory or by a skilled practitioner. A single sample from around 0.8 m depth in the centre of the proposed land application area may be acceptable in deep krasnozems, sands or particularly evenly graded soils.

Soil texture and structure determine the soil's ability to accept effluent, which in turn determines the appropriate effluent loading rate. For example, highly dispersive soils are problematic due to the damaging effect that excessive sodium can have in destroying the soil structure, leading to a decrease in soil permeability, and very low effluent loading rates are therefore recommended for highly dispersive soils (refer Section 8). Designers should also be aware that, even though they are not classified as highly dispersive, krasnozem and many other volcanic-derived soils in this area are prone to exhibiting reduced permeability after prolonged contact with highly sodic sewage effluents (Patterson, 1998).

An indication of the broad soil category of a site can be obtained from *Soil Landscapes of the Lismore-Ballina* or *Tweed 1:100,000 Sheet* Morand (1994). However, soil parameter values within any one soil type can be highly variable. As part of the initial desk top study the soil unit from this text should be ascertained in order to identify *likely* site and soil limitations as well as indicate likely phosphorous sorption rates. Table 2 will assist in this process.

Table 2: **Soil Landscapes in Byron Shire (showing likely limitations for effluent dispersal, and phosphorous sorption.** Sources: Morand (1994), P-sorption analyses by EAL, Southern Cross University 1998.

Soil Unit (Morand, 1994)	**Code** (Morand 1994)	**Broad Soil Type**	**Likely limitations** Asterisk (*) indicates comments from Morand (1994)	**P-sorption kg/ha/m** (Morand, 1994)
Bagotville	**Ba**	Sandy Duplex	Flood prone footslopes*.	8,000
Bangalow	**Bg**	Red Basaltic	Steep, shallow*. May need benching and/or SDI on slopes.	10,000
Billinudgel	**Bi**	Yellow and red podzols	Acidic, hardsetting soils, mod. CEC	10,000
Black Rock	**Br**	Sandy podzol	Waterlogging, high watertables, low CEC*.	1,000
Coolamon	**Co**	Red Basaltic / Dark Basaltic	Steep, shallow, stony soils, mass movement*.	10,000
Disputed Plain	**Dp**	Alluvial (highly reactive)	Waterlogged, impermeable soils, high watertables*.	10,000
Eltham	**el**	Red Basaltic	Locally waterlogged, flood hazard, proximity to streams. *	10,000
Ewingsdale	**ew**	Red Basaltic	High permeability, but mass movement hazard near drainage lines, waterlogging on lower slopes.*	10,000
Mount Burrel	**mb**	Red Basaltic / Dark Basaltic	Steep slopes, mass movement*. May need benching and/or SDI on slopes.	10,000
Minyon	**mi**	Sandy / Clayey Duplex	Steep slopes, rockiness, seasonal waterlogging and shallow soils (all localised)*	8,000
Mullumbimby	**mu**	Alluvial clays	Flood hazard, seasonal waterlogging, high watertables. May need mounds.	10,000
Myocum		Alluvial clays	Flood hazard, seasonal waterlogging, high watertables. May need mounds.	10,000
North Casino	**nc**	Alluvial (highly reactive)	Shrink-swell soils, localised waterlogging and high watertables*.	10,000
Nightcap	**ni**	Varied: includes Red Basaltic, Clayey Duplex	Steep slopes, mass movement, rockiness*	8,000
Nimbin Rocks	**Nr**	Steep thin volcanic soils	Severe limitations for development on cliff-footslopes. Not suitable for OSMS.	---
Rosebank	**Ro**	Red Basaltic	Steep slopes, mass movement*. May need benching and/or SDI on slopes.	10,000
Terania	**te**	Alluvial (varied, not highly reactive, and doesn't easily fit Great Soil Group or profile categories)	Close to watercourse, flooding, stream-bank erosion, slumping*.	10,000
Tuckean	**tu**	Humic Gley	Unsuitable for effluent dispersal.	
Tyagarah	**ty**	Alluvial /Sandy Podzolic	Waterlogging, high watertables, low CEC*.	1,000
Wollongbar	**wo**	Red Basaltic	High permeability*.	10,000

5.2.1 Soil Texture Classification

Soil texture may be measured by the behavior of a small amount of soil, incrementally moistened and kneaded into a small ball (bolus), then manipulated between the thumb and forefinger to form a ribbon. The soil is then categorised from the behavior of the moistened bolus and the length the squeezed ribbon achieves before shearing or failing

There are six broad texture categories which are used to classify the likely permeability of soil, as set out in Table 3. Each texture group and any change in texture group within the soil profile should be recorded. The following table is provided to assist in determining the soil texture category.

Table 3: **Soil Texture Grades.** Source: Northcote (1979) and AS/NZS1547(2000).

Soil Category (Texture Group)	Grade of Soil Texture	Behavior of moist bolus	Indicative ribbon length before failure (mm)
1 - Gravels & sands	Sand	nil to very slight coherence, won't mould, single grains adhere to fingers	Less than 5
	Loamy sand	slight coherence	≤ ~6.35
	Clayey sand	slight coherence, sticky when wet, many sand grains stick to fingers, discolours fingers with clay stain	6.35-13
2 - Sandy loams	Sandy loam	bolus just coherent, v.sandy to touch, dominant sand grains readily visible	13-25
	Fine sandy loam	bolus coherent; fine sand can be felt and heard when manipulated (clearly seen under hand lens)	13-25
	Light sandy clay loam	strongly coherent bolus, sandy touch, med. size sand grains easily visible	20-25
3 - Loams	Loam	bolus coherent, spongy, smooth (not sandy / silky) feel when manipulated	~ 25
	Loam, fine sandy	bolus coherent and slightly spongy, fine sand can be felt and heard when manipulated	~ 25
	Silt loam	coherent bolus; very smooth to silky when manipulated	~ 25
	Sandy clay loam	strongly coherent bolus, sandy touch, med. size sand grains in finer matrix	25-38
4 - Clay loams	Clay loam	coherent plastic bolus, smooth	38-50
	Silty clay loam	coherent smooth bolus, plastic and silky to touch	38-50
	Fine sandy clay loam	coherent bolus, fine sand can be felt and heard when manipulated	38-50
5 - Light clays	Sandy clay	plastic bolus; fine to med. sands seen, felt or heard in clayey matrix	50-75
	Silty clay	plastic bolus; smooth and silky to manipulate	50-75
	Light clay	plastic bolus; smooth to touch; slight resistance to shearing between thumb and forefinger	50-75
	Light medium clay	plastic bolus; smooth to touch; slightly greater resistance to shearing between thumb and forefinger.	~ 75
6 - Medium to heavy clays	Medium clay	plastic bolus; like plasticine & can be moulded into rods without fracture; some resistance to ribboning shear.	≥ 75
	Heavy clay	Smooth plastic bolus; like stiff plasticine; can be moulded into rods without fracture; firm resistance to ribboning shear.	≥ 75

5.2.2 Soil Structure

The soil structure is to be determined from visual assessment of the site and from borehole testing, through the examination of exposed soil surfaces. Table 4 summarises the common soil structures.

Table 4: Soil structure according to degree of pedality. Source (AS/NZS1547, 2000)

Degree of Pedality	Appearance
Massive	Coherent, with any partings both vertically and horizontally spaced at greater than 100 mm. Pieces do not break along planes of weakness but break according to stress loads
Single grained	Loose incohesive, structureless e.g. sands
Weak	Peds indistinct and barely observable on pit face. When disturbed approximately 30% consist of peds smaller than 100mm
Moderate	Peds well formed and evident.. but not distinct in undisturbed soil. When disturbed 30% - 60% consists of peds smaller than 100mm
Strong	Peds quite distinct in undisturbed soil. When disturbed >60% consists of peds smaller than 100mm

5.2.3 Soil Permeability Determination

Accurate soil permeability assessment is encouraged but is often quite problematic. A preferred method for field evaluation using a constant-head permeameter is provided in Appendix 4.1 F of AS/NZS1547 (2000). Alternatively, AS 1547 (2000) provides indicative permeabilities based on textural and structural soil characteristics (refer Appendix 4.2 of AS1547 cited above).

5.2.4 Colour Description

The colour of a soil is often a good indicator of state of saturation of the soil, in turn reflecting the oxygen availability in the soil. For example, red or brown colours generally indicate well aerated soils lying above the standing water table, while grey or white soils are often found in saturated or periodically saturated soils.

A detailed colour description of the soil profile should therefore be conducted during the soil assessment. The soils should be described in the moist condition by the following colours: black, white, grey, red, brown, orange, yellow, green or blue. The classification can be modified as required by the words pale, dark or mottled. Transitional colours may be described as a combination of these colours (e.g. red-brown).

When a soil horizon has a predominant colour with mottles of another colour, it is described in the form: (predominant colour) mottled (secondary colour), e.g. grey mottled red-brown. Where two colours are present in roughly equal proportions, the colour description is described in the form: mottled (first colour) and (second colour), e.g. mottled brown and red-brown.

5.2.5 Assessment of Coarse Fragments

Coarse fragments include hard rock material and nodules or segregations. These may be separated from the fine earth component of a soil sample by using a 2 mm sieve. This is a difficult process when a soil is moist and heavy, in which case a field estimate using abundance charts is acceptable. A visual estimate of abundance should be recorded, along with the size range of rock fragments and their corresponding amounts, using Table 5a and 5b.

Table 5. Abundance (a) and Size (b) of Coarse fragments Source: (AS/NZS1547, 2000)

Class	% of coarse fragments
Very few	<2
Few	2-10
Common	10-20
Many	20-50
Abundant	50-90
Profuse	>90

Type of rock	Size of coarse fragments mm
Fine gravel	2-6
Medium gravel	6-20
Coarse gravel	20-60
Cobbles	60-200
Stones	200-600
Boulders	>600

Where coarse fragments occupy more than 20% of soil volume *and* larger pores correspondingly accompany these coarse fragments, the flow of water is not expected to be impeded. Where coarse fragments occupy more than 20% of the soil volume but large pores accompanying the larger fragments are not present, the water flow is expected to be impeded and the Soil Category should be increased by one class e.g. a Clay Loam should be classed as a Light Clay for permeability estimation purposes.

Where there are more than 20% cobbles, stones and boulders, this can impede surface preparation and excavation and contribute to trench collapse.

5.2.6 Field pH

The pH of a soil can alter the availability of nutrient elements for plant uptake and can cause metal toxicities if pH is too low or too high. Acid soils tend to be leached of major plant nutrients e.g. calcium, magnesium, nitrogen and possibly molybdenum, while phosphorus may not be present in plant-available form. Alkaline soils are often deficient in iron, manganese, copper or zinc (Morand, 1994). A field pH test, using a calibrated field instrument or colour-test-strips, should be undertaken to determine the acidity/alkalinity of the soils. Soil pH of between 6.5 to 8 is ideal for plant uptake of phosphorous, potassium and nitrogen.

5.2.7 Dispersive Class (Modified Emerson Aggregate test)

The Modified Emerson Aggregate test provides a simple field assessment of a soil's aggregate stability. It is carried out using effluent or a prepared solution with similar qualities as the effluent to be applied to the soil being tested (for septic tank effluent this is equivalent to a solution with Sodium Absorption Ratio (SAR) of 5 and EC around 1000 μS/cm) (Patterson, 1998).

The test involves placing about three 5mm diameter undisturbed soil aggregates from the soil profile into a beaker of the above solution, and leaving undisturbed for 24 hours. The behavior of the aggregates is then recorded from the following:

Class 1: Material disperses completely.
Class 2: Aggregates disperse (clouds solution appreciably)
Class 3: Aggregates slake - smaller aggregates/particles fall off the original aggregate
Class 4: No change to aggregate, therefore non-dispersive.

If any of the replicates are in Classes 3 or 4 then the soil shall be considered *dispersive* and the Soil Category should be considered Grade 6, as though for a Texture Grade of Medium to Heavy Clays (refer Table 3 above and AS/NZS1547, 2000 for further information). In such cases, gypsum will need to be worked into the land application area at a predetermined rate in order to prevent soil structure degradation. Further ameliorative measures, such as the expansion of the land application area or provision of a larger reserve field, is also likely to be required to compensate for the likely long-term reduction in permeability in the land application area.

5.3. Site Constraints and Possible Solutions

The information in preceding sections should be used to make an assessment of the proposed land application area(s), and to identify any constraints for treatment or dispersal of effluent. Should any site or soil limitations be found, applicants or their consultants must clearly report them in the assessment report, highlighting all limitations and detailing the appropriate mitigation measures intended to be taken to address these limitations. Tables 6 and 7 show some common site and soil constraints, and the measures which might be employed to overcome them or ameliorate their effects.

Table 6: Limiting Site Conditions for Land Application Areas and Suggested Solutions

Site Feature	Examples of limiting conditions	Suggested solutions to limitations
Slope For steeper ground use narrow ETA beds or SSI	Slopes >15%	Enhanced treatment, sub-surface irrigation over larger area. Irrigation with wider spaced SDI emitters along contour for very steep or highly constrained sites.
Landform	Convergent (drainage-concentrating) land shape	Stormwater diversion bunds above concentrating areas, larger application area.
Exposure Good aspect and exposure to sun enhances evapotranspiration rates	Land application area faces SW or SE quadrants, and/or trees sheltering from sun-wind	Shade plants trimmed often, expand land application area or improve effluent.
Distance to Water Body and man-made features Potential for polluting downstream waters or neighbouring properties	<100m to permanent surface water OR <250m to domestic groundwater wells OR <40m to other waters (e.g. farm dams, intermittent waterways, dry gullies and drainage channels) OR <6m if up-gradient and <3m if down-gradient of property boundaries, swimming pools, driveways and buildings (In the case of ETA beds: <12m if up-gradient and <6m if down-gradient of property boundaries, but 6m/3m as above for pools etc)	Enhanced treatment of effluent, expand land application area, ensure that drainage is diverted around land application area.
Run-off/seepage from upstream lands	Run-on periodically saturates Land Application Area.	Swales, diversion drains, subsurface drainage.
Flooding Potential	Land application area below 1 in 20 year flood contour OR Treatment system below 1 in 100 year flood contour	Pump and electrical components must be out of 1:100 year flood zone, consider SDI with wet-weather storage or raised application area (e.g. mounds).
Site Drainage	Signs of surface dampness	If due to shading, trim trees or find alternative area. If due to stormwater, adjust surface drainage
Vegetation indicating waterlogging	Presence of sedges etc that indicate waterlogged soil	Swales or diversion drains to control drainage, improve treatment, expand application area or use raised mounds.
Surface Condition	Bare ground or cracking	Add or amend surface soils, improve treatment.
Fill	Land application area contains fill	Attempt to find alternative area, or replace fill with stable, compacted mixture of sand and clay soil. Ensure geotechnical stability will not be compromised by effluent
Erosion/Mass Movement	Rills, slips	Promote vegetation growth, improve drainage, get geotechnical advice.

The following table provides a summary of common soil problems which may be encountered in Byron Shire, with an indication of when the soil characteristic may limit on-site effluent dispersal, and possible amelioration measures for constrained land application areas.

Table 7: Soil limitations and suggested solutions

Soil Feature	Examples of limiting conditions	Suggested solutions to limitations
Dispersive or swelling Soils using modified Emerson Aggregate test	Soils in proposed land application area found to be dispersive (i.e. Class 3 or 4 in Table 4.1.1 of AS1547:2000), sodic or prone to shrink-swell characteristics.	Add gypsum or otherwise amend soil. Improve or increase second-stage treatment, and/or increase application areas.
Coarse Fragments(Coarse fragments, rocks, boulders impede absorption)	Rock fragments occupy >20% of soil volume	Increase size of land application area proportionally.
Field pH pH extremes inhibit plant growth	pH < 5.5 or >8	Improve or increase second-stage treatment. Conditioning with lime may assist if pH<5.5

6. CHOOSING A TREATMENT SYSTEM

This section provides information to assist in selecting the most suitable treatment system that will satisfy the needs of the given homeowner and adequately deal with any site constraints (such as close proximity to waterway or small block size). For each treatment system, general information is given regarding its function and form, and important information relevant to the operation and maintenance of each system is provided.

More detailed information for use in the design and sizing of each treatment system is provided in Appendix A. Designers are also strongly encouraged to do further reading and research (e.g. Crites & Tchobanoglous,1998; Metcalf & Eddy, 2002) to ensure that they understand all relevant aspects of all treatment systems under consideration. Applications based on innovative designs or emerging technologies are encouraged, provided sufficient technical justification can be provided to support their stated performance expectations.

Designers and prospective owners should be aware that each system will require some monitoring and maintenance, specified by Byron Shire Council in the Approval to Operate for that sewage management system (refer Appendix G). Highly mechanised systems such as aerated wastewater treatment systems and sub-surface irrigation fields generally have quarterly maintenance requirements, whilst most other systems need to be checked and maintained by a suitably skilled service-provider at least once a year. Designers and prospective owners should ensure that they are aware of the monitoring and maintenance requirements and consider their costs when choosing the system.

6.1. SOURCE CONTROL

6.1.1 Water-Saving Devices

The size and cost of treatment and land application systems are directly related to the volume of effluent that must be dealt with. Thus, activities or devices that minimise the generation of effluent at the source can often bring about a significant reduction in the cost and size of the OSMS. Careful consideration should therefore be given to the water consuming appliances used in the household (e.g. washing machines, flush toilets, shower heads, leaking plumbing).

Installing water efficient fittings and appliances in the household to minimise wastewater generation rates can achieve significant reductions in the size and cost of treatment and land application components of OSMS. Installing composting toilets rather than flushing toilets can achieve the greatest single reduction.

The designer is then required to refer to AS1547 (2000) to determine appropriate wastewater generation rates, based on what the household water source will be (e.g. tank water or reticulated supply) and whether water-saving devices are installed. Note that Council will need to confirm that any water-saving devices claimed in the design are installed when it inspects the OSMS (refer Section 10). The daily volume of household effluent that the OSMS will need to cater for is then estimated by multiplying the number of persons expected to reside there (see above) with the expected effluent generation rate from AS1547 (2000). These calculations are performed within a subroutine of the Byron OSMS Design Model (refer Appendix C).

6.1.2 Waterless Compost Toilets

Compost toilets significantly reduce the amount of treatment required for sewage by eliminating faeces and urine from the wastewater stream at the source. By eliminating the need for toilet flushing, they also reduce household water usage by as much as 30%. Consequently, the size and complexity of the treatment component of the OSMS can be significantly reduced, as only greywater is generated by the household. Nevertheless, it should be noted that compost toilets still generate a small amount of leachate that will need to be directed to the greywater management system or a small trench.

Details regarding the design and functioning of composting toilets are provided in Appendix A5. Operation and Maintenance advice is provided in Appendix G. All compost toilet installations shall be strictly in accordance with the requirements of the Local Government Act 1993.

6.2. Primary Treatment

Primary treatment refers to the physical removal of solids and organic matter through settling and sedimentation. Collection tanks (i.e. septic and greywater tanks) for raw effluent provide significant primary treatment through settlement and anaerobic digestion of organic solids by microbes. Primary treatment results in an effluent that is lower in suspended solids and biochemical oxygen demand (organic matter), but does not significantly reduce nutrient levels. The level of primary treatment depends on the residence time of the sewage in the tank, which in turn depends on the size of the tank, the volume occupied by scum and sludge layers and the volume of water used in the house.

6.2.1 Septic Tanks

The septic tank operates as a small anaerobic digester. Septic tank effluent is much lower in settled solids than the raw influent, but is still concentrated in nutrients and biochemical oxygen demand and generally requires some level of secondary treatment before it is suitable for land application (refer Section 6.3). Additional information regarding the function, sizing and management of septic tanks is provided in Appendix A. Operation and maintenance advice is provided in Appendix G.

6.2.2 Greywater Treatment

"Greywater" (or sullage) is the term used for all household wastewater excluding toilet wastes, for example the wastewater generated in a house with only composting toilets. Greywater generally contains lower nutrients but can still contain significant levels of pathogens, e.g. from showering and nappy washing. NSW Health requires that greywater be disposed of below ground level unless it has been adequately disinfected.

Greywater must be collected in an in-ground sullage tank (sized in accordance with NSW Health requirements, refer Appendix A), where primary treatment can occur, before being dispersed into the soil. Where the site is unconstrained, it can be piped directly from the sullage tanks into a suitably sized sub-surface land application system (refer Appendices B and C), but it should be understood that this is likely to reduce the operational life of the land application system. Byron Council therefore recommends that effluent from the sullage tank be further filtered and/or treated before land application (e.g. in a reed-bed or sandfilter).

The size of the application area required to safely disperse of greywater depends on effluent volumes and household inputs, and may be calculated using Byron Shire Council's OSMS Design Model (refer Appendix C). The minimum allowable size for a greywater dispersal bed must be calculated based on the nutrient uptake and hydraulic capacity of the land application system, but in no cases shall it be smaller than 10 m^2 per person in the household. This minimum figure is based on hydraulic dispersion capabilities of most soils, and would only be considered appropriate for at least partial-secondary treated greywater (refer Section 6.3).

6.2.3 Effluent Filters

An effluent filter is a coarse screen filter that fits into the outlet of a primary treatment tank. Effluent filters reduce Total Suspended Solids (TSS) carry over and thereby extend the operational life of land application components. Effluent filters are required to be fitted on the outlets of both septic and greywater tanks. Homeowners shall be made aware of the frequency and mode of cleaning before a particular filter is selected (refer Appendix G).

6.3. SECONDARY & PARTIAL-SECONDARY TREATMENT

For the purposes of these Design Guidelines, the term "secondary treatment" applies to systems which produce effluents containing less than:

- 20mg/L BOD
- 30mg/L Total Suspended Solids
- 30 mg/L Nitrogen
- 10 mg/L Phosphorus

(Source: Dept Natural Resources, Interim Code of Practice for On-site Sewerage Facilities, 1999)

It is noted that the above performance standard is from Queensland, and that the equivalent design standard in NSW does not provide criteria for nutrients, but the above criteria is nonetheless offered in these Design Guidelines for additional guidance.

Council acknowledges that there are smaller treatment system options (e.g. smaller scale reed-beds), which will significantly improve the quality of effluent, but wouldn't necessarily reach the "secondary" performance standards listed above. For the purpose of these Design Guidelines, these options are termed "partial-secondary" treatment systems (refer Glossary for definitions). **The minimum standard of treatment generally accepted for blackwater-inclusive OSMSs in Byron Shire is to a partial-secondary standard which achieves a 20% reduction in total nitrogen.**

The choice of a treatment system to achieve secondary or partial-secondary effluent quality at any given property will involve balancing the strengths and weaknesses of the available treatment options, summarised in Table 8 and discussed in more detail in Appendix A. Constrained land application areas, e.g. within stated buffer distances (Section 5.1.1) or on poor soils or steep slopes, will generally require higher levels of treatment or larger land application areas to ensure that pollution of waterways is avoided.

By reducing the concentration of nutrients and suspended materials, the level of effluent treatment has a proportional impact on the size of the land application area required (as calculated by the OSMS Design Model, see Appendix C). Homeowners and system designers have the option to choose better quality (e.g. secondary) treatment and small land application areas, or lesser quality (partial-secondary) treatment combined with larger application areas, provided that the partial-secondary treatment option achieves at least a 20% reduction in total nitrogen for blackwater-inclusive systems.

Table 8. Strengths and weaknesses of secondary treatment systems. Source: Davison (2003)

Performance criterion	AWTS	Single pass sand filter	Recirculating sand filter	Reed bed (horizontal flow wetland)
Power required?	Yes	Pump needed on flat ground	Yes	No
Fall of site	Any	1m fall if no pump	Any	Flat to moderate slope
Surface area	Small	~ 4m^2 /person	<3m^2 /person	4-6m^2 /person
Maintenance	High – quarterly contactor required	Owner can do checks, annual contractor to service	Owner can do checks, annual contractor to service	Owner can do checks, annual contractor to service
Construction cost	High	High	High	Moderate
Nitrification	Good	Good	Good	Poor to moderate
Nitrogen removal	Low	Low	Good	Moderate to good
Intermittent dosing needed?	No	Yes	Yes	No
Tolerance to peak loads	Low	Low	Moderate	Very good
Tolerance to low loads (holidays)	Low	OK	OK	OK
Visual impact	Low unless above ground	Can be hidden	Can be hidden	Moderate, can be landscaped
Awareness? Does the device invite user participation & hence awareness/ commitment?	No	No	No	Yes

6.3.1 Aerated Wastewater Treatment Systems (AWTS)

Aerated wastewater treatment systems (AWTS) have become popular in recent years, and a range of proprietary systems is available on the market. AWTS's are small-scale package treatment plants that are conceptually similar to large-scale sewage treatment facilities. They typically produce an effluent which, with sufficient filtering, can be distributed straight into a subsurface dispersal system (i.e. partial secondary effluent quality with 20% nitrogen reduction).

AWTS's depend on steady-state microbiological conditions, reliable electrical supply and regular maintenance of mechanical and electronic components to sustain reliable treatment. Failure or a sustained interruption in any part of the system, e.g. as a result of power interruptions or when a tourist dwelling is unoccupied during the off-season, can lead to a definite health and environmental risk until sufficient microorganisms are once again restored to adequately treat the effluent. Furthermore, AWTS's require regular (quarterly) maintenance to ensure that adequate disinfection (via chlorination) is maintained if this is required by their NSW Health Accreditation. This is why Byron Shire Council will usually only approve sub-surface irrigation as the land application method connected to an AWTS.

The sometimes high up-front and quarterly monitoring and maintenance costs associated with AWTS must also be considered when choosing an AWTS. Maintenance requirements for AWTSs are detailed in Appendix G.

6.3.2 Sand Filters

Sand filters (or derivations using other media) are an alternative type of secondary treatment device popular in the Europe and North America. Sand filters are generally of two types: single-pass and recirculating. Sand filters work best when the effluent is spread in even, pulsed doses over the top of the sand-bed. This can be achieved under gravity using a dosing siphon if sufficient static head (fall) is available, or more commonly by electric pump. Adequate primary treatment and good filtering must be maintained to prevent too much carry over of suspended solids and consequent clogging of the upper layers of sand media.

A disadvantage of some single pass sand-filters is their poor nitrogen-removing performance (though good nitrifying capacity). This can be remedied either by deepening the filter to ensure an anaerobic zone or by recirculating a proportion of the highly nitrified sand-filter effluent back over the sand filter or into the carbon-rich septic tank for rapid denitrification (USEPA, 2003). Recirculating sand filters usually provide better N-removing capability and better overall treatment performance than single-pass sand filters. However they are more expensive and complicated to construct, and require additional pump power.

More detail on the design and performance of sand filters is provided in Appendix A. Operation and maintenance requirements for sand filters are provided in Appendix G.

6.3.3 Subsurface Flow Reed Beds (Constructed Wetlands)

Constructed wetlands, or reed-beds, comprise a constructed impermeable basin in which water or effluent is kept slightly below the surface of a gravel substrate which supports the growth of wetland plants (usually reeds but can also be shrubs or trees). The effluent is biologically treated as it moves slowly through the root zone of the wetland plants.

Reed-beds are an increasingly popular type of secondary treatment device due to their aesthetic appeal, their reliable treatment performance capacities once the reeds are fully established, and their somewhat lower construction costs and maintenance requirements compared to other options. They are also passive devices not necessarily reliant upon power or pumps, and therefore economical to operate in the long term.

Details of reed-bed design requirements are provided in Appendix A. Sizing options for secondary and partial-secondary quality effluents is incorporated into the OSMS Design Model. Operation and maintenance requirements for sand filters are provided in Appendix G

6.4. Tertiary Treatment

In domestic on-site sewage management, tertiary treatment is generally taken to mean disinfection of secondary-treated effluent, but it may also include additional secondary treatment, filtration, and/or nutrient removal.

6.4.1 Disinfection

There are a number of options for effective long-term disinfection for on-site systems. Chlorination is commonly used with AWTS's. Some systems use bromine, UV light or ozone to disinfect. For surface spray or dripper-under-mulch irrigation systems, the effluent *must* be disinfected after partial-secondary treatment. Subsurface irrigation requires partial-secondary or secondary treatment, but does not require disinfection. NSW Health regulations require that disinfection of AWTS effluent occurs in most cases, even for sub-surface applications.

6.5. Other Considerations

6.5.1 Maximisation of Effluent Take-up by Plants

Land application areas calculated by the OSMS Design Model or similar means should be considered minimum requirements only. Council encourages all applications to maximise re-use of effluent into the filtering matter of plants, and any alternative applications that achieve a higher re-use than is required to comply with these design Design Guidelines are encouraged. Those wishing to distribute effluent in a manner that best serves their garden, and still complies with Council and State guidelines, are welcome to submit plans for consideration by Council that will better meet this objective.

6.5.2 Phosphorus Removal

Land application areas located on sandy soils may need suitable soils to be imported into the land application area to aid in phosphorus removal. Filters specifically designed to remove phosphorus may be incorporated into secondary treatment devices (e.g. through the use of media with a high phosphorus-sorption capacity). The media in such systems will need to be replaced once it becomes saturated with phosphorus.

6.5.3 Wet-Weather Storage

The NSW guidelines (E&HPG, 1998) highlight the desirability of not irrigating effluent during wet-weather, as this may lead to occasional surcharging and contamination of run-off waters with effluent. Byron Shire Council agrees with this sentiment but believes that, for single domestic applications, the expense, difficulty and increased risks to householders of contacting the effluent often outweigh the potential health and environmental risks of effluent-contaminated run-off during very wet periods. These Design Guidelines do not therefore mandate that wet-weather effluent storage must occur in single domestic installations, but designers should consider wet-weather storage a useful potential tool for improving environmental security on highly constrained sites (e.g. flood-prone lands or those over shallow groundwaters).

6.5.4 Holding Tanks / Pump Wells

Many modern OSMS systems require pumping effluent to or from various components, and this generally necessitates either an internal or external pump well. Pump wells, also commonly referred to as holding tanks or collection wells, enable the storage of effluent until it reaches a pre-set level in the tank at which time a pump is activated and the accumulated effluent is pumped through to the next component or the land application system.

The sizing of pump wells shall be in accordance with the advice provided by NSW Health in their "Septic Tank and Collection Well Accreditation Guideline" (refer Section 1.4 for download address), and provide sufficient storage space for at least seven days accumulated effluent in case of pump failure or blockage. Smaller holding tanks are acceptable for dosing siphons which have no opportunity for mechanical break-down. Audio and/or visual alarms must be installed in a manner that will alert the homeowner to the presence of a high-level condition in the tank. Backflow prevention devices must also be installed where appropriate.

6.5.5 Component Overflows

If overflows occur, it is important that effluent is not contacted by residents but also that the overflow is visible and cannot be readily ignored for sustained periods. Council encourages the installation of appropriately sized emergency overflow trenches, provided that inlets from the component are not sub-surface connections.

6.5.6 Pit or Pan Toilets

Due to the risk these types of toilets pose to human health and the environment, simple pit or pan toilets are now required to be upgraded to more suitable toilets such as composting toilets with greywater treatment.

7. CHOOSING A LAND APPLICATION SYSTEM

Effluent quality plus site and soil-specific parameters largely determine the appropriate land application system for any given situation, but cost and maintenance requirements are also clearly relevant in making the necessary choices. The strengths and weaknesses of various land application systems are summarised in Tables 4.2B1 and 4.2B2 of AS/NZS1547 (2000), whilst a brief description of each option is provided in the following sections. **Greater detail of each land application system may be found in Appendix B, and maintenance requirements are provided in Appendix G.**

The sizing of the land application area may be calculated using the OSMS Design Model, as outlined in Appendix C. Reserve application areas, with equivalent characteristics to the primary field, shall be designated and set aside in all new applications. The reserve field may be required if the primary application field fails over time due to, for example, reductions in permeability caused by interactions with sodic effluent or the soil's capacity to absorb phosphorus becomes super-saturated.

7.1. Absorption Trenches

The traditional absorption trench is the archetypal "disposal-only" system. Because there is little opportunity for reuse or treatment through plant uptake and because it is difficult to distribute effluent evenly in a way that does not pollute in the long-term, traditional trenches are discouraged in new OSMS installations. Systems which rely on soil absorption as the principal mechanism, e.g. absorption trenches, generally do not comply with the requirements of these Design Guidelines or the NSW EHP Guidelines 1998 (p119).

On some highly constrained lots where insufficient space is available for any other form of land application, absorption trenches may be the only viable option for effluent dispersal. In these cases, Byron Shire Council would generally expect that absorption trenches be preceded by at least secondary treatment, and that all necessary efforts would be made to disperse effluent evenly over the entire length of the trenches (e.g. by pumping or intermittently dosing).

On highly permeable soils which are located a sufficient distance above the standing water table beneath, it may sometimes be acceptable to use a "discharge control trench", in which the trench beneath the distribution pipe is deepened and filled with washed sand (refer AS/NZS1547, 2000 for design details).

On other types of highly constrained site (e.g. where only very small land application area is available), it is sometimes appropriate to distribute effluent in "micro-trenches". These micro-trenches comprise narrow, shallow, gravel-filled trenches in which sub-surface irrigation pipes are installed. The advantages of micro-trenches is that by shallowly laying them along the contour and pumping the effluent into them, they can distribute effluent reliably, evenly and intermittently. Assuming that stormwater is adequately diverted, micro-trenches provide a good opportunity for reuse by plants and only a low risk of effluent surcharging during wet periods.

7.2. EvapoTranspiration/Absorption (ETA) Beds

EvapoTranspiration (ET) and EvapoTranspiration/Absorption (ETA) beds are wider and shallower than traditional absorption trenches, thereby providing a much greater opportunity for uptake by plants and reduced dependence on infiltration and soil assimilation capacities to treat the effluent. ET and ETA beds have a number of limitations, discussed in some detail in Appendix B3. Due to these limitations and their relatively high expense, ET and ETA beds are not encouraged in Byron Shire. If they are required to be installed, a great deal of care is required in their design and installation to ensure that effluent is spread evenly over the entire bed space.

Owners of ETA beds should maintain appropriate vegetation on the beds. Mowed grass is the preferred vegetation cover, although shrubs and trees can be planted suitable distances away from the edge of ETA beds (see Appendix B3 for details).

7.3. Sub-surface Drip Irrigation (SDI)

Sub-surface drip irrigation (SDI), also commonly referred to as sub-surface irrigation (SSI), is a good means of distributing treated effluent because it can distribute small, measured doses to evenly spaced centres in relatively undisturbed soil. This ensures a very reliable distribution available for rapid root uptake, and minimises the risk of the irrigation field becoming saturated during extended rainfall. Sub-surface irrigation is particularly appropriate where there are site or soil limitations or limitations, such as steep slopes, on heavy impermeable (often termed “puggy”) soils, and can even be used with care on highly permeable sandy soils.

Sub-surface irrigation systems must be designed and installed by suitably qualified persons, and must be flushed to remove sediment/slime at least once per year, and preferably quarterly, by a qualified professional as part of the maintenance requirements. Suitably located pressure-release valves and flush pits must be provided to allow this regular flushing maintenance without causing pollution.

There are a number of different types of proprietary SDI systems on the market. Council requires that all new installations use pressure-compensated emitters, and strongly prefers the use of non-drain varieties. Additional details regarding design and operation of subsurface irrigation systems is provided in Appendix B4, and operation and maintenance requirements are provided in Appendix G.

7.4. Spray Irrigation

Above-ground spray irrigation requires prior tertiary disinfection of sewage (NSW Health). Within the Byron Shire, spray irrigation of effluent is not favored due to public health risks from aerosol-transmitted pathogens and the particular need to add toxic substances (such as chlorine) to disinfect the effluent before above-ground release. There may be some circumstances (e.g. on larger agricultural holdings in which the proposed land application area is a considerable distance from any houses, where spray irrigation may be accepted.

Refer Appendix G for maintenance requirements.

7.5. Surface Dripper-Under-Mulch Irrigation

Byron Shire includes productive farming area where effluent reuse can be particularly beneficial. The irrigation of effluent by above-ground drippers in plantations may be appropriate in some rural and reafforestation applications. Surface dripper-under-mulch options may be considered for domestic situations in Byron Shire, but higher maintenance and monitoring conditions will be required to ensure that the mulch remains in place over the drippers and that casual access by children, vehicles and livestock is restricted by a vegetative border, fence or similar device. Disinfection of effluent is generally required. Refer Appendix G for other maintenance requirements.

7.6. Special Components Used in Land Application Areas

Besides the components described above and in Appendix B, there are a number of important auxiliary components which are generally found in land application systems:

7.6.1 **Indexing Valves**

Indexing valves allow for up to six (6) separate land application areas (beds or irrigation areas), to be used. The indexing valve will apply a set volume of effluent to the first application area after which the pump turns off and the valve automatically switches to the next application area where the process is repeated.

7.6.2 **Dosing Siphons**

Gravity-driven dosing siphons are becoming more popular in the North Coast region. These are unpowered devices that ensure effluent reaches the treatment or dispersal system in a periodic “slug” rather than a constant dribble, thus providing more even distribution and more successful treatment and/or dispersal of effluent. Siphons are generally located after the collection tank (grey or blackwater) and may be used to deliver effluent to sand-filters and/or ETA beds. They are recommended in sloping sites where a fall of over at least two meters exists between system elements (refer to product literature for more detailed advice).

8. CALCULATING THE LAND APPLICATION AREA

Once the site and soil assessment has been completed and an assessment made on what effluent treatment and dispersal options are available, the next step is to calculate the size of land application area that would be required for each option. This is often an iterative process, as greater treatment will enable the installation of a smaller application field and vice versa. Consultation with your plumber or other professionals may also assist in determining the most sustainable and cost-effective solution for your situation. In accordance with recommendations in EPHG (1998), reserve application fields are required for new systems.

A computer model is available from Byron Shire Council to calculate the area required for the land application area and to test the relative benefits of the various treatment systems, referred to herein as the Byron OSMS Design Model or more simply as the Design Model. Designers are welcome to submit designs based on any other model or rationale, provided that the calculations and parameters are sufficiently justified and are consistent with the principles and requirements set out in these Design Guidelines. The OSMS Design Model, which comprises a 3 megabyte file in a Microsoft Excel Workbook (in 3 spreadsheets) is available for free download on Council's website – www.byron.nsw.gov.au, or for a cost-recovery fee on CD-Rom from Council's offices in Mullumbimby. The model's theory and operation are described in Appendix C - User Manual for Byron OSMS Design Model. Designers will also soon be able to apply to Council for a copy of a more comprehensive document which describes how the Design Model works and how default parameters have been derived.

In essence, Byron Shire Council's philosophy for land applications areas is to make them big enough to ensure that the treated effluent will have sufficient opportunity for plants within the area to take up all of the water and all of the nutrients applied. Council's OSMS Design Model deliberately includes some risk-based allowances for nitrogen, for example increasing the required land area where systems are built close to creeks and reducing the required land area where systems are built on very large blocks in which the vegetated areas around the land application area can be safely assumed to take up any excess nitrogen before it reaches the property boundary (refer Appendix C). Phosphorus tends to be adsorbed to clay particles and is therefore much less mobile, and so the philosophy with this nutrient is to calculate the capacity of the soils with the land application area to adsorb phosphorus over 50 years, minus that expected to be taken up by plants (refer Appendix C).

The land application areas calculated using these Design Guidelines and the Byron OSMS Design model assume that the site is not significantly constrained (refer Section 5). Where OSMSs are to be installed on blocks which are constrained by one or more factors(refer Section 5), ameliorative actions such as providing additional treatment or larger land application areas are likely to be required (refer Tables 6 and 7).

Note that very high treatment levels can in some circumstances enable the OSMS Design model to allow very small land application areas. To ensure that enough area is allocated to safely disperse the treated effluent without leading to periodic super-saturation, a minimum area of 15 m^2/bedroom (10 m^2/person) must be allocated for greywater–only systems and 22.5 m^2/bedroom (15 m^2/person) must be allocated for systems treating combined effluents including blackwater. Note that these minimum land application areas are based on the assumption that the site has suitable soils (light clays), that the black-water effluents are treated to at least partial-secondary standard, and that no constraints apply to the site. If these conditions are not met, a larger land application area will be required to provide an equivalent level of environmental security.

If using Council's Design Model, the input worksheet, output (Council Report) worksheet and the Design Model worksheet must all be submitted with the application. The model's input parameters should all be determined from the evaluation carried out by the designer for that specific application, and should all be justified in the accompanying report.

The OSMS Design Model will not allow operation for Soil Category 6 (Medium to Heavy Clays, or dispersive or shrink-swell soils). To calculate the effluent dispersal area in this situation it will generally be necessary to provide secondary treatment of effluent and to ameliorate soil conditions if they are dispersive, then to apply the computer model as though the site had a weakly structured Light Clay soil with DLR value of 5mm/day.

OSMS designers must be aware that computers models will not do all the thinking for the them; professional judgment must be used at all times. For example, a system designer needs to think whether the quality of the effluent is suitable for a given land application system, regardless of the area which the model calculates to be suitable.

9. DETAILS REQUIRED IN OSMS DESIGN REPORTS

Once all of the necessary investigations, site/soil assessments, and design calculations have been completed, the information must be compiled into a detailed OSMS Design Report. Two (2) copies of the report to must be submitted to Council as part of the Application to Install or Alter a Sewage Management Facility. The report will need to be submitted with a "Section 68" form available from Byron Shire Council. Assessment and inspection fees will be payable for new or previously unassessed systems, but fee exemptions currently apply where an upgrade is being proposed to an existing, approved OSMS without being tied to an upgrade or extension to the house.

The details required in all consultants OSMS reports supporting an application to Council are as follows:

- *Proposed system*: A summary of the proposed system components is to be presented in the report on or near the first page so that the type and size of system to be installed is clear to Council officers, owners and installers.
- *Number of residents:* This is calculated to be the number of bedrooms times 1.5, unless the actual number of people residing in the dwelling is greater, in which case the number of expected residents should be used (refer Section 2.3).
- *Site Specific Information:* Reports are to be specific, succinct and with information relevant to the site under review. Justification of the type and sizing of system nominated is to be clearly set out in the report. Reports must state the date/s that site inspections were conducted and who conducted them (with qualifications if relevant).
- *Site Limitations:* Reports are to accurately indicate the distances of dry gullies, watercourses or any other environmental features in relation to the land application area. Should a proposed system need to be located within the relevant buffer distance (Section 5.1.1;) or should a site be determined to possess environmental limitations, upfront acknowledgement of the limitation and explanation of how it is proposed for the limitation to be managed is to be reported (e.g. by maximising the distance from waterways, improving treatment such as with a reed bed, sand filter, AWTS, etc, or increasing the size of the proposed application area). It is unacceptable for important relevant issues to be dealt with implicitly or to not be commented upon.
- *Owner's Acknowledgement:* Effluent management reports are to include a statement by the owner that they are aware of the type of system being nominated in the report and of the maintenance schedule required to be carried out for the nominated system. Reports without acknowledgement by the owner that they understand what is being proposed and are willing to commit to the recommended maintenance schedule will be rejected.
- *Irrigation Design Reports:*
  - Irrigation design is a specialised field. Should subsurface irrigation be nominated as the proposed land application system it may be appropriate to have the detailed irrigation design performed by a specialist other than the one performing the soil and site evaluation. For this reason, it is permissible to provide a conceptual plan of the application field, clearly stating the size, type and approximate layout of the proposed irrigation system, with the Design Report. If Council approves the proposed system, a detailed irrigation design in accordance with the relevant Approved Drawing will need to be submitted for approval prior to application for a Permit to begin the installation. Alternately, the detailed irrigation design may be submitted with the Design Report to save processing time.
  - All detailed irrigation designs are to be produced by a person with suitable experience in irrigation design.
  - Irrigation designs submitted to Council are to include the information set out in the Irrigation Design Check List (Appendix F).

- *Site Plans*: All reports are to include two site plans as follows:

  1) a small scale contoured location plan extending to surrounding areas; and

  2) a larger scaled plan showing the location of the following components;

     - the proposed sewage treatment components
     - pegged out effluent application areas including soil analysis bore locations;
     - water supply wells and bores;
     - driveways, buildings and facilities;
     - environmentally sensitive areas including permanent or seasonal waterways;
     - major landforms around the site, including steep and flat areas, built and natural bunds, berms, drains or gullies that might divert run-off onto or around effluent application areas;
     - buffers surrounding the effluent application areas.

- *Layout of land application area:* This may be either a detailed plan or, if stated in the application, a conceptual diagram with a detailed design to be provided and approved before installation commences.

- *Full specifications and engineering details of proposed Treatment System(s):* Details of the chosen systems along with justification for the choice and proposed sizings of system components. Where relevant, calculations used in the design shall be submitted to allow Council to assess all individual components of the sewage management system including construction, installation, operation and maintenance.

- *Printout of all calculations and input parameters used to calculate land application area and OSMS component sizings.* If using Council's OSMS Design Model, the input worksheet, output (Council Report) worksheet and the Design Model worksheet must all be submitted with the application. Justification must be provided if any non-default values have been used as inputs to the model.

- *Completed site and soil assessment forms shall be appended.*

- *Plans of management, designed to be extracted from report and kept in a logical location for easy future reference by the resident/home owner.* A pro-forma for household OSMS management plans is provided as Appendix G. Council recommends that this pro-forma be used as a basis by the system designer to prepare an individualised management plan for each system. Management plans shall include operation, maintenance and service requirements of all components of the proposed sewage management system. This information must be specific to the particular system proposed, and provide all necessary instructions for the occupier/owner or service personnel to manage the system properly, including an emergency action plan in the event of a breakdown. Generic reports irrelevant to the site or type of system installed will be rejected.

  A clear maintenance schedule shall be included in the Management Plan, stipulating the type of system and its components including treatment device and land application area the system. Responsibilities for undertaking inspection and maintenance tasks (i.e. owner or servicing agent), and specific time frames or conditions for servicing the various components must be provided.

  Where possible, component manufacturers and the service agents who will be responsible for maintenance of the system must also be nominated, along with contact details.

  It will be a condition of approval that the completed management plan shall be stored and/or displayed in an appropriate place for the benefit of current and future occupiers, owners and service personnel. A final inspection will not be granted unless the service schedule is displayed, and applications which do not provide management plans will be rejected.

10. INSTALLERS REQUIREMENTS

Once Council Approval for the system design has been granted, licensed installers shall ensure that they have been provided with both the Council-stamped design plans and a copy of Council's Conditions of Approval, and then follow the procedure set out below to begin the installation process. Installers of irrigation systems are required to have a current trade certificate in plumbing, drainage or related trade or discipline.

- *Drainage Permit:* All plumbers are required to obtain a drainage permit from Council prior to commencement of work on site. Inspections will not be carried out unless the plumber has obtained a drainage permit from Council. In order for a drainage permit to be issued by Council, an approval to install the system must have been finalised with Council and a detailed irrigation design will need to have already been submitted and approved.

- *Irrigation Installations*: Irrigation systems are to be installed by a qualified tradesman or a professional with suitable experience in irrigation installation.

- *Maintenance Reports:* All on-site sewage management systems require regular maintenance by the home-owner and periodically also by service providers in order to ensure that the system operates reliably. Most AWTSs and sub-surface drip irrigation systems require quarterly maintenance by appropriately experienced service providers, and most other systems require an annual service by a similar provider (refer to Council's Conditions of Approval for detailed requirements).

  It will be a requirement of all Approvals to Operate that a form similar to those provided in Appendices E (for Treatment System Service Form) and/or F (Irrigation System Service Form) is to be submitted to Council within 7 days of servicing the system or component.

- *Inspections*: Land application areas are to be planted out in accordance with the approval and/or effluent report prior to occupation of the dwelling (suitable plants for effluent application fields are provided as Appendix D). Permission to occupy will be generally refused should the nominated land application area and planting schedule not be completed.

  Inspections of external drainage lines and the whole effluent dispersal system can only be carried out by Council Officers. Private certifiers or designers do not have authority to inspect any aspect of on-site sewage installations or drainage.

  It is a requirement that the installer contacts Council prior to back-filling any sub-surface installation so that the system can be inspected and tested.

  It is necessary to provide a minimum of 48 hours' notice for a Council inspection.

  Consultant's reports and Council Approvals indicating that land application areas on a specific site are to include the application of lime, loam, gypsum, sand dosing or similar are to be complied with. Certification of such activities shall be provided by the plumber/installer and submitted to Council. Final inspection will not be approved until such certification is submitted to Council.

  Failure to obtain an inspection in accordance with an Approval by Council is an Offence under the Local Government Act 1993. Persons breaching this legislation are liable to prosecution or infringement notices which will result in a monetary penalty.

- Variations: Council expects systems to be installed in strict accordance with the plans which it has approved. If it becomes necessary for any reason to substantially alter the design or configuration of the treatment and/or land application systems, a s96 (for systems approved as part of the D.A.)

or s106 (for systems approved under s68 of Local Government Act) application will need to be sought and approved **before** proceeding with the amended installation. Where the necessary amendments are of a very small or insubstantial nature (check with Council if unsure), it is permissible to install the altered system provided that a “Works as Executed” diagram is provided within two weeks of the installation. The Works as Executed diagram must clearly show the size of all OSMS components and their position relative to major features (e.g. house, driveway and/or waterways).

11. GLOSSARY AND ACRONYMS

Absorption: absorption and/or uptake of effluent into soil by gravity and capillary action.

Absorption area/trench/bed: a land application system which uses soil absorption and gravity to distribute and dispose of effluent.

Adsorption: physical or chemical attachment of substances to the surface of soil particles.

Aerobic/Anaerobic: In the presence/absence of oxygen. Biological break-down occurs by different micro-organisms adapted to the aerobic or anaerobic conditions.

Aerated Wastewater Treatment System (AWTS): an oxygenated sewage treatment process typically involving: settling of solids and flotation of scum; oxidation and consumption of organic matter through aeration; clarification - secondary settling of solids, and disinfection of wastewater before irrigation.

Batch System: a composting toilet system involving two or more alternating chambers, and in which compost is produced in batches.

Bedroom:: In Byron Shire, the calculations for number of persons for which an OSMS is expected to cater for is 1.5 per bedroom. For the purposes of these Design Guidelines, a "bedroom" is a room in a house which is specified on the Council-approved plans as being one built for the purposes of sleeping within it.

Best Management Practice: practices currently employed and recommended by government and industry as preferred and affordable approaches. In domestic on-site sewage management, current best management practice generally includes partial-secondary treatment and broadly dispersed application of effluent to soils in the root zone.

Biochemical Oxygen Demand (BOD): the amount of oxygen required for the biological decomposition of organic matter, usually measured over a period of 5 days (BOD_5).

Blackwater: human excreta and water grossly contaminated with human excreta, for example toilet wastewater.

Boulder: a rock with middle dimension greater than 600mm.

Compost Toilet: a treatment unit which breaks down faeces and organic material into a compost like material through the action of micro-organisms and invertebrates. See AS/NZS1547, 2000.

Constructed wetland: also known as **Reed Beds**, these comprise a constructed basin in which water or effluent is kept at or near the surface of the gravel substrate. The effluent is treated as it moves slowly through the root zone of densely planted water-plants (usually reeds).

Crop factor: a value utilised in water balance modeling to estimate variations in evapotranspiration due to crop type, seasonal conditions and age of crop.

Design Loading Rate: the rate at which effluent is to be applied, based on the Long Term Acceptance Rate (LTAR) (see definition below), reduced by a factor of safety.

Dispersive soil: a soil that tends to disperse and erode, especially in presence of high-sodicity effluent.

Durable aggregate: aggregate, metal or stones which are graded to AS 2758.1 for single size coarse aggregate for nominal sizes, usually ranging from 20mm to 50mm,

Effluent filter: a device placed in the outlet of septic or greywater tanks to prevent or reduce solids entering the effluent dispersal area or next treatment step. Effluent filters are not considered "partial-secondary treatment" and do not provide secondary treatment (defined below).

Effluent: Liquid which has passed through a treatment system.

Evaporation: the transfer of water from a liquid to a gas

Evapotranspiration: natural process transfers water from soil by evaporation and from plants by transpiration

Evapotranspiration/absorption (ETA) bed: a specially prepared bed or area which promotes evaporation, transpiration and absorption of effluent.

Faecal Coliforms: a type of bacteria that live only in the gut of warm-blooded animals. Can be detected in the general environment if that environment is contaminated with mammalian excreta, and therefore can act as an indicator of recent faecal contamination, possibly by humans.

Geotextile: a water-permeable fabric used mainly to retain and stabilise soils. Care must be taken to ensure that suitable geotextile spacing sizes and thickness are selected for the particular task.

Greywater: the component of domestic sewage which excludes toilet and urinal wastes.

Groundwater: the body of water held in the soil and rock pores; includes water above (unsaturated conditions) and below (saturated conditions) the water table and seepage from springs etc.

Indexing Valve: a device (also called a **K-rain valve**) which allows for up to 6 separate land application areas to irrigated in sequence.

Irrigation Systems: pressurised effluent dispersal systems, such as proprietary Wasteflow or Netafim, which deliver treated effluent to the sub-surface (typically 100 mm depth) of the application area via valves, pipes and emitters.

Infiltration: the downward passage of water into the soil.

Land Application Area: the land area over which treated sewage is applied

Long Term Acceptance Rate (LTAR): the average sustainable rate effluent can be absorbed over the long term into a particular soil, expressed in litres per square metre per day. This rate is influenced by effluent water quality, method of dosing, the soil permeability and by the slime layer which builds up at the interface with the receiving soil.

Nutrients: chemical elements that are essential for sustained plant or animal growth. The major nutrients essential for plant growth are nitrogen, phosphorus and potassium; in excess, nitrogen and phosphorus are potentially serious pollutants encouraging nuisance growths of algae and aquatic plants in waters and (in the case of nitrate) posing a direct human health risk.

On-site sewage management system (OSMS): includes all types of human waste storage and treatment facilities, e.g. septic tanks, cesspits, compost toilets, urinals. Also includes the wastewater application (dispersal) area, e.g. absorption trenches, irrigation fields.

OSMS Design Model: a computer model based on a Microsoft Excel workbook which can be used to estimate appropriate sizings for land application areas and reed-beds.

Pan Evaporation: the loss of water by evaporation measured in a "Class A" pan. The nearest weather station collecting Pan Evaporation data is at Alstonville.

Partial-Secondary Treatment: Post-primary treatment not necessarily designed to achieve secondary treatment quality (see below) is more generally referred to in these Design Guidelines as partial-secondary treatment. In Byron Shire, partial-secondary treatment methods must be able to demonstrate that they can reduce contained nitrogen by at least 20% to be acceptable for blackwater-inclusive systems. Designers should also note that an ability to provide partial-secondary treatment does not necessarily mean that these effluents will be suitable for all forms of irrigation without further filtration, and an irrigation specialist should be consulted.

Pathogens: micro-organisms that may potentially cause disease or sickness. These include, but are not limited to bacteria, protozoa and viruses.

Percolation: a general term describing the downward rate of water movement through a soil or through a biological mat within an effluent dispersal system.

Permeability: a calculated value derived from the rate at which a head of liquid is absorbed into soil, usually measured in m/d as Saturated Hydraulic Conductivity (K_{sat}).

Primary Treatment: In on-site sewage management, primary treatment is taken to mean the initial reduction of suspended solids and organic matter from the household by means of settlement, anaerobic digestion and/or floatation in septic tanks or the primary settling chambers of AWTS.

Reed-beds: see Constructed Wetlands

Run-on: surface water flowing on to an irrigation area because of run-off occurring higher up the slope.

Scum**:** the floating material which accumulates above the more liquid layer in a septic tank or other primary treatment device. Scum-forming material includes oils, grease, soaps and plastics.

Secondary Treatment: For the purposes of these Design Guidelines, the term "secondary treatment" applies to systems which can produce effluents containing no more than:

- 20mg/L BOD
- 30mg/L Total Suspended Solids
- 30 mg/L Nitrogen
- 10 mg/L Phosphorus

Septage: The semi-liquid material that is pumped out of septic (or interceptor) tanks, consisting of liquid, scum, and sludge.

Septic Tank: effluent storage container in which primary treatment of household effluent occurs under anaerobic conditions. Septic-tank treatment process comprise sedimentation of settleable solids, flotation of oils and fats and anaerobic digestion of sludge.

Sewage: Untreated or partially treated human wastes generated from toilets, baths, sinks, lavatories, laundries, and other plumbing fixtures in places of human habitation, employment, or recreation.

Sewage management facility: a human waste storage facility, or a waste treatment device intended to process sewage, including a drain connected to such a facility or device.

Sewerage: The network of collection drains carrying domestic wastewater or effluent away from properties for off-site treatment.

Sewerage work: for the purposes of Council approvals, sewerage works include the construction, alteration, extension, disconnection, removal, ventilation, flushing or cleansing of any sewerage service pipes or fittings or fixtures communicating or intended to communicate, directly or indirectly, with Council's sewerage system

Single Households: these Design Guidelines apply to single households, which is defined here as the domestic residence of a single family or small group of people (<10 persons).

Sludge: mainly organic semi-solid product produced by wastewater treatment processes

Sub-surface Irrigation: pressurised effluent dispersal system. Irrigation lines are buried 100mm below the ground surface and effluent is emitted slowly and widely.

Sullage: another term for greywater (see definition above)

Tertiary treatment:. For the purpose of these Design Guidelines, tertiary treatment involves disinfection of secondary treated effluent, but may also include further post-secondary treatment, filtration, and nutrient removal.

Transpiration: the transfer of water to the atmosphere through plants.

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