Clarence Valley Council

Technical Support Document for OSMS Number 3 – Design Guidelines for consultants

Contents

Design Guidelines for a Wastewater Consultant

This Support Document provides details on;

- Section 1 - Design Steps for an OSSM Report
- Section 2 – Site and Soil Evaluation Procedures
- Section 3 - Overcoming Site Constraints
- Section 4 - Choosing a treatment System
- Section 5 - Choosing a Land Application System
- Section 6 - Calculating the Land Application Area
- Section 7 - Details to be provided in OSSM Reports
- Section 8 - Summary of Land Application and Effluent Treatment Systems

Please note this support document has been provided by Lismore and Byron Council's and has been adapted to Clarence Valley Council's specific requirements. Lismore and Byron Bay Council's are gratefully acknowledged for their assistance providing this information.

Section 1 - Design Steps for an OSSM Report

A number of steps are involved in successfully designing an OSMS. 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.

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

Step	Task
1	Undertake desktop research
2	Identify wastewater sources and water utilising devices, and estimate hydraulic loads
3	Conduct detailed site and soil assessment to identify potential limitations of the site and soil for accepting effluent
4	Identify suitable treatment and land application options and consult with client to determine preferred options
5	Design treatment system
6	Determine the most suitable method of land application system and calculate the size of the land application area.
7	Measure the proposed land application area. Compile a diagram showing layout of proposed land application area
8	Compile the above information in a detailed design report, including preparation of OSMS Management Plan for homeowners
9	Submit 2 copies of the report to Council for approval with the septic tank application.

Desktop Research

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

Estimating Wastewater Generation

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. <u>In Clarence Valley Council, this is calculated on the basis of the number of bedrooms multiplied by 1.5 persons per bedroom,</u> 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 *AS/NZS1547(2012)* 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. 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 *AS/NZS1547(2012)*.

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.

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. 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 this Strategy 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.

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.

Some types of pathogens, e.g. viruses and helminths, are able to survive outside the body for months. 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.

Section 2 - 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 this appendix all the relevant and necessary information that professional assessors are required to understand.

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.

Site Evaluation Procedures

Most of the following information is drawn from the Australian Standard *AS/NZS1547(2012)*. The information below will help you evaluate your site's capacity to manage on-site sewage.

Slope Angle (Refer also *AS/NZS1547(2012)*)

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.

Slope shape

The shape of the slope may either assist or hinder drainage. 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 *AS/NZS1547(2012)* for more detailed diagrams of the various types of slope shape and their implications for OSMS.

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(2012)* for further advice.

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. A water balance model based on Alstonville climate records (for pan evaporation data), 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(2012)* for further advice.

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(2012)*)

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.

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. Amelioration measures should be considered to compensate for the constraint.

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).
Council accepts that the following buffer distances cannot always be met.

Recommended buffer distances for various systems are shown below. The values given are a minimum based on ideal site and soil conditions. If these conditions are less than ideal, the minimum buffer distances should be increased.

System	Recommended Buffer Distances
All land application systems	100 metres to permanent surface waters (e.g. river, streams, lakes etc) 250 metres to domestic groundwater well 40 metres to other waters (e.g. farm dams, intermittent waterways and drainage channels, etc)
Surface spray irrigation	6 metres if area up-gradient and 3 metres if area down-gradient of driveways and property boundaries 15 metres to dwellings 3 metres to paths and walkways 6 metres to swimming pools
Surface drip and trickle irrigation	6 metres if area up-gradient and 3 metres if area down-gradient of swimming pools, property boundaries, driveways and buildings
Subsurface irrigation	6 metres if area up-gradient and 3 metres if area down-gradient of swimming pools, property boundaries, driveways and buildings
Absorption system	12 metres if area up-gradient and 6 metres if area down-gradient of property boundary 6 metres if area up-gradient and 3 metres if area down-gradient of swimming pools, driveways and buildings

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. Where it is proposed to place the treatment system or land application area within 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 and proposed amelioration measures to be taken to reduce health and environmental risks in the reduced buffers.

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(2012)*). 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.

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.

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 channelled (concentrated) runoff on site, as well as any runoff likely to move onto neighbouring properties, should be noted on the site plan (refer also *AS/NZS1547(2012)*) and avoided in the siting of the Land Application Area.

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.

Surface Condition

Note cracks, hardness, previous compaction patterns, dampness and the location of seepage areas (refer also *AS/NZS1547(2012)*).

Fill

The location, depth and type of any fill should be noted on the site plan, as shown in *AS/NZS1547(2012)*). 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.

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(2012)*). 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.

Soil Evaluation

The relevant soil properties of each proposed land application area should be investigated and assessed in accordance with *AS/NZS1547(2012)* and this strategy 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 *AS/NZS1547(2012)*. 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 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.

An indication of the broad soil category of a site can be obtained (where available) from *Soil Landscapes of the Woodburn 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.

Soil Texture Classification

Soil texture may be measured by the behaviour 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 behaviour 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; Gravels and Sands, Sandy Loams, Loams, Clay Loams and Light Clays. Each texture group and any change in texture group within the soil profile should be recorded.

AS/NZS1547(2012) provides TABLE E1 ASSESSMENT OF SOIL TEXTURES in Appendix E to assist in determining the soil texture category.

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 E4 STRUCTURE from *AS/NZS1547(2012)* summarises the common soil structures into five categories; Massive, Single Grained, Weak, Moderate and Strong.

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 G of *AS/NZS1547(2012)*. Alternatively, *AS/NZS1547(2012)* provides indicative permeabilities based on textural and structural soil characteristics (refer Appendix L, M and N *AS/NZS1547(2012)*).

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.

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.

TABLE E2 ABUNDANCE OF COARSE FRAGMENTS and TABLE E3 SIZE OF COARSE FRAGMENTS from *AS/NZS1547(2012)* provides a summary of Size and Abundance of Coarse Fragments.

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.

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.

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 mS/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 behaviour 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 E1 *AS/NZS1547(2012)* 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.

Section 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.
TABLE A1 EXAMPLES OF DESIGN RISK REDUCTION MEASURES from *AS/NZS1547(2012)* demonstrates some common site and soil constraints, and the measures which might be employed to overcome them or ameliorate their effects.

Section 4 - 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 in Section 8 of this Technical Support Document.

Designers and prospective owners should be aware that each system will require some monitoring and maintenance. 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.

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 Section 8 of this Technical Support Document.

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.

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. Additional information regarding the function, sizing and management of septic tanks is provided in Section 8 of this document.

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. <u>NSW Health requires that greywater be disposed of below ground level unless it has been adequately disinfected</u>.

Greywater must be collected in an in-ground sullage tank (sized in accordance with NSW Health requirements, refer Section 8 of this appendix), 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, but it should be understood that this is likely to reduce the operational life of the land application system. 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 a nutrient and hydraulic capacity of the land application system or Clarence Valley Council's OSMS Design Model.

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.

Secondary Treatment

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

- 20mg/L BOD
- 30mg/L Total Suspended Solids

This additional information is offered for an additional guidance.

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.

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.

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.

The sometimes high up-front and quarterly monitoring and maintenance costs associated with AWTS must also be considered when choosing an AWTS.

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.

Reed beds are usually required to be constructed from solid moulds such as plastic tanks or concrete troughs, Concrete is preferred.
Details of reed-bed design requirements are provided in Section 8 of this report.

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.

Section 5 - 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 APPENDIX K *AS/NZS1547(2012),* whilst a brief description of each option is provided in the following sections. *Greater detail of each land application system may be found in Section 8 of this document.*

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 unless they are on large lots with a suitable soil away from any constraints.

EvapoTranspiration Absorption (ETA) Beds

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. 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.

Mound Systems

Mounded systems are effluent dispersal devices constructed above the land-surface from imported fill material, usually sand capped with soil. These raised beds are used in situations where drainage of the natural soil is a problem, or where the underlying groundwater seasonally reaches a height of less than 1.2 m below ground level, or areas where flooding occurs periodically. Water dispersal is by evapotranspiration and some soil absorption. Denitrification can be achieved within mounded land-application systems by using intermittent loading.

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.

CVC requires that Sub-surface irrigation systems must be designed and/or certified, installed and maintained by CID (Certified Irrigation Designer) or suitably qualified persons.

Surface Spray / Dripper-Under-Mulch Irrigation

In spray irrigation systems, disinfected, secondary treated, accredited treatment systems disperse effluent over the land application area by sprinklers.
Spray irrigation can be environmentally insecure under wet climatic conditions. There are also health risks associated with spray irrigation due to the potential for contact of effluent with humans, animals and vegetation for consumption. Therefore spray irrigation is required to meet a number of requirements set out in Section 8.

Surface dripper-under-mulch options may be considered under similar circumstances to spray irrigation, but added maintenance and monitoring conditions will be required to ensure that the mulch remains in place over the drippers. Drippers-under-mulch share the same environmental and health concerns as spray irrigation and further details can be found in Section 8.

Special Components Used in Land Application Areas

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

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.

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) to deliver effluent to ETA beds. They are recommended in sloping sites where a fall of over at least 1 meter exists between system elements.

Other Considerations

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.

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. Clarence Valley 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

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).

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 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.

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.

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.

Section 6 – 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 where there are constraints on a lot.

In essence, Clarence Valley 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.

Where OSMSs are to be installed on blocks which are constrained by one or more factors, ameliorative actions such as providing additional treatment or larger land application areas are likely to be required.

Designers are to size disposal area taking into account water and nutrient balances. Clarence Valley Council recommends designs which have used the Clarence Valley Council Computer Design Model.

If using the Design Model, the input 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.

OSMS designers must be aware that computers models will not do all the thinking for 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.

If a designer is not using a model and calculating nutrient balances the consultant must justify all figures used in the calculations.

Section 7 - 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 Clarence Valley Council. Assessment and inspection fees will be payable.

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.

- *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 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.

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

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

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

- o the proposed sewage treatment components
- o effluent application areas including soil analysis bore locations;
- o water supply wells and bores;
- o driveways, buildings and facilities;
- o environmentally sensitive areas including permanent or seasonal waterways;
- o 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;
- o buffers surrounding the effluent application areas.

S *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.

S *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.

S *Printout of all calculations and input parameters used to calculate land application area and OSMS component sizings.* If using the OSMS Design Model, the input 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.

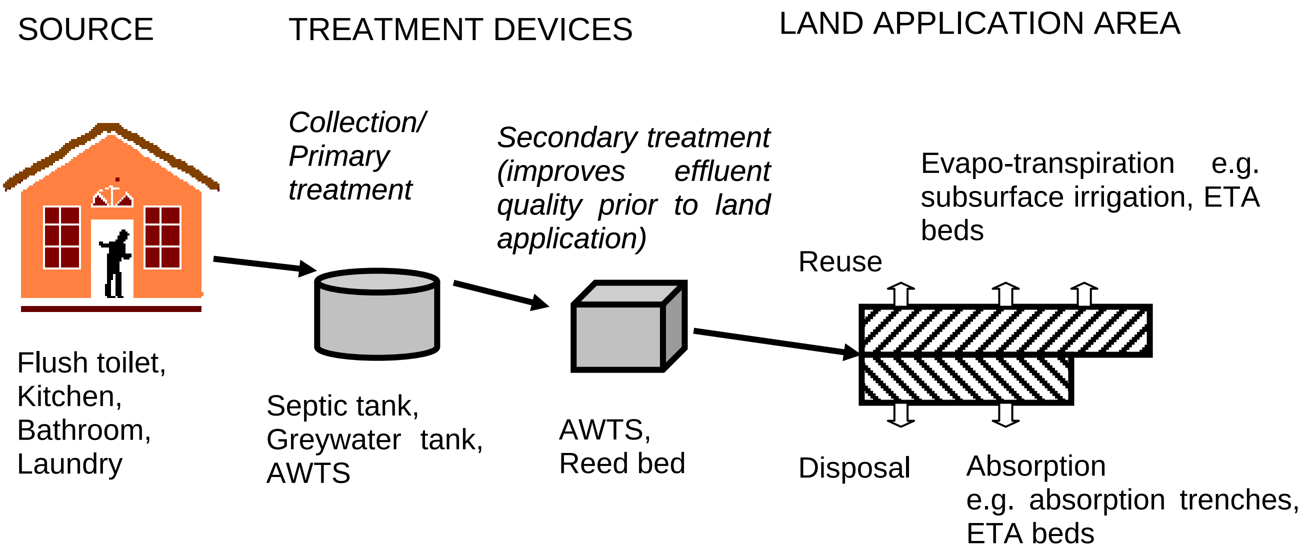
S Completed site and soil assessment forms shall be appended.

S *Plans of management kept in a logical location for easy future reference by the resident/home owner.* Council recommends that the system designer should 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.

Section 8 – Summary of Effluent Treatment and Land Application Systems

(Note Technical Support Document Number 4 – "Example Standard Designs" should also be consulted for specific Design information for treatment and disposal systems)

An on-site sewage management system 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.



<u>Figure 1:</u> Major Components of On-Site Sewage Management Systems (OSMSs)

There are a number of different treatment systems available in the North Coast area and the performance of these can vary due to climatic conditions, population characteristics, loading cycles, human dietary habits, and influent quality. Only the main options are discussed in the following sections, but designers are encouraged to monitor and take advantage of innovative technologies as they emerge.

The following design constants are applicable to all treatment systems:

- Adequate access must be kept available to safely maintain the system.
- A means of monitoring the vital elements of each treatment component must be provided.
- If overflow occurs from any component, the predicted overflow points must be visible and in as safe a position as possible to reduce or eliminate casual contact.

Effluent Treatment Options

Septic & Sullage (Greywater) Tanks

The septic tank used for single houses is a small anaerobic settlement and digestion plant, which reduces suspended solids from the wastewater and breaks them down to smaller particles. The resultant effluent is lower in settled solids but still high in biological oxygen demand (BOD), nutrients and pathogens. Septic tank effluent requires further biological treatment before release to the environment. Modern septic tanks have been greatly improved by the installation of at least one internal buffer to reduce solids carry-over (Figure A1), by ensuring that the tanks are large enough to provide sufficient opportunity for settlement of solids, and making the tanks water-tight.

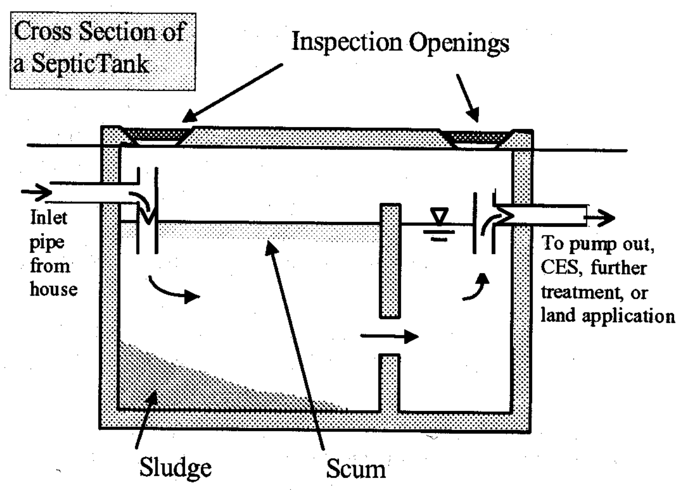


Figure A1: Cross-section of a typical septic tank

When the effluent from the house reaches the septic tank, most solids settle to the bottom (commonly termed "sludge") whilst most fats, oils and greases float to form a crust at the top, and the middle zone is occupied by effluent which has a chance to settle before overflowing to the secondary treatment system.

The addition of enzymes or other proprietary additives may sometimes have short-term benefits in reducing smells and blockages, but are not strongly encouraged because they can increase solids carry-over and should not be relied on to maintain functionality of the tank. On the other hand, the addition of proprietary bacteria supplements is permitted and encouraged. These proprietary bacteria can assist by reducing the amount of sludge build-up and therefore increasing the time between the pumping out of the tank, and by reducing the smell of the tank.

Induct vents are no longer considered desirable on septic tanks due to these structures allowing flies and mosquitoes to breed in the tank (E&HP Guidelines, 1998). For larger septic tank size (>3000L), grease traps are no longer required. Smaller grease traps are not recommended as they need to be maintained often and have sometimes been found to be too small to trap grease effectively. Kitchen wastewaters can be connected directly into an appropriately sized septic tank with a baffle installed (E&HP Guidelines, 1998). Where it is absolutely necessary for some reason to use a smaller septic tank, consideration should be given to installation of a suitably sized grease trap.

The Australian Standard for septic tanks is AS1546 (1998). All septic tanks need to be manufactured in accordance with this standard, and have an appropriate AS Standards Mark. While alternate tank shapes are mentioned in the standard, in the Tweed-Richmond and Clarence Valley region the only types widely available “off the shelf” are cylindrical tanks. Cast-in-situ tanks are specified in Section 7 of AS1546. The NSW Health Department Register certifies manufacturers of the septic tanks and collection wells.

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”. Septic tank sizes are nominated for domestic flows of up to 14,000 L per week or daily flows of 2000 L. The serviceable life of the tank is stated as 15 years. The suggested minimum tank sizes (unless NSW Health Guidelines mandate larger tank) are set out in APPENDIX J *AS/NZS1547(2012)* . If the correct size of tank is not available locally, Council requires that the next largest available tank be installed.

The location of the septic tank must be at a greater distance than 1.5m from any building, and the base of the tank must not be within 45^0 (angle of repose) from the base of any footing or foundation. Allowances must also be made for easy access to the tank in order for the pumping contractor to get a truck near the septic tank so that the contents of the tank can be periodically pumped out (desludging the tank).

Septic tanks do not substantially reduce nitrogen, and the OSMS Design Model does not therefore allocate any nitrogen reduction in its calculations for septic–only systems. In all but greywater-only systems, partial-secondary treatment will usually be required after primary treatment in septic tanks.

Effluent (Outlet) Filters

An effluent filter is a simple plastic filter which is fitted into the outlet of the septic tank. Effluent filters are used to reduce the potential “carry over” of suspended solids. This will improve the efficiency and longevity of the land application system or secondary treatment device. It should be noted that an effluent filter does not provide partial-secondary treatment of the effluent.

It is recommended that the effluent filter should be of a robust type and preferably fitted to the outside of the tank so that owners do not have to place their hands in the tank, and for ease of maintenance. One means of doing this is by fitting a “U” trap on the outlet, another is to install a type of filter that can be cleaned by jetting water through it whilst still in place using a suitable hose attachment (i.e. a hose “wand”).

Aerated Wastewater Treatment Systems (AWTSs)

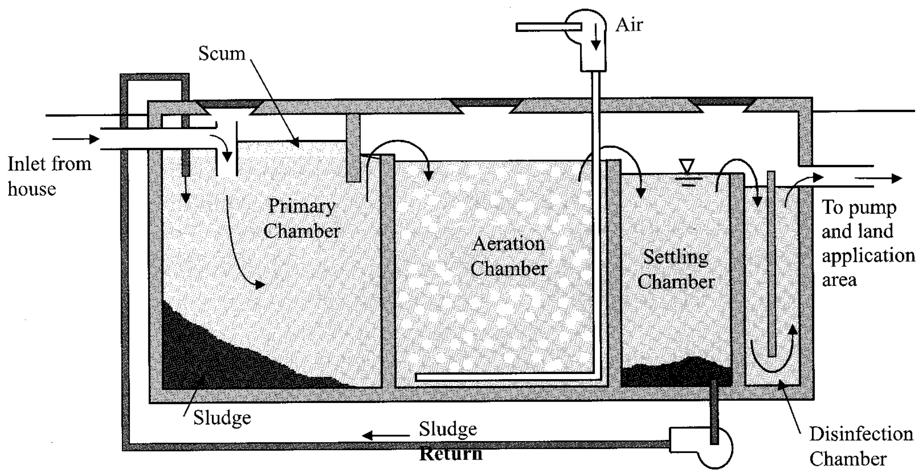
Aerated wastewater treatment systems (AWTSs) provide a relatively simple solution to OSMS selection. These systems are scaled-down sewage treatment plants, and usually include both anaerobic and aerobic zones and a number of pumps. AWTSs typically settle solids and float scum in an anaerobic chamber, much like a septic tank, and then aerate the effluent in a second chamber (Figure A2). The aerobic process usually consists of injecting compressed air into the effluent to promote the growth of aerobic bacteria for 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 period of poor treatment performance until sufficient micro-organisms are once again restored to adequately treat the effluent.

Disinfection in AWTS is generally required as part of NSW Health's accreditation procedures, and usually consists of chlorination in the final collection chamber. Council is aware that some people choose not to disinfect their effluent in subsurface applications, and agree that this is largely a matter of choice and warranty obligations. Homeowners should be aware that sub-surface emitters may tend to get blocked if high nutrient loads cause a build-up of biomatter in the soil pores surrounding the emitters, and that at least periodic dosing of chlorine should be considered in these cases. Other ways to avoid this problem is to use non-drain emitters or emitters which release miniscule doses of poison to prevent root intrusion and reduce biomass production in the immediate vicinity of the emitter (e.g. Wasteflow, Netafim).

Some AWTSs include an activated sludge process that enables the breakdown of sludge and a theoretically better effluent quality without the need for periodic de-sludging. The aerated section of the AWTS oxidises the wastewater and organic matter is consumed. A clarification process is carried out through secondary settling of solids.

All AWTSs are accredited by the NSW Health Department pursuant to the Local Government (General) Regulations 2005. The AWTS must be installed in accordance with their accreditation conditions issued by NSW Health.



<u>Figure A2:</u> Cross Section of an AWTS

When functioning correctly, AWTS provide a significantly higher level of treatment than simple septic tanks. The design model allows a nitrogen reduction capacity of 20% to AWTS's.

Reed Beds (Constructed Wetlands)

(Please note that Lismore City Council also have a document "The use of Reed Beds for the Treatment of Sewage and Wastewater from Domestic Households" It is recommended that if you consider constructing a reed bed that this document should be sought.)

Constructed wetlands, or reed-beds, comprise a sealed basin containing gravel, in which primary treated effluent is kept slightly below the surface of the gravel substrate. The effluent is biologically treated as it moves slowly through the root zone of densely planted wetland plants (usually reeds/rushes but can also be shrubs or trees) in gravel. In order to minimise the risk of infection and disease through contacting the effluent, reed-beds should be constructed in a way that keeps the top of the effluent at least 5 cm below the top of the gravel bed.

The design of reed beds for sewage treatment is a specialised field. Treatment performance is largely dictated by the time (termed "residence time") that the primary-treated effluent spends in the reed bed, as this determines the contact-time with the bacteria-coated gravel and roots in the bed. Installers and home-owners should be made aware that installation of a reed-bed will generally necessitate one more Council inspection (with associated fees) than other OSMS systems due to the delay in establishing the reeds.

The following provides a brief summary of the main aspects of design that need to be considered when designing and constructing a reed bed for on-site treatment of effluent.

Minimum surface areas for Secondary and Partial-secondary Treatment

Due to the detailed level of monitoring data available for reed beds (Davison et al, 2002; Headley, 2003), Council's OSMS Design Model permits the designer to install reed beds sized to achieve either "secondary-standard" or "partial-secondary" effluent quality, with the difference in treatment level related to the size of the reed bed. According to the approach adopted by Council in the accompanying guidelines, the area required for land application can be reduced by treating the effluent to a higher quality. Reed-beds which are not big enough to provide secondary standard effluent can be assigned an expected nitrogen reduction factor from the OSMS Design Model, starting at a minimum of 20% nitrogen reduction. Larger application areas are required for lesser-treated effluents.

Recent studies on the North Coast (Davison et al. 2002) indicate that a reed bed with a 5 day residence time will provide secondary treatment (i.e. achieving BOD < 20mg/L, TSS < 30 mg/L, N < 30 mg/L). A reed bed with a 5 day residence time will be also be assumed to remove a default value of 40% of the total nitrogen loading from applied effluent in Byron and Lismore's design model. Systems designed using the Kadlec and Knight (DLWC Wetlands Manual, 1998) methods will be accepted.

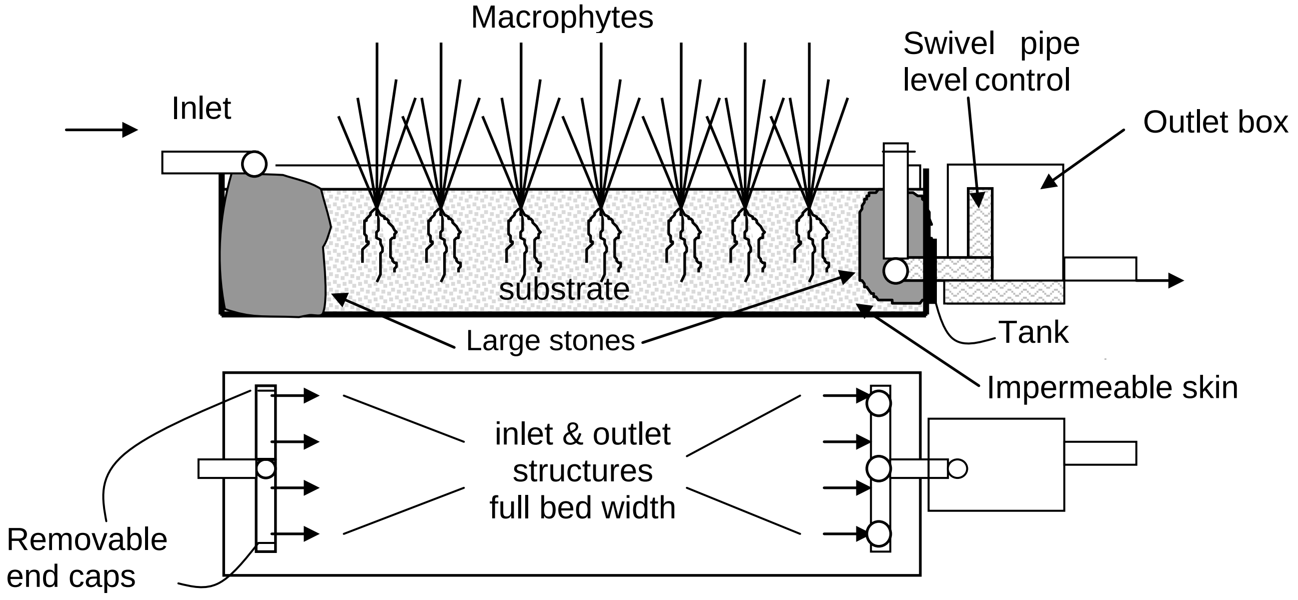
A reed bed with a 7 day residence time would be considered more appropriate in constrained sites, e.g. application systems over shallow groundwaters, or within 100 m of a waterway (refer Table 8 Site Limitations).

Reed Bed Construction

There are essentially five functional elements to a reed bed as shown in Figure A5. These are:

- the containment system, also termed liner or skin;
- the substrate or porous medium;
- the macrophytes or aquatic plants;
- the inlet structure; and
- the outlet structure.

This section describes some of the constraints and possibilities in relation to each of these elements.



<u>Figure A5:</u> Elevation and plan views of a simplified reed bed showing major components

Containment Device (Liner)

The purpose of the reed bed liner, also termed skin or under-skin, is to prevent the loss of wastewater and the penetration of macrophyte roots from the bed while excluding surface water, groundwater, adjacent soil and weeds. It therefore needs to be impermeable, durable and resistant to penetration by macrophyte roots. Materials that have been used on the NSW North Coast include fabricated reinforced concrete troughs/tubs, polyethylene troughs/tubs and flexible liner membranes. Of these, Council prefers and recommends the use of concrete troughs/tubs as problems have been frequently encountered sealing and maintaining the structural integrity of light-weight flexible plastic liners.

Fabricated concrete troughs/tubs
Fabricated concrete troughs/tubs are readily available on the market and are considered highly suitable for reed-bed liners due to their robustness and ease of maintaining a seal on the base and around inlet and outlet fittings. Rectangular troughs are preferred due to the minimisation of “dead spots” where little effluent circulation occurs, however they are less stable on steeply sloping sites.

The edge/lip of the reed bed liner needs to be raised and constructed in such a way that upslope surface runoff is diverted around the bed. A minimum lip height of 100 mm above ground level is usually required in reed-beds in order to prevent ingress of runoff. Diversion drains or swales may also be required. A stronger, higher lip (150 mm) is required for systems installed in slopes of >10%. Internally, Council requires a minimum free-board of at least 100 mm from the lip of the liner to the gravel surface, with effluent remaining a further 50 mm below the gravel surface to provide emergency storage for wet-weather periods or pump failures.

Substrate

The choice of wetland substrate will depend on the type and quality of influent, the desired quality of effluent and the need to minimise the risk of clogging. Gravel of 10mm diameter is preferred, but up to 20 mm diameter is acceptable. As a rule, media consisting of larger particles will have higher hydraulic conductivities and be less prone to clogging, but smaller particles provides more treatment surfaces and is easier to spread. It is essential to place larger stones/rocks, >50mm, around the inlet and outlet pipes to allow for ease of checking for root intrusion. However, these coarser substrates inhibit plant growth and therefore should not be used throughout the entire reed bed.

Macrophytes

Various macrophytes have been used in reed beds throughout the world with species from the genera *Phragmites, Schoenoplectus* and *Typha* being the most commonly used. Macrophytes that have been successfully used in this region are *Schoenoplectus validus* (river club rush), *Typha orientalis* (bull rush), *Phragmites australis* (common reed), *Bolboschoenus fluviatilis* (marsh clubrush), *Lepironia articulata* (grey rush*), Baumea articulata* (jointed twigrush), *Lomandra hystrix* (not *longifolia*), Carex bichenoviana. *Phragmites australis* should never be planted if flexible plastic liners are to be used.

Tube stock for most wetland plant species may be purchased from nurseries that specialise in wetland plants. These plants can also be propagated vegetatively by dividing root clumps obtained from existing constructed wetlands. An initial planting density of at least 3 plants/m^2 is required for new installations.

Inlet structure

The inlet structure for small reed beds, usually trench arch or a slotted 100 mm diameter PVC spreader pipe, should extend almost the full width of the reed bed and should be placed below the gravel surface, with large stones placed around it.

Inlet areas of wetlands are prone to accumulation of sludge, so it is important that the inlet is accessible and monitorable for maintenance or de-sludging. The rocks (50 – 100 mm) around the inlet reduce clogging and allow easy access for maintenance and removal of intruding roots.

Outlet Structure

A simple outlet structure design incorporates a PVC pipe spanning the reed bed width and drilled with holes of approximately 15 mm diameter and surrounded by larger stones (up to 100 mm). Figure A5 shows an outlet structure option consisting of a series of 150 mm diameter, capped, vertical towers spaced evenly across the width of the bed. Effluent enters the towers via 15-25 mm diameter holes surrounded by stones > 50 mm diameter. Access to the towers is available should clogging of the holes occur. The reed bed is connected to an outlet box containing a device such as a swivel pipe, which can be used to adjust the water level in the reed bed. A series of variable length stand pipes can achieve the same result. In this way the wetland can be temporarily flooded to help control terrestrial weeds during establishment. If doing so, extreme care should be taken to avoid contact with the effluent by people and pets.

Controlled water level lowering can encourage downward root penetration, promoting oxygenation of the lower level of the bed and thereby enhancing treatment at that level. Being able to lower the water level may therefore be useful for maintenance or repair work if required in the future.

Baffles

Baffles can improve reed-bed designs by lengthening flow-paths and demarcating inlet and outlet structures, limiting the clogging growth of reed roots into the structures.

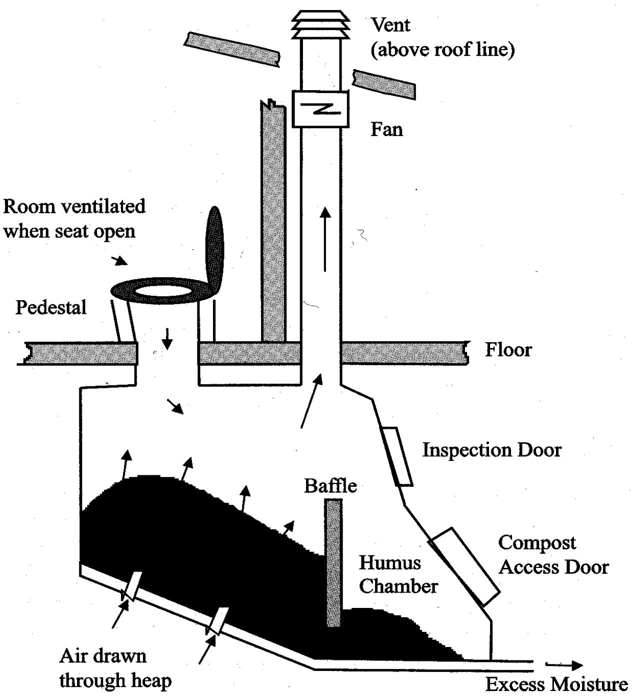
Reed bed shape

Having determined the total area of the bed or beds (using the OSMS Design Model) the next step is to decide on its actual shape. Rectangular plans, while not always the most aesthetically pleasing, will be more hydraulically efficient (less likely to have dead zones) than curved configurations. Aspect ratios (length to width) for rectangular beds of 3:1 down to 1:1 (i.e. square) are generally favoured in the literature. The wider the bed, the less likely it is to clog. On sloping ground a long thin bed may be desirable for structural reasons. In such cases a longer section of large stones should be installed at the front end of the bed.

Where multiple tubs are to be used to provide sufficient reed-bed size, designers have a choice to place the tubs in parallel or series. Parallel options are generally preferred but require a reliable means of distributing effluent evenly, e.g. with tipping buckets. Placing one tub after another in series may be an acceptable alternative, but designers must include hydraulic calculations to confirm that the hydraulic loads can be handled by the first tank, noting that this same first tank is liable to clog due to the higher sedimentation and nutrient loads that it is likely to accept.

Waterless Compost Toilets

Dry composting toilets may be either commercial units such as the Clivus Multrum, Nature Loo and the Rota Loo purchased “off the shelf” or constructed individually on-site (owner built) following a specific design plan. All compost toilets in NSW must meet the *NSW Health Department Waterless Composting Toilet Approval Guideline 1997*. There are two basic types: batch and continuous-flow systems. A diagram of a continuous-flow type compost toilet is given in Figure A6.



<u>Figure A6:</u> Cross-section schematic of a continuous–flow type compost toilet

Dry composting toilets require a carbon-rich bulking agent such as wood shavings, shredded leaves, shredded paper, or preferably a mixture of these, which needs to be applied after each use of the toilet. This bulking agent also covers the faecal material and aids in reducing any odours from the compost. The toilets must be vented and some have mechanical ventilation to ensure good air flow around the compost heap. After a period of time faecal and bulking material is decomposed into a friable humus-like compost material, which is removed from a door at the base of the toilet.

The use of a compost toilet will remove the toilet component from the wastewater flow of a dwelling or development. However, the household greywaters and the liquid wastes from the composting toilet will still need to be collected and treated in an appropriate manner. The reduced flow rates are incorporated into the OSMS Design Model. Greywater can be treated in conventional septic tanks, AWTSs, reed beds, or in systems specifically designed and approved for greywater.

Leachate from the compost toilet must be directed to the greywater tank or its own designated trench. This can actually help the biological process in the greywater tank by adding valuable bacteria. If a reedbed is used the nutrients in the leachate help promote reed growth. Leachate management must be included in any treatment design that involves the use of a compost toilet.

It is important to ensure that flies and rodents are excluded from the interior of the toilet. Thus, stainless steel fly-wire should be placed over any exposed ventilation openings and the toilet lid kept closed when not in use. It is also important to minimise the introduction of excessive moisture to the heap by hosing or cleaning.

Greywater Systems

Greywater is the wastewater produced from sinks, washing machines, showers and dishwashers while blackwater is that produced from a flush toilet. It has become popular to collect or divert greywater and apply it to gardens and lawns. However, greywater can be infectious and must be treated before any form of disposal.

A greywater treatment device collects and treats greywater to a similar standard as an AWTS for discharge to a subsurface disposal field. Greywater treatment systems must be accredited by NSW Public Health.

The basic greywater system expected to accompany composting toilets involves the greywater being collected in a collection tank (minimum size 1800 Litres) before being dispersed in a sub-surface evapo-transpiration/absorption (ETA) bed. The size of the greywater land application area will vary depending on wastewater loading and treatment level. In general the size of land application area required for greywater will be less than that required for combined blackwater and greywater systems due to the lower nutrient and hydraulic loadings of greywater alone.

Separate Systems versus Combined Systems

There are differing views on the desirability of separate or combined on-site wastewater treatment and disposal systems. The usual split separates greywater from blackwater. Some experts advocate an all waste system in preference to separately treated greywater and blackwater, because of the increased clogging which occurs with greywater alone, due to its higher C/N ratio generating polysaccharides (Laak, 1986 cited in Patterson, 1994).

The use of compost toilets presupposes a separate greywater system. There are situations where the design of the structure and the characteristics of the land require two systems which may or may not be split along strict greywater /black water lines.

A combined system is less costly due to the need to purchase only one tank and install one disposal field, particularly if an AWTS is used. As the minimum size for a septic tank is 3000L the separation of treatment is less economic. On the other hand a separate system provides a slightly longer retention time, hence better treatment, as two separate tanks have a greater combined capacity than one.

Disinfection

There are a number of options for effective long-term disinfection for on-site systems, the most common being chlorination and UV radiation. Disinfection through a UV lamp can be fairly cheaply achieved and there is no need to use harsh chemicals although maintenance of these devices has proven to be problematic. Chlorination disinfection is used with many AWTS installations. Any form of disinfection generally requires a well clarified effluent, low in organic matter and suspended solids (i.e. secondary treated) in order to be effective.

Subsurface irrigation does NOT require disinfection of effluent unless it is a specific requirement of the manufacturer or NSW Health, but does require at least partial-secondary treatment. For surface spray or dripper under mulch irrigation systems the effluent must be disinfected as well as secondary treated.

In designing any OSMS, it is important that the risks to householders and system maintainers from pathogens in sewage and solid wastes are minimised and considered. Care should be taken to ensure that contact with sewage can be kept to an absolute minimum during routine maintenance and that no residents or neighbours will be exposed to pathogens during normal operation of the OSMS.

Land Application Options

The E&HP Guidelines (1998) and *AS/NZS1547(2012)* describe the various systems that are available for land application areas in some detail. The intention of this section is not to reproduce information that is readily available elsewhere but to expand and highlight points that are particularly relevant to the Clarence Valley.

Subsurface land application systems are preferred as they minimise the potential for human contact and rapid release to the environment (Stewart et al., 1983). Evapotranspiration mechanisms are considered the most environmentally suitable means of managing treated effluent because of the ability of the plants to reduce pollution loads while at the same time enhancing the beauty of the locality. The subtropical climate allows a large range of plants to be selected for this purpose compared to other parts of NSW.

Land application systems can get overloaded with effluent and fail over time, and an alternate land application area must be designated and set aside for future use should the primary application field become less able to accept effluent or its contained nutrients over time. It is recognised that some existing properties do not have sufficient room for an alternative application area. In these cases it is important that a higher level of effluent treatment be performed, and preferable to be able to alternate the available land application areas, thereby allowing each area to "rest" in an unsaturated state for significant periods each day.

Absorption Trenches

Absorption trenches rely on infiltration of effluent into the ground beneath. Historically this was the only wastewater dispersal method used in the region, irrespective of the soil type. Absorption trenches do not provide for substantial re-use as the effluent is concentrated below the root zone, forcing most of the water downwards to potentially pollute underlying groundwater. They are also prone to failure in clay soils (predominant in the Clarence Valley) due to clogging and hydraulic overloading. For these reason traditional absorption trenches are not generally considered an acceptable or sustainable form of long-term land application system.

Because absorption trenches offer almost no opportunity for vegetation to pump-out and reuse nutrient-rich effluents, comprehensive justification would need to be provided should an absorption system be proposed. If trench designs are to be submitted, they should as a minimum be designed in accordance with *AS/NZS1547(2012)*.

Mound Systems

Careful consideration needs to be given to the installation of this type of effluent dispersal system due to the high rainfall of this region, difficulties in construction and the adverse environmental consequences of system failure. If a mounded application bed is proposed, the design and sizing of each mound shall be in strict accordance with *AS/NZS1547(2012)* recommendations.

If they are to be used, mounded beds must be carefully constructed and turfed to prevent erosion and to maximise shedding of rainfall off the bed. The down-hill side of the mound should not exceed a slope of 1 in 3 (33%), which can become difficult to achieve even on moderately sloping sites. To enhance maintenance capabilities and to assess the risk of surcharging or other forms of failure, Council requires that observation ports (e.g. made from capped and slotted 50 mm PVC riser pipes) are placed in at least 4 positions per mound to enable regular evaluation during maintenance visits.

Mound systems must be bathed or dug in to the natural ground level 300mm during installation. Mounds must be turfed otherwise justification must be given for Council to allow seeding.

It should be noted that not all of the washed coarse sand available from local suppliers on the North Coast is suitable for use in mound systems; in some cases it will require additional washing and grading. Sand media used in filters may be characterised through its effective size (ES) and uniformity coefficient (UC)

Clarence Valley Council requires that the sand to be used in the construction of Wisconsin Mounds be analyzed by an accredited laboratory. The sand is to have an effective size ranging from .25 – 1.00mm, a uniform co-efficient of <4 and percentage of fines <4%. A copy of the laboratory analysis is to be provided to Council prior to the final inspection and written confirmation of the purchase of the approved sand is to be provided to Council prior to issue of the Approval to Operate an On-site Wastewater Management System.

When coupled to a NSW Department of Health accredited AWTS or Secondary Treatment System, Council will allow the construction of mound systems based on the hydraulic requirements of the Clarence Valley Council OSM design model. The hydraulic design must be based on 150L/person/day from AS/NZS 1547:2012.The Nutrient LAA required by the OSM design model must still be designated on the site.

Evapotranspiration Absorption Beds (ETA beds)

ETA beds allow effluent to be taken-up by evaporation and transpiration mechanisms above the bed as well as allowing some of the effluent to percolate through the permeable base of the bed.

As well as providing treatment and reuse of a proportion of the effluent through evapo-transpiration, ETA beds can be quite robust and need relatively little maintenance when properly designed and installed.

Where ETA beds are to be installed, the following design features are required unless sufficient justification is provided for alternative designs:

- Design and installation must comply with the requirements of *AS/NZS1547(2012).*
- Distribution of effluent is to be via one distribution pipe per 1.5 m-wide bed, with one extra pipe required for each additional 0.5-1.0m in width.
- Distribution pipes are **NOT** to have geotextile socks fitted to them as this may lead to the pipes clogging.
- The beds must be installed completely flat, and checked by means of laser level or super-saturating the ground and adjusting any puddle areas.
- Maximum length of each bed shall be 30m, and central-feed systems are preferred.
- The distribution system must be designed and installed to ensure even distribution throughout the beds. Splitter boxes must be accessible and stably installed. Distribution pipes must be installed absolutely flat and should be drilled on the sides rather than the bases, so that effluent wells out evenly rather than seeps out the first few holes.

- Ø Monitoring ports (e.g. slotted and capped PVC pipe) must be installed in at least 2 locations per bed,
- Ø Beds must be mounded and grassed to reduce rainfall penetration and encourage evapotranspiration.
- Ø Shrubs are recommended to be planted no closer than one (1) metre from the sidewall of the ETA bed or trench and small trees no closer than five (5) metres. Large trees, such as, eucalypts, figs or mangoes should be planted a minimum of 20 metres from the beds, to avoid root damage in the distribution system and reduce shading of the ETA beds.
- Ø On sloping sites of up to 10%, ETA beds shall be terraced along the slope and reinforced as required to ensure that they will be stable in the long term. Qualified geotechnical advice should be sought if beds are to be installed on slopes of greater than 10% or on unstable soils.
- Ø Adequate run-on diversion mounds or trenches must be provided to prevent run-on onto the beds. On highly sloping or constrained sites, Council further recommends that a swale be constructed downstream of the beds and planted with vetiver grass or other high-nutrient loving plants to assimilate any occasional surcharges from the beds.

Irrigation Dispersal Systems

The most dependable and most popular means of dispersing effluent in a way that maximises uptake by plants within the land application area is by means of pumped irrigation. Appropriate design of pumped irrigation systems for domestic wastewaters requires a good understanding of pumps, pipes and emitters. For this reason, CVC requires that Sub-surface irrigation systems must be designed and/or certified, installed and maintained by CID (Certified Irrigation Designer) or suitably qualified persons.
Irrigation designs are to include all the information set out in the Irrigation Design Check List (Technical Support Document Number 5). Sub surface irrigation, spray irrigation or surface irrigation under mulch designs are to be installed by a suitably qualified person with experience in irrigation installation.

All effluent dispersal by irrigation including subsurface is to be maintained on a regular basis in accordance with their conditions of approval for the installation. An Irrigation Maintenance Report (refer Technical Support Document Number 5) is to be submitted to Council annually. This annual report should have details of the quarterly services undertaken throughout the year.

Sub-Surface Drip Irrigation (SDI)

Sub-surface drip irrigation (SDI) systems, also commonly referred to as sub-surface irrigation (SSI). They have a precise and even distribution capability. Sub-surface drip irrigation is particularly appropriate where there are site or soil limitations or limitations, such as steep slopes or on heavy impermeable (often termed “puggy”) soils, and can even be used with care and greater spacing on highly permeable sandy soils.

The sub-surface drip irrigation dispersal method is discussed in the E&HP Guidelines (1998) and APPENDIX M *AS/NZS1547(2012)* in some detail.

Sub-surface Irrigation laterals must be spaced 600mm apart and be required to have a dripper spacing of 300 mm unless otherwise justified.

CVC requires that Sub-surface irrigation systems must be designed and/or certified, installed and maintained by CID (Certified Irrigation Designer) or suitably qualified persons.
SDI systems 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. “Non-drain” emitters have the dual advantage of not draining out after the pump cycle has finished and are also much less prone to root invasion.

- Design and installation must comply with the requirements of *AS/NZS1547(2012).*
- The maximum size for a single sub-surface irrigation field is 500 m^2. If a bigger application area than this is required to reliably disperse the household effluent, it should be broken up into smaller fields and the effluent load should be alternated through the fields via an indexing valve.
- Pumps must be sized to match the hydraulic characteristics and requirement of the irrigation system, including friction losses through pipes and filters.
- Flushing velocity in all flush lines shall be between 0.8 m/s and 2 m/s.
- Gravel-filled flushing pits should be adequately sized to accept design flush loads and be located below the bottom point in each field. If return lines are to be provided to the septic tank, they must be inserted below the crust level so as not to disturb the crust.
- Discharge rates from emitters should be matched to the permeability of the soil.
- Pump-out volumes shall be sufficient to charge pipe system for durations of between 15 and 30 minutes, twice to four times per day.
    - As stated in Clarence Valley Council’s On-site Wastewater management Strategy, due to the complex nature of subsurface drip irrigation systems Council may require designs verified by an accredited irrigation designer.

Surface Spray Irrigation

Consideration for surface spray irrigation will only be given for properties who can satisfy Council that all health and environmental risks have been considered. The system must be designed and installed by a suitably qualified person in accordance with *AS/NZS1547(2012)* and the conditions set out below:

- Submit Section 68 Application form including site and soil assessment and a detailed diagram showing the layout of the sprinklers (predicted diameter of the sprinkler throw/pattern) including the spacing of sprinkler heads.
- Minimum Lot size of 4000m^2
- A treatment system accredited by the NSW Department of Health for Surface Spray Irrigation
- The proposed Land Application Area (LAA) must be sized in accordance with the OSM Design Model (using SDI parameter) with a minimum LAA of 400m^2

- An Indexing valve must evenly distribute effluent to fixed heavy droplet sprinklers on hard risers with a throw radius not exceeding 2m, height 400mm, flow rate 0.05 L/s and operating pressure of 80-100 kPa to negate the risk of aerosol dispersion
- Lateral and sprinkler spacing is typically 5m (approx 1 sprinkler per 20m^2)
- The proposed LAA must meet all recommended buffer distances in accordance with the Environment & Health Protection Guidelines 1998, Table 5
- The installation of a 120micron, 50mm (2inch) inline filter may be required. Comment is to be provided if the inline filter is not required.
- The manifold and delivery laterals must be colour coded (lilac wastewater) 25mm polyethylene pipe buried a minimum of 100mm below the ground surface.
- Details of the pump must be supplied with the application.
- Install at least two clearly visible warnings at the boundaries of the LAA with wording such as “Recycled Effluent – Avoid Contact – Do Not Drink”
- On completion of the works the sprinklers will be tested by the plumber in the company of a Council officer.

The surface spray irrigation area is to be maintained on a quarterly basis as per the conditions of the Approval for the installation. An irrigation maintenance contract is to be entered into and a quarterly maintenance report is to be submitted to Council along with or included in your AWTS quarterly service report.

Surface Dripper Under Mulch Irrigation

Surface dripper-under-mulch options may be considered under similar circumstances to spray irrigation, but added maintenance and monitoring conditions will be required to ensure that the mulch remains in place over the drippers.
In addition to the conditions for surface spray irrigation, the Dripper Under Mulch System must be designed and installed in accordance with the following conditions:

- The covering of mulch must be maintained and not allow any pipework to become exposed
- If the AWTS is not accredited for surface spray irrigation then a 300mm cover of mulch must be maintained at all time.
- The LAA must be planted with a water and nutrient tolerant plant species (please see local nurseries for specific species)
- The LAA must be planted at an appropriate density for effective evapotranspiration (please see local nurseries for species specific information)
- The LAA must be contained by a garden border or edge

Additional Reference Information

There is a large amount of literature regarding on-site wastewater management. For further details than is provided in this strategy refer to the following web sites.

NSW Department of Local Government at www.dlg.nsw.gov.au. This site has a large amount of information about current and past on-site wastewater management programs and documents such as the On-site Wastewater Risk Assessment System (OSRAS).

NSW Department of Health at www.health.nsw.gov.au/public-health/ehb/general/. Information on the accreditation of wastewater management facilities by NSW Health is also available on the NSW Health web site.

Sydney Catchment Authority – Design and Installation of On-site Wastewater Mangement Systems http://www.sca.nsw.gov.au/publications/publications/designing-and-installing-on-site-wastewater-systems

Irrigation Australia's list of Certified Irrigation Designer's
http://irrigation.org.au/certification/listing-of-certified-irrigation-designers