KYOGLE COUNCIL

ON-SITE SEWAGE AND WASTEWATER MANAGEMENT STRATEGY

1.0 INTRODUCTION

1.1 Background

Kyogle Council has embraced recent legislative changes toward the management of on-site sewerage management. The aim of the new legislation is to redirect New South Wales towards sustainable on-site management of domestic sewerage and wastewater. These changes encompass improved health and environmental outcomes by enhancing the capacity of Kyogle Council to monitor, manage and regulate sewerage pollution, in accordance with the principles of ecologically sustainable development. To address these regulatory reforms Kyogle Council has produced this On-Site Sewage and Wastewater Management Strategy. The strategy comprises two components being:

1) A Technical Strategy for the design of on-site sewage management systems;

2) A Management and Implementation Strategy – for the on-going operation of on-site sewage management systems.

On-site sewage and wastewater management and disposal is regulated by a number of guidelines and legislation, these include the recent amendment to *the Local Government (Approvals) Regulations, 1999*. This regulation defines a `sewage management facility` as:

- *a human waste storage facility; and*
- *a waste treatment devise intended to process sewage and includes a drain connected to such a facility or devise;*

The *Local Government (Approvals) Regulation 1993*, as amended by the *Local Government (Approvals) Amendment (Sewage Management) Regulation 1998* was gazetted on March 6, 1998. The amendments do not alter the existing powers and duties of the Council to regulate the installation of and operation of on-site sewage management systems under Section 68 and 124 of the *Local Government Act*, 1993. However, the new regulation stipulates:

- ♦ Council's responsibilities and powers to regulate the installation and ongoing operation of on-site sewage management systems;
- ♦ Performance standards for on-site sewage management, including protection of public health and prevention of environmental damage;
- ♦ Accreditation roles and responsibilities of NSW Health;
- ♦ Responsibilities of owners to seek a renewable approval to operate the facility; and
- ♦ Council's responsibilities to develop a strategy for on-site sewage management within its area.

1.2 Scope

The on-site sewage management regulations and guidelines provide a framework for implementation of ecologically sustainable on-site sewage management practices over the next three to five years. Management of existing on-site systems and addressing sewage management for all new sewage management installations is a major focus of this strategy.

It is intended that this should be achieved, as far as possible, by a process of implementation of appropriate guidelines for site evaluation criteria, maintenance requirements and operating requirements for all sewage management systems. Community and user education is also to be undertaken to complement the strategy in a manner which is sensitive to local circumstances.

This Strategy encompasses all single dwelling domestic on-site wastewater disposal systems within the Kyogle Council area.

This strategy is divided into Four (4) Sections as follows:

Section 1 Introduction to Kyogle Council On-Site Sewage and Wastewater Management Strategy

Section 2 Kyogle Council On-Site Sewage and Wastewater Strategy

Part A – Assessment / Design Guide for the Approval of on-Site Management Systems

Part B – On-Site Management Systems Design Document

Part C – Site Assessment Reporting Procedures

Section 3 Approval to Operate Sewage and Wastewater Management and Implementation

Section 4 Community Information Documentation

Section 1 – Kyogle Council's On-Site Sewage and Wastewater Management Strategy Introduction Document gives a background to the strategy, placing it in context and explaining the aims, goals and objectives of the strategy.

Section 2 – The Kyogle Council Technical Performance Standards comprises:

- Part A – *"Kyogle Council On-Site Sewage and Wastewater Strategy – Assessment / Design Guide for On-Site Management Systems"*. This document includes design of wastewater and disposal systems, selection of appropriate wastewater management options and design of generic systems based on site limitation for specific soil types.
- Part B – *"Kyogle Council On-Site Sewage and Wastewater Strategy – On-Site Management Systems Design Document"* aims to minimise the potential for failure of on-site wastewater systems by stipulating design criteria based on the daily disposal model, treatment systems, disposal systems, installation procedure and requirements, and sample plans of management.
- Part C – *"Kyogle Council On-Site Sewage and Wastewater Strategy – Site Assessment Reporting* Procedures – is aimed at informing plumbers, consultants and the like, on the reporting requirements associated with the lodgement of an application to council to install, construct or alter a sewage management system.

Section 3 – Approval to Operate – Management and Implementation. This document outlines Council's procedure in issuing renewable approvals to operate sewage and wastewater management systems.

Section 4 – Community Information Document. This is an information document for the general community which explains the strategy and the background to the legislative changes to on-site sewage and wastewater management. It also informs the public on what is required when lodging an application for a new or upgraded on-site sewage management system and the Approval to operate systems.

1.3 Citation

This strategy, which may be cited as the "Kyogle Council On-Site Sewage and Wastewater Management Strategy" has been adopted by Kyogle Council on the 28th March 2000. It is also to be included in DCP 2 - Development in Rural Areas under the provisions of Section 68 of the *Environmental Planning and Assessment Act 1979.*

1.4 Commencement Date

This strategy shall become effective from the 28th March 2000.

1.5 Application

This strategy shall apply from the commencement date to all development consents and construction certificates and applications made under section 68 of the Local Government Act, relating to or affected by the matters contained in the strategy.

1.6 Relationship

This strategy applies to all land within the Kyogle Council areas.

This strategy supersedes all previous information issued by Kyogle Council with respect to on-site wastewater treatment and disposal.

In the event of any inconsistency between this Strategy and previous Development Control Plans, Policies or Codes, this wastewater strategy shall prevail. However this strategy may be defined more specifically in future plans relating to specific areas.

1.7 Regulations

- AS 1546 (1998) - On Site Domestic Wastewater Treatment Units
- AS1547 (1994) - Disposal Systems for Effluent from Domestic Premises
- DR 96034 - Draft Australian Standard
- Local Government Regulations 1993
- Local Government Act 1993
- Local Government (Approvals) Amendment (Sewage Management) Regulations 1998
- Protection of the Environment Operations Act 1997
- Public Health Act 1991
- Council LEP's
- Environment & Health Protection Guidelines *"On-Site Sewage management for Single Households"*

1.8 Aims

This Management Strategy has a number of aims, including:

- providing a framework to manage and regulate the impact of on-site sewage management systems in the Kyogle Council area, and to ensure user accountability
- to provide appropriate information to the general community, plumbers and consultants to improve on-site sewage management.
- to apply the Kyogle Council On-Site Sewage and Wastewater Management Strategy for assessment of proposed on-site wastewater systems design.

1.9 Objectives

The general objectives of this strategy plan are:

- to ensure the protection of the surrounding environment including groundwater; surface water; land and vegetation through the selection of a system suitable for that particular site;
- to aid in the prevention of public health risk from on-site sewage disposal;
- to continue in maintaining and improving community amenity;
- to ensure maximum re-use of resources;
- to ensure ecologically sustainable development;
- to ensure that these guidelines can be continually updated as new technology is developed;
- to recognise the value of wastewater for the possibilities of effective reuse of this resource;

- to aid in the public recognition of on-site sewage treatment systems such as requiring on going maintenance and a monitoring program which will involve the land owner/resident and the Local Council
- to create a framework for improved management of on-site wastewater disposal systems.

1.10 Goals

To achieve the objectives outlined above, the following goals have been set:

- to create and maintain a database of all existing on-site sewage systems.
- to ensure that all sewage management systems and land application areas comply with environmental and health protection guidelines and Council operating requirements.
- to reduce the frequency of system failure as a result of householder misuse.
- Site inspection of existing OSMS systems will only be required in identified high risk situations, or to determine levels of risk to public health and the environment, or when requested.
- to consult with Aerated Wastewater Treatment Systems service agents to ensure that quarterly maintenance reports are submitted, also certifying that land application areas comply with site requirements and are not failing.
- to review Council development standards and approval criteria for subdivisions, development and building to ensure that appropriate provision is made for sustainable on-site sewage management when residential development occurs in non-sewered areas.
- to review and update Kyogle Councils On-Site Sewage and Wastewater Management Strategy

2.0 Definitions

Absorption rate: rate of discharge of water into soil.

Aerated Wastewater Treatment System (AWTS): a wastewater 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.

Biochemical Oxygen Demand (BOD): the amount of oxygen required for the biological decomposition of organic matter.

Compost Toilet: treatment units which employ the process of biological degradation in which organic material is converted into a compost like material through the action of micro-organisms and invertebrates, See Draft Australian Standard, DR 96086

Continuous System: a composting toilet using a single chamber

Design Irrigation Rate: the rate at which water can be irrigated onto soil without causing harmful long term environmental effects

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 Water: treated water which has passed through a treatment system,

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

Evapotranspiration: removing water from soil by evaporation and from plants by transpiration

Evapotranspiration bed: A prepared bed or area where evaporation and transpiration is encouraged

Evapotranspiration/absorption: a prepared bed or area, which embodies the principals of evaporation, transpiration and absorption

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 human excreta, and therefore can act as an indicator of recent faecal contamination

Geotextile: a water permeable material used in foundation stabilisation, soil particles moved by water erosion are designed not to pass thorough the Geotextile fabric, (care should be taken as there are different fabric spacing sizes and qualities,)

Greywater: (sullage) the component of domestic wastewater which does not contain human excreta

Land Application Area: the area over which treated wastewater is applied

Long Term Acceptance Rate: (LTAR) the long term average rate effluent water can be absorbed into the natural soil at a selected disposal site, expressed in Litres per square metre per day. This rate is influenced by effluent water quality, method of dosing the soil permeability and the slim layer interface equilibrium of the receiving soil

Pan Evaporation: the loss of water by evaporation measured in a Class A pan under controlled conditions

Pathogens: micro-organisms that are potentially disease causing; these include, but are not limited to bacteria, protozoa and viruses

Permeability: (P) the general term used to describe the rate of water movement through a soil

Scum: The floatable material which accumulates on the liquid during primary wastewater treatment. Material includes oils, grease, soaps and plastics

Septic Tank: wastewater treatment device that provides a preliminary form of treatment for wastewater, comprising sedimentation of settleable solids, flotation of oils and fats, and anaerobic digestion of sludge

Sewage Management: any activity carried out for the purpose of holding or processing, or reusing or otherwise disposing of, sewage or by-products of sewage

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

Soil Absorption: (includes leach drains, drain fields, absorption trenches, seepage beds and seepage pits) subsurface land application systems that rely on the capacity of the soil to accept and transmit the applied hydraulic load

Sullage: see greywater

Transpiration: the transfer of water to the atmosphere through plants

Wastewater: Water discharges from a dwelling or other activity which are of a lower quality than the Sensitive Water Standard as defined by the EPA.

PART A

Assessment/Design Guide for the Approval of On-Site Management Systems

1.0 INTRODUCTION

In order to manage the installation of on-site sewerage and wastewater disposal and treatment Kyogle Council has developed this strategy.

This Manual is an extension of the *Environment and Health Protection Guidelines - On-site Sewage Management for Single Households* dated February 1998, and does not seek to replace this document but rather to provide the detail necessary to allow operation of the Guidelines in this Council Area. The Strategy is considered necessary as part of the new Environment and Health Protection Guidelines (E&HPG) for On-Site Treatment of Domestic Wastewater for Single Households, developed by the Department of Local Government, Environment and Protection Authority, Department of Health and Department of Land and Water Conservation in 1998.

The new Guidelines were developed in order to provide for a sustainable solution when considering both public health risk and environmental pollution. Page 9 of the E&HPG states, "this document (E&HPG) is a set of guidelines; it is not a design and operations manual. It provides guidance on possible ways to meet environmental and health outcomes". This Design Guide complements the earlier E&HPG and provides the necessary design details for the Kyogle Council area.

This Design Guide is one part of the Kyogle Council Sewerage and Wastewater Strategy, with Part B the Design Document and Part C the Site Assessment and Report Procedures. Part B provides the background information for both Part A and Part C and is the basis of the daily effluent disposal computer model spreadsheet. Part C consists of a basic outline of the requirements for the on-site assessment and evaluation of sites and soils for the suitability of treatment and disposal systems.

The Council area has a strong rural industry. Many parts of the area are being more closely developed as farm sizes become smaller. The rural residential component of the area's development has seen the reduction in farm sizes in some parts of the region below viable farm sizes. People are choosing to live in the rural areas but work elsewhere to support their lifestyle choice.

This strategy seeks to achieve a balance between the desire for development and the need for environmental care. Development which balances the built environment with the natural systems will ensure this region maintains its unique qualities.

Failure of on-site wastewater treatment and disposal systems are considered a major water quality threat to the environment. At the time of writing, Australian Standard AS1547 is currently under review as DR 96034 *On-site Domestic Wastewater Management,* and the E&HPG reflect stricter environmental controls than were previously applied to on-site wastewater treatment and disposal.

On-site sewage and wastewater systems are required to be designed for the site specific conditions and regularly maintained in order to reduce potential contamination to public health and the surrounding environment. Section B of this strategy recommends some design criteria and a sample Plan of Management for the operation and maintenance of on-site systems. The on-site effluent disposal system is to be managed in accordance to with the Approval to Operate a Sewage Management System issued by Council.

2.0 SITE EVALUATION

The results of examination of many wastewater disposal system have shown that the evaluation of site conditions is of paramount importance. This has been reflected in the Environment and Health Protection (E&HP) Guidelines which nominate that a suitable treatment and disposal system shall be chosen due to site constraints and the quality of wastewater.

The E&HP Guidelines state that the disposal systems should be sized on the most limiting factor of either of the following:

- BOD_5,
- Total Nitrogen,
- Total Phosphorous,
- Hydraulic Loading,

- Site Assessment Details.

In the study attached to this design strategy these parameters have been considered along with Sodium and the movement of Pathogens.

Nutrient and BOD_5 loading can vary from different house holds due to the pretreatment processes including:

- Straight septic tanks
- Aerated Wastewater Treatment Systems (AWTS)
- Incorporating reed beds and/or sand filters into the design

Hydraulic loading can differ through the use of:

- Composting toilets
- Water conserving devices (AAA water restrictors)
- Number of people per household.

To remove some of this variability the strategy nominates design parameters, such as the predicted quality of effluent using each system. If alternate figures are to be used by consultants, (such as expected water quality, or hydraulic load), justification will need to be given for doing so supported by detailed professional assessment by suitably qualified persons.

3.0 DESIGN OF WASTEWATER TREATMENT AND DISPOSAL SYSTEMS

Wastewater treatment and disposal systems need to be designed for specific site conditions found at each site. The design of systems is required to follow specific criteria in accordance with this Strategy and the nominated Standards:

- That the wastewater disposal systems be sized using a soil classification and daily water balance in accordance with the rainfall and evaporation data collected from authorised recording stations recording both rainfall and evaporation. The recommended disposal areas be designed with comparison between the area required to dispose of Nitrogen, Phosphorus, Sodium and Pathogens as well as the daily wastewater design flow. Details of the design methodology are provided in the accompanying strategy study.
- The soils in the proposed disposal area are to be classified using the a collective term for the soil names and related to the soil landscapes. From this classification permeability figures have been determined and shall be used in the calculation of the disposal bed size.
- Selection of the site for the treatment tank and disposal area shall be carried out based on the detailed site evaluation and the disposal area calculations.
- The appropriate treatment tank and disposal system for the site and land use shall be based on all the parameters nominated in Section B of this strategy, being Nitrogen, Phosphorus, Sodium, Pathogen, Hydraulic, slope, aspect, soil type, flow rate, treatment tank performance, buffers and setbacks. All these parameters must meet the deign standards nominated in Section B of this strategy.
- All designs must follow the generic sketches provided for the selected disposal method and use NSW Public Health Approved pre treatment devices unless specifically approved by the individual Local Council. If an alternative design is proposed it must be supported by a detailed scientific investigation addressing all the parameters raised in section B of this strategy.
- The use of a standard design does not negate the need for a site assessment and operations report as per this manual. Design reports submitted should include the appropriate design selected, drawings (even if this is one of the standard designs) to allow formal approval to be given by Council and inclusion of the design details in the Wastewater Management System Register. The inspection then carried out by Council from time to time will verify the design and its performance.

4.0 SELECTION OF APPROPRIATE WASTEWATER MANAGEMENT OPTION

To assist in the selection of the most appropriate treatment and disposal option for an individual site, Tables 1 to 7 evaluate the limitations of various site conditions and constraints and suggest appropriate types of systems. These tables do not substitute for undertaking soils tests and site inspections or undertaking calculations to size disposal areas.

TABLE 1: ALLUVIAL SOILS - HIGHLY REACTIVE SOILS

Example Soil Landscapes: Leycester, Tatham, Disputed Plains, North Casino

SITE CONDITION		LOW LIMITATION	MEDIUM LIMITATION	HIGH LIMITATION	COMMENTS
SOIL CHARACTERISTICS		P sorption = > 6000	P Sorp = 2000-6000	P Sorp = <2000	Conservative P sorption values is 10,000kg P sorp/ha at 100cm depth but can fall below 7,500kg/ha; if in doubt soil analysis shall be undertaken.
SOIL PERMEABILITY **(LTAR)**		4 -7.5mm/day	3 - 4mm or 7.5 - 10mm	<3mm or >10mm	Conservative design LTAR use 5mm/day and DIR 11mm/week. Soils are generally poorly drained due to high clay content, but usually have an LTAR of 7mm/day.
DISPERSIVENESS		Class 1	Class 2 or Class 3	Class 4	
SLOPE OF DISPOSAL AREA		0 - 10%	11-15%	16 – 20%	For steeper ground use narrow evapotranspiration/ absorption beds or subsurface irrigation; in undisturbed vegetated areas with adequate buffer distances, surface irrigation can be undertaken.
ASPECT		North	North east to north west	South	
EXPOSURE		Full sun and wind	Partly sheltered	Full shelter	
DEPTH TO WATER TABLE OR BEDROCK		>4m	4 to 2m	<2m	
DISTANCE TO INTERMITTENT CREEK OR DRY GULLY	**Ave Slope** **0-10%** **11-15%** **>16%**	 >35m	 35 to 25m 50 to 40m 85 to 75m	 <25m <40m <75m	These distances are determined on site or from survey maps
DISTANCE PERMANENT WATER WAY	**Ave Slope** **0-10%** **11-15%** **>16%**	 >50m	 50 to 40m 70 to 60m	 <40 m <60m <120m	
SODICITY **(exchangeable sodium potential)**[5]		0-5	5-10	>10	This soil type generally has ESP within the minor limitation, however the subsoils of soil landscape Distributed Plains have a moderate limitation.
FIELD pH		6 - 8	4.5 - 6	Other	Lime can be added to allow system to fall in moderate or minor limitation category
FLOOD POTENTIAL DISPOSAL SYSTEM TREATMENT SYSTEM		 Rare, above 1 in 20 year contour Above 1 in 100 year contour		 Below 1 in 20 year Contour Below 1 in 100 year contour	Locate treatment system above flood way, such that vents, openings and electrical components are not affected by outside water. A lot of these soils may be classed as high.
ELECTRICAL CONDUCTIVITY **(dS/m)**		<4	4-8	>8	Generally not considered a problem in these soils, if suspected as a problem then soil:water test to be undertaken
BULK DENSITY **(g/cm³)**		<1.4		>1.4	Not required for single sites, an indication of bulk density is compaction, these soils can become compacted when wet and have traffic over them
COARSE FRAGMENTS (%)		0-20	20-40	>40	
SITE DRAINAGE		No visible signs of surface dampness		Surface wet, vegetation characteristic of wet area	These soils may be damp due to the high clay content, it is most likely that imported soil will be required
RUN-ON AND UPSLOPE SEEPAGE		Minor	Moderate	High – diversion not practical	Install catch drain above disposal field, if diversion not practical consider alternative location or design system to accommodate for this
CATION EXCHANGE CAPACITY **($cmol^+/kg$)**[6]		>15	5-15	<5	Generally moderate to high CEC, on average this soil type has above 25 $cmol^+/kg$ (Morand, 1994)
MINIMUM SYSTEM REQUIRED:					
TREATMENT TYPE MINIMUM REQUIRED		Any approved system	Any approved system, if septic, use additional filter or improved disposal field	Any approved system, if septic, use additional wetland or sand filter	
DISPOSAL SYSTEM		Any disirable system, eg subsurface	Evapotranspiration/a bsorption bed	mounded disposal bed or other above enclosures	
GENERAL COMMENTS ON SYSTEMS		Some systems will be of this type	Most sites will be of this category	Some systems will be of this type	

TABLE 2: DARK BASALTIC SOILS - CHOCOLATE SOILS

Example Soil Landscape: Georgica, McKee, Mackeller, Fredrick

SITE CONDITION	LOW LIMITATION	MEDIUM LIMITATION	HIGH LIMITATION	COMMENTS
SOIL CHARACTERISTICS	P sorption = > 6000	P Sorp = 2000-6000	P Sorp = <2000	Conservative P sorption values is 12,000kg P sorp/ha at 100cm depth but can fall below 7,500kg/ha, if in doubt soil analysis shall be undertaken.
SOIL PERMEABILITY (LTAR)	4 -7.5mm/day	3 - 4mm or 7.5 - 10mm	<3mm or >10mm	Conservative design LTAR use 5mm/day and DIR 11mm/week. Soils are generally poorly drained due to high clay content, but usually have an LTAR of 7mm/day.
DISPERSIVENESS	Class 1	Class 2 or Class 3	Class 4	
SLOPE OF DISPOSAL AREA	0 - 10%	11-15%	16 – 20%	For steeper ground use narrow evapotranspiration/ absorption beds or subsurface irrigation; in undisturbed vegetated areas with adequate buffer distances, surface irrigation can be undertaken.
ASPECT	North	North east to north west	South	
EXPOSURE	Full sun and wind	Partly sheltered	Full shelter	
DEPTH TO WATER TABLE OR BEDROCK	>4m	4 to 2m	<2m	
DISTANCE TO INTERMITTENT CREEK OR DRY GULLY — **Ave Slope** **0-10%** **11-15%** **>16%**	 >35m	 35 to 25m 50 to 40m	 25m 40m 75m	These distances are determined on site or from survey maps
DISTANCE PERMANENT WATER WAY — **Ave Slope** **0-10%** **11-15%** **>16%**	 >50m	 50 to 40m 70 to 60m	 40m 60m 120m	
SODICITY (exchangeable sodium potential)[5]	0-5	5-10	>10	This soil type generally has ESP within the minor limitation
FIELD pH	6 - 8	4.5 - 6	Other	
FLOOD POTENTIAL **DISPOSAL SYSTEM** **TREATMENT SYSTEM**	Rare, above 1 in 20 year contour Above 1 in 100 year contour		Below 1 in 20 year Contour Below 1 in 100 year contour	Locate treatment system above flood way, such that vents, openings and electrical components are not affected by outside water. A lot of these soils may be classed as high.
ELECTRICAL CONDUCTIVITY (dS/m)	<4	4-8	>8	Generally not considered a problem in these soils, if suspected as a problem then soil:water test to be undertaken
BULK DENSITY **(g/cm^3)**	<1.4		>1.4	Not required for single sites, an indication of bulk density is compaction, these soils can become compacted when wet and have traffic over them
COARSE FRAGMENTS (%)	0-20	20-40	>40	
SITE DRAINAGE	No visible signs of surface dampness		Surface wet, vegetation characteristic of wet area	
RUN-ON AND UPSLOPE SEEPAGE	Minor	Moderate	High – diversion not practical	Install catch drain above disposal field, if diversion not practical consider alternative location or design system to accommodate for this
CATION EXCHANGE CAPACITY **($cmol^+/kg$)**[6]	>15	5-15	<5	Generally moderate to high CEC, on average this soil type has above 15 $cmol^+/kg$ (Morand, 1994)
MINIMUM SYSTEM REQUIRED:				
TREATMENT TYPE MINIMUM REQUIRED	Any approved system	Any approved system, if septic, use additional filter or improved disposal field	Any approved system, if septic, use additional wetland or sand filter	
DISPOSAL SYSTEM	Any disirable system, eg subsurface	Evapotranspiration/ absorption bed	mounded disposal bed or other above enclosures	
GENERAL COMMENTS ON SYSTEMS	Some systems will be of this type	Most sites will be of this category	Some systems will be of this type	

TABLE 3: KRASNOZEMS OR RED BASALTIC SOILS

Example Soil Landscapes: Bangalow, Eltham, Ewingsdale, Wollongbar

SITE CONDITION		LOW LIMITATION	MEDIUM LIMITATION	HIGH LIMITATION	COMMENTS
SOIL CHARACTERISTICS		P sorption => 6000	P Sorp = 2000-6000	P Sorp = <2000	Conservative P sorption values is 10,000kg P sorp/ha at 100cm depth , if in doubt soil analysis shall be undertaken.
SOIL PERMEABILITY (LTAR)		10mm/day	5-7.5mm or 12.5-20mm	<5mm or >20mm	Generally has a measured LTAR in excess of 20mm/day which is considered too rapid, however over time the soils perform like silty clays and will clog therefore soil conditioning is required
DISPERSIVENESS		Class 1	Class 2 or Class 3	Class 4	
SLOPE OF DISPOSAL AREA		0 - 10%	11-15%	16 – 20%	Planting required in natural ground between disposal area to allow for additional hydraulic uptake, thinner evapotranspiration/absorption systems to be used on steep sites
ASPECT		North	North east to north west	South	
EXPOSURE		Full sun and wind	Partly sheltered	Full shelter	
DEPTH TO WATER TABLE OR BEDROCK		>4m	4 to 2m	<2m	
DISTANCE TO INTERMITTENT CREEK OR DRY GULLY	**Ave Slope** **0-10%** **11-15%** **>16%**	>35m	35 to 25m 50 to 40m	25m 40m 75m	These distances are determined on site or from survey maps
DISTANCE PERMANENT WATER WAY	**Ave Slope** **0-10%** **11-15%** **>16%**	>50m	50 to 40m 70 to 40m	40m 60m 120m	
SODICITY (exchangeable sodium potential)[5]		0-5	5-10	>10	Generally has ESP within the minor limitation, however soil landscapes of Bangalow, Rosebank and Ewingsdale have a moderate limitation.
FIELD pH		6 - 8	4.5 - 6	Other	
FLOOD POTENTIAL **DISPOSAL SYSTEM** **TREATMENT SYSTEM**		Rare, above 1 in 20 year contour Above 1 in 100 year contour		Below 1 in 20 year Contour Below 1 in 100 year contour	Locate treatment system above flood way, such that vents, openings and electrical components are not affected by outside water. A lot of these soils may be classed as high.
ELECTRICAL CONDUCTIVITY (dS/m)		<4	4-8	>8	Generally not considered a problem in these soils, if suspected as a problem then a soil:water test to be undertaken
BULK DENSITY (g/cm^3)		<1.6		>1.6	Not required for single sites, an indication of bulk density is compaction, rare if these soils become compacted
COARSE FRAGMENTS (%)		0-20	20-40	>40	
SITE DRAINAGE		No visible signs of surface dampness		Surface wet, vegetation characteristic of wet area	These soils usually have good drainage due to the high aggregate nature of soil profile
RUN-ON AND UPSLOPE SEEPAGE		Minor	Moderate	High – diversion not practical	Install catch drain above disposal field, if diversion not practical consider alternative location or design system to accommodate for this
CATION EXCHANGE CAPACITY ($cmol^+/kg$)[6]		>15	5-15	<5	Generally low to moderate CEC, on average this soil type has above 15 $cmol^+/kg$ (Morand, 1994)
MINIMUM SYSTEM REQUIRED:					
TREATMENT TYPE MINIMUM REQUIRED		Any approved system	Any approved system, if septic, use additional filter or improved disposal field	Any approved system, if septic, use additional wetland or sand filter	
DISPOSAL SYSTEM		Any disirable system, eg subsurface	Evapotranspiration/ absorption bed	Evapotranspiration/ absorption bed or mounded disposal bed or other above enclosures	
GENERAL COMMENTS ON SYSTEMS		Sites on this soil type will generally be of	Sites do not usually does not fall within this category	Some sites may fall within this category	These soils are known to clog up quickly and some systems are failing on the Alstonville plateau, within this area moderate limitation

	this group			systems should be installed

TABLE 4: SANDY DUPLEX SOILS -
INCLUDING LITHOSOLS, PODZOLIC SOILS (SAND BASED TOPSOILS)
Example Soil Landscapes: Coffee Camp, Nammoona, Yorklea, Bagotvale, Wollumbin

SITE CONDITION		LOW LIMITATION	MEDIUM LIMITATION	HIGH LIMITATION	COMMENTS
SOIL CHARACTERISTICS		P sorption => 6000	P Sorp = 2000-6000	P Sorp = <2000	Conservative P sorption values is 8,000kg P sorp/ha at 100cm depth if in doubt soil analysis shall be undertaken. May vary depending on amount of sand, increasing sand content lowers P Sorption (about 2,000 kg P sorp/ha)
SOIL PERMEABILITY (LTAR)		10mm/day	5-7.5mm or 12.5-20mm	<5mm or >20mm	Permeability varies depending on depth of soil
DISPERSIVENESS		Class 1	Class 2 or Class 3	Class 4	
SLOPE OF DISPOSAL AREA		0 - 10%	11-15%	16 – 20%	Steep ground requires narrow evapotranspiration/ absorption beds or subsurface irrigation; in undisturbed vegetated areas with adequate buffer distances, surface irrigation can be undertaken Free draining soils require planting between disposal areas to assist to control downslope seepage
ASPECT		North	North east to north west	South	
EXPOSURE		Full sun and wind	Partly sheltered	Full shelter	
DEPTH TO WATER TABLE OR BEDROCK		>4m	4 to 2.5m	<2.5m	If close to water table improved treatment system required
DISTANCE TO INTERMITTENT CREEK OR DRY GULLY	**Ave Slope** **0-10%** **11-15%** **>16%**	>55m	55 to 45m 60 to 50m	45m 50m 100m	If distance are less than nominated then a better system
DISTANCE PERMANENT WATER WAY	**Ave Slope** **0-10%** **11-15%** **>16%**	>70m	70 to 60m 85 to 75m	<55m <75m <125m	
SODICITY (exchangeable sodium potential)[5]		0-5	5-10	>10	These soils generally have an average ESP of 4.6%
FIELD pH		6 - 8	4.5 - 6	Other	
FLOOD POTENTIAL **DISPOSAL SYSTEM** **TREATMENT SYSTEM**		Rare, above 1 in 20 year contour Above 1 in 100 year contour		Below 1 in 20 year Contour Below 1 in 100 year contour	Locate treatment system above flood way, such that vents, openings and electrical components are not affected by outside water. A lot of these soils may be classed as high.
ELECTRICAL CONDUCTIVITY (dS/m)		<4	4-8	>8	Generally not considered a problem in these soils, if suspected as a problem then a soil:water test to be undertaken
BULK DENSITY (g/cm^3)		<1.8		>1.8	Not required for single sites, an indication of bulk density is compaction, subsoils can become compacted when wet and have traffic over them
COARSE FRAGMENTS (%)		0-20	20-40	>40	
SITE DRAINAGE		No visible signs of surface dampness		Surface wet, vegetation characteristic of wet area	The subsoils may be retain moisture due to the high clay content, it is most likely that imported soil will be required
RUN-ON AND UPSLOPE SEEPAGE		Minor	Moderate	High – diversion not practical	Install catch drain above disposal field, if diversion not practical consider alternative location or design system to accommodate for this
CATION EXCHANGE CAPACITY ($cmol^+/kg$)[6]		>15	5-15	<5	These soils generally have an average CEC of 13.5, although some soil types can be higher
MINIMUM SYSTEM REQUIRED:					
TREATMENT TYPE MINIMUM REQUIRED		Any approved system	Any approved system, if septic, use additional filter or improved disposal field	Any approved system, if septic, use additional wetland or sand filter	
DISPOSAL SYSTEM		Any disirable system, eg subsurface	Evapotranspiration/ absorption bed	mounded disposal bed or other above enclosures	

GENERAL COMMENTS ON SYSTEMS	Sites do not usually does not fall within this category	Majority of sites classified of this soil type will be of this category	Some sites may fall within this category	These soils are generally unsuitable for any on-site sewage system without the use of imported soils due to the stoniness of the sites soils

TABLE 5: CLAYEY DUPLEX SOILS -
PODZOLIC SOILS (LOAM BASED TOPSOIL), GREY EARTHS
Example Soil Landscapes: Calico, Burringbar, Byrril

SITE CONDITION	LOW LIMITATION	MEDIUM LIMITATION	HIGH LIMITATION	COMMENTS
SOIL CHARACTERISTICS	P sorption => 6000	P Sorp = 2000-6000	P Sorp = <2000	Conservative P sorption values is 8,000kg P sorp/ha at 100cm depth if in doubt soil analysis shall be undertaken.
SOIL PERMEABILITY (LTAR)	10mm/day	5-7.5mm or 12.5-20mm	<5mm or >20mm	
DISPERSIVENESS	Class 1	Class 2 or Class 3	Class 4	
SLOPE OF DISPOSAL AREA	0 - 10%	11-15%	16 – 20%	Steep ground requires narrow evapotranspiration/absorption beds or subsurface irrigation; in undisturbed vegetated areas with adequate buffer distances, surface irrigation can be undertaken
ASPECT	North	North east to north west	South	
EXPOSURE	Full sun and wind	Partly sheltered	Full shelter	
DEPTH TO WATER TABLE OR BEDROCK	>4m	4 to 2.5m	<2.5m	
DISTANCE TO INTERMITTENT CREEK OR DRY GULLY — **Ave Slope** **0-10%** **11-15%** **>16%**	 >55m	 55 to 45m 60 to 50m	 45m 50m 150m	If distance are less than nominated then a better system
DISTANCE PERMANENT WATER WAY — **Ave Slope** **0-10%** **11-15%** **>16%**	 >70m	 70 to 60m 85 to 75m	 60m 75m 150m	
SODICITY (exchangeable sodium potential)[5]	0-5	5-10	>10	These soils generally have an average ESP of 5.2%
FIELD pH	6 - 8	4.5 - 6	Other	
FLOOD POTENTIAL **DISPOSAL SYSTEM** **TREATMENT SYSTEM**	 Rare, above 1 in 20 year contour Above 1 in 100 year contour		 Below 1 in 20 year Contour Below 1 in 100 year contour	Locate treatment system above flood way, such that vents, openings and electrical components are not affected by outside water. A lot of these soils may be classed as high.
ELECTRICAL CONDUCTIVITY (dS/m)	<4	4-8	>8	Generally not considered a problem in these soils, if suspected as a problem then a soil:water test to be undertaken
BULK DENSITY (g/cm^3)	<1.6		>1.6	Not required for single sites, an indication of bulk density is compaction, these soils can become compacted when wet and have traffic over them
COARSE FRAGMENTS (%)	0-20	20-40	>40	
SITE DRAINAGE	No visible signs of surface dampness		Surface wet, vegetation characteristic of wet area	These soils may be damp due to the high clay content, it is most likely that imported soil will be required
RUN-ON AND UPSLOPE SEEPAGE	Minor	Moderate	High – diversion not practical	Install catch drain above disposal field; if diversion not practical consider alternative location or design system to accommodate for this
CATION EXCHANGE CAPACITY ($cmol^+/kg$)[6]	>15	5-15	<5	These soils generally have an average CEC of 16.1, although some soil types can be higher
MINIMUM SYSTEM REQUIRED:				
TREATMENT TYPE	Any approved system	Any approved system, if septic, use additional filter or improved disposal field	Any approved system, if septic, use additional wetland or sand filter	

DISPOSAL SYSTEM	Any disirable system, eg subsurface	Evapotranspiration/absorption bed	mounded disposal bed or other above enclosures	
GENERAL COMMENTS ON SYSTEMS	Some sites may fall within this category	Sites on this soil type will generally be of this group	Some sites may fall within this category	

TABLE 6: HUMIC GLEY SOILS - SWAMP SOILS
Example Soil Landscapes: Tweed, Cobaki

SITE CONDITION		LOW LIMITATION	MEDIUM LIMITATION	HIGH LIMITATION	COMMENTS
SOIL CHARACTERISTICS		P sorption => 6000	P Sorp = 2000-6000	P Sorp = <2000	Analysis of this soil type should be undertaken
SOIL PERMEABILITY (LTAR)		10mm/day	5-7.5mm or 12.5-20mm	<5mm or >20mm	Usually very poorly drained
DISPERSIVENESS		Class 1	Class 2 or Class 3	Class 4	
SLOPE OF DISP. AREA		0 - 10%	11-15%	16 – 20%	
ASPECT		North	North east to north west	South	
EXPOSURE		Full sun and wind	Partly sheltered	Full shelter	
DEPTH TO WATER TABLE OR BEDROCK		>4m	4 to 2m	<2m	Water table is generally high within these soils, and therefore a better system is required, resulting in higher quality effluent and an above ground system, eg mounds or within enclosures
DISTANCE TO INTERMITTENT CREEK OR DRY GULLY	**Ave Slope** **0-10%** **11-15%** **>16%**	>55m	55 to 45m 60 to 50m	45m 50m 100m	If distance are less than nominated then a better system
DISTANCE PERMANENT WATER WAY	**Ave Slope** **0-10%** **11-15%** **>16%**	>70m	<60m <75m	<60m <75m <150m	
SODICITY (exchangeable sodium potential)[5]		0-5	5-10	>10	These soils generally have an average ESP of 3.7%
FIELD pH		6 - 8	4.5 - 6	Other	
FLOOD POTENTIAL **DISPOSAL SYSTEM** **TREATMENT SYSTEM**		Rare, above 1 in 20 year contour Above 1 in 100 year contour		Below 1 in 20 year Contour Below 1 in 100 year contour	Locate treatment system above flood way, such that vents, openings and electrical components are not affected by outside water. A lot of these soils may be classed as high.
ELECTRICAL CONDUCTIVITY (dS/m)		<4	4-8	>8	The majority of these soils have a moderate to high limitation due to EC, if considered to have low EC information is required to support argument
BULK DENSITY (g/cm^3)		<1.8		>1.8	Not required for single sites, an indication of bulk density is compaction, these soils can become compacted when wet and have traffic over them
COARSE FRAGMENTS (%)		0-20	20-40	>40	
SITE DRAINAGE		No visible signs of surface dampness		Surface wet, vegetation characteristic of wet area	These soils are usually damp to wet and imported soil is usually required, and an above ground disposal system is recommended
RUN-ON AND UPSLOPE SEEPAGE		Minor	Moderate	High – diversion not practical	Install catch drain above disposal field, if diversion not practical consider alternative location or design system to accommodate for this
CATION EXCHANGE CAPACITY ($cmol^+/kg$)[6]		>15	5-15	<5	These soils generally have an average CEC of 4, although some soil types can be higher
MINIMUM SYSTEM REQUIRED:					
TREATMENT TYPE MINIMUM REQUIRED		Any approved system	Any approved system, if septic, use additional filter or improved disposal field	Any approved system, if septic, use additional wetland or sand filter	
DISPOSAL SYSTEM		Any disirable	Evapotranspiratio	mounded disposal	

	system, eg subsurface	n/absorption bed	bed or other above enclosures	
GENERAL COMMENTS ON SYSTEMS	Sites do not usually does not fall within this category	Some sites may fall within this category	Sites on this soil type will generally be of this group	These soils are generally unsuitable for any on-site sewage system without the use of imported soils

TABLE 7: PODZOL SOILS - SANDY SOILS
Example Soil Landscapes: Kingscliff, Pottsville

SITE CONDITION	LOW LIMITATION	MEDIUM LIMITATION	HIGH LIMITATION	COMMENTS
SOIL CHARACTERISTICS	P sorption => 6000	P Sorp = 2000-6000	P Sorp = <2000	Average P sorption values on average are 1,000kg P sorp/ha at 100cm depth if in doubt soil analysis shall be undertaken.
SOIL PERMEABILITY (LTAR)	10mm/day	5-7.5mm or 12.5-20mm	<5mm or >20mm	
DISPERSIVENESS	Class 1	Class 2 or Class 3	Class 4	
SLOPE OF DISP. AREA	0 - 10%	11-15%	16 – 20%	
ASPECT	North	North east to north west	South	
EXPOSURE	Full sun and wind	Partly sheltered	Full shelter	
DEPTH TO WATER TABLE OR BEDROCK	>1.5m	>1m	<1m	
DISTANCE TO INTERMITTENT CREEK OR DRY GULLY — **Ave Slope** **0-10%** **11-15%** **>16%**	 >95m	 95 to 85m 160 to 140m	 <85m <140m <220m	If distance are less than nominated then a better system
DISTANCE PERMANENT WATER WAY — **Ave Slope** **0-10%** **11-15%** **>16%**	 >105m	 105 to 95m 160 to 150m	 <95m <105m <250m	
SODICITY (exchangeable sodium potential)[5]	0-5	5-10	>10	These soils generally have an average ESP of 8.8%
FIELD pH	6 - 8	4.5 - 6	other	
FLOOD POTENTIAL **DISPOSAL SYSTEM** **TREATMENT SYSTEM**	 Rare, above 1 in 20 year contour Above 1 in 100 year contour		 Below 1 in 20 year Contour Below 1 in 100 year contour	Locate treatment system above flood way, such that vents, openings and electrical components are not affected by outside water. A lot of these soils may be classed as high.
ELECTRICAL CONDUCTIVITY (dS/m)	<4	4-8	>8	The majority of these soils have a moderate to high limitation due to EC, if considered to have low EC information is required to support argument
BULK DENSITY (g/cm^3)	<1.8		>1.8	Not required for single sites, an indication of bulk density is compaction, these soils can become compacted when wet and have traffic over them
COARSE FRAGMENTS (%)	0-20	20-40	>40	
SITE DRAINAGE	No visible signs of surface dampness		Surface wet, vegetation characteristic of wet area	These soils are usually damp to wet and imported soil is usually required, and an above ground disposal system is recommended
RUN-ON AND UPSLOPE SEEPAGE	Minor	Moderate	High - diversion not practical	Install catch drain above disposal field, if diversion not practical consider alternative location or design system to accommodate for this
CATION EXCHANGE CAPACITY ($cmol^+/kg$)[6]	>15	5-15	<5	These soils generally have an average CEC of 4, although some soil types can be higher
MINIMUM SYSTEM REQUIRED:				
TREATMENT TYPE MINIMUM REQUIRED	Any approved system	Any approved system, if septic, use additional filter or improved disposal field	Any approved system, if septic, use additional wetland or sand filter	
DISPOSAL SYSTEM	Any disirable system, eg subsurface	Evapotranspiration/absorption bed	Mounded disposal bed or other above enclosures	
GENERAL COMMENTS ON SYSTEMS	Sites do not usually does not fall within this category	Some sites may fall within this category	Sites on this soil type will generally be of this group	These soils are generally unsuitable for any on-site sewage system without the use of imported soils

5.0 WASTEWATER DISPOSAL SYSTEMS MANAGEMENT PLANS

A selection of management plans is attached for the various types of disposal systems currently in use in this region. Generic design drawings have also been prepared showing cross sections and general layouts. Specific plans will be required for each site as detailed in Part B and C of this Design Guide.

The use of a standard design does not negate the need for a site assessment and operations report as per this manual. Design reports submitted should include the appropriate design selected, drawings (even if this is one of the standard designs) to allow formal approval to be given by Council and inclusion of the design details in the Wastewater Management Approval Register. The inspection then carried out by Councils from time to time will verify the design and its performance.

PART B

On-Site Management Systems Design

1.0 INTRODUCTION

This report is Part B, the Design Document, of the Kyogle Council On-Site Sewage and Wastewater Strategy. The purpose of the design document is to provide supporting information to ensure sites are adequately assessed and on-site sewage and wastewater systems are designed to ensure protection to human health and the surrounding environment.

This Design Document covers issues which need to be considered when designing on-site sewage and wastewater disposal systems. Issues to be considered include:

- Daily Disposal Model;
- Site Assessment;
- Classification of the soils and
- Choosing a suitable on-site wastewater treatment and disposal system

1.1 Daily Disposal Model

The purpose of the daily disposal model is to recognise the processes involved in designing a suitable disposal system. The model has been developed as a computer spreadsheet which considers a number of environmental factors based on daily rainfall and evaporation records, and is dependant on the preferred treatment system. The runoff generation features of this model are based on the Boughton Model.

The computer model is based on the information within this document, however it has been developed as a simplified version and will determine the treatment and disposal system required based on nutrient loadings, hydraulic loadings and environmental factors.

Information on site and soil assessment will largely determine the required treatment system to be installed at particular sites. There are seven broad soil classes which are to be used for the model, these are described below.

1.2 Site Assessment

A site assessment is to be carried out for each proposed on-site sewage and wastewater system. The site assessment will consist of a desktop study where information about the surrounding areas is documented, including whether the site is near contaminated areas, Acid Sulphate Soils, environmentally sensitive areas etc. The second step of the site assessment includes an actual site visit where the site is traversed on foot and boreholes are taken to record the existing soil profile, depth to bedrock, slope, aspect, exposure etc. A check list is provided in Part C to ensure all required information is recorded.

The amount of information required varies depending on whether the proposed development is a single lot, a subdivision/rezoning or an existing site.

1.3 Soil Assessment

There are seven broad soil classes which have been grouped by similar characteristics:

- Alluvial Soils (Highly Reactive)
- Basaltic Soils (Chocolate) Soils
- Krasnozems (Red Basaltic) Soils
- Sandy Duplex (Sandy Podzolic) Soils
- Clay Duplex (Clay Podzolic) Soils
- Humic Gleys and
- Sandy (Podsol) soils

The soil assessment will be used in conjunction with the site assessment to ascertain whether a particular site has **low, medium or high limitations**. The three limitation categories will determine the type of treatment system and disposal system that is most suitable for that site.

1.4 *Choosing the Correct On-Site Sewage and Wastewater System*

The correct system which is to be installed is ascertained from a combination of site and soil assessment. The subject soils are assessed and placed within the seven broad categories, as discussed above, and the most desirable on-site sewage and wastewater treatment and disposal system chosen based on a variety of site characteristics.

The results of this stage is then inserted within the computer model provided as part of the Design Model, discussed above.

2.0 DAILY DISPOSAL MODEL

2.1 *Introduction*

A model has been developed which is capable of describing some of the processes involved in on-site disposal of wastewater. The model is based on published technical material in the hydrological literature and consequently, is similar in some respects to other models.

The runoff generation features of this model are based on the Boughton Model. A water balance is kept which accounts for all inputs and outflows, although the balance itself is limited by the approximations used and the assumptions of homogeneity of the land. The balance is calculated on daily rests and is based on daily rainfall and evaporation records.

2.2 *Water Balance Equation*

A suitable water balance equation for modelling effluent disposal is:

$$SM_{i+1} = SM_i + R_e - E_{tp} - DR + DI$$

Where:

SM_i is either the soil moisture in the plant root zone at the start of time period i, or the depth of storage available in the void spaces of a disposal bed

R_e is the depth of effective rainfall,

E_{tp} is the total evapotranspiration for the time period I,

DI is the depth of effluent applied to the disposal area in time period, I, where appropriate.

DR is the drainage of water below the root zone in time period, I, (ie the percolation).

Where modelling plant evapo-transpiration, SM_i is assumed to range between "field capacity", defined as the water content at which gravity drainage ceases and the soil can be regarded as saturated, and "wilting point", defined as the moisture content at which plant life is no longer sustained and the soil is dry. The soil moisture holding capacity is the moisture content which ranges between these two limits.

2.3 *Soil Moisture Capacity*

Water is stored within the pore space of a soil. Most of this water is only temporarily stored by the soil is eventually returned to the atmosphere by direct evaporation from the surface or by plant transpiration. The amount of water temporarily stored by the soil can range from about 10 to 400mm/metre depth, depending on the soil type, temperature and time since the last rainfall or irrigation event.

Soil moisture ranges between field capacity, which is the maximum moisture content which a soil can temporarily retain in the unsaturated zone, and permanent wilting point, which is the point at which plants are unable to extract enough moisture from the soil and wilt permanently. The difference between field capacity and permanent wilting point is called the available water, and is a measure of the moisture available for plant roots.

The available water for various soil types is summarised in Charman & Murphy (1991, page 164):

Table 1 - Available Water

Textural Class	Available Water (m/m)
Coarse sand	0.083
Sand	0.150
Fine Sand	0.200
Very Fine Sand	0.225
Loamy coarse sand	0.108
Loamy sand	0.158
Loamy fine sand	0.217
Loamy very fine sand	0.217
Coarse sandy loam	0.125
Sandy loam	0.175
Fine sandy loam	0.192
Very fine sandy loam	0.217
Loam	0.175
Silty loam	0.200
Silt loam	0.192
Sandy clay loam	0.150
Clay loam	0.183
Silty clay loam	0.192
Sandy Clay	0.142
Silty clay	0.183
Clay	0.175

It is suggested that median values be used for conservative analysis. The actual depth of the roots of a crop will determine the total available water. For example, if the rooting depth is 0.5metres and the available water is 100mm/m, then the total available water is 50mm.

2.4 Total Evaporation (Evapotranspiration)

The estimation of total evaporation requires the following factors to be taken into account:

- plant transpiration characteristics including specific factors for the individual site,
- the albedo relationship between the plants and the soil,
- the soil moisture state of the plants and the soil at any given time, and whether the leaves of the plant are wet,
- the weather, in particular, the humidity, wind speed and net radiation.

In view of this complexity, physical integration methods such as evaporation pans have traditionally been used for measuring evaporation. Daily evaporation data in Australia is normally measured using Class A Evaporation pans, which are 121cm diameter and 25.5cm deep. Grayson et al (1996) indicate that class A pan evaporation data "are not particularly accurate estimates of natural evaporation. Other more accurate methods for computing evapotranspiration are available and should be used unless only pan data are available." Watts & Hancock (1985) show that data for evaporation pans collected by competent observers only a few miles apart vary markedly, ie systematic variation in the instrument rather than variations in climate, and recommend that evaporation should be calculated using solar radiation data and a physically based combination formula.

A comprehensive approach is possible, but comprehensive data, particularly net radiation data, is collected at relatively few sites and estimation of radiation from sunlight traces has many shortcomings. Accurate estimation of albedo requires specialised equipment, although experienced professionals can provide a reasonable estimate in most cases. Site specific factors such as plant cover and aspect are also important and make a real estimation of evaporation difficult. The effect of frequent application of water on evaporation can then be more accurately modelled using pan evaporation data. Grayson cites research by Chiew et al. (1995) to relate Class A pan evaporation to the reference crop evapotranspiration using the equation on the following page.

$ET_0 = G (PAN)$

Where:

ET_0 = Penman-Monteith reference crop evapotranspiration

PAN = Class A pan Evaporation

G = The Gradient of the ET_0 - PAN Regression line

The reference crop evapotranspiration is formally defined as "the rate of evapotranspiration from a hypothetical crop with an assumed crop height (0.12m) and a fixed canopy resistance (70 s m^{-1}) and albedo (0.23) which would closely resemble evapotranspiration from an extensive surface of green grass cover of uniform height, actively growing, completely shading the ground and not short of water" (Smith et. al., 1992).

Grayson reproduces Chiew's calculation of the gradient of the ET_0 - PAN regression line for 16 sites around Australia. The site closest to the study area is Brisbane, which has the following values of G:

	Summer	Autumn	Winter	Spring
Brisbane	0.78	0.75	0.66	0.74

To simplify modelling in the daily disposal model, the gradient of the ET_0 - PAN regression line was averaged as **0.74**.

To estimate actual evapotranspiration, the reference crop evapotranspiration is multiplied by a crop factor "f":

$E_{tp} = f \times ET_0$

where:

f is the crop factor derived from agricultural data,

ET_0 is the Penman-Monteith reference crop evapotranspiration

On days where soil moisture was considered limiting (ie $SM_i/SMH < 0.5$):

$E_{tp} = f \times ET_0 \times [2 \times SM_i/SMH]$

where:

SM_i is the soil moisture content on day i,

SMH is the soil moisture holding capacity

The crop factor "f" will vary depending on the type of plants used in the effluent disposal area and the period in the growing season. These are discussed further below.

2.5 Effective Rainfall

The rainfall that lodges on plants or runs off the bed surface without entering the bed and therefore not effective in raising soil moisture. Rainfall intensity data, topographic slopes and other data have been used to estimate the effectiveness of rainfall in the past both for practical and theoretical studies (see Toro, 1989 and ASAE, 1980).

A simple approach has been taken to rainfall depths; the total rainfall depth is assumed to have small components, which lodges on plant foliage, but the remainder is available for infiltration into the soil. This is considered the most rational use of the daily rainfall data.

Infiltration is assumed to cease when soil moisture reaches field capacity, and the remainder of rainfall is assumed to produce runoff. For conservative analysis, the water balance equation in Section B.2 is undertaken in the order shown, ie on days where rainfall will cause soil moisture to increase to field capacity, no irrigation is possible. This may not be strictly true as, for example, rainfall on a given day could commence following irrigation.

For the purposes of this model the effective rainfall is dependant on the selected disposal bed or area. The planted and mounded bed with a weed matt cover will deflect more rain than a relatively flat grassed lawn type area. Table 2 gives figures for the effective rain that will be captured in the disposal bed.

Table 2 - Effective Captured Rain in the Disposal Bed.

Description of Bed	Effective rain captured %
Mounded & Planted bed with weed matt cover	65
Mounded & Planted bed with mulch cover	75
Level bed & Planted	80
Level bed with grass	85

2.6 Discretisation of Time

SPCC (1984) and AS1547-1994 suggest the use of a monthly time step and average values for rainfall and evaporation in calculations. There is some inaccuracy in this method which may lead to inaccuracies in the estimation of the volume of storage required because:

- the soil moisture storage accessible to most plants on a daily basis is not necessarily the same as the sum of the likely evapotranspiration and rainfall for the month,
- average monthly values may incorrectly estimate the periods of near zero evapotranspiration.
- Average monthly figures do not reflect that during high rainfall intensity events, more rainfall may run off the plants and the disposal area simply because it cannot get into the ground,
- the disposal bed may be saturated for some individual days but over a whole month not have been regarded as full when the average is taken,

McLennan & Murtagh (1992) likewise conclude that use of the monthly model is inadvisable in some common circumstances. Consequently, a daily time step is adopted in this model, with evaporation and rainfall data from reliable sources. It is inappropriate to use rainfall and evaporation figures from different locations. The relationship between rainfall and evaporation is more important when determining the required disposal area and storage than the absolute rainfall and evaporation.

There are two reliable pan evaporation recording stations which can be used for the Kyogle Council area with data for both rainfall and evaporation - Alstonville Agricultural Station for the period 1970 to 1998 and Tabulam for the period 1993 to 1998. The model has used information from both stations to represent the different rainfall and evaporation relationships within the Council area.

2.7 Modelling of Deep Drainage

Where daily application is practised and soil root zones are deep, deep drainage (percolation) from the saturated bottom of the root zone or below is possible without causing deterioration of plant health from anaerobic soil conditions.

In daily modelling it is generally assumed that the root zone soil would contribute a fixed depth of water to drainage, if the soil root zone had a soil moisture content of 95% of field capacity or more.

Wet weather storage will be required when the soil within the wastewater disposal area has exceeded field capacity and has reached saturation point. Wet weather storage calculations are a component of the computer model.

2.8 Crop Factor "f"

The evapotranspiration from a crop is normally determined from the reference crop ET_0:

$$E_{tp} = ET_0 \times f$$

where

E_{tp} = crop evapotranspiration

f = crop coefficient

Crop coefficients are empirical ratios of crop ET to the reference ET, and reflect the physiology of the crop and the degree of crop cover. The crop coefficient includes evaporation from both the soil and plant surfaces. It should be noted that the contribution of soil evaporation is strongly dependent upon the surface soil wetness and exposure, while transpiration is primarily dependent on the amount and nature of the plant leaf area and the availability of water within the root zone.

Some values of crop coefficients from the FAO Paper 33, 1979, Table 18 (cited in Faulkner and Jones) are:

Table 3: Crop Coefficients

Crop	Initial Stage	Crop Development	Mid-Season	Late Season	At Harvest
Banana	0.50-0.65	0.80-0.90	1.00-1.20	1.00-1.15	1.00-1.15
Barley	0.30-0.40	0.70-0.80	1.05-1.20	0.70-0.80	0.20-0.25
Citrus		overall value	0.65-0.90		
Grass	0.30-0.40	0.70-0.80	1.00	1.00	1.00
Lucerne	0.30-0.40	overall value	0.85-1.20		
Soybeans	0.30-0.40	0.70-0.80	1.00-1.15	0.70-0.80	0.30-0.50
Sugarcane	0.40-0.50	0.70-1.00	1.00-1.30	0.75-0.80	0.50-0.60
Wheat	0.30-0.40	0.70-0.80	1.05-1.20	0.65-0.70	0.20-0.25

The crop coefficient varies markedly depending on the current section of the growing cycle. For domestic effluent disposal, it is considered that effluent will normally not be used for irrigating a commercial crop, and that vegetation selection will be based on ease of maintenance. It is also considered that domestic effluent irrigated plants will not be harvested for human consumption.

Most investigation regarding crop coefficients relates to agricultural production. Myers (1992) relates crop coefficients to the canopy mass of trees in *Pinus radiata* plantations, and shows research results which indicate crop factors between 1.0 and 1.2 for a mean foliage mass of between 12 and 16 t ha^{-1}. Later research by Myers et al (1996) indicates that plantation water use by *P. radiata* and eucalypt species on the same site is similar for the same stage of development, and that eucalypts are not inherently more proliferate consumers of water than pines when soil water is not limiting.

It is considered that the most common crops for surface and subsurface disposal of effluent will be native tree species, grass or lucerne. Although the disposal area will be maintained, the crop will generally not be harvested, and hence evapotranspiration from the disposal area can be designed for when crop coverage is complete. The reference crop coefficients K_c which it is considered should be adopted are:

Grass = 1.00

Lucerne = 1.03

Eucalypts = 1.10

These give the following crop evapotranspiration coefficient "f":

Grass = 0.74 x 1.00 = **0.74**

Lucerne = 0.74 x 1.03 = **0.76**

Eucalypts* = 0.74 x 1.10 = **0.81**

**Evapotranspiration only systems must be represented as grass until full size plant growth has established.*

2.9 Model Parameters

The daily model has several parameters, which require input resulting from information sought from the site assessment. These parameters are listed below along with the range of acceptable values when applicable for the Richmond catchment.

2.9.1 Daily Wastewater Flow

There has been some study within the region as to the amount of water used in typical households and averaged to a per person figure. The Demand Management work carried out by the relevant authorities seeking to ascertain the need for water supply can be used to assist in calculating the amount of wastewater produced.

The Demand Management Studies are centered around reticulated water supplies and allowance needs to be made for the roofwater harvesting supplies which are common in the rural communities of this region. The Draft Australian standard prepared to replace AS 1547 recognises that these figures vary depending on source and the final end use. The Appendix TS Doc 1A in Draft Australian Standard DR96034, the Water Wise Manual and the Rous Regional Demand Management Strategy have been used to develop the following flow figures presented in **Table 4 and 5:**

It is important to recognise in this region that many of the on-site systems are in rural or semi rural locations where water collection from roofs, bores, creeks or dams is common. Many households would not use the design flows as applicable throughout the state of NSW or Australia. A further study is expected to commence later this year which specifically tests 20 residences in a non-sewered village and the surrounding rural area to determine the volume of wastewater produced. This study may result in changes to the typical flow rates being quoted in this study.

Table 4: Typical Wastewater Flows

Source	**Typical Wastewater Flows in Litres/person/day**	
	On-site Roofwater Harvesting Water Supply	**Reticulated, community supply from borehole, creek or spring**
Household with standard facilities (including automatic cloths washing machine)	140	180
Household with full AAA rated water saving fixtures	115	145
Households with extra fixtures such as dishwashers	170	220
Household (blackwater only)	50	60
Household (sullage only)	90	120
Motels/Hotels		
- guests, residents staff	140	180
- non-resident staff	30	40
- reception rooms	20	30
- bar trade (per customer)	20	25
- restaurant (per dinner)	20	30
Community Halls		
- banqueting	20	30
- meetings	10	15
Restaurants (per diner)		
- dinner	20	30
- lunch	15	25
Tea Rooms (per customer)		
- no restroom facilities	10	15
- with restroom facilities	15	25
School (pupils plus staff)	30	40
Dry Industrial, commercial	30	50
Camping Grounds		
- fully serviced	100	130
- recreation areas	50	65

Typical water usage figures for households with ordinary fittings are listed below, sourced from *Wise Water Management – A Demand Management Manual for Urban Authorities* (Water Services Association of Australia, November 1998) for Brisbane; note flows are for a reticulated supply at 300kPa pressure. Further comparison is also made with information sourced from the Rous Regional Demand Management Strategy:

Table 5: Flow per Fixture

Fixture	Flow per day (L/house/day)	Percentage of Total %	Efficient Water Usage (L/p/day) Ch. 8	Rous Regional Demand Strategy# (L/p/day)
Shower	164	14	58.4*	32
Bath	30	3		
Basin	27	2		5.3
Total bathroom	**221**	**18**		
Toilet	186	15	18	21
Laundry	134	12	86/house	30
Kitchen	44	4		11
Total Indoor	**586**	**48**		**99**
Outdoor use	646	52		132

* shower rose flow rate 7.3L/min, average shower time 8 minutes.
\# The Rous figures in the above table are based on average figure per household and should not be mistaken for the peak or minimum water flows.

Should there be a application which does not fit into these Table 4 & 5 then individual assessment will be considered, provided information is provided to support the proposed flow rates. Rates taken from other region will need to be adjusted for effects of climate, usage, water quality, source type along with the effects of water conservation management controls and general water usage supervision.

2.9.2 Effluent Concentration (N)

Nitrogen is present in wastewater in various forms and remains in the treated effluent but the form may change. The presence of nitrogen is important as biological treatment of wastes can only proceed in the presence of sufficient nitrogen. There are four main forms of nitrogen, which are of interest in wastewater treatment;

- Organic Nitrogen – nitrogen in the form of proteins, amino acids and urea, 40% of the nitrogen can be of this form.
- Ammonia nitrogen – nitrogen as ammonium salts, $(NH_4)_2CO_3$, or as free ammonia.
- Nitr**i**te nitrogen – an intermediate oxidation stage not normally present in large amounts.
- Nitr**a**te nitrogen – final oxidation product of nitrogen.

Nitrogen is removed through a complex set of processes, such as vegetation uptake (major removal process), volatilisation, denitrification and soil absorption (which is limited and reversible).

If the organic nitrogen is not taken up by the plants or retained by the soil then it can travel or percolate with the water through the soil in the form of nitrate as nitrate is soluble. It is most critical from the viewpoint of the environment because of its leaching characteristic. There is likely to be nitrate present in ground water and this does indicate the final stage of the nitrification process, figures of 10mg/L are expected without concern. In order for nitrogen to be consumed by organisms it must be available in the organic nitrogen (urea) or nitrate forms. Typical figures for nitrogen uptake are 120-150kg/ha/year for fresh growth of eucalypts and before canopy closure and 50kg/ha/year after closure. Grasses such as typha and phragmites have a higher uptake up to figures of 300kg/ha/year are quoted. If the disposal bed is constructed as a wetland or wetland like then the performance of the typha etc. can increase to 5656kg/ha/year, (Martens 1998). Table 3 shows the design values for the Tweed Richmond catchments. Typical rates of nitrogen in the wastewater effluent after pretreatment in various tanks is provided in Table 6 below.

Table 6: Rate of Nitrogen Uptake

Species in Disposal Area	Nitrogen Uptake Rate (kg/ha/year)	Nitrogen Uptake Rate ($mg/m^2/day$)
Eucalypts	50 (long term)	14
Eucalypts	120 –150 (<4 years)	33 – 41
Grasses (Typha & or Phragmities or fresh pasture)	300	82
Phragmities & or Typha^{+}	5656	1550
Turf	200*	55*

(Source: Gardner, 1995 & Myers *et al*, 1994)
* Martens 1998
$^{+}$ in a wetland situation spaced as close as possible but at least 9 new stems per m^2

Patterson (1994) showed in a study at Armidale that soil nitrogen is mobile but that "at distances of more than 50m the nitrogen content was so low as to be deficient for plant growth". He also noted that "the movement of nitrogen from the irrigation area as nitrate does not bind readily to soil particles, in most forms is highly soluble and will move with soil water."

Intermittent loading of the soil with hydraulics would improve wastewater transmissibility and favours nitrogen removal by nitrification/denitrification as stated by Andreadakis and Christouolas, (1982). Denitrification occurs during the anaerobic loading phase while nitrification occurs during resting when aerobic conditions dominate, Patterson (1994). This would occur more effectively in disposal beds which are mounded and planted to effectively receive more oxygen.

If the movement of nitrogen through the soil profile is to occur it has to be driven by leaching water. The design used in the daily model are based on the soil permeability and do not recognise the movement of water out of the disposal bed zone. Storage capacities of wastewater effluent during wet days is calculated in the model and should be controlled by soil moisture sensors.

Assuming a simple disposal system where the effect of wash through by rainwater is possible, then the degree of potential pollution can be calculated. For example, based on Witt research in 1974 a typical household of 5 persons would generate total nitrogen volumes of about 2.2kg N/person/year, which gives a total nitrogen mass of:

Total Nitrogen 2.2 x 5 = 11kg/year.

The yearly quantity of wastewater with no water saving and reticulated water flow is

5 x 180 x 365 = 328.5kL/y/household

Simply, this results in a concentration of 33.5mg/L/household

Adding rainwater to this equation, there is an additional average of 1500mm of rain falling on the disposal area, which is say $400m^2$, in area. Assuming that 50% enters the soil profile, this adds 300kL to dilute the Nitrogen. The final concentration then becomes

$33.5/300,000 = 1x10^{-4}mg/L$

The high rainfall in the Richmond Tweed Region can cause significant dilution. If the disposal area is sized correctly, the leachate will not move out of the disposal area and a daily model more closely recognises the storage requirements and bed sizes than a monthly model. Daily fluctuations can then be reflected and the bed sized appropriately. Note it will be discussed later that the more permeable soils should be slowed by soil conditioning to control the movement of leachate.

The ratio of carbon to nitrogen is important as the ability for plants and micro-organisms to consume nitrogen depends on the carbon availability. The optimum C:N ratio is about 20:1. This occurs when plants are used and the disposal area can build up a ground litter or mulch with a shallow wastewater disposal water level. A nitrogen balance for each site should be carried out to ensure that the potential amount of nitrogen uptake by the disposal area is matched to the inflowing load, the following calculations are suggested:

The production figures for nitrogen are sourced from Witt *et al.* 1974, as follows:

Table 7: Production Figures for N in kg/person/year

Parameter	Toilet	Kitchen	Dishwasher	Laundry	Bath	Total
Total N	1.5	0.16	0.18	0.26	0.1	2.2

The overall N balance equation becomes dependant on the uptake rates of various disposal methods. The use of an AWTS compared to a baffled septic tank can also change the effluent concentration being applied to the land application area. The following table gives some values for N in the effluent after treatment.

Table 8: Nitrogen Performance Rates for Treatment Systems (mg/L)

Treatment Type	N in Effluent (Bevis & Gardner)	N in Effluent (Martens)	N in Effluent (EHPGuidelines)	Design Performance	Design Performance
Septic Tank	50 – 60	45 – 60	50 – 60	54 (mg/L)	No change %
AWTS	25 – 50	10 – 40	25 – 50	33 (mg/L)	0 - 34%

Example:

Assume a 3000L Septic tank with a 5 person household having a reticulated water supply and total wastewater flow of 5 x 180 = 900L per day. Assume the owner preferred disposal area type is an evapotranspiration/absorption bed planted with various species such as grasses (typha & phragmites), and shrubs.

The simple nutrient balance equation is **Nitrogen In = Nitrogen Out** to maintain the natural balance in the soil and not increase background N levels.

Nitrogen loading rate from treated effluent = 5 people x 2.2kg/yr/N = 11kg/year (assume no reduction for the performance of the septic tank).

Allowance for 20% loss in nitrogen due to denitrification in the system then the Nitrogen concentration would be reasonable = 8.8kg/year

Nitrogen uptake rate for grasses in evapotranspiration/absorption bed = 300kg/ha/year

Disposal area for zero increase in nitrogen (8.8kg/yr)/(300 kg/ha/yr) = 293m^2

If the disposal area is equal to or greater than 293m^2 then there would be no available Nitrate to be leached out of the disposal area it would all be taken up by the plants.

From using the daily model to perform these calculations an easy comparison can be made between the hydraulic load and the required area to dispose of effluent water.

Another example of the use of the nitrogen balance equation calculation is:

Assume a 3000L Septic tank with a 4 person household having a non-reticulated water supply, AAA rated water conservation fittings and total wastewater flow of 115 x 4 = 460L per day. The final disposal area is subsurface irrigation under a turfed or a lawn area.

The simple nutrient balance equation is Nitrogen In = Nitrogen Out to maintain the natural balance in the soil and not increase background N levels.

Nitrogen loading rate from treated effluent = 4 x 2.2 = 8.8 kg/year (assume no reduction for the performance of the septic tank).

The alternate loading factor, creating alternate anaerobic and aerobic conditions in the disposal bed means no allowance should be made for denitrification as it is difficult to establish with confidence that the subsurface irrigation area would be aerated at all.

Nitrogen uptake rate for turf is 200kg/ha/year (Table 6)

Disposal area for zero increase in nitrogen (8.8kg/yr)/ (200kg/ha/yr) = 440m^2

Thus if the disposal area is equal to or greater than 440m^2 then there would be no available Nitrate to be leached out of the disposal area it would all be taken up by the plants.

Similar comparisons can be made using the daily model to perform these calculations and easy comparison can be made between the hydraulic loading and nitrogen requirements to calculate the area required for disposal of effluent water.

2.9.3 Effluent Concentration Phosphorus

There are two (2) nutrients that are of principal concern in the design of wastewater disposal systems and they are phosphorus and nitrogen. The forms of phosphorous after treatment within the septic tank or grease trap are orthophosphate, polyphosphate and organic phosphate. EPA (1995) state that the orthophosphates are available immediately for biophysical reactions in the soil/plant system. The availability of polyphosphates is limited by their hydrolysis which proceeds very slowly in most soils. Organic phosphates are broken down biologically to polyphosphates and then to orthophosphates. Phosphorous is removed from effluent through biological, chemical and physical process in soil, with minor uptake by vegetation.

Phosphorus in on-site wastewater originates from two main sources: detergents containing phosphates and secondly human excreta. Anaerobic digestion in conventional septic tanks converts most of the phosphorus into soluble orthophosphates.

The sites soil has a high phosphorous sorption capacity which indicates phosphate fixing to iron, aluminium or calcium compounds as well as certain clay complexes (Morand, 1994). The amount of uptake of Phosphorus depends on the P sorption capacity of the soil and the uptake rate of the vegetation in the disposal bed.

Phosphorus quickly binds with the iron and aluminium in soil and becomes unavailable to plants, especially when the soil pH is below 5. Phosphorus is easily fixed in the soils, while crops and pasture take up 5 to 20% of the applied Phosphorus. When Phosphorus is broadcast in permanent pastures the P accumulates on the soil surface and is readily available to plants when moisture allows roots to grow to the surface. Organic matter the end product of decomposition is humus, a black crumbly substance, which stores nutrients for plant growth, holds moisture and improves soil structure. Phosphorus is unlikely to move through the soil as it binds to the soil profile, figures of 1–5 mm P movement are quoted in some texts. However, in coarse textured sandy soils, or soils which are noncalcareous, low in organic matter shallow depth to water table or bedrock, and with saturating rain Phosphorus may leach or transport through the soil. Therefore by combining clays to the sandy soils to reduce the possibility of leaching will actually hold Phosphorus in the disposal area.

Phosphorus can be more readily available to plant when the soil pH is neutral.

The Phosphate ions are removed from the soil solution by several mechanisms, including adsorption, precipitation, plant uptake, and biological immobilisation.

The Environment and Health Protection Guidelines (1998) state that wastewater disposal systems are to be disposed on the most limiting factor of either hydraulic, BOD or nutrient loadings.

Table 9: Rate of Phosphorus Uptake by Plants

Species in Disposal Area	Phosphorus Uptake Rate (kg/ha/year)	Phosphorus Uptake Rate ($mg/m^2/day$)
Eucalypts	10 – 12 (long term)	2.7 – 3.3
Eucalypts	20 (<4 years)	5.5
Grasses (typha, phragmities, in a prepared bed)	30	8.2
Typha, phragmities in a wetlands bed	85	23.3
Turf or lawn	20	5.48
Avocado’s	12	3.3
Sugar Cane	45	12.33
Macadamia Trees	45	12.33
Tea Tree	20	5.48

(Source: CSIRO Effluent Irrigated Plantations; Myers et al 1994;)

Table 10: Rate of Phosphorus Uptake by Soils

Soils in Disposal Area	Average Phosphorus Uptake Rate+ (kg/ha/m*) 15mg/L Effluent Concentration
Alluvial (Highly Reactive Soils)	10,000
Dark Basaltic Soils (Chocolate Soils)	12,000
Krasnozems (red basaltic)	12,000
Sandy Duplex Soils (Sandy Podzolic)	8,000
Clayey Duplex Soils	8,000
Humic Gley Soils	N/A to be tested
Podzols sandy soils	1,000

* the soil depth per metre
+ Average Phosphorours Sorption Rate for different soil types, analysed by Environmental Analysis Laboratory, Southern Cross University.

The assumptions in Table 10 is that the "P" concentration of the effluent water is between the range of 5 to 30mg/L.

Patterson (1994) showed that there was "almost no movement of phosphorus away from the irrigation area" for an effluent irrigated pasture, this fact is also supported by Barrow (1989).

Movement of phosphorus through the soil profile seems to only occur in coarse grained soils with high water flows.

The production figures for Phosphorus are sourced from Witt *et al.* 1974, as follows:

Table 11: Production Figures for P in kg/person/year

Parameter	Toilet	Kitchen	Dishwasher	Laundry	Bath	Total
Total P	0.2	0.15	0.3	0.8	0.01	1.5

The overall Phosphorus balance equation becomes dependant on the uptake rates of various disposal methods and the soil sorption rate. The use of an AWTS compared to a baffled septic tank can also change the effluent concentration being applied to the land application area. The following table gives some values for P in the effluent after treatment.

Table 12: Phosphorus Performance Rates for Treatment Systems (mg/L)

Treatment Type	P in Effluent (Beavers & Gardner)	P in Effluent (Martens)	N in Effluent (EHP Guidelines)	Design Performance (mg/L)	Design Performance %
Septic Tank		10 – 15	10 – 15	12	No Change
AWTS	7 – 12	10 – 20	10 – 15	10	No Change

The figure in Table 11 above are based on a Raw Sewerage P concentration of 10 - 20mg/L

The extent of Phosphorus movement can then be estimated using the Ryden & Pratt formula, as follows:

Assume that the flow is a slug flow which means that no Phosphorus moves downwards until the storage capacity of the upper soil layers are filled, (Ryden & Pratt 1980). Using a rearranged version of the Ryden & Pratt equation it is possible to determine the disposal area required to retain phosphorus and allow for its uptake by plants.

$$\text{Disposal Area } (m^2) = \frac{Ip \times 10000}{[(Ps(Wtd - Bwt)/T) + Hp]}$$

Where:

Ip	=	Phosphorus content of the effluent kg/ha/year
Ps	=	Phosphorus sorption rate of the soil kg/ha/year
Wtd	=	Water table depth m
Bwt	=	Buffer to the water table, depends on soil permeability usually 0.5m

Hp = Phosphorus removed by plants kg/ha/year

T = Time in years, taken as 50 years.

The following is an example based on Phosphorus loadings of a certain application system:

Assume a 3000L Septic tank with a 5 person household having a reticulated water supply and total wastewater flow of 180 x 5 = 900L per day. The disposal area is an evapotranspiration/absorption bed planted with various species such as grasses (sedges & phragmites), and shrubs. The depth to the water table is 2.3m.

The simple Phosphorus balance equation is Phosphorus In = Phosphorus adsorbed + Phosphorus uptake by plants to maintain the natural balance in the soil and not increase background P levels.

A typical household of 5 persons would generate total phosphorus volumes of about, 1.5kg P/person/year (Witt, 1974).

Total Phosphorus 1.5 x 5 = 7.5kg/year.

Phosphorus loading rate from treated effluent = 7.5 kg/year (assume no reduction for the performance of the septic tank).

Phosphorus uptake rate for grasses in a prepared bed. = 30kg/ha/year (table 9)

Phosphorus adsorption rate for (sand soils) podzols = 1,000kg/ha/m (table 10)

Table 11 percentage improvements could be used if the treatment option selected has a better performance. The Ryden & Pratt equation can be used to calculate the effected disposal area or required disposal area.

The Phosphorus sorption rate of the soil is determined by laboratory analysis but typical figures for the Tweed Richmond region have been determined see Table 10. In this example for a sand soils or podzols the P_s is 1,000kg/ha/year.

The depth to the water table at the site need to be determined W_{td} and a buffer B_{wt} allowed to ensure the disposal bed is large enough to not interact with the subsoils water. In cases where the water table is greater than 10m use 10m as the depth and a buffer of 0.5m.

The plant uptake for this example, grasses take up 30kg/ha/year = H_p

Time is the time taken for the soil to be saturated with Phosphorus, this is suggested by the E&HP Guidelines to be 50 years. This figure needs to be a significant time and should relate to the length of time the land use is to be present on the site. Some development have a sunset clause and this could be substituted at the discretion of the Local Council.

The equation then is calculated as follows:

$$\text{Disposal Area} = \frac{7.5 \times 10000}{[(1000 \times (2.3 - 0.5)/50) + 30]}$$

$$= 1136\text{m}^2$$

The following is an example based on Phosphorus loadings:

Assume a 3000L Septic tank with a 4 person household having a non-reticulated water supply and total wastewater flow of 115 x 4 = 460L per day. The disposal area is a subsurface irrigation area using turf or lawn.

The simple Phosphorus balance equation is Phosphorus In = Phosphorus adsorbed + Phosphorus uptake by plants to maintain the natural balance in the soil and not increase background P levels.

A typical household of 4 persons would generate total phosphorus volumes of about, 1.5kg P/person/year (Witt, 1974).

Total Phosphorus 1.5 x 4 = 6kg/year.

Phosphorus loading rate from treated effluent = 6 kg/year (assume no reduction for the performance of the septic tank).

Phosphorus uptake rate for turf or lawn. = 20kg/ha/year (table 9)

Phosphorus adsorption rate for sand soils podzols = 1,000kg/ha/m (table 10)

Table 11 percentage improvements could be used if the treatment option selected has a better performance. The Ryden & Pratt equation can then be used to calculate the required disposal area.

Calculate over 50 years as before.

The equation then is calculated as follows:

$$\text{Disposal Area} = \frac{6 \times 10000}{[(1000 \times (2.3 - 0.5)/50) + 20]} = 1071m^2$$

Another way to understand this movement of Phosphorus is to consider the Phosphorus to be moving like a front advance through the soil profile as the disposal area and its immediate surrounds fill with Phosphorus. Then the equation can be rearranged to see how long the Phosphorus takes to move 1 meter as follows:

Time for 1m = 1000/((60000/1071) – 20) = 27.7 years to penetrate one metre of soil depth.

Therefore, for a soil depth, in this case water table depth less buffer (2.3 – 0.5) = 1.8m the time for the Phosphorus to reach this level is

27.7 x 1.8 = 50year, the period as suggested in the E&HP Guidelines.

In the alternative way of understanding the movement of "Phosphorus" in soil, if the depth to the water table is less than 2.3m the Phosphorus disposal area will need to be increased or the plant species changed to a higher Phosphorus uptaking plant.

If the soil in the disposal area is conditioned by the lining of the disposal bed with compacted Krasnozem 0.3m thick, using the P sorption value for Krasnozem of 12000kg/ha/m from Table 10 then the two examples would then become:

$$\text{Conditioned Disposal Area} = \frac{6 \times 10000}{\frac{(1000 \times (2.3 - 0.3 - 0.5) + (12000 \times 0.3))}{50} + 30}$$

$= 428m^2$ (Evaptranspiration/absorption bed with typha & phragmites grasses)

and/or

$$\text{Conditioned Disposal Area} = \frac{6 \times 10000}{\frac{(1000 \times (2.3 - 0.3 - 0.5) + (12000 \times 0.3))}{50} + 20}$$

$= 462m^2$ (for turf or lawn)

The daily model is set up to allow ease of comparison between different types of disposal systems and an interactive approach will quickly lead to the most effective solution. These above calculations for Phosphorous have been included in the daily model, along with the Nitrogen and Hydraulic, for ease of application. The model also automatically compares the Nitrogen area requirements with the Phosphorus and Hydraulic areas and selects the largest area to determine the final disposal area for the particular application.

2.9.4 Operation of Daily Effluent Model

The daily effluent disposal model is contained on an Excel Spreadsheet for ease of operation. Parameters which need to be entered by the user are indicated in blue, and the appropriate source of the data from this report is indicated with notes in the Spreadsheet. The model can be used for either absorption or irrigation/evapo-transpiration systems by modifying the following parameters:

- For absorption systems, the depth and void space ratio of the disposal trench needs to be entered into the spreadsheet. The product of these factors gives the depth of storage in the trench, and
- For irrigation or evapo-transpiration systmes, the depth of the topsoil (rooting zone) and the available water needs to be entered into the spreadsheet. The product of these factors gives the soil moisture holding capacity.

The model performs a daily water balance over the period of record, and calculates the maximum number of consecutive days on which disposal could not be undertaken ("Max cum stor") and the total number of days in the period of record in which disposal is not possible ("Storage required"). If no wet-weather storage is possible in the system (such as with septic systems), this gives an indication of the number of days on which an overflow from the disposal area will occur. The designer of the system needs to balance the number of days on which overflows from the disposal area occur against the sensitivity of the receiving environment.

2.10 *Pathogen Reduction By On Site Treatment*

Of a major concern to designers of on-site treatment systems is the human health component. Interests include bacteria, viruses, protozoans and helminths. In the past septic tank have been responsible for the contamination of surface and subsurface waters. Septic tank effluent contains concentrations of $10^5 – 10^6$ organism per 100ml making it unsuitable for irrigation, (Whelan & Parker 1981). However once the effluent water passes through the biomat of the disposal bed the organism levels can drop significantly. On the other hand some AWTS systems use chlorine to reduce organism to target levels, which is introducing a chemical control requiring almost constant monitoring and management for effective performance. Studies by Rawlinson and Jelliffe (1995), showed figures of between 40 to 70% failure rates for AWTS with respect to disinfection.

Viruses are more resistant to disinfection than bacteria, (Ashbolt 1995) and can be carried over in effluent. Electrostatic adsorption to organic matter and clay particles, followed by microbial attack appear the major decay process (Yates & Yates 1988).

The most effective disinfection method for on-site disposal systems is based on survival times for viruses in groundwater, which is also dependant on temperature (Yates & Yates 1988). Pathogen removal can also occur in subsurface flow wetlands through a combination of several factors such as, natural die off, predation, antibiosis, sedimentation, filtration, aggregation, entrapment in the biofilm, desiccation, oxidation, adsorption to organic matter and exposure to biocides (Ottova et al 1997, Reed et al. 1995; Rivera et al 1995; Brix 1993; Hilton 1993). Generally removal rates are higher in vegetated beds than beds without vegetation. Increased oxidation due to root penetration is believed to promote faecal coliform die-off along with the antibiotic effect and root excretion, (Brix and Ottova). Removal is exponential with respect to distance along the wetland channel (Green et al. 1997; Butler et al. 1993). Faecal coliform removal is commonly above 98% in subsurface systems (Ottava), with removal of 1 – 2 logs (orders of magnitude) at 3 – 7 days detention being common (Reed et al 1995).

Work carried out by Jelliffe (1996) has calculated minimum setback distances from watercourses for both septic (no disinfection) and AWTS (with disinfection) treated effluent, based on the Beaves & Gardner (1993) method of calculating virus attenuation in soils. The minimum setback distances to sensitive areas, such as watercourses, dams, bed rock outcrops, etc. varies depending on the permeability of the soil and the slope. Clearly more highly permeable soils at high slopes require larger set back distances. A mid point number in these calculation is 10% land slope and a 1.5m/day Permeability results in a 38m setback distance for “No” disinfection and 16m “with” disinfection for virus attenuation in the soils only.

Minimum setback distances to watercourses for each of the soil classes outlined in Section B.5 were determined using the work by Jelliffe (1966) and Beaves & Gardner (1993).

Representative permeability’s for the Soil Groups were taken for the worst case from test results in Appendix 7.2.4 of Morand (1994) and Morand (1996) and from other studies by this office and the Local Councils. The worst case was adopted so that public health and safety is maximised. The absolute minimum setback distance permitted for disposal areas to permanent watercourses shall be the distances shown in Table 13. The proximity to the water body may not be the critical issue if the water table is close to the surface, or if bed rock is also close allowing a more direct link to the sensitive location.

Table 13 - Minimum Setback Distances to Sensitive Locations Tweed/Richmond Region

Soil Group	Worst Case Permeability	Buffer Distance (m)		
		<10%	11-15%	>15%
Alluvial clays (HR)	1m/day	40	60	120
Dark Basaltic	1m/day	40	60	120
Krasnozem	1m/day	40	60	120
Sandy Duplex	2m/day	60	75	150
Clayey Duplex	2m/day	60	75	150
Humic Gleys	**To be Calculated**	60	75	150
Podsols	4m/day	95	150	250

Source: Jelliffe (1996), Beaves and Gardner (1993)

The distances to dry gullies, or a gully which only flows during heavy rain, is a special case as they are common in parts of the Council area. The setback distances can be similarly calculated as in table 13 above. Thus a second table has been prepared to show the setback distances to the gullies, see Table 14.

The setback distance to the gully may not be the limiting factor as the water table would often be intersected before a dry gully. If there is a good connection between the dry gully and the water table then this will often be demonstrated by the presence of water or dampness in the gully floor. In this case the gully must be regarded as a "wet gully" and the set back distances of Table 13 applied. This is particularly the case in the more highly permeable soils.

Table 14 - Minimum Setback Distances to Dry Gullies with water flow only during heavy rain, Tweed/Richmond Region (m)

Soil Group	Worst Case	Av. Slope 0-10%		Av. Slope 11-15%		Av. Slope 16-20% or Greater	
	Permeability	No Dis.	Dis.	No Dis.	Dis.	No Dis.	Dis.
Alluvial	1m/day	25	10	40	15	75	30
Dark Basaltic	1m/day	25	10	40	15	75	30
Krasnozem	1m/day	25	10	40	15	75	30
Sandy Duplex	2m/day	55	20	75	30	150	65
Clayey Duplex	2m/day	55	20	75	30	150	65
Humic Gleys	To be calculated	55	20	75	30	150	65
Podzols	4m/day	95	45	150	65	310	130

No Dis. - treatment does not include disinfection
Dis. - treatment includes disinfection

2.11 Salinity and Alkalinity Hazard

Faulkner and Jones (1996) outline the potential hazards of sodium for both plant growth in a disposal area and on soil structure:

"Some crops have a low tolerance of sodium in water combined as chloride, sulphate, bicarbonate or carbonate. Such crops can accumulate unhealthy levels of sodium in their tissues resulting in poor growth and even death of the plant. Sodium may also cause deflocculation of clay and clay loam soil particles, resulting in deterioration of the soil structure. These soils are sticky when wet and crack when dry and are often known as "sodic soils". (p89)

Soluble salts are always present in soils, but some can be harmful to crop growth. Accumulation of salts in the upper layers of a soil and on the soil surface can eventually render a soil infertile. NSWEPA (1995) indicate that damage to sensitive crops is likely at sodium concentrations above 70mg/L. Insoluble salts are found in the soil structure and linked with clay particles. There is a continuous interchange or exchange of salts as ions between the two, to establish an equilibrium situation. Soluble salts can be extracted by suitable drainage, and the insoluble salts linked with clay particles can be exchanged by chemical reaction. There is a limit to the number if exchangeable ions which can be held in any soil, and the limiting number is termed the cation exchange capacity (CEC).

The soil structure can be damaged when an applied effluent contains more sodium than calcium or magnesium, which reduces permeability, aeration, infiltration rate and soil workability. Increasing salinity also increases the suction pressure needed by roots to extract moisture from a soil, therefore reducing the available water.

The sodium hazard of a soil can be measured using either the Exchangeable Sodium Percentage (ESP) or the Sodium Adsorption Ratio (SAR):

SAR = Soluble sodium concentration / √ [Soluble calcium + magnesium)/2]

ESP = (exchangeable sodium content)/ (cation exchange capacity) x 100

= 100 (-0.0126 + 0.01475 x SAR) / [1+(-0.0126 + 0.01475 x SAR]

Patterson (1994) indicates that structural stability of Australian soils decrease when the ESP exceeds 5, while Faulkner and Jones (1996) recommend that the SAR of a soil should remain less than 9.0 to prevent deflocculation. Northcote and Skene (cited in Morand, 1994) indicate that soils with an ESP greater than 6 are considered sodic.

An indication of the SAR of the proposed disposal area can be ascertained with by a field test, the Modified Emerson Aggregate Test or reputable reference data. If a particular site requires a more detailed assessment such as would be the case with a high risk site, then SAR should be tested on site. Sites with an ESP greater than **9** are generally unsuitable for in-situ use as an effluent disposal area. Where the ESP of a soil exceeds 9, soil conditioning by mixing a suitable additive such as gypsum with the soil may be undertaken to enable an area to be used for effluent disposal. The proposed disposal area would need to be tested a second time, following the addition of the additive to verify that the ESP is below 9.

The Modified Emerson Aggregate test provides a field assessment of the aggregate stability (Dispersivness) by using typical greywater - water with detergent added or Sodium Absorption Ration (SAR) 5 solution. The test involves placing about three 5mm diameter soil aggregates from the profile within a beaker of either of the above solutions, and left undisturbed for 5 hours. If the end result is that the soil is dispersive then gypsum will have to applied to the disposal area at a predetermined rate in order to aid in the prevention of degradation to the soil structure.

A soil is deemed to be saline depending on the quantity of soluble salts it contains. Soil salinity is normally measured using the conductivity of the soil water, and the higher the conductivity, the higher the salinity. Plants have been arbitrarily classified into four groups, High Tolerance, Medium Tolerance, Low Tolerance and Very Low Tolerance, according to their tolerance to salts in the water in contact with their roots. These classifications have been based on the maximum electrical conductivity of the saturated soil extract, which will give an acceptable reduction in growth rate for the crop under Australian conditions. Reid (cited in NSWEPA, 1995) gives some soil salinities at which plant yield reductions of 10 and 50 per cent may be expected:

Plant	EC_e (μS/cm) 10% reduction	EC_e (μS/cm) 50% reduction
High Tolerance		
Barley (grain)	10,000	18,000
Couch Grass	8,500	14,700
Perennial Ryegrass	6,900	12,200
Medium Tolerance		
Lucerne	3,400	8,800
Cocksfoot	3,100	9,600
Low Tolerance		
White clover	2,300	5,700

If plant transpiration is being considered for effluent disposal, then the salinity of the site soil needs to be considered and the disposal area corrected using the above table to account for any reduction in plant yield due to the existing site salinity.

For example, it is proposed to plant a disposal area with an ECe of 2900µS/cm with white clover. From the table above, the crop yield is reduced by 10%, and hence the disposal area needs to be increased by:

$$\frac{1.00}{(1.00\text{-}10\%)} = 11\%$$

NSWEPA (1995) recommend that to minimise permeability and aeration problems, an applied effluent should have a maximum SAR of **6**. In systems with no leaching (ie evapotranspiration only systems), the maximum permissible EC in the effluent is **250µS/cm** (ie a C_1 salinity hazard). In systems with leaching, the maximum permissible EC in the effluent **750µS/cm** (ie a C_2 salinity hazard) although the EC should generally not exceed **500µS/cm**.

3.0 SOILS WITHIN THIS REGION

Soils within the subject area have derived from a number of environmental factors being climate, parent rock, topography and natural vegetation.

Each particular disposal site must be inspected by a competent professional and a determination made of the site conditions. With respect to the soils on a subject site it is proposed that the soils be classified accordingly to the following soil groups which are considered to be a broad coverage of the soils within the Council area.

For each soil type listed below, key characteristics are provided, which will then become the design standard for wastewater disposal design for that soil group. The use of a standard design does not negate the need for a site assessment and operations report as per this manual. Design reports submitted should include the appropriate design selected, drawings (even if this is one of the standard designs) to allow formal approval to be given by Council and inclusion of the design details in the Wastewater Management Approval Register. The inspection then carried out by Council from time to time will verify the design and its performance.

3.1 Alluvial Soils (Highly Reactive Soils)

Soil Landscapes Include: Leycester, Tatham, Distributed Plains, North Casino

These soils are the result of the alluvial deposits and in the Richmond Valley are of basaltic and shale origin. These soils occur on the flats and lower slopes of the larger creeks and flats through the study area. The soils are derived from Basaltic parent material of Lamington Volcanics, being Lismore Basalts. Associated soil groups have developed from alluvial deposits including **Meadow Soil, Wiesinboden, Prairie Soils and Black Earths** (old classification system of Great Soils Group) or Australian Soil Classification System Isbell 1996. The soils range in textural classes from **loams to clays** depending on the nature of the catchment from which the alluvium was derived.

The surface soil is dark grey or black consisting of clay or clay loam, which is sticky when wet and cracks on drying. When soils are waterlogged for extensive periods they become acid throughout the profile, this is common in the coast area in a mix of different soils.

These soils are high in organic matter and basic mineral elements, but deficient in phosphorous, sulphur and molybdenum (Richmond Valley Naturalists Club *et al*, 1975).

This group contains the heavy textured pug soils (60-80% clay) which are acidic throughout (pH 5.0) with a slight rise in pH in the deep subsoil (pH 6.5).

The Wiesenboden soils occur in association with Meadow Soils in the middle and upper reaches of the Richmond River. These are undifferentiated clay soils with gley horizons, occurring in treeless situations subject to flooding and waterlogging.

The Prairie Soils and Black Earths, occurring in better drained valleys near Casino and Kyogle are dark clays, with strongly structured top and subsoils. The pH is near neutral in the topsoil and increases in alkalinity in depth. These soils do not show the gley horizons.

The soils can be strongly acid and highly plastic and tend to have a tendency to become waterlogged. There is a high aluminium toxicity potential.

Permeability: These soils generally have low permeability of rarely in excess of 300mm/day (usually less than 100mm/day) which is equivalent to a Long Term Acceptance Rate of not more than 20L/m^2/day (20mm/day).

The following conservative DIR and LTAR should be used to design the disposal area, unless evidence is given for alternative rates.

Structure	Conservative LTAR (mm/day)
High/Moderate Pedality	5
Weakly Pedal	5
Massive	Not Recommended – Choose Alternate Design

Cation Exchange Capability: Moderate to high cation exchange capacity, which infers that the soils can retain specific pollutants. These soils are able to adsorb an amount of exchangeable positive ions such as calcium, magnesium, potassium, sodium, hydrogen, aluminium and manganese. These ions interchange between the soil solution and the clay or organic complexes within the soil, and is usually affected by the soils pH.

Phosphorous Sorption: The phosphorous sorption of these soils are very high, however it can very from different sites, with a range of P sorption at 1m being from 6,000 to in excess of 27,000 kg P Sorption/ hectare. Average P sorption values for this soil is 17,000 kg P Sorption/hectare, based on information supplied by the Environmental Analysis Laboratory at Southern Cross University.

The conservative P sorption value to be used is **10,000 kg** P Sorption/hectare for this soil type

Sodicity: The exchangeable sodium percentage (ESP) of these soils is relatively low to medium, between 0 -10%. Soils with an ESP of more than 15% are strongly sodic and will disperse. A simple Modified Emerson Aggregate Test should be undertaken to determine the class of dispersiveness, which would relate to the ESP of the soil.

Electrical Conductivity: The EC of these soils is generally less than 4dS/m, which does not pose a problem to on-site effluent disposal.

Field pH: The field pH of the soil should be taken on site, although general pH 1:5 Soil:Water is in the range of 5 to 6. Lime should be used within the disposal bed to increase pH levels to around 6 to 7 in order to optimise plant growth to uptake nutrients.

Bulk Density: Soil compaction can occur within these soils which increases the bulk density. Some soils may have soils with a bulk density of above 1.4g/cm which would require a high standard of effluent treatment and disposal system. Soils with a high bulk density have a massive structure which would be required to be deep ripped or mixed with imported soil to improve the porosity of the soil.

Site Drainage: The soils of this site usually have poor drainage due to the high shrink swell ratio and high clay content. Imported soil such as sand or gravel will possibly be required to improve the distribution of wastewater through the disposal area.

Effluent Disposal: The soils within this group are relatively shallow, rocky and localised waterlogging can occur. At all times waterlogged soils should be avoided, such as the soils adjacent to creeks. Adequate drainage should be provided. A broad view of the subject locality should be taken to ensure no localised water logging can occur.

Preferred Systems: The preferred disposal systems on these soil types include mounds or similar, evapotranspiration/absorption beds, surface and subsurface irrigation. Absorption systems are not recommended.

3.2 Dark Basaltic Soils - Chocolate Soils

Soil Landscapes Include: Georgica, McKee, Mackeller, Fredrick

Friable dark **clay loams and clay** soils with weak to moderate horizon differentiation. Derived from Lamington Volcanics: Lismore Basalts. These soils occur in areas of less than 1,400mm of annual rainfall, being areas north of Casino, and extend from Lismore to the Queensland border. In the Tweed Valley the soils are found on the dissected basaltic scarps of the upper watershed, usually on steeper slopes. Near Kyogle the soils with reddish chocolate topsoils and subsoils are associated with chocolate.

Loose basalt rocks or “floaters” are common and the soils are shallow. The soils are dark, brown, chocolate colour and have a clay to clay-loam topsoil and a sticky clay subsoil which restricts drainage.

The depth of the soil above the weathering basalt rarely exceeds 1.5m.

Reddish chocolate soils are found where iron rich parent materials outcrop and mix with soil developed on basalt.

Permeability: These soils generally have low permeability of rarely in excess of 300mm/day (usually less than 100mm/day) which is equivalent to a Long Term Acceptance Rate of not more than 20L/m^2/day (20mm/day).

The following conservative DIR and LTAR should be used to design the disposal area, unless evidence is given for alternative rates.

Structure	Conservative LTAR (mm/day)
High/Moderate Pedality	5
Massive -Weakly Pedal	5

Cation Exchange Capability: Moderate to high cation exchange capacity, which infers that the soils can retain specific pollutants. These soils are able to adsorb an amount of exchangeable positive ions such as calcium, magnesium, potassium, sodium, hydrogen, aluminium and manganese. These ions interchange between the soil solution and the clay or organic complexes within the soil, and is usually affected by the soils pH.

Phosphorous Sorption: The phosphorous sorption of these soils are very high, however it can vary from different sites, with a range of P sorption at 1m being in the range from 7,000 to in excess of 26,000 kg P Sorption/hectare.

Average P sorption values for this soil is about 18,000 kg P Sorption/hectare, based on information supplied by the Environmental Analysis Laboratory at Southern Cross University.

The conservative P sorption value to be used is **12,000 kg** P Sorption/hectare for this soil type

Sodicity: The exchangeable sodium percentage (ESP) of these soils is relatively low to medium, between 0 -10%. Soils with an ESP of more than 15% are strongly sodic and will disperse. A simple Modified Emerson Aggregate Test should be undertaken to determine the class of dispersiveness, which would relate to the ESP of the soil.

Electrical Conductivity:

The EC of these soils is generally less than 4dS/m, which does not pose a problem to on-site effluent disposal

Field pH: The field pH of the soil should be taken on site, although general pH 1:5 Soil:Water is in the range of 5 to 6. Lime should be used within the disposal bed to increase pH levels to around 6 to 7 in order to optimise plant growth to uptake nutrients.

Bulk Density: Soil compaction can occur within these soils which increases the bulk density. Some soils may have soils with a bulk density of above 1.4g/cm which would require a high standard of effluent treatment and disposal system. Soils with a high bulk density have a massive structure which would be required to be deep ripped or mixed with imported soil to improve the porosity of the soil.

Site Drainage: The soils of this site usually have poor drainage due to the high shrink swell ratio and high clay content. Imported soil such as sand or gravel will possibly be required to improve the distribution of wastewater through the disposal area.

Effluent Disposal: The soils within this group are relatively shallow, rocky and mostly occur on slopes. It is not recommended that disposal be undertaken in areas of known mass movement or landslips, and adequate drainage and distribution of wastewater must be provided at all times.

Preferred Systems: On slopes the preferred disposal systems consists of skinny evapotranspiration/absorption trenches, or subsurface irrigation systems. These soils are generally unsuitable for absorption trench systems unless otherwise proven.

3.3 Krasnozems Or Red Basaltic Soils

Soil Landscapes Include: Bangalow, Eltham, Ewingsdale, Wollongbar

Usually deep, red, well structured acid and porous clay soils mostly found on basalt parent materials in areas where rain exceeds 1,200mm. These soils are found on the Alstonville Plateau to Goonellabah to the Ballina escarpment and from Dorroughby to Federal.

These soils are red to red-brown in colour and are clay loam soils with little to no change within the soil profile in either texture or colour. These soils are usually deep, have good structure are free draining, despite the high content of clay (60-80%). The red oxides are largely responsible for fixation of phosphorous and hence low availability of this element to plants in this soil type.

Aluminium toxicity is high and can lead to toxicity in plants, this is due largely to the low pH of the soils. Neutralising the soils by the addition of lime to the soil profile will aid in the prevention of metal toxicities and will improve the availability of P to plants.

Permeability: These soils generally have high permeability, which can exceed 1,000mm/day due to the highly aggregate nature. Over time Krasnozems will tend to clog, especially when receiving a constant rate of wastewater, when they resemble more like silty clay than a loam clay.

The following conservative DIR and LTAR should be used to design the disposal area, unless evidence is given for alternative rates.

Structure	Conservative LTAR (mm/day)
High/Moderate Pedality	10

Cation Exchange Capability: Moderate cation exchange capacity, which infers that the soils can retain specific pollutants. These soils are able to adsorb an amount of exchangeable positive ions such as calcium, magnesium, potassium, sodium, hydrogen, aluminium and manganese. These ions interchange between the soil solution and the clay or organic complexes within the soil, and is usually affected by the soils pH.

Phosphorous Sorption: The phosphorous sorption of these soils are very high, however it can very from different sites, with a range of P sorption at 1m being in the range from 5,500 to in excess of 47,000 kg P Sorption/hectare.

Average P sorption values for this soil is 13,500 kg P Sorption/hectare (without extreme readings), based on information supplied by the Environmental Analysis Laboratory at Southern Cross University.

The conservative P sorption value to be used is **10,000 kg** P Sorption/hectare for this soil type

Sodicity: The exchangeable sodium percentage (ESP) of these soils is relatively low to medium, between 0 -10%. Soils with an ESP of more than 15% are strongly sodic and will disperse. A simple Modified Emerson Aggregate Test should be undertaken to determine the class of dispersiveness, which would relate to the ESP of the soil.

Electrical Conductivity: The EC of these soils is generally less than 4dS/m, which does not pose a problem to on-site effluent disposal.

Field pH: The field pH of the soil should be taken on site, although general pH 1:5 Soil:Water is in the range of 5 to 6. Lime should be used within the disposal bed to increase pH levels to around 6 to 7 in order to optimise plant growth to uptake nutrients.

Bulk Density: Soil compaction can occur within these soils which increases the bulk density. Some soils may have soils with a bulk density of less than 1.4g/cm which is not a limiting factor for on-site sewage disposal.

Site Drainage: The soils of this site usually have moderate to very good drainage.

Effluent Disposal: The soils within this group are generally deep although some soils are known to be relatively shallow and contain coarse fragments of shall.

Preferred Systems: On slopes the preferred disposal systems consists of skinny evapotranspiration/absorption trenches, or subsurface irrigation systems. These soils are generally unsuitable for absorption trench systems unless otherwise proven.

3.4 Sandy Duplex Soils (Sandy Podzolic)

Soil Landscapes Include: Coffee Camp, Nammoona, Yorklea

Shallow soils showing minimal profile development and dominated by the presence of weathering rock and rock fragments. Soils have a loamy sand textural class. These soils are located on ridges and crests overlying Kangaroo Creek Sandstone of quartz sandstone, conglomerate. These soils occur within the Goolmangar, Terania, Jiggi, Leycester and Horseshoe Creek drainage networks.

The colour of the B horizon reflects the description of the profile.

Water logging can be expected due to the clay subsoil. The sandy podsolic are usually very low in plant nutrients.

Permeability: These soils generally have moderate to high/rapid permeability, can be well in excess of 1,000mm/day due to the high content of sand. Within the clayey subsoil permeability can be more moderate.

The following conservative DIR and LTAR should be used to design the disposal area, unless evidence is given for alternative rates.

Structure	Conservative LTAR (mm/day)
High/Moderate Pedality	10
Weakly Pedal	10
Massive	10

Cation Exchange Capability: Low to moderate Cation Exchange Capacity, which infers that the soils can not retain specific pollutants. Incorporation of clay or organic matter within the soil profile will improve the CEC for these soils.

Phosphorous Sorption: These soils have moderate to high phosphorous sorption, and can be up to about 18000 kg P Sorption/hectare, for the clayey subsoils. This is based on information supplied by the Environmental Analysis Laboratory at Southern Cross University.

The conservative P sorption value to be used is **8,000 kg** P Sorption/hectare for the subsoils of soil type. More of a sandy based soils which do not possess a clayey subsoil will have a lower P sorption of less than 2,000 kg P Sorption/hectare.

Sodicity: The exchangeable sodium percentage (ESP) of these soils is relatively low to medium, between 0-5%. Soils with an ESP of more than 15% are strongly sodic and will disperse. A simple Modified Emerson Aggregate Test should be undertaken to determine the class of dispersiveness, which would relate to the ESP of the soil.

Electrical Conductivity: The EC of these soils is generally less than 4dS/m, which does not pose a problem to on-site effluent disposal. Some areas with more sandy soils and a high water table may have a higher EC, if in doubt an analysis should be undertaken.

Field pH: The field pH of the soil should be taken on site, although general pH 1:5 Soil:Water is in the range of 5 to 6, although some soils are known to be more alkaline with a pH of 8. Lime should be used within the disposal bed to increase pH levels to around 6 to 7 in order to optimise plant growth to uptake nutrients.

Bulk Density: Some soils may have soils with a bulk density of above 1.8g/cm, which would require a high standard of effluent treatment and disposal system. Soils with a high bulk density have a massive structure, which would be required to be deep ripped or mixed with imported soil to improve the porosity of the soil. Generally these soils have a bulk density of less than 1.8g/cm.

Site Drainage: These soils are generally shallow and stony, with a high permeability rate. Generally the site drainage of these soils is good. Sites must be investigated to ensure that there are no short cuts between the proposed disposal area and groundwater.

Effluent Disposal: The soils within this group are relatively shallow, rocky and rock outcrops can occur. Some sites within this soil group may be unsuitable for any type of effluent disposal due to there high percentage of fragments (gravel soils) which would not maintain plant growth and would permit leaching of contaminants off site.

The soils have a low available water-holding capacity and are strongly acid. It is considered that these soils are not suitable for effluent disposal as they are. Improvement such as incorporating organic material within the soil can increase water holding capacity and CEC.

Preferred Systems: On slopes the preferred disposal systems consists of skinny evapotranspiration/absorption trenches, or subsurface irrigation systems. These soils are generally unsuitable for absorption trench systems unless otherwise proven. Lime should also be added to neutralise the soils, in order to maximise nutrient uptake of P and N by plants.

3.5 Clayey Duplex Soils (Loam Based Podzolic Soils)
Soil Landscapes Include: Calico, Burringbar, Byrril

Acid soils with a strong textural contrast between the loamy topsoils and clay subsoils. Some podsolic soils occur on the Walloon Coal Measures being grey claystone and shales and fine to medium-grained, soft, grey lithic sandstones.

The colour of the B horizon reflects the description of the profile.

The texture of the A horizon is dependent on the sediments from which the soil is developed. The Walloon Coal Measures will have clay loam topsoils.

Permeability: These have low to moderate permeability, depending on the structure of the soil profile. The B horizons tends to be hardsetting when dry and very plastic when wet being because of clay texture.

Structure	Conservative LTAR (mm/day)
High/Moderate Pedality	10
Weakly Pedal	5
Massive	5

Cation Exchange Capability: Low to moderate Cation Exchange Capacity, which infers that the soils can not retain specific pollutants. Incorporation of organic matter within the soil profile will improve the CEC for these soils.

Phosphorous Sorption: These soils have moderate to high phosphorous sorption, and can be up to about 18,000 kg P Sorption/hectare, for the clayey subsoils. This is based on information supplied by the Environmental Analysis Laboratory at Southern Cross University.

The conservative P sorption value to be used is **8,000 kg** P Sorption/hectare for the subsoils of soil type.

Sodicity: The exchangeable sodium percentage (ESP) of these soils is between 5-10%, which is medium. Soils with an ESP of more than 15% are strongly sodic and will disperse. A simple Modified Emerson Aggregate Test should be undertaken to determine the class of dispersiveness, which would relate to the ESP of the soil. Over time the soil structure of these soils will degrade due to sodium within wastewater. Sites with this soil type should have a management plan for the resident, which involves the application of gypsum onto the soils.

Electrical Conductivity: The EC of these soils is generally less than 4dS/m, which does not pose a problem to on-site effluent disposal.

Field pH: The field pH of the soil should be taken on site, although general pH 1:5 $CaCl_2$ is in the range of 3.5 to 5. Lime should be used within the disposal bed to increase pH levels to around 6 to 7 in order to optimise plant growth to uptake nutrients.

Bulk Density: Some soils may have soils with a bulk density of above 1.4g/cm, which would require a high standard of effluent treatment and disposal system. Soils with a high bulk density have a massive structure, which would be required to be deep ripping or mixing with imported soil to improve the porosity of the soil. Generally these soils have a bulk density of less than 1.4g/cm.

Site Drainage: These soils are generally shallow and stony, with a high permeability rate. Generally the site drainage of these soils is good. Sites must be investigated to ensure that there are no short cuts from the proposed disposal area entering watertables etc.

Effluent Disposal: These soils tend to be dispersive/sodic and hardsetting. The subsoils being of clay can become saturated therefore careful planning will need to be undertaken when designing a disposal system for this soil type. Systems that rely only on soil absorption are not recommended for this soil type.

Preferred Systems: On slopes the preferred disposal systems consists of skinny evapotranspiration/absorption trenches, or subsurface irrigation systems. These soils are generally unsuitable for absorption trench systems unless otherwise proven. Lime should also be added to neutralise the soils, in order to maximise nutrient uptake of P and N by plants.

3.6 *Humic Gley Soils - Swamp Soils*

Soil Landscapes Include: Tweed, Cobaki

Gley soils occur in the south of the study area, between Woodburn and Whiporie. These soils have developed from sandstone under poor drainage conditions with a high water table causing the blue grey colour of the B horizon.

Most potentially acid sulphate soils and actual acid sulphate soils are found within this soil type.

Permeability: These soils generally have low permeability due to the often waterlogged conditions, high watertable and high clay content within subsoils.

Generally these soils should be avoided for on-site sewage disposal unless above ground systems are used and therefore no permeability rates are provided.

Cation Exchange Capability: These soils usually have a high Cation Exchange Capacity, which infers that the soils can retain specific pollutants.

Phosphorous Sorption: These soils have high phosphorous sorption. No results are provided as on-site inspection should be carried out and P sorption analysis undertaken if consultant recommends that on-site wastewater disposal can in fact be undertaken.

Sodicity: The exchangeable sodium percentage (ESP) of these soils is relatively low to medium, between 0 -5%. Soils with an ESP of more than 15% are strongly sodic and will disperse. A simple Modified Emerson Aggregate Test should be undertaken to determine the class of dispersiveness, which would relate to the ESP of the soil.

Electrical Conductivity: The EC of these soils is generally in excess of 5dS/m, which can pose a problem to on-site effluent disposal. Analysis should be undertaken if considering these soils for on-site wastewater disposal.

Field pH: The field pH of the soil should be taken on site, although general pH 1:5 ($CaCl_2$) is 2 -5. Lime could be used within the disposal bed to increase pH levels to around 6 to 7 in order to optimise plant growth to uptake nutrients. Acid Sulphate Soils may also occur within these soils, and disturbing of this material is not recommended, above ground disposal systems with imported fill should be considered.

Bulk Density: These soils do compact when wet, although generally they have a bulk density in less than 1.8g/cm.

Site Drainage: These soils are usually poorly drained and are often water logged. These soils are generally unsuitable for on-site sewage disposal.

Effluent Disposal: These soils are generally unsuitable for effluent disposal, unless disposal systems are installed suitable for high limitations. Due to the high potential for acid sulphate soils it is highly recommended that on-site inspections are carried out and soil be analysed for the above soil factors.

Preferred Systems: Enclosed systems or mounded systems should be used, consisting of imported fill. Deep trenches are not recommended.

3.7 *Podzols - Sandy Soils*

Soil Landscapes Include: Kingscliff, Pottsville

Acid sandy soils with strongly differentiated horizons including a bleached horizon above a coffee coloured pan and coloured subsoil. Sand deposits cover large areas of the narrow coastal plain and are found in within the towns close to the coastline. These soils occur on highly siliceous, sandy parent materials. Such materials include old coastal sand dunes, sandstones and siliceous granites. The associated soils include siliceous sands, humus podzols and peaty podzols.

Permeability: Moderate to high permeability which is often restricted by the underling indurated sand (coffee rock).

Structure	Conservative LTAR (mm/day)
High/Moderate Pedality	10
Weakly Pedal	10
Massive	10

Cation Exchange Capability: These soils have low cation exchange capacity, which permits leaching of pollutants to the groundwater. Clay or organic material should be incorporated within the disposal area to condition the natural soils.

Phosphorous Sorption: The phosphorous sorption of these soils is very low. The soils have a low phosphorus fixation and the predicted Phosphorus sorption rate is 1,455kg/ha/y at 1m, although some soils may have a lower P sorption rate to this.

The conservative P sorption value to be used is **1,000 kg** P Sorption/hectare for this soil type

Sodicity: The exchangeable sodium percentage (ESP) of these soils is medium, between 5-10%. Soils with an ESP of more than 15% are strongly sodic and will disperse. A simple Modified Emerson Aggregate Test should be undertaken to determine the class of dispersiveness, which would relate to the ESP of the soil.

Electrical Conductivity: The EC of these soils is generally moderate to high with some readings below 8dS/m, which does pose a problem to on-site effluent disposal

Field pH: The field pH of the soil should be taken on site, although general pH 1:5 ($CaCl_2$) is 3-5. Lime could be used within the disposal bed to increase pH levels to around 6 to 7 in order to optimise plant growth to uptake nutrients. Acid Sulphate Soils may also occur within these soils.

Bulk Density: These soils do compact when wet, although generally have a bulk density less than 1.8g/cm.

Site Drainage: These soils can become poorly drained at times due to either high watertables or underlying bedrock, although other areas have better site drainage due to the deeper soil profile.

Effluent Disposal: The soils of this class usually overly high watertable, are highly permeable and can be shallow.

Preferred Systems: The preferred disposal systems on these soil types include Mounds or similar, evapotranspiration/absorption beds, surface and subsurface irrigation. Absorption systems are not recommended for these soils. It is proposed that clay or organic matter be incorporated within the disposal system which will increase the P sorption and water holding capacity.

4.0 SITE ASSESSMENT

The site assessment task in the design of wastewater disposal systems is critical to the overall successful long term operation of an environmentally sustainable system. There are different situations that require different levels of information such as:

4.1 Rezoning and New Subdivisions

A full site assessment is required prior to rezoning. This site assessment is to determine restrictions of the site and will require a degree of laboratory analysis which is not required for single site assessment.

Additional requirements for this type of development include:

- Determination of Phosphorous sorption rates;
- Nutrient balances calculations for the catchments involved
- Sodicity;
- Electrical Conductivity;
- Bulk Density;
- Cation Exchange Capacity.

A qualified professional must sign off on the soil type.

All the details must be verified for each site along with a calculation of the maximum disposal area required, and minimum allotment size sought allowing for buffers and safety factors. The maximum range of options is to be maintained at the rezoning stage and therefore the Council will wish to see a reports which canvases options and selects the option that uses the most land. The allotment size will then be selected.

The effectiveness of covenants as a means of controlling the wastewater management system type is not considered satisfactory. In effect this means the largest land area option will be used as the base for sizing the proposed building envelope and allotment size.

4.2 Existing Systems

Existing systems need to be evaluated for activities such as the following

- proposed extension to an existing dwelling;
- change of use;
- increase to the amount of activity of the development, eg. a café opening for breakfast, lunch and dinner.
- a failing existing on-site system.

The 'Approval to Operate' condition, scheduled to be enforced on July 1st, 1999 under the Local Government Approval Regulation Amendments (1998), requires Council to inspect existing systems and to issue a Certificate of Approval on the basis of the performance of the system. Improvements to the existing system will be discussed as required following these inspections, and as a result of improvements carried out changes to the conditions of the licence may result. Any additions that are carried out between inspections will be noted and owners asked to rectify the situation.

On an existing allotment, where a dwelling and existing septic system may have been removed and a new system is proposed to be installed, it is recommended that the soil be sampled and tested for the following parameters:

- phosphorous sorption (P sorption) to ascertain the amount of phosphorous the soil is able to uptake after it has already been used for effluent disposal.
- Nitrogen form and levels,
- pH
- Sodicity
- Bacteriological counts

The tests should include a background test at a location removed from the existing disposal area, and tests at different levels within the soil horizon. As a guide, two sample holes should be dug in the soils within the known disposal area and soil sampled at two levels within each test hole, at say 200mm and 500mm depths. A third sample hole should be dug remote from the site but within the same neighbourhood to ascertain the background levels naturally occurring in the soil.

In addition to these above requirements a site evaluation as listed below will be required.

4.3 Failing Systems

Should the on-site wastewater disposal system be failing the following steps should be undertaken to rectify the problem:

1. The land owner should seek advice from a qualified plumber or consultant in the first instance to determine the source of the system failure on-site.
2. Contact Council's Planning, Environmental and Community Services Department to discuss your particular situation. The cause of failure for on-site system is site specific. Upgrading a failing system depends on many parameters such as the type of treatment system installed on-site, the amount of water used, soil type of the site, distance from sensitive areas such as watercourses and gullies and the amount of land that is available on-site.

   Council's Environmental Health Officers will advise on what needs to be done in order to make your effluent treatment system and disposal area work in a satisfactory manner.
3. Complete the *required "Application To Install, Construct or Alter a Sewage Management Facility and Issue an Operating Licence"* and submit to Council.

   The application is to be accompanied by a site evaluation conducted by an appropriately qualified person, such as a plumber or consultant.

4.4 Additions, Change of Use

In addition to the above requirements a site evaluation as listed below will be required.

4.4.1 New Development on Land Previously Zoned

Any site requiring on-site wastewater disposal should be examined in accordance with the following parameters. This assessment would then be used to determine the appropriate location for on-site wastewater disposal. There may be situations where the wastewater has to be selected first, irrespective of the house siting, as no other locations on the allotment would be environmentally suitable.

4.5 Site and Soil Evaluation Parameters

A check list is provided as part of Part C *Site Assessment Report Procedures* for a quick reference guide for consultants, plumbers and the general public.

Boreholes are required to be dug to examine the soil profile at the subject site where on-site disposal is proposed to be located. For systems relying mostly on evapotranspiration, boreholes will be required to be dug to at least 800mm. Absorption systems will require deeper holes to determine the location of watertables and bedrock, a minimum depth required is 1.2m

The following provides a definition and methodology to the required parameters.

4.5.1 Soil Texture Classification

It is important that texture grades within the soil profile be identified to aid in the classification of one of the seven soil classes, being **Alluvial, Basaltic, Krasnozems, Sandy Podzolic, Clayey Duplex, Humic Gleys and Sandy Podsols**.

Soil texture is a measure of the behaviour of a small amount of soil when moistened and kneaded into a ball (bolus) and then manipulated between the thumb and forefinger to form a ribbon.

There are nineteen grades of texture, which are commonly recognised and which are determined from the behaviour of the moistened bolus. Soils are made from four basic soil properties being sand, silt, clay and organic matter which affect the texture characteristics of a soil sample.

There are six broad texture groups, which can be used to determine the textural grades of the profile. Soil texture will be used to determine the Each texture grade change within the soil profile should be recorded and examined for pH.

1) Sand

Sand: Nil to slight coherence, can't mould, single grains adhere to fingers, clay content always <10 & commonly <5

Loamy Sand: Slight coherence, ribbon to about 5mm, 5-10% clay content

Clayey Sand: Slight coherence, sticky when wet, many sand grains stick to fingers, ribbon 5-15mm, discolours fingers with clay stain, 5-10% clay content.

2) Sandy Loam

Sandy loam: ball just coherent, very sandy to touch, ribbon 15-25mm, medium size sand grains clay content 10-15%

Light Sandy Clay Loam: strongly coherent ball, sandy to touch; ribbon 20-25mm 15-20% clay content.

3) Loam

Loam: ball coherent, spongy, smooth feel when manipulated, form ribbon of about 25mm ~25% clay content

Silt Loam: Coherent ball; smooth to silky when manipulated ribbon 25mm `25% clay content (>25% silt)

Sandy Clay Loam: strongly coherent ball, sandy to touch, medium size grains, ribbon 25-40mm. 20-30% clay content.

4) Clay loam

Clay Loam: Coherent plastic ball, smooth ribbon 40-50 mm. 30-35% clay content.

Silty Clay Loam: Coherent smooth plastic and silky to touch ribbon 40-50mm 30-35% clay content (silt > 25%)

Fine Sandy Clay Loam: Coherent ball, fine sand felt and heard when manipulated, ribbon 38-50 mm. 30 - 35% clay content.

5) Light Clays

Sandy Clay: Plastic ball; fine to medium sand grains heard or seen. Ribbon 50-75 mm. 35-40% clay content

Silty clay: plastic ball; smooth , silky to manipulate; 50-75mm ribbon. 35-40% clay content (>25% silt)

Light clay: plastic ball; smooth to touch; slight resistance to shearing between thumb and forefinger 50-75mm ribbon. 35-40% clay content

Light medium clay: plastic ball; smooth to touch; slightly greater resistance to shearing between thumb and forefinger about 75mm ribbon. 40-45% clay content.

6) Medium to Heavy Clays

Medium Clay: plastic ball; like plasticine and can be moulded into rods without fracture; some resistance to ribboning shear; form ribbon of 75mm or more. 45-55% clay content

Heavy Clay: Smooth plastic ball; like stiff plasticine; can be moulded into rods without fracture; firm resistance to ribboning shear; will form ribbon of 75mm or more. Above 50% clay content.

4.5.2 Soil Structure

The soil structure is to be determined from visual assessment of the site and borehole testing, through the examination of exposed soil surfaces. A summary of soil structures is:

Degree of Pedality	Appearance
Massive	Coherent, lacking any partings both vertically and horizontally over a distance > 400mm. Pieces do not break along planes of weathering.
Single Grained	Loose incoherent eg sandy soils
Weakly	Peds indistinct and barely observable on pit face. When disturbed approximately 30% consists of peds smaller than 100mm
Moderately	Peds well formed and evident but not distinct in undisturbed soil 30% to 60% when disturbed consists of peds smaller than 100mm
Highly	Peds quite distinct in undisturbed soil. >60% when disturbed consists of peds smaller than 100mm

4.5.3 Colour Description

A colour description of the soil profile should be given, and 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 pale, dark or mottled.

4.5.4 Slope Assessment

The slope of the site should be determined in the field through the use of such instruments as a clinometer or protractor, or via a formal survey of the site. It is necessary to record the shape of the slope, either concave, convex or straight as concave slopes are generally unsuitable for wastewater disposal.

A minimum distance of 20 metres will be required to determine the degree of slope. It is strongly recommended that the site be surveyed which will aid greatly in slope assessment.

4.5.5 Aspect

A compass should be used to ascertain the direction of the slope, with North and North East facing slopes being the recommended positions due to high evapotranspiration, and higher crop factors can be used.

4.5.6 Exposure

The exposure to sunlight and prevailing winds is an asset to disposal areas as there will be an increase in the uptake of water vapour through both evapotranspiration and straight evaporation, depending on the disposal system selected.

4.5.7 Boulders/Floaters/Rock Outcrops

The site must be traversed on foot and record the presence of any boulders/floaters or rock outcrops which may allow wastewater to shortcut the disposal field and enter water supplies.

4.5.8 Distance to Waterways

An accurate distance must be recorded to the nearest waterway including intermittent creeks and gullies. Setback distances are determined by the seven soil classes and slopes. A survey will aid in the determination of distance.

4.5.9 Run on and Upslope Seepage

Any run-on or upslope seepage must be recorded, if uncontrollable by the construction of a catch drain above the disposal field, then an alternative location must be chosen.

4.5.10 Flooding Potential

The flooding potential of the site must be determined, especially for the lower areas of Richmond River Shire Council and around New Brighton within Byron Shire Council. All disposal areas should be above the 1 in 20 year flood height, and treatment systems be above the 1 in 100 year flood level. The NSW Department of Public Works may be able to supply flood height records.

4.5.11 Site Drainage

Any visible signs of poor drainage should be noted such as hard packed soils, vegetation growth characteristic of damp sites, pooling of water. It is not recommended that disposal areas be installed within sites with poor drainage.

4.5.12 Fill

Clean fill consisting of soil, which has settled and is on a stable site may be used for wastewater disposal, however other types of fill with coarse fragments etc, and located on steep sites are not to be used for wastewater disposal, unless conditioned.

4.5.13 Erosion/Mass Movement

The property must be assessed for existing mass movement and erosion, such as gullies, slips and rills. Adequate drainage controls must be undertaken to ensure that wastewater is not concentrated within one location, and upslope runoff is diverted around the disposal.

4.5.14 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. A field pH level 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.

4.5.15 Modified Emerson Aggregate test (SAR 5)

This is a modification of the Emerson Aggregate Test (Emerson 1967). This test provides a field assessment of the aggregate stability (Dispersivness) by using typical greywater - water with detergent added or Sodium Absorption Ration (SAR) 5 solution. The test involves placing about three 5mm diameter soil aggregates from the profile within a beaker of either of the above solutions, and left undisturbed for 5 hours.

Three reworked aggregates, such as the ones used for texture classification are also placed in a beaker of SAR 5 solution or typical greywater for 2 hours.

The behaviour of the aggregates is then recorded from the following:

Class 1: No change to aggregate, therefore non-dispersive.

Class 2: Aggregates slake - smaller aggregates/particles fall off the original aggregate

Class 3: Aggregates disperse (cloud solution)

Class 4: Worked bolus material disperses.

If the end result is that the soil is dispersive then gypsum will have to applied to the disposal area at a predetermined rate in order to aid in the prevention of degradation to the soil structure.

Table 14: Recommended Site Evaluation Form

SITE ASSESSMENT				
Details of Proposed Development				
Address Lot, DP Number				
Local Government Area				
Date of assessment				
Proposed Water Supply				
Recent Weather Conditions				
SITE DESCRIPTION				
Allotment Size				
Existing Vegetation				
Slope (%)				
Slope Type Convex/Concave				
Aspect				
Exposure				
Boulders/Floaters/Rock Outcrops				
Run on and Upslope seepage				
Flooding Potential Above 1 in 20 year for disposal area and above 1 in 100 year for treatment system				
Site Drainage				
Vegetation				
Surface Condition Bare ground, cracking etc				
Fill				
Erosion/mass movement Rills, slips etc				
Depth to Ground Water				
RESULTS OF LABORATORY ASSESSMENT (required for existing lots and subdivision/rezoning)				
	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**
Sodicity				
Electrical Conductivity				
Bulk Density				
Phosphorous Sorption				
Cation Exchange Capacity				

Table 15: Recommended Soil Assessment

SOIL ASSESSMENT							
		SOIL DESCRIPTION					
Horizon	Depth (mm)	Texture	Structure	Colour	Coarse Fragments	Soil pH	Dispersive Class

4.6 Suitable Nutrient & Water Scavenging Plant Species

Grasses /Reeds/Groundcovers:

Baumea acuta	Sedge
B. articulata	Sedge
B. juncea	Sedge
B. nuda	Sedge
B. rubignosa	Sedge
B. teretifolia	Sedge
Brachyscome diversifolia	Native Daisy
Carex appressa.	Tussock Sedge
Cyprus spp.	Sedge
Hibbertia scandens	Guinea Golden Vine
Juncus articulatus	Jointed rush
J. polyanthemos	Sedge
J. prismatocarpus	Sedge
J. usitatus	Common rush
Lomandra longifolia	Lomandra
Phragmites australis	Bull Rushes
Schoenoplectus spp.	Sedge
Typha latifolia	Bulrush

Shrubs: (≤2m)

Angiozanthus flavidus	Kangaroo Paw
Austromyrtus inopholia	Thread Barbed Myrtle
Backea spp	Drawf Backea
Banksia aemula	Banksia
Blandfordia grandifoia	Christmas Bell
B. nobilis	Christmas Bell
Boronia parvifloria	Swamp Boronia
Callistemon citrinus	Austraflora Firebrand
C. pachyphyllus	Bottlebrush
C. viminalis	Little John, Captain Cook and Rose Opal varieties
Crinum campanulatum	Crinum Lily
Dianella caerulea	Blue Flax Lily
Doodia aspera	Rasp Fern
Hibiscus diversifolius	Swamp hibiscus
Hymenosporum flavuum	Native Frangipani
Leptospermum flavescens	Tea Tree
L. juniperinum	Tea Tree
L. laevigatum	Coast tea tree
L. semibaccatum	Tea Tree
Melaleuca decussata	Cross Leaved Honey Myrtle
M. squamea	
Syzygium australe	Aussie compact Lilly Pilly

5.0 TREATMENT SYSTEMS

There are a number of different system available in the Kyogle Council area and the performance of these can vary due to climatic conditions, population characteristics, loading cycles, human dietary habits, and water quality.

In small treatment situations, digestion of wastewater can be carried out in unheated tanks with no facilities for gas collection, such as the conventional septic tank. These systems are most satisfactory in warm climates where digestion can occur all year. The septic tanks used for single houses are in fact a small anaerobic oxidation plant, which removes suspended solids from the wastewater and breaks them down anaerobically. The resultant effluent is low in settled solids but high in BOD and requires biological treatment before release to the surface water. BOD could be reduced through an aerated process, and is reduced within the evapotranspiration/absorption beds, as opposed to only absorption beds. The septic tank to be installed must have at least one internal buffer.

Other solids would settle to the bottom of the tank, whilst most fats, oils and greases would float, and the middle zone of wastewater within the tank would overflow to the disposal beds. No enzymes will be added to the system but natural bacteria is permitted. This bacteria can be added to the system which will reduce the amount of sludge and therefore increasing the time between the tank having to be pumped out, and reduces the smell of the tank.

Induct vents are no longer required on the septic tanks due to these structures allowing flies and mosquitoes to breed in the tank (EPA NSW et al 1998). Due to the larger septic tank size, (>3000L) grease traps are no longer required. The smaller tanks were found to be too small to trap grease effectively. With the larger tanks the kitchen wastes can be connected directly into the septic tank with a baffle installed.

A new product which is claimed to perform well in a septic tank is a plastic tube type filter used to reduce the potential for carry over of suspended solids, to a level of about 30 ppm, or less, this will help prevent the voids in the disposal bed from clogging.

The location of the septic tank must be at a greater distance then 1.5m from any building, and access will need to be provided to maintain a truck and suction hose to the tank de-sludging.

All septic tanks will need to be manufactured in accordance with Standards Australia, and have an appropriate AS Standards Mark. Tanks must also be certified approved by NSW Health. Lists are available of the currently approved tanks at the Council offices, a copy of the current list is attached to this strategy.

There are other systems such as Compost Toilets which split the functions by collecting the faecal material and urine in a compost toilet. There is still a need to collect and treat the liquid produced from these systems along, with the grey water from the development.

The types of on-site disposal systems are listed below:

5.1 Septic Tanks

Otis and Boyle (1976) together with the Department of Water Resources, Victoria (1988) state that provided that a number of conditions are met, it is considered suitable to use a septic tank as an economic on-site treatment system. Patterson (1994) states that a dual chambered, gas baffled septic tank should be employed to encourage the highest quality of treatment prior to on-site land disposal.

The Australian Standard for Septic tanks is AS1546 - 1998. Septic tank sizes are nominated for domestic flows of up to 14,000 Litres per week or daily flows of 2000 Litres. AS1546 states that the function of a septic tank is to provide a relatively still zone of adequate size for all domestic flows. Scum and solids are separated from the wastewater flow and must be periodically removed. The serviceable life of the tank is stated as 15 years. The minimum tank size is 3000L for loads of 1 to 5 persons and 4500L for 6 to 10 persons. Split systems are recognised in DR 96034 and Table 2.1 of AS1546 - 1998 nominates the relevant capacities.

While alternate tank shapes are mentioned in the standard, in the Tweed Richmond region there are only cylindrical tanks available “off the shelf”. Cast-in-situ tanks are specified in Section 7 of AS 1546. The NSW Health Department Register Certifies manufacturers of the septic tanks and collection wells.

5.2 Aerated Wastewater Treatment Systems

Aerated wastewater treatment systems (AWTS) are becoming more common following NSW Health Department certification in 1983. These systems consists of anaerobic and aerobic processes. They have multi chambered tanks, which provide primary treatment through settling and an aeration process. They typically settle solids and float scum in an anaerobic chamber, much like a septic tank then aerate in a second chamber. The aerobic process consists of injecting compressed air into the effluent for secondary treatment. Disinfection usually consists of chlorination in the collection chamber (Patterson, 1994). Failure in any part of the system could lead to a definite health risk (Office of Local Government, 1987) for surface irrigation.

Some AWTS include an activated sludge process which enables the breakdown of sludge and a theoretically better effluent quality without the need for periodic de-sludging.

Patterson (1994) states that AWTS cannot remove sodium from the effluent stream so that sodium salts will accumulate in the soil profile, presenting a toxic environment to the plants and adversely affecting soil physical conditions

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. When the effluent water is to be disposed subsurface or underground and absorbed through the soil, and or taken up by plant roots and evaporated, it is considered that disinfection is unnecessary as no human contact is possible.

There are a number of brands which are certified by the NSW Health Department pursuant to Clause 95B Local Government regulations 1993.

Some of these wastewater disposal units have spare capacity, which provides for up to 2 days additional wastewater storage, at the design flow rates, this provision will improve disinfection performances and may also improve other effluent characteristics.

The minimum size for AWTS tanks would be in accordance with accreditation from NSW Department of Health.

5.3 Sand Filters

Pretreating wastewater through sand filters could improve the hydraulic performance of the soil by removing a large proportion of the organic matter (Andreadakis and Christouolas, 1982). Sand filters do not reduce the nutrient loadings of wastewater. Patterson (1994) indicates that sand filters have been employed successfully between the septic tank and surface irrigation system to reduce total solids in effluent by the aerobic actions of a zoogloeal slime surrounding the sand particles.

The process of the sand filters vary from manufacturer to manufacturer and all of the systems involve final disposal of effluent water as similar to other systems discussed in this study. Nitrogen can be reduced in the sand filter but phosphorus is not removed in any significant amount.

No recirculating sand filters have been accredited by NSW Health at the time of writing. Other sand filters do not require accreditation.

5.4 Artificial Wetlands

Patterson (1994) state that artificial wetlands consisting of either gravel filled trenches, reed bed treatment systems or aquatic lagoons, are more suited to larger developments, from which the effluent from a number of houses is accumulated. A two year study, by Patterson showed that Biochemical Oxygen Demand (BOD_5) could be reduced up to a maximum annual removal of 98%, total suspended solids (TSS) 94% and total nitrogen 67% by the systems operating at hydraulic detention times of 2 to 10 days.

The use of wetland systems will be an individual site specific solution system and as such individual designs will be required. The design should cover all the parameters of the WHO water quality standards and establish that the expected performance achieves the General Waters Standard. This requirement is in with the assumption that the effluent water derived from the outlet of the wetland is likely to be reused directly for irrigation of reuse and as such has to meet a higher standard than the subsurface disposal system. A management plan for the operation and performance monitoring will also have to be individually developed for each wetland design.

Some wetland systems have been used as a polishing treatment technique prior to plantation irrigation. That is the artificial wetland may be installed between a septic tank and the irrigation area. The long term loading rate for artificial wetlands used as polishing systems is a wetland surface area $4m^2$ per person.

A variety of plants should be used in the wetland to avoid monoculture effects and harvesting to ensure constant vigorous growth is to be encouraged. The medium for the support of the wetland plants should be clean stone of 20 to 50mm diameter and flow systems should be arranged to avoid dead corners where water flow can bypass and short circuiting result. Detention time is critical and baffles may be required to ensure water flow through all section of the wetland. Square tanks are not favoured as there is likely to be a short circuiting effect reducing detention time in the wetland. It is very important with wetland design that the detention time be maximised. For example the detention time should be calculated on a minimum of 5 days and a desirable 7 days storage at design flows within the wetland. The void space ratio must be used in the calculations in allowing the amount of water in the wetland to be determined. An example is provided below of use of a wetland disposal system:

Assume a 3000L Septic tank with a 5 person household having a reticulated water supply and total wastewater flow of 180 x 5 = 900L per day. The disposal area is an evapotranspiration/ absorption bed planted with various species such as grasses (sedges & phragmites), and shrubs. The depth to the water table is 2.3m.

A holding tank or collection chamber is required and this is most simply provided by a 3000L baffled septic tank.

The simple nutrient balance equation is **Nitrogen In = Nitrogen Out** to maintain the natural balance in the soil and not increase background N levels.

Nitrogen loading rate from treated effluent = 5 people x 2.2kg/yr/N = 11kg/year (assume no reduction for the performance of the septic tank) however the wetland reduces nitrogen at a rate of 5656kg/ha/year see table 6.

Allowance for 20% loss in nitrogen due to denitrification in the system as there is likely to be alternating aerobic and anaerobic effects in the system. However assume a conservative stance that the wetland does not denitrify then the Nitrogen concentration would remain at 11kg/year

Nitrogen uptake rate for wetland planted with typha and phragmities grasses is

= 5656kg/ha/year (table 6)

Nitrogen uptake rate for grasses in evapotranspiration/absorption bed

= 300kg/ha/year (table 6)

Assume the wetland is $4m^2$ per person = 5 x 4 = $20m^2$

The nitrogen reduction in the wetland is then

= 11 - (20 x 0.5656)

= - 0.3kg that is all the nitrogen is taken up in the wetland.

In actual fact the wetland is likely to take up to 70% in the long term thus there would be a remainder of nitrogen of = 30% x 11kg

= 3.3kg remaining per year.

Disposal area for zero increase in nitrogen (3.3kg/yr)/(300 kg/ha/yr)

= 110$\mathbf{m^2}$

The simple Phosphorus balance equation is Phosphorus In = Phosphorus adsorbed + Phosphorus uptake by plants to maintain the natural balance in the soil and not increase background P levels.

A typical household of 5 persons would generate total phosphorus volumes of about, 1.5kg P/person/year (Witt, 1974).

Total Phosphorus 1.5 x 5 = 7.5kg/year.

Phosphorus loading rate from treated effluent = 7.5 kg/year (assume no reduction for the performance of the septic tank).

Phosphorus uptake rate for wetland planted with typha and phragmities grasses in a wetland bed.

= 85kg/ha/year (table 9)

Phosphorus uptake rate for grasses in a prepared disposal bed.

= 30kg/ha/year (table 9)

Phosphorus adsorption rate for (sand soils) podzols

= 1,000kg/ha/m (table 10)

Table 11 percentage improvements could be used if the treatment option selected has a better performance. The Ryden & Pratt equation can be used to calculate the effected disposal area or required disposal area.

The Phosphorus sorption rate of the soil is determined by laboratory analysis but typical figures for the Tweed Richmond region have been determined see Table 10. In this example for a sand soils or podzols the P_s is 1,000kg/ha/year.

The depth to the water table at the site need to be determined W_{td} and a buffer B_{wt} allowed to ensure the disposal bed is large enough to not interact with the subsoils water. In cases where the water table is greater than 10m use 10m as the depth and a buffer of 0.5m.

The equation then is calculated as follows:

$$\text{Wetland area for P disposal} = \frac{7.5 \times 10000}{[(1000 \times (2.3 - 0.5)/50) + 30 + 85]}$$

$$= 496\text{m}^2$$

20m^2 is provided in the wetland and the balance 476m^2 would need to be provided in the disposal bed.

5.5 Added Bacteria

There are other products on the market which reduce nutrient levels in the wastewater stream significantly. One such method, which could be applicable for specific situations, is by incorporating imported bacteria into the system. The amount of sludge would be reduced and also the N.P.K value of the wastewater improved. Further nutrient removal occurs by the process involving the fixing of nitrogen as nitrates by ionic exchange with soil particles as well as the root tips of plants.

5.6 Compost Toilets

The literature nominates that there are two types of Compost Toilets, a water less composting toilet and a wet compost toilet. Both types are approved as Humus Closets by the NSW Health Department.

5.6.1 Waterless Compost Toilets

There is a draft Australian Standard for Waterless Composting Toilets dated April 1996 numbered DR 96086. Compost is a mixture of decomposing vegetable refuse, manure etc for fertilising and conditioning soils. The dry compost produced from a compost toilet would normally be composted again with garden compost before it is used as a soil conditioner in the planted garden. Jenkins (1994) states that the complete elimination of pathogens would occur after both these composting processes.

Dry composting toilets may be either constructed individually on-site following a specific design plan or commercial units such as the Clivus Multrum and the Rota Loo purchased “off the shelf”. The off the shelf model by Rota Loo is a batch system which involves alternating chambers at irregular intervals.

Dry composting toilets require a bulking agent such as saw dust 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 are vented and some have mechanical ventilation to ensure good air flow in difficult situations around the compost heap. After a period of time compost is produced from the toilet, and removed from a door at the base of the toilet.

Low temperatures can cause the compost toilet to be less effective; this is not the case in the Tweed Richmond region where the subtropical climate is suitable for compost toilets. The process is biological and involves micro-organisms attacking the faecal heap and gradually composting the material to humus. The time taken to reduce the material to humus is variable, and the operator of a compost toilet must recognise that the compost heap is a living thing and needs to be cultivated and protected. There are texts available for those wishing to use a compost toilet and these should be read and understood so that the compost process is encouraged by the household activities.

The use of a compost toilet will remove the toilet component from the water flows or discharges from the dwelling or development. The “Grey water” will still need to be collected and treated in an appropriate manner. The reduced flow rates can be calculated from the table in section B1 above. Grey water can be treated in conventional septic tanks or AWTS or in tanks specifically deigned for that purpose, see below. It is desirable to collect the water flow from the compost unit in the grey water system and include it in any treatment design prepared. This can actually help the biological process in the greywater tank by adding valuable bacteria.

NSW Public Health have approved three companies who manufacture compost toilets and a copy of that list is attached to this strategy study.

5.6.2 Wet Composting Toilets

The Dowmus company supply a wet composting toilet, where the compost from the garden is mixed with the water from household activities, to the Tweed Richmond Region. This system claims to be able to recycle all organic wastes in the same tank without the use of chemicals and with no grease trap. Effluent water would then be disposed of on-site and the size of the disposal area calculated as per the daily model.

5.7 Greywater Systems

Greywater is known as the wastewater produced from the sinks, washing machines, showers, dishwashers while blackwater is the wastewater produced from the toilet. Currently there are no systems approved by NSW Public Health solely for greywater treatment, but there are systems being sold in this Region. The process is that the greywater is processed or filtered in some way before it is then dispersed in a disposal bed. The size of the greywater disposal area would be calculated using the daily model.

There is a greywater system which disposes of the greywater by using aerated wood chip piles alternately loaded, with the resulting humus being used on the garden. The effluent water would also need to be disposed of as per the daily model calculations. Approval by NSW Public Health has not been obtained at the time of writing this strategy study.

Another greywater system is the greenhouse system where the water is initially filtered before being pumped to the greenhouse. In the greenhouse the soils and plants tank up the nutrients and water. The literature states that in warmer climates the irrigation could be provided outdoors. Rock filters are used and pumps may be necessary to move the water around the site.

Constructed wetlands can also be used as a greywater purification system. The sizing of the wetlands is critical and a biological analysis should be undertaken to determine the effluent water quality at the outlet end of the wetland. As with all of these biological system it is advantageous to have two or more constructed wetlands which act in parallel. As the wetlands need maintenance and plant replacement from time to time one of the beds can be taken out of service while the other continues to operate.

Intermittent sand filters can also be used for filtration of greywater although this is more common in other parts of the world. For example in the United States, the USEPA has a design manual which included filters and their sizing.

5.8 The Green Belt System

The so called “green belt” system, which has achieved some prominence in the Byron Shire Council area, is a system which needs to be designed as evapotranspiration/absorption bed. The science of this system is the same as the evapotranspiration/absorption bed and the calculations for sizing, to meet the standards required by this strategy study, must be followed as for other systems.

5.9 The Hybrid Toilet System

A new toilet (blackwater) system is the “Hybrid Toilet System” which incorporates parts of the various other technologies to provide a high quality effluent, with no main power usage, low e.coli and low maintenance. This technology was developed in Australia at and with James Cook University, Townsville City Council and others.

The system involves a drop toilet (no flush) into a primary tank where solids are retained and broken down into a liquid form. The effluent passes to a second tank for treatment before being disposed of in an absorption bed disposal area. The system is closed and is not influenced by rainwater other than in the disposal area. The only power is a solar powered exhaust fan. Sludge would need to be pumped out every 5 years. Both the primary and secondary tank are filled with water at the time of installation. The tanks are sized to provide 43 days storage in the primary tank and 25 days in the secondary tank. The secondary tank contains media with a high void space ratio and incorporates upflow and downflow water features. This intricate flow path ensures maximum contact with the biomass at all times.

6.0 DISPOSAL SYSTEMS

There are a number of different disposal system available in the Council area and much is written in various texts. The E&HP Guidelines (1998) and the draft Australian Standard DR96034 describe the various systems in some detail. The intention of this study is not to reproduce information that is readily available but to highlight points that are relevant to the Kyogle Council area. The Council area has a large climatic variation and as such different systems will be more appropriate in different localities. The final disposal system selection is most dependant on the site conditions but is still a combination of a number of parameters.

Stewart (et al, 1983) state that subsurface disposal systems for treating effluent are socially acceptable as they are out of sight. Slow infiltration systems such as soil absorption trenches achieve the greatest degree of treatment, while rapid infiltration systems such as sand filters also achieve a high level of removal of organic and bacteria but have limitations for the removal of nitrogen compared to slow absorption systems (Thomas, 1985). Many residents of this region have selected planted beds utilising evapotranspiration as part of the disposal method because of the ability of the plants to enhance the beauty of the locality. The subtropical climate allows a large range of plans to be selected for this purpose compared to other parts or NSW.

Wherever possible alternate disposal areas should be provided for. In existing subdivisions if there is available area, an alternative area should be nominated.

Generic sketches are provided for most of these disposal options incorporating the design requirements for the Tweed Richmond region.

6.1 Evapotranspiration Beds

These evapotranspiration (ET) only systems rely only on the disposal of water via evaporation and are more suited to climates where rainfall is lower than evaporation. Day and Willatt (1982) suggest that due to the evaporative loss of water, specific ion toxicity could occur. The loss of water through evapotranspiration leads to the concentration of sodium, potassium, chloride, zinc, copper and other wastewater ions, which may be toxic to flora and fauna. Patterson (1994) indicates that evapotranspiration beds have a life of about 7 years, due to the sodium toxicity. A typical evaporation bed would be relatively shallow and planted with vigorous growing plants which uptake high amounts of water. Harvesting of plants would be suggested and replacement at regular intervals to ensure vigorous growth is maintained. Two or more beds should be employed to allow decommissioning of a bed for replanting, this should be carried out during the dry season. Some infiltration is required to leach salts away from the root zone.

6.2 Absorption Beds

These beds rely only on absorption of effluent water into the ground. Traditionally this was the only wastewater disposal method used in the Tweed Richmond Region, irrespective of the soil type. There are two types of trenches used in this region, one with a plastic arch and the second with concrete arch. The space in the trench is filled with clean stone usually sourced from local quarries. There should always be more than one trench to allow for reconditioning or replacement. The only method of replacement would be to dig the trench up and remove it from site at the same time widening the trench. The soil could then be reconditioned chemically by the addition of gypsum and other chemicals depending on a detailed soil analysis.

It should be noted that absorption beds are often located below turfed areas, which are regularly mowed. There must be some evapotranspiration occurring as the grass above the absorption bed is usually green all year, while the remainder of the lawn will brown off due to lack of water. This provides a factor of safety in the design calculation for these types of disposal system.

6.3 Mound Systems

These Mounded systems are effluent drainfields constructed on the surface of the soil from imported fill material. Patterson (1994) states that the system can operate with a low rate dosing pump to inject effluent into a distribution system buried on the mound. The main use of the mounded bed system is in situations where drainage of the natural soil is a problem. Other uses are in locations where low height flooding may occur. They are used as an alternative to below ground drainage fields. Water disposal would be by evaporation and some low level of soil absorption. Denitrification can be carried out within this system with intermittent loading.

6.4 Evapotranspiration/absorption Beds

These beds are a combination of evaporation beds with a permeable base. The beds are usually mounded to reduce rain penetration and are planted with water loving plants species. Distribution of the effluent water through the beds is critical as the plants need to be well watered to survive. The soils in the bed may need to be conditioned by the addition of coarse granular sand like material, to improve water movement through the bed.

The beds will act as an artificial wetland if the water movement can be ensured through the bed. To encourage this even movement of water distribution pipes are included. The closer to the surface these pipes are placed the better the water flow will be and the less chance of the pipes being damaged by the stronger plant roots. The hair roots of the plants may wrap around the pipes but they should not penetrate the pipe structure as the pipes would have a geotextile sock. Even if the pipe is damages in some way the whole bed is designed to be a large wetland and allow water movement through both vertically as well as horizontally. Experience in this region is that if there is available water in the bed the plant roots do not need to concentrate around the pipes.

There is a management plan for the evapotranspiration/absorption beds which does recognise the requirement for plant harvesting and plant replacement at regular intervals. Just as plant in the garden need to be pruned plants in the disposal bed need pruning. Because of the rapid growth the need for pruning may be greater, young growth is to be encouraged and can be promoted by pruning.

The pipes used in this system can be plastic subsoil drainage pipes with a geotextile sock or if the bed is up grade of the tank pumping through a leaky pipe or similar pipe would be appropriate. The space between the beds can also be planted with suitable species, which desire nutrients. With this additional planting the area between the beds can be included in calculations for the disposal of nutrients.

6.5 Sub-surface Irrigation

The sub-surface disposal method is discussed in the E&HP Guidelines and DR 96034 in some detail. In the Kyogle Council area sub-surface irrigation is provided on slopes as follows:

0-5% **-** Effluent may be gravity fed into 100mm dia. ag pipe or pressure compensated drainage line.

5-15% **-** Effluent is to be pressure compensated and designed by an irrigation design consultant.

>15% **-** Effluent is to be terraced, pressure compensated and designed by an irrigation design consultant.

It is recommended that the pressurised irrigation system be used with an indexing valve or similar to pressurise specific irrigation lines at one time. The irrigation area may be planted with small trees or shrubs, or even a plantation situation. There are some installations where sub-surface irrigation is used on a turfed and mowed area.

The soils in the disposal area must be conditioned with rotary hoeing and addition of sands to break down the soil structure. The amount of conditioning depends on the soil type. The distribution pipes can either be subsoil pipes with geotextile sock or a pressure pipe such as a leaky pipe.

6.6 Spray Irrigation

Within the Kyogle Council area the use of spray irrigation is generally not favoured due to the risks to public health, therefore the use of subsurface irrigation is generally required. In extreme cases such as areas with high bedrock or water table in areas of good vegetation growth, the use of spray irrigation may be permissible.

The distribution of treated effluent by spray irrigation above surface has occurred in this region as part of the AWTS disposal method over about the past 15 years. Disinfection is required with this form of disposal as there is a chance of human contact with the effluent. The irrigation fields usually involved above ground micro sprays placed in garden beds. These garden beds would need to be appropriately signed to warn people of the use of sewer effluent and the soils conditions as well as special plants selected.

6.7 Dripper Irrigation

The Kyogle Council area is a productive farming area with many plantations growing a variety of crops. Disposal of wastewater effluent by drippers in plantations is appropriate in some rural application. The plantation would normally not be an area where children would play but warning signs should be placed advising of the use of sewer effluent.

Situations where this type of disposal has been used involve residences in rural areas where the plantation surrounds the dwelling. Often there minimal space available around the dwelling which would resemble the normal house yard but the plantation is nearby and the trees need to be watered. Drippers are placed on the ground surface at the tree base and a mound is usually placed around the tree to ensure that all water is kept at the tree roots.

6.8 Separate Systems versus Combined Systems

There are differing views on the desirability of separate or combined on-site wastewater treatment and disposal systems. The split is normally taken as being greywater split from blackwater. Patterson (1994) states that an all waste system is preferred to treat greywater and blackwater, while those advocating compost toilets prefer split systems. There is also the situation where the design of the structure and the characteristics of the land mean that the wastewater is most effectively treated in two systems which may or may not be split along the grey water black water line.

A separate system does not block as frequently as a combined system, due to blackwater usually causing the most frequent blockages (Terry Dougherty, Richmond River Shire Council, pers. Comm.). A separate system also provides a longer retention time to the AS 1547 - 1994 recommended septic tank size.

The combined system is less costly due to need to purchase only one tank and installation of one disposal field and pipes etc. particularly if an AWTS is used. As the minimum size for the septic tank is 3000L the separation of treatment is less economic. There is some consideration that the total separation of greywater from the blackwater remove a significant amount of useful bacteria, which assist in the treatment of the greywater.

6.9 Disinfection

There are a number of options for effective long term disinfection for small systems. The most fool proof method is the use of long resident times in the system and elimination of human contact.

The use of UV light disinfection is growing throughout the country and there are now systems available, which are suitable for small domestic flows. The cost of these units is still fairly high in relation to the overall system cost and as a result they have not been extensively used. There area applications for certain types of development where the flows are larger and cost is not such an issues where UV disinfection is required. They system does require a relatively high degree of maintenance in that the user must ensure that the tubes are clean so that the UV light can penetrate the effluent.

Chlorination disinfection is the system used with AWTS installations. The use of surface irrigation in the Kyogle Council area is generally not favoured but may be allowed in case specific circumstances and in its place subsurface irrigation is now required. As a result chlorination is not required as no water comes to the surface and human contact is eliminated.

7.0 MAINTENANCE PLANS

7.1 Maintenance For Treatment And Disposal System

For longevity of the on-site sewage management system the following maintenance regime should be employed by the owner/occupier of the dwelling.

- Bleach, bleach-based products, whiteners, nappy soakers and spot removers shall not be disposed of into the on-site system. They shall be disposed of on a disused area of a garden, well away from the disposal area.
- Hygiene products, condoms, tampons, sanitary napkins, disposable nappies and cotton buds shall not be disposed of via the on-site disposal system. They should be disposed of into garbage bins in sealed plastic bags.
- Only the recommended amounts of disinfectants should be used. Biodegradable products for septic systems are recommended.
- The treatment tank should be serviced annually including the assessment of sludge and scum levels, and checking for blockages of the outlet and inlet square junctions on a regular basis, at least annually;
- Runoff diversion banks to be inspected annually and maintenance as required undertaken to ensure that surface runoff is diverted around each of the disposal areas.
- No vehicular, stock or pedestrian access should be made across the disposal field
- Vegetation from the irrigation area may need to be harvested and area replanted with new plants every five years, depending on plant condition. This work should be undertaken during dry season (August to October). Plants can be cut back by 1/3 allowing the plants to take up more nutrients when they put on new plant growth, and removes build up of nutrients from the treatment system as stated by McFarlane (1996). Disposal area shall be isolated and allowed to dry out prior to maintenance being undertaken.
- Effluent from disposal system should not be discharged to the stormwater system or over the ground
- The effluent distribution pipes are to be inspected for blockage etc. when the aggregate is cleaned and flush cleaned or replaced as required.

Some signs of system failure are listed below, if any of these occur contact the plumber who installed the system.

- Surface ponding and run-off of treated wastewater;
- degradation of soil structure - eg sheet and rill erosion, surface crusts, or hard surfaces are evident;
- poor vegetation growth;
- unusual odours.

7.2 Maintenance of the Aerated Wastewater Treatment Systems

AWTS require regular servicing and maintenance, on a quarterly or three monthly basis.

The owner therefore must enter a service contract with a service agent authorised by the Local Council.

The service agent must be able to provide service within 24 hours of being notified of a system malfunction.

At each 3 month service, all mechanical, electrical and functioning parts of the AWTS should be checked, including:

- all pumps,
- the air blower, fan or air venturi,
- the alarm system,
- the operation of the sludge return system, where installed,
- pH from a sample taken from the irrigation chamber,
- check on sludge accumulation in the septic tank (primary treatment chamber) and the clarifier where appropriate,
- a sludge bulking test is required annually if activated sludge or contact aeration is used,
- at the completion of the service a report submitted.

The AWTS to be installed will be approved by the NSW Public Health, any upgrading or renewal of Approval to Operate registration must be regularly attended to by the management of the development. The Council will require annual Approval to Operate of the whole wastewater treatment and disposal system and will require a fee for this licence.

An annual report is to be submitted to the Council indicating the servicing that has been carried out on the system. These reports must be signed by the authorised agent as correct. Test of the effluent from the AWTS must be carried out each year and included in the annual report. The parameters to be test are BOD, NFR, Faecal Coliform, chlorine residue.

7.3 Plan of Management for Composting Toilets

As per On-site Wastewater Management Systems for Domestic Households, 1996

Operation

It is intended that the house holder should:

- Record the commissioning date of each chamber for multi chamber systems;
- Ensure that the toilet lid is closed when the toilet is not in use to control fly breeding;
- Ensure that the material is spread evenly over the compost heap;
- Ensure that the compost is clear of the chute;
- Clean the pedestal by hand, with minimal use of water and no use of disinfectants; and
- Consult the service agent if odour and vermin become excessive.

Checking of the composting toilet should be undertaken periodically and weekly for continuous batch systems.

Maintenance

High maintenance levels are required for composting toilets. A list of maintenance required is as follows:

- Annual servicing of the toilet which should include the check of operation of the fan and check of the amount and spreading of the compost within the compost chamber;
- Compost is only to be disposed after the minimum composting period has lapsed, as stated by the NSW Public Health Certificate. The minimum composting period is twelve months;
- Compost should be buried on site under clean friable soil to a depth of 75mm, and in a position which is not subject to erosion or flooding;
- Compost must not be buried in an area used for cultivation of crops for human consumption, unless:
- Compost is placed in a separate lidded compost bin providing aeration, for at least three months, with no further addition; and
- compost has seasoned underground for at least three months;
- Compost, including partially composted material must not be removed from the premises unless written consent from the council is obtained. The council may specify removal and disposal requirements.

7.4 Plan of Management for Aquatic Plant Treatment System

It is proposed that the system be checked regularly for adequate plant growth, that plants have no signs of disease and there is a full canopy cover with in the system.

The plants should be cutback at least every quarter of the year. Up to 1/3 of the plant material can be removed, which will encourage new plant growth which will inturn encourage additional uptake of water and nutrients.

Checking for blockages near the inlet and outlet of the system should be undertaken regularly, such as every two weeks. Gloves should be worn when cleaning the system.

Laboratory testing of wastewater is suggested to obtain the treatment operation of the APT system.

8.0 REFERENCES

Ashbolt, N.J. (1995) Health Related Water Microbiology: Australia leads but where next? *Water*, May/June, 32-36.

Barnes, D., Bliss, P.J., Gould, B.W. & Vallentine, H.R. (1981). *Water and Wastewater Engineering Systems*, Pitman Books Ltd, London.

Barrow, J. (1989) Surface Reactions of Phosphate in Soil. *Agricultural Science* 2, 23-27.

Beavers, P.D. & Gardner, E.A. (1993). Prediction of Virus Transport Through Soils. In *AWWA 15th Annual Convention*, Gold Coast.

Charman, P.E.V. & Murphy, B.W. (1991). *Soils - Their Properties & Management*, Univesity of Sydney Press: Sydney.

DLG, EPA, NSW Health DLWC, DUAP (1998).*On-site Sewage Management for Single Households*,

CSIRO (1995) *Effluent Irrigated Plantations Design and Management*, CSIRO technical Paper No. 2

Eckenfelder, W Wesley Jr. (1980) *Principles of Water Quality Management* CBI Publishing Company: Boston.

EPA (1995). *The Utilisation of Treated Effluent by Irrigation - Draft Environmental Guidelines for Industry*. EPA 95/20. February 1995.

Faulkner R., and Jones M. (1996) *An Introduction to Irrigation Engineering*. Department of Resource Engineering, University of New England, Hydrology and Water Management Series 2.

Gardner, E.A. (1995) Concepts and practices for the reuse of effluent using irrigation. In *Wastewater*. IIR Conference, Sydney, October.

Grayson B., Argent M., Nathan R., McMahon T., and Mein R (1996) *Hydrological Recipes - Estimation Techniques in Australian Hydrology*. Cooperative Research Centre for Catchment Hydrology, Melbourne.

Geary, P.M. & Gardner E.A (1996) On-Site Disposal of Effluent. in *Innovative Approaches to the On-Site Management of Waste and Water*, Southern Cross University, 26 November 1996.

Gidiuli M., Kuruvilla M & Ho G. (undated) *Comparison of Options Currently Available in Australia for the Removal of Nutrients & On-site Disposal of Domestic Sewage*, Murdoch University.

Herricks Edwin E. (ed), (1995), *Stormwater Runoff & Receiving Systems – Impact, Monitoring and Assessment*, Lewis Publishers: New York.

Jellife P.A., Sabburg G. and Wollf J. (1995) Key Factors in Minimising Water Pollution from Unsewered Areas. In *Proceedings of 16th AWWA Federal Convention*, Sydney.

Jelliffe, P. (1996) Site Specific Design & Other On-Site Sewerage Treatment and Disposal Issues in *Innovative Approaches to the On-Site Management of Waste and Water*, Southern Cross University, 26 November 1996.SCU 26/11/96

Jenkins J. C., (1994) *The Humanure Handbook A Guide to Composting Human Manure*. Jenkins Publishing, USA.

Martens and Associates P/L (1998). *Options for Ecologically Sustainable Treatment and Reuse of Wastewater* Byron Bay.

Mc:ennan G. & Murtagh J. (1992) *Water Budgeting for Effluent Irrigation in High Rainfall Areas.* AWWA Recycled Water Seminar, Wagga Wagga, May.

Morand D.T., (1994). *Soil Landscapes of the Lismore-Ballina 1:100 000 Sheet* Report, Soil Conservation Service of NSW, Sydney.

Morand D.T., (1996). *Soil Landscapes of the Murwillumbah - Tweed 1:100 000 Sheet* Report, Soil Conservation Service of NSW, Sydney.

Myers, Brian J. (1992). *Effluent loading rates for irrigated plantations - a water balance model*. Australian Forestry. **55**, 39-47.

Myers B.J., Bond W.J., O'Brien N., Polglase P., Smith C.J. and Theiveyanathan S. (1994) Wagga Effluent plantation project. Technical Report. CSIRO Division of Forestry User Series No 17, Canberra

Myers B.J., Theiveyanathan S., O'Brien N. and Bond W. (1995) *Growth and water use of Eucalyptus grandis and Pinus radiata plantations irrigated with effluent*. Tree Physiology. 26, 213-219.

Patterson R. (1994) *On Site Treatment and Disposal of Septic Tank Effluent*. PHD Thesis, University of New England, Armidale.

Patterson R. (1996) Environmental Indicators for Effective Effluent Re-Use in *Watertech 1998*. AWWA Conference, Brisbane.

Preferred Options, (1997). *Rous Regional Demand Management Strategy – Final Report*,

Rawlinson, L.V. (1993) *Review of On-Site Wastewater Systems*. Report prepared for Environment Protection Authority, Southern Tablelands Region, NSW.

Reed S.C., Crites R.W. & Middlebrooks E.J. (1995) *Natural Systems for Waste Management and Treatment*. 2nd Edition. McGraw Hill: Sydney.

Richmond Valley Naturalist Club & Lismore Gem & Mineral Society (1975) *Geological Features of the Richmond Valley*. Author: Lismore.

Ryden J.C. & Pratt P.F. (1980) Phosphorus removal from wastewater applied to land. Hilgardi, 48, 1-36.

Smith M. (ed), Allen, R., Monteith, J.L., Perrier, A., Santos Pereira l. and Sergen A (1992) *Expert Consultation on Revision of FAO Methodology for Crop Water Requirements*. Land and Water Division, Food and Agriculture Organisation of the United Nations.

Standards Australia (1998) *AS1546 - On Site Domestic Wastewater Treatment Units.*

Standards Australis (1996) *DR 96086 Waterless Composting Toilets.*

Standards Australia (1996) *DR 96034 - On-Site Domestic Wastewater management (Revision of AS 1547)*

State Pollution Control Commission (1984) *Guidelines for the Use of Reclaimed Water*. Publication No WP-7. Sydney.

Tebbutt, (1971) *Principles of Water Quality Control* Pergamon Press: Oxford.

Watts P., and Hancock N. (1985) *Evaporation and Potential Evaporation – A Practical Approach for Agricultural Engineers* in Conference on Agricultural Engineering, Institution of Engineers, Bundaberg, Australia, pp27-30.

Whelan, B.R. & Parker, W.F. (1981) Bacterial and chemical transmission through sand. A field study in groundwater pollution from a septic tank in Perth, Western Australia. In *Groundwater Resources of the Swan Coastal Plain*. Proceedings of a Symposium, University of WA, May, 313-333.

White,S (ed) (1998) *Wise Water Management – A Demand Management Manual for Water Utilities,* Water Services Association of Australia Research Report No 86.

Witt M., Siegrist R. and Boyle W.C. (1974). Rural Household wastewater characterisation. In *Home Sewage Disposal* Proceedings of the National Home Sewage Disposal Symposium, ASAE. 79-88.

Yates, M.V. & Yates, S.R. (1988). *Modelling mircobial fate in the subsurface environment*. CRC Critical Regions in Environmental Control 17, 307-311

SECTION 3

Approval to Operate a Sewage and Wastewater Management System – Implementation and Management Strategy

1.0 INTRODUCTION

The *Local Government (Approvals) Amendment (Sewage Management) Regulation of 1998*, requires owners of premises with on-site sewage management systems to apply to Council for approval to operate a system of sewage management. The *'Approval to Operate'* licence allows Council to monitor performance of each sewage management system on a regular basis and to recover an annual fee to cover reasonable costs.

The effect of the new legislation is to give Council new regulatory control and to enable fees to be charged for regulatory services provided in relation to existing systems.

On-site sewage and wastewater systems include:

- Septic Tanks/Collection well
- Aerated Wastewater Treatment Systems (AWTS)
- Wet Composting Toilet
- Recirculating Sandfilter
- Septic Closet
- Waterless Composting Toilet
- Chemical Closet
- Greywater Treatment Device
- Pan
- Cesspit
- Pumpout

2.0 ON-SITE MANAGEMENT AND IMPLEMENTATION STRATEGY

2.1 Responsibilities

The legislative reforms place responsibility upon Council (regulatory authority), owners of existing systems prior to April 6, 1998 and owners of approved systems installed after the nominated date. The strategy addresses these responsibilities as follows:

a) Council, as the approval authority, shall provide:

   i) Standard letters, applications and approvals.
   ii) Software to manage applications, approvals and renewal activities.
   iii) Community consultation and media materials.

b) Approval processes

   i) Evaluation of applications, determination and issuing of renewable approvals to operate an on-site waste management facility.
   ii) Provision of technical advice.

c) Random Audits – Will be undertaken by Council to determine compliance with the principles of the legislation. Non-conforming activities will result in an appropriate negotiated work program and/or enforcement procedures. This option will rely on the owner's assessment for establishment of a data base in the first instance, and then amended as necessary by audit information. A random audits program would require determination of percentage of premises to be inspected in any nominated period and therefore identifying necessary resources.

d) Owner Certificates – This concept enables owners of existing systems to undertake an assessment of the system's operating performance against a nominated criteria. This is the least cost option for owners, while the random audits program encourages the adoption of the legislative principles. Attachment 1 illustrates by a flow diagram the anticipated involvement of stake-holders.

2.2 *Administrative Procedures*

As the approval authority, Council is required to undertake a number of administrative procedures to ensure the effective implementation and management of the regulatory reforms. It is recommended that:

a) Issuing of Approvals to Operate – that an approval to operate for existing systems be issued on receipt of the standard application form, relying on the owner's assessment of the system's performance. This would enable a key education opportunity informing owners/operators of best practice management techniques for their system. An owner's assessment will provide an opportunity for reducing costs to owners and an associated Random Audit Program will support owner assessments and encourage a greater level of honesty in performance assessments undertaken.

   The approval would be issued for a five (5) year period. All systems will be subject to a nominated Random Audit Program. Following a satisfactory audit/inspection, the approval would be reissued again for a further five (5) year period. Where an owner's assessment indicates that a system does not comply with the nominated performance standards, or where they were unable to determine operating performance, it is considered that these owners be requested to contact Council's Planning, Environmental and Community Services Department to review the assessment in the first instance.

   Where upgrading works are considered appropriate, it will be recommended that the owner engage a competent person to prepare an application for submission to Council to seek approval to alter the existing system. Upon approval and satisfactory completion of works, an approval to operate the system will be issued.

b) Multiple Systems on Individual Properties – All systems on individual properties require approval for their continued operation. To provide an appropriate degree of flexibility in this matter, it is not required where the owner can demonstrate that the system is not in use and can be decommissioned.

c) Aerated Waste Water Treatment Systems – Are currently the only on-site waste management facility that have an approved structure requiring audits of their system's performance on a quarterly basis by a competent person. This requirement was introduced by the NSW Department of Health approval process. Representations to Council from owners of aerated waste water treatment systems suggest that the systems are currently subject to a management structure that satisfies the principle of the regulatory reforms, and therefore should be exempt from any additional auditing programme. Surveys undertaken by local authorities have identified that a significant number of systems, although regularly inspected by industry, were not operating to required performance standard. It is therefore recommended that aerated waste water treatment systems be incorporated into the management programme.

d) Administrative Charging – The level of service, and therefore associated cost structures, is a very sensitive issue surrounding the legislative reforms. The current registration fee of $30.00, was identified as a combined fee consisting of administration and desk top audit components. The Licence to Operate and the Renewal Licence is set at $7.00 per annum for the next 5 years. The Licence fee includes costs associated with inspections of systems during the Random Audit Program.

e) Risk Assessment/Audit Programme – From information distributed by the Department of Local Government and comments received during public consultation, it has been suggested to develop categories for on-site sewerage management systems. Categories would align to land size and location. The proposed categories to be used in the initial audit program are as follows:

   - <u>Category 1</u> - identified as being lots sized less than 10,000m^2 (1 hectare) or systems located within a village environment, as identified by the Local Environmental Plan. Any allotment within 50 metres to a water course.

- Category 2 - identified as being lots sized less than 25,000m^2 (2.5 hectares) but greater than 10,000m^2. Any allotments which are within 100 metres but not closer than 50 metres of a water course.
- Category 3 - would be any other property.

The nominated categories will be utilised for the initial approval process. The nominated audit programme (on-site inspection) would then be utilised to fine tune the risk classification through an assessment incorporating a broader range of parameters, ie soil, slope, operating performance, etc.

Once the initial audit of a property had been completed a risk classification would be assigned to each property. This risk classification would determine the frequency of inspections required in future years. Risk classifications would align to the principle of the higher the risk, the greater the potential to impact on the environment and public health, and therefore more frequent auditing activities would be undertaken on those systems. Three risk classifications have been identified, ie high, medium and low.

- High Risk – classification may be identified as being lots sized less than 10,000m^2 (1 hectare) or systems located within a village environment, as identified by the Local Environmental Plan which have on-site systems that are not operating within design parameters or having disposal areas within 50 metres of a water course.
- Medium Risk – classification may be identified as being lots sized greater than 10,000m^2 (1 hectare) which have on-site systems that are not operating within design parameters.
- Low Risk – classification would be properties which have on-site systems that are operating within design parameters.

It is intended that a higher percentage of inspections would be undertaken on systems within Category 1, as it is assumed that such systems have a greater potential to impact on the environment and public health. It is anticipated that all systems will be inspected within the first five year period. Those premises, however, which are classified high or medium risk category would have a higher potential of being re-inspected. The five year cycle is considered reasonable when the matter of sewerage management is assessed against Council's current environmental programme and resource commitments.

f) Upgrading of Existing Systems – The upgrading of existing systems, where necessary, should be guided by an appropriate procedure to ensure a reasonable balanced and consistent approach by staff in regulatory positions. The following three (3) matters form the foundation of any such procedure:

i) Recognise that the document "Environmental and Health Protection Guidelines On-Site Sewage Management for Single Households" only provides guidance for existing systems in that it nominates key performance criteria recommended for any on-site sewage management facility.

ii) Assessments are to be based against the nominated performance measures.

iii) Level of risk to public health and the environment to determine timeframe for any works or ungrading works programme.

g) Community Consultation – Community consultation is a critical component of the Strategy and must be undertaken to ensure that the community has a thorough understanding of the legislative reforms and the local implementation measures adopted to improve sewage management practices. It is considered appropriate that the development of consultation materials maximise the opportunity for education incorporating information on, and not limited to:

i) Maintenance of on-site systems;

ii) Tenant education – rental properties;

iii) System friendly detergents; and

iv) Design standards and technology.