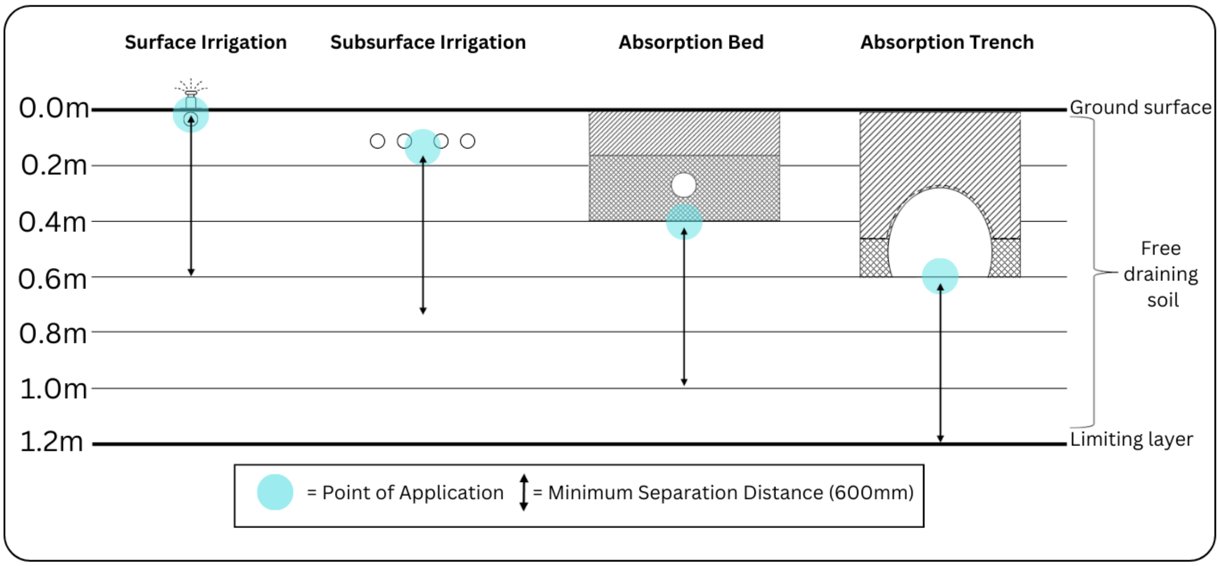
SITE ASSESSMENT AND DESIGN EXERCISE

Prior to commencing, it is important to understand the relevance of soil information gathered in the field, and how to interpret that information and successfully apply the methodology outlined in the TAS OWMS Guideline (2017) and AS/NZS 1547:2012 to determine:

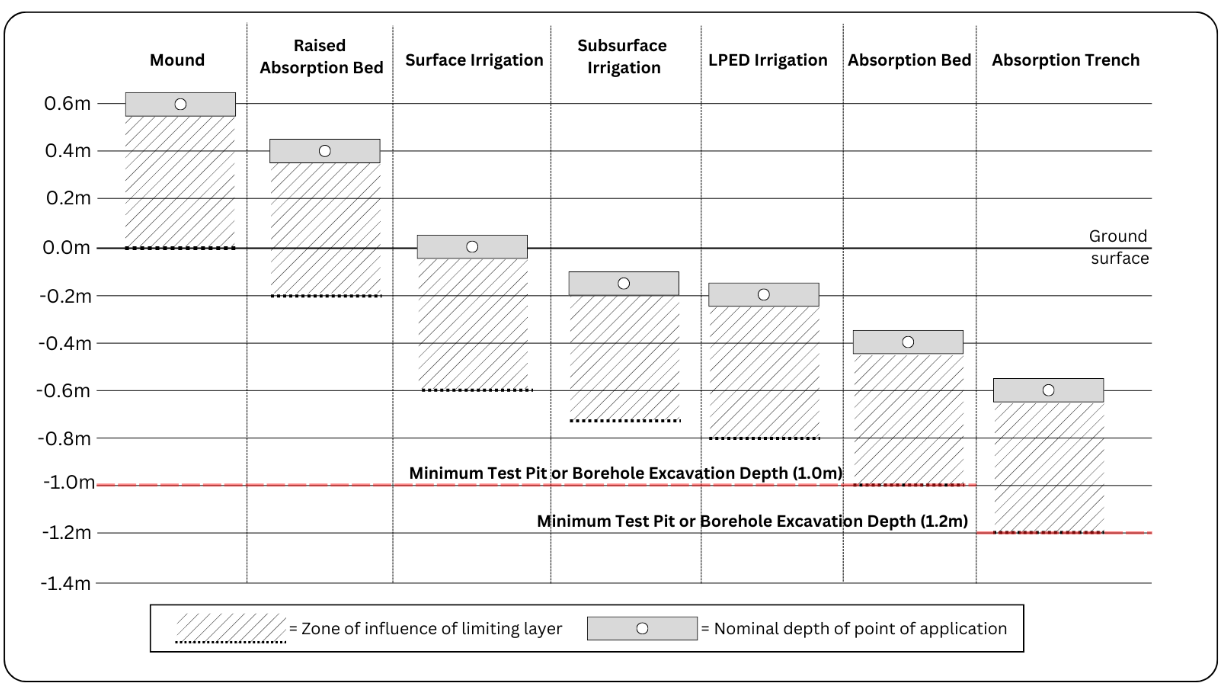
1. The most-limiting horizon (limiting layer) within the 'zone of influence' for the proposed effluent land application system, and
2. The appropriate soil loading rate (SLR) for the observed characteristics of the limiting layer.

To achieve this, we must understand two (2) important concepts.

Base of Application Area (or POA) – The point at which effluent is applied to the soil. This is the level of the emitters in an irrigation system; base of a bed or trench system or base of a distribution bed in a raised (e.g. mound) system design.



Separation distance – The vertical separation between the point of application and a limiting layer. The minimum acceptable distance is 0.6m for groundwater (GW) and 0.5m for a limiting layer (or constraint).



For this task we will work in small groups to complete a site assessment and design exercise for an onsite wastewater management system.

<u>Step One – Interpreting the Soil Log</u>

(i) A 'typical' soil borehole log is provided below, along with a photograph of the excavated core. As seen, the core has been drilled to a depth of 1.2m and three (3) soil 'horizons' are identified.

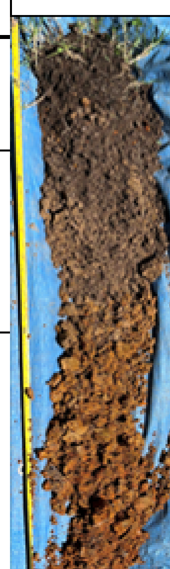
On the log, mark the <u>point of application</u> and draw the minimum <u>separation distance</u> for the following effluent application systems: (a) absorption trench; (b) ETA bed; (c) Wisconsin sand mound and (d) sub-surface irrigation system.

Note how different application systems intercept with the observed soil horizons and how selection of an appropriate 'limiting layer' is guided by the POA.

Soil Bore Log

Client:	Mr & Mrs Dirt	**Test Pit No:**	**BH 2**
Site:	Somewhere up the back	Excavated/logged by:	
Date:	Yesterday	Excavation type:	Shovel, auger & crowbar
Notes:	- refer to site plan for position of test pit		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Photo Log	Identify the POA and required separation distance for each of the following LAA types: Trench	ETA/Bed	Sand Mound	Irrigation	Depth (m)
														0.6
														0.5
														0.4
														0.3
														0.2
														0.1
0.1		A1	SL	Moderate	Dark brown	No	2 - 10%	SM						-0.1
0.2							2-6mm							-0.2
0.3		A2	SCL	Moderate	Dark greyish brown	No	2 - 10%	SM						-0.3
0.4							2-6mm							-0.4
0.5														-0.5
0.6							2 - 10%	D						-0.6
0.7														-0.7
0.8		B	LC	Strong	Strong brown	Red and Orange (moderate)	6-20mm	D						-0.8
0.9														-0.9
1.0														-1.0
1.1														-1.1
1.2						Minor gley								-1.2
1.3														-1.3

Step Two – Preliminary LAA Sizing

AS/NZS 1547:2012 supports a simple sizing methodology for effluent application systems based on an **'areal loading'** rate calculation.

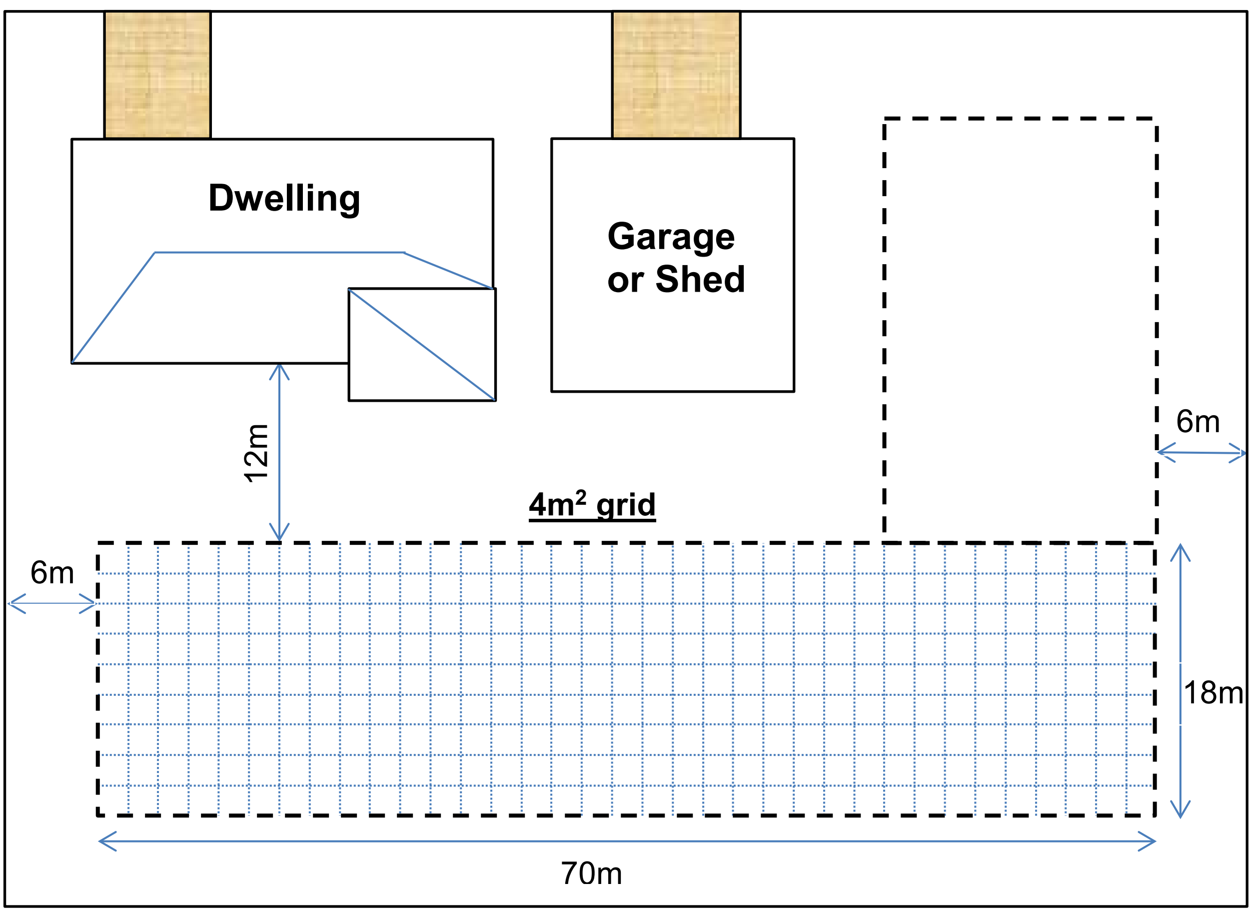
$$\mathbf{A}\ (m^2) = \mathbf{Q}\ (L) \div \textbf{soil loading rate}\ (DLR, DIR, BLR)\ (mm/day)$$

Assume that you are designing an OWMS for a new dwelling to be constructed on a Site, with reticulated water supply, and a design hydraulic load of **600L/day**.

(ii) To examine the relative land area requirements for a range of EAA systems, use Table 5.2 from AS/NZS 1547:2012 (see following pages) to determine the applicable (soil) loading rate and minimum system area required for each of the following LAA types, based on the associated 'limiting' soil condition from Step 1.

LAA System Type	Loading Rate (mm/day)	Minimum Size (m^2)
Absorption Trench/bed		
ETA bed		
Mound		
Irrigation area		

(iii) On the example Site Plan (below), sketch out how each LAA configuration might be arranged for this example Site.



Step Three - Fieldwork

Use the **Soil Survey Sheet** and **Appendix 2** (following pages) to record details of your site and soil assessment.

Auger a hole and lay the soil out carefully to represent the soil profile. Excavate a soil pit adjacent to the auger hole and note how much more clear a picture you obtain of the soil profile by digging a soil pit.

Use the skills you have learned earlier to assess the soil texture by hand and feel for each horizon (layer) you can distinguish in the soil profile. Compile this information and the results of the other soil observations listed on the table (Soil Survey Sheet).

(iv) What is the **'texture and structure'** of the most-limiting soil horizon or constraint in the identified land application area (LAA)?

____

Remember: Minimum vertical separation to limiting layer is 0.6m (conservative).

(v) Would it be possible to mitigate the limiting condition identified for a LAA design? If so, how might you do that?

____

Step Four – Design Conditions

Assume that you are designing an OWMS for a **three-bedroom** dwelling and detached **one-bedroom** studio on the Site you have just investigated. Reticulated (town) water supply and WELS-rated water fixtures will be provided.

(vi) What is the **'design occupancy'** for each of the buildings (OWMS Guideline, 2017)?

____

(vii) What is the **total occupancy (EP)** for the development, and on what basis have you made this determination?

____

(viii) Calculate the **'design hydraulic load'** using Table H1 of AS/NZS 1547:2012?

____

TABLE H1

TYPICAL DOMESTIC WASTEWATER DESIGN FLOW ALLOWANCES – AUSTRALIA

Source	**Typical wastewater design flows** (L/person/day)	
Residential premises	**On-site roof water tank supply**	**Reticulated water supply**
	120	150
Source: Australian Bureau of Statistics. Water Account 2004/2005. Chapter 7 Figure 7.3		

Step Five – Acceptable Design Solution (OWMS Guideline, 2017)

(ix) The TAS OWMS Guideline (Table 3) provides 'acceptable solution' sizing values (per bedroom) for LAAs based on three (3) criteria: Soil Category, Effluent Quality and Slope gradient.

Qualifying notes are used to further define requirements for dispersive soil conditions (Note ii) and reserve area (Note iii).

Assuming the 'average slope' is 10-20%, calculate an **'acceptable solution'** LAA design for the Site you have assessed today and describe the design steps taken.

Treatment System: (Primary / Secondary) ______________________________

LAA System type: ______________________________

Dispersive Soil conditions? ______________________________

Applicable Soil Category ______________________________

Minimum LAA required? ______________________________

Reserve Area required? ______________________________

Table 3 Minimum Land Application Area

Soil category for top 1.5m of soil profile as listed in AS/NZS 1547, (refer notes)	Area required per bedroom for primary treatment effluent (m^2) reduce by 50% if secondary treated effluent discharged to a trench, bed or mound	Area required per bedroom for irrigated secondary treated effluent (m^2)		
			Slope	
		<10%	10-20%	>20%
1 (Sand)	50	50	60	100
2 (Sandy loam)	60	55	66	110
3 (Loam)	90	70	84	140
4 (Clay loam)	120	80	96	160
5 (Light clay)	180	100	120	200
6 (Clay)	180	130	156	260

Notes to Table 3:

i. Where the soil in the upper 1.5 m of the soil profile comprises two or more soil categories, the required area must be calculated on the basis of the requirements for the predominant soil category.

ii. If dispersive soils or a limiting layer are encountered within the upper 1 m of the soil profile, then the area required must be calculated on the basis of the requirements for Category 6 soil.

iii. Minimum land application area for primary treated wastewater including land that is reserved for future waste land application.

iv. Slope means the average gradient of the land across the land application area.

Step Five – Performance-based Design Solution

If an 'acceptable design' solution is not possible, a risk-based design may be considered using the AS/NZS 1547:2012 'areal loading' procedure described in Step 2.

(x) Discuss amongst your group and decide upon the **'most suitable'** OWMS design for the Site layout (below) and the soil conditions you have assessed today.

Treatment System: (Primary / Secondary), Why? ________________________________

LAA System type: ____

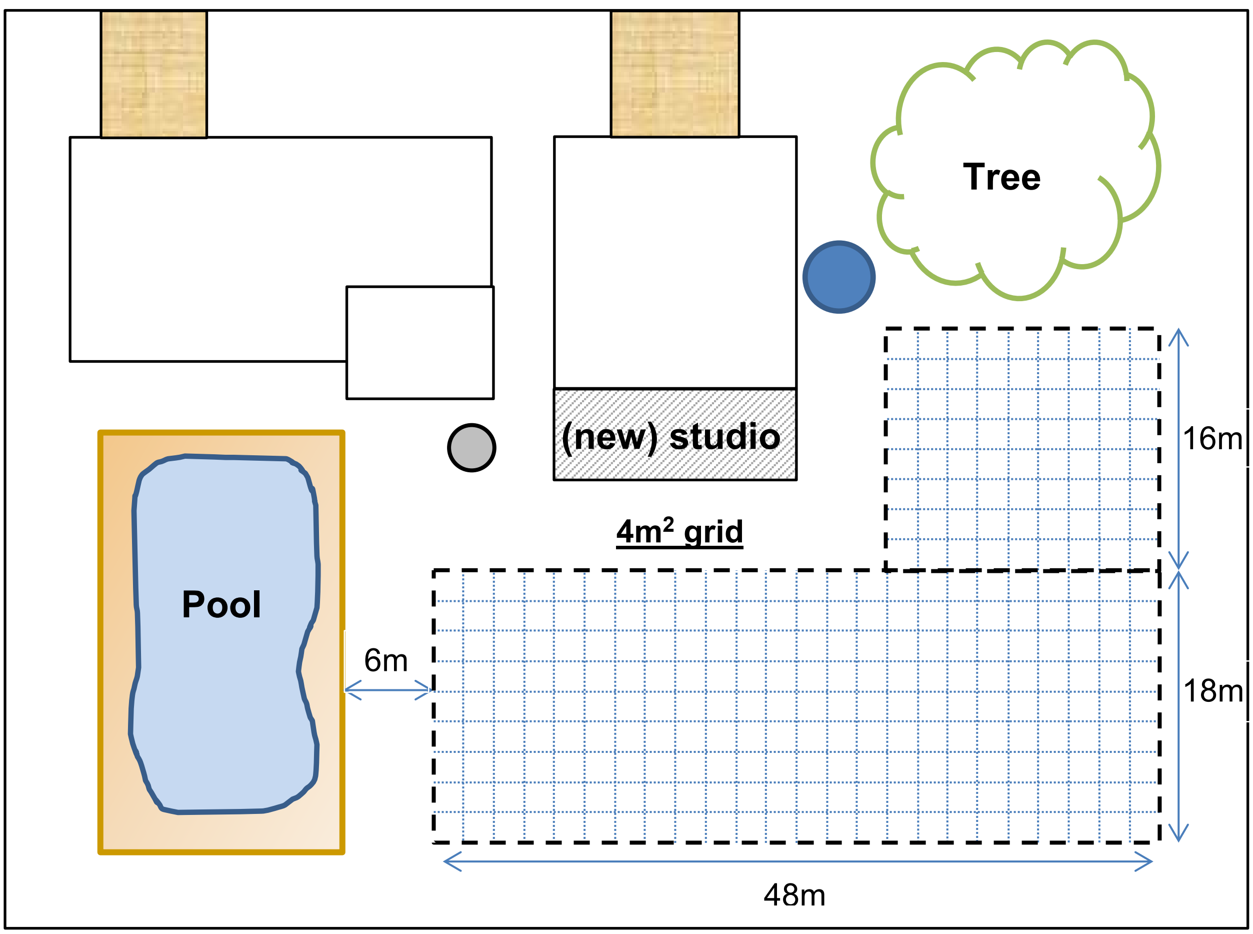
Applicable Soil Loading Rate: (mm/day) ________________________________

Mitigation proposed: (What/Why?) ____________________________________

____

(xi) Prepare a case to justify your system selection and determine the appropriate sizing and arrangement for your system on the following development site.

LAA required (m^2): ____



Each group will have an opportunity to present their design and will be expected to explain / rationalise how they have reached their conclusions.

TABLE 5.2

SOIL CATEGORIES AND RECOMMENDED DESIGN IRRIGATION/LOADING RATES (DIR/DLR) FOR LAND-APPLICATION SYSTEMS

Soil Category	Soil texture	Structure	Indicative permeability (K_{sat}) (m/d)	Design irrigation/loading rate (DIR/DLR) (mm/day)						
				Trenches and beds (see Table L1)			ETA/ETS beds and trenches (Table L1)	Drip and spray irrigation (Table M1)	LPED irrigation (Table M1)	Mounds (basal area) (Table N1)
				Primary treated effluent		Secondary treated effluent				
				Conservative rate	Maximum rate					
1	Gravels and sands	Structureless (massive)	> 3.0	(see Note 1 of Table L1 for DLR values)			(see Note 4 of Table L1)	5 (see Note 2 of Table M1)	(see Note 3 of Table M1)	32
2	Sandy loams	Weakly structured massive	> 3.0						4	24
			1.4 – 3.0	15	25	50				
3	Loams	High/ moderate structured	1.5 – 3.0	15	25	50		4 (see Note 1 of Table M1)	3.5	24
		Weakly structured or massive	0.5 – 1.5	10	15	30				16
4	Clay loams	High/ moderate structured	0.5 – 1.5	10	15	30	12	3.5 (see Note 1 of Table M1)	3	16
		Weakly structured	0.12 – 0.5	6	10	20	8			8
		Massive	0.06 – 0.12	4	5	10	5			(see Note to Table N1)
5	Light clays	Strongly structured	0.12 – 0.5	5	8	12	8	3 (see Note 1 of Table M1)	2.5 (see Note 4 of Table M1)	8
		Moderately structured	0.06 – 0.12	(see Notes 2 and 3 of Table L1)	5	10	5 (see Notes 2, 3, and 5 of Table L1)			(see Note to Table N1)
		Weakly structured or massive	< 0.06			8				
6	Medium to heavy clays	Strongly structured	0.06 – 0.5					2 (see Note 2 of Table M1)	(see Note 3 of Table M1)	
		Moderately structured	< 0.06							
		Weakly structured or massive	< 0.06							

TABLE L1
RECOMMENDED DESIGN LOADING RATES FOR TRENCHES AND BEDS

Soil category	Soil texture	Structure	Indicative permeability (K_{sat})(m/d)	Design loading rate (DLR) (mm/d) — Trenches and beds — Primary treated effluent — Conservative rate	Primary treated effluent — Maximum rate	Secondary treated effluent	ETA/ETS beds and trenches
1	Gravels and sands	Structureless (massive)	> 3.0	20 (see Note 1)	35 (see Note 1)	50 (see Note 1)	(see Note 4)
2	Sandy loams	Weakly structured	> 3.0	20 (see Note 1)	30 (see Note 1)	50 (see Note 1)	
		Massive	1.4 – 3.0	15	25	50	
3	Loams	High/ moderate structured	1.5 – 3.0	15	25	50	
		Weakly structured or massive	0.5 – 1.5	10	15	30	
4	Clay loams	High/ moderate structured	0.5 – 1.5	10	15	30	12
		Weakly structured	0.12 – 0.5	6	10	20	8
		Massive	0.06 – 0.12	4	5	10	5
5	Light clays	Strongly structured	0.12 – 0.5	5	8	12	8
		Moderately structured	0.06 – 0.12	(see Notes 2 & 3)	5	10	5 (see Notes 2, 3, & 5)
		Weakly structured or massive	< 0.06			8	
6	Medium to heavy clays	Strongly structured	0.06 – 0.5				
		Moderately structured	< 0.06				
		Weakly structured or massive	< 0.06				

NOTES:

1 The treatment capacity of the soil and not the hydraulic capacity of the soil or the growth of the clogging layer govern the effluent loading rate in Category 1 and weakly structured Category 2 soils. Land application systems in these soils require design by a suitably qualified and experienced person, and distribution techniques to help achieve even distribution of effluent over the full design surface (see L6.2 and Figure L4 for recommended discharge method by discharge control trench). These soils have low nutrient retention capacities, often allowing accession of nutrients to groundwater.

2 To enable use of such soils for on-site wastewater land application systems, special design requirements and distribution techniques or soil modification procedures will be necessary. For any system designed for these soils, the effluent absorption rate shall be based upon soil permeability testing. Specialist soils advice and special design techniques will be required for clay dominated soils having dispersive (sodic) or shrink/swell behaviour. Such soils shall be treated as Category 6 soils. In most situations, the design will need to rely on more processes than just absorption by the soil.

3 If K_{sat} < 0.06 m/d, a full water balance for the land application can be used to calculate trench/bed size (see Appendix Q).

4 ETA/ETS systems are not normally used on soil Categories 1 to 3.

5 For Category 6 soils ETA/ETS systems are suitable only for use with secondary treated effluent.

(Source: AS/NZS 1547:2012 Standards Australia)

TABLE M1

RECOMMENDED DESIGN IRRIGATION RATE (DIR) FOR IRRIGATION SYSTEMS

Soil Category (see Note 1)	**Soil texture**	**Structure**	**Indicative permeability** (K_{sat}) (m/d)	**Design irrigation rate (DIR)** (mm/day)		
				Drip irrigation	**Spray irrigation**	**LPED irrigation**
1	Gravels and sands	Structureless (massive)	> 3.0	5 (see Note 2)	5	(see Note 3)
2	Sandy loams	Weakly structured	> 3.0			4
		massive	1.4 – 3.0			
3	Loams	High/ moderate structured	1.5 – 3.0	4 (see Note 1)	4	3.5
		Weakly structured or massive	0.5 – 1.5			
4	Clay loams	High/ moderate structured	0.5 – 1.5	3.5 (see Note 1)	3.5	3
		Weakly structured	0.12 – 0.5			
		Massive	0.06 – 0.12			
5	Light clays	Strongly structured	0.12 – 0.5	3 (see Note 1)	3	2.5 (see Note 4)
		Moderately structured	0.06 – 0.12			
		Weakly structured or massive	< 0.06			
6	Medium to heavy clays	Strongly structured	0.06 – 0.5	2 (see Note 2)	2	(see Note 3)
		Moderately structured	< 0.06			
		Weakly structured or massive	< 0.06			

NOTES:

1 For Category 3 to 5 soils (loams to light clays), the drip irrigation system needs to be installed in an adequate depth of topsoil (in the order of 150 – 250 mm of *in situ* or imported good quality topsoil) to slow the soakage and assist with nutrient reduction.

2 For Category 1, 2, and 6 soils, the drip irrigation system has a depth of 100 – 150 mm in good quality topsoil (see CM1 and M3.1).

3 LPED irrigation is not advised for Category 1 or Category 6 soils – drip irrigation of secondary effluent is the preferred irrigation method.

4 LPED irrigation for Category 5 soils needs a minimum depth of 250 mm of good quality topsoil (see M5 and CM7.1).

(Source: AS/NZS 1547:2012 Standards Australia)

TABLE N1
RECOMMENDED MOUND DESIGN LOADING RATES

<table>
<tr><th>Soil Category</th><th>Soil texture</th><th>Structure</th><th>Indicative permeability (K_{sat})(m/d)</th><th>Design loading rate (DLR) (mm/d)</th></tr>
<tr><td>1</td><td>Gravels and sands</td><td>Structureless (massive)</td><td>> 3.0</td><td>32</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Sandy loams</td><td>Weakly structured</td><td>> 3.0</td><td>24</td></tr>
<tr><td>Massive</td><td>1.4 – 3.0</td><td>24</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Loams</td><td>High/ moderate structured</td><td>1.5 – 3.0</td><td>24</td></tr>
<tr><td>Weakly structured or massive</td><td>0.5 – 1.5</td><td>16</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">Clay loams</td><td>High/ moderate structured</td><td>0.5 – 1.5</td><td>16</td></tr>
<tr><td>Weakly structured</td><td>0.12 – 0.5</td><td>8</td></tr>
<tr><td>Massive</td><td>0.06 – 0.12</td><td>5 (see Note)</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Light clays</td><td>Strongly structured</td><td>0.12 – 0.5</td><td>8</td></tr>
<tr><td>Moderately structured</td><td>0.06 – 0.12</td><td rowspan="5">5 (see Note)</td></tr>
<tr><td>Weakly structured or massive</td><td>< 0.06</td></tr>
<tr><td rowspan="3">6</td><td rowspan="3">Medium to heavy clays</td><td>Strongly structured</td><td>0.06 – 0.5</td></tr>
<tr><td>Moderately structured</td><td>< 0.06</td></tr>
<tr><td>Weakly structured or massive</td><td>< 0.06</td></tr>
<tr><td colspan="5">NOTE: To enable use of such soils for on-site wastewater land application, special design requirements and distribution techniques or soil modification procedures will be necessary. For any system designed for these soils, the effluent absorption rate shall be based upon soil permeability testing. Specialist soils advice and special design techniques will be required for clay dominated soils having dispersive (sodic) or shrink/swell behaviour. Such soils shall be treated as Category 6 soils. In most situations, the design will need to rely on more processes than just absorption by the soil.</td></tr>
</table>

(Source: AS/NZS 1547:2012 Standards Australia)

Appendix 1. Model site report

1.0 Site Evaluator(s)
Name:
Company/ Agency:
Address:
Tel:
E-mail:
Date:

2.0 Site Information (Desktop evaluation)	
Site address:	
Local Government Area:	Lot/ DP:
Client/ Owner/ Developer:	
Address:	
Tel:	
Email:	
Site Description (General):	
Area of lot, LEP zoning, location in landscape, topography, slope, buildings, services and neighbouring properties uses:	
Proposed Development (new or renovated buildings/ planned improvements:	
Map name and scale (topographic/ orthophoto):	
Site Plan and photograph(s) of site and soils:	
Are the following features marked on Site Plan:	
Location of OWMS components (treatment tank, plumbing, EAA) and any existing OWMS components:	
Waterways, drainage lines and dams:	
Stands of trees/ shrubs:	
Bores/ wells:	
Buildings/ driveways/ pools/ fences (existing and proposed):	
Other sensitive receptors:	

North arrow, scale, slope (gradient and direction), lot boundaries, borehole locations, buffers to sensitive receptors:
Available EAA and excluded areas:
2.1 Geology (from geological map)
2.2 Soil Landscape (from soil landscape map)
2.3 Climate:
Data source:
Average annual rainfall: mm
Average annual evaporation: mm
Intensity/ seasonal variation:
2.4 Intended water supply source and design flows
Reticulated Roof collection of rainwater Bore/ well/ dam back-up
Water saving devices (confirm star rating): None 3-star 4-star or greater
Number of bedrooms:
Total design water use (derived per bedroom) (L/day):
2.5 Existing local onsite systems
Common neighbouring system:
Typical performance/ problems evident:
2.6 Discuss owner preference:
2.7 Registered groundwater bores within 100m (use/ details):
2.8 Sensitive receptors in local area (drinking water catchment/ vulnerable environments/ aquaculture/ food crops):
2.9 Hazard mapping (flood potential/ bushfire/ acid sulphate soils/ geotechnical hazards):

3.0 Site Evaluation
Date:
Weather on day of site evaluation:
Weather in week preceding site evaluation:
3.1 Existing OSMS type/ condition/ dimensions/ capacity (if any):
Existing treatment tank/s (septic/ AWTS/ GT):
Existing EAA (type/ condition/ size/ layout)
3.2 Site characteristics and limitations (at EAA)
Slope (gradient (%) and direction):
Topographic position of EAA/ landform:
Ground cover/ vegetation:
Exposure – aspect/ shading
Surface and subsurface drainage (flow paths towards waterways/ sensitive features)
Run-on and seepage:
Erosion potential (slope/ soil erosivity/ exposure):
Fill (presence/ stability):
Surface rocks (presence/ proximity):
Sensitive receptors:
3.3 Previous use of EAA and degree of soil disturbance:
Fill, compaction, contamination:
3.4 Site stability:
Expert assessment required: Yes/ No
If yes, attach slope stability report and risk assessment
3.5 Photograph of EAA attached: Yes/ No

4.0 Soil Assessment (One sheet required for each soil test pit or borehole)

Client:	Date:	
Lot Number:	D.P.:	Grid reference:
Location of test pits or boreholes to be marked on site plan (plan attached)	GPS reference coordinates	
Borehole number:		
Slope:	Landscape position:	Parent material:
AHD (m):	Surface condition:	Vegetation:
Indicative surface drainage:	Indicative subsurface drainage:	
Depth to bedrock/ hard pan (m):	Depth to soil watertable (seasonal/ permanent) (m):	

Layer	Lower depth mm	Layer	Colour (moist) & mottles	Field texture	Structure	Moisture	Soil category#	Sample I.D.	Indicative permeabilit y (mm/day)	Coarse Fragments	Other Comments
1											
2											
3											
4											

4.1 Additional field/ laboratory test results (as applicable)

	Layer 1	Layer2	Layer3	Layer4
pH: (1:5 soil:water)				
Electrical conductivity (dS/m) (1:5 soil:water)				
Emerson class (EAT)				
Exchangeable sodium percentage (%)				
Phosphorus sorption capacity (mg/kg)				

Other				

Notes

- Only the first part of the Emerson Aggregate test is required
- Soil Category refers to soil textures as outlined in Table 4-6

5.0 General comments

5.1 Environmental and health issues of significance identified in site and soil assessment (moderate and major limitation) and mitigation measures proposed to offset limitations:

Feature	Limitation identified	Mitigation measures

5.2 Buffer distances available to:

Feature	Required buffer (m)	Available buffer (m)
Permanent watercourse (river, creek, lake):		
Intermittent watercourse (gully, drainage line, dam):		
Groundwater bore/ well		
Site boundaries:		
Buildings:		
Recreation areas (pool):		
In-ground water tank:		
Retaining wall/ embankment:		
Groundwater:		
Hardpan/ bedrock:		
Sensitive receptors:		

5.3 Land area available (site size - constrained areas) (m^2):

5.4 System selection

Consideration of connection to centralised sewerage system/ distance:

Type of treatment system(s) best suited to site:

Rationale:

Type of effluent application option(s) best suited to site:

Rationale:

Recommended design loading rate: Design wastewater loading: litres per day (from 2.4) Design loading rate: litres per square metre per day
Rationale:
Total land area required for system and effluent application option:
Is there sufficient EAA for the system selected? Yes/ No
Is there sufficient land area for additional/ reserve EAA? Yes/ No
If so, what additional EAA is available? m^2
5.5 Other comments/ special design considerations required:

Model Parameter	Units	Symbol	Source	Value													
Design Wastewater Load	L/day	Q	Wastewater generation														
Design Loading Rate (DLR) / Design Irrigation Rate (DIR)	mm/day	DLR / DIR	AS/NZS 1547:2012 and SSE														
Void Space Ratio	-	V	1 (soil/ no storage), 0.3 (gravel media) 0.45 (sand media), 0.5 (arch)[1]														
Retained Rainfall Coefficient	-	RrC	0.7 (>30% slope), 0.8 (10-30% slope), 0.9 (0-10% slope), 1.0 (flat ground)														
Nominated EAA	m^2	EAA_N	Nominated area by user														
Monthly Parameters					**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Days in month	days	D	-		31	28	31	30	31	30	31	31	30	31	30	31	365
Precipiation	mm/month	P	Median monthly data (BoM or SILO)														
Daily evaporation	mm/day	E_d	Mean daily data (BoM or SILO)														
Evaporation	mm/month	E	*$E_d \times D$*														
Crop Factor	-	Cf	0.4-0.9[1] (varies with crop type and season)														
Model Inputs																	
Retained rainfall	mm/month	Rr	*P x RrC*														
Applied Effluent	mm/month	W	*$(Q^*D) \div EAA_N$*														
Inputs	mm/month	I	*(Rr + W)*														
Model Outputs																	
Evapotranspiration	mm/month	Et	*E x Cf*														
Percolation	mm/month	B	*DLR/DIR x D*														
Outputs	mm/month	O	*(Et + B)*														
Model Storage																	
Monthly storage	mm/month	S_M	*$(I - O) \div V$*														
Cumulative storage	mm/month	S_C	*$S_M + (S_M$ for month prior)*														
Area required for no storage	m^2/month	EAA_S	*$(Q \times D) \div (ET\text{-}Rr\text{+}B)$*														
Model Results																	
Limiting storage	mm/month	S_L	*Maximum monthly S_c value*														
EAA Required (no storage)	m^2	EAA	*Maximum monthly EAA_S value*														

KEY	
User input	Calculated value

Notes

1. Patterson (2006)

Figure A6–1. Water balance spreadsheet template

Model Parameter	Units	Symbol	Source	Value
Design Wastewater Load	L/day	Q	Wastewater generation	
Total nitrogen in effluent	mg/L	TN	Table 5-2 of the Guideline or site-specifc effluent quality data[1]	
Total phosphorus in effluent	mg/L	TP	Table 5-2 of the Guideline or site-specific effluent quality data[1]	
Design life of system	years	L	Reasonable service life of 50 years	
P-sorption soil capacity	mg/kg	P_{sorp}	Site-specific/ soil landscape-specific laboratory data or Table 4-7 of the Guideline	
P-sorption soil capacity field coefficient	%	$P_{sorp}C$	Capacity of a soil to sorb phosphorus in the field is 25-75% less than in measured lab conditions[2]	
Soil depth for P-sorption	m	D	Soil depth from base of EAA to limiting layer and/or depth of excavation based on SSE	
Bulk density of soil	g/cm^3	B	1.8 (sandy loam), 1.7 (fine sandy loam), 1.6 (loams and clay loams), 1.4 (clays)[3]	
Nitrogen plant uptake	$kg/m^2/year$	NPU	90 (good quality woodland), 65 (poor quality woodland), 240 (managed lawn), 120 (unmanaged lawn), 280 (improved pasture), 99 (perennial pasture), 150 (managed shrubs and some trees), 75 (unmanaged shrubs and some trees)[4]	
Phosphorus plant uptake	$kg/m^2/year$	PPU	25 (good quality woodland), 20 (poor quality woodland), 30 (managed lawn), 12 (unmanaged lawn), 24 (improved pasture), 11 (perennial pasture), 16 (managed shrubs and some trees), 8 (unmanaged shrubs and some trees)[4]	
Model Inputs				
Appiled total nitrogen	kg/year	TN_A	*(Q x TN x 365) ÷ 1,000,000*	
Applied total phosphorus	kg/year	TP_A	*(Q x TP x 365) ÷ 1,000,000*	
Model Outputs				
Subsoil nitrogen cycle losses[5]	kg/year	NL	TN_A x 20%	
Phosphorus sorption by soil	kg/m^2	PS	$[(P_{sorp} \div 1,000,000) \times (B \times 1,000)] \times D \times P_{sorp}C$	
Phosphorus plant uptake over design life	kg/m^2	PPU_L	*(PPU ÷ 10,000) x L*	
Model Results				
Minimum area required for nitrogen uptake	m^2	NUA_N	$[(TN_A - NL) \div NPU] \times 10,000$	
Minimum area required for phosphorus uptake	m^2	NUA_P	$(TP_A \times L) \div (PS + PPU_L)$	
Minimum area for nutrient uptake	m^2	NUA	*Maximum value from NUA_N and NUA_P*	

KEY	
User input	Calculated value

Notes

1. Data only should be considered where NATA accredited laboratory results can be supplied to support the nutrient (effluent) quality peformance of a specific treatment system.

2. Patterson (2001)

3. Hazelton & Murphy (2016)

4. WaterNSW (2023a)

5. Geary and Gardener (1996)

Figure A6–2. Nutrient balance spreadsheet template