Site and Soil Assessment for On-Site Effluent Management System

Assessment Site: 842 Ridge Road, Cooks Gap NSW 2850

Client: Daniel Pike, 842 Ridge Road, Cooks Gap NSW 2850

(Our Reference: 37188-ER01_A)

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Disclaimer

This report has been prepared solely for Daniel Pike in accordance with the scope provided by the client and for the purpose(s) as outlined throughout this report.

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Project Name:	Lot 65 DP251603, 842 Ridge Road, Cooks Gap NSW 2850
Client:	Daniel Pike
Project No.	37188
Report Reference	37188-ER01_A
Date:	2.09.2021
Revision:	Revision A

Prepared by:	**Reviewed by:**
[redacted]	[redacted]
Jeremy Wiatkowski Senior Laboratory Technician	Luke Morris B.E. MIEAust CPEng (NPER) Director

1.0 SYSTEM OVERVIEW

The following table provides a summary of the information for a sustainable onsite effluent management system proposed at Lot 65 DP251603, 842 Ridge Road, Cooks Gap NSW 2850. The following sections of this report provide site specific details justifying the section type.

Table 1: System Overview

Site Assessor	Jeremy Wiatkowski
Client	Daniel Pike
Site Location	"Lot 65 DP251603", 842 Ridge Road, Cooks Gap NSW
No. of Bedrooms	4 Bedrooms
Water Source	Rainwater roof collection
Estimated Daily Flow (L/day)	600L/Day based on 5 people by at 120L/person/day
Tank Recommendation	AWTS Septic System
Tank Capacity	As per section 6.3 the minimum size tank required is 3200-3500L
Sub Soil Assessment Class	Field assessment and subsequent laboratory tests have classed the subsoil as category 3, as shown in section 3.5.
Sub Soil Recommended Hydraulic Loading mm/day (DIR/DLR)	Drip and spray systems in category 3 soils have a design loading rate of 4mm/day. (Refer to Table 7)
Recommended Effluent Application Type	Due to the presence of shallow soil and bedrock, it is recommended that irrigation fields to be utilised to disperse of onsite wastewater via an AWTS septic tank.
Effluent Design Criteria	As per section 7.0 the minimum application area was determined by calculating the requirements of hydraulic loading. As shown, 3 irrigation fields of 166.4m^2 each is required to dispose of the secondary treated effluent.
Notes	1. It should also be noted that the AWTS requires a continuous power supply – and the system should not be switched off when not in use. 2. In the event the AWTS is powered down for more than 1-2 days, recommissioning will normally take between 2-4 weeks to establish a stable treatment process. 3. Appropriate subsurface irrigation components are to be selected. 4. AWTS's are particularly sensitive to cleaning products containing disinfectants and bleaches. They are also sensitive to herbicides, weedicides and pharmaceuticals such as antibiotics.

2.0 INTRODUCTION

2.1 Overview

Barnson Pty Ltd on behalf of Daniel Pike has prepared this report for submission to Mid-Western Regional Council. This report provides direction for sustainable on-site effluent management for a 4-bedroom residence, on Lot 65 DP251603, at 842 Ridge Road, Cooks Gap NSW (refer **Figure 1).**

2.2 Key References

The following key references were utilised as part of this assessment:

- AS/NZS 1547:2012. *On-site Domestic Wastewater Management;*
- NSW Government 1998. *On site Sewerage Management for Single Households* (The Silver Book/OSMSH);
- NSW Government 2000. *The Easy Septic Tank Guide.* Developed by Social Change Media for the NSW Department of Local Government;
- NSW Health, 2001. 'Septic Tank and Collection Well Accreditation Guidelines";
- Mid-Western Regional Council Local Environment Plan, 2012;
- Mid-Western Local Environment Plan, 2011;
- Murphy B.W. & Lawrie J.W. 1998. Soil Landscapes of the Dubbo 1:250 000 Sheet Report, DLWC.
- Sydney Catchment Management Authority, 2019. *Designing and Installing On-Site Wastewater Systems;*

2.3 Disposal System

Figure 1 illustrates the site location and **Figure 2** illustrates the site buffer plan.

The proposed effluent disposal system for this site is via an AWTS septic tank and areas to be utilised to disperse of onsite wastewater.

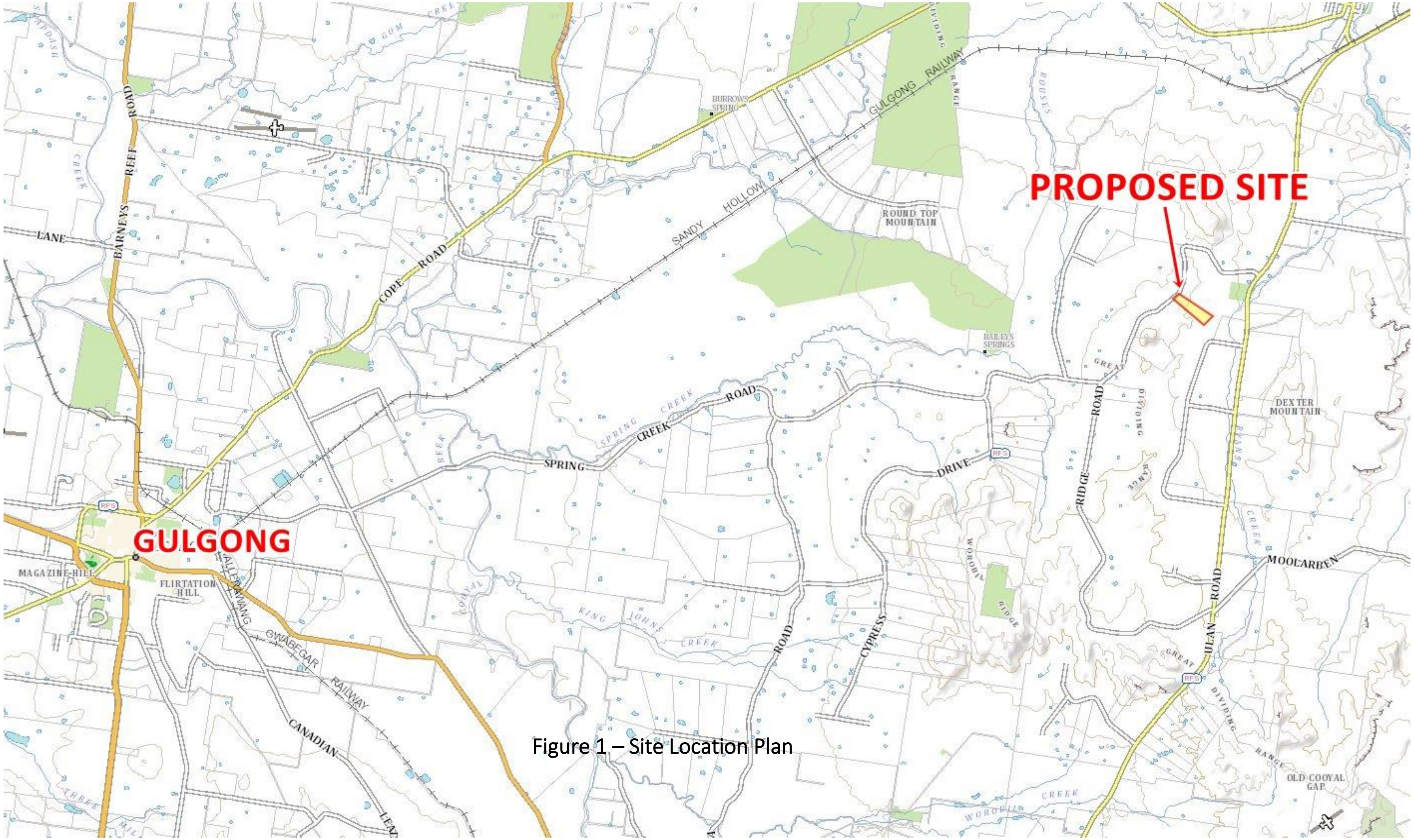

Figure 1 – Site Location Plan

ACTUAL SITING OF THE EFFLUENT APPLICATION AREA IS THE RESPONSIBILITY OF THE LICENCED PLUMBER. THE PRESCRIBED BUFFER AREA/SETBACKS ARE TO BE ADHERED TO UNLESS INSTRUCTED BY COUNCIL OTHERWISE.

15m BUFFER ON DWELLINGS AND 3m TO PATHS AND WALKWAYS

REFER TO SECTION 5.0 OF BARNSON REPORT 37188-ER01 FOR MID WESTERN REGIONAL COUNCIL REQUIREMENTS

NOT TO SCALE

Figure 2 – Site Buffer Plan

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Client:	DANIEL PIKE	Design	JW	Certification	
Project:	EFFLUENT MANAGEMENT SYSTEM PROJECT LINE 2	Drawn	JW		
		Check	LM	Drawing Number	Revision
Drawing Title:	PROPOSED BUFFERS DRAWING TITLE LINE 2	Original Sheet Size = A4		37188-GD01	A

3.0 SITE AND SOIL EVALUATION

3.1 Site Evaluators Details

The following table provides an overview of the evaluator's particulars.

Table 2: Details

Name / Role	Jeremy Wiatkowski
Role/ Qualifications	Senior Geotechnical Technician
Company	Barnson Pty Ltd
Company Address	1/36 Darling Street Dubbo NSW 2830
Contact Details	1300 BARNSON
Date of Assessment	13/08/2021

3.2 Site Information

The following table provides an overview of the site information.

Table 3: Site Particulars

Address/Locality	842 Ridge Road, Cooks Gap NSW Lot 65 DP251603
Local Government Area	Mid-Western Regional Council
Owner	Daniel Pike
Block Configuration	Approximately 10.32ha
Intended Water Supply	Rainwater roof collection supplied
Intended Power Supply	Supplied

3.3 Desktop Assessment

The following information was obtained via desktop review of the site.

Table 4: Desktop Assessment Details

Climate Overview[1]		Annual Average Rainfall for Gulgong is 605.5mm. Warm summers with large evaporative deficit, cool winters with small evaporative deficit. The mean summer monthly rainfall (January) is 62.2mm. The mean winter rainfall (July) is 43.3mm.
Soil Landscape Reference[2]	Area has been mapped within the 'Dexter" Landscape Group. Siliceous Sands and Yellow Solodic Soils dominate in the area.	
	Surface Conditions	Loose
	Drainage	Excessively Well Drained
	Available water holding capability	Low to Moderate
	Water table depth	>80cm
	Depth to bedrock	50 to >80cm
	Flood hazard	Nil
	Expected Nutrient deficiencies	Nitrogen, Phosphorous
	Soil Salinity	Low
	Erosion Hazard	Moderate
Underlying Geology[3]		*"Granite, granodiorite, adamellite, minor gabbro diorite, porphyry.".*
Groundwater Review		One water bore was found within 500m of the proposed site, as illustrated in **Figure 3.** The area is mapped as being groundwater vulnerable as per the Mid-Western Regional Council LEP map GRV_005 **Figure 4.**

[1] Bureau of Meteorology online Climate Data website

[2] NSW Soil and Land Information System

[3]New South Wales 1:1000000

3.4 Groundwater Review

One water bore was identified as occurring within the general area of the allotment. Information relating to historic groundwater report details on water bearing zones and standing water levels is provided in the table below.

Table 5: Groundwater Review

Groundwater Bore Reference	Total Depth (m)	Water Bearing Zones (m)	Standing Water Level (m)	Yield (L/s)	Salinity Yield
GW047172 Bore Irrigation	15.20	9.40-11.00	4.60	1.50	Not provided

Using available groundwater information from local bores, it can be determined that in the local vicinity the standing water level is greater than 4.60m below the ground surface and the water bearing zones are greater than 9.40m below the ground surface.

No groundwater was encountered during the site investigation. From this information, it can be determined that in this locality, subsequent contamination by secondary treated effluent is not a risk factor.

3.5 Surface Water Review

The site drains to the farms dams located to the southwest of the proposed application area.

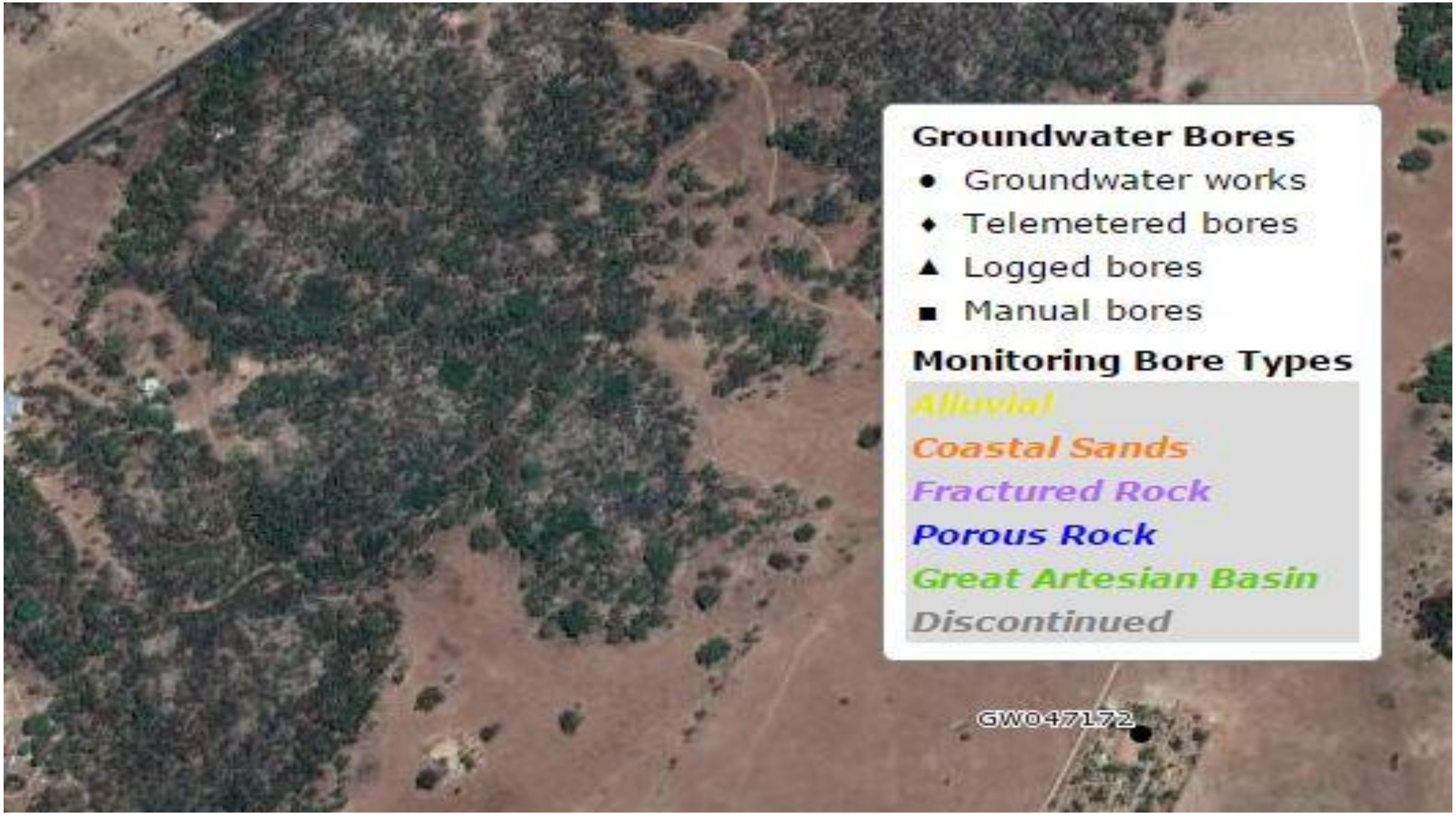

Figure 3 – Groundwater Bore Locations

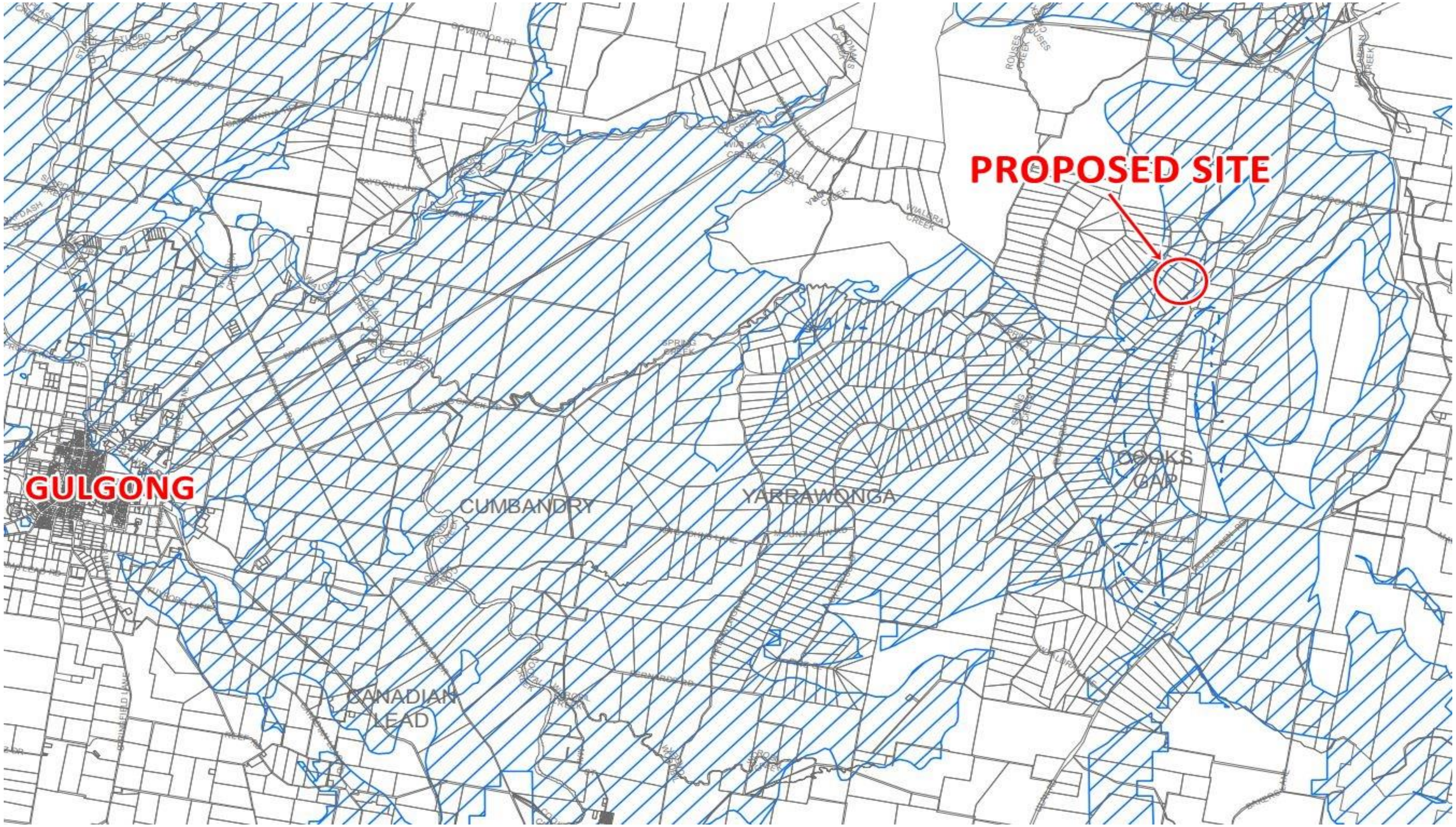

Figure 4 – Groundwater Vulnerability Map GRV_005

3.6 Field Assessment Information

A field inspection was conducted on 13/08/2021. The following table provides detail on the site assessment as well as the field and laboratory results.

Table 6: Site Assessment Details

Water Balance Attached		See *Appendix A*
Exposure		Good exposure.
Slope		The site has moderate to heavy slope to the southwest.
Elevation		Approximately 565m.
Run-On		None
Seepage		None
Erosion Potential		Low due to vegetation cover.
Site Drainage		The site drains to the farms dams located to the southwest of the proposed application area
Fill		None encountered
Surface rock/Outcrops		None encountered
Is there sufficient land area for:	Application system, including buffers	Yes
	Reserve application system	Yes

3.7 Soil Assessment

A soil sample was taken and returned to Barnson Pty Ltd for analysis on 13/08/2021. The sample was collected to a depth of 800mm during the site investigation as per AS1289.1.2.1.6.5.3. Laboratory and results are provided at Appendix B. Field assessment parameters were also obtained. The following table provides detail on both field and laboratory assessment results.

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Table 7: Soil Assessment Details

Depth to bedrock or hardpan via field assessment		0.6m
Depth to high soil water table via field assessment		No groundwater encountered at time of investigation
Soil Analysis	pH – subsoil $CaCl_2$ (lab) subsoil	4.05
	Emerson Test Result –subsoils (Lab)	6
	Liquid Limit, Plastic Limit, Plasticity Index, Linear Shrinkage. (%)	LL = 26 PL = 19 PI = 7 LS = 5.5 See Borelog in **Appendix B**
	Estimated Soil Category –topsoil, subsoil A,	2,3
	Structure massive, weak, high, moderate, strong (Field)	Highley/Moderate Structures
	Soil Profile description	See Borelog in Appendix B
	Sub soil Permeability (from table 5.2 of AS 1547:2012)	1.5-3(k_{sat}) (m/d) 62.5-125 (mm/hr) (Infiltration is Moderatly Fast)
	Recommended Hydraulic Loading for disposal system (from Table 5.2 of AS 1547:2012)	4mm per day (For effluent disposal drip/spray)

4.0 SITE AND SOIL LIMITATION ASSESSMENT

The following two limitation tables are a standardised guide to the site and soil characteristics which may limit the suitability of the site for effluent disposal, and which require attention through specific management practises. The tables have been reproduced from the NSW Government endorsed '*On-Site Sewerage Management for Single Households*' (1998), Tables 8 and 9. The highlighted categories represent site and soil conditions of the land covered in this report.

Table 8: Site Limitation Assessment

Site Feature	Relevant System	Minor Limitation	Moderate Limitation	Major Limitation	Restrictive Feature
Flood Potential	All land application systems	> 1 in 20 years		Frequent below 1 in 20 years	Transport in wastewater off site
	All treatment application systems	Components above 1 in 100 years		Components below 1 in 100 years	Transport in wastewater off site system failure
Exposure	All land application systems	High sun and wind exposure		Low sun and wind exposure	Poor evaporation transpiration
Slope %	Surface Irrigation	0-6	6-12	>12	Runoff, erosion potential
	Sub-surface irrigation	0-10	10-20	>20	Runoff, erosion potential
	Absorption	0-10	10-20	>20	Runoff, erosion potential
Landform	All systems	Hillcrests, convex side slopes and plains	Concave side slopes and foot slopes	Drainage plains and incised channels	Groundwater pollution hazard, resurfacing hazard
Run-on and upslope seepage	All land Application Areas	None-low	Moderate	High, diversion not practical	Transport of wastewater off site
Erosion potential	All land application systems	No sign of erosion potential		Indications of erosion e.g. rils, mass failure	Soil degradation and off-site impact
Site drainage	All land application systems	No visible signs of surface dampness		Visible signs of surface dampness, such as moisture-tolerant veg	Groundwater pollution hazard, resurfacing hazard
Fill	All systems	No fill	Fill present		Subsidence
Land area	All systems	Area available	Area not available		Health and pollution risk
Rock and rock outcrop	All land application systems	<10%	10-20%	>20%	Limits system performance
Geology	All land application systems	None		Major geological discontinuities, fractured or highly porous regolith	Groundwater pollution hazard

Table 9: Soil Limitation Assessment

Soil feature	Relevant system	Minor limitation	Moderate limitation	Major limitation	Restrictive feature
Depth to bedrock or hardpan (m)	Surface and sub-surface irrigation	> 1.0	0.5-1.0	< 0.5	Restricts plant growth
	Absorption	> 1.5	1.0-1.5	< 1.0	Groundwater pollution hazard
Depth to seasonal water table (m)	Surface and sub-surface irrigation	> 1.0	0.5-1.0	< 0.5	Groundwater pollution hazard
	Absorption	> 1.5	1.0-1.5	< 1.0	Groundwater pollution hazard
Permeability Category	Surface and sub-surface irrigation	2b, 3 and 4	2a, 5	1 and 6	Excessive runoff and waterlogging
	Absorption	3, 4		1, 2, 5, 6	Percolation
Coarse fragments %	All systems	0-20	20-45	>40	Restricts plant growth, affects trench installation
Bulk density (g/cc) SL L, CL C	All land application systems	 < 1.8 < 1.6 < 1.4	 > 1.8 > 1.6 >1.4		restricts plant growth, indicator of permeability
pH	All land application systems	> 6.0	4.5-6.0	-	Reduces plant growth
Electrical conductivity (dS/m)	All land application systems	<4	4-8	>8	Restricts plant growth
Sodicity (ESP)	Irrigation 0-40cm; absorption 0-1.2mtr	0-5	5-10	> 10	Potential for structural degradation
CEC mequiv/100g	Irrigation systems	> 15	5-15	< 5	Nutrient leaching
P sorption kg/ha	All land application systems	> 6000	2000-6000	< 2000	Capacity to immobilise P
Modified Emerson Aggregate Test – depressiveness	All land application systems	Classes 3-4	Class 2	class1	Potential for Structural degradation.

5.0 SYSTEM REQUIREMENTS

5.1 Mid-Western Regional Council Setback Requirements

The Mid-Western Regional Council 'On-Site Sewage Management Plan' (2008), provides recommended buffer distances. For this design, the following must be taken into consideration.

All Land Application Systems

- 80m to permanent surface waters (e.g. river, streams, lakes, etc.);
- 50m to domestic groundwater well on applicant's property and 200m to any groundwater well located on a neighbouring property;
- 40m to other waters (e.g. farm dams, intermittent waterways and drainage channels, etc.)

Surface Spray Irrigation

- 6m if area up-gradient and 3m if area down-gradient of driveways and property boundaries;
- 15m to dwellings;
- 3m to paths & walkways;
- 6m to swimming pools;

Surface, Trickle & Subsurface Irrigation

- 6m if area up-gradient and 3m if area down-gradient of swimming pools, property boundaries, driveways and buildings;

Other site setback requirement as per AS/NZS 1547:2012 are provided in ***Appendix C***.

An assessment of the area has indicated that the proposed treatment system adheres to the above buffer requirements.

5.2 Design Allowances - AS/NZS1547:2012 Table H1

In accordance with AS/NZS1547:2012 Table H1, the recommended design flow allowance for use in Australia, using on site rainwater roof collection supply is 120L/person/day. Given the proposed residence is 4 bedrooms in total, the number of persons is calculated at 5.

6.0 SEPTIC TANK SELECTION AND CALCULATION

6.1 Silver Book/ NSW Health Guidelines

The '*On-Site Sewerage Management for Single Households*' (1998) guideline is based on the NSW Health guideline for septic tank capacity. Therefore, the calculation is the same.

Secondary effluent treated will be provided by a NSW Health accredited septic tank. The NSW Health '*Septic Tank and Collection Well Accreditation Guidelines*' (2001), set a sludge allowance of 1550L irrespective of the number of persons or which the septic tank is to be designed. It should be noted that in accordance with this guideline, a septic tank designed for a minimum of 5 persons needs to be desludged approximately every 4 years.

The general formula to calculate the minimum septic tank capacity in litres is:

$$S + (DF\ x\ N) = C$$

$$Sludge + (Daily\ Flow\ X\ No. of\ Persons) = Capacity\ of\ the\ tank$$

Residence - When DF = 120L/per person/per day and N =5, therefore DF x N =**600L**

$$1550L + 600L = 2150L$$

Table 2 in the NSW Health Guidelines provides a minimum of 2300L tank capacity.

6.2 AS/NZS 1547:2012 Requirements

A more conservative approach is outlined in AS/NZS1547:2012, Appendix J. A more conservative figure of 200L per person for all waste tanks is provided, giving a daily flow volume of 1000L for the residence. Therefore, a minimum capacity tank of **3200-3500L** is required for a residence with a design flow of <1000L. This conservative rate is to ensure that the unit has capacity to cope with peak discharge rates or for temporary or unusual overloads and includes no allowance for food waste disposal units. This tank design capacity also allows for the storage of sludge and scum at a rate of 80L/person/year. It should be noted that the higher cost of installing a larger septic tank may be offset by a reduced pump out frequency. Too frequent pump out removes microorganisms needed for degradation of wastewater solids. The longer pump out interval has beneficial implications for conservation of resources in that the volume of seepage requiring treatment and disposal can be reduced significantly.

6.3 System Recommendation

The following table provides details on the system selection.

Table 10: System Selection Details

Consideration of connection to centralised sewerage system	Distance to sewer	>16km
	Potential for future connection?	None planned
	Potential for reticulated water?	None planned
Expected Wastewater volume (litres/day)	**Residence** – 4-bedroom residence, potential occupancy of 5 people. Typical wastewater design flow is 120L/person per day in accordance with Table H3 of AS/NZS1547:2012 for households with full water reduction facilities, supplied by rainwater roof collection supply. Therefore, 5 people at 120L per person per day gives a total load of 600L/day	
Type of Treatment system best suited	3200-3500L septic tank system– as per NSW Health accredited system https://www.health.nsw.gov.au/environment/domesticwastewater/Pages/awts.aspx	

Water conservation measures should be adapted to the greatest extent possible in the house, particularly in relation to the high-water use activities of showering, clothes washing and toilet flushing. AAA rated plumbing appliances and fittings should be used. Measures including use of front-loading washing machines, low volume shower roses and dual flush toilets can reduce water usage by 30-40%. Detergents low in phosphorous and sodium should be used as much as possible. Following these measures will ensure the greatest lifespan for this effluent treatment and disposal system.

7.0 EFFLUENT MANAGEMENT

Barnson Pty Ltd has analysed the proposed on-site waste management system in accordance with the NSW Government endorsed *'Silver Book'* (1998) and AS/NZS1547:2012 On-site Domestic Wastewater Management', with additional advice sought from the Sydney Catchment Management Authority '*Designing and installing On-site Wastewater Systems'* 2019 guideline. For this site, given the climate and soil constraints, irrigation is considered the most appropriate effluent management device.

7.1 Irrigation Area Calculation

In accordance with these documents, the irrigation area for surface and subsurface irrigation must *be the largest area calculated for Nitrogen and Phosphorous loading and permeability loading.* Balances assume an effluent generation rate for a 4-bedroom dwelling on rainwater roof collection of 600L/day.

7.2 Hydraulic Loading Method

Hydraulic loading is the amount of liquid applied to land over a specified time interval. The hydraulic loading rate must be such that surface ponding or run-off and excessive percolation of the treated wastewater does not occur. As per the *Silver Book* 2012 the following formula can be used to estimate the size of the irrigation area for secondary treated effluent.

$$A = Q/DIR$$

Where Q = 600L/day and the DIR = 4mm/day (as per AS 1547:2012)

Therefore

$$A = 600/4$$

$$A=150\ m^2$$

7.3 Nutrient and Organic Matter Balances

In accordance with the *'Silver Book'* (1998), a nutrient balance should be conducted prior to the hydraulic balance, as the calculations provide a good initial estimate of area requirements.

The Daily flow rate (Q) for this property has been assessed as is 600L/day.

7.4 Nitrogen Loading

The following formula is provided:

$$A = (C \times Q)/Ln$$

Where A = land area (m^2) C = concentration of nutrient (mg/L)

Q = treated wastewater flow rate (L/d)

L_n = critical loading rate of nutrient ($mg/m^2/d$)

It is appropriate to assume 20% loss by, denitrification – therefore given nitrogen has a nominal value of 37mg/L, C = 37 X 0.8 = 29.6 mg/L

In this case, L_n can be determined as 240kg/ha/yr. – this figure is obtained from Appendix 1 of the Sydney Catchment Management Authority '*Designing and installing On-site Wastewater Systems'* 2019 guideline, for Lawn - Fully Managed (Clippings Removed) for the uptake of nitrogen.

L_n = 240kg/ha/yr. = 24000mg/m^2/year

Therefore

$$A = (29.6 \times 600 \times 365)/24000$$

A= 270.1m^2

7.5 Phosphorus Loading

In the general formula used to determine irrigation size based on Phosphorous loading is:

$$A = Pgenerated/(PAbsorbed + PUptake)$$

The nominal Phosphorus Sorption Capacity (mg/kg) of 200mg/kg together with the nominal bulk density value of Loams being 1.7g/cm^3 (nominal value as per *Interpreting soil results*), the Phosphorus sorption capacity was estimated to be 3400kg/ha.

$P_{generated}$ = the amount of phosphorus generated over time, and is calculated as –

$P_{generate}$	= total phosphorous (TP) concentration x volume of wastewater produced over 50 years

= TP X Q L/day X 365 days X 50years, where 12mg/L (as per the 'Silver book) and Q = 600L/day

= 12 X 600 X 365 X 50

= 131400000mg

= 131.4kg

Where $P_{absorbed}$ = the amount of phosphorus that can be absorbed without leaching over 50 years. As per the 'Silver Book', this is typically 1/3 of the P sorption Value.

= PSorb X 1/3

= 3400kg/ha X 1/3

= 1133.3333333kg/ha

= 0.113kg/m^2

P_{Uptake} = the amount of P uptake by vegetation over 50 years.

For Lawn - Fully Managed (Clippings Removed) 30 kg/ha/year will be used (as per SCA,2019), which is equivalent to 8.21372778mg/m2/day.

Therefore, P_{Uptake} = 8.21372778 (mg/m^2/day) x 365 (days per year) x 50 (years)

= 149900.53199mg/m^2/day

= 0.1499kg/m^2

$$A = Pgenerated/(PAbsorbed + PUptake)$$

Where, P_{gen} = 131.4 P_{Abs} = 0.113kg/m^2 and P_{uptake} = 0.1499kg/m^2

$$A = 131.4/(0.113 + 0.1499)$$

$$\boldsymbol{A = 499.3}\text{m}^2$$

7.6 Water Balance & Irrigation Area Size

The purpose of the water balance is to assess the sensitivity of the design to the various inputs and outputs of the system. An irrigation area too small will result in saturated soils for long periods. An irrigation area too large will result in poor dispersal of effluent over the area and during dry periods will result in vegetation dying.

A water balance for the area is contained at **Appendix A**. This balance utilises the 70th percentile monthly rainfall data as provided in the *Bureau of Meteorology*. The water balance calculation utilised is this report is the **minimum area method** as per Table A6.2 of the *Silver Book.* Based on the average annual liquid loading, H (the amount of wastewater that maybe applied per year, is calculated as 1586.5mm/year. Therefore, using historical data, the land area required is:

$$A = 365 \times \frac{Q}{H}$$

A = land area (m2)

Q = average treated wastewater flow rate (L/day) – 600L/day

H = average annual liquid loading (mm/yr.) – 1586.5mm/year

$$A = \frac{365 \times 600}{1586.5}$$

A= 138.04m^2

Therefore, based on the largest required minimum area, the Phosphorus Loading balance requirement of **499.3m^2** is required for effluent disposal. Irrigation fields are most effective in 200m^2, therefore in this instance 3 fields of 166.4m^2 is recommended.

8.0 EFFLUENT MANAGEMENT PRESCRIPTIONS

8.1 Effluent Treatment

For this property effluent will be treated by an NSW Health Accredited system capable of achieving secondary standards suitable for surface or sub-surface irrigation. The chosen tank should be operated and maintained in accordance with the manufacture's requirements. Records of maintenance carried out on the system should be kept by the property owners for at least 10 years.

8.2 Effluent Disposal- Irrigation

Effluent can be dispersed by subsurface drip, surface drip or surface spray irrigation. Note that subsurface drip and surface drip irrigation offer advantages in utilising effluent for landscape planting, whilst sprays are effective on grassy areas. Drip and sub-surface irrigation lines require an in-line filter and a flush valve to guard against blockages. Treated effluent must be applied to vegetated areas and not bare ground.

The sizing of the effluent irrigation area is based on the nutrient balances and water balances calculated in Section 7 of this report. 3 fields of 166.4m^2 totalling an area of **499.3m^2** has been assessed as being suitable for irrigation purposes. **Figure 1** illustrates an indicative area suitable for irrigation. This area is to be protected from disturbances and will not be suitable for lawn growth, play areas and foot traffic. The area should be fenced off and protected from vehicles, livestock, domestic animals and children. Lawn grass cover of the area is recommended and should be slashed, removed and kept well maintained when it is greater than 10cm long. Shrub species can also be used in the land application area. **Appendix D** provides a list of species suitable for use in the MWRC LGA, taking into consideration Appendix 7 of the *Silver Book* and the *Upper Macquarie Catchment Revegetation Species Guideline.*

The effluent disposal area should be protected from potential run on and stormwater via an upslope diversion drain or beam. An example from the *Design and Installation of On-Site Wastewater Treatment* (2019) guideline is provided at **Appendix E.**

It is also critical to ensure an appropriate pump to adequately service the demands of the effluent application area is met.

9.0 RECOMMENDATIONS & CONCLUSIONS

As per the '*On-Site Sewerage Management for Single Households'* (1998) publication, stakeholders should be aware that all on site systems and components have a finite life and at some point, will require replacement. Septic tanks and AWTSs generally require replacement every 25 years, whereas effluent disposal systems can have an expected life between 5-15 years. The owner is encouraged to obtain a copy of the NSW Government "The Easy Septic Guide" (2000) available from - https://www.olg.nsw.gov.au/wp-content/uploads/Easy-septic-guide.pdf

The irrigation area shall be designed to accept the discharge from the AWTS and convey it securely and evenly to the land application area. The aim is to ensure uniform distribution of the effluent over the design area to help achieve effective aerobic/anaerobic decomposition within the soil. Typical design sketches as per AS 1547:2012 and *Design and Installation of On-Site Wastewater Treatment (*2012) are provided at **Appendix E.**

****As stated in AS1547-2012 section 5.5.3.4, a reserve irrigation area of similar size to the current design should be considered as part of the risk management process to be available on a site for expansion or for resting of the land application system.*

Installation instructions shall be provided by the manufacturer or designer. Barnson will not be liable for the incorrect installation and/or construction of the system unless when inspected by Barnson the installation and construction of the system holds true to the design featured in this report. Installation should be in accordance with the prescriptions within AS 1547:2012.

Barnson has not verified the accuracy or completeness of this data, except otherwise stated in this report. The recommendations for the proposed system as suggested in this report are based on historical data obtained for the area. Barnson will not be liable in relation to incorrect recommendations should any information provided by the client be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed.

The accuracy of geotechnical engineering advice provided in this report may be limited by unobserved variations in ground conditions across the site in areas between and beyond test locations and by any restrictions in the sampling and testing which was able to be carried out, as well as by the amount of data that could be collected given the project and site constraints. These factors may lead to the possibility that actual ground conditions and materials behaviour observed at the test locations may differ from those which may be encountered elsewhere on the site.

If the sub-surface conditions are found to differ from those described in this report, we should be informed immediately to evaluate whether recommendations should be reviewed and amended if necessary.

Please do not hesitate to contact the undersigned if you have enquires regarding this report.

Yours Faithfully

[redacted]

Jeremy Wiatkowski

Senior Laboratory Technician

Reviewed By

[redacted]

Luke Morris

B.E. MIEAust CPEng (NPER)

Director

Appendix A – Water Balance Calculation

Phosphours Balance

Job Number 37188-ER01_A

Phosphorus Sorption capacity - calculated to a depth of 1m if possible

Weighted pSorb from lab results - as per SCA pg 203

Soil Depth	pSorption (mg/	pSorption/soil layer
0-20	250	5000
20-40	420	8400
40-70	560	16800
70-100	580	17400

Weighted Psorp = Column C/thickness

Weighted Psorp = 200 mg/kg

OR USE Psorption Uptake values for soil type as per Appendix 1 of SCA pg 207

BULK Density - use the following, unless determined by lab/field (SCM pg, 207)

Soil Type	g/cm3
Sandy Soil	1.8
Fine sandy loam*	1.7
Intermediate	1.5
clay	1.3

*Interpruting soil test results

Need to calculate the pSorption of the soil in kg/ha, using the bulk density and Weighted Psorb mg/kg

Note - use top 1m of the soil

1 hecatre = 10,000m2

Therefore in the top 1m of soil = 10,000m2 X 1m X Bulk density

17000 tonnes/hectare of soil (update with Bulk density)

Convert tonnes to kg 17000000 kg

Therefore the pSorption is value mg/kg X kg of soil you have

3400000000 mg/hectare

Convert mg/ha to kg/ha	3400

Irrigation Area = $P_{generated}$ / $P_{absorbed}$ + P_{uptake})

$P_{generated}$ = total phosphorus (TP) concentration x volume (V)of wasewater produced in 50 years

TP = 12mg/L (from silver book, unless otherwise obtained from effluent/AWTS outputs)

V = Q x 365 days x 50 years, where Q is daily flow L/d

Q L/day =	600	
$P_{generated}$ =	131400000	mg
Convert to kg	131.40	kg

$P_{absorbed}$ = in soil is between 1/4 and 1/2 of the the phosphorus sorption capacity, therefore in accordance with the silver book, use 1/3

Is value x 1/3 =	1133.333333	kg/ha
convert to kg/m2	0.113	kg/m2

P_{uptake} = the amount of vegetation uptake over 50 years

Is value from SCA pg207 X 365 days X50 years

Value (kg/ha/year) 30 (choose from SCM Appendix 1... or use 12 for unmaintained lawn)

Convert to mg/m2/day 8.21373 (using conversion factor from per year to per day)

Therefore total = amount mg/m2/day X 365 days X 50 years

Which is 149900.532

Convert to kg/m2 0.14990 kg/m2

Irrigation Area = $P_{generated}$ / $P_{absorbed}$ + P_{uptake})

$P_{generated}$ = 131.40

$P_{absorbed}$ = 0.113

P_{uptake} = 0.1499

Irrigation Area =	499.2	m2

Minimum Area Method Water Balance an Wet Weather Storage Calculations

Barnson Job No	37188-ER01_A	
Location :	Cooks Gap	

Design Wastewater Flow	Q	l/day	600
Design Percolation Rate	R	mm/day	4

Climate Zone	3 C	*As per Soil Landscapes of Dubbo 1:250 000* **Dropdown Box**

Paramter	Symbol	Formula	Units	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Days in Month	(D)	n/a	days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation (70th percentile)	(P)	n/a	mm/month	94	86	76	64	70	75	60	66	60	81	78	96	906
Evaporation	(E)	n/a	mm/month	229	178	155	104	51	46	41	58	89	130	165	229	1475
Crop Factor (as per Silver Book)	(C)	n/a	n/a	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Outputs																
Evapotranspiration	(ET)	E X C	mm/month	160.3	124.6	108.5	72.8	35.7	**32.2**	28.7	40.6	62.3	91	115.5	160.3	1032.5
Percolation	(B)	(R/7)xD	mm/month	124.0	112.0	124.0	120.0	124.0	120.0	124.0	124.0	120.0	124.0	120.0	124.0	1460.0
Outputs		(ET +B)	mm/month	284.3	236.6	232.5	192.8	159.7	152.2	152.7	164.6	182.3	215.0	235.5	284.3	2492.5
Inputs																
Precipitation (70th percentile)	(P)	n/a	mm/month	94	86	76	64	70	75	60	66	60	81	78	96	906
Possible Efflient Irrigation	(W)	(ET + B) -P	mm/month	190.3	150.6	156.5	128.8	89.7	77.2	92.7	98.6	122.3	134.0	157.5	188.3	**1586.5**
Actual Effluent Production	(I)	H/12	mm/month	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2
Inputs		(P +I)	mm/month	226.2	218.2	208.2	196.2	202.2	207.2	192.2	198.2	192.2	213.2	210.2	228.2	1038.2
Storage	(S)	(P+I) - (ET+B)	mm/month	-58.1	-18.4	-24.3	3.4	42.5	55.0	39.5	33.6	9.9	-1.8	-25.3	-56.1	
Cumulative Storage	(M)	n/a	mm	0.0	0.0	0.0	3.4	45.9	100.9	140.4	174.0	**184.0**	182.2	156.9	100.8	

Note - H = sum of W

Irrigation Area	(L)	365 x Q/H	m²	**138.0**
Storage	(v)	Largest M	mm	**184.0**
		(V xL)/1000	m³	**25.4**

Appendix B - Borehole Logs & Laboratory Testing Results

Barnson
1/36 Darling Street
Dubbo, NSW 2830
Telephone: 1800 BARNSON

BOREHOLE NUMBER 1

CLIENT Daniel Pike
PROJECT NAME Septic Design
PROJECT NUMBER 37188
PROJECT LOCATION 842 Ridge Road, Cooks Gap NSW

DATE STARTED 24/8/21 **COMPLETED** 24/8/21
R.L. SURFACE
DATUM
DRILLING CONTRACTOR Barnson
SLOPE 90°
BEARING ---
EQUIPMENT GT-10 Drill Rig
HOLE LOCATION Borehole 1
HOLE SIZE 90mm
LOGGED BY HC
CHECKED BY NR
NOTES

Method	Samples	Depth (m)	Graphic Log	Classification Symbol	Material Description	Dynamic Cone Penetrometer Blows / 100mm (0 4 8 12 16 20 24 28 32)	Additional Observations
Flight Auger & Tungsten Carbide (T.C) Bit		0.0			Silty SAND: dark brown	0, 1	TOPSOIL
		0.2		GM	Gravelly SAND: brown: slightly moist: loose to medium dense: low plasticity	2, 2, 4	RESIDUAL
	Disturbed Sample LS = 5.5% PI = 7%	0.5				3, 3, 32	
		0.7			Borehole 1 terminated at 0.7m		REFUSAL ON SEDIMENTARY ROCK
		1.0					

Barnson
1/36 Darling Street
Dubbo, NSW 2830
Telephone: 1800 BARNSON

BOREHOLE NUMBER 2

CLIENT Daniel Pike
PROJECT NAME Septic Design
PROJECT NUMBER 37188
PROJECT LOCATION 842 Ridge Road, Cooks Gap NSW

DATE STARTED 24/8/21 **COMPLETED** 24/8/21
R.L. SURFACE
DATUM
DRILLING CONTRACTOR Barnson
SLOPE 90°
BEARING ---
EQUIPMENT GT-10 Drill Rig
HOLE LOCATION Borehole 2
HOLE SIZE 90mm
LOGGED BY HC
CHECKED BY NR
NOTES

Method	Samples	Depth (m)	Graphic Log	Classification Symbol	Material Description	Dynamic Cone Penetrometer Blows / 100mm	Additional Observations
Flight Auger & Tungsten Carbide (T.C) Bit		0.0 – 0.2			Silty SAND: dark brown	0, 1	TOPSOIL
		0.2 – 0.6		GM	Gravelly SAND: brown: slightly moist: loose to medium dense: low plasticity	2, 2, 3, 4, 32	RESIDUAL
		0.6			Borehole 2 terminated at 0.6m		REFUSAL ON SEDIMENTARY ROCK
		1.0					

Material Test Report

Report Number:	**37188-1**
Issue Number:	1
Date Issued:	26/08/2021
Client:	Daniel Pike
	842 Ridge Road, Cooks Gap NSW 2850
Contact:	Daniel Pike
Project Number:	37188
Project Name:	Septic Design
Project Location:	842 Ridge Road, Cooks Gap NSW
Work Request:	5261
Sample Number:	D21-5261A
Date Sampled:	13/08/2021
Dates Tested:	13/08/2021 - 26/08/2021
Sampling Method:	AS 1289.1.2.1 6.5.3 - Power auger drilling
Sample Location:	**Borehole 1, Depth: 700mm**
Material:	Brown Gravelly SAND

barnson
DESIGN.PLAN.MANAGE
Barnson Pty Ltd
Dubbo Laboratory
16 L Yarrandale Road Dubbo NSW 2830
Phone: 1300 BARNSON
Email: nreardon@barnson.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

[redacted]

Approved Signatory: Nick Reardon
Laboratory Manager

NATA Accredited Laboratory Number: 9605

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	26		
Plastic Limit (%)	19		
Plasticity Index (%)	**7**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	5.5		
Cracking Crumbling Curling	None		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	Brown Gravelly SAND		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	19		

Appendix C - Site Setback Requirements

TABLE R1
GUIDELINES FOR HORIZONTAL AND VERTICAL SETBACK DISTANCES
(to be used in conjunction with Table R2)

Site feature	**Setback distance range** (m) (See Note 1)	**Site constraint items of specific concern** (from Table R2) (see Note 1)
	Horizontal setback distance *(m)*	
Property boundary	1.5 – 50 (see Note 2)	A, D, J
Buildings/houses	2.0 – > 6 (see Note 3)	A, D, J
Surface water (see Note 4)	15 – 100	A, B, D, E, F, G, J
Bore, well (see Notes 5 and 6)	15 – 50	A, C, H, J
Recreational areas (Children's play areas, swimming pools and so on) (see Note 7)	3 – 15 (see Notes 8 and 9)	A, E, J
In-ground water tank	4 – 15 (see Note 10)	A, E, J
Retaining wall and Embankments, escarpments, cuttings (see Note 11)	3.0 m or 45° angle from toe of wall (whichever is greatest)	D, G, H
	Vertical setback distance *(m)*	
Groundwater (see Notes 5, 6, and 12)	0.6 – > 1.5	A, C, F, H, I, J
Hardpan or bedrock	0.5 – ≥ 1.5	A, C, J

NOTES:

1 The overall setback distance should be commensurate with the level of risk to public health and the environment. For example, the maximum setback distance should be adopted where site/system features are on the high end of the constraint scale. The setback distance should be based on an evaluation of the constraint items and corresponding sensitive features in Table R2 and how these interact to provide a pathway or barrier for wastewater movement.

2 Subject to local regulatory rules and design by a suitably qualified and experienced person, the separation of a drip line system from an upslope boundary, for slopes greater than 5%, may be reduced to 0.5 m.

TABLE R1
GUIDELINES FOR HORIZONTAL AND VERTICAL SETBACK DISTANCES
(to be used in conjunction with Table R2) (continued)

3	Setback distances of less than 3 m from houses are appropriate only where a drip irrigation land application system is being used with low design irrigation rates, where shallow subsurface systems are being used with equivalent low areal loading rates, where the risk of reducing the bearing capacity of the foundation or damaging the structure is low, or where an effective barrier (designed by a suitably qualified and experienced person) can be installed. This may require consent from the regulatory authority.
4	Setback distance from surface water is defined as the areal edge of the land application system to the edge of the water. Where land application areas are planned in a water supply catchment, advice on adequate buffer distances should be sought from the relevant water authority and a hydrogeologist. Surface water, in this case, refers to any fresh water or geothermal water in a river, lake, stream, or wetland that may be permanently or intermittently flowing. Surface water also includes water in the coastal marine area and water in man-made drains, channels, and dams unless these are to specifically divert surface water away from the land application area. Surface water excludes any water in a pipe or tank.
5	Highly permeable stony soils and gravel aquifers potentially allow microorganisms to be readily transported up to hundreds of metres down the gradient of an on-site system (see R3, Table 1 in Pang et al. 2005). Maximum setback distances are recommended where site constraints are identified at the high scale for items A, C, and H. For reading and guidance on setback distances in highly permeable soils and coarse-grained aquifers see R3. As microbial removal is not linear with distance, data extrapolation of experiments should not be relied upon unless the data has been verified in the field. Advice on adequate buffer distances should be sought from the relevant water authority and a hydrogeologist.
6	Setback distances from water supply bores should be reviewed on a case-by-case basis. Distances can depend on many factors including soil type, rainfall, depth and casing of bore, direction of groundwater flow, type of microorganisms, existing quality of receiving waters, and resource value of waters.
7	Where effluent is applied to the surface by covered drip or spray irrigation, the maximum value is recommended.
8	In the case of subsurface application of primary treated effluent by LPED irrigation, the upper value is recommended.
9	In the case of surface spray, the setback distances are based on a spray plume with a diameter not exceeding 2 m or a plume height not exceeding 0.5 m above finished surface level. The potential for aerosols being carried by the wind also needs to be taken into account.
10	It is recommended that land application of primary treated effluent be down gradient of in-ground water tanks.
11	When determining minimum distances from retaining walls, embankments, or cut slopes, the type of land application system, soil types, and soil layering should also be taken into account to avoid wastewater collecting in the subsoil drains or seepage through cuts and embankments. Where these situations occur setback clearances may need to be increased. In areas where slope stability is of concern, advice from a suitably qualified and experienced person may be required.
12	Groundwater setback distance (depth) assumes unsaturated flow and is defined as the vertical distance from the base of the land application systems to the highest seasonal water table level. To minimise potential for adverse impacts on groundwater quality, minimum setback distances should ensure unsaturated, aerobic conditions in the soil. These minimum depths will vary depending on the scale of site constraints identified in Table R2. Where groundwater setback is insufficient, the ground level can be raised by importing suitable topsoil and improving effluent treatment. The regulatory authority should make the final decision in this instance. (See also the guidance on soil depth and groundwater clearance in Tables K1 and K2.)

TABLE R2

SITE CONSTRAINT SCALE FOR DEVELOPMENT OF SETBACK DISTANCES

(used as a guide in determining appropriate setback distances from ranges given in Table R1)

Item	Site/system feature	Constraint scale (see Note 1) LOWER ← Examples of constraint factors (see Note 2)	→ HIGHER	Sensitive features
A	Microbial quality of effluent (see Note 3)	Effluent quality consistently producing ≤ 10 cfu/100 mL *E. coli* (secondary treated effluent with disinfection)	Effluent quality consistently producing ≥ 10^6 cfu/100 mL *E. coli* (for example, primary treated effluent)	Groundwater and surface pollution hazard, public health hazard
B	Surface water (see Note 4)	Category 1 to 3 soils (see Note 5) no surface water down gradient within > 100 m, low rainfall area	Category 4 to 6 soils, permanent surface water <50 m down gradient, high rainfall area, high resource/environmental value (see Note 6)	Surface water pollution hazard for low permeable soils, low lying or poorly draining areas
C	Groundwater	Category 5 and 6 soils, low resource/environmental value	Category 1 and 2 soils, gravel aquifers, high resource/environmental value	Groundwater pollution hazard
D	Slope	0 – 6% (surface effluent application) 0 – 10% (subsurface effluent application)	> 10% (surface effluent application), > 30% subsurface effluent application	Off-site export of effluent, erosion
E	Position of land application area in landscape (see Note 6).	Downgradient of surface water, property boundary, recreational area	Upgradient of surface water, property boundary, recreational area	Surface water pollution hazard, off-site export of effluent
F	Drainage	Category 1 and 2 soils, gently sloping area	Category 6 soils, sites with visible seepage, moisture tolerant vegetation, low lying area	Groundwater pollution hazard
G	Flood potential	Above 1 in 20 year flood contour	Below 1 in 20 year flood contour	Off-site export of effluent, system failure, mechanical faults
H	Geology and soils	Category 3 and 4 soils, low porous regolith, deep, uniform soils	Category 1 and 6 soils, fractured rock, gravel aquifers, highly porous regolith	Groundwater pollution hazard for porous regolith and permeable soils
I	Landform	Hill crests, convex side slopes, and plains	Drainage plains and incise channels	Groundwater pollution hazard, resurfacing hazard
J	Application method	Drip irrigation or subsurface application of effluent	Surface/above ground application of effluent	Off-site export of effluent, surface water pollution

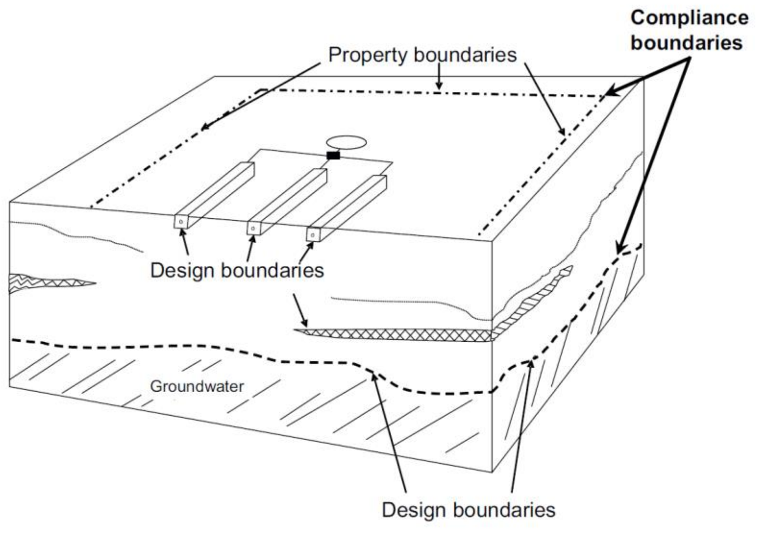
NOTES:

1 Scale shows the level of constraint to siting an on-site system due to the constraints identified by SSE evaluator or regulatory authority. See Figures R1 and R2 for examples of on-site system design boundaries and possible site constraints.

2 Examples of typical siting constraint factors that may be identified either by SSE evaluator or regulatory authority. Site constraints are not limited to this table. Other site constraints may be identified and taken into consideration when determining setback distances.

TABLE R2
SITE CONSTRAINT SCALE FOR DEVELOPMENT OF SETBACK DISTANCES
(used as a guide in determining appropriate setback distances from ranges given in Table R1) (continued)

3	The level of microbial removal for any on-site treatment system needs to be determined and it should be assumed that unless disinfection is reliably used then the microbial concentrations will be similar to primary treatment. Low risk microbial quality value is based on the values given in ARC (2004), ANZECC and ARMCANZ (2000), and EPA Victoria *(Guidelines for environmental management: Use of reclaimed water* 2003).
4	Surface water, in this case, refers to any fresh water or geothermal water in a river, lake, stream, or wetland that may be permanently or intermittently flowing. Surface water also includes water in the coastal marine area and water in man-made drains, channels, and dams unless these are to specifically divert surface water away from the land application area. Surface water excludes any water in a pipe or tank.
5	The soil categories 1 to 6 are described in Table 5.1. Surface water or groundwater that has high resource value may include potable (human or animal) water supplies, bores, wells, and water used for recreational purposes. Surface water or groundwater of high environmental value include undisturbed or slightly disturbed aquatic ecosystems as described in ANZECC and ARMCANZ (2000).
6	The regulatory authority may reduce or increase setback distances at their discretion based on the distances of the land application up or downgradient of sensitive receptors.



(Adapted from USEPA 2002)

FIGURE R1 EXAMPLE OF DESIGN AND COMPLIANCE BOUNDARIES FOR APPLICATION OF SETBACK DISTANCES FOR A SOIL ABSORPTION SYSTEM

Appendix D – Recommended Species List

APPENDIX 7

VEGETATION SUITABLE FOR LAND APPLICATION AREAS

Botanical Name	Approximate Height	Common Name or Variety
Grasses		
Carex spp.		
Lomandra longifolia		
Microlaena stipoides		
Oplismenus imbecillis		
Pennisetum alopecuroides	40 - 80 cm	Available as lawn turf
Poa lab		
Stipa spp.		
Ground cover/ climbers		
Hibbertia scandens		Snake vine
Hibbertia stellaris		
Isotoma fluviatalis	Prostrate	
Kennedia rubicunda	Climber	Dusky coral pea
Scaevola albida		
Scaevola ramosissima		
Veronica plebeia		
Viola hederacea		Native violet
Sedges/ grasses/ small plants		
Anigozanthus flavidus	2m	Kangaroo Paw
Baumea acuta		
Baumea articulata	Sedge	
Baumea juncea	Sedge	
Baumea nuda	Sedge	
Baumea rubiginosa	Sedge	
Baumea teretifolia	Sedge	
Blandfordia grandiflora	30-90cm	Christmas Bell
Blandfordia nobilis	30-90cm	Christmas Bell
Brachyscome diversifolia	Clump	Native Daisy
Carex appressa	Sedge	
Cotula coronopifolia	10-20cm	Waterbutton
Crinum pedunculatum	<2m	Swamp Lily
Cyperus polystachyos	Sedge	
Dianella caerulea	Low plant	Blue Flax Lily
Epacris microphylla	50cm -1m	
Ferns		
Gahnia spp.	Tall Grass	
Juncus spp.	0.5 m Rush	
Lobelia trigonocaulis	5-10cm	
Lomandra spp.	Grass	
Patersonia fragilis		Native Iris
Patersonia glabrata		Native Iris
Patersonia occidentalis		Native Iris
Ranunculus graniticola	5cm	
Restio australis	Reed	
Restio tetraphyllus	1m	
Sowerbaea juncea	Sedge	Rush Lily
Tetratheca juncea	<30cm	
Xyris operculata	<1m	Tall Yellow Eye

Botanical Name	Approximate Height	Common Name or Variety
Shrubs		
Agonis flexuosa nana		
Baekea linifolia	1 - 2.5 m	
Baekea utilis	1-2.5 m	
Baekea virgata	< 4 m	
Banksia aemula	1 - 7 m	
Banksia robur	0.5 - 2 m	
Bauera ruboides	0.5 - 1.5 m	
Callistemon	2 - 3 m	Burgundy
Callistemon	2 - 4 m	Eureka
Callistemon	3 - 4 m	Harkness
Callistemon	3 - 4.5 m	Kings Park Special
Callistemon	2 - 3 m	Mauve Mist
Callistemon	1 - 2.5 m	Red Clusters
Callistemon	2 - 3 m	Reeves Pink
Callistemon citrinus	50 - 80 cm	Austraflora Firebrand
Callistemon citrinus	2 - 4 m	Splendens
Callistemon citrinus	60cm – 1m	White Ice
Callistemon linearis	1 - 3 m	
Callistemon macropunctatus	2 - 4 m	
Callistemon pachyphyllus	2 - 3 m	
Callistemon pallidus	1.5 - 4 m	
Callistemon paludosus	3 - 7 m	
Callistemon pinifolius	1 - 3 m	
Callistemon rigidus	1.5 - 2.5 m	
Callistemon salignus	3 – 10m	
Callistemon shiresii	4 - 8 m	
Callistemon sieberi	1.5 - 2 m	
Callistemon sieberi	50 - 80 cm	Austraflora Little Cobber
Callistemon subulatus	1 - 2 m	
Callistemon viminalis	1 - 2 m	Captain Cook
Callistemon viminalis	5 - 10 m	Dawson River
Callistemon viminalis	3 - 5 m	Hannah Ray
Callistemon viminalis	50 cm - 1 m	Little John
Callistemon viminalis	1.5 - 2 m	Rose Opal
Callistemon viminalis	2 - 3 m	Western Glory
Goodenia ovata	1 - 1.5 m	
Hibiscus diversifolius	1 - 2 m	Swamp hibiscus
Kunzea capitata	1 - 2 m	
Leptospermum flavescens	< 2 m	Tea-tree
Leptospermum juniperinum	1 m	Tea-tree
Leptospermum lanigerum	1 - 2 m	Woolly tea-tree
Leptospermum squarrosum	< 2 m	Tea-tree
Melaleuca alternifolia	4 - 7 m	
Melaleuca decussata	1 - 2 m	Cross-leaved honey myrtle
Melaleuca lanceolata	4 - 6 m	
Melaleuca squamea	1 - 2 m	
Melaleuca thymifolia		

Botanical Name	Approx Height	Common Name or Variety
Trees		
Acacia elongata	> 2 m	
Acacia floribunda	2 - 4 m	Gossamer wattle
Agonis flexuosa	5 - 6 m	Willow myrtle
Allocasuarina diminuta	1.5 m	
Allocasuarina paludosa	0.5 - 2 m	
Angophora floribunda	Large tree	
Angophora subvelutina	Large tree	
Callicoma serratifolia	< 4m	
Casuarina cunninghamiana	10 - 30 m	River she-oak
Casuarina glauca	6 - 12 m	Swamp oak
Elaeocarpus reticulatis	Large tree	Blueberry ash
Eucalyptus amplifolia	Large tree	
Eucalyptus botryoides (coastal areas)	10 - 30 m	
Eucalyptus camaldulensis (west of ranges)	15 - 20 m	River red gum
Eucalyptus deanei	Large tree	Blue Mountains blue gum
Eucalyptus elata	Large tree	River Peppermint
Eucalyptus grandis	10 - 20 m	Flooded gum
Eucalyptus longifolia	20 m	Woollybutt
Eucalyptus pilularis	30 - 40 m	Blackbutt
Eucalyptus punctata	< 35 m	Greygum
Eucalyptus robusta	20 - 30 m	Swamp mahogany
Eucalyptus saligna (coastal)	30 - 50 m	Sydney blue gum
Eucalyptus tereticornis	30 - 40 m	Forest red gum
Eucalyptus viminalis (ranges)	20 - 40 m	Ribbon gum
Acmena smithii	10 - 20 m	Lilli pilli
Flindersia australis	< 40 m	Native teak
Hymenosporum flavuum	3 - 6 m	Native frangipani
Melaleuca armillaris	3 - 4 m	Bracelet honey myrtle
Melaleuca decora	4 - 7 m	
Melaleuca ericifolia	6 m	
Melaleuca halmaturorum	4 - 6 m	
Melaleuca hypericifolia	2 - 3 m	
Melaleuca linariifolia	4 - 8 m	Snow in summer
Melaleuca quinquenervia	5 - 7 m	Broad paperbark
Melaleuca squarrosa	6 m	
Melaleuca stypheloides	6 - 15 m	
Melia azedarach	15 - 20 m	
Pittosporum spp.		
Syzgium paniculatum	8 - 10 m	Bush cherry
Tristania laurina	5 - 15 m	Kanuka
Viminaria juncea	2 - 3 m	Golden spray

Source: Australian Plants Society

Appendix E - Concept Design Sketches - Irrigation System

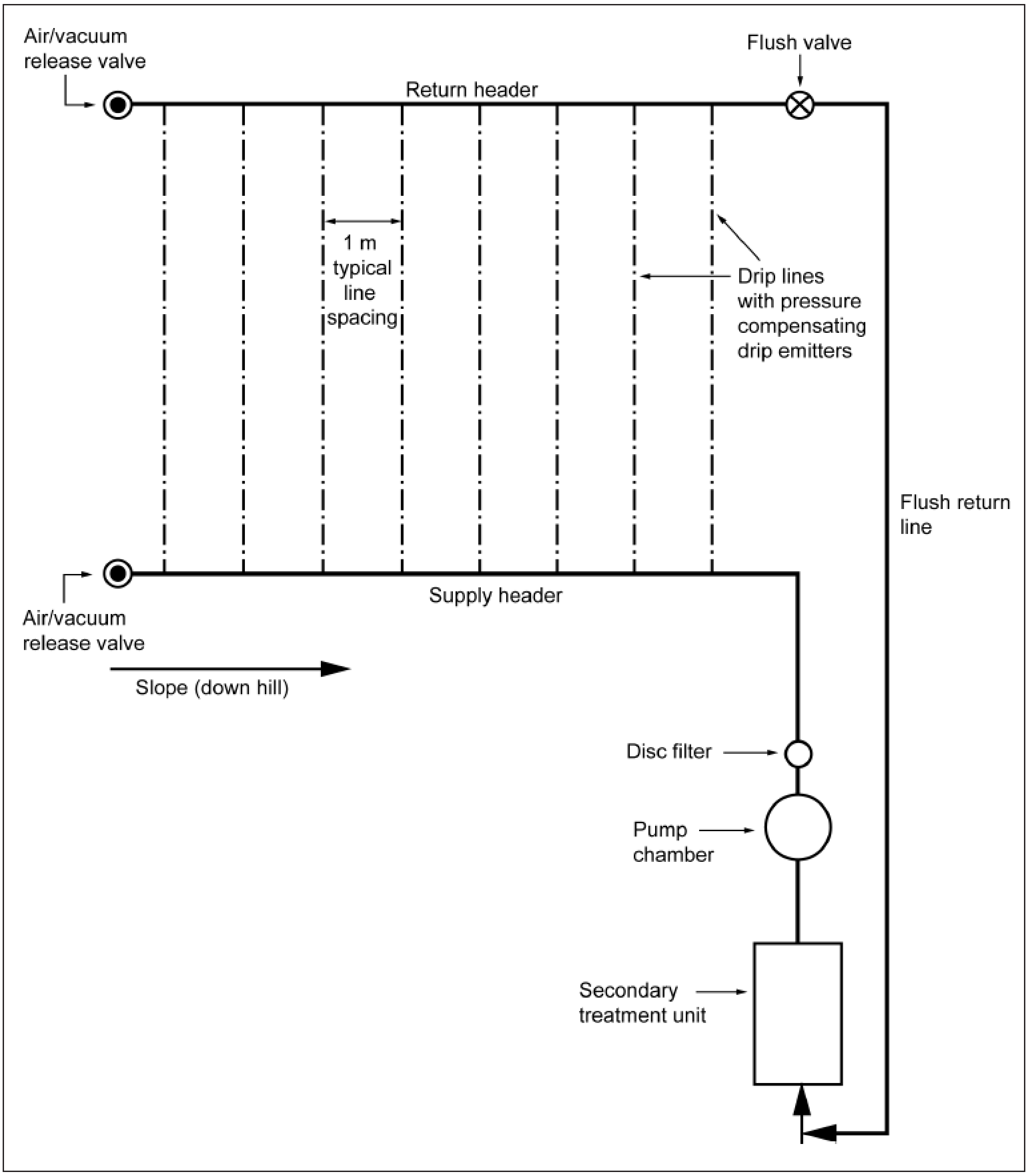


FIGURE M1 DRIP IRRIGATION SYSTEM – EXAMPLE LAYOUT OF COMPONENTS

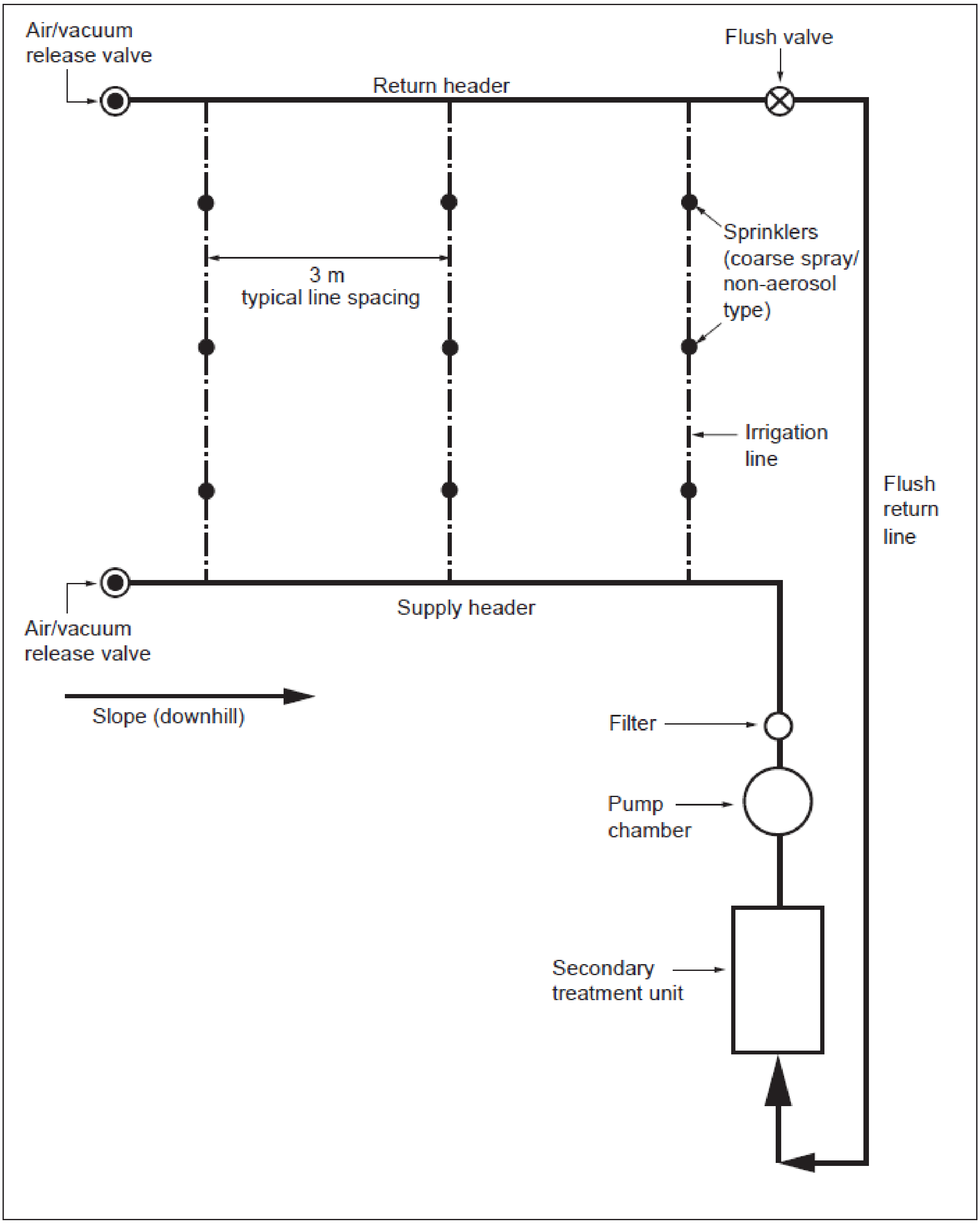
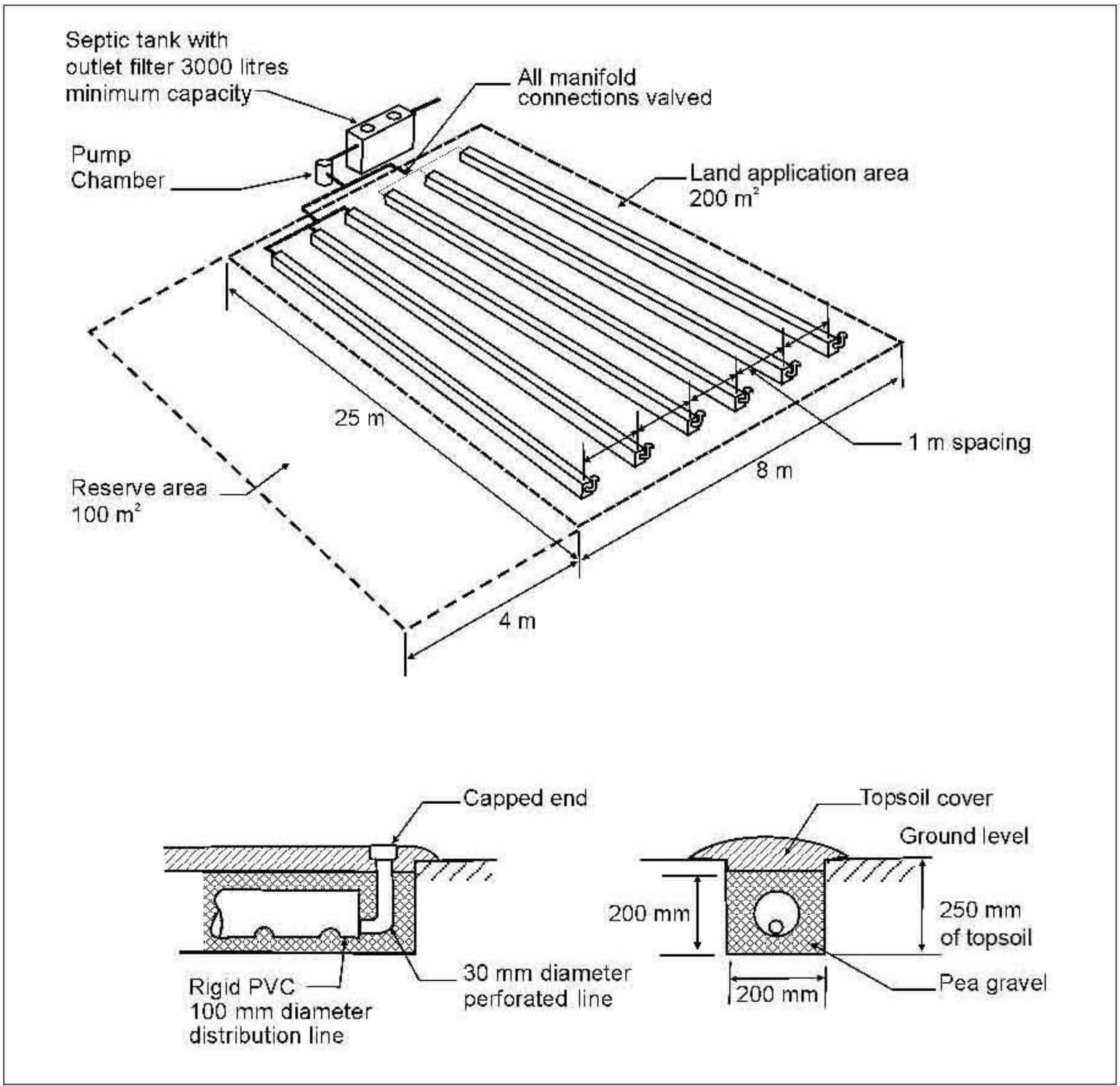


FIGURE M2 SPRAY IRRIGATION SYSTEM – EXAMPLE LAYOUT OF COMPONENTS



NOTES:

1 Example system sized for 700 L/d and DIR of 3.5 mm/d in soil Category 3 (see Table M1).

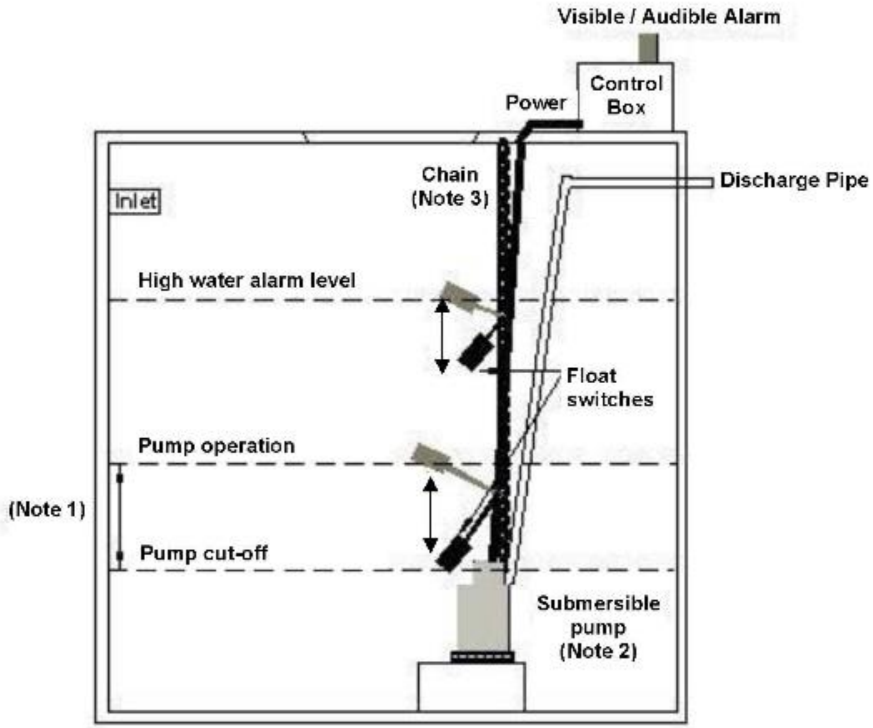
2 Preferred dosing method is by a 6-way automatic sequencing valve.

3 Good quality topsoil to 250 mm depth is required.

4 Flexible 100 mm diameter corrugated drainage line can be used in place of rigid PVC.

5 Distribution aggregate of 10 mm to 15 mm size can be used in place of pea gravel.

FIGURE M3 SHALLOW SUBSURFACE LPED IRRIGATION – EXAMPLE SYSTEM



Notes

1 The depth of effluent pumped within each cycle of the float switch (ie the depth between pump Cut-off and Operation) is calculated by:

depth of pumped effluent (m) x basal tank area (m^2) x 1,000 = discharge volume (litres per pump cycle).

This volume must match the hydraulic capabilities of the receiving component based on flow rate and total dynamic head.

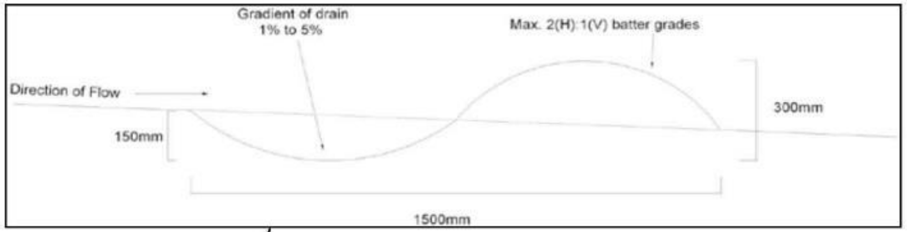
2 Submersible pump used as an example only. The pump will need to be selected based on the specific task. It may be a centrifugal pump or vortex pump depending on the type of effluent being pumped and the hydraulic characteristics of the system. It may sit on top of the tank and draw effluent from the tank.

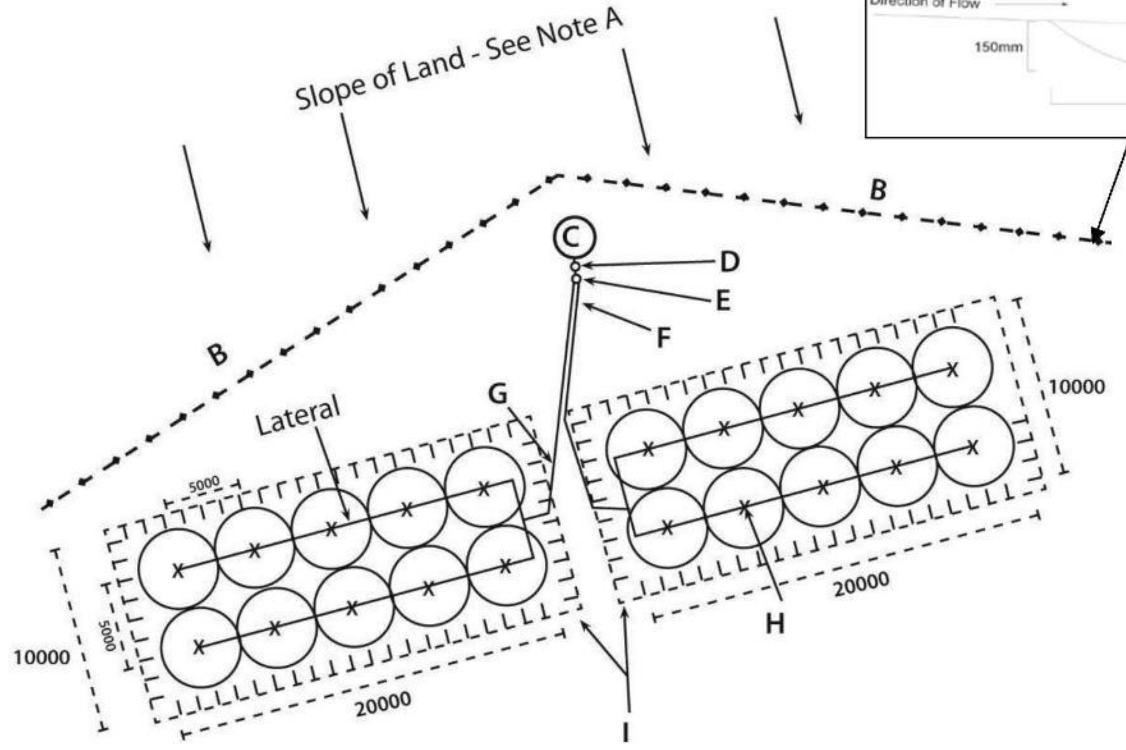
3 Submersible pumps must not be removed from a tank by their power cord. Heavier pumps may require the installation of a solid steel bar configuration according to manufacturer's specifications.

4 Cumulative storage must be assessed carefully to ensure that the pump well is large enough to buffer peak loads without the level exceeding that at which the high level alarm is triggered. The pump well should be sized to ensure that the volume of storage in the pump well reaches the low-level cut-off depth at least once every week.

Standard Drawing 12B - Demand Dose Pump well

(not to scale)





Surface Irrigation Area Construction

A Slope should not exceed 7% over the irrigation area. Landscaping may be required where appropriate.

B An earth bank diversion drain should be constructed upslope of the area to divert stormwater run-on if this is appreciable (see Inset A and Standard Drawing No.12B).

C Secondary treatment system (with disinfection) – the irrigation pump must provide adequate head at the highest sprinkler in the irrigation system at a flow rate that matches the output of the system. This figure will vary when alternative sprinklers are used - check with council and the supplier that alternative sprinklers are acceptable. A full hydraulic design should be carried out on each system.

D A 100-150 micron cylindrical filter should be installed prior to the sequencing valve and cleaned regularly.

E An automatic, hydraulically operated sequencing valve should be installed to deliver effluent evenly to the two (or more) areas. If preferred the valve can be set up to deliver effluent to the four laterals independently.

F In situations where the irrigation areas are above the pump well non-return valves should be installed.

G The effluent distribution pipe from the tank to the irrigation area should be buried a minimum of 300 mm below the ground surface. The manifold and laterals within the effluent irrigation area should be 25 mm polyethylene pipe buried 100-150 mm below the ground surface. Exact layout will depend on individual circumstances. Lateral and sprinkler spacing is typically 5 m.

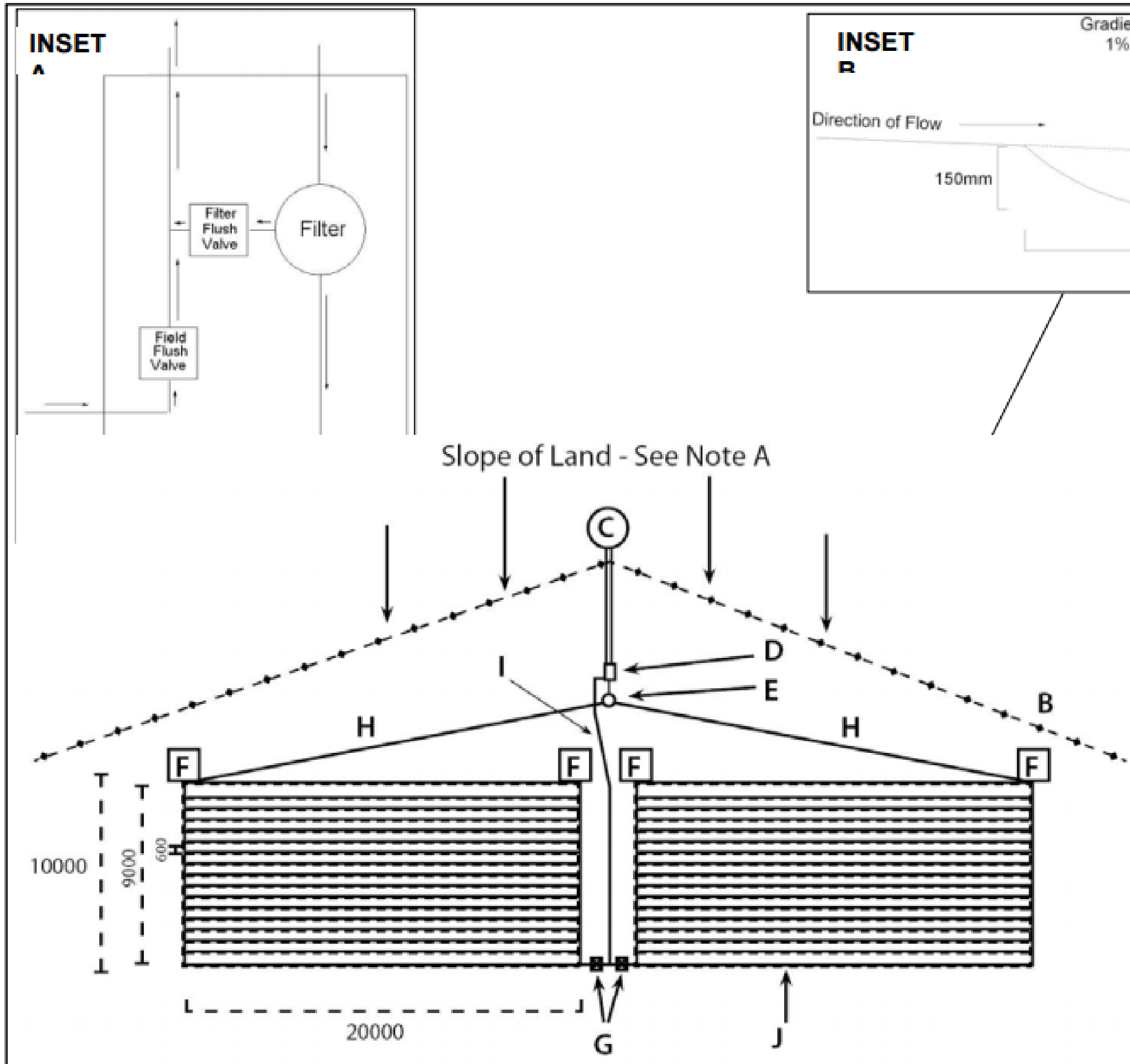
H Standard design based on use of typical heavy droplet rotary sprinklers with design throw radius 2 m, height 400 mm, flow rate 0.05 L/s and operating pressure of 80-100 kPa. Some pop-up and/or gear driven models may have different characteristics. Approval will be at the discretion of council.

I Irrigation areas can be either landscaped garden beds or lawn areas. The irrigation area should be planted with species appropriate for effluent irrigation (see the 'Silver Book', Department of Local Government, 1998).

This standard design has been based on a generic area of 400m² for irrigation based on typical conditions. It does not eliminate the need for a site and soil evaluation to be carried out or any additional consideration of site specific issues. It should be used as a generic guide only.

Standard Drawing 12C - Surface Irrigation of Effluent

(not to scale)



This standard design has been based on a generic area of 400 m^2 for irrigation based on typical conditions. It does not eliminate the need for a site and soil evaluation to be carried out or any additional consideration of site specific issues. It should be used as a generic guide only.

Subsurface Irrigation Area Construction

A Design for relatively uniform slope. Additional design work may be required where slope exceeds 12% or if system is to be installed over undulating ground.

B An earth bank diversion drain must be constructed upslope of the area to divert stormwater run-on if this is appreciable (see Inset B and Standard Drawing No.13A).

C Secondary treatment system – the irrigation pump must provide a *minimum* 20 m head and a flow rate that matches the design output of the selected dripline. Flow rate will vary depending on emitter spacing, flow rate and lineal metres of line. A full hydraulic design must be carried out. Each area should be capable of discharging a minimum of 80 L/min.

D Filtration and flushing mechanism (see Inset A) – a field flush valve must be installed on the return line to facilitate periodic flushing to the treatment tank. An additional filter flush valve should be installed downstream of the field flush valve. A 100-150 micron cylindrical filter should be installed and cleaned regularly. Where there are potential problems in returning irrigation field flush back to the treatment tank, a small (approximately 3 m x 0.6 m) absorption area sited below the effluent irrigation area can be used to accommodate the flushed effluent.

E An automatic, hydraulically operated sequencing valve should be installed to deliver effluent evenly to the two areas.

F Air release valves must be installed at high points in each area. Additional air release valves may be required in undulating terrain.

G Check valves are required for each irrigation field to facilitate periodic flushing.

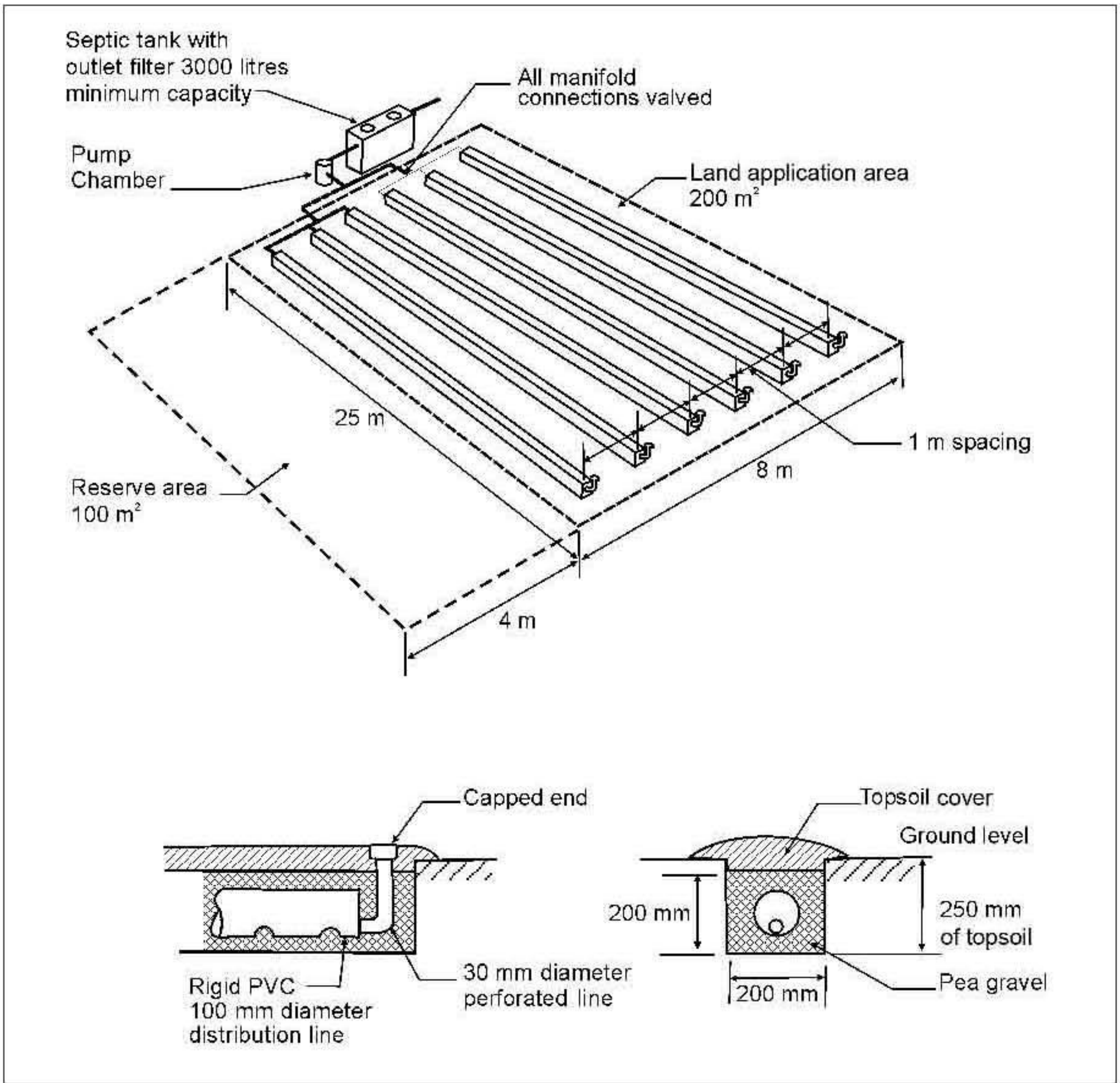
H Distribution manifolds should be 25 mm uPVC or polyethylene pipe buried 300 mm below the ground surface.

I Flushing return manifold should be 25 mm uPVC or polyethylene pipe buried 100-150 mm below the ground surface within the irrigation area. Outside this area, the pipe must be buried at a minimum of 300 mm depth.

J Pressure compensating (PC) subsurface drip line laterals (typically 16 mm) with emitters and laterals at approximately 600 mm spacings (maximum 1,000 mm spacings) and buried to a depth 100-150 mm. Only subsurface dripline specifically designed for effluent irrigation must be used.

Standard Drawing 13B - Subsurface Effluent Irrigation

(not to scale)



NOTES:

1 Example system sized for 700 L/d and DIR of 3.5 mm/d in soil Category 3 (see Table M1).

2 Preferred dosing method is by a 6-way automatic sequencing valve.

3 Good quality topsoil to 250 mm depth is required.

4 Flexible 100 mm diameter corrugated drainage line can be used in place of rigid PVC.

5 Distribution aggregate of 10 mm to 15 mm size can be used in place of pea gravel.

FIGURE M3 SHALLOW SUBSURFACE LPED IRRIGATION – EXAMPLE SYSTEM

Appendix F - Site Photos

Plate 1 – Overview of proposed site

Plate 2 – Overview of proposed site