On-site effluent management study

253 Burrundulla Road, Burrundulla NSW 2850

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Document control					
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Rev	**Report number**	**Date**	**Prepared by**	**Checked by**	**Revision details/status**
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1. Summary

Proposed development and situation	A rural-residential lot requires evaluation for suitability of on-site application of effluent from a proposed dual occupancy dwelling. This report describes the assessment and recommends a suitable effluent treatment and application system.
Investigation	A site assessment and soil assessment was undertaken using the Australian Standard 1547, *On-site domestic wastewater management*, Sydney Catchment Authority guidelines, *Designing and Installing On-site Wastewater Systems (*2019) and the Environment and Health Protection Guidelines, *On-site sewage management for single households* (1998), Department of Urban Affairs and Planning, as guidelines. Suitable wastewater application systems, sizing and location for the site are recommended. The evaluation is based on a dwelling with three potential bedrooms.
Type of land application and **treatment** systems considered best suited to the site	The recommended system is: • **Surface or sub-surface irrigation with an irrigation area of 533 square metres.** Gypsum should be applied to the application area during construction and annually to maintain permeability and reduce topsoil dispersion. • **Secondary wastewater treatment system** accredited by NSW Health.
Location	The location of the effluent application area is identified in Appendix 1.
Notes	Construction of the treatment and application systems should be according to AS1547 and Sydney Catchment Authority Guideline *Designing and Installing On-Site Wastewater Systems* (2019). Gypsum should be applied to the application area during construction and annually to maintain permeability. Secondary treatment systems require regular maintenance to ensure effective operation. Maintenance scheduling should be undertaken in accordance with manufacturers and NSW Health guidelines. The water balance is calculated using full water saving devices such as dual flush toilets (6/3 litre water closets), water reduction cycles on dishwashers, aerator faucets fitted to taps, front loader washing machines and water reducing shower heads. A maintained grass sward is the recommended vegetation over the irrigation area. Appendix 4 is a checklist of do's and don'ts to ensure correct operation of the wastewater system.

2. Introduction

A rural-residential lot requires evaluation for on-site application of effluent from a proposed new dual occupancy dwelling. A site and soil assessment were undertaken on 25 September 2023 and soil samples analysed. This report describes the site and soil investigation and recommends a suitable effluent treatment and application system.

3. Scope

A site assessment and soil assessment was undertaken using the Australian Standard 1547, *On-site domestic wastewater management*, Sydney Catchment Authority guidelines, *Designing and Installing On-site Wastewater Systems* (2019) and the Environment and Health Protection Guidelines, *On-site sewage management for single households* (1998), Department of Urban Affairs and Planning, as guidelines. Suitable wastewater application systems, sizing and location for the site are recommended.

4. Site information

Address of site	253 Burrundulla Road Burrundulla NSW 2850
Local Government	Mid-Western Regional Council
Client	Navigate Planning
Size	Approximately 15.4ha
Location, shape, layout	A plan of the relevant areas of the site and proposed effluent application area is described in Appendix 1.
Photograph(s) attached	Yes
Intended water supply	Rainwater Reticulated water supply Bore/Groundwater
Development	Dual occupancy dwelling
Expected wastewater flows	Number of bedrooms – 3 Number of persons – 4 Flows per person – 120 litres/person **Total** expected wastewater flow is 480 litres/day Flows are calculated using full water saving devices such as dual flush toilets (6/3 litre water closets), water reduction cycles on dishwashers, aerator faucets fitted to taps, front loader washing machines and water reducing shower heads. Re-calculation of the hydraulic balance and application area is required for dwellings containing a differing number of potential bedrooms.
Local experience of on-site management systems nearby	All systems are known to work satisfactorily in the locality providing they are adequately designed and maintained.

Setting	This lot is in a rural setting where the average dwelling density is less than 1 dwelling per 1ha and therefore less than the 1 per 0.4 hectares required for groundwater protection (Geary & Gardner 1996, Land Management for Urban Development, Australian Society of Soil Sciences, Qld).
Current land-use	Vacant, grazing
Climate	Summers are warm to hot and winters are cool to cold with little or no effective evaporation. Rainfall is distributed evenly throughout the year with an average annual rainfall of 629mm and pan evaporation of 1,755mm (Bureau of Meteorology, Mudgee).

5. Site assessment

Work undertaken	**Details**
Date	25 September 2023
Details	Site inspection, borehole construction, soil sampling
Weather on day and preceding week	Hot, <25mm rain in preceding week

Site feature	**Assessment**	**Limitation**
Vegetation	Grasses and broadleaved weeds	Minor
Flood potential: 1 in 20 year 1 in 100 year	 Nil Moderate	Moderate
Exposure Site aspect Shelter belts Topographical feature or structure	High North Nil Nil	Minor
Slope	0-1% in application area	Minor
Landform	Mid to lower slope	Minor
Run-on and seepage: Comment	Run-on and sub-surface seepage is expected to be moderate. Diversion banks may be required to divert flow from upslope.	Moderate
Erosion potential: Erodibility Erosion hazard	 The topsoil and subsoil have a low erodibility. Erosion hazard is low and is reduced when vegetated.	Minor
Site drainage	Moderate. Heavily mottled clays from 700mm indicating seasonal groundwater flows.	Moderate
Fill	Nil	Minor

Groundwater: Level of protection Bores and wells in the area and their purpose	Low A search of the Water NSW Groundwater map identified one groundwater bores (GW802466) located approximately 70m north of the recommended application area. No water bore is present between 100m and 500m of the recommended application area. The Sydney Catchment Authority recommends a draw-down analysis using an appropriate methodology such as Cromer et. al 2001 be undertaken when an effluent application area is located within 100m of a bore used for domestic consumption. The Cromer methodology was applied to the bore as calculated in Appendix 5. A buffer distance of 21m is required around the bores located 70m north. The buffer distance is available.	Minor
Surface water: Permanent waters, streams, lakes *(Recommended buffer distance 100m)* Other waters, intermittent waterways *(Recommended buffer distance 40m)*	Cudgegong River approximately 450m north Nil	Minor
Buffer distances from recommended application area to: Boundary premises *(Recommended buffer distance 3-12m)* Swimming pools *(Recommended buffer distance 6m)* Buildings *(Recommended buffer distance 3m)*	>6m Nil >6m	Minor
Area required for application system(s): Area available (including buffers):	533m^2 minimum area required for irrigation systems. 53m^2 minimum area required for trench systems (including mitigations). Potential application area of greater than 2,000m^2 available (Appendix 1).	Minor
Surface rocks, rock outcrops	Nil	Minor
Geology/ regolith	This site is located within the Cudgegong Soil Landscape and Craigmore Soil Landscape. <u>Craigmore Soil Landscape</u> The physiographic unit is recent alluvial deposits. The geological unit is Cza, Quaternary alluvium, older alluvium on higher terrace. Parent rocks are sources of	Minor

	alluvium are mostly metasediments of the Capertee Rise. Parent materials are Quaternary alluvium and eluvium, sand, silt, clay, some gravel. <u>Cudgegong Soil Landscape</u> Lower terraces of Cudgegong soil landscape comprises various alluvial deposits of sand and loams with higher terraces of red Podzolic soils and red-brown earths. Some yellow Podzolic-Solodic soils overlying iron manganese hardpans. Leached red earths and yellow podzolic soils also present. The physiological unit is recent alluvial deposits. Geological units is quaternary alluvium and recent alluvial deposits on the modern floodplain of the Cudgegong River. Parents rock are sources of alluvium are mostly metasediments of the Capertee rise. The parent material is alluvium (eSPADE v2.2).	
Environmental concerns: Native plants intolerant of phosphorous High water table Water way/wetland Community water storage	 Nil Nil None nearby None nearby	Minor
Site stability: Is expert assessment necessary	No, not expected to affect system performance	Minor

6. Soil assessment

Soil was assessed on site on 25 September 2023 by borehole construction to a depth of 1.5 metres or drill refusal with a Landcruiser mounted eziprobe drill rig with flight auger.

The soil profile was described and representative samples collected for the determination of physical and chemical properties. Soil physical property measurements undertaken included: dispersion description, texture, colour, pH, and salinity. The laboratory tests for physical properties were undertaken by Envirowest Testing Services and results are presented in the following table

Depth (mm)	Description	Sampled (mm)	Texture group	Moisture	Emerson aggregate test*	pH (1:5 water)	ECe dS/m
Test hole 1							
0-300	Strong brown fine sandy clay loam with fine gravels	100	FSCL	M	3	6.1	0.57
300-1000	Dark yellowish brown sandy gravelly clay loam	600	SGC	M	-	6.4	0.23
1000-1500	Yellowish brown sandy gravelly clay with weathered rock inclusions and grey and yellow mottled clays	1000	SGC	M	-	6.6	0.15
1500	End of hole at investigation depth						

Test hole 2							
0-400	Dark brown fine sandy clay loam with fine gravels	100	FSCL	M	3	5.8	0.86
400-700	Dark greyish brown sandy gravelly clay with trace mottling	600	SGC	M	3	6.4	0.75
700-1000	Dark grey silty clay with coarse sand to fine gravels with grey and yellow mottles	800	ZC	M	3	6.7	0.45
1000-1300	Dark greyish brown silty clay with heavily mottled clays	-	ZC	M	-	-	-
1300-1500	Yellowish brown silty clay with heavily mottled clays	-	ZC	M	-	-	-
1500	End of hole at investigation depth						

M=Moist, D=Dry, W=Wet, *1= highly dispersive (slakes, complete dispersion), 2= moderately dispersive (slakes, some dispersion), 3= slightly dispersive (slakes, some dispersion after remoulding), 4= non-dispersive (slakes, carbonate or gypsum present), 5= non-dispersive (slakes, dispersion in shaken suspension) 6= non-dispersive (slakes, flocculates in shaken suspension), 7= non-dispersive (no slaking, swells in water), 8= non-dispersive (no slaking, does not swell in water).

Site feature	Assessment	Limitation
Depth to bedrock	Greater than 1,500mm in recommended application area *(600mm below application base recommended)*	Minor
Depth to high water table	Approximately 700mm in recommended application area *(600mm below application base recommended)*	Moderate
Coarse fragments	Gravel identified throughout the soil profile	Minor
Bulk density	Good (estimated)	Minor
pH	Slightly acidic *(4.5-8.5 optimum range)*	Minor
Salinity	Non-Saline *(<4.0 dS/m desirable threshold)*	Minor
Phosphorus sorption capacity	6,500 kg/ha estimated *(SCA, 2019)*	Minor
Nutrient balance	Water is not expected to move off site, nutrients will be utilised by the vegetation and stored in the soil. The subsoil is a moderately drained silty clay to sandy gravelly clay that will immobilise moderate quantities of nitrogen (in ammonium and organic forms) as derived from primary treatment systems.	Moderate
Cation exchange capacity	Moderate (estimated). Will provide adequate retention of nutrients for plant growth.	Minor
Dispersiveness (Emerson aggregate test)	Slightly dispersive fine sandy clay loam topsoil over slightly dispersive sandy gravelly clay to silty clay subsoil. Regular application of gypsum recommended at the rate of 1kg per square metre of application area.	Moderate
Soil structure	Strongly structured	Minor
Soil texture and permeability category	Clay Loam (100mm) CL Light clay (600mm) LC	Minor

7. System selection

7.1 Estimation of land application areas from hydraulic loadings

Rainfall water balance and land application area calculations are presented in Appendix 3 and summarised in the following table. Design flow rates for the dwelling are 480L/day based on the use of water saving features. Wet weather storage areas included in the water balance utilise the storage capacity of the soil. The design application rate was determined from Tables L1, M1, N1 in AS1547 using the permeability classification of the subsoil.

Factors Affecting Design Loading and Sizing	**Design application rate (AS1547) (mm/day)**	**Size required for effluent application**
Hydraulic loading for different application systems - Surface/sub-surface irrigation - Absorption/evapotranspiration absorption trenches	 3 8	 533m^2 53m^2
Notes	The proposed loading will provide for leaching of salts out of the root zone and prevent the soil from becoming sodic. The proposed infiltration rates will protect the catchment against off-site nutrient movement.	

7.2 Centralised sewerage systems

Consideration of connection to a centralised sewerage system Approximate distance to nearest feasible connection: Potential for future connection to centralised sewerage: Potential for future connection to reticulated water:	 <2km high / medium / low / already connected high / medium / low / already connected

7.3 Suitability of application systems

Application system	**Treatment system**	**Site limitations of the application system**	**Modifications to mitigate constraints**	**Suitability**
Absorption system	Septic tank	Slightly dispersive subsoil Moderately drained subsoil	Nil	No
Evapotranspiration system	Septic tank	Slightly dispersive subsoil Moderately drained subsoil	Nil	No
Surface irrigation	Secondary	Slightly dispersive topsoil Flood potential moderate for 1 in 100 year	Regular application of gypsum at a rate of 1kg/m^2 Access openings to tanks or other parts of system should be sealed to prevent ingress of water during flood events Tank installation to be undertaken in accordance with local council guidelines	Yes

Sub-surface irrigation	Secondary	Slightly dispersive topsoil Flood potential moderate for 1 in 100 year	Regular application of gypsum at a rate of 1kg/m^2 Access openings to tanks or other parts of system should be sealed to prevent ingress of water during flood events Tank installation to be undertaken in accordance with local council guidelines	Yes

7.4 System recommendation

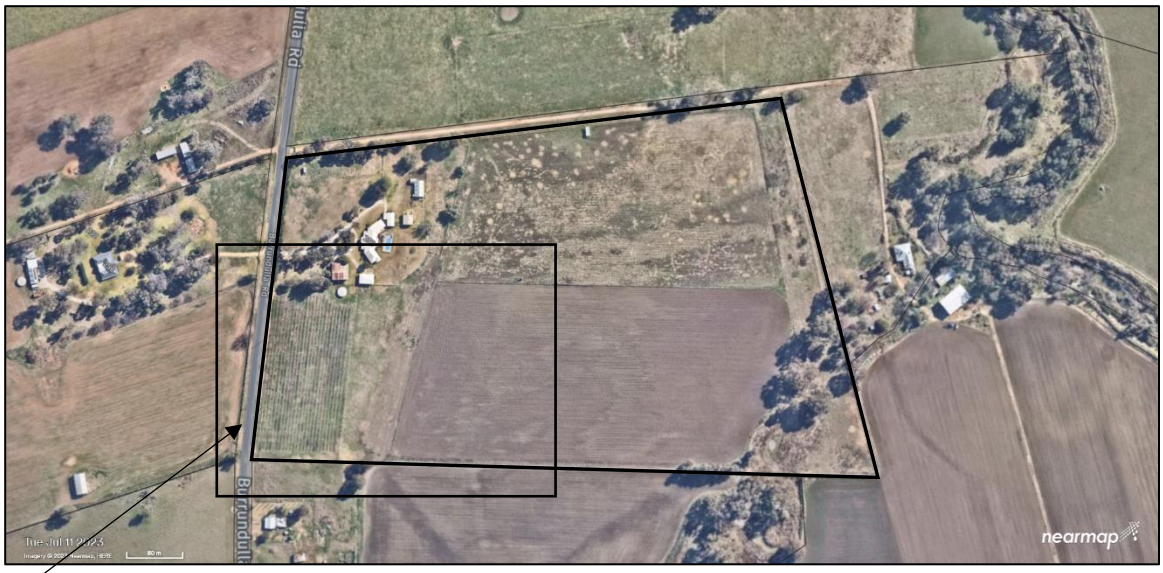
Type of land application and **treatment** systems considered best suited to the site	The recommended system is: • **Surface or sub-surface irrigation with an irrigation area of 533 square metres.** Gypsum should be applied to the application area during construction and annually to maintain permeability and reduce topsoil dispersion. • **Secondary wastewater treatment system** accredited by NSW Health.
Location	The location of the effluent application area is identified in Appendix 1.
Notes	Construction of the treatment and application systems should be according to AS1547 and Sydney Catchment Authority Guideline *Designing and Installing On-Site Wastewater Systems* (2019). Gypsum should be applied to the application area during construction and annually to maintain permeability. Secondary treatment systems require regular maintenance to ensure effective operation. Maintenance scheduling should be undertaken in accordance with manufacturers and NSW Health guidelines. The water balance is calculated using full water saving devices such as dual flush toilets (6/3 litre water closets), water reduction cycles on dishwashers, aerator faucets fitted to taps, front loader washing machines and water reducing shower heads. A maintained grass sward is the recommended vegetation over the irrigation area. Appendix 4 is a checklist of do's and don'ts to ensure correct operation of the wastewater system.

8. General comments

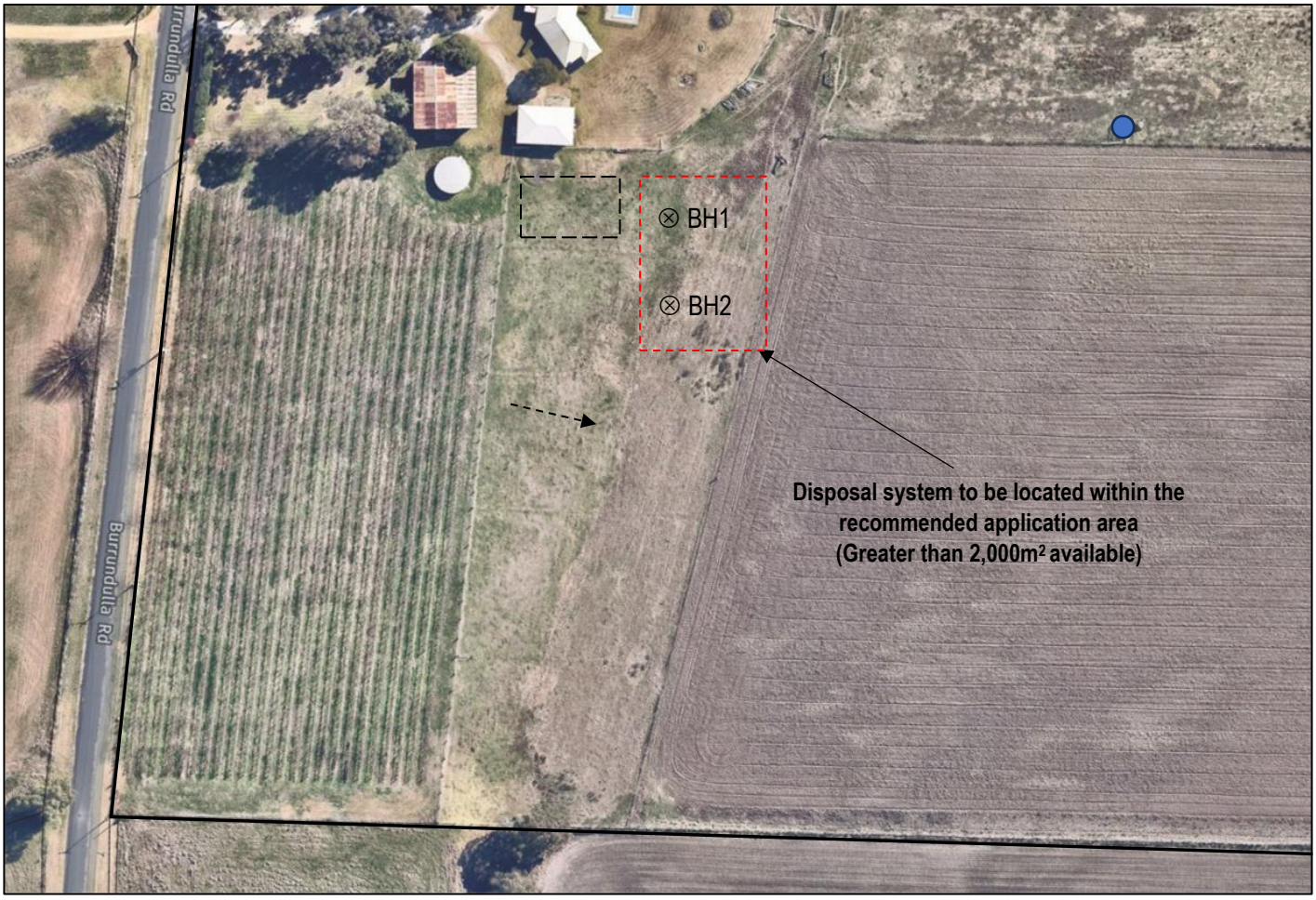
Are there any specific environmental constraints?	Wastewater should be evenly applied over the application area.
Are there any specific health constraints?	Restrict access to people and stock as recommended in AS1547 and summarised in Appendix 4.
Any other comments?	The topsoil is capable of supporting plant growth that will optimise evapotranspiration and wastewater usage.

9. Report limitations and intellectual property

This report has been prepared for the use of the client to achieve the objectives given the clients requirements. The Australian Standard 1547, *On-site domestic wastewater management*, and the Environment and Health Protection Guidelines, *On-site sewage management for single households* (1998) Department of Urban Affairs and Planning, have been used as guidelines in this report. Where system limitations or uncertainties are known, they are identified in the report. No liability can be accepted for failure to identify conditions or issues which arise in the future and which could not reasonably have been predicted using the scope of the investigation and the information obtained. No guarantee can be made that the wastewater system will achieve all performance criteria because of operational factors and the inherent variable and unpredictable nature of the soil. All components of the wastewater system have a limited life.



Burrundulla Road



Legend

⊗ Borehole location

Existing water bore

Slope

Proposed building envelopes

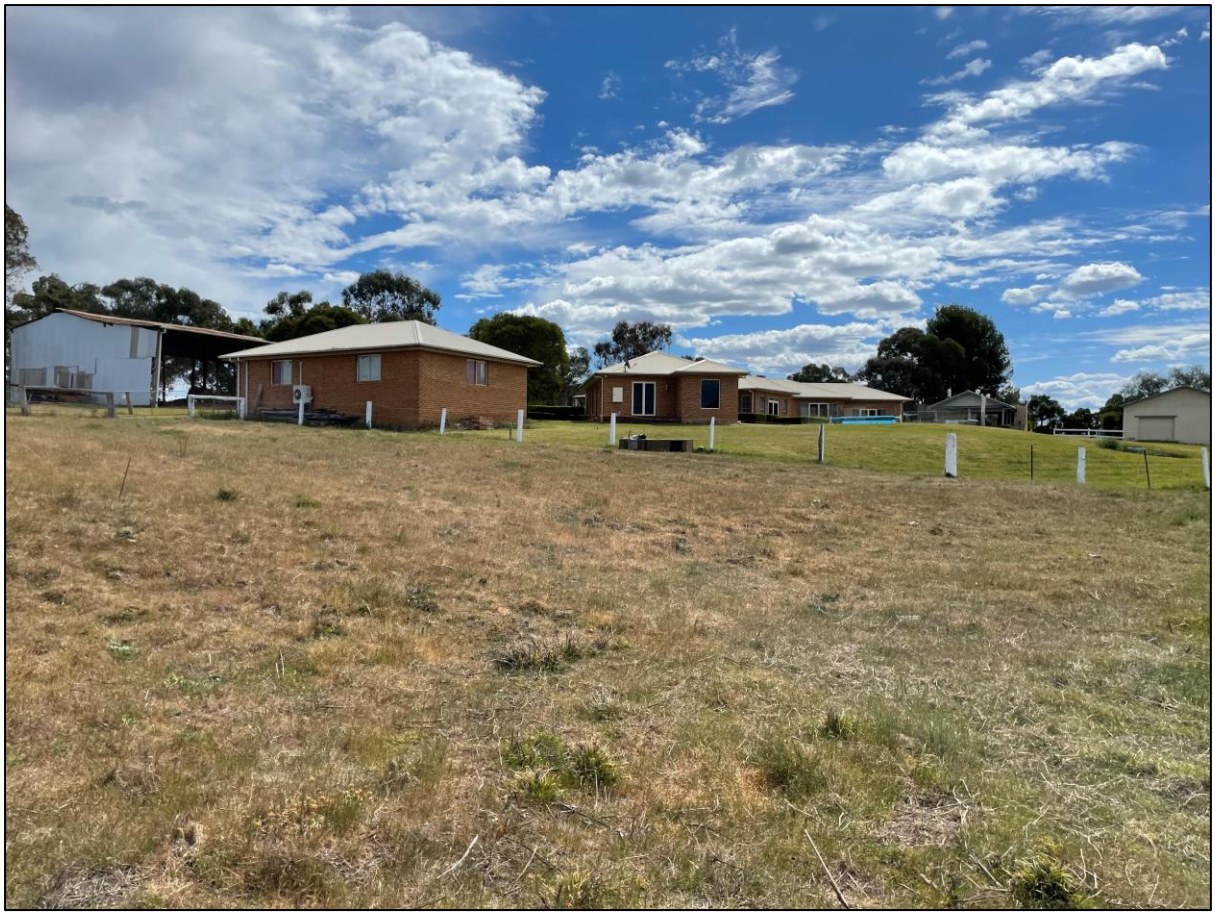
Recommended application area (Greater than 2,000m² available)

Approximate Scale 1: 2,200

0 22 44 88m

Appendix 1. Aerial image, site plan and borehole location		
253 Burrundulla Road, Burrundulla NSW		
	Envirowest Consulting Pty Ltd	
Job: R16181e1	Drawn by: TS	Date: 24/10/2023

Appendix 2. Photographs of the site



Looking southwest over the recommended application area

Appendix 3a. Monthly water balance determine the wastewater application area required (Irrigation systems)

Design wastewater flow	Q	L/day	480	120	L/person/day	4	persons
Design percolation rate	R	mm/wk	21	3	mm/day		
Land area	L	m2	78				
Effective precipitation	EP		0.9	(10% runoff)			

Parameter	**Symbol**	**Formula**	**Units**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**total**
days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	P		mm/month	70	72	46	32	36	41	42	36	49	56	78	72	629
Evaporation	E		mm/month	272.8	221.2	195.3	126	77.5	48	52.7	74.4	102	158.1	207	220	1755
Crop factor	C		-	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.8
Inputs																
Effective Precipitation	EP		mm/month	62.73	64.62	41.4	28.98	32.13	37.17	37.62	32.22	43.83	50.4	70.2	64.8	566
Effluent irrigation	W	QXD/L	mm/month	190.8	172.3	190.8	184.6	190.8	184.6	190.8	190.8	184.6	190.8	184.6	190.8	2246
Inputs		P+W	mm/month	253.5	236.9	232.2	213.6	222.9	221.8	228.4	223.0	228.4	241.2	254.8	255.6	2812
Outputs																
Evaportranspiration	ET	ExC	mm/month	245.52	199.1	175.8	113.4	69.8	43.2	47.4	67.0	91.8	142.3	186.3	198.0	1580
Percolation	B	R/7xD	mm/month	93.0	84.0	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	1095
Outputs		ET+B	mm/month	338.5	283.1	268.8	203.4	162.8	133.2	140.4	160.0	181.8	235.3	276.3	291.0	2675
Storage	S	(EP+W)-(ET+B)	mm/month	-85.0	-46.2	-36.6	10.2	60.1	88.6	88.0	63.0	46.6	5.9	-21.5	-35.4	
Cumulative storage	M		mm	0.0	0.0	0.0	10.2	70.3	158.9	246.9	309.9	356.6	362.4	341.0	305.5	

Storage	V	largest M	mm	362.4
		Soil storage	mm	376.0
		Storage required	mm	-13.6
		VxL/1000	m^3	**-1.1**
Irrigation area			m^2	**78**

	water holding capacity	depth (mm)	Totals(mm)
Topsoil	34%	100	34
Subsoil	38%	900	342
			376

Appendix 3b. Estimation area requirement from organic matter and nutrient balances (Irrigation systems)

Estimated effluent flow	(Q)	480	L/day
Soil depth		1.5	m

Organic matter balance

BOD (C)	20	mg/L
treated wastewater flow rate (Q)	480	L/day
critical loading rate of BOD (Lx)	3000	$mg/m^2/day$
land area required (A)	**3.2**	m^2

Nitrogen balance

nutrient concentration	37	mg/L
treated wastewater flow rate	480	L/day
critical loading rate of nutrient	50	$mg/m^2/day$
land area required (A)	**355**	m^2

Determination of nitrogen critical loading rate

Nitrogen load (kg/year)	6.5	kg/year	
Loss 20% denitrification	5.2	kg/year	
Load to soil	146.0	kg/ha/year	assumed irr. area from table $355m^2$
Vegetation usage	200.0	kg/ha/year	
Residual (potential leaching)	-54.0	kg/ha/year	

Typical nitrogen uptake (Myers et al. 1984)		
Pastures	300 kg/ha/year	82 mg/m2/day
Pine	350 kg/ha/year	96 mg/m2/day
Eucalypts	180 kg/ha/year	49 mg/m2/day

Phosphorus balance

Phosphorus sorption capacity per metre=			6,500	kg/ha
Phosphorus sorption capacity of profile=			9,750	kg/ha
Soil factor			0.33	
Critical loading=		3 $mg/m^2/day$		
P concentation*=		12	mg/L	
P adsorbed=	phosphorus sorption capacity x soil factor			
	3217.5			
	0.32175	kg/m^2		
Puptake=	critical loading x days/year x	50	years	
	54750			
	0.0548	kg/m^2		
Pgenerated=	total phosphorus concentration x wastewater volume in 50 years			
	105120000			
	105	kg		
	Pgenerated / (Padsorbed + Puptake)			
Land area required	**279.2**	**m^2**		

Appendix 4. Checklist for effective management of wastewater systems

Domestic wastewater system

DO

- Check household products for suitability of use with a septic tank.
- Conserve water, prolonged period of high water use can lead to application area failure. For optimum operation, avoid daily and weekly surges in water flows. Spas are not recommended.
- Scrape cooking dishes and plates prior to washing to reduce solid load.
- Maintain the system with regular servicing as per the manufacturer's instructions.

DON'T

- Dispose of excessive solid material, fats, lint or large water volumes into drains.

Land application area

- Construct and maintain diversion drains around the top-side of the application area to divert surface water.
- The application area should be a grassed area, which is maintained at 10-30cm height.
- The area around the perimeter can be planted with small shrubs to aid transpiration of the wastewater.
- Ensure run-off from the roof or driveway is directed away from the application area.
- Periodic application of gypsum may be necessary to maintain the absorptive capacity of the soil.
- **Do not** erect any structures or paths on the land application area.
- **Do not** graze animals on the land application area.
- **Do not** drive over the land application area.
- **Do not** plant large trees that shade the land application area thereby reducing transpiration of water.
- **Do not** let children or pets play on the land application area.
- **Do not** extract untreated groundwater for potable use.

Appendix 5. Buffer distances for bores

The recommended buffer distance for on-site effluent management systems to groundwater wells is 100m. One bore is located 70m north and downslope from the recommended application area. The size of the buffer distance from the bores can be reduced by determining the separation distance required between the bore and an on-site application system.

The separation distance is the distance required between a bore and a land application system to prevent contamination of the bore with effluent that may enter the bore. The separation distance is determined from the radius of influence of a bore plus the setback distance.

The radius of influence of a bore can be calculated from the aquifer and bore hydraulic characteristics as an application of the viral die-off method of Cromer *et al*. (2004). The viral die-off method estimates the time required for viruses in the contaminated water to be inactivated (reduced to acceptable number by natural mortality processes) as they move down gradient in the groundwater. The distance travelled during the travel time is the setback distance. Darcy's law is used to estimate the travel time.

The model for estimating the setback distance is:

$dg = (t\text{-}dv.P/K) / (P/K.\ i)$

where:
d_g = setback distance (m)
t = time (days)
d_v = vertical distance to water table (m)
P = porosity of fraction (decimal)
K = hydraulic conductivity (m/day)
i = groundwater gradient (fraction)

The model for estimating the radius of influence of a water bore is:

$r = 1.5[(KHt\text{-}/S)^{0.5}]$ *which is reasonably valid for* $t=Kt/SH \geq 1$

where:
r= radius of influence
K= aquifer permeability (m/day)
H= initial thickness of the water (m) in the fully penetrating bore
t= time of pumping (t, days)
S= specific yield (S fraction, dimensionless)

A land application system should not be located within the maximum radius of influence of a bore. Additionally, the appropriate separation distance is the radius of influence of the bore plus the setback distance for viral die-off when application systems are located up gradient of the bore. The application system will be located upslope approximately 70m of the bore therefore the radius of influence and setback distance is a sufficient buffer distance.

No impact from the application of effluent is expected on the domestic bore. Bores surrounding the site are unconfined aquifers.

An assessment of potential impacts on non-confined aquifers was undertaken by modelling. The viral die-off method of Cromer *et al.* (2004) was used to calculate the radius of influence and subsequently the minimum separation distance required to the well.

Viral die off time was estimated to be a reduction in order of magnitude of 3 at a groundwater temperature of 9˚C equivalent to 300 days. This is expected to be a conservative estimate in viral die-off.

Bore 70m north of application area (GW028796)
The model parameters for estimating the radius of influence of the water bore were:
K= aquifer permeability (m/day) = 0.5
H= initial thickness of the water (m) in the fully penetrating bore= 3.9
t= time of pumping (t, days) = 100
S= specific yield (S fraction, dimensionless) = 12.63

The radius of influence was subsequently calculated to be 6 metres.

The model parameters for measuring the setback distance of the groundwater bore were:
d_g= setback distance (m)
t= time (days) = 300
d_v= vertical distance to water table (m) = 3.6
p= porosity of fraction (decimal) = 0.2
k= Hydraulic conductivity (m/day) = 0.5
i= groundwater gradient (fraction) = 0.02

The calculated setback distance was subsequently calculated to be 15 metres.

The appropriate separation distance is the radius of influence plus the calculated setback distance, which is subsequently calculated to be 21m. The buffer distance is available.