On-site effluent management study

Proposed cabins

99 Mount Pleasant Lane, Buckeroo NSW

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Proposed development and situation

Five one bedroom cabins are proposed at 99 Mount Pleasant Lane, Buckeroo NSW. The cabins will include a bathroom and kitchenette.

An on-site effluent assessment to determine suitability for accepting wastewater from the proposed development is required as part of the development application.

Objectives

Undertake a site and soil assessment using the Australian Standard 1547, *On-site domestic wastewater management*, the Environment and Health Protection Guidelines, *On-site sewage management for single households* (1998), Department of Urban Affairs and Planning and the Government of South Australia *On-site Wastewater Systems Code* as guidelines. Suitable wastewater application systems, sizing and location for the wastewater are recommended.

The assessment included determination of expected flows, site and soil assessment and recommendation of suitable wastewater treatment and application systems.

Investigation

A desktop study was conducted using available soil information from adjacent sites, expected wastewater flows and collection of available site information. Soil was assessed for parameters to determine suitable application areas and rate of wastewater disposal.

Recommended land application and treatment system

The recommended system for the proposed development is:

- **Surface (drip) or subsurface irrigation area of 740 square metres.**
- **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.

Gypsum should be applied to the application area during construction and every two years to maintain permeability.

The water balance is calculated using full water saving devices such as dual flush toilets, water reduction cycles on dishwashers, aerator faucets fitted to taps and water reducing shower heads.

Secondary treatment systems require regular maintenance to ensure effective operation. Maintenance scheduling should be undertaken in accordance with manufacturers and NSW Health guidelines.

Fencing should be erected around the application area to prevent access. Signage should be displayed identifying the area of treated effluent.

1. Introduction

Five one bedroom cabins are proposed at 99 Mount Pleasant Lane, Buckeroo NSW. The cabins will include a bathroom and kitchenette.

An on-site effluent assessment to determine suitability for accepting wastewater from the proposed development is required as part of the development application.

2. Scope

Undertake a site and soil assessment using the Australian Standard 1547, *On-site domestic wastewater management*, the Environment and Health Protection Guidelines, *On-site sewage management for single households* (1998), Department of Urban Affairs and Planning and the Government of South Australia *On-site Wastewater Systems Code* as guidelines. Suitable wastewater application systems, sizing and location for the wastewater are recommended.

3. Site identification

3.1 Location

The site is 99 Mount Pleasant Lane, Buckeroo (Appendix 1) and has an area of approximately 12 hectares.

3.2 Council area

Mid-Western Regional Council

3.3 Client

Michael Ferris
99 Mount Pleasant Lane
Buckeroo NSW

3.4 Development

Cabins are proposed for the northern section of 99 Mount Pleasant Lane, Buckeroo NSW (Appendix 1). The development will include five one bedroom cabins which will sleep up to two people per cabin. Each cabin will include a handbasin, shower, toilet and kitchenette.

3.5 Current land-use

The recommended application area is currently grazing farmland. Grapevines were removed from the site approximately 3 years ago.

4. Site condition and surrounding environment

An assessment of the site was made from a desktop. Information for the desktop study was obtained from topographic maps, aerial photographs, database searches and previous reports.

4.1 Topography

The site is located on a mid-slope. Aspect of the site is south west. Slopes are very gently inclined and less than 1% in the application area. Elevation is approximately 480 metres above sea level.

4.2 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 NSW).

4.3 Hydrogeology

4.3.1 Surface water

Surface water on the site is expected to mostly infiltrate. Any excess surface water flows south west into intermittent drainage lines and dams. Lawsons Creek is located approximately greater than 1km south of the recommended application area. Lawsons Creek flows into the Cudgegong River.

4.3.2 Groundwater

One registered groundwater bore is located approximately 300m south east of the recommended application area. The bore is licensed for irrigation use. Water bearing zones are from 61m in sandstone. Standing water level at the time of drilling was at 28m.

No impact on groundwater is expected from the application of effluent on the site.

4.4 Vegetation

Vegetation cover on the site was dominated by prairie grass, milk thistle and Patterson's curse. Vegetation cover within the investigation area was 100% indicating no salinity issues are located on the site.

The vegetation is not a limitation to on-site effluent system. The vegetation does not indicate site characteristics which are a limitation to on-site effluent system.

4.5 Soil type and geology

The site is located within the Craigmore Soil Landscape (eSpade 2022). The dominant soils are non-calcic brown soils and red earths on very old alluvium. The geological unit is Quaternary alluvium. Parent rock are metasediments and parent materials comprise alluvium, eluvium, sand, silt, clay and some gravel.

No erosion is expected at the site. The soil has a low erodibility and erosion hazard in the proposed application area.

4.6 Local experience

An existing system services the dwelling at 111 Mount Pleasant Lane, Buckeroo NSW. The system was inspected in December 2020 and comprised a 3,000L septic tank and approximately 40m of absorption trenches. The users of the existing system reported that the system was working well and did not identify any signs of failure including odour, water ponding or excessive vegetation.

5. Investigation methods

Soil information was derived from results of an on-site effluent assessment undertaken at 111 Mount Pleasant Lane, Buckeroo NSW by Envirowest Consulting Pty Ltd in January 2021 (report number R12670e). Soil landscape maps, vegetation types and client information indicates the soil assessed in 2021 is representative of the soil in the investigation area.

The soil profile was described, and samples were collected from the boreholes at representative depths for the determination of soil properties. Soil properties measurements undertaken included:

dispersion, texture, colour, pH and electrical conductivity (salinity). The tests were undertaken by Envirowest Testing Services.

Soil electrical conductivity (EC) results of the 1:5 (soil:water suspension) were converted to saturated extracts (ECe). EC values are converted to ECe by using a multiplier factor (Hazelton and Murphy 1992), which is dependent on the soil texture (Table 1). Saline soils are defined as those with an electrical conductivity (ECe) greater than 4 dS/m (Charman and Murphy 2001). Soil salinity ratings and effects on plant growth are presented in Table 2.

Table 1. ECe texture based conversion factors (Charman and Murphy 2001)

Soil texture	Conversion factor
Loamy sand, clayey sand, sand	23
Sandy loam, fine sandy loam, light sandy clay loam	14
Loam, loam fine sandy, silt loam, sandy clay loam	9.5
Clay loam, silty clay loam, fine sandy clay loam	8.6
Sandy clay, silty clay, light clay	7.5
Light medium clay, medium clay, heavy clay	5.8

Table 2. Soil salinity ratings based on ECe readings

Salinity rating	ECe (dS/m)*	Effects on Plants
Non saline (NS)	0-2	Salinity effects negligible
Slightly saline (SS)	2-4	Very salt sensitive plant growth restricted
Moderately saline (MS)	4-8	Salt sensitive plant growth restricted
Highly saline (HS)	8-16	Only salt tolerant plants unaffected
Extremely saline (ES)	>16	Only extremely tolerant plants unaffected

*ECe - Electrical conductivity of a saturated extract

Soil with ECe below 2 dS/m will have negligible effects on plant growth and soil stability. Soil with ECe of between 2 and 4 dS/m may restrict very salt sensitive plant growth. Soil with ECe between 4 and 8 dS/m will restrict the growth of salt sensitive plants.

Samples collected were analysed for dispersion using the Emerson aggregate test. Table 3 details the eight dispersion ratings.

Table 3. Emerson dispersion classes

Class	Description
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

6. Results

6.1 Soil

Description of soil over the site is provided in the following sections and summarised in Table 4.

6.1.1 Soil profile

The soil profile was a light brown silty clay loam topsoil to a depth of 200mm. Subsoil was yellowish brown to brownish yellow sandy clay. Trace ironstone was identified from 500mm. Topsoil samples were non-dispersive and subsoil was highly dispersive to non-dispersive.

Table 4. Soil analysis results

Depth (mm)	Description	Sampled (mm)	Texture group	Moisture	Emerson aggregate test*	pH (1:5 water)	ECe dS/m
Test hole 1							
0-200	Light brown silty clay loam	100	ZCL	D	5	6.7	0.60
200-600	Yellow sandy clay with gravel	600	SC	D	2	5.9	0.23
600-1200	Brownish yellow sandy clay with trace ironstones	1200	SC	D	5	6.1	0.60
1500	End of hole at investigation depth						
Test hole 2							
0-200	Light brown silty clay loam	100	ZCL	D	5	6.9	0.26
200-500	Yellowish brown sandy clay	500	SC	D	1	5.8	0.08
500-1200	Brownish yellow sandy clay with trace ironstones	1000	SC	D	5	6.2	0.98
1500	End of hole at investigation depth						

M=Moist, D=Dry, WP= Wet plastic limit *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) N/A= test unable to be undertaken due to soil properties.

6.1.2 Depth to bedrock

Greater than 1,500mm in recommended application area *(600mm below application base recommended).*

6.1.3 Surface rocks, rock outcrops

No rock outcrops in the application area. Rocks will not be a limitation to the application of effluent.

6.1.4 Depth to groundwater

No free water was identified in the boreholes to the drilling depth. Depth to groundwater is not expected to be a limitation to the application of effluent.

6.1.5 Coarse fragments

Ironstone was identified in the subsoil profile and is not considered a limitation to the application of effluent.

6.1.6 Bulk density

Bulk density was estimated to be good from field assessment and the land-use history. Bulk density will not limit plant growth. The soil has not been extensively cultivated and no clay pans are located on the site.

6.1.7 pH

The pH was slightly acidic between 5.8 and 6.7. The levels present will not significantly affect the growth of most species.

6.1.8 Salinity
No salt tolerant vegetation was observed. The electrical conductivity of the soil of all samples tested was non-saline. All electrical conductivity values in the soil samples collected were less than 0.6 dS/m, where 4 dS/m is considered the saline threshold.

6.1.9 Dispersion
Dispersion was estimated by soil analysis of the Emerson aggregate test. The topsoil samples collected were non-dispersive. Subsoil samples were non-dispersive to highly dispersive.

Maintenance of vegetation on the application area and the regular application of gypsum will prevent any reduction in infiltration or erosion problems associated with the slightly dispersive soils. The periodic application of gypsum is recommended

6.1.10 Soil structure
The soils were assessed to have a moderate soil structure.

7. On-site effluent management
7.1 Slope
Slope is a potential limitation to application of wastewater. Steep slopes can cause greater run-off during wet weather. The application of wastewater from absorption trench systems is limited to slopes of 15% or less and for sub-surface irrigation systems of 30% or less. Application area location and system selection prevent slope from limiting the application of effluent on the site. Slopes within the recommended application area are less than 1%.

7.2 Buffer distances for drainage lines and dams
The proximity of drainage lines and dams does not restrict the area available for the application of wastewater. Application areas need to be a minimum of 40m from drainage lines and dams.

7.3 Buffer distances for bores
No registered groundwater bores are located within 100m of the recommended application area on the NSW Government Water NSW website (2022). One bore is located at approximately 300m south east of the site. The bore is licensed for irrigation and has water bearing zones and standing water levels at greater than 28m.

No impact on groundwater is expected from the application of effluent on the site.

7.4 Distances to boundary premises, driveways and dwellings
A buffer distance of 6m to buildings and driveways is available. A buffer distance of 6m to lot boundaries is available and considered sufficient to prevent off-site movement of wastewater.

7.5 Rock outcrops
No rock outcrops were identified on the site.

7.6 Shallow bedrock
No shallow bedrock was identified in the application area.

7.7 Dispersive soil

The topsoil was found to be non-dispersive over a highly dispersive to non-dispersive subsoil. Soil dispersiveness is not a limitation for irrigation systems. The regular application of gypsum is recommended to reduce soil dispersion in the application areas.

7.8 Environmental concerns

Native Plants	Nil
High water table	Nil
Community water storage	None nearby
Waterway/wetland	None nearby

7.10 Available area and reserve area

Greater than 3,000m^2 is available for wastewater irrigation (Appendix 1). This provides sufficient area for effluent application as well as providing reserve areas.

7.11 Access to application area

Access to the application area by site visitors should be restricted. Signage should be displayed notifying visitors that treated effluent is applied to the area.

8. Wastewater design

8.1 Estimated flows

Number of cabins – 5

Number of bedrooms – 1 bedroom per cabin

Number of people – 2 people per cabin

Total number of people – 10 people

Flows per person – 100 litres/person

Total expected wastewater flow is **1,000 litres**.

Flows are calculated using full water saving devices such as dual flush toilets, water reduction cycles on dishwashers, aerator faucets fitted to taps and water reducing shower heads.

Daily flow rate estimations were taken from the SA *On-site Wastewater Systems Code* (April 2013).

Re-calculation of the daily wastewater flow is required for additional wastewater production.

8.2 Hydraulic balance calculations and nutrient balance

The interactions between soil, climate, topography and the hydraulic and nutrient loadings were modelled based on the design in DUAP (1998). The model provides estimates consistent with more complex models and meets environmental performance objectives.

The parameters used in the model were as follows:

- Wastewater flows of 1,000 litres per day.

- Estimated absorption rate of light clay for irrigation systems of 3mm/day for secondary treatment systems
- Estimated absorption rate of light clay for trenching systems of 8mm/day for primary treatment systems
- Phosphorus sorption of 6,500kg/ha
- Rainfall data for Mudgee, NSW
- Evaporation data for Mudgee, NSW
- Nitrogen concentration of wastewater of 37mg/L
- Phosphorous concentration of wastewater of 12mg/L
- BOD concentration of wastewater of 30mg/L

The estimated area required is presented in Appendix 2.

9. System selection

9.1 Estimation of land application areas from hydraulic loadings

Rainfall water balance and land application area calculations are presented in Appendix 2 and are summarised in the following table. Design flow rates for the function centre is 1,000L/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 - Absorption trench - Evapotranspiration / absorption trench - Surface/sub-surface irrigation	 8 8 3	 90m^2 90m^2 740m^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.	

9.2 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

9.3 Suitability of application systems

Application system	**Treatment system**	**Site limitations of the application system**	**Modifications to mitigate constraints**	**Suitability**
Absorption system	Septic tank	Long trench length makes even water distribution difficult to achieve Highly dispersive subsoil	Nil	No
Evapotranspiration system	Septic tank	Long trench length makes even water distribution difficult to achieve Highly dispersive subsoil	Nil	No

Surface irrigation	Secondary	Nil	Nil	Yes
Sub-surface irrigation	Secondary	Nil	Nil	Yes

10. Recommendations

Recommended land application and treatment system

The recommended system for the proposed development is:

- **Surface (drip) or subsurface irrigation area of 740 square metres.**
- **Secondary wastewater treatment system** accredited by NSW Health.

Location

The location of the effluent application area is identified in Appendix 2.

Notes

Construction of the treatment and application systems should be according to AS1547.

Gypsum should be applied to the application area during construction and every two years to maintain permeability.

The water balance is calculated using full water saving devices such as dual flush toilets, water reduction cycles on dishwashers, aerator faucets fitted to taps and water reducing shower heads.

Secondary treatment systems require regular maintenance to ensure effective operation. Maintenance scheduling should be undertaken in accordance with manufacturers and NSW Health guidelines.

Fencing should be erected around the application area to prevent access. Signage should be displayed identifying the area of treated effluent.

11. 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.

This report including data contained, its findings and conclusions remain the intellectual property of Envirowest Consulting Pty Ltd. A licence to use the report for the specific purpose identified is granted after full payment for the services involved in preparation of the report. This report should not be used by persons or for purposes other than those stated, and not reproduced without the permission of Envirowest Consulting Pty Ltd.

Legend

Slope

Lot boundary

Recommended application area (greater than 3,000m² available)

Proposed access

Approximate Scale 1: 3,000

0 30 60 120m

Appendix 1. Site plan and proposed effluent application area		
99 Mount Pleasant Lane, Buckeroo NSW		
	Envirowest Consulting Pty Ltd	
Job: R14453e1	Drawn by: LD	Date: 5/8/2022

Appendix 2a. Monthly water balance determine the wastewater application area required (irrigation systems)

Design wastewater flow	Q	L/day	1000	100	L/person/day	10	persons
Design percolation rate	R	mm/wk	21	3	mm/day		
Land area	L	m2	162				
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	191.4	172.8	191.4	185.2	191.4	185.2	191.4	191.4	185.2	191.4	185.2	191.4	2253
Inputs		P+W	mm/month	254.1	237.5	232.8	214.2	223.5	222.4	229.0	223.6	229.0	241.8	255.4	256.2	2819
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	-84.4	-45.6	-36.0	10.8	60.7	89.2	88.5	63.6	47.2	6.5	-20.9	-34.8	
Cumulative storage	M		mm	0.0	0.0	0.0	10.8	71.5	160.7	249.2	312.8	360.0	366.5	345.6	310.8	

Storage	V	largest M	mm	366.5
		Soil storage	mm	372.0
		Storage required	mm	-5.5
		VxL/1000	m^3	**-0.9**
Irrigation area			m^2	**162**

	water holding capacity	depth (mm)	Totals(mm)
Topsoil	34%	200	68
Subsoil	38%	800	304
			372

Appendix 2b. Estimation area requirement from organic matter and nutrient balances (irrigation systems)

Estimated effluent flow	(Q)	1000	L/day
Soil depth		1.5	m

Organic matter balance

BOD (C)	20	mg/L
treated wastewater flow rate (Q)	1000	L/day
critical loading rate of BOD (Lx)	3000	$mg/m^2/day$
land area required (A)	**6.7**	m^2

Nitrogen balance

nutrient concentration	37	mg/L
treated wastewater flow rate	1000	L/day
critical loading rate of nutrient	50	$mg/m^2/day$
land area required (A)	**740**	m^2

Determination of nitrogen critical loading rate

Nitrogen load (kg/year)	13.5	kg/year			
Loss 20% denitrification	10.8	kg/year			
Load to soil	146.0	kg/ha/year	assumed irr. area	740	m2
Vegetation usage	200.0	kg/ha/year	from table		
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 concentration*=		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
	219000000				
	219	kg			
	Pgenerated / (Padsorbed + Puptake)				
Land area required	**581.7**	**m^2**			

Appendix 3. Checklist for effective management of wastewater systems

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.
- **Don't** erect any structures or paths on the land application area.
- **Don't** graze animals on the land application area.
- **Don't** drive over the land application area.
- **Don't** plant large trees that shade the land application area thereby reducing transpiration of water.
- **Don't** let children or pets play on the land application area.
- **Don't** extract untreated groundwater for potable use.