Archaeo-Environments Pty Ltd
heritage soils and landscape

2 Gleesons Road
Axe Creek

LAND CAPABILITY ASSESSMENT

Land Capability Assessor
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Rev 2 August 12 2022

LAND CAPABILITY ASSESSMENT
2 Gleesons Road, Axe Creek

SUMMARY

A land capability assessment has been commissioned by Villawood for proposed subdivision and development at 2 Gleesons Road, Axe Creek. It is proposed to subdivide a property of 37.87ha into four lots as follows :

Lot No	Area (ha)
1	9.47
2	9.23
3	9.72
4	9.45

The property included rolling sedimentary terrain cleared in the 19th century for agricultural use. Local terrain includes undulating sedimentary hills which drain toward Sweenies Creek in the centre of the block. The property is for the most part cleared, with some fine scattered mature eucalypts along the Creek and rising ground to the west. Soils are typically reddish-brown silty clay above weathered sedimentary bedrock varying from shallow depth in the upper landscape to at 50-90cm within mid and lower slopes. A field inspection was conducted on May 24, 2022.

The assessment was focused on the entire property, with building and waste water envelopes nominated broadly across Lots 1-4. Waste water envelopes are large and well set back from Sweenies Creek, an undefined swale within Lots 1 and 2 and a dam in Lot 3. The waste water envelopes are also well buffered from surrounding blocks on all sides.

It is estimated that waste water discharge from a 4BR dwelling on each lot would be approximately 750 litres/day. Within local soils of DLR of 4 litres/m^2/day, an area of 365m^2 could be allocated for waste water disposal. The WWE within each lot is large enough to accommodate both a primary and reserve field as well as design to suit final dwelling location. It is suggested that a conventional waste water system would be suitable within this setting. A secondary waste water treatment (sand filter) system would also be suitable and allow use of higher grade treated water on garden beds or trees. This could be accommodated within the nominated waste water envelope.

It is recommended that a cover of vegetation be established in the area of the waste water envelope to both stabilise and restore the soil surface in this area as well as improve transpiration and use of subsoil moisture.

ABOUT THE AUTHOR

Dr Chris Day DPhil, MIFA Director, Archaeo-Environments Ltd
Chris has over 30 years experience in geology, geomorphology, soils and heritage work which included 12 years in Bendigo and Benalla with DSE. This included management of catchment and salinity research teams and soil and soil permeability (recharge) mapping as a basis for Dryland Salinity Management Plans across the Avoca, Loddon, Campaspe and Goulburn Broken Catchments.

1 INTRODUCTION

A land capability assessment was commissioned by Villawood Properties for proposed 4 lot subdivision at 2 Gleesons Road, Axe Creek.

Lot and Plan Number: Lot 2 Section 15 Parish of Eppalock
Local Government (Council): GREATER BENDIGO COUNCIL
RURAL LIVING ZONE - SCHEDULE 2 (RLZ2)

Greater Bendigo Council requires that a Land Capability Assessment (LCA) be carried out as part of the Planning Permit process in relation to a residential development of the subject property. This provision is to ensure that wastewater disposal for any residential development will be as environmentally sustainable as possible.

The LCA approach is conservative, aimed at the protection of environmental (and human) health. It is not intended to support a particular proposal, but rather to describe the existing land parcel and suggest how adverse environmental impacts of the proposal may be minimised. The Septic Tank Code of Practice requires that a Land Capability Assessment should "...allow Council to be fully informed in preparing conditions for the development".

2 BACKGROUND

2.1 BRIEF

The Land Capability Assessment is an assessment of :

- Principal geographic features and soils of the area associated with the proposed development.
- Principal land constraints as they presently relate to the proposal.
- Impact assessment of the proposed development with respect to:-
- - house siting,
- - wastewater treatment and reuse.
- - vegetation,
- - drainage and access
- Summary of land management options to mitigate potential environmental impacts.

Field work was conducted on May 24 2022.

2.2 DATA SCOPE AND LIMITATIONS

Mapping and assessment has been conducted at a scale of 1 : 1000 and provides a guide and professional overview of site conditions. Terrain mapping, soil properties, climatic and botanical data are based on reconnaissance field-work and regional data sources for the purpose of reasonable and relevant estimates. As physical conditions, soils and local hydrology may vary over time, the overview assessment on which estimates are made in this report are limited to 18 months. The report should be used within the scope and scale of the brief and not for detailed design or property layout works or for any development beyond those of the brief.
The report and recommendations therein are to be used to provide guidance toward - but do not guarantee – planning permission. It is not to be used, in full or in part, by any other party without written permission from the author.

3 LOCATION AND SETTING

3.1 LOCATION

The subject block will be subdivided into 4 Lots at 2 Gleesons Road, Axe Creek and is characterised by gentle-moderately sloping sedimentary. The block lies about 5km south-east of Strathfieldsaye near Bendigo (Fig 1).

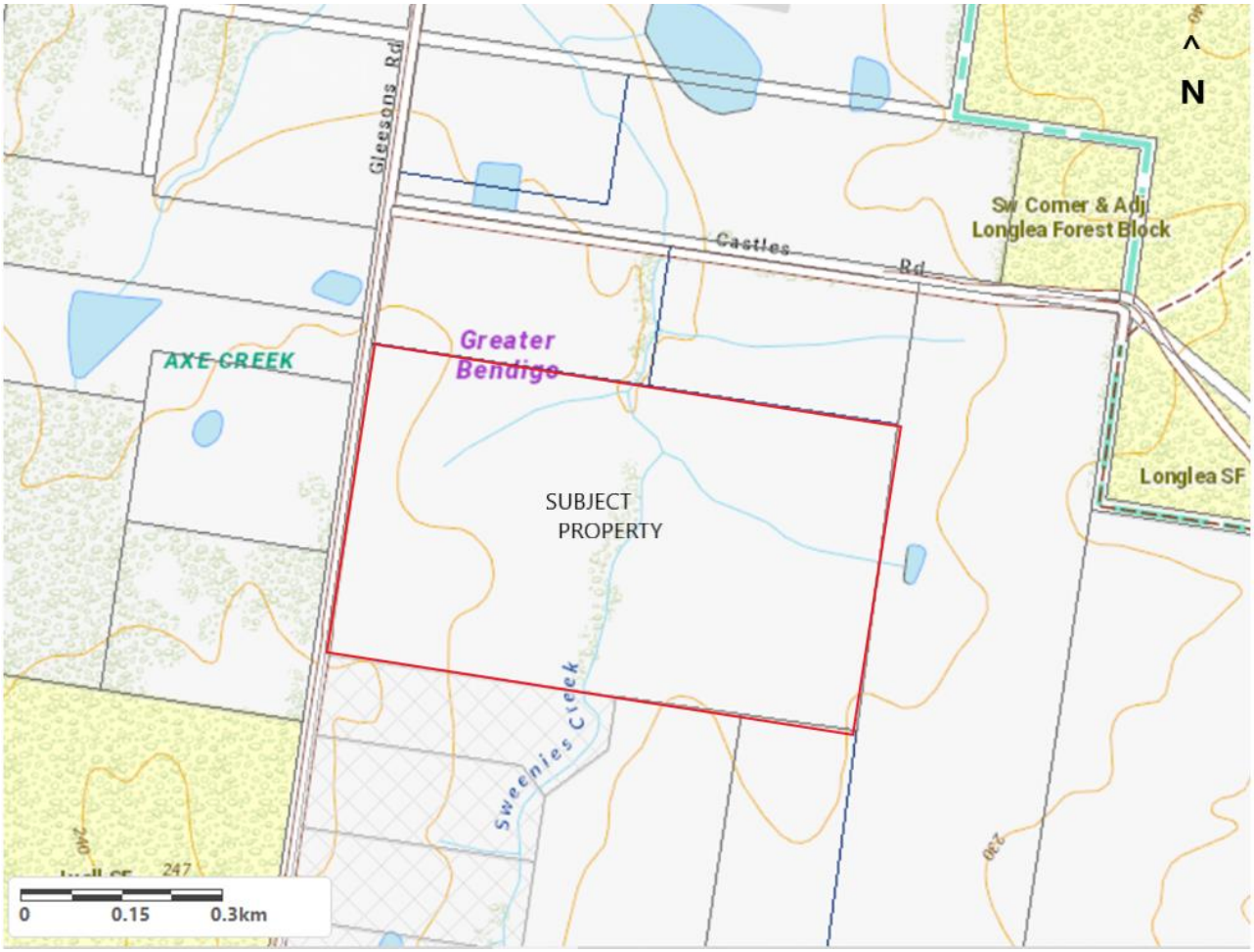

Fig 1 Location Map showing subject property at 2 Gleesons Road, Axedale

3.2 LAND USE/BUILDINGS/INFRASTRUCTURE

The block is the product of tree clearance in the 19C and development. Power is available via power lines from Gleesons Road. Access to the property is via Gleesons Road.

4.0 SUB-DIVISION AND DEVELOPMENT PLANS

It is proposed that the subject property be subdivided into 4 lots with site plan shown in Fig 3. Location of building and waste water envelopes are discussed below. The aim of the current LCA is to assess suitability of the block for development of a dwelling and appropriate waste water disposal system. Recommendations for waste water (WW) disposal are discussed in Section 9.0.

Local soil and landform descriptions as well as waste water envelopes are discussed in Section 7.

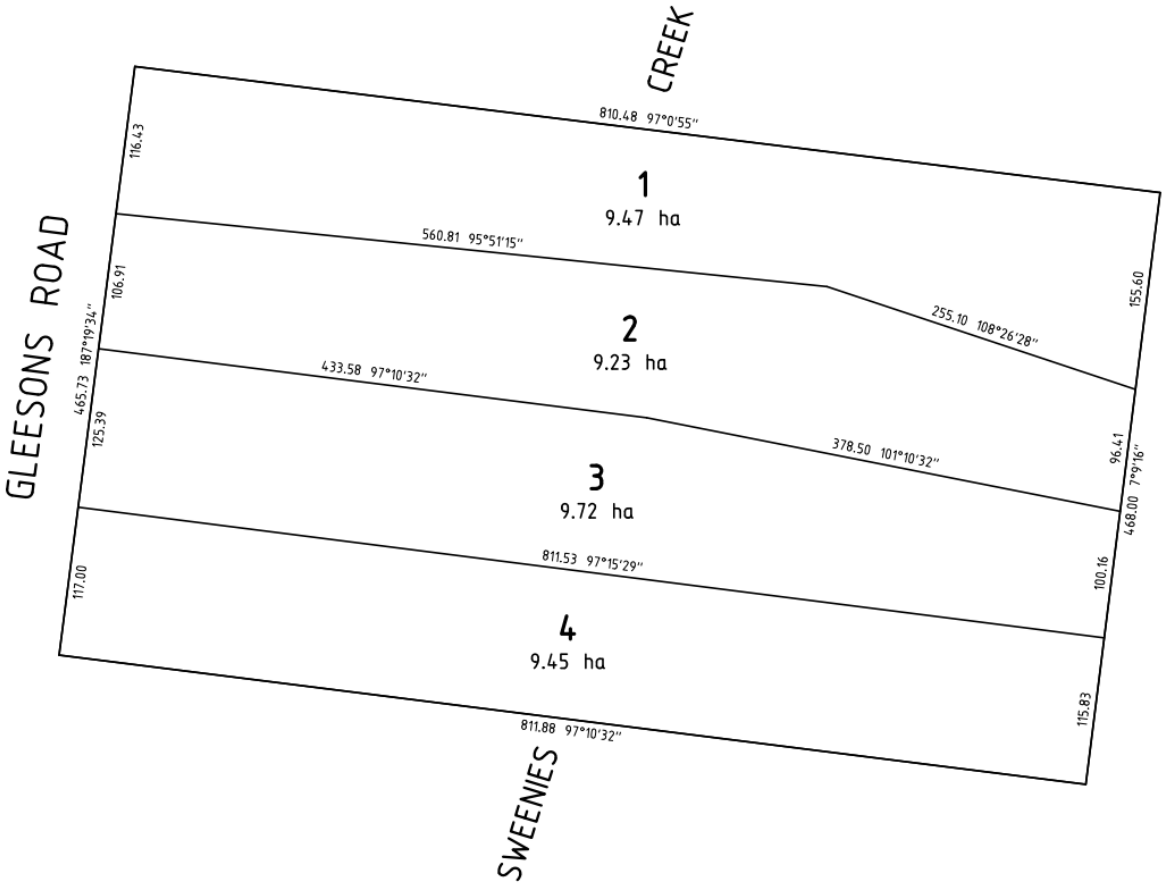

Fig 3 Subdivision Plan

5.0 LOCAL LANDSCAPE AND ENVIRONMENT

5.1 TOPOGRAPHY

The subject block occupies undulating terrain mapped as (Glen Cooee land system) within the report : Land Inventory of the Campaspe Catchment (Lorimer and Schoknect 1987).This land system describes :

A gently undulating area with few rocky slopes occurs on Ordovician sediments to the south and east of Bendigo, usually between the steeper ridges of the Kimbolton land system and the alluvial plains of the Axe Creek land system. The gentle landscape tends to occur on the softer mudstones; however, both differential erosion and geological structure appear to be involved.

Soil depth overlying the sandstones and mudstones is often shallow, even on the gentler slopes. Shallow stony uniform loams and gradational soils occur on the steeper slopes and crests. Yellow mottled sodic duplex soils predominate on the gentle slopes and in the drainage depressions, where they are often overlain by sandy wash

Slopes within the subject property are east and west toward Sweenies Creek at 0 – 6%. Surfaces are well grassed and stable. There is some rock out crop notably on a crest in the SW of the property. Relief varies from 230-240mAHD from north to south.

Plate 1 View to north-east across the subject property and proposed 4 lot subdivision showing gentle-moderately undulating sedimentary terrain.

5.2 CLIMATE

Annual rainfall is 550-600mm/year
Rainfall is less than evaporation from October to March.
Rainfall distribution and storm events have the greatest impact on land degradation, particularly summer thunderstorms. Soil saturation at the end of high rainfall seasons may limit subsoil drainage.

5.3 VEGETATION

The property is for the most part cleared and characterised by a gentle hillcrest in the south-west with general northerly aspect (0-6%) on rolling sedimentary terrain. A scatter of remnant eucalypts lie along Sweenies Creek with isolated clumps on crests within Lot 1 and 3. Otherwise there is a cover of unimproved grasses with some sedges in lower lying ground in Lots 1 and 2.

5.4 SURFACE DRAINAGE

The subject property does not lie within a Proclaimed Water Supply Catchment. The block drains locally toward the north via Sweeneys Creek which flows broadly parallel to Axe Creek which it joins about 4km to the north. Sweenies Creek is a significant drainage line with receives runoff from several low seasonal drainage swales across the block. There are two dams on each side of the Creek.

Relevant Observations :

- Slopes are gentle and are generally well drained.
- Some low lying parts of lot 1 and 2 may become seasonally wet during winter.
- Soils are silty loam above silty clay sub soils which are susceptible to dispersion.
- There is no evidence of dryland salinity within the waterway.

5.5 WATERTABLE DEPTH

There are two groundwater bores recorded within the property on the Visualising Victoria's Groundwater (VVG) website (Fig 4). None of these bores were identified in the field. An estimate of the regional water table is available from this source which integrates and interpolates regional watertable level data. On this basis the watertable within the subject property is 5-10m deep. No seeps or springs were noted within or surrounding the subject property.

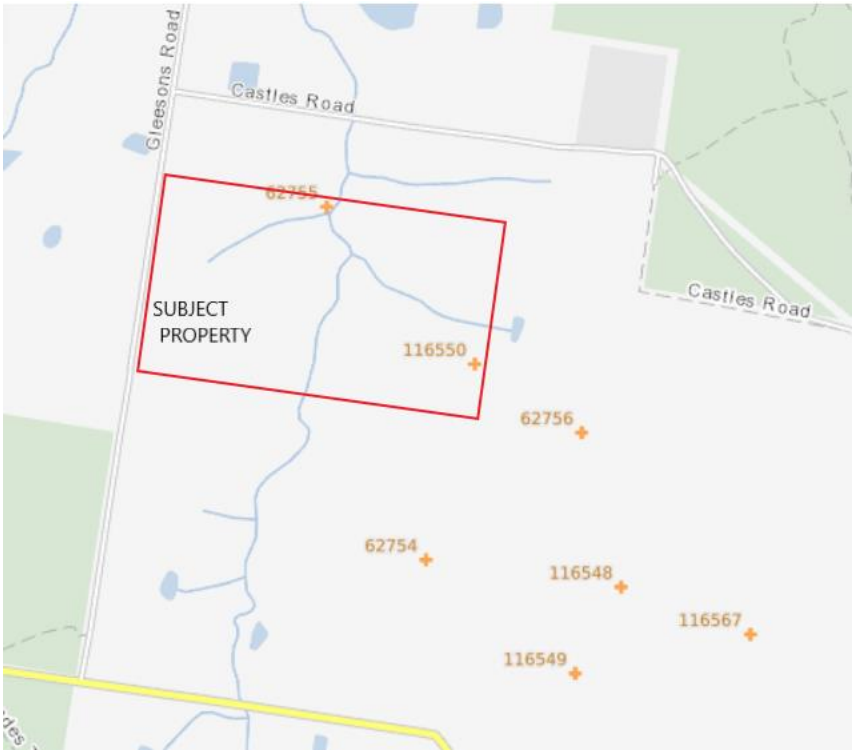

Fig 4 Location of registered bores within and around the subject property.

6.0 INVENTORY AND IMPACT OF CURRENT AND PLANNED LAND MANAGEMENT

6.1 AGRICULTURE

The is currently used for limited grazing.

6.2 FENCING

The block is fenced throughout and fences are in good condition.

6.3 MINING

There is no evidence of mining throughout the block.

6.4 BORES AND DAMS

There are 2 dams and 2 registered bores on the property recorded on the VVS website.

6.5 UTILITIES

There is no town water and power is available from the southern part of the property.

7.0 LAND CHARACTERISTICS, BUILDING AND WASTE WATER ENVELOPES FOR LOTS 1- 4.

A site investigation was conducted on 24 May 2022 which included a soil auger survey and land capability assessment. Development is proposed on parts of each lot which lie west of Sweenies Creek. These are summarised below for lots 1-4.

7.1 LOT 1

Lot 1 is the northernmost lot located on gently sloping ground with an open crest in the NW part of the lot and a gentle swale across the lower block. Lot 1 is not occupied with buildings or infrastructure. There are small clumps of remnant eucalypts across this crest with slopes of unimproved grasses (Plate 2).

Soils across much of Lot 1 within mid and lower slopes are reddish-brown silty clay soils. A site inspection was made of local soils within a similar setting in Lot 2 (Plate 3). Soils are typically brown loam above reddish-brown clays to a depth up to 80+cm. Estimated soil infiltration rate is 6-12cm/day. This profile is consistent with descriptions from the land systems report (Schoknecht 1988) The generalised auger profile description is shown in Table 2 below. Soil depth across the gentle hillcrest in the NW corner will be shallower (<50cm).

There are few constraints to location of a building envelope across the western side of the block. Location of a waste water envelope across Lot 1 is constrained by a 40m setback from an undefined drainage swale across the lower part of this lot and from Sweenies Creek (100m or 50m subject to choice of secondary or primary waste water treatment) (EPA Septic Tank Code of Practice publication No. 891.4, 2016). Final dwelling location will be subject to future owner choice. Shallower soil depth on the hillcrest may require excavation works although weathered bedrock is not an impediment to deep percolation.

The combined building and waste water envelope in Lot 1 is shown in Fig 5.

Plate 2 View to west toward gently sloping ground and gentle hillcrest in NW part of Lot 1 showing general area suitable for building and waste water disposal .

Table 1 Soil profile : general profile Lots 1, 2 and 3

AH 1 Depth (cm)	Description	Profile
0-8	Brown sandy loam	
8-40	Brown sandy clay loam	
40-80+	Reddish-brown light clay	

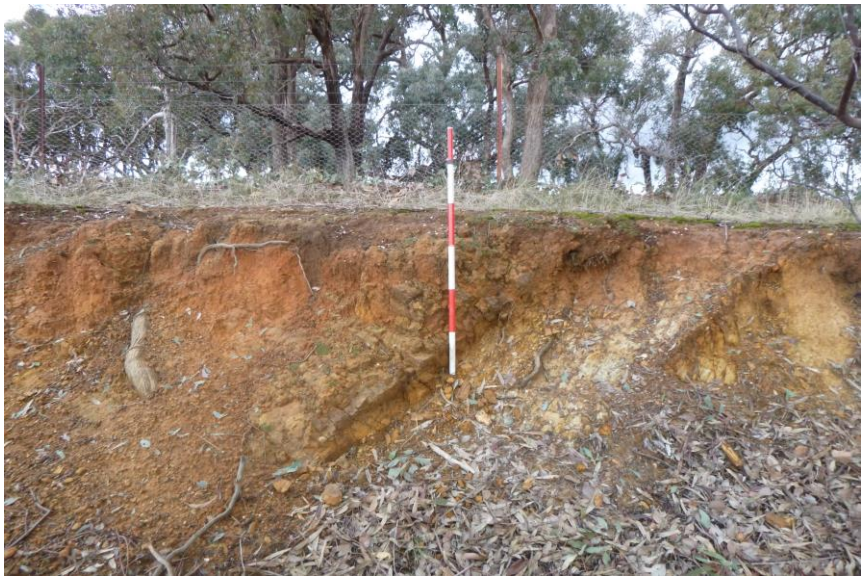

Plate 3 Soil profile typical shallow stoney sedimentary soils

Soil properties relevant to the proposed waste water envelope include :

- Soils within and near the waste water envelope are well structured silty loam topsoil with deeper light-clay subsoils up to 100cm deep.
- These light clay subsoils at 0.58 – 0.85m deep represent the limiting layer. The relevant soil classification according to Table 9 EPA Publication 891.4, is light clay (Class 4b) with estimated percolation rates of 0.12- 0.5m/day and design loading rates of DLR 4L/m^2/day.

NB Soil properties were observed from hand excavated auger holes. Where necessary and available, soil information was also noted from additional soils including tree throw profiles, gully edges, erosion or earthwork scars. Soil descriptions have also been extrapolated from local soil studies and profile description from land systems reports – in this case a description of local soils and land systems for the Glen Cooee land system by Lorimer and Schocknect 1987 - specifically that of undulating sedimentary slopes. Soil percolation estimates are for the most part based on the authors 12 years experience with the Soil Conservation Authority and later DSE based in Bendigo – work which included infiltration tests across a wide range of soils for dryland salinity research. These tests formed the basis of soil recharge maps which were used in Dryland Salinity Management Plans within the Loddon, Campaspe, Avoca and Goulburn-Broken Catchments.

7.2 LOT 2

Lot 2 is located in the centre-north of the subject property on gentle-moderate midslopes. The lot includes a gentle drainage swale across the middle of the block. Slopes are for the most part 2-5% to the east (Plate 4).

Soils across much of Lot 2 within mid and lower slopes are reddish-brown silty clay soils. A site inspection was made of local soils within the centre of Lot 2 (Table 1 above). Soils are described above and are typically brown loam above reddish-brown clays to a depth up to 80+cm. Estimated soil infiltration rate is 6-12cm/day. This profile is consistent with descriptions from the land systems report (Schoknecht 1988) The generalised auger profile description is shown in Table 1 above.

There are few constraints to location of a building envelope across the block. Location of a waste water envelope across Lot 2 is constrained by setbacks (40m) from an undefined drainage swale across the centre of the lot and 100m from Sweenies Creek (50m or 100m subject to choice of secondary or primary waste water treatment) (EPA Septic Tank Code of Practice publication No. 891.4, 2016). Final dwelling location will be subject to future owner choice.

The combined building and waste water envelope in Lot 2 is shown in Fig 5.

Plate 4 View to south-west across lower part of Lot 2

7.4 LOT 3

Lot 3 is located in the centre-south of the subject property on gentle-moderate midslopes. There is a gentle hillcrest in mid-block. Slopes are for the most part 2-5% to the east (Plate 5).

Soils across much of Lot 3 within mid and lower slopes are reddish-brown silty clay soils. General soil description is shown in Table 1 above with soils typically brown loam above reddish-brown clays to a depth up to 80+cm. Estimated soil infiltration rate is 6-12cm/day. This profile is consistent with descriptions from the land systems report (Schoknecht 1988) The generalised auger profile description is shown in Table 3 below. Soil depth across the gentle hillcrest in mid block will be shallower (<50cm).

There are few constraints to location of a building envelope across Lot 3. Location of a waste water envelope is constrained by setbacks (30m for secondary treatment and 60m for primary treatment) from an isolated dam in the western part of the block and from Sweenies Creek (50m or 100m subject to choice of secondary or primary waste water treatment) (EPA Septic Tank Code of Practice publication No. 891.4, 2016). Final dwelling location will be subject to future owner choice.

The combined building and waste water envelope in Lot 3 is shown in Fig 5.

Plate 5 View to west toward western/upper part of Lot 3 showing location of dam and gentle 2-3% slopes.

7.4 LOT 4

Lot 4 is located to the south of the subject property on gentle-moderate midslopes with a hillcrest in the SW part of the block. This lot is subject to a bushfire overlay and BMP. Slopes are for the most part 2-5% to the east, which a few localised steeper slopes on the edge of the hillcrest to the west.

Soils across much of Lot 4 within mid and lower slopes are yellow-brown silty clay soils. A site inspection was made of local soils within the centre of Lot 4 (Plate 6) and within an area of likely colluvial soils. Soils are typically brown loam above reddish-brown clays to a depth up to 90+cm. Estimated soil infiltration rate is 6-12cm/day. This profile is consistent with descriptions from the land systems report (Schoknecht 1988) The generalised auger profile description is shown in Table 2 and 3 below. Soil depth across the gentle hillcrest in the upper block and south-west part of Lot 4 has some reef bedrock outcrop which will require excavation works and shallower soils (<50cm)(Plate 7-8).

There are few constraints to location of a building envelope across the block. Location of a waste water envelope across Lot 4 is constrained by setbacks from Sweenies Creek (50m or 100m subject to choice of secondary of primary waste water treatment) (EPA Septic Tank Code of Practice publication No. 891.4, 2016). Final dwelling location will be subject to future owner choice. The combined building and waste water envelope in Lot 4 is shown in Fig 5.

Table 2 Lot 4 soil profile : midslope

AH 1 Depth (cm)	Description	Profile
0-8	Brown sandy loam	
8- 56	Brown sandy clay loam	
56-90+	Yellow-brown light clay above weathered bedrock	

Table 3 Lot 4 soil profile : upper slope

AH 1 Depth (cm)	Description	Profile
0-8	Brown sandy loam	
8-22	Brown sandy clay loam	
22-45cm	Yellow-brown silty clay and weathered parent material.	

Plate 6 Location of AH2. View to east across mid-lower slopes of Lot 4.

Plate 7 View to north showing bedrock outcrop in SW part of Lot 4.

Plate 8 View to west across Lot 4 from lower slopes toward hillcrest in SW corner.

Setbacks

All lots are set back 100m from Sweenies Creek. This can be conditionally reduced with use of secondary treatment to 50m There is a dam in Lot 3 with a 30m setback which is conditional on secondary treatment, otherwise a 60m set back is recommended. The wastewater envelopes within lots 1 and 2 are setback 40m from an undefined drainage swale. The waste-water envelopes are also well set back from boundary fencelines neighboring blocks and adjoining land uses which suggests that boundary effects are low. Setback distances are published in the EPA Septic Code (2016).

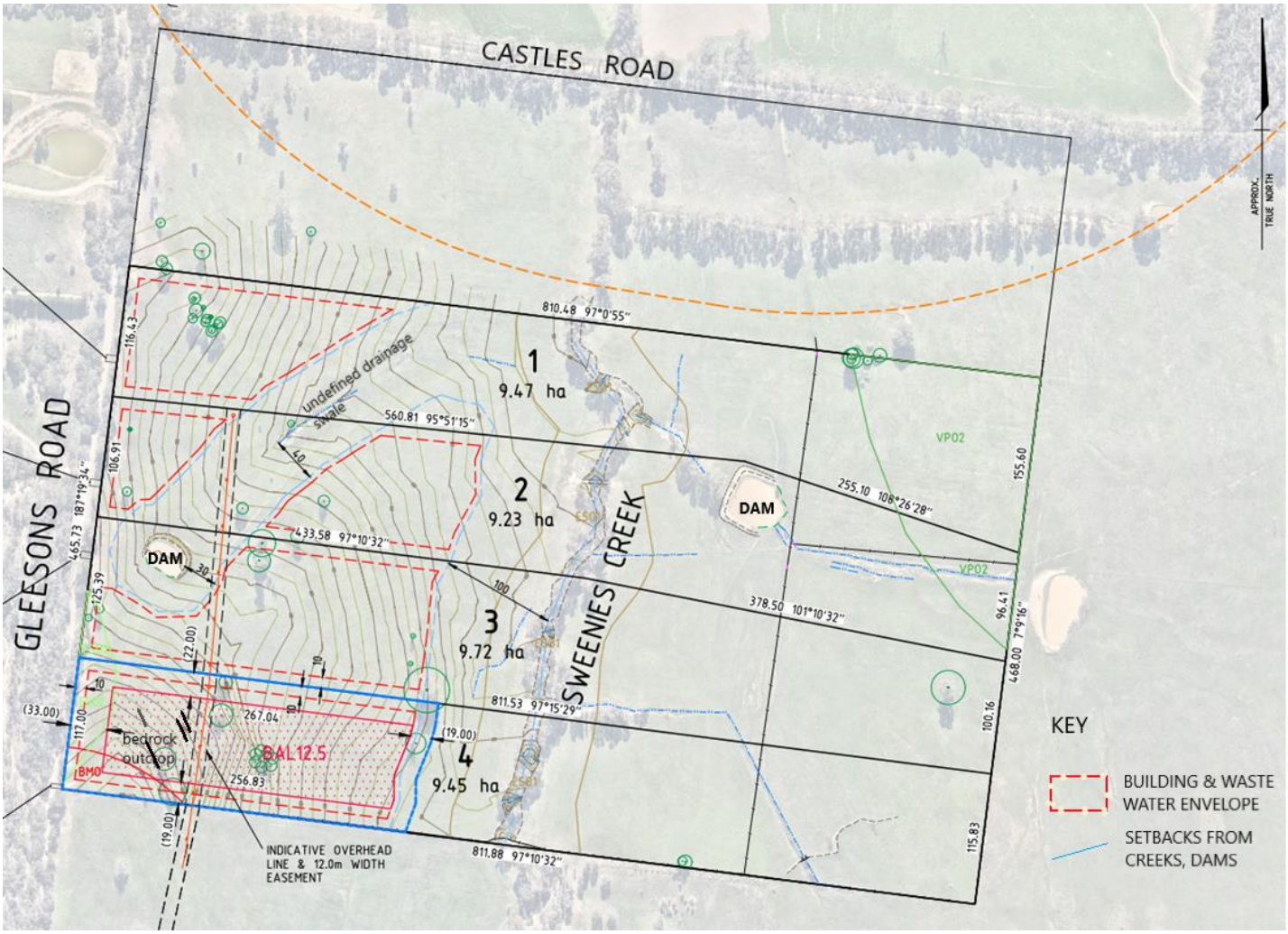

Fig 5 Subject property showing four lots with location of combined building and waste water envelopes with prescribed setbacks assuming use of a primary WW system. The size of both BE and WWE in each lot indicates suitability of large areas based on slope, soil type and setbacks across the property. Setback conditions are described above.

8.0 LAND CAPABILITY ASSESSMENT AND RECOMMENDATIONS

INTRODUCTION

The Land Capability Assessment (LCA) provided within this report aims at identifying land constraints associated with any proposed development of the property and to recommend management programs to address these constraints and thereby reduce the environmental impact of the proposed changed land use.

The emphasis is on water management issues and land degradation with an emphasis on the southern part of the subject property which is the area of the nominated building and waste water envelope.

8.1 CONSTRAINTS

For the proposed 4 lot residential development and proposed wastewater systems, the property is considered to present some general constraints.

- No sewer connection or town water
- Rainfall exceeding evaporation between March and October will mean that waste-water drainage during these periods will be reduced.
- Local soils are highly permeable to a depth of some 80cm above reddish-grey clays. These soils may become saturated during winter.

8.2 MITIGATING CIRCUMSTANCES

Factors which mitigate these constraints include :

- Annual rainfall is moderate
- The various lots are large, well separated from neighbouring land uses and with few boundary effects
- The proposed building and waste water envelope is well setback from waterways and dams
- Watertable depth is estimated to be > 5-10m in the area of the building and waste water envelopes.
- Summers are expected to dry out soil profiles
- Slopes are gentle and well drained.

8.3 ASSUMPTIONS

Several assumptions are made regarding this development proposal:-

- That the existing dwelling would have a maximum of 4 bedrooms with estimated daily water use of 750 litres/day.
- It is suggested that these are upper level estimates

8.4 RISK RATING

Considering all of the above factors, the various proposals on each lot are regarded as having a fair (land capability rating 3). The rating is composed from a series of – sometimes mutually exclusive - site characteristics. In other words, it is possible that both low ranking and high ranking factors can be found on the same block. However, in accordance with EPA requirements and LCA guidelines- the final rating is based on the most constraining feature. In the case of the subject block, there are a series of soils and site features which generates a fair risk rating (see Appendix A).

9.0 ON-SITE WASTE WATER MANAGEMENT

The assessed environmental risk indicates that future residential development on this land will need moderate management programs in place to address various issues, particularly on-site domestic wastewater treatment & disposal.

9.5.1 Wastewater treatment and disposal on site

Introduction

It is considered that on-site waste water development would be similar in each of the four lots. While reticulated sewerage would minimize the potential human health impact, this is not likely to occur in the foreseeable future and wastewater associated with the new dwelling on this site will have to be treated and disposed of by an on-site process.

The comments and recommendations below are aimed at limiting the potential human health and environmental risks associated with practical domestic wastewater management for the subject development. The discussion below is in general accordance with the EPA Guideline *"Septic Tanks Code of Practice"* Publication 891.4 (2016) and the Information Bulletin *"Land Capability Assessment for Onsite Domestic Wastewater Management"* Publication 746.1.

9.5.2 Treatment

Given the fair environmental risk, a conventional system with trench disposal would be suitable within the suggested WWE in each of Lots 1-4, with some limitations, described below.

Conventional system

A conventional system is a passive system, which does not require connection to electricity. If carefully located, installed and routinely inspected there should be a low risk of failure or break down. A conventional system can also be used for intermittent occupancy patterns.

Treatment

- Treatment should be via a septic tank having an EPA Certificate of Approval and with fittings meeting Australian Standards AS1546.
- The tank should be inspected annually and pumped out every three years or earlier if required. Pump outs should be reported to Council.

Disposal Field

- As described in section 7.0 the waste water envelopes have been mapped according to local site conditions together with placement of the building envelope in Figure 5.

Land application : Size of waste water envelope

Two methods have been used to estimate required size of land application area (waste water envelope) :

(i) DESIGN LOADING RATE

The critical time for wastewater application will be during the winter period. Based upon the estimated household discharge for a planned 4 BR house (up to 750L/day) and with an application rate (DIR) of 4/m^2/day (Class 4C soils) based on low percolation rates on local silty clay soils onto a disposal area (garden or treed), there would be a requirement for an area of 188m^2 to address the wastewater disposal needs for any new dwelling on this property.

(ii) WATER – NITROGEN BALANCE

A water-nitrogen balance using various rainfall, environmental and effluent volumes has been generated for proposed discharge from a 4 bedroom dwelling (Table 4 below). Based on Water-Nitrogen Balance Calculations shown above which assumes 750L/day waste water use and effective rainfall, evapotranspiration and soil seepage parameters, the irrigation area (no wet month storage) = 365m^2

Table 4 Water Balance (Courtesy P Williams & Assoc.)

Paul Williams & Associates Pty Ltd — CHRIS DAY 03

WATER/NITROGEN BALANCE (20/30): With no wet month storage.

Rainfall Station: Castlemaine/ **Evaporation Station:** Creswick

Location: Moonlight Flat
Date: Aug 2022
Client: Chris Day

ITEM		UNIT	#	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Days in month:			D	31	28	31	30	31	30	31	31	30	31	30	31	365
Evaporation (Mean)		mm	A	205	176	124	75	47	27	27	43	66	105	126	152	1168
Rainfall (9th Decile wet year adjusted)		mm	B1	45	38	34	46	73	70	79	89	79	72	58	45	729
Effective rainfall		mm	B2	40	34	31	42	65	63	71	80	72	65	52	41	656
Peak seepage Loss[1]		mm	B3	124	112	124	120	124	120	124	124	120	124	120	124	1460
Evapotranspiration(IXA)		mm	C1	92	79	56	34	21	12	12	19	30	47	57	68	528
Waste Loading(C1+B3-B2)		mm	C2	176	157	149	112	80	69	65	64	78	106	124	152	1332
Net evaporation from lagoons (10(0.8A-B1xlagoon area(ha)))		L	NL	0	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Wastewater		L	E	23250	21000	23250	22500	23250	22500	23250	23250	22500	23250	22500	23250	273750
Total Irrigation Water(E-NL)/G		mm	F	64	58	64	62	64	62	64	64	62	64	62	64	750
Irrigation Area(E/C2)annual.		m^2	G													**365**
Surcharge		mm	H	-112	-100	-85	-50	-16	-7	-1	0	-17	-42	-63	-88	0
Actual seepage loss		mm	J	12	12	39	70	108	113	123	124	103	82	57	36	878
Direct Crop Coefficient:			I	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	Shade:
Rainfall Retained:	90	%	K	1. Seepage loss (peak) equals deep seepage plus lateral flow: 4mm (<10% ksat)												
Lagoon Area:	0	ha	L	CROP FACTOR												
Wastewater(Irrigation):	750	L	M	0.7	0.7	0.7	0.6	0.5	0.45	0.4	0.45	0.55	0.65	0.7	0.7	Pasture:
Seepage Loss (Peak):	4	mm	N	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	Shade:
Irrig'n Area(No storage):	**365**	m^2	P2	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	Buffalo:
Application Rate:	**2.1**	mm	Q	1	1	1	1	1	1	1	1	1	1	1	1	Woodlot
Nitrogen in Effluent:	30	mg/L	R	NITROGEN UPTAKE:												
Denitrification Rate:	20	%	S													
Plant Uptake:	220	kg/ha/yr	T													
Average daily seepage:	2.4	mm	U													
Annual N load:	6.57	kg/yr	V													
Area for N uptake:	**299**	m^2	W													
Application Rate:	**2.5**	mm	X													

Species:	Kg/ha.yr	pH	Species:	Kg/ha.yr	pH	Species:	Kg/ha.yr	pH
Ryegrass	200	5.6-8.5	Bent grass	170	5.6-6.9	Grapes	200	6.1-7.9
Eucalyptus	90	5.6-6.9	Couch grass	280	6.1-6.9	Lemons	90	6.1-6.9
Lucerne	220	6.1-7.9	Clover	180	6.1-6.9	C cunn'a	220	6.1-7.9
Tall fescue	150-320	6.1-6.9	Buffalo (soft)	150-320	5.5-7.5	P radiata	150	5.6-6.9
Rye/clover	220		Sorghum	90	5.6-6.9	Poplars	115	5.6-8.5

NOMINATED WW APPLICATION AREA

(i) According to DLR estimates cited above, the estimated irrigation area = 188m^2

(ii) According to Water - Nitrogen Balance* above the estimated irrigation area (no storage) = 365m^2

*This value is highly dependent on (conservative) soil percolation estimates and an overestimate of monthly rainfall.

Accounting for both methods of WWE approximation, the estimate of the area required for land application = **365m^2.** As discussed there is sufficient area for disposal of treated effluent within the primary WWE (750m^2) shown in Fig 5.

9.5.3 Trench length and layout

There is ample room for design of a waste water field of these dimensions shown In Figure 3. According to the Australian Standards (AS 1547-2012) trench length can be estimated according to the formula : L = Q/DLR x W where :

L =	required trench length	(?)
Q =	effluent volume	750L
D =	design loading rate (m/day)	4mm/day
W =	trench width	1m

Using the above formula, the required trench length would be = 188 metres. It is considered at this setting that 120m would be sufficient length. Layout design may vary, with 4 trenches (such as 30m long, 60cm+ wide and 60cm deep) with appropriate setbacks. Other configurations may suit, subject to site conditions and plumbing contractor advice.

120m trenching would fit well within a WWE of 365m^2 accounting for trench separation of 1-2m and buffer distances (Fig 6).

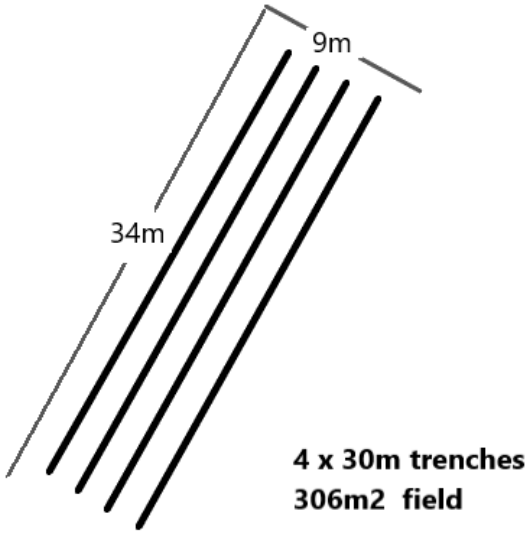

Fig 6 Effluent trench length option with indicative dimensions of WW field.

9.5.4 General

- Some deep ripping and application of gypsum may be necessary to improve permeability within the clay horizon at 60-80cm. It is also recommended that a cover of vegetation be established in the area of the waste water envelope to both stabilize and restore the soil surface in this area as well as improve transpiration and use of subsoil moisture.
- Presence of shallow weathered sedimentary bedrock is not an impediment to deep percolation.
- Areas of shallow bedrock will require excavation for installation of septic tank and effluent trenches.
- Areas around the new selected disposal fields should be vegetated with pasture and shrubs to enhance soil water use.
- To ensure the viability of the vegetation on a disposal field, it may occasionally be necessary for supplementary watering in very dry times.
- The active disposal field should be restricted from access by vehicles, children, pets and visitors.
- At any future change of occupier, the relevant wastewater management program should be reassessed by Council, and new tenants should be made familiar with management and permit requirements
- If there are plans for house extensions, or if connection to town water takes place, the wastewater management program should be reviewed by Council.

10.0 LIMITATIONS OF THIS REPORT

This report is solely for the use of Client Villawood and City of Greater Bendigo. Any reliance of this report by third parties shall be at such party's sole risk and may not contain sufficient information for purposes of other parties or for other uses. This report shall only be presented in full and may not be used to support any other objective than those set out in the report, except where written approval with comments are provided by Archaeo-Environments Pty Ltd.

Limitations are summarised in Appendix B. This document is not intended to reduce the level of responsibility accepted by Archaeo-Environments Pty Ltd but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

APPENDIX A
LAND CAPABILITY RATING

	Land Capability Class Rating				
Land Features	Very Good (1)	Good (2)	**Fair (3)**	Poor (4)	Very Poor (5)
General Characteristics Site Rating					
Site drainage/runoff	very slow	slow	**moderate**	rapid	very rapid
Flood/inundation potential (yearly return exceedance)	never		**<1 in 100**	<1 in 20	>1 in 20
Slope (%)	**0-2**	**1-2%**	**8 to 12**	12 to 20	>20
Landslip		**never**			Present or past failure
Seasonal water table depth (m)	>5	> 8	**2.5 - 2**	2.0 - 1.5	<1.5
Rainfall (mm/yr)	<450	450 - 650	**550-600**	750 - 1000	>1000
Nature of development (% of allotment)	**>80**	70 – 80	60-70	50-60	<50
Pan Evaporation (mm/yr)	>1500	1250 - 1500	**1000 - 1250**		<1000
Water supply (reticulated or tank water)	tank	Tank/reticulated	**tank**		
Soil Characteristics					
Structure	High	**Moderate-good**	Weak	Massing	Single Graded
Profile depth	>2	**0.8 – 1m**		1.5 - 1.0	<1
Percolation (mm/hr)	50 - 75	12-18 mm/hour	**15 - 20** **150 - 300**	300 - 500	<15 >500
Limestone deposits		**nil**		Present	Present
Emersion test	4, 6, 8	**N/a**	7	2, 3	1

APPENDIX B
LIMITATIONS

This report has been prepared for the specific purpose outlined in the proposal and no responsibility is accepted for the use of this document, in whole or part, in other purposes or contexts.

The scope and period of services are as described in the proposal. Conditions may exist which were undetectable given the limited nature of the enquiry AE ltd was engaged to assess with respect to the site. Conditions may vary between sample sites, with special conditions within the study area not revealed by the assessment and which have therefore not been accounted for in the report. Additional studies and actions may therefore be required.

It is recognised that time affects the information and assessment provided in this report. The opinions of AE Ltd are based on information current at the time the report was produced. It is understood that the services provided by AE Ltd lead to opinions based on the actual conditions of the study area at the time the study area was visited. These opinions cannot be used to assess effects of any subsequent changes in the quality of the site or its surroundings or any laws and regulations.

Any advice made in this report, are based on conditions from published sources and the investigation described herein. Where information provided by the client or other sources have been used, it is assumed that the information is correct unless otherwise stated. No responsibility is accepted by AE Ltd for incomplete or inaccurate data supplied by others.

This report is provided for the sole use by the client. Any use a third party makes of this report or any reliance on decisions made based on it is the sole responsibility of such third parties. AE Ltd accepts no responsibility for any damages incurred by a third party as a result of decisions made based on this report.