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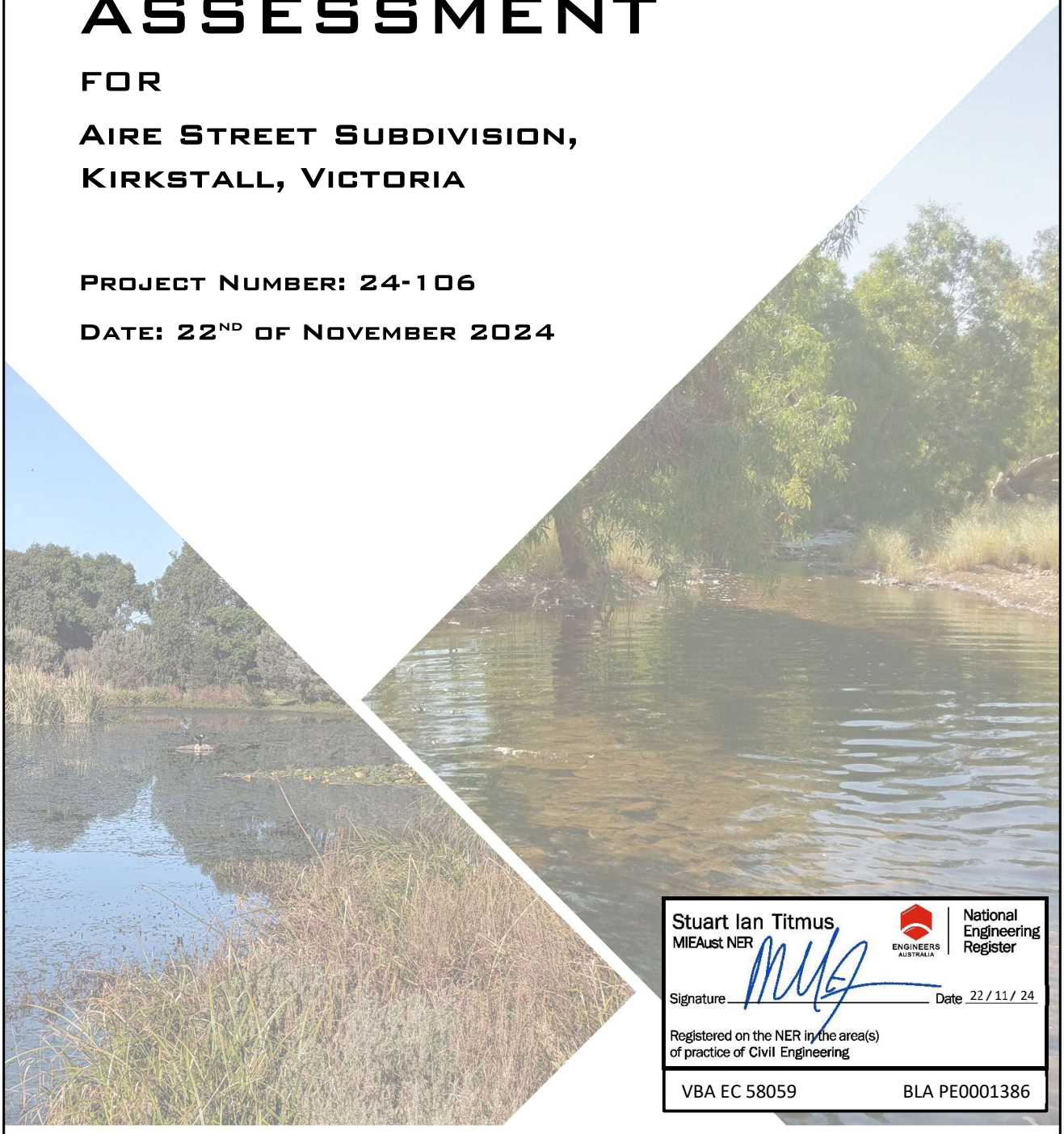
LAND CAPABILITY ASSESSMENT

FOR

AIRE STREET SUBDIVISION, KIRKSTALL, VICTORIA

PROJECT NUMBER: 24-106

DATE: 22ND OF NOVEMBER 2024



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MIEAust NER
ENGINEERS AUSTRALIA | National Engineering Register
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Registered on the NER in the area(s) of practice of Civil Engineering

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COMPASS ASSURANCE SERVICES ISO 9001 · ISO 45001 · ISO 14001

QUALITY	ISO 9001
SAFETY	ISO 45001
ENVIRONMENT	ISO 14001

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Client Contact	[redacted]
Project Number	24-106
Document Name	24-106 – 68 Aire St, Kirkstall LCA

Document History

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Land Capability Assessment for On-site Wastewater Management

Reviewer: [redacted]

Accreditation: BEngSc (Civil), MEngTech (Civil), MIEAust

(CET) Centre for Environmental Training

Land Capability Assessment for On-site Wastewater Management

Table of Contents

1.0 Introduction

SITEC Pty Ltd has been engaged to undertake a Land Capability Assessment (LCA) for a proposed subdivision at Aire Street, Kirkstall. The field investigation and report have been undertaken and prepared by suitably experienced staff. SITEC Pty Ltd has appropriate professional indemnity insurance for this type of work. Our professional indemnity insurance is available on request.

This document provides information about the site and soil conditions. It also provides a detailed LCA for the approximately 1.698ha area and includes a conceptual design for a suitable onsite wastewater management system, including recommendations for monitoring and management requirements.

We provide recommendations for both the treatment system and land application area (LAA)

2.0 Description of the Development

Table 1 Site Description

Site Address:	Aire Street, Kirkstall VIC 3283
Owner / Developer:	[redacted]
Postal Address:	68 Aire Street, Kirkstall VIC 3283
Contact:	[redacted]
Council Area:	Moyne Shire Council
Allotment Size:	1.698ha
Domestic Water Supply:	The site will have water tanks on each lot to supply potable water to each dwelling
Anticipated Wastewater Load:	Assume a proposed 3-bedroom residence @ 4 people maximum occupancy. Design wastewater load is 150L/person/day. This design load is sourced from AS/NZS 1547:2012
Availability of Sewer:	The area is unsewered and unlikely to be sewered in the short to medium term future

3.0 Key Site Features

[redacted] undertook site investigations on the 14th of October 2024. A range of site features were assessed in terms of the degree of limitation they present for a range of onsite wastewater management systems.

Table 2 summarises the key features in relation to effluent management at the site.

Figure 1 provides a locality plan and indicates the location of the site of the proposed development.

Appendix A provides a site plan describing the location of the proposed development works and physical site features and location of soil sampling/test sites.

Figure 1 – Locality Plan

Table 2 Site Features

Feature	
Climate	The site has a temperate climate with a warm summer and cold winter. The site experiences an average annual rainfall of 726mm (Warrnambool Airport Ndb 090186 gauge) and an average of 117 rain days per year. Average annual pan evaporation is taken as 1300 mm.
Exposure	The site has some trees bordering the eastern, western & northern lot boundaries, and some trees on the eastern section of the site, with an eastern aspect with high sun exposure.
Vegetation	Grass across the site with site, some trees located as per above
Slope	The proposed effluent management areas have slight slopes, with gradients between 0-2%.
Fill	Natural soil profiles were observed throughout the site. No fill was observed, and no filling is proposed in the effluent management area.
Rocks and Rock Outcrop	No surface rocks evident at the site.
Erosion Potential	No evidence of sheet or rill erosion. The erosion hazard is low.
Surface Water	The site is slightly sloping with slow overland drainage.
Flood Potential	The development site and area available for application of treated effluent lies above the 1:100 year flood level.
Stormwater run-on and Upslope seepage	The Site experiences some stormwater run-on. There were visible signs of surface dampness, but no signs of spring activity or hydrophilic vegetation in the preferred effluent management areas.
Groundwater	There are no signs of shallow groundwater tables above 1.5m depth. There is a groundwater bore (No. 122947) on the site
Site drainage and Subsurface Drainage	The site may experience stormwater run-on and has a minor run-off hazard.
Recommended Setback Distances	All setback distances recommended in Table 5 of the *EPA Publication 891.4 (2016) Code of practice – onsite wastewater management* are achievable.

3.1 Soil Assessment and Constraints

The site's soils have been assessed for their suitability for onsite wastewater management by a combination of soil survey and desktop review of published soil survey information as outlined below.

3.2 Published Soils Information

Reference to the geological survey of Victoria map sheet Portland SJ-54-11, indicates that the underlying site consists of Miocene period calcarenite, marl and silt.

3.3 Soil & Survey Analysis

A soil survey was carried out at the site to determine suitability for application of treated effluent. The site was found to consist of brown soft topsoil, overlying brown/orange/yellow highly plastic clay, overlying brown/orange/yellow clayey-sand/sand.

Figure 2 Typical soil sample found on site

Three boreholes were completed on site, and were excavated by a Trueline trailer-mounted auger. The locations of tests are shown in **Appendix A**. The details of the boreholes can be found in **Appendix B**. *Table 3* describes the soil constraints for the test site in detail.

After analysis of the soil structure and drainage characteristics the soil category has been determined to be Category 5b in accordance with Table 5.2 AS/NZS1547:2012. We have based the electrical conductivity, Emerson aggregate class and pH results off previous tests performed on the same category of soils found in the area (see **Appendix C** for test results).

Table 3 Soil Assessment

Feature	Assessment	Level of Constraint	Mitigation Measures
Slope	Slight slope indicates potential for stormwater runoff into land application areas (LAA's)	Moderate	Recommend construction of stormwater diversion drains to prevent runoff into land application area (LAA) where appropriate.
Flooding	All proposed sites for the land application areas are above the 1 in 100 year flood level	NA	NN
Groundwater	No groundwater within 5m of the surface. There is a groundwater bore (No. 122947) on the site; it is currently being used for stock water purposes. This bore will remain once the development is commenced. (source *Visualising Victoria's Groundwater* website)	Minor	Ensure LAA is located minimum buffer distance of 20m away from groundwater bores
Rock Fragments	No rock fragments were encountered throughout soil profile	NA	NN
Climate & Exposure	On average there is an excess of rainfall over evaporation during the wettest months. Site has good exposure to sun and wind.	Moderate	Water balance will be used to calculate LAA field size
Buffer/Setback Distances	All buffer/setback distances in Table 5 of the EPA Victoria 2016 are achievable	NA	NN
Water Table Depth	No groundwater encountered. Pits terminated at max. 2.0m depth. *Visualising Victoria's Groundwater* website confirms on water table above 5m depth.	NA	NN

Feature	Assessment	Level of Constraint	Mitigation Measures
Soil Permeability & Design Loading Rates	Based on field soil texture assessment, inferred K_{sat} value is 0.06-0.12m/day. A DIR of 5.0mm/day has been adopted for evapotranspiration absorption beds and trenches	Moderate	The monitoring program described in *Section 5.0* and soil amelioration recommended below should be sufficient to mitigate issues with soil permeability.
Soil Texture & Structure	Topsoil (<300mm): Loam (Category 3)	Minor	NN
	Subsoil (>300mm): Light Clay (Category 5b) in accordance with AS/NZS1547:2012)	Moderate	Soil amelioration recommended. Increasing organic content and apply dry gypsum and organic matter to improve soil structure and permeability
Electrical Conductivity	EC (1:5 soil:water suspension) ranges from 0.152 (subsoil) to 0.432 deciSiemens (dS) per metre (topsoil), which is moderately saline.	Moderate	Recommend soil amelioration with gypsum.
Emerson Aggregate Class	Topsoil: EA Class 2/3 (slight slaking with partial dispersion)	Moderate	Recommend soil amelioration with either lime or gypsum.
	Subsoil: EA Class 3/3 (fully slaked with no dispersion).	Moderate	Recommend soil amelioration with either lime or gypsum.
pH	Topsoil pH was measured as 6 & Subsoil pH was measured as 6.5 which is neutral. Soil conditions do not appear to be affecting plant growth.	Minor	NN
Erosion Potential	Due to slope and rainfall during wet months, erosion potential has been assessed as possible.	Minor	NN

NN: not needed
NA: not applicable

For the soil in the proposed land application area, several features present minor to moderate constraints, but in each case a mitigation measure is presented to address the specific constraint in such a way as to present an acceptable wastewater management solution.

3.4 Overall Land Capability Rating

Based on the results of the site and soil assessment tabled above and provided in the Appendices, the overall land capability of the proposed effluent management areas are moderately constrained, however, the effluent management system will be designed, installed, and maintained in ways which will mitigate these factors.

4.0 The Management Program

This LCA has been prepared to accompany a development application to the Moyne Shire Council for new septic systems for Aire Street subdivision. As such, this report provides recommendations for treatment and land application systems that are appropriate to land capability. The following sections provide an overview of a suitable system, with sizing and design considerations and justification for its selection. Detailed design for the system is beyond the scope of this study but should be undertaken at the time of building application and submitted to council.

4.1 Treatment System

While the constraints noted in *Table 3* are considered moderate, provided that the mitigation measures described are followed we recommend that primary treatment systems utilising a suitable effluent distribution system be used to provide primary treatment to all wastewater and to meet Environmental Protection Authority requirements for irrigation. The system must be approved by the EPA and issued with a numbered Certificate of Approval. The local council must also issue a permit prior to the installation of the unit. When applying for an on-site wastewater treatment system, refer to Table J1 (AS/NZS 1547:2012 – see below) for minimum septic tank sizing, cross-referencing against the architectural plans for the proposed dwelling for number of bedrooms and estimated house population. However, it is noted that the Moyne Shire Council requires a minimum tank size of 3,200 L (greater than the minimum 3,000L in Table J1) – therefore 3,200 L has been determined as the minimum tank size for this subdivision.

TABLE J1
ALL-WASTE SEPTIC TANK OPERATIONAL CAPACITIES

Population equivalent (persons)	**Number of bedrooms**	**Design flow** (L/day)	**Tank capacity** (L)
1 – 5	1 – 3	1000	3000
6 – 7	4	1000 – 1400	3500
8	5	1400 – 1600	4000
9 – 10	6	1600 – 2000	4500

4.2 Land Application

The preferred system for this subdivision is a conventional trench bed system. Conventional bed systems use subsurface absorption of effluent into the soil to treat wastewater.

4.3 Sizing the Land Application Area

To determine the necessary size of the irrigation area water and nutrient balance modelling has been undertaken in accordance with EPA Publication 891.4 (2016) *Code of practice – onsite wastewater management.*

The results (shown in *Table 4* below) show that the required irrigation area is 199m^2, the larger of the areas calculated by the water and nutrient balance; however, as a conventional bed system has been nominated as the application system, bed spacing requirements necessitate that an area of 224m^2 be used for land application (See **Appendix E** for bed sizing calculations).

Table 4 Required LAA area for individual lots

Balance Calculation	Area Required
Water Balance	170m^2
Nitrogen Balance	199m^2
Phosphorous Balance	198m^2
Conventional Bed LAA	**224m^2** (see **Appendix E**)

The calculations are summarised below, with full details in **Appendix D**.

Water Balance

The water balance can be expressed by the following equation:
Precipitation + Effluent Applied = Evapotranspiration + Percolation

Data used in the water balance includes:

- Median monthly rainfall, mean monthly pan evaporation (Warrnambool Airport Ndb 090186 gauge);
- Daily effluent load – 600 L/day
- Design loading rate (DLR) – 5 mm/day; (rapidly drained)
- Crop factor – 0.6- 0.8 ; and
- Retained rainfall 80%. (some natural runoff due to slope)

The nominated area method is used to calculate the area required to balance all inputs and outputs, without the need for wet weather storage. As a result of these calculations, at least 170m^2 of area is required to achieve zero wet weather storage.

Nutrient Balance

A nutrient balance has been undertaken to check that the LAA is of sufficient size to ensure nutrients are assimilated by the soils and vegetation. The model used here is based on simplistic methodology but improves on this by incorporating more variables in the respective nutrient cycles to more accurately model actual processes. It acknowledges that a proportion of nitrogen will be retained in the soil through processes such as mineralisation (the conversion of organic nitrogen and ammonia) and volatilisation (Geary and Gardner 1996). It also accounts for crop growth rates (and hence nutrient uptake rates) for a typical pasture.

Some assumptions used in the modelling follow:

- Hydraulic loading - 600 L/day;

- Nitrogen concentration in effluent - 25 mg/L.
- Nitrogen percentage lost to soil processes - 20%
- Phosphorus concentration in effluent - 10 mg/L.
- Critical nutrient loading rates - 220 kg/ha/year for nitrogen and 60 kg/ha/year for phosphorus.
- Soil phosphorus sorption capacity - 2520 kg/ha of soil. (Details in **Appendix D**)
- Design life of system - 50 years.

The area required for nitrogen assimilation is 199 square metres, while phosphorus requires 198 square metres.

Summary and Discussion

The preferred irrigation area is based on the larger of the water and nutrient balance calculations. An area of at least 224 square metres must be provided (see **Appendix E** for details). It is worth noting that the modelling includes several significant factors of conservatism:

- From the nutrient balances, in the absence of site-specific data very conservative estimates of crop nutrient uptake rates and total nitrogen lost to soil processes have been adopted.
- It is unlikely that the proposed dwelling will have 4 people staying there full time.

4.4 Siting and Configuration of the Land Application Area

The new land application areas should be isolated from high pedestrian and/or vehicle traffic areas, be excluded from areas where livestock have access to and be protected from rainwater runoff/run-on by a diversion drain configured like the one designated on the site plan in **Appendix A**.

Appendix A shows indicative envelopes of land that is suitable for effluent management. The clients will be allowed flexibility in selecting the final location and configuration of the septic system when applying for their on-site wastewater application through council providing it remains in accordance with the EPA Publication 891.4 (2016) *Code of practice – onsite wastewater management* & Australian Standards.

Appendix A shows indicative areas, to scale, of the areas suitable for siting the new land application areas (LAA's) according to the water and nutrient balance, with the minimum LAA area noted.

It is recommended that the owners consult an irrigation expert familiar with wastewater irrigation equipment, to help design and install the irrigation system. The irrigation plan must ensure good, even application of effluent.

Irrigation lines should be installed along the contour where possible. When irrigation lines need to be installed down a slope then non leakage emitters must be installed to manufacture's specifications. For slopes greater than 10% the DIR value should be reduced by the figure shown in Table M2 AS/NZS 1547:2012.

4.5 Treatment System Description

A detailed treatment system design is beyond the scope of this report, however a general description of a conventional bed system is provided here for the information of the client and Council.

The conventional bed is "*a design that has existed for decades. The effluent is piped from the septic tank to a shallow underground trench of stone or gravel. A geofabric or similar material is then placed on top of the trench so sand, dirt, and other contaminants do not enter the clean stone.*

Effluent filters through the stone and is then further treated by microbes once it reaches the soil below the gravel/stone trench/bed." (US EPA website 2023)

Conventional beds are up to 4000mm wide (max) by 300-600mm deep (dependant on soil) excavated in the topsoil layer to enable shallow distribution of effluent into the soil below the bed system. Effluent is distributed through a slotted or drilled distribution line no longer than 30m max. per run (EPA Publication 891.4 2016 Code of Practice, Section 3.10.1 *Absorption Trench Systems*), laid parallel with the horizontal bottom of the trench. The internal diameter of the pipe shall be not less than 80mm.

No trees are to be planted inside the irrigated area. Trees can be planted around the irrigated area.

Effluent shall not be used for irrigating fruit or vegetables. An adequate cover of fertile and porous topsoil material will be provided, and vegetation will be established when the irrigation areas have a low soil permeability.

4.6 Setback Distances

Setback distances from LAAs are required to help prevent human contact, maintain public amenity and protect sensitive environments. Council generally adopts the following nominal buffers, described in EPA Publication 891.4 (2016) *Code of practice – onsite wastewater management* Table 5.

- 20 metres from potable or non-potable groundwater bores
- 60 metres from watercourses that are non-potable (when using primary treatment); and
- 100 metres from watercourses in a potable water supply catchment.
- 6 metres if area up-gradient and 3 metres if area down-gradient of property boundaries, swimming pools and buildings.

All nominal buffers are achieved.

5.0 Monitoring, Operation and Maintenance

Maintenance is to be carried out in accordance with the certificate of approval and Council's permit conditions. The system proposed above will only function adequately if appropriately maintained. Residents will be required to carry out maintenance as discussed below.

To ensure the treatment system functions adequately, residents must:

- Restrict the use of germicides (such as strong detergents, disinfectants, toilet cleaners and bleaches) as they will kill the bacteria which makes the septic work.
- Inspect the system at least annually and desludging of the tank to occur approximately once every 5 years, or as otherwise directed by the council or septic inspector.
- Keep a record of all maintenance (including tank pump-outs and the location of the system, tank inspection and access openings) and send copies of the maintenance reports to the local council in accordance with the septic tank permit and Certificate of Approval.
- Do not add or alter any part of your system without council approval.
- Ensure that only suitable trained persons work on the system.
- Check sludge level, pumps and alarms regularly.
- Arrange for an inspection of the system, at least annually.
- Pump out the tank in accordance with the permit conditions.

To ensure the land application system functions adequately, residents must:

- Regularly harvest (mow) vegetation within the LAA and remove this to maximise uptake of water and nutrients.
- Monitor and maintain the subsurface irrigation system following the manufacturer's recommendations, including flushing of irrigation lines.
- Regularly clean in-line filters;
- Not erect any structures over the LAA;
- Minimise vehicle access to the LAA, to prevent compaction; and
- Ensure that the LAA is kept level by filling any depressions with good quality topsoil (not clay).

Good water conservation is an important aspect in the overall management of onsite systems. It will be important for the ongoing performance of both the treatment and land application system that they are not overloaded hydraulically. AAA rated plumbing is recommended for all future water fixtures.

6.0 Stormwater Management

As mentioned above, stormwater run on may occur at this site. The construction and maintenance of a diversion drain will mitigate this risk – see the Site Plan in **Appendix A**. Roof stormwater must not be disposed in the LAA.

7.0 Conclusion

As a result of our investigations, we recommend that sustainable onsite wastewater management systems can be built for Aire Street subdivision, Kirkstall.

Specifically, we recommend the following:

- Primary treatment from a conventional septic system;
- Installation of septic tanks as per Section 4.1;
- Land application of wastewater within a 224 m^2 conventional bed land application area;
- Installation of water saving devices in the proposed dwelling to reduce the effluent load for onsite disposal;
- Use of low phosphorus and low sodium (liquid) detergents to improve effluent quality and maintain soil properties;
- Application of dry gypsum/lime and organic matter to LAA to improve soil structure and permeability
- Operation and management of the treatment and disposal system in accordance with manufacturer's recommendations and the recommendations made in this report

8.0 References

Standards Australia / Standards New Zealand (2012). AS/NZS 1547:2012 *On-site domestic wastewater management.*

Standards Australia / Standards New Zealand (2006). AS/NZS 1477:2006 *PVC pipes and fittings for pressure applications.*

Standards Australia / Standards New Zealand (2000). AS 2698.2:2000 *Plastics pipes and fittings for irrigation and rural applications, Part 2: Polyethylene rural pipe.*

Environmental Protection Agency Victoria (2016). EPA Publication 891.4 (2016) *Code of practice – onsite wastewater management*

Isbell, R.F. (1996). The Australian Soil Classification. CSIRO Publishing, Melbourne.

Geary, P. and Gardner, E. (1996). On-site Disposal of Effluent. In Proceedings from the one day conference *Innovative Approaches to the Management of Waste and Water*, Lismore 1996.

United States Environmental Protection Agency (2023), *US EPA website*, US Government, accessed 24/01/2024, < https://www.epa.gov/septic/types-septic-systems>

9.0 Abbreviations, Descriptions and Definitions

The following table lists some common abbreviations and drainage system descriptions and their definitions which may be referred to in this report.

Table 5 - Common Abbreviations Associated with Stormwater Management Plans

Abbreviation	Description
ARI	Annual Recurrence Interval
AS/NZS	Australian Standard/New Zealand Standards
CEC	Cation Exchange Capacity
CMA	Catchment Management Authority
DIR	Design Irrigation Rate
DLR	Design Loading Rate
EA	Emerson Aggregate
EAC	Emerson Aggregate Class
EC	Electrical Conductivity
EPA	Environmental Protection Authority
LCA	Land Capability Assessment
LAA	Land Application Area
LPED	Low Pressure Effluent Distribution
SAR	Sodium Absorption Ratio

Appendix A – Site Plans

LEGEND:

H1 — BOREHOLE LOCATION

ASSUMED LAND APPLICATION AREA

GROUNDWATER BORE 20m SETBACK

EXISTING STRUCTURE

DIVERSION DRAIN

SITEC CONSULTING ENGINEERS

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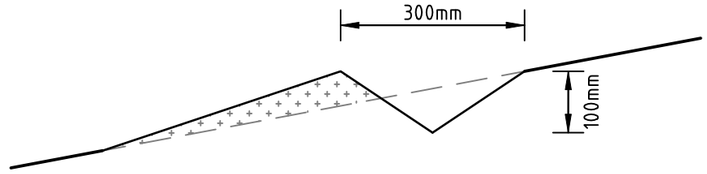
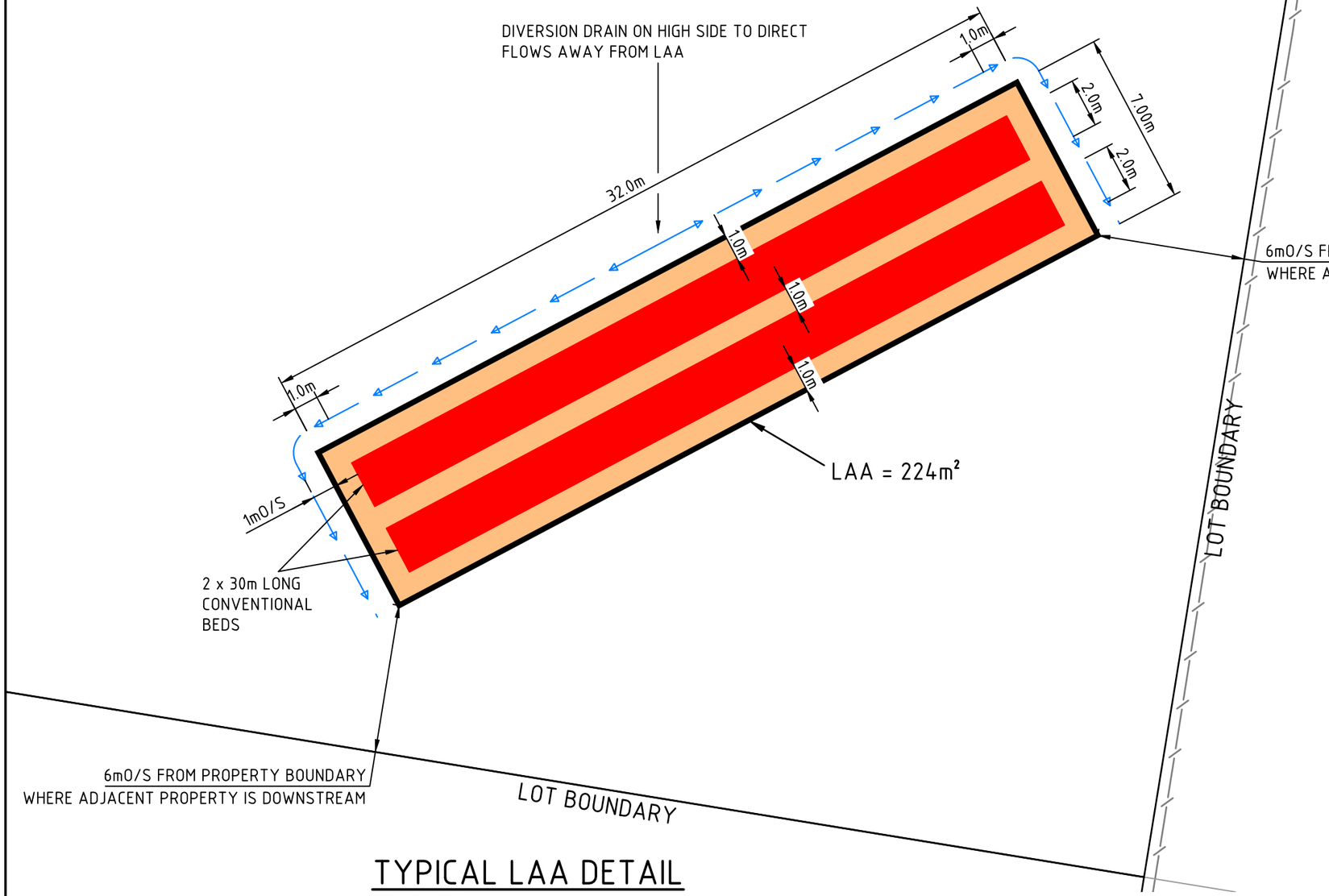
PROJECT

PROPOSED 6 LOT SUBDIVISION
AIRE STREET
KIRKSTALL
LAND APPLICATION AREA

SIZE	SCALE	PROJECT No.	SHEET No.	REV
A3	AS SHOWN	24-106	1 OF 2	A



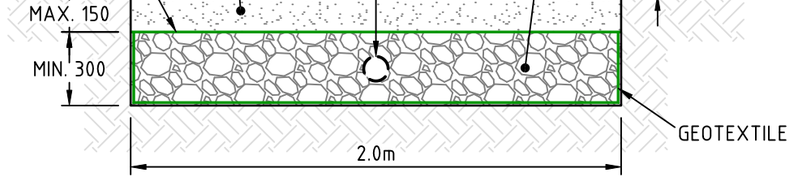
DIVERSION DRAIN
TYPICAL SECTION



TYPICAL LAA DETAIL
SCALE 1:200.

0 5 10 15 20
HORIZONAL SCALE (m)

LEGEND:
- ASSUMED LAND APPLICATION AREA
- TRENCH
- DIVERSION DRAIN



TYPICAL BED DETAIL
SCALE 1:25

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PROJECT
PROPOSED 6 LOT SUBDIVISION
AIRE STREET
KIRKSTALL
LAND APPLICATION AREA DETAILS

SIZE	SCALE	PROJECT No.	SHEET No.	REV
A3	AS SHOWN	24-106	2 OF 2	A

Appendix B – Bore Logs

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184 FAIRY STREET
WARRNAMBOOL VICTORIA 3280
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Engineering Bore Logs

Borehole No: 1
Sheet No: 1
Job No:

Client: [redacted]		Date:	14/10/2024
Project: LCA		Logged By:	[redacted]
Location: 68 Aire Street Kirkstall			
Drill model: Truline trailer mounted	Slope 90 deg	RL Surface:	N.A
Hole Diameter: 100mm	Bearing - deg	Datum:	N.A

Material Description	Depth (mm)	Graphic Log	Water	Moisture Condition	Unified Classification	Structure, additional observations	Notes Samples Tests	Method	Support
TOPSOIL Brown, slightly moist, soft topsoil	0			SM	OH	<100kPa			
CLAY Brown, slightly moist, soft highly plastic clay	300			SM	CH	<100kPa			
CLAY Brown, moist, firm, highly plastic clay	600			M	CH	>100kPa			
SAND Light brown, dry, firm, clayey sand	900			D	SC	>100kPa			
SAND Light brown/orange, dry, firm, sand	1200			D	SP	>100kPa			
SAND Light brown/yellow, dry firm sand	1400			D	SP	>100kPa			
SAND Brown/orange, dry, firm sand	1700			D	SP	>100kPa			
TERMINATED	2000								

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Engineering Bore Logs

Borehole No: 2
Sheet No: 1
Job No:

Client: [redacted]		Date:	14/10/2024
Project: LCA		Logged By:	[redacted]
Location: 68 Aire Street Kirkstall			
Drill model: Truline trailer mounted	Slope 90 deg	RL Surface:	N.A
Hole Diameter: 100mm	Bearing - deg	Datum:	N.A

Material Description	Depth (mm)	Graphic Log	Water	Moisture Condition	Unified Classification	Structure, additional observations	Notes Samples Tests	Method	Support
TOPSOIL Brown, slightly moist, soft topsoil	0			SM	OH	<100kPa			
CLAY Brown, moist, firm, highly plastic, clay	300			M	CH	>100kPa			
CLAY Brown/orange/yellow, moist, firm, highly plastic clay	600			M	CH	>100kPa			
SAND Light brown/orange, dry, firm, sand	800			D	SP	>100kPa			
SAND Light brown, dry, stiff, sand with grravel pieces	1000			D	SP	>100kPa			
ROCK Light brown, rock refusal	1150								

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Engineering Bore Logs

Borehole No: 3
Sheet No: 1
Job No:

Client: [redacted]		Date:	14/10/2024
Project: LCA		Logged By:	[redacted]
Location: 68 Aire Street Kirkstall			
Drill model: Truline trailer mounted	Slope 90 deg	RL Surface:	N.A
Hole Diameter: 100mm	Bearing - deg	Datum:	N.A

Material Description	Depth (mm)	Graphic Log	Water	Moisture Condition	Unified Classification	Structure, additional observations	Notes Samples Tests	Method	Support
TOPSOIL Brown, slightly moist, soft topsoil	0			SM	OH	<100kPa			
CLAY Brown, moist, firm, highly plastic clay	300			M	CH	>100kPa			
CLAY Light brown, moist, firm highly plastic clay	600			M	CH	>100kPa			
SAND Light brown/yellow, dry, firm, sand	900			D	SP	>100kPa			
SAND Light brown/orange, dry, stiff, sand	1200			D	SP	>100kPa			
ROCK Refusal Rock	1300								

Appendix C – Test Data

Record of Dispersion in Water

Soil	Completely Disperse, Class 1	Partially Disperse, Class 2	Slake 1, 2 or 3	Water Stable, swell Class 7	Water Stable, no swell Class 8
1		2/3			
2			3/2		
3			3/3		

	Soil 1	Soil 2	Soil 3
Start of Test (11/12/2023, 11:00AM)			
End of Test (12/12/2023, 1:50PM)			

Record of EC Testing

(soil samples tested in a 1:5 soil:water suspension)

Soil (soil texture)	EC reading (meter reading) (uS/cm)	EC as dS m^{-1} (EC reading / 1000)	Salinity Hazard
1	432	0.432	medium EC, many crops affected
2	209	0.209	low EC, very sensitive crops affected
3	152	0.152	low EC, very sensitive crops affected

Record of pH in Test Soils

(soil samples tested in a 1:5 soil:water suspension)

Soil Sample	Measured pH	Comment
1	6	range suitable for growth in most plants
2	6	range suitable for growth in most plants
3	6.5	range suitable for growth in most plants

Appendix D – Water & Nutrient Balance

Nominated Area Water Balance & Storage Calculations

Site Address **Aire Street, Kirkstall** **Job No: 24-106**

INPUT DATA			**NOTES**	
Design Wastewater Flow (L/day)	Q	600	Based on 3br/4 person house @ 150 L/p/day	(Table 4) EPA 891.3
Design DLR (mm/week)	DLR	35		(Table H2) AS/NZS 1547:2012
Daily DIR (mm/day)		5		Table M1 AS/NZS 1547:2012
Nominated Land Application Area (m^2)	L	170		
Crop Factor	C	0.7-0.8		
Retained Rainfall	Rf	0.8	Assume some natural runoff from site due to slope	
Rainfall Data		Warrnambool Airport - 090172		
Evaporation Data		BOM Average - West Coast		

Parameter	**Symbo**	**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**	
Rainfall - Average	R		mm/month	32.9	32.2	47.9	52.5	73.5	78.6	85.7	95	73.7	61.8	50.4	46.1	**730.3**	
Evaporation - Average	E		mm/month	180	175	140	110	65	35	50	55	70	125	150	160	**1300**	
Crop Factor	C			0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8		
OUTPUTS																	
Evaportransporation	ET		mm/month	80	65	50	35	30	30	30	35	45	75	85	85	**645**	
Percolation	B		mm/month	155.0	140.0	155.0	150.0	155.0	150.0	155.0	155.0	150.0	155.0	150.0	155.0	**1825.0**	
Outputs			mm/month	235.0	205.0	205.0	185.0	185.0	180.0	185.0	190.0	195.0	230.0	235.0	240.0	**2470**	
INPUTS																	
Retained Rainfall	RR		mm/month	26.32	25.76	38.32	42	58.8	62.88	68.56	76	58.96	49.44	40.32	36.88	**584.24**	
Effluent Irrigation	W		mm/month	109.4	98.8	109.4	105.9	109.4	105.9	109.4	109.4	105.9	109.4	105.9	109.4	**1288.235**	
Inputs			mm/month	135.7	124.6	147.7	147.9	168.2	168.8	178.0	185.4	164.8	158.9	146.2	146.3	**1872.475**	
STORAGE CALCULATIONS																	
Storage remaining from previous month																	
Storage from month	S		mm/month	-99.3	-80.4	-57.3	-37.1	-16.8	-11.2	-7.0	-4.6	-30.2	-71.1	-88.8	-93.7	(adjust until <0)	

MINIMUM AREA REQUIRED FOR ZERO STORAGE (m2) = **170**

Site Address	Aire Street, Kirkstall	Job No: 24-106

Nitrogen Balance

Daily N Load

Effluent concentration N	25	mg/l	EPA Publication 1911.2 (2021) between 10 - 30mg/L
Annualised Daily Hydraulic Load	600	l/day	
Daily Load	15000	mg/day	
Annual N Load	5475000	mg/year	

Losses

Estimate losses through denitrification, volatilzation, microbial attack

Loss	20%		As per Victroian LCA Framework (2014)
Annual N Load	4.38	kg/year	
Allow for uptake by plants	220	kg/Ha/yr	Table 6 EPA Publication 1911.2 (2021) - Ryegrass

Minimum Area Required **199 m2**

Phosphorus Balance

Annual P Load

Effluent concentration P	10	mg/l	
Annualised Daily Hydraulic Load	600	l/day	
Annualised Daily P Load	6000	mg/day	
Annual N Load	2190000	mg/year	
Annual N Load	2.19	kg/year	

Losses

Determine P sorption each year for 50 years

Assumed P Sorption =	120	mg/kg	90-160 mg/kg AS/NZS 1547:2012 Appendix S
Assumed Soil bulk density =	1400	kg/m^3	
Soil Depth =	1.5	m	(Depth to groundwater > 1.5m as per boreholes)
Total P Sorption for 50 years =	2.52E+09	mg/Ha	
Total P Sorption for 50 years =	2520	kg/Ha	
Total P Sorption =	50.40	kg/Ha/yr	
Allow for uptake by plants	60	kg/Ha/yr	Table 6 EPA Publication 1911.2 (2021) - Ryegrass

Minimum Area Required **198 m2**

Appendix E – Conventional Bed Calculations

Site: Aire Street, Kirkstall **Job No. 24-106**

Conventional Bed Sizing Calculations

(AS/NZ 1547:2012, Appendix L Section L4.2 Sizing):

$$L = \frac{Q}{DLR \times (W/F)}$$

L = length in m

Q = 600 (design daily flow in L/day)

DLR = 5 (design loading rate in mm/day)

W = 2 (width in m)

F = 1 (loading factor to reflect improved storage in the design)

$$L = \frac{600}{5 \times (2/1)}$$

L = 60 m

$$No.\ of\ Trenches = \frac{L}{M}$$

Where:

L = 60 m (total required length of trenches in m)

M = 30 m (Max. length of trenches in m as per Section 4.5)

$$No.\ of\ Trenches = \frac{60}{30}$$

No. of Trenches = 2

LAA Sizing

$$Length\ of\ LAA = X + O$$

Where:

$x =$ 30 m (trench length in m)

$O =$ 2 m (total of minimum offsets on both ends of trench in m - (1 +1)

$$Length\ of\ LAA = 30 + 2$$

$$Length\ of LAA = 32\ \text{m}$$

$$Width\ of\ LAA = Y + W$$

Where:

$Y =$ 4 m (Total of combined trench widths in m: 2 + 2)

$W =$ 3 m (total minimum offsets on both sides of trench in m - 1 + 1 + 1)

$$Width\ of\ LAA = 4 + 3$$

$$Width of LAA = 7\ \text{m}$$

$$Dimensions\ of\ LAA = 32\text{m} \times 7\text{m} = 224\text{m}^2$$

Adjustment to LAA to suit balance calculations

Bed area must be equal to or greater than the greatest of the balance area calculations. As the bed area exceeds the greatest of the balance area calculations (nitrogen area requires min. 199m^2), no adjustments to LAA is necessary.

Assume LAA = 224m²