LOT 222 HARDEY RD, GLEN FORREST

SITE & SOIL EVALUATION

Prepared for

Mundaring Gospel Trust
c/- Statewest Planning
PO Box 1377
MIDLAND WA 6936

Report No. J20006
24 November 2023

BAYLEY ENVIRONMENTAL SERVICES
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Sundowner Nominees Pty Ltd as trustee for the Bayley Cook Family Trust ABN 20 822 598 897
trading as Bayley Environmental Services

EXECUTIVE SUMMARY

INTRODUCTION

The Mundaring Gospel Trust proposes to develop a small membership-based shop, a meeting hall (place of worship) and a childcare centre on Lot 222 Hardey Road, Glen Forrest. Each building will be served by a separate on-site effluent disposal system. Lot 222 and the adjacent Lot 221 will be created from the existing Lot 20 Hardey Rd under subdivision approval 162343 and will have an area of 5,900 square metres.

Structerre Pty Ltd carried out a Site & Soil Evaluation (SSE) of Lot 20 Hardey Rd in September 2020. Bayley Environmental Services (BES) carried out a further SSE in December 2021, focussing on the areas proposed for effluent disposal and drainage.

ON-SITE EFFLUENT DISPOSAL

Land Capability

The Site & Soil Evaluation found that the site is suitable for on-site effluent disposal in accordance with the Government Sewerage Policy (GSP). In particular:

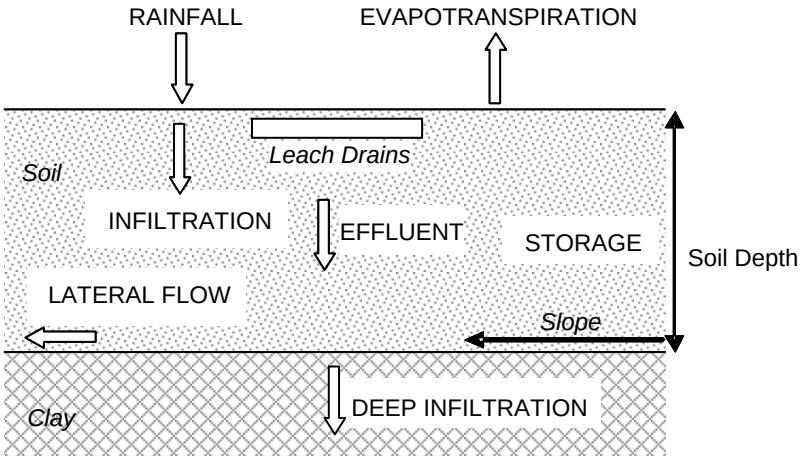
- The slope of the site is less than 20%.
- No groundwater or confining layers were detected at less than 2m depth.
- The soil permeability in the shallow profile is moderate to high and suitable for effluent disposal via leach drains, drip or spray irrigation.
- The soil PRI is expected to be high to very high.
- There are no surface watercourses within 500m of the site.
- The site is not within a public drinking water source protection area or sewage sensitive area.

Site Capacity

The assimilative capacity of the site can be estimated by a site water balance. Effluent disposal will add water to the soil profile over what is naturally input by rainfall. The water balance of the site will consist of inputs (rain and effluent) and outputs (evapotranspiration, storage, deep infiltration and lateral flow). In a steady state, the input and output volumes are equal as per the following equation:

$$R + E = Et + St + DI + LF$$

The diagram below illustrates this water balance.



Using parameters for effluent generation published by the Health Department, rainfall and evaporation data from the Bureau of Meteorology, estimated site population numbers supplied by the Mundaring Gospel Trust and site characteristics from on-site testing, the water balance model shows that:

- The modelled scenario results in an overall effluent loading rate of 6.73 mm/day. This is well below the AS1547:2012 recommended design loading rates (DLR) of 10mm/day for septic tank/leach drains and 30mm/day for ATU/leach drains.

- In both summer and winter under all conditions except 1-day extreme rainfall, deep infiltration capacity will exceed net water loading (effluent plus rainfall minus evaporation), so no lateral flow or change in soil storage will occur.

- Under short-term extreme rainfall (139 mm in one day, equivalent to January 2018), net water loading will marginally exceed deep infiltration capacity. The excess will be stored in the soil profile or removed by lateral flow, with the remainder removed by deep infiltration over the following day.

- Under all conditions, the combination of evapotranspiration, deep infiltration, soil storage and lateral flow is sufficient to ensure that no saturation of the soil profile or surfacing of effluent will occur.

System Selection and Sizing

Given the favourable site characteristics, effluent disposal may be carried out by means of conventional septic tank/leach drain systems or by secondary treatment systems (e.g. ATU) with either surface or drip irrigation or leach drains.

Based on the soil types, effluent volumes and expected patterns of use, the following effluent treatment and disposal systems are proposed:

• Shop	Treatment	ATU system
	Disposal	2 x 6m end-to-end flatbed leach drains
• Hall	Treatment	Septic tanks
	Disposal	2 x 7m end-to-end flatbed leach drains
• Childcare	Treatment	ATU system
	Disposal	2 x 20m parallel flatbed leach drains

These sizings are preliminary and will be subject to detailed design prior to construction.

DRAINAGE

Runoff from the three development stages will be captured in bioretention basins located in the south-east corner of each stage. The basins have been sized to capture and infiltrate all runoff from a 15mm 1-hour storm and to detain and compensate the flow from critical storms up to 100-year ARI (1% AEP), releasing the excess flow at no more than pre-development rates.

Runoff from larger or longer-duration storms will overflow the basins via a pipeline on the eastern boundary of Lot 222 into the adjacent Lot 221, in line with the existing flow paths. The sizing of the basins will ensure that the rate of overflow will be no greater than before development. The outflow from the pipe will be suitably protected to prevent erosion and scouring.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Background

The Mundaring Gospel Trust proposes to develop a small membership-based shop, a meeting hall (place of worship) and a childcare centre on Lot 222 Hardey Road, Glen Forrest. Each building will be served by a separate on-site effluent disposal system. Lot 222 and the adjacent Lot 221 will be created from the existing Lot 20 Hardey Rd under subdivision approval 162343 and will have an area of 5,900 square metres. Figure 1 shows the proposed development plan. Figure 2 shows an aerial view of the site and surroundings.

Structerre Pty Ltd carried out a Site & Soil Evaluation (SSE) of Lot 20 Hardey Rd in September 2020. The SSE included soil probing at eight locations and permeability testing at four locations across the site. The Shire of Mundaring subsequently requested further information, especially on soil conditions in the areas proposed for effluent and drainage disposal.

Bayley Environmental Services (BES) carried out a further SSE in December 2021, focussing on the areas proposed for effluent disposal and drainage. The SSE included:

- test pits to 1.9m – 2.8m at twelve sites with an 8-tonne excavator;
- constant-head permeability tests at 0.5m and/or 1m depth at nine sites;
- examination of surface conditions including topography, surface soils, hydrology and vegetation; and
- collation of published information including topography, hydrology and geology.

The site works on Lot 222 are not part of this proposal but the results of these tests are included for completeness.

The BES test pitting was carried out in August 2021 and the permeability tests in September 2021. The Shire of Mundaring's then Senior Environmental Health Officer Mr Martin Shurlock attended the site and observed some of the test pitting.

1.2 Qualifications and Experience of Assessor

This report has been prepared by Phillip Bayley, an Environmental Scientist with 39 years' experience including 34 years as a private consultant. Phillip Bayley has undertaken over 70 site & soil assessments and land capability assessments for onsite effluent disposal since 2006.

The investigations and analyses presented in this report have been undertaken in accordance with Australian Standard AS1547:2012 – *Onsite Domestic Wastewater Management* and the *Government Sewerage Policy 2019.*

2.0 EXISTING ENVIRONMENT

2.1 Climate

Glen Forrest, like the rest of the Perth region, has a strongly seasonal rainfall, with most of the annual rain falling between May and September in association with winter cold fronts. Occasional heavy falls may occur from summer thunderstorms. The long-term average annual rainfall for Bickley (the closest Bureau of Meteorology weather station with long-term data) is 1,088.8mm, of which 78% falls between May and September.

Figure 3 shows a rainfall occurrence chart for Bickley.

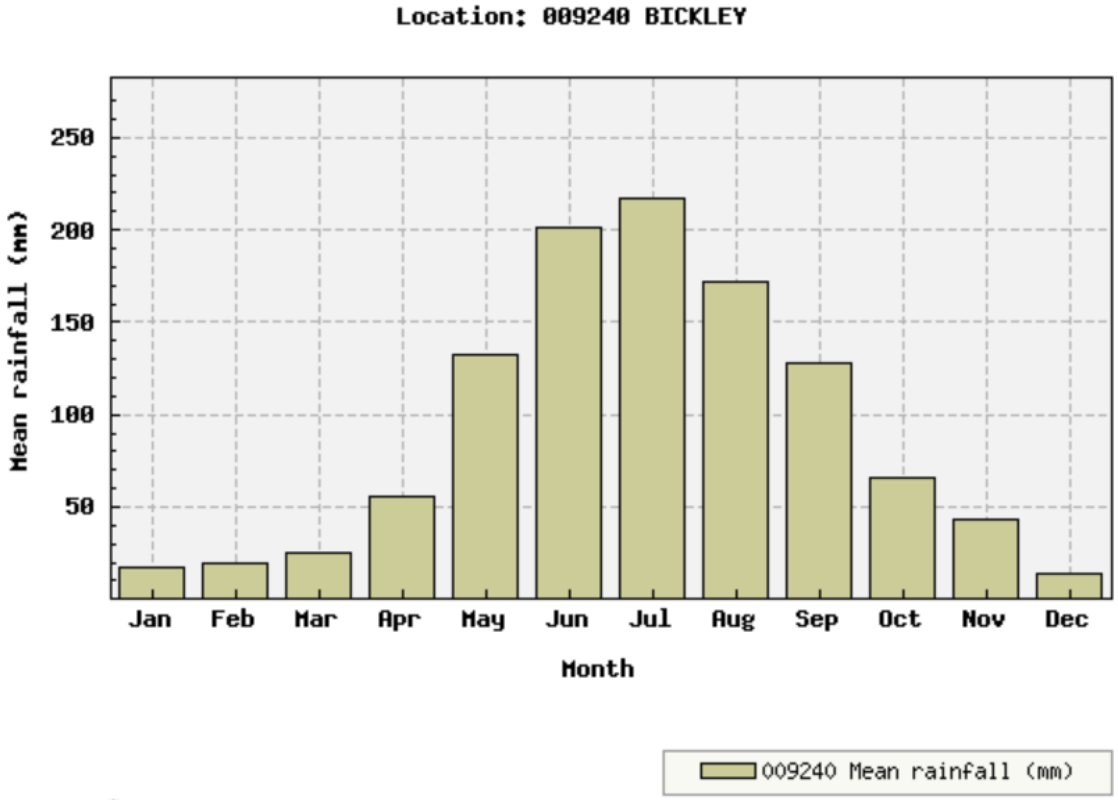


Figure 3 Bickley Mean Rainfall

Table 2.1 Rainfall Intensity for Glen Forrest

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	1.70	1.87	2.44	2.85	3.26	3.85	4.32
2 min	2.99	3.25	4.14	4.78	5.44	6.39	7.16
3 min	4.00	4.37	5.60	6.48	7.41	8.71	9.78
4 min	4.84	5.30	6.83	7.94	9.09	10.7	12.0
5 min	5.55	6.09	7.89	9.20	10.5	12.4	14.0
10 min	8.04	8.88	11.6	13.6	15.6	18.4	20.6
15 min	9.70	10.7	14.0	16.4	18.8	22.2	24.8
20 min	11.0	12.1	15.8	18.5	21.2	24.9	27.9
25 min	12.0	13.2	17.3	20.2	23.1	27.1	30.4
30 min	12.9	14.2	18.5	21.6	24.7	29.0	32.5
45 min	15.1	16.6	21.4	25.0	28.6	33.7	37.8
1 hour	16.9	18.5	23.8	27.6	31.7	37.4	42.1
1.5 hour	19.7	21.5	27.5	32.0	36.8	43.6	49.4
2 hour	22.0	24.0	30.6	35.6	41.0	48.9	55.6
3 hour	25.8	28.0	35.7	41.7	48.2	57.9	66.3
4.5 hour	30.3	32.8	41.8	49.0	56.9	69.0	79.5
6 hour	33.9	36.7	46.9	55.1	64.2	78.1	90.4
9 hour	39.7	43.1	55.2	64.9	75.8	92.6	107
12 hour	44.3	48.2	61.9	72.8	84.8	104	120
18 hour	51.5	56.1	72.2	84.7	98.3	120	139
24 hour	57.1	62.3	80.2	93.7	108	131	151
30 hour	61.7	67.5	86.7	101	116	139	159
36 hour	65.7	71.9	92.2	107	122	146	166
48 hour	72.3	79.2	101	116	132	156	175
72 hour	82.9	90.9	115	131	147	170	189
96 hour	91.8	101	127	144	160	184	203
120 hour	99.9	109	138	157	174	199	218
144 hour	108	118	149	169	189	216	237
168 hour	116	127	160	183	206	236	260

Note:
The 50% AEP IFD **does not** correspond to the 2 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 1.44 ARI.
* The 20% AEP IFD **does not** correspond to the 5 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 4.48 ARI.

2.2 Physiography

2.2.1 Topography

The site is located on the undulating surface of the Darling Plateau on a southeast-facing slope at the head of a catchment of a minor tributary of the Helena River. The elevation of the site ranges from about 250m AHD at the northern boundary to 245m AHD in the south-east corner. The slope varies from about 4% to 9%, averaging 6% across the site. The slope is generally even, with no significant topographic convergences.

Figure 4 shows topographic contours over the site.

2.2.2 Geology and Soils

The Geological Survey of Western Australia (Smurthwaite, 1986) describes the site as Laterite (LA_1/Czl): "…massive, hard, cemented, vuggy and pisolitic; up to 4m thick, overlain by and associated with gravels of residual origin".

The Department of Agriculture (King & Wells, 1990) mapped the site as "Dwellingup (D2): Gently undulating terrain with well drained, shallow to moderately deep gravelly brownish sands, pale brown sands and earthy sands overlying lateritic duricrust."

Test pitting to between 1.9m and 2.8m at twelve locations focussed on the proposed effluent disposal and drainage areas found a predominantly orange-brown gravelly clay to clay-loam soil profile, which was mostly uniform across the site. Despite the GSWA and DoA mapping, laterite was notably absent from most test pits on the site. Figure 4 shows the test pit locations. Appendix A shows soil logs from the test pits.

The soils observed in the test pits correspond with Soil Category 4 (Clay-Loam) as described in Australian Standard AS1547:2012 and the Government Sewerage Policy.

2.2.3 Acid Sulphate Soils

The site is elevated, with soils formed in-situ. There are no factors that would give rise to acid sulphate soils. No further ASS assessment is considered necessary before development.

2.2.4 Phosphorus Retention Index

The iron-rich soils that occur at the site are expected to have a high to very high PRI and consequently a high capacity to adsorb phosphorus. No PRI testing or soil modification is considered to be necessary.

2.2.5 Soil Permeability

Constant-head permeability tests were carried out at 0.5m and/or 1m depth at nine locations in and around the proposed effluent disposal and drainage areas. The tests at 0.5m depth gave hydraulic conductivities (Ks) ranging from 0.7m/day to 8m/day, with an average of 3.75m/day and a median of 3.5m/day. The single test at 1m depth showed no measurable infiltration after one hour. Within and near the proposed land application areas for Lot 222, the mean hydraulic conductivity from five tests was 4.24m/day.

The measured Ks values show that the shallow soil profile has adequate permeability for effluent disposal by leach drains or drip irrigation and for infiltration of stormwater. Figure 4 shows the permeability test locations. Appendix B shows the detailed test results.

2.3 Hydrology

2.3.1 Surface Drainage

There is no defined surface drainage on the site. Given the permeable sandy surface soils and leaf litter over most of the site, surface runoff would occur only briefly during and after very heavy rainfall.

The nearest surface drainage feature is a small creek (possibly a drain) that rises west of Hardey Rd about 500m south and downslope of the site.

2.3.2 Groundwater

No shallow groundwater was encountered during the test pitting and none is expected to occur at the site, given the elevation, the generally permeable soil profile and the absence of significant rock or heavy clay.

3.0 ON-SITE EFFLUENT DISPOSAL

3.1 Site Capability

The capability of the site to support on-site effluent disposal has been assessed against the criteria set out in AS1547:2012 and the Government Sewerage Policy 2019. Table 3.1 summarises the criteria and the degree to which they are satisfied by the site.

Table 3.1 On-site Effluent Disposal Capability

Factor (AS1547:2012 or GSP)	*Criterion*	*Site Characteristics*	*Complies*
Lot size	1,000m^2 for infill development outside SSAs	Minimum 1,500m^2 for each stage	Yes
Slope	<20%	4-9%	Yes
Groundwater depth	>1.5m below discharge point	None detected <2m Expected >6m	Yes
Soil permeability (Ks)	>0.06 m/day	1.7-8 m/day	Yes
Distance from watercourses and significant wetlands	>100m	500m	Yes
Inundation and flooding	Not subject to inundation or flooding in a 10% AEP (1 in 10 year) rainfall event	Not subject to inundation	Yes

Table 3.1 shows that the site meets the requirements of the Government Sewerage Policy for on-site effluent disposal.

3.2 Effluent System Conceptual Design

3.2.1 Treatment and Disposal

Given the favourable site characteristics, effluent disposal may be carried out by means of conventional septic tank/leach drain systems or by secondary treatment systems (e.g. ATU) with either surface or drip irrigation or leach drains.

Septic tank/leach drain systems are the simplest and most economical to install and operate on suitable sites. However, ATU systems (or other systems that produce secondary treated effluent) with leach drains can operate at higher loading rates and therefore require a smaller land application area.

It is proposed that effluent from the shop and childcare centre will be treated by ATU systems in order to minimise the area required for effluent disposal. The meeting hall will be used only on two days per week, which is not well suited to an ATU system. It is therefore proposed that the meeting hall will use a septic system to cope with the intermittent effluent loads.

The treated effluent will be disposed of by flatbed leach drains in a dedicated land application area (LAA) in the north-east corner of each stage (Figure 5).

The surface of the LAAs will be planted with grass and possibly shallow-rooted garden plants to function as both a disposal field and a passive recreation area.

3.2.2 System Sizing

Sizing of the effluent treatment systems has been based on advice from the Mundaring Gospel Trust and the Health Department's *Supplement to Regulation 29 and Schedule 9 – Wastewater System Loading Rates (2021).* The sizing parameters adopted are:

- Shop

	Population	*Effluent rate*		*Total effluent*
Staff	5	70 lpd		350 lpd
Customers	50/day	10 lpd		500 lpd
			Total	850 lpd

- Hall

	Population	*Effluent rate*		*Total effluent*
Worshippers	50/day	10 lpd		500 lpd
			Total	500 lpd

- Childcare

	Population	*Effluent rate*		*Total effluent*
Staff	10	70 lpd		700 lpd
Children	46	45 lpd		2,070 lpd
			Total	2,770 lpd

The volume of effluent that can be disposed in a land application area depends on the size of the LAA, the quality of the effluent and the permeability of the soil. Australian Standard AS1547:2012 gives recommended Design Loading Rates (DLR) and Design Irrigation Rates (DIR) for leach drains and irrigation systems. The soils at this site correspond to AS1547012 Category 4: High/moderate Structured Clay-Loams (indicative Ks = 0.5 – 1.5 m/day). Australian Standard AS:NZS 1547:2000 *Onsite Domestic Wastewater Management* recommends a Design Loading Rate (DLR) of up to 30 mm/day for secondary-treated effluent in Category 4 soils.

The calculated leach drain and LAA sizings on each of the stages is:

- Shop
  - Configuration: 2 x 6m end-to-end flatbed leach drains
  - Leach drain area: 2.5m width x 13.8m length
  - LAA size (including boundary and pavement setbacks): 5.5m width x 16.8m length = 92.4m^2
- Hall
  - Configuration: 2 x 7m end-to-end flatbed leach drains
  - Leach drain area: 2.5m width x 15.8m length
  - LAA size (including boundary and pavement setbacks): 5.5m width x 18.8m length = 103.4m^2

- Childcare Configuration 2 x 20m parallel flatbed leach drains
  Leach drain area 6.8m width x 20m length
  LAA size (including boundary and pavement setbacks)
  9.8m width x 23m length = 225.4m^2

Figure 5 shows the footprints of these land application areas and leach drains in each stage. The layout may be varied at the detailed design stage provided that the minimum sizing and setbacks are maintained. Appendix C shows the detailed sizing calculations.

3.2.3 Site Capacity

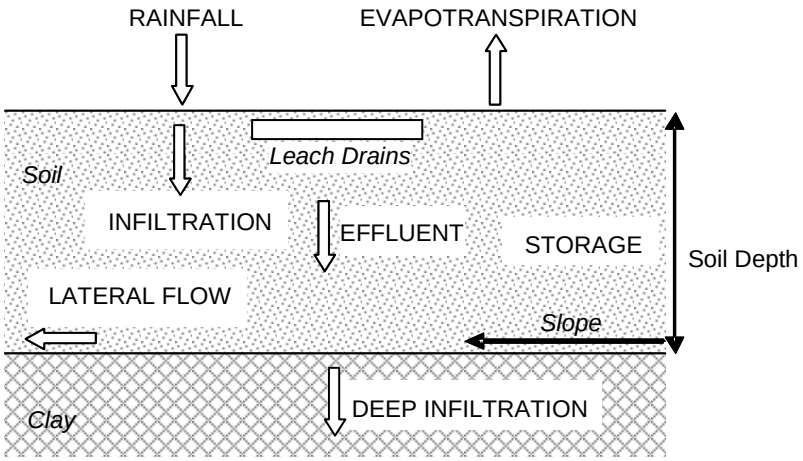
The overall site capacity for effluent disposal depends on the ability of the site soils to accept and assimilate effluent without risk of soil saturation, surfacing of effluent or adverse effects on the downstream environment.

The assimilative capacity of the site can be estimated by a site water balance. Effluent disposal will add water to the soil profile over what is naturally input by rainfall. The water balance of the site will consist of inputs (rain and effluent) and outputs (evapotranspiration, storage, deep infiltration and lateral flow). In a steady state, the input and output volumes are equal as per the following equation:

$$R + E = Et + St + DI + LF$$

where: R = Rainfall
E = Effluent load
Et = Evapotranspiration
St = Change in soil storage
DI = Deep infiltration
LF = Lateral flow

The diagram below illustrates this water balance.



The water balance parameters adopted for the land application areas are shown below. The effluent volumes are based on the site population and effluent generation rates as set out in Section 3.2.2 and Appendix C as follows:

Effluent Volume (L/day)	2,875
Application Area (m^2)	427
Effluent Loading Rate (mm/day)	6.73
Slope	6%
Ks (soil) (m/day)	3.5
Ks (subsoil) (m/day)	0.1
Soil Depth (m)	1
Soil Porosity[1]	46%
Rainfall Recharge Coefficient	100%

[1] stormwater.pca.state.mn.us/index.php/Soil_water_storage_properties

In order for the effluent disposal area to function effectively, the following water balance conditions need to be met:

Long Term (winter)

Effluent + Rainfall – Evapotranspiration **<** Deep Infiltration + Lateral Flow

Short Term (1 day)

Effluent + Rainfall – Evapotranspiration **<** Deep Infiltration + Storage

Medium Term (1 week)

Effluent + Rainfall – Evapotranspiration **<** Deep Infiltration + Lateral Flow.

Appendix D shows the water balance model for the land application areas. The model shows that:

- In both summer and winter under all conditions except 1-day extreme rainfall, deep infiltration capacity will exceed net water loading (effluent plus rainfall minus evaporation), so no lateral flow or change in soil storage will occur.

- Under short-term extreme rainfall (139 mm in one day, equivalent to January 2018), net water loading will marginally exceed deep infiltration capacity. The excess will be stored in the soil profile or removed by lateral flow, with the remainder removed by deep infiltration over the following day.

- Under all conditions, the combination of evapotranspiration, deep infiltration, soil storage and lateral flow is sufficient to ensure that no saturation of the soil profile or surfacing of effluent will occur.

4.0 DRAINAGE

Runoff from the three development stages will be captured in bioretention basins located in the south-east corner of each stage, as shown on Figure 5. Permeability testing at five sites in the vicinity of the proposed basins returned permeabilities ranging from 1.7m/day to 8m/day, with a mean of 4.24m/day and a median of 4.85m/day. For design purposes a permeability of 2m/day has been adopted. The areas of buildings, car parks and soft surfaces (open space, play areas and land application areas) are taken as shown on the proposed development plan (Figure 1).

In accordance with current DWER protocols, the basins have been sized to capture and infiltrate all runoff from a 15mm 1-year storm and to detain and compensate the flow from critical storms up to 100-year ARI (1% AEP), releasing it at no more than pre-development rates. Table 4.1 shows the preliminary runoff calculations and basin sizing.

Table 4.1 Preliminary Basin Sizing

Stage *Event*	*Area (m^2)*	*Runoff (L/sec)*[1]		*Storage Required (m^3)*	*Water Depth (m)*
		Pre Dev	*Post Dev*		
Shop	2,050				
15mm 1hr		-	5.42	19.5	0.5
5 yr 5 min		10.2	38.3	6.2	0.24
100 yr 5 min		27.2	75.2	9.2	0.3
Hall	1,500				
15mm 1hr		-	2.79	10.0	0.5
5 yr 5 min		7.5	21.9	2.8	0.26
100 yr 5 min		19.9	44.4	4.1	0.3
Childcare	2,350				
15mm 1hr		-	3.72	13.4	0.5
5 yr 5 min		11.7	30.8	3.6	0.24
100 yr 5 min		31.2	63.1	4.8	0.27

1. Due to the small areas and short runoff paths, the critical storm duration for 5-year and 100-year storms is very short, in the order of three minutes. For design purposes, the critical storm duration has been conservatively taken as five minutes, which gives a larger required storage volume.

Runoff from larger or longer-duration storms will overflow the basins via a pipeline on the eastern boundary of Lot 222 into the adjacent Lot 221, in line with the existing flow paths. The sizing of the basins will ensure that the rate of overflow will be no greater than before development. The outflow from the pipe will be suitably protected to prevent erosion and scouring.

Calculations using the Rational Method (Institute of Engineers Australia, 1987) and a modified Copas equation show that:

- The basins have capacity to retain and infiltrate all runoff from a 15mm ARI 1-hour storm, with a maximum depth of water in the basins of 0.5m and a residence time of about six hours.

- The basins have capacity to capture and infiltrate all runoff from a critical (5-minute) 5-year ARI (20% AEP) storm, with a maximum water depth of 0.26m and a residence time of about three hours.

- The basins have capacity to capture and compensate the runoff from a critical (5-minute) 100-year ARI (1% AEP) storm, with a water depth of 0.3m and a residence time of about 3.5 hours.

Appendix E shows the runoff and basin sizing calculations. The calculations and basin dimensions shown are preliminary and will be subject to detailed design prior to construction.

5.0 REFERENCES

Institute of Engineers, Australia (1987). *Australian Rainfall and Runoff: A Guide to Flood Estimation.* Institute of Engineers, Australia, Barton, ACT.

King P.D. and Wells M.R. (1990). *Darling Range Rural Land Capability Study.* Land Resources Series No. 3. Department of Agriculture, South Perth.

Smurthwaite A.J. (1986). *1:50,000 Environmental Geology Series: Mundaring Part Sheets 2134 II & 2134 III.* Geological Survey of Western Australia, Perth.

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Figures

SHOP:
AREA LOT DESIGNATED = 2050 m²
AREA SHOP = 297 m²
EFFLUENT DISPOSAL = 205 m² MIN

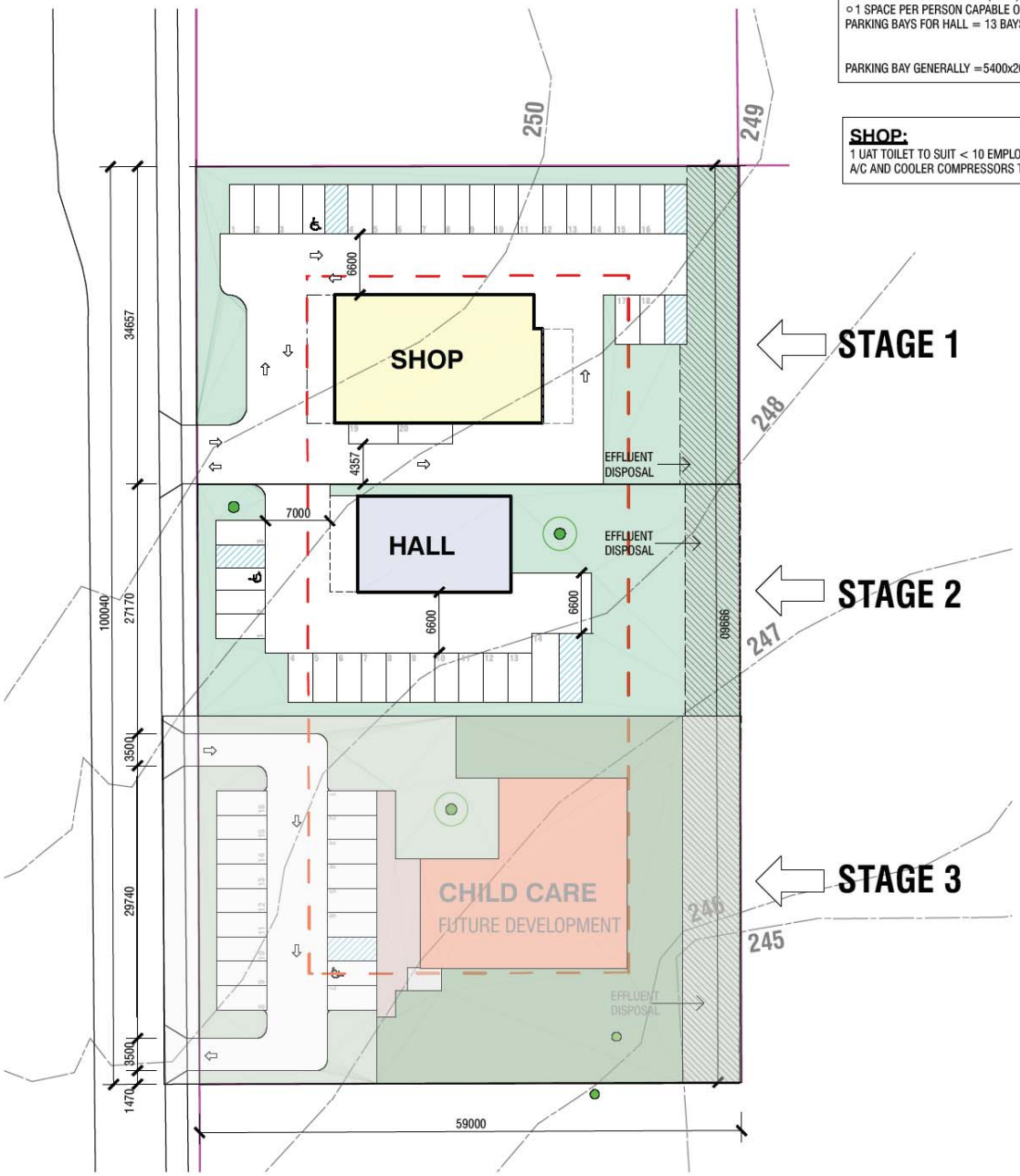
CAR PARKING CALCULATION:
○ 1 SPACE x 15 m² GLA IN LOCAL CENTRE
PARKING BAYS FOR SHOP = 20 BAYS (MINIMUM) +1 ACCESSIBLE BAY MINIMUM

HALL:
AREA LOT DESIGNATED = 1500 m²
AREA HALL = 175 m²
EFFLUENT DISPOSAL = 150 m² MIN

CAR PARKING CALCULATION (50PP):
○ 1 SPACE PER PERSON CAPABLE OF BEING ACCOMMODATED
PARKING BAYS FOR HALL = 13 BAYS(MINIMUM) +1 ACCESSIBLE BAY MINIMUM

PARKING BAY GENERALLY =5400x2600 mm

SHOP:
1 UAT TOILET TO SUIT < 10 EMPLOYEES
A/C AND COOLER COMPRESSORS TO BE LOCATED AT EAST ELEVATION-ROOF MOUNTED



LOCATION PLAN OPTION C
SCALE 1:500

North

STAGE	REV.	DESCRIPTION	DATE
CP		CONCEPT LOCATION PLAN	06/10/23
	1	SHOP AREA MODIFICATIONS & 2 CAR BAYS ADDED	12/10/23
	2	LOCATION PLAN OPTION B ADDED	16/10/23
	3	LOCATION PLAN OPT C & D	26/10/23
	4	SWEPT PATH ADDED TO SHOP PLAN FOR TRANSPORT DESIGN	08/11/23
	5	STAGED NOTATIONS ADDED	09/11/23

design synergy
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VITRUVIAN ELEMENT PTY LTD
t/f Morris Family Trust | abn 70 356 286 124

MUNDARING GOSPEL TRUST
7 HARDEY ROAD,
GLEN FORREST
LOCATION PLAN OPT C

PROJECT No 10650923

DESIGNED	CHECKED	DWG N°	REV
DS	DS	A 1.0	5
SHEET SIZE	DATE		
A3	9/11/2023		

Figure 1

PROPOSED DEVELOPMENT PLAN

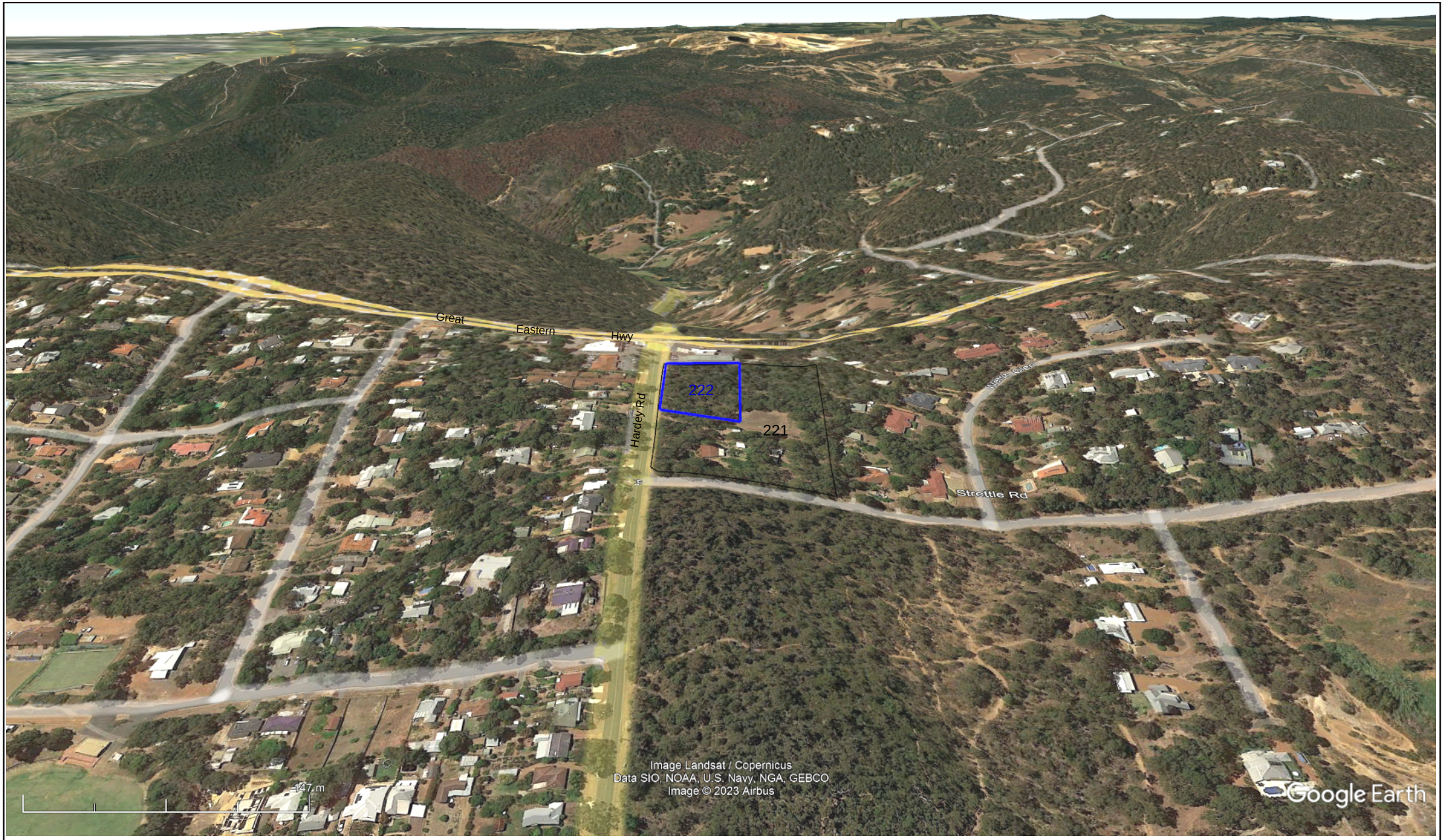


Figure 2

THE SITE AND SURROUNDINGS

bayley environmental services

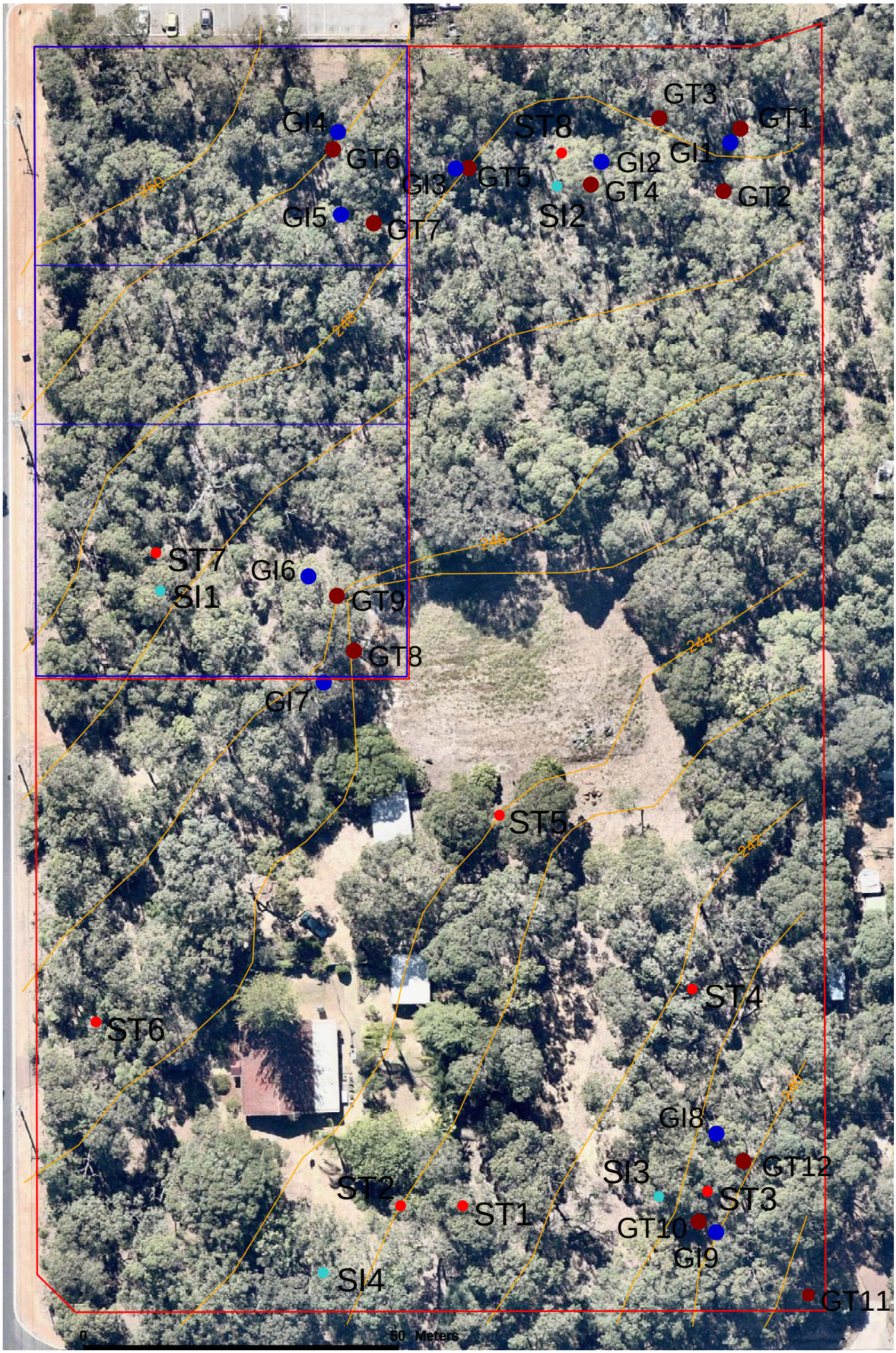


Figure 4

ENVIRONMENTAL FEATURES

bayley environmental services

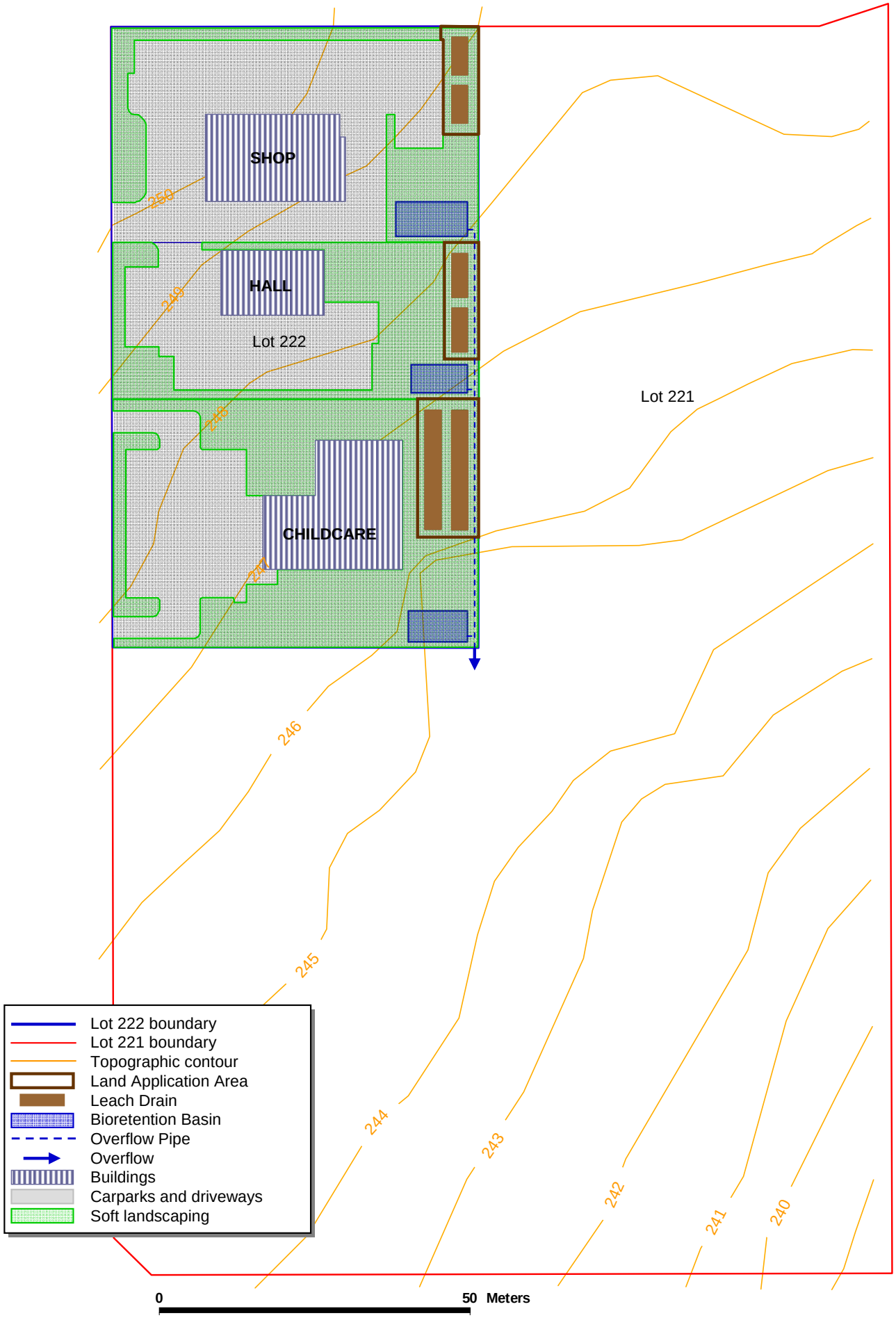


Figure 5

DRAINAGE AND EFFLUENT DISPOSAL

All elements shown are subject to detailed design

bayley environmental services

Appendix A

Soil Logs

SOIL PROFILE LOG

PROJECT NUMBER:	J20006
SITE ID:	GT1
EASTING:	415427
NORTHING:	6469863
METHOD:	8t excavator
TOTAL DEPTH (mbgl):	2.5
REFUSAL (Y/N):	N
DATE:	24/08/2021
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.1	Dark grey-brown topsoil		
0.1 - 0.7	Orange-brown gravelly loam		
0.7 - 2.5	Orange/red mottled well structured loamy clay with occasional lateritic stones		

SOIL PROFILE LOG

PROJECT NUMBER:	J20006
SITE ID:	GT2
EASTING:	415421
NORTHING:	6469855
METHOD:	8t excavator
TOTAL DEPTH (mbgl):	2.5
REFUSAL (Y/N):	N
DATE:	24/08/2021
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.2	Dark grey-brown topsoil		
0.2 - 0.7	Pale yellow-brown gravelly loam		
0.7 - 1.0	Orange clay-loam		
1.0 - 2.5	Pale yellow-brown well structured loamy clay with orange, red & white mottles		

SOIL PROFILE LOG

PROJECT NUMBER:	J20006
SITE ID:	GT3
EASTING:	415414
NORTHING:	6469867
METHOD:	8t excavator
TOTAL DEPTH (mbgl):	2.5
REFUSAL (Y/N):	N
DATE:	24/08/2021
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.15	Dark grey-brown topsoil		
0.15 - 0.5	Yellow-brown slightly gravelly loam		
0.5 - 1.0	Orange clay-loam		
1.0 - 2.5	Pale orange-yellow loamy clay with red & white mottles		

SOIL PROFILE LOG

PROJECT NUMBER:	J20006
SITE ID:	GT4
EASTING:	415403
NORTHING:	6469857
METHOD:	8t excavator
TOTAL DEPTH (mbgl):	2.5
REFUSAL (Y/N):	N
DATE:	24/08/2021
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.15	Dark grey-brown gravelly topsoil		
0.15 - 0.6	Yellow-brown gravelly loam		
0.6 - 0.9	Orange loamy clay		
0.9 - 2.5	Pale yellow-brown well-structured clay-loam with orange, red & white mottles		

SOIL PROFILE LOG

PROJECT NUMBER:	J20006
SITE ID:	GT5
EASTING:	415383
NORTHING:	6469855
METHOD:	8t excavator
TOTAL DEPTH (mbgl):	2.8
REFUSAL (Y/N):	N
DATE:	24/08/2021
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.1	Dark grey-brown topsoil		
0.1 - 0.6	Yellow-brown gravelly loam		
0.6 - 1.4	Orange clay-loam, slightly mottled		
1.4 - 2.8	Pale yellow-brown loamy clay, well structured with orange, white & red mottles		

SOIL PROFILE LOG

PROJECT NUMBER:	J20006
SITE ID:	GT6
EASTING:	415356
NORTHING:	6469862
METHOD:	8t excavator
TOTAL DEPTH (mbgl):	2.5
REFUSAL (Y/N):	N
DATE:	24/08/2021
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.15	Dark grey-brown gravelly topsoil		
0.15 - 0.6	Pale yellow-brown gravelly loam with occasional laterite cobbles to 200mm		
0.6 - 1.8	Orange gravelly loamy clay with red mottles		
1.8 - 2.5	Pale yellow-brown loamy clay with red, white & orange mottles		

SOIL PROFILE LOG

PROJECT NUMBER:	J20006
SITE ID:	GT7
EASTING:	415369
NORTHING:	6469851
METHOD:	8t excavator
TOTAL DEPTH (mbgl):	2.5
REFUSAL (Y/N):	N
DATE:	24/08/2021
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.15	Dark grey-brown topsoil		
0.15 - 1.0	Pale yellow-brown gravelly loam with occasional laterite cobbles to 300mm		
1.0 - 2.5	Orange loamy clay with red & white mottles		

SOIL PROFILE LOG

PROJECT NUMBER:	J20006
SITE ID:	GT8
EASTING:	415358
NORTHING:	6469783
METHOD:	8t excavator
TOTAL DEPTH (mbgl):	2.5
REFUSAL (Y/N):	N
DATE:	24/08/2021
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.1	Dark brown topsoil		
0.1 - 0.6	Brown gravelly loam		
0.6 - 1.9	Orange gravelly loamy clay with occasional red mottles		
1.9 - 2.5	Pale yellow-brown loamy clay with occasional red mottles		

SOIL PROFILE LOG

PROJECT NUMBER:	J20006
SITE ID:	GT9
EASTING:	415361
NORTHING:	6469797
METHOD:	8t excavator
TOTAL DEPTH (mbgl):	2.8
REFUSAL (Y/N):	N
DATE:	24/08/2021
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.15	Dark grey-brown topsoil with laterite outcrop at surface		
0.15 - 0.8	Pale yellow-brown gravelly loam with frequent large laterite boulders to 1m		
0.8 - 2.8	Orange-brown gravelly clay-loam, well structured with occasional white mottles		

SOIL PROFILE LOG

PROJECT NUMBER:	J20006
SITE ID:	GT10
EASTING:	415423
NORTHING:	6469690
METHOD:	8t excavator
TOTAL DEPTH (mbgl):	2.1
REFUSAL (Y/N):	N
DATE:	24/08/2021
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.15	Dark grey-brown topsoil		
0.15 - 0.6	Yellow-brown sandy, slightly gravelly loam		
0.6 - 1.4	Orange gravelly clay-loam		
1.4 - 2.1	Pale yellow-brown sandy to loamy clay with red & white mottles		

SOIL PROFILE LOG

PROJECT NUMBER:	J20006
SITE ID:	GT11
EASTING:	415438
NORTHING:	6469681
METHOD:	8t excavator
TOTAL DEPTH (mbgl):	1.9
REFUSAL (Y/N):	N
DATE:	24/08/2021
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.2	Dark grey-brown topsoil		
0.2 - 0.6	Yellow-brown gravelly loam		
0.6 - 1.3	Orange slightly mottled loamy clay		
1.3 - 1.9	Pale yellow-brown loamy clay with red & white mottles.		

SOIL PROFILE LOG

PROJECT NUMBER:	J20006
SITE ID:	GT12
EASTING:	415425
NORTHING:	6469699
METHOD:	8t excavator
TOTAL DEPTH (mbgl):	2.0
REFUSAL (Y/N):	N
DATE:	24/08/2021
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.2	Grey-brown topsoil		
0.2 - 0.8	Pale yellow-brown gravelly loam		
0.8 - 1.5	Orange clay-loam with occasional red mottles		
1.5 - 2.0	Red, white & orange mottled well structured loamy clay		

Appendix A: Soil profiles

STRUCterre consulting engineers

Project Lot 20 Hardey Street, Glen Forrest
Client

Test No. **BH01**

Project No.	D221884	**Logged By**	Luke Young	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J331254	**Date**	20/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:					
		SC: Clayey SAND: fine to medium grained, low plasticity, trace gravel, brown	MD	0.5 - 1.0	T	M	
		CH: Sandy CLAY: low plasticity, trace gravel, brown	VSt			D to M	
1		Terminated at 1.10 m					
2							
3							

Remarks
1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability: Hole stable
3. Samples taken: As indicated
4. Co-ordinate system: WGS 84

STRUCterre consulting engineers

Project Lot 20 Hardey Street, Glen Forrest

Client

Test No. **BH02**

Project No.	D221884	**Logged By**	Luke Young	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J331254	**Date**	20/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	Samples		Moisture	Water Level
				Depth	Type		
		Topsoil:					
		CH: Sandy CLAY: low plasticity, trace gravel, brown	VSt			D to M	
		Terminated at 0.50 m					
1							
2							
3							

Remarks

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

STRUCterre consulting engineers

Project Lot 20 Hardey Street, Glen Forrest

Client

Test No. **BH03**

Project No.	D221884	**Logged By**	Luke Young	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J331254	**Date**	20/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:					
		SC: Clayey SAND: fine to medium grained, low plasticity, with gravel, brown	L - MD	0.2 - 0.7	T		
			D				
		Terminated at 0.70 m					
1							
2							
3							

Remarks
1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability: Hole stable
3. Samples taken: As indicated
4. Co-ordinate system: WGS 84

STRUCterre consulting engineers

Project Lot 20 Hardey Street, Glen Forrest

Client

Test No. **BH04**

Project No.	D221884	**Logged By**	Luke Young	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J331254	**Date**	20/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	Samples		Moisture	Water Level
				Depth	Type		
		Topsoil:					
		SC: Clayey SAND: fine to medium grained, low plasticity, brown	L - MD				
		CH: Sandy CLAY: low plasticity, brown	F	1.5 - 2.5	T	M	
1							
		CH: Sandy CLAY: low plasticity, trace gravel, pale brown					
2							
		Terminated at 2.50 m				D to M	
3							

Remarks
1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: As indicated
4. Co-ordinate system: WGS 84

STRUCterre consulting engineers

Project Lot 20 Hardey Street, Glen Forrest

Client

Test No. **BH05**

Project No.	D221884	**Logged By**	Luke Young	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J331254	**Date**	20/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	Samples		Moisture	Water Level
				Depth	Type		
		Topsoil:					
		SC: Clayey SAND: low plasticity, with gravel, brown (Laterite)					
		GP: Sandy GRAVEL: low plasticity, with clay, brown (Laterite)					
1			L-MD				
2							
		Terminated at 2.50 m				D to M	
3							

Remarks
1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

STRUCterre consulting engineers

Project Lot 20 Hardey Street, Glen Forrest

Client

Test No. **BH06**

Project No.	D221884	**Logged By**	Luke Young	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J331254	**Date**	20/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	Samples		Moisture	Water Level
				Depth	Type		
		Topsoil:					
		SC: Clayey SAND: low plasticity, with gravel, brown (Laterite)					
		GP: Sandy GRAVEL: low plasticity, with clay, brown (Laterite)					
1			L-MD				
2						D to M	
		Terminated at 2.50 m					
3							

Remarks
1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

STRUCterre consulting engineers

Project Lot 20 Hardey Street, Glen Forrest

Client

Test No. **BH07**

Project No.	D221884	**Logged By**	Luke Young	**Machine**	Soil Retrieval Probe	**Easting**	
Job No.	J331254	**Date**	20/08/2019	**Hole Dia.**	65mm	**Northing**	

Depth	Graphic	Stratum Description	Consistency	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:					
		SC: Clayey SAND: fine to medium grained, low plasticity, trace silt, brown (Laterite)	L				
1			MD - D			M to W	
2		Terminated at 2.10 m				D to M	
3							

Remarks
1. Termination reason: Target depth
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84

Appendix B

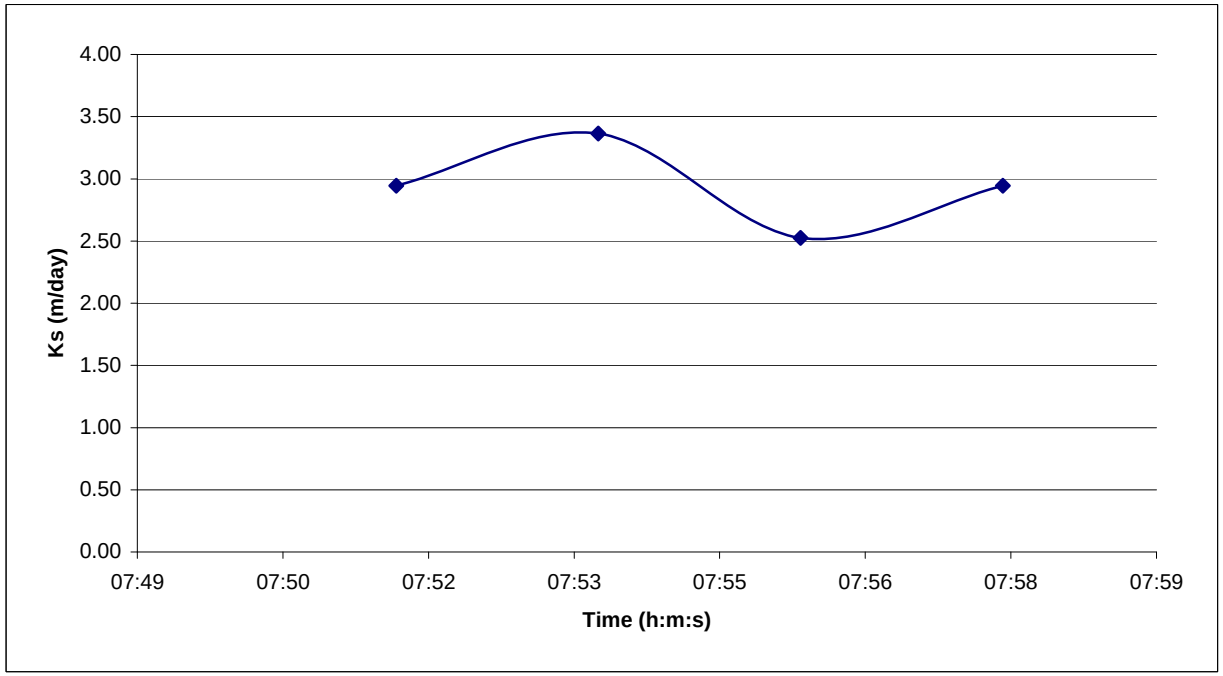
Permeability Test Results

SOIL PERMEABILITY TEST

Site No.	GI1
Date	14/09/21
Easting	415425
Northing	6469863
Depth	0.5

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
07:50:00	41.6		
07:52:00	40.9	0.7	**2.94**
07:54:00	40.1	0.8	**3.37**
07:56:00	39.5	0.6	**2.52**
07:58:00	38.8	0.7	**2.94**
		38.8	

H =	25
r =	**4.5**



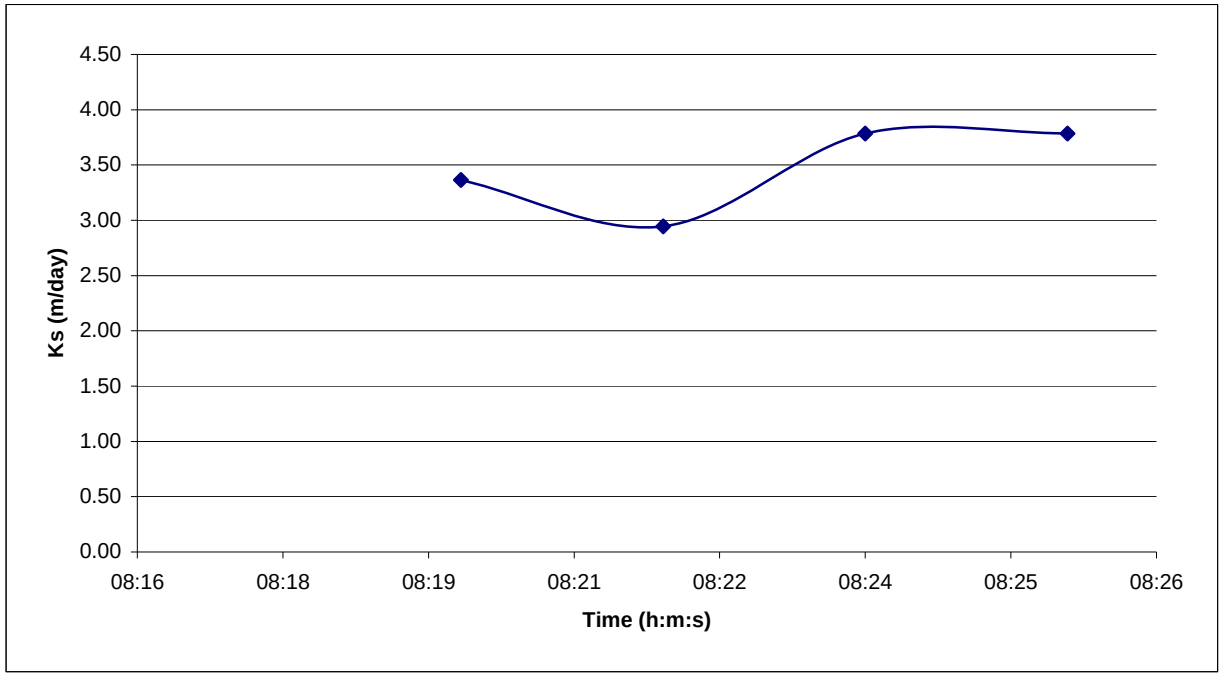
Ks = 3 m/day

SOIL PERMEABILITY TEST

Site No.	GI2
Date	14/09/21
Easting	415405
Northing	6469860
Depth	0.5

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
08:18:00	35.1		
08:20:00	34.3	0.8	**3.37**
08:22:00	33.6	0.7	**2.94**
08:24:00	32.7	0.9	**3.79**
08:26:00	31.8	0.9	**3.79**
		31.8	

H =	25
r =	**4.5**



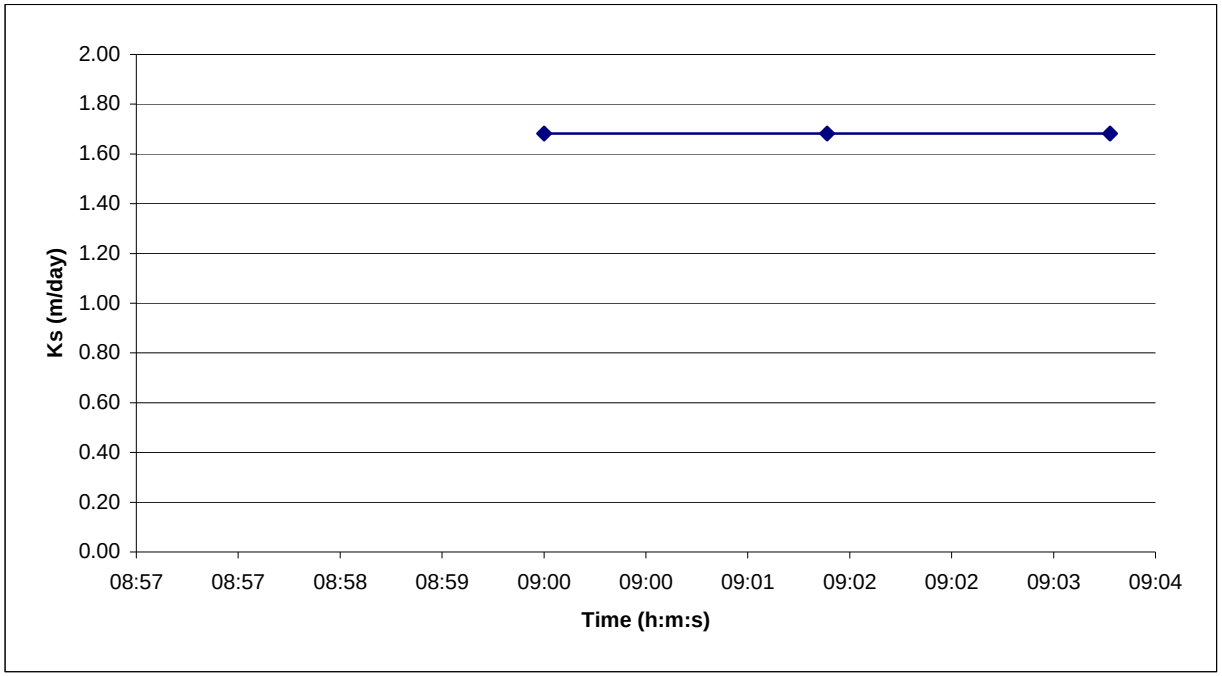
Ks = 3.5 m/day

SOIL PERMEABILITY TEST

Site No.	GI3
Date	14/09/21
Easting	415382
Northing	6469859
Depth	0.5

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
08:58:00	25.1		
09:00:00	24.7	0.4	**1.68**
09:02:00	24.3	0.4	**1.68**
09:04:00	23.9	0.4	**1.68**
		23.9	

H =	25
r =	**4.5**



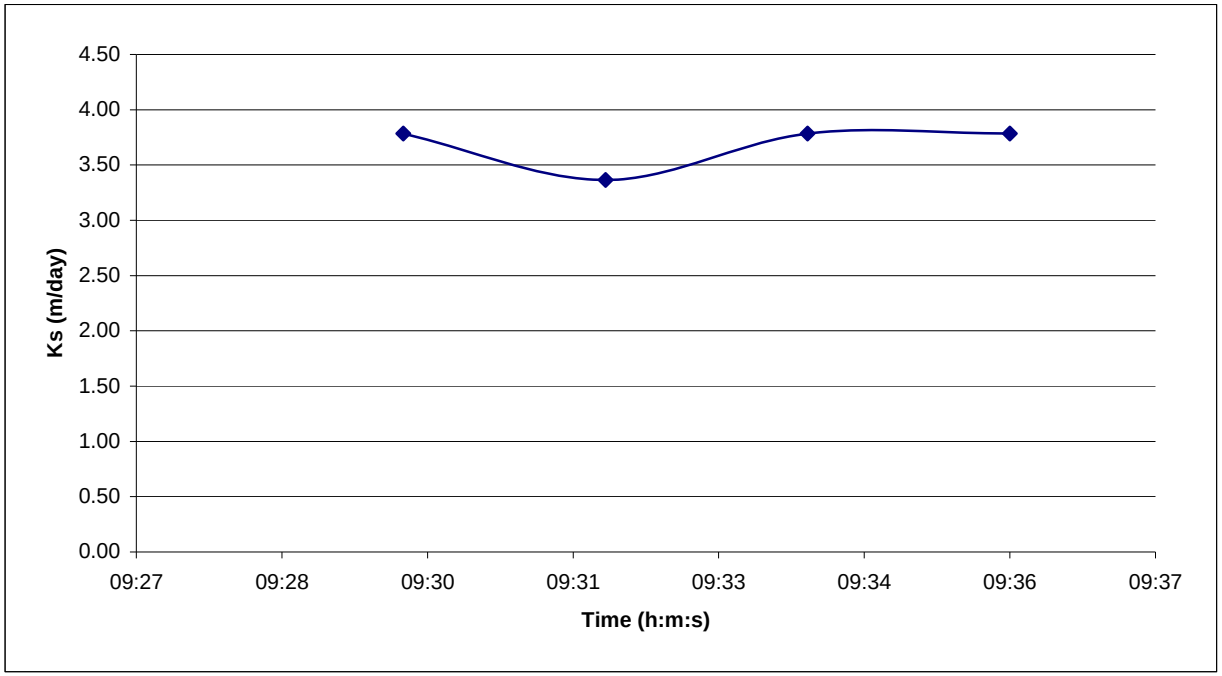
Ks = 1.7 m/day

SOIL PERMEABILITY TEST

Site No.	GI4
Date	14/09/21
Easting	415363
Northing	6469865
Depth	0.5

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
09:28:00	21.3		
09:30:00	20.4	0.9	**3.79**
09:32:00	19.6	0.8	**3.37**
09:34:00	18.7	0.9	**3.79**
09:36:00	17.8	0.9	**3.79**
		17.8	

H =	25
r =	**4.5**



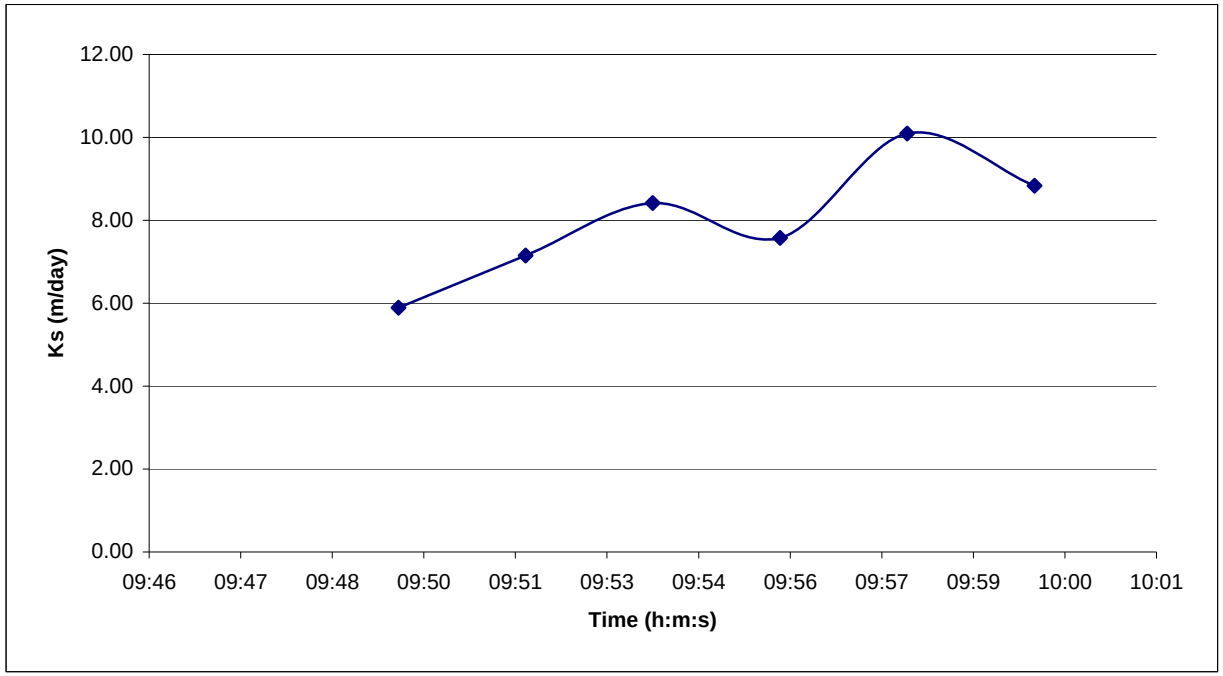
Ks = 3.7 m/day

SOIL PERMEABILITY TEST

Site No.	GI5
Date	14/09/21
Easting	415364
Northing	6469852
Depth	0.5

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
09:48:00	43		
09:50:00	41.6	1.4	**5.89**
09:52:00	39.9	1.7	**7.15**
09:54:00	37.9	2	**8.41**
09:56:00	36.1	1.8	**7.57**
09:58:00	33.7	2.4	**10.10**
10:00:00	31.6	2.1	**8.83**
		31.6	

H =	25
r =	**4.5**



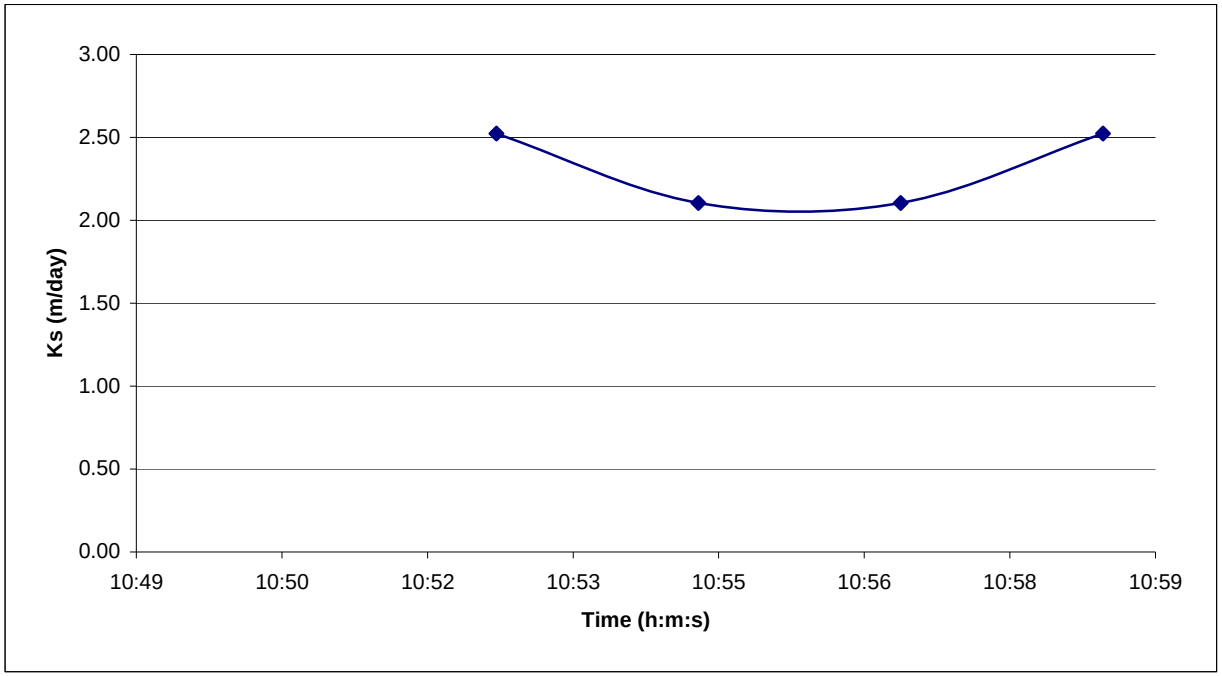
Ks = 8 m/day

SOIL PERMEABILITY TEST

Site No.	GI6
Date	14/09/21
Easting	415359
Northing	6469795
Depth	0.4

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
10:51:00	27.4		
10:53:00	26.8	0.6	**2.52**
10:55:00	26.3	0.5	**2.10**
10:57:00	25.8	0.5	**2.10**
10:59:00	25.2	0.6	**2.52**
		25.2	

H =	25
r =	**4.5**



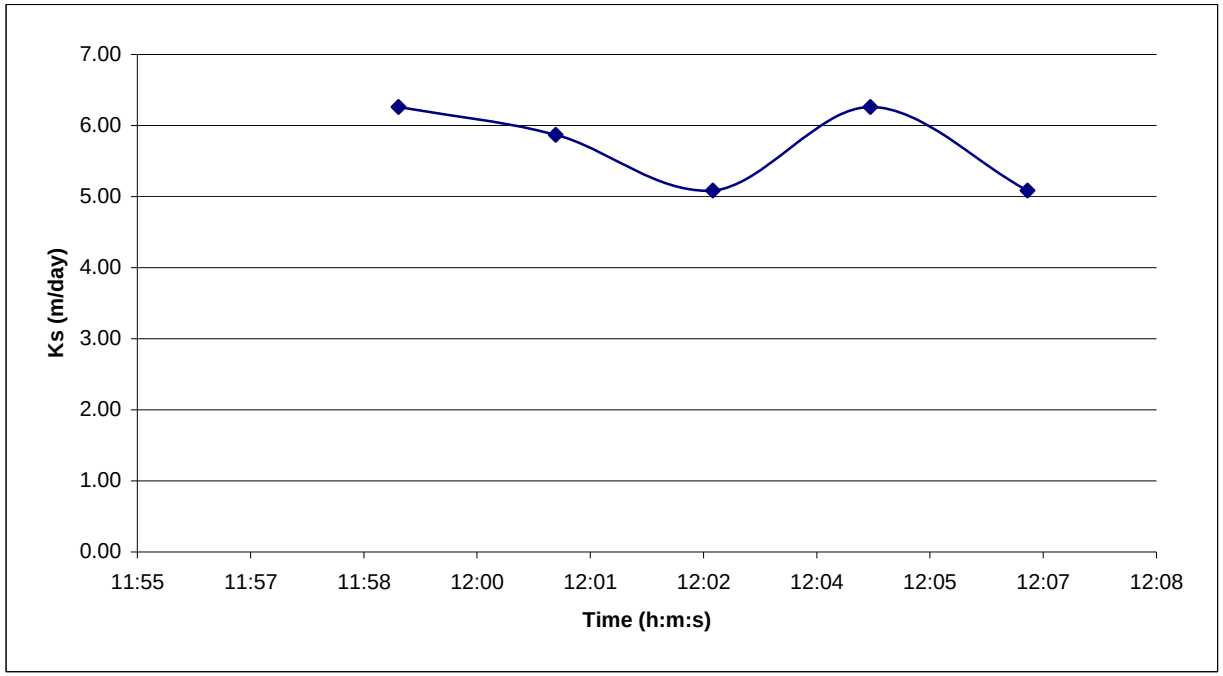
Ks = 2.3 m/day

SOIL PERMEABILITY TEST

Site No.	GI7
Date	14/09/21
Easting	415425
Northing	6469711
Depth	0.4

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
11:57:00	20.6		
11:59:00	19	1.6	**6.26**
12:01:00	17.5	1.5	**5.87**
12:03:00	16.2	1.3	**5.09**
12:05:00	14.6	1.6	**6.26**
12:07:00	13.3	1.3	**5.09**
		13.3	

H =	25
r =	**5**



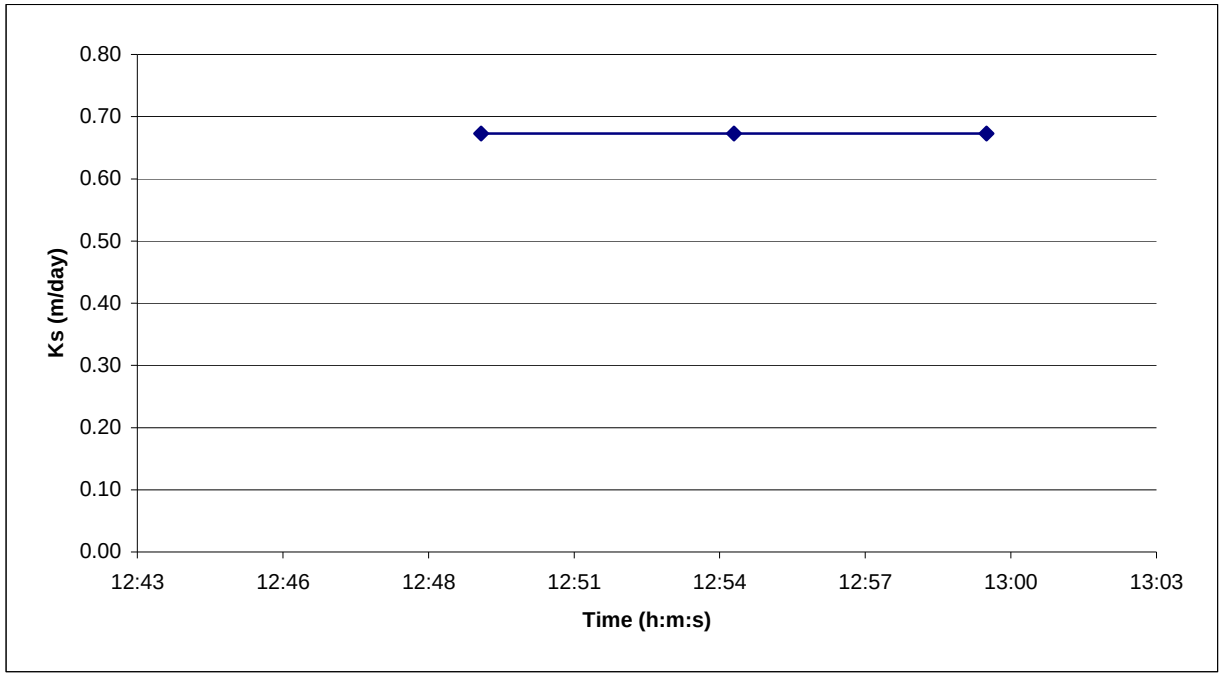
Ks = 5.5 m/day

SOIL PERMEABILITY TEST

Site No.	GI8
Date	14/09/21
Easting	415423
Northing	6469693
Depth	1

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
12:45:00	40.8		
12:50:00	40.4	0.4	**0.67**
12:55:00	40	0.4	**0.67**
13:00:00	39.6	0.4	**0.67**
		39.6	

H =	25
r =	**4.5**



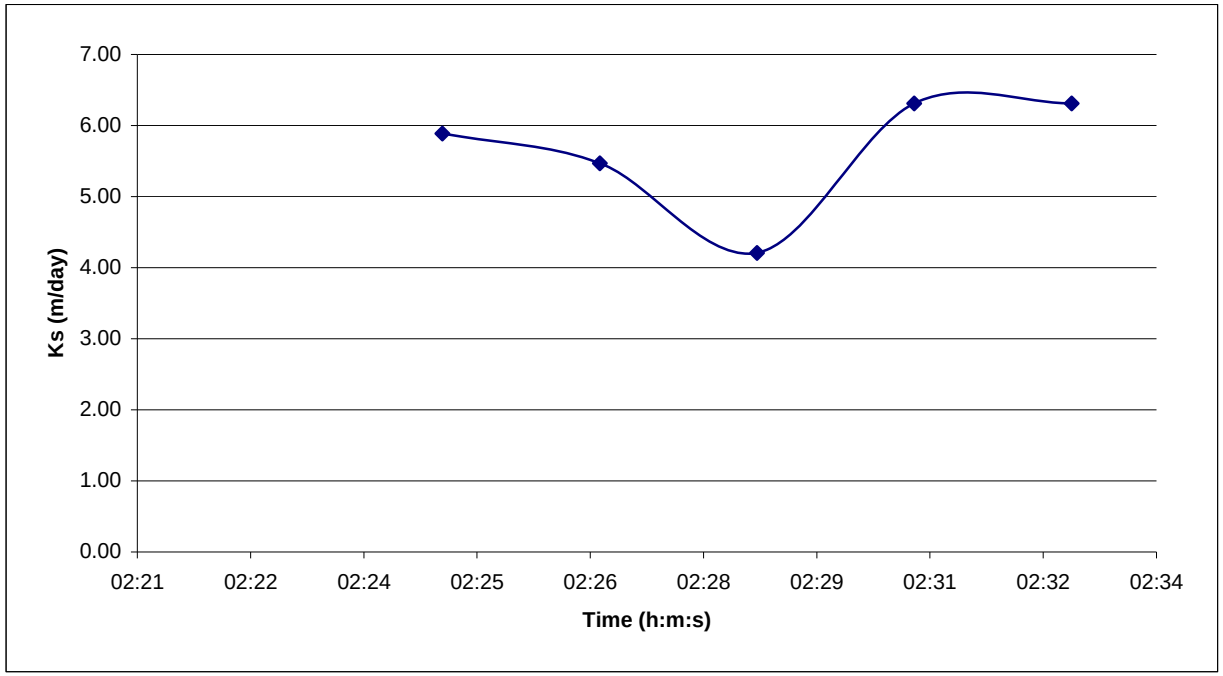
Ks = 0.7 m/day

SOIL PERMEABILITY TEST

Site No.	GI9s
Date	14/09/21
Easting	415423
Northing	6469690
Depth	0.5

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
02:23:00	25		
02:25:00	23.6	1.4	**5.89**
02:27:00	22.3	1.3	**5.47**
02:29:00	21.3	1	**4.21**
02:31:00	19.8	1.5	**6.31**
02:33:00	18.3	1.5	**6.31**
		18.3	

H =	25
r =	**4.5**



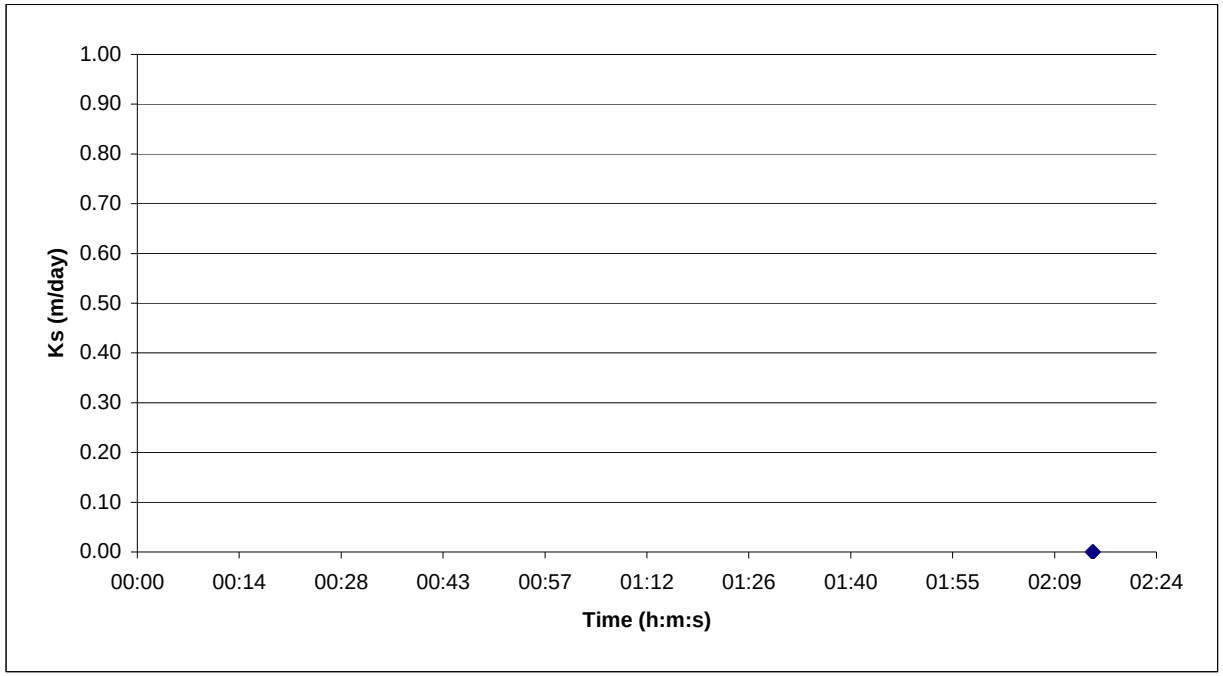
Ks = 5.5 m/day

SOIL PERMEABILITY TEST

Site No.	GI9d
Date	14/09/21
Easting	415423
Northing	6469690
Depth	1

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
01:15:00	35		
02:15:00	35	35	

H =	25
r =	**4.5**



Ks = **0 m/day**

Appendix C

Effluent Generation and System Sizing

EFFLUENT GENERATION AND SYSTEM SIZING - SHOP

	Population		Effluent lpd			
					0	
Staff	**3**		**70**		210	
Customers	**20**		**10**		200	
	0				0	
Daily flow					**410**	=R 3.7037
Total site area	**0.205**	ha				

SEPTIC TANK SIZING

Reserve capacity	1820
Daily flow	410
Total capacity	2230

FLATBED LEACH DRAIN SIZING - WITH SEPTIC

DLR	**15**	mm/day										
Infiltrative area required	27.3	m2										
Leach drain infiltrative width	2.4	m										
Leach drain external width	2.5	m										
Effluent per m	36	litres/day										
Length of LD required	11	m	(	0.9	x	12.5	m or	2	x	5.7		m)
Total width - parallel (including boundary setbacks)	10.4	m										
Total area - parallel (including boundary setbacks)	97	m2										

IRRIGATION AREA SIZING

DIR	3.5	mm/day
Area required	117	m2

FLATBED LEACH DRAIN SIZING - WITH ATU

DLR	**30**	mm/day										
Infiltrative area required	13.7	m2										
Leach drain infiltrative width	2.4	m										
Leach drain external width	2.5	m										
Effluent per m	72	litres/day										
Length of LD required	6	m	(	1.0	x	10	m or	2.0	x	2.8		m)
Total width - parallel (excluding boundary setbacks)	6.8	m										
Total area - parallel (excluding boundary setbacks)	19	m2										

CONVENTIONAL LEACH DRAIN SIZING - WITH SEPTIC

DLR	**15**	mm/day										
Infiltrative area required	27.3	m2										
Leach drain infiltrative width	0.4	m										
Leach drain external width	0.6	m										
Effluent per m	6	litres/day										
Length of LD required	68	m	(	5.5	x	12.5	m or	6.0	x	11.4		m)
Total width - parallel (including boundary setbacks)	16.2	m										
Total area - parallel (including boundary setbacks)	233	m2										

CONVENTIONAL LEACH DRAIN SIZING - WITH ATU

DLR	**30**	mm/day										
Infiltrative area required	13.7	m2										
Leach drain infiltrative width	0.4	m										
Leach drain external width	0.6	m										
Effluent per m	12	litres/day										
Length of LD required	34	m	(	2.7	x	12.5	m or	2.0	x	17.1		m)
Total width - parallel (excluding boundary setbacks)	3.0	m										
Total area - parallel (excluding boundary setbacks)	51	m2										

EFFLUENT GENERATION AND SYSTEM SIZING - HALL

	Population		Effluent lpd			
				0		
				0		
Occupants	**50**		**10**	500		
	0			0		
Daily flow				**500**	=R	6.1728
Total site area	**0.15**	ha				

SEPTIC TANK SIZING

Reserve capacity	1820
Daily flow	500
Total capacity	2320

FLATBED LEACH DRAIN SIZING - WITH SEPTIC

DLR	**15**	mm/day										
Infiltrative area required	33.3	m2										
Leach drain infiltrative width	2.4	m										
Leach drain external width	2.5	m										
Effluent per m	36	litres/day										
Length of LD required	14	m	(	1.1	x	12.5	m or	2	x	6.9		m)
Total width - parallel (including boundary setbacks)	10.4	m										
Total area - parallel (including boundary setbacks)	110	m2										

IRRIGATION AREA SIZING

DIR	3.5	mm/day
Area required	143	m2

FLATBED LEACH DRAIN SIZING - WITH ATU

DLR	**30**	mm/day										
Infiltrative area required	16.7	m2										
Leach drain infiltrative width	2.4	m										
Leach drain external width	2.5	m										
Effluent per m	72	litres/day										
Length of LD required	7	m	(	1.0	x	10	m or	2.0	x	3.5		m)
Total width - parallel (excluding boundary setbacks)	6.8	m										
Total area - parallel (excluding boundary setbacks)	24	m2										

CONVENTIONAL LEACH DRAIN SIZING - WITH SEPTIC

DLR	**15**	mm/day										
Infiltrative area required	33.3	m2										
Leach drain infiltrative width	0.4	m										
Leach drain external width	0.6	m										
Effluent per m	6	litres/day										
Length of LD required	83	m	(	6.7	x	12.5	m or	6.0	x	13.9		m)
Total width - parallel (including boundary setbacks)	16.2	m										
Total area - parallel (including boundary setbacks)	274	m2										

CONVENTIONAL LEACH DRAIN SIZING - WITH ATU

DLR	**30**	mm/day										
Infiltrative area required	16.7	m2										
Leach drain infiltrative width	0.4	m										
Leach drain external width	0.6	m										
Effluent per m	12	litres/day										
Length of LD required	42	m	(	3.3	x	12.5	m or	2.0	x	20.8		m)
Total width - parallel (excluding boundary setbacks)	3.0	m										
Total area - parallel (excluding boundary setbacks)	63	m2										

EFFLUENT GENERATION AND SYSTEM SIZING - CHILDCARE

	Population		Effluent lpd			
				0		
Children	**46**		**45**	2070		
Staff	**10**		**70**	700		
	0			0		
Daily flow				**2770**	=R	21.828
Total site area	**0.235**	ha				

SEPTIC TANK SIZING

Reserve capacity	1820
Daily flow	2770
Total capacity	4590

FLATBED LEACH DRAIN SIZING - WITH SEPTIC

DLR	**15**	mm/day									
Infiltrative area required	184.7	m2									
Leach drain infiltrative width	2.4	m									
Leach drain external width	2.5	m									
Effluent per m	36.0	litres/day									
Length of LD required	77	m	(	6.2	x	12.5	m or	2	x	38.5	m)
Total width - parallel (including boundary setbacks)	10.4	m									
Total area - parallel (including boundary setbacks)	438	m2									

IRRIGATION AREA SIZING

DIR	3.5	mm/day
Area required	791	m2

FLATBED LEACH DRAIN SIZING - WITH ATU

DLR	**30**	mm/day									
Infiltrative area required	92.3	m2									
Leach drain infiltrative width	2.4	m									
Leach drain external width	2.5	m									
Effluent per m	72.0	litres/day									
Length of LD required	38	m	(	4.0	x	10	m or	2.0	x	19.2	m)
Total width - parallel (excluding boundary setbacks)	6.8	m									
Total area - parallel (excluding boundary setbacks)	131	m2									

CONVENTIONAL LEACH DRAIN SIZING - WITH SEPTIC

DLR	**15**	mm/day									
Infiltrative area required	184.7	m2									
Leach drain infiltrative width	0.4	m									
Leach drain external width	0.6	m									
Effluent per m	6.0	litres/day									
Length of LD required	462	m	(	36.9	x	12.5	m or	6.0	x	76.9	m)
Total width - parallel (including boundary setbacks)	16.2	m									
Total area - parallel (including boundary setbacks)	1295	m2									

CONVENTIONAL LEACH DRAIN SIZING - WITH ATU

DLR	**30**	mm/day									
Infiltrative area required	92.3	m2									
Leach drain infiltrative width	0.4	m									
Leach drain external width	0.6	m									
Effluent per m	12.0	litres/day									
Length of LD required	231	m	(	18.5	x	12.5	m or	2.0	x	115.4	m)
Total width - parallel (excluding boundary setbacks)	3.0	m									
Total area - parallel (excluding boundary setbacks)	346	m2									

Appendix D

Water Balance

WATER BALANCE

Parameters

Irrigation area =	427	m2
Winter rain (May-Sep) =	0.846	m
Summer rain (Oct-Apr) =	0.248	m
1-day rain (Jan 2018) =	0.139	m
7-day rain =	0.139	m
Winter evap (May-Sep) =	0.345	m
1-day evap (Jan) =	0.0084	m
7-day evap (winter) =	0.0158	m
Summer extreme rain (Nov 2020) =	0.169	m/month
Winter extreme rain (July 2021) =	0.459	m/month
Summer evap (Oct-Apr) =	1.381	m
November evap =	0.195	m
July evap =	0.053	m
Slope =	0.06	
Ksoil =	3.5	m/day (average measured value)
Ksubsoil (summer) =	0.1	m/day (nominal)
Ksubsoil (winter) =	0.1	m/day
Effluent Volume =	2.875	m3/day
Soil depth =	1	m
Soil porosity =	0.46	
Rainfall recharge coefficient =	100	%

Notes

Rainfall data are from Bickley
Evaporation data are from Medina

Water Balance Calculations

Summer	Rain + effluent - evap =	-0.32
(Dec-Mar)	Deep inf capacity =	12.13
Winter	Rain + effluent - evap =	1.53
(May-Sep)	Deep inf capacity =	15.30
	Lat flow =	16.83
1-day	Rain + effluent - evap =	0.14
extreme	Deep inf capacity =	0.10
(Nov 2020)	Storage capacity =	0.46
	Lat flow capacity =	0.11
	DI + Storage =	0.56
	DI + Storage + Lat flow =	0.77
7-day	Rain + effluent - evap =	0.17
extreme	Deep inf capacity =	0.70
(winter)	Storage capacity =	0.46
	Lat flow capacity =	0.77
	DI + Storage =	1.16
	DI + storage + lat flow =	2.63
Summer	Rain + effluent - evap =	0.18
extreme	Deep inf capacity =	3.10
(Nov 2020)	Lat flow capacity =	2.83
Winter	Rain + effluent - evap =	0.61
extreme	Deep inf capacity =	3.10
(July 2021)	Lat flow capacity =	3.20
	DI + lat flow =	9.30

Appendix E

Runoff Calculations

1 YEAR ARI 1 HOUR FLOWS - POST DEVELOPMENT

Rainfall Intensity i (mm/h)	15	Minor storm
Cr Roof	0.95	
Cr Carpark	0.8	
Cr OS	0	
Cr Basin	1	
Permeability k (m/hr)	0.0833	

Catchment	Roof	Carpark	OS	Basin	Total	Ai	Q (L/s)	Vinflow (m3)
Shop	313	1175	499	63	2050	1301	5.42	19.5
Hall	175	577	708	41	1500	668	2.79	10.0
Childcare	394	588	1321	48	2350	892	3.72	13.4

Basin Sizing

	Storm Event	Depth	Side Slopes (1:x)	No. Basins	Base Width	Base Length	Top Width (m)	Top Length (m)	Volume	Effective Volume	Surface Area (m2)	Volume check	5yr Volume check	100yr Volume check
Shop	15mm	0.5	4	1	**1.5**	**7.5**	5.5	11.5	16.9	19.7	63	ok	ok	ok
Hall	15mm	0.5	4	1	**0.5**	**5**	4.5	9.0	8.8	10.3	41	ok	ok	ok
Childcare	15mm	0.5	4	1	**1**	**5.5**	5.0	9.5	11.5	13.4	48	ok	ok	ok

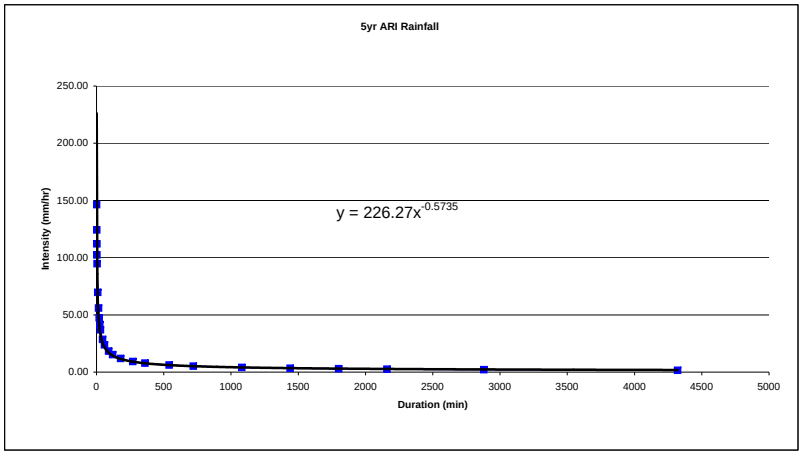
5 YEAR ARI CRITICAL FLOWS - PRE & POST DEVELOPMENT

CATCHMENT	AREAS (m2)					EFFECTIVE AREAS (m2)		TIME OF CONCENTRATION PRE DEVELOPMENT					TIME OF CONCENTRATION POST-DEVELOPMENT					CRITICAL STORM INTENSITY (mm/h)		FLOW			STORAGE				
	Roof	Carpark	OS	Basin	Total	Pre	Post	Longest Path (m)	RL Top (mAHD)	RL Bottom (mAHD)	Slope (m/km)	TC (mln)	Longest Path (m)	RL Top (mAHD)	RL Bottom (mAHD)	Slope	TC (mln)	Pre-Dev	Post-Dev	Pre Dev	Post Dev	Total Flow (m3)	Storage Req (m3)	Effective Storage (m3)	Volume Check	Water Depth (m)	Overflow (m3)
Shop	313	1175	499	63	2050	410	1534	55	250.5	248.5	36.36	5.0	55	250.5	248.5	36.36	5.0	89.9	89.9	10.24	38.30	11.49	6.17	17.10	ok	0.24	0.00
Hall	175	577	708	41	1500	300	876	52	250.5	247.5	57.69	5.0	52	250.5	247.5	57.69	5.0	89.9	89.9	7.49	21.87	6.56	2.84	8.97	ok	0.26	0.00
Childcare	394	588	1321	48	2350	470	1234	59	250.5	245.8	79.66	5.0	59	250.5	245.8	79.66	5.0	89.9	89.9	11.74	30.83	9.25	3.55	11.69	ok	0.24	0.00

Runoff Coefficients	Pre-Dev	Post-Dev
Cr Roof	0.2	1
Cr Carpark	0.2	0.9
Cr OS	0.2	0.2
Cr Basin	0.2	1

Rainfall IFD

Event	Duration (mins)	Intensity (mm/hr)	Event Rainfall (mm)
1 min	1	146.40	2.44
2 min	2	124.20	4.14
3 min	3	112.00	5.6
4 min	4	102.45	6.83
5 min	5	94.68	7.89
10 min	10	69.60	11.6
15 min	15	56.00	14
20 min	20	47.40	15.8
25 min	25	41.52	17.3
30 min	30	37.00	18.5
45 min	45	28.53	21.4
1 hr	60	23.80	23.8
1.5 hr	90	18.33	27.5
2 hr	120	15.30	30.6
3 hr	180	11.90	35.7
4.5 hr	270	9.29	41.8
6 hr	360	7.82	46.9
9 hr	540	6.13	55.2
12 hr	720	5.16	61.9
18 hr	1080	4.01	72.2
24 hr	1440	3.34	80.2
30 hr	1800	2.89	86.7
36 hr	2160	2.56	92.2
48 hr	2880	2.10	101
72 hr	4320	1.60	115



100 YEAR ARI CRITICAL FLOWS - PRE & POST DEVELOPMENT

CATCHMENT	AREAS (m2)				EFFECTIVE AREAS (m2)	TIME OF CONCENTRATION PRE DEVELOPMENT							TIME OF CONCENTRATION POST-DEVELOPMENT					CRITICAL STORM INTENSITY (mm/h)		FLOW		STORAGE					
	Roof	Carpark	OS	Basin	Total	Pre	Post	Longest Path (m)	RL Top (mAHD)	RL Bottom (mAHD)	Slope (m/km)	TC (mln)	Longest Path (m)	RL Top (mAHD)	RL Bottom (mAHD)	Slope	TC (mln)	Pre-Dev	Post-Dev	Pre Dev	Post Dev	Total Flow (m3)	Storage Req (m3)	Effective Storage (m3)	Volume Check	Water Depth (m)	Overflow (m3)
Shop	313	1175	499	63	2050	615	1701	55	250.5	248.5	36.36	5.0	55	250.5	248.5	36.36	5.0	159.3	159.3	27.21	75.24	22.57	9.20	18.27	ok	0.3	0.00
Hall	175	577	708	41	1500	450	1004	52	250.5	247.5	57.69	5.0	52	250.5	247.5	57.69	5.0	159.3	159.3	19.91	44.43	13.33	4.06	9.58	ok	0.3	0.00
Childcare	394	588	1321	48	2350	705	1425	59	250.5	245.8	79.66	5.0	59	250.5	245.8	79.66	5.0	159.3	159.3	31.19	63.05	18.92	4.83	12.49	ok	0.27	0.00

Runoff Coefficients	Pre-Dev	Post-Dev
Roof	0.3	1
Carpark	0.3	1
Cr OS	0.3	0.3
Cr Basin	0.3	1

Rainfall IFD

Event	Duration (mins)	Intensity (mm/hr)	Event Rainfall (mm)
1 min	1	259.20	4.32
2 min	2	214.80	7.16
3 min	3	195.60	9.78
4 min	4	180.00	12
5 min	5	168.00	14
10 min	10	123.60	20.6
15 min	15	99.20	24.8
20 min	20	83.70	27.9
25 min	25	72.96	30.4
30 min	30	65.00	32.5
45 min	45	50.40	37.8
1 hr	60	42.10	42.1
1.5 hr	90	32.93	49.4
2 hr	120	27.80	55.6
3 hr	180	22.10	66.3
4.5 hr	270	17.67	79.5
6 hr	360	15.07	90.4
9 hr	540	11.89	107
12 hr	720	10.00	120
18 hr	1080	7.72	139
24 hr	1440	6.29	151
30 hr	1800	5.30	159
36 hr	2160	4.61	166
48 hr	2880	3.65	175
72 hr	4320	2.63	189