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WATER



LOCAL WATER MANAGEMENT STRATEGY

Lot 39 Lakes Road, North Dandalup

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Executive Summary

Valley Holdings WA Pty Ltd are progressing the development of Lot 39 Lakes Road, North Dandalup located within the Shire of Murray as rural residential development. The site is currently zoned 'Rural' and Valley Holdings WA Pty Ltd are seeking this to be zoned as 'Special Rural' through an amendment to the Local Planning Scheme.

This Local Water Management Strategy (LWMS) has been prepared to support rezoning of the site. An inventory of the key elements for inclusion in the LWMS report, together with a cross-reference to the relevant sections in this document is presented in Table 1.

Table 1: Key LWMS items and details

Key LWMS items	Details
Introduction (Section 1)	The site, Lot 39 Lakes Road, North Dandalup, is within the Shire of Murray, covering an area of approximately 197 ha. Valley Holdings WA Pty Ltd are seeking approval to rezone the site from 'Rural', to 'Special Rural', through an amendment to the Local Planning Scheme to support future subdivision.
Climate (Section 2.2)	The site is characterised by a Mediterranean climate. Mean annual rainfall from the Karnet weather station (009111) is 1,121 mm/year. The site experiences monthly mean minimum temperatures between 6.4°C and 15.8°C, and monthly mean maximum temperatures between 15.5°C and 30.7°C.
Topography (Section 2.3)	Elevation of the site is very flat, with 2 m topographic contours ranging from 20 meters Australian Height Datum (m AHD) in the centre of the site, to a slight rise of 26 m AHD on the eastern side of the site
Geology (Section 2.4)	The majority of the site is mapped as Guildford clay Qpg. Areas in the west-south-west of the site underlying the North Dandalup River have been mapped as Qrw, and Bassendean Sands have been mapped on the eastern side of the site associated with the slight rise in topography as well as in the south of the site. The whole site has been mapped as having a "moderate to low risk" of ASS.
Groundwater (Section 2.7)	The site is underlain by the Perth - Superficial, Perth - Lower Leederville, and Perth Cattamarra Coal aquifers. Groundwater flow is in a south-westerly direction. Hydrographs from three nearby DWER bores screened in the Superficial Aquifer, show groundwater levels since August 2008 ranging from 20.06 m AHD to 22.81 m AHD, with a shallow depth to groundwater. On-site groundwater monitoring commenced in April 2025.
Surface hydrology (Section 2.8)	The site is located in the North Dandalup River catchment, which is a sub-catchment of the Murray River. The North Dandalup River and North Dandalup River Tributary run through the site in a north-east to south-west direction. Flood mapping across the site produced from the GHD (2010) modelling for the 1% AEP event ranges from 24.75 m AHD in the north-east of the site to 19.5 m AHD in the south-west of the site, with the floodplain extending over sections of the site.
Wetlands (Section 2.9)	The majority of the site has been mapped as a Multiple Use Wetland (MUW) (ID 15802, 6021, 6022, 6030, 6031). The North Dandalup River has been mapped as a Conservation Category Wetland (CCW) (ID 13313 and 6018).
Water Conservation (Section 4)	The use of water efficient fixtures and fittings within households will be promoted, to reduce household potable water use. A groundwater licence for POS irrigation is not expected to be required.



<p>Stormwater (Section 5)</p>	<p>management</p>	<p>The following design objectives and criteria are adopted in the stormwater management strategy and preliminary drainage design:</p> <ul style="list-style-type: none"> ▪ Manage stormwater quantity and quality with a water sensitive urban design approach which seeks to minimise drainage infrastructure and long-term maintenance requirements. ▪ Maintain pre-development peak flow rates from the site, to protect downstream properties and receiving watercourses from increased flood risk. ▪ Manage, retain and/or detain, and treat stormwater run-off from constructed impervious surfaces generated by the first 15 mm of rainfall at-source as much as practical. ▪ Habitable floor levels to be at least 0.3 m above the 1% AEP flood level of the urban drainage system and road reserve. ▪ Habitable floor levels to be at least 0.5 m above the 1% AEP flood level of the North Dandalup River and North Dandalup River Tributary. <p>The general approach for stormwater management at the site is to detain water in roadside swales/drains to pre-development discharge rates to the North Dandalup River.</p>
<p>Groundwater (Section 6)</p>	<p>management</p>	<p>Due to the site being developed as rural residential lots, no specific groundwater level management measures are proposed i.e. subsoils. Groundwater quality will primarily be managed through the stormwater drainage design and maintenance.</p>
<p>Monitoring (Section 8)</p>		<p>Pre-development monitoring commenced in April 2025. The post-development monitoring program will involve groundwater levels and water quality on a quarterly basis (with additional groundwater level monitoring to occur monthly over the period peak groundwater levels typically occur (June, August, September and November), and opportunistic monitoring of surface water levels and quality during the monitoring period.</p>
<p>Implementation (Section 9)</p>		<p>Details regarding the UWMP requirements, roles, and responsibilities related to water management have been provided.</p>



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1. Introduction

1.1. Project background

Valley Holdings WA Pty Ltd are progressing the development of Lot 39 Lakes Road, North Dandalup located within the Shire of Murray (the site). The site location is shown on Figure A. The site is proposed for rural residential development and a foreshore reserve associated with the North Dandalup River and North Dandalup River Tributary Creek,

This Local Water Management Strategy (LWMS) has been prepared to support the Scheme Amendment submission for the site.

1.2. Planning background and proposed structure plan

The site is currently zoned 'Rural', with the intent to rezone the land to 'Special Rural', through an amendment to the Local Planning Scheme to support future subdivision. The proposed concept layout is expected to comprise approximately 121 lots as well as road reserves and floodplain/ foreshore reserve area. The proposed concept layout is provided as Appendix A.

1.3. Previous water management planning

GHD (2010) produced the Floodplain Development Strategy (FDS), Murray drainage and water management plan and associated studies which included the subject site. Key criteria from these studies that relate to this LWMS include:

- Proposed development has an adequate level of flood protection.
- Proposed development does not detrimentally impact on the existing flooding regime of the general area.
- The public has adequate protection from flood hazard (e.g. flow depth and velocity, frequency and duration of overtopping of road crossings).
- Proposed development (i.e. filling, building, etc) that is located outside of the floodway is considered acceptable with respect to major flooding. However, a minimum habitable floor level of 0.50 m above the adjacent 1% AEP flood level is recommended to ensure adequate flood protection.
- Proposed development (i.e. filling, building, etc) that is located within the floodway and is considered obstructive to major flows is not acceptable as it would detrimentally impact on the existing flooding regime of the general area. No new dwellings are acceptable within the floodway.

1.4. Design objectives

This LWMS has been prepared in accordance with State Planning Policy 2.9: *Water Resources* (Government of Western Australia, 2007a) and has been developed with reference to the following guidance documents:

- Western Australia State Water Plan (Government of Western Australia, 2007b)
- Better Urban Water Management (Department of Planning and Infrastructure, 2008)
- Interim: Developing a Local Water Management Strategy (Department of Water, 2008)
- Stormwater Management Manual for Western Australia (Department of Water, 2004-2007) (Updated 2022)
- Floodplain development strategy, Murray drainage and water management plan and associated studies (GHD 2010)
- Water monitoring guidelines for better urban water management strategies and plans (Department of Water, 2012a)
- Operating Policy 4.3: Identifying and establishing waterways foreshore areas (Department of Water, 2012)
- Liveable Neighbourhoods (Western Australian Planning Commission, 2015)



- Decision Process for Stormwater Management in Western Australia (Department of Water and Environmental Regulation (DWER), 2017)
- Australian rainfall and runoff, a guide to flood estimation (Commonwealth of Australia, 2019).
- Draft State Planning Policy 2.9: Planning for Water (SPP 2.9) (WAPC, 2021).

These documents guide how stormwater will be managed in the development and influence the form and function of the public open space and the developable area.

The LWMS details the integrated water management strategies to facilitate future urban water management planning. The LWMS will achieve integrated water management through the following design objectives:

- Effectively manage the risk to human life, property damage and environmental degradation from water contamination, flooding, and waterlogging.
- Maintain and if possible, improve water quality (surface and groundwater) within the development in relation to pre-development water quality.
- Reduce potable water consumption within both public and private spaces using practical and cost-effective measures.
- Implement best management practices in regard to stormwater and groundwater management.
- Incorporate where possible, low maintenance, cost-effective landscaping, and stormwater treatment systems.
- Reduce the use of natural resources (e.g., sand fill) where possible.

1.5. Previous studies

Other studies completed for the site as part of the proposed amendment include:

- 1818 Lakes Road North Dandalup, determination of foreshore setback (Bayley Environmental Services 2025a)
- Lot A39 Lakes Road, North Dandalup, Land capability for on-site effluent disposal (Bayley Environmental Services 2025b)

The neighbouring lot to the east of the site has also recently undergone subdivision for rural residential lots and a number of reports were prepared as part of this approval process. These reports include:

- Lot 1 Lakes Road and Lot 2 Shanns Road North Dandalup, Local Water Management Strategy (Bayley Environmental Services 2020)
- Urban Water Management Plan Lot 1 Lakes Road – “Riverwood Estate” Stage 1 North Dandalup (DEC 2021)
- Geotechnical investigation, Lot 1 Lakes Road, North Dandalup WA (Structerre consulting 2021)
- Urban Water Management Plan, Lots 1 and 2 Lakes Road North Dandalup, WA (kctt 2023)



2. Existing environment

2.1. Site location and surrounding land use

The site is located in North Dandalup, within the Shire of Murray, covering an area of approximately 197 ha. The site has been used for grazing land and has been predominantly historically cleared of native vegetation, with sections of remnant vegetation associated with the river as well as fence lines.

The site is bounded by:

- Lakes Road to the north
- Agricultural grazing land which is proposed to be developed as special rural development as part of the Riverwood Estate to the east.
- Agricultural land to the south and west of the site
- Shanns Road to the south.

The site location is shown on Figure A.

2.2. Climate

North Dandalup experiences a Mediterranean climate with cool, wet winters and hot, dry summers. Climate data has been taken from the Karnet weather station (009111), which has data available since 1963 (BoM 2025). The highest mean maximum temperature is 30.7°C which has been recorded in January, and the lowest minimum temperature is 6.3°C which has been recorded in July. Mean annual rainfall is 1,121 mm/year. The monthly mean climatic data for rainfall and temperature is summarised in Table 2. As a comparison, Serpentine weather station (009039), with its similar relative location to the Darling Scarp compared to the site and long data set dating from 1905 has a mean annual rainfall from 1961 to 1990 of 899 mm. Average annual pan evaporation is between 1800 mm and 1600 mm. The closest BoM site which has evaporation data available is Medina.

Table 2: Monthly rainfall and temperature statistics from Karnet weather station (009111)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean rainfall (mm)	17.6	20.3	25.1	63.7	137.5	203.2	219.9	182.4	129.1	74.0	43.7	17.7	1121.0
Mean max temp (°C)	30.7	30.5	27.8	23.3	19.2	16.4	15.5	16.0	17.7	20.9	24.5	28.3	22.6
Mean min temp (°C)	15.4	15.9	14.4	11.9	9.1	7.3	6.3	6.4	7.3	9.0	11.4	13.6	10.7
Pan evaporative (mm)#	273	249	210	119	80	61	60	70	100	149	197	261	1829

Source: BoM 2025, Climate data online

From Medina station

2.3. Topography

The topography of the site has a slight gradient from the north-east to the south-west corner of the site towards the North Dandalup River. Based on supplied 2m topographic contours, elevations range across the site from 20 meters Australian Height Datum (m AHD) in the centre of the site, to a slight rise of 26 m AHD on the eastern side of the site (Figure B).

A site survey completed by Harley Dykstra (23/04/2025) identified the sites' topography to range from 18 m AHD associated with the North Dandalup River to 26 m AHD on the eastern side of the site.



2.4. Geology

2.4.1. Regional surface geology

Surface geology mapping by the Department of Agriculture (1989) indicates the site is characterised as Bassendean Sand overlying alluvial clays of the Guildford formation. The units have been described in greater detail below:

- **P1a** – flat to very gently undulating plain with deep acidic mottled yellow duplex soils. Shallow pale sand to sandy loam over clay, imperfect to poorly drained
- **P1b** – flat to very gently undulating plain with deep acidic mottled yellow duplex soils. Moderately deep pale sand to loamy sand over clay, imperfectly drained.
- **P8** – broad poorly drained flats and poorly drained stream channels with moderately deep to deep sands over mottled clays, acidic or less commonly alkaline grey and yellow duplex soils to uniform bleached or pale brown sands over clay.
- **P9** – shallowly incised stream channels of minor creeks and rivers with deep acidic mottled duplex soils.
- **B1** – extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands, sometimes with a pale yellow B horizon or a weak iron organic hardpan at depths generally greater than 2 m.
- **B2** – flat to very gently undulating sandplain with well to moderately well drained deep bleached grey sands with a pale yellow b horizon or a weak iron organic hardpan.

The Geological Survey of Western Australia mapping identified the following surface geology units across the site:

- Guildford clay (Qpg) – alluvium (clay, loam sand and gravel)
- Bassendean Sand (Qpb) – quartz sand (dunes)
- Swamp and lacustrine deposits (Qrw) – peat, peaty sand and clay

As illustrated on Figure C, the majority of the site is mapped as Guildford clay (Qpg), whilst areas in the west-south-west of the site underlying the North Dandalup River have been mapped as Qrw, and Bassendean Sands (Qpb) have been mapped on the eastern side of the site associated with the slight rise in topography as well as in the south of the site.

2.4.2. Site investigations/ geotechnical report

The Geotech report for the adjacent property (Structerre 2021) on Lot 1 Lakes Road found the subsurface profile encountered comprised topsoil to 0.2 m, loose to medium dense sand trace silt to varying depths of between 0.4 m to 1.9 m and underlain by clayey sand and gravelly clay to the investigated depth of 2.5 m, and could be classified as Class S.

Installation of the five groundwater monitoring bores across the site to depths of between 5.5 m to 11 m found the underlying soil profile to typically consist of:

- Sand/topsoil with some organics of depths to 0.4, 0.5 and 0.8 m
- Sand up to depths between 2 m and 3 m in some bores
- Sandy clay over clayey sand with trace gravel.

The Land Capability Assessment completed for the site included the excavation of 12 test pits to depths of up to 2.7 m which documented that the test pits on areas of the Pinjarra Plain to have soil profiles consisting of grey-brown and orange-brown silty or clayey sand overlying sandy or lateritic play at about 1 m (Bayley Environmental Services 2025b). While test pits located on the Bassendean Dunes had soil profiles of grey to white sand over a yellow sand at about 1 m, with an iron-enriched hardpan at some locations at about 2.5 m depth.

Soil permeability is documented in the land capability report (Appendix B), and based on eight constant-head infiltration tests, ranged from 1 m/day to 21 m/day (Bayley Environmental Services 2025b) indicates that permeability of the shallow soils is generally moderate in Pinjarra Plain soils to very high in the Bassendean Sands.



A detailed Site and Soil Evaluation (SSE) report will be prepared at subdivision stage of development.

2.4.3. Acid sulfate soils

Acid Sulphate Soil (ASS) is naturally occurring soil containing iron sulphides, which when oxidised, can lead to acidification of soils and groundwater and, consequently, extensive environmental damage. DWER broad-scale ASS risk mapping is based on surface geology mapping and provides a broad-scale indication of the risk of occurrence of ASS. The whole site has been mapped as having a “moderate to low risk” of ASS within the upper 3 m of the soil profile (DWER 2025a) (Figure 4). ASS is therefore not considered to be a significant issue on the subject land. If significant dewatering were proposed, it would be prudent to monitor the abstracted water and treat with lime before disposal if necessary.

2.5. Contaminated sites

A search of the DWER contaminated sites database (DWER 2025b), found there are no registered contaminated sites located on or in close proximity to the site. The closest sites are within the North Dandalup townsite, where there are two locations remediated for restricted use.

2.6. Public drinking water source areas

The Perth Groundwater Map (DWER 2015c) shows that the site is not located within a Public Drinking Water Source Protection Area (PDWSA). The nearest PDWSA is the P1 protection area of the North Dandalup dam catchment area, which is approximately 8.7 km to the east of the site. No well head protection zones were identified on-site or within the immediate site surrounds.

2.7. Groundwater

2.7.1. Hydrogeology and aquifers

Groundwater resource mapping available from the DWER Water Register (DWER 2025d) shows the site is located in the Murray groundwater management area and the Nambeelup subarea, and underlain by the following aquifers:

- Perth Superficial Swan
- Perth Lower Leederville
- Perth Cattamarra Coal

The Murray groundwater allocation plan (DoW 2012) guides water licencing and sets allocation limits in all aquifers of the Murray groundwater area. These allocation limits were revised in 2022. The Peel Integrated Water Initiative (PIWI) covered the Nambeelup subarea. There have been recent declines in the water level 0.15 m/year from 2013 to 2021 of the Nambeelup subarea attributed to reduced rainfall and localised abstraction (DWER 2022). According to the Water Register (DWER 2025d), there is currently water available in each of the aquifers underlying the site.

Regionally the Superficial Aquifer is fresh, with salinity as TDS ranging between 250-500 mg/L. Groundwater is also generally fresh in the Leederville aquifers (500 mg/L to 1000 mg/L) and in the Yarragadee aquifer, groundwater is generally brackish, with salinity as TDS > 1000 mg/L. High nutrient concentrations may occur in the Superficial Aquifer in areas that have been heavily fertilised (DoW 2012c).

The Nambeelup groundwater subarea is 281 km² in size (DoW 2012c). The Superficial Aquifer in this subarea comprises the Quaternary Superficial formations and Rockingham Sand. The superficial formations include Bassendean Sand, Guildford Clay and Yoganup Formation. The sediments consist of sand, clayey sand and sandy clay with clay content increasing from west to east. The Upper and Lower Leederville aquifers are generally unconfined, becoming confined to the west due to the interbedded shale, clay and sandstone layers. The Cattamarra Coal Measures consists of interbedded sandstone, siltstones and shales with



minor coal seams. The top of the Cattamarra aquifer increases in a westerly direction. It occurs at depths ranging from 10 metres adjacent to the Darling scarp (where it directly underlies the superficial formation) to greater than 250 metres where it is faulted to occur alongside the Yarragadee Formation further to the west (DoW 2012c).

2.7.2. Regional groundwater levels

There are no regional groundwater contours available from DWER, however it has been reported that groundwater flows in a south-westerly direction (DoW 2012c).

There are two DWER bores located on the southern boundary of the site (AWRC number 61410644 and 61210645) and another just to the north of the site (AWRC 61410643). These bores are screened in the Superficial Aquifer and have groundwater levels available from August 2008 to November 2018 from 61410644 and 61410643 and from August 2008 to February 2025 for 61410645. Hydrographs from these bores show water levels ranging from 20.06 m AHD to 22.3 m AHD (61410643), 21.55 m AHD to 22.81 m AHD (61410644) and 20.28 m AHD to 22.5 m AHD (61410645) with measured water levels following typical temporal patterns, with the depth to water ranging from 0.72 m to 2.9 m (61410643), 2.15 m to 3.41 m (61410644) and 2.48 m to 4.83 m respectively. Hydrographs are provided as Appendix C.

2.7.3. Site groundwater levels

Site specific groundwater monitoring has been commissioned as part of this stage of development, with eight bores installed across the site in April 2025, with the bores at MB2, MB3 and MB4 including two separate nested bores, including a shallow bore screened in the shallow unconfined aquifer and a separate slightly deeper bore within what is considered the regional superficial aquifer. The bore logs are included in Appendix D and the location of the bores is shown on Figure H.

Monthly monitoring is proposed to occur from April to October 2025 to capture the 2025 winter peak from these bores as well as two DWER bores (HS101A and HS101B). Following this, a review of the results and correspondence with DWER will occur as to whether further monitoring is required to obtain an additional winter peak in 2026.

Groundwater levels recorded as meters below top of casing (mbTOC) to date are presented in Table 3. Groundwater levels measured to date have ranged from 1.881 mb TOC to 6.26 mb TOC. However, it should be noted that when the bores MB1, MB2 and MB3 were installed, water levels rose under pressure and so the water levels recorded at these bores may not be suitable for establishing design levels / groundwater separation distances.

The bores have not been surveyed as yet, however an estimation of ground and bore casing elevations taken from high-resolution LiDAR data has been used to provide an estimate of groundwater levels in m AHD (Table 4). These will be updated once the bores have been surveyed.

Table 3: Measured groundwater levels (mb TOC)

Date	Groundwater levels (mb TOC)									
	MB1	MB2	MB2s	MB3	MB3s	MB4	MB4s	MB5	HS101A	HS101B
16/04/2025	4.407	6.26	dry	3.40	dry	2.87	3.80	2.72	-	-
27/05/2025	4.6	6.27	dry	3.68	dry	2.94	4.00	2.98	-	-
16/06/2025	4.29	5.61	dry	3.35	dry	2.75	3.84	3.03	-	-
27/06/2025	-	-	dry	-	dry	-	3.60	-	4.34	dry
16/07/2025	2.430	3.744	dry	1.941	1.881	1.923	3.160	1.736	3.942	dry



Table 4: Groundwater levels estimated (m AHD)

Date	Groundwater levels (m AHD)									
	MB1	MB2	MB2s	MB3	MB3s	MB4	MB4s	MB5	HS101A	HS101B
16/04/2025	20.77	20.76	-	20.97	-	19.67	18.74	22.19	-	-
27/05/2025	20.58	20.75	-	20.69	-	19.60	18.54	21.94	-	-
16/06/2025	20.88	21.41	-	21.02	-	19.79	18.70	21.88	-	-
27/06/2025	-	-	-	-	-	-	18.94	-	-	-
16/07/2025	22.749	23.279	-	22.429	-	20.619	19.382	23.178	-	-

Maximum Groundwater Levels (MGLs) have been estimated using the June monitoring results and comparing to long-term monitoring data from the nearby DWER monitoring bores, using an adjustment factor to represent the MGL from the available data (2008-2025) for the DWER bores. The calculated MGL values have been interpolated across the site with MGLs ranging from 24 m AHD (MB5) on the eastern side of the site to 17 m AHD in the southwest of the site (Figure 1). Based on topographic information, the depth to MGL ranges from 0.32 m at MB5 to 3 m in the southeast of the site and 3.76 m at MB2 in the northeast of the site. The MGL analysis will be updated when the 2025 monitoring has been completed and the winter peak is known.



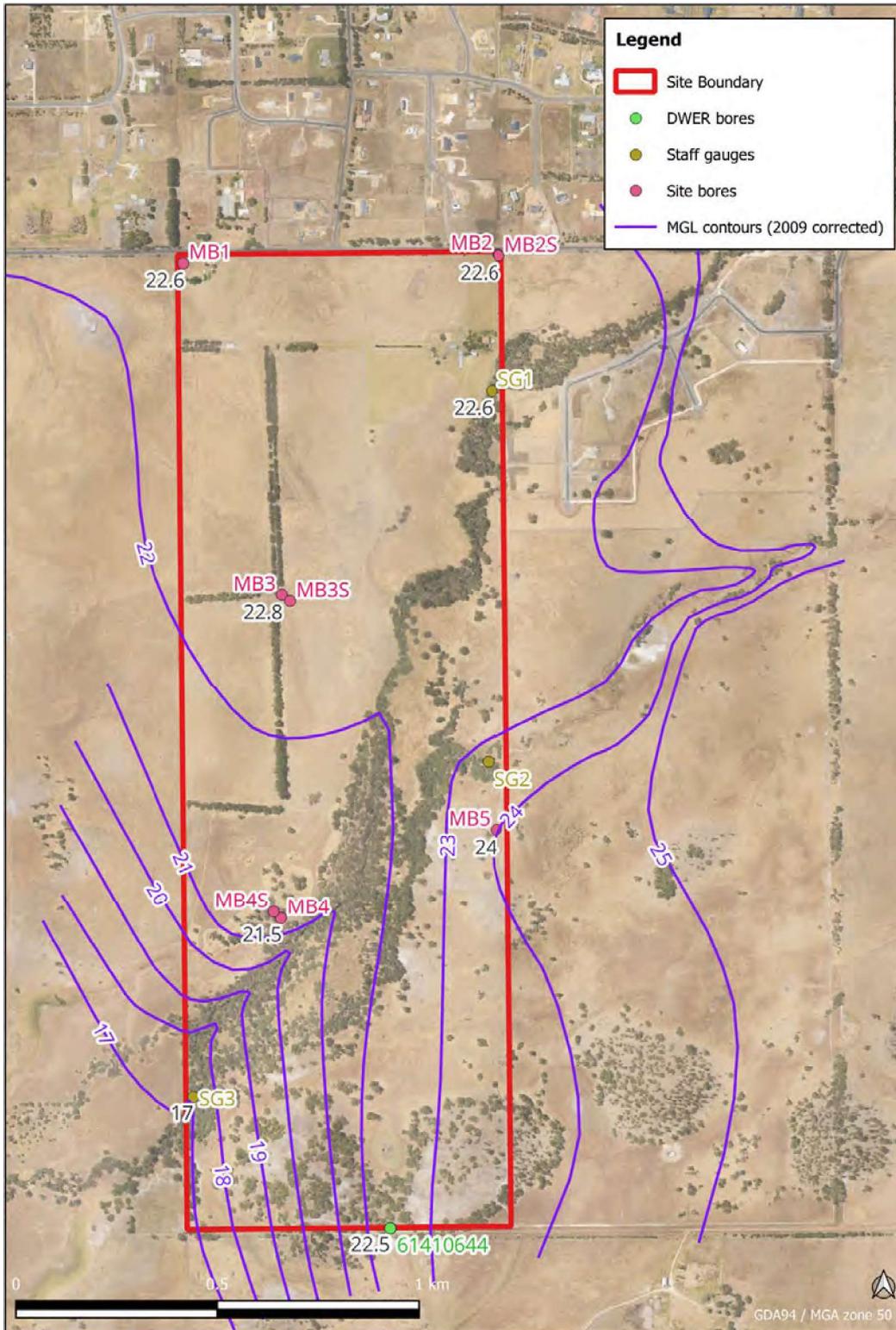


Figure 1: Maximum groundwater levels (m AHD)

2.7.4. Groundwater quality

As previously mentioned in Section 2.7.1, the Superficial Aquifer in the Nambeelup subarea has been reported to be fresh with salinity as TDS ranging from 250-500 mg/L (DoW 2012c), and potentially high nutrient concentrations from agricultural practices. The three DWER bores in closest proximity to the site (61410643, 61410644 and 61410645) do not have any nutrient or metal water quality data available from the WIN database (DWER 2025e). Mean



nutrient results from other DWER bores within a four-kilometre radius of the site are provided in Table 5.

Table 5: Mean groundwater quality results for nearby DWER bores

ID	NH ₄ -N (mg/L)	NO ₃ -N (mg/L)	TN (mg/L)	FRP (mg/L)	TP (mg/L)
FWG^a	0.08	0.15	1.2	0.04	0.065
WQIP^b			1.2		0.1
LTIWG^c			5		0.05
Average from DWER bores	0.54	4	2.70	0.25	0.23

a ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, guidelines for low land rivers in the south-west of Australia

b DWER 2025f. Gabi Warlang Bidi Water quality improvement plan for the Peel-Harvey estuary system

c ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, guidelines for long term irrigation water

Groundwater quality monitoring is included as part of the site monitoring program, with quarterly monitoring of in-situ parameters: Electrical Conductivity (EC), temperature and pH. Samples are also collected quarterly for analysis of a nutrient suite including: Total Kjeldahl Nitrogen (TKN), ammonia (NH₄-N), nitrite (NO₂-N), nitrate (NO₃-N), dissolved organic nitrogen (DON), total nitrogen (TN), filterable reactive phosphorus (FRP), total phosphorus (TP), as well as chloride, sulfate and E.coli. A sample will also be taken annually for analysis of a metal suite (Al, Ca, Fe, K, Mg, Na, S, As, Cd, Cr, Cu, Ni, Pb, Hg, and Zn). Results obtained to date (April and July 2025) are presented Table 6 and Table 7 and laboratory certificates are included in Appendix E, with further results to be reported when they are available.

From the groundwater quality monitoring events, ammonia and nitrogen oxides were below ANZG (2018) guidelines for samples taken from MB1 to MB4, however samples taken from all bores for the April monitoring had TN results above the ANZG (2018) guideline values. Similarly results for phosphate were all below the guideline value, but TP results from all bores from the April monitoring event were above the ANZG (2018) and WQIP (2025) guideline values (Table 6), indicating that organic nitrogen and phosphorus were the main constituents. For other results, E. Coli ranged from <10 cfu/100 mL to >800 cfu/100 mL. Field measured pH indicated that the groundwater was slightly acidic, with pH ranging from 4.81 to 6.24.

Table 6: Site groundwater nutrient results

Bore ID	Date	NH ₄ -N (mg/L)	NO _x -N (mg/L)	TKN (mg/L)	TN (mg/L)	FRP (mg/L)	TP (mg/L)
FWG^a		0.08	0.15		1.2	0.04	0.065
WQIP^b					1.2		0.1
LTIWG^c					5		0.05
MB1	16/04/2025	0.031	0.0070	1.6	1.6	0.011	0.57
	17/07/2025	0.024	0.0085	<0.10	<0.10	0.0086	<0.050
MB2	16/04/2025	0.064	<0.050	1.5	1.5	<0.050	0.11
	17/07/2025	0.057	<0.050	0.15	0.16	0.019	<0.050
MB3	16/04/2025	0.075	0.015	2.0	2.0	0.0077	0.16
	17/07/2025	0.075	<0.050	0.22	0.22	0.027	<0.050
MB4	16/04/2025	0.072	<0.0050	1.2	1.2	<0.0050	0.44
	17/07/2025	0.058	0.0052	0.14	0.14	0.013	0.81
MB5	16/04/2025	0.30	0.42	3.0	3.4	<0.0050	0.14
	17/07/2025	0.31	0.022	0.52	0.55	<0.0050	<0.050
HS101A	17/07/2025	<0.0050	2.1	<0.10	2.1	<0.0050	<0.050

a ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, guidelines for low land rivers in the south-west of Australia

b DWER 2025e. Gabi Warlang Bidi Water quality improvement plan for the Peel-Harvey estuary system

c ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, guidelines for long term irrigation water



Table 7: Site groundwater quality results

Bore ID	Date	Temperature (°C) (field)	pH (field)	EC (µS/cm) (field)	Thermotolerant coliforms	E. Coli (cfu/100 mL)	Chloride (mg/L)	Sulfate (mg/L)
MB1	16/04/2025	20.0	6.24	1,877	<10	<10	460	130
	17/07/2025	20.7	5.99	2,050	<10	<10	530	130
MB2	16/04/2025	19.1	6.21	3,540	10	10	1000	120
	17/07/2025	19.8	5.85	4,170	<10	<10	1200	190
MB3	16/04/2025	18.3	5.45	14,800	>800	630	5800	850
	17/07/2025	18.8	4.81	16,700	<10	<10	6300	850
MB4	16/04/2025	19.5	6.16	2,281	>800	>800	630	44
	17/07/2025	19.6	6.09	2,283	<10	<10	680	42
MB5	16/04/2025	21.9	6.17	1,198	50	50	44	82
	17/07/2025	19.5	5.89	1,119	<10	<10	260	90
HS101A	17/07/2025	20.1	5.16	121	<1	<1	16	10

2.8. Surface hydrology

The site is located in the North Dandalup River catchment, which is a sub-catchment of the Murray River. The North Dandalup River and North Dandalup River Tributary run through the site in a north-east to south-west direction. The main channel is mostly well-defined and deeply incised (Bayley Environmental Services 2025a). Another creek line also confluences with the North Dandalup River within the site boundary. Lakes Road to the north of the site is drained via table drains towards North Dandalup River. The pre-development hydrology is shown on Figure E.

Site specific surface water monitoring is being undertaken as part of this stage of works to inform the surface water modelling, drainage design and to develop post-development surface water quality targets. The surface water monitoring includes the installation of three staff gauges and capacitance loggers along the North Dandalup River, located at the upstream, middle and downstream locations along the North Dandalup River within the site boundary.

2.8.1. Flooding

GHD produced a catchment drainage model using MIKE 21 software for the Murray Drainage and Water Management Plan (2010), which includes three major rivers; Serpentine, Murray and Harvey as well as several other smaller rivers including the North Dandalup River, producing flood mapping for critical events. This flood mapping was developed via a two-dimensional hydraulic model of the flood study area and verified against available streamflow data. For the area specific to the site, catchments were simulated using a RORB model.

Design flood estimates were generated for a number of catchments, with ND1, NDT1 and NDT2 being the closest extraction points to the site reported from the model. The location of these are shown on Figure F. The modelled peak discharge and water levels for the critical events for the previously mentioned sites from this model are provided in Table 8.

Flood mapping (DWER 2025g) across the site produced from the GHD (2010) modelling for the 1% AEP event ranges from 24.75 m AHD in the north-east of the site to 19.5 m AHD in the south-west of the site, with the floodplain extending over sections of the site, as shown on Figure F.

As per the floodplain development strategies, development that is located outside of the floodway is considered acceptable with regards to major flooding events, with a minimum habitable floor level at least 0.5 m above the adjacent 1% AEP flood level, with proposed development located outside of the floodway. In this instance where the 1% AEP floodplain mapping has not been delineated into a floodway and flood fringe areas, proposed development in the 1% floodplain will be assessed on a case-by-case basis.



Table 8: Modelled peak discharge (m³/s) and water levels (m AHD)

Site ID	Event (% AEP)	Peak discharge (m ³ /s)	Peak water level (m AHD)
NDI	20	14.59	26.79
	10	19.55	26.85
	1	35.33	26.96
NDT1	20	0.38	30.98
	10	0.60	30.98
	1	1.40	30.98
NDT2	20	1.13	33.02
	10	1.44	33.03
	1	2.49	33.05

Source: GHD 2010

2.8.2. Site water levels

Surface water level loggers and staff gauges have been installed at three locations across the site (SG1, SG2 and SG3), the location of these is shown on Figure H. Due to installation issues, logger data is only available from SG1 to date, with data from all loggers to be presented in future. Water levels are logged in 10 minute intervals and from 28/05/2025 to 27/06/2025 water depths ranged from 84.8 mm to 347.2 mm from SG1, as shown in Figure 2.

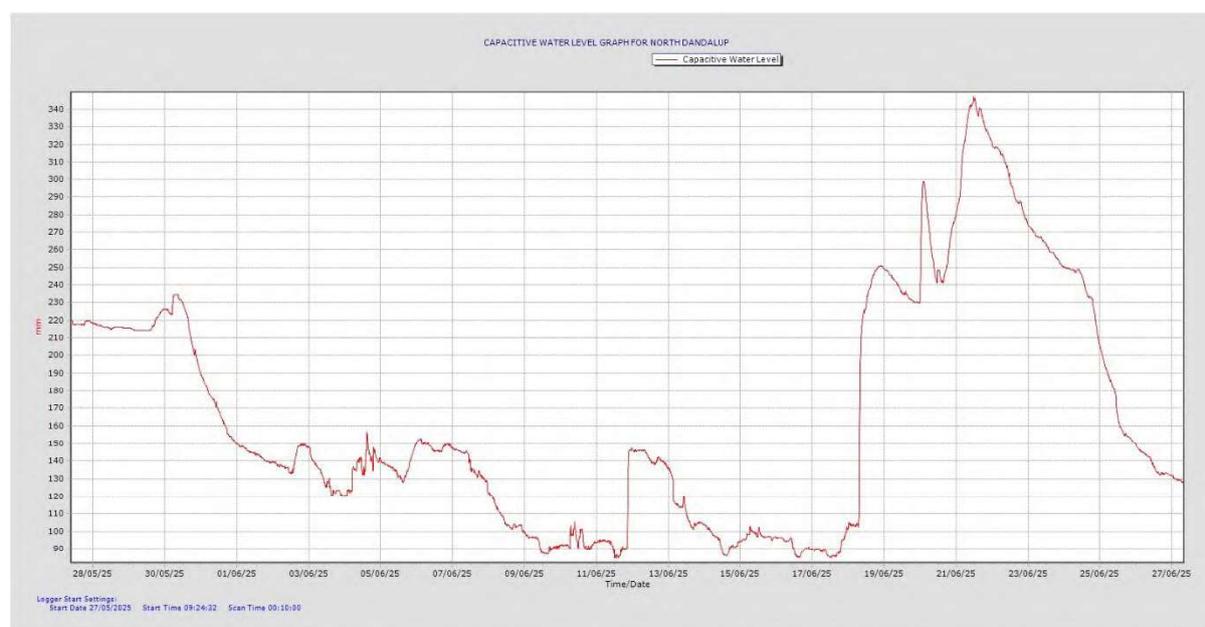


Figure 2: Water levels recorded from SG1 from 28/05/2025 to 27/06/2025

2.8.3. Surface water quality

DWER have previously undertaken physico-chemical monitoring since 2003 to present of the AWRC site 6140103 on the North Dandalup River, located on Lakes Road prior to the North Dandalup River traversing the adjacent Lot. Conductivity at 25°C has averaged 397 µS/cm and pH has averaged 7.1.

As part of the pre-development surface water monitoring, monthly water quality samples will be taken when water is present for analysis of field physico-chemical parameters, as well as taking samples for laboratory analysis of anions and nutrient suite TKN, NH₄-N, NO₂-N, NO₃-N, DON, TN, FRP, TP, as well as a bi-annual analysis of a metal suite (Al, Ca, Fe, K, Mg, Na, S, As, Cd, Cr, Cu, Ni, Pb, Hg, and Zn). These results will be reported as they become available. E.coli is being sampled as the proposed rural residential lots will require their own



on-site sewerage treatment systems. Results obtained to date from the April 2025 monitoring event are presented in Table 9 and laboratory certificates are included as Appendix E.

For the April 2025 monitoring event, nutrient surface water results were all below the guideline values (Table 9), however exceedances occurred from all three sites for the July monitoring event. While turbidity results were low for all sites (Table 10). Field measured pH indicated that surface water was slightly acidic.

Table 9: Site surface water nutrient results

Bore ID	Date	NH ₄ -N (mg/L)	NO _x -N (mg/L)	TKN (mg/L)	TN (mg/L)	FRP (mg/L)	TP (mg/L)
FWG^a		0.08	0.15		1.2	0.04	0.065
WQIP^b					1.2		0.1
SG1	16/04/2025	0.0068	<0.0050	0.62	0.62	<0.0050	<0.05
	16/07/2025	0.022	0.71	1.2	1.9	<0.0050	<0.05
SG2	16/04/2025	-	-	-	-	-	-
	16/07/2025	0.045	1.2	3.3	4.5	0.079	0.20
SG3	16/04/2025	0.0059	<0.0050	0.48	0.48	<0.0050	0.056
	16/07/2025	1.2	2.0	3.9	5.9	0.63	0.76

a ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, guidelines for low land rivers in the south-west of Australia

b DWER 2025e. Gabi Warlang Bidi Water quality improvement plan for the Peel-Harvey estuary system

Table 10: Site surface water quality results

Bore ID	Date	Temperature (°C) (field)	pH (field)	EC (µS/cm) (field)	Turbidity (NTU)	Chloride (mg/L)	Sulfate (mg/L)
FWG^a					10-20		
WQIP^b							
SG1	16/04/2025	18.3	6.56	359.1	7.0	82	9.1
	16/07/2025	11.9	6.81	504	3.6	120	19
SG2	16/04/2025	-	-	-	-	-	-
	16/07/2025	13.2	6.36	828	7.6	170	100
SG3	16/04/2025	18.1	6.55	399.2	2.0	87	9.2
	16/07/2025	12.6	6.93	968	5.2	230	58

2.9. Geomorphic wetlands

Geomorphic wetland mapping shows the majority of the site has been mapped as a Multiple Use Wetland (MUW) (ID 15802, 6021, 6022, 6030, 6031). The North Dandalup River has been mapped as a Conservation Category Wetland (CCW) (ID 13313 and 6018) (DBCA 2025). Geomorphic wetland mapping is shown on Figure G.

2.10. Vegetation and flora

As previously mentioned in Section 2.1, the majority of the site has been historically cleared. Mapping by Hedde *et al.* (1980) identified the site as Guildford Complex, described as an Open Forest of Jarrah, Marri and Wandoo with Flooded Gum and Paperbarks on streamlines and wetlands, and an understorey including *Banksia grandis*, *Kingia australis*, *Xanthorrhoea preissii* and species of *Hardenbergia* and *Hibbertia*. The riparian vegetation is mostly restricted to the banks and flats of the river (Bayley Environmental Services 2025a). In the north of the site fringing vegetation extends from a few metres to 60 metres from the main river channel, while in the south the fringing vegetation extends up to 300 metres wide.

Beard (1979) mapped the site as Medium Woodland of Jarrah, Marri and Wandoo.



A site assessment by Western Environmental found the vegetation to be in a Degraded to Completely Degraded condition. The vegetation assessment also included identification of 853 potential and suitable black cockatoo nesting trees, with six then classified as Bamford Class 3 and 153 classified as Bamford class 4.

Bushfire assessment is being completed by Western Environmental for the site (Western Environmental, 2025, pers. comm.). Only portions of the site are mapped as bushfire prone areas, with the vegetation associated with the North Dandalup River requiring a 21 m setback, which would be achieved through the foreshore buffer requirement.

2.11. Heritage

2.11.1. Aboriginal heritage

A search of the Department of Planning Lands and Heritage (DPLH 2025a) Aboriginal Cultural Heritage Inquiry System database identified that the North Dandalup River is a registered site (ID 27937): creation/dreaming narrative; hunting place; landscape/seascape feature; plant resource; water source.

2.11.2. Historic heritage

A search of the DPLH's inherit database (DPLH 2025b) indicated there are no places listed on the Register of Heritage Places within the site.

2.12. Summary of environmental constraints and opportunities

The previous sections have identified the following key constraints and opportunities for development at the site in regard to the current existing environment:

- The majority of the site is mapped as Guildford clay (Qpg), which would be expected to have low infiltration rates. Areas in the west-south-west of the site underlying the North Dandalup River have been mapped as Qrw, and Bassendean Sands have been mapped on the eastern side of the site associated with the slight rise in topography as well as in the south of the site. Soil permeability indicates that permeability of the shallow soils is generally moderate very high.
- Site specific groundwater monitoring is just commencing, but based on neighbouring DWER bores, a shallow depth to groundwater is anticipated.
- The North Dandalup River 1% floodplain area has been mapped over portions of the site, which requires 0.5 m clearance to habitable floor levels.
- The majority of the site is classified as a 'Multiple Use Wetland' (MUW). The North Dandalup River and tributary which traverses the site has been mapped as a Conservation Category Wetland (CCW) (ID 13313 and 6018).
- The majority of native vegetation on the site has previously been cleared for agricultural purposes, with remnants associated with the river and fence lines.



3. Water servicing

3.1. Potable water supply

Potable water supply will be provided by connection to the Water Corporation network.

3.2. Wastewater servicing

On-site wastewater disposal is proposed for development via ATUs to be installed by lot owners. A Land Capability Assessment has been prepared by Bayley Environmental Services to characterise the site soil and hydrologic conditions and demonstrate that the land is capable of supporting onsite effluent disposal. The assessment (provided in Appendix B) has been prepared in accordance with the Australian Standard AS1547:2012 – Onsite Domestic Wastewater Management and the Government Sewerage Policy 2019. It is expected that a Site and Soil Evaluation will be required as a condition of subdivision approval following winter testing and once lot boundaries are known.

3.3. Non-potable water supply

The site currently has a groundwater licence for the abstraction of 32,750 kL from the Lower Leederville aquifer. There may be the opportunity to trade this for new lot owners for the site. Lot owners wishing to abstract groundwater (via bores or dams) for irrigation of horse pastures will need to obtain an abstraction licence from the DWER if the irrigation area is over 0.2 ha.



4. Water conservation

Conservation of water through fit-for-purpose use and best management practices is encouraged for efficient water use. Fit-for-purpose describes the use of water that is of a quality suitable for the required use of the water. Fit-for-purpose principles have been utilised in the water conservation strategy for the site.

4.1. Proposed strategy

The State Water Plan (Government of Western Australia 2007b) is a strategic policy and planning framework to meet the state's water demands to the year 2030. While the site is not within Perth, more recently the Waterwise Perth Plan 2 (DWER 2022) has a number of targets for 2030 with a focus on the current residential water supplied of 91 kL per person per year. Further to this, the Murray Drainage and Water Management Plan (Government of Western Australia, 2011) states that 30% of total water use should be from suitable non-potable water sources.

The above targets are expected to be achieved primarily through the following:

- No potable water should be used outside the homes and buildings where alternative water sources are available (with garden and landscape irrigation by lot-owners expected to be via private groundwater bore in most cases), and
- Achieve efficient use of scheme water, eg. via water efficient fixtures and fittings (WELS) installed in households.

4.1.1. Household water conservation

The water consumption target is generally achieved through the installation of WELS rated waterwise fittings and appliances inside the house in accordance with building regulations. These include:

- All tap fittings, except bath outlets, garden taps and toilets must be a minimum 4-star WELS rated.
- All showerheads must be a minimum of 3-star WELS rated.
- An outdoor private swimming pool or spa associated with a Class 1 building must be supplied with a cover or blanket.
- All internal hot water outlets (such as taps, showers and washing machine water supply fittings) must be connected to a hot water system or a recirculating hot water system with pipes installed and insulated in accordance with AS/NZS 3500.

In addition, lot owners will be encouraged to install grey water systems for the irrigation of individual household landscaping, as well as rainwater tanks. Rainwater tanks can be connected to water using fixtures such as toilets, washing machines and external taps to reduce potable water demand as well as assisting in reducing stormwater run-off.

4.1.2. POS irrigation

The only POS area is the foreshore of the North Dandalup River and North Dandalup River Tributary Creek, which will not require any permanent irrigation.



5. Stormwater management

5.1. Stormwater management principles

The drainage strategy for the development has been developed with reference to the principles and objectives outlined in relevant guidance documents including *Decision process for stormwater management in Western Australia* (DWER, 2017) and *Better Urban Water Management* (WAPC, 2008).

The drainage strategy aims to utilise and tie into the existing topography and drainage features of the site, with stormwater conveyance primarily provided by roadside swales which are typically graded to the North Dandalup River floodplain. The overarching objectives include providing effective surface water conveyance to prevent flooding whilst maintaining post-development discharge volumes and rates relative to pre-development conditions. The key water management objectives and how they will be met is outlined in Table 11.

Table 11: Water management objectives and actions to meet them

Objectives	Actions
Flood protection (1% AEP)	<ul style="list-style-type: none"> Minimum habitable floor levels will need to be constructed at least 0.5m above the 1% AEP flood level in the adjacent North Dandalup River. Flow paths for the major events (>20% AEP up to and including the 1% AEP) have been provided for in the roadside swales as well as drains and associated easements through low-lying areas of some lots.
Serviceability (20% AEP)	<ul style="list-style-type: none"> The drainage design ensures that roads will remain passable in the minor 20% AEP event using a roadside swale network to contain and convey these minor event flows.
Ecological protection (minor events, 15 mm)	<ul style="list-style-type: none"> Small rainfall events (eg. the first 15mm of rainfall) which carry the majority of pollutant loads from road surfaces will be retained and infiltrated within the vegetated roadside swales.
Groundwater level management	<ul style="list-style-type: none"> A network of roadside swales as well as drains (within easements) through low-lying lots areas will assist with controlling groundwater levels and preventing groundwater inundation.
Maintaining and if possible improving groundwater and surface water quality discharging from the site compared to pre-development	<ul style="list-style-type: none"> Runoff from the 15 mm event will generally be retained and infiltrated on-site within roadside swales, thus encouraging infiltration and entrainment of pollutants within the soil profile rather than discharge off-site. Roadside swales will be constructed with soil having PRI 10 or greater to retain phosphorus. Opportunities for providing planted biofilter areas at outlets from the drainage swale network (ie. prior to connection to the natural watercourses) will be investigated as part of the detailed design at subdivision stage. A post-development monitoring program will be implemented to confirm the surface and groundwater quality.

5.2. Stormwater drainage design

A drainage concept has been prepared by the project engineers Tabec and is provided in Appendix F. The concept illustrates the intent to use a network of roadside drains and culverts (at intersections and crossovers) to convey flow with the natural topography generally towards North Dandalup River, or (where consistent with existing conditions) to drainage features and existing flow paths at the site boundary.



Also shown in the appended drainage concept design is the intent to modify existing agricultural drains that traverse the site, to realign these with lot boundaries and have associated easements. The strategy is to maintain the ability for these agricultural drains to provide drainage relief for low-lying parts of the flat and very gently undulating site (thus limiting the occurrence of surface water or perched groundwater inundation) whilst avoiding impractical easement alignments through the middle of lots.

5.2.1. Lot drainage

The proposed development is to convert the site to 'Special Rural', with rural residential lots. Given the large lot sizes, and small proportion of which will be impervious surfaces, there will be minimal change to the overall runoff contribution from lot areas.

Buildings are expected to be situated on elevated or slightly filled / raised pads to facilitate wastewater disposal. This will also enable the use of soakwells to retain runoff from roof surfaces. Any overflow from these, as well as runoff from other impervious surfaces such as sheds and driveways, will likely be directed to garden beds and other pervious areas within the lots.

Lot owners will be responsible for managing stormwater flows within and from their properties. This includes ensuring that existing grading and flow paths are maintained, and that overland flow is not obstructed where it currently exists.

5.2.2. Road reserve

A network of roadside swales will be used to convey road runoff towards the natural watercourses. The roadside swales will be utilised along the full extent of the road reserve, on one or both sides of the road reserve depending on the topography and cross section. The drainage design will incorporate culverts at driveways and intersections to convey flows to the North Dandalup River or North Dandalup River Tributary. All crossovers shall have a minimum DN375 Class 4 culverts to allow conveyance of stormwater events under the driveway crossovers to Shire of Murray standards.

Retaining small rainfall events as close to the source as possible is particularly important for the management of water quality. Rainfall events up to 15 mm account for the majority of pollutants from road surfaces. Run-off generated from rainfall events up to 15 mm will be retained and infiltrated as close to source, and as high in the catchment, as possible with the aim to maintain the pre-development hydrologic regime and maximise close-to-source treatment and infiltration of stormwater.

The roadside swales will be constructed in soil with a PRI value of 10 or greater and will incorporate low rock riffles or weirs at regular intervals, to assist in reducing velocities, trapping sediment and ensuring that the first 15 mm of rainfall runoff is retained and infiltrated as close to source as possible.

The roadside swales will also assist in attenuating stormwater flow rates and volumes during larger rainfall events. As the overall increase to imperviousness across the site is low, and the roadside swales provide attenuation of the direct runoff from the road surfaces, post-development runoff volumes and peak discharge rates will not differ significantly from existing conditions.

5.3. Stormwater modelling

Hydrologic and hydraulic modelling have been undertaken in XPSWMM to assess the impact of the proposed development in relation to pre-development versus post-development stormwater discharge rates.

XPSWMM simulates hydrological (rainfall-runoff) processes as well as storage, infiltration, and conveyance through the road drainage system to estimate and major event stormwater volumes, depths and discharge rates. The model used design rainfall (IFD) data sourced from Bureau of Meteorology (in accordance with ARR 2019) for the full range of storm durations to identify the critical event duration for all aspects of the modelling assessment.

5.3.1. Modelling methodology

Intensity-frequency-duration (IFD) rainfall depths utilised in the hydrologic modelling (described in later sections of this report) were obtained from the Bureau of Meteorology



(BoM). Temporal rainfall distributions were downloaded from the Australian Rainfall and Runoff (ARR) data hub (Babister, Trim, Testoni, & Retallick, 2016). Climate modification has been applied based on the default socioeconomic pathway and the rate of temperature change under the current and near-term scenario. The final results are presented in Table 12 below.

Table 12: Design Rainfall Depths (mm)

AEP	63.2%	50%	20%	10%	5%	2%	1%
Duration (hrs)							
1	60.4	66.0	85.5	100.6	116.9	140.3	160.4
1.5	64.3	70.3	91.1	107.0	124.7	149.2	170.4
2	67.7	74.0	95.8	112.5	130.3	155.9	177.1
3	73.4	80.2	103.2	120.3	139.2	164.8	187.1
4.5	83.0	90.4	114.7	133.7	151.5	178.2	198.3
6	91.7	99.7	125.9	143.7	162.6	188.2	208.3
9	100.1	108.8	135.9	154.8	172.6	198.3	218.3
12	108.9	118.1	147.0	166.0	183.8	210.5	231.7
18	118.1	128.1	158.2	178.2	197.1	225.0	246.1
24	60.4	66.0	85.5	100.6	116.9	140.3	160.4
30	64.3	70.3	91.1	107.0	124.7	149.2	170.4
36	67.7	74.0	95.8	112.5	130.3	155.9	177.1

The hydrologic models included division of the catchment into sub-catchments which are further sub-categorized according to land use types such as impervious and pervious lot areas and road reserves. Roads were assumed to be comprised of 60% impervious area and 40% pervious verge area etc. Impervious lot areas are assumed to comprise of 15% of total lot areas based on comparison with similar scale rural residential subdivisions in the area. Impervious lot areas were modelled with loss rates reflective of the requirement for lot owners to manage stormwater onsite, with the expected outcome being the first approximately 15 mm of rainfall being managed in soakwells with larger events being directed to adjacent pervious areas; the continuing loss rate applied to impervious lot areas represents increased runoff compared to that modelled for pre-development conditions.

Pervious lot areas (in both pre- and post-development scenarios) have been classified based on soil type, geological characteristics, topography, and drainage conditions. Loss rates were determined using the SCS Curve Number method.

The losses and Manning's roughness parameters used in the hydrological modelling are provided in Table 13.

Table 13: Modelled loss rates and manning's n (routing coefficient)

Land use type	Initial loss (mm)	Continuing loss (mm/hr)	Proportional Loss	Curve Number	Manning's n
Predev A-C	-	-	-	69	0.055
Predev B-D	-	-	-	69	0.060
Predev E	-	-	-	79	0.065
Predev F-G-H	-	-	-	69	0.060
Southern catchments	-	-	-	65	0.065
Road Reserve	1.5	-	0.4	-	0.030
Impervious Lot Area	15	2.0	-	-	0.025



Adopted model assumptions are as follows:

- Potential infiltration through the roadside drains was conservatively excluded.
- Culverts depicted in the concept drainage plan have been modelled with somewhat arbitrary sizes based on conveyance 20% AEP event without overtopping the road reserve.
- Runoff routing was modelled with the Laurenson routing method using sub-catchment areas, slopes and routing parameter calculated with the Manning's n values.
- Manning's "n" for concrete culverts are assumed to be 0.014.
- Manning's "n" for roadside drains are assumed to be 0.050.
- Swale and road section is modelled based on typical road section provided in the drainage concept plan.

Based on the assumptions above, a relatively detailed 1D stormwater drainage model was developed in XPSWMM to simulate both the pre-development and post-development scenarios and to assess the impact of the development on stormwater discharge rates.

5.3.2. Pre-development scenario

Figure I illustrates the modelled sub-catchments under the pre-development scenario. A total of eleven general outlet locations have been identified across the site. Several of these outlets discharge directly into the North Dandalup River or its tributaries, while others convey flow out of the site via sheet flow or existing agricultural drainage networks.

The site contains multiple agricultural drains that influence the drainage patterns of various sub-catchments. Specifically:

- Catchments A and C are drained towards the western site boundary via agricultural drains.
- A portion of Catchment B discharges directly into the North Dandalup River.
- Some flow is conveyed from upstream areas and discharged within Catchment I, ultimately entering the North Dandalup River.

These drainage features play a key role in defining the surface water hydrology and flow directions of the site in its existing condition.

5.3.3. Post-development scenario

As described in Section 5.2, the drainage strategy incorporates roadside swales to collect and convey runoff from roads as well as any upgradient lot runoff. The majority of residential lots are expected to grade naturally towards the road drainage system. However, as no earthworks are proposed within the lots, some parcels may continue to grade away from the road, resulting in sheet flow discharge toward site boundaries. This is consistent with pre-development conditions. To maintain existing flow patterns and effective drainage of the site post-development, re-aligned agricultural drains have also been incorporated along lot boundaries where required.

Expected lot sizes are minimum 1 hectare with a relatively small proportion expected to be impervious. To manage stormwater at the source, all constructed impervious areas will be required to retain or detain the first 15 mm of rainfall runoff within lot boundaries, thereby reducing potential increases in runoff during small storm events. However, it is acknowledged that larger rainfall events may result in increased overall runoff from lots (albeit only a minor increase) due to the presence of these impervious areas. To account for this, the hydrological modelling conservatively assumes that 15% of each lot area will be impervious. These areas were modelled with decreased losses to reflect their impact on total discharge from the site.

Figure J presents the modelled sub-catchments within the development site under the post-development scenario. The sub-catchment labelling maintains a reference to pre-development conditions — for example, Catchment A1 corresponds to the part of pre-development Catchment A, and A1–A4 collectively represent the original whole Catchment A area.

Certain catchments, such as Catchment E1, are not connected to the road drainage network and continue to discharge as sheet flow directly into the North Dandalup River, its tributaries, or beyond the site boundary, consistent with pre-development flow paths.



5.3.4. Modelling Results

The modelled pre- and post-development catchments both total approximately 144.2 ha in area. The 1% AEP event results in an overall site discharge of 4.54 m³/s under pre-development conditions and 4.77 m³/s post-development. For the 20% AEP event, the site discharge increases from 1.21 m³/s (pre-development) to 1.41 m³/s (post-development).

The modelling indicates that post-development discharges are generally consistent with pre-development conditions. It is also noted that the modelling conservatively excluded several hydrological processes or hydraulic features that will in practice further reduce the post-development discharges; the modelling excluded infiltration within roadside swales, crossovers and associated culverts, and the proposed low weirs or rock riffles which are intended to reduce velocities and promote infiltration and retention of pollutants. It is therefore considered that there would be negligible increase to stormwater discharge rates post-development.

5.4. Flood Management

To determine the floodway extent of the North Dandalup River, a 2D hydraulic model was developed using a detailed (1 m horizontal resolution) digital terrain model developed from site-specific LiDAR survey over the site. Catchment flows used in the hydraulic model were generated with a relatively simple hydrological model of the upstream catchments.

Hydrological model parameters were based on ARR recommended values for the region with these values and routing parameters then adjusted (within reasonable ranges of textbook values and based on professional judgement) in order to achieve a close fit to the North Dandalup River 1% AEP peak flow presented in the *Floodplain Development Strategy* (GHD, 2010) (summarised in Table 8 above).

The generated flow hydrographs for both the North Dandalup River and the minor tributary were then used as flow inputs to the 2D flood model. The floodway was defined by iteratively applying a nominal setback from the top of channel (with local widening in some more critical flow areas) until an afflux of ≤ 0.2 m was achieved at the site boundaries (for both the North Dandalup River and its tributary).

The 1% AEP predevelopment floodplain and flood levels as modelled by Pentium Water are displayed on Figure K. Figure L shows the defined 1% AEP floodway extent, while Figure M shows the modelled floodway afflux. It should be noted that the afflux presented in Figure M is only relevant to the floodway definition exercise described above; it does not represent the actual afflux that will result from the development. This is because the extent of filling / encroachment on the floodplain caused by the development will be drastically less than that modelled for the purpose of hydraulic assessment of the floodway (ie. large portions of the lots that overlap the flood fringe will remain unfilled, with only relatively small building envelope areas actually being filled).

5.5. Foreshore management

A Determination of Foreshore Setback assessment was undertaken by Bayley Environmental Services (2025) and is provided as Appendix G. This included a biophysical assessment of the watercourse and definition of an appropriate foreshore setback boundary following policy and guidance documents *River Restoration Series No. RR16 – Determining Foreshore Reserves* (WRC, 2001) and *Foreshore Policy 1 - Identifying the Foreshore Area* (WRC, 2002).

It is anticipated that a condition of future subdivision approval will be the preparation of a Foreshore Management Plan to address rehabilitation, completion criteria and ongoing management of the foreshore reserve. These details will be determined through the preparation and approval of a future Foreshore Management Plan or similar, and those aspects relevant to drainage and water management will be documented in a future UWMP(s).



5.6. Water quality treatment

The drainage system will manage stormwater and surface water quality via the following measures:

- promote infiltration of runoff in roadside swales by constructing these within permeable sand material (with minimum PRI 10) and incorporating low weirs / rock riffles to slow and retain small event flows
- erosion and dust control during construction
- incorporate planted stormwater management areas where possible at the outlets of roadside drains and agricultural drains to promote stormwater filtration, treatment and nutrient uptake (locations of vegetated stormwater treatment areas to be confirmed at detailed design)
- post-development monitoring to ensure that water quality targets are being met.

5.6.1. Vegetation

As described above, vegetation will be included in targeted stormwater management areas where possible to help prevent erosion, maintain soil infiltration, restrict water flows, and remove particulate and soluble pollutants, particularly nutrients. The plants will be appropriately selected based on their intended function, using endemic species where possible. The location of planting and species to be used within stormwater management areas will be identified within the subsequent UWMPs; it is anticipated that these will be at the outlet of constructed drains prior to discharge to natural watercourses.



6. Groundwater management

The main principles of groundwater management are to protect underlying groundwater resources by minimising the export of nutrients through maintaining or improving the quality of groundwater leaving the site and to protect infrastructure from groundwater inundation.

6.1. Groundwater level management

Under existing conditions, groundwater levels at the site are partially controlled by the natural watercourses and constructed (agricultural) drains. Pre-development monitoring is currently in progress which includes monitoring bores screened within both the surficial soil horizons (to capture potential shallow perching) and the slightly deeper sand horizons which are reflective of the regional superficial aquifer.

The proposed rural residential development will not significantly change the hydrological conditions or groundwater levels at the site. Consistent with the current conditions, agricultural drains are proposed to be retained or modified, along with the use of roadside swales, to provide drainage relief for lower-lying parts of the site and prevent groundwater inundation in those areas. Existing drains will for the most part be realigned with lot boundaries and have associated easements over them consistent with their drainage function.

It is expected that a Site and Soil Evaluation will be required as a condition of subdivision approval following winter testing and once lot boundaries are known.

6.2. Groundwater quality management

Groundwater quality monitoring at the site to date has identified slightly to moderately elevated total nitrogen and total phosphorus concentrations (above relevant water quality guidelines), which appear to be associated mostly with organic forms of these nutrients. In the monitoring undertaken to date, inorganic forms of nitrogen and phosphorus have generally been below water quality guideline values.

Groundwater quality impacts from the development are expected to be minimal due to:

- Use of appropriate wastewater management systems within lots
- The expected high phosphorus retention capacity of the site soils which will reduce the proportion of garden inputs (ie. fertiliser use) to leach to groundwater.

In addition, the stormwater drainage system comprises roadside swales which will provide opportunity for stormwater and associated pollutant loads to be captured and retained onsite. This will reduce the mobilisation of contaminants that are typically transported during first flush rainfall events, instead allowing these to be retained and infiltrated in the catchment, providing further opportunity for nutrient uptake and attenuation through the soil profile.

Groundwater quality will be monitored post-development to verify that pre-development water quality is being maintained or improved.



7. Subdivision management

7.1. Erosion and sediment control

Erosion and sediment control will be undertaken during construction to maintain the integrity of the drainage network and protect downstream waterways. This will include:

- The civil contractor will use water and/or polymer dust suppression material for dust control during construction work.
- Cutoff drains or bunds to be used to control runoff from disturbed areas and direct this to sediment basins, to prevent uncontrolled discharge of sediment-laden runoff from works areas.
- Sediment controls such as silt fences to be used for works that interface with North Dandalup River and any other watercourses.

7.2. Waste and construction management

Waste management plans will include provisions for stormwater protection through:

- Prompt removal of litter when discovered
- Discouraging waste dumping in drains and drainage swale through restricted access (i.e., bollards) and signage
- Providing sufficient public facilities for rubbish disposal
- All development construction projects, including road and infrastructure construction, will be subject to sediment and erosion control measures.



8. Monitoring

8.1. Pre-development monitoring

As outlined in Sections 2.7.3 and 2.8, a pre-development groundwater and surface water monitoring program is currently being completed.

8.2. Post-development monitoring

The objective of post-development monitoring is to demonstrate that there are no directly attributable significant impacts from the new urban development on water resources (DoW 2012a).

The proposed period for post-development monitoring is three years and will include groundwater and surface water monitoring.

8.2.1. Groundwater

Post-development groundwater monitoring is proposed for the five on-site bores. If the pre-development bores are damaged or destroyed during construction, then a replacement bore would be installed as close as possible.

Groundwater levels and water quality is proposed to be monitored on a quarterly basis (January, April, July and October). Groundwater bores would be purged, and in-situ parameters would be monitored including pH, EC, and temperature until stabilised. Following this, samples would then be collected and sent for laboratory analysis of the following nutrient suite: total nitrogen (TN), ammonia (NH₄-N), nitrogen oxides (NO_x-N), Total Kjeldahl Nitrogen (TKN), total phosphorus (TP) and filterable reactive phosphorus (FRP), as well as an annual analysis of a suite of metals including: (Al, Ca, Fe, K, Mg, Na, S, As, Cd, Cr, Cu, Ni, Pb, Hg, and Zn) and E.coli.

8.2.2. Surface water

Post-development surface water monitoring is proposed to ensure that the North Dandalup River and North Dandalup River Tributary Creek have not been detrimentally impacted by the development. The post-development monitoring will include measuring water levels from staff gauges and capacitance loggers at the three sites on the North Dandalup River. Surface water quality would be monitored on a quarterly basis if water is present. This would include in-situ measurement of pH, EC, and temperature and collection of grab samples for laboratory analysis of anions and a nutrient suite (TN, TKN, NH₄-N, NO_x-N, TP, and FRP) as well as annual analysis of a metal suite (Al, Ca, Fe, K, Mg, Na, S, As, Cd, Cr, Cu, Ni, Pb, Hg, and Zn) and E.coli.

8.3. Trigger values

At this stage trigger values based on pre-development monitoring results cannot be established as the monitoring program has only just commenced. These will be reported in the subsequent UWMP. The monitoring results will be compared to the baseline values obtained from the pre-development monitoring with trigger values set at 20% above the mean pre-development results as well as comparing to ANZG guidelines (ANZG 2018) for wetlands and lowland rivers in the south-west of Australia.

8.4. Contingency measures

In the event post-development data exceeds trigger values by at least 20% on two consecutive occasions, initially the Shire of Murray and DWER will be notified, and an investigation will be undertaken to establish the likely cause of the exceedances, the most likely impacts, and available mitigation strategies.

The primary contingency measure available in the event of deterioration in water quality will include assessment of whether the pollution is a point or diffuse source. This will require an investigation into the location of the contamination and an assessment of whether the pollution is due to the development or an external factor. At that point, a specific contingency plan will be implemented, which may include:



- Removal of the pollution
- Assessment into the functionality of the drainage system
- Further soil amendment in infiltration / treatment areas
- Increased planting of nutrient stripping vegetation in biofiltration areas
- Review of drainage maintenance plans to ensure correct practices are being implemented
- Increased public awareness and education programs
- Increased monitoring program including monitoring up-gradient of the site to determine potential off-site nutrient sources

8.5. Reporting

The results obtained from post-development monitoring will be compared to pre-development monitoring trigger values set and ANZG guidelines (ANZG, 2018) and submitted to the Shire of Murray and DWER. The report will analyse any variations the development has had on the hydrological conditions and present necessary contingency measures where required.



9. Implementation

9.1. Further work to be completed at the UWMP stage

Following rezoning of the site, it is anticipated that an Urban Water Management Plan (UWMP) will be required as a condition of subdivision approval for the development, and will include the following design measures in more detail:

- Compliance with this LWMS’ criteria and objectives to the satisfaction of the Shire of Murray.
- Detailed stormwater drainage design including locations, dimensions, and final levels for drainage infrastructure, bioretention and flood storage areas, stormwater flow paths, and areas of inundation.
- Specific detailed information on structural and non-structural BMPs to be implemented.
- Final subdivision layout including any earthworks, minor and major drainage layouts, and overland flow paths.
- Management of subdivision works, including details of license application for dewatering or dust suppression if required.
- Detailed post-development monitoring program including sampling locations, parameters, and frequency, as well as water quality trigger levels.
- Finalised implementation plan including roles and responsibilities of all parties involved

In addition to the UWMP the following items are also anticipated to be required to support subdivision:

- Foreshore management plan for the North Dandalup River
- Form 3P application to interfere with bed and banks permit

9.2. Implementation plan

The proposed roles and responsibilities for future work for the subsequent UWMP as well as works associated with the LWMS are presented in Table 14. These will be refined at the UWMP stage.

Table 14: Roles and responsibilities for implementation

Principle	Role	Responsibility	Timescale
Monitoring	Surface water and groundwater monitoring	The proponent	Quarterly surface water levels and quality monitoring at three locations. Quarterly groundwater level and quality monitoring at five on-site bores and an additional DWER bore.
Reporting	Report on monitoring results	The proponent	Report on the 2025 pre-development monitoring results to SoM / DWER. At the completion of three years of post-development groundwater and surface water monitoring
	UWMP	The proponent	As a condition of subdivision
Subdivision management	Construction and site works management	The proponent	As required during construction until handover to Shire of Murray
	Waste and pollution management	The proponent	As required during construction until handover to Shire of Murray
	Dust suppression and erosion control	The proponent	As required during construction until handover to Shire of Murray



Principle	Role	Responsibility	Timescale
Drainage infrastructure	Visual inspections, rectifying issues and maintenance	The proponent	As required following practical completion until handover to Shire of Murray
POS and foreshore areas	Landscaping, revegetation, and ongoing replanting	The proponent	As specified within the POS design/ foreshore management plan documentation until handover to Shire of Murray
	Foreshore management plan	The proponent	As required at the subdivision stage
	Bed and banks permit	The proponent	Prior to modification of banks of the river or tributary (eg. as part of constructing road crossings)
Public information	Supply of information and educational packages	The proponent	Upon settlement with residents



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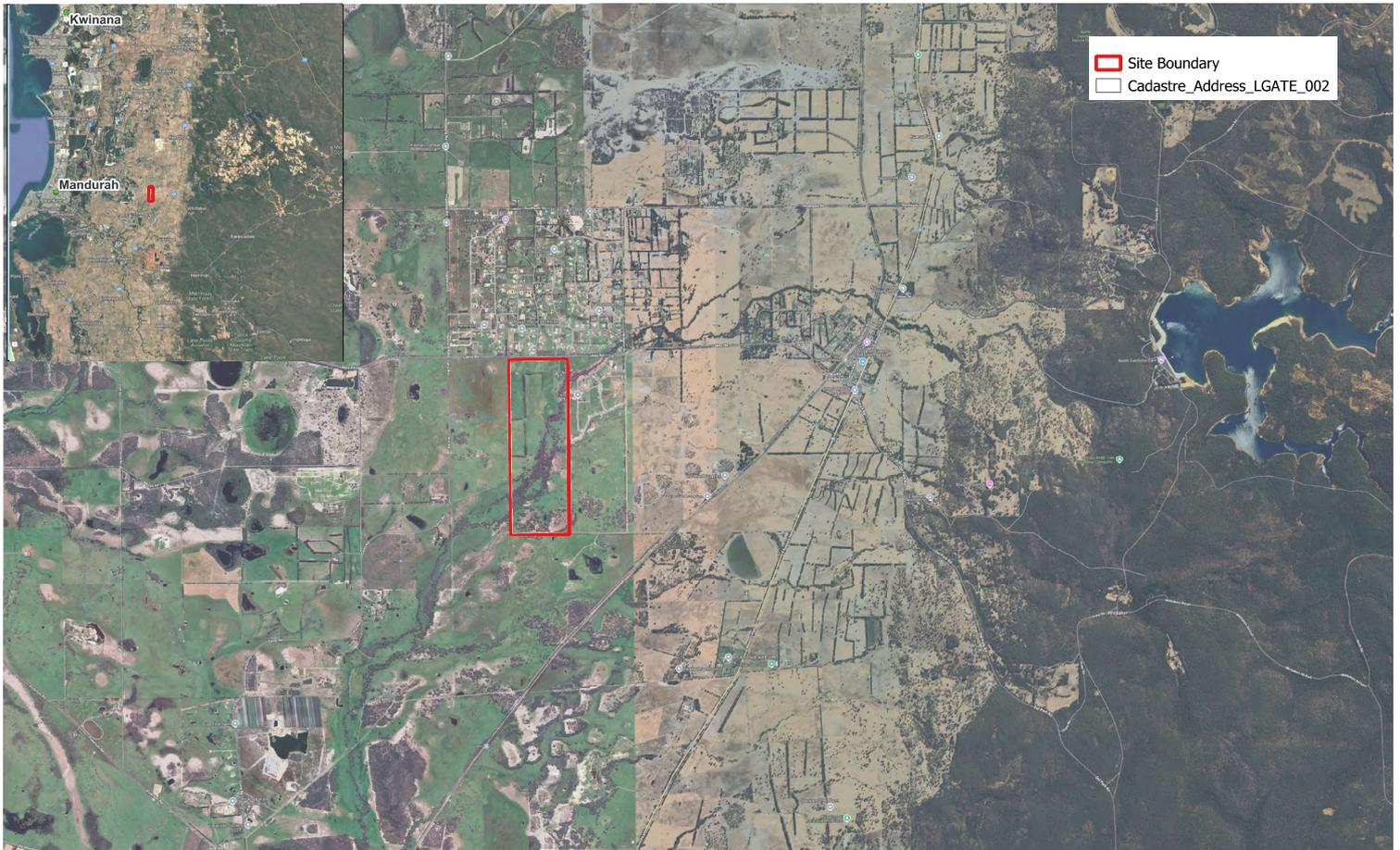
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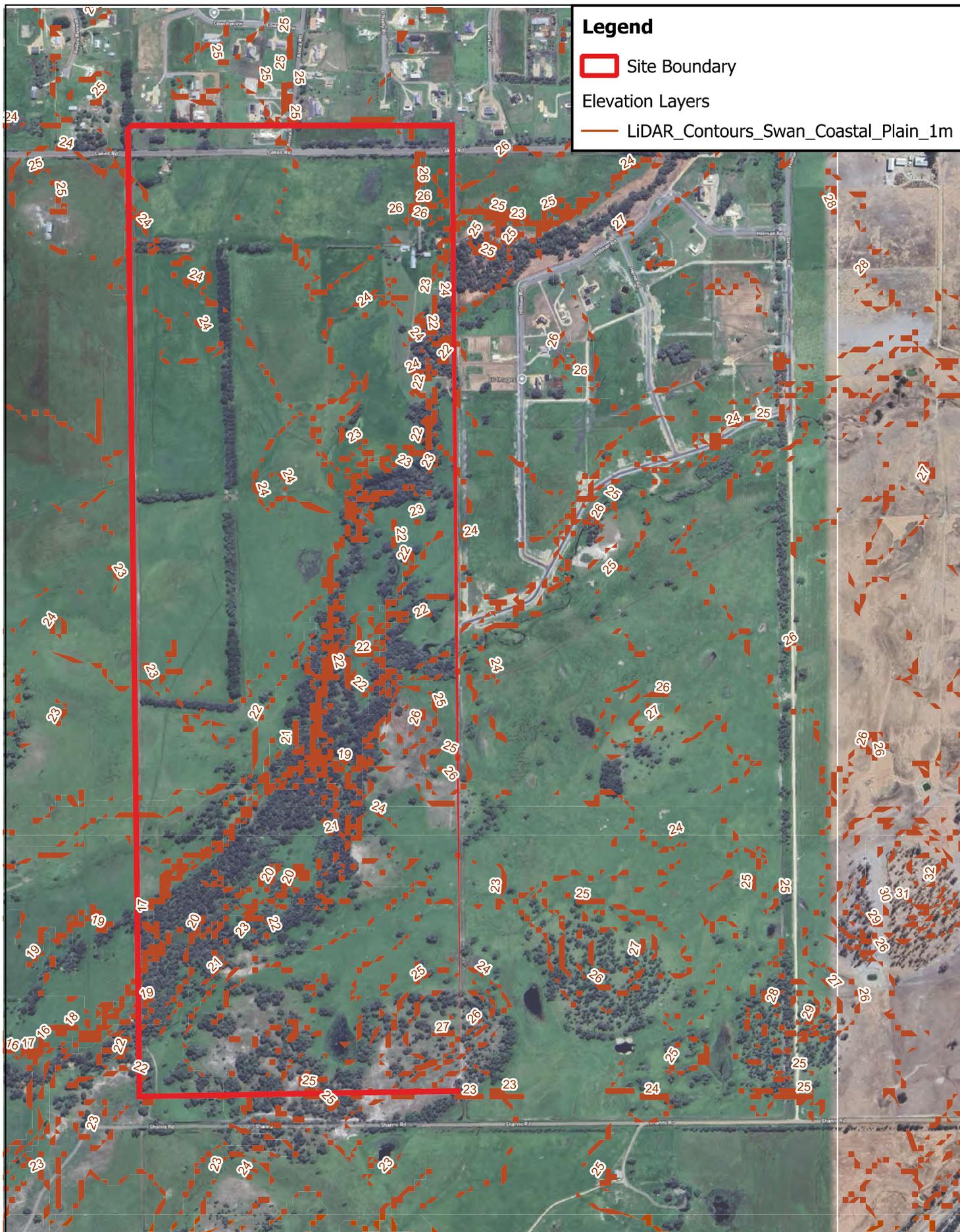
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Figure A

Site location



Legend

 Site Boundary

Elevation Layers

 LiDAR_Contours_Swan_Coastal_Plain_1m



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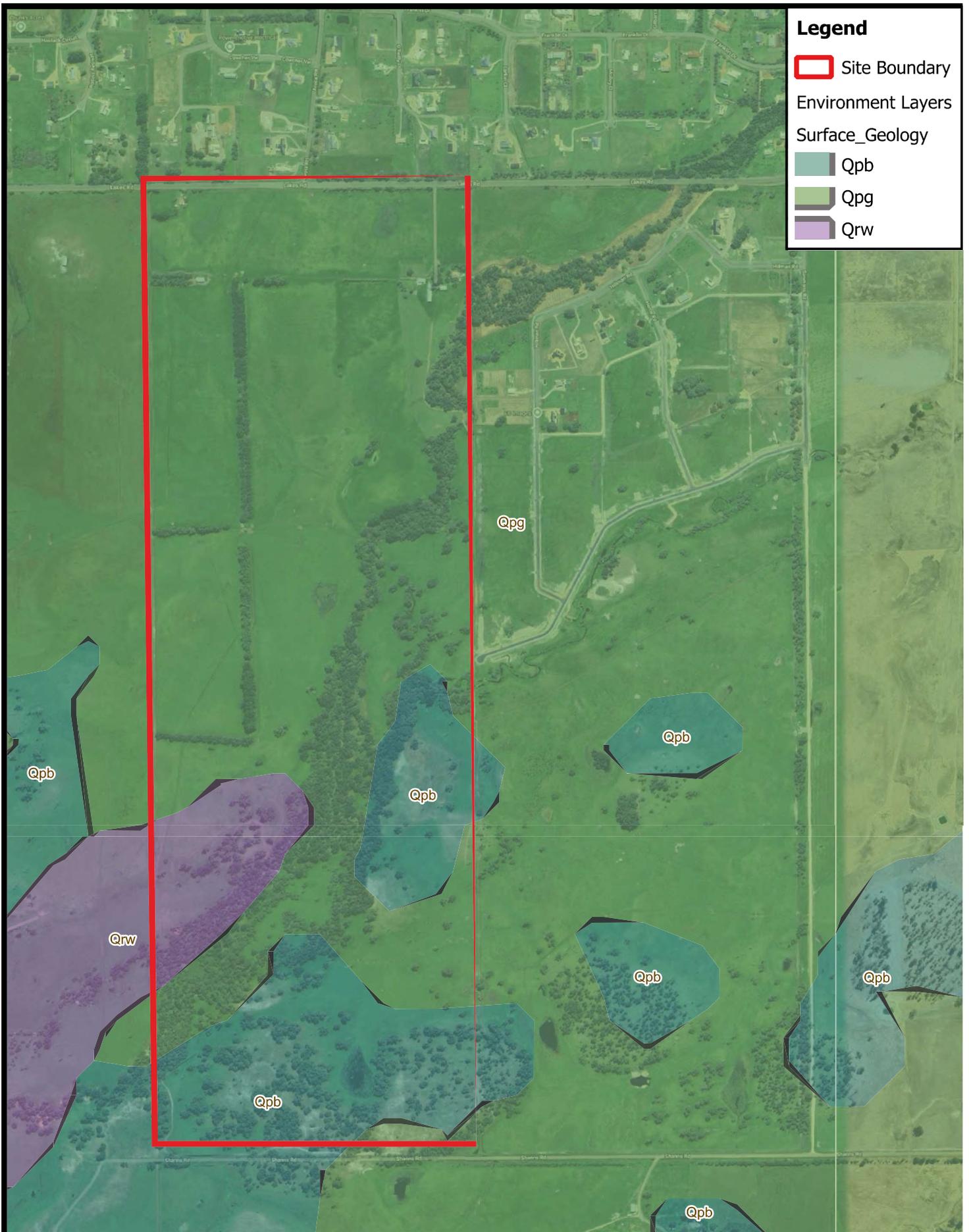
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GDA94 / MGA zone 50

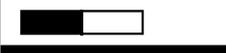
Figure B

1 m topographic contours



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Figure C

Surface geology



Legend

 Site Boundary

Environment Layers

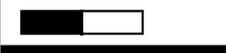
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 Moderate to low risk



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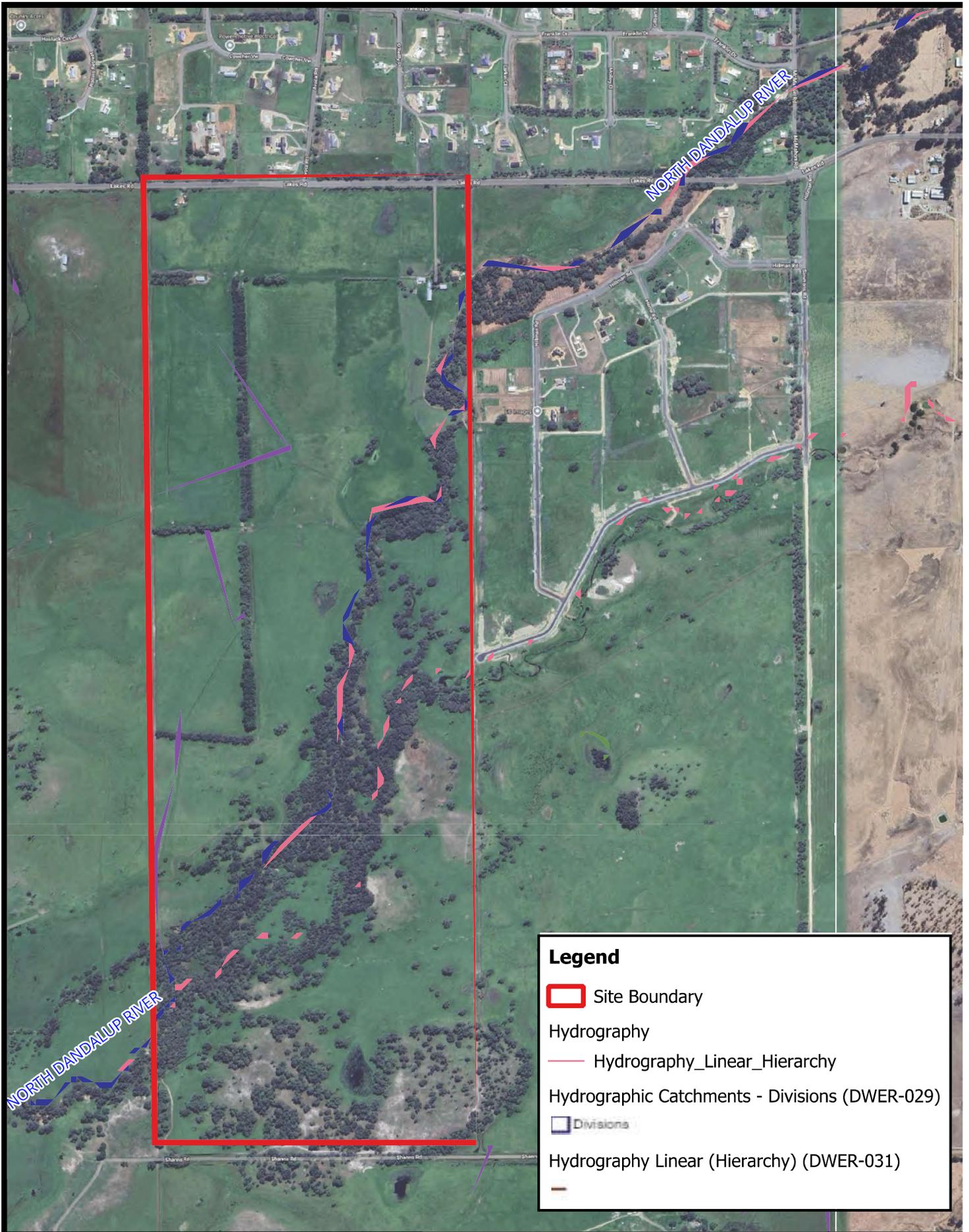
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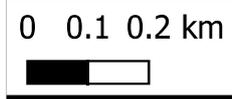
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Figure D

Acid sulfate soil risk mapping



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Figure E
Pre-development hydrology



Legend

FPM Floodplain Area (DWER-020)

EXT_TYPE

- 1 in 5 (20%) AEP floodplain
- 1 in 10 (10%) AEP floodplain
- 1 in 20 (5%) AEP floodplain
- 1 in 25 (4%) AEP floodplain
- 1 in 50 (2%) AEP floodplain
- 1 in 100 (1%) AEP floodplain
- Designated flood event floodplain
- 1 in 200 (0.5%) AEP floodplain
- 1 in 500 (0.2%) AEP floodplain
- 1 in 1000 (0.1%) AEP floodplain
- 1 in 2000 (0.05%) AEP floodplain
- 1 in 5000 (0.02%) AEP floodplain
- Maximum channel capacity
- Probable maximum flood

FPM Extent of Flooding (DWER-017)



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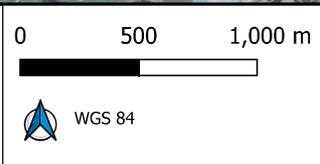
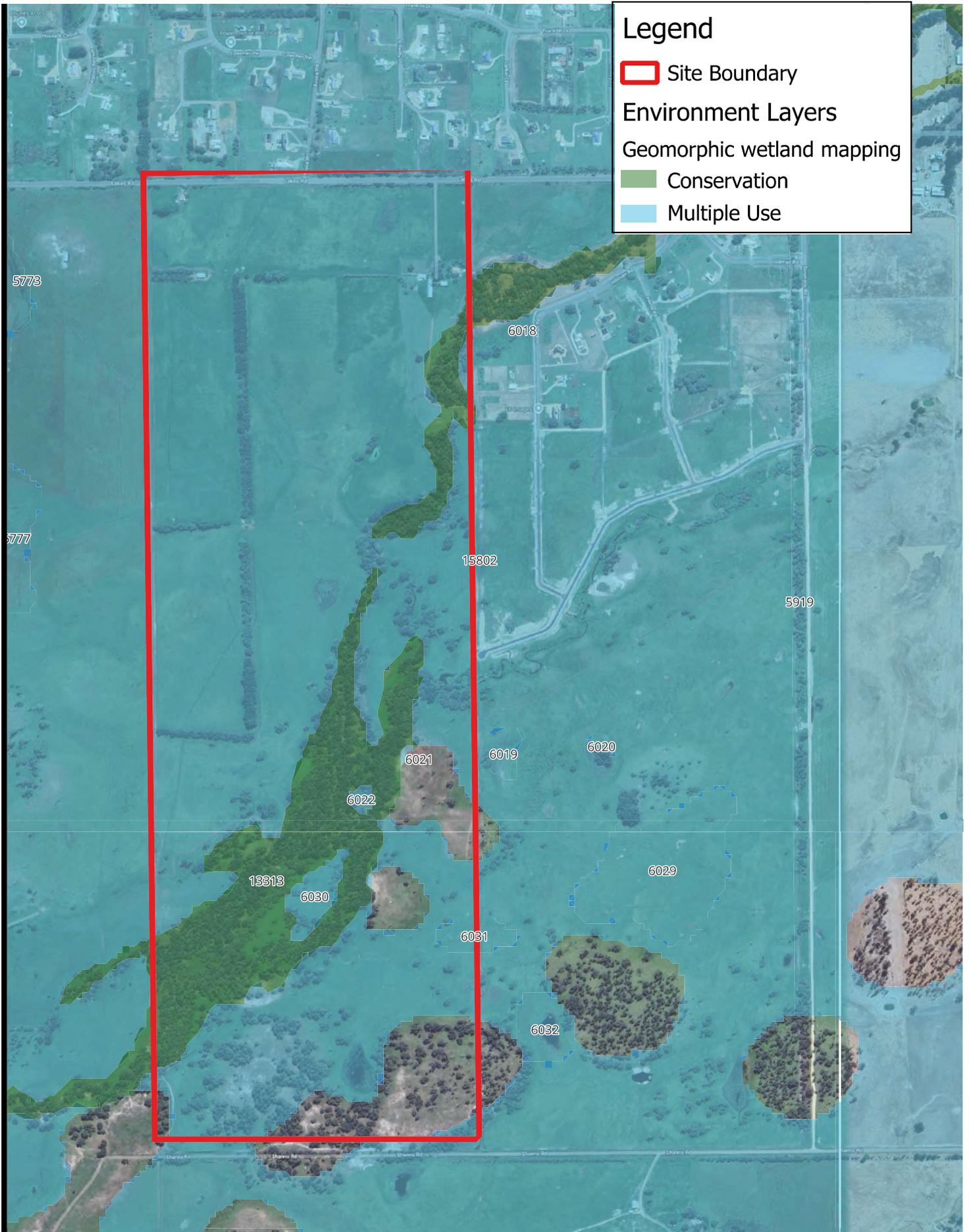


Figure F
 DWER floodplain mapping for the 1% AEP event for the North Dandalup River

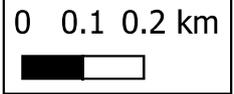


Legend

- Site Boundary
- Environment Layers**
- Geomorphic wetland mapping
- Conservation
- Multiple Use

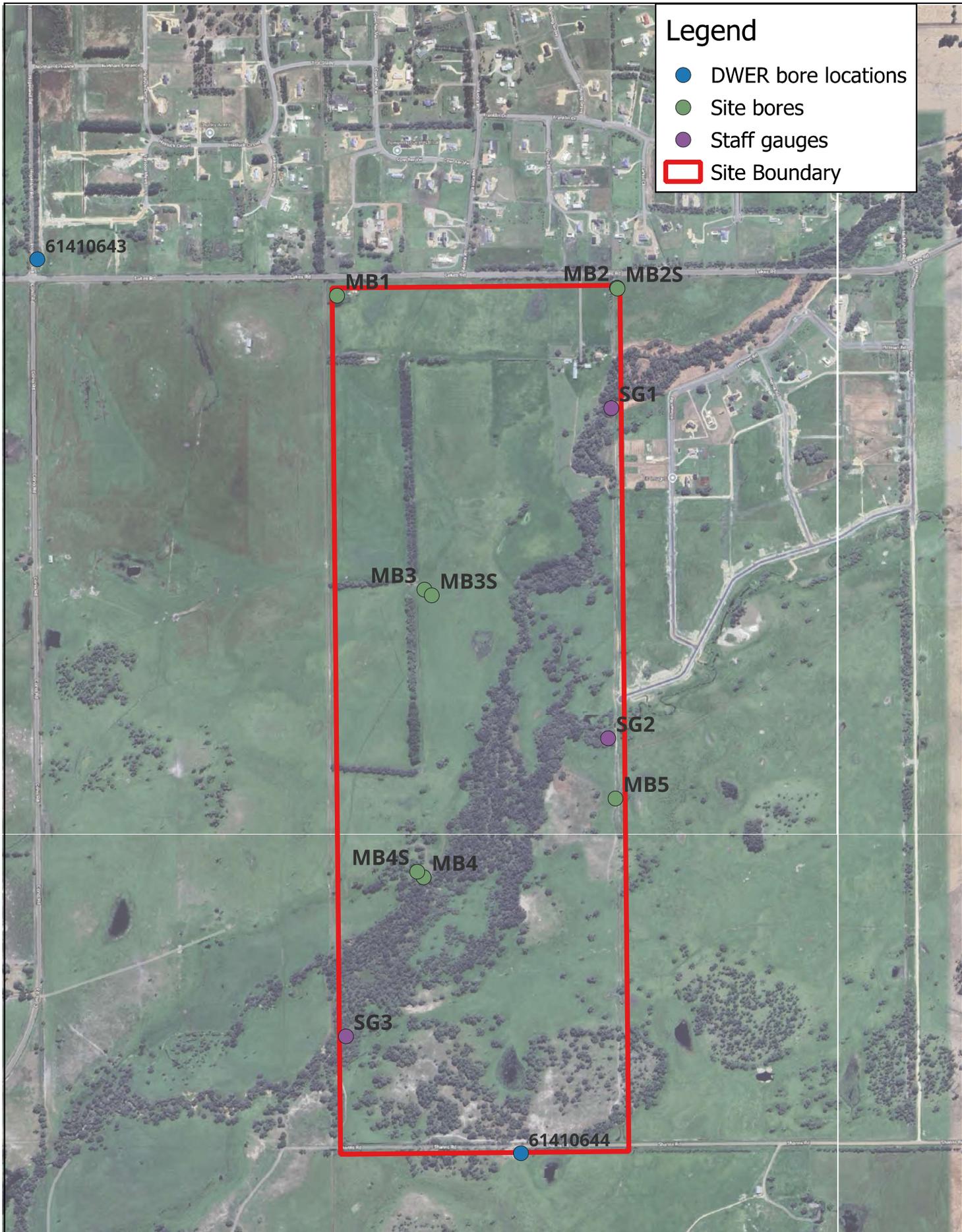


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Figure G
 Geomorphic wetland mapping



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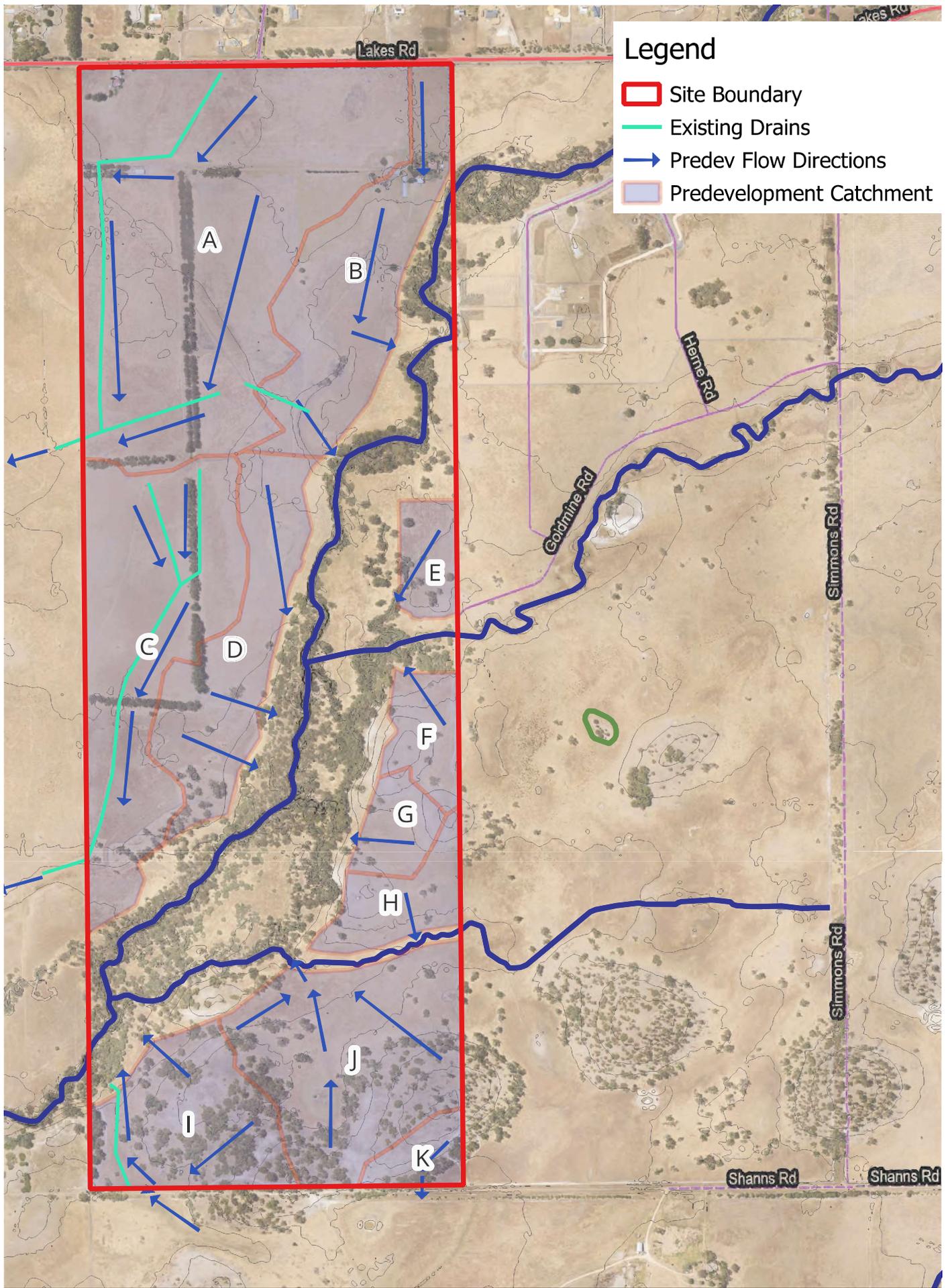
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Figure H

Pre-development groundwater and surface water monitoring locations



Legend

- Site Boundary
- Existing Drains
- Predev Flow Directions
- Predevelopment Catchment



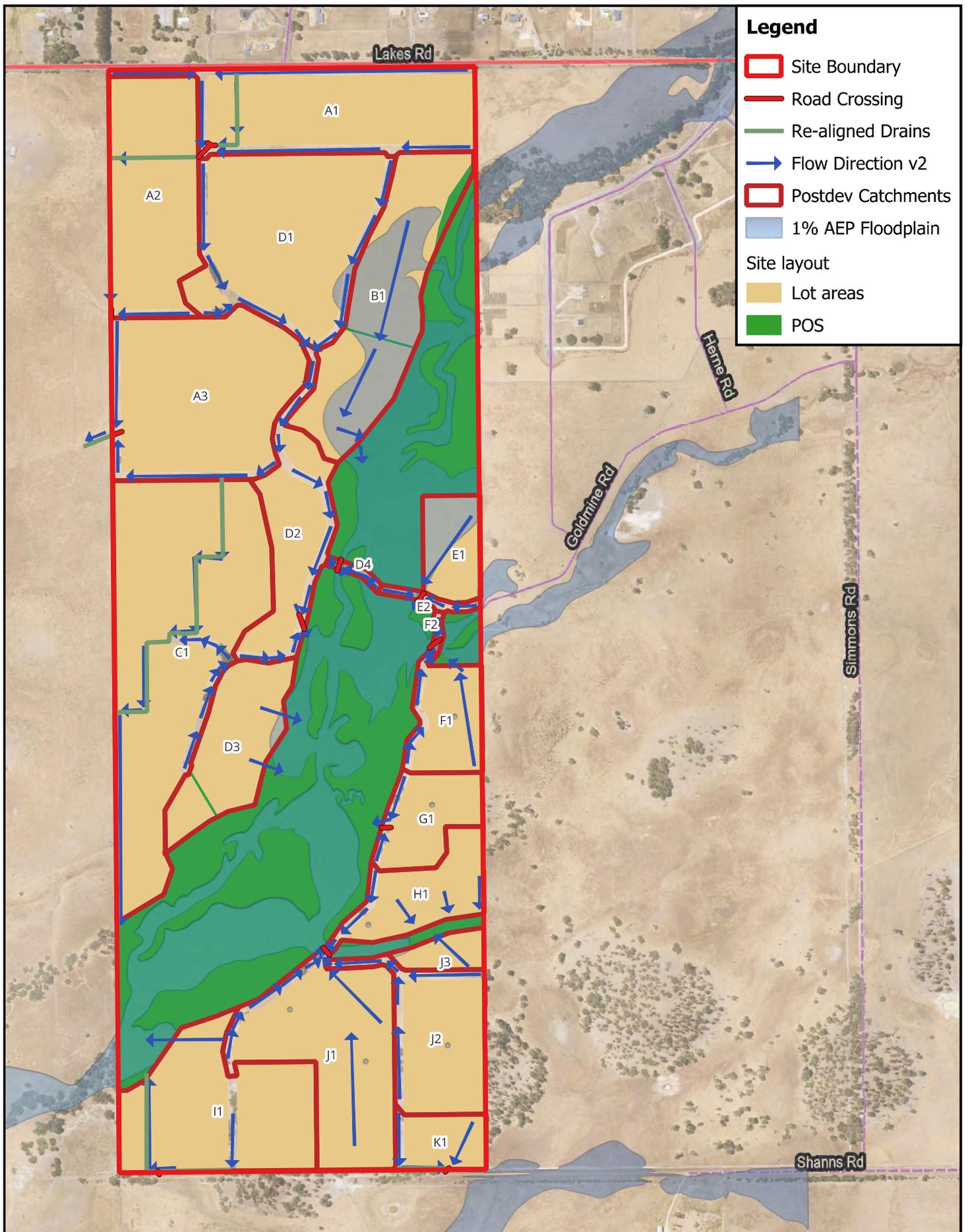
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 Drawn by: Daniel Williams
 Date: 16/07/2025
 Scale: 1:11000
 Page size: A4
 Sources: data.gov.au,
 DWER, landgate

0 0.1 0.2 0.3 0.4 km

GDA94 / MGA zone 50

Figure I

Pre-Development Catchments



Project code:
 Drawn by: Rachel Murray
 Date: 25/07/2025
 Scale: 1:11000
 Page size: A4
 Sources: data.gov.au, DWER,
 landgate

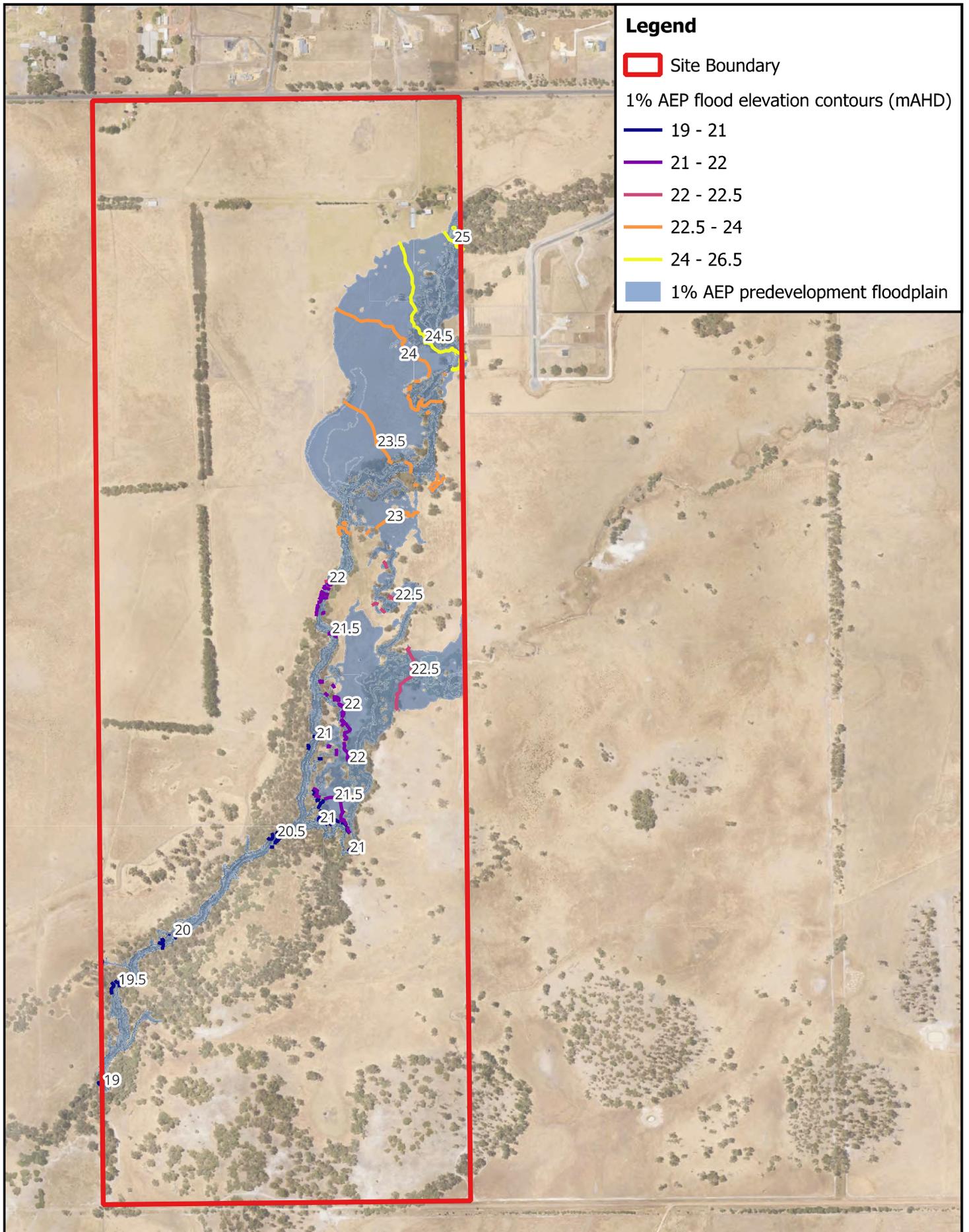
0 100 200 m



GDA94 / MGA zone 50

Figure J

Post-Development Catchments



Legend

- Site Boundary
- 1% AEP flood elevation contours (mAHD)
- 19 - 21
- 21 - 22
- 22 - 22.5
- 22.5 - 24
- 24 - 26.5
- 1% AEP predevelopment floodplain

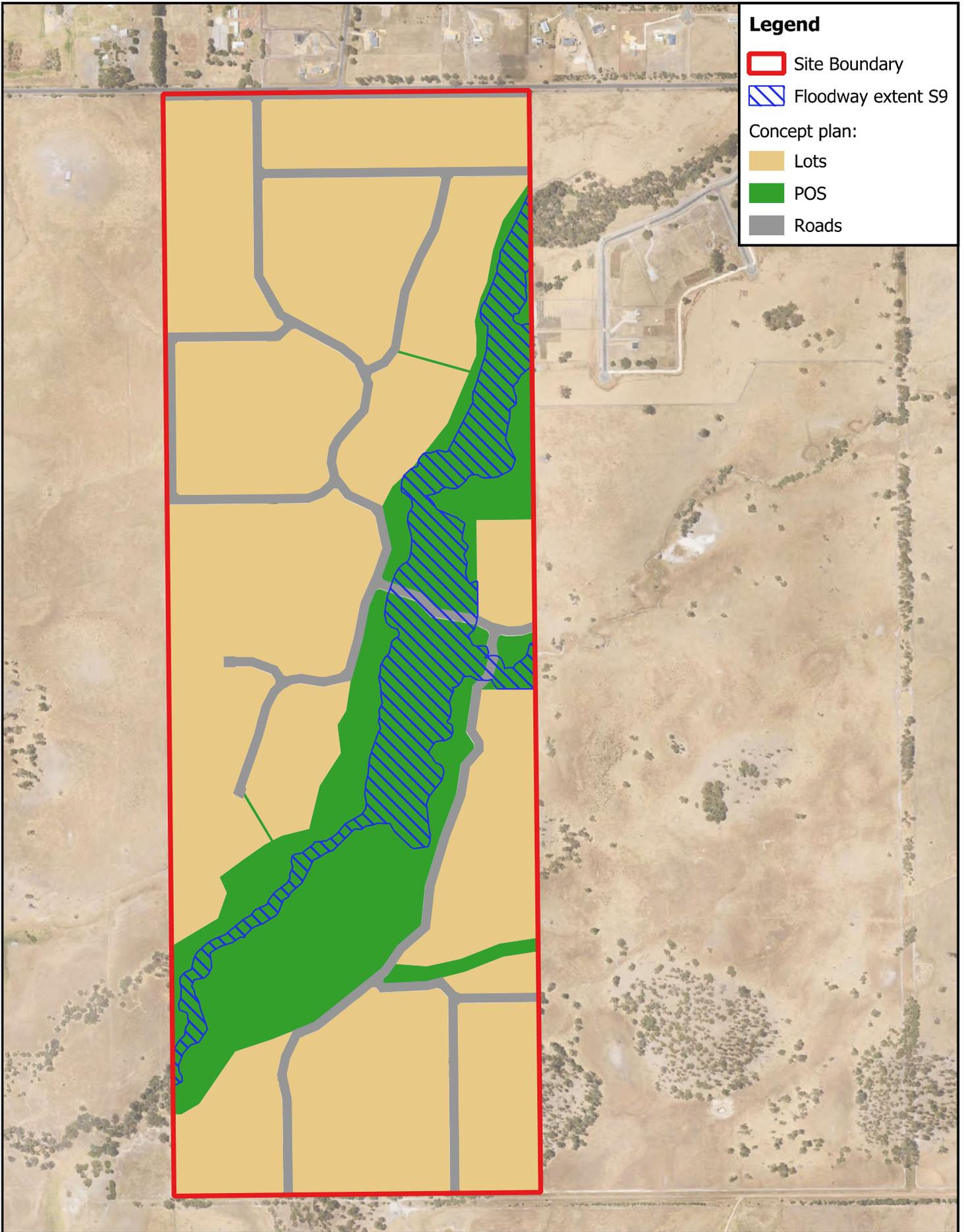


Project code: PW035823
 Drawn by: Rachel Murray
 Date: 21/07/2025
 Scale: 1:11000
 Page size: A4
 Sources: data.gov.au, DWER,
 landgate



Figure K

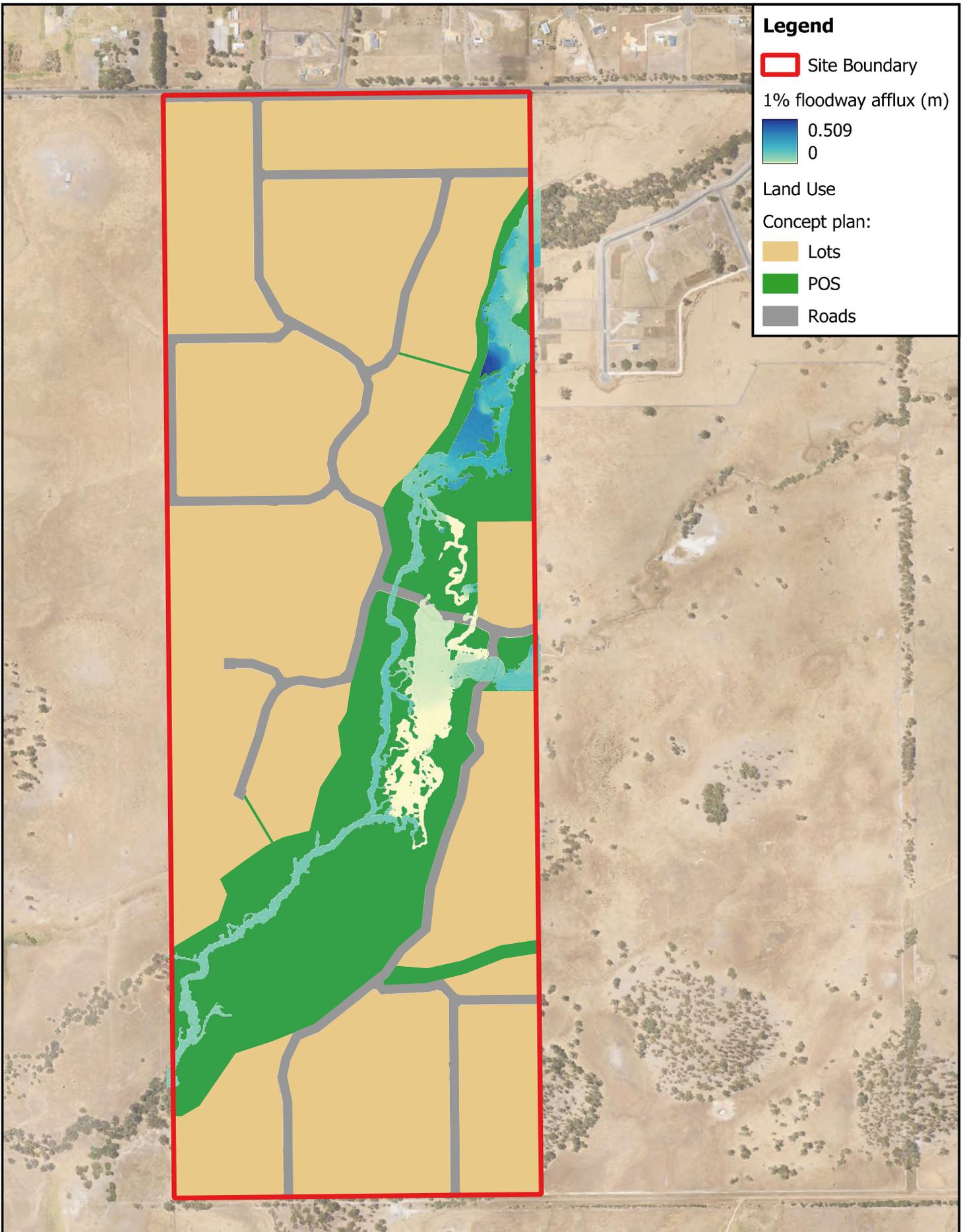
1% AEP Predevelopment Floodplain



Project code:
 Drawn by: Rachel Murray
 Date: 28/07/2025
 Scale: 1:11000
 Page size: A4
 Sources: data.gov.au, DWER,
 landgate



Figure L
 1% AEP Flood Extent



Project code: PW035823
 Drawn by: Rachel Murray
 Date: 21/07/2025
 Scale: 1:11000
 Page size: A4
 Sources: data.gov.au, DWER,
 landgate

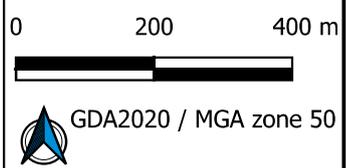
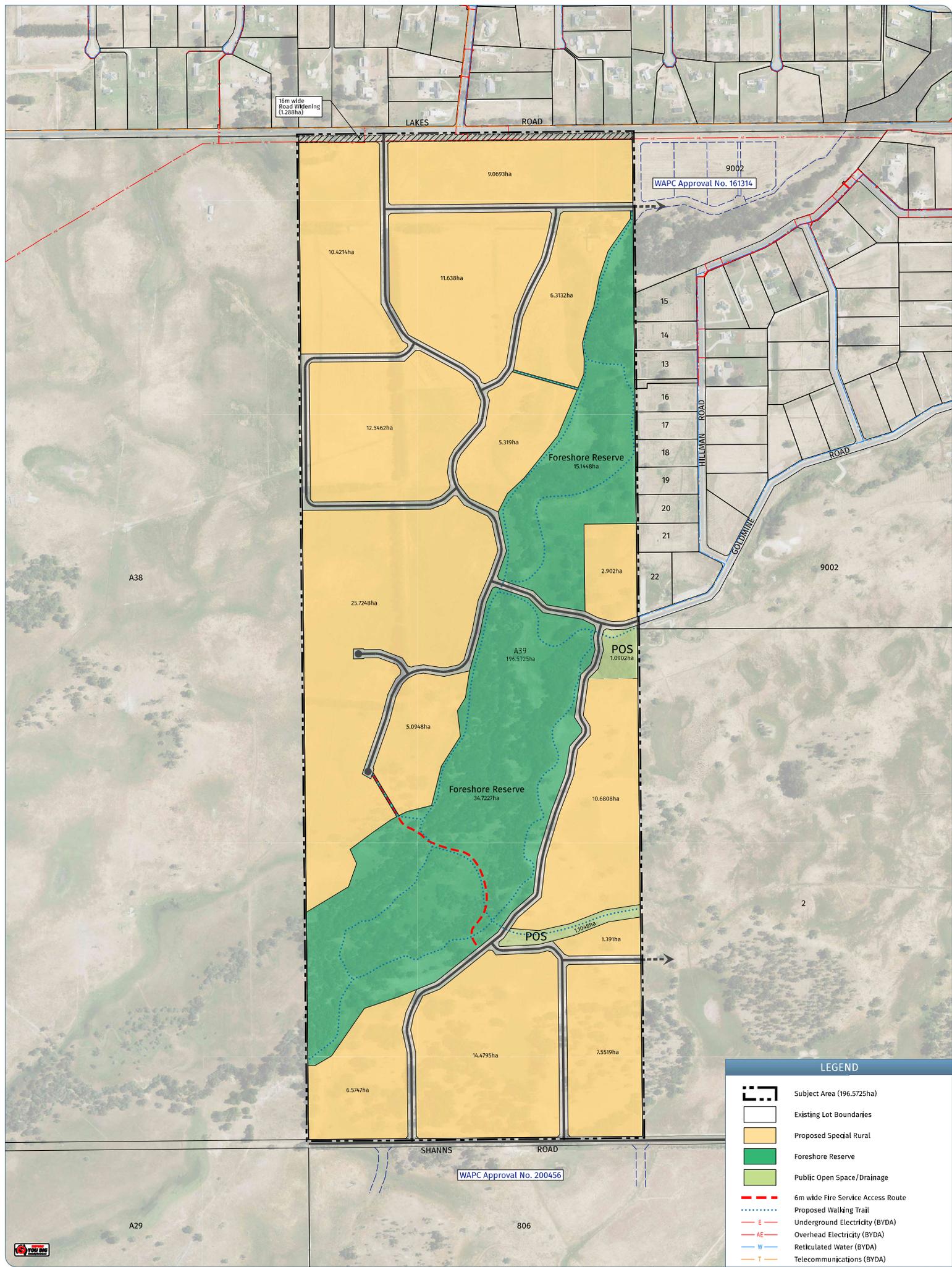


Figure M

1% AEP Floodway Afflux

Appendix A: Site layout



LEGEND

- Subject Area (196.5725ha)
- Existing Lot Boundaries
- Proposed Special Rural
- Foreshore Reserve
- Public Open Space/Drainage
- 6m wide Fire Service Access Route
- Proposed Walking Trail
- Underground Electricity (BYDA)
- Overhead Electricity (BYDA)
- Reticulated Water (BYDA)
- Telecommunications (BYDA)

CONCEPT SUBDIVISION - CELLS

Lot A39 (No. 1818) Lakes Road,
NORTH DANDALUP

Plan No. | 2450-05
 Date | 10/07/25
 Drawn | NP
 Checked | MB
 Revision | A

PERTH & FORRESTDALE:
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ALBANY | BUNBURY | BUSSELTON | FORRESTDALE | PERTH

Scale | 1:4000 @ A1

Harley Dykstra
 PLANNING & SURVEY SOLUTIONS



NOTE: This plan has been prepared for planning purposes. Areas, Centres and Openings shown are subject to survey.

Appendix B: Land Capability Report

Bayley Environmental, 2025

LOT A39 LAKES RD, NORTH DANDALUP

**LAND CAPABILITY FOR ON-SITE
EFFLUENT DISPOSAL**

Prepared for

Valley Holdings WA Pty Ltd

252 Fitzgerald St
PERTH WA 6000

Report No. J25003

7 August 2025

BAYLEY ENVIRONMENTAL SERVICES

30 Thomas Street

SOUTH FREMANTLE WA 6162

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4	Hydrology
5	Maximum Groundwater Level
6	On-site Effluent Disposal Constraints

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Appendix	Title
A	Soil Logs
B	Permeability Test Results

1.0 INTRODUCTION

Valley Holdings WA Pty Ltd proposes to rezone Lot A39 (No. 1818) Lakes Road, North Dandalup (the subject land) for rural-residential use. The rezoning is intended to facilitate the future subdivision of the 194.7ha property into approximately 120 lots with a minimum size of 1ha. All lots will employ on-site effluent disposal. Figure 1 shows an aerial photograph of the subject land and surroundings.

Bayley Environmental Services was commissioned in March 2025 to undertake site investigations and prepare a report to demonstrate the capability of the subject land to support on-site effluent disposal. The investigations included:

- excavation of twelve test pits to depths of up to 2.7m to inspect soil profiles and search for confining layers (rock, clay) and shallow groundwater occurrence;
- constant-head infiltration tests to 0.5m depth at eight locations to measure soil permeability;
- inspection of site slope, aspect, surface conditions, vegetation and drainage;
- collation of information and data from previous investigations on the subject land; and
- assessment of the subject land's capability for effluent disposal in accordance with AS1547:2012 – *Onsite Domestic Wastewater Management* and the *Government Sewerage Policy 2019*.

A detailed Site and Soil Evaluation (SSE) report will be prepared in accordance with AS1547:2012 and the GSP prior to subdivision of the land.

2.0 EXISTING ENVIRONMENT

2.1 Climate

North Dandalup has a strongly seasonal rainfall, with most 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 Mandurah, the closest Bureau of Meteorology weather station in a similar geographical setting, is 882mm, of which over 80% falls between the months of May and September. Figure 2 shows rainfall occurrence for Mandurah.

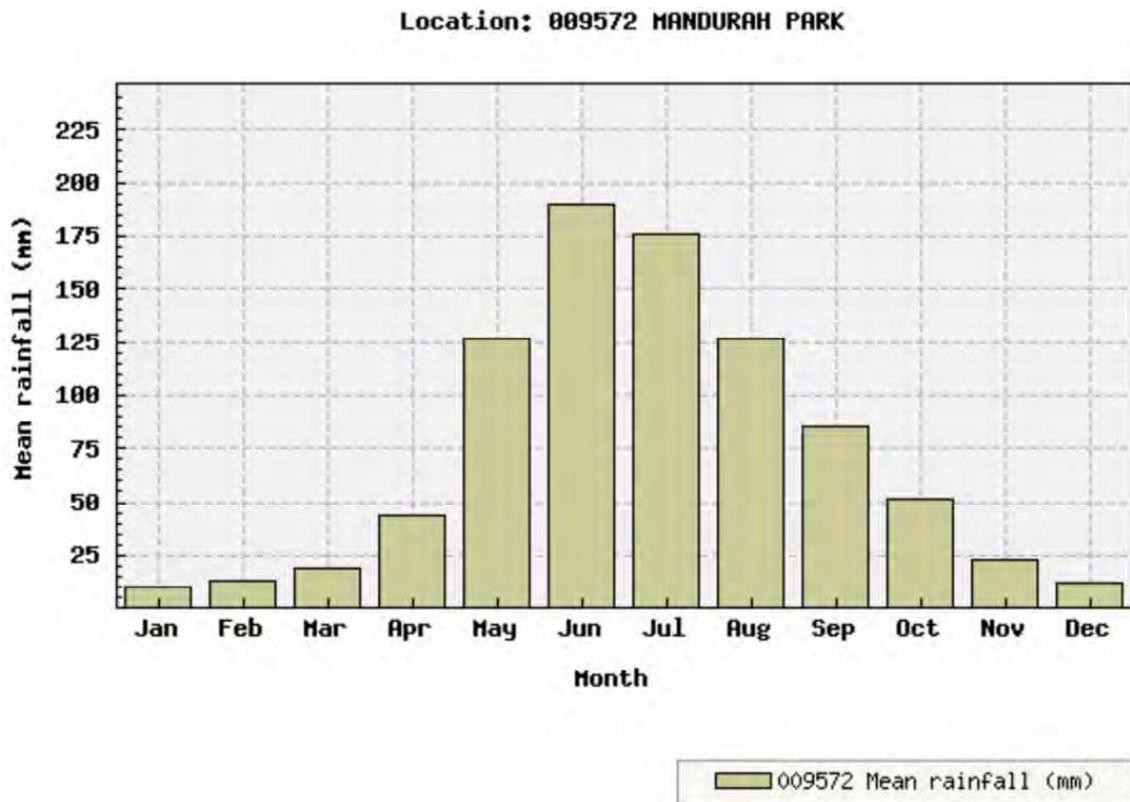


Figure 2 Mandurah Mean Rainfall

2.2 Topography

The north-western half (approximately) of the subject land is largely a low plain at an elevation of 22-26m AHD, sloping very gently to the south-west at a gradient of less than 0.4%. The south-eastern part is a mosaic of low sand dunes and intervening sandy swales at elevations of 20-27m AHD, with slopes ranging from 0.7% to 7%.

In the centre of the subject land, the land drops sharply into the incised channel of the North Dandalup River at elevations of 16.5-22.5m AHD.

2.3 Geology and Soils

The subject land is situated on the Pinjarra Plain, which consists of shallow sandy soils overlying alluvial silty clays. The Geological Survey of Western Australia (Archer *et al*, 1978) mapped most of the subject land as S10: Thin veneer of Bassendean sand over Guildford Formation sandy clay (Qpb/Qpa), while the higher areas and low dunes were mapped as S8: Deep grey Bassendean sand (Qpb). The watercourse of the North Dandalup River and its immediate surroundings was mapped as Alluvium (Qha).

The Department of Agriculture (Wells, 1989) mapped the lower-lying parts of the subject land as Pinjarra Plan (P1a, P1b, P8, P9) and the dunes as Bassendean Dune and Plain System (B1, B2). These land units are described by Wells (1989) as follows:

Pinjarra Plain

Broad low-relief plain west of the foothills, on mostly Pleistocene fluvial sediments and some Holocene alluvium associated with major active drainage systems. Major soils are naturally poorly drained and many swamps occur.

- P1a Gently undulating plain with deep acid mottled yellow duplex soils having sand to sandy loam surface and generally shallow topsoil over clay subsoil.
- P1b Gently undulating plain with deep acid mottled yellow duplex soils having sand to sandy loam surface and generally moderately deep topsoil over clay subsoil.
- P8 Broad imperfectly to poorly drained flats and ill-defined stream channels with moderately deep to deep sands over mottled clays; acid gley and yellow duplex soils to uniform bleached pale brown sands over clay.
- P9 Generally shallowly incised stream channels of minor creeks and rivers with deep acidic mottled yellow duplex soils.

Bassendean Dune and Plain System

Very low relief, leached, grey siliceous Pleistocene sand dunes, intervening sandy and clayey swamps and gently undulating plains; occurring immediately west of, and partly overlying, the Pinjarra Plain.

- B1 Very low relief dunes and areas of undulating sand plain of deep bleached grey sands with either a pale yellow B horizon or an iron-organic hardpan at depths generally greater than 2m.
- B2 Sand plain of deep well drained bleached grey sand with an iron-organic hardpan or less commonly a pale yellow B horizon, generally at 1 - 2m depth.

Test pitting at twelve locations across the subject land (Figure 3) found soil profiles in the lower areas (Pinjarra Plain) generally consisting of grey-brown and orange-brown silty or clayey sand overlying sandy or lateritic clay at about 1m. The test pits on the

dunes found a profile of grey to white sand over a yellow sand at about 1m, with an iron-enriched hardpan sometimes present at about 2.5m. These results generally accord with the GSWA and DoA mapping. Figure 3 shows the geology and soils of the subject land. Appendix A shows soil logs from the test pits.

2.4 Soil Permeability

Constant-head permeability tests at 0.5m depth at eight locations across the subject land May 2025 (Figure 3) returned permeabilities of between 1m/day and 21m/day. The result of 21m/day came from a site on a grey sandy Bassendean dune. Table 2.1 summarises the permeability test results. Appendix B shows the detailed test results.

Table 2.1 Permeability Test Results

<i>Location (see Figure 3)</i>	<i>Soil Type</i>	<i>Permeability (m/day)</i>
LI1	Brown sand on orange-brown pebbly silt	2
LI2	Yellow-brown sand	2.5
LI3	Yellow-brown clayey sand	1
LI4	Orange-brown clayey sand	1.5
LI5	White sand	4.5
LI6	White sand on pale brown sand	21
LI7	White sand on brown sand	7.5
LI8	Yellow-brown clayey sand	2

The test results show that the permeability of the shallow soils is generally moderate in the Pinjarra Plain soils and high to very high in the grey Bassendean sands.

2.5 Phosphorus Retention Index

No phosphorus retention index (PRI) tests have been carried out on the subject land to date, but previous testing on land to the immediate east and south has shown that the Pinjarra Plain soils generally have moderate to very high PRI (typically 20-120), while the Bassendean Sand soils have very low PRI (typically <1).

The Health Department does not require a minimum PRI beneath land application areas where secondary effluent treatment systems with nutrient removal capability are used. Nevertheless, soil PRI testing will be undertaken during the preparation of a Site & Soil Evaluation (SSE) report prior to subdivision.

2.6 Soil Category

The soil observations at 0.5m depth, together with the measured permeabilities, suggest that the soils of the P1a/b, P8 and P9 land units belong to soil category 2: Sandy Loams, while those in the B1 and B2 units are category 1: Gravels and Sands, as defined by AS1547:2012.

2.7 Acid Sulphate Soils

The soils of the site are mapped by DBCA as low to moderate ASS risk, mostly at depths of over 3m. The nearest mapped high ASS risk area is a wetland located about 1.8km north-west of the subject land.

The development of the subject land is expected to involve little excavation or dewatering (required for installation of underground power, water and communications only), and none below 3m depth. ASS is therefore not considered to be a significant issue on the subject land. If significant dewatering were proposed, it would be prudent to monitor the abstracted water and treat with lime before disposal if necessary.

2.8 Hydrology

2.8.1 Surface Drainage

The major surface drainage feature of the subject land is the North Dandalup River, which flows diagonally across the site from the north-east corner to the south-west corner. The river bed is deeply incised in parts and falls from an elevation of about 22.5m AHD at the north-eastern boundary of the subject land to about 16.5m AHD at the south-western boundary. The top of the bank falls from about 24.5m AHD to 19m AHD over the same distance. Away from the river, the land rises gently to the north-west and south-east at gradients of between about 3% and less than 0.2%

Two main tributaries enter the river within the subject land. The first is a creekline that rises adjacent to the South Western Highway 3.5km east of the subject land and joins the river just south of the centre of the subject land. The second is a minor creek that rises in farm paddocks 1.5km to the east and joins the river just before its exit from the subject land. Several shallow paddock drains flow into the river from the north-western part of the subject land. A number of small seasonal billabongs occur along the margins of the river and its tributaries, particularly in the south of the site. Figure 4 shows the surface hydrology of the subject land.

Pentium (2025) mapped parts of the subject land as susceptible to flooding in a 1-in-10 year (10% AEP) flood event. The flooding is wholly contained within the proposed foreshore reserve of the North Dandalup River and does not impinge on the

development area with the exception of two small areas in the south-east, which can be readily avoided for effluent disposal.

2.8.2 Groundwater

Groundwater occurs at shallow depth throughout the subject land. The regional groundwater flow is to the west-southwest but local flows and levels are influenced in winter by the creeks and drains on the subject land. The presence of low-permeability clay subsoils in parts of the site means that a perched water table is likely to develop in those areas during wet winter periods.

Figure 5 shows preliminary estimated maximum groundwater levels (MGL) based on on-site bore readings by Pentium in June 2025. Figure 5 also shows estimated depths to the MGL based on the Pentium groundwater data and detailed topographic surveys by Harley Dykstra. Due to the slope of the land, the groundwater table will not rise above the ground surface except in localised areas such as the billabongs mentioned in Section 2.8.1, most of which are within the foreshore reserve. Instead, where the groundwater table reaches the surface it will become surface runoff. Further late-winter groundwater measurements will be undertaken prior to the preparation of an SSE report in support of a subdivision application.

Parts of the subject land are susceptible to waterlogging by groundwater rise and ponding of rainfall during wet winters, with the extent depending on the seasonal and short-term rainfall. Figure 5 shows the extent of surface inundation or saturation visible in August 2017, which is the greatest extent visible on aerial photography by Nearmap and Landgate since 1974. Where inundation is likely to occur, filling, subsoil drains and/or shallow swales will be used to prevent its occurrence and remove any ponded water from the vicinity of land application areas.

2.8.3 Wetlands

The DBCA maps most of the subject land as palusplain (seasonally waterlogged plain). Three areas of higher dunes in the south are mapped as dry land. Site inspection shows that the North Dandalup River is a well-defined watercourse, not a palusplain.

2.9 **Sewage Sensitive Area**

The subject land is mapped as a sewage sensitive area (SSA) under the Government Sewerage Policy due to its location within the Peel-Harvey coastal plain catchment and its proximity to Conservation category wetlands.

3.0 CAPABILITY FOR ON-SITE EFFLUENT DISPOSAL

3.1 Soil Permeability

The results of permeability testing at eight locations in accordance with AS1547:2012 as described in Section 2.4 show that the soils of the site have adequate permeability to support on-site effluent disposal. The very high permeability of the soils on the Bassendean dunes (B1/B2 soil types) means that pressure dosing of leach drains may be required in these areas to ensure even distribution of effluent.

3.2 Watercourse Setbacks

The Government Sewerage Policy prohibits effluent disposal within 100m of waterways, significant wetlands and drains that discharge into waterways or significant wetlands without treatment. Figure 6 shows the areas within 100m of the North Dandalup River and its tributaries where effluent disposal will not be permitted. The paddock drains west of the river will be realigned to follow lot boundaries and planted to create living streams, and therefore will not require a 100m setback.

3.3 Groundwater Separation

Figure 5 shows that the MGL is expected to be within 1.5m of the ground surface over a large proportion of the subject land. Fill will be required on most lots to achieve the required 1.5m clearance from the effluent discharge point to the MGL.

Figure 6 shows the estimated fill requirements for subsoil drip irrigation or flatbed leach drains, including 0.1m of soil cover over the drip lines or leach drains. The fill will be composed of uncompacted permeable sand or loam with an *in situ* saturated hydraulic conductivity of at least 0.5m/day. Given the mandatory use of secondary treatment systems with nutrient removal capability, the Heath Department does not set PRI requirements for the soil beneath LAAs in sewage sensitive areas.

Where the MGL is predicted to be at the ground surface, subsoil drains will be installed at the natural ground level to limit groundwater rise into the fill.

3.4 Inundation

The Government Sewerage Policy prohibits effluent disposal on land that is subject to inundation in a 10-year storm. This includes inundation due to external (e.g. riverine flooding) and local (e.g. rainfall ponding) factors.

Figure 4 shows that the proposed development areas on the site are all outside of the predicted 10-year ARI floodplain of the North Dandalup River and tributaries with the exception of two small areas in the south-east, which can be readily avoided for effluent disposal.

In areas where the MGL is predicted to be at the ground surface, filling, subsoil drainage and/or shallow (~0.3m) swales will be used to prevent surface ponding and to drain any ponded water away from the vicinity of the land application areas. The swales and subsoil drains will discharge into roadside swales. Where the swales cross boundaries between lots, they will be protected by easements in favour of the Shire of Murray. The swales will be densely planted with native species to filter nutrients and sediments from the water prior to discharge from the subject land.

3.5 Site Capability Summary

The capability of the subject land 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 AS1547:2012 factors and the degree to which they are satisfied by the subject land.

Table 3.1 On-site Effluent Disposal Capability

<i>Factor (AS1547:2012 or GSP)</i>	<i>Criterion</i>	<i>Site Characteristics</i>	<i>Complies</i>
Slope	<20%	≤7%	Yes
Groundwater depth	1.5m below discharge point	0 – 4.5m	Fill required in some areas
Soil permeability (Ks)	>0.06 m/day	1 – 21 m/day at 0.5m	Yes
Soil PRI	>15	Very low to very high	Secondary treatment - soil amendment not required
Distance from surface watercourses, significant wetlands and untreated drains	>100m	All effluent disposal >100m from watercourses	Yes
Lot area	1ha in SSAs	1ha	Yes
Inundation and flooding	Not subject to inundation or flooding in a 10% AEP (1 in 10 year ARI) rainfall event	Local ponding may occur in places after heavy rainfall	Local drainage and filling required

The table shows that the subject land generally meets the requirements of the Government Sewerage Policy, but that filling and/or drainage will be required in some areas.

4.0 CONCLUSION AND RECOMMENDATIONS

This investigation has found that the subject land is capable of supporting on-site effluent disposal on one-hectare or larger lots. Some special measures are required to ensure that the effluent disposal is environmentally sustainable.

- The minimum lot size of 1ha meets the minimum for lots in sewage sensitive areas. All lots will have ample space for a land application area sized in accordance with Section 3.3.
- Filling will be required in some areas to meet the required 1.5m depth to the maximum groundwater level. The fill should be composed of uncompacted permeable sand or loam with an *in situ* saturated hydraulic conductivity of at least 0.5m/day.
- Shallow swales may be required in some areas to eliminate surface ponding after heavy rainfall in areas where the MGL is predicted to reach the ground surface.
- All effluent disposal systems will be located at least 100m from surface watercourses.
- The soils have adequate permeability for effluent disposal.
- If leach drains are used in areas of Bassendean Sand (B1 and B2 soils), pressure distribution of effluent will be required to ensure even distribution of effluent over the base of the leach drain. The general use of ATU systems will ensure that this is achieved.

A Site and Soil Evaluation (SSE) report will be prepared prior to application for subdivision. The SSE will include the results of late-winter measurements and soil PRI testing, and will include conceptual sizing and location of land application areas on all lots within the subdivision.

5.0 REFERENCES

Archer R.H., Biggs E.R., Hirschberg K.-J.B. & Wilde S.A. (1978). *Pinjarra Urban Geology 2032-I*. 1:50,000 Urban Geology Series. GSWA, Perth.

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Government of Western Australia (2019). *Government Sewerage Policy*. Dept of Planning, Lands & Heritage, Perth.

Health Department of Western Australia (2001). *Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units (ATUs)*. Health Department of WA, Perth.

Standards Australia (2012). *Australian/New Zealand Standard 1547:2012 – On-site Domestic Wastewater Management*. SAI Global Ltd, Sydney.

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Figures

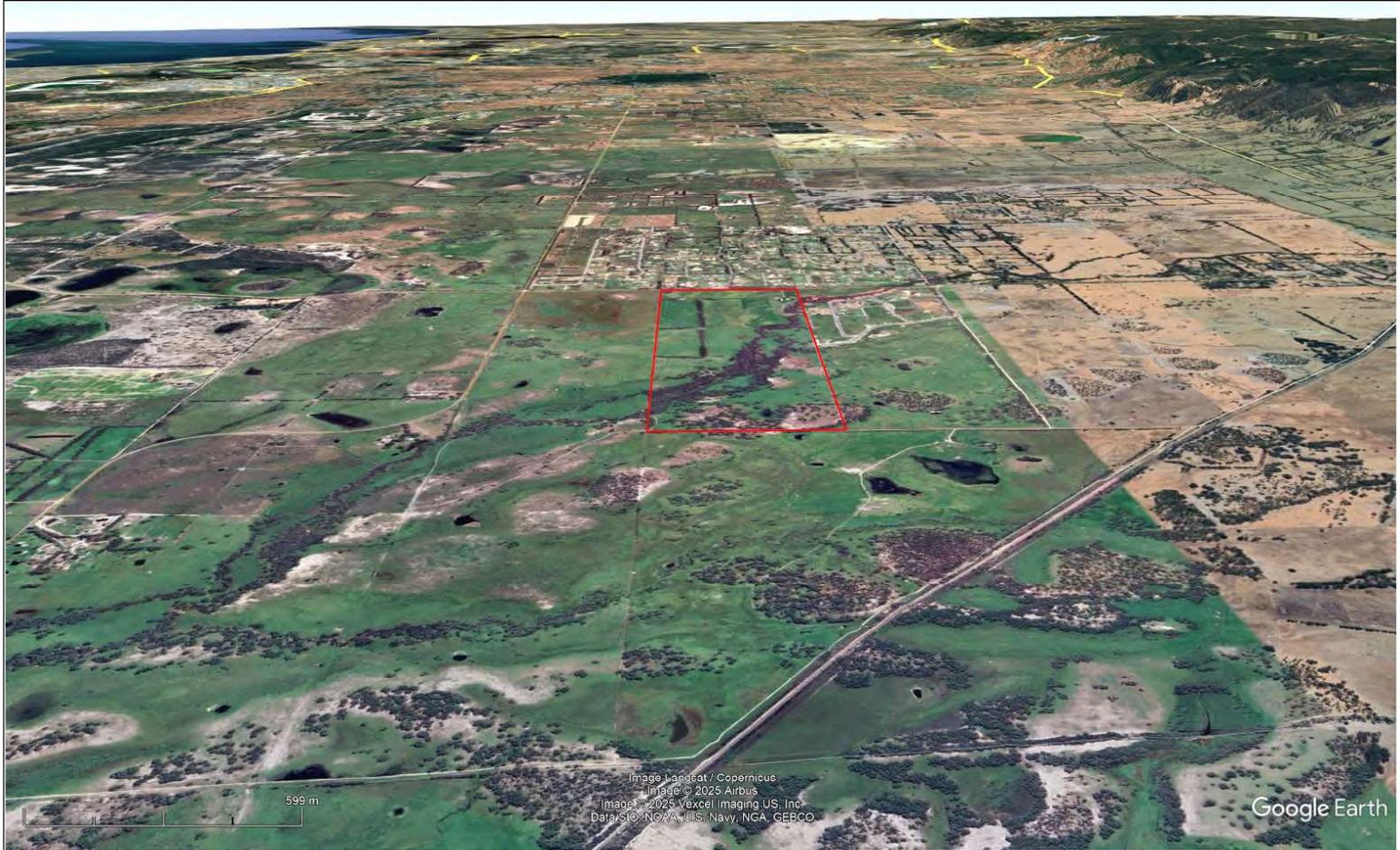
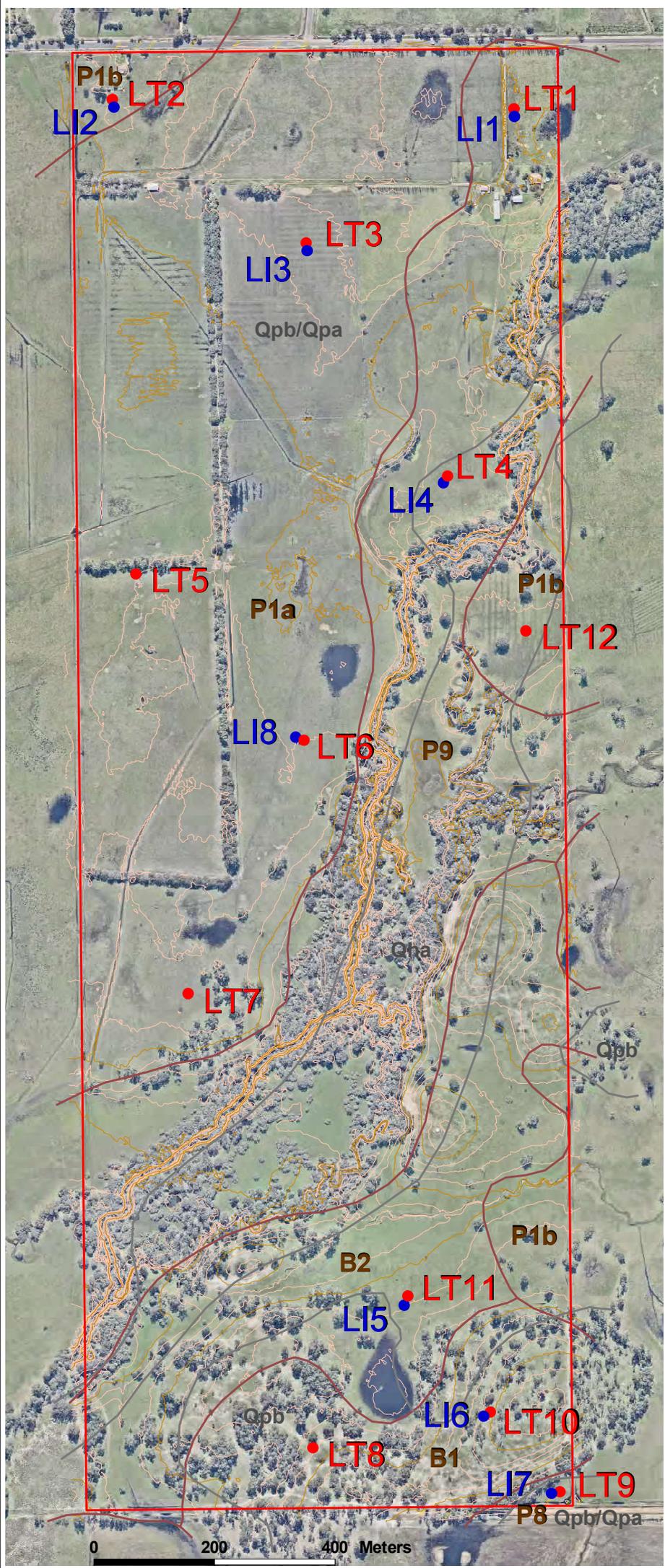


Figure 1

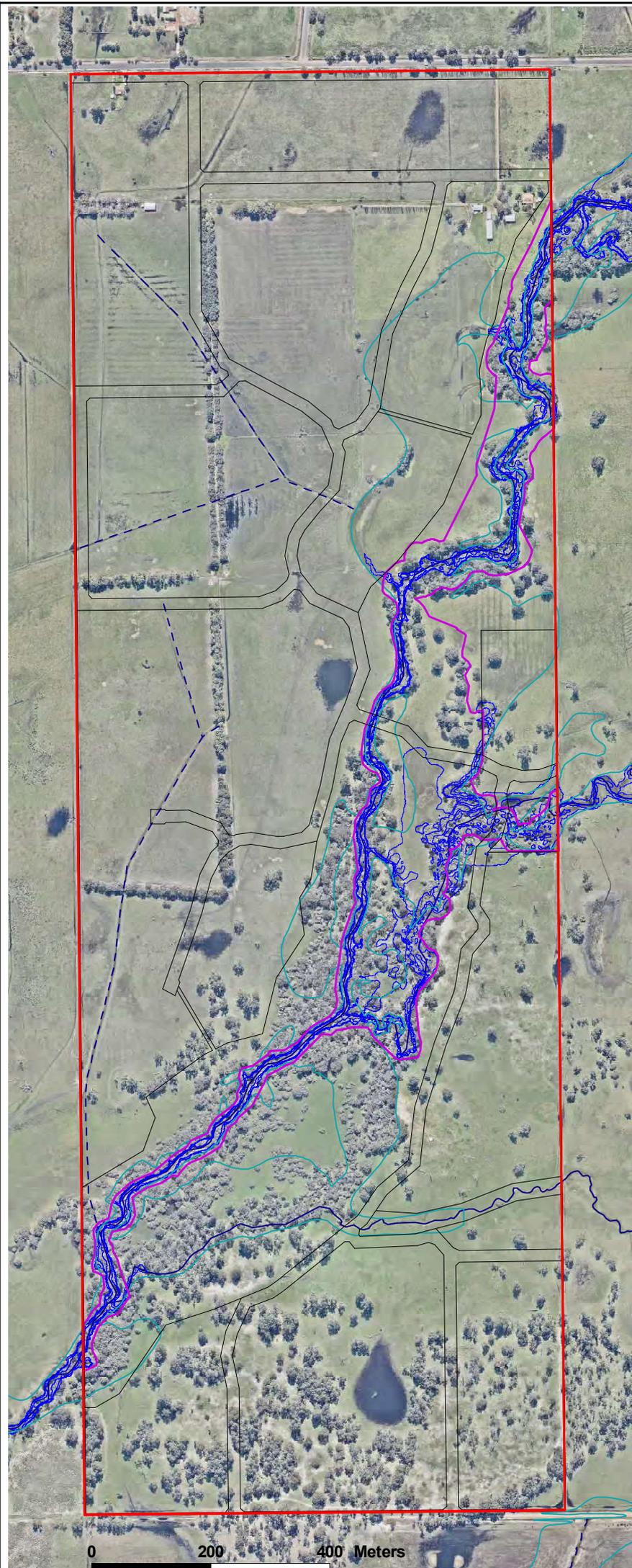
THE SITE AND SURROUNDINGS





- Subject land boundary
- 1m topo contour
- 0.25m topo contour
- Geology boundary (GSWA)
- Soil/landform boundary (DoA)
- Test pit
- Permeability test

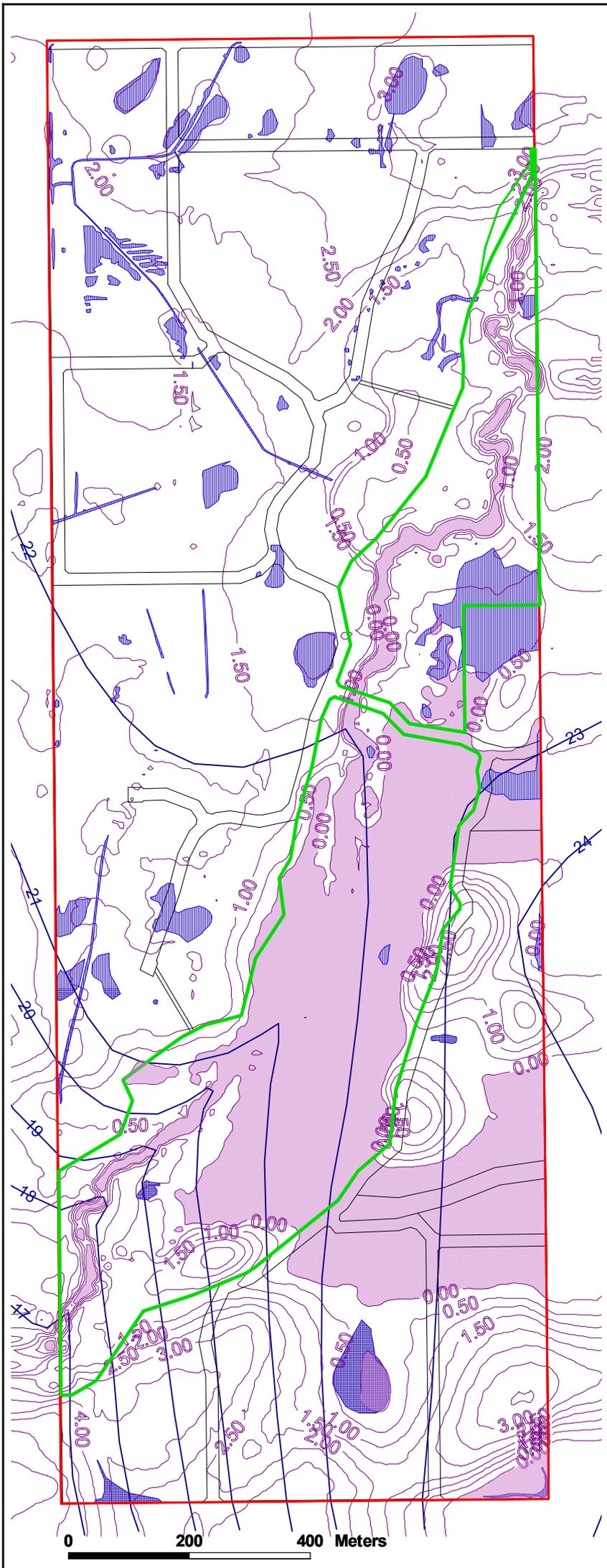
Figure 3
PHYSIOGRAPHY



- Subject land boundary
- Conceptual development cell
- Watercourse
- - - Paddock drain
- 100yr ARI floodway (Pentium)
- 100yr ARI floodplain (DWER)
- 10yr ARI floodplain (Pentium)

Figure 4

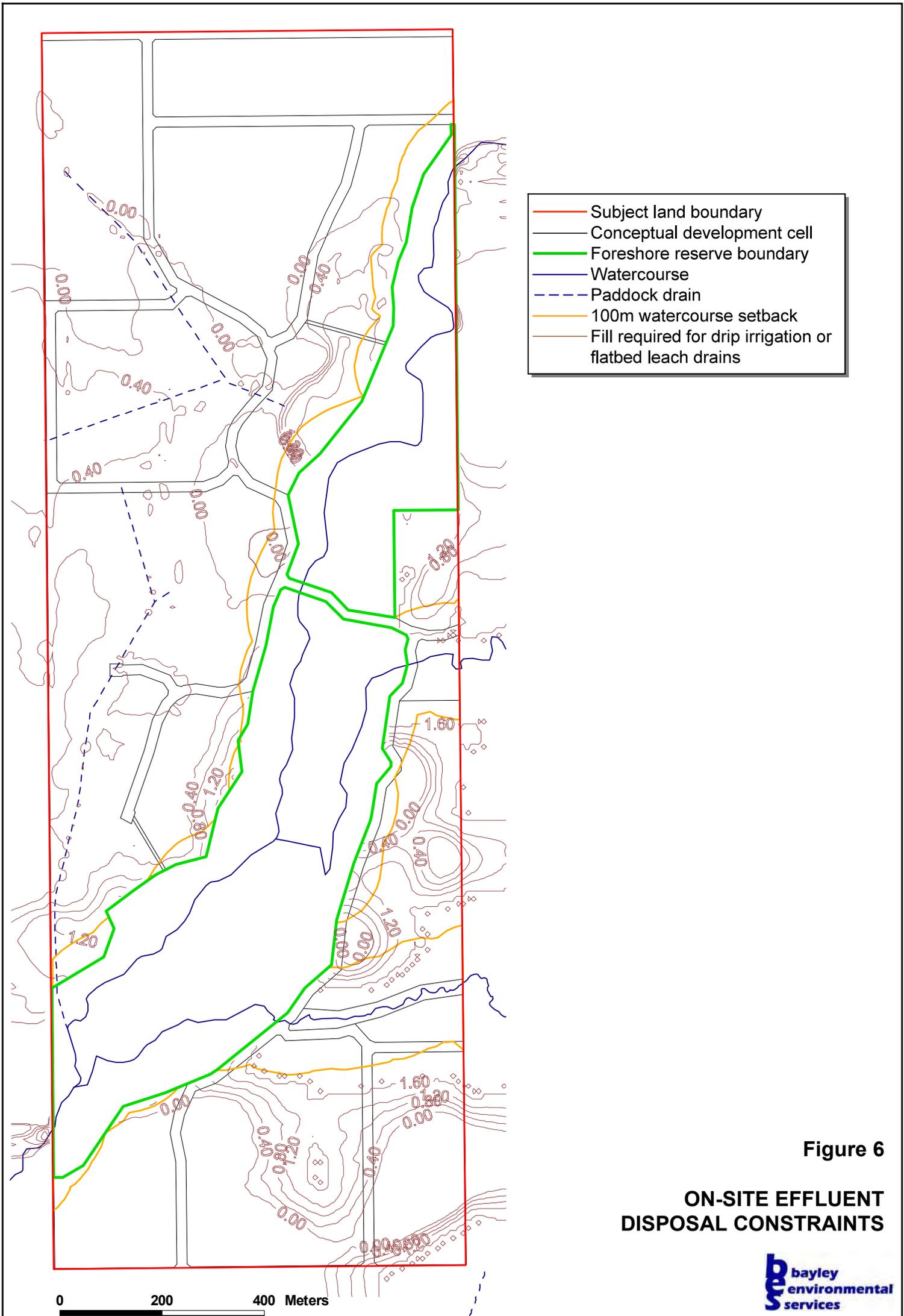
HYDROLOGY



- Subject land boundary
- Conceptual development cell
- Foreshore reserve boundary
- Maximum groundwater level (MGL)
- Depth to MGL
- MGL at ground surface
- Saturated/inundated in August 2017

Figure 5

MAXIMUM GROUNDWATER LEVEL



- Subject land boundary
- Conceptual development cell
- Foreshore reserve boundary
- Watercourse
- - - Paddock drain
- 100m watercourse setback
- ▨ Fill required for drip irrigation or flatbed leach drains

Figure 6

ON-SITE EFFLUENT DISPOSAL CONSTRAINTS

Appendix A

Soil Logs

Appendix B

Permeability Test Results

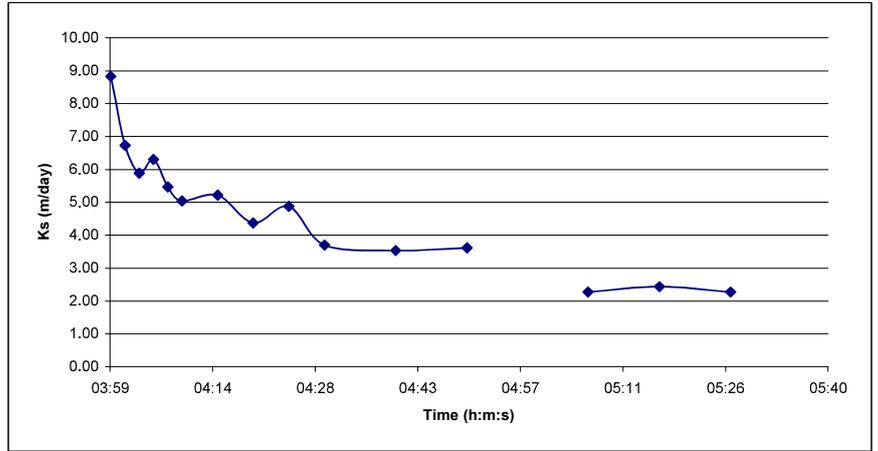
SOIL PERMEABILITY TEST

Site No.	L11
Date	22/05/25
Easting	393203
Northing	6401616
Depth	0.5

Brown sand on orange-brown pebbly silt

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
03:58:00	42.9		
04:00:00	40.8	2.1	8.83
04:02:00	39.2	1.6	6.73
04:04:00	37.8	1.4	5.89
04:06:00	36.3	1.5	6.31
04:08:00	35	1.3	5.47
04:10:00	33.8	1.2	5.05
04:15:00	30.7	3.1	5.22
04:20:00	28.1	2.6	4.37
04:25:00	25.2	2.9	4.88
04:30:00	23	2.2	3.70
04:40:00	18.8	4.2	3.53
04:50:00	14.5	4.3	3.62
		14.5	
04:57:00	41.9		
05:07:00	39.2	2.7	2.27
05:17:00	36.3	2.9	2.44
05:27:00	33.6	2.7	2.27
		33.6	

H =	25
r =	4.5



Ks = 2 m/day

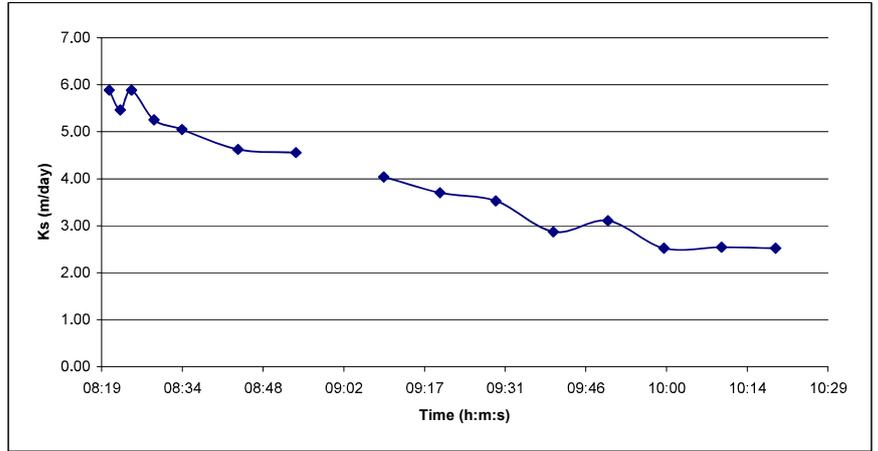
SOIL PERMEABILITY TEST

Site No.	L12
Date	23/05/25
Easting	398540
Northing	6401624
Depth	0.5

Yellow-brown sand

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
08:19:00	34.5		
08:21:00	33.1	1.4	5.89
08:23:00	31.8	1.3	5.47
08:25:00	30.4	1.4	5.89
08:29:00	27.9	2.5	5.26
08:34:00	24.9	3	5.05
08:44:00	19.4	5.5	4.63
08:54:20	13.8	5.6	4.56
09:00:00	43.8		
09:10:00	39	4.8	4.04
09:20:00	34.6	4.4	3.70
09:30:00	30.4	4.2	3.53
09:40:15	26.9	3.5	2.87
09:50:00	23.3	3.6	3.11
10:00:00	20.3	3	2.52
10:10:15	17.2	3.1	2.54
10:19:55	14.3	2.9	2.52
		14.3	

H =	25
r =	4.5



Ks = 2.5 m/day

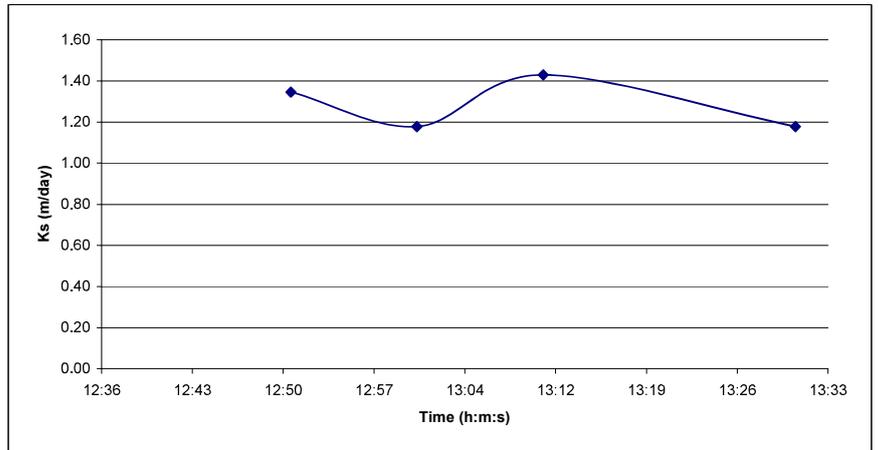
SOIL PERMEABILITY TEST

Site No.	L13
Date	23/05/25
Easting	398858
Northing	6401385
Depth	0.5

Yellow-brown clayey sand

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
12:41:00	20.8		
12:51:00	19.2	1.6	1.35
13:01:00	17.8	1.4	1.18
13:11:00	16.1	1.7	1.43
13:31:00	13.3	2.8	1.18
		13.3	

H =	25
r =	4.5



Ks = 1 m/day

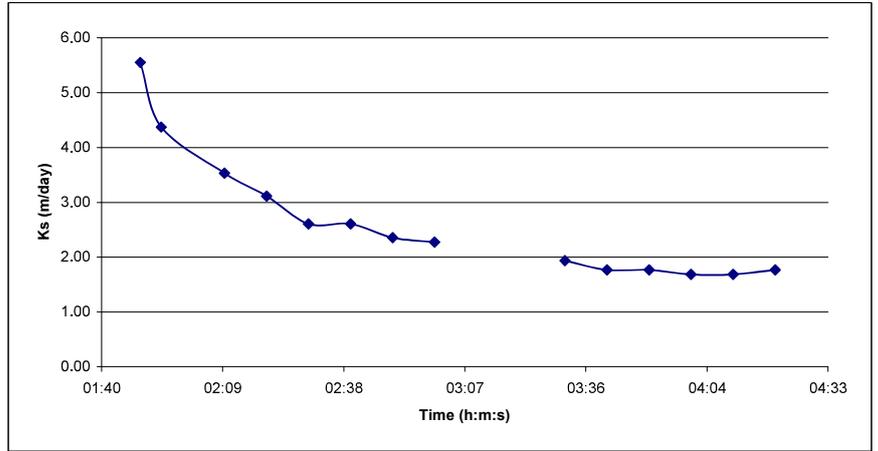
SOIL PERMEABILITY TEST

Site No.	L14
Date	23/05/25
Easting	399084
Northing	6400998
Depth	0.5

Orange-brown clayey sand

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
01:45:00	40.5		
01:50:00	37.2	3.3	5.55
01:55:00	34.6	2.6	4.37
02:10:00	28.3	6.3	3.53
02:20:00	24.6	3.7	3.11
02:30:00	21.5	3.1	2.61
02:40:00	18.4	3.1	2.61
02:50:00	15.6	2.8	2.36
03:00:00	12.9	2.7	2.27
		12.9	
03:21:00	44.3		
03:31:00	42	2.3	1.94
03:41:00	39.9	2.1	1.77
03:51:00	37.8	2.1	1.77
04:01:00	35.8	2	1.68
04:11:00	33.8	2	1.68
04:21:00	31.7	2.1	1.77
		31.7	

H =	25
r =	4.5



Ks = 1.5 m/day

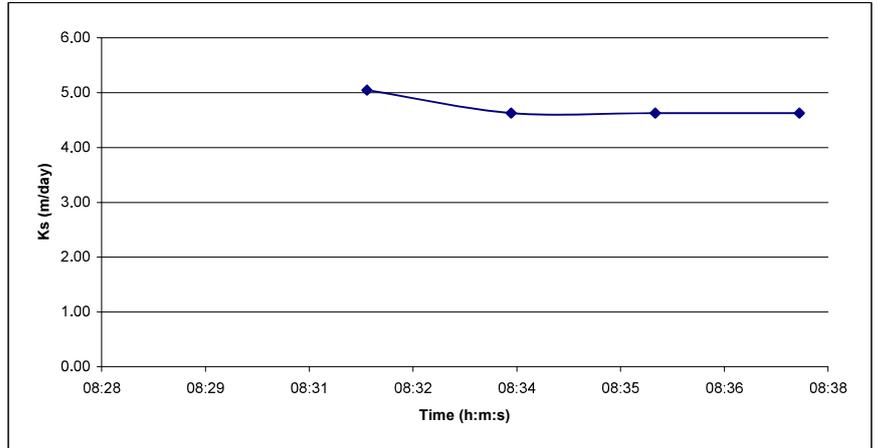
SOIL PERMEABILITY TEST

Site No.	L15
Date	26/05/25
Easting	399021
Northing	6399619
Depth	0.5

White sand

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
08:30:00	41.8		
08:32:00	40.6	1.2	5.05
08:34:00	39.5	1.1	4.63
08:36:00	38.4	1.1	4.63
08:38:00	37.3	1.1	4.63
		37.3	

H =	25
r =	4.5



Ks = 4.5 m/day

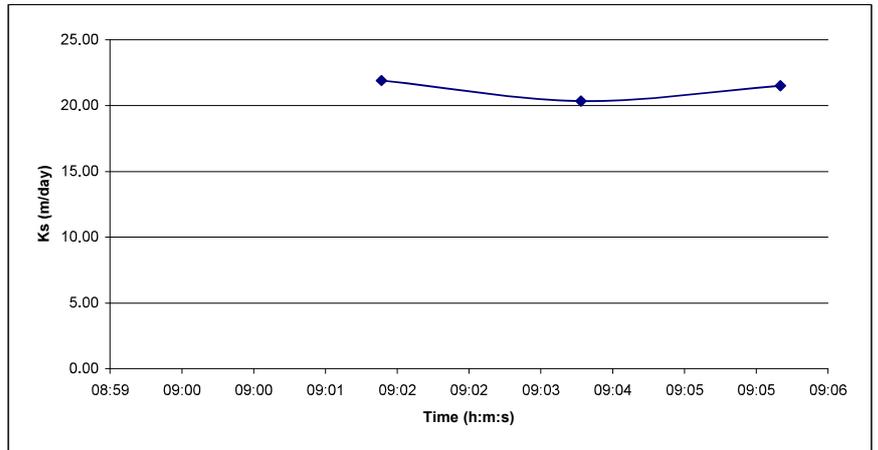
SOIL PERMEABILITY TEST

Site No.	L16
Date	26/05/25
Easting	399154
Northing	6399434
Depth	0.5

White sand on pale brown sand

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
09:00:00	28.4		
09:02:00	22.8	5.6	21.92
09:04:00	17.6	5.2	20.35
09:06:00	12.1	5.5	21.52
		12.1	

H =	25
r =	5



Ks = 21 m/day

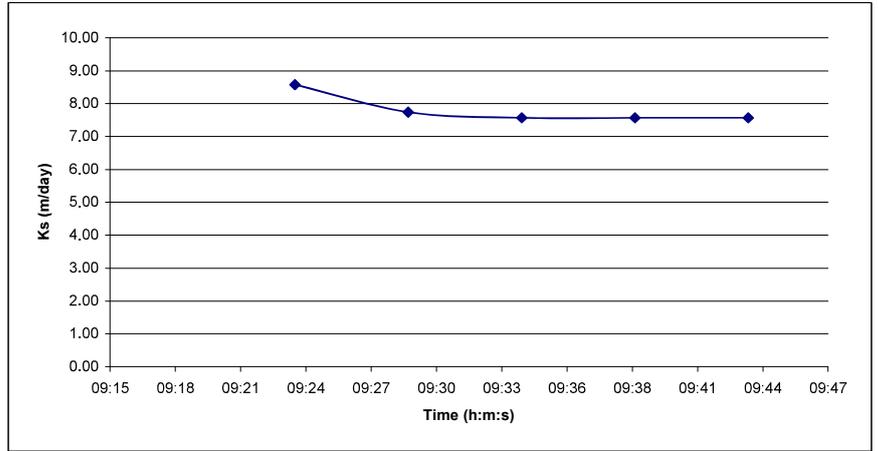
SOIL PERMEABILITY TEST

Site No.	LI7
Date	26/05/25
Easting	399266
Northing	6399305
Depth	0.5

White sand on brown sand

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
09:19:00	39.5		
09:24:00	34.4	5.1	8.58
09:29:00	29.8	4.6	7.74
09:34:00	25.3	4.5	7.57
09:39:00	20.8	4.5	7.57
09:44:00	16.3	4.5	7.57
		16.3	

H =	25
r =	4.5



Ks = 7.5 m/day

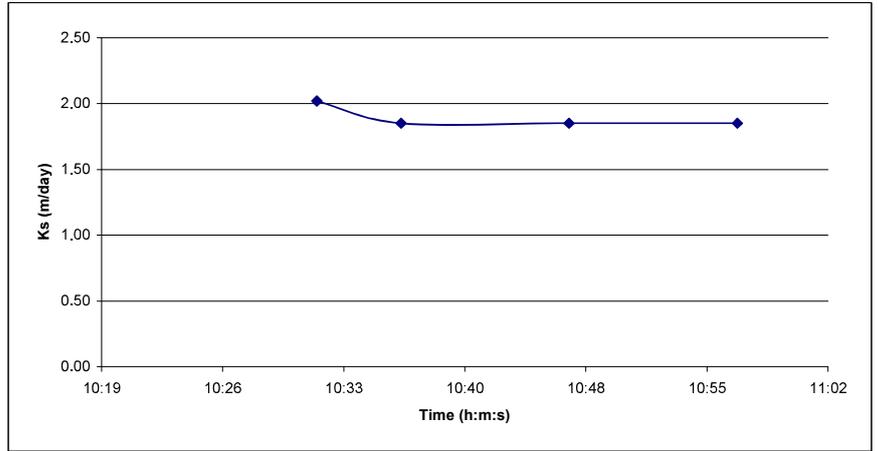
SOIL PERMEABILITY TEST

Site No.	L18
Date	26/05/25
Easting	398844
Northing	6400566
Depth	0.5

Yellow-brown clayey sand

Time (h:m:s)	Weight (kg)	Change in Weight (kg)	Ks (m/d)
10:27:00	41.4		
10:32:00	40.2	1.2	2.02
10:37:00	39.1	1.1	1.85
10:47:00	36.9	2.2	1.85
10:57:00	34.7	2.2	1.85
		34.7	

H =	25
r =	4.5



Ks = 2 m/day

Appendix C: DWER groundwater bore hydrographs

Water information reporting database, 2025

Department of Water and Environmental Regulation

HYPLOT V134 Output 13/02/2024

Period 11 Year 01/01/2008 to 01/01/2019

2008-18

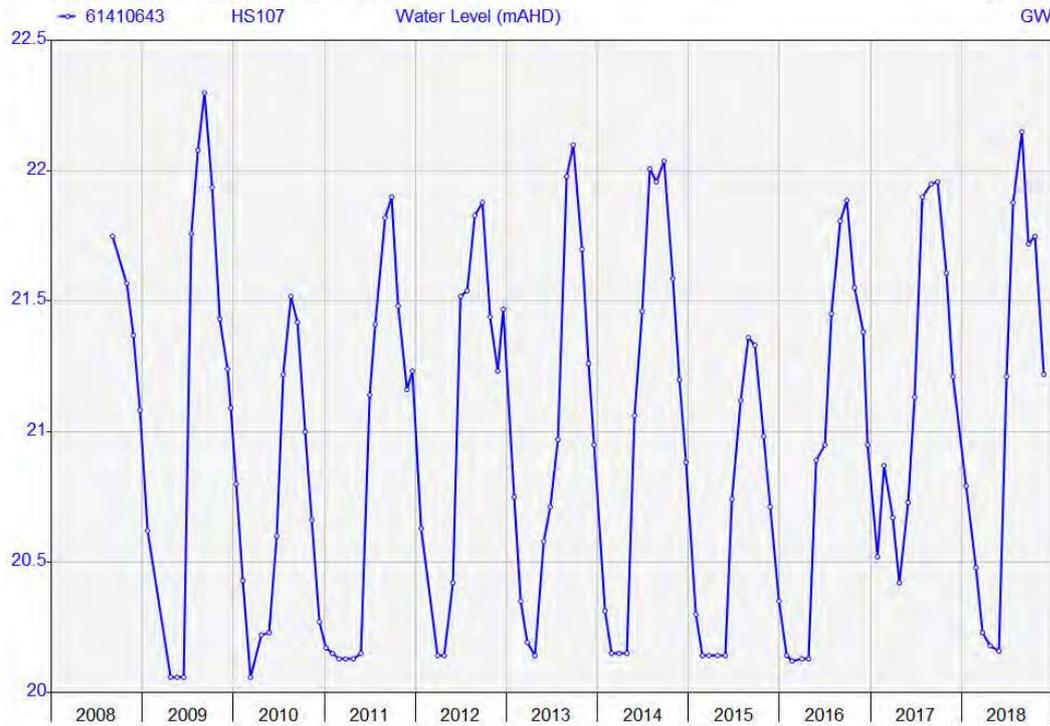


Figure 1: DWER bore 61410643 water levels (m AHD)

Department of Water and Environmental Regulation

HYPLOT V134 Output 13/02/2024

Period 11 Year 01/01/2008 to 01/01/2019

2008-18

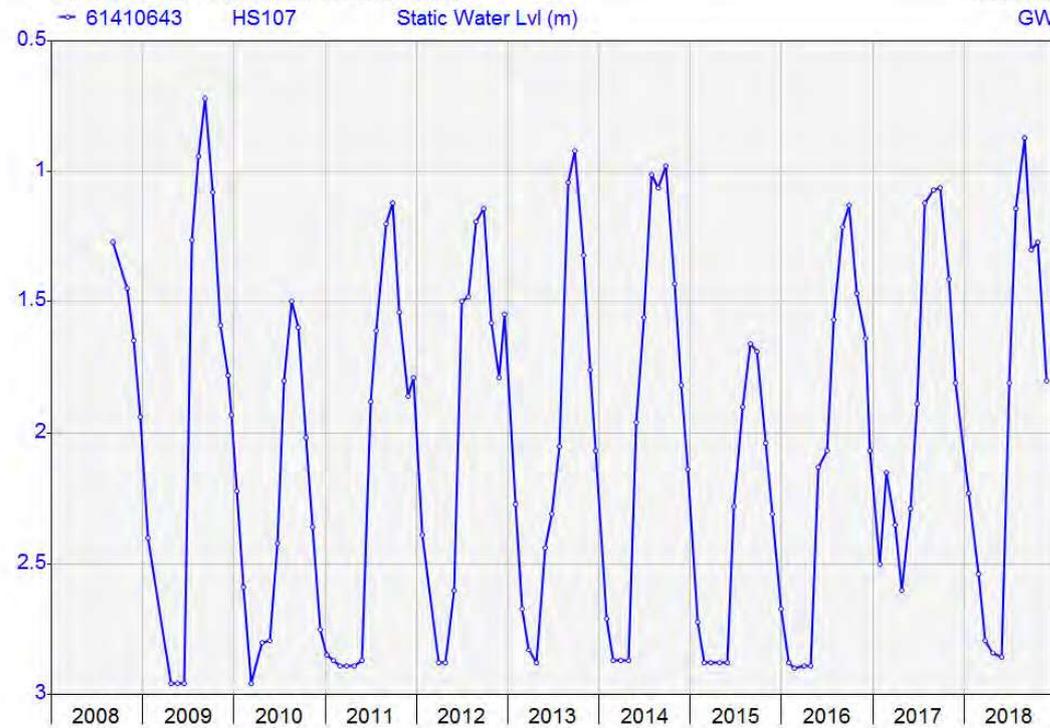


Figure 2: DWER bore 61410643 static water levels (m)

Department of Water and Environmental Regulation

HYPLOT V134 Output 13/02/2024

Period 11 Year 01/01/2008 to 01/01/2019

2008-18

61410644 HS101B Water Level (mAHD)

GW

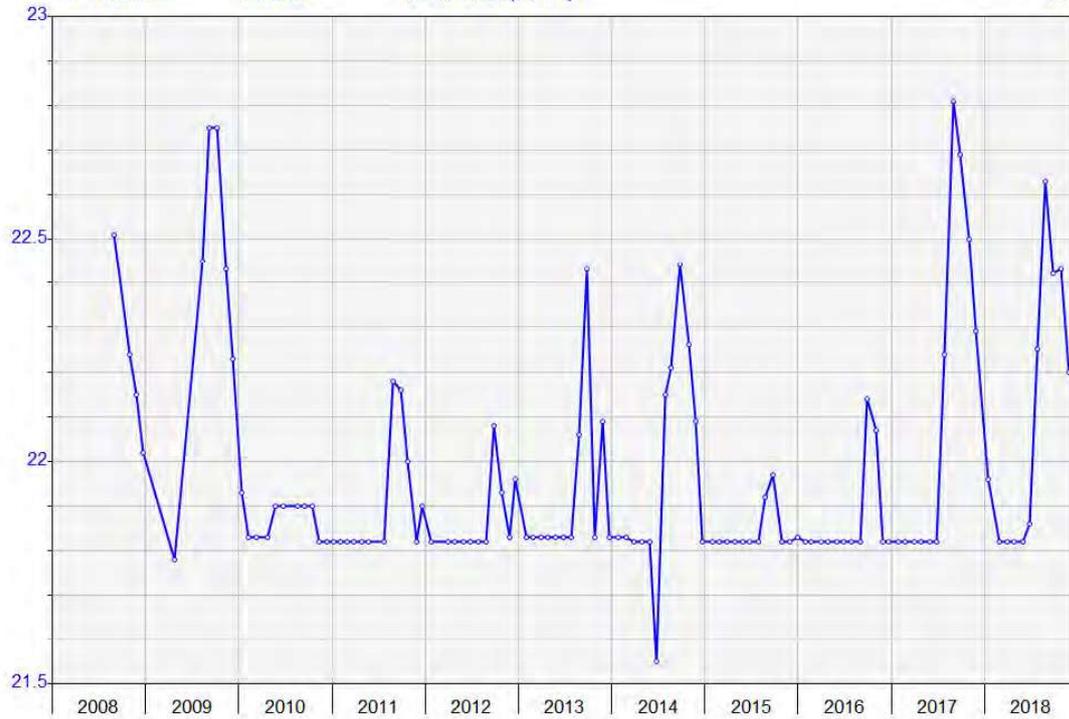


Figure 3: DWER bore 61410644 water levels (m AHD)

Department of Water and Environmental Regulation

HYPLOT V134 Output 13/02/2024

Period 11 Year 01/01/2008 to 01/01/2019

2008-18

61410644 HS101B Static Water Lvl (m)

GW

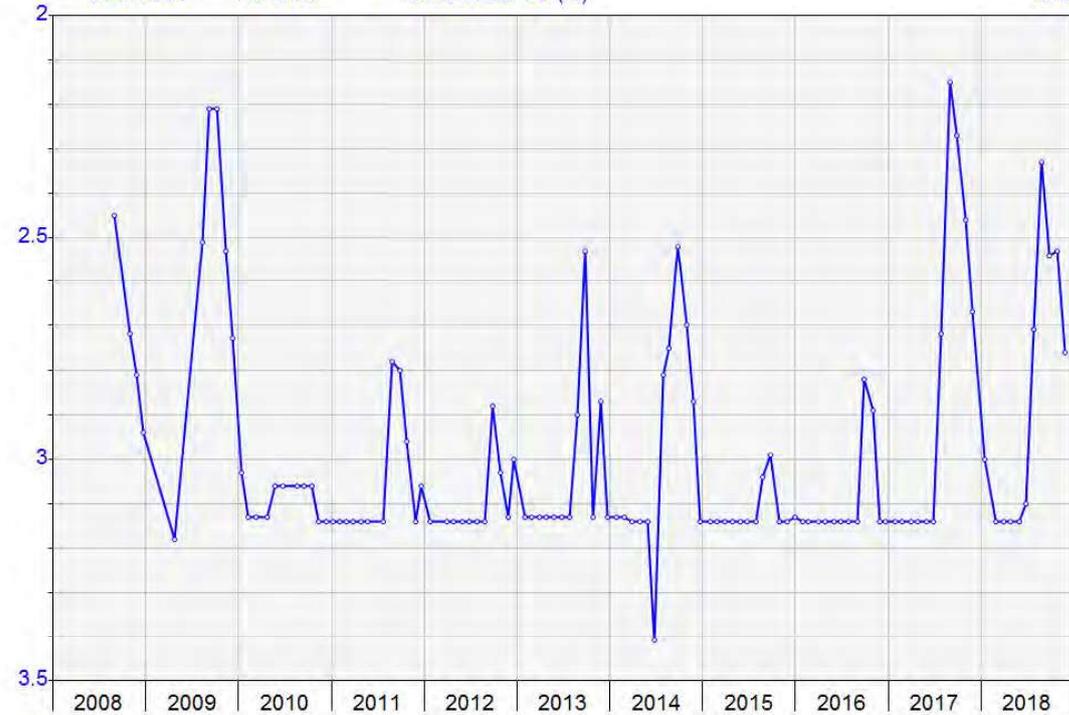


Figure 4: DWER bore 61410644 static water levels (m)

Department of Water and Environmental Regulation

HYPLOT V134 Output 20/02/2025

Period 18 Year 01/01/2008 to 01/01/2026

2008-25

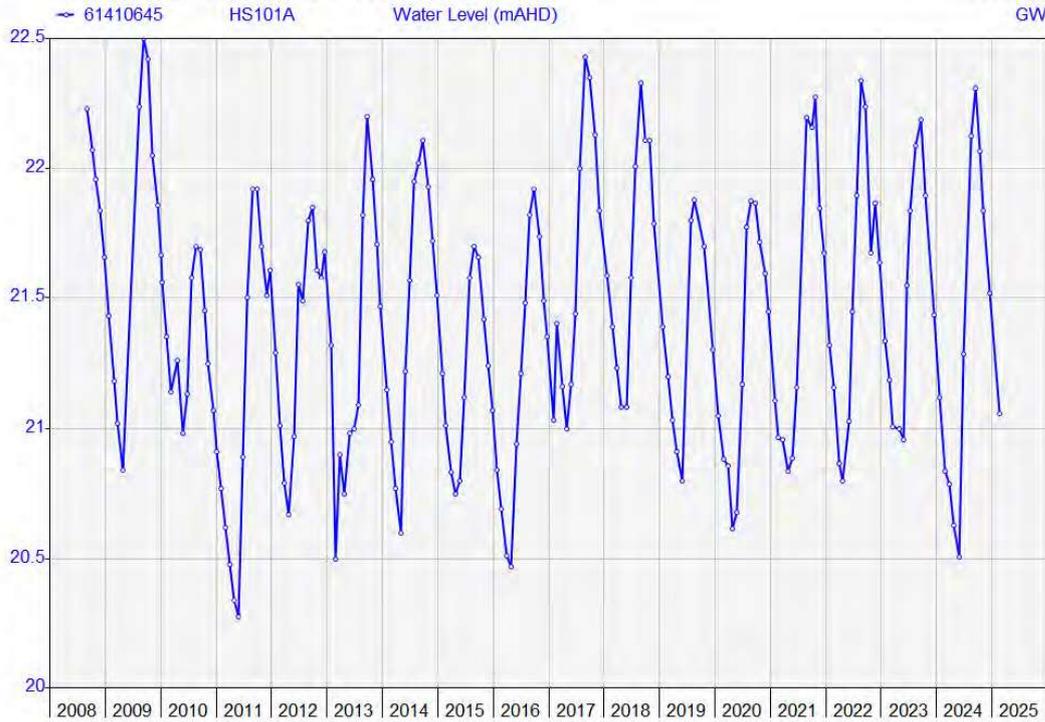


Figure 5: DWER bore 61410645 water levels (m AHD)

Department of Water and Environmental Regulation

HYPLOT V134 Output 20/02/2025

Period 18 Year 01/01/2008 to 01/01/2026

2008-25

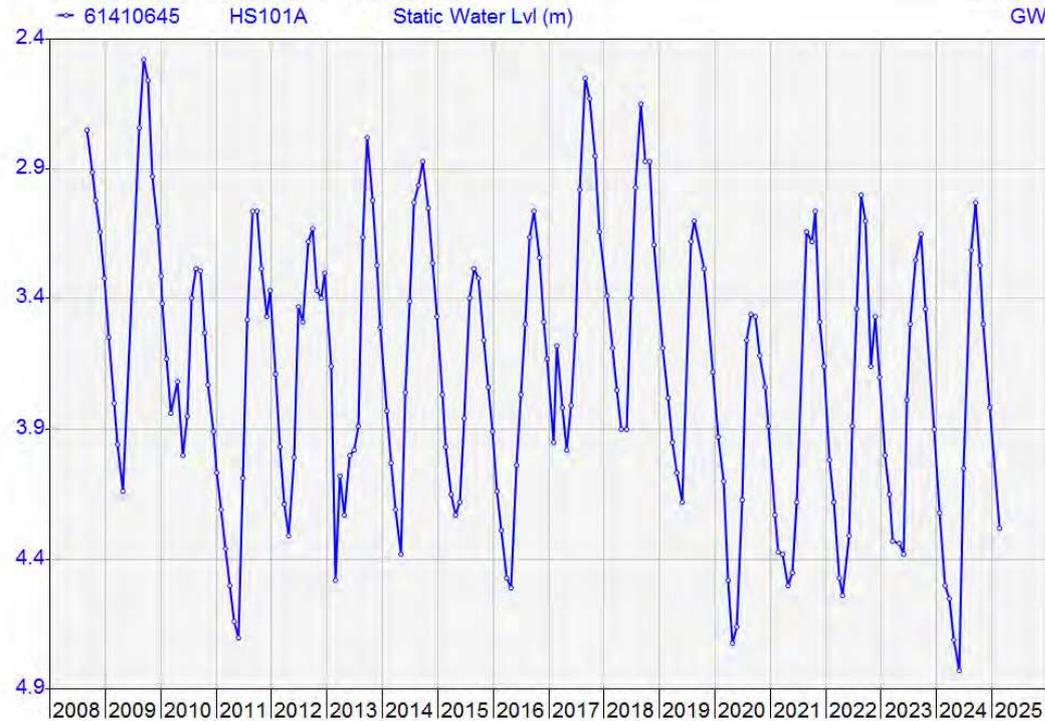


Figure 6: DWER bore 61410645 static water levels (m)

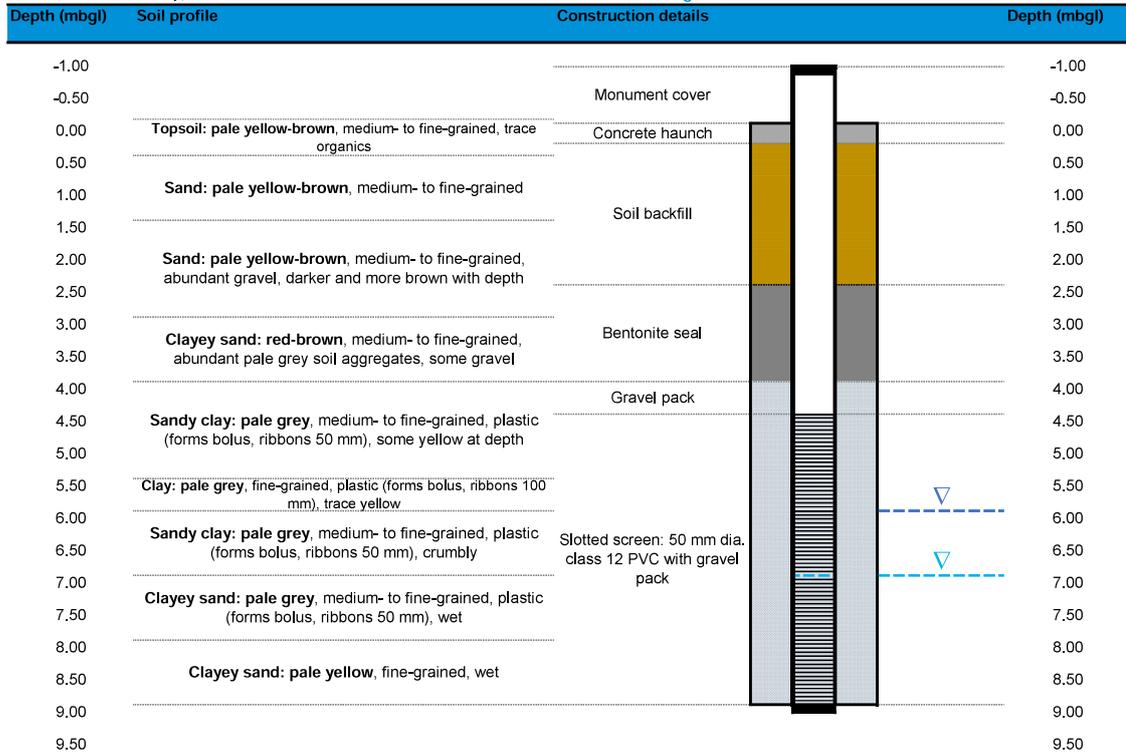
Appendix D: Site groundwater bore logs

PENTIUM WATER



BORE CONSTRUCTION LOG

Project number: PW035823	Driller: DPP
Site name: Lakes Rd, North Dandalup	Method: Hollow stem auger
Date: 11.4.25	Total depth (m): 9.0
Bore ID: MB1	Depth to water (m): 7.0
Scientist(s): Jake Faranda	Easting:
Weather: Sunny, warm	Northing:



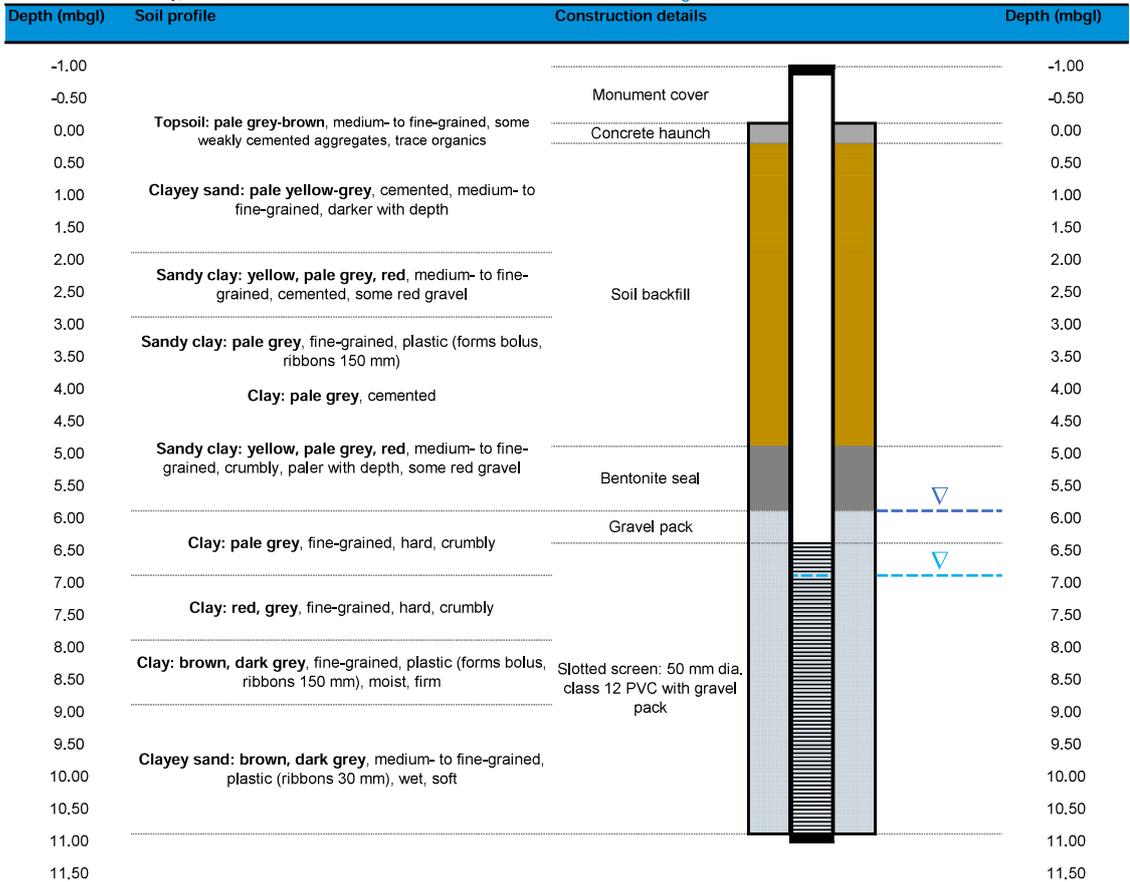
Note: water rose to 6 mbgl after drilling (shown dark blue), depth to water recorded above represents confined/pressurised water level.

PENTIUM WATER



BORE CONSTRUCTION LOG

Project number: PW035823	Driller: DPP
Site name: Lakes Rd, North Dandalup	Method: Push probe 4.9 m, hollow stem auger to depth
Date: 11.4.25	Total depth (m): 11.0
Bore ID: MB2	Depth to water (m): 9.0
Scientist(s): Jake Faranda	Easting:
Weather: Sunny, mild	Northing:



Note: water rose to 6 mbgl after drilling (shown dark blue), depth to water recorded above represents confined/pressurised water level.

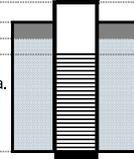
PENTIUM WATER



BORE CONSTRUCTION LOG

Project number: PW035823	Driller: DPP
Site name: Lakes Rd, North Dandalup	Method: Hollow stem auger
Date: 11.4.25	Total depth (m): 2.0
Bore ID: MB2S	Depth to water (m): not encountered
Scientist(s): Jake Faranda	Easting:
Weather: Sunny, mild	Northing:

Depth (mbgl)	Soil profile	Construction details	Depth (mbgl)
-1.00			-1.00
-0.50			-0.50
0.00	Topsoil: pale grey-brown, medium- to fine-grained, some weakly cemented aggregates, trace organics	PVC with plug, no cover Bentonite seal Gravel pack	0.00
0.50			0.50
1.00	Clayey sand: pale yellow-grey, cemented, medium- to fine-grained, darker with depth	Slotted screen: 50 mm dia. class 12 PVC with gravel pack	1.00
1.50			1.50
2.00			2.00
2.50	Sandy clay: yellow, pale grey, red, medium- to fine-grained, cemented, some red gravel		2.50
3.00			3.00
3.50	Sandy clay: pale grey, fine-grained, plastic (forms bolus, ribbons 150 mm)		3.50
4.00	Clay: pale grey, cemented		4.00
4.50			4.50
5.00	Sandy clay: yellow, pale grey, red, medium- to fine-grained, crumbly, paler with depth, some red gravel		5.00
5.50			5.50
6.00			6.00
6.50	Clay: pale grey, fine-grained, hard, crumbly		6.50
7.00			7.00
7.50	Clay: red, grey, fine-grained, hard, crumbly		7.50
8.00			8.00
8.50	Clay: brown, dark grey, fine-grained, plastic (forms bolus, ribbons 150 mm), moist, firm		8.50
9.00			9.00
9.50			9.50
10.00	Clayey sand: brown, dark grey, medium- to fine-grained, plastic (ribbons 30 mm), wet, soft		10.00
10.50			10.50
11.00			11.00
11.50			11.50



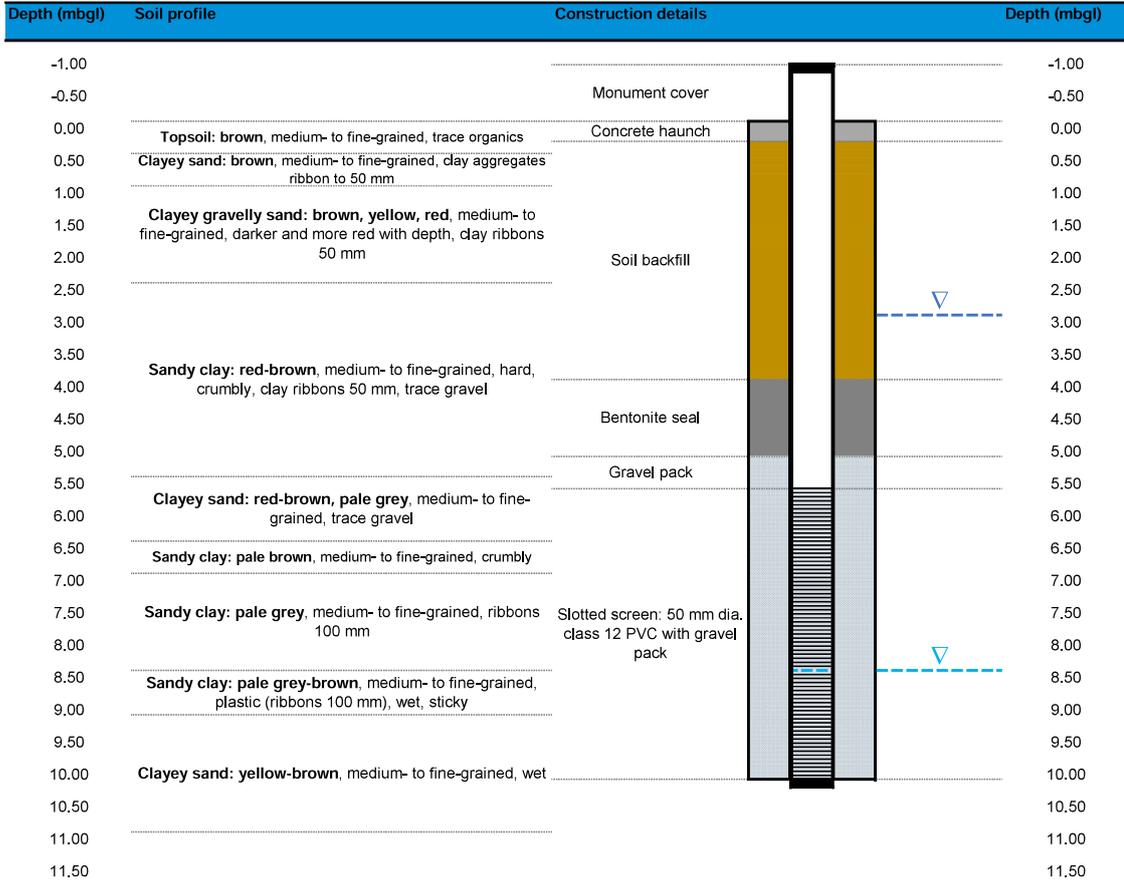
Note: shallow bore installed adjacent MB2 to monitor perched water on clay

PENTIUM WATER



BORE CONSTRUCTION LOG

Project number: PW035823	Driller: DPP
Site name: Lakes Rd, North Dandalup	Method: Hollow stem auger
Date: 11.4.25	Total depth (m): 10.2
Bore ID: MB3	Depth to water (m): 8.5
Scientist(s): Jake Faranda	Easting:
Weather: Sunny, warm	Northing:



Note: water rose to 3 mbgl after drilling (shown dark blue), depth to water recorded above represents confined/pressurised water level.

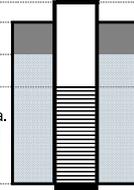
PENTIUM WATER



BORE CONSTRUCTION LOG

Project number: PW035823	Driller: DPP
Site name: Lakes Rd, North Dandalup	Method: Hollow stem auger
Date: 11.4.25	Total depth (m): 2.5
Bore ID: MB3S	Depth to water (m): not encountered
Scientist(s): Jake Faranda	Easting:
Weather: Sunny, warm	Northing:

Depth (mbgl)	Soil profile	Construction details	Depth (mbgl)
-1.00			-1.00
-0.50		PVC with plug, no cover	-0.50
0.00	Topsoil: brown, medium- to fine-grained, trace organics	Bentonite seal	0.00
0.50	Clayey sand: brown, medium- to fine-grained, clay aggregates ribbon to 50 mm	Gravel pack	0.50
1.00			1.00
1.50	Clayey gravelly sand: brown, yellow, red, medium- to fine-grained, darker and more red with depth, clay ribbons 50 mm	Slotted screen: 50 mm dia. class 12 PVC with gravel pack	1.50
2.00			2.00
2.50			2.50
3.00			3.00
3.50			3.50
4.00	Sandy clay: red-brown, medium- to fine-grained, hard, crumbly, clay ribbons 50 mm, trace gravel		4.00
4.50			4.50
5.00			5.00
5.50			5.50
6.00	Clayey sand: red-brown, pale grey, medium- to fine-grained, trace gravel		6.00
6.50			6.50
7.00	Sandy clay: pale brown, medium- to fine-grained, crumbly		7.00
7.50			7.50
8.00	Sandy clay: pale grey, medium- to fine-grained, ribbons 100 mm		8.00
8.50			8.50
9.00	Sandy clay: pale grey-brown, medium- to fine-grained, plastic (ribbons 100 mm), wet, sticky		9.00
9.50			9.50
10.00	Clayey sand: yellow-brown, medium- to fine-grained, wet		10.00
10.50			10.50
11.00			11.00
11.50			11.50



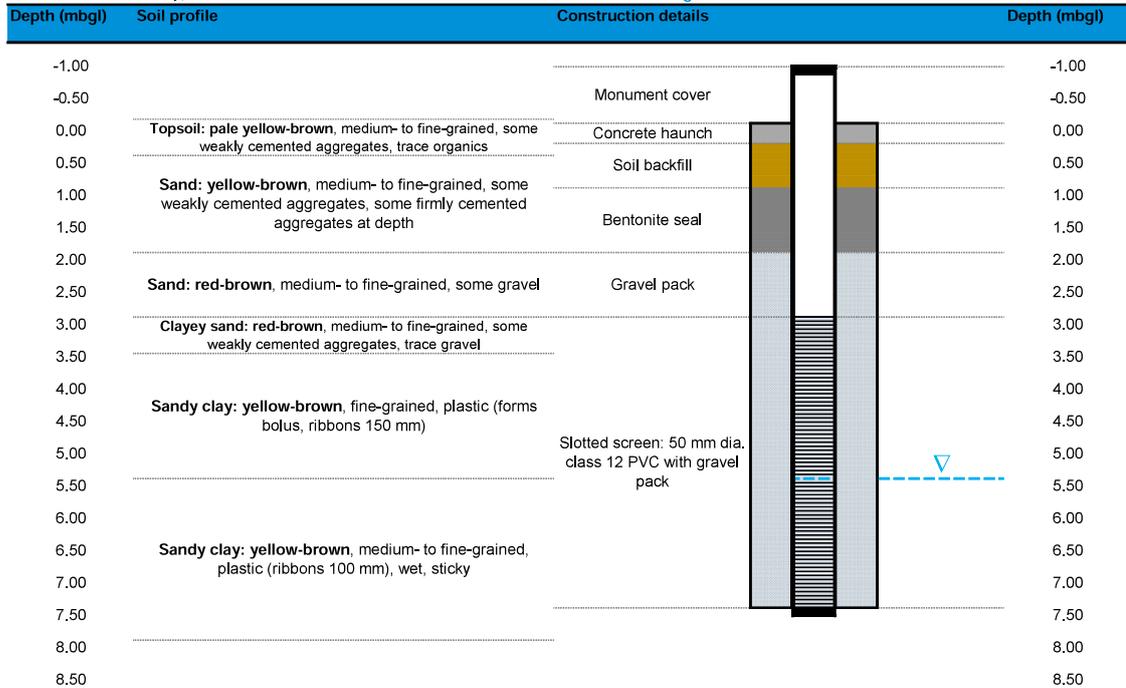
Note: shallow bore installed adjacent MB3 to monitor perched water on clay

PENTIUM WATER



BORE CONSTRUCTION LOG

Project number: PW035823	Driller: DPP
Site name: Lakes Rd, North Dandalup	Method: Hollow stem auger
Date: 11.4.25	Total depth (m): 7.5
Bore ID: MB4	Depth to water (m): 5.5
Scientist(s): Jake Faranda	Easting:
Weather: Sunny, warm	Northing:



Note: no water rise after drilling, aquifer maybe unconfined near river (20 m away)

PENTIUM WATER



BORE CONSTRUCTION LOG

Project number: PW035823	Driller: DPP
Site name: Lakes Rd, North Dandalup	Method: Hollow stem auger
Date: 11.4.25	Total depth (m): 4.0
Bore ID: MB4S	Depth to water (m): not encountered
Scientist(s): Jake Faranda	Easting:
Weather: Sunny, warm	Northing:

Depth (mbgl)	Soil profile	Construction details	Depth (mbgl)
-1.00			-1.00
-0.50			-0.50
0.00	Topsoil: pale yellow-brown, medium- to fine-grained, some weakly cemented aggregates, trace organics	PVC with plug, no cover	0.00
0.50		Bentonite seal	0.50
1.00	Sand: yellow-brown, medium- to fine-grained, some weakly cemented aggregates, some firmly cemented aggregates at depth		1.00
1.50		Gravel pack	1.50
2.00			2.00
2.50	Sand: red-brown, medium- to fine-grained, some gravel		2.50
3.00	Clayey sand: red-brown, medium- to fine-grained, some weakly cemented aggregates, trace gravel	Slotted screen: 50 mm dia. class 12 PVC with gravel pack	3.00
3.50			3.50
4.00	Sandy clay: yellow-brown, fine-grained, plastic (forms bolus, ribbons 150 mm)		4.00
4.50			4.50
5.00			5.00
5.50			5.50
6.00			6.00
6.50	Sandy clay: yellow-brown, medium- to fine-grained, plastic (ribbons 100 mm), wet, sticky		6.50
7.00			7.00
7.50			7.50
8.00			8.00
8.50			8.50

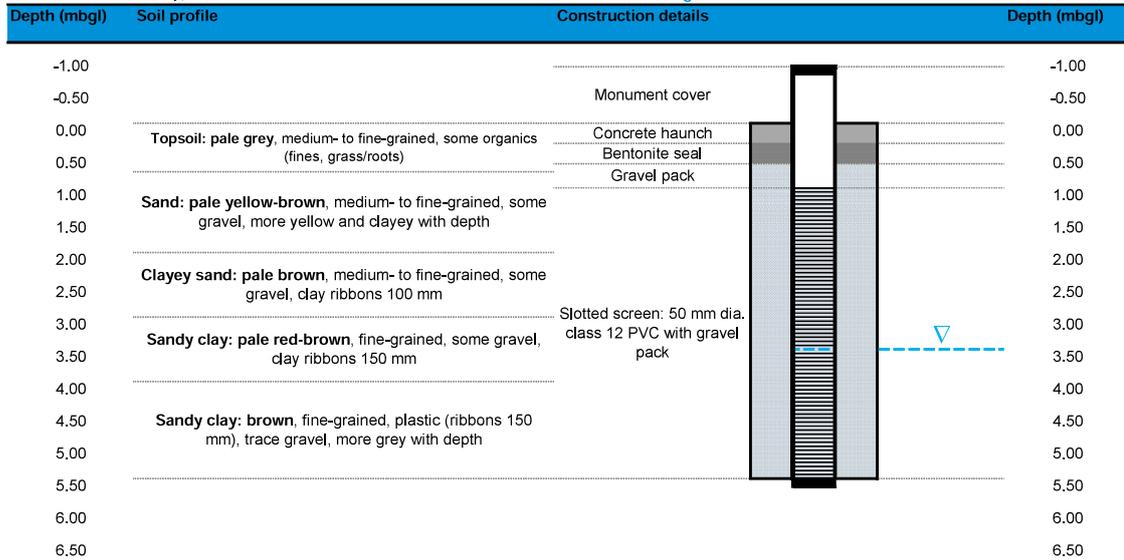
Note: shallow bore installed adjacent MB4 to monitor perched water on clay

PENTIUM WATER



BORE CONSTRUCTION LOG

Project number: PW035823	Driller: DPP
Site name: Lakes Rd, North Dandalup	Method: Hollow stem auger
Date: 11.4.25	Total depth (m): 5.5
Bore ID: MB5	Depth to water (m): 3.5
Scientist(s): Jake Faranda	Easting:
Weather: Sunny, warm	Northing:



Note: no water rise after drilling, aquifer maybe unconfined south of river

Appendix E: Laboratory results

MPL, 2025

Certificate of Analysis PGD1300

Client Details

Client	Pentium Water Pty Ltd
Contact	M. Leaming
Address	Level 1, 640 Murray St, West Perth, WA, 6005

Sample Details

Your Reference	PW035823 (North Dandalup)
Number of Samples	9 Water
Date Samples Received	16/04/2025
Date Instructions Received	16/04/2025

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for soils and on an as received basis for other matrices.

Report Details

Date Results Requested by	29/04/2025
Date of Issue	29/04/2025

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025. Tests not covered by NATA are denoted with *.

Authorisation Details

Results Approved By	Jessica Miller, Microbiological Supervisor Lien Tang, Assistant Operations Manager Lucas Yij, Inorganics Team Leader Sally Rogers, Senior Microbiological Analyst Varsha Ho Wing, Inorganics and Metals Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PGD1300

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PGD1300-01	SG1	Water	16/04/2025	16/04/2025
PGD1300-02	SG3	Water	16/04/2025	16/04/2025
PGD1300-03	SGZ	Water	16/04/2025	16/04/2025
PGD1300-04	MB1	Water	16/04/2025	16/04/2025
PGD1300-05	MB2	Water	16/04/2025	16/04/2025
PGD1300-06	MB3	Water	16/04/2025	16/04/2025
PGD1300-07	MB4	Water	16/04/2025	16/04/2025
PGD1300-08	MB5	Water	16/04/2025	16/04/2025
PGD1300-09	MBZ	Water	16/04/2025	16/04/2025

Certificate of Analysis PGD1300

Acid Extractable Metals (Water)

Envirolab ID	Units	PQL	PGD1300-01	PGD1300-02	PGD1300-03	PGD1300-04	PGD1300-05
Your Reference			SG1	SG3	SGZ	MB1	MB2
Date Sampled			16/04/2025	16/04/2025	16/04/2025	16/04/2025	16/04/2025
Phosphorus	mg/L	0.050	<0.050	0.056	<0.050	0.57	0.11

Envirolab ID	Units	PQL	PGD1300-06	PGD1300-07	PGD1300-08	PGD1300-09
Your Reference			MB3	MB4	MB5	MBZ
Date Sampled			16/04/2025	16/04/2025	16/04/2025	16/04/2025
Phosphorus	mg/L	0.050	0.16	0.44	0.14	0.15

Certificate of Analysis PGD1300

Inorganics - Physical Parameters (Water)

Envirolab ID	Units	PQL	PGD1300-01	PGD1300-02	PGD1300-03
Your Reference			SG1	SG3	SGZ
Date Sampled			16/04/2025	16/04/2025	16/04/2025
pH	pH units		7.3	7.5	7.5
Electrical Conductivity	µS/cm	2.0	480	490	480
Turbidity	NTU	0.10	7.0	2.0	2.4

Certificate of Analysis PGD1300

Inorganics - Ionic Balance and Indexes (Water)

Envirolab ID	Units	PQL	PGD1300-01	PGD1300-02	PGD1300-03	PGD1300-04	PGD1300-05
Your Reference			SG1	SG3	SGZ	MB1	MB2
Date Sampled			16/04/2025	16/04/2025	16/04/2025	16/04/2025	16/04/2025
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	21	17	17	[NA]	[NA]
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	[NA]	[NA]
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	[NA]	[NA]
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	21	17	17	[NA]	[NA]
Chloride	mg/L	1.0	82	87	86	460	1000
Sulfate	mg/L	1.0	9.1	9.2	9.2	130	120

Envirolab ID	Units	PQL	PGD1300-06	PGD1300-07	PGD1300-08	PGD1300-09
Your Reference			MB3	MB4	MB5	MBZ
Date Sampled			16/04/2025	16/04/2025	16/04/2025	16/04/2025
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	[NA]	[NA]	[NA]	[NA]
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	[NA]	[NA]	[NA]	[NA]
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	[NA]	[NA]	[NA]	[NA]
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	[NA]	[NA]	[NA]	[NA]
Chloride	mg/L	1.0	5800	630	250	1000
Sulfate	mg/L	1.0	850	44	82	140

Certificate of Analysis PGD1300

Inorganics - Miscellaneous and Common Anions (Water)

Envirolab ID	Units	PQL	PGD1300-01	PGD1300-02	PGD1300-03
Your Reference			SG1	SG3	SGZ
Date Sampled			16/04/2025	16/04/2025	16/04/2025
Acidity	mg/L	5.0	<5.0	<5.0	<5.0

Certificate of Analysis PGD1300

Inorganics - Nutrients (Water)

Envirolab ID Your Reference Date Sampled	Units	PQL	PGD1300-01 SG1 16/04/2025	PGD1300-02 SG3 16/04/2025	PGD1300-03 SGZ 16/04/2025	PGD1300-04 MB1 16/04/2025	PGD1300-05 MB2 16/04/2025
Ammonia as N	mg/L	0.0050	0.0068	0.0059	0.0069	0.031	0.064
Nitrate as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.050 [3]
Nitrate as NO3 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.20 [3]
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.050 [4]
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.20 [4]
NOx as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.0070	<0.050 [3]
TKN as N by calculation	mg/L	0.10	0.62	0.48	0.45	1.6	1.5
Organic Nitrogen by calc.	mg/L	0.10	0.61	0.47	0.45	1.5	1.5
Total Nitrogen	mg/L	0.10	0.62	0.48	0.46	1.6	1.5
Phosphate as P	mg/L	0.0050	<0.0050	0.017	<0.0050	0.011	<0.050 [3]

Envirolab ID Your Reference Date Sampled	Units	PQL	PGD1300-06 MB3 16/04/2025	PGD1300-07 MB4 16/04/2025	PGD1300-08 MB5 16/04/2025	PGD1300-09 MBZ 16/04/2025
Ammonia as N	mg/L	0.0050	0.075	0.072	0.30	0.079
Nitrate as N	mg/L	0.0050	0.0065	<0.0050	0.40	<0.050 [3]
Nitrate as NO3 by calculation	mg/L	0.020	0.029	<0.020	1.8	<0.20 [3]
Nitrite as N	mg/L	0.0050	0.0086	<0.0050	0.017	<0.050 [4]
Nitrite as NO2 by calculation	mg/L	0.020	0.028	<0.020	0.057	<0.20 [4]
NOx as N	mg/L	0.0050	0.015	<0.0050	0.42	<0.050 [3]
TKN as N by calculation	mg/L	0.10	2.0	1.2	3.0	2.3
Organic Nitrogen by calc.	mg/L	0.10	1.9	1.1	2.7	2.2
Total Nitrogen	mg/L	0.10	2.0	1.2	3.4	2.3
Phosphate as P	mg/L	0.0050	0.0077	<0.0050	<0.0050	<0.0050

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Microbiological Suite (Water)

Envirolab ID	Units	PQL	PGD1300-04	PGD1300-05	PGD1300-06	PGD1300-07	PGD1300-08
Your Reference			MB1	MB2	MB3	MB4	MB5
Date Sampled			16/04/2025	16/04/2025	16/04/2025	16/04/2025	16/04/2025

Thermotolerant Coliforms	cfu/100mL	1	<10 [1]	10 [2]	>800	>800	50 [2]
E.coli	cfu/100mL	1	<10 [1]	10 [2]	630	>800	50 [2]

Envirolab ID	Units	PQL	PGD1300-09
Your Reference			MBZ
Date Sampled			16/04/2025

Thermotolerant Coliforms	cfu/100mL	1	20 [2]
E.coli	cfu/100mL	1	20 [2]

Certificate of Analysis PGD1300

Result Comments

Identifier	Description
[1]	Microbiological testing PQL raised due to high sample turbidity and/or matrix interference.
[2]	Count is an estimate.
[3]	PQL(s) has/have been raised due to matrix interference.
[4]	Duplicate %RPD may be flagged as an outlier to routine laboratory acceptance, however, where one or both results are <10*PQL, the RPD acceptance criteria increases exponentially.

Certificate of Analysis PGD1300

Method Summary

Method ID	Methodology Summary
Calc	Calculation
Calc - TKN	TKN determined by calculation (Total Nitrogen - NOx).
INORG-001	pH - Measured using pH meter and electrode. Please note that the results for water analyses are indicative only, as analysis can be completed outside of the recommended holding times. Solids are reported from a 1:5 water extract unless otherwise specified. Alternatively, pH is determined in a 1:5 extract using 0.01M calcium chloride or a solid is extracted at a ratio of 1:2.5 (AS1289.4.3.1), pH is measured in the extract.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C. Soil results reported from a 1:5 Soil:Water extract unless otherwise specified. Please note Resistivity is estimated by calculation and may not correlate with results otherwise obtained using the Resistivity current method (based on AS 1289.4.4.1), depending on the nature of the soil being analysed.
INORG-005	Acidity - determined by titration based on APHA latest edition 2310 B. Solids reported from a 1:5 water extract unless otherwise specified. Free Carbon Dioxide - determined titrimetrically in accordance with APHA latest edition,4500-CO2 C.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition 2320-B. Solids reported from a 1:5 water extract unless otherwise specified. Total Carbon Dioxide - determined by calculation in accordance with APHA latest edition,4500-CO2 D.
INORG-022	Turbidity - measured nephelometrically using a turbidimeter, in accordance with APHA latest edition, 2130-B.
INORG-055	Nitrate/Nitrite/NOx/TKN - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils/solids are analysed following a water extraction.
INORG-057	Ammonia - determined colourimetrically. Water samples are filtered on receipt prior to analysis. Soils and OHS media are analysed following a water extraction. Alternatively, Ammonia can be extracted from soil using 1M KCl.
INORG-060	Phosphate - determined colourimetrically using APHA latest edition 4500 P E. Water samples are filtered on receipt prior to analysis. Soils are analysed from a water extract.
INORG-081	Anions determined by Ion Chromatography. Waters samples are filtered on receipt prior to analysis. Solids are analysed from a water extract. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
INORG-127	Total Nitrogen by high temperature catalytic combustion with chemiluminescence detection. Organic Carbon forms (inorganic, organic, total) determined using a TOC/NDIR analyser via combustion. Dissolved forms require filtering prior to determination.
METALS-020	Determination of various metals by ICP-OES. Where salts (oxides, chlorides etc.) are calculated from the element concentration stoichiometrically there is no guarantee that the salt form is completely soluble in the acids used in the preparation.
MICRO-001B	E. coli/Thermotolerant coliforms: Microbial Water Analysis - in accordance with MICRO-001 (AS4276.5-latest edition). Recommended maximums based on NHMRC Australian Drinking Water Guidelines. Please note that results for this test derived from counts outside of the range 10-80 are considered approximate as per AS4276.1.

Certificate of Analysis PGD1300

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Certificate of Analysis PGD1300

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volumes are typically provided by customers (often as flow rate(s) and sampling time(s) and/or simply volume(s) sampled or exposure times (determines 'volume' passive badges are exposed to)). Hence in such circumstances the volume measurement is inevitably not covered by Envirolab's NATA accreditation. An exception may occur where Envirolab Newcastle does the sampling where accreditation exists for certain types of sampling and hence volume determination(s). Note air volumes are often used to determine concentrations for dust and/or analyses on filters, sorbents and in impingers. For canister sampling, the air volume is covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PGD1300

Client Details

Client	Pentium Water Pty Ltd
Your Reference	PW035823 (North Dandalup)
Date Issued	29/04/2025

Recommended Holding Time Compliance

Recommended holding time exceedances exist - See detailed list below

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	Yes	No Outliers
Matrix Spike	Yes	No Outliers
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PGD1300

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
Total Phosphorus Water	1-7	16/04/2025	23/04/2025	24/04/2025	Yes
	8-9	16/04/2025	23/04/2025	28/04/2025	Yes
EC Water	1-3	16/04/2025	17/04/2025	22/04/2025	Yes
pH Water	1-3	16/04/2025	17/04/2025	22/04/2025	Yes
Turbidity Water	1-3	16/04/2025	22/04/2025	23/04/2025	No
Alkalinity Suite Water	1-3	16/04/2025	17/04/2025	22/04/2025	Yes
Chloride Water	1-4, 7-9	16/04/2025	17/04/2025	18/04/2025	Yes
	5-6	16/04/2025	17/04/2025	22/04/2025	Yes
Sulfate Water	1-4, 7-9	16/04/2025	17/04/2025	18/04/2025	Yes
	5-6	16/04/2025	17/04/2025	22/04/2025	Yes
Acidity Water	1-3	16/04/2025	22/04/2025	22/04/2025	Yes
Nitrogen - Ammonia Water	1-9	16/04/2025	23/04/2025	23/04/2025	Yes
Nitrogen - Nitrate Water	1-4, 6-8	16/04/2025	23/04/2025	23/04/2025	Yes
	5, 9	16/04/2025	23/04/2025	24/04/2025	Yes
Nitrogen - Nitrite Water	1-4, 6-8	16/04/2025	23/04/2025	23/04/2025	No
	5, 9	16/04/2025	23/04/2025	24/04/2025	No
Nitrogen - NOx Water	1-4, 6-8	16/04/2025	23/04/2025	23/04/2025	No
	5, 9	16/04/2025	23/04/2025	24/04/2025	No
Nitrogen - Total N Water	1-9	16/04/2025	23/04/2025	24/04/2025	Yes
Phosphate as P Water	1-4, 6-9	16/04/2025	23/04/2025	23/04/2025	No
	5	16/04/2025	23/04/2025	24/04/2025	No
TKN as N calc Water	1-9	16/04/2025	23/04/2025	29/04/2025	Yes
E. coli & T.T.coli Water	4-9	16/04/2025	16/04/2025	17/04/2025	Yes

Quality Control PGD1300

METALS-020 | Acid Extractable Metals (Water) | Batch BGD4188

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BGD4188-DUP1# Samp QC RPD %	PGD1300-01 Samp QC RPD %		
Phosphorus	mg/L	0.050	<0.050	<0.050 <0.050 [NA]	<0.050 0.0522 [NA] [4]	99.9	91.2

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-020 | Acid Extractable Metals (Water) | Batch BGD4189

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				PGD1300-08 Samp QC RPD %	BGD4189-DUP2# Samp QC RPD %		
Phosphorus	mg/L	0.050	<0.050	0.142 0.139 [NA]	<0.050 <0.050 [NA]	97.0	95.2

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-001 | Inorganics - Physical Parameters (Water) | Batch BGD3658

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %
				BGD3658-DUP1# Samp QC RPD %	BGD3658-DUP2# Samp QC RPD %	
pH	pH units		5.6	5.9 6.0 0.505	8.1 8.1 0.493	102
Electrical Conductivity	µS/cm	2.0	<2.0	98000 98800 0.810	10000 9890 1.26	102

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-022 | Inorganics - Physical Parameters (Water) | Batch BGD3744

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %
				BGD3744-DUP1# Samp QC RPD %	BGD3744-DUP2# Samp QC RPD %	
Turbidity	NTU	0.10	<0.10	0.480 0.530 9.90	13.8 13.8 0.00	95.0

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-006 | Inorganics - Ionic Balance and Indexes (Water) | Batch BGD3658

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %
				BGD3658-DUP1# Samp QC RPD %	BGD3658-DUP2# Samp QC RPD %	
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	3000 3100 3.34	84.0 75.6 10.5	[NA]
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 <5.0 [NA]	<5.0 <5.0 [NA]	[NA]
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 <5.0 [NA]	<5.0 <5.0 [NA]	[NA]
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	3000 3100 3.34	83.9 75.6 10.5	93.9

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-081 | Inorganics - Ionic Balance and Indexes (Water) | Batch BGD3680

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				PGD1300-01 Samp QC RPD %	BGD3680-DUP2# Samp QC RPD %		
Chloride	mg/L	1.0	<1.0	82.3 82.0 0.356	3870 3910 1.03	93.7	96.2
Sulfate	mg/L	1.0	<1.0	9.12 8.77 3.88	54.3 53.7 1.14	90.4	117

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-005 | Inorganics - Miscellaneous and Common Anions (Water) | Batch BGD3918

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %
				BGD3918-DUP1# Samp QC RPD %	BGD3918-DUP2# Samp QC RPD %	
Acidity	mg/L	5.0	<5.0	208 247 17.1	349 385 9.67	90.4

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

Quality Control PGD1300

INORG-057 | Inorganics - Nutrients (Water) | Batch BGD3996

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BGD3996-DUP1# Samp QC RPD %	PGD1300-04 Samp QC RPD %		
Ammonia as N	mg/L	0.0050	<0.0050	0.0112 0.0128 [NA]	0.0308 0.0313 1.67	99.2	108
Nitrate as N	mg/L	0.0050	<0.0050	0.0114 0.00628 [NA] [4]	<0.0050 <0.0050 [NA]	106	126
Nitrate as NO3 by calculation	mg/L	0.020	<0.020			[NA]	[NA]
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050 <0.0050 [NA]	<0.0050 <0.0050 [NA]	80.6	70.8
Nitrite as NO2 by calculation	mg/L	0.020	<0.020			[NA]	[NA]
NOx as N	mg/L	0.0050	<0.0050	0.0116 0.00652 [NA] [4]	0.00696 0.00840 [NA]	106	126
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050 <0.0050 [NA]	0.0112 0.0110 [NA]	93.8	111

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-127 | Inorganics - Nutrients (Water) | Batch BGD4033

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				PGD1300-01 Samp QC RPD %	BGD4033-DUP2# Samp QC RPD %		
Total Nitrogen	mg/L	0.10	<0.10	0.625 0.579 7.59	0.416 0.395 [NA]	111	97.5

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

MICRO-001B | Microbiological Suite (Water) | Batch BGD3525

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %
				BGD3525-DUP1# Samp QC RPD %	BGD3525-DUP2# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]

Analyte	Units	PQL	Blank	DUP3	LCS %
				BGD3525-DUP3# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 <1 [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 <1 [NA]	[NA]

Analyte	Units	PQL	Blank	DUP7	DUP6	LCS %
				BGD3525-DUP7# Samp QC RPD %	BGD3525-DUP6# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]

Analyte	Units	PQL	Blank	DUP9	DUP8	LCS %
				BGD3525-DUP9# Samp QC RPD %	BGD3525-DUP8# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 <1 [NA]	1.00 1.00 [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 <1 [NA]	1.00 1.00 [NA]	[NA]

Analyte	Units	PQL	Blank	DUPB	DUPA	LCS %
				BGD3525-DUPB# Samp QC RPD %	BGD3525-DUPA# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	1.00 <1 [NA]	<1 <1 [NA]	[NA]
E.coli	cfu/100mL	1	<1	1.00 <1 [NA]	<1 <1 [NA]	[NA]

Analyte	Units	PQL	Blank	DUPC	LCS %
				BGD3525-DUPC# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	2.00 5.00 [NA]	[NA]
E.coli	cfu/100mL	1	<1	2.00 <1 [NA]	[NA]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

Quality Control PGD1300

QC Comments

Identifier	Description
[2]	Count is an estimate.
[4]	Duplicate %RPD may be flagged as an outlier to routine laboratory acceptance, however, where one or both results are <math><10 \times \text{PQL}</math>, the RPD acceptance criteria increases exponentially.

Certificate of Analysis PGG1000

Client Details

Client	Pentium Water Pty Ltd
Contact	J. Faranda
Address	Level 1, 640 Murray St, West Perth, WA, 6005

Sample Details

Your Reference	PW035823 - North Dandalup
Number of Samples	4 Surface Water
Date Samples Received	16/07/2025
Date Instructions Received	16/07/2025

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for soils and on an as received basis for other matrices.

Report Details

Date Final Results Expected	23/07/2025
Date of Issue	21/07/2025

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Authorisation Details

Results Approved By	Jessica Miller, Microbiological Supervisor Lien Tang, Assistant Operations Manager Michael Mowle, Development Chemist - Inorganics and Metals Varsha Ho Wing, Inorganics and Metals Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PGG1000

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PGG1000-01	SG1	Surface Water	16/07/2025	16/07/2025
PGG1000-02	SG2	Surface Water	16/07/2025	16/07/2025
PGG1000-03	SG3	Surface Water	16/07/2025	16/07/2025
PGG1000-04	SGZ	Surface Water	16/07/2025	16/07/2025

Certificate of Analysis PGG1000

Acid Extractable Metals (Surface Water)

Envirolab ID	Units	PQL	PGG1000-01	PGG1000-02	PGG1000-03	PGG1000-04
Your Reference			SG1	SG2	SG3	SGZ
Date Sampled			16/07/2025	16/07/2025	16/07/2025	16/07/2025
Phosphorus	mg/L	0.050	<0.050	0.20	0.76	0.21

Certificate of Analysis PGG1000

Inorganics - Physical Parameters (Surface Water)

Envirolab ID	Units	PQL	PGG1000-01	PGG1000-02	PGG1000-03	PGG1000-04
Your Reference			SG1	SG2	SG3	SGZ
Date Sampled			16/07/2025	16/07/2025	16/07/2025	16/07/2025
Turbidity	NTU	0.10	3.6	7.6	5.2	7.0

Certificate of Analysis PGG1000

Inorganics - Ionic Balance and Indexes (Surface Water)

Envirolab ID Your Reference Date Sampled	Units	PQL	PGG1000-01 SG1 16/07/2025	PGG1000-02 SG2 16/07/2025	PGG1000-03 SG3 16/07/2025	PGG1000-04 SGZ 16/07/2025
Bicarbonate Alkalinity as CaCO ₃	mg/L as CaCO ₃	5.0	30	27	52	27
Carbonate Alkalinity as CaCO ₃	mg/L as CaCO ₃	5.0	<5.0	<5.0	<5.0	<5.0
Hydroxide OH ⁻ as CaCO ₃	mg/L as CaCO ₃	5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CaCO ₃	mg/L as CaCO ₃	5.0	30	27	52	27
Chloride	mg/L	1.0	120	170	230	170
Sulfate	mg/L	1.0	19	100	58	100

Certificate of Analysis PGG1000

Inorganics - Miscellaneous and Common Anions (Surface Water)

Envirolab ID	Units	PQL	PGG1000-01	PGG1000-02	PGG1000-03	PGG1000-04
Your Reference			SG1	SG2	SG3	SGZ
Date Sampled			16/07/2025	16/07/2025	16/07/2025	16/07/2025
Acidity	mg/L	5.0	6.8	5.2	7.1	11

Certificate of Analysis PGG1000

Inorganics - Nutrients (Surface Water)

Envirolab ID Your Reference Date Sampled	Units	PQL	PGG1000-01 SG1 16/07/2025	PGG1000-02 SG2 16/07/2025	PGG1000-03 SG3 16/07/2025	PGG1000-04 SGZ 16/07/2025
Ammonia as N	mg/L	0.0050	0.022	0.045	1.2	<0.0050
Nitrate as N	mg/L	0.0050	0.70	1.2	1.9	0.0056
Nitrate as NO3 by calculation	mg/L	0.020	3.1	5.2	8.6	0.025
Nitrite as N	mg/L	0.0050	<0.0050	0.028	<0.050 [4]	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	0.093	<0.20 [4]	<0.020
NOx as N	mg/L	0.0050	0.71	1.2	2.0	0.0056
Dissolved Organic Nitrogen by calc	mg/L	0.10	0.76	1.8	2.1	3.0
TKN as N by calculation	mg/L	0.10	1.2	3.3	3.9	3.6
Total Dissolved Nitrogen	mg/L	0.10	1.5	3.0	5.3	3.1
Organic Nitrogen by calc.	mg/L	0.10	1.2	3.2	2.7	3.6
Total Nitrogen	mg/L	0.10	1.9	4.5	5.9	3.6
Phosphate as P	mg/L	0.0050	<0.0050	0.079	0.63	0.018

Certificate of Analysis PGG1000

Microbiological Suite (Surface Water)

Envirolab ID	Units	PQL	PGG1000-01	PGG1000-02	PGG1000-03	PGG1000-04
Your Reference			SG1	SG2	SG3	SGZ
Date Sampled			16/07/2025	16/07/2025	16/07/2025	16/07/2025
Thermotolerant Coliforms	cfu/100mL	1	40 [2]	>800	150	>800
E.coli	cfu/100mL	1	40 [2]	>800	150	>800

Certificate of Analysis PGG1000

Result Comments

Identifier	Description
[2]	Count is an estimate. Results derived from counts outside of the range of 10-80 are considered an estimate as per AS4276.1
[4]	PQL(s) has/have been raised due to matrix interference.

Certificate of Analysis PGG1000

Method Summary

Method ID	Methodology Summary
Calc	Calculation
Calc - DON	Calculation of Dissolved Organic Nitrogen. Analysis conducted on filtered sample (0.45µm)
Calc - TKN	TKN determined by calculation (Total Nitrogen - NOx).
INORG-005	Acidity - determined by titration based on APHA latest edition 2310 B. Solids reported from a 1:5 water extract unless otherwise specified. Free Carbon Dioxide - determined titrimetrically in accordance with APHA latest edition,4500-CO2 C.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition 2320-B. Solids reported from a 1:5 water extract unless otherwise specified. Total Carbon Dioxide - determined by calculation in accordance with APHA latest edition,4500-CO2 D.
INORG-022	Turbidity - measured nephelometrically using a turbidimeter, in accordance with APHA latest edition, 2130-B.
INORG-055	Nitrate/Nitrite/NOx/TKN - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils/solids are analysed following a water extraction.
INORG-057	Ammonia - determined colourimetrically. Water samples are filtered on receipt prior to analysis. Soils and OHS media are analysed following a water extraction. Alternatively, Ammonia can be extracted from soil using 1M KCl.
INORG-060	Phosphate - determined colourimetrically using APHA latest edition 4500 P E. Water samples are filtered on receipt prior to analysis. Soils are analysed from a water extract.
INORG-081	Anions determined by Ion Chromatography. Waters samples are filtered on receipt prior to analysis. Solids are analysed from a water extract. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
INORG-127	Total Nitrogen by high temperature catalytic combustion with chemiluminescence detection. Organic Carbon forms (inorganic, organic, total) determined using a TOC/NDIR analyser via combustion. Dissolved forms require filtering prior to determination.
METALS-020	Determination of various metals by ICP-OES. Where salts (oxides, chlorides etc.) are calculated from the element concentration stoichiometrically there is no guarantee that the salt form is completely soluble in the acids used in the preparation.
MICRO-001B	E. coli/Thermotolerant coliforms: Microbial Water Analysis - in accordance with MICRO-001 (AS4276.5-latest edition). Recommended maximums based on NHMRC Australian Drinking Water Guidelines. Please note that results for this test derived from counts outside of the range 10-80 are considered approximate as per AS4276.1.

Certificate of Analysis PGG1000

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Certificate of Analysis PGG1000

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volumes are typically provided by customers (often as flow rate(s) and sampling time(s) and/or simply volume(s) sampled or exposure times (determines 'volume' passive badges are exposed to)). Hence in such circumstances the volume measurement is inevitably not covered by Envirolab's NATA accreditation. An exception may occur where Envirolab Newcastle does the sampling where accreditation exists for certain types of sampling and hence volume determination(s). Note air volumes are often used to determine concentrations for dust and/or analyses on filters, sorbents and in impingers. For canister sampling, the air volume is covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PGG1000

Client Details

Client	Pentium Water Pty Ltd
Your Reference	PW035823 - North Dandalup
Date Issued	21/07/2025

Recommended Holding Time Compliance

No recommended holding time exceedances

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	No	Duplicate Outliers Exist - See detailed list below
Matrix Spike	No	Matrix Spike Outliers Exist - See detailed list below
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PGG1000

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
Total Phosphorus Water	1-4	16/07/2025	17/07/2025	17/07/2025	Yes
Turbidity Water	1-4	16/07/2025	18/07/2025	18/07/2025	Yes
Alkalinity Suite Water	1-4	16/07/2025	16/07/2025	17/07/2025	Yes
Chloride Water	1-4	16/07/2025	17/07/2025	17/07/2025	Yes
Sulfate Water	1-4	16/07/2025	17/07/2025	17/07/2025	Yes
Acidity Water	1-4	16/07/2025	17/07/2025	17/07/2025	Yes
Dissolved Organic N (calc) Water	1-4	16/07/2025	17/07/2025	18/07/2025	Yes
Nitrogen - Ammonia Water	1-4	16/07/2025	16/07/2025	16/07/2025	Yes
Nitrogen - Nitrate Water	1-4	16/07/2025	16/07/2025	16/07/2025	Yes
Nitrogen - Nitrite Water	1-4	16/07/2025	16/07/2025	16/07/2025	Yes
Nitrogen - NOx Water	1-4	16/07/2025	16/07/2025	16/07/2025	Yes
Nitrogen - Total Dissolved Water	1-4	16/07/2025	17/07/2025	18/07/2025	Yes
Nitrogen - Total N Water	1-4	16/07/2025	17/07/2025	17/07/2025	Yes
Phosphate as P Water	2-4	16/07/2025	16/07/2025	16/07/2025	Yes
	1	16/07/2025	16/07/2025	17/07/2025	Yes
TKN as N calc Water	1-4	16/07/2025	17/07/2025	21/07/2025	Yes
E. coli & T.T.coli Water	1-4	16/07/2025	16/07/2025	16/07/2025	Yes

Outliers: Duplicates

INORG-006 | Inorganics - Ionic Balance and Indexes (Water) | Batch BGG2707

Sample ID	Duplicate ID	Analyte	% Limits	RPD
BGG2707-DUP1#	DUP1	Bicarbonate Alkalinity as CaCO3	20.00	32.3
BGG2707-DUP1#	DUP1	Total Alkalinity as CaCO3	20.00	35.3
BGG2707-DUP2#	DUP2	Bicarbonate Alkalinity as CaCO3	20.00	58.1
BGG2707-DUP2#	DUP2	Total Alkalinity as CaCO3	20.00	58.1

Outliers: Matrix Spike

INORG-057 | Inorganics - Nutrients (Water) | Batch BGG2709

Sample ID	Analyte	% Limits	% Recovery
BGG2709-MS1#	Ammonia as N	70 - 130	##[3]

Quality Control PGG1000

METALS-020 | Acid Extractable Metals (Water) | Batch BGG2761

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BGG2761-DUP1# Samp QC RPD %	BGG2761-DUP2# Samp QC RPD %		
Phosphorus	mg/L	0.050	<0.050	<0.050 <0.050 [NA]	1.98 1.95 1.55	100	98.2

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-022 | Inorganics - Physical Parameters (Water) | Batch BGG2988

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %
				BGG2988-DUP1# Samp QC RPD %	BGG2988-DUP2# Samp QC RPD %	
Turbidity	NTU	0.10	<0.10	0.460 0.430 [NA]	31.5 30.6 2.90	99.5

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-006 | Inorganics - Ionic Balance and Indexes (Water) | Batch BGG2707

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %
				BGG2707-DUP1# Samp QC RPD %	BGG2707-DUP2# Samp QC RPD %	
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	144 200 32.3	53.5 29.4 58.1	[NA]
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 6.40 [NA]	<5.0 <5.0 [NA]	[NA]
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 <5.0 [NA]	<5.0 <5.0 [NA]	[NA]
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	144 206 35.3	53.5 29.4 58.1	94.8

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-081 | Inorganics - Ionic Balance and Indexes (Water) | Batch BGG2802

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BGG2802-DUP1# Samp QC RPD %	BGG2802-DUP2# Samp QC RPD %		
Chloride	mg/L	1.0	<1.0	92.0 92.0 0.00782	11.8 11.8 0.0799	90.1	102
Sulfate	mg/L	1.0	<1.0	25.7 25.7 0.0510	4.61 4.58 [NA]	90.3	99.6

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-005 | Inorganics - Miscellaneous and Common Anions (Water) | Batch BGG2800

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %
				BGG2800-DUP1# Samp QC RPD %	BGG2800-DUP2# Samp QC RPD %	
Acidity	mg/L	5.0	<5.0	42.7 42.4 0.869	29.8 36.4 19.9	96.7

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-057 | Inorganics - Nutrients (Water) | Batch BGG2709

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BGG2709-DUP1# Samp QC RPD %	BGG2709-DUP2# Samp QC RPD %		
Ammonia as N	mg/L	0.0050	<0.0050	2330 2260 2.90	36.0 33.7 6.59	109	##[3]
Nitrate as N	mg/L	0.0050	<0.0050	0.110 0.115 4.53	4.45 4.40 1.20	112	96.3
Nitrate as NO3 by calculation	mg/L	0.020	<0.020			[NA]	[NA]
Nitrite as N	mg/L	0.0050	<0.0050	0.0546 0.0546 0.00916	0.380 0.382 0.701	114	125
Nitrite as NO2 by calculation	mg/L	0.020	<0.020			[NA]	[NA]
NOx as N	mg/L	0.0050	<0.0050	0.164 0.169 3.05	4.83 4.78 1.05	112	89.2
Phosphate as P	mg/L	0.0050	<0.0050	0.0595 0.0569 4.49	5.61 5.63 0.456	112	71.1

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

Quality Control PGG1000

INORG-127 | Inorganics - Nutrients (Water) | Batch BGG2905

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BGG2905-DUP1# Samp QC RPD %	PGG1000-01 Samp QC RPD %		
Total Nitrogen	mg/L	0.10	<0.10	2320 2400 3.20	1.91 1.95 2.51	108	119

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-127 | Inorganics - Nutrients (Water) | Batch BGG2914

Analyte	Units	PQL	Blank	DUP1	LCS %	Spike %
				PGG1000-01 Samp QC RPD %		
Total Dissolved Nitrogen	mg/L	0.10	<0.10	1.49 1.52 2.43	111	79.6

MICRO-001B | Microbiological Suite (Water) | Batch BGG2785

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %
				BGG2785-DUP1# Samp QC RPD %	BGG2785-DUP2# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]

Analyte	Units	PQL	Blank	DUP3	DUP4	LCS %
				BGG2785-DUP3# Samp QC RPD %	BGG2785-DUP4# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]

Analyte	Units	PQL	Blank	DUP5	DUP6	LCS %
				BGG2785-DUP5# Samp QC RPD %	BGG2785-DUP6# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]

Analyte	Units	PQL	Blank	DUP7	LCS %
				BGG2785-DUP7# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<10	<10 <10 [NA]	[NA]
E.coli	cfu/100mL	1	<10	<10 <10 [NA]	[NA]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

QC Comments

Identifier	Description
[1]	Microbiological testing PQL raised due to high sample turbidity and/or matrix interference.
[3]	Spike recovery is not applicable due to the relatively high analyte background in the sample (>3* spike level). However, the LCS recovery is within acceptance criteria.

Certificate of Analysis PGG1004

Client Details

Client	Pentium Water Pty Ltd
Contact	J. Faranda
Address	Level 1, 640 Murray St, West Perth, WA, 6005

Sample Details

Your Reference	PW035823 - North Dandalup
Number of Samples	6 Groundwater
Date Samples Received	16/07/2025
Date Instructions Received	16/07/2025

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for soils and on an as received basis for other matrices.

Report Details

Date Final Results Expected	23/07/2025
Date of Issue	22/07/2025

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Authorisation Details

Results Approved By	Jessica Miller, Microbiological Supervisor Lien Tang, Assistant Operations Manager Michael Mowle, Development Chemist - Inorganics and Metals Varsha Ho Wing, Inorganics and Metals Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PGG1004

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PGG1004-01	MB1	Groundwater	16/07/2025	16/07/2025
PGG1004-02	MB2	Groundwater	16/07/2025	16/07/2025
PGG1004-03	MB3	Groundwater	16/07/2025	16/07/2025
PGG1004-04	MB4	Groundwater	16/07/2025	16/07/2025
PGG1004-05	MB5	Groundwater	16/07/2025	16/07/2025
PGG1004-06	HS101A	Groundwater	16/07/2025	16/07/2025

Certificate of Analysis PGG1004

Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PGG1004-01	PGG1004-02	PGG1004-03	PGG1004-04	PGG1004-05
Your Reference			MB1	MB2	MB3	MB4	MB5
Date Sampled			16/07/2025	16/07/2025	16/07/2025	16/07/2025	16/07/2025
Phosphorus	mg/L	0.050	<0.050	<0.050	<0.050	0.81	<0.050

Envirolab ID	Units	PQL	PGG1004-06
Your Reference			HS101A
Date Sampled			16/07/2025
Phosphorus	mg/L	0.050	<0.050

Certificate of Analysis PGG1004

Inorganics - Ionic Balance and Indexes (Groundwater)

Envirolab ID	Units	PQL	PGG1004-01	PGG1004-02	PGG1004-03	PGG1004-04	PGG1004-05
Your Reference			MB1	MB2	MB3	MB4	MB5
Date Sampled			16/07/2025	16/07/2025	16/07/2025	16/07/2025	16/07/2025

Chloride	mg/L	1.0	530	1200	6300	680	260
Sulfate	mg/L	1.0	130	190	850	42	90

Envirolab ID	Units	PQL	PGG1004-06
Your Reference			HS101A
Date Sampled			16/07/2025

Chloride	mg/L	1.0	16
Sulfate	mg/L	1.0	10

Certificate of Analysis PGG1004

Inorganics - Nutrients (Groundwater)

Envirolab ID Your Reference Date Sampled	Units	PQL	PGG1004-01 MB1 16/07/2025	PGG1004-02 MB2 16/07/2025	PGG1004-03 MB3 16/07/2025	PGG1004-04 MB4 16/07/2025	PGG1004-05 MB5 16/07/2025
Ammonia as N	mg/L	0.0050	0.024	0.057	0.075	0.058	0.31
Nitrate as N	mg/L	0.0050	0.0070	<0.0050	<0.0050	0.0052	0.022
Nitrate as NO3 by calculation	mg/L	0.020	0.031	<0.020	<0.020	0.023	0.096
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	0.0085	<0.0050	<0.0050	0.0052	0.022
Dissolved Organic Nitrogen by calc	mg/L	0.10	<0.10	<0.10	0.16	<0.10	0.14
TKN as N by calculation	mg/L	0.10	<0.10	0.15	0.22	0.14	0.52
Total Dissolved Nitrogen	mg/L	0.10	<0.10	0.15	0.23	0.16	0.48
Organic Nitrogen by calc.	mg/L	0.10	<0.10	<0.10	0.14	<0.10	0.21
Total Nitrogen	mg/L	0.10	<0.10	0.16	0.22	0.14	0.55
Phosphate as P	mg/L	0.0050	0.0086	0.019	0.027	0.013	<0.0050

Envirolab ID Your Reference Date Sampled	Units	PQL	PGG1004-06 HS101A 16/07/2025
Ammonia as N	mg/L	0.0050	<0.0050
Nitrate as N	mg/L	0.0050	2.1
Nitrate as NO3 by calculation	mg/L	0.020	9.2
Nitrite as N	mg/L	0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020
NOx as N	mg/L	0.0050	2.1
Dissolved Organic Nitrogen by calc	mg/L	0.10	<0.10
TKN as N by calculation	mg/L	0.10	<0.10
Total Dissolved Nitrogen	mg/L	0.10	2.1
Organic Nitrogen by calc.	mg/L	0.10	<0.10
Total Nitrogen	mg/L	0.10	2.1
Phosphate as P	mg/L	0.0050	<0.0050

Certificate of Analysis PGG1004

Microbiological Suite (Groundwater)

Envirolab ID	Units	PQL	PGG1004-01	PGG1004-02	PGG1004-03	PGG1004-04	PGG1004-05
Your Reference			MB1	MB2	MB3	MB4	MB5
Date Sampled			16/07/2025	16/07/2025	16/07/2025	16/07/2025	16/07/2025
Thermotolerant Coliforms	cfu/100mL	1	<10 [1]	<10 [1]	<10 [1]	<10 [1]	<10 [1]
E.coli	cfu/100mL	1	<10 [1]	<10 [1]	<10 [1]	<10 [1]	<10 [1]

Envirolab ID	Units	PQL	PGG1004-06
Your Reference			HS101A
Date Sampled			16/07/2025
Thermotolerant Coliforms	cfu/100mL	1	<1
E.coli	cfu/100mL	1	<1

Certificate of Analysis PGG1004

Result Comments

Identifier	Description
[1]	Microbiological testing PQL raised due to high sample turbidity and/or matrix interference.

Certificate of Analysis PGG1004

Method Summary

Method ID	Methodology Summary
Calc	Calculation
Calc - DON	Calculation of Dissolved Organic Nitrogen. Analysis conducted on filtered sample (0.45µm)
Calc - TKN	TKN determined by calculation (Total Nitrogen - NOx).
INORG-055	Nitrate/Nitrite/NOx/TKN - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils/solids are analysed following a water extraction.
INORG-057	Ammonia - determined colourimetrically. Water samples are filtered on receipt prior to analysis. Soils and OHS media are analysed following a water extraction. Alternatively, Ammonia can be extracted from soil using 1M KCl.
INORG-060	Phosphate - determined colourimetrically using APHA latest edition 4500 P E. Water samples are filtered on receipt prior to analysis. Soils are analysed from a water extract.
INORG-081	Anions determined by Ion Chromatography. Waters samples are filtered on receipt prior to analysis. Solids are analysed from a water extract. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
INORG-127	Total Nitrogen by high temperature catalytic combustion with chemiluminescence detection. Organic Carbon forms (inorganic, organic, total) determined using a TOC/NDIR analyser via combustion. Dissolved forms require filtering prior to determination.
METALS-020	Determination of various metals by ICP-OES. Where salts (oxides, chlorides etc.) are calculated from the element concentration stoichiometrically there is no guarantee that the salt form is completely soluble in the acids used in the preparation.
MICRO-001B	E. coli/Thermotolerant coliforms: Microbial Water Analysis - in accordance with MICRO-001 (AS4276.5-latest edition). Recommended maximums based on NHMRC Australian Drinking Water Guidelines. Please note that results for this test derived from counts outside of the range 10-80 are considered approximate as per AS4276.1.

Certificate of Analysis PGG1004

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Certificate of Analysis PGG1004

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volumes are typically provided by customers (often as flow rate(s) and sampling time(s) and/or simply volume(s) sampled or exposure times (determines 'volume' passive badges are exposed to)). Hence in such circumstances the volume measurement is inevitably not covered by Envirolab's NATA accreditation. An exception may occur where Envirolab Newcastle does the sampling where accreditation exists for certain types of sampling and hence volume determination(s). Note air volumes are often used to determine concentrations for dust and/or analyses on filters, sorbents and in impingers. For canister sampling, the air volume is covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PGG1004

Client Details

Client	Pentium Water Pty Ltd
Your Reference	PW035823 - North Dandalup
Date Issued	22/07/2025

Recommended Holding Time Compliance

No recommended holding time exceedances

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	Yes	No Outliers
Matrix Spike	No	Matrix Spike Outliers Exist - See detailed list below
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PGG1004

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
Total Phosphorus Water	1-6	16/07/2025	17/07/2025	17/07/2025	Yes
Chloride Water	1-6	16/07/2025	17/07/2025	17/07/2025	Yes
Sulfate Water	1-6	16/07/2025	17/07/2025	17/07/2025	Yes
Dissolved Organic N (calc) Water	2-6	16/07/2025	17/07/2025	18/07/2025	Yes
	1	16/07/2025	17/07/2025	21/07/2025	Yes
Nitrogen - Ammonia Water	1-6	16/07/2025	17/07/2025	17/07/2025	Yes
Nitrogen - Nitrate Water	1-3, 6	16/07/2025	17/07/2025	17/07/2025	Yes
	4-5	16/07/2025	17/07/2025	18/07/2025	Yes
Nitrogen - Nitrite Water	1-3, 6	16/07/2025	17/07/2025	17/07/2025	Yes
	4-5	16/07/2025	17/07/2025	18/07/2025	Yes
Nitrogen - NOx Water	1-3, 6	16/07/2025	17/07/2025	17/07/2025	Yes
	4-5	16/07/2025	17/07/2025	18/07/2025	Yes
Nitrogen - Total Dissolved Water	2-6	16/07/2025	17/07/2025	18/07/2025	Yes
	1	16/07/2025	17/07/2025	21/07/2025	Yes
Nitrogen - Total N Water	1-6	16/07/2025	17/07/2025	18/07/2025	Yes
Phosphate as P Water	1-3, 5-6	16/07/2025	17/07/2025	17/07/2025	Yes
	4	16/07/2025	17/07/2025	18/07/2025	Yes
TKN as N calc Water	1-6	16/07/2025	17/07/2025	22/07/2025	Yes
E. coli & T.T.coli Water	1-6	16/07/2025	16/07/2025	16/07/2025	Yes

Outliers: Matrix Spike

INORG-055 | Inorganics - Nutrients (Water) | Batch BGG2753

Sample ID	Analyte	% Limits	% Recovery
PGG1004-02	Nitrite as N	70 - 130	##[2]

Quality Control PGG1004

METALS-020 | Acid Extractable Metals (Water) | Batch BGG2761

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BGG2761-DUP1# Samp QC RPD %	BGG2761-DUP2# Samp QC RPD %		
Phosphorus	mg/L	0.050	<0.050	<0.050 <0.050 [NA]	1.98 1.95 1.55	100	98.2

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-081 | Inorganics - Ionic Balance and Indexes (Water) | Batch BGG2802

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BGG2802-DUP1# Samp QC RPD %	BGG2802-DUP2# Samp QC RPD %		
Chloride	mg/L	1.0	<1.0	92.0 92.0 0.00782	11.8 11.8 0.0799	90.1	102
Sulfate	mg/L	1.0	<1.0	25.7 25.7 0.0510	4.61 4.58 [NA]	90.3	99.6

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-057 | Inorganics - Nutrients (Water) | Batch BGG2753

Analyte	Units	PQL	Blank	DUP1	LCS %	Spike %
				PGG1004-01 Samp QC RPD %		
Ammonia as N	mg/L	0.0050	<0.0050	0.0242 0.0246 [NA]	103	114
Nitrate as N	mg/L	0.0050	<0.0050	0.00704 0.00720 [NA]	109	120
Nitrate as NO3 by calculation	mg/L	0.020	<0.020		[NA]	[NA]
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050 <0.0050 [NA]	103	##[2]
Nitrite as NO2 by calculation	mg/L	0.020	<0.020		[NA]	[NA]
NOx as N	mg/L	0.0050	<0.0050	0.00846 0.00838 [NA]	109	120
Phosphate as P	mg/L	0.0050	<0.0050	0.00861 0.00788 [NA]	113	108

INORG-127 | Inorganics - Nutrients (Water) | Batch BGG2906

Analyte	Units	PQL	Blank	DUP1	LCS %	Spike %
				BGG2906-DUP1# Samp QC RPD %		
Total Nitrogen	mg/L	0.10	<0.10	57.8 59.7 3.15	111	96.8

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-127 | Inorganics - Nutrients (Water) | Batch BGG2914

Analyte	Units	PQL	Blank	DUP1	LCS %	Spike %
				BGG2914-DUP1# Samp QC RPD %		
Total Dissolved Nitrogen	mg/L	0.10	<0.10	1.49 1.52 2.43	111	79.6

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

Quality Control PGG1004

MICRO-001B | Microbiological Suite (Water) | Batch BGG2785

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %
				BGG2785-DUP1# Samp QC RPD %	BGG2785-DUP2# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]

Analyte	Units	PQL	Blank	DUP3	DUP4	LCS %
				BGG2785-DUP3# Samp QC RPD %	BGG2785-DUP4# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]

Analyte	Units	PQL	Blank	DUP5	DUP6	LCS %
				BGG2785-DUP5# Samp QC RPD %	BGG2785-DUP6# Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 <1 [NA]	<1 <1 [NA]	[NA]

Analyte	Units	PQL	Blank	DUP7	LCS %
				PGG1004-01 Samp QC RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<10 <10 [NA]	[NA]
E.coli	cfu/100mL	1	<1	<10 <10 [NA]	[NA]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

QC Comments

Identifier	Description
[1]	Microbiological testing PQL raised due to high sample turbidity and/or matrix interference.
[2]	Spike recovery is outside routine acceptance criteria (70-130%), this may be due to suspected non-homogeneity and/or matrix interference effects. However, an acceptable recovery was achieved for the LCS.

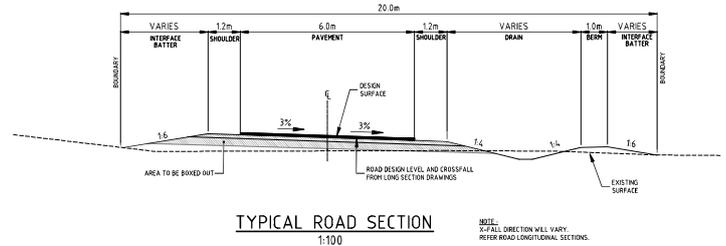
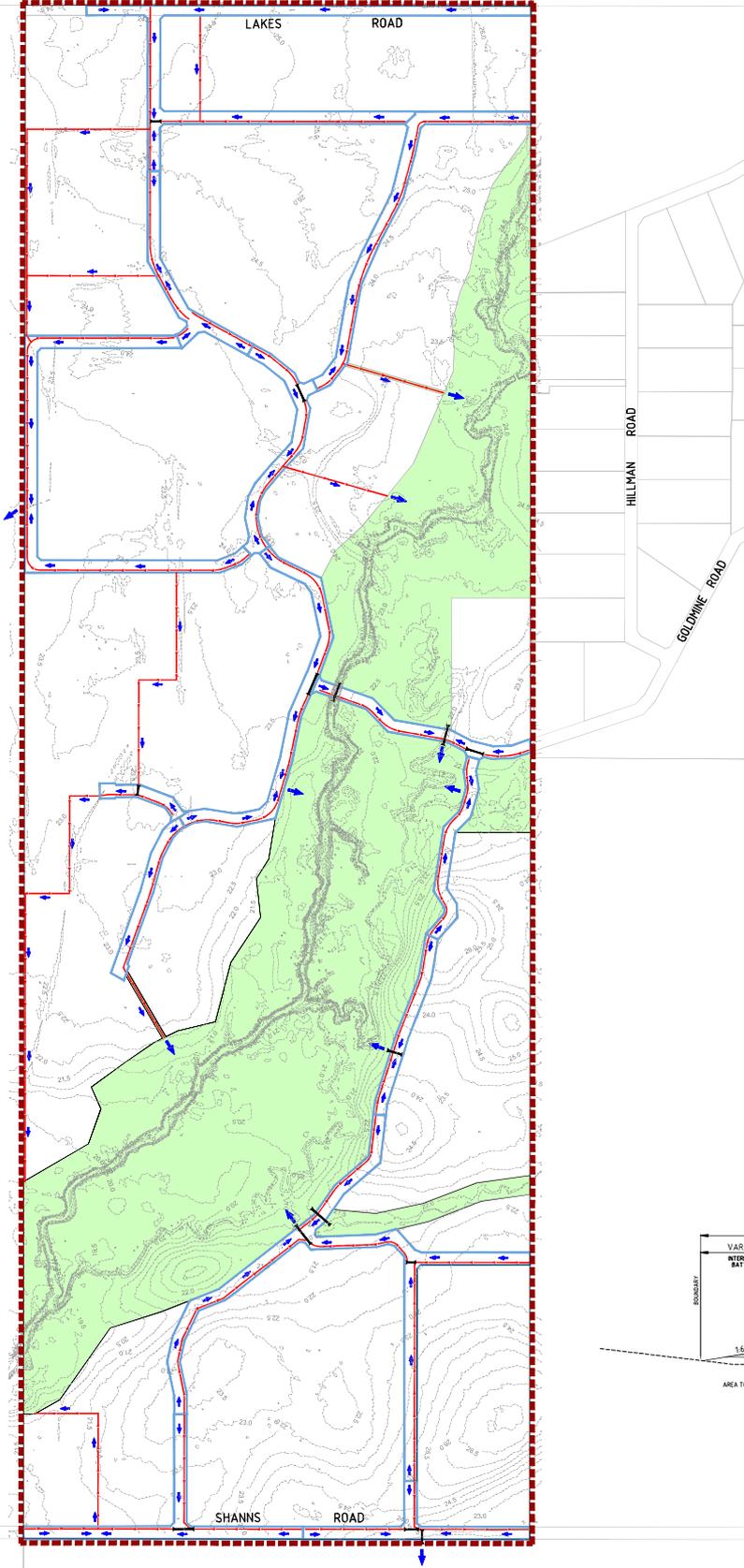
Appendix F: Drainage concept

Tabec, 2025



LEGEND

- SITE BOUNDARY
- ROAD CATCHMENT
- SWALE WITH FLOW DIRECTION
- FLOW DIRECTION
- CULVERT
- EXISTING SURFACE CONTOURS (0.5m INTERVAL)



PLAN
SCALE 1:4000

SCALE 1:4000 0 80 160 240 320 400 480 560 640 720 800 880 960 1040 1120 1200

A1

Z:\N\1818 Lakes Rd - TABEC - 1818 - 1818.dwg 04/02/20 15:55:33 phewen

No.	DATE	DRAWN	APPROVED	AMENDMENT
B	28.07.25	KS	AB	LAYOUT AND CATCHMENTS UPDATED
A	03.07.25	KS	AB	ISSUED FOR INFORMATION

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KS	AB		KS	AB	
DRAWN	CHECKED	DATE	DRAWN	CHECKED	DATE
KS	AB		KS	AB	

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PROJECT	1818 LAKES ROAD, NORTH DANDALUP
TITLE	DRAINAGE CONCEPT PLAN
DRAWING NUMBER	2581-SK-001
ISSUE	B

Appendix G: Determination of foreshore setback

Bayley Environmental, 2025

1818 LAKES RD NORTH DANDALUP
DETERMINATION OF FORESHORE SETBACK

Prepared for

Valley Holdings WA Pty Ltd
252 Fitzgerald St
PERTH WA 6000

Report No. J25003
7 August 2025

BAYLEY ENVIRONMENTAL SERVICES
30 Thomas Street
SOUTH FREMANTLE WA 6162

INTRODUCTION

Valley Holdings WA Pty Ltd proposes to rezone Lot A39 (No. 1818) Lakes Road, North Dandalup (the subject land) for rural-residential use. The rezoning is intended to facilitate the future subdivision of the 194.7ha property into approximately 120 lots with a minimum size of 1ha. Figure 1 shows the location of the subject land. Figure 2 shows an aerial photograph of the site and surroundings.

The North Dandalup River flows through the centre of the subject land. In accordance with WAPC Policy DC2.3, the river and its immediate surrounds will be protected in a foreshore reserve. Bayley Environmental Services was commissioned in March 2025 to determine an appropriate foreshore setback for the development.

Foreshore reserve requirements for waterways are governed by WAPC Development Control Policy No. DC2.3: *Public Open Space in Residential Areas*. DC2.3 specifies a default foreshore reserve width of 30 metres for waterways but includes provision to vary the default setback for reasons of topography, condition of banks, floodway protection or other factors. DPAW policy on foreshore setbacks is set out in River Restoration Series No. RR16 – *Determining Foreshore Reserves* (WRC, 2001) and Foreshore Policy 1 - *Identifying the Foreshore Area* (WRC, 2002). These documents also set out a methodology for determining the foreshore setback in each case. The assessment of the foreshore setback for the subject land presented in this report follows the methodology described in RR16.

DETERMINATION OF FORESHORE SETBACK USING THE METHODOLOGY SET OUT IN RIVER RESTORATION SERIES 16

Step 1: Background information and preliminary investigations

Waterway significance and management issues

The North Dandalup River is a major tributary of the Murray River, which is the major river of the Peel Region. The North Dandalup River is significant in ecological, hydrological and amenity terms. The principal management issues facing the river are water quality, which has suffered as a result of nutrient inputs from development in its catchment, and the loss of riparian vegetation due to agricultural clearing and stock trampling in the lower reaches of the river.

The North Dandalup River was dammed by a small pipehead dam in 1971. The larger North Dandalup Dam was opened in 1995. The effect of the damming has been to significantly reduce flows from the upper catchment into the lower reaches of the river. The main North Dandalup Dam has not overflowed since its commissioning in 1995.

Aerial photography

Figures 1-3 show aerial photographs of the river within the subject land.

Maps of extent of floodway and floodplains, topographical features, cadastral boundaries, soils, underlying geology and vegetation complexes.

These features are shown on Figure 3.

Relevant reports on the river and region

The Murray Drainage and Water Management Plan (DWMP) (DoW, 2011) presented the results of stream gauging and flood modelling for the North Dandalup River. The Floodplain Management Strategy (GHD, 2010) undertaken for the DWMP concluded that the North Dandalup Dam would not overflow in any storm event less than 500-year ARI, and that the upper catchment would therefore not contribute to flood levels in the lower reaches of the river.

Site Visit

A detailed inspection of the river within the subject land was carried out in April 2025. Figure 4 shows photographs of the river and its fringing vegetation.

Relevant stakeholders

Lot 39 Lakes Rd is owned by Mr Bruce Campbell. Valley Holdings WA Pty Ltd is negotiating to purchase the subject land and is the proponent of the development plan.

Step 2: Biophysical criteria of the waterway

Floodway and floodplain – 1 in 100 yr flood levels, peak flow and river hydrology

The main channel of the river through the subject land is mostly well defined and deeply incised. In the north the banks are relatively gentle, with slopes of around 30%. In the south the watercourse is more deeply incised, with banks up to 4m high and in places nearly vertical.

The Department of Water (DoW) mapped the 100-year floodplain of the North Dandalup River in 2011 as part of the Murray DWMP. Figure 3 shows the DoW floodplain mapping. The DoW study did not differentiate the floodway from the flood fringe. The DoW modelling predicted that the 100-year ARI flood level would be 26.25m AHD at Lakes Road, 25m AHD at the eastern boundary of the subject land and 19.5m AHD at the south-western boundary.

Pentium (2025) modelled the extent of the 100-year floodway using XPSWMM in July 2025. In essence, the modelling simulates filling of the floodplain to the point where the filling obstructs the 100-year flow sufficiently to cause an increase of 0.2m in river levels upstream. The remaining “unfilled” part of the floodplain is designated as the floodway and the region outside of this is designated as the flood fringe.

In this case, the modelling focussed on those sections within the subject land where the floodplain impinged on developable land. Elsewhere, the modelling went only so far as to show that the floodway was wholly contained within the proposed foreshore reserve. As a result, the modelling over-estimates the extent of the floodway in some parts of the subject land.

Figure 3 shows the boundaries of the floodway resulting from the Pentium (2025) modelling.

Landforms and drainage lines important to watercourse function

The river bed falls from an elevation of about 22.5m AHD at the north-eastern boundary of the subject land to about 16.5m AHD at the south-western boundary. The top of the bank falls from about 24.5m AHD to 19m AHD over the same distance. Away from the river, the land rises gently to the north-west and south-east at gradients of between about 3% and less than 0.2%

Two main tributaries enter the river within the subject land. The first is a creekline that rises adjacent to the South Western Highway 3.5km east of the subject land and joins the river just south of the centre of the subject land. Calculations using the rational method indicate that the critical (2-3 hour) 100-year ARI storm would generate peak flows of approximately 21m³/sec in this tributary at its entry to the subject land.

The second tributary is a minor creek that rises in farm paddocks 1.5km to the east and joins the river just before its exit from the subject land. Rational method calculations

suggest that a critical (50 minute) 100-year ARI storm would generate a peak flow of approximately 4.5m³/sec in this tributary at its entry to the subject land.

The junctions of these tributaries are complex, with multiple channels and overflows. Other minor paddock drains flow into the river from the north-west. Figure 3 shows the tributaries.

Soil types prone to erosion

The North Dandalup River follows a meandering course within the subject land. The river is undercutting its banks on the outside of several bends and depositing sediment on the insides of the bends. The soils surrounding the river channel are light, friable silts and sandy clays, which are easily eroded by the water flow. In the south of the subject land there are a number of cut-off meanders that show where the river has changed its course over time.

Landgate aerial photography since 1974 shows that the alignment of the watercourse within and near the subject land has not changed significantly in that time (www.landgate.wa.gov.au/corporate.nsf/web/Aerial+Photography). However, the visible undercutting on some parts of the bank suggests that it would be prudent to allow for some movement of the channel over time.

Soils that support riparian vegetation

The Geological Survey of Western Australia (GSWA, 1978) maps the North Dandalup River bed as Qha: Holocene Alluvium, with soils of Clayey Sandy Silt (Msc1). Away from the immediate vicinity of the river the GSWA maps the land as Qpb/Qpa: Thin veneer of Bassendean Sand over Guildford Formation sandy clay.

Riparian vegetation

The riparian vegetation in the subject land is mostly restricted to the banks and flats of the river, with the remainder of the subject land being mostly cleared. In the northern half of the subject land, the native fringing vegetation extends to between a few metres and 60m from the main river channel. In the south, the main channel and tributaries form a network of channels and billabongs, and the fringing vegetation forms a patchy band up to 300m wide.

The native fringing vegetation consists mostly of mature Marri (*Corymbia calophylla*), Flooded Gum (*Eucalyptus rudis*) and Swamp Paperbark (*Melaleuca raphiophylla*) over bare ground, pasture grasses and weeds. Occasional *Astartea ?fascicularis*, *Acacia ?cyanophylla* and sedges (*Juncus sp.*) occur in the watercourse but there is otherwise little native understorey or mid storey due to heavy cattle grazing and trampling. A number of weeds including Asian Bulrush (*Typha orientalis*), Narrow-leaf Cottonbush (*Gomphocarpus fruticosus*), Kikuyu (*Pennisetum clandestinum*), Couch Grass (*Cynodon dactylon*) and Veldt Grass (*Ehrharta sp.*) are also present in the watercourse. Near the centre of the subject land on the southern side of the channel is a patch of planted eucalypts, probably Bluegum (*E. globulus*). There is also a small number of Wandoo (*E. wandoo*) in this area, which may be naturally occurring or planted.

The overall condition of the vegetation is Degraded to Completely Degraded. Figure 4 shows views of the river and its fringing vegetation.

The riparian vegetation in the vicinity of the subject land is mapped by Heddle *et al.* (1980) as 32: Guildford Complex, described as "...a mixture of open-forest, in sections a tall open-forest, of marri-wandoo-jarra and a woodland of *E. rudis*-*M. raphiophylla* along the streams..." Heddle *et al.* (1980) noted that the Guildford Complex has been heavily logged and cleared since European settlement due to its fertile soils and good water availability, with the result that little of the complex remains undisturbed. In 1997, when the Peel Region Scheme Environmental Review was being prepared, approximately 4.2% of the Guildford Complex remained in the Peel Region and only 0.02% was reserved.

The riverine vegetation of the North Dandalup River, including that within the subject land, has been mapped as a Regionally Significant Natural Area under the *Swan Bioplan: Peel Regionally Significant Natural Areas* (EPA Bulletin EPB12, December 2010). This designation has no statutory force but indicates the EPA's view of the vegetation as regionally significant.

Habitat areas

The watercourse and fringing vegetation offer limited habitat for disturbance-tolerant birds and terrestrial fauna. Kangaroos were observed in the fringing woodland during the site inspection. The lack of dense understorey means that small mammals such as Quenda would be unlikely to persist in the area. Birds observed during the site inspection included magpies, ravens, willie wagtails, honeyeaters, thornbills and twenty-eight parrots. No black cockatoos were seen or heard, although the marri trees near the watercourse would probably be used as a food resource.

Adjacent land use with potential to affect the foreshore

The current grazing land use on the subject land has had significant impacts on the river, including clearing of fringing vegetation, trampling and bank erosion. In places the river banks are severely eroded by cattle accessing the river. This erosion is ongoing.

Development of the subject land as planned will benefit the river by removing the impact of cattle and allowing native vegetation to regenerate, thereby helping to stabilise the river banks. Development will also provide opportunities for rehabilitation of degraded parts of the foreshore.

Aboriginal Heritage Sites

The watercourse of the North Dandalup River is listed on the DPLH Aboriginal Heritage Database as registered Aboriginal heritage site No. 27937: Mythological. The mapped site extends 30m each side of the centreline of the watercourse and is associated with the Waugyl mythology. Figure 3 shows the mapped boundaries of the Aboriginal site.

Authorisation under Section 18 of the Aboriginal Heritage Act will be required for any physical work or ground disturbing activities within the boundaries of the registered site.

Step 3: Other factors

Fire Management

The vegetation in the foreshore zone currently presents a low fire hazard due to the absence of heavy understorey or middle storey vegetation. With the removal of grazing there could be increased growth of grasses and weeds, which could pose an increased fire risk unless it were managed. Therefore, weed control, removal or mowing of grasses and/or replacement with native low understorey species will be required to manage the fire hazard.

Risks and consequences resulting from the proposed foreshore alignment

The principal consequence of establishing a foreshore reserve in this location will be the opportunity to undertake rehabilitation of the foreshore. This will improve the ecological value of the foreshore as well as providing increased social amenity.

The main risk in the proposed alignment is the possibility of flooding above the modelled 100 year flood level, which could affect development outside the foreshore setback. However, any buildings within the flood fringe will have a floor level at least 0.5m above the modelled 100-year flood level so the risk of property damage is low.

Step 4: Finalisation of the alignment

Rationale for the alignment

The key factors in the delineation of the foreshore setback are:

- Compliance with policy - The WAPC's Development Control Policy 2.3 specifies a default minimum setback of 30m from waterways. The foreshore reserve extends between 30m and 265m from the top of the river bank.
- 100 year floodway - The proposed foreshore reserve encompasses the entire 1-year ARI floodplain of the river, as modelled by Pentium (2025).
- Vegetation - The foreshore setback includes all remaining riparian vegetation. It also includes all of the riverine fringing vegetation mapped as Peel Regionally Significant Natural Area (RSNA).
- Shoreline processes - The foreshore setback is sufficiently wide to accommodate anticipated variations in the alignment of the watercourse, including undercutting of the outside of bends in the foreseeable future.
- Aboriginal heritage - The registered Aboriginal heritage site no. 27937 extends 30m each side of the river banks. The Aboriginal site is within the minimum default 30m foreshore reserve.

Map of Foreshore Setback

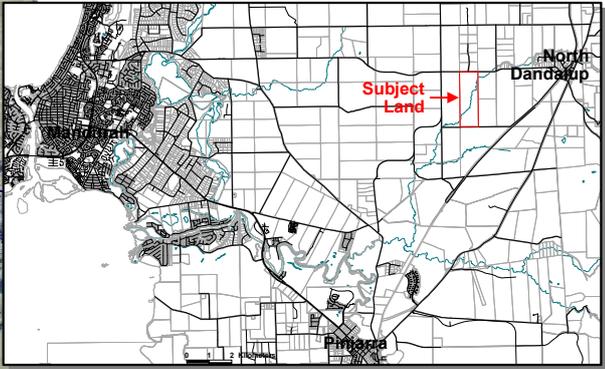
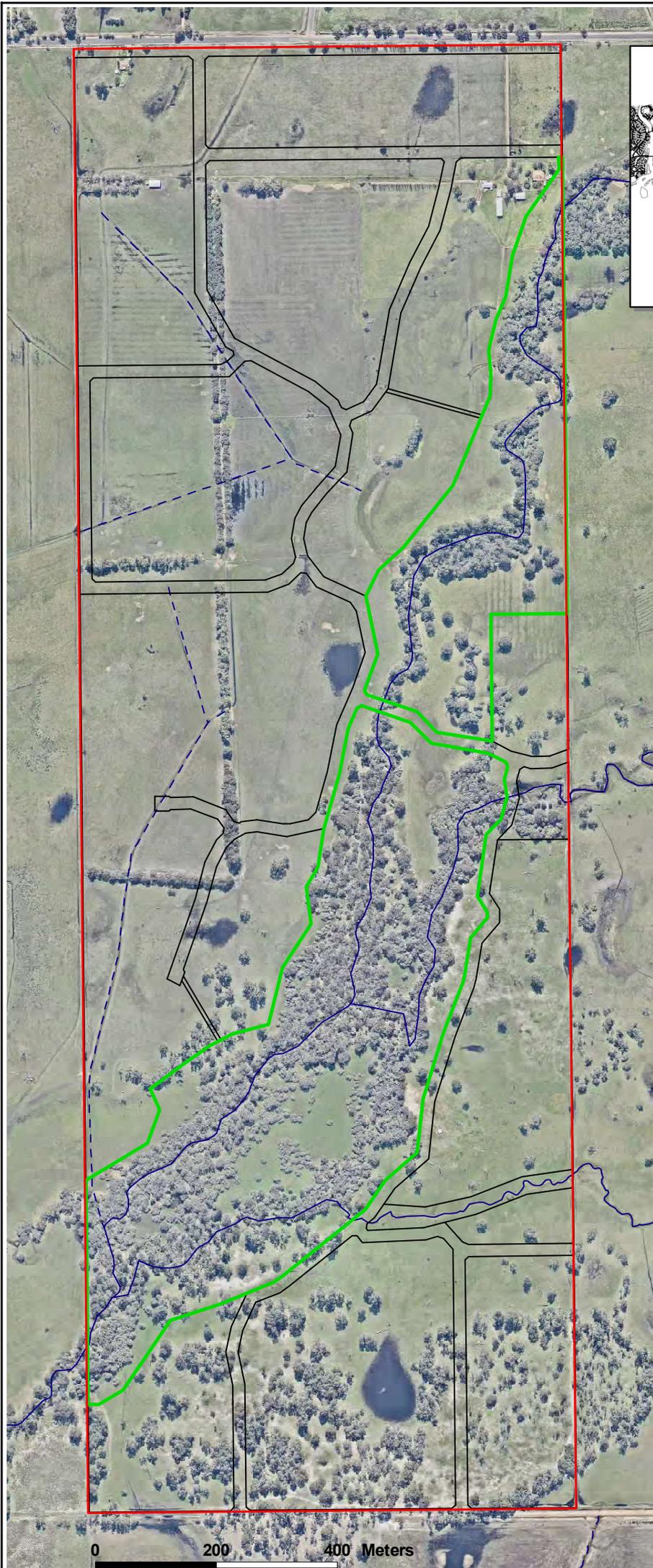
Figure 1 shows the proposed boundary of the foreshore reserve.

FORESHORE TENURE AND MANAGEMENT

The river and foreshore within the subject land are currently privately owned and zoned rural under both the Shire of Murray Town Planning Scheme (TPS) and the Peel Region Scheme (PRS). With the rezoning and subdivision of the subject land, the river and foreshore reserve are expected to be ceded as Public Open Space to the Shire.

A condition of subdivision approval is expected to be the preparation of a Foreshore Management Plan to address rehabilitation, completion criteria and ongoing management of the foreshore reserve. Once the rehabilitation works set out in the Foreshore Management Plan have been completed and the agreed completion criteria have been achieved, the foreshore reserve will be handed over to the Shire of Murray, to be managed primarily for conservation.

Figures



- Subject land boundary
- Conceptual road alignment
- Watercourse
- - - Paddock drain
- Proposed foreshore reserve

Figure 1

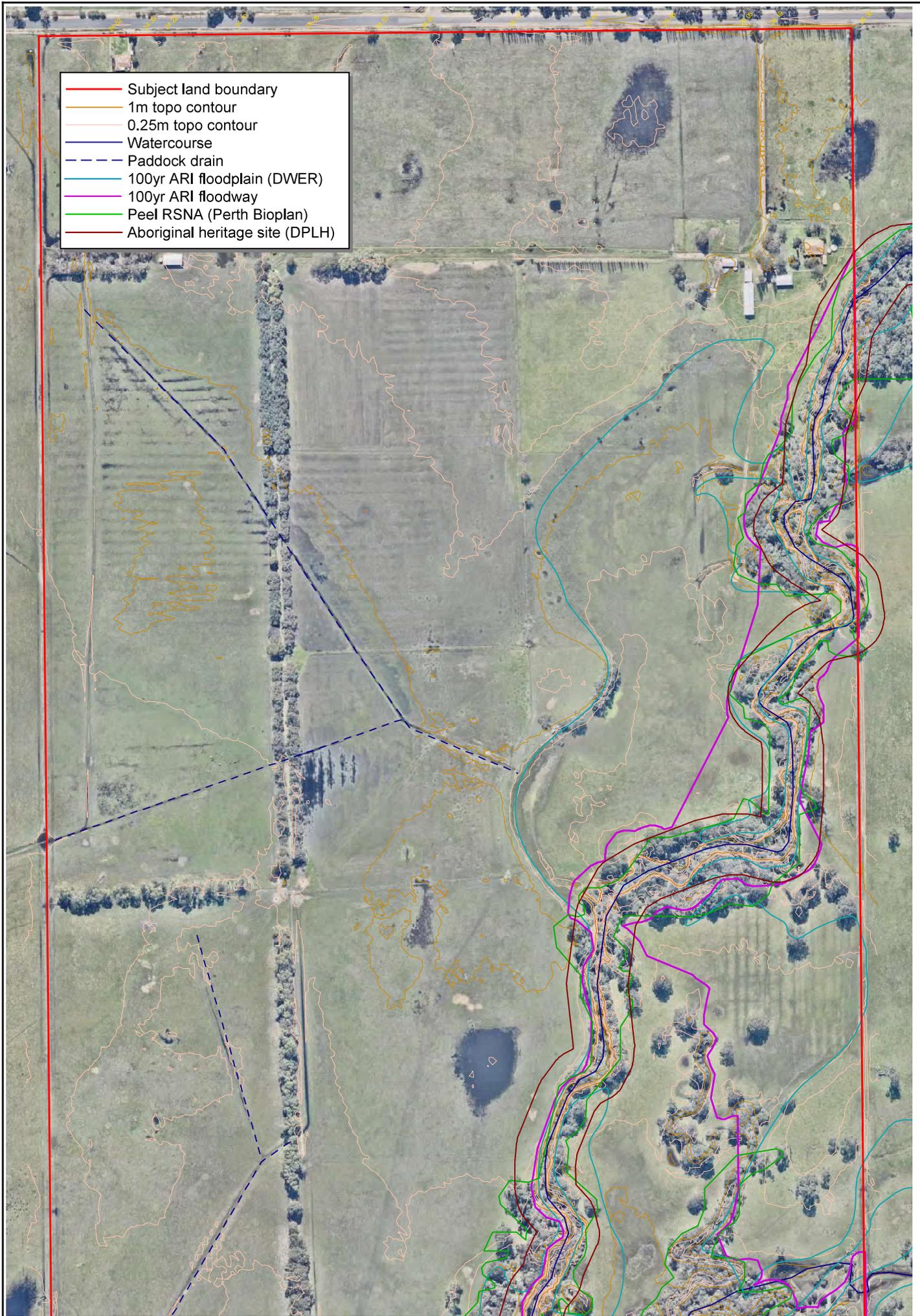
LOCATION AND LAYOUT



Figure 2

THE SITE AND SURROUNDINGS





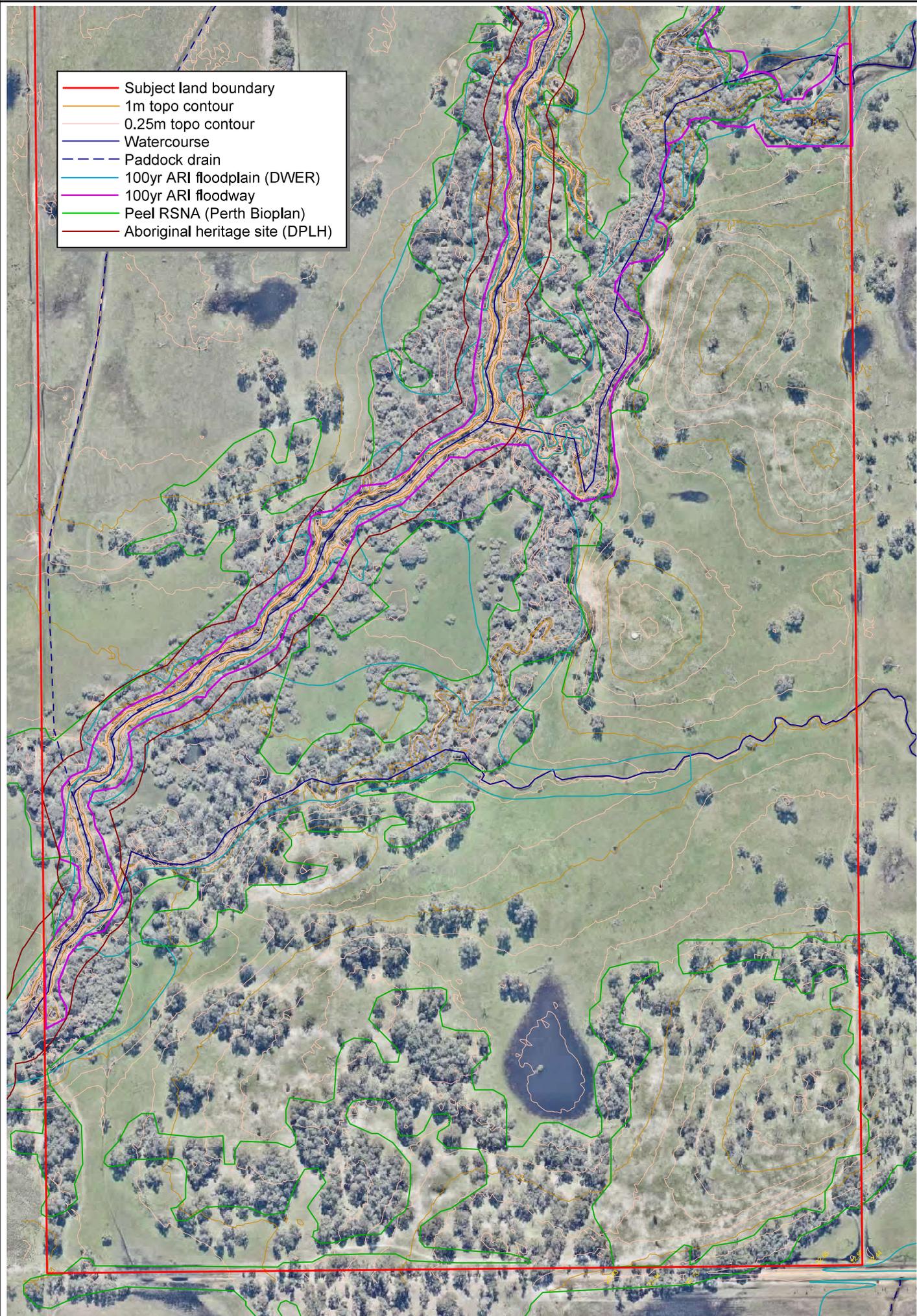
- Subject land boundary
- 1m topo contour
- 0.25m topo contour
- Watercourse
- - - Paddock drain
- 100yr ARI floodplain (DWER)
- 100yr ARI floodway
- Peel RSNA (Perth Bioplan)
- Aboriginal heritage site (DPLH)

0 100 Meters

Figure 3a

ENVIRONMENTAL FEATURES





0 100 Meters

Figure 3b

ENVIRONMENTAL FEATURES



101



103



105



108



109



112



116

See Figure 4c for photo locations

Figure 4a
WATERCOURSE
PHOTOGRAPHS



117



121



126



132



134



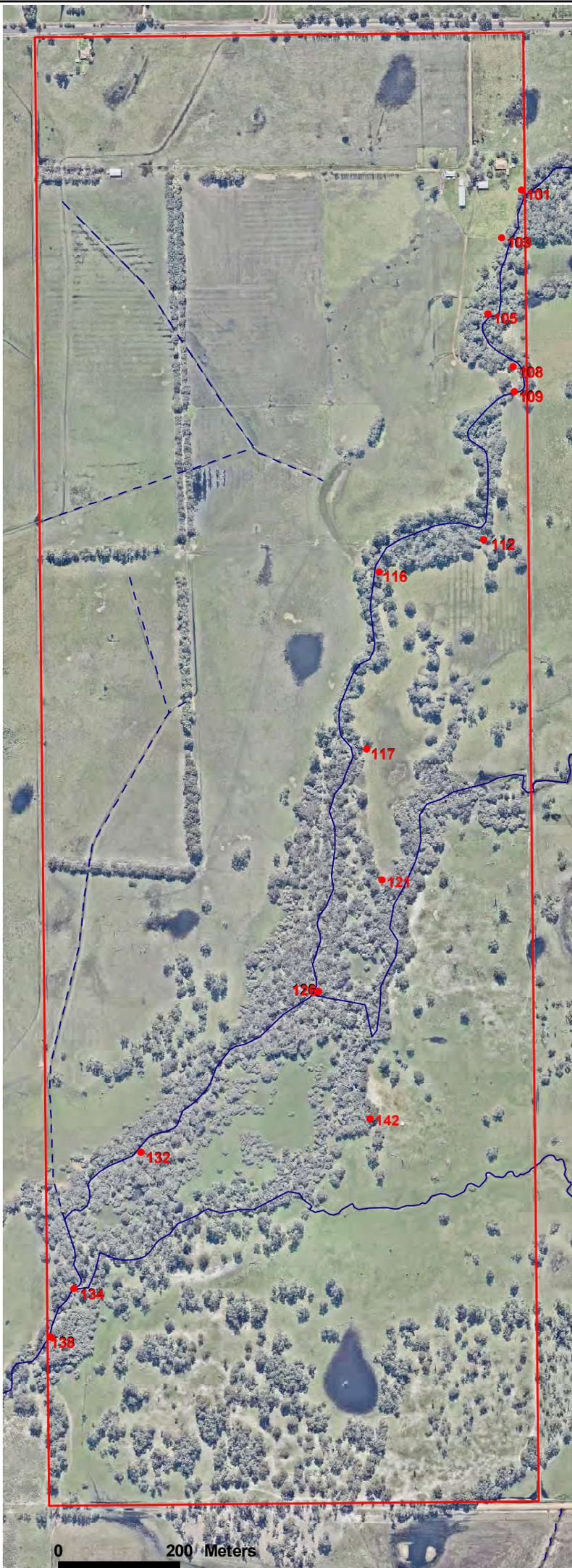
138



142

See Figure 4c for photo locations

Figure 4b
WATERCOURSE
PHOTOGRAPHS



- Subject land boundary
- Photo point (see Figures 4a & 4b)

Figure 4c

**WATERCOURSE
PHOTOGRAPHS**

Appendix H: LWMS checklist

Local water management strategy item	Deliverable		Notes
Executive summary			
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Table 1: Design elements and requirements for best management practices and critical control points	<input checked="" type="checkbox"/>	Executive summary, Table 1
Introduction			
Total water-cycle management principles and objectives Planning background Previous studies		<input checked="" type="checkbox"/>	Section 1.2, 1.4, 1.5
Proposed development			
Structure plan, zoning and land use Key landscape features Previous land use	Site context plan Structure Plan	<input checked="" type="checkbox"/>	Section 1.2, 2.1 Appendix A
Landscape – proposed public open space areas, public open space credits, water source, bore(s), lake details, irrigation areas (if applicable)	Landscape plan	<input type="checkbox"/>	
Design criteria			
Agreed design objectives and source of objectives		<input checked="" type="checkbox"/>	Section 1.4
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		<input checked="" type="checkbox"/>	Section 2.7.3, 2.7.4, 2.8.2, 2.8.3, 2.12
Site conditions – existing topography/contours, aerial photo underlay, major physical features	Site condition plan	<input checked="" type="checkbox"/>	Section 2.3, Figure B
Geotechnical – topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geotechnical plan	<input type="checkbox"/>	Section 2.4.2, 2.4.3
Environmental – areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental plan plus supporting data where appropriate	<input checked="" type="checkbox"/>	Section 2.9, 2.10
Surface water – topography, 100-year floodways and flood fringe areas, water quality of	Surface water plan	<input checked="" type="checkbox"/>	Figure F

Local water management strategy item	Deliverable		Notes
flows entering and leaving (if applicable)			
Groundwater – topography, pre-development groundwater levels and water quality, test bore locations	Groundwater plan plus site investigations	<input checked="" type="checkbox"/>	Section 2.7.3, 2.7.4
Water sustainability initiatives			
Water efficiency measures – private and public open spaces including method of enforcement		<input checked="" type="checkbox"/>	Section 4
Water supply (fit-for-purpose) strategy, agreed actions and implementation		<input checked="" type="checkbox"/>	Section 3.1
Wastewater management		<input checked="" type="checkbox"/>	Section 3.2
Stormwater management strategy			
Flood protection – peak flow rates, volumes and top water levels at control points, 100-year flowpaths and 100-year detention storage areas	100-year-event plan Long section of critical points	<input type="checkbox"/>	Section 5.3, 5.4
Manage serviceability – storage and retention required for the critical 5-year ARI storm events Minor road should be passable in the 5-year ARI event	5-year event plan	<input type="checkbox"/>	Section 5.2
Protect ecology – detention areas for the 15 mm event, areas for water quality treatment and types of agreed structural and non-structural best management practices and treatment trains (including indicative locations). Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	15 mm event plan Typical cross sections	<input type="checkbox"/>	Section 5.2, 5.6
Groundwater management strategy			
Post-development groundwater levels, existing and likely final surface levels, outlet controls, and subsoil drain areas/exclusion zones	Groundwater/subsoil plan	<input type="checkbox"/>	Section 6
Actions to address acid sulfate soils or contamination		<input type="checkbox"/>	
The next stage – subdivision and urban water management plans			
Content and coverage of future urban water management plans to be completed at subdivision.		<input checked="" type="checkbox"/>	Section 9.1

Local water management strategy item	Deliverable		Notes
Include areas where further investigations are required before detailed design			
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements		<input checked="" type="checkbox"/>	Section 8.2
Implementation			
Developer commitments		<input checked="" type="checkbox"/>	Section 9
Roles, responsibilities, funding for implementation		<input checked="" type="checkbox"/>	Section 9.2
Review		<input checked="" type="checkbox"/>	