PENTIUM WATER

LOCAL WATER MANAGEMENT STRATEGY

Mariginiup - Precinct 15

Document Number: STOMAR_01

Date: 22/08/2023

Document Status

Version	Purpose of document	Authored by	Reviewed by	Review Date
Rev 0	Final for submission	KatGre	GerEdw	22/08/2023

Approval for Issue

Name	Signature	Date
Shane McSweeney		22/08/2023

Prepared By

Pentium Water Pty Ltd

Level 1, 640 Murray Street
West Perth, Western Australia 6005

Phone: +61 (0) 8 6182 1790

Email: admin@pentiumwater.com.au

Author: Katie Greaves

Position: Hydrologist

Reviewer: Gerard Edwards

Approved by: Gerard Edwards

Version: Rev 0

Date: 22 August 2023

Prepared For

Stockland Property Management Pty Ltd

Level 12, Durack Centre, 263 Adelaide Terrace.
Perth, Western Australia 6005

Phone: +61 (0) 8 6141 8284

Email: damian.shephard@stockland.com.au

Contact: Damian Shephard

Position: Regional Manager, Residential WA

Tables

List of Figures

(Compiled within report text)

Appendices

SUMMARY

Planning framework

This Local Water Management Strategy (LWMS) has been prepared to support the Mariginiup District Structure Plan (DSP) which comprises of 315.30 ha of passive rural land with a tenant running a small bobcat and site preparation business. The site is approximately 25 km North of Perth CBD and 6 km to Joondalup Train station/centre and freeway. The objective of this LWMS is to demonstrate that the land has the capacity to support the proposed land use change with best practice water management outcomes in terms of water supply, stormwater, surface water and groundwater management. This LWMS will recognise the principles, objectives, and requirements of total water cycle management as outlined in the *State Planning Policy 2.9 Water Resources* (Government of WA, 2006), *Liveable Neighbourhoods* (WAPC, 2007) and the *Stormwater Management Manual for WA* (DWER, 2004 – 2007), including the *Decision process for stormwater for stormwater management in WA* (DWER, 2017). The LWMS will also broadly state the water quantity and quality management objectives to be achieved.

The proposed development will include total water cycle management principles and objectives guided by the Better Urban Water Management Framework (WAPC 2008). This document also provides a synthesis of the project methodology and has been prepared to provide a detailed strategy to address all key issues associated with the project delivery, including Stockland's sustainability imperatives.

LWMS key elements

An inventory of the key elements for inclusion in the LWMS report, together with a cross-reference to the relevant section in this document, is presented in Table 1.

Table 1: Key LWMS reporting elements

LWMS elements	Design objectives/comments
Introduction (Section 1)	▪ Stockland Property Management Pty Ltd is seeking Structure Olan approvals for Precinct 15 which is a 315.30 ha passive rural land located in Mariginiup. ▪ The site is currently zoned 'Urban deferred' under the Metropolitan Region Scheme (MRS) and so a request will need to be lodged with the Western Australia Planning Commission to lift the Urban Deferment as part of the project delivery. ▪ A state-run MRS Amendment process is also required to reserve public land uses, namely reservation of Primary Distributor Roads, Integrator Arterial Roads, Parks and Recreation Reserves, Transit Corridors and High School reserves. ▪ The transit corridor will be the subject of further investigations and assessment by the Public Transport Authority before a final alignment and the exact positioning of stations is determined and land criteria reserved under MRS.
Topography (Section 2.3)	▪ The topography of this site is comprised of Spearwood and Bassendean low dune systems running north-south direction. ▪ Surface elevation, as shown by topographic contours, range from approximately 46 mAHD in low-lying wetlands to 59 mAHD along a north-south running dune.
Geology (Section 2.4)	▪ The site splits up between the western Spearwood sands which are pale and olive yellow, medium to coarse grained, subangular quartz with traces of feldspar of residual origin. ▪ The Eastern Bassendean sands which are very light grey at the surface, yellow at depth, fine to medium grained sub-rounded quartz of eolian origin.

	▪ These soils comprise of sands with high permeability but low nutrient retention which prevents the discharge of increased nutrient loads to the downstream environment. This presents implications for future development.
Groundwater (Section 2.11)	▪ The site is underlain by the Superficial, Leederville and Yarragadee aquifers. ▪ A monitoring program has been undertaken on site from July 2022 to now (August 2023) ▪ Maximum groundwater levels taken during this time ranged from 43.37 to 49.44 mAHD ▪ Depth to groundwater ranged from 0.86 m below ground level (mbgl) (MB8 in September 2022) to 8.63 mbgl (MB01 in July 2023). ▪ Groundwater flow is generally east to west. ▪ The average annual maximum groundwater level (AAMGL) for Precinct 15 ranges from approximately 43.5 to 48.5 mAHD.
Surface water (Section 2.12)	▪ The site has three depression areas which are the wetlands indicated by DWER. Surface water flows into these depression areas and does not have a defined drainage system that directs surface water out of the site area. The general surface water flow defined by the topography is in an eastward direction.
Wetlands (Section 2.9)	▪ Several wetlands are mapped within the site boundary, including Multiple Use wetland (MUW) in the north-eastern portion of the site and Resource Enhancement wetland (REW) and MUW located through the centre of the site. ▪ A number of wetlands are also located within close proximity of the site. ▪ Some of the wetlands located on site are associated with cultural heritage values.
Water source planning (Section 3)	▪ There is a Public Drinking Water Source Area (PDWSA) boundary running across the eastern part of the site and is under the MWSSD (Metropolitan Water Supply Sewerage and Drainage) Act 1909 or the Country Areas Water Supply Act 1947 enforced by DWER. ▪ Pentium Water has prepared two irrigation scenarios based on the Precinct 15 Land designation plan (STOMA-1-003B) provided by CDP. - Base case scenario: The total irrigation demand of 126,995 kL/yr with two primary schools including two co-located school ovals, one High school and Public Open Space. - Conservative scenario: The total irrigation demand of 443,895 kL/yr with two primary schools including two co-located school ovals, one High school, Public Open Space, and regional playing fields (located in the southeast corner of Precinct 15). ▪ No groundwater resources are available for allocation in the aquifers beneath Precinct 15 at present. ▪ Stockland will be required to transfer existing licences during the acquisition of new properties that contain existing licences or through trades for existing licences and land use changes across the precinct and district.
Water conservation strategies (Section 4)	▪ Landscape packages which adopt Waterwise principles will be encouraged. ▪ Detailed landscape plans for POS areas will be provided at subdivision stage which detail the proposed landscape treatments, plantings, community facilities and integration of drainage areas with the POS landscape design.
Stormwater management (Section 5)	▪ The following design criteria are adopted in the drainage strategy and concept drainage design: - The first 15 mm of rainfall to be infiltrated close-to-source or treated in bioretention basins within each catchment to mimic predevelopment conditions. - In larger storm events runoff will be managed within flood basins, or discharge into REW (UFI:15443), Little Mariginiup Lake or Lake Adams.

Groundwater management (Section 0)	▪ The proposed Controlled Groundwater Level (CGL) for the East Wanneroo DSP area is the 1986 to 1995 AAMGL, which is considered appropriate for Precinct 15 without adjustment. The DWMS specifies that subsoil drainage is to be at the CGL, and that the subsoil drainage pipework is to underlie the surface water infiltration basins. A clearance of at least 0.5 m from the basin invert to the CGL will therefore be required to allow for the subsoil drainage pipework to have an invert level at CGL and to allow for infiltration from the surface water basins.
Monitoring and reporting (Section 7)	▪ The monitoring completed so far has captured two winter peaks (2022 and 2023). A further five months of monitoring is required to fulfill the 18 months monitoring commitment as outlined in the DWMS (Urbaqua 2021). ▪
Potential future monitoring requirements (Section 8)	▪ Section 8 provides details of UWMP requirements and the roles and responsibilities related to implementation of the LWMS.

1. INTRODUCTION

1.1. Purpose

This LWMS has been prepared on behalf of Stockland to support the Mariginiup – Precinct 15 Local Structure Plan (LSP) of the Mariginiup landholding within the City of Wanneroo (the City) (Figure 1). LSP approval is being sought for the site which comprises approximately 315.3 ha of passive rural land and a tenant running a small bobcat and site preparation business in the suburb of Mariginiup.

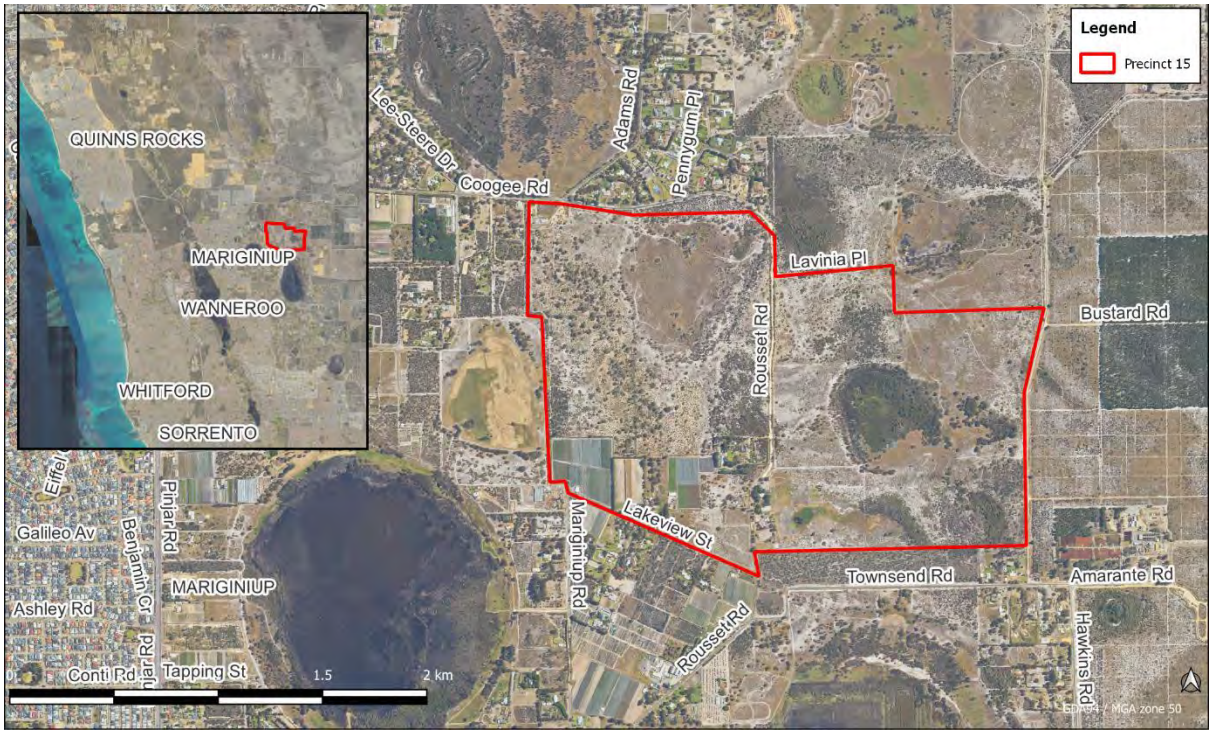


Figure 1: Site plan and location

1.2. Planning background

The LSP is part of the East Wanneroo District Structure Plan (DSP), which was prepared by Urbaqua on behalf of the Department of Planning, Lands and Heritage (DPLH). The DSP was prepared to guide land use planning and development of approximately 8,300 hectares (ha) across a small portion of Pinjar, most of Mariginiup and Jandabup, the eastern part of Wanneroo, Gnangara and south-west Lexia. The DSP was approved by the West Australian Planning Commission (WAPC) in August 2021.

1.3. Planning context

The subject site is zoned 'Urban Deferred' with the eastern parts of 2 lots (2 and 7542) termed 'rural water protection' under the Metropolitan Region Scheme (MRS). A request will need to be lodged with the Western Australia Planning Commission (WAPC) to lift the Urban Deferment (once the original reasons for deferral have been addressed) as part of the project delivery.

A state-run MRS Amendment process is also required to reserve public land uses, namely reservation of Primary Distributor Roads, Integrator Arterial Roads, Parks and Recreation Reserves, Transit Corridors and High School reserves. The transit corridor will be the subject of further investigations and assessment by the Public Transport Authority before a final alignment and the exact positioning of stations is determined and land criteria reserved under MRS.

1.4. Proposed structure plan

The LSP covers approximately 315.3 ha and will be developed to provide housing, a town centre, regional sporting fields, primary and high schools and public open space (POS). The LSP is shown in Figure 1.

1.5. Irrigation demand

The total final POS irrigation demand for Precinct 15 is currently estimated to be 443,895 k/yr over the total development area of 315.3 ha, including the 45 ha Regional Playing Fields outlined in the DSP. Stockland do not currently hold any groundwater licences for the project to date, however, will be looking to acquire allocations held by existing land users via trade.

This volume is considered sufficient to irrigate all proposed POS and future education precincts including the two primary schools including two co-located school ovals, one high school, POS and Regional Playing Fields (located in the southeast corner of Precinct 15).

An alternate water source being pursued for non-potable water supply for this development is subsoil drainage harvesting. Subsoil drainage harvesting is considered an environmentally sustainable and innovative solution as it is capitally inexpensive and easily collected via the standard subdivision drainage infrastructure. The water source is considered “new” as it is created by the change to the natural water balance caused by development.

1.6. Design objectives

This LWMS is in accordance with State Planning Policy 2.9: Water Resources (Government of WA 2007) and has been developed with reference to the following guidance documents:

- Interim: Developing a Local Water Management Strategy (Department of Water 2008)
- Better Urban Water Management (Department of Planning and Infrastructure 2008)
- Stormwater Management Manual for Western Australia (Department of Water 2004–2007)
- Liveable Neighbourhoods (Western Australian Planning Commission 2003)
- Water resource considerations when controlling groundwater levels in urban development (Department of Water 2013)
- Draft Specification separation distances for groundwater controlled urban development (IPWEA 2016)
- Decision Process for Stormwater Management in Western Australia (DWER 2017)

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:

- Protection of important environmental assets and water resources
- Deliver functional and integrated public open space
- Manage flooding and inundation risks to human life and property
- Ensure the efficient re-use of water resources

1.7. Key documents and previous studies

A number of on-site investigations have been completed and relied upon to prepare this LWMS including:

- District Water Management Strategy (Urbaqua, 2021)
- East Wanneroo District Structure Plan (DPLH, 2021)
- Assessment of Proposed Environmental Outcomes (Emerge, 2019)
- Engineering Servicing Report (Cossill & Webley, 2019)
- Environmental Assessment Study (Emerge Associates, 2018)
- Preliminary Environmental Assessment of Planning Investigation Areas (Emerge Associates, 2018)
- Strategic Bushfire Hazard Level Assessment – Bushfire Management Plan (BPAD, 2018)

2. EXISTING ENVIRONMENT

2.1. Site location and existing and historical land use

Precinct 15 is approximately 25 km North of Perth CBD and 6 km to Joondalup Train station/centre and freeway. The site is undeveloped and has scattered vegetation throughout. The site consists of the following lots:

- Lots 803 Mariginiup Road
- Lots 13, 16, 17, 18, 804 Lakeview Street
- Lots 1, 2, 1673, 2287, 2361, 3335 Rousset Road
- Lot 7542 McCaffrey Road

Table 2 is a summary of the main current land uses and structures, associated with the site and/or identified during the site walkover and from a review of available geographic information systems.

Table 2: Site land uses, structures and/or sensitive receptors

Lot	Industry/Land Use	Risk to water quality
2, 803, 1673, 3335 and 7542	Bush	No
1	Agistment, kennels, chicken farm	Yes
13, 16, 18, 804	Nursery, Horticulture, Turf farm	Yes
17, 2287	Residential	No

2.2. Climate and rainfall

2.2.1. Baseline

The site is typical of the Swan Coastal Plain being warm and dry during summer and cooler and wetter during the winter period. Baseline rainfall (1961-1990 as defined by DWER, 2015) at Mariginiup is 761 mm by using data drill output, which interpolates rainfall between nearby stations. Rainfall between 1990 to 2021 is 3.8% lower than the baseline rainfall at 732.4 mm.

Baseline pan evaporation (E_{pan}) for Mariginiup is approximately 1,800 mm based on BOM mapping (BOM 2022a). The potential evapotranspiration (PET) for Mariginiup is approximately 1,400 mm based on BOM mapping (BOM 2022b), which equates to ~0.78 E_{pan}.

Table 3: Climate and rainfall data

Weather statistic (mm/mt)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Baseline rainfall (1961-1990)	12.2	13.7	14.0	44.0	100.9	165.4	159.1	115.3	74.7	43.8	21.6	8.6	761
Rainfall (1990-2017)	15.2	15.6	19.5	36.0	90.7	135.4	148.2	119.4	78.5	40.3	24.3	9.3	732.4
Baseline pan evaporation (E_{pan})	1,800 mm annually												
Baseline potential evapotranspiration (PET)	1,400 mm annually												

2.3. Topography

Topographic contours indicate elevation across the site ranges from 46 metres above height datum (mAHD) in low lying wetlands on the western boundary of the site to 59 m AHD along a dune running north-south in the south-western portion of the site, as shown in Figure 2.

The topography of this site is comprised of Spearwood and Bassendean low dune systems running north-south direction.

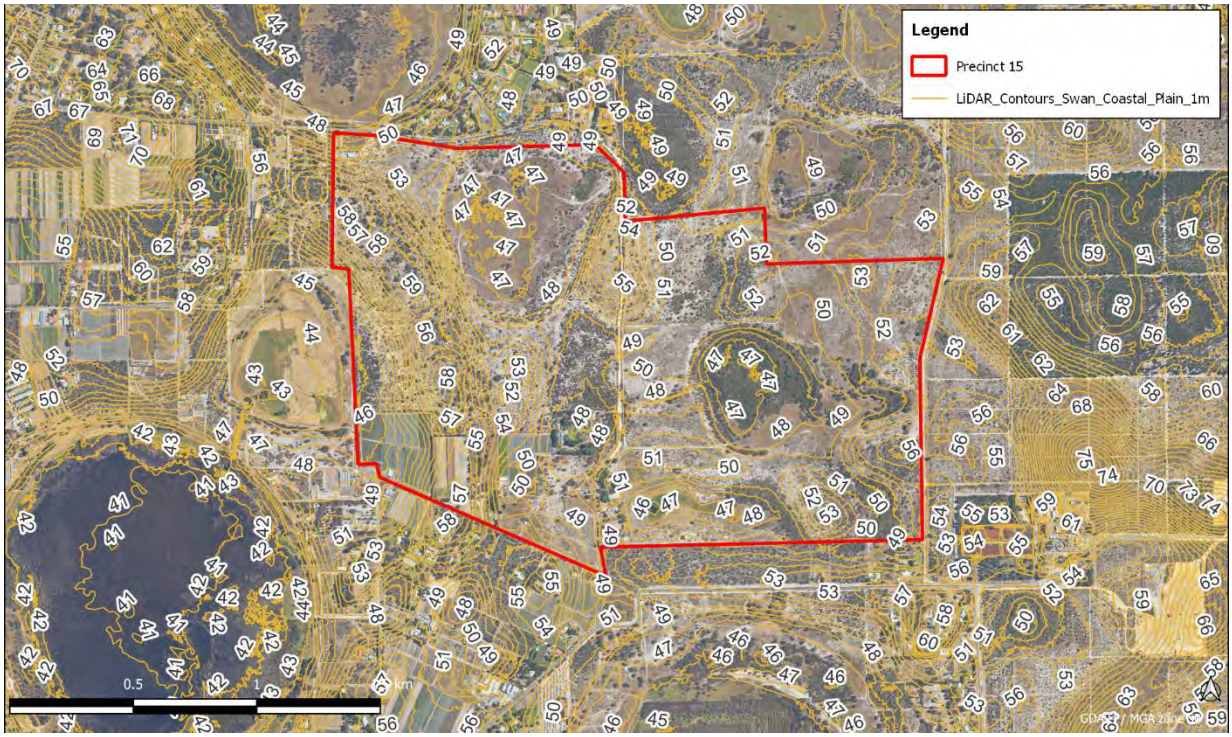


Figure 2: Topography

2.4. Geology

2.4.1. Regional Mapping

Geology mapping indicates the majority of the site is underlain by Spearwood sands (S7) in the western portion of the site and Bassendean Sands (S8 and S10) in the eastern portion (Figure 3) (Gozzard 1986). Spearwood sands typically consist of pale and olive yellow, medium to coarse grained, subangular quartz with traces of feldspar of residual origin. Bassendean sands (S8) are typically very light grey at the surface, yellow at depth, and comprised of fine to medium grained sub-rounded quartz of eolian origin, while Bassendean sands classified as sand over clay-sand/sandy clay (S10) are typified by light grey to yellow depth of aeolian origin and form as a thin veneer over strong, brown silts and clays. The lower elevation areas are mapped as being underlain by Peaty clay (Cps) of lacustrine origin typified by dark grey and black clays with variable sand content.

These soils comprise of sands with high permeability but low nutrient retention which prevents the discharge of increased nutrient loads to the downstream environment. This presents implications for future development.

The superficial formation is underlain by the Jandabup, Mariginiup subareas while the Wanneroo confined subarea as part of the Leederville and Yarragadee formation.

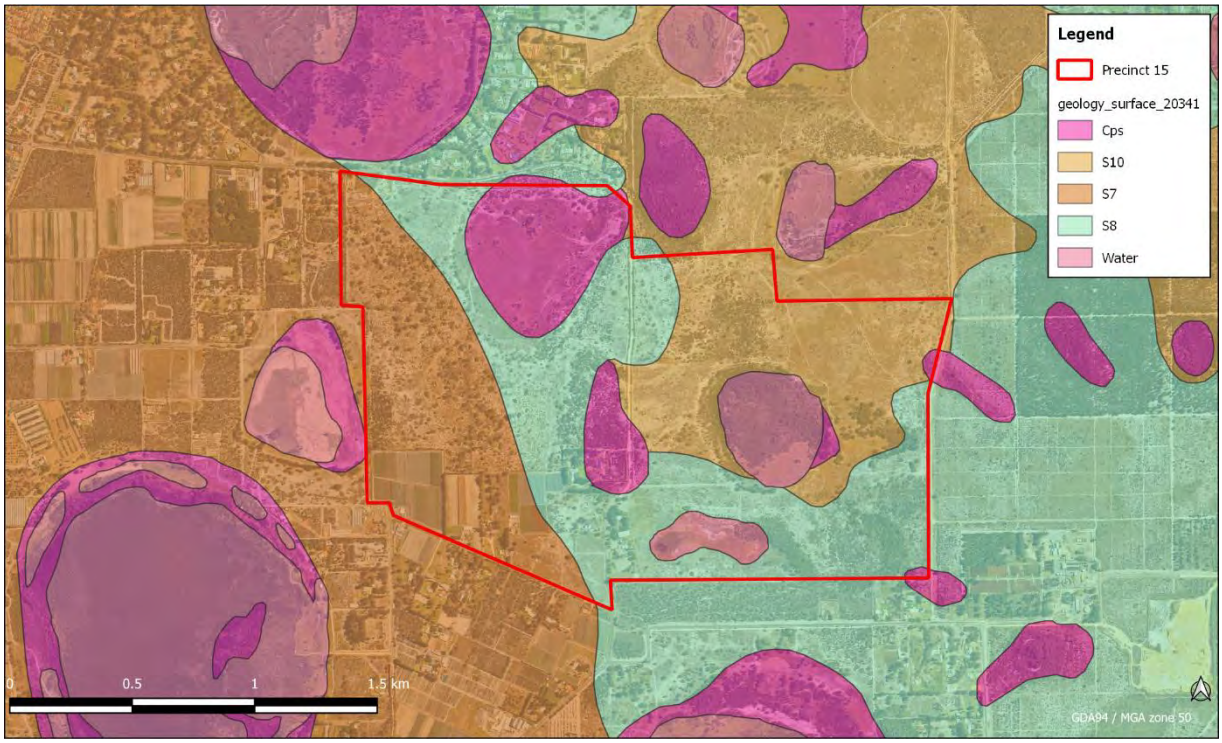


Figure 3: Geology

2.4.2. Site investigations

Douglas Partners was engaged by Stockland to undertake two preliminary geotechnical investigations across two different locations within the site in July 2022. Sand was intersected at surface in all locations. Groundwater was observed in two test pit locations: located on the westernmost edge of the site and at a depth of 3 m (42.9 mAHD, CPT53) and located in the south-eastern portion of the site at a depth of 2.3 m (45.4 mAHD, pit 116).

2.4.2.1. Infiltration rates

A total of 11 in situ infiltration tests were conducted across the two sites with the results summarized in Table 4. The results indicate a field permeability value of between 7 m/day and greater than 20 m/day.

Refer to Appendix A for both reports (Douglas Partners 2022a and Douglas Partners 2022b). The Engineering Service Report has been included in Appendix B.

Table 4: Infiltration testing results (Douglas Partners, 2022a and Douglas Partners, 2022b)

Test Location	Depth (m)	Measured Permeability (m/day)	In situ ground conditions at testing site
Lot 803 Coogee Road and Lot 1673 Rousset Road			
55	0.5	>20	SAND SP, trace silt, loose to medium dense
56	0.5	7	SAND SP, trace silt, medium dense
57	0.5	13	SAND SP, trace silt, medium dense
58	0.5	>20	SAND SP, trace silt, loose
59	0.5	>20	SAND SP, trace silt, medium dense
60	1.5	>20	SAND SP, trace silt, medium dense

61	0.5	>20	SAND SP, trace silt
Rousset Road report			
123	1.0	>20	SAND SP, trace silt, medium dense
124	1.0	>20	SAND SP, trace silt, medium dense
125	1.0	12	SAND SP, trace silt, medium dense
126	1.0	>20	SAND SP, trace silt, loose

2.5. Acid sulphate soils

The eastern section of the site is identified as having a 'High to Moderate Risk' of Acid Sulphate Soils (ASS) as per ASS risk mapping as shown in Figure 4 (DWER, 2017). Areas of ASS cannot be confirmed or removed at this stage of the development and will need to be determined by an ASS investigation, potentially with sampling the site. Due to this risk, there will be a requirement for an ASS Management Plan to be prepared as part of the development and subdivision of the site.

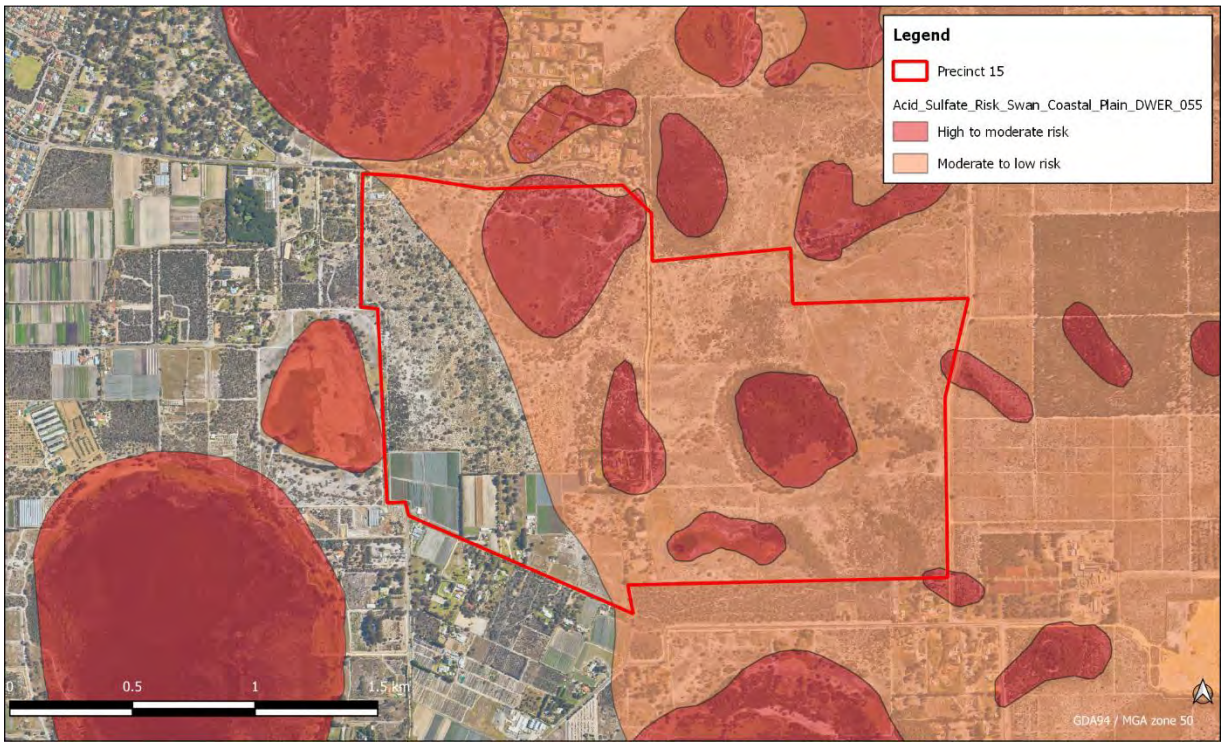


Figure 4: Acid Sulfate Soils

2.6. Contaminated sites

A review of the DWER a Contaminated Sites Register did not identify any known contaminated site under Section 11 of the Act within the Site or in the immediate surrounds. There are a number of sites where the former land use presents a contamination risk.

Further investigations are likely to be required to determine the extent of contaminated soil and/or groundwater, particularly where indicated as possible, as a result of current or past land use.

2.7. Aboriginal Heritage

The North-eastern section of the subject site is identified as an Aboriginal Heritage site (ID 22160). A heritage enquiry of the site identifies that the subject site is on the land within or adjacent to the Whadjuk People Indigenous Land Use Agreement. An Aboriginal desktop heritage assessment of the site and surrounding area was undertaken by Horizon Heritage Management in January 2023. The assessment concluded that no registered archaeological sites are located within the site; however, it is possible that surface expressions of in situ cultural material (artefacts) could be present (Horizon 2023). These were noted to be potentially located around the margins of landscape features like lakes, swamps, wetlands and any sand features that may occur within the site.

Place ID 22160 was determined to be largely associated with CCW UFI 14241 to the north of the site and found to only slightly intersect in the north central portion of the site. It was determined to be a very significant and sensitive area (healing area) important for Aboriginal spiritual health and cultural well-being (Horizon 2023). Horizon recommended Place ID 22160 is afforded protection under the *Aboriginal Heritage Act 1972*, and that an Aboriginal Heritage Management Plan (AHMP) should be prepared and implemented prior to vegetation clearing and other ground disturbance works occur during development of the site (2023).

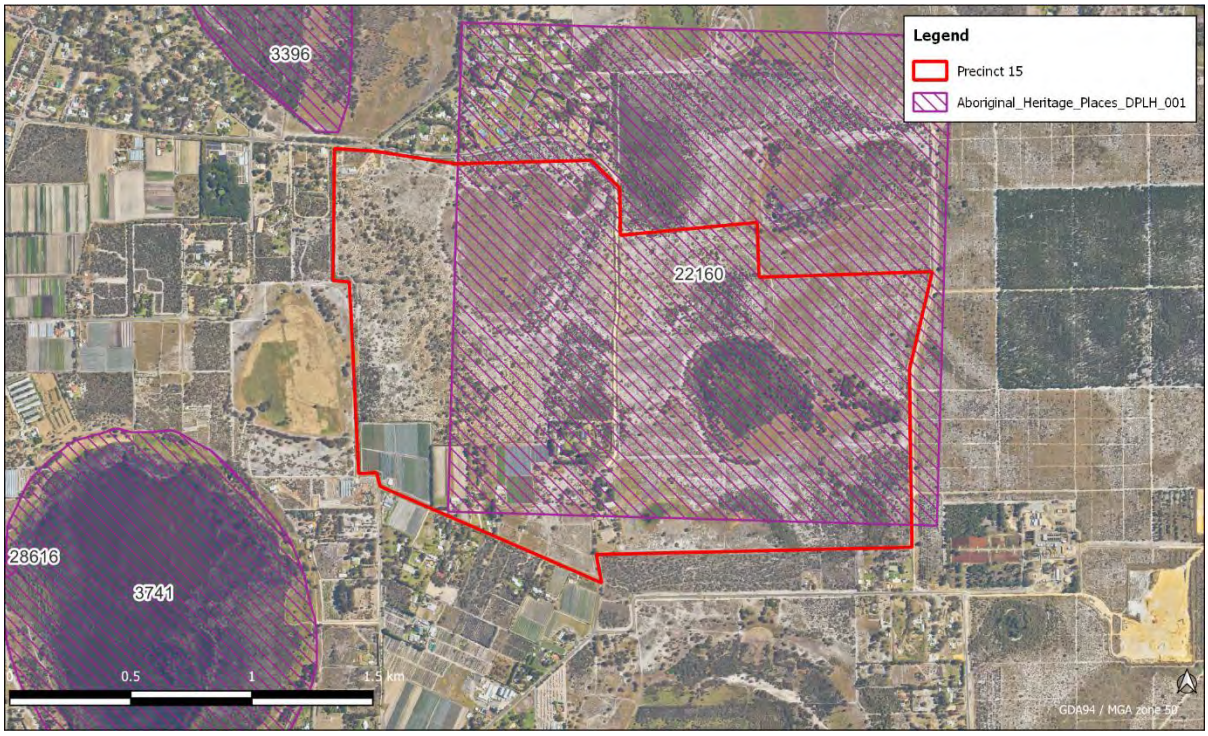


Figure 5: Aboriginal Heritage sites

2.8. Bush Forever sites

A search of the Western Australian Local Government Association Administrative Planning Categories mapping tool (WALGA 2018) did not identify any Bush Forever sites within the site. The nearest Bush Forever sites are site no. 147 (West of the site) and 324 (South of the site), as shown in Figure 6.

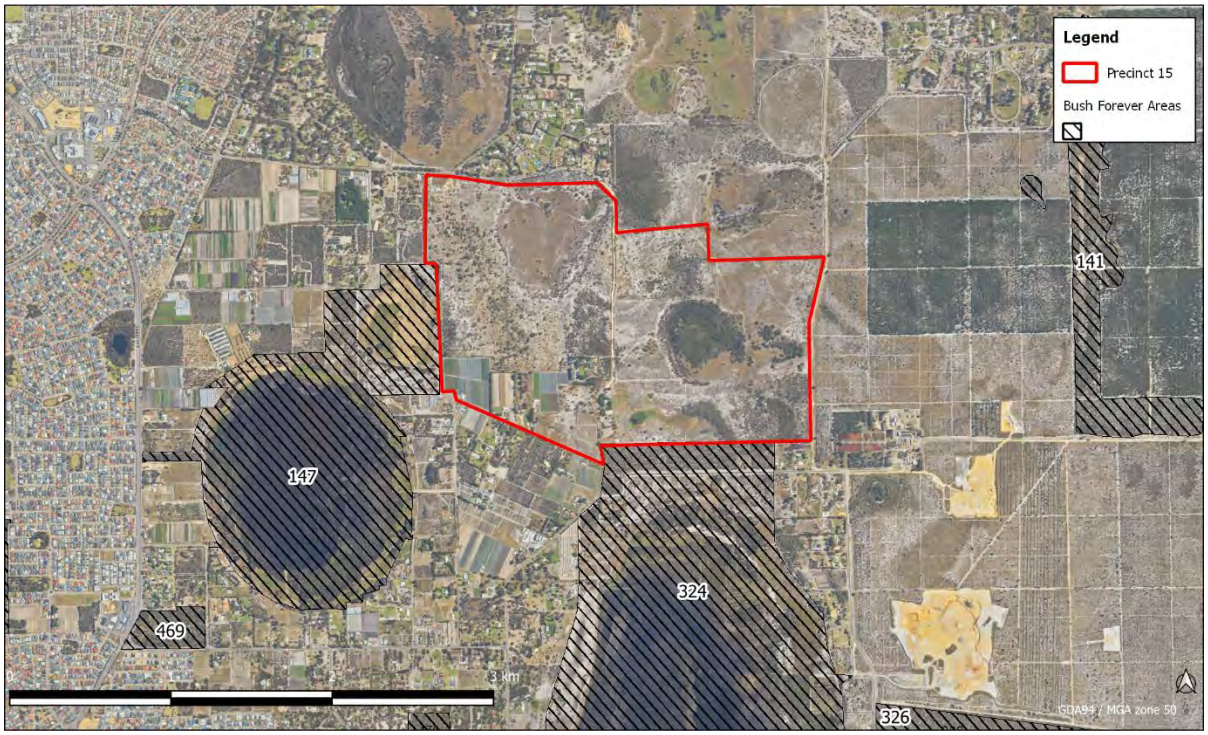


Figure 6: Bush Forever sites

2.9. Wetlands

Several wetlands are mapped within the site boundary (DBCA, 2018). The north-eastern section of the site is mapped as a multiple use (MUW, UFI 15022). Resource enhancement (REW) and MUW are located through the centre of the site and to the east and have the following UFI: 8164, 14244, 14245, 14247, 14248, 14252, 14253, 15442 and 15443. As such, future land uses, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through Landcare.

A number of wetlands are also located within close proximity of the site and are shown along with wetlands located on site in Figure 7.

It is noted that a number of wetlands located on site are associated with cultural heritage values, as noted in Section 2.7. It has been recommended that Traditional Owners and Aboriginal people with knowledge of the area are engaged as part of the local structure planning to understand and protect cultural heritage values.

The site constraint adds an additional layer to the development of the site with the project requiring additional expertise as part of the project team.

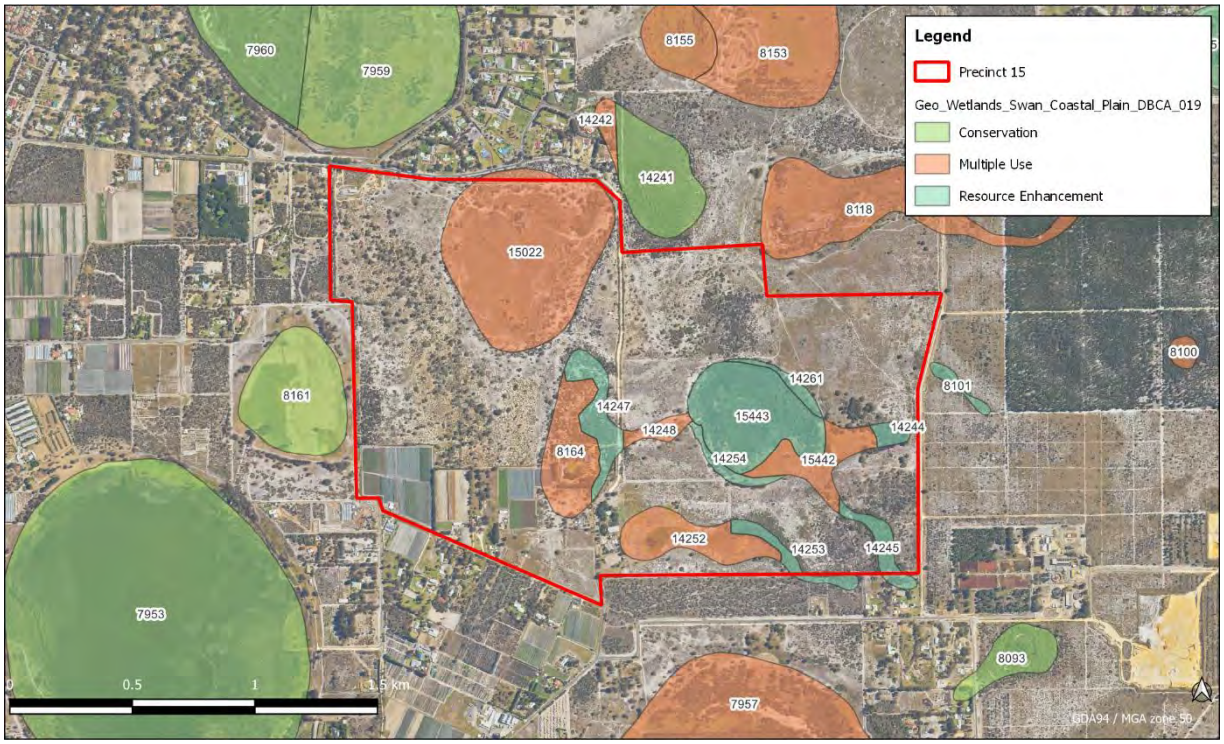


Figure 7: Geomorphic wetlands

2.10. Public drinking water source areas

The Gnangara Underground Water Pollution Control Area is located between about 10 km and 70 km north of Perth. It stretches from the northern suburbs of the Perth Metropolitan Region of Western Australia to the adjacent rural Shires of Gingin and Chittering. The Gnangara UWPCA (also referred to as control area) defines the central area of the Gnangara groundwater system that provides public drinking water supply as part of the Integrated Water Supply Scheme (IWSS).

This Public Drinking Water Source Area (PDWSA) runs through the eastern part of Precinct 15. There is also a Wellhead Protection Zone for bores in the area, with both displayed in Figure 8.

It is anticipated that rezoning of the land within PDWSAs to any urban land use will trigger reclassification of areas of P1 and P2 to P3* areas, as outlined in WQPN 38, and all developments will require connection to deep sewerage.

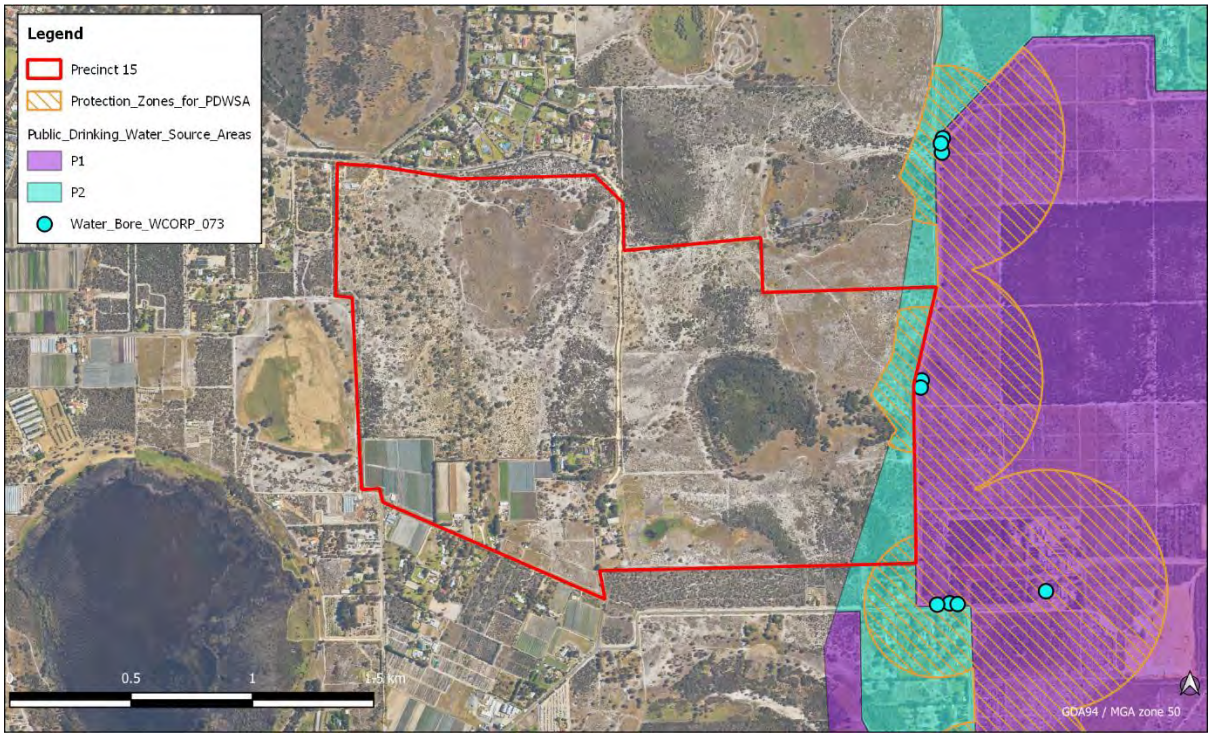


Figure 8: PDWSA and Wellhead Protection Zones

2.11. Groundwater

2.11.1. Aquifers

The site is situated on the Swan Coastal Plain and in the Wanneroo groundwater area. There are three groundwater sub-areas associated with the site: Wanneroo Confined, Mariginiup and Jandabup. This site is part of the Wanneroo groundwater system which comprises of the following hydrogeological units (aquifers), including the:

- Unconfined Superficial aquifer
- Confined Leederville aquifer
- Confined Yarragadee aquifer

Local hydrology is dominated by infiltration and evapotranspiration with almost no runoff due to the highly conductive sandy soils on site (refer Section 2.4.1). Infiltrated rainwater is expected to directly recharge the Wanneroo groundwater system as it does in the bordering Gnangara groundwater system. Surface water is generally confined to wetlands disposed throughout the site which are surface expressions of the Superficial aquifer in low lying land.

Regional groundwater mapping indicates groundwater across the site generally flows from east to west (DWER 2022a).

2.11.2. Regional groundwater levels

The Perth Groundwater Map (DWER 2022a), which provides an indication of regional groundwater levels, shows the historic Maximum Groundwater Level (MGL) at the site to be approximately 48 mAHD in the north-easternmost corner of the site. The lowest historic MGL on site is approximately 43 mAHD and is mapped in the south-westernmost corner of the site.

2.11.3. Groundwater levels

Groundwater bores were installed by Pentium in May and August 2022 for the purpose of pre- and post-development monitoring, with groundwater monitoring being undertaken on site monthly during winter and otherwise quarterly since installation. Peak groundwater levels monitored on site have been detailed in Table 5. Groundwater monitoring by DWER or other is not known to have been historically undertaken on site.

Table 5: Pre-Development groundwater levels

Bore ID	Easting	Northing	Max level (mAHD)
MB01	390962.44	6490187.16	47.57
MB02	389710.88	6490567.29	45.98
MB03	388679.98	6490545.1	43.47
MB04	388812.15	6491385.53	43.37
MB05	389059.4	6490979.67	44.99
MB06	389460.21	6490282.31	45.39
MB07	390497.58	6490157.22	46.26
MB08	390212.74	6489928.47	46.08
MB09	391051.74	6490943.05	49.44
MB10	389828.51	6491076.36	46.61
MP5	389296.54	6490851.38	45.57
MP11	389786.88	6490297.79	45.97
MP12	390437.42	6490306.56	46.34
MP13	390244.68	6489831.05	46.13

Groundwater levels across the site have ranged from a minimum of 42.50 mAHD in April 2023 (MB04) to a maximum of 49.44 mAHD in November at MB09. Relative to existing surface levels, the measured groundwater levels ranged from a minimum of 0.86 metres below ground level (mbgl) at MB8 in September 2022 to a maximum of 8.63 mbgl at MB01 in July 2023.

Groundwater contours across the site based on the MGL are shown in Figure 9 and indicate groundwater flows generally east to west, consistent with regional mapping.

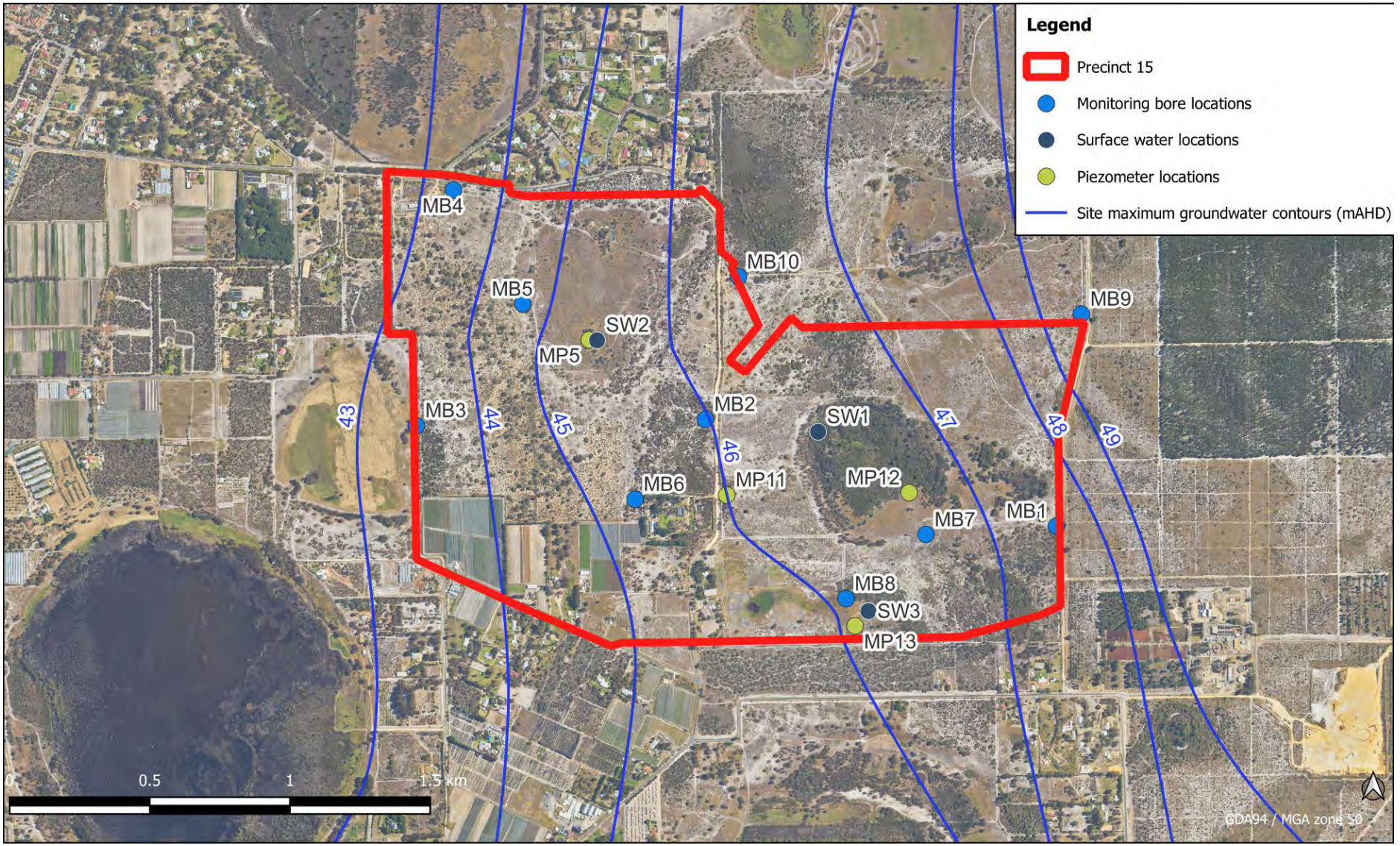


Figure 9: Site maximum groundwater contours

2.11.3.1. AAMGL calculation

The 1986 to 1995 AAMGL was determined for the EWDSP area as follows:

- Shallow bores across the EWDSP area were identified from Water Information Reporting data (DWER 2022b). For this assessment, shallow bores were those in which the top of the screen was less than 15 m below the average 1986 to 1995 water level in the bore. Where there were groups of nested or adjacent bores, the highest screened bore that had a mostly complete set of water level data was selected for the CGL.
- Water level data for these bores was extracted from the Water Information Reporting database (DWER 2022b).
- 90 shallow screened bores were selected for the estimation of the CGL, 85 of which had 8 or more years of maximum (winter) water levels measured between June and November. For these bores the AAMGL was calculated as the average of the annual maximum water levels.
- The remaining 5 bores had 6 or less years of maximum winter water level data. For these bores the AAMGL was calculated by adjusting the measured maximum water level to an AAMGL, using an average adjustment estimated from the 80 bores that had a complete data record.
- The lakes within the EWDSP area are throughflow wetlands, so are expressions of the groundwater table. An AAMGL was estimated for the lakes that had measured surface water levels over the period from 1986 to 1995, including Lake Mariginiup, Lake Jandabup, Lake Gnangara, Lake Adams and Lake Badgerup.
- The calculated AAMGL for Lake Mariginiup and Lake Jandabup were compared to the Gnangara Mound Criteria (Government of Western Australia 2009) and water thresholds presented in both the DWMS (Urbaqua 2021) and a recent review of the thresholds (Kavazos et al. 2020). The calculated AAMGLs for each of these lakes was within the preferred range of lake water levels (i.e., the AAMGL was above the preferred minimum peak water level (spring) and below the absolute maximum peak.
- The CGL surface was generated by contouring (using a kriging analysis) the bore and lake AAMGL values across the EWDSP area.
- The CGL within the vicinity of Precinct 15 is shown in Figure 10.

In the absence of long-term groundwater level data for the site, the 1986 to 1995 AAMGL has been adopted for the site.

Maximum groundwater levels recorded on site in 2022 and 2023 (as discussed in Section 2.11.3) were slightly higher than the AAMGL across the site. It is noted that total rainfall recorded for the month of August in 2022 at the closest BoM weather station (Wanneroo, BoM 9105) was significantly higher (by approximately 100 mm) than both the baseline rainfall (1961 to 1990) and average rainfall (1990 to 2017) as outlined in Section 2.2.1. As the maximum groundwater levels were recorded in the months following this historically high month of rainfall, and without more recent long-term site-specific groundwater data, it is still recommended that the 1986 to 1990 AAMGL is adopted for the site.

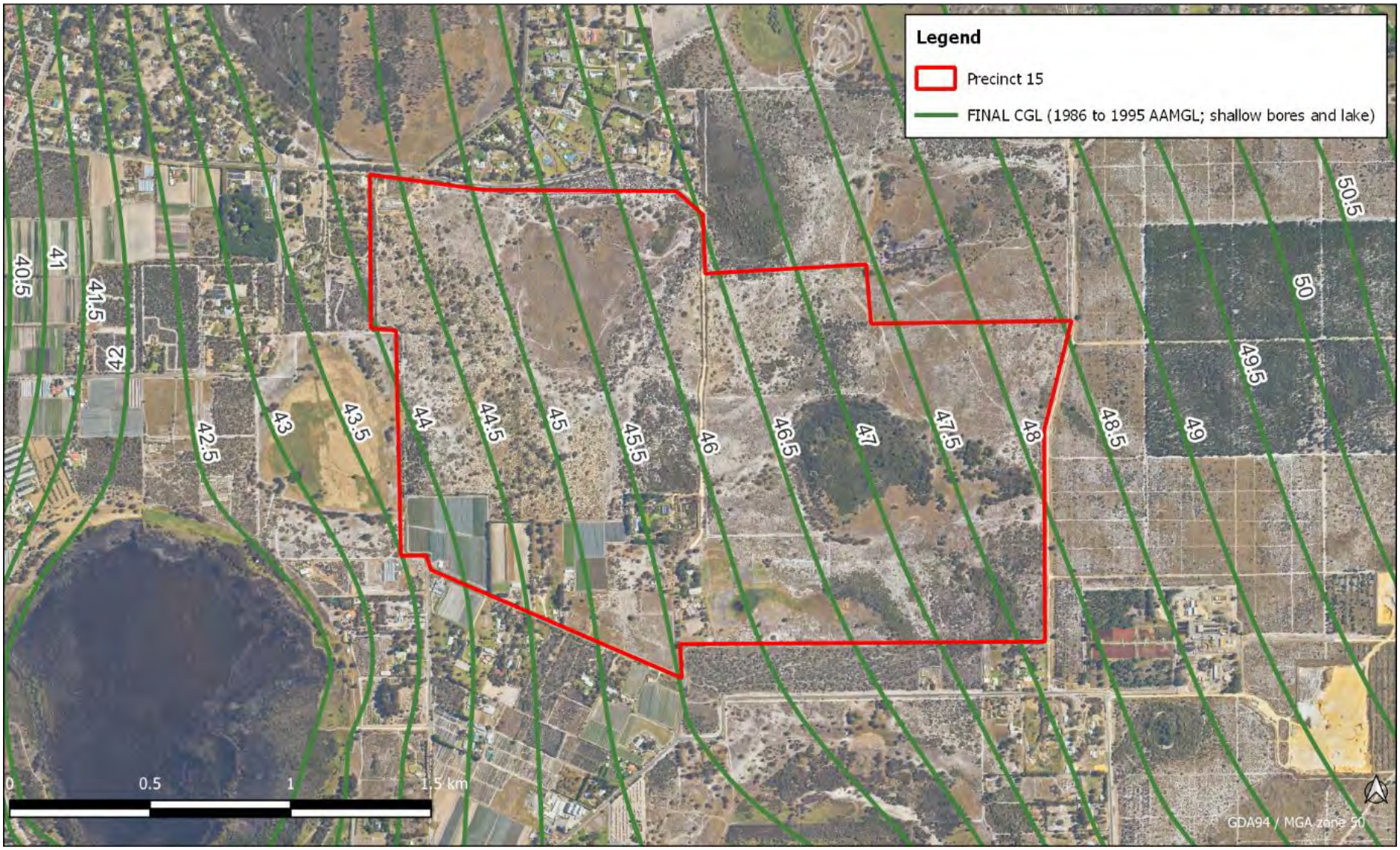


Figure 10: AAMGL/adopted CGL (1986 to 1995)

2.11.3.2. MGL discussion

The proposed controlled groundwater level (CGL) for the EWDSP area is the 1986 to 1995 average annual maximum groundwater level (AAMGL) as discussed in Section 2.11.3.1 and as was endorsed through the DWMS (Urbaqua, 2021).

2.11.4. Groundwater quality

Groundwater was sampled by Pentium Water in July and October 2022 and January, April and July 2023 from bore locations as shown in Figure 9. The field measured physico-chemical parameters and laboratory measured nutrient concentrations from 10 bores that are within the site boundary are provided in Table 6. These have been compared with ANZECC (2000) freshwater guideline values (FWG) for lakes, reservoirs and wetlands.

The monitoring results indicate groundwater beneath the site is acidic (average pH 5.6 and fresh (377 µS/cm). Total Nitrogen (TN) exceeds the ANZECC guideline (average 3.01 mg/L) in all bores. Total Phosphorus (TP) also exceeded the ANZECC guideline in all bores (average 0.01 mg/L).

The elevated nutrient levels are expected to be due to the long-term agricultural activities in the region and soil organic content. Given that two of the three sampling events were taken during or just after the winter months (i.e., rainy season), nutrient flushing into the groundwater system can be expected and a contributing factor to elevated nutrient levels.

Table 6: Groundwater quality results

Parameter	Mean parameter values July and October 2022 and January 2023										
	MB01	MB02	MB03	MB04	MB05	MB06	MB07	MB08	MB09	MB10	ANZECC
pH	6.68	6.32	6.66	6.50	4.79	4.85	4.75	4.82	4.87	5.73	6.5-8.0
EC (µS/cm)	465.8	360.3	663	336.5	136	466.6	153.8	557.3	239.5	388.3	300-1,500
TN (mg/L)	3.1	1.1	7.6	1.7	1.2	2.4	4.5	4.7	2.5	1.4	0.35
TKN (mg/L)	2.5	1.0	7.4	1.6	0.9	2.4	2.6	3.3	1.1	1.4	N/A
NH3 (mg/L)	0.009	0.063	0.055	0.011	0.013	0.282	0.182	0.158	0.078	0.676	0.01
PO4 (mg/L)	0.0077	0.022	0.022	0.016	<0.005	<0.005	0.062	0.017	<0.005	<0.005	0.005
TP (mg/L)	0.044	0.04	0.07	0.04	0.06	0.10	0.45	0.11	0.06	0.05	0.01

Highlighted cells indicate parameters at or outside ANZECC (2000) guideline values

PO4 – Phosphate NH3 - Ammonia

2.12. Surface hydrology

The pre-development sub-catchment boundary is presented in Figure 11. The majority of the site drains into local depressions that are associated with MUW and REW wetlands located within the site (DBCA, 2018).

Surface water that drains into these depression pond and infiltrate. In the west of the site there is a north to south ridge, and runoff generated on the western side of the ridge drains into Little Mariginiup Lake (CCW 8161) that is located to the west of the site boundary.

Surface water features are shown in Figure 11.

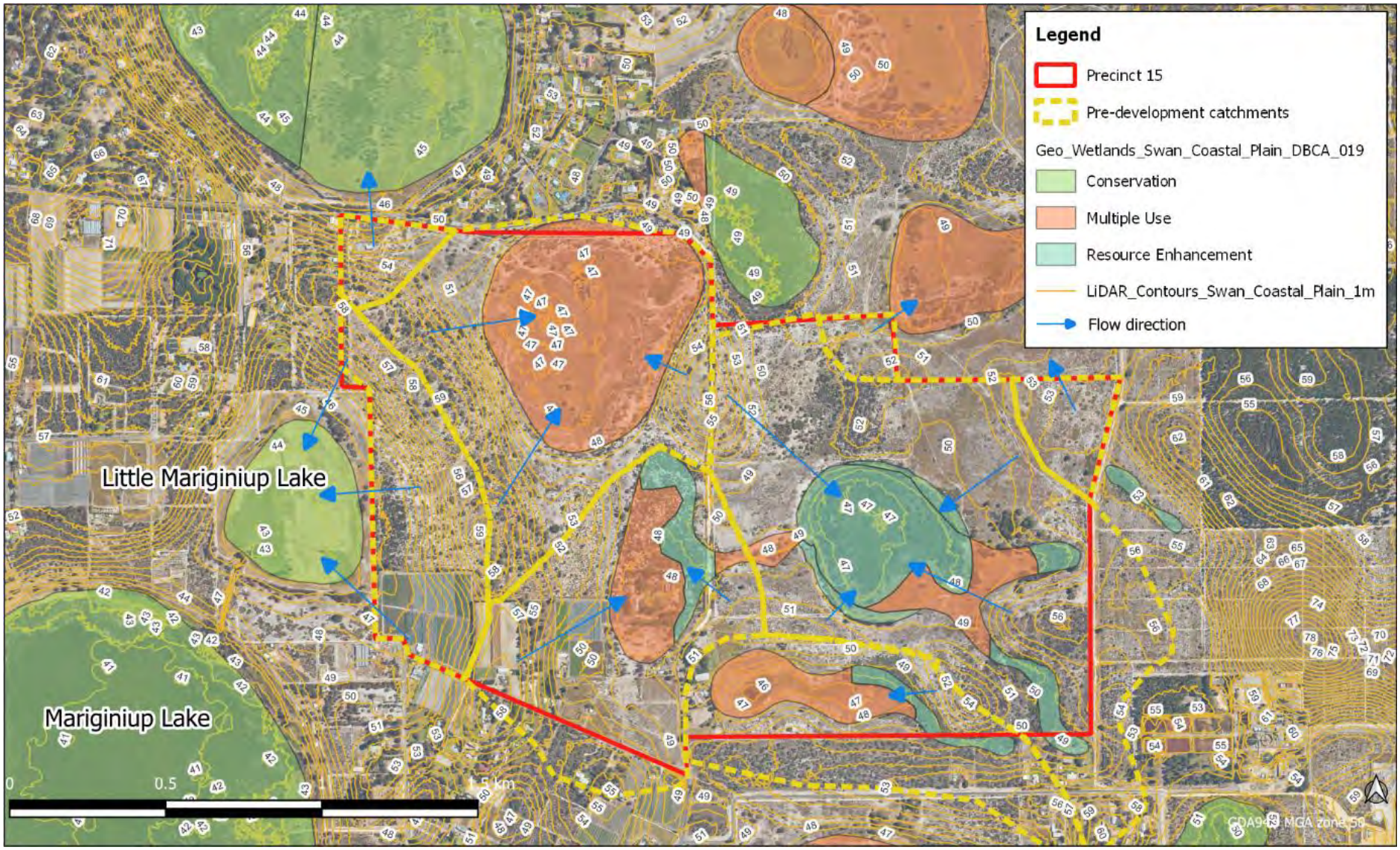


Figure 11: Pre-development surface water drainage

2.12.1. Catchment hydrology

Based on a review of publicly available datasets published by DWER, the site does not contain any mapped natural waterways. Some areas of the site experience minimal separation between land surfaces and groundwater levels, artificial drainage may have been installed in some areas of the site. Surface water is limited to intermittent local flows in shallow agricultural and road drains.

2.12.2. Pre-development flood modelling

A pre-development 1-dimensional surface water model of the entire East Wanneroo DSP area was constructed to provide an estimate on the likely volumes and top water levels in key wetlands during minor and major flood events (Urbaqua, 2021). It was noted that the increase to top water levels from the storage of surface water in key wetlands (including Lake Mariginiup, located nearby) from major and minor events was not considered to be significant (Urbaqua, 2021).

2.12.3. Surface water quantity and flow monitoring

Surface water was not expressed at the surface during any of the monitoring events across 2022 and 2023).

There is no record of historical monitoring of the wetlands on site.

2.12.4. Surface water quality monitoring

Surface water quality monitoring was not undertaken during the monitoring period as each of the locations were dry.

3. WATER SOURCE PLANNING

3.1. Potable water supply

There is a Public Drinking Water Source Area (PDWSA) boundary running across the eastern part of the site and is under the MWSSD (Metropolitan Water Supply Sewerage and Drainage) Act 1909 or the *Country Areas Water Supply Act 1947* enforced by DWER. The Gnangara UWPCA (also referred to as control area) defines the central area of the Gnangara groundwater system that provides public drinking water supply as part of the Integrated Water Supply Scheme (IWSS).

It is acknowledged that the Precinct 15 site is within the P2 area (approximately 14.6 hectares). It is understood that the Western Australian Planning Commission (WAPC) will support development across the DSP and within Precinct 15 and therefore we anticipate that this 14.6 hectares of currently zoned P2 land will be re classified as P3*.

3.2. Non-potable water supply

3.2.1. Requirements

As per the water conservation principle of "No potable water should be used outside of homes and buildings with the use of water to be as efficient as possible" in *Better Urban Water Management* (WAPC 2008)..

3.2.2. Irrigation demand analysis

The reduced irrigation rate of 6,750 kL/ha/yr has been adopted for Precinct 15. Pentium Water has prepared two irrigation scenarios outlined below and in Table 7 and Table 8. It should be noted that these irrigation demand estimates are based on the Precinct 15 Indicative Master Plan (STOMA-1-010) provided by CDP as shown in Appendix C.

- Base case scenario: The total irrigation demand of 126,995 kL/yr with two primary schools including two co-located school ovals, one High school and Public Open Space.
- Conservative scenario: The total irrigation demand of 443,895 kL/yr with two primary schools including two co-located school ovals, one High school, Public Open Space, and regional playing fields (located in the southeast corner of Precinct 15).

The conservative irrigation demand is identical to the base case scenario but includes the 45-hectare Regional Playing Fields outlined in the DSP and their associated considerable irrigation demand.

Table 7: Base Case irrigation Scenario

Area	Total Area (Ha)	Irrigated Area (Ha)	Irrigation Rate (kL/Ha/yr)	Total Water Demand (kL/yr)
Primary School 1	3.5	0.7	6,750	4,725
Primary School 2	3.5	0.7	6,750	4,725
Co-located school Oval 1	1.5	1.05	10,000	10,500
Co-located school Oval 2	1.5	1.05	10,000	10,500
High School	10	2	10,000	20,000
Public Open Space	18.9	11.34	6,750	76,545
Total Irrigation Demand	**28.90**	**16.84**		**126,995**

Table 8: Conservative irrigation Scenario

Area	Total Area (Ha)	Irrigated Area (Ha)	Irrigation Rate (kL/Ha/yr)	Total Water Demand (kL/yr)
Primary School 1	3.5	0.7	6,750	4,725
Primary School 2	3.5	0.7	6,750	4,725
Co-located school Oval 1	1.5	1.05	10,000	10,500
Co-located school Oval 2	1.5	1.05	10,000	10,500
High School	10	2	10,000	20,000
Public Open Space	18.9	11.34	6,750	76,545
Regional Playing Fields	*45.2*	*31.64*	*10,000*	*316,400*
Total Irrigation Demand	**84.10**	**48.48**		**443,895**

3.2.3. Groundwater allocation availability

The DSP site is located within the Wanneroo groundwater area. The following aquifers are present in the area:

- Perth – Superficial Swan (Unconfined, Mariginiup and Jandabup subareas).
- Perth – Leederville (Confined, Wanneroo Confined subarea).
- Perth – Yarragadee North (Confined, Wanneroo confined subarea).

Pentium Water has completed an analysis of the currently available groundwater allocations in the underlying aquifers (within Precinct 15) and adjoining groundwater subareas. Pentium Water requested a groundwater resource allocation report from DWER on 15 June 2022, which is a document that outlines the groundwater allocation status. No groundwater resources are available for allocation in the aquifers beneath Precinct 15 (or the groundwater subareas illustrated in Figure 12). No groundwater allocation will be made available by DWER, and no new groundwater licence will be provided to Stockland for the irrigation of POS or ROS within Precinct 15 as it currently stands.

Despite the facts above, groundwater licences are highly likely to be made available across the precinct as land use change progresses and the current licenced volumes as well as additional recharge to the superficial aquifer will be sufficient to irrigation the POS and ROS demands across Precinct 15. In light on this, no additional requirements to secure non-potable water to meet irrigation demand is required at this point in the planning process and this has been accepted by DWER as a practical position for Precinct 15 (pers. comm. J. Macintosh, DWER).

Figure 12 and Figure 13 below shows Precinct 15 including the groundwater subareas and the groundwater licence areas respectively. Figure 14 illustrates the current groundwater licences within Precinct 15 that could be traded or transferred to Stockland. The details of these existing licences are outlined in Table 9.

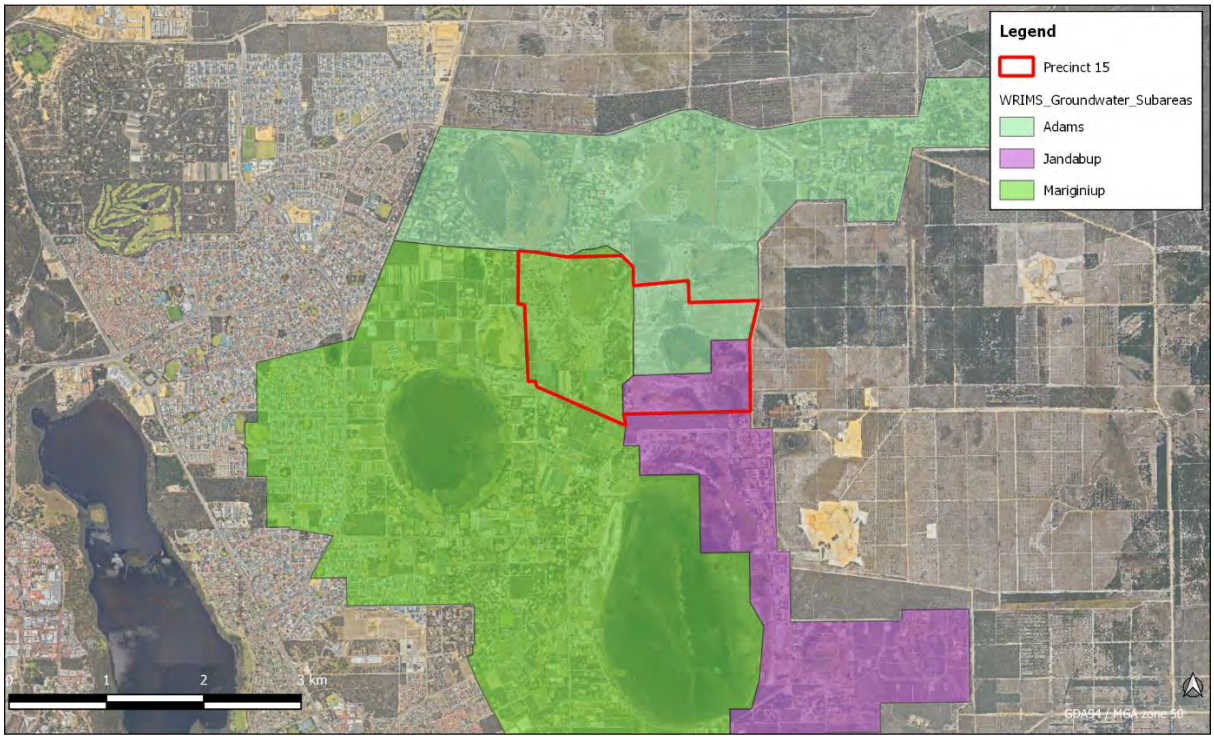


Figure 12: Extent of Precinct 15 and its groundwater subareas

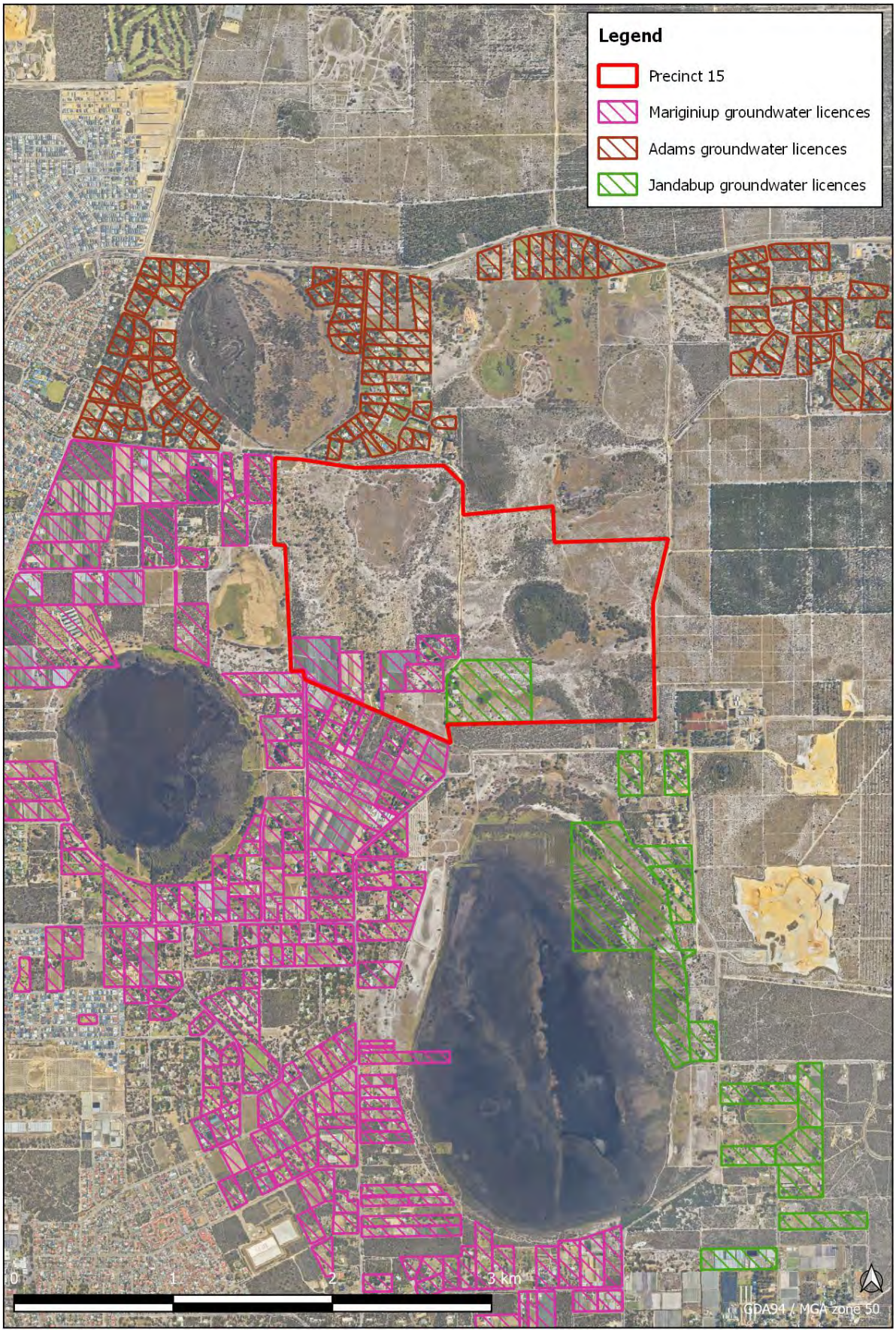


Figure 13: Extent of Precinct 15 including interior and exterior groundwater allocations

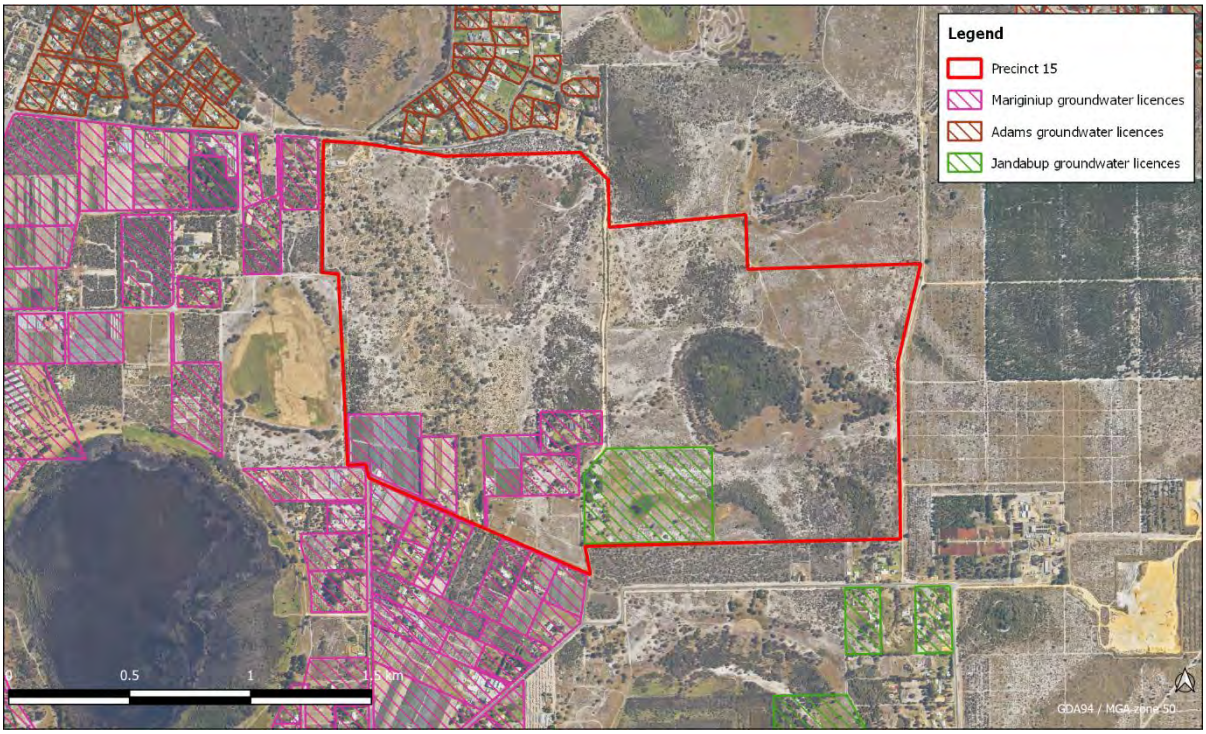


Figure 14: Groundwater licences within Precinct 15 and nearby licences

3.2.4. Groundwater allocation transfers or licence trading

There are mechanisms in place for trading and transfers of groundwater licences under the *Rights in Water and Irrigation Act 1914*. Each application is assessed on an individual, transparent and equitable basis in accordance with the requirement of the Act.

Given the current lack of availability of groundwater from the current resources then Stockland will be required to transfer existing licences during the acquisition of new properties that contain such licences or through trades for existing licences within the three groundwater subareas covering the property: Adams, Mariginiup and Jandabup.

The licences outlined in Table 9 could be transferred to Stockland should Stockland continue to acquire land within Precinct 15. Or Stockland could simply look to trade for these licences with the existing owners outside of a land acquisition deal.

Table 9: Groundwater licences within Precinct 15 and their respective subareas

Lot number	Owner(s) & Licence Address	Groundwater Licence Number(s)	Groundwater Allocation (kL)	Aquifer	Subarea
L804	**Shafto Pty Ltd**; Lot 804 Lakeview St, Mariginiup	178568	120,000	Superficial	Mariginiup
L16	**Tedesco, Andrew Joseph**; 16 Lakeview St, Mariginiup	81436	45,650		
L18	**Vince and John Guida**; Lot 18 Lakeview St, Mariginiup	47232	54,650		
L2361	**Delich, Dujo, Delich, Mara**; Lot2361 Rousset Rd, Mariginiup	86336	4,700		

Lot number	Owner(s) & Licence Address	Groundwater Licence Number(s)	Groundwater Allocation (kL)	Aquifer	Subarea
L2287	**Kevin George Stubbs**; 2287 Rousset Rd, Mariginiup 6078 WA	200368 & 200527	16,800 & 3150 respectively		
L1	**Agostino Nominees Pty Ltd**; Lot 1 Rousset Rd, Mariginiup	87316	23,600		Jandabup
Total Allocation available in the superficial aquifer within Precinct 15			268,550 kL/yr		

*Includes full allocation of GWL200368 which is split over two precincts and may not contribute fully to Precinct 15 water allocation

3.3. Wastewater servicing

The site, as well as all developments within the East Wanneroo DSP area, are to comply with the requirements of the Government Sewerage Policy (DPLH 2019). Facilities across the site (POS, residential lots etc.) are proposed to be connected to deep sewerage.

4. WATER CONSERVATION STRATEGIES

4.1. Proposed strategy

The State Water Plan (2007) is a strategic policy and planning framework to meet the state's water demands to the year 2030. One of the key targets is to reduce potable water consumption to 40 kL–60 kL per person per year. Water conservation measures will be adopted at the site to create a "Waterwise" development and minimise water-servicing requirements. The water conservation strategy will aim to reduce water demand through incorporating a variety of effective initiatives. These are described in more detail below.

4.2. Water conservation measures

The development will adopt the following water conservation measures:

- A Waterwise landscaping strategy which utilises largely native plant species with limited exotic species in select areas only to provide feature planting.
- Front yard Waterwise landscaping packages may be promoted to new home buyers. These may include the use of plant species with low water requirements, minimal turf, mulch, and soil conditioner to increase water retention.
- 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 fitting) must be connected to a hot water system or a recirculating hot water system with pipes installed and insulated in accordance with AS/NZS3500.
- Lot owners will be encouraged to install greywater systems for irrigation of individual household landscaping.
- Lot owners will also be encouraged to install rainwater tanks. Rainwater tanks can be connected to water using fixtures such as toilets, washing machines and external taps to reduce potable water demand.

4.3. Water appliances and fittings

As a minimum, builders will be required to fit Waterwise appliances and fittings within all display homes at the site. This will include the use of water efficient taps, showers, and water heating systems as well as Waterwise garden designs and irrigation schemes. Educational material will be made available via the use of education boards and pamphlets within display homes.

4.4. Waterwise landscaping

Landscape plans for POS areas will be provided at subdivision stage which detail the proposed landscape treatments, plantings, community facilities and integration of drainage areas with the POS landscape design. A preliminary landscape masterplan is provided in Appendix D.

The following general principles will be adopted wherever possible in the landscape design:

- Promote the use of native plants with low water and fertiliser requirements.
- Promote landscape treatments sympathetic to climate conditions and prevailing site conditions – e.g. soil types, topography, environment, wetlands etc.
- Utilise "cluster or clump" plantings to provide useable shade areas and better use of reticulated water in preference to single item or symmetrical planting regimes.
- Irrigate grass and garden areas at appropriate time so as to reduce evaporative loss and minimise transpiration losses.
- Ensure that irrigation regime is responsive to prevailing weather conditions.

5. STORMWATER MANAGEMENT

5.1. Drainage principles and criteria

The key aspects and principles of stormwater management to be adopted for the site, consistent with the DWMS (Urbaqua, 2021), are outlined below:

- Small rainfall events are to be managed at source (in lots and streets) wherever possible.
- All small event stormwater management systems are to be accommodated outside of retained wetlands and their buffers.
- Where the depth to groundwater is limited and subsurface drainage systems are required, the design of at source stormwater infiltration systems should be informed by consideration of the interaction between infiltrated stormwater and the controlled groundwater level.
- Where it is not feasible to retain or infiltrate small rainfall events at source without impacting amenity, the use of systems such as rainwater tanks, raingardens and detention tanks should be considered as alternatives to more traditional systems.

5.2. Post development catchments

Post development, the site will consist of 20 catchments as presented in Figure 15. The concept earthworks design and preliminary drainage catchment plan was prepared by Cossill and Webley, and is provided in Appendix E and F respectively.

In small rainfall events runoff generated within catchments Basin 15, Basin 16, Basin 20B and South-east School will infiltrate close-to-source or managed in internal bioretention basins. In large storm events runoff generated in these catchments will discharge into REW (UFI:15443).

Runoff generated in small rainfall events within Catchments Basin 1 and Basin 3 will infiltrate close-to-source or be managed in bioretention basins. In large storm events runoff will discharge from these catchments into Lake Adams and Little Mariginiup Lake.

Runoff generated within the remaining catchments (Basin 9, Basin 21, Basin 12, Basin, 6, Basin 8, Basin 7, Basin 20A, Basin 17, Basin 19 and LLC) will be managed internally in bioretention and flood basins.

Each basin will be under-drained via subsoil pipe network that has been sized to allow for a basin infiltration rate of 1 m/day. Further details of the subsoil drainage network are provided in Section 6.2.1.

The land use breakdown within each catchment is detailed in Table 10 below.

Figure 15: Post-development surface water drainage

Table 10: Land use breakdown (ha)

Basin ID	POS/Drainage/ REW	School	Carpark	Recreation	Community/ Neighbourhood centre	Residential (R30-40) >300m2)	Road reserve	Commercial	Total
Basin 1	4.148	0	0	0	0	9.002	7.371	0.080	20.600
Basin 3	3.216	0	0	0	0	17.110	10.984	0	31.310
Basin 9	1.819	3.500	0	0	0	16.880	6.776	0	29.975
LLC	-	-	-	-	-	-	-	-	8.200
Basin 12	1.174	0	0	0	0	14.512	7.114	0	22.800
Basin 8	0.530	0	0	0	0	4.941	4.659	0	10.130
Basin 7	1.063	0	0	0	0	5.036	4.371	0	10.470
Basin 21	0.9	0	0	0	0	6.578	3.542	0	11.02
Basin 6	2.686	0	0	0	0	4.473	1.291	0	8.450
Basin 19	1.281	4.80	1.784	0	4.761	2.279	3.726	0	18.630
South-east School	0	3.644	0	0	0	0	0	0	3.644
Basin 20A	0.573	0	0	0	0	2.812	1.425	0	4.789
Basin 17	0.454	0	0	0	0	4.659	2.677	0	7.781
Basin 20B	0.827	0	0	0	0	7.174	2.910	0	10.911
Basin 15	2.481	0	0	0	0	4.048	2.932	0	9.460
Basin 16	0.494	0	0	0	0	11.023	6.153	0	17.715
South Recreation	1.8	0	1.5	7.6	0	0	5.261	0	16.161
South-east Recreation	5.311	0	0	0	0	0	0	0	5.311
East Recreation	10	0	0.8	12.96	0	0	0.8	0	24.56
REW	28.789	0	0	0	0	0	0	0	28.789
Total	**67.546**	**11.944**	**4.084**	**20.56**	**4.761**	**110.545**	**71.992**	**0.08**	**291.494**

5.3. Stormwater management strategy

5.3.1. Minor drainage system including the small (15mm) event

5.3.1.1. Lot drainage >300 m²

Residential lots greater than 300 m² in size will be fitted with soakwells within the lot boundary sized to infiltrate the first 15 mm of rainfall.

5.3.1.2. Road reserve

Road runoff will drain to roadside swales or POS, or to either at-source infiltration solutions (i.e. rain gardens, tree pits) or a combination of the above and include draining to basins via a pit and pipe system that will provide bioretention treatment for up to the first 15 mm of rainfall runoff. Managing small rainfall events via close-to-source infiltration will effectively mimic the pre-development

hydrological regime of the site and reduce both the volume and peak flow rate of stormwater discharging into the REW.

5.3.1.3. Other land use types

The first 15 mm of rainfall from schools, recreation, community/ neighbourhood and carparks will be retained within the lot boundaries using soakwells, rainwater tanks or other WSUD methods. Note that all runoff generated within the currently denoted railway reserve through the precinct is assumed to be managed within that rail reserve boundary and does not contribute the drainage basins designs outlined for the POS areas.

5.3.1.4. Bioretention treatment

The effective impervious area was calculated within each catchment as 10% of lots and community/neighbourhood centres; and 80% or Road Reserve area, as summarised in Table 11. Bioretention treatment will be provided for the first 15 mm of rainfall that falls on effective impervious areas within the basins.

The current calculations and assumptions allow for all drainage to be accommodated in bioremediation basins within POS. We understand that this is not proposed to be the outcome, however it provides some conservatism to the calculations of encumbered POS that does not receive a credit through the urban design process.

The required bioretention treatment basin areas for each catchment are detailed in Table 13.

Table 11: Effective impervious area for bioretention treatment

Catchment	Effective impervious area (ha)*
Basin 1	6.797
Basin 3	10.498
Basin 9	7.109
Basin 12	7.142
Basin 8	4.221
Basin 7	4.000
Basin 21	3.491
Basin 6	1.480
Basin 19	3.685
Basin 20A	1.421
Basin 17	2.608
Basin 20B	3.045
Basin 15	2.750
Basin 16	6.025
Total	**64.274**

5.3.2. Major drainage system

The roadside pipe and pit network and swales will be sized to convey the 20% Annual Exceedance Probability (AEP) event. In larger events runoff may be conveyed within the road reserves, with a maximum depth of 0.2 m in the 1% AEP event.

Stormwater modelling was undertaken to size the required bioretention and flood storage in the 1% AEP storm event required in each basin using XPSWMM. The loss rates adopted for each land use type is detailed in Table 12 below.

Basins located adjacent to REW (UFI 15443) including basins 15, 16 and 20B have been sized to retain the 1 Exceedance Year (EY) (1 year) event. In larger storm events they will discharge into the REW which will provide additional flood storage.

Basin 1 and Basin 3 have been sized to retain the 1 EY event and in larger storm events will discharge into Lake Adams and Little Mariginiup Lake.

As REW (UFI 15443), Lake Adams and Little Mariginiup Lake will be less than 0.5 m deep in the 1% AEP event as they are relatively large in size as compared to their contributing catchments.

All other basins within the site have been sized for the full retention and infiltration of up to the 1% AEP event with a maximum depth of 1.2 m.

Table 12: Uniform Loss rates

	Drainage/ POS	School	Carpark	Recreation	Community/ Neighbourhood centre	Road reserve	Residential (R30-40) >300m2
Initial Loss (mm)	20	15	5	15	15	4	15
Proportional loss	0.2	0.2	0.15	0.2	0.2	0.2	0.2

5.4. Modelling results

The bioretention treatment and flood storage areas required in each catchment and is detailed in Table 13 below. The sizing of the basins assumes an infiltration rate of 1 m/day.

Table 13: Stormwater basin designs based on 1 m/day infiltration rate

Basin ID	Bioretention treatment area for first 15 mm rainfall (1 in 3 side slopes)			Area at 0.31 m depth (m2)	20% AEP (1 in 6 side slopes)			1% AEP (1 in 6 side slopes)			Outlets to (in > first 15 mm rainfall event)
	Base area (m2)	Area at 0.3 m (m2)	Volume (m3)		Max depth (m)	Top area (m2)	Max volume (m3)	Depth (m)	Top area (m2)	Max volume (m3)	
Basin 1	1600	0.30	1747	502	NA	NA	NA	NA	NA	NA	Lake Adams
Basin 3	2500	0.3	2683	777	NA	NA	NA	NA	NA	NA	Little Mariginiup Lake
Basin 9	1521	1665	480	15200	0.54	16000	4050	1.2	17900	15224	NA
Basin 12	1521	1665	480	11670	0.55	12300	3427	1.2	14110	12592	NA
Basin 8	1024	1142	325	5041	0.56	5520	1776	1.2	6691	5716	NA
Basin 7	961	1076	307	5329	0.56	5800	1700	1.2	7022	5831	NA
Basin 21	676	773	229	5776	0.54	6260	1603	1.2	7534	5777	NA
Basin 6	289	353	96	4225	0.54	4630	1226	1.2	5746	4432	NA
Basin 19	1089	1211	356	9800	0.54	10410	2786	1.2	12060	10033	NA
Basin 20A	289	353	98	2116	0.60	2460	804	1.2	3226	2635	NA
Basin 17	576	666	186	3844	0.55	4230	1247	1.2	5300	4102	NA
Basin 20B	1225	1354	387	NA	NA	NA	NA	NA	NA	NA	REW (UFI:15443)
Basin 15	1089	1211	345	NA	NA	NA	NA	NA	NA	NA	REW (UFI:15443)
Basin 16	2401	2581	747	NA	NA	NA	NA	NA	NA	NA	REW (UFI:15443)

6. GROUNDWATER MANAGEMENT

6.1. Overview

A district groundwater management scheme will control post-development groundwater level rise through subsoil drainage in areas that are likely to either become submerged or have shallow depth to groundwater if no groundwater control measures are implemented. The groundwater management scheme is to be informed by a detailed groundwater model that is currently under development. In the absence of the groundwater model results and the groundwater management scheme design, planning must follow requirements stipulated in the DWMS (Urbaqua, 2021).

6.2. Groundwater control

The DWMS proposed the controlled groundwater level (CGL) be represented by the 1986 to 1995 AAMGL, but notes:

> *The impacts of using an AAMGL rather than MGL (maximum groundwater level) as the CGL near wetlands and important environmental values will require further consideration when detailed modelling is undertaken for the preparation of the local water management strategy for each precinct.*

The DWMS also states:

> *Where local structure planning is proceeding in advance of the detailed local groundwater modelling being available, the local structure plan must:*
>
> - *Install groundwater management systems (subsoil drains) at invert levels based on the determined controlled groundwater level (CGL) in areas where the predicted future groundwater level is within 2m of the future design surface.*

The CGL, clearance of the drainage basins to CGL, and subsoil drainage extent have been assessed in accordance with the requirements specified in the DWMS.

6.2.1. Controlled Groundwater Level (CGL)

The proposed CGL for the East Wanneroo DSP area is the 1986 to 1995 average annual maximum groundwater level (AAMGL), which is considered appropriate for Precinct 15 without adjustment. Several surface water infiltration basins have been identified across the site, as shown in Figure 15. The DWMS specifies that subsoil drainage is to be at the CGL, and the subsoil drainage pipework will underlie the surface water infiltration basins. A clearance of at least 0.5 m from the basin invert to the CGL will therefore be required to allow for the subsoil drainage pipework to have an invert level at CGL and to allow for infiltration from the surface water basins.

6.3. Groundwater modelling

No specific groundwater modelling has been undertaken to provide groundwater level comparisons between “no-development” and “post-development” model scenarios as it is understood this work is being completed by DPLH. The proponent for Precinct 15 understands that modifications to the drainage design and earthworks design may be required to as a result of the upcoming Groundwater Management Scheme design process.

6.4. Groundwater Management Responses

Subsoil drains will be located beneath road reserves and POS areas to aid infiltration. The detailed design of the subsoil drainage network has not yet been undertaken.

The subsoil drainage design response will also consider the subsoil drainage pipe sizing in response to an appropriate infiltration rate at each POS area. Currently, the flood storage basins have been sized based on an assumed infiltration rate (continuing loss) of 1 m/d.

The DWMS describes a groundwater management scheme that will be controlled by subsoil drainage. Precinct 15 is an undulating area with several post-development surface water catchment draining internal to the precinct and not draining to major lakes or wetlands. The project team understands that these internally draining catchments will be governed by the groundwater harvesting scheme and subsoil drainage abstraction during rainfall events will be critical.

The current earthworks design and subsoil drainage design allows for catchments to drain subsoil drainage to low points in the landscape where it is anticipated a pumping system will abstraction or transfer subsoil drainage to a disposal or final use location. The engineering drawings appended to the report illustrate the preliminary design as it relates to the subsoil drainage networks and its likely abstraction and transfer locations.

The current urban design and engineering drainage design supports flexibility in response to the future groundwater management scheme and is consistent with the known design principles. The urban design responds to the likely infrastructure demands and land take of the groundwater management scheme.

7. MONITORING REQUIREMENTS

7.1. Pre-development monitoring

Pre-development monitoring is on-going across the Precinct 15 development. Details are provided in Section 2.11.3. The monitoring completed captured a winter peak for 2022, with monitoring to continue for a further year to capture a total of two consecutive winter peaks.

7.2. During and post-development monitoring

During post-development, monitoring will be carried out at the site to detect changes to water quality and verify the performance of the proposed management strategies. The proposed period for post-development monitoring is no less than 18 months, as outlined in the DWMS (Urbaqua, 2021). Additional monitoring may be required at the site and should be confirmed with DWER.

Post-development groundwater monitoring will occur on a quarterly basis for levels and quality at 10 groundwater bore locations, with site specific bores MB05 to MB10 being additionally monitored on a monthly basis during winter (June to October). Groundwater loggers installed at each of the bores will continue to collect continuous groundwater level data. The same water quality parameters that were sampled pre-development will be sampled for a period of no less than 18 months after practical completion of the development.

Bores that were monitored pre-development will attempt to be located for post-development monitoring. Where bores have been either destroyed or are no longer available for use, a new bore is to be installed in a location as close to possible as the original bore to ensure consistency in the monitoring regime.

Surface water monitoring will be undertaken at the same frequency (monthly field sampling and bi-annual sampling for laboratory testing), duration and locations as pre-development monitoring. Surface water quality will be measured for the same water quality parameters as the groundwater monitoring. Exact locations will be determined in the respective UWMPs. Capacitance loggers installed at the four surface water locations monitored pre-development will continue to collect continuous surface water level data.

7.3. Trigger values

Baseline water quality will be established after a minimum 18 months (2 winters) of continuous pre-development data collection. Appropriate trigger levels will be determined for contingency action at the conclusion of this period of data collection.

7.4. Reporting

Annual reporting is proposed to review the post-development monitoring program and recommend revisions where necessary to improve understanding of surface water and groundwater systems.

8. FURTHER INVESTIGATIONS

8.1. Further work

The preparation of Urban Water Management Plans (UWMPs) will be required as a condition of subdivision approval and will include the following design measures in more detail:

- Compliance with this LWMS criteria and objectives to the satisfaction of the CoW and DWER
- Detailed stormwater drainage design including final levels and dimensions for bioretention and flood storage areas
- Specific detailed information on structural and non-structural Best Management Practices to be implemented within each subdivision
- Final subdivision layout including final cut and fill levels, minor and major drainage layout and overland flow paths
- Management of subdivision works including details of licence application for dewatering or dust suppression if required
- Updated POS landscaping design drawings which will include design contours, cross-sections, storage areas, plant species, fertiliser regimes and irrigation scheduling
- Detailed monitoring program for both groundwater and surface water monitoring including sampling locations
- Finalised implementation plan including roles and responsibilities of all parties involved.

8.2. Implementation plan

The proposed operation and maintenance program is outlined in Table 14 below.

Table 14: LWMS roles and responsibilities

Principle	Role	Responsibility	Time-scale
Monitoring	Groundwater monitoring	The proponent	Quarterly groundwater levels and water quality monitoring of bores for a period of 18 months following practical completion, with a review after 18 months.
	Surface water monitoring	The proponent	Quarterly surface water levels and water quality monitoring for a period of 18 months following practical completion, with an initial review after 18 months.
Irrigation bore	Bore monitoring and maintenance	The proponent until POS handover. Bore to be serviced prior to pump handover to CoW.	As per the bore licence conditions specified by DWER until handover to the CoW.
Subdivision management	Construction and site works management	The proponent	As required during construction until handover to the CoW.
	Waste and pollution management	The proponent	As required during construction until handover to the CoW.
	Erosion Control	The proponent	As required during construction.

Principle	Role	Responsibility	Time-scale
POS and landscaped community areas	Maintenance of drainage infrastructure	The proponent	As specified within the POS design documentation until handover to CoW.
	Fertiliser application	The proponent	As specified within the POS design documentation until handover to CoW.
	Irrigation systems	The proponent	As specified within the POS design documentation until handover to CoW.

9. REFERENCES

ANZECC/ARMCANZ. (2000). Australian Guidelines for Water Quality Monitoring and Reporting. http://www.ea.gov.au/water.

Bureau of Meteorology (BOM) (2022a). Evaporation: Average Monthly & Annual Evaporation. Accessed 6 October 2022. http://www.bom.gov.au/watl/evaporation/

Bureau of Meteorology (BOM) (2022b). Average aerial potential evapotranspiration. Accessed 3 November 2022. http://www.bom.gov.au/jsp/ncc/climate_averages/evapotranspiration/index.jsp?maptype=3&period=an#maps

Department of Biodiversity, Conservation and Attractions (DBCA) (2018). Geomorphic wetland mapping.

Department of Planning and Infrastructure (DoPI) (2008). Better Urban Water Management.

Department of Planning, Lands and Heritage (DPLH), 2019. Government Sewerage Policy, Perth.

Department of Water (DoW) (2004–2007). Stormwater Management Manual for Western Australia. Government of Western Australia.

Department of Water (DoW) (2008). Interim: Developing a Local Water Management Strategy

Department of Water (DoW) (2013). Water resource considerations when controlling groundwater levels in urban development.

Department of Water and Environmental Regulation (DWER) (2017). Acid Sulfate Soil risk mapping.

Department of Water and Environmental Regulation (DWER) (2017). Decision Process for Stormwater Management in Western Australia

Department of Water and Environmental Regulation (DWER) (2022a). Perth Groundwater Map. https://maps.water.wa.gov.au/Groundwater/

Department of Water and Environmental Regulation (DWER) (2022b). Water Information Reporting, Department of Water and Environmental Regulation, Government of Western Australia. Available from: https://wir.water.wa.gov.au/Pages/Water-Information-Reporting.aspx

Douglas Partners 2022a. Preliminary Geotechnical Investigation. Proposed Residential Development Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA. Prepared for Stockland Development Pty Ltd. October 2022. Rev 0.

Douglas Partners 2022b. Preliminary Geotechnical Investigation. Proposed Residential Development Stage 2 – Rousset Road, Mariginiup, WA. Prepared for Stockland Development Pty Ltd. October 2. Rev 0.

Gozzard, JR. 1986. Perth Metropolitan Region 1:50,000 Environmental Geology Series Fremantle. Perth, Western Australia. Muchea Sheet.

Horizon Heritage Management (Horizon) (2023). Precinct 15 Central Mariginiup Local Structure Plan Aboriginal Heritage Desktop Assessment Report.

IPWEA (2016). Specification separation distances for groundwater controlled urban development.

Urbaqua (2021). East Wanneroo District Structure Plan. District Water Management Strategy. Prepared for Department of Planning, Lands and Heritage. March 2021.

Western Australian Planning Commission (WAPC) (2003). Liveable Neighbourhoods.

This page has been left blank

Appendix A: Geotechnical reports

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Preliminary Geotechnical Investigation

Proposed Residential Development
Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

Prepared for
Stockland Development Pty Ltd

Project 212040.00
October 2022

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	212040.00	Document No.	R.001.Rev0
Document title	Report on Preliminary Geotechnical Investigation Proposed Residential Development		
Site address	Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA		
Report prepared for	Stockland Development Pty Ltd		
File name	212040.00.R.001.Rev0.DP Report - Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA.docx		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Brendan Divilly	Dan Reaveley & Frederic Verheyde	7 October 2022

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	-	Mr Mathew Johns, Stockland Development Pty Ltd

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		7 October 2022
Reviewer		**7 October 2022**

bsi ISO 9001 Quality Management Systems CERTIFIED
FS 604853

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
36 O'Malley Street
Osborne Park WA 6017
Phone (08) 9204 3511

Table of Contents

Douglas Partners
Geotechnics | Environment | Groundwater

Appendix B: Drawings

Test Pit Logs

CPT Results

Borehole Logs

Appendix C: Laboratory Test Certificates

Report on Preliminary Geotechnical Investigation
Proposed Residential Development
Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

1. Introduction

This report presents the results of a preliminary geotechnical investigation undertaken for a proposed residential development at Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA. The investigation was commissioned in an email dated 16 June 2022 by Mr Mathew Johns of Stockland Development Pty Ltd and was undertaken in accordance with Douglas Partners' proposal P212040.00.P.001.Rev1 dated 5 May 2022.

It is understood that the proposed development will comprise a residential subdivision, including lots, pavement, wastewater pump station, services and public open space.

The aim of the investigation was to assess the subsurface soil and groundwater conditions across the site in order to provide preliminary comments on:

- The suitability of the site for urban development, from a geotechnical standpoint;
- The extent of uncontrolled fill, rock, peaty soils and depth of topsoil, where encountered;
- Excavation conditions and depths of available sand for re-use, where encountered;
- The suitability of site soils as fill, including advice regarding the preparation, placement and compaction of topsoil and sand, including the suitability of the use of topsoil by blending with clean sand for use as structural fill;
- Site preparation, compaction, remediation and earthworks to allow for urban development;
- A preliminary site classification in accordance with AS 2870-2011;
- Geotechnical design parameters for retaining wall design and foundation design, including soil friction angle and allowable bearing capacity;
- Suitable design parameters for pavements, including a suitable California bearing ratio (CBR) for the subgrade encountered at the site and provide comments on road construction;
- The permeability of shallow soils and the suitability of the site to accept on-site stormwater disposal;
- The groundwater level and perched water table levels beneath the site at the time of the field work, if encountered; and
- Recommendations for further geotechnical investigation.

The investigation included five cone penetration tests (CPT), the excavation of 51 test pits, seven in situ infiltration tests and laboratory testing of selected samples. The details of the field work are presented in this report, together with comments and recommendations on the items listed above.

2. Site Description

The site comprises an area, approximately 124 ha in size, identified as Lot 803 Coogee Road and Lot 1673 Rousset Road in Mariginiup, WA. It is bordered by Rousset Road to the east, Coogee Road and undeveloped land to the north, and rural residential properties and market gardens along all other boundaries (Refer to Drawing 1, Appendix B).

At the time of the field work, the site was generally vacant and was covered in sparse bushland and cleared areas, except for the north-west corner of the site which included a large shed, some sea containers and hardstand area. Vegetation generally comprised medium to large sized trees, shrubs and short grass.

Based on publicly available LiDAR data, the ground surface level across the site varies between approximately RL 46 m AHD and RL 59 m AHD.

The Muchea 1:50,000 Environmental Geology sheet indicates that shallow sub surface conditions across the western half of the site consist of sand derived from Tamala Limestone, while the eastern half consists of Bassendean Sand and peaty clay associated with swamp deposits.

The Perth Groundwater Atlas indicates that the groundwater level ranged between approximate levels of RL 43 m AHD and RL 45 m AHD in May 2003, approximately 2 m to 15 m below existing surface levels.

Published acid sulfate soil risk mapping indicates the western half of the site is located in an area mapped as “no known risk of acid sulfate soils occurring within 3 m of natural soil surface”. The eastern half of the site has areas mapped as both “high to moderate risk of acid sulfate soils occurring within 3 m of natural soil surface” and “moderate to low risk of acid sulfate soils occurring within 3 m of natural soil surface. The areas mapped as “high to moderate” risk are associated with the peaty clay swamp deposits as depicted by the published geological mapping.

3. Field Work Methods

Field work for the investigation was carried out on 5 and 7 July 2022 and comprised:

- The excavation of 51 test pits (Locations 1 to 50 and 1A).
- Perth sand penetrometer (PSP) testing adjacent to each test pit location.
- CPT at five locations (51 to 54 and 54A).
- Seven in situ infiltration tests (Locations 55 to 61).

The test pits were excavated to a maximum depth of 2.7 m using an 8-tonne backhoe, equipped with a 450 mm wide toothed bucket. PSP tests were carried out at the test pit locations in accordance with AS 1289.6.3.3 to assess the in-situ density of the shallow soils.

Each test pit was logged in accordance with AS 1726–2017 by a suitably experienced engineer from Douglas Partners. Soil samples were recovered from selected locations for subsequent laboratory testing.

The infiltration tests were performed using the falling head method at depths of between 0.5 m and 1.5 m at locations 55 to 61.

Test locations were determined using a handheld GPS and are marked on Drawing 3. Approximate ground surface levels at the test locations have been derived from publicly available LiDAR data (DEM derived from 5 m grid).

4. Field Work Results

4.1 Ground Conditions

Logs of the ground conditions and results of the field testing are presented in Appendix B, together with notes defining descriptive terms and classification methods, in Appendix A.

Ground conditions across the site generally comprised:

- **Topsoil (SAND and ORGANIC SAND SP and SP-SM)** – dark grey-brown sandy and organic sandy topsoil, trace silt to with silt, between 0.06 m and 0.2 m thick at all test locations except 1, 1A and 59.
- **Localised FILL (Gravelly SAND and SAND SP-SM)** – fine to medium grained, pale yellow-brown and brown gravelly sand and sand fill, with silt, to a depth of 0.3 m at locations 1 and 1A. The fill at location 1A included various waste materials including demolition rubble. domestic refuse and organic material.
- **SAND (SP and SP-SM)** – fine to medium grained, grey and yellow-brown sand, trace silt to with silt underlying the topsoil and fill, to termination depths of between 0.5 m and 2.7 m at the test pit locations and to termination depths of up to 10 m at the CPT locations (except at CPT54 where cemented material was encountered at depth, as discussed further below). The sand was generally in a loose and loose to medium dense condition, becoming medium dense at depth. The depth and level of the base of the loose and loose to medium dense soils encountered at the test locations are shown in Table 1.
- **Localised Cemented Soils (Silty SAND and Silty ORGANIC SAND SM) -** dark brown cemented silty sand and cemented silty organic sand, to a depth of 0.6 m at location 9 and to a termination depth of 1.25 m at location 21. The cemented silty organic sand at location 21 was moderately to strongly cemented.

  Some inferred cemented material (possibly weakly to moderately cemented sand or very low to low strength limestone) was encountered below about 6 m depth at CPT54.

The ground conditions at the location of the proposed temporary sewer pump station (location 53) comprised loose to medium dense sand to 1.5 m, overlying medium dense sand to 6.4 m and dense sand to a termination depth of 10.2 m.

Table 1: Summary of Depth and Level of Base of Loose and Loose to Medium Dense Soils

Test Location	Ground Surface Level [1] (m AHD)	Depth of Loose and Loose to Medium Dense Soil (m)	Level of Base of Loose and Loose to Medium Dense Soil [2] (m AHD)
2	51.6	0.9	50.7
3	51.9	1.15	50.8
8	48.6	1.3	47.3
14	49.9	0.9	49.0
15	54.7	1.15	53.5
16	53.7	1.05	52.6
17	57.1	1.8	55.3
18	53.9	1.15	52.7
22	51.9	1.25	50.6
24	48.3	0.45	47.8
26	46.9	0.75	46.1
27	52.0	0.45	51.5
28	57.8	0.9	56.9
30	49.2	0.9	48.3
32	54.9	1.3	53.6
33	48.2	1.25	46.9
35	50.8	1.2	49.6
36	48.2	1.05	47.1
37	50.2	1.05	49.1
38	51.3	1.05	50.2
39	55.1	1.45	53.6
40	56.1	1.15	54.9
41	47.7	1.05	46.6
42	50.7	0.75	49.9
45	48.1	0.75	47.3
46	58.7	1.15	57.5
47	54.5	1.7	52.8
49	52.9	0.9	52.0
50	48.5	1.15	47.3
51	58.9	2.9	56.0
52	59.3	2.4	56.9
53	45.9	1.5	44.4
54	59.5	4.5	55.0
54A	59.3	4.0	55.3

Test Location	Ground Surface Level [1] (m AHD)	Depth of Loose and Loose to Medium Dense Soil (m)	Level of Base of Loose and Loose to Medium Dense Soil [2] (m AHD)
55	46.9	Deeper than 1.05	Less than 45.8
58	48.6	Deeper than 1.05	Less than 47.5
59	46.2	0.45	45.7

Notes for Table 1: [1]: Approximate surface level derived from LiDAR data.
[2]: Level of Base of Loose Soils = Estimated Surface Level – Depth of Loose Soils. Levels should be considered as approximate.

4.2 Groundwater

Groundwater was observed within CPT53 at a depth of 3 m (RL 42.9 m AHD) on 7 July 2022. Groundwater was not encountered at the remainder of the test pits or CPT undertaken between 5 and 7 July 2022. The test pits were immediately backfilled following sampling, which precluded longer-term monitoring of groundwater levels.

It should be noted that groundwater levels are affected by climatic conditions and land usage and will therefore vary with time.

4.3 Permeability

Seven in-situ permeability tests using the falling head method were carried out between depths of between 0.5 m and 1.5 m at locations 55 to 61. An estimated permeability value has been derived from the in situ test data using a formula based on a calculation by Hvorslev (1951). Results of the permeability analysis are summarised in Table 2.

Table 2: Summary of Permeability Analysis

Test Location	Depth (m)	Measured Permeability (m/day) [1]	In situ Ground Conditions at Testing Depth
55	0.5	>20	SAND SP, trace silt, loose to medium dense
56	0.5	7	SAND SP, trace silt, medium dense
57	0.5	13	SAND SP, trace silt, medium dense
58	0.5	>20	SAND SP, trace silt, loose
59	0.5	>20	SAND SP, trace silt, medium dense
60	1.5	>20	SAND SP, trace silt, medium dense
61	0.5	>20	SAND SP, trace silt

5. Laboratory Testing

A geotechnical laboratory testing programme was carried out by a NATA registered laboratory and comprised the determination of

- the particle size distribution of ten samples; and
- the organic content of eight samples.

The test report sheet is given in Appendix C and the results are summarised in Table 3.

Table 3: Results of Laboratory Testing for Soil Identification

Test Location	Depth (m)	Fines (%)	Sand (%)	Gravel (%)	Organic Content (%)	Material
1A	0.4	4	96	0	1.4	SAND SP, trace silt
3	0.1	3	97	0	1.4	TOPSOIL / SAND SP, trace silt and organics
6	0.1	7	92	1	5.2	TOPSOIL / ORGANIC SAND SP-SM, with silt
18	0.1	4	96	0	2.7	TOPSOIL / ORGANIC SAND SP, trace silt
21	1.0	-	-	-	5.9	Cemented Silty ORGANIC SAND
26	0.45	5	95	0	1.5	SAND SP, trace silt
27	0.1	-	-	-	2.4	TOPSOIL / ORGANIC SAND SP-SM, with silt
36	0.1	3	97	0	1.3	TOPSOIL / SAND SP, trace silt and organics
55	0.5	1	99	0	-	SAND SP, trace silt
56	0.5	4	96	0	-	SAND SP, trace silt
57	0.5	4	96	0	-	SAND SP, trace silt
59	0.5	2	98	0	-	SAND SP, trace silt

Where:
Fines = Particles finer than 75 µm.
Sand = Particles between 2.36 mm and 75 µm.
Gravel = Particles larger than 2.36 mm.

6. Proposed Development

It is understood that the proposed development will consist of a residential subdivision, with associated lots, wastewater pump station, services, pavements, and public open space. Earthworks across the site are likely to comprise large cut to fill operations.

7. Comments

7.1 Site Suitability

The investigation indicates that the site is generally underlain by topsoil and sand as described in Section 4.1 above. In addition to the above, the testing across the site encountered an isolated area of uncontrolled fill at locations 1 and 1A, some surficial loose sandy soils and an isolated layer of cemented silty organic sand (location 21). The uncontrolled fill and layer of cemented silty organic sand is likely to require further assessment and delineation.

The encountered loose sand and buried cemented silty organic sand are geotechnical constraints that will require consideration in the earthworks strategy for the site.

However, it is considered that following suitable site preparation, the site is generally suitable for the proposed residential development. Suitable site preparation should include the excavation and removal of uncontrolled fill, removal or blending of the surficial topsoil, possible removal of the encountered buried cemented silty organic sand and suitable compaction of the loose soils across the site.

The ground conditions at the location of the proposed temporary sewer pump station (location 53) comprise sand and are considered geotechnically suitable. Groundwater was encountered at a depth of 3 m at this location, so dewatering will be required during construction.

Therefore, from a geotechnical standpoint, the land is physically capable of development, provided that the provisions outlined in the subsequent subsections of the report are incorporated in the development plans.

7.2 Site Classification

The shallow ground conditions beneath the site generally comprise loose sand, becoming medium dense with depth.

Based on the results of the investigation and in accordance with AS 2870-2011, a site classification 'Class P' applies to the site, owing to the presence of uncontrolled fill, loose sand and buried organic soils. It is considered that following suitable site preparation, the site could be re-classified as 'Class A'. Suitable site preparation includes in particular excavation and removal of uncontrolled fill, stripping or blending of the surficial topsoil, removal of any buried organic soils (eg location 21) and suitable compaction of all loose soils encountered across the majority of the site.

7.3 Excavation Conditions

The encountered ground conditions generally comprise sand. Conventional earthmoving equipment (such as large excavators and scrapers) should be generally suitable for excavations across the site within the encountered granular soils.

The cemented silty organic sand encountered at location 21 resulted in test pit refusal using an 8-tonne backhoe. It is anticipated that large excavators will be required to excavate cemented materials, with associated low excavation rates.

7.4 Geotechnical Suitability for Re-Use of In Situ Materials

7.4.1 Re-Use of Natural Sand

The encountered shallow natural sand with trace fines, classified 'SP' in the logs in Appendix B, is considered geotechnically suitable for reuse as structural fill material provided it is free from organic matter and particles greater than 150 mm in size.

Isolated areas of the site which include sand with fines (classified as SP-SM), generally underlying the topsoil, would also be considered suitable for re-use as fill, however, with possibly a lower permeability than typically specified in general earthworks specifications (5 m/day). Therefore, if reusing the sand with fines is further considered, a detailed assessment of the permeability of these soils is recommended to assess any impact on its reuse with regards to drainage characteristics.

7.4.2 Topsoil

Topsoil was encountered across the site to depths of between 0.06 m and 0.2 m.

Based on the results of the investigation, the topsoil encountered across the site is generally considered suitable for reuse as part of a topsoil and clean sand blend, for use as a structural filling material, provided that the topsoil is suitably prepared, and the controls outlined below are adopted. A preliminary blending ratio of 3:1 (clean sand:topsoil) is suggested, based on observations made during the site investigation and the laboratory results regarding organic content.

It is suggested that any large roots or other oversized organics are first removed or screened from the topsoil/organic sand, prior to blending. Stripping the topsoil and passing through a mechanical screening plant is suggested.

Following screening, topsoil should be sufficiently mixed and blended with clean sand so that it forms a generally homogenous material. The use of earthwork plant to suitably turn over the two materials to form a blended material is recommended. The blending process should be assessed by a geotechnical engineer.

The blending of topsoil with clean sand will likely decrease the permeability of the sand, therefore some consideration should be given to possible adverse implication on site drainage, if blended topsoil material is used as fill material across the site. Consideration could be given to further assess the permeability of blended topsoil material at various blending ratios, to assess a suitable blending ratio and associated filling permeability. Douglas Partners would be pleased to further assist with this assessment if required.

7.5 Site Preparation

7.5.1 Site Stripping

All deleterious material, including vegetation, uncontrolled fill (locations 1 and 1A) and topsoil (if not blended,) should be stripped from the proposed development areas of the site.

Any tree roots remaining from clearing operations within the proposed development area should be completely removed to a depth of 0.6 m, and the excavation backfilled with material of similar geotechnical properties to the surrounding ground and suitably compacted.

Further assessment of the buried cemented silty organic sand at location 21 is suggested to determine if this material is suitable to remain in situ, or if it requires removal. The occurrence of similar material elsewhere beneath the site cannot be precluded at this stage and therefore further geotechnical field assessment at a relatively high testing frequency during detailed design of the proposed development should be considered to assess the occurrence of otherwise of such material across the proposed development area.

7.5.2 Proof Rolling and Compaction

Following the site stripping (Section 7.5.1), and excavation to formation level (in areas of cut) it is recommended that the exposed ground be proof rolled with a heavy smooth drum roller (say minimum 15 tonnes deadweight) in vibrating mode.

Any areas that show signs of excessive deformation during compaction should be compacted until deformation ceases or, alternatively, the poor-quality material should be excavated and replaced with suitable structural fill and compacted.

Owing to the depth of loose sand across the site, it is suggested that significant compactive effort using heavy vibrating rollers (say 16 tonne minimum) is applied to the subgrade following stripping. Although the depth of loose soils is up to 4.5 m, based on the proposed earthworks plan, these locations are in areas of significant cut (cuts up to 9 m deep), and as such the loose sands may not impact the development following earthworks.

Following proof rolling to confirm suitable foundation material, the site should be tested using a Perth Sand Penetrometer (PSP) to a depth of 2 m below formation level, or shallower refusal, by a suitably experienced geotechnical engineer.

Compaction control of sand could be carried out using a PSP test in accordance with test method AS 1289.6.3.3. All areas within proposed building and pavement envelopes should be compacted to achieve a minimum blow count of 8 blows per 300 mm penetration to a depth of not less than 1.0 m below foundation level.

7.5.3 Imported Fill

If required, imported fill should comprise free draining, cohesionless, well graded sand that:

- contains less than 5% by weight of particles less than 75 microns in size;
- contains no particles greater than 150 mm in size; and
- is free of organic and other deleterious materials.

It is recommended that test certificates are reviewed and approved by the geotechnical engineer prior to importing material to site.

Other materials could be considered, provided they are granular and non-reactive, and following review by a geotechnical engineer.

7.5.4 Fill Placement

Any fill should be placed in layers not exceeding 300 mm loose thickness and compacted near optimum moisture content with a roller of say 15 tonne deadweight.

7.5.5 Compaction Testing

Sand fill should be compacted to 95% relative to modified maximum dry density (MMDD). Compaction control of the sand fill could be carried out using a Perth sand penetrometer (PSP) test in accordance with test method AS 1289.6.3.3. All areas within the proposed building and pavement envelopes should be compacted to achieve a minimum blow count of 8 blows per 300 mm penetration to a depth of not less than 1.0 m below foundation or subgrade level, or a correlation between MMDD and PSP blow counts should be established to determine the compaction target.

The top 300 mm in the base of any excavation should be re-compacted using a vibratory plate compactor prior to construction of any footings. Inspection of footing excavations by a geotechnical engineer is also recommended.

7.6 Foundation Design

Shallow foundation systems comprising slab, pad and strip footings should be suitable to support typical one and two storey residential buildings.

Footings of buildings covered by AS 2870-2011 should be designed to satisfy the requirements of this standard for the site classification discussed in Section 7.2, provided that site preparation is carried out in accordance with Section 7.5.

If a proposed building is not covered by AS 2870-2011 then the foundation should be designed using engineering principles. Following suitable site preparation and densification of the loose sand across the site, a presumptive allowable bearing pressure of 200 kPa is considered suitable for pad footings up to 3 m in width, or strip footings up to 1.5 m wide, founded at a minimum depth of 0.5 m in sandy soils that are at least medium dense. This should ensure that total and differential settlements are less than 20 mm.

The majority of the settlement indicated above is anticipated to occur as loads are applied during construction. Further long-term settlements are likely to be less than half of the settlement estimated above.

Douglas Partners can provide additional analysis if required once footing specifics are finalised.

The base of any foundation excavation should be compacted and assessed by a geotechnical engineer.

7.7 Design Parameters for Excavations and Retaining Systems

7.7.1 Safe Batter Slopes

It is recommended that batter slopes not steeper than 1.5H:1V (horizontal : vertical) be adopted for temporary excavations not deeper than 3 m in sand material above groundwater. For deeper excavations (above groundwater), average batter slopes not steeper than 2H:1V should be adopted, with horizontal benches at least 1 m wide at 3 m intervals in height. These recommended batter angles should be re-assessed if loads are to be applied near the top of the batter or if there is a possibility of substantial overland water flow. Permanent batter slopes should not be steeper than 2H:1V.

The above safe batter slope angles are not suitable below groundwater, under which case dewatering or the use of positive excavation supports (next section) should be considered.

7.7.2 Retaining Structures

The design of flexible or rigid walls should be undertaken using a triangular pressure distribution and the earth pressure parameters given in Table 4. In addition to the soil pressure, wall design should also allow for external loads such as buildings, live loads, hydrostatic pressure or construction activities.

Table 4: Soil Parameters for Retaining Wall Design

Soil Type	Soil Unit Weight Above Water Table γ (kN/m^3)	Drained Angle of Friction Φ' (Degrees)	Undrained Shear Strength C_U (kPa)	Coefficient of Earth Pressure – Active K_a	Coefficient of Earth Pressure – at Rest K_0	Coefficient of Earth Pressure – Passive K_p
Sand - loose	18	28	0	0.36	0.53	2.7
Sand – medium dense	20	32	0	0.31	0.47	3.2

7.8 Pavement Design Parameters

As noted in Section 4.1, the shallow soils across the site generally comprise sand. Based on field observations and Douglas Partners' experience, a preliminary subgrade CBR of 12% is recommended for the design of flexible pavements founded on sand subgrade, provided that such subgrade is compacted to achieve a dry density ratio of not less than 95% relative to modified compaction.

7.9 Stormwater Drainage and Permeability

The results of the permeability testing in Section 4.3 indicate a field permeability value of between 7 m/day and greater than 20 m/day for the shallow sand across the site.

Observed ground conditions and permeability results indicate that on-site stormwater disposal using soakwells and sumps is generally feasible into the encountered sand trace fines (classified 'SP' on the logs in Appendix B) where ground conditions at the base of such systems comprise sand and there is sufficient clearance above groundwater and any impervious layers such as cemented sand. A minimum clearance of 0.5 m is suggested between the base of drainage systems and groundwater, organic sand or cemented sand.

The infiltration capability of sand often reduces over time due to silt build up at the base of soakwells and sumps, and therefore such systems should be regularly maintained.

7.10 Further Investigation

It is suggested that further investigation by way of test pits is undertaken in the vicinity of location 21 to determine the extent of the buried cemented organic soils and to further characterise the material properties. Depending on the results of this assessment (for instance if the material is assessed to be unsuitable to be left in place), further test pitting across the site might be recommended in order to assess whether similar unsuitable material occurs elsewhere beneath the site, as previously discussed in Section 5.1.

8. References

AS 1289.6.3.3. (1997). *Methods for testing soils for engineering purposes - Soil strength and consolidation tests - Determination of the penetration resistance of a soil - Perth sand penetrometer test.* Reconfimed 2013: Standards Australia.

AS 1726. (2017). *Geotechnical Site Investigations.* Standards Australia.

AS 2870. (2011). *Residential Slabs and Footings.* Standards Australia.

Department of Environment. (2004). *Perth Groundwater Atlas, Second Edition, Dec 2004.*

Hvorslev, M. J. (1951). *Time lag and soil permeability in groundwater observations.* US Army Corps of Engineers Waterways Experiment Observation Station, Bulletin 36, Vicksburg, Mississippi.

9. Limitations

Douglas Partners (DP) has prepared this report for this project at Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA in accordance with DP's proposal dated 5 May 2022 and acceptance received from Mr Mathew Johns dated 16 June 2022. The work was carried out under an Agreement

dated 10 August 2022. This report is provided for the exclusive use of Stockland Development Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope of work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of fill of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such fill may contain contaminants and hazardous building materials.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Cone Penetration Tests

Douglas Partners

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

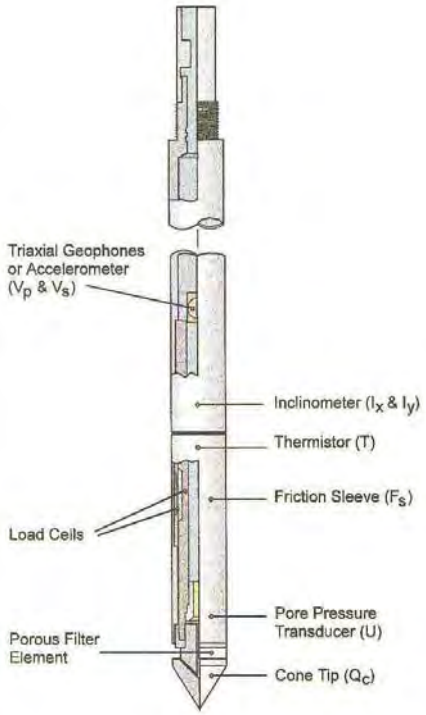


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.

Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (q_c, f_s, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V_s), compression wave velocity (V_p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

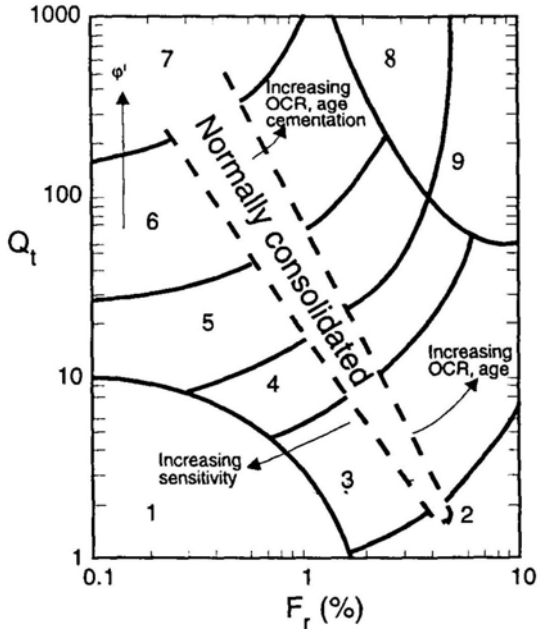


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G_0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

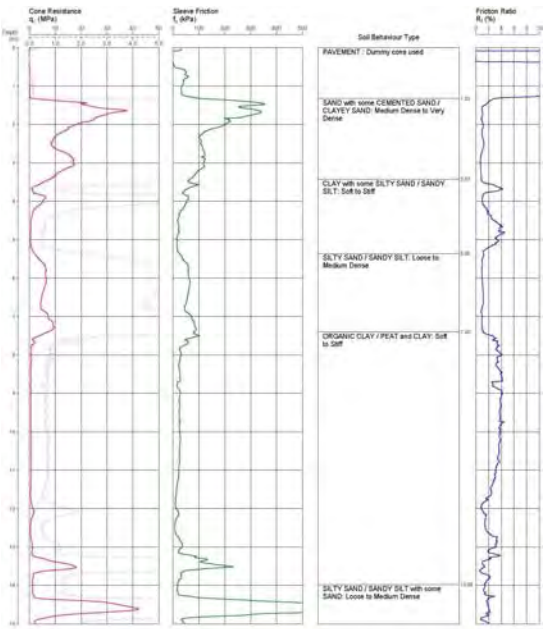


Figure 4: Sample Cone Plot

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) — Non-cohesive and free-running.
- Moist (M) — Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) — Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

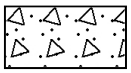
Symbols & Abbreviations

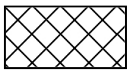
Graphic Symbols for Soil and Rock

General

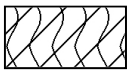

Asphalt

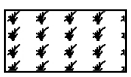

Road base

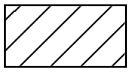

Concrete

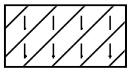

Filling

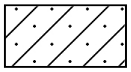
Soils


Topsoil

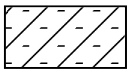

Peat

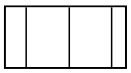

Clay

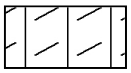

Silty clay

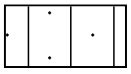

Sandy clay

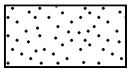

Gravelly clay

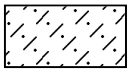

Shaly clay

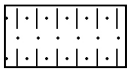

Silt


Clayey silt


Sandy silt


Sand

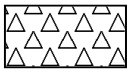

Clayey sand


Silty sand


Gravel

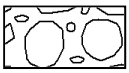

Sandy gravel


Cobbles, boulders

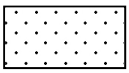

Talus

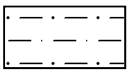
Sedimentary Rocks

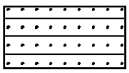

Boulder conglomerate

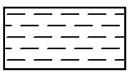

Conglomerate


Conglomeratic sandstone

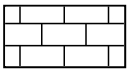

Sandstone


Siltstone

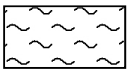

Laminite

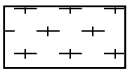

Mudstone, claystone, shale

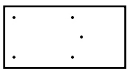

Coal


Limestone

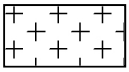
Metamorphic Rocks

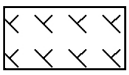

Slate, phyllite, schist

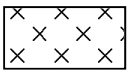

Gneiss

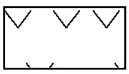

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote

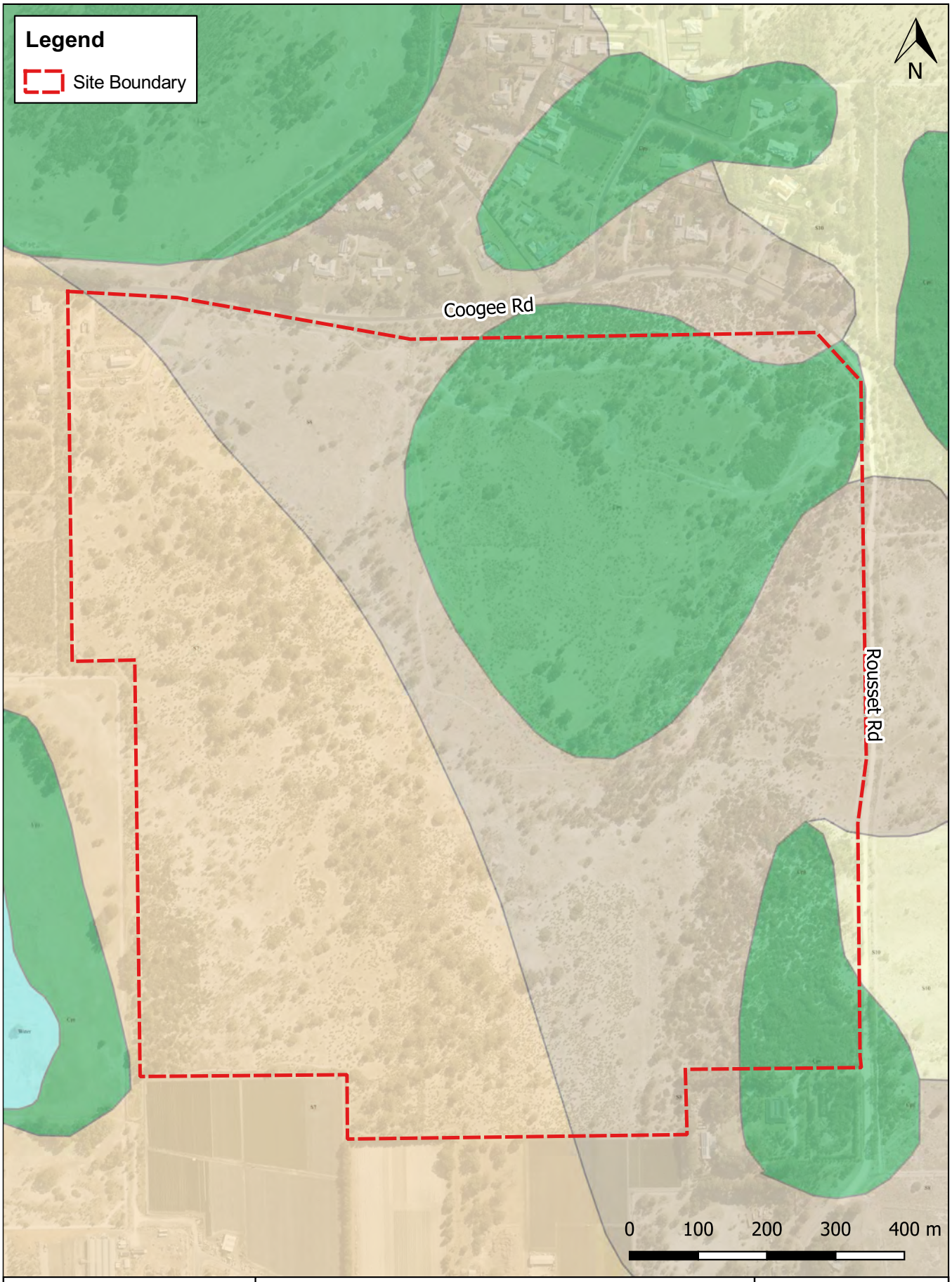

Tuff, breccia


Porphyry

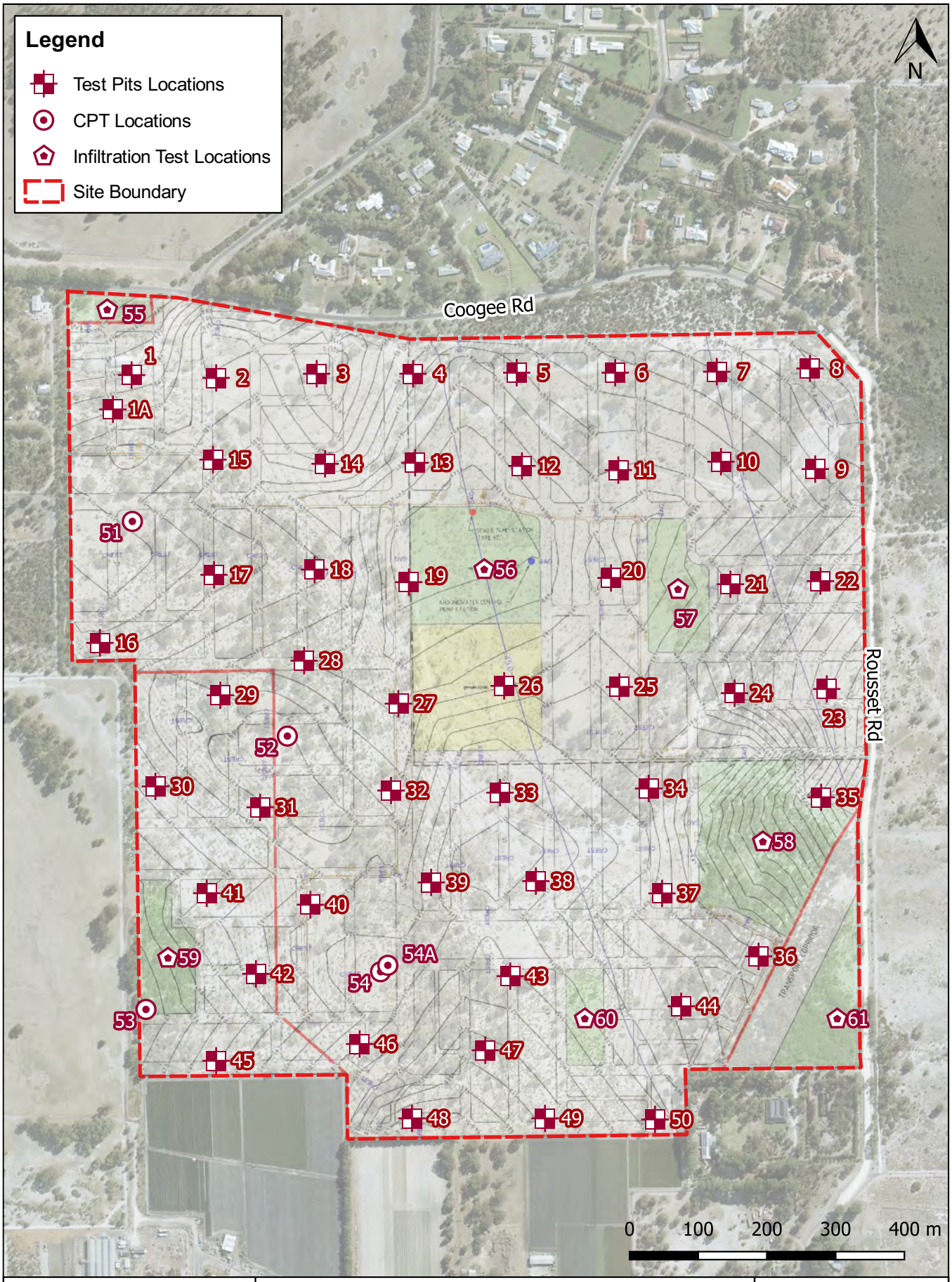
Appendix B

Drawings
Test Pit Logs
CPT Results
Borehole Logs

Douglas Partners Geotechnics | Environment | Groundwater	**Location Plan - Aerial** **Proposed Residential Development** **Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA**	PROJECT: 212040.00 Drawing No: 1 REV: 0
	CLIENT: Stockland Development Pty Ltd	DATE: 6/10/2022



Douglas Partners Geotechnics | Environment | Groundwater	**Location Plan - Geological Mapping** **Proposed Residential Development** **Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA**	PROJECT: 212040.00 Drawing No: 2 REV: 0
	CLIENT: Stockland Development Pty Ltd	DATE: 6/10/2022



Douglas Partners Geotechnics | Environment | Groundwater	**Test Locations** **Proposed Residential Development** **Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA**	PROJECT: 212040.00 Drawing No: 3 REV: 0
	CLIENT: Stockland Development Pty Ltd	DATE: 6/10/2022

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 51.2 m AHD*
EASTING: 388683
NORTHING: 6491310

PIT No: 1
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
51	0.15	FILL/Gravelly SAND SP-SM: fine to medium grained, pale yellow-brown, fine to coarse sized crushed limestone, with silt, moist, fill.		D	0.2				
	0.3	FILL/SAND SP-SM: fine to medium grained, dark brown, with silt, trace gravel, moist, medium dense, fill.		B	0.5				
50	1	SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.65 m depth.							
49	1.8	Pit discontinued at 1.8m (Collapsing conditions)							
48	2								
	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 54.3 m AHD*
EASTING: 388656
NORTHING: 6491260

PIT No: 1A
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
54	0.3	FILL/SAND SP-SM: fine to medium grained, brown, with silt, trace gravel, moist, medium dense, fill. General waste particles such as bricks, tiles, organics and domestic refuse observed in fill.		D	0.4				
	0.45	- becoming dark brown from 0.15 m depth.							
		SAND SP: fine to medium grained, dark grey, trace silt, moist, medium dense. Possibly fill.							
53	1.0	SAND SP: fine to medium grained, yellow-brown, trace silt, moist, medium dense. Sand derived from Tamala Limestone.							
		Pit discontinued at 1.0m (Target depth)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 51.6 m AHD*
EASTING: 388806
NORTHING: 6491306

PIT No: 2
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
51	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, with rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale grey from 0.6 m depth.							
	1	- becoming medium dense from 0.9 m depth.							1
50	1.7	Pit discontinued at 1.7m (Collapsing conditions)							
	2								
49									
	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 51.9 m AHD*
EASTING: 388953
NORTHING: 6491312

PIT No: 3
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.2	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, loose, topsoil.		D	0.1				
51	1	SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand. - becoming pale grey from 0.45 m depth. - becoming medium dense from 1.15 m depth.							
50	1.8 2	Pit discontinued at 1.8m (Collapsing conditions)							
49	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 49.2 m AHD*
EASTING: 389093
NORTHING: 6491312

PIT No: 4
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
49	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.							
48	1								1
	1.8	Pit discontinued at 1.8m (Collapsing conditions)							
47	2								
46	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.4 m AHD*
EASTING: 389244
NORTHING: 6491313

PIT No: 5
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, with roots and rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.							
46	1	- becoming pale brown from 0.4 m depth.							1
	2.0	Pit discontinued at 2.0m (Collapsing conditions)							2
45	2								
44	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.4 m AHD*
EASTING: 389387
NORTHING: 6491313

PIT No: 6
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.2	TOPSOIL/ORGANIC SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, medium dense, topsoil.		D	0.1				
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale brown from 0.4 m depth.							
46	1								1
	1.8	Pit discontinued at 1.8m (Collapsing conditions)							
45	2								
44	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.1 m AHD*
EASTING: 389535
NORTHING: 6491315

PIT No: 7
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace roots and rootlets, moist, topsoil.		D	0.05				
		SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.							
47	1	- becoming pale brown from 0.8 m depth.							1
	1.4	Pit discontinued at 1.4m (Collapsing conditions)							
46	2								
45	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.6 m AHD*
EASTING: 389670
NORTHING: 6491320

PIT No: 8
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace roots and rootlets, moist, topsoil.							
	1	SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
47	1.3	Pit discontinued at 1.3m (Collapsing conditions)							
	2								
46	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.9 m AHD*
EASTING: 389678
NORTHING: 6491173

PIT No: 9
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, topsoil.		D	0.05				
	0.4	SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand.							
	0.6	Cemented Silty SAND SM: fine to medium grained, dark brown, moist, medium dense. Coffee Rock, observed on the northern wall of the pit.							
	1	SAND SP: fine to medium grained, brown, trace silt, moist, medium dense. Bassendean Sand. - becoming pale brown from 1.3 m depth.							
46	2	2.0 Pit discontinued at 2.0m (Collapsing conditions)							
45	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.4 m AHD*
EASTING: 389541
NORTHING: 6491184

PIT No: 10
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand.		D	0.5				
		- becoming pale grey from 0.7 m depth.							
46	1								1
	1.6	Pit discontinued at 1.6m (Collapsing conditions)							
45	2								
44	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 46.9 m AHD*
EASTING: 389392
NORTHING: 6491172

PIT No: 11
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
46	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, topsoil.							
	0.3	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, medium dense. Bassendean Sand.		D	0.4				
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale brown from 0.45 m depth.							
45	2.1	Pit discontinued at 2.1m (Collapsing conditions)							
44									

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.1 m AHD*
EASTING: 389251
NORTHING: 6491178

PIT No: 12
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
46	1	SAND SP: fine to medium grained, pale brown, trace silt, moist, medium dense. Bassendean Sand.							
45	2	2.0 Pit discontinued at 2.0m (Collapsing conditions)							
44	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.1 m AHD*
EASTING: 389096
NORTHING: 6491182

PIT No: 13
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, topsoil.		D	0.1				
	0.3	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, loose. Bassendean Sand.							
46	1	SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.							1
	1.9	Pit discontinued at 1.9m (Collapsing conditions)							
45	2								
44	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 49.9 m AHD*
EASTING: 388965
NORTHING: 6491181

PIT No: 14
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
49	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
	1	- becoming pale grey and medium dense from 0.9 m depth.							1
48	1.4	Pit discontinued at 1.4m (Collapsing conditions)							
	2								
47	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⊻	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 54.7 m AHD*
EASTING: 388802
NORTHING: 6491187

PIT No: 15
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
54	0.2	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, trace rootlets, moist, loose, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
	1	- becoming pale grey from 1.0 m depth. - becoming medium dense from 1.15 m depth.							1
53	1.5	Pit discontinued at 1.5m (Collapsing conditions)							
52	2								
	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 53.7 m AHD*
EASTING: 388637
NORTHING: 6490920

PIT No: 16
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
53	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.		D	0.1				
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Sand derived from Tamala Limestone. - becoming pale yellow from 0.3 m depth.							
	1	- becoming yellow-brown from 0.9 m depth. - becoming medium dense from 1.05 m depth.							
52	1.9	SAND SP-SM: fine to medium grained, brown, with silt, moist, weakly cemented. Possibly Bassendean Sand.							
	2								
51	2.7	Pit discontinued at 2.7m (Collapsing conditions)							
	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 57.1 m AHD*
EASTING: 388803
NORTHING: 6491019

PIT No: 17
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
57	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, with roots and rootlets, moist, topsoil.		D	0.2				
		SAND SP: fine to medium grained, pale yellow, trace silt, moist, loose. Sand derived from Tamala Limestone.							
56	1	- becoming yellow-brown from 0.65 m depth.							1
	1.9	- becoming medium dense from 1.8 m depth.							
55	2	Pit discontinued at 1.9m (Collapsing conditions)							
54	3								

Dynamic Penetrometer Test (blows per 150mm): 5 10 15 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 53.9 m AHD*
EASTING: 388949
NORTHING: 6491027

PIT No: 18
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
53	0.15	TOPSOIL/ORGAINC SAND SP: fine to medium grained, dark grey-brown, trace silt, trace rootlets, moist, topsoil.		D	0.1				
	1	SAND SP: fine to medium grained, grey-brown, trace silt, moist, loose. Sand derived from Tamala Limestone. - becoming yellow-brown from 0.35 m depth. - becoming medium dense from 1.15 m depth.							
52	2								
	2.4	Pit discontinued at 2.4m (Collapsing conditions)							
51	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.3 m AHD*
EASTING: 389087
NORTHING: 6491009

PIT No: 19
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, pale grey, trace silt, trace rootlets to 0.7 m depth, moist, medium dense. Bassendean Sand.							
46	1								1
	1.9	Pit discontinued at 1.9m (Collapsing conditions)							
45	2								
44	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.0 m AHD*
EASTING: 389381
NORTHING: 6491015

PIT No: 20
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.2	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, medium dense, topsoil.		D	0.05				
		SAND SP: fine to medium grained, pale brown, trace silt, moist, medium dense. Bassendean Sand.							
46	1	- becoming pale orange-brown from 1.25 m depth.							
45	2								
	2.2	Pit discontinued at 2.2m (Collapsing conditions)							
44	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.5 m AHD*
EASTING: 389555
NORTHING: 6491006

PIT No: 21
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale brown from 0.4 m depth.							
	0.8	- becoming brown from 0.7 m depth.							
	1	Cemented Silty ORGANIC SAND SM: fine to medium grained, dark brown, moist, moderately to strongly cemented. Coffee Rock.		D	1.0				
46	1.25	Pit discontinued at 1.25m (Hard digging)							
	2								
45	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 51.9 m AHD*
EASTING: 389686
NORTHING: 6491010

PIT No: 22
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
51	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale grey from 0.4 m depth.							
	1	- becoming medium dense from 1.25 m depth.							1
		- becoming yellow-brown from 1.5 m depth.							
50	1.9	Pit discontinued at 1.9m (Collapsing conditions)							
	2								
49	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 55.2 m AHD*
EASTING: 389695
NORTHING: 6490853

PIT No: 23
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
55	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand.		D	0.3				
54	1	- becoming pale grey from 0.45 m depth.							1
	1.8	Pit discontinued at 1.8m (Collapsing conditions)							
53	2								
52	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.3 m AHD*
EASTING: 389561
NORTHING: 6490847

PIT No: 24
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.		D	0.05				
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale grey from 0.4 m depth.							
47	1	- becoming medium dense from 0.45 m depth.							
	2	2.0 Pit discontinued at 2.0m (Collapsing conditions)							
46									
	3								
45									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.1 m AHD*
EASTING: 389393
NORTHING: 6490856

PIT No: 25
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, brown, trace silt, moist, medium dense. Bassendean Sand.		D	0.5				
46	1	- becoming pale brown from 1.0 m depth.							
	2								
45	2.1	Pit discontinued at 2.1m (Collapsing conditions)							
44	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 46.9 m AHD*
EASTING: 389225
NORTHING: 6490858

PIT No: 26
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
46	0.2	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, medium dense, topsoil.							
		SAND SP: fine to medium grained, dark grey-brown, trace silt, trace rootlets, moist, loose to medium dense. Bassendean Sand.		D	0.45				
		- becoming pale brown from 0.7 m depth.							
	1	- becoming medium dense from 0.75 m depth.							1
45		- becoming brown from 1.5 m depth.							
	2								2
	2.5	- becoming moist to wet from 2.4 m depth.							
		Pit discontinued at 2.5m (Collapsing conditions)							
44	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 52.0 m AHD*
EASTING: 389071
NORTHING: 6490832

PIT No: 27
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
52	0.15	TOPSOIL/ORGANIC SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.		D	0.1				
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand. - becoming pale grey and medium dense from 0.45 m depth.							
51	1								1
	1.5	Pit discontinued at 1.5m (Collapsing conditions)							
50	2								
49	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 57.8 m AHD*
EASTING: 388934
NORTHING: 6490894

PIT No: 28
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
57	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, pale yellow, trace silt, moist, loose. Sand derived from Tamala Limestone.							
	1	- becoming yellow-brown and medium dense from 0.9 m depth.							
56	2								
	2.1	Pit discontinued at 2.1m (Collapsing conditions)							
55	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 58.4 m AHD*
EASTING: 388812
NORTHING: 6490844

PIT No: 29
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
58	0.2	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace roots and rootlets, moist, medium dense, topsoil.		D	0.1				
		SAND SP: fine to medium grained, pale yellow, trace silt, moist, medium dense. Sand derived from Tamala Limestone.							
	1	- becoming yellow-brown from 0.6 m depth.							
57									
	2								
	2.3	Pit discontinued at 2.3m (Collapsing conditions)							
56									
	3								
55									

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 49.2 m AHD*
EASTING: 388718
NORTHING: 6490711

PIT No: 30
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
49	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, with rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
48	1	- becoming medium dense from 0.9 m depth. - becoming pale grey from 1.0 m depth.							1
	1.5	Pit discontinued at 1.5m (Collapsing conditions)							
47	2								
46	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 56.1 m AHD*
EASTING: 388870
NORTHING: 6490681

PIT No: 31
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
56	0.2	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace roots and rootlets, moist, medium dense, topsoil.							
55	1	SAND SP: fine to medium grained, pale yellow, trace silt, moist, medium dense. Sand derived from Tamala Limestone. - becoming yellow-brown from 0.85 m depth.							1
54	1.8	Pit discontinued at 1.8m (Collapsing conditions)		D	1.8				
53	2								
	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 54.9 m AHD*
EASTING: 389061
NORTHING: 6490705

PIT No: 32
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
54	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey-brown, trace silt, moist, loose. Sand derived from Tamala Limestone.		D	0.5				
		- becoming pale grey-brown from 0.35 m depth.							
		- becoming pale brown from 0.7 m depth.							
		- becoming yellow-brown from 0.75 m depth.							
		- becoming medium dense from 1.3 m depth.							
53	1.8	Pit discontinued at 1.8m (Collapsing conditions)							
52									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.2 m AHD*
EASTING: 389219
NORTHING: 6490702

PIT No: 33
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
	1	- becoming pale brown from 0.7 m depth.							1
47		- becoming medium dense from 1.25 m depth.							
	1.9	Pit discontinued at 1.9m (Collapsing conditions)							
46	2								
	3								
45									

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.0 m AHD*
EASTING: 389436
NORTHING: 6490708

PIT No: 34
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
47	1	SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.3 m depth. - with roots to 0.35 m depth.							1
	1.6	Pit discontinued at 1.6m (Collapsing conditions)							
46	2								
45	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 50.8 m AHD*
EASTING: 389687
NORTHING: 6490695

PIT No: 35
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
50	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale grey from 0.3 m depth.							
	1	- becoming medium dense from 1.2 m depth.							1
49	1.5	Pit discontinued at 1.5m (Collapsing conditions)							
	2								
48	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.2 m AHD*
EASTING: 389596
NORTHING: 6490464

PIT No: 36
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.		D	0.1				
		SAND SP: fine to medium grained, pale brown, trace silt, moist, loose. Bassendean Sand.							
47	1	- becoming medium dense from 1.05 m depth.							
	2.0	Pit discontinued at 2.0m (Collapsing conditions)							
46	2								
45	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 50.2 m AHD*
EASTING: 389455
NORTHING: 6490556

PIT No: 37
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
50	0.1	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey-brown, trace silt, moist, loose. Bassendean Sand.							
		- becoming grey from 0.35 m depth.							
49	1	- becoming pale grey from 0.9 m depth.							1
		- becoming medium dense from 1.05 m depth.							
	1.4	Pit discontinued at 1.4m (Collapsing conditions)							
48	2								
47	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 51.3 m AHD*
EASTING: 389271
NORTHING: 6490573

PIT No: 38
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
51	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale grey from 0.45 m depth.							
50	1	- becoming medium dense from 1.05 m depth.							1
	1.5	Pit discontinued at 1.5m (Collapsing conditions)							
49	2								
48	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 55.1 m AHD*
EASTING: 389119
NORTHING: 6490572

PIT No: 39
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
55	0.2	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey, with silt, with roots and rootlets, moist, loose, topsoil.		D	0.05				
		SAND SP: fine to medium grained, yellow-brown, trace silt, moist, loose. Sand derived from Tamala Limestone.							
54	1	- tree root, 0.1 m diameter, at 0.8 m depth.							
		- becoming medium dense from 1.45 m depth.							
53	2 2.0	Pit discontinued at 2.0m (Collapsing conditions)							
52	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 56.1 m AHD*
EASTING: 388943
NORTHING: 6490539

PIT No: 40
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
56	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, yellow-brown, trace silt, moist, loose. Sand derived from Tamala Limestone.							
55	1	- becoming medium dense from 1.15 m depth.							
54	2.0	Pit discontinued at 2.0m (Collapsing conditions)							
53	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.7 m AHD*
EASTING: 388792
NORTHING: 6490556

PIT No: 41
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.2	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, with rootlets, moist, medium dense, topsoil.		D	0.1				
		SAND SP: fine to medium grained, grey, trace silt, moist, loose to medium dense. Bassendean Sand.							
	1	- becoming pale grey from 0.6 m depth.							
		- becoming medium dense from 1.05 m depth.							
46	1.5	Pit discontinued at 1.5m (Collapsing conditions)							
	2								
45	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 50.7 m AHD*
EASTING: 388864
NORTHING: 6490438

PIT No: 42
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
50	0.2	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, with rootlets, moist, loose, topsoil.		D	0.1				
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
49	1	- becoming pale grey from 0.65 m depth. - becoming medium dense from 0.75 m depth.							1
	1.8	Pit discontinued at 1.8m (Collapsing conditions)							
48	2								
	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 52.5 m AHD*
EASTING: 389234
NORTHING: 6490435

PIT No: 43
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
52	0.2	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, medium dense, topsoil.		D	0.1				
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.5 m depth.							
51	1.8	Pit discontinued at 1.8m (Collapsing conditions)							
50									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.8 m AHD*
EASTING: 389483
NORTHING: 6490391

PIT No: 44
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.		D	0.1				
	1	SAND SP: fine to medium grained, grey-brown, trace silt, moist, medium dense. Bassendean Sand. - becoming grey from 0.3 m depth. - becoming pale grey from 0.45 m depth.							1
47	1.9								
	2	Pit discontinued at 1.9m (Collapsing conditions)							
46	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.1 m AHD*
EASTING: 388806
NORTHING: 6490312

PIT No: 45
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, with rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose to medium dense. Bassendean Sand.							
		- becoming pale grey from 0.4 m depth.							
47	1	- becoming medium dense from 0.75 m depth.							1
	1.4	Pit discontinued at 1.4m (Collapsing conditions)							
46	2								
45	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 58.7 m AHD*
EASTING: 389015
NORTHING: 6490336

PIT No: 46
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
58	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, yellow-brown, trace silt, moist, loose. Sand derived from Tamala Limestone.		D	0.4				
	1	- becoming orange-brown from 1.0 m depth. - becoming medium dense from 1.15 m depth.							1
57	1.6	Pit discontinued at 1.6m (Collapsing conditions)							
	2								
56	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 54.5 m AHD*
EASTING: 389198
NORTHING: 6490327

PIT No: 47
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
54	0.2	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, medium dense, topsoil.		D	0.1				
	1	SAND SP: fine to medium grained, yellow-brown, trace silt, moist, loose to medium dense. Sand derived from Tamala Limestone.							1
53		- becoming medium dense from 1.7 m depth.							
	1.9	Pit discontinued at 1.9m (Collapsing conditions)							
52	2								
	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 56.9 m AHD*
EASTING: 389091
NORTHING: 6490228

PIT No: 48
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
56	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, topsoil.							
	0.3	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, medium dense. Sand derived from Tamala Limestone.							
	1	SAND SP: fine to medium grained, pale yellow-brown, trace silt, trace rootlets to 1.8 m depth, moist, medium dense. Sand derived from Tamala Limestone. - becoming yellow-brown from 0.6 m depth.							
55	2								
	2.4	Pit discontinued at 2.4m (Collapsing conditions)							
54	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 52.9 m AHD*
EASTING: 389285
NORTHING: 6490228

PIT No: 49
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
52	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, pale yellow-brown, trace silt, moist, loose. Sand derived from Tamala Limestone.							
	1	- becoming medium dense from 0.9 m depth. - becoming yellow-brown from 1.0 m depth.							1
51	1.9	Pit discontinued at 1.9m (Collapsing conditions)							
	2								
50	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.5 m AHD*
EASTING: 389445
NORTHING: 6490227

PIT No: 50
PROJECT No: 212040.00
DATE: 5/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale grey from 0.5 m depth.							
47	1	- becoming medium dense from 1.15 m depth.							1
	1.6	Pit discontinued at 1.6m (Collapsing conditions)							
46	2								
	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Stockland Development Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

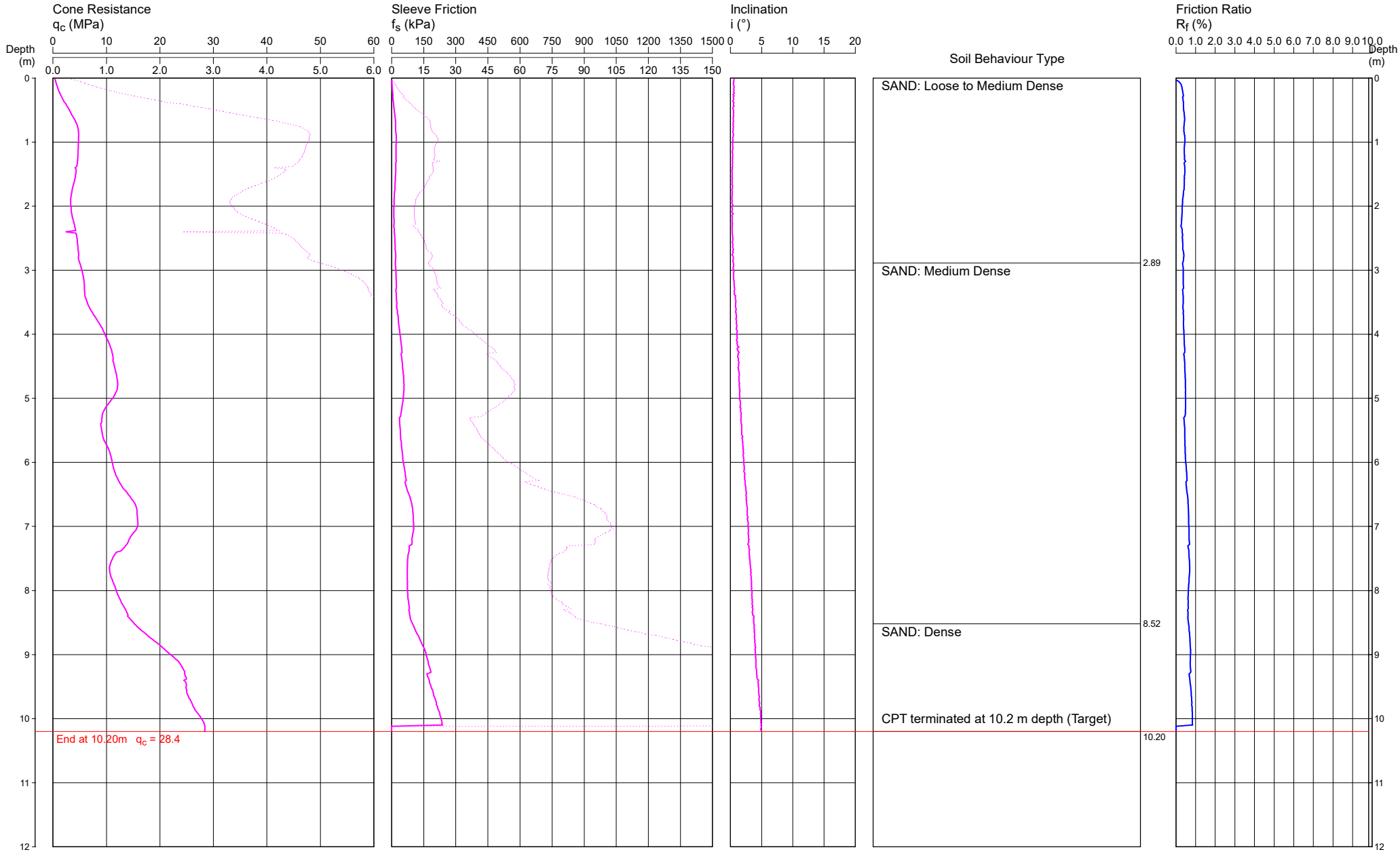
REDUCED LEVEL: 58.9 m AHD*

COORDINATES: 388684E 6491097N

CPT 51

DATE 7/07/2022

PROJECT No: 212040.00



REMARKS: *Surface level derived from publicly available LiDAR 5 m.
Dry to 9.9 m depth.

File: P:\212040.00 - MARIGINIUP, 803 Coogee & 1673 Rousset Rd\4.0 Field Work\CPT\212040 - CPT 51.CP5

Cone ID: Probedrill **Type:** EC42

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Stockland Development Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

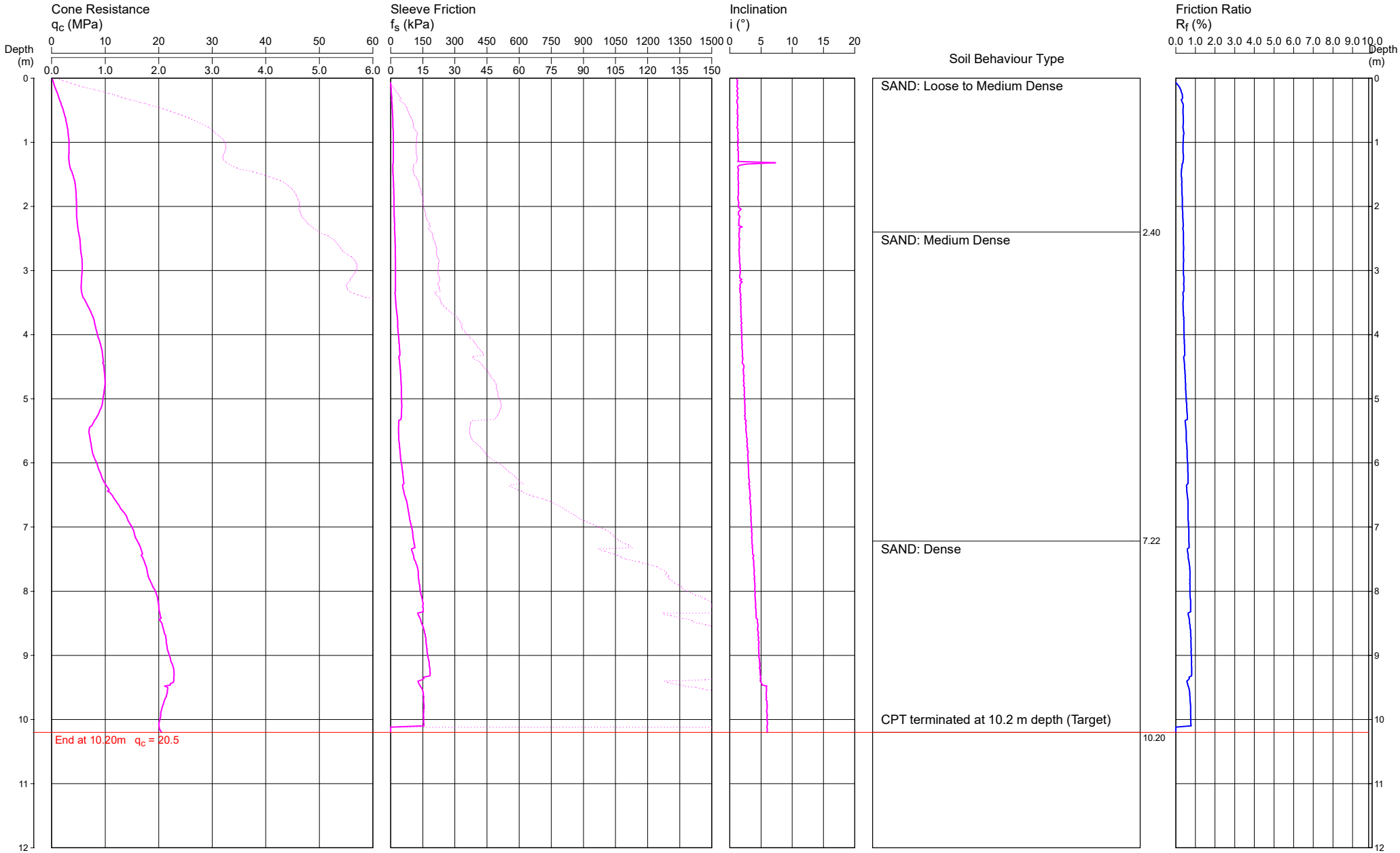
REDUCED LEVEL: 59.3 m AHD*

COORDINATES: 388910E 6490785N

CPT 52

DATE 7/07/2022

PROJECT No: 212040.00



REMARKS: *Surface level derived from publicly available LiDAR 5 m.
Dry to 10.1 m depth.

File: P:\212040.00 - MARIGINIUP, 803 Coogee & 1673 Rousset Rd\4.0 Field Work\CPT\212040 - CPT 52.CP5

Cone ID: Probedrill **Type:** EC42

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Stockland Development Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

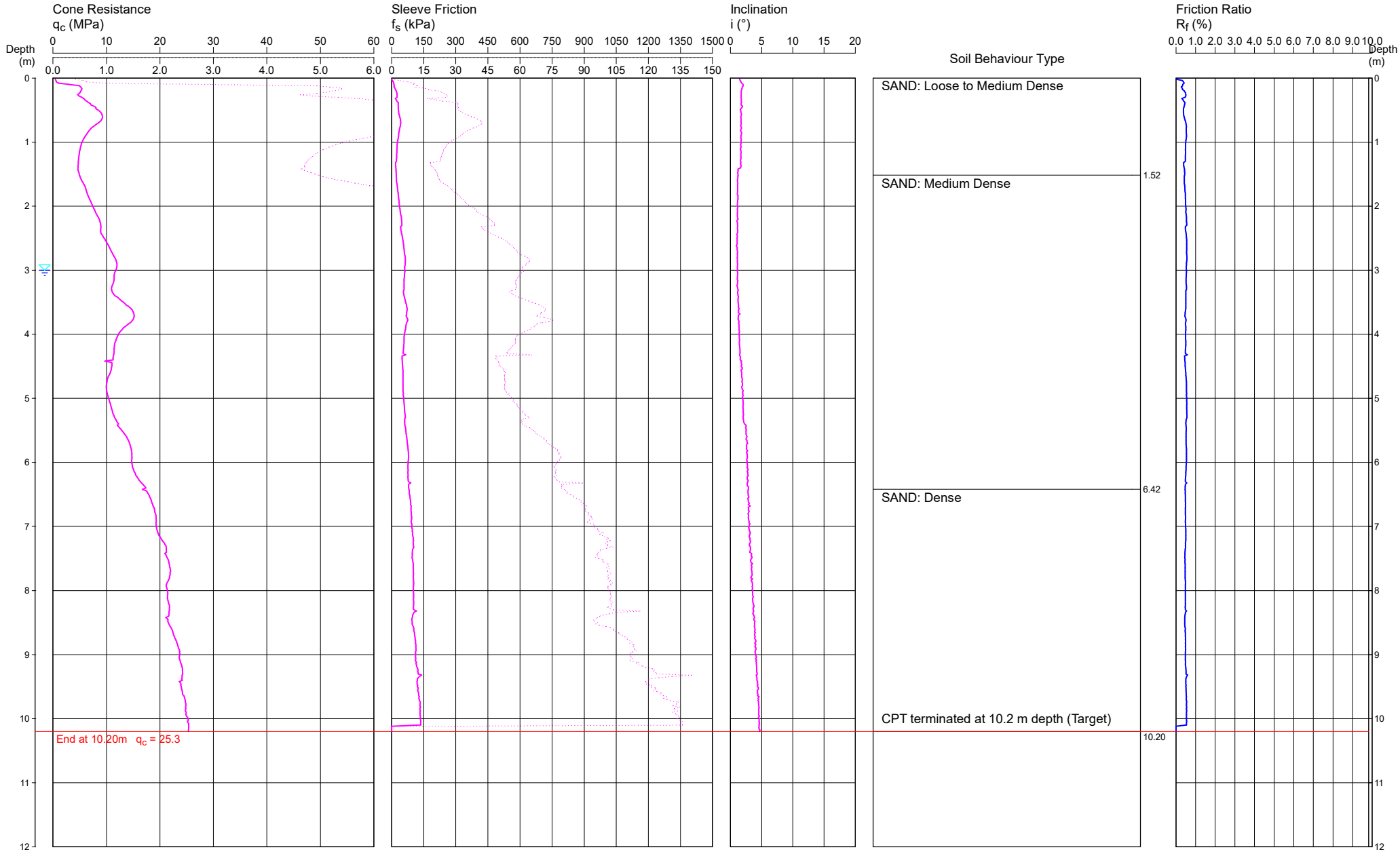
REDUCED LEVEL: 45.9 m AHD*

COORDINATES: 388704E 6490987N

CPT 53

DATE 7/07/2022

PROJECT No: 212040.00



REMARKS: *Surface level derived from publicly available LiDAR 5 m. Groundwater measured at 3 m depth.

File: P:\212040.00 - MARIGINIUP, 803 Coogee & 1673 Rousset Rd\4.0 Field Work\CPT\212040 - CPT 53.CP5

Cone ID: Probedrill **Type:** EC42

Water depth after test: 3.00m depth (measured)

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Stockland Development Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

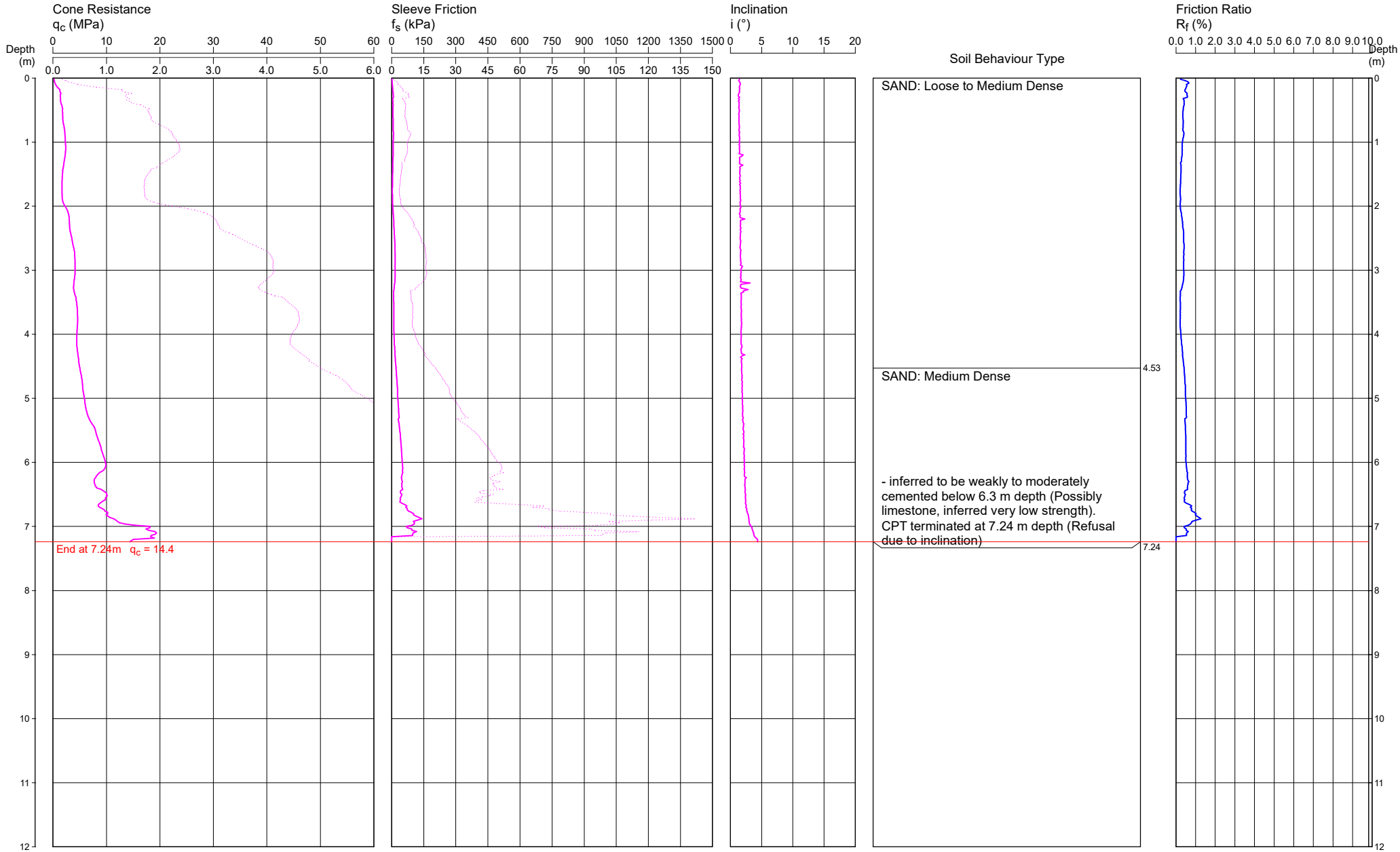
REDUCED LEVEL: 59.5 m AHD*

COORDINATES: 389045E 6490442N

CPT 54

DATE 7/07/2022

PROJECT No: 212040.00



REMARKS: *Surface level derived from publicly available LiDAR 5 m.
Dry to 7.1 m depth.

File: P:\212040.00 - MARIGINIUP, 803 Coogee & 1673 Rousset Rd\4.0 Field Work\CPT\212040 - CPT 54.CP5

Cone ID: Probedrill **Type:** EC42

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Stockland Development Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

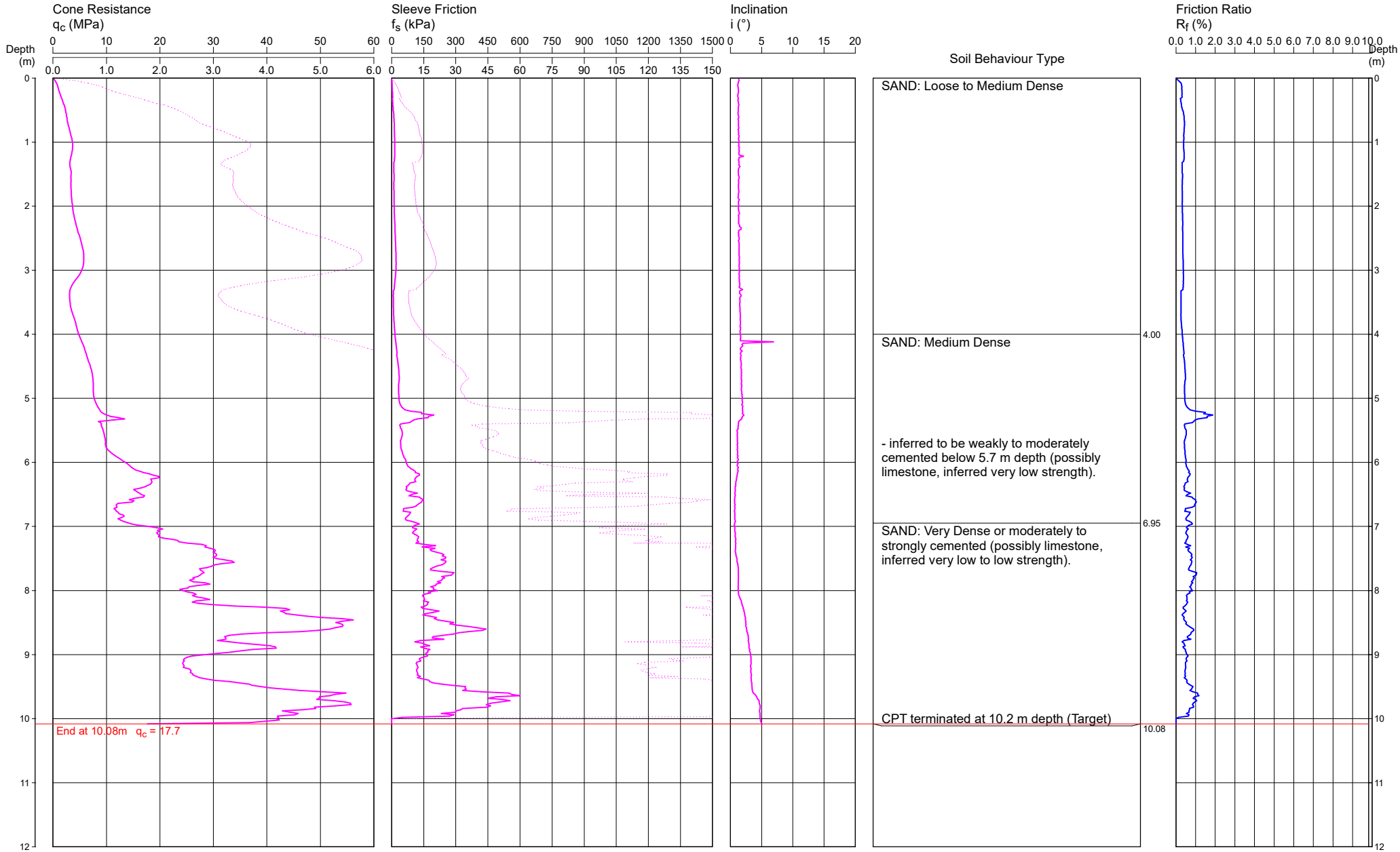
REDUCED LEVEL: 59.3 m AHD*

COORDINATES: 389056E 6490451N

CPT 54A

DATE 7/07/2022

PROJECT No: 212040.00



REMARKS: *Surface level derived from publicly available LiDAR 5 m. Dry to 10 m depth.

File: P:\212040.00 - MARIGINIUP, 803 Coogee & 1673 Rousset Rd\4.0 Field Work\CPT\212040 - CPT 54A.CP5

Cone ID: Probedrill **Type:** EC42

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 46.9 m AHD*
EASTING: 388648
NORTHING: 6491405
DIP/AZIMUTH: 90°/--

BORE No: 55
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
46	0.06	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown and grey-brown, with silt, trace rootlets, moist.							
		SAND SP: fine to medium grained, grey-brown, trace silt, moist, very loose. Bassendean Sand.							
	0.5	- becoming loose to medium dense from 0.45 m depth.		D	0.5				
		Bore discontinued at 0.5m (Target depth)							
45	1								1
	2								2
44	3								3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 110 mm diameter hand auger **DRILLER:** AA **LOGGED:** AA **CASING:** N/A

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.1 m AHD*
EASTING: 389196
NORTHING: 6491027
DIP/AZIMUTH: 90°/--

BORE No: 56
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace roots and rootlets, moist.							
		SAND SP: fine to medium grained, grey-brown, trace silt, moist, medium dense. Bassendean Sand.							
	0.5	Bore discontinued at 0.5m (Target depth)		D	0.5				
46	1								1
45	2								2
44	3								3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 110 mm diameter hand auger **DRILLER:** AA **LOGGED:** AA **CASING:** N/A

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.3 m AHD*
EASTING: 389478
NORTHING: 6490998
DIP/AZIMUTH: 90°/--

BORE No: 57
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist.							
		SAND SP: fine to medium grained, grey-brown, trace silt, moist, medium dense. Bassendean Sand.							
	0.5	Bore discontinued at 0.5m (Target depth)		D	0.5				
46	1								1
45	2								2
44	3								3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 110 mm diameter hand auger **DRILLER:** AA **LOGGED:** AA **CASING:** N/A

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.6 m AHD*
EASTING: 389602
NORTHING: 6490631
DIP/AZIMUTH: 90°/--

BORE No: 58
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, trace rootlets, moist.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale grey from 0.4 m depth.							
	0.5	Bore discontinued at 0.5m (Target depth)		D	0.5				
47	1								1
	2								2
46	3								3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 110 mm diameter hand auger **DRILLER:** GG **LOGGED:** GG **CASING:** N/A

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 46.2 m AHD*
EASTING: 388736
NORTHING: 6490461
DIP/AZIMUTH: 90°/--

BORE No: 59
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
46	0	SAND SP: fine to medium grained, dark grey-brown, trace silt and rootlets, moist, loose. Bassendean Sand.							
	0.5	- becoming medium dense from 0.45 m depth.		D	0.5				
		Bore discontinued at 0.5m (Target depth)							
45	1								1
44	2								2
43	3								3

5 10 15 20

RIG: 110 mm diameter hand auger **DRILLER:** AA **LOGGED:** AA **CASING:** N/A

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 52.9 m AHD*
EASTING: 389343
NORTHING: 6490373
DIP/AZIMUTH: 90°/--

BORE No: 60
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
52	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist.							
		SAND SP: fine to medium grained, grey-brown, trace silt, moist, medium dense. Bassendean Sand.							
	1	- becoming yellow-brown from 0.3 m depth.							1
	1.5	Bore discontinued at 1.5m (Target depth)		D	1.5				
51	2								2
50	3								3

Dynamic Penetrometer Test (blows per 150mm) scale: 5, 10, 15, 20

RIG: 110 mm diameter hand auger **DRILLER:** AA **LOGGED:** AA **CASING:** N/A

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.7 m AHD*
EASTING: 389710
NORTHING: 6490373
DIP/AZIMUTH: 90°/--

BORE No: 61
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
48	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, trace rootlets, moist.							
		SAND SP: fine to medium grained, grey, trace silt, moist. Bassendean Sand.							
	0.5			D	0.5				
		Bore discontinued at 0.5m (Target depth)							
47	1								1
	2								2
46	3								3

RIG: 110 mm diameter hand auger **DRILLER:** GG **LOGGED:** GG **CASING:** N/A

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level derived from publicly available LiDAR 5 m.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix C

Laboratory Test Certificates

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - ASTM D2974-14 (Test Method C)

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7024
Client Address:	-	*Report No.*	WG22.12208-12215_1_ORG
Project:	Proposed Residential Development	*Sample No.*	WG22.12208-12215
Location:	Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA	*Date Sampled:*	Not Specified
Sample Identification:	Various - See below	*Date Tested:*	8/08/2022

TEST RESULTS - Organic Content

Sampling Method: Sampled by Client, Tested as Received

Testing Completed By: WGLS - JG

Furnace Temperature (°C): 440

Sample Number	Sample Identification	Ash Content (%)	Organic Content (%)
WG22.12208	TP 1A, 0.4 m	97.3	2.7
WG22.12209	TP 3, 0.1 m	94.1	5.9
WG22.12210	TP 6, 0.1 m	98.5	1.5
WG22.12211	TP 18, 0.1 m	97.3	2.7
WG22.12212	TP 21, 1.0 m	93.0	7.0
WG22.12213	TP 26, 0.45 m	98.5	1.5
WG22.12214	TP 27, 0.1 m	97.6	2.4
WG22.12215	TP 36, 0.1 m	98.7	1.3

Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 07/October/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

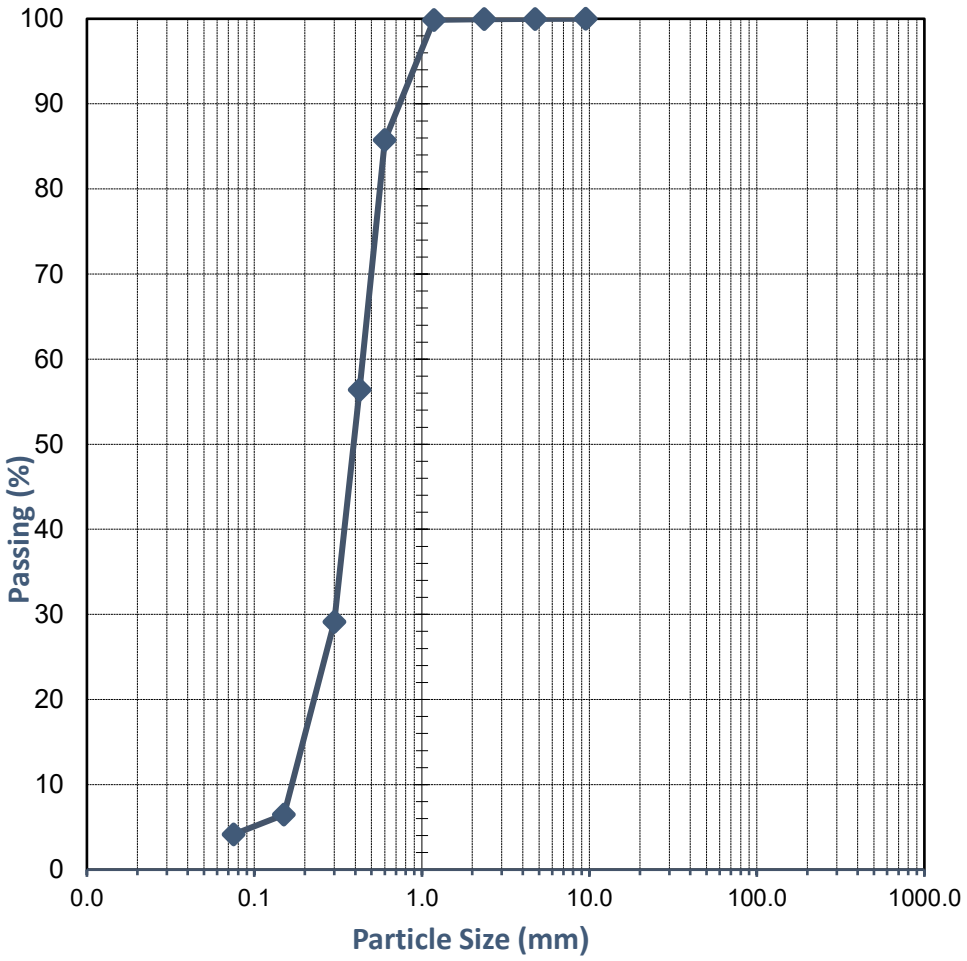
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7024
Client Address:	-	*Report No.*	WG22.12208_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12208
Location:	Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA	*Date Sampled:*	Not Specified
Sample Identification:	TP 1A, 0.4 m	*Date Tested:*	05/08 - 08/08/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	100
0.600	86
0.425	56
0.300	29
0.150	6
0.075	4



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 08/August/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

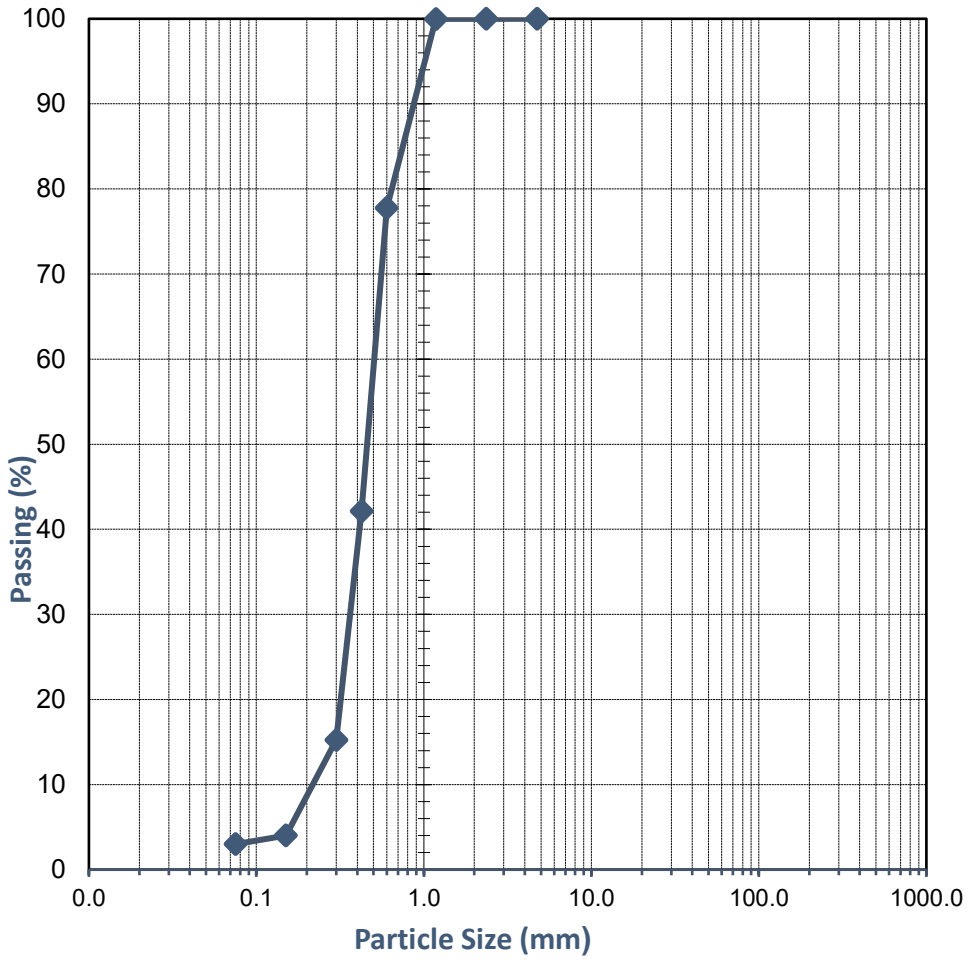
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7024
Client Address:	-	*Report No.*	WG22.12209_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12209
Location:	Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup,	*Date Sampled:*	Not Specified
Sample Identification:	TP 3, 0.1 m	*Date Tested:*	05/08 - 08/08/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	78
0.425	42
0.300	15
0.150	4
0.075	3



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 08/August/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

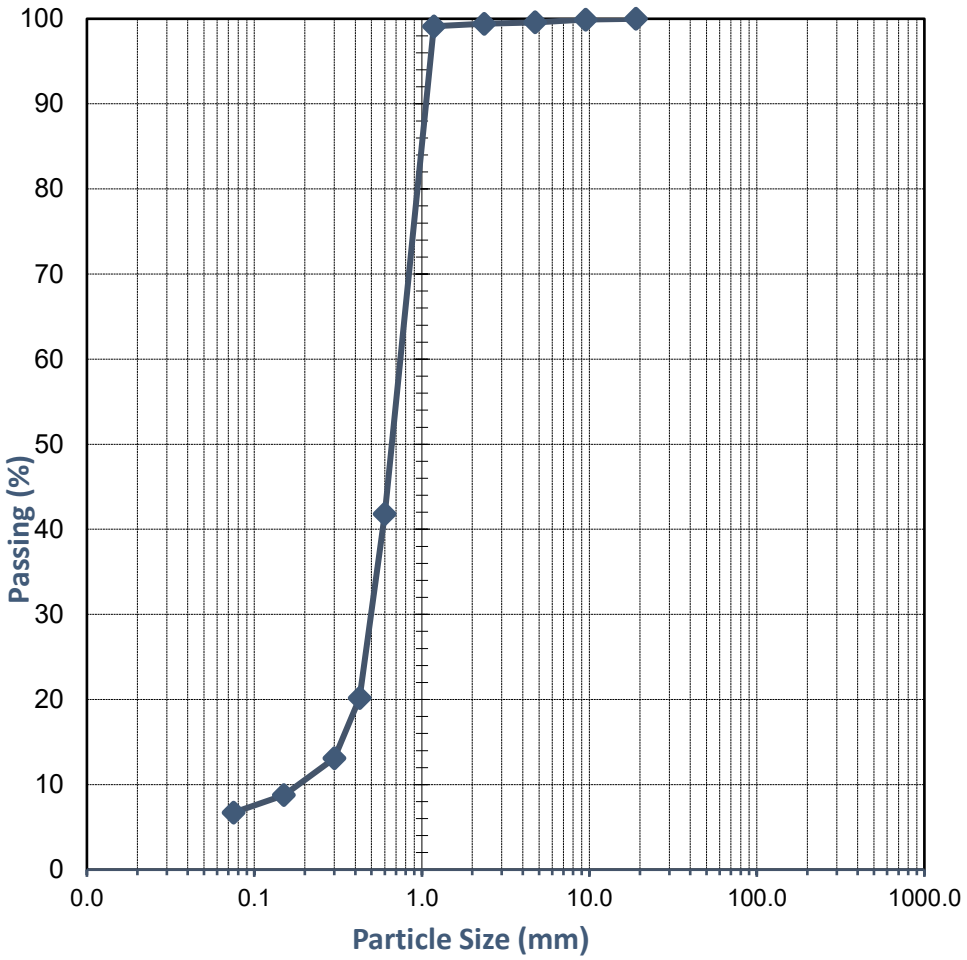
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7024
Client Address:	-	*Report No.*	WG22.12210_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12210
Location:	Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA	*Date Sampled:*	Not Specified
Sample Identification:	TP 6, 0.1 m	*Date Tested:*	05/08 - 08/08/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	100
9.5	100
4.75	100
2.36	99
1.18	99
0.600	42
0.425	20
0.300	13
0.150	9
0.075	7



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 08/August/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

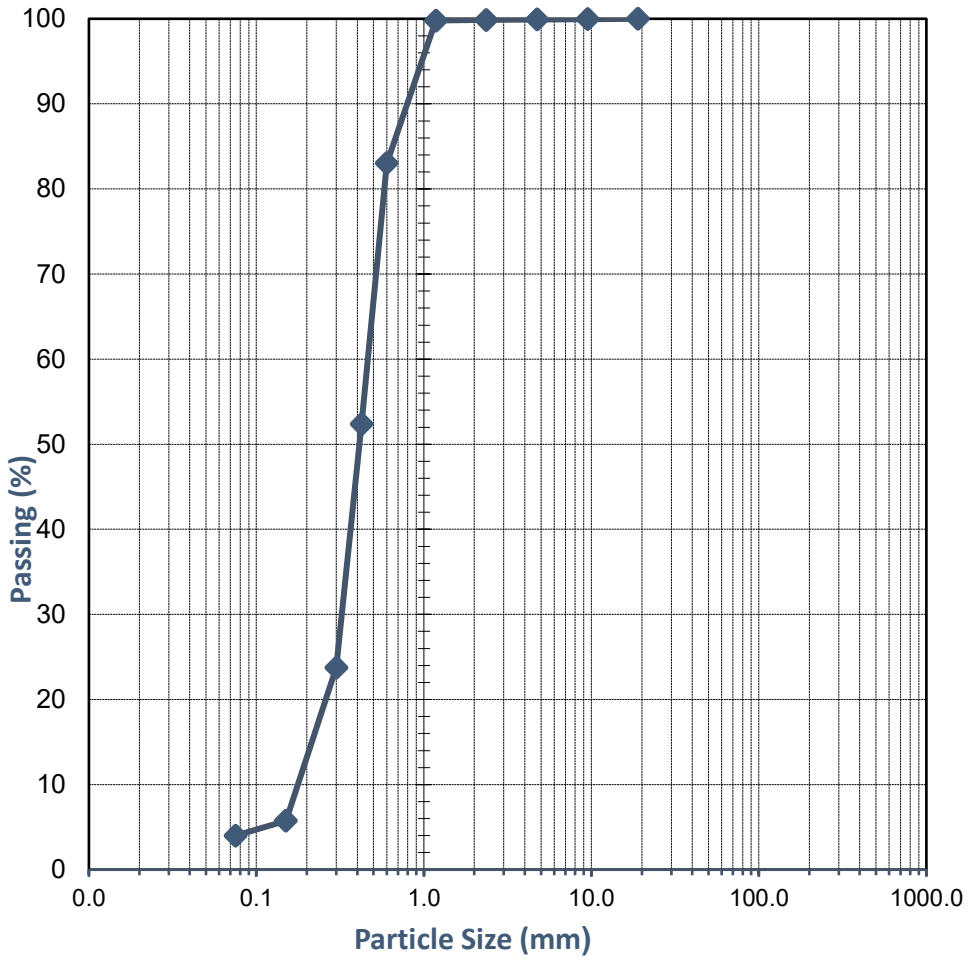
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7024
Client Address:	-	*Report No.*	WG22.12211_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12211
Location:	Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup,	*Date Sampled:*	Not Specified
Sample Identification:	TP 18, 0.1 m	*Date Tested:*	05/08 - 08/08/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	100
9.5	100
4.75	100
2.36	100
1.18	100
0.600	83
0.425	52
0.300	24
0.150	6
0.075	4



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 08/August/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

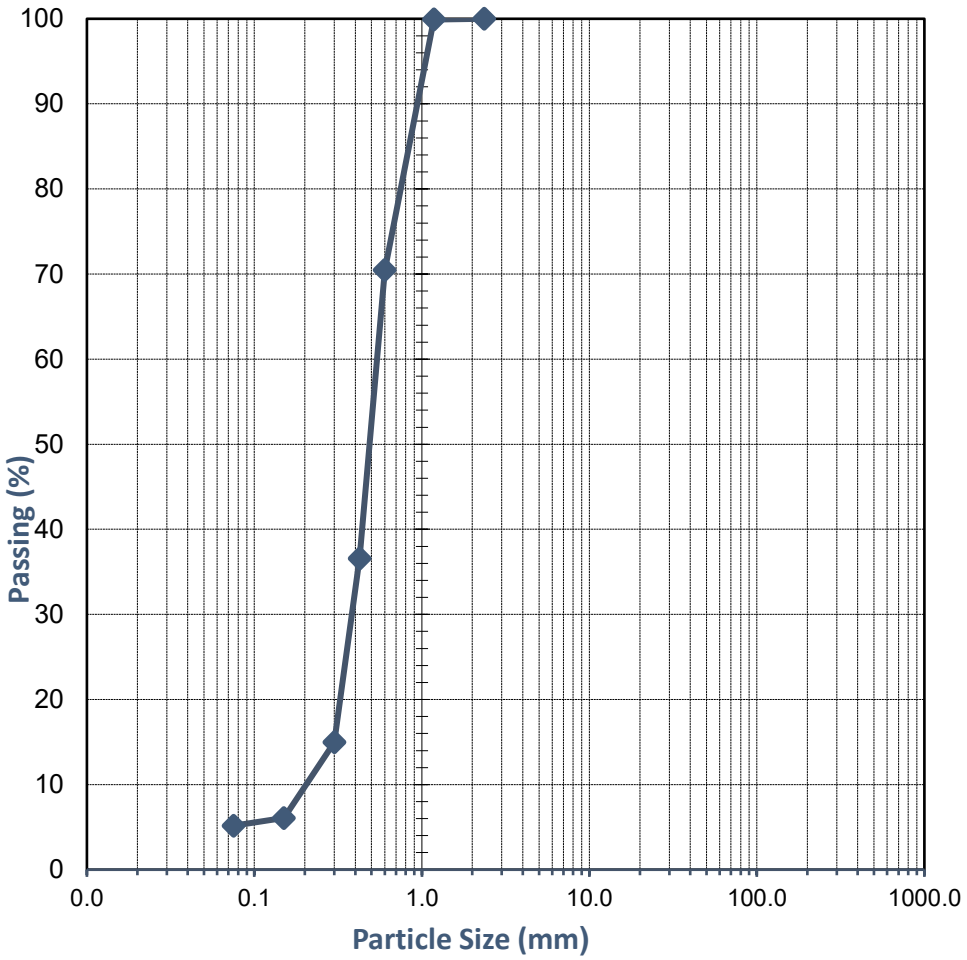
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7024
Client Address:	-	*Report No.*	WG22.12213_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12213
Location:	Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup,	*Date Sampled:*	Not Specified
Sample Identification:	TP 26, 0.45 m	*Date Tested:*	05/08 - 08/08/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	100
0.600	70
0.425	37
0.300	15
0.150	6
0.075	5



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 08/August/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

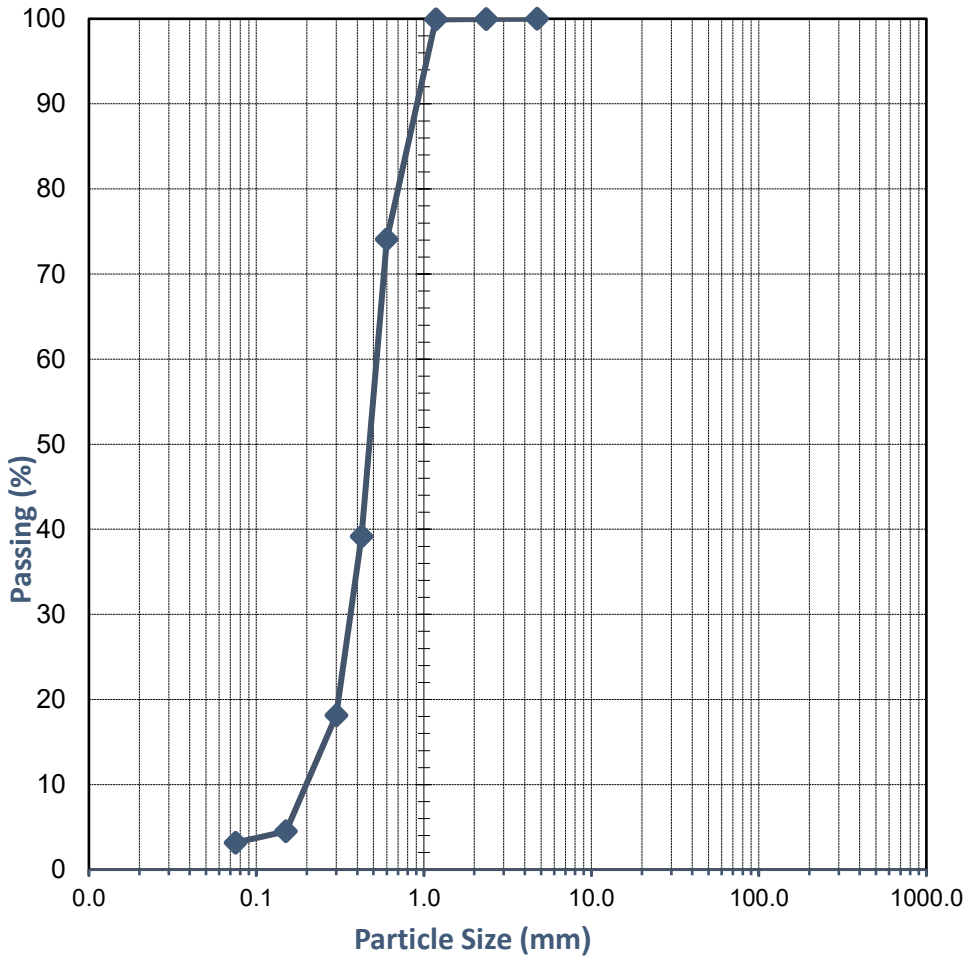
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7024
Client Address:	-	*Report No.*	WG22.12215_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12215
Location:	Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA	*Date Sampled:*	Not Specified
Sample Identification:	TP 36, 0.1 m	*Date Tested:*	05/08 - 08/08/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	74
0.425	39
0.300	18
0.150	5
0.075	3



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 08/August/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

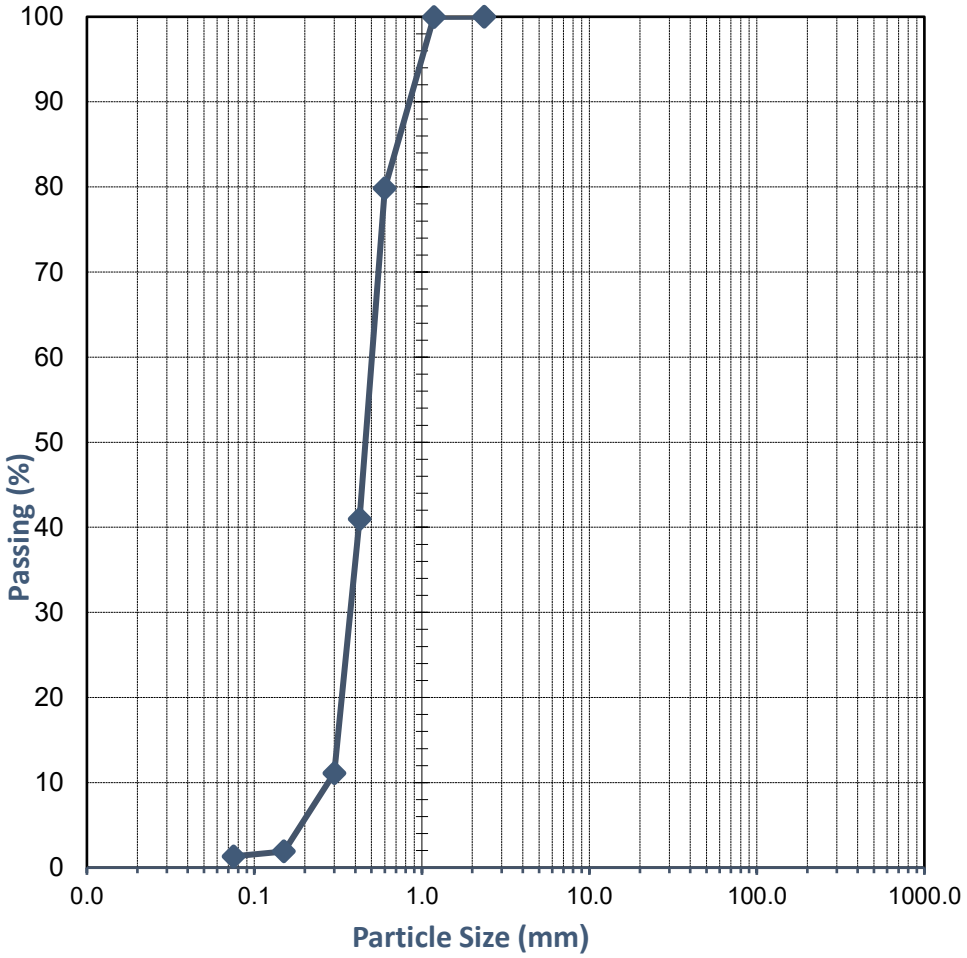
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7006
Client Address:	-	*Report No.*	WG22.12030_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12030
Location:	Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup,	*Date Sampled:*	Not Specified
Sample Identification:	Perm 55, 0.5 m	*Date Tested:*	3/8 - 4/8/22

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	100
0.600	80
0.425	41
0.300	11
0.150	2
0.075	1



Comments:

Approved Signatory: C Budimir

Name: Connor Budimir

Date: 04/August/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

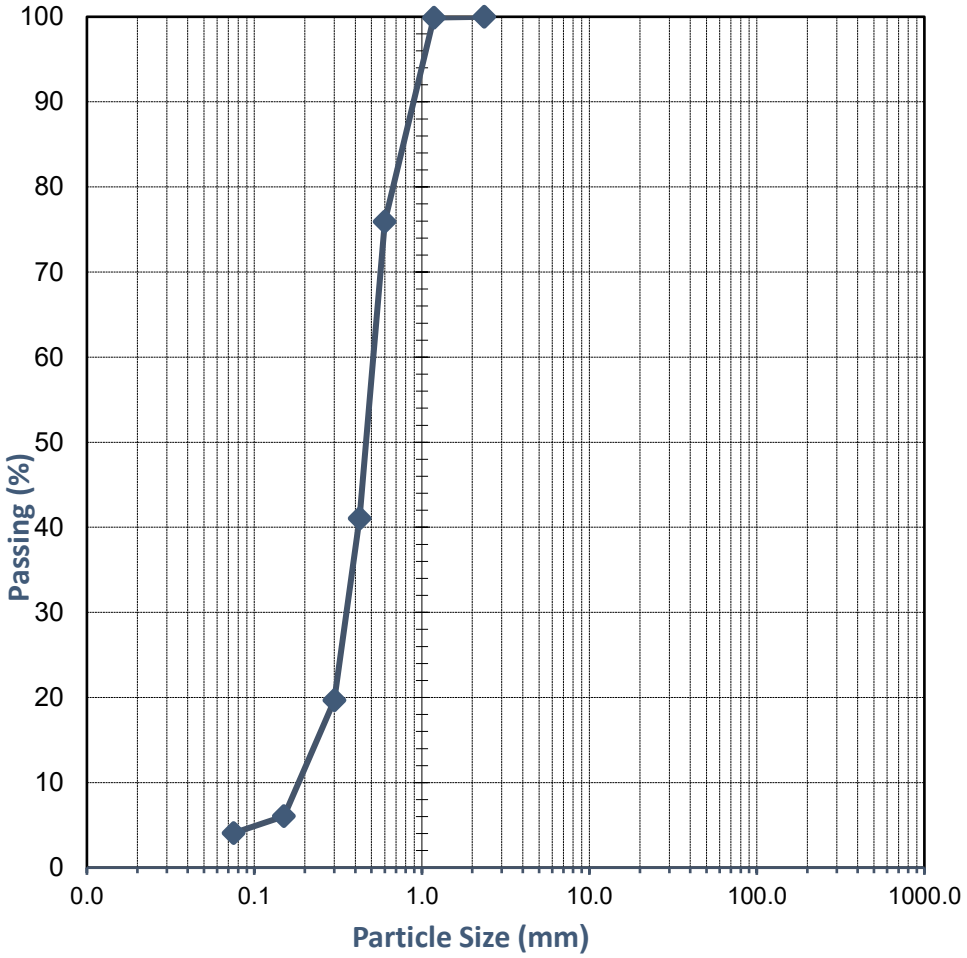
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7006
Client Address:	-	*Report No.*	WG22.12031_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12031
Location:	Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup,	*Date Sampled:*	Not Specified
Sample Identification:	Perm 56, 0.5 m	*Date Tested:*	3/8 - 4/8/22

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	100
0.600	76
0.425	41
0.300	20
0.150	6
0.075	4



Comments:

Approved Signatory:

Name: Connor Budimir

Date: 04/August/2022

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

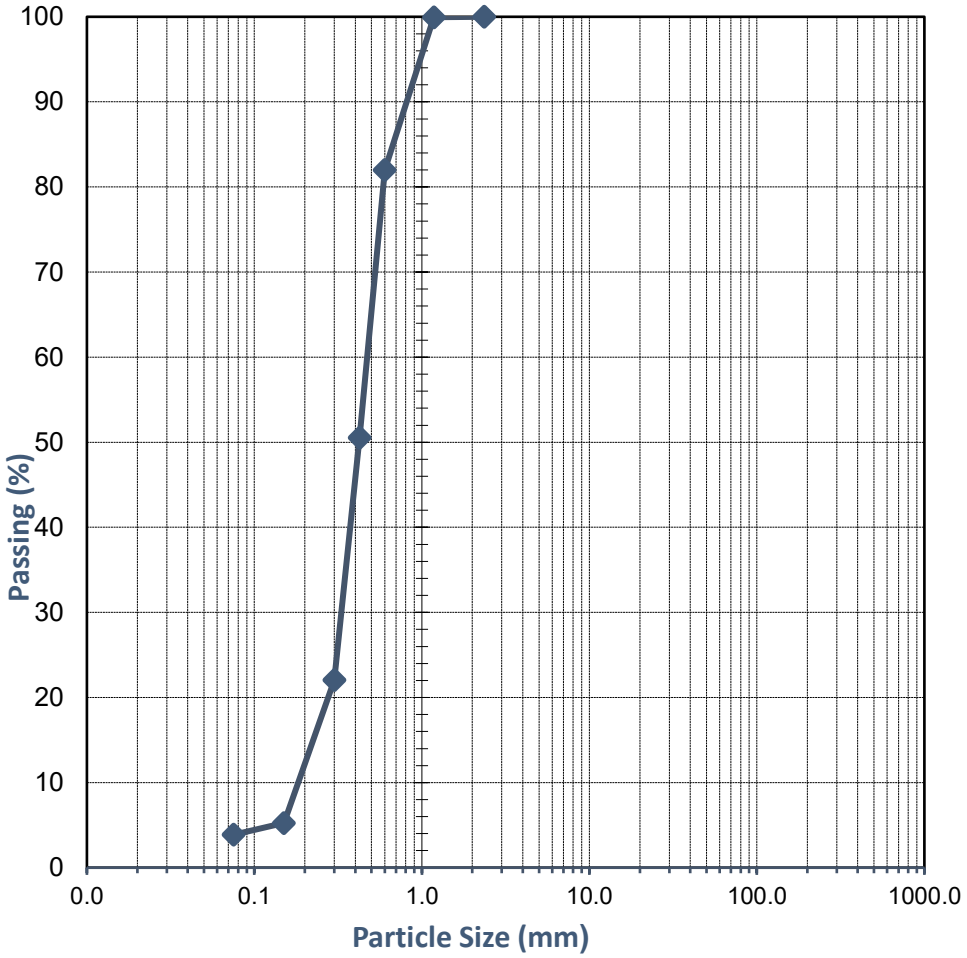
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7006
Client Address:	-	*Report No.*	WG22.12032_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12032
Location:	Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup,	*Date Sampled:*	Not Specified
Sample Identification:	Perm 57, 0.5 m	*Date Tested:*	3/8 - 4/8/22

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	100
0.600	82
0.425	51
0.300	22
0.150	5
0.075	4



Comments:

Approved Signatory:

Name: Connor Budimir

Date: 04/August/2022

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

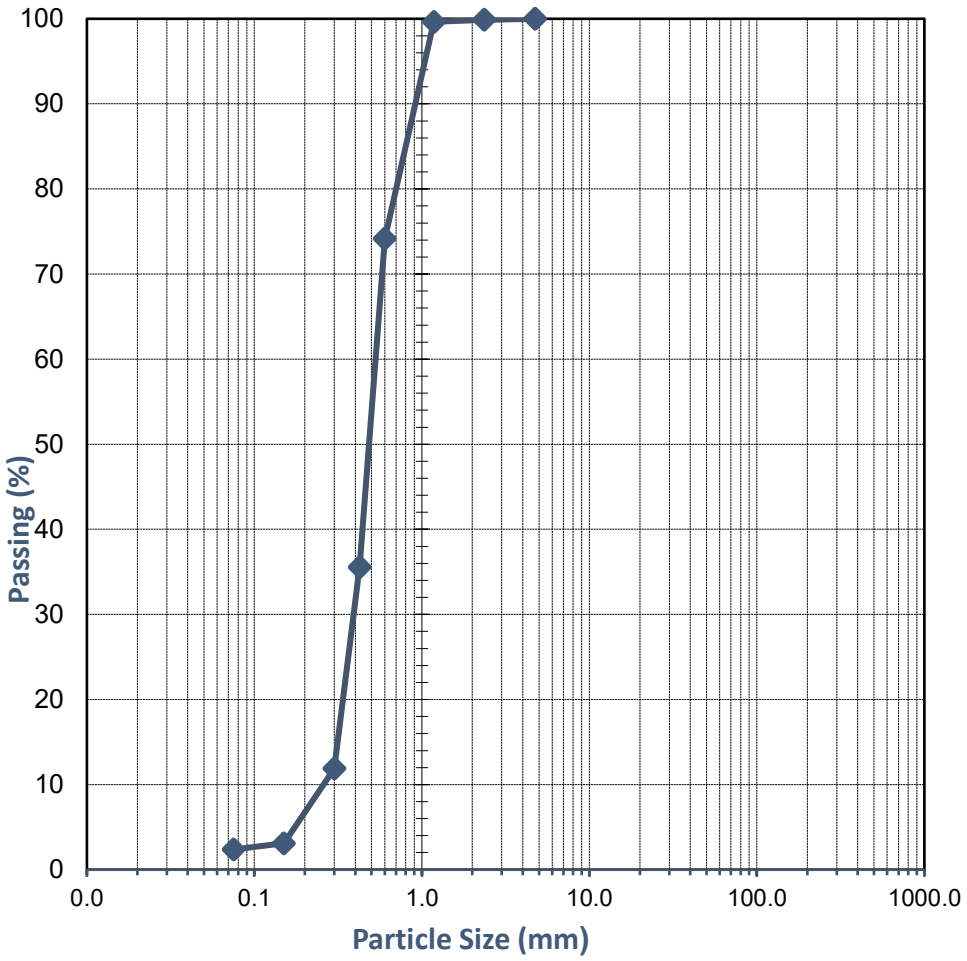
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7006
Client Address:	-	*Report No.*	WG22.12033_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12033
Location:	Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA	*Date Sampled:*	Not Specified
Sample Identification:	Perm 59, 0.5 m	*Date Tested:*	04/08 - 05/08/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	74
0.425	36
0.300	12
0.150	3
0.075	2



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 05/August/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Preliminary Geotechnical Investigation

Proposed Residential Development
Stage 2 - Rousset Road, Mariginiup, WA

Prepared for
Stockland Development Pty Ltd

Project 212040.00
October 2022

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	212040.00	Document No.	R.002.Rev0
Document title	Report on Preliminary Geotechnical Investigation Proposed Residential Development		
Site address	Stage 2 - Rousset Road, Mariginiup, WA		
Report prepared for	Stockland Development Pty Ltd		
File name	212040.00.R.002.Rev0.DP Report - Stage 2 - Rousset Road, Mariginiup, WA.docx		

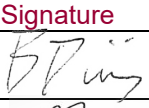
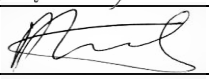
Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Brendan Divilly	Dan Reaveley & Frederic Verheyde	26 October 2022

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	-	Mr Mathew Johns, Stockland Development Pty Ltd
	1	-	Mr Brad Marshall, Cossill & Webley

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		26 October 2022
Reviewer		26 October 2022

bsi ISO 9001 Quality Management Systems CERTIFIED
FS 604853

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
36 O'Malley Street
Osborne Park WA 6017
Phone (08) 9204 3511

Table of Contents

Douglas Partners
Geotechnics | Environment | Groundwater

Appendix B: Drawings

Test Pit Logs

Borehole Logs

Appendix C: Laboratory Test Certificates

Report on Preliminary Geotechnical Investigation
Proposed Residential Development
Stage 2 - Rousset Road, Mariginiup, WA

1. Introduction

This report presents the results of a preliminary geotechnical investigation undertaken for the proposed Stage 2 residential development on Rousset Road in Mariginiup, WA. The investigation was commissioned in an email dated 16 June 2022 by Mr Mathew Johns of Stockland Development Pty Ltd and was undertaken in accordance with Douglas Partners' proposal P212040.00.P.001.Rev1 dated 5 May 2022.

It is understood that the proposed development will comprise a residential subdivision, including lots, pavement, services and public open space.

The aim of the investigation was to assess the subsurface soil and groundwater conditions across the site at limited test locations in order to provide preliminary comments on:

- The suitability of the site for urban development, from a geotechnical standpoint.
- Uncontrolled fill, rock, peaty soils and depth of topsoil, where encountered at the test locations.
- Excavation conditions and depths of available sand for re-use, where encountered.
- The suitability of site soils as fill, including advice regarding the preparation, placement and compaction of topsoil and sand, including the suitability of the use of topsoil by blending with clean sand for use as structural fill.
- Site preparation, compaction, remediation and earthworks to allow for urban development.
- A preliminary site classification in accordance with AS 2870-2011.
- Geotechnical design parameters for retaining wall design and foundation design, including soil friction angle and allowable bearing capacity.
- Suitable design parameters for pavements, including a suitable California bearing ratio (CBR) for the subgrade encountered at the site and provide comments on road construction.
- The permeability of shallow soils and the suitability of the site to accept on-site stormwater disposal.
- The groundwater level and perched water table levels beneath the site at the time of the field work, if encountered.
- Recommendations for further geotechnical investigation.

The investigation included the excavation of 18 test pits, four in situ infiltration tests and laboratory testing of selected samples. The details of the field work are presented in this report, together with comments and recommendations on the items listed above.

2. Site Description

The site comprises an area of approximately 126 ha in size and is identified as Lot 2 and Part Lot 3335 Rousset Road, and Lot 7542 McCaffrey Road, in Mariginiup, WA. It is bordered by Rousset Road to the west, Boundary Road to the east, rural residential properties and undeveloped land to the south, and similar undeveloped land to the north (Refer to Drawing 1, Appendix B).

At the time of the field work, the site was generally vacant and was covered in sparse bushland and cleared areas. Vegetation generally comprised medium to large sized trees, shrubs and short grass.

Based on publicly available LiDAR data, the ground surface level across the site varies between approximately RL 47 m AHD and RL 57 m AHD.

The Muchea 1:50,000 Environmental Geology sheet (shown on Drawing 1) indicates that shallow sub surface conditions across the majority of the northern half of the site comprise Bassendean Sand overlying clayey deposits of the Guildford Formation (shown on the drawing as S10). The majority of the southern half of the site consists of Bassendean Sand (S8). The central area of the site is also mapped as comprising a water body, surrounded by peaty clay associated with swamp deposits (Cps). Other small areas of peaty clay associated with swamp deposits are indicated to occur in isolated parts of the site.

The Perth Groundwater Atlas indicates that the groundwater level ranged between approximate levels of RL 45.5 m AHD and RL 47.5 m AHD in May 2003, approximately 2 m to 11 m below existing surface levels.

Published acid sulfate soil risk mapping indicates the majority of the site is located in an area mapped as “moderate to low risk of acid sulfate soils occurring within 3 m of natural soil surface”. The remaining portions of the site are mapped as “high to moderate risk of acid sulfate soils occurring within 3 m of natural soil surface”. These areas mapped as “high to moderate” risk are associated with the water bodies and peaty clay swamp deposits as depicted by the published geological mapping.

3. Field Work Methods

Field work for the investigation was carried out on 6 and 7 July 2022 and comprised:

- The excavation of 18 test pits (Locations 101 to 118).
- Perth sand penetrometer (PSP) testing adjacent to each test pit location.
- Four in situ infiltration tests (Locations 123 to 126).

The test pits were excavated to a maximum depth of 3 m using an 8-tonne backhoe, equipped with a 450 mm wide toothed bucket. PSP tests were carried out at the test pit locations in accordance with AS 1289.6.3.3 to assess the in-situ density of the shallow soils.

Each test pit was logged in accordance with AS 1726–2017 by a geotechnical engineer. Soil samples were recovered from selected locations for subsequent laboratory testing.

The infiltration tests were performed using the falling head method at a depth of 1 m at locations 123 to 126.

Test locations were determined using a handheld GPS and are marked on Drawing 2. Approximate ground surface levels at the test locations have been derived from publicly available LiDAR data (DEM derived from 5 m grid).

4. Field Work Results

4.1 Ground Conditions

Logs of the ground conditions and results of the field testing are presented in Appendix B, together with notes defining descriptive terms and classification methods, in Appendix A.

Ground conditions across the site generally comprised:

- **Topsoil (SAND SP and SP-SM)** – dark grey-brown sandy and organic sandy topsoil, trace silt to with silt, between 0.05 m and 0.2 m thick at all test locations.
- **SAND (SP and SP-SM)** – fine to medium grained, dark grey-brown, grey, brown and yellow-brown sand, trace silt to with silt underlying the topsoil to termination depths of between 1 m and 3 m at the test locations. The sand was generally in a loose condition, becoming medium dense at depth. The depth and level of the base of the loose soils encountered at the test locations are shown in Table 1.
- **Localised Cemented Soils (SAND SP and Cemented Silty SAND SM) -** dark brown, pale brown and orange-brown weakly cemented sand and silty sand ('coffee rock'), from depths between 1.0 m and 2.2 m extending to termination depths between 1.7 m and 3 m at locations 102, 111 and 115.
- **Localised Organic Soils (PEATY SAND and ORGANIC SAND SP-SM) –** dark grey-brown peaty sand and brown organic sand with silt, to a depth of 0.4 m and 1.35 m respectively at location 107.

Table 1: Summary of Depth and Level of Base of Loose Soils

Test Location	Ground Surface Level [1] (m AHD)	Depth of Loose Soil (m)	Level of Base of Loose Soil [2] (m AHD)
101	51.3	1.05	50.2
102	52.5	1.05	51.4
103	49.8	0.9	48.9
108	49.3	0.9	48.4
109	49.6	1.1	48.5
112	50.8	0.9	49.9
113	55.9	0.9	55.0
114	51.8	1.15	50.6
117	52.7	0.9	51.8
118	49.3	0.9	48.4

Test Location	Ground Surface Level [1] (m AHD)	Depth of Loose Soil (m)	Level of Base of Loose Soil [2] (m AHD)
125	50.5	0.75	49.8
126	51.4	deeper than 1.0 m	less than 50.3

Notes for Table 1: [1]: Approximate surface level derived from LiDAR data.
[2]: Level of Base of Loose Soils = Estimated Surface Level – Depth of Loose Soils. Levels should be considered as approximate.

4.2 Groundwater

Groundwater was observed at a depth of 2.3 m (RL 45.4 m AHD) at test location 116 on 7 July 2022. Groundwater was not encountered within testing depth at the other test pits. The test pits were immediately backfilled following sampling, which precluded longer-term monitoring of groundwater levels.

It should be noted that groundwater levels are affected by climatic conditions and land usage and will therefore vary with time.

4.3 Permeability

Four in-situ permeability tests using the falling head method were carried out at depths of 1.0 m at locations 123 to 126. An estimated permeability value has been derived from the in situ test data using a formula based on a calculation by Hvorslev (1951). Results of the permeability analysis are summarised in Table 2.

Table 2: Summary of Permeability Analysis

Test Location	Depth (m)	Measured Permeability (m/day) [1]	In situ Ground Conditions at Testing Depth
123	1.0	>20	SAND SP, trace silt, medium dense
124	1.0	>20	SAND SP, trace silt, medium dense
125	1.0	12	SAND SP, trace silt, medium dense
126	1.0	>20	SAND SP, trace silt, loose

5. Laboratory Testing

A geotechnical laboratory testing programme was carried out by a NATA registered laboratory and comprised the determination of

- the particle size distribution of four samples; and
- the organic content of six samples.

The test report sheet is given in Appendix C and the results are summarised in Table 3.

Table 3: Results of Laboratory Testing for Soil Identification

Test Location	Depth (m)	Fines (%)	Sand (%)	Gravel (%)	Organic Content (%)	Material
106	0.4	6	94	0	1.3	SAND SP-SM, with silt
107	0.3	27	63	0	25.7	PEATY Silty SAND SM
107	1.0	9	91	0	4.0	ORGANIC SAND SP-SM, with silt
111	0.1	5	95	0	6.6	TOPSOIL / ORGANIC SAND SP, trace silt
111	2.8	-	-	-	0.8	SAND SP-SM, with silt
117	0.1	-	-	-	3.9	TOPSOIL / ORGANIC SAND SP, trace silt

Where:
Fines = Particles finer than 75 µm.
Sand = Particles between 2.36 mm and 75 µm.
Gravel = Particles larger than 2.36 mm.

6. Proposed Development

It is understood that the proposed development will consist of a residential subdivision, with associated lots, services, pavements, and public open space. Earthworks across the site are anticipated to comprise large cut to fill operations. Proposed development plans were not available at the time of writing.

7. Comments

7.1 Site Suitability

The investigation indicates that the site is generally underlain by topsoil and sand as described in Section 4.1 above. In addition to the above, the testing across the site encountered some surficial loose sandy soils and an isolated area of peaty and organic sand (location 107). The layer of organic material is likely to require further assessment and delineation.

The encountered loose sand and buried organic soils are geotechnical constraints that will require consideration in the earthworks strategy for the site.

However, it is considered that following suitable site preparation, the site is generally suitable for the proposed residential development. Suitable site preparation should include removal or blending of the surficial topsoil, removal of any peaty soils and organic sand and suitable compaction of the loose soils across the site.

Based on this preliminary assessment, from a geotechnical standpoint, the land is considered to be physically capable of development, provided that the provisions outlined in the subsequent subsections of the report are incorporated in the development plans.

7.2 Site Classification

The shallow ground conditions beneath the site generally comprise loose sand, becoming medium dense with depth.

Based on the results of the investigation and in accordance with AS 2870-2011, a site classification 'Class P' applies to the site, owing to the presence of loose sand and areas of organic soils. It is considered that following suitable site preparation, the site could be re-classified as 'Class A'. Suitable site preparation includes in particular stripping or blending of the surficial topsoil, removal of any organic soils (eg location 107) and suitable compaction of all loose soils encountered in the upper zone of the soil profile across the majority of the site.

7.3 Excavation Conditions

The encountered ground conditions generally comprise sand. Conventional earthmoving equipment (such as large excavators and scrapers) should be generally suitable for excavations across the site within the encountered granular soils.

The weakly cemented sand encountered at locations 102, 111 and 115 could generally be excavated using an 8-tonne backhoe. Some provision for larger excavators would be prudent to excavate cemented materials, with associated possible low excavation rates.

7.4 Geotechnical Suitability for Re-Use of In Situ Materials

7.4.1 Re-Use of Natural Sand

The encountered shallow natural sand with trace fines, classified 'SP' in the logs in Appendix B, is considered geotechnically suitable for reuse as structural fill material provided it is free from organic matter and particles greater than 150 mm in size.

Isolated areas of the site which include sand with fines (classified as SP-SM), generally underlying the topsoil, would also be considered suitable for re-use as fill, however, with possibly a lower permeability than typically specified in general earthworks specifications (5 m/day). Therefore, if reusing the sand with fines is further considered, a detailed assessment of the permeability of these soils is recommended to assess any impact on its reuse with regards to drainage characteristics.

7.4.2 Topsoil

Topsoil was encountered across the site to depths of between 0.05 m and 0.2 m.

Based on the results of the investigation, the topsoil encountered across the site is generally considered suitable for reuse as part of a topsoil and clean sand blend, for use as a structural filling material, provided that the topsoil is suitably prepared, and the controls outlined below are adopted. A preliminary blending ratio of 3:1 (clean sand:topsoil) is suggested, based on observations made during the site investigation and the laboratory results regarding organic content.

It is suggested that any large roots or other oversized organics are first removed or screened from the topsoil/organic sand, prior to blending. Stripping the topsoil and passing through a mechanical screening plant is suggested.

Following screening, topsoil should be sufficiently mixed and blended with clean sand so that it forms a generally homogenous material. The use of earthwork plant to suitably turn over the two materials to form a blended material is recommended. The blending process should be assessed by a geotechnical engineer.

The blending of topsoil with clean sand will likely decrease the permeability of the sand, therefore some consideration should be given to possible adverse implication on site drainage, if blended topsoil material is used as fill material across the site. Consideration could be given to further assess the permeability of blended topsoil material at various blending ratios, to assess a suitable blending ratio and associated filling permeability. Douglas Partners would be pleased to further assist with this assessment if required.

7.5 Site Preparation

7.5.1 Site Stripping

All deleterious material, including vegetation and topsoil (if not blended,) should be stripped from the proposed development areas of the site.

Any tree roots remaining from clearing operations within the proposed development area should be completely removed to a depth of 0.6 m, and the excavation backfilled with material of similar geotechnical properties to the surrounding ground and suitably compacted.

Further assessment of the peaty and organic sand at location 107 is suggested to determine the extent of this unsuitable material. The occurrence of similar material elsewhere beneath the site cannot be precluded at this stage and therefore further geotechnical field assessment at a relatively high testing frequency during detailed design of the proposed development should be considered to assess the occurrence of otherwise of such material across the proposed development area.

7.5.2 Proof Rolling and Compaction

Following the site stripping (Section 7.5.1), and excavation to formation level (in areas of cut) it is recommended that the exposed ground be proof rolled with a heavy smooth drum roller (say minimum 15 tonnes deadweight) in vibrating mode.

Any areas that show signs of excessive deformation during compaction should be compacted until deformation ceases or, alternatively, the poor-quality material should be excavated and replaced with suitable structural fill and compacted.

Owing to the depth of loose sand across the site, it is suggested that significant compactive effort using heavy vibrating rollers (say 15 tonne minimum) is applied to the subgrade following stripping.

Following proof rolling to confirm suitable foundation material, the site should be tested using a Perth Sand Penetrometer (PSP) to a depth of 1 m below formation level, or shallower refusal, by a suitably experienced geotechnical engineer.

Compaction control of sand could be carried out using a PSP test in accordance with test method AS 1289.6.3.3. All areas within proposed building envelopes and pavement areas should be compacted to achieve a minimum blow count of 8 blows per 300 mm penetration to a depth of not less than 1.0 m below foundation level.

7.5.3 Imported Fill

If required, imported fill should comprise free draining, cohesionless, well graded sand that:

- contains less than 5% by weight of particles less than 75 microns in size;
- contains no particles greater than 150 mm in size; and
- is free of organic and other deleterious materials.

It is recommended that test certificates are reviewed and approved by the geotechnical engineer prior to importing material to site.

Other materials could be considered, provided they are granular and non-reactive, and following review by a geotechnical engineer.

7.5.4 Fill Placement

Any fill should be placed in layers not exceeding 300 mm loose thickness and compacted near optimum moisture content with a roller of say 15 tonne deadweight.

7.5.5 Compaction Testing

Sand fill should be compacted to 95% relative to modified maximum dry density (MMDD). Compaction control of the sand fill could be carried out using a Perth sand penetrometer (PSP) test in accordance with test method AS 1289.6.3.3. All areas within the proposed building and pavement envelopes should be compacted to achieve a minimum blow count of 8 blows per 300 mm penetration to a depth of not less than 1.0 m below foundation or subgrade level, or a correlation between MMDD and PSP blow counts should be established to determine the compaction target.

The top 300 mm in the base of any excavation should be re-compacted using a vibratory plate compactor prior to construction of any footings. Inspection of footing excavations by a geotechnical engineer is also recommended.

7.6 Foundation Design

Shallow foundation systems comprising slab, pad and strip footings should be suitable to support typical one and two storey residential buildings.

Footings of buildings covered by AS 2870-2011 should be designed to satisfy the requirements of this standard for the site classification discussed in Section 7.2, provided that site preparation is carried out in accordance with Section 7.5.

If a proposed building is not covered by AS 2870-2011 then the foundation should be designed using engineering principles. Following suitable site preparation and densification of the loose sand across the site, a preliminary allowable bearing pressure of 200 kPa is considered suitable for pad footings up to 3 m in width, or strip footings up to 1.5 m wide, founded at a minimum depth of 0.5 m in sandy soils that are at least medium dense. This should ensure that total and differential settlements are less than 20 mm. It is recommended that suitable allowable bearing pressures for building not covered by AS2870 be further assessed once details of these structures are known.

The majority of the settlement indicated above is anticipated to occur as loads are applied during construction. Further long-term settlements are likely to be less than half of the settlement estimated above.

The base of any foundation excavation should be compacted and assessed by a geotechnical engineer.

7.7 Design Parameters for Excavations and Retaining Systems

7.7.1 Safe Batter Slopes

It is recommended that batter slopes not steeper than 1.5H:1V (horizontal : vertical) be adopted for temporary excavations not deeper than 3 m in sand material above groundwater. For deeper excavations (above groundwater), average batter slopes not steeper than 2H:1V should be adopted, with horizontal benches at least 1 m wide at 3 m height intervals. These recommended batter angles should be re-assessed if loads are to be applied near the top of the batter or if there is a possibility of substantial overland water flow. Permanent batter slopes should not be steeper than 2H:1V.

The above safe batter slope angles are not suitable below groundwater, under which case dewatering or the use of positive excavation supports (next section) should be considered.

7.7.2 Retaining Structures

The design of flexible or rigid walls should be undertaken using a triangular pressure distribution and the earth pressure parameters given in Table 4. In addition to the soil pressure, wall design should also allow for external loads such as buildings, live loads, hydrostatic pressure or construction activities.

Table 4: Soil Parameters for Retaining Wall Design

Soil Type	Soil Unit Weight Above Water Table γ (kN/m^3)	Drained Angle of Friction Φ' (Degrees)	Undrained Shear Strength C_U (kPa)	Coefficient of Earth Pressure – Active K_a	Coefficient of Earth Pressure – at Rest K_0	Coefficient of Earth Pressure – Passive K_p
Sand - loose	18	28	0	0.36	0.53	2.7
Sand – medium dense	20	32	0	0.31	0.47	3.2

7.8 Pavement Design Parameters

As noted in Section 4.1, the shallow soils across the site generally comprise sand. Based on field observations and Douglas Partners' experience, a preliminary subgrade CBR of 12% is recommended for the design of flexible pavements founded on sand subgrade, provided that such subgrade is compacted to achieve a dry density ratio of not less than 95% relative to modified compaction.

7.9 Stormwater Drainage and Permeability

The results of the permeability testing in Section 4.3 indicate a field permeability value of between 12 m/day and greater than 20 m/day for the shallow sand across the site.

Observed ground conditions and permeability results indicate that on-site stormwater disposal using soakwells and sumps is generally feasible into the encountered sand that includes some trace of fines (classified 'SP' on the logs in Appendix B) where ground conditions at the base of such systems comprise sand and there is sufficient clearance above groundwater and any impervious layers such as cemented sand. A minimum clearance of 0.5 m is suggested between the base of drainage systems and groundwater, organic sand or cemented sand.

The infiltration capability of sand often reduces over time due to silt build up at the base of soakwells and sumps, and therefore such systems should be regularly maintained.

7.10 Further Investigation

It is suggested that further investigation by way of test pits is undertaken in particular in the vicinity of location 107 to determine the extent of the buried organic soils and to further characterise the material properties. Further test pitting across the site, at a higher frequency than currently undertaken, is also recommended in order to assess whether similar unsuitable material occurs elsewhere beneath the site, as previously discussed in Section 7.5.1.

Cone penetration testing is also suggested across the site, particularly in proposed areas of deep cut.

8. References

AS 1289.6.3.3. (1997). *Methods for testing soils for engineering purposes - Soil strength and consolidation tests - Determination of the penetration resistance of a soil - Perth sand penetrometer test.* Reconfimed 2013: Standards Australia.

AS 1726. (2017). *Geotechnical Site Investigations.* Standards Australia.

AS 2870. (2011). *Residential Slabs and Footings.* Standards Australia.

Department of Environment. (2004). *Perth Groundwater Atlas, Second Edition, Dec 2004.*

Hvorslev, M. J. (1951). *Time lag and soil permeability in groundwater observations.* US Army Corps of Engineers Waterways Experiment Observation Station, Bulletin 36, Vicksburg, Mississippi.

9. Limitations

Douglas Partners (DP) has prepared this report for this project at Lot 2 and Part Lot 3335 Rousset Road and Lot 7542 McCaffrey Road in Mariginiup, WA in accordance with DP's proposal dated 5 May 2022 and acceptance received from Mr Mathew Johns dated 16 June 2022. The work was carried out under an Agreement dated 10 August 2022. This report is provided for the exclusive use of Stockland Development Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions

across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope of work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of fill of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such fill may contain contaminants and hazardous building materials.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) — Non-cohesive and free-running.
- Moist (M) — Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) — Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

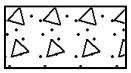
Symbols & Abbreviations

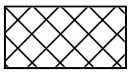
Graphic Symbols for Soil and Rock

General

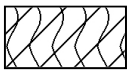

Asphalt

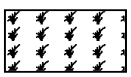

Road base

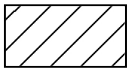

Concrete

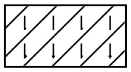

Filling

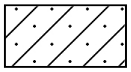
Soils


Topsoil

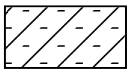

Peat

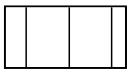

Clay

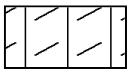

Silty clay

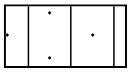

Sandy clay

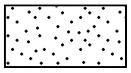

Gravelly clay

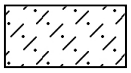

Shaly clay

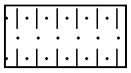

Silt


Clayey silt


Sandy silt


Sand

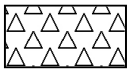

Clayey sand


Silty sand


Gravel

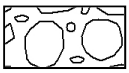

Sandy gravel


Cobbles, boulders

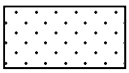

Talus

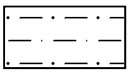
Sedimentary Rocks

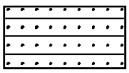

Boulder conglomerate

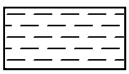

Conglomerate


Conglomeratic sandstone

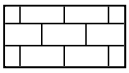

Sandstone


Siltstone

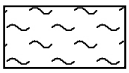

Laminite

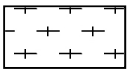

Mudstone, claystone, shale

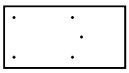

Coal


Limestone

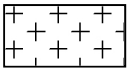
Metamorphic Rocks

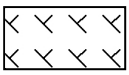

Slate, phyllite, schist

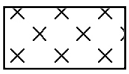

Gneiss

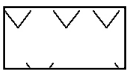

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite

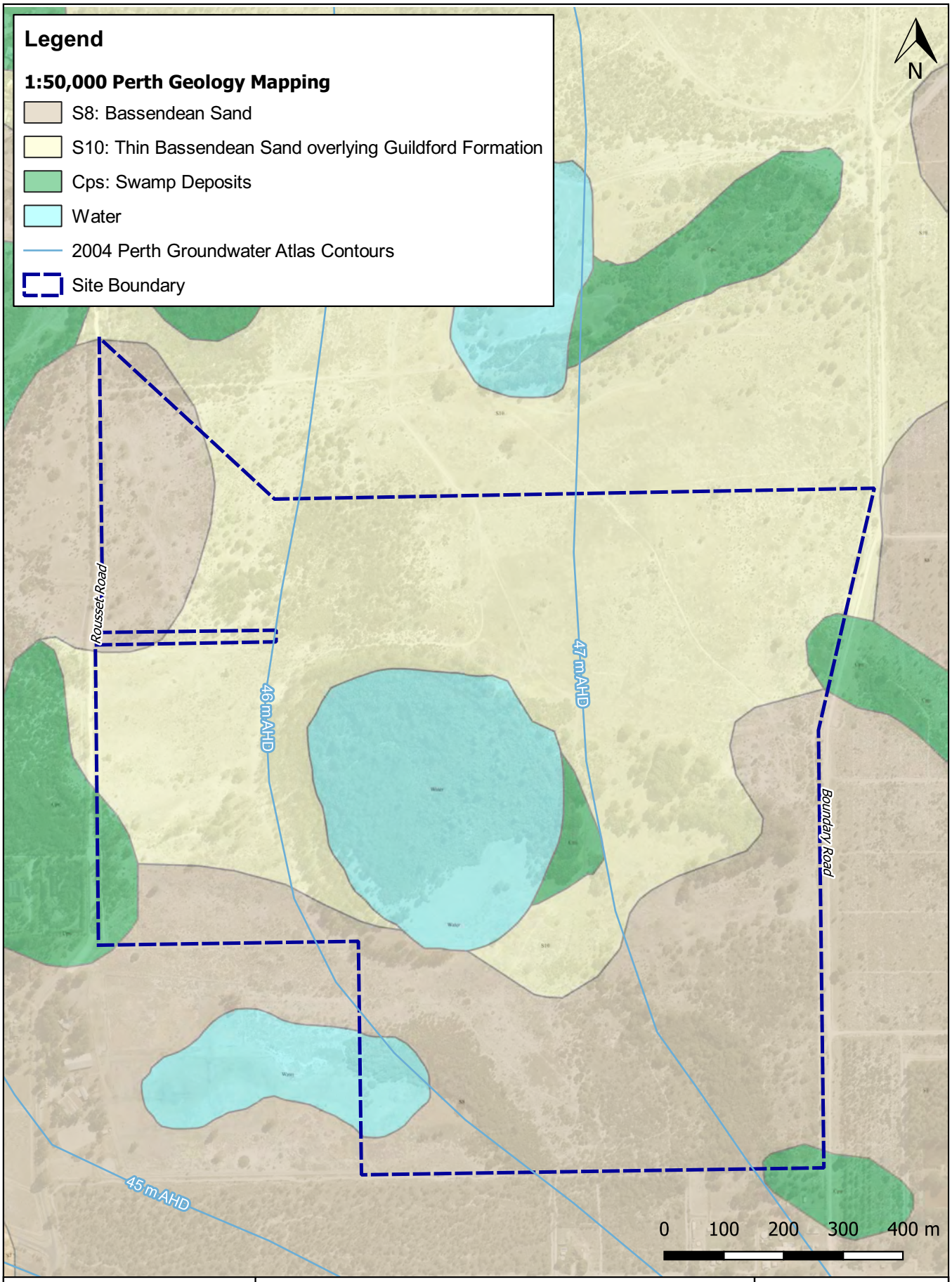

Dacite, epidote


Tuff, breccia

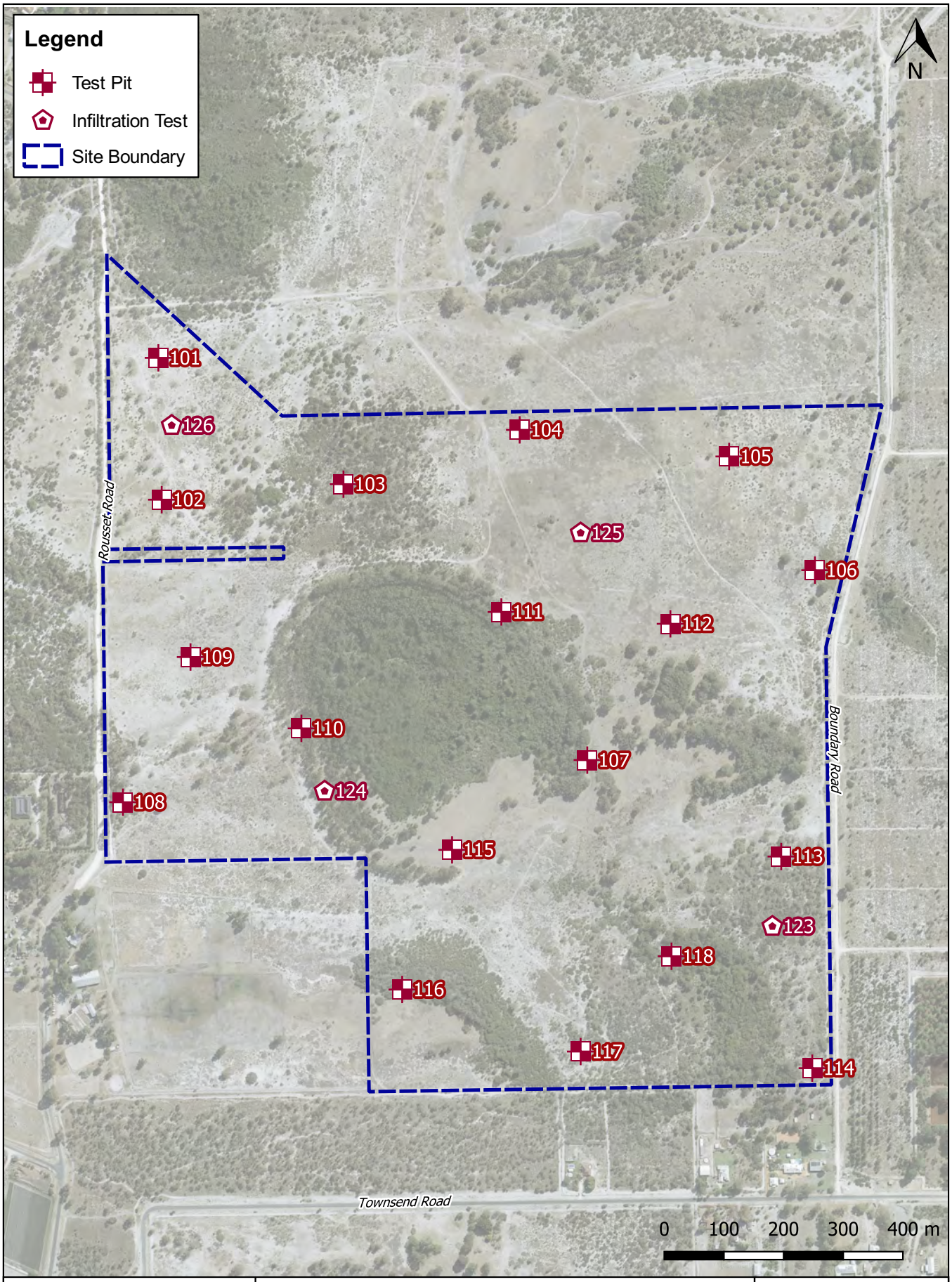

Porphyry

Appendix B

Drawings
Test Pit Logs
Borehole Logs



Douglas Partners Geotechnics | Environment | Groundwater	**Location Plan - Geological Mapping** **Proposed Residential Development** **Stage 2 - Rousset Road, Mariginiup, WA**	PROJECT: 212040.00 Drawing No: 1 REV: 0
	CLIENT: Stockland Development Pty Ltd	DATE: 25/10/2022



Douglas Partners Geotechnics | Environment | Groundwater	**Test Locations** **Proposed Residential Development** **Stage 2 - Rousset Road, Mariginiup, WA**	PROJECT: 212040.00 Drawing No: 2 REV: 0
	CLIENT: Stockland Development Pty Ltd	DATE: 25/10/2022

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 51.3 m AHD*
EASTING: 389851
NORTHING: 6490993

PIT No: 101
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
51	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale grey from 0.5 m depth.							
50	1	- becoming medium dense from 1.05 m depth.							1
	1.5	Pit discontinued at 1.5m (Collapsing conditions)							
49	2								
48	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 52.5 m AHD*
EASTING: 389857
NORTHING: 6490756

PIT No: 102
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
52	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.		D	0.1				
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Sand derived from Tamala Limestone. - becoming pale yellow from 0.4 m depth.							
		- becoming yellow-brown from 0.8 m depth.							
51	1	- becoming medium dense from 1.05 m depth.							1
		- becoming orange-brown and weakly cemented from 1.5 m depth.							
	1.7	Pit discontinued at 1.7m (Collapsing conditions)							
50	2								
	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

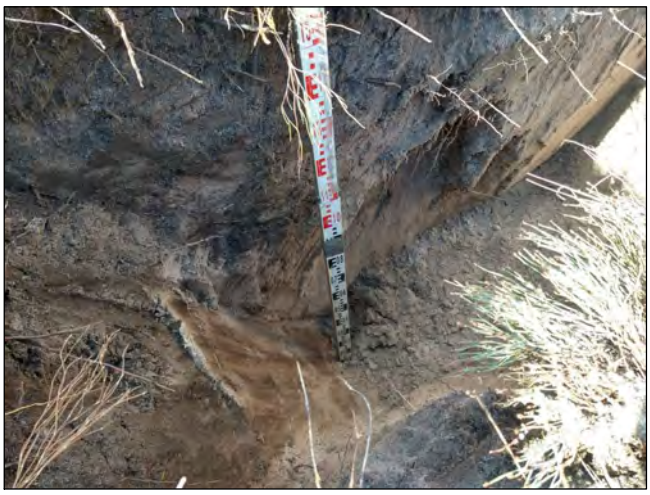
CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 49.8 m AHD*
EASTING: 390162
NORTHING: 6490782

PIT No: 103
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
49	0.2	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, loose, topsoil.		D	0.1				
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
	1	- becoming pale grey from 0.65 m depth.							
		- becoming medium dense from 0.9 m depth.							
48	2								
	2.2	Pit discontinued at 2.2m (Collapsing conditions)							
47	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20



RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 51.0 m AHD*
EASTING: 390457
NORTHING: 6490873

PIT No: 104
PROJECT No: 212040.00
DATE: 6/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
51	0.2	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, loose, topsoil.							
50	1	SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.35 m depth.							1
49	1.5	Pit discontinued at 1.5m (Collapsing conditions)							
48	2								
	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 52.8 m AHD*
EASTING: 390808
NORTHING: 6490828

PIT No: 105
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
52	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
	1	SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.4 m depth.							1
51	1.6	Pit discontinued at 1.6m (Collapsing conditions)							
	2								
50	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 52.4 m AHD*
EASTING: 390952
NORTHING: 6490637

PIT No: 106
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
52	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, topsoil.		D	0.1				
	0.5	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, medium dense. Bassendean Sand. - becoming dark grey from 0.35 m depth.		D	0.4				
51	1	SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale brown from 0.4 m depth.							
50	2								
	2.1	Pit discontinued at 2.1m (Collapsing conditions)							
49	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.3 m AHD*
EASTING: 390570
NORTHING: 6490319

PIT No: 107
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.2	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, with roots and rootlets, moist, medium dense, topsoil.		D	0.3				
	0.4	PEATY Silty SAND SM: fine to medium grained, dark grey-brown, moist, medium dense. Swamp Deposits.							
		ORGANIC SAND SP-SM: fine to medium grained, brown, with silt, moist, medium dense. With pockets of Cemented Silty SAND SM (Coffee rock). Swamp Deposits.							
47	1	- becoming brown, with pockets of Cemented Silty SAND SM (coffee rock) from 0.4 m depth.		D	1.0				
		- becoming dense to very dense from 0.6 m depth.							
	1.35	SAND SP: fine to medium grained, pale brown, trace silt, moist. Bassendean Sand.							
46	2								
	3	3.0 Pit discontinued at 3.0m (Target depth)							
45									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 49.3 m AHD*
EASTING: 389792
NORTHING: 6490248

PIT No: 108
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
49	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, topsoil.		D	0.1				
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- tree root of diameter of 0.08 m observed at 0.6 m depth.							
48	1	- becoming medium dense from 0.9 m depth. - becoming pale grey from 1.0 m depth.							1
47	2 2.0	Pit discontinued at 2.0m (Collapsing conditions)							2
46	3								

Dynamic Penetrometer Test (blows per 150mm): 5 10 15 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 49.6 m AHD*
EASTING: 389905
NORTHING: 6490492

PIT No: 109
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
49	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale grey from 0.25 m depth.							
	1								1
		- becoming medium dense from 1.1 m depth.							
48	1.5	Pit discontinued at 1.5m (Collapsing conditions)							
	2								
47	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.3 m AHD*
EASTING: 390091
NORTHING: 6490372

PIT No: 110
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, with roots and rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.35 m depth.							
47	1								1
	2								2
	2.1	Pit discontinued at 2.1m (Collapsing conditions)							
46									
	3								
45									

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 48.9 m AHD*
EASTING: 390426
NORTHING: 6490567

PIT No: 111
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
48	0.2	TOPSOIL/ORGANIC SAND SP: fine to medium grained, dark grey-brown, trace silt, with roots and rootlets, moist, medium dense, topsoil.		D	0.1				
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.35 m depth.							
	1	- becoming grey-brown from 0.9 m depth.		D	1.0				1
		- becoming brown from 1.5 m depth.							
47	2								2
	2.2	SAND SP-SM: fine to medium grained, dark brown, with silt, with pockets of Cemented Silty SAND SM (coffee rock), weakly cemented.							
				D	2.8				
46	3								3
	3.0	Pit discontinued at 3.0m (Target depth)							

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 50.8 m AHD*
EASTING: 390710
NORTHING: 6490547

PIT No: 112
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
50	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, topsoil.							
	0.55	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, moist, loose. Bassendean Sand. - becoming dark grey from 0.3 m depth.							
	1	SAND SP: fine to medium grained, pale grey, trace silt, moist, loose. Bassendean Sand. - becoming medium dense from 0.9 m depth.							1
49	1.7	Pit discontinued at 1.7m (Collapsing conditions)							
	2								
48	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 55.9 m AHD*
EASTING: 390896
NORTHING: 6490157

PIT No: 113
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
55	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale grey from 0.3 m depth.							
	1	- becoming medium dense from 0.9 m depth.							1
54	1.8	Pit discontinued at 1.8m (Collapsing conditions)							
	2								
53	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 51.8 m AHD*
EASTING: 390948
NORTHING: 6489802

PIT No: 114
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
51	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale grey from 0.3 m depth.							
	1								1
		- becoming medium dense from 1.15 m depth.							
	1.4	Pit discontinued at 1.4m (Collapsing conditions)							
50	2								
49	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.6 m AHD*
EASTING: 390344
NORTHING: 6490168

PIT No: 115
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.1	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, topsoil.							
	0.25	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, medium dense. Bassendean Sand.							
		SAND SP: fine to medium grained, pale brown, trace silt, moist, medium dense. Bassendean Sand.							
46	1	- becoming brown, weakly cemented from 1.0 m depth.							
	2								
	2.1	Pit discontinued at 2.1m (Collapsing conditions)							
45	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.7 m AHD*
EASTING: 390260
NORTHING: 6489934

PIT No: 116
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, topsoil.		D	0.1				
	0.3	SAND SP-SM: fine to medium grained, dark grey-brown, with silt, trace rootlets, moist, medium dense. Bassendean Sand.							
		SAND SP: fine to medium grained, pale grey, trace silt, moist, medium dense. Bassendean Sand.							
	1	- becoming pale brown from 0.5 m depth.							1
46		- becoming brown from 1.6 m depth.							
	2							▽	2
	2.4	- groundwater observed at 2.3 m depth.							
45		Pit discontinued at 2.4m (Collapsing conditions)							
	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: Groundwater observed at 2.3 m depth.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 52.7 m AHD*
EASTING: 390559
NORTHING: 6489830

PIT No: 117
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
52	0.15	TOPSOIL/ORGANIC SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.		D	0.1				
		SAND SP: fine to medium grained, pale grey, trace silt, moist, loose. Bassendean Sand.							
		- tree trunk observed at 0.3 m depth.							
		- trace roots and rootlets to 0.5 m depth.							
	1	- becoming medium dense from 0.9 m depth.							1
51	1.4	Pit discontinued at 1.4m (Collapsing conditions)							
	2								
50	3								

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 49.3 m AHD*
EASTING: 390712
NORTHING: 6489990

PIT No: 118
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
49	0.15	TOPSOIL/SAND SP: fine to medium grained, grey-brown, trace silt, trace rootlets, moist, topsoil.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale grey from 0.35 m depth.							
48	1	- becoming medium dense from 0.9 m depth.							
		- becoming pale brown from 1.2 m depth.							
47	2	- becoming brown from 2.0 m depth.							
	2.1	Pit discontinued at 2.1m (Collapsing conditions)							
46	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne backhoe, 450 mm toothed bucket

LOGGED: GG

SURVEY DATUM: MGA94 Zone 50 J

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 53.7 m AHD*
EASTING: 390881
NORTHING: 6490040
DIP/AZIMUTH: 90°/--

BORE No: 123
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
53	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, moist.							
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.45 m depth.							
52	1.0	Bore discontinued at 1.0m (Target depth)		D	1.0				
51									

RIG: 110 mm diameter hand auger **DRILLER:** GG **LOGGED:** GG **CASING:** N/A

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 47.9 m AHD*
EASTING: 390130
NORTHING: 6490267
DIP/AZIMUTH: 90°/--

BORE No: 124
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, moist.							
		SAND SP: fine to medium grained, grey, trace silt, moist, medium dense. Bassendean Sand. - becoming pale grey from 0.35 m depth.							
	1.0	Bore discontinued at 1.0m (Target depth)		D	1.0				
46	2								
45	3								

RIG: 110 mm diameter hand auger **DRILLER:** GG **LOGGED:** GG **CASING:** N/A

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 50.5 m AHD*
EASTING: 390559
NORTHING: 6490700
DIP/AZIMUTH: 90°/--

BORE No: 125
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
50	0.15	TOPSOIL/SAND SP-SM: fine to medium grained, grey-brown, with silt, moist.							
	0.3	SAND SP-SM: fine to medium grained, grey, with silt, moist, medium dense.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand.							
		- becoming pale brown from 0.6 m depth.							
		- becoming medium dense from 0.75 m depth.							
49	1.0	Bore discontinued at 1.0m (Target depth)		D	1.0				1
48									

RIG: 110 mm diameter hand auger **DRILLER:** GG **LOGGED:** GG **CASING:** N/A

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Stage 2 - Rousset Road, Mariginiup, WA

SURFACE LEVEL: 51.4 m AHD*
EASTING: 389874
NORTHING: 6490880
DIP/AZIMUTH: 90°/--

BORE No: 126
PROJECT No: 212040.00
DATE: 7/7/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
51	0.05	TOPSOIL/SAND SP-SM: fine to medium grained, grey brown, with silt, trace rootlets, moist.							
		SAND SP: fine to medium grained, grey, trace silt, moist, loose. Bassendean Sand. - becoming pale grey from 0.3 m depth.							
50	1.0	Bore discontinued at 1.0m (Target depth)		D	1.0				1
49	2								
48	3								

RIG: 110 mm diameter hand auger **DRILLER:** GG **LOGGED:** GG **CASING:** N/A

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50 J. *Surface level derived from publicly available LiDAR 5 m.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix C

Laboratory Test Certificates

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - ASTM D2974-14 (Test Method C)

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7024
Client Address:	-	*Report No.*	WG22.12202-12207_1_ORG
Project:	Proposed Residential Development	*Sample No.*	WG22.12202-12207
Location:	Stage 2 - Rousset Road, Mariginiup, WA	*Date Sampled:*	Not Specified
Sample Identification:	Various - See below	*Date Tested:*	5/08/2022

TEST RESULTS - Organic Content

Sampling Method: Sampled by Client, Tested as Received

Testing Completed By: WGLS - JG

Furnace Temperature (°C): 440

Sample Number	Sample Identification	Ash Content (%)	Organic Content (%)
WG22.12202	TP 106, 0.4 m	98.7	1.3
WG22.12203	TP 107, 0.3 m	74.3	25.7
WG22.12204	TP 107, 1.0 m	96.0	4.0
WG22.12205	TP 111, 0.1 m	93.4	6.6
WG22.12206	TP 111, 2.8 m	99.2	0.8
WG22.12207	TP 117, 0.1 m	96.1	3.9

Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 07/October/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599

Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

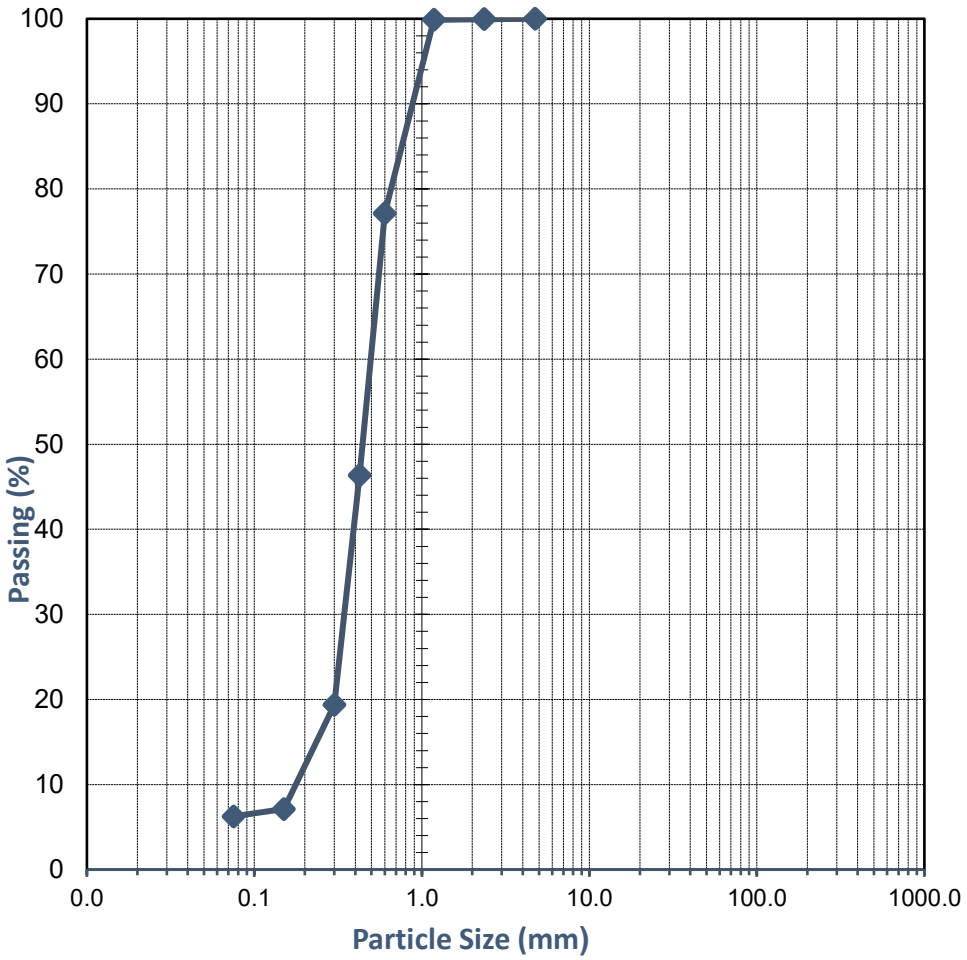
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7024
Client Address:	-	*Report No.*	WG22.12202_2_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12202
Location:	Stage 2 - Rousset Road, Mariginiup, WA	*Date Sampled:*	Not Specified
Sample Identification:	TP 106, 0.4 m	*Date Tested:*	05/08 - 08/08/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	77
0.425	46
0.300	19
0.150	7
0.075	6



Comments: Report replaces WG22.12202_1_PSD. Report reissued due to udpated location.

Approved Signatory:

Name: Cody O'Neill

Date: 07/October/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

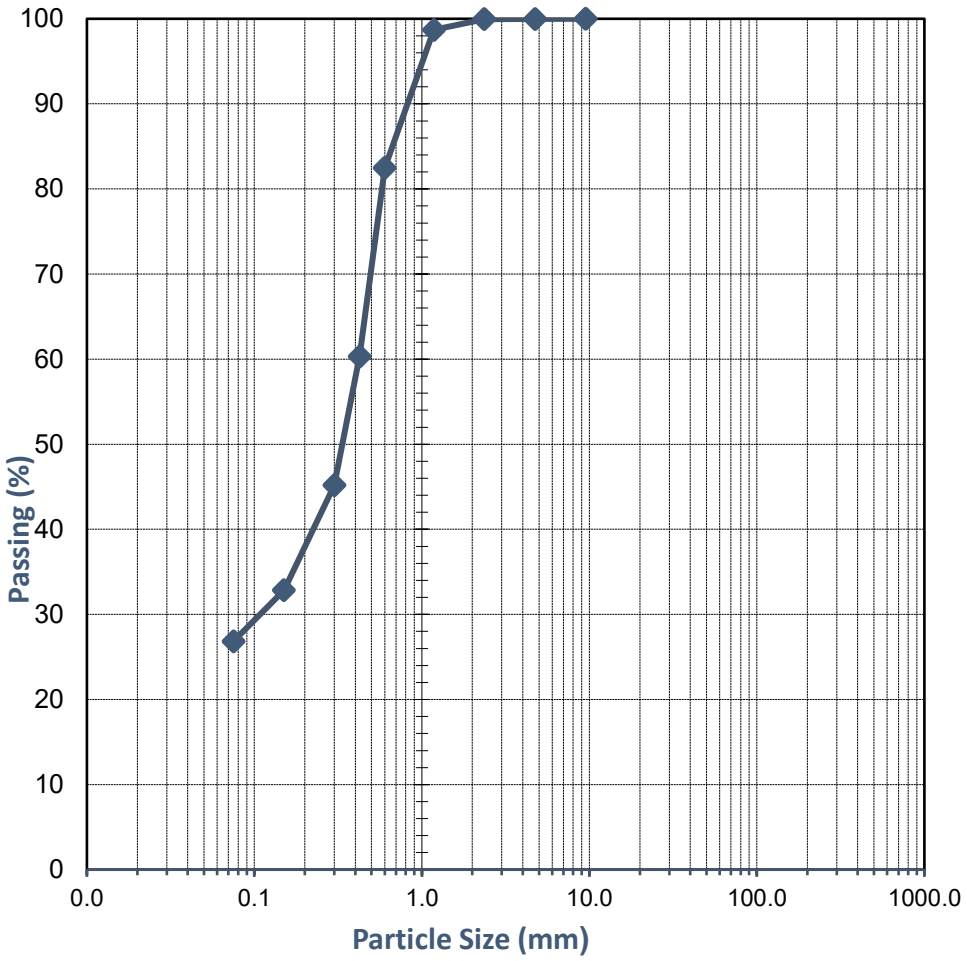
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7024
Client Address:	-	*Report No.*	WG22.12203_2_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12203
Location:	Stage 2 - Rousset Road, Mariginiup, WA	*Date Sampled:*	Not Specified
Sample Identification:	TP 107, 0.3 m	*Date Tested:*	05/08 - 08/08/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	99
0.600	82
0.425	60
0.300	45
0.150	33
0.075	27



Comments: Report replaces WG22.12203_1_PSD. Report reissued due to updated location.

Approved Signatory:

Name: Cody O'Neill

Date: 07/October/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

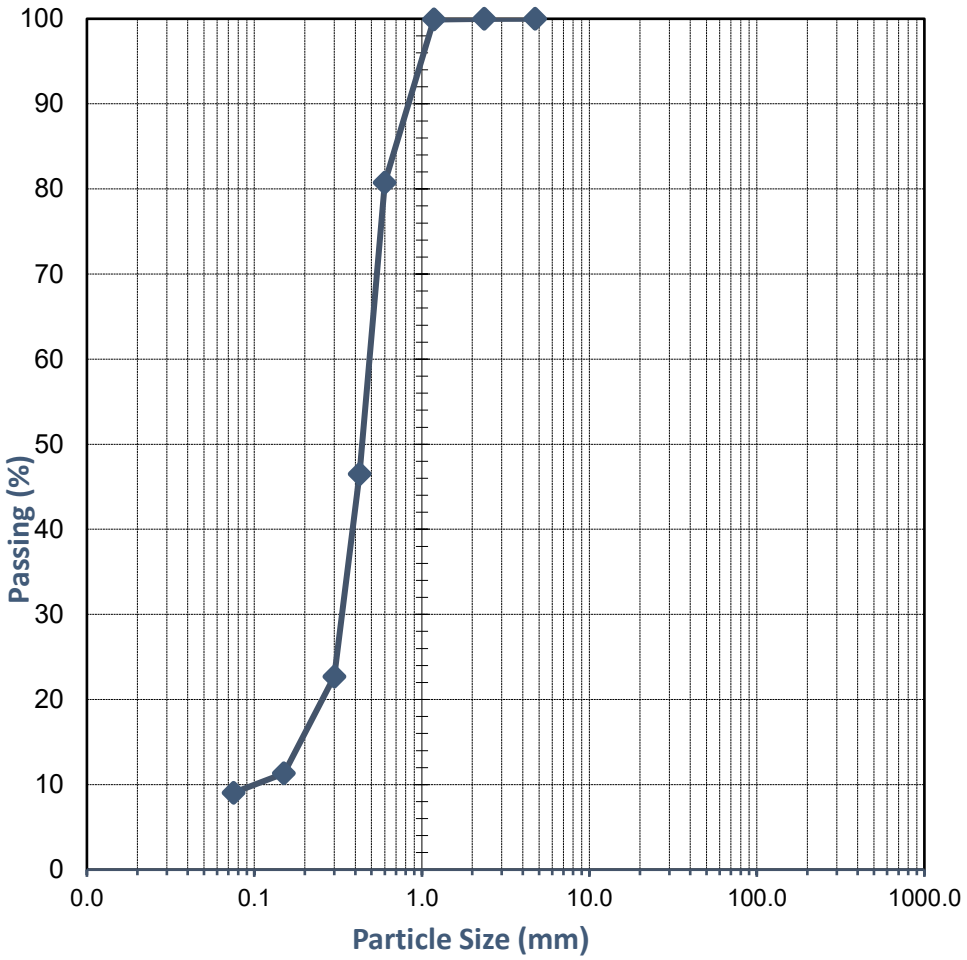
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7024
Client Address:	-	*Report No.*	WG22.12204_2_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12204
Location:	Stage 2 - Rousset Road, Mariginiup, WA	*Date Sampled:*	Not Specified
Sample Identification:	TP 107, 1.0 m	*Date Tested:*	05/08 - 08/08/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	81
0.425	47
0.300	23
0.150	11
0.075	9



Comments: Report replaces WG22.12204_1_PSD. Report reissued due to updated location.

Approved Signatory:

Name: Cody O'Neill

Date: 07/October/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

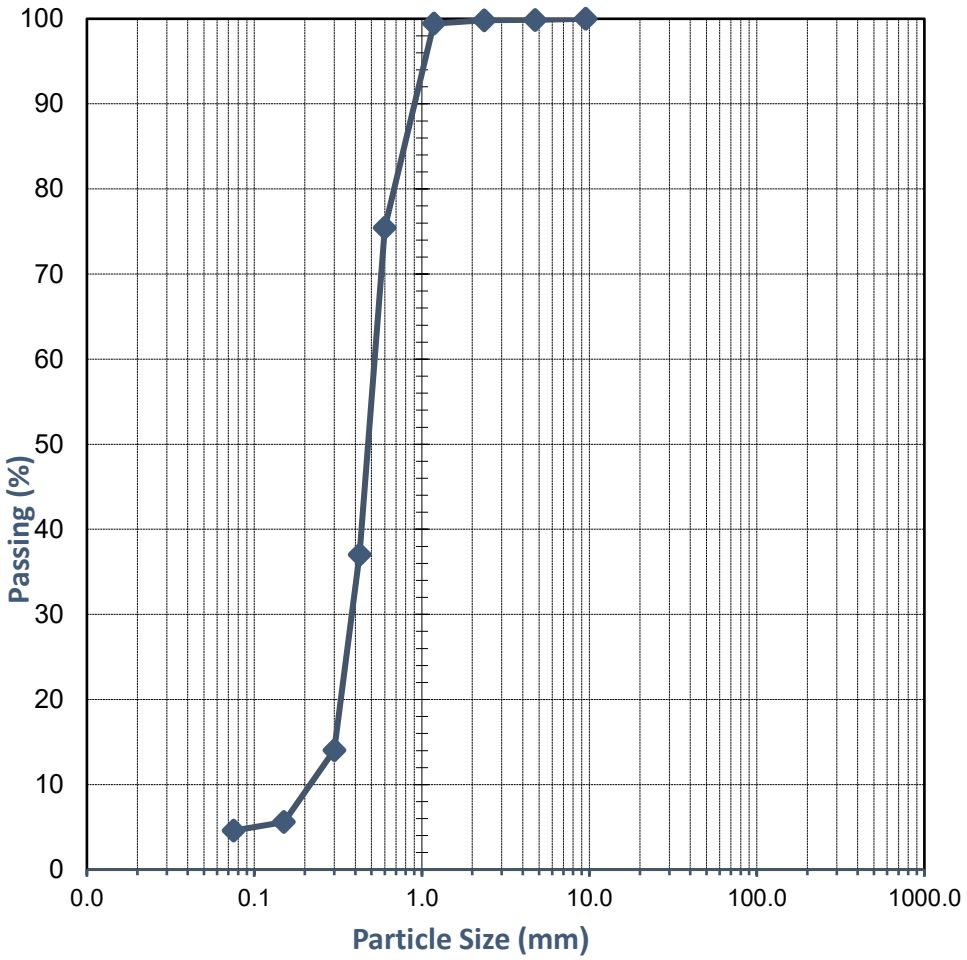
TEST REPORT - AS 1289.3.6.1

Client:	Stockland Development Pty Ltd	*Ticket No.*	S7024
Client Address:	-	*Report No.*	WG22.12205_2_PSD
Project:	Proposed Residential Development	*Sample No.*	WG22.12205
Location:	Stage 2 - Rousset Road, Mariginiup, WA	*Date Sampled:*	Not Specified
Sample Identification:	TP 111, 0.1 m	*Date Tested:*	05/08 - 08/08/2022

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	99
0.600	75
0.425	37
0.300	14
0.150	6
0.075	5



Comments: Report replaces WG22.12205_1_PSD. Report reissued due to updated location.

Approved Signatory:

Name: Cody O'Neill

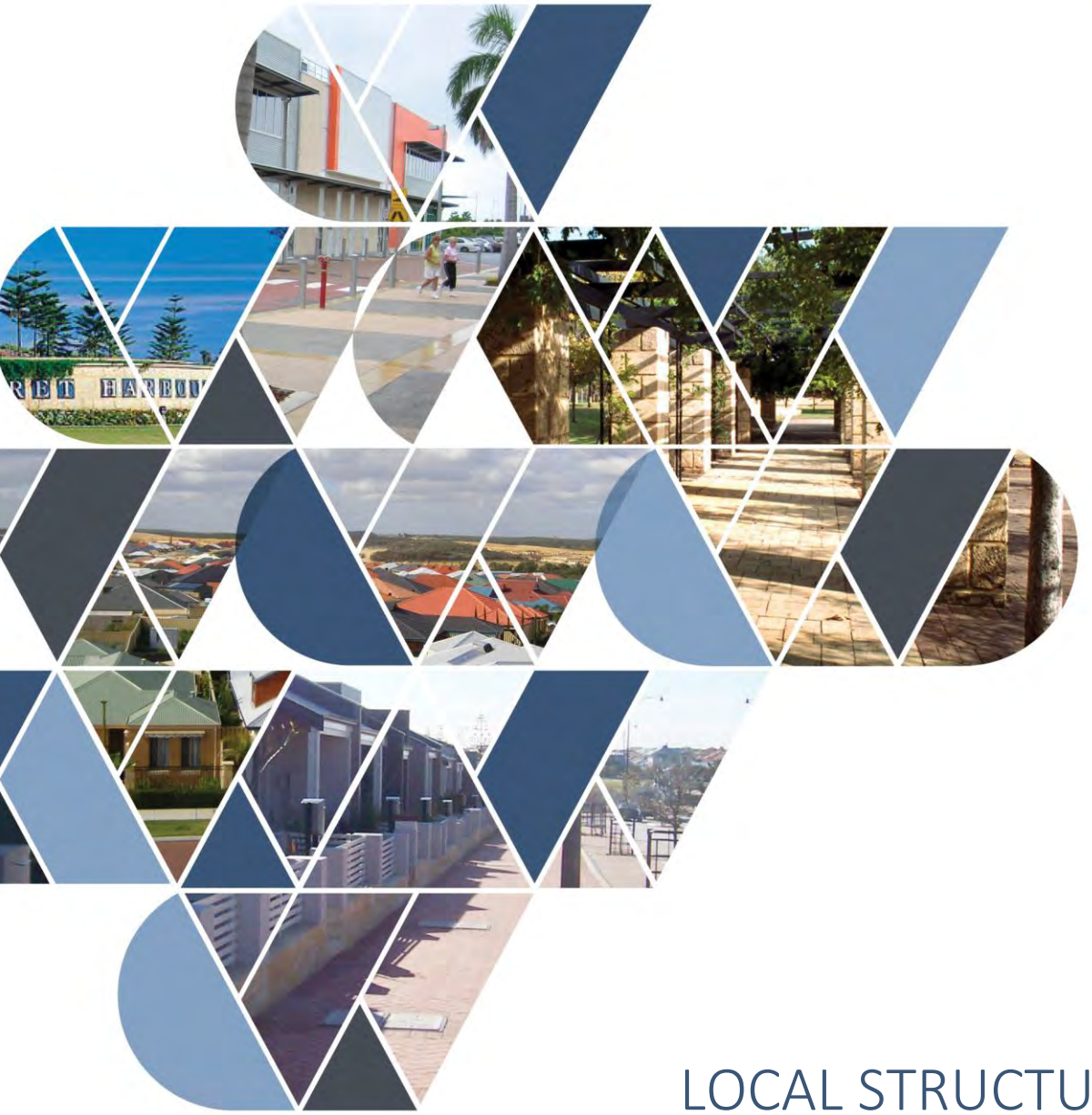
Date: 07/October/2022

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

Appendix B: Engineering Service Report

Cossill & Webley
CONSULTING ENGINEERS



LOCAL STRUCTURE PLAN
ENGINEERING REPORT
PRECINCT 15 EAST
WANNEROO,
MARIGINIUP
February 2023

Level 2, 431 Roberts Road,
Subiaco WA 6008.
PO Box 680 Subiaco, WA 6904

T (08) 9422 5800
E admin@cosweb.com.au
W cosweb.com.au

CONTENTS

1. EXECUTIVE SUMMARY

This report has been prepared by Cossill & Webley Pty Ltd (CW) for the East Wanneroo Precinct 15 Local Structure Plan (Mariginiup). It summarises the results of a review of the civil engineering aspects which have informed and support the delivery of the structure plan amendment for a proposal to residential and are related to the future servicing of the developed land.

This report provides details on each major infrastructure type and a servicing strategy for the implementation required for the development of the LSP area. The level of detail provided is consistent with the requirements of a Local Structure Plan, and acknowledges further detailed work will be required at the time of subdivision.

The engineering review has covered siteworks, roadworks, stormwater drainage, sewerage, water supply and utility services.

The investigation has found the land is capable of supporting development in accordance with the proposed Local Structure Plan with a logical progressive extension of infrastructure and base capacity.

The existing ground conditions and past land uses will not limit the proposed urban development.

Road access to the development will initially be via the existing Coogee Road to the north, which connects to Joondalup Drive to the west.

Sewer infrastructure will be provided via a gravity network internal to the LSP area and provision of new Waste Water Pumping Stations (WWPS). There is currently capacity for new flows generated from the EWDSP area within the existing network west of Precinct 15. The Water Corporation would need to make this capacity available for the proposed development and agree an interim outfall for the LSP area.

Water supply can be provided via an extension of the existing water reticulation network to the north and west.

Initial power supply can be provided by extension of the existing high voltage HV underground infrastructure in Coogee Road from the Wanneroo Zone Substation.

Telecommunications are available from existing services to the west.

The investigations and preparation of this report is largely based on preliminary advice from the various service authorities. The information is current as of February 2023, and is subject to change as development proceeds in the corridor resulting in the extension of service infrastructure and the creation of new capacity.

2. INTRODUCTION

This report has been prepared by Cossill & Webley Pty Ltd (CW) for Local Structure Plan for Precinct 15 of the East Wanneroo District Structure Plan (EWDSP) in Mariginiup. It summarises the results of a review of the civil engineering aspects which have informed and support the delivery of the structure plan amendment and are related to the future servicing of the developed land.

The preparation of the Precinct 15 Local Structure Plan has been carried out by a team of consultants, led by CDP Town Planning & Urban Design on behalf of Stockland, and covers an area of approximately 325 hectares which could yield approximately 3800 dwellings.

The Precinct 15 LSP area is identified by the red boundary presented below in Figure 1

Figure 1

Figure 1 - Site Plan (MNG Maps 2022)

3. SITE DESCRIPTION

The Precinct 15 LSP is situated within the City of Wanneroo, approximately 45 kilometres north of the Perth city centre. The Site is bound by existing rural and rural-residential properties. The majority of the site has been cleared historically prior to 1965 for grazing purposes. There has been some regrowth across the site since this time. Vegetation types vary from shrubs and low lying bushes through to mature trees of significant height. *Figure 2* below refers.

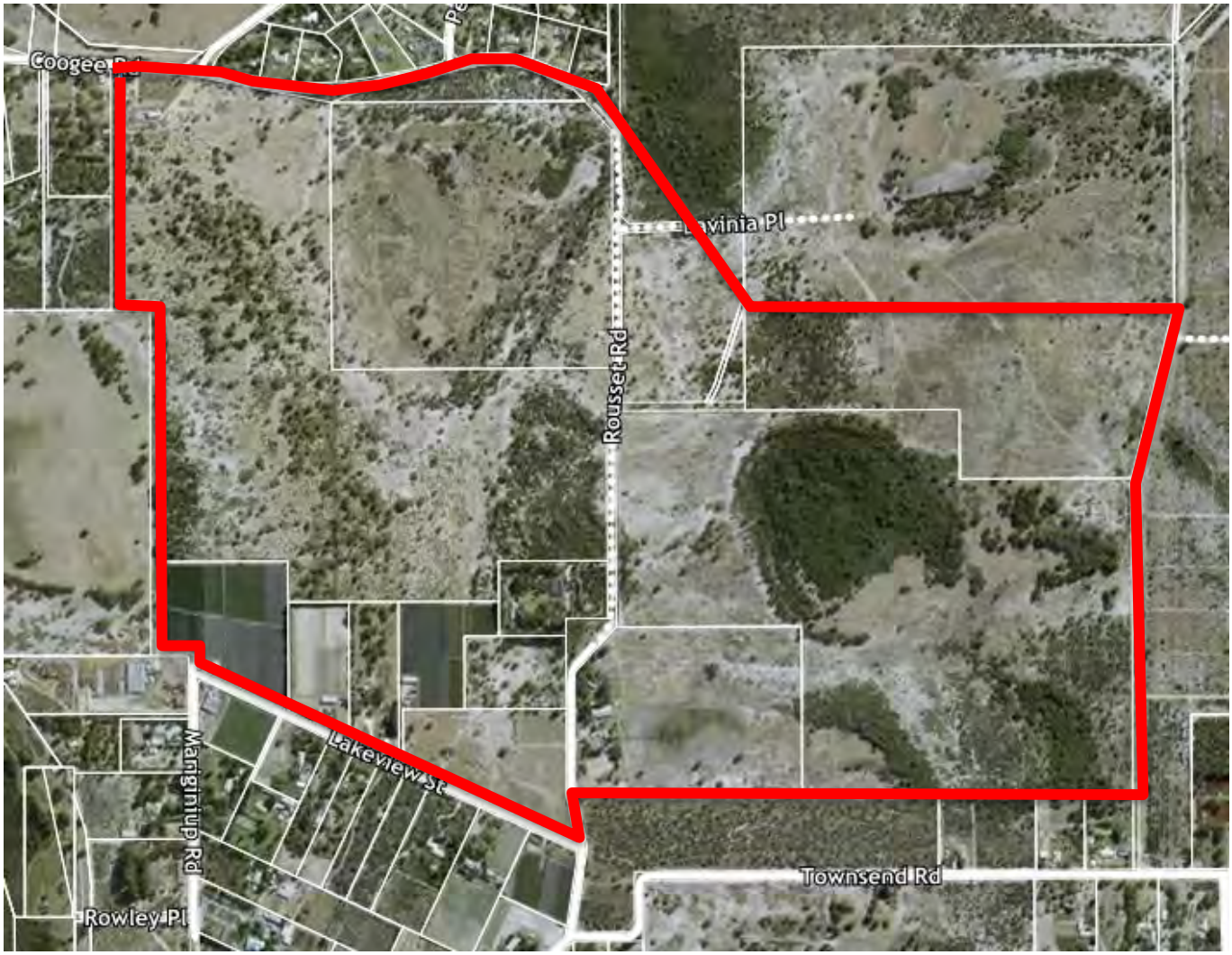


Figure 2 – Aerial Photography (MetroMap 2022)

3.1 Acid Sulphate Soils

A desk top review of the Department of Environment and Conservation's ASS Risk Map for the North Metropolitan Region for potential acid sulphate soils (ASS) indicates that the site has varying degrees of risk for encountering ASS across the site, ranging from no known risk of ASS occurring within 3m of the natural soil surface (or deeper) on the western edge of the LSP area, to low to moderate and moderate to high risk of encountering ASS in eastern portions of the Site. Figure 3 below refers

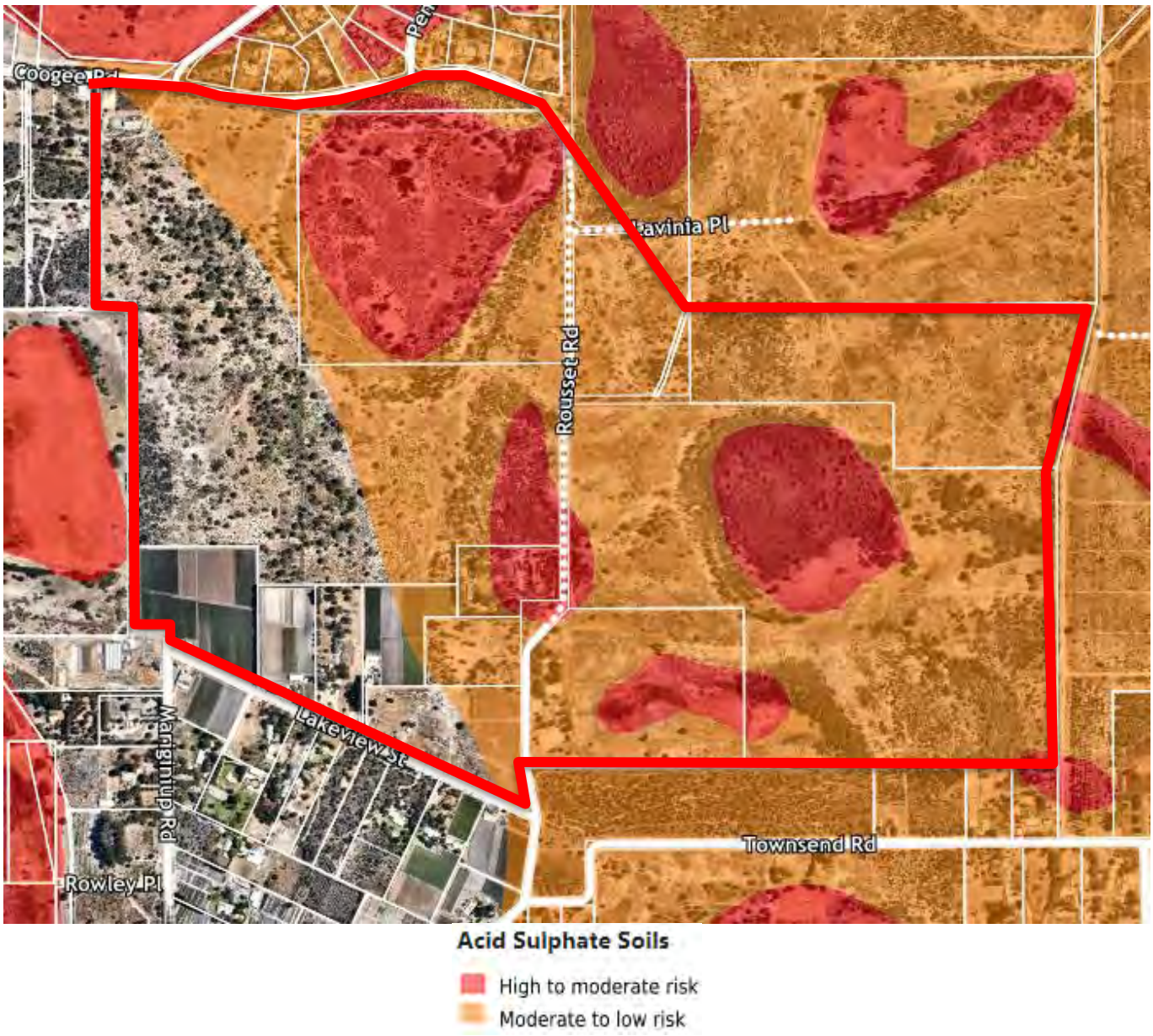


Figure 3 – Aerial Photography (MetroMap 2022)

Areas of high/moderate risk are typically located where Peaty Clays are denoted on the Geological Survey of Western Australia Perth Metropolitan Region soils map, and are coincident with lower areas of the site in closer proximity to the groundwater table.

Management of ASS soils or dewatering effluent requires the preparation of an Acid Sulphate Management Plan which is adhered to during construction works. Management of this issue is typical within the land development construction industry in Perth and can be appropriately managed through the course of the development.

As the planning for the Site progresses, further testing will be undertaken to determine the presence of ASS on Site, and the potential impact on proposed development

3.2 Existing Topography

Elevation contours across the Site are presented below in *Figure 4*.

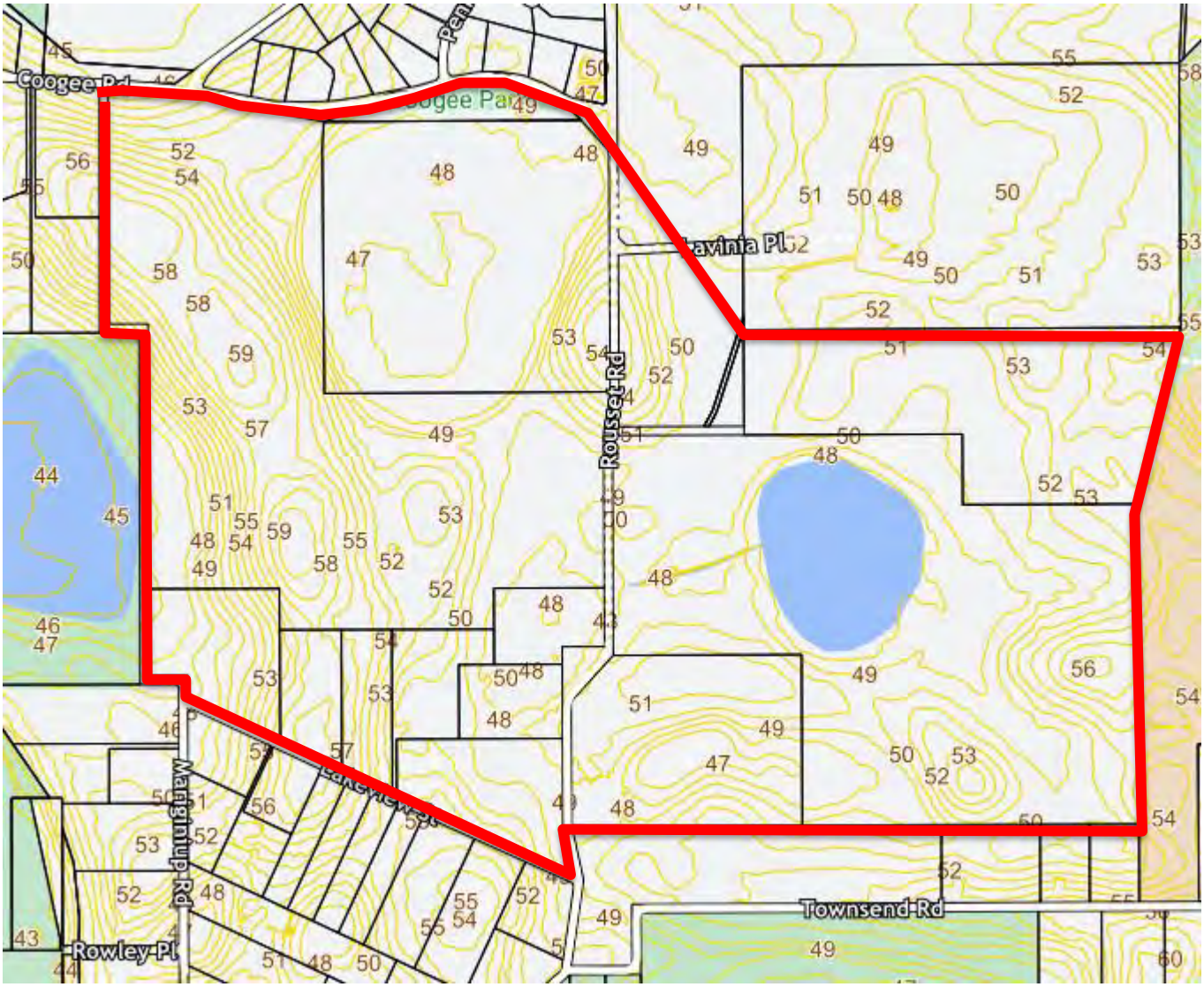


Figure 4 – Site Contours (MNG Access, 2023)

In the western portion of the Site, the landform is defined by a ridge at approximately RL 57 – 59m AHD which runs from the intersection of Coogee Road and Pinelake Trail down to Lakeview Street in the south. Land generally falls away from this ridge to Little Mariginiup Lake in the west, which sits outside the LSP area, and a low area at approximate RL 47m AHD within the LSP area. East of Rousset Road, levels vary, but generally the periphery of the LSP area grades down into a centrally located wetland area at approximately RL 48m AHD.

3.3 Geology

The Geological Survey of Western Australia Perth Metropolitan Region Soils Maps indicates that the Site is typified by a variety of soil types as presented in *Figure 5* below.

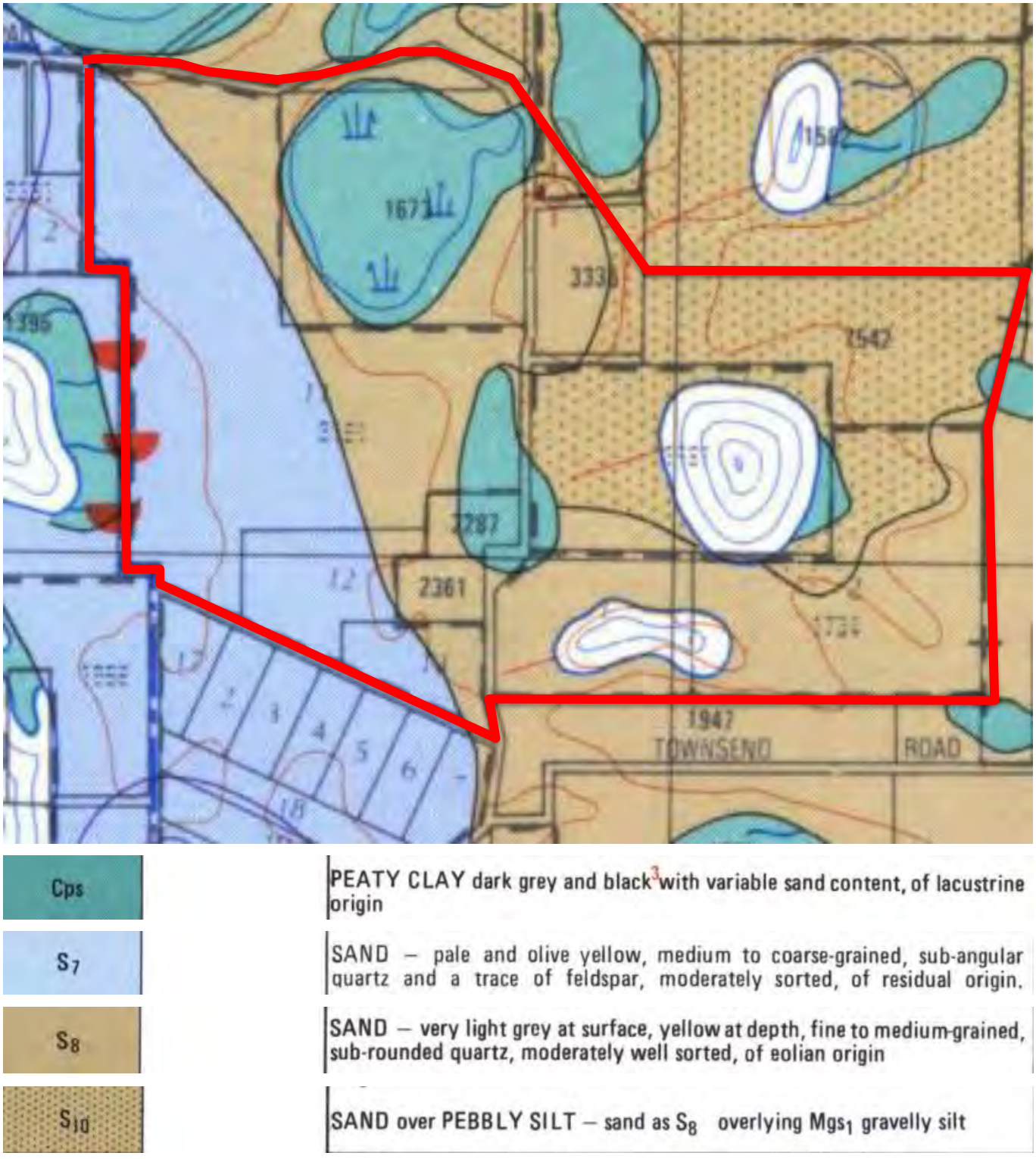


Figure 5 - Geotechnical Information (Geological Survey of WA)

Along the main ridgeline in the western portion of the Site, and immediately west to the Site's boundary, the Geological Survey of Australia indicates that the geological conditions of the Site is Sand derived from Tamala Limestone. East of the ridgeline, the Site is largely a combination of Bassendean Sands and Bassendean Sands over Guildford Formation in the form of Pebbly Silt. In lower areas of the Site, the Geological Survey of Australia suggests that Peaty Clays could be encountered.

Both the Sand derived from Tamala Limestone and Bassendean Sands are soil types are well suited to urbanisation, and are generally very permeable, allowing for the on-site disposal of runoff from newly created roads and lots. Where Bassendean Sand overlays Guildford Formation consideration of the thickness of the sand layer will be need to be made to ensure that an adequate separation from the underlying Guildford layer is achieved to meet geotechnical requirements. Guildford Formations such as Pebbly Silts are generally found in areas where the water table is close to the surface, and may require removal of thicker topsoil layers, blending with free draining sand and subsurface drainage to support development. Management of this soil type is not unusual within the Perth Metropolitan region, and does not pose a significant risk to the development.

Whilst the geological formations can support urban development, ground improvement works will be required in the Peaty Clay swamp areas.

Two preliminary site-specific geotechnical investigations have been undertaken over the LSP area by Douglas Partners, and are included as Appendices to this report. The geotechnical investigation generally concurs with the soils maps, however no Peaty Clay was encountered in the western part of the site. Some localised organic material was found in the west, along with peaty sands in the east. The geotechnical report accompanying the investigation outlines preliminary site classifications, and site preparation requirements for urbanisation. The geotechnical report confirms the Site is suitable for urban development and provides advice on the disposal of stormwater runoff and construction requirements. The geotechnical report confirms that the majority of the site will be Class A under the Australian Standard AS2870 – Residential Slabs and Footings code.

The Site is considered to be well suited for future urban development in terms of topography and soils and will provide a suitable foundation for roads, infrastructure and residential development.

3.4 Groundwater

The Annual Average Maximum Groundwater Level (AAMGL) varies from just above RL 52.0m AHD on the eastern boundary to just below RL 46.0m AHD at the western boundary according to the Department of Water's Perth Groundwater Map, as shown on Figure 6 below.

Figure 6 – Maximum Groundwater Levels (DWER, 2023)

A District Water Management Strategy (DWMS) has been prepared for the East Wanneroo District Structure Plan. This DWMS confirmed that groundwater across the EWDSP is likely to rise approximately 4-5 metres post development. This is as a result of the following:

- Water Corporation discontinuing to use their shallow aquifer bores when the site coverts from P1 to P3 to support development
- Shallow groundwater bores associated with the special residential lots are decommissioned with development and increased densities across the site
- Vegetation clearing is completed in order to support the density of the proposed development

- Groundwater recharge from drainage soakwells associated with the development, as opposed to evapotranspiration from the existing surface.

The DWMS anticipates that groundwater rise should be managed by "Controlled Groundwater Levels" and dealt with through a network of subsoil pipes gravitating to strategically located tanks and pumps that controls future groundwater levels to the pre-development levels (or existing levels). Further detail on this is included in the Local Water Management Strategy (LWMS) prepared for the LSP submission.

4. SITEWORKS & EARTHWORKS

4.1 Typical Earthwork Strategy

Siteworks for urban development typically comprise the clearing of existing vegetation and, where necessary, the earthworking of existing ground to facilitate future development.

In Perth it is often the case that the extent of siteworks is dictated by the density and nature of development and by the finished ground shape required for building houses. Increased densities and decreasing lot sizes has led to a current trend for the development areas to be fully earthworked to create level lots which are terraced utilising inter-allotment retaining walls.

This approach provides a number of positive outcomes:

- It reduces house building costs.
- It rationalises retaining wall layouts and designs consistent with Local Authority specifications.
- It enables lots to be terraced up natural slopes to maintain elevation and views.

The Precinct 15 LSP has been designed in accordance with the following objectives:

- To allow for the retention of existing vegetation and topography within the designated open space, chiefly along the elevated ridge line in the western parts of the precinct and within the large central wetland of the eastern precinct
- To allow for roads and development sites to be graded to best follow the existing topography and to best reflect the existing landscape.

A preliminary earthworks design has been prepared for the Precinct 15 LSP area and is presented in Appendix A in Drawing 6496-LSP1-SK290. This design generally allows for the retention of vegetation along the elevated ridge line in the western parts of the precinct and within the large central wetland of the eastern precinct, and maintaining a cut-fill balance west of the rail line site to make best use of Basic Raw Materials (BRM) and to minimise the need to import fill to the site east of the rail line.

4.2 Basic Raw Materials

It is preferable to minimise the importation of clean fill sand to the Site, not only to reduce costs (imported fill can typically equate to around 30% - 40% of development costs), but also to ensure the most appropriate use of basic raw materials. Considerations that have been investigated to minimise the need to import clean fill sand include the following:

- Establishing a subsoil network and creating a controlled groundwater level, this has the net effect of reducing the volume of imported material brought to a development to maintain clearance from groundwater, and also has the potential of assisting with irrigation.;
- Adopting a planning layout which is sympathetic to existing natural contours, to ensure that stormwater drainage design is optimised such that required development levels do not require excessive filling over the existing topography.

- Optimising the location of any critical sewer infrastructure (such as Waste Water Pumping Stations), to ensure that sewer controls minimise the need to fill areas of the development.

The above controls will be reviewed in further detail as part of the design process to ensure that the volume of imported fill necessary for development is minimised.

The Department of Mines and Petroleum have mapped the area as having the potential to contain deposits of sand in the south-west of the LSP area. An excerpt of the Basic Raw Materials mapping is presented below.

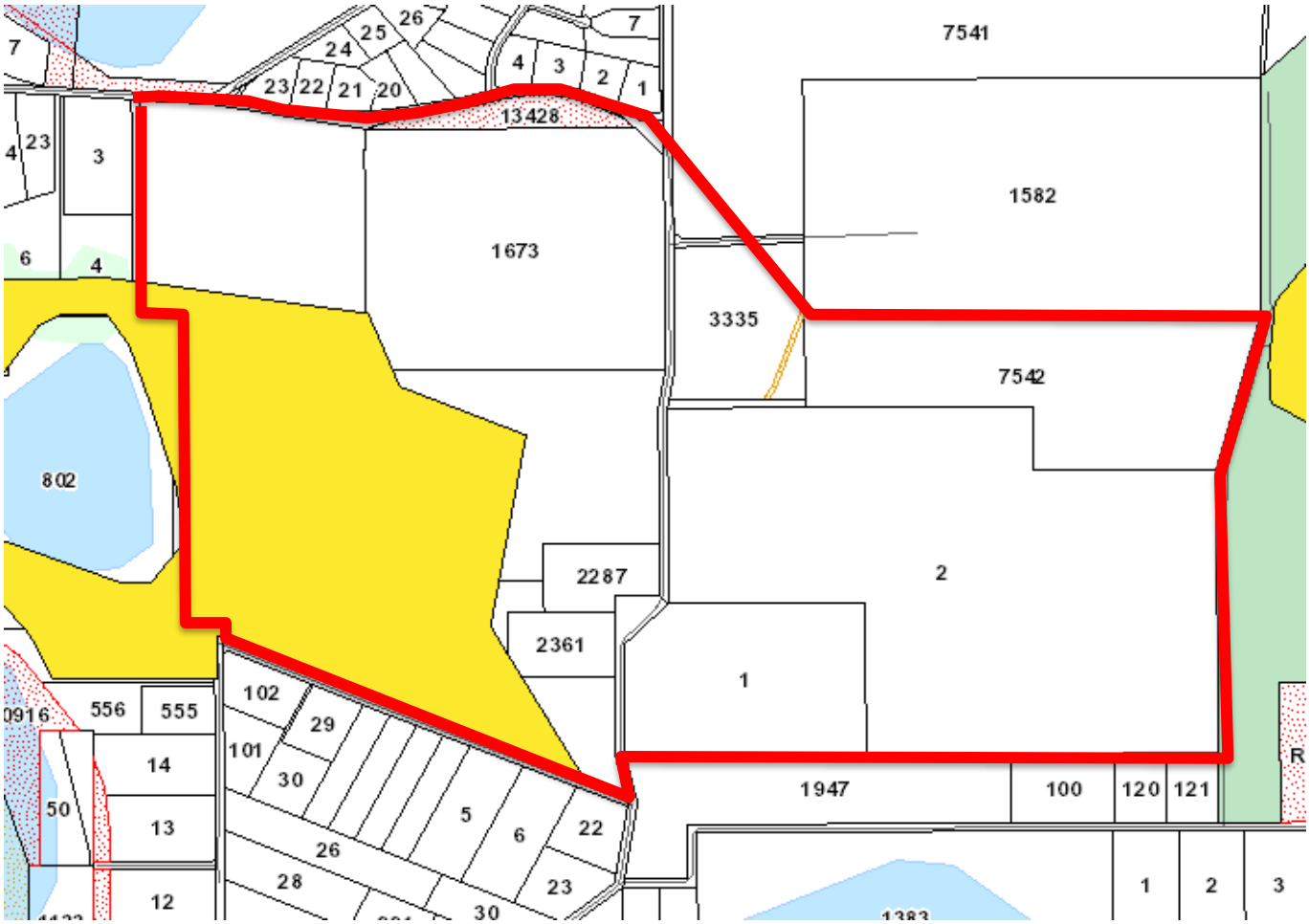


Figure 7 – Basic Raw Materials (DMIRS, 2023)

Review of the Site and historical photography confirms that the sand deposits depicted below have not previously been, nor are currently being mined. A review of the Department of Mines, Industry Regulation and Safety' publicly available data suggests that there are no live or pending mining tenements over the LSP area.

5. DRAINAGE STRATEGY

5.1 Integrated Urban Water Management

A Local Water Management Strategy (LWMS) has been prepared for the Site by Pentium as a separate document. This provides a basis for ongoing development to ensure that appropriate allowances are made for total water management including the minimisation of scheme water use and the maximisation of recharge of stormwater runoff.

Stormwater drainage management is proposed by adopting a Water Sensitive Urban Design (WSUD) approach. Objectives of WSUD include:

- Detention of stormwater rather than rapid conveyance;
- Use of stormwater to conserve potable water;
- Use of vegetation for filtering purposes; and
- Water efficient landscaping.

For the LSP area, the main WSUD practices which should be incorporated into the ongoing implementation of the site as follows:

1.5.1 Stormwater Management

Stormwater recharge of the shallow aquifer should be maximised through the adoption of 'Best Management Practices', which promote the dispersion and infiltration of runoff. These include the consideration of porous paving for roads or car parks where appropriate and acceptable to the Local Authority, and drainage soakwells to infiltrate runoff from buildings and private open space areas and the disposal of road runoff into infiltration basins within areas of public open space POS.

1.5.2 Water Quality Management

The maximisation of the quality of recharge water through the adoption of "Best Management Practices", which promote the disposal of runoff via water pollution control facilities (including vegetated swales and basins, detention storage and gross pollutant traps) and the implementation of non-structural source controls (including urban design, street sweeping, community education, low fertiliser landscaping regimes, etc.).

5.2 Stormwater Collection and Management

The LSP land largely consists of free draining sand with substantial cover to the prevailing groundwater. Areas of peaty clays, may require cut-to-fill earthworks to provide adequate separation to assist infiltration at source. Overall, therefore, the land is highly suited to the implementation of the WSUD management practices outlined above.

It is anticipated that runoff within future residential allotments will be contained on-site. Stormwater disposal will be via soakwells or other infiltration facilities which form part of the building and private open space development.

Drainage from public roads and lanes can be managed in a number of ways depending on the nature of the adjacent land uses, the extent of traffic and pedestrians and the objectives for drainage management.

Runoff from storms up to 1 in 5 years ARI would be conveyed via an underground pipe system to low point infiltration basins consistent with the requirements of the City of Wanneroo.

Roads and POS will be designed to cater for the surface overflow for more severe storms with building pads constructed at least 300 millimetres above the 1 in 100 year ARI flood or storage level at any location.

The dispersion of stormwater disposal will maximise the area of recharge down through the soil profile to the shallow aquifer, thereby, maximising the potential for nutrient stripping and water quality improvements.

The LWMS details the stormwater drainage plan for the Precinct 15 LSP. The plan shows the approximate location of stormwater disposal sites based on a preliminary assessment of finished development levels.

The LWMS also includes tabulated data for areas required at each low point infiltration swale to cater for the 1 in 1 year, 1 in 5 year and 1 in 100 year ARI storms.

6. Roadworks & Footpaths

6.1 Traffic and Transportation

An assessment of the traffic and transport planning for the Precinct 15 LSP area has been undertaken by Transcore.

The results of this assessment include a recommended hierarchy for the roads within the Precinct 15 LSP area and the future subdivision development together with recommendations for public transport services, pedestrian and cyclist facilities.

In all cases the engineering review has taken account of the recommendations outlined in the Transcore report and they will be incorporated into future detailed subdivision planning and design.

6.2 Regional Roads

Joondalup Drive and Pinjar Road west of the Site are both classified as an Other Regional Road (ORR) under the Metropolitan Regional Scheme (MRS), and are the closest regional roads to the Site. On this basis, Joondalup Drive will be required to provide a regional road access function for the development until the regional road network identified in the EWDSP are constructed. For Precinct 15 this includes the Whiteman-Yanchep Highway east of the site, and connection of Lakeview Street through to highway. Additional Integrator Arterials through the EWDSP area are proposed to ultimately extend south from Precinct 15 and will also form the traffic network. The figure below show the proposed road hierarchy in the EWDSP area.

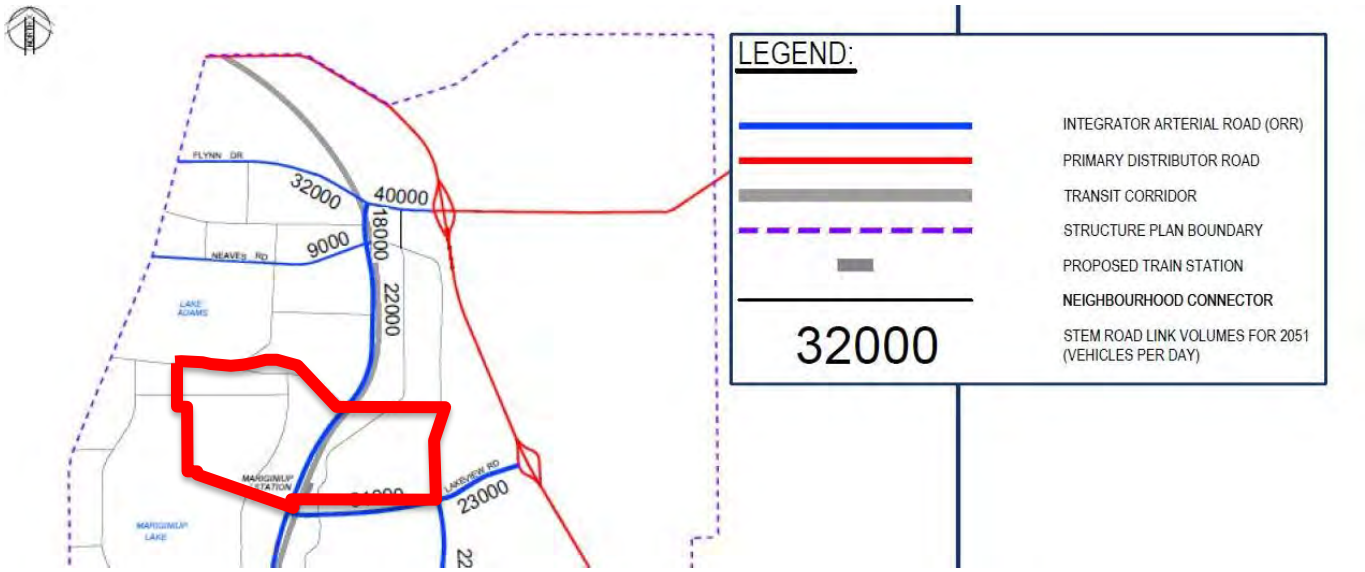


Figure 8 – East Wanneroo Higher Order Road Hierarchy (Cardno, 2019)

In the interim, Joondalup Drive provides the direct primary distributor function in the absence of the freeway.

Road access to Joondalup Drive would currently occur via connection to Coogee Road(which becomes Tumbleweed Drive) in the north, which connects onto Joondalup Drive west of the Site.

6.3 Future Development Roads

The Precinct 15 LSP area comprises a network of development roads including an Integrator Arterial Road as shown in Figure 8 above which is proposed to run parallel to the proposed rail reserve on an approximate north-south alignment through the centre of the site. This future Integrator Arterial connects to the proposed Whiteman-Yanchep Highway east of the LSP area via Lakeview Road, which is also proposed as an Integrator Arterial A Road. Figure 9 below refers.

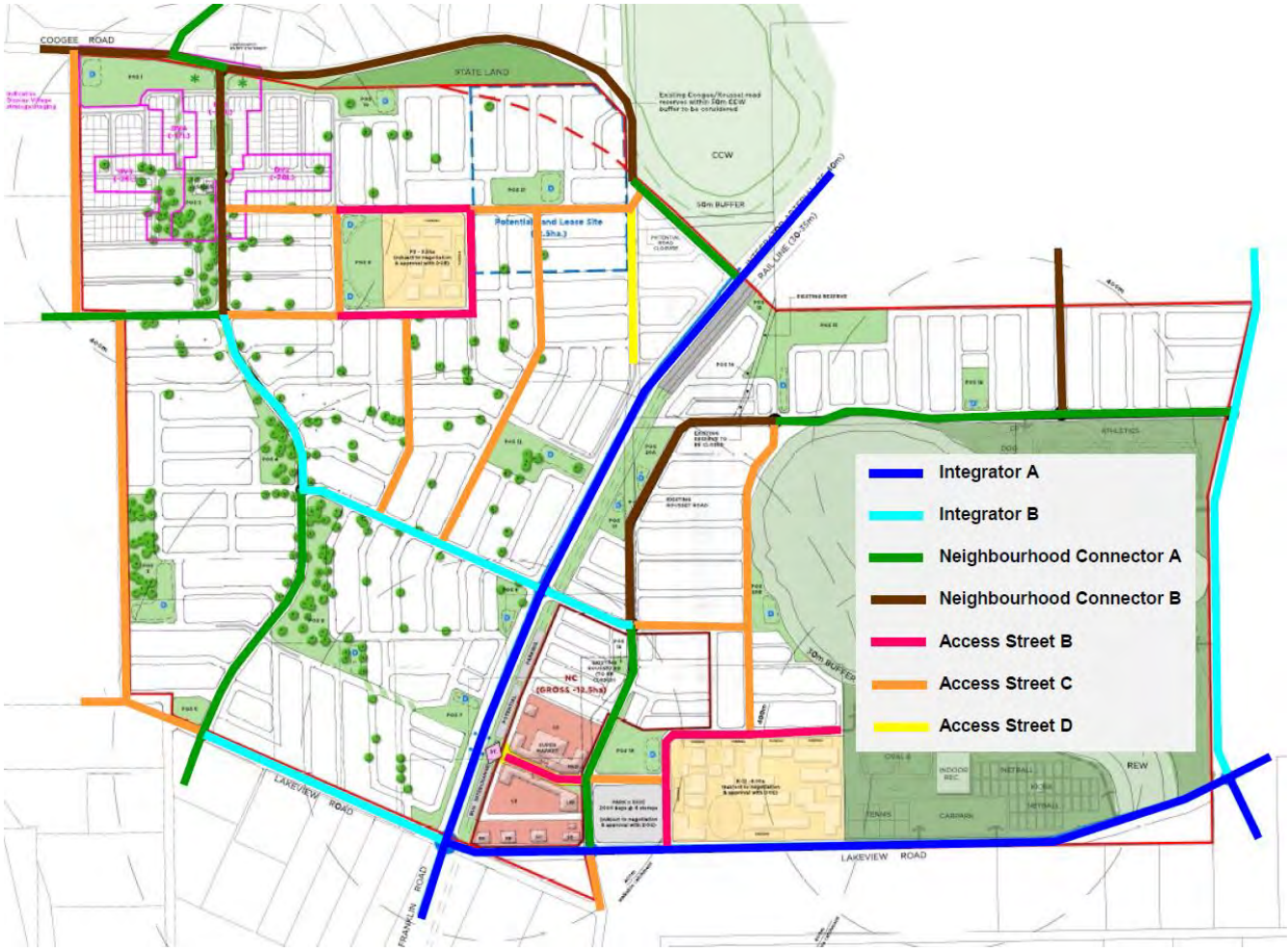


Figure 9 – Precinct 15 Road Hierarchy (Transcore, 2022)

Other Integrator Arterial Roads Neighbourhood Connectors and higher order Access Streets adjacent to and within the LSP area are shown in the Figure above. The Precinct 15 LSP proposes an urban design hierarchy for the development roads, which is an expansion of the traffic hierarchy, to better reflect the intended functions of the roads and their corresponding streetscape characters.

In all cases the road cross-sections will be designed to cater for utility services, on standard verge alignments, street trees, parking embayments where appropriate, off-street and on-street cycling lanes in accordance with the overall pedestrian and cycling network.

The engineering design of roads will be carried out to comply with the Department of Planning's Liveable Neighbourhoods recommendations for design speeds and sight distances and with the requirements of the City of Wanneroo. Roadworks will generally consist of kerbed and asphalted pavements.

In particular, it is proposed that the development roads be designed to suit lower vehicle operating speeds to ensure safer operation and improved pedestrian movement. The lower speeds on local roads will also support initiatives to adopt smaller street truncations and associated intersection curve radii where suitable.

6.4 Footpaths

Footpaths will be provided in accordance with *Liveable Neighbourhoods* and the City of Wanneroo standards and will consist of one path in every road, and shared paths in Neighbourhood Connector and other roads as outlined in the Transcore's Traffic Report accompanying the LSP.

7. WASTEWATER

The Site falls within the Water Corporation's Jandabup Sewer District as shown in *Figure 10* below.

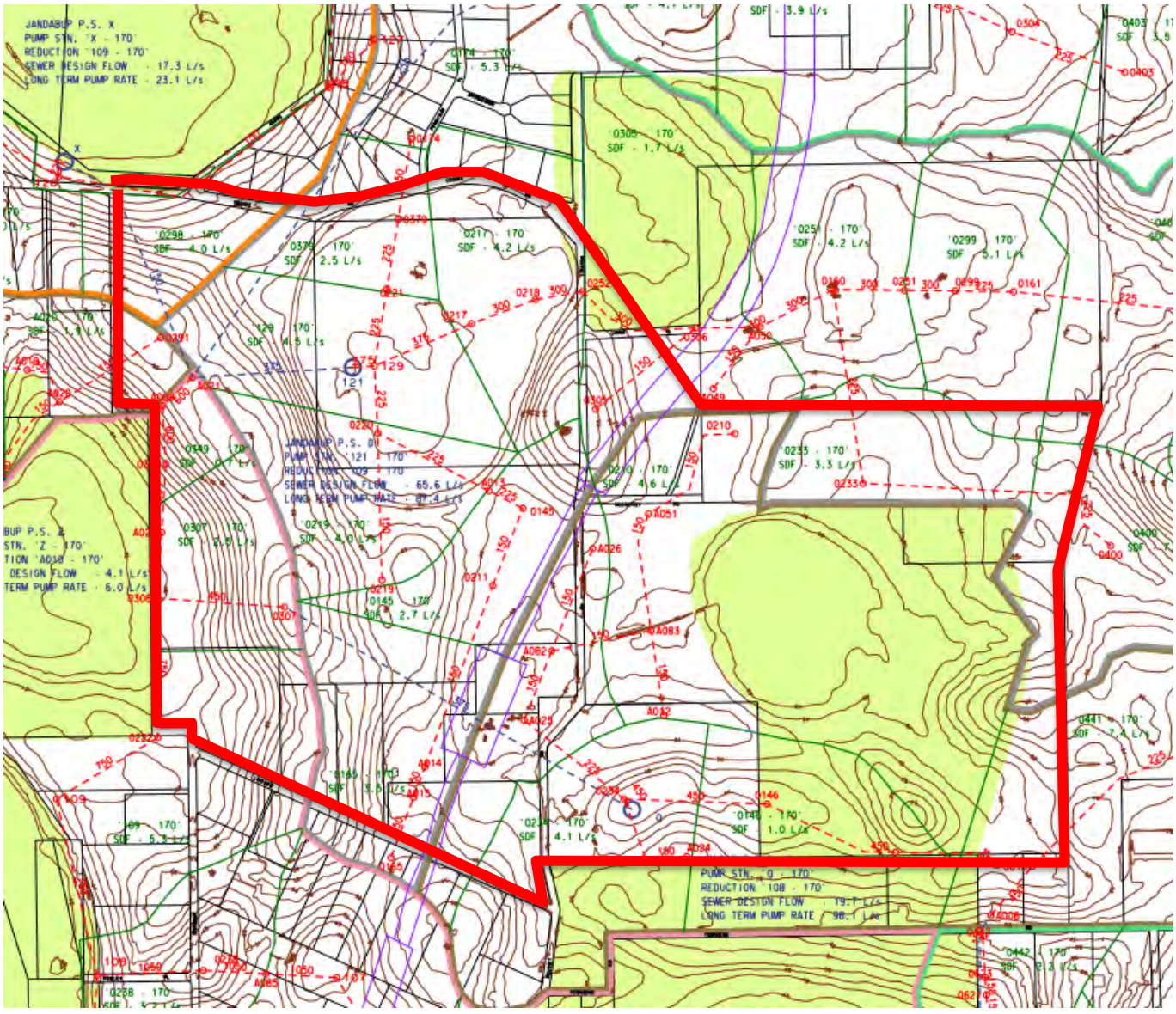


Figure 10 - Conceptual Long Term Wastewater Scheme Planning (Water Corporation, 2022)

The Water Corporation planning indicates that the Site falls within the catchment of five proposed future Waste Water Pumping Stations (WWPS).

- The north-west corner of the site within the orange catchment boundary is proposed to be serviced by the future Jandabup WWPS X, located north-west of the Site across Coogee Road and adjacent Lake Adams
- A small portion of the site along the western boundary within the grey catchment boundary is proposed to gravitate west to the future Jandabup WWPS Z located west of the Site at the eastern end of Ranch Road adjacent Little Mariginiup Lake
- Western edge of the Site within the pink catchment boundary is proposed to gravitate south via Collector Sewer to the future Jandabup WWPS A located south of the site at the southern end of Mariginiup Lake.
- The majority of the western portion of the Site & a portion of the north-eastern part of the site, defined by the grey catchment boundary, which captures wastewater flows within the site to gravitate to the proposed Jandabup WWPS D. Jandabup WWPS D would then pump flows west to the future collector sewer within the pink catchment described above for Jandabup WWPS A.
- The majority of the eastern portion of the Site, defined by the olive catchment boundary, which captures wastewater flows within the site to gravitate to the proposed Jandabup WWPS Q. Jandabup WWPS Q would then pump flows west to the future collector sewer within the pink catchment described above for Jandabup WWPS A.

It is noted that the Water Corporation's Wastewater Planning is largely based upon existing ground contour information, as there is typically no detail on the finished levels within the planning areas at the time that the planning is initially prepared.

As referenced earlier in the report, Cossill & Webley have prepared preliminary earthworks levels across the Site, which in turn has allowed the preparation of a preliminary sewer design and catchment plan. The preliminary sewer catchment plan is included as an appendix to this report.

Based upon the preliminary design levels completed, the majority of the western portion of the Site will be serviced by the Jandabup WWPS D, largely in line with the Water Corporation's Wastewater Planning. All of the eastern portion of the Site and a portion of the west will be serviced by Jandabup WWPS Q.

Along the western extremities of the Site, a portion of the NW corner of the site will likely fall into the catchment of future Jandabup WWPS X. The majority of land on the western periphery of the Site will ultimately grade out to Jandabup WWPS A.

As indicated by the Water Corporation's planning, development of the site in an ultimate sense requires the delivery of a number of higher order infrastructure items, which are not currently available, so it is likely an interim solution will be required to service the Site.

The Water Corporation has advised the existing wastewater network in proximity to the Site has a limited capacity available at a discharge point into the existing DN375 Neerabup Collector Sewer located on Joondalup Drive. The figure below shows the location of the discharge point relative to the Site.

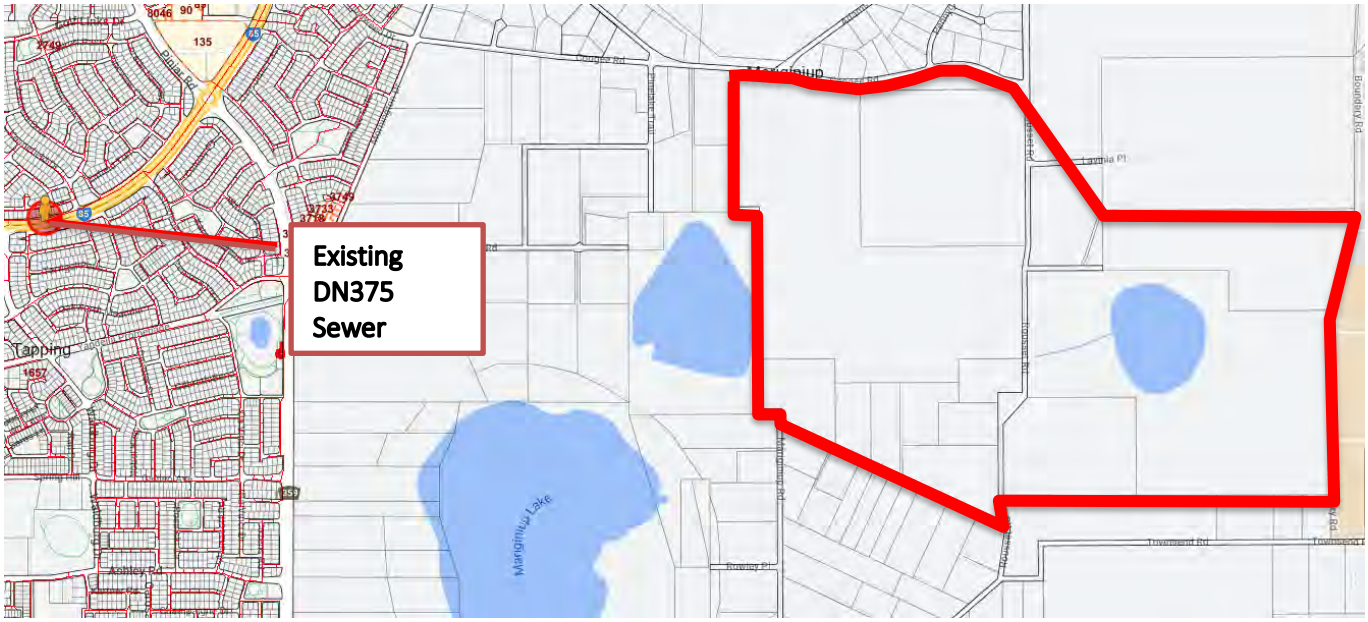


Figure 11 – Existing Sewerage Infrastructure (Water Corporation, 2023)

It is understood that the capacity available in the existing network is in the order of 18L/s, possibly higher. This capacity would allow approximately 1300 lots to connect to the wastewater network.

In discussions with the Water Corporation, they have advised that the available capacity in the network is intended to be utilised as an initial discharge point for the first phase of the proposed Jandabup A WWPS, with the capacity to be used to service the development of Precinct's 6, 7 & 8 identified in the EWDSP. The location of these precincts is immediately west of Precinct 15 as indicated below.

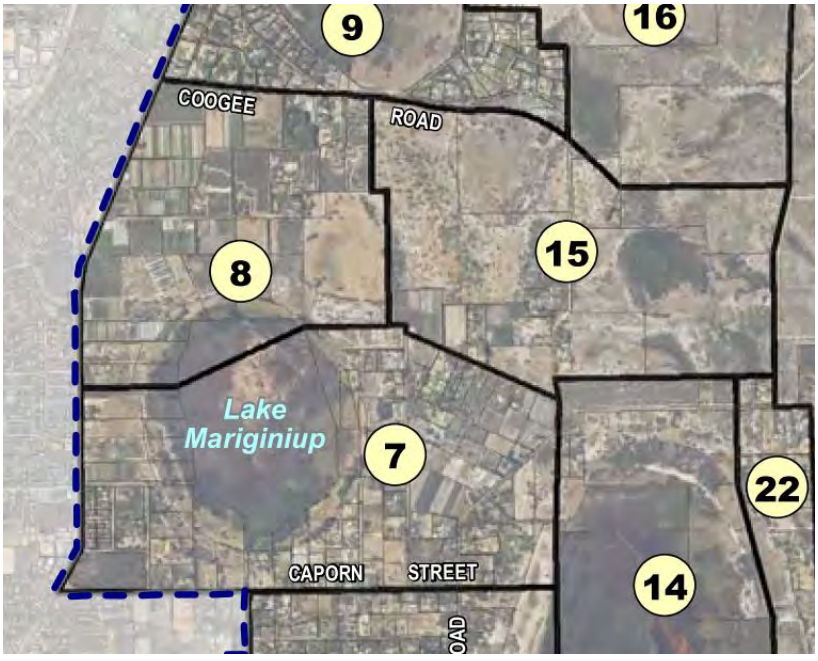


Figure 12 – EWDSP Precinct Plan (DPLH, 2021)

As can be seen in the Figure above, the nature of the existing landholdings within Precincts 6 – 8 is quite fragmented. Precinct 15 includes far less individual landholdings, with the majority of Precinct 15 held by a single proponent. The consolidated nature of existing landholdings within Precinct 15 in conjunction with the fact a single major proponent controls the majority of the landholdings within the Precinct means that the delivery of the development from the planning through to construction is much more likely to occur in a timely manner.

It has been confirmed that there is existing capacity within the network nearby. An interim connection to the existing network is physically possible from Precinct 15, and would allow progression of the development in the area whilst the necessary planning and implementation of upgrades required to the existing network for additional capacity is undertaken concurrently by the Water Corporation to ensure that the balance of the EWDSP area can be delivered unimpeded as it progresses.

8. WATER RETICULATION

8.1 Water Resources

Precinct 15 is within the Water Corporation's water licence area. Precinct 15 is proposed to be serviced with water from the Wanneroo Reservoir tank site located on Steven Street in Wanneroo. This tank is currently fed from the existing Wanneroo Groundwater Treatment Plant (GWTP) located to the east of the Precinct 15 as presented in the Figure below.

Ultimately, an additional bore main from the GWTP to the Wanneroo Reservoir is proposed, which will be augmented via a new supply from the proposed Alkimos Desalination plant. From discussions with the Water Corporation the route of the proposed desalination trunk main is still at a planning stage, and a route external to the EWDSP area is under consideration.

As part of the consideration of future development of the EWDSP area, the Water Corporation has completed high level planning over the EWDSP which has determined that a series of large volume trunk mains connecting the Wanneroo Reservoir to other regional water storage facilities within the Integrated Water Supply Scheme will be required as development progresses. The construction of these mains will be deferred until such time as water supply demand requires the Water Corporation to construct the mains. The optimal route for the construction of these mains will be assessed by the Water Corporation ahead of delivery of the mains, and will consider development within the EWDSP at that point in time. Within the Precinct 15 area, should distribution mains be required they will likely follow routes of higher order roads where there is a greater reserve width which more readily accommodates retrofit of infrastructure.

There is existing water infrastructure west of the Precinct 15 area at the intersection of Coogee Road and Mornington Drive that includes both larger reticulation mains as well as a distribution main. Connection to the existing network should provide adequate water supply to allow initiation of development in the area.

9. POWER SUPPLY

There is an existing high voltage underground power cable in Coogee Road which extends power from the existing "Wanneroo Zone Substation" located at the intersection of Wanneroo Road and Clarkson Ave west of Precinct 15. There is 25 to 30MVA projected to be available from this sub-station, which will be sufficient to service future development of Precinct 15.

It is anticipated that the local network will be incrementally extended from the existing HV feeder located in Coogee Road into Precinct 15. A series of HV feeds, switch stations and transformers will be required throughout Precinct 15 to meet individual site requirements.

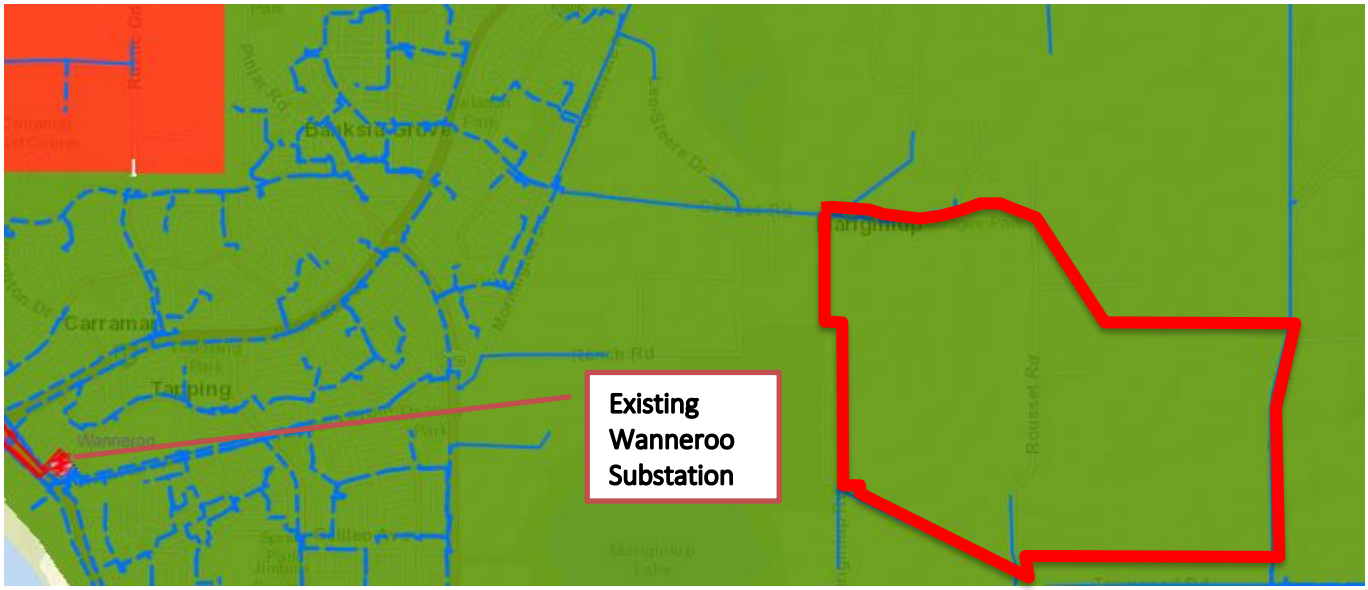


Figure 13 – Network Capacity and Existing Overhead Powerlines (Western Power)

10. TELECOMMUNICATIONS

The Site is within NBN's fixed line footprint, and hence can be serviced with optic fibre under their roll-out scheme for greenfield developments.

Under the Federal Government's Telecommunications in New Developments Policy, developers are responsible for contributing to the cost of delivering the NBN™ network in new developments. This includes contributing to part of the costs of the build (civils and any backhaul required) as well as a $600 per lot deployment change.

Through the NBN, the ownership issues of delivering the wholesale fibre to the home system have been transferred to the Government with more than 100 retail service providers offering services over the network. There are other private telecommunication providers that can also offer similar services.

Developers of new residential estates have the option to pay NBN or an alternative service provider for provision of a high speed broadband network. In either case the developer will install pit and pipe infrastructure that can accommodate a future high speed broadband network.

The current design practice for road reserves, pavement and verge provisions will make adequate allowance for services including broadband in accordance with the agreed Utilities Service Providers handbook. There will be some local land requirements for equipment sites, similar to current provisions which will be accommodated at detailed subdivision stage.

11. CONCLUSION

The Precinct 15 LSP area has planned strategies for water and sewerage supply and other public utility services are available or can be extended to service the proposed urban area.

There are no engineering impediments to the development, though co-ordination and co-operation with the relevant Service Authorities will be required as the development progresses.

Appendix A

Report on Preliminary Geotechnical Investigation – Proposed Residential Development Lot 803 Coogee Road and Lot 1673 Rousset Road, Mariginiup, WA

Appendix B

Report on Preliminary Geotechnical Investigation – Proposed Residential Development Stage 2 - Rousset Road, Mariginiup, WA

Appendix C

Preliminary Earthworks Plan

LEGEND	
DESCRIPTION	SYMBOL
SUBJECT LAND BOUNDARY	
DEAD TREE	
HIGH AMENITY	
MODERATE AMENITY	
LOW AMENITY	
EXISTING SURFACE CONTOUR	25.0
FINISHED SURFACE DESIGN CONTOUR	25.0

NOTE:
THE LOCATION OF DRAINAGE BASINS SHOWN ARE INDICATIVE ONLY. BASINS HAVE BEEN LOCATED WHERE STORAGE WILL BE REQUIRED BASED ON THE SITE GRADING SHOWN.
THE SIZE OF THE BASINS SHOWN DO NOT REPRESENT ACTUAL STORAGE REQUIREMENTS.

REV	DATE	DRN	CKD	APP	AMENDMENT
D	27.02.23	AAD	BRM	B. MARSHALL	CGL CONTOURS UPDATED
C	20.01.23	AAD	BRM	B. MARSHALL	UPDATED TO REVISED PLANNING LAYOUT, ISSUED FOR INFORMATION
B	22.08.22	AAD	BRM	B. MARSHALL	UPDATED TO REVISED PLANNING LAYOUT, ISSUED FOR INFORMATION
A	03.08.22	AAD	-	-	ISSUED FOR INFORMATION

N

DIAL BEFORE YOU DIG www.1100.com.au

1:4000 0m 80 160 240

Cossill & Webley CONSULTING ENGINEERS
Mailing Address PO Box 680 Subiaco WA 6904
Street Address B12 (Level 2) 431 Roberts Road Subiaco WA 6008
T (08) 9422 5800 F (08) 9422 5801 E admin@cosweb.com.au

CLIENT: Stockland

APPROVED: BRAD MARSHALL 27.02.23

DESIGNED: AAD

SCALE: 1:4000

PROJECT: MARIJINIUP - LOCAL STRUCTURE PLANNING

TITLE: PRELIMINARY EARTHWORKS PLAN

WAPC No. N/A

DRAWING No. 6496-LSP1-SK200

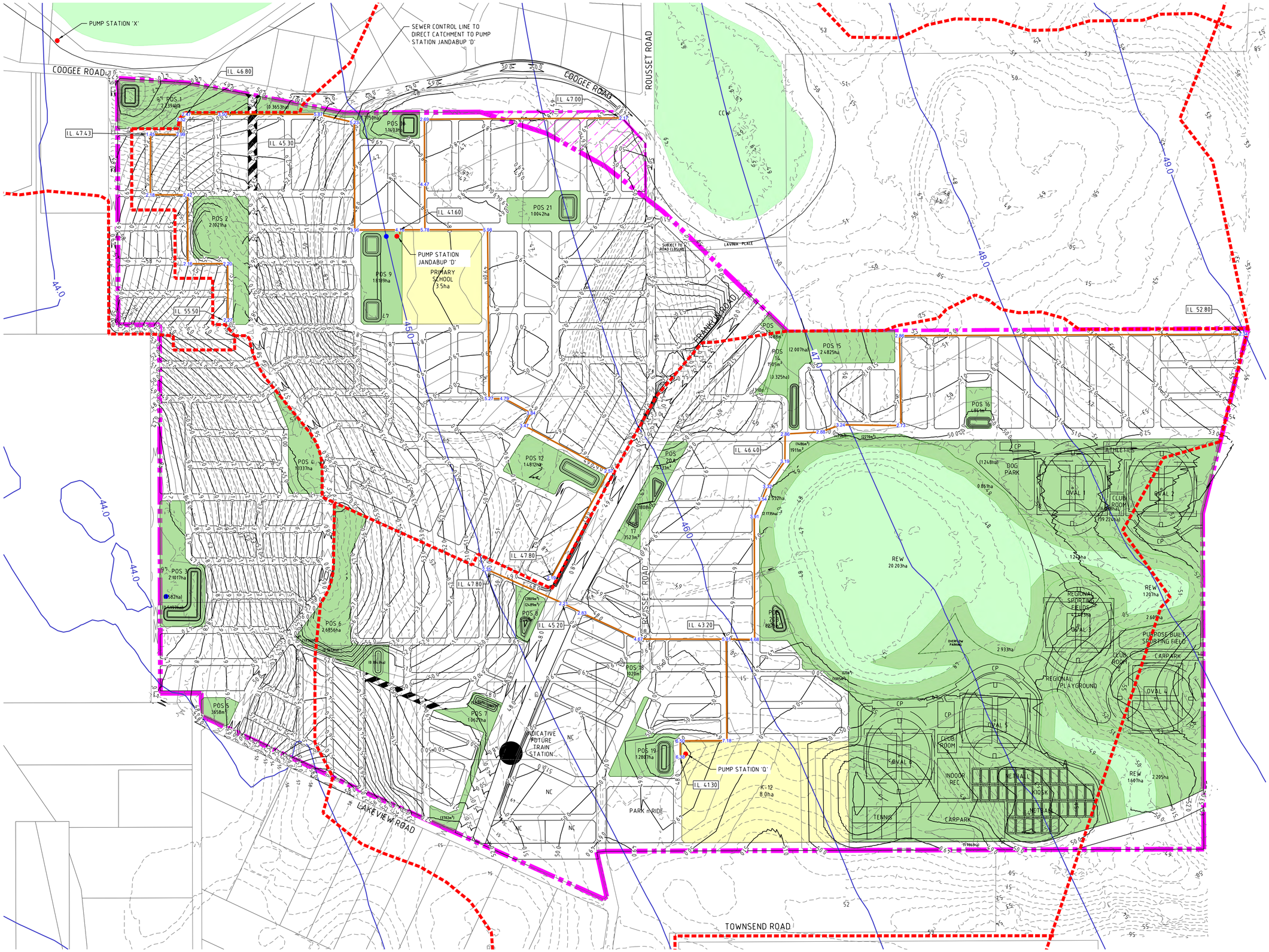
REVISION D

ORIGINAL SIZE A1

P:\6496 Precinct 15 East Wanneroo\6496-LSP1\Acad\6496-LSP1-SK200.dwg, 27/02/2023 12:34:39 PM, AaronDavies, Digital Signing PDF.pc3, 1:1, - CW Reference

Appendix D

Preliminary Sewer Catchment Plan



LEGEND

DESCRIPTION	SYMBOL
SUBJECT LAND BOUNDARY	
SEWER CATCHMENT BOUNDARY	
PROPOSED GRAVITY SEWER AND ACCESS CHAMBER OR MAINTENANCE SHAFT	
SEWER ACCESS CHAMBER DEPTH (APPROXIMATE ONLY)	7.43
FINISHED SURFACE DESIGN CONTOUR	25.0

NOTE:
REFER WATER CORPORATION PLANNING JANDABUP SD170.

REV	DATE	DRN	CKD	APP	AMENDMENT
A	20.01.23	AAD			ISSUED FOR INFORMATION

N

1:4000 0m 80 160 240

DIAL BEFORE YOU DIG www.1100.com.au

Cossill & Webley CONSULTING ENGINEERS
Mailing Address: PO Box 680 Subiaco WA 6904
Street Address: B12 (Level 2) 431 Roberts Road Subiaco WA 6008
T (08) 9422 5800 F (08) 9422 5801 E admin@cosweb.com.au

CLIENT: Stockland

APPROVED 20.01.23 CHECK PRINT

DESIGNED AAD

SCALE 1:4000

PROJECT: MARIJINIUP - LOCAL STRUCTURE PLANNING

TITLE: PRELIMINARY SEWER CATCHMENT PLAN OPTION 2

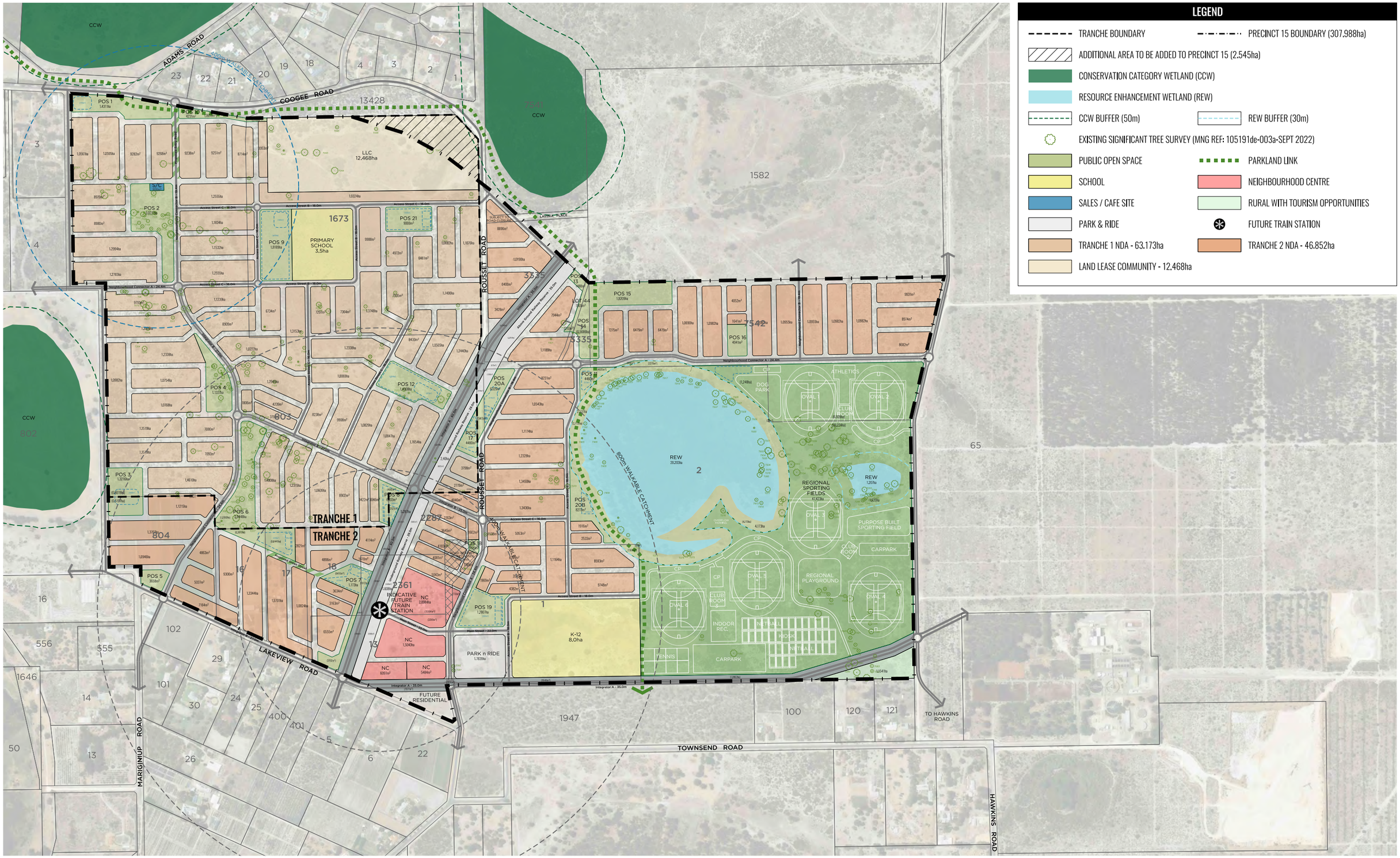
WAPC No. N/A

DRAWING No. 6496-LSP1-SK401

REVISION A

ORIGINAL SIZE A1

Appendix C: Precinct 15 Indicative master plan



INDICATIVE MASTER PLAN

Precinct 15

A Stockland Project

DRAFT

NORTH

Scale: 1:10 000 @ A3

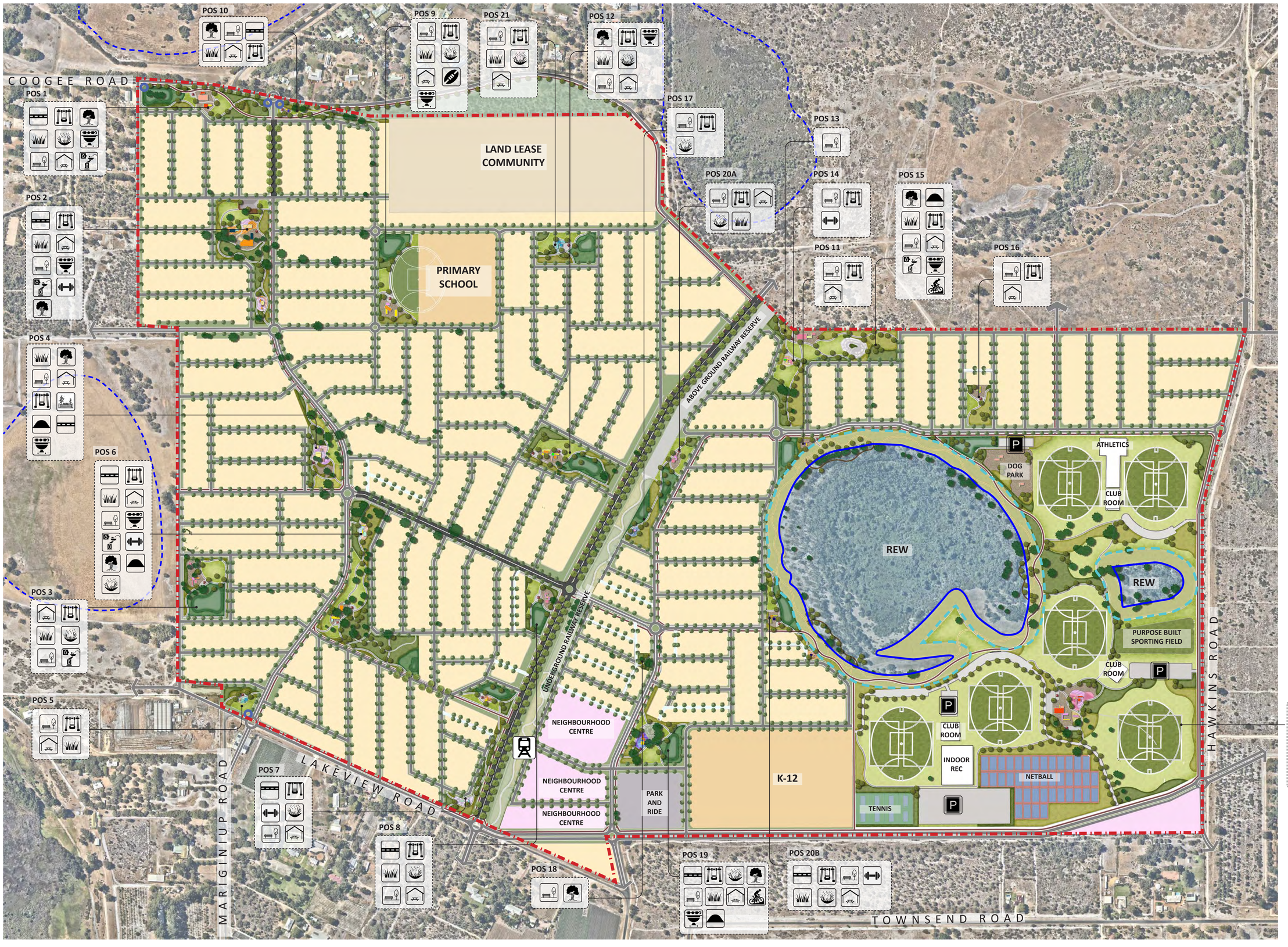
0 100 200 300m

PLAN: STOMA-1-010 REVISION: M
DATE: 15/06/2023 DRAWN: JP
PROJECTION: MGA 50 PLANNER: BK
DATUM: AHD CHECK: JH

cdp
Town Planning & Urban Design

Unit 2, 464 Murray Street
Perth WA 6000
(08) 6333 1888
info@cdpaus.com.au
www.cdpaus.com.au

Appendix D: Landscaping masterplan



LEGEND

- EXISTING LARGE TREE
- OPEN TURF
- FITNESS AREA
- BOARDWALK
- BASIN & SWALES
- DUAL USE PATH
- PLAYING FIELD
- CARPARK
- PLAYGROUND
- PARK SHELTER
- BBQ
- PICNIC SETTING
- DOG PARK
- CRUSHED LIMESTONE TRACK
- DRINK FOUNTAIN
- BENCH SEAT
- BMX BIKE TRACK
- COMMUNITY GARDEN
- FUTURE TRAIN STATION
- TURF MOUND
- EXTENT OF WORK
- REW
- REW BUFFER
- CCW
- ENTRY SIGNAGE
- EXISTING TREES
- PROPOSED PLANTING
- PROPOSED TURF
- PROPOSED REVEGETATION/ UNIRRIGATED TUBESTOCK

REGIONAL SPORTING COMPLEX

MARIGINIUP- Stockland

LANDSCAPE MASTERPLAN

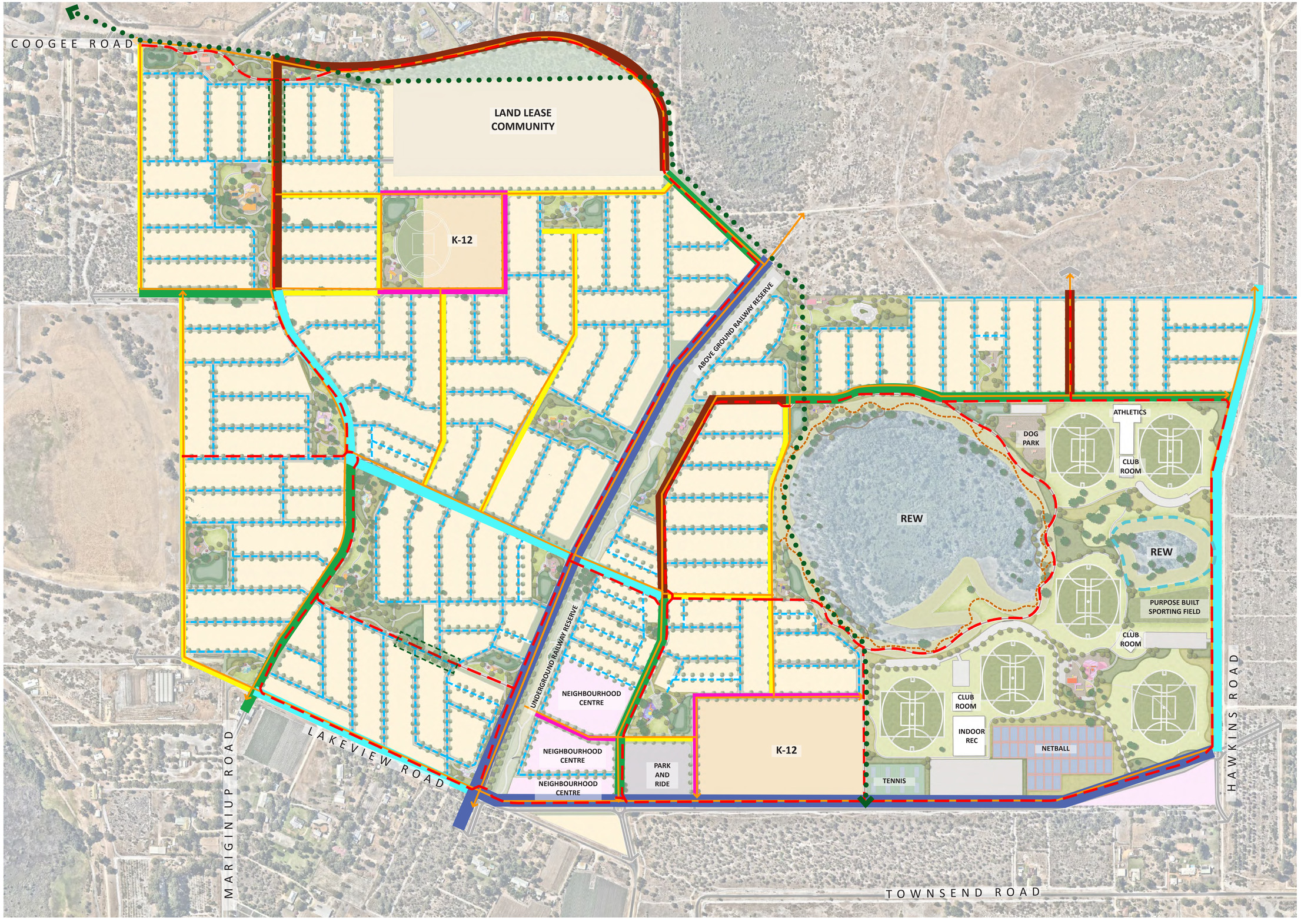
DWG **MAR01_DES**
REV **B**
DATE **2023-08-09**

0 40 80 120 160 200 m

SCALE **1 : 4000 @ A1**

emerge ASSOCIATES

U:\CURRENT PROJECTS\Mariginiup - Stockland\02 Concept & Reports\01 CODE Title of works\Indd\MAR-Mariginiup.indd



LEGEND

- Road Integrator A
- Road Integrator B
- Neighbourhood Connector A
- Neighbourhood Connector A
- Access Street A
- Access Street B
- Access Street D
- Pedestrian Footpath
- Crushed limestone/trail
- Dual Use Path
- Parkland Link
- Green Street

MARIGINIUP- Stockland

LANDSCAPE CIRCULATION PLAN

DWG **MAR01_DES**
REV **B**
DATE **2023-08-09**

0 40 80 120 160 200 m

SCALE **1 : 4000 @ A1**

emerge ASSOCIATES

U:\CURRENT PROJECTS\Mariginiup - Stockland\02 Concept & Reports\01 CODE Title of works\Indd\MAR-Mariginiup.indd

COOGEE ROAD

LAND LEASE COMMUNITY

K-12

ABOVE GROUND RAILWAY RESERVE

UNDERGROUND RAILWAY RESERVE

NEIGHBOURHOOD CENTRE

NEIGHBOURHOOD CENTRE

NEIGHBOURHOOD CENTRE

PARK AND RIDE

K-12

MARIGINIUP ROAD

LAKEVIEW ROAD

HAWKINS ROAD

ATHLETICS

DOG PARK

CLUB ROOM

REW

REW

PURPOSE BUILT SPORTING FIELD

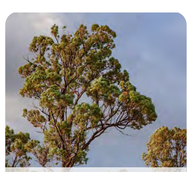
CLUB ROOM

CLUB ROOM

INDOOR REC

NETBALL

TENNIS



Eucalyptus gamphocephala
Tuart

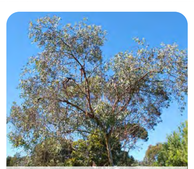
Melaleuca viridiflora
Broad Leafed Paperbark

Eucalyptus marginata
Jarrah

Brachychiton populneus
Kurrajong

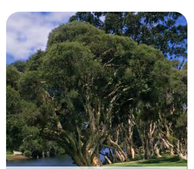
Eucalyptus torwood
Hybrid Coral Gum

Corymbia ficifolia
Red Flowering Gum



Eucalyptus woodwardii
Lemon-flowered Gum

Eucalyptus decipiens
Redheart



Melaleuca rhaphiophylla
Swamp Paperbark

Agonins flexuosa
Willow Myrtle

Hibiscus tiliaceus rubra
Cottonwood Hibiscus

Magnolia grandiflora
Southern Maganolia

MARIGINIUP- Stockland

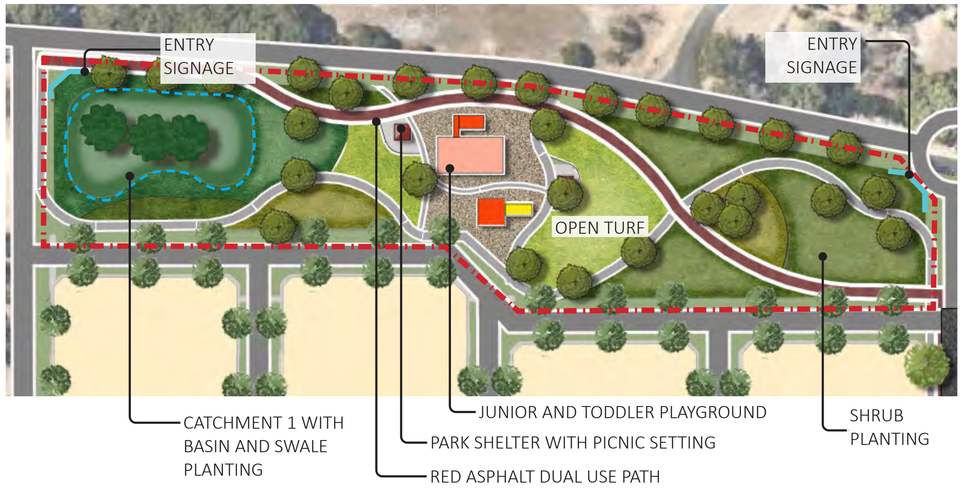
LANDSCAPE STREET TREE MASTERPLAN

DWG **MAR01_DES**
REV **B**
DATE **2023-08-09**
0 40 80 120 160 200 m
SCALE **1 : 4000 @ A1**

emerge ASSOCIATES

U:\CURRENT PROJECTS\Mariginiup - Stockland\02 Concept & Reports\01 CODE Title of works\Indd\MAR-Mariginiup.indd

POS 1 CONCEPT



DRAINAGE LEGEND - CATCHMENT 1

FIRST 15mm BRA DETAILS

Depth(m):	0.30
Base Area(m^2)	1600
Top Area(mAHD):	1747
Slope	1:3

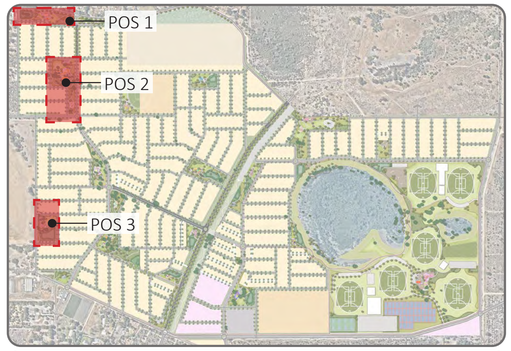
POS TYPOLOGY
- Neighborhood Park

SIZE
- 1.43 ha + Verge

CONCEPT
- D.U.P on northern side of the POS to provide connection to road integrators
- Existing trees to be retained
- Shrub revegetation under existing vegetation
- Provide a pedestrian link through estate
- Significant trees to be retained where possible
- Picnic area with shelter, picnic setting and BBQ area
- Playground to provide activity space
- Open turf to provide activity area to residents
- Provide entry signage
- Drainage basin as per LWMS

ENVIRONMENTAL CONSIDERATIONS
- Existing trees and vegetation to be retained where possible.
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.
- Provide a buffer to the adjacent road

FUNCTIONS / MATERIALS
- Existing trees to be retained
- Open turf area for outdoor activity
- Shelter with table settings and BBQ will provide opportunity for socialisation
- Playground for kids
- Connected path to open space perimeter, with connections to the broader path network.
- Entry signage to convey directions and enhance the character of the estate



LOCATION PLAN

POS TYPOLOGY
- Neighborhood Park

SIZE
- 1.3 ha + Verge

CONCEPT
- Concrete footpath to provide connection to road integrators
- Existing trees to be retained
- Shrub revegetation under existing vegetation
- Provide a pedestrian link through estate
- Provide Dog park with agility equiptment
- Significant trees to be retained where possible
- Picnic area with shelter and picnic setting
- playground to provide activity space
- Open turf to provide activity area to residents
- Drainage basin as per LWMS

ENVIRONMENTAL CONSIDERATIONS
- Existing trees and vegetation to be retained where possible.
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.
- Provide a buffer to the adjacent road

FUNCTIONS / MATERIALS
- Existing trees to be retained
- Open turf area for outdoor activity
- Shelter and picnic settings
- Nature Playground for kids
- Dog park for Dog agility play opportunities for residents
- Connected path to open space perimeter, with connections to the broader path network.

- TURF
- SHRUB PLANTING (AMENITY)
- LOW FUEL PLANTING
- BASIN
- LOT
- DUAL USE PATH
- FOOTPATH
- MULCH ONLY
- STREET TREES
- EXISTING TREES
- PROPOSED TREES
- CRUSHED LIMESTONE PATH
- BOARDWALK
- REVEGETATION
- EXTENT OF WORK
- REW
- REW BUFFER

POS 2 CONCEPT

POS TYPOLOGY
- Neighborhood Park

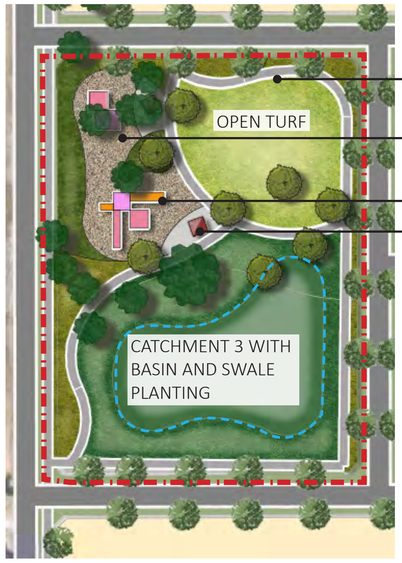
SIZE
- 2.02 ha + Verge

CONCEPT
- D.U.P on eastern side of the POS to provide connection to road integrators
- Existing trees to be retained
- Shrub revegetation under existing vegetation
- Provide a pedestrian link through estate
- Significant trees to be retained where possible
- Picnic area with shelter, picnic setting and BBQ area
- Playground to provide activity space
- Open turf to provide activity area to residents
- Provide fitness area for residents

ENVIRONMENTAL CONSIDERATIONS
- Existing trees and vegetation to be retained where possible.
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.

FUNCTIONS / MATERIALS
- Existing trees to be retained
- Open turf area for outdoor activity
- Shelter with table settings and BBQ will provide opportunity for socialisation
- Playground for kids
- Connected path to open space perimeter, with connections to the broader path network.
- Outdoor excercise area provide fitness oppotunities for the residents

POS 3 CONCEPT



DRAINAGE LEGEND - CATCHMENT 3

FIRST 15mm BRA DETAILS

Depth(m):	0.30
Base Area(m^2)	2500
Top Area(mAHD):	2683
Slope	1:3

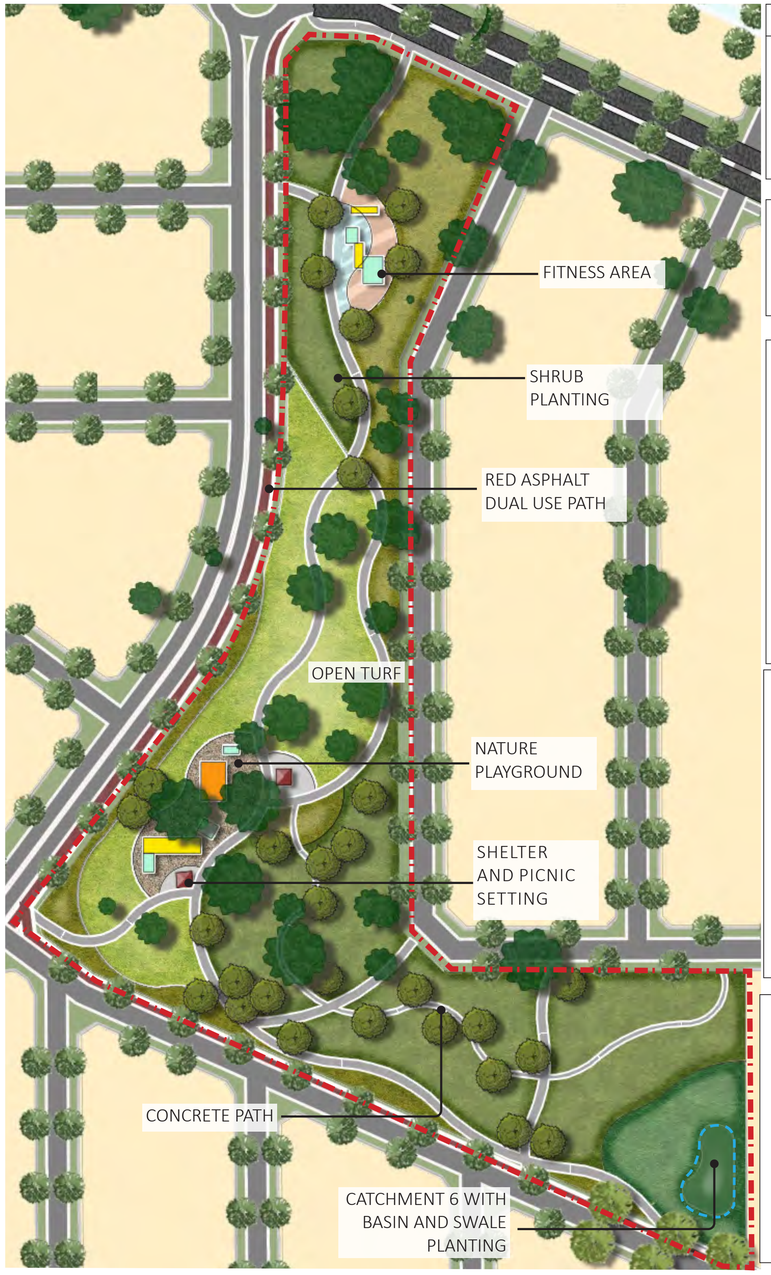
MARIGINIUP- Stockland

LANDSCAPE DETAILED PLAN POS 1, 2 AND 3

DWG **MAR01_DES**
REV **B**
DATE **2023-08-09**
0 10 20 30 40 50 m
SCALE **1 : 1000 @ A1**

emerge ASSOCIATES

POS 6 CONCEPT



DRAINAGE LEGEND - CATCHMENT 6

FIRST 15mm BRA DETAILS

Depth(m):	0.30
Base Area(m^2)	289
Top Area(mAHD):	353
Slope	1:3

POS TYPOLOGY
- Neighborhood Park

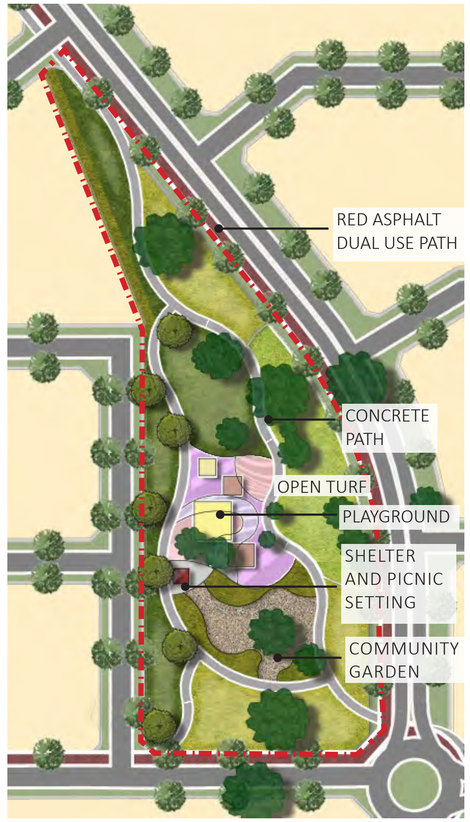
SIZE
- 2.94 ha + Verge

CONCEPT
- D.U.P on western side of the POS to provide connection to road integrators
- Existing trees to be retained
- Shrub revegetation under existing vegetation
- Provide a pedestrian link through estate
- Significant trees to be retained where possible
- Picnic area with shelter, picnic setting and BBQ area
- Playground to provide activity space
- Open turf to provide activity area to residents
- Provide fitness area
- Drainage basin as per LWMS

ENVIRONMENTAL CONSIDERATIONS
- Existing trees and vegetation to be retained where possible.
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.
- Provide a buffer to the adjacent road

FUNCTIONS / MATERIALS
- Existing trees to be retained
- Open turf area for outdoor activity
- Shelter with table settings and BBQ will provide opportunity for socialisation
- Playground for kids
- Outdoor excercise area provide fitness oppotunities for the residents
- Connected path to open space perimeter, with connections to the broader path network.

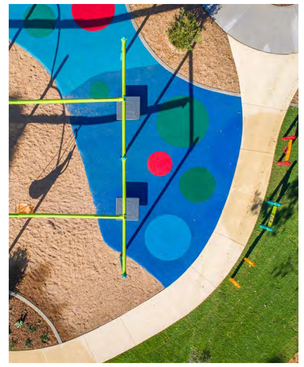
POS 4 CONCEPT

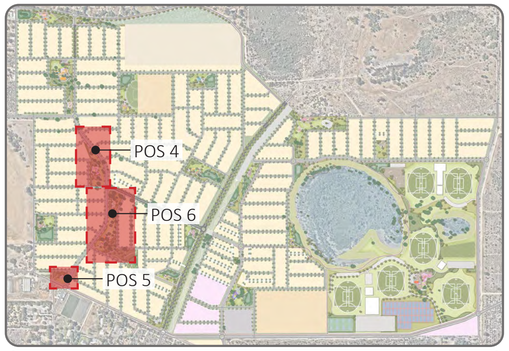


POS TYPOLOGY
- Neighborhood Park

SIZE
- 1.13 ha + Verge

CONCEPT
- D.U.P on eastern side of the POS to provide connection to road integrators
- Existing trees to be retained
- Shrub vegetation under existing vegetation
- Provide a pedestrian link through estate
- Significant trees to be retained where possible
- Picnic area with shelter, picnic setting and BBQ area
- playground to provide activity space
- Open turf to provide activity area to residents
- Provide fitness area for residents





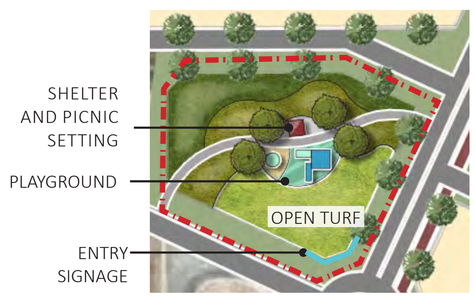
LOCATION PLAN

ENVIRONMENTAL CONSIDERATIONS
- Existing trees and vegetation to be retained where possible.
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.

FUNCTIONS / MATERIALS
- Existing trees to be retained
- Open turf area for outdoor activity
- Shelter with table settings and BBQ will provide opportunity for socialisation
- Playground for kids
- Connected path to open space perimeter, with connections to the broader path network.
- Community garden with recycled materials to provide family activity opportunity for residents

- TURF
- SHRUB PLANTING (AMENITY)
- LOW FUEL PLANTING
- BASIN
- LOT
- DUAL USE PATH
- FOOTPATH
- MULCH ONLY
- STREET TREES
- EXISTING TREES
- PROPOSED TREES
- CRUSHED LIMESTONE PATH
- BOARDWALK
- REVEGETATION
- EXTENT OF WORK
- REW
- REW BUFFER

POS 5 CONCEPT



POS TYPOLOGY
- Pocket Park

SIZE
- 3,658 m^2 + Verge

CONCEPT
- Playground for kids
- Shelter and picnic settings
- Plantings to provide buffer to external road
- Small turf area to provide open space
- Provide a pedestrian link through estate from the road
- Entry signage to convey directions and enhance the character of the estate

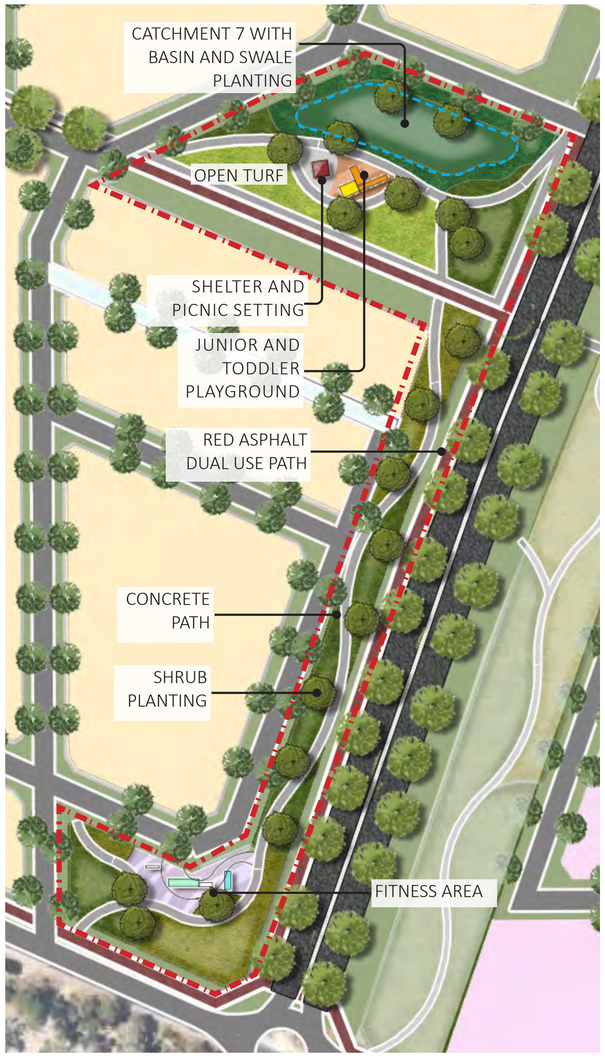
MARIGINIUP- Stockland

LANDSCAPE DETAILED PLAN POS 4, 5 AND 6

DWG **MAR01_DES**
REV **B**
DATE **2023-08-09**
0 10 20 30 40 50 m
SCALE **1 : 1000 @ A1**

emerge ASSOCIATES

POS 7 CONCEPT



DRAINAGE LEGEND - CATCHMENT 7

FIRST 15mm BRA DETAILS

Depth(m):	0.30
Base Area(m^2)	961
Top Area(mAHD):	1076
Slope	1:3

POS TYPOLOGY
- Neighborhood Park

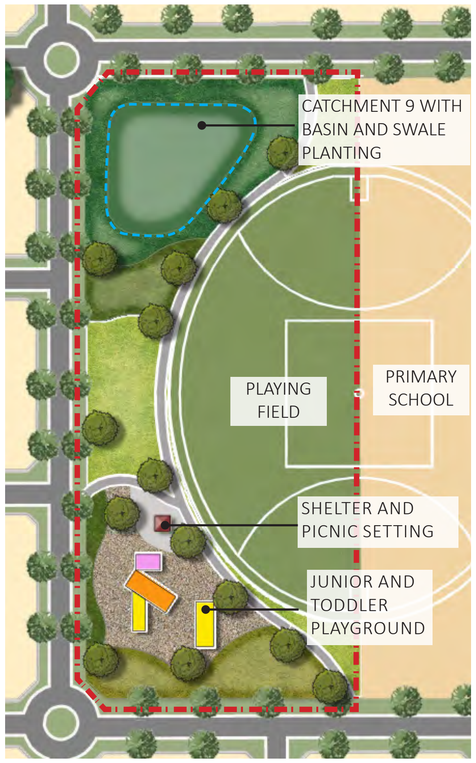
SIZE
- 1.17 ha + Verge

CONCEPT
- D.U.P most side of the POS to provide connection to road integrators
- Shrub vegetation to provide buffer along main integrator
- Provide a pedestrian link through estate
- Picnic area with shelter and picnic setting
- playground to provide activity space
- Open turf to provide activity area to residents
- Provide fitness area for residents
- Drainage basin as per LWMS

ENVIRONMENTAL CONSIDERATIONS
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.
- Provide a buffer to the adjacent road

FUNCTIONS / MATERIALS
- Open turf area for outdoor activity
- Shelter and picnic settings
- Playground for kids
- Fitness area for residents
- Connected path to open space perimeter, with connections to the broader path network and DUP
- Outdoor excercise area provide fitness oppotunities for the residents

POS 9 CONCEPT



DRAINAGE LEGEND - CATCHMENT 9

FIRST 15mm BRA DETAILS

Depth(m):	0.30
Base Area(m^2)	1521
Top Area(mAHD):	1665
Slope	1:3

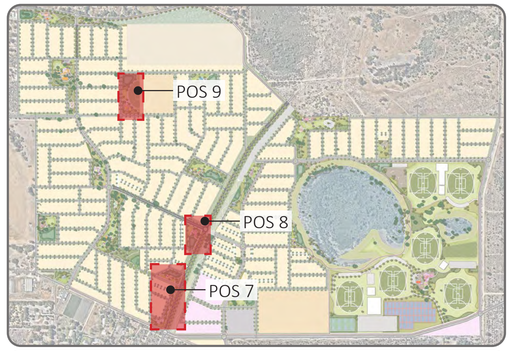
POS TYPOLOGY
- Neighbourhood Park

SIZE
- 1.81 ha + Verge

CONCEPT
- Concrete footpath to provide connection to road integrators
- Picnic area with shelter, picnic setting and BBQ area
- playground to provide activity space
- Open turf to provide activity area
- Provide Playing field to share with Primary School
- Drainage basin as per LWMS

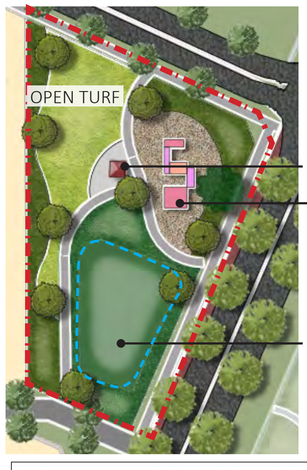
ENVIRONMENTAL CONSIDERATIONS
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.
- Provide a buffer to the adjacent road

FUNCTIONS / MATERIALS
- Open turf area for playing field and outdoor activity
- Shelter with table settings and BBQ will provide opportunity for socialisation
- Playground for kids
- Connected path to open space



LOCATION PLAN

POS 8 CONCEPT



DRAINAGE LEGEND - CATCHMENT 8

FIRST 15mm BRA DETAILS

Depth(m):	0.30
Base Area(m^2)	1024
Top Area(mAHD):	1142
Slope	1:3

POS TYPOLOGY
- Local Park

SIZE
- .660 ha + Verge

CONCEPT
- Concrete footpath to provide connection to road integrators and DUP
- Picnic area with shelter and picnic setting
- playground to provide activity space
- Open turf to provide activity area
- Significant trees to be retained where possible
- Drainage basin as per LWMS

FUNCTIONS / MATERIALS
- Open turf area for playing field and outdoor activity
- Shelter and picnic settings
- Playground for kids
- Connected path to open space

ENVIRONMENTAL CONSIDERATIONS
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.
- Provide a buffer to the adjacent road

- TURF
- SHRUB PLANTING (AMENITY)
- LOW FUEL PLANTING
- BASIN
- LOT
- DUAL USE PATH
- FOOTPATH
- MULCH ONLY
- STREET TREES
- EXISTING TREES
- PROPOSED TREES
- CRUSHED LIMESTONE PATH
- BOARDWALK
- REVEGETATION
- EXTENT OF WORK
- REW
- REW BUFFER

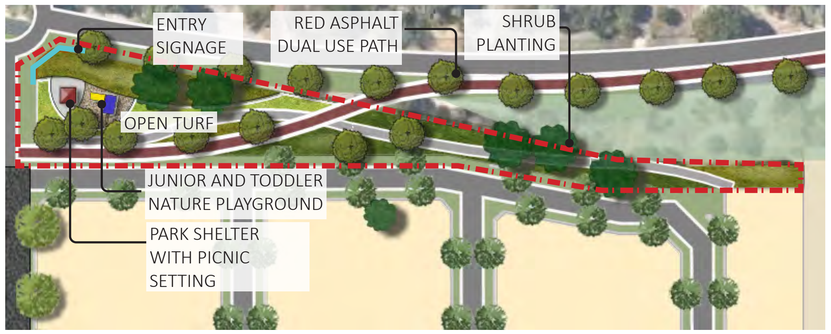
MARIGINIUP- Stockland

LANDSCAPE DETAILED PLAN POS 7, 8 AND 9

DWG **MAR01_DES**
REV **B**
DATE **2023-08-09**
0 10 20 30 40 50 m
SCALE **1 : 1000 @ A1**

emerge ASSOCIATES

POS 10 CONCEPT



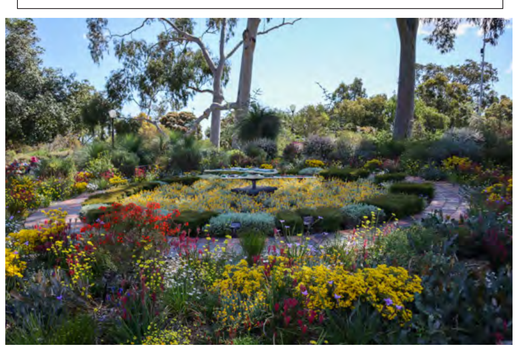
POS TYPOLOGY
- Pocket Park

SIZE
- .4231 ha + Verge

CONCEPT
- D.U.P on northern side of the POS to provide connection to road integrators
- Shrub vegetation to provide buffer along main integrator
- Provide a pedestrian link through estate
- Significant trees to be retained where possible
- Picnic area with shelter and picnic setting
- playground to provide activity space
- Open turf to provide activity area to residents
- Provide entry signage

ENVIRONMENTAL CONSIDERATIONS
- Existing trees and vegetation to be retained where possible.
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.
- Provide a buffer to the adjacent road

FUNCTIONS / MATERIALS
- Existing trees to be retained
- Open turf area for outdoor activity
- Shelter and picnic settings
- Playground for kids
- Entry signage to convey directions and enhance the character of the estate
- Connected path to open space perimeter, with connections to the broader path network.



POS 12 CONCEPT

DRAINAGE LEGEND - CATCHMENT 12

FIRST 15mm BRA DETAILS	
Depth(m):	0.30
Base Area(m²)	1521
Top Area(mAHD):	1665
Slope	1:3

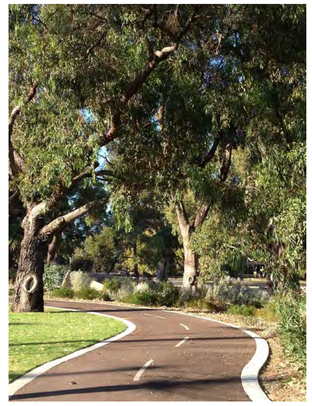
POS TYPOLOGY
- Neighborhood Park

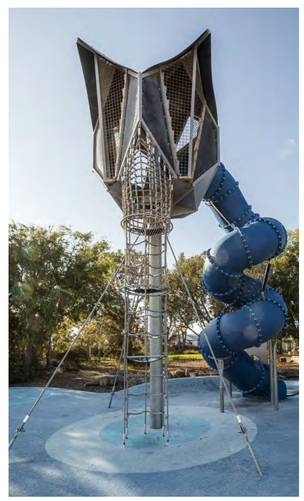
SIZE
- 1.4 ha + Verge

CONCEPT
- D.U.P near eastern side of the POS to provide connection to road integrators
- Significant trees to be retained where possible
- Shrub vegetation
- Provide a pedestrian link through estate
- Picnic area with shelter, picnic setting and BBQ area
- All ages playground to provide activity space
- Open turf to provide activity area to residents
- Drainage basin as per LWMS

ENVIRONMENTAL CONSIDERATIONS
- Existing trees and vegetation to be retained where possible.
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.
- Provide a buffer to the adjacent road

FUNCTIONS / MATERIALS
- Existing trees to be retained
- Open turf area for outdoor activity
- Shelter with table settings and BBQ will provide opportunity for socialisation
- Playground for all ages
- Connected path to open space with connections to the broader path



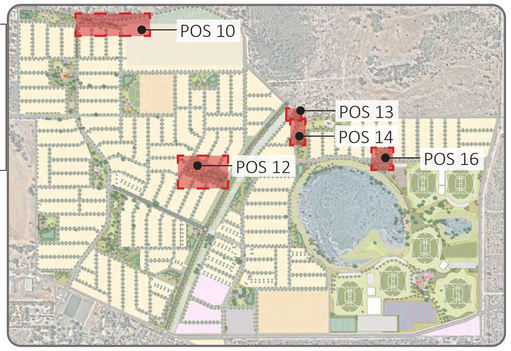


POS 13 CONCEPT

POS TYPOLOGY
- Pocket Park

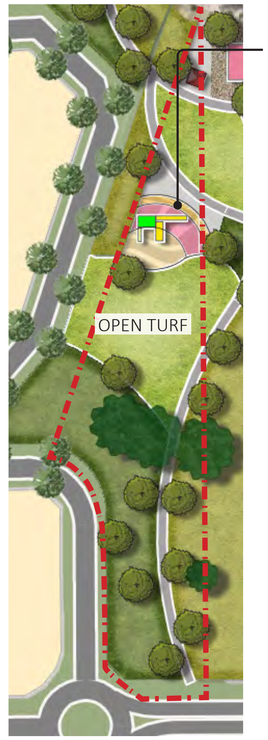
SIZE
- 1,488 m² + Verge

CONCEPT
- Plantings to provide buffer to external road
- Provide a pedestrian link through estate and



LOCATION PLAN

POS 14 CONCEPT

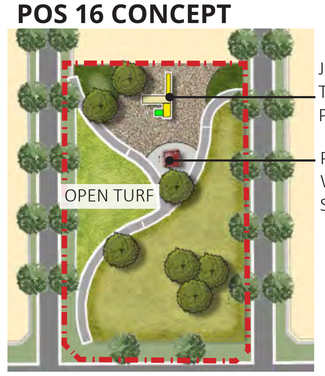


POS TYPOLOGY
- Local Park

SIZE
- 5,686 m² + Verge

CONCEPT
- Shelter and picnic settings
- Plantings to provide buffer to external road
- Small turf area to be part of connecting POS turf area to provide a wider open space
- Significant trees to be retained where possible
- Outdoor excercise area provide fitness oppotunities for the residents
- Provide a pedestrian link through estate from the road through connecting POS

POS 16 CONCEPT



POS TYPOLOGY
- Pocket Park

SIZE
- 4,941 m² + Verge

CONCEPT
- Plantings to provide buffer to external road
- Small Playground for kids
- Provide a pedestrian link through estate and from the road
- Drainage basin as per LWMS

- TURF
- SHRUB PLANTING (AMENITY)
- LOW FUEL PLANTING
- BASIN
- LOT
- DUAL USE PATH
- FOOTPATH
- MULCH ONLY
- STREET TREES
- EXISTING TREES
- PROPOSED TREES
- CRUSHED LIMESTONE PATH
- BOARDWALK
- REVEGETATION
- EXTENT OF WORK
- REW
- REW BUFFER

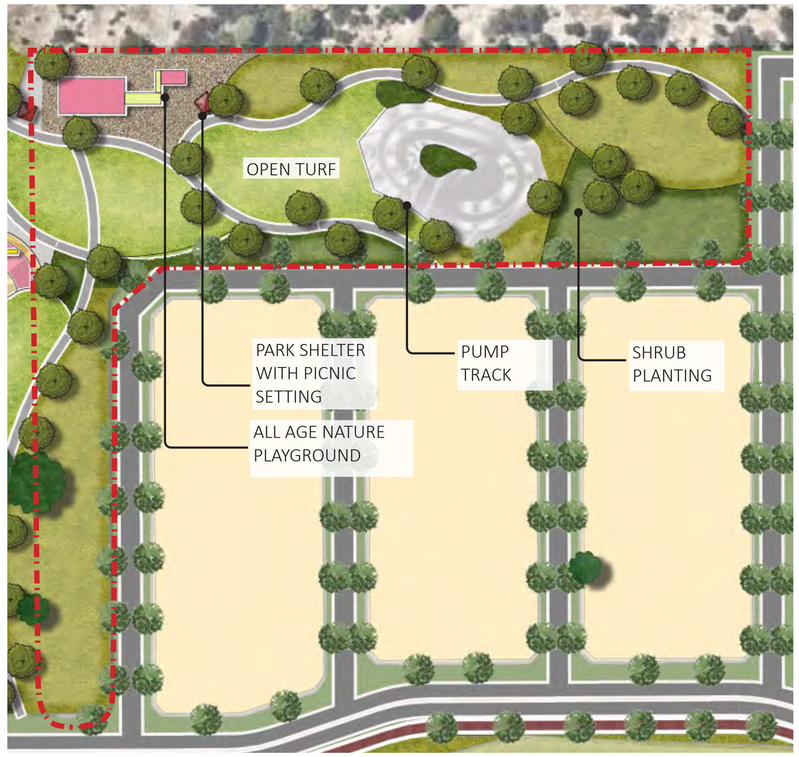
MARIGINIUP- Stockland

LANDSCAPE DETAILED PLAN POS 10, 12, 13, 14 and 16

DWG **MAR01_DES**
REV **B**
DATE **2023-08-09**
0 10 20 30 40 50 m
SCALE **1 : 1000 @ A1**

emerge ASSOCIATES

POS 15 CONCEPT



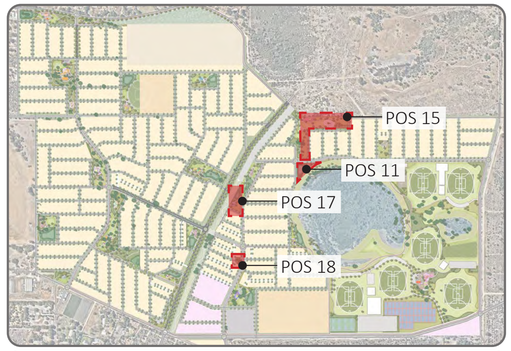
POS TYPOLOGY
- Neighbourhood Park

SIZE
- 1.92 ha + Verge

CONCEPT
- Concrete footpath to provide a pedestrian link through estate and connecting the POS to road integrators
- Shrub vegetation to provide as a buffer to adjacent road
- Picnic area with shelter, picnic setting and BBQ area
- All ages playground to provide activity space
- Provide pump track
- Open turf to provide activity area to residents
- Turf mounding to create a unique landscape topography
- Drainage basin as per LWMS

ENVIRONMENTAL CONSIDERATIONS
- Existing trees and vegetation to be retained where possible.
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.
- Provide a buffer to the adjacent road

FUNCTIONS / MATERIALS
- Existing trees to be retained
- Open turf area for outdoor activity
- Shelter with table settings and BBQ will provide opportunity for socialisation
- All age Nature Playground for kids
- Pump track will create exercise and play opportunity as well as socialisation
- Connected path to open space perimeter, with connections to the broader path network.
- Provide a pedestrian link through estate and connecting POS from the road



LOCATION PLAN

POS 11 CONCEPT

DRAINAGE LEGEND - CATCHMENT 11

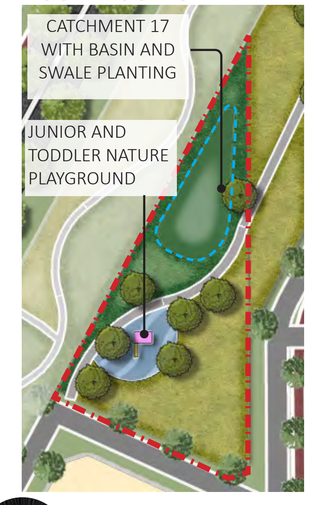
FIRST 15mm BRA DETAILS	
Depth(m):	0.30
Base Area(m^2)	1089
Top Area(mAHD):	1211
Slope	1:3

POS TYPOLOGY
- Pocket Park

SIZE
- 4,941 m^2 + Verge

CONCEPT
- Plantings to provide buffer to external road
- Small Playground for kids
- Provide a pedestrian link through estate and from the road
- Drainage basin as per LWMS

POS 17 CONCEPT



DRAINAGE LEGEND - CATCHMENT 17

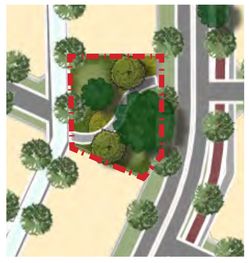
FIRST 15mm BRA DETAILS	
Depth(m):	0.30
Base Area(m^2)	576
Top Area(mAHD):	666
Slope	1:3

POS TYPOLOGY
- Pocket Park

SIZE
- 4,480 m^2 + Verge

CONCEPT
- Plantings to provide buffer to external road
- Small Playground for kids
- Provide a pedestrian link through estate and connecting POS from the road
- Drainage basin as per LWMS

POS 18 CONCEPT



POS TYPOLOGY
- Pocket Park

SIZE
- 1,020 m^2 + Verge

CONCEPT
- Plantings to provide buffer to external road
- Significant trees to be retained where possible
- Provide a pedestrian link through estate from the road

- TURF
- SHRUB PLANTING (AMENITY)
- LOW FUEL PLANTING
- BASIN
- LOT
- DUAL USE PATH
- FOOTPATH
- MULCH ONLY
- STREET TREES
- EXISTING TREES
- PROPOSED TREES
- CRUSHED LIMESTONE PATH
- BOARDWALK
- REVEGETATION
- EXTENT OF WORK
- REW
- REW BUFFER

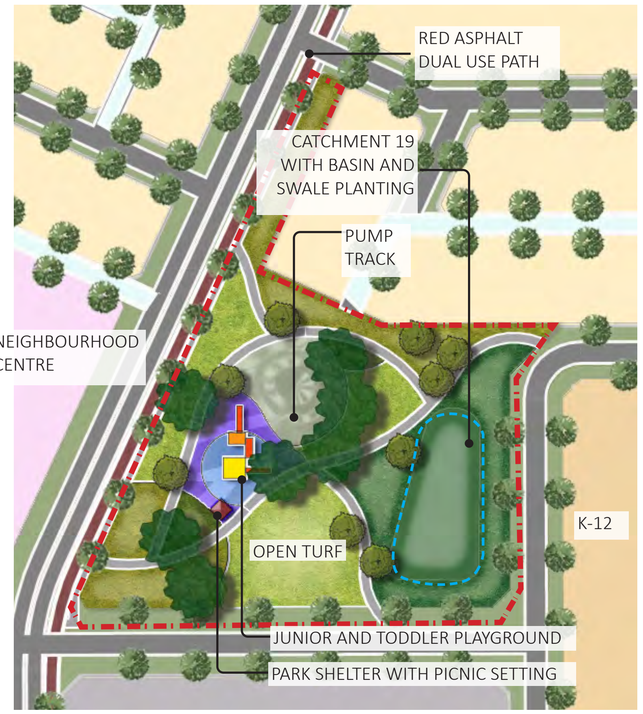
MARIGINIUP- Stockland

LANDSCAPE DETAILED PLAN POS 15,17 AND 18

DWG **MAR01_DES**
REV **B**
DATE **2023-08-09**
0 10 20 30 40 50 m
SCALE **1 : 1000 @ A1**

emerge ASSOCIATES

POS 19 CONCEPT



DRAINAGE LEGEND - CATCHMENT 19

FIRST 15mm BRA DETAILS

Depth(m):	0.30
Base Area(m^2)	1089
Top Area(mAHD):	1211
Slope	1:3

POS TYPOLOGY
- Neighbourhood Park

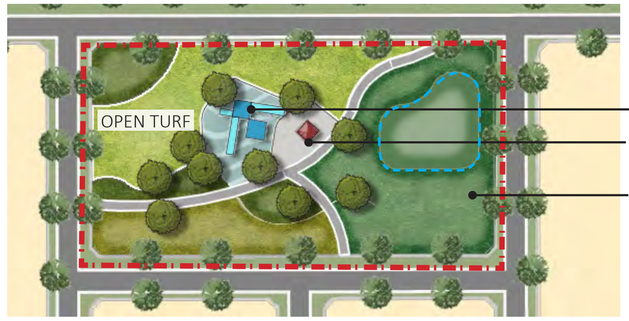
SIZE
- 1.28 ha + Verge

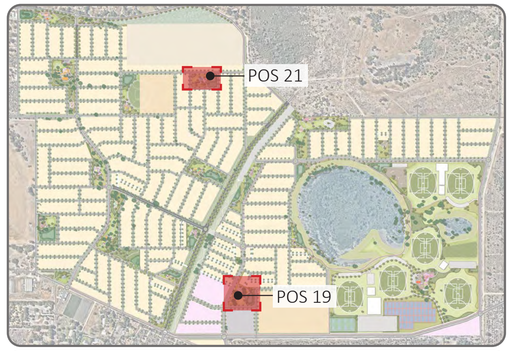
CONCEPT
- D.U.P on western side of the POS to provide connection to road integrators
- Concrete footpath to provide connection to road integrators
- Shrub vegetation to provide buffer from adjacent road
- Provide a pedestrian link through estate from neighbourhood centre
- Opportunity of BMX bike tracks to be implemented in existing tree canopy at where is appropriate
- Open turf to provide activity area to residents
- Turf mounding to create a unique landscape topography
- Significant trees to be retained where possible
- Picnic area with shelter, picnic setting and BBQ area
- Playground to provide activity space
- Drainage basin as per LWMS

FUNCTIONS / MATERIALS
- Playground for kids
- Turf mounding to create unique landscape topography
- Pump track will create exercise and play opportunity as well as socialisation
- Shelter with table settings and BBQ will provide opportunity for socialisation
- Existing trees to be retained
- Open turf area for outdoor activity
- Connected path and pedestrian link to open space perimeter, with connections to the neighbourhood centre, school and train station

ENVIRONMENTAL CONSIDERATIONS
- Existing trees and vegetation to be retained where possible.
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.
- Provide a buffer to the adjacent road

POS 21 CONCEPT





LOCATION PLAN

DRAINAGE LEGEND - CATCHMENT 21

FIRST 15mm BRA DETAILS

Depth(m):	0.30
Base Area(m^2)	676
Top Area(mAHD):	773
Slope	1:3

POS TYPOLOGY
- Local Park

SIZE
- .9 ha + Verge

FUNCTIONS / MATERIALS
- Existing trees to be retained
- Open turf area for outdoor activity
- Shelter and picnic settings
- Playground for kids
- Connected path to open space perimeter, with connections to the broader path network.

CONCEPT
- Shrub vegetation to provide as buffer to adjacent road
- Provide a pedestrian link through estate
- Significant trees to be retained where possible
- Picnic area with shelter and picnic setting
- playground to provide activity space
- Open turf to provide activity area to residents
- Drainage basin as per LWMS

ENVIRONMENTAL CONSIDERATIONS
- Existing trees and vegetation to be retained where possible.
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.
- Provide a buffer to the adjacent road

TURF
SHRUB PLANTING (AMENITY)
LOW FUEL PLANTING
BASIN
LOT
DUAL USE PATH
FOOTPATH
MULCH ONLY
STREET TREES
EXISTING TREES
PROPOSED TREES
CRUSHED LIMESTONE PATH
BOARDWALK
REVEGETATION
EXTENT OF WORK
REW
REW BUFFER

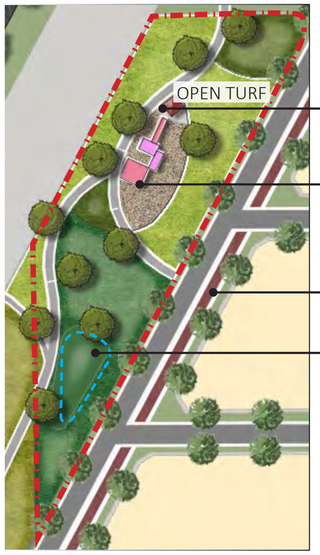
MARIGINIUP- Stockland

LANDSCAPE DETAILED PLAN POS 19 AND 21

DWG **MAR01_DES**
REV **B**
DATE **2023-08-09**
0 10 20 30 40 50 m
SCALE **1 : 1000 @ A1**

emerge ASSOCIATES

POS 20A CONCEPT



CONCEPT
- Shrub vegetation to provide buffer to adjacent road
- Provide a pedestrian link through estate and connecting POS from the road
- Picnic area with shelter and picnic setting
- Playground to provide activity space
- Open turf to provide activity area to residents
- Drainage basin as per LWMS

ENVIRONMENTAL CONSIDERATIONS
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.
- Provide a buffer to the adjacent road

DRAINAGE LEGEND - CATCHMENT 20A

FIRST 15mm BRA DETAILS	
Depth(m):	0.30
Base Area(m^2)	289
Top Area(mAHD):	353
Slope	1:3

POS TYPOLOGY
- Local Park

SIZE
- .6329 ha + Verge

FUNCTIONS / MATERIALS
- Open turf area for outdoor activity
- Shelter and picnic settings
- Playground for kids
- Connected path to open space perimeter, with connections to the broader path network.

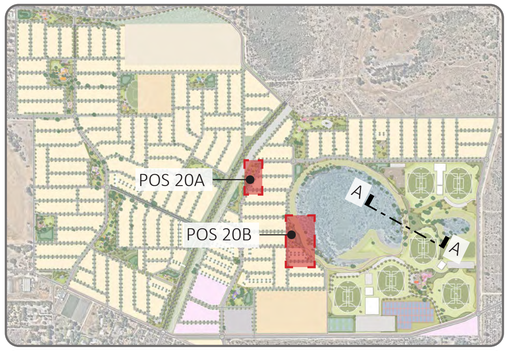
DRAINAGE LEGEND - CATCHMENT 20B

FIRST 15mm BRA DETAILS	
Depth(m):	0.30
Base Area(m^2)	1225
Top Area(mAHD):	1354
Slope	1:3

POS TYPOLOGY
- Local Park

SIZE
- .8273 ha + Verge

FUNCTIONS / MATERIALS
- Open turf area for outdoor activity
- Shelter and picnic settings
- Playground for kids
- Outdoor excercise area provide fitness oppotunities for the residents
- Connected path to open space perimeter, with connections to the broader path network and DUP



LOCATION PLAN

CONCEPT
- D.U.P on southern side of the POS to provide connection to road integrators
- Provide fitness area for residents
- Shrub vegetation to provide buffer to adjacent road
- Provide a pedestrian link through estate and REW
- Picnic area with shelter and picnic setting
- playground to provide activity space
- Open turf to provide activity area to residents
- Drainage basin as per LWMS

ENVIRONMENTAL CONSIDERATIONS
- Low fuel planting to minimise the threat area intensity for bushfire prone areas
- Water-wise native planting and planting
- Source local materials where possible to minimise transport requirements and provide local employment.
- Consider long-term maintenance requirements.

LEGEND
- TURF
- SHRUB PLANTING (AMENITY)
- LOW FUEL PLANTING
- BASIN
- LOT
- DUAL USE PATH
- FOOTPATH
- MULCH ONLY
- STREET TREES
- EXISTING TREES
- PROPOSED TREES
- CRUSHED LIMESTONE PATH
- BOARDWALK
- REW
- REVEGETATION
- EXTENT OF WORK
- REW
- REW BUFFER

REGIONAL POS SECTION

SECTION A-A

SCALE **1 : 200 @ A1**

MARIGINIUP- Stockland

LANDSCAPE DETAILED PLAN POS 20A AND 20B

DWG **MAR01_DES**
REV **B**
DATE **2023-08-09**
0 10 20 30 40 50 m
SCALE **1 : 1000 @ A1**

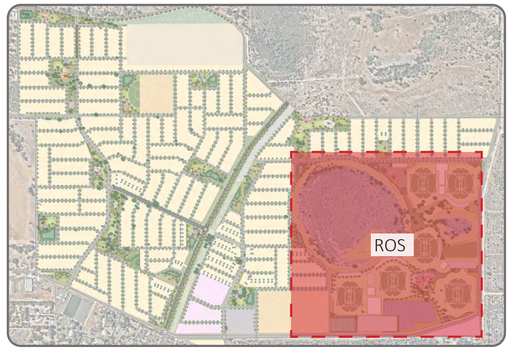
emerge ASSOCIATES

POS TYPOLOGY
- Sports POS

SIZE
- 47.423 ha + Verge

CONCEPT POS 7
- Playing field to provide with senior 6xAFL oval, 2
- Dual use path to provide cyclists and pedestrian with connection to wetland area
- Connected path to open space perimeter, with connections to the broader path network and DUP
- Provide a pedestrian link through estate, REW and road integrators
- All age playground to provide play space
- Fitness area to provide exercise space
- 2x Shelter with picnic settings to provide BBQ area
- Shrub vegetation to provide buffer to adjacent road
- Open turf to provide activity area to residents
- Mounded turf to create good views to the playing field as well as to provide opportunities for sitting, laying, and gathering
- Large area of existing vegetation & significant trees to be retained and protected
- Dog park with agilities to be included in the POS
- Drainage basin as per LWMS design

ENVIRONMENTAL CONSIDERATIONS
- Large area of existing vegetation to be retained and protected for local flora and fauna habitat
- Revegetation planting around REW buffers to enhance local flora and fauna habitat. Palette aligns with spring survey results
- Significant existing trees to be retained in open space where possible
- Water-wise native planting.
- Consider long-term maintenance requirements.
- Source local materials where possible to minimise transport requirements and provide local employment.
- Dirt and crushed limestone track/path in existing vegetation area instead of



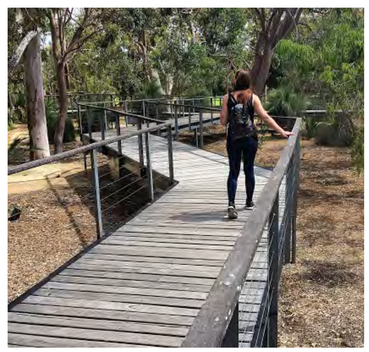
LOCATION PLAN

FUNCTIONS / MATERIALS
- Significant existing trees to be retained
- Playing field including 6x AFL Senior oval
- Open turf area for outdoor activity
- Mounded turf to create good views
- Shelter with table settings and BBQ will provide opportunity for socialisation
- All-age playground for all people
- Dog park for dog agility play opportunity for residents
- Turf mounding to create unique landscape topography
- Boardwalk to provided good view above drainage basin
- Limestone path in shrub planting
- Outdoor excercise area provide fitness oppotunities for the residents
- Connected path to open space perimeter, with connections to the broader path network and DUP

LEGEND
- TURF
- SHRUB PLANTING (AMENITY)
- LOW FUEL PLANTING
- BASIN
- LOT
- DUAL USE PATH
- FOOTPATH
- MULCH ONLY
- STREET TREES
- EXISTING TREES
- PROPOSED TREES
- CRUSHED LIMESTONE PATH
- BOARDWALK
- REW
- REVEGETATION
- EXTENT OF WORK
- REW
- REW BUFFER

DRAINAGE LEGEND - CATCHMENT 16

FIRST 15mm BRA DETAILS	
Depth(m):	0.30
Base Area(m^2)	2401
Top Area(mAHD):	2582
Slope	1:3



MARIGINIUP- Stockland
LANDSCAPE DETAILED PLAN REGIONAL SPORTING COMPLEX

DWG MAR01_DES
REV B
DATE 2023-08-09
0 10 20 30 40 50 m
SCALE 1 : 1000 @ A1

emerge ASSOCIATES

STREET TREE PLANTINGS


Eucalyptus gomphocephala

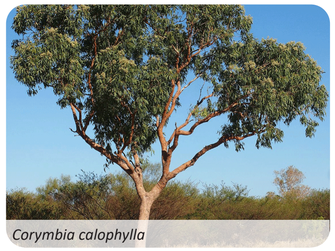

Jacaranda mimosifolia


Olea europaea (Swan Hill)

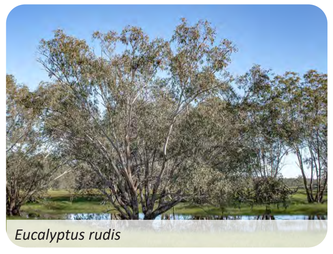

Melaleuca leucadendron

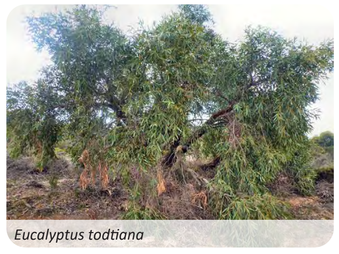

Agonis flexuosa


Callistemon 'KPS'


Corymbia calophylla


Eucalyptus gomphocephala


Eucalyptus rudis


Eucalyptus todtiana


Eucalyptus marginata


Melaleuca rhaphiophylla

SHRUB PLANTING


Acacia lasiocarpa


Conostylis aculeata ssp. preissii


Dianella revoluta


Dampiera linearis


Eremophila maculata


Grevillea crithmifolia


Grevillea thelemanniana


Hemiandra pungens


Patersonia occidentalis


Olearia axillaris


Rhagodia baccata


Darwinia citriodora


Dianella cassa blue


Eremophila glabra


Lepidosperma calcicola


Lepidosperma gladiatum


Lomandra longifolia


Meeboldina scariosa

MARIGINIUP- Stockland

LANDSCAPE PLANTING PALETTE - PUBLIC OPEN SPACE AND STREETSCAPE

DWG **MAR01_DES**
REV **B**
DATE **2023-08-09**

emerge ASSOCIATES

U:\CURRENT PROJECTS\Mariginiup - Stockland\02 Concept & Reports\01 CODE Title of works\Indd\MAR-Mariginiup.indd

REVEGETATION PLANTING


Anigozanthos manglesii


Adenanthos cygnorum


Adenanthos cygnorum

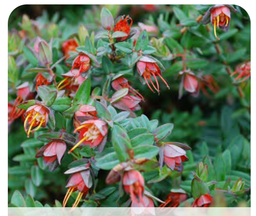

Acacia pulchella


Beaufortia squarrosa


Baumea juncea


Banksia grandis


Calothamnus sanguineus


Darwinia citriodora


Eucalyptus rudis


Hypocalymma angustifolium


Juncus pallidus


Jacksonia sternbergiana


Kunzea glabrescens


Kennedia prostrata


Regelia inops


Verticordia densiflora

LOW FUEL PLANTING


Anigozanthos manglesii


Austrostipa compressa


Conostylis aculeata


Dampiera linearis


Juncus pallidus


Kennedia prostrata


Kunzea recurva


Melaleuca thymoides


Patersonia occidentalis

MARIGINIUP- Stockland

LANDSCAPE PLANTING PALETTE - PUBLIC OPEN SPACE AND STREETSCAPE

DWG **MAR01_DES**
REV **B**
DATE **2023-08-09**

emerge ASSOCIATES

Appendix E: Concept earthworks design

LEGEND	
DESCRIPTION	SYMBOL
SUBJECT LAND BOUNDARY	
DEAD TREE	
HIGH AMENITY	
MODERATE AMENITY	
LOW AMENITY	
EXISTING SURFACE CONTOUR	25.0
FINISHED SURFACE DESIGN CONTOUR	25.0

NOTE:
THE LOCATION OF DRAINAGE BASINS SHOWN ARE INDICATIVE ONLY. BASINS HAVE BEEN LOCATED WHERE STORAGE WILL BE REQUIRED BASED ON THE SITE GRADING SHOWN.
THE SIZE OF THE BASINS SHOWN DO NOT REPRESENT ACTUAL STORAGE REQUIREMENTS.

REV	DATE	DRN	CKD	APP	AMENDMENT
E	09.03.23	RJW	BRM	B. MARSHALL	ROAD/LOT/POS LAYOUT AMENDED
D	27.02.23	AAD	BRM	B. MARSHALL	CGL CONTOURS UPDATED
C	20.01.23	AAD	BRM	B. MARSHALL	UPDATED TO REVISED PLANNING LAYOUT, ISSUED FOR INFORMATION
B	22.08.22	AAD	BRM	B. MARSHALL	UPDATED TO REVISED PLANNING LAYOUT, ISSUED FOR INFORMATION
A	03.08.22	AAD	-	-	ISSUED FOR INFORMATION

N

DIAL BEFORE YOU DIG www.1100.com.au

0m 80 160 240
1:4000

Cossill & Webley CONSULTING ENGINEERS

Mailing Address
PO Box 680
Subiaco WA 6904

Street Address
B12 (Level 2) 431 Roberts Road
Subiaco WA 6008

T (08) 9422 5800 F (08) 9422 5801 E admin@cosweb.com.au

CLIENT: Stockland

APPROVED: 09.03.23

DESIGNED: AAD

SCALE: 1:4000

PROJECT: MARIJINIUP - LOCAL STRUCTURE PLANNING

TITLE: PRELIMINARY EARTHWORKS PLAN

WAPC No.: N/A

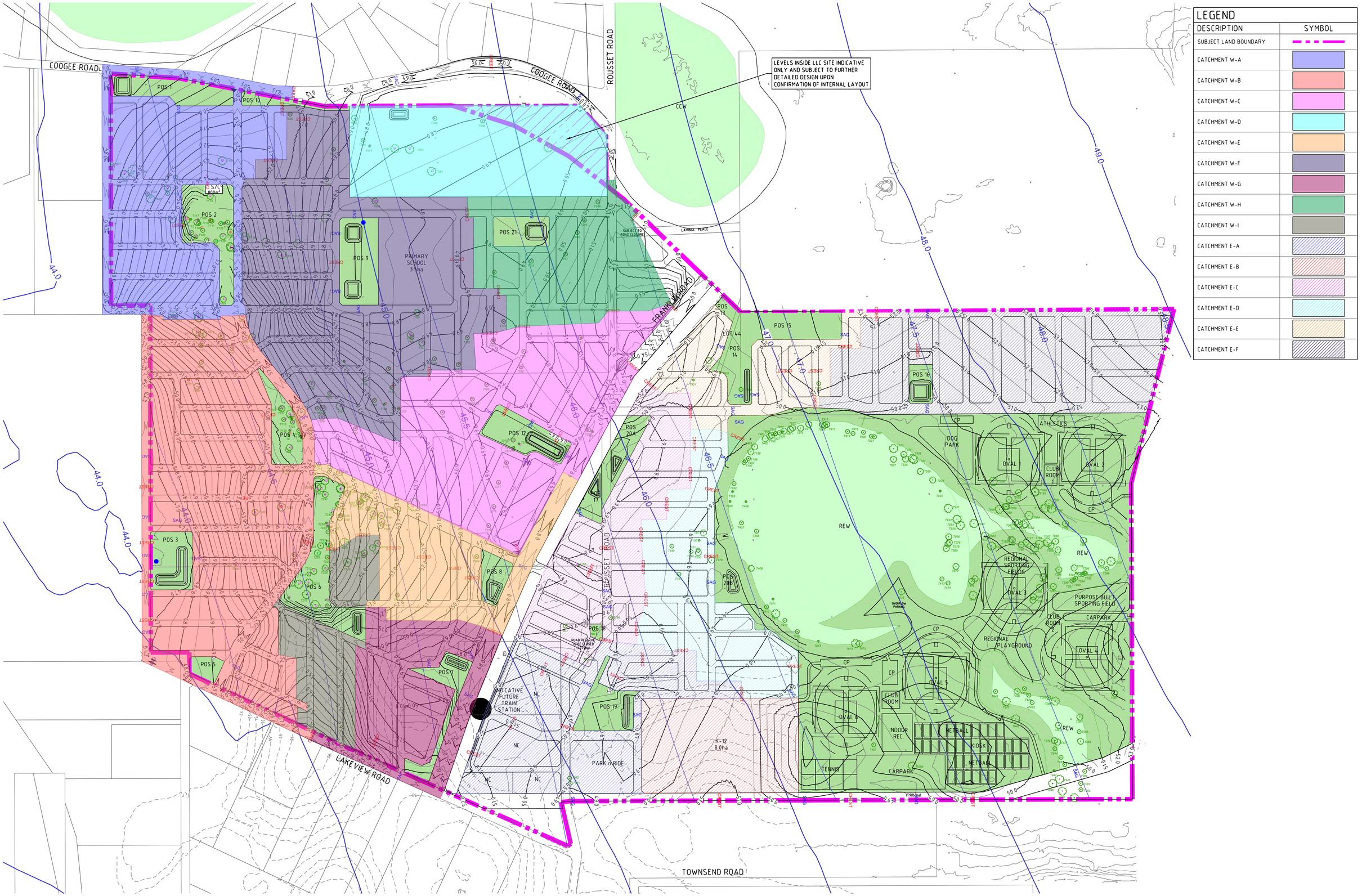
DRAWING No.: 6496-LSP1-SK200

REVISION: E

ORIGINAL SIZE: A1

P:\6496 Precinct 15 East Wanneroo\6496-LSP1\Acad\6496-LSP1-SK200.dwg, 8/03/2023 3:04:33 PM, robw, Digital Signing PDF pc3, 1:1, - CW Reference

Appendix F: Preliminary drainage catchment plan



LEGEND

DESCRIPTION	SYMBOL
SUBJECT LAND BOUNDARY	
CATCHMENT W-A	
CATCHMENT W-B	
CATCHMENT W-C	
CATCHMENT W-D	
CATCHMENT W-E	
CATCHMENT W-F	
CATCHMENT W-G	
CATCHMENT W-H	
CATCHMENT W-I	
CATCHMENT E-A	
CATCHMENT E-B	
CATCHMENT E-C	
CATCHMENT E-D	
CATCHMENT E-E	
CATCHMENT E-F	

REV	DATE	DRN	CKD	APP	AMENDMENT
E	27.07.23	AAD	BRM	B. MARSHALL	ROAD/LOT/POS LAYOUT AMENDED
D	09.03.23	RJW	BRM	B. MARSHALL	ROAD/LOT/POS LAYOUT AMENDED
C	20.01.23	AAD	BRM	B. MARSHALL	UPDATED TO REVISED PLANNING LAYOUT, ISSUED FOR INFORMATION
B	29.08.22	AAD	BRM	B. MARSHALL	CATCHMENTS ON EAST SIDE OF RAIL ADDED
A	22.08.22	AAD	BRM	B. MARSHALL	ISSUED FOR INFORMATION

N

DIAL BEFORE YOU DIG www.1100.com.au

1:4000 0m 80 160 240

Cossill & Webley CONSULTING ENGINEERS
Mailing Address PO Box 680 Subiaco WA 6904
Street Address B12 (Level 2) 431 Roberts Road Subiaco WA 6008
T (08) 9422 5800 F (08) 9422 5801 E admin@cosweb.com.au

CLIENT Stockland

APPROVED 27.07.23 BRAD MARSHALL

DESIGNED AAD

SCALE 1:4000

PROJECT MARIJINIUP - LOCAL STRUCTURE PLANNING

TITLE PRELIMINARY DRAINAGE CATCHMENT PLAN

WAPC No. N/A

DRAWING No. 6496-LSP1-SK710

REVISION E

ORIGINAL SIZE A1

P:\6496 Precinct 15 East Wanneroo\6496-LSP1\Acad\6496-LSP1-SK710.dwg, 27/07/2023 12:33:22 PM, AaronDavies, Digital Signing PDF.pc3, 1:1, - CW Reference

Appendix G: LWMS checklist

Appendix G: Local Water Management Strategy Checklist

Local Water Strategy Strategy item	Deliverable	Check box	Notes
Summary			
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Table 1: Key LWMS reporting elements outlines the requirements for best management practices and critical control points	✓	
Introduction			
Total water-cycle management – principles and objectives Planning background Previous studies		✓	Total water cycle management objectives discussed in Section 1.6
Proposed development			
Structure plan, zoning and land use Key landscape features Previous land use	Structure plan Site context plan	✓	Structure plan / site context plan included in Figure 15 and discussed in Section 1.4 Existing land use discussed in Section 2.1 and proposed land use discussed in Section 5.2
Landscape – proposed public open space areas, public open space credits, water source, bore(s), irrigation areas (if applicable)		✓	Landscaping and irrigation discussed in Section 4
Design criteria			
Agreed design objectives and source of objectives		✓	Section 1.6
Pre-development environment			
Existing information and more detailed assessment (monitoring).		✓	Sections 1.6 and 2

Local Water Strategy Strategy item	Deliverable	Check box	Notes
How do the site characteristics affect the design?			Pre-development groundwater levels and quality discussed in Section 2.11 and surface water discussed in Section 2.12
Site conditions – existing topography/contours, aerial photo underlay, major physical features	Site condition plan	✓	Figure 2 Section 2.3
Geotechnical – topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geotechnical plan	✓	Section 2.4.2 discussed results of geotechnical investigation. Acid sulfate soils discussed in Section 2.5 Geotechnical report provided in Appendix A
Environmental – areas of significant flora or fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental plan plus supporting data where appropriate	✓	Sections 2.6, 2.8 and 2.9 Figures 6 and 7
Surface water – topography, 100-year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface water plan	✓	Figure 11 Section 2.12
Groundwater – topography, pre-development groundwater levels and water quality, test bore locations	Groundwater plan plus site investigations	✓	Figures 9 and 10 Section 2.11
Water sustainability initiatives			
Water efficiency measures – private and public open spaces including method of enforcement		✓	Section 3
Water supply (fit-for-purpose) strategy, agreed actions and implementation		✓	Section 3
Wastewater management		✓	Section 3.3
Stormwater management strategy			
Flood protection – peak flow rates, volumes and top water levels at	100-year event plan Long section of critical points	✓	Sections 5.3 and 5.4

Pentium Water Pty Ltd | ACN: 655 914 015 | Level 1, 640 Murray St West Perth WA
T +61 (0) 8 6182 1790| **E** info@pentiumwater.com.au | **pentiumwater.com.au**

Local Water Strategy Strategy item	Deliverable	Check box	Notes
control points, 100-year flowpaths and 100-year detention storage areas			Figure 15 post-development surface water drainage Table 13: Stormwater basin design
Manage serviceability – storage and retention required for the critical 5-year ARI storm events Minor roads should be passable in the 5-year ARI event	5-year-event plan	✓	Section 5.4 Figure 15 post-development surface water drainage Table 13: Stormwater basin design
Protect ecology – detention areas for the 1-year 1-hour ARI 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	1-year-event plan Typical cross-sections	✓	Figure 15 post-development surface water drainage Table 13: Stormwater basin design
Groundwater management strategy			
Post-development groundwater levels, existing and likely final surface levels, outlet controls, and subsoil drain areas/exclusion zones	Groundwater/subsoil plan	✓	Section 6
Actions to address acid sulfate soils or contamination		✓	Section 2.5
The next stage – subdivision and urban water management plans			
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required before detailed design.		✓	Section 8
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		✓	Section 7
Implementation			

Pentium Water Pty Ltd | ACN: 655 914 015 | Level 1, 640 Murray St West Perth WA
T +61 (0) 8 6182 1790| **E** info@pentiumwater.com.au | **pentiumwater.com.au**

Local Water Strategy Strategy item	Deliverable	Check box	Notes
Developer commitments		✓	Section 8.2
Roles, responsibilities, funding for implementation		✓	Section 8.2
Review		✓	Section 8.2

Pentium Water Pty Ltd | ACN: 655 914 015 | Level 1, 640 Murray St West Perth WA
T +61 (0) 8 6182 1790| **E** info@pentiumwater.com.au | **pentiumwater.com.au**