Prepared for:

ARABIAN COURT PTY LTD

Lot 102 Arabian Court, Champion Lakes

Urban Water Management Plan

(WAPC Subdivision Approval No.162858)

March 2024

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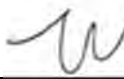
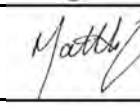
Author	Cynthia Hu		13 March 2024
Checked by	Matthew Yan		13 March 2024
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1. EXECUTIVE SUMMARY

TABLE 1: SUMMARY OF UWMP DESIGN PRINCIPLES AND CRITERIA

Key Guiding Principles		
• Facilitate implementation of sustainable best practice in urban water management • Encourage environmentally responsible development • Provide integration with planning processes and clarity for agencies involved with implementation • To minimise public risk, including risk of injury or loss of life. • Protection of infrastructure and assets from flooding and inundation To maintain the total water cycle.		
Category	**LWMS Criteria**	**UWMP Design**
Stormwater Management	• Flood mitigation with finished floor level minimum of 0.5 m above the mapped 1% AEP flood level of the Wungong River floodplain. • Landscape design measures to reduce applied nutrient loads. • At source infiltration of at least small storm events (15mm). • Water quality treatment systems and water sensitive urban design structures designed in accordance with the Stormwater Management Manual for Western Australia (DoW, 2009a) Chapter 9 (Structural Controls) and Australian Runoff Quality (Engineers Australia, 1997).	• Lot 102 is not within the Wungong River floodplain; hence, the 0.5 m flood mitigation level is not applicable. However, finished floor levels are a minimum 0.3 m above the 1% AEP top water level of the Flood Management Area [FMA] within the POS. • The first 15 mm of rainfall from residential lots retained and infiltrated within lots. Runoff from road reserves treated in vegetated treatment areas in the downstream FMA or road swales within the southern verge of the Arabian court along the south-west boundary. • Stormwater runoff from minor and major events retained and infiltrated in the FMA with a pipe outflow/overland flow at pre-development rate.
Groundwater Management	• Subsurface drainage to limit additional rainfall recharge to the water table and protect infrastructure. • Manage fertiliser and pesticide application in streetscapes and POS areas by using appropriate application rates specified in maintenance operation plans. • Use of local native plants and trees for garden beds.	• Residential lots have minimum 1.5 m separation from the pre-development MGL. • Subsoil drainage installed beneath the central BRA and southern edge of the POS. Subsoil drainage discharges alongside an existing vehicular track in the foreshore reserve. • Subsoil beneath POS and BRA is precautionary and set a minimum 0.4 m above the pre-development MGL.
Water Conservation and Sustainability	• Household Scheme water target use of 110 kL/person/year. • Ensure that non-potable water supply systems are considered as part of an integrated water supply. • Use of waterwise landscaping practices both at a precinct and lot scale.	• Aim to achieve the State Water Plan target for water use of 100 kL/person/yr. • Alternative fit for purpose water sources considered where appropriate and cost-effective. • All houses built to current NCC guidelines including include water efficient fixtures and fittings. • Local native plants constitute a minimum of 50% of landscape and streetscape treatment.
Water Quality	• Adopt nutrient load reduction design objectives for stormwater runoff. • Use of amended soils and bioretention systems to treat stormwater.	• Structural and non-structural controls used to form a treatment train approach for water quality management. • Use of local native plants in the landscape and streetscape treatments and street sweeping to manage road runoff. • The 'small event' storage vegetated to function as a treatment zone. The area is underlain with minimum 300 mm of amended soil material with PRI ≥ 10. The amended soil installed has a minimum saturated hydraulic conductivity of 5 m/day.

TABLE 2: SUMMARY OF RESPONSIBILITIES AND FUNDING

Management Issue	Responsibility and Funding		
	Developer	City of Armadale	Lot Owner
Street Drainage Construction	✓		
Maintenance • Two years, including two winters (period between a successful Practical Completion Inspection and a defects inspection with a written confirmation of City acceptance)	✓		
• Street sweeping and drainage cleaning (eduction of sediment) to be undertaken immediately prior to the end of the 12 month defect liability period inspection.	✓		
• Ongoing (from notification of City acceptance)		✓	
Bio-Retention areas and Flood Storage Construction	✓		
Maintenance • Two years, including two winters (period between a successful Practical Completion Inspection and a defects inspection with a written confirmation of City acceptance)	✓		
• Ongoing (from notification of City acceptance)		✓	
Street Sweeping • Two years, including two winters (period between a successful Practical Completion Inspection and a defects inspection with a written confirmation of City acceptance)	✓		
• Ongoing (from notification of City acceptance)		✓	
Lot Drainage Installation of underground storage units (e.g. soakwells)			✓

A number of assumptions have been made in the preparation of this report. Table 3 highlights a few key assumptions, but not all. Other assumptions and parameters are more comprehensively documented in this report.

TABLE 3: KEY HYDROLOGICAL PARAMETER VALUES USED IN THIS REPORT

Parameters	Section	Value or Source
Design Rainfalls	5	Bureau of Meteorology (2016)
Rainfall temporal patterns	5	Australian Rainfall & Runoff (Ball et al., 2019)
Hydraulic conductivity of imported fill	5,6	Minimum 5 m/day

2. PROPOSED SUBDIVISION

Lot 102 Arabian Court (referred to as the Study Area) is located within the south-east corridor of the Perth Metropolitan Region in the City of Armadale, approximately 22 km south-east of the Perth CBD and 5 km north-west of Armadale, Figure 1.

It is bound by Lot 101 and 103 Arabian Court, to the north-east and north-west, Lake Rd to the east, Arabian Court to the south and west, with the Wungong River located approximately 200 m north-west.

Lot 102 is situated within the Lake Road Precinct C Structure Plan, and forms the first stage of this residential development.

The subdivision will create 69 residential lots, with Lot density of R25 and R40 with average lot size of 388 m^2, incorporate a 0.28 ha central dual function drainage and active/passive recreational area and a balance of Lot 101 adjacent to Lot 101 Arabian Court with an area of 0.09 ha, Figure 1. The internal configuration of lots may be refined in future as long as the net developable area remains as per the existing subdivision area.

The Subdivision Plan for the Study Area is shown on Figure 1. Table 4 provides a breakdown of the proposed land use areas within the Study Area.

TABLE 4: LAND USE BREAKDOWN

Land Use Description	Study Area
R25 Residential Lots	2.50
R40 Residential Lots	0.17
Road Reserve	1.06
Public Open Space (POS)	0.28
Balance of Lot 11	0.09
Total	**4.10**

3. PLANNING APPROVALS

3.1 Regional Planning

The Study Area is currently zoned *Urban* in the Metropolitan Region Scheme (DPLH, 2023a) and *Urban Development* in the City of Armadale Town Planning Scheme No. 4 (City of Armadale, 2005). The Study Area and wider LSP area were re-zoned from *Rural living 2* to *Urban Development* via Town Planning Scheme No. 4, Amendment No. 88 (gazetted 19 March 2019).

A District Water Management Strategy [DWMS] for the Study Area is not available.

3.2 Local Structure Plan

The Study Area falls within the Lake Road Precinct C Structure Plan [LSP] (Rowe Group, 2023), Figure 1.

A Local Water Management Strategy [LWMS] in support of the Rowe Group (2023) LSP was prepared by Environnivate (Environnivate, 2023).

3.3 Subdivision Approval

The Study Area has subdivision approval with conditions under WAPC No. 162858, 03 October 2022, Appendix A.

This report has been prepared to satisfy Condition 3:

> " *Prior to the commencement of subdivisional works, an urban water management plan is to be prepared and approved, in consultation with the Department of Water and Environmental Regulation, consistent with any approved Local Water Management Strategy. (Local Government)* "

4. EXISTING SITE CHARACTERISTICS

4.1 Climate

The Champion Lakes area is characterised by a Mediterranean climate with warm dry summers and cool wet winters.

Rainfall data is provided by the nearby Bureau of Meteorology *Forrestdale* rain gauge (Site ID. 009257), 4.5 km south-west of the Study Area, Figure 2.

The average annual rainfall, 1986 to 2022, for Forrestdale was 828 mm, with 30-year and 10-year averages of 795 mm and 789 mm, respectively. This represents a 4% (30-year average) and 5% (10-year average) decrease from the average annual rainfall for Forrestdale. The general decline in rainfall observed across Forrestdale rain gauge is consistent with the decreasing rainfall trend across south-west Western Australia (DoW, 2015). The seasonal rainfall distribution has also altered since 1990, with a reduction of average monthly totals in the winter months, but no reduction or increases in the summer months.

Average annual pan evaporation is estimated at 1,700 mm for the Study Area from gridded BoM (2017) 1975-2005 average pan evaporation data and is similar to annual evaporation recorded at the Department of Primary Industries and Regional Development (DPIRD) Wattleup weather station in in 2020 of 1,661 mm; in 2021 of 1,652 mm; and in 2022 of 1,679 mm; but is lower than the estimated pan evaporation of 1,900 mm from Luke *et al.* (1987).

4.2 Topography

The topography of the Study Area shown on Figure 3 identifies a slight topographic mound in the south-west (25 mAHD). The Study Area is generally flat and the topographic gradient is generally from the east to west (24-25 mAHD).

4.3 Geology and Soils

Regional surface geology mapping by Jordan (1986) is shown on Figure 4. It indicates the Study Area is generally mapped as "S10" *Bassendean Sand*, being sands overlying sandy clay to clayey sand of the Guildford Formation, of eolian origin.

A detailed geotechnical investigation was conducted over the Study Area by Structerre (2023) on 6 December 2023. The investigation included soil retrieval probes to a depth of 2.5 m at 6 locations (BH1 to BH6), and percolation tests to measure permeability at 5 locations, Figure 4.

The subsurface profile summarised by Structerre (2023) is as follows:

- *0.2 m (depth to base of strata) -*
  Topsoil
- *1.3 -2.5+ m (depth to base of strata) -*
  NATURAL: SAND (fine to medium grained), non-plastic, loose grading to dense.
- *1.3 -1.8+ m (depth to base of strata) –*
  NATURAL: Clayey Sandy GRAVEL (fine to medium grained), high plasticity (BH1 to BH4 only).
- *Not Penetrated (>2.5m) –*
  NATURAL: SAND (fine to medium grained), non plastic, loose grading to dense (BH5 & BH6).

Structerre (2023) concluded the soils encountered are consistent with the expected site conditions as predicted in the regional mapping. Groundwater or perched water was not encountered across the site to a depth of 2.5 m and the site is considered suitable for on-site drainage. For on-site disposal of stormwater runoff, soakwells should be

positioned a minimum 1.2 m or the depth of soakwell (whichever is greater) from any proposed or existing foundations (inlcuding those beyond the boundaries of the site) to minimise the risk of differential settlement.

Lots can be classified as Class "A" subject to providing or maintaining adequate sand cover (>1.5m) above the underlying reactive clayey sandy gravel deposits within the site.

In-situ permeability testing by Structerre (2032) derived permeability > 20 m/day at all 5 test locations (BH2 to BH6). Testing was only performed within the sand layer at a depth of 0.75 – 1.0 m. Significantly lower permeability and perching would occur within the next 0.3 m depth as the sand transitions into the underlying clayey layer.

In general, the subsurface conditions summarised in Structerre (2023) are consistent with the regional mapping (Jordan, 1986). A copy of the Structerre Geotechnical Investigation (2023) is attached as Appendix B.

4.4 Acid Sulphate Soils

The Study Area is generally classified as Class 2, having moderate to low risk of Acid Sulphate Soils (ASS) occurring less than 3 m from surface but high to moderate risk of A.S.S beyond 3 m of natural soil surface, Figure 4 (DWER, 2017b).

Soil and groundwater samples were collected during installation of monitoring bores by Bowman & Partners Environmental to validate the regional mapping. Findings include slight scattered indications of ASS risk within 2.5 mbgl to 5 mbgl and the highest indication of ASS risk at MB6 (3 mbgl to 4.5 mbgl) which recorded the lowest pH of 3.4 in December 2014.

A further ASS investigation will be performed as part of detailed geotechnical investigation and will confirm any management requirement if ASS is identified.

4.5 Groundwater

4.5.1 Regional Hydrogeology

Superficial Aquifer

The superficial aquifer in the vicinity of the Study Area, referred to as the Jandakot Mound, has an extent of approximately 552 km^2. The aquifer has a maximum thickness of 40 m and includes three formations which are, in order of increasing depth: Bassendean Sand; Gnangara Sand; and Ascot Formation. Aquifer transmissivities range between 200 to 1,000 m^2/day (Davidson & Yu, 2008).

The Bassendean Sand consists of fine- to coarse-grained, moderately-sorted, sub-rounded to rounded quartz sand. The sand is mapped as highly permeable with horizontal hydraulic conductivity ranging between 10 m to 50 m/day. In the Jandakot area where 'coffee rock' is present, limonite cement may reduce the horizontal hydraulic conductivity to less than 10 m/day (Davidson & Yu, 2008).

Gnangara Sand is present beneath the Bassendean Sand and consists of pale-grey, fine- to very coarse-grained, very poorly-sorted, sub-rounded to rounded quartz and feldspar (Davidson & Yu, 2008).

The Ascot Formation is present beneath the Gnangara Sand. The Ascot Formation consists of hard to friable, grey calcarenite with thinly interbedded sand, with shell fragments commonly near the base of the formation. Sands are fine- to coarse-grained and are poorly sorted and angular to rounded in shape (Davidson, 1995).

Ascot Formation overlies the Kardinya Shale (part of the Osborne Formation) and which is a confining bed, consisting of moderately to tightly consolidated, interbedded siltstones and shales (Davidson, 1995).

Vertical fluctuations in the groundwater table may be several metres and occur seasonally, consistent with Perth's winter-dominated Mediterranean rainfall pattern. Rainfall recharge to the superficial aquifer is 15 to 25% of total annual rainfall (Davidson, 1995).

Leederville Aquifer

The Osborne Formation overlies the Leederville Formation from approximately – 15 mAHD to -110 mAHD and includes the Kardinya Shale (confining bed) and Henley Sandstone formations. The Henley Sandstone formation is included in the Leederville Aquifer (Davidson & Yu, 2008).

The Leederville Aquifer is a major drinking water resource with groundwater salinity beneath the Jandakot Mound typically < 500 mg/L TDS ('fresh').

Yarragadee Aquifer

The South Perth Shale underlies the Leederville Aquifer and acts as the confining bed between the Leederville and Yarragadee aquifers (Davidson & Yu, 2008).

The Yarragadee aquifer is major water resource with groundwater salinities south of Perth typically 1,000 to 2,000 mg/L TDS.

4.5.2 Groundwater Levels

Pre-development groundwater level monitoring was conducted by Bowman & Partners between September 2014 and October 2017 on behalf of Sureland Property for the Precinct C area in 7 bores, MB4 to MB10, Figure 5. Environnivate also measured groundwater levels between October 2021 and September 2022 in 5 bores, MB5 to MB9. The bores were installed by Bowman & Partners in September 2014 to depths of 3.8 m to 6.6 m and screened in the lowest 3 m. Of these bores, MB5 within the Study Area and is located 25 m away the south-west boundary of the Study Area.

Bore details are presented in Table 5 and locations shown in Figure 5.

Groundwater levels recorded in the LWMS bores are shown on Figure 6. Seasonal water table fluctuation is typically 0.04 to 0.32 m in the LWMS area. Since 1975, there has been a general decline in groundwater levels due to declining rainfall and the associated reduction in aquifer recharge, and increased groundwater abstraction.

From the LWMS pre-development monitoring, groundwater flow direction was south-east to north-west to Wungong River. The groundwater flow direction was in line with regional groundwater contour mapping (DoE, 2004).

TABLE 5: DETAILS OF GROUNDWATER MONITORING BORES

Bore ID	Coordinates		Natural Surface (mAHD)	Total Depth (mbToC)	Top of Casing (mAHD)	Screened Length (m)	Installation Date
	Easting	Northing					
MB4	404146.3	6445537.5	21.53	4.34	22.05	3.5	11 September 2014
MB5	404394.3	6445397.8	24.92	3.83	25.39	3.0	10 September 2014
MB6	404567.7	6445687.5	24.37	4.93	25.08	3.0	10 September 2014
MB7	404325.3	6445902.2	21.78	6.61	22.38	5.5	10 September 2014
MB8	404270.5	6445781.5	21.81	5.53	22.34	3.0	10 September 2014
MB9	404371.7	6445641.1	23.50	5.59	24.15	4.5	10 September 2014
MB10	404256.6	6445418.0	24.06	4.62	24.81	3.0	11 September 2014

Notes: mbToC = metres below Top of Casing; mAHD = metres Australian Height Datum;

There are no suitable DWER long term monitoring bores located nearby the Study Area to assess the Average Annual Maximum Groundwater Level (AAMGL). Whilst groundwater levels recorded in September 2014 were the highest between 2017 to 2022, Environnate (2023) considered they are a reasonable estimate of the Maximum Groundwater Level (MGL) as rainfall received in that year was above average.

The September 2014 groundwater level contour is shown in Figure 7. The groundwater levels recorded by Bowman & Partners between 2014 and 2017 for MB4 to MB10 and Environnivate from 2021 to 2022 for MB5 to MB9 are presented in Table 6.

TABLE 6: RECORDED GROUNDWATER LEVELS 2014 TO 2017 AND 2021 TO 2022

Recorded Date	MB4	MB5	MB6	MB7	MB8	MB9	MB10
22/09/14	21.41	24.01	22.91	20.21	18.86	21.13	22.15
23/05/16	18.70	21.82	Dry	18.52	17.82	Dry	Dry
01/07/16	20.97	23.51	21.25	18.90	18.15	19.39	Dry
29/07/16	20.95	23.86	22.29	19.46	18.43	20.02	22.83
25/08/16	21.16	23.95	22.62	19.96	18.66	20.55	23.17
28/09/16	21.35	23.85	22.62	20.45	18.86	20.93	23.56
25/10/16	20.89	23.68	22.54	20.48	18.98	20.97	23.19
25/11/16	20.05	23.35	22.13	19.65	18.88	19.93	21.20
08/09/17	21.07	23.73	22.63	20.53	18.99	20.97	22.59
06/10/17	21.05	23.76	22.68	20.60	19.15	21.01	22.77
20/10/21	-	23.64	22.63	20.35	19.04	21.06	-
09/02/22	-	Dry	Dry	18.19	Dry	Dry	-
08/04/22	-	Dry	Dry	16.71	Dry	Dry	-
15/06/22	-	23.28	Dry	18.9	18.28	Dry	-
07/09/22	-	23.87	22.69	20.44	18.89	20.74	-
Max Recorded Level	**21.41**	**24.01**	**22.91**	**20.60**	**19.15**	**21.13**	**23.56**

4.5.3 Groundwater Quality

Pre-development groundwater quality monitoring was conducted in LWMS bores MB4 to MB10 on 22 September 2014, and from October 2021 to September 2022 for bores MB5, MB6 and MB8. Nutrients and dissolved metals were sampled and analysed across the pre-development monitoring period.

Bore MB5 is the only LWMS bore within the Study Area. Monitoring results from sampling at MB5 are summarised in Table 7.

TABLE 7: PRE-DEVELOPMENT GROUNDWATER QUALITY, MB5 SAMPLING RESULTS

Parameter	PQL	Guidance Value	22-Sept 14	18-Dec 14	24-Sept 15	20-Oct 21	15-Jun 22	07-Sept 22
Physico-chemical/Other								
pH *lab*	-	6.5-8.5[1]	5.3	5.9	5.2	5.9	4.9	5.6
EC (mS/cm) *lab*	0.01	≤1[1]	0.27	0.71	-	0.38	0.54	0.31
Nutrients (mg/L)								
NH_3_N	0.02	≤0.41[2]	<0.02	0.12	0.08	0.03	<0.02	0.02
NO_x_N	0.01	-	0.15	0.10	0.15	0.02	<0.01	<0.01
TKN	0.2	-	-	-	-	0.40	<0.20	0.60
TN	0.2	-	1.60	1.60	4.50	0.40	<0.20	0.60
PO_4_P	0.01	-	<0.01	0.04	-	<0.01	0.02	0.02
TP	0.01	-	2.20	1.30	4.40	0.18	0.37	0.30
Alkalinity (mg/L)								
Alkalinity (total) as CaCO3	5	-	6	15	-	9	<5	<5
Dissolved Metals (mg/L)								
Aluminium, Al	0.01; 0.05	≤0.2[2]	-	-	-	-	0.06	<0.05
Arsenic, As	0.001	≤0.01[2]	<0.001	0.002	-	0.001	<0.001	<0.001
Boron, B	0.05	≤4[2]	-	-	-	-	<0.05	<0.05
Cadmium, Cd	0.0001	≤0.002[2]	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001
Chromium, Cr	0.001	≤0.05[2]	0.004	0.047	-	<0.001	0.002	<0.001
Copper, Cu	0.001	≤1[1], ≤2[2]	-	-	-	<0.001	<0.001	<0.001
Lead, Pb	0.001	≤0.01[2]	0.002	0.013	-	<0.001	<0.001	<0.001
Manganese, Mn	0.01; 0.005	≤0.1[1], ≤0.5[2]	-	0.14	-	-	<0.01	<0.005
Mercury, Hg	0.0001	≤0.001[2]	<0.0001	-	-	<0.0001	<0.0001	<0.0001
Nickel, Ni	0.001	≤0.02[2]	0.003	0.023	-	0.002	0.004	<0.001
Selenium, Se	0.001	≤0.01[2]	-	<0.001	-	-	<0.001	<0.001
Zinc, Zn	0.001	<0.02[1]	0.009	0.029	-	<0.005	0.006	<0.005

Notes:
PQL = Practical Quantification Limit; defined at the lowest concentration at which an analyte can be detected in a sample with a reasonable degree of accuracy and precision.
ND = No detection.
1. ADWG (2011) *aesthetic* guideline values. Exceedances printed in brown.
2. ADWG (2011) *health* guideline values. Exceedances printed in orange.

A summary of the pre-development monitoring results at MB5 is as follows:

- The groundwater is acidic with pH value ranged from 4.9 to 5.9.
- Maximum Electrical Conductivity was 0.71 mS/cm and is considered fresh/marginal.
- Total Nitrogen (TN) concentrations ranged between 0.2 mg/L and 4.5 mg/L in MB5 and was mostly in the form of organic nitrogen.
- Total dissolved phosphorus (TP) concentrations ranged from 0.18 to 4.4 mg/L and dissolved phosphate ranged from <0.01 to 0.04 mg/L.
- Majority of the metal concentrations were less than the Australian Drinking Water Guidelines (ADWG) for health and/or aesthetic guideline values (NHMRC & NRMMC, 2011). Pb and Ni concentrations slightly exceeded health

guideline values on 2 occasions and Mn and Zn concentrations slightly exceeded aesthetic guideline values also on 2 occasions.

- Most metal concentrations were below the PQL.

4.5.4 Groundwater Resources for Irrigation

The Department of Water and Environmental Regulation manages the groundwater of the State under the Rights in Water and Irrigation Act 1914 (RIWI Act). The Study Area is located within the City of Armadale sub-area of the Perth Groundwater Management Area.

The superficial aquifer is the most feasible irrigation supply for the Study Area.

The DWER groundwater allocation limit and water allocations from the superficial aquifer are shown in Table 8 and are based on a Resource Allocation Report from DWER as at 31 October 2023.

TABLE 8: DWER GROUNDWATER RESOURCE ALLOCATION AND LIMIT, OCTOBER 2023

GW Sub-Area	Aquifer	Allocation Limit Licensable component, (kL/yr)	Allocated & Committed Volume (kL/yr)	% Allocated & Committed	Remaining Volume (kL/yr)
City of Armadale	Superficial Swan	4,000,000	3,934,690	98.37	14,089

As of 31 October 2023, the superficial aquifer was 98.37% allocated with 3,934,690 kL/year.

A water source is required for the irrigation of streetscapes and establishment and ongoing irrigation of vegetated and turfed areas within the POS.

Arabian Court Pty Ltd has been issued Licence to Take Water GWL209729(1) with a volume of 1,500 kL/yr for irrigation of public open space (Appendix C). This volume of water is sufficient to irrigate the designated POS area within the Study Area, refer Section 7.1.

4.6 Surface Water Hydrology

The Study Area is located within the Swan Avon Canning River catchment (DoW, 2009) of the Canning River system.

There are no existing watercourses or surface water features drain into the Study area. Rainfall runoff generated within the Study Area flow from south-east to north-west to Wungong River ultimately. The Study Area is not within the floodplain area of Wungong River.

Pre-development, there is a minor open drain lies within the western side of the Arabian Court road reserve that flows southeast to northwest through Lot 105 and ultimately discharges to Wungong River.

Lake Rd drainage system adjacent to the southeast boundary of the Study Area receives flow from the local catchment east of Lake Rd and discharges to the Second Rd Main Drain, which discharges to the Wungong River. Water Corporation has confirmed a 1% and 20% AEP allowable peak discharge of 120 L/s and 70 L/s from the Study Area to the Lake Rd drainage system (Environnivate, 2023).

4.7 Wetlands and Vegetation

Geomorphic Wetland mapping of the Swan Coastal Plain (DBCA, 2018), Figure 8, shows the Study Area is mapped as Multiple Use dampland (UFI 15421). This was classified as Resource Enhancement dampland (UFI 15421) previously and was reclassified to Multiple Use dampland using published protocol. Multiple Use wetlands are the lowest management category assigned to wetlands and are generally considered appropriate for development.

A botanical survey of vegetation condition was completed by Bowman & Partners Environmental [BPE] in 2015 for the LWMS area. The vegetation condition within the Study Area in the southern corner was classified as *Degraded to Completed Degraded* with the remainder of the site *Completely Degraded* (BPE, 2021).

A targeted survey for the threatened plant species *Morelotia australiensis* of the Study Area was conducted by PGV Environmental in 2021 which included an assessment of the vegetation map prepared for the site by BPE in 2015. The targeted survey (PGV Environmental, 2021) observed no *Morelotia australiensis* on site but consider prospective for *Morelotia australiensis* at the south-west corner of the Study Area with a stand of Marri Woodland with some native vegetation understorey. The targeted survey (PGV Environmental, 2021) refines the previous vegetation map by BPE (2021) with a smaller extend of Marri Woodland and include areas of Paperbark on the north-east corner of the Study Area.

The summary of the vegetations cover the Study Area as following: the Study Area is covered by a mix of vegetations. The northern tip and along a portion of the eastern boundary is covered by paperbark trees (*Melaleuca preissiana*). Along the north-east boundary is covered by Victoria Tea trees (*Leptospermum laevigatum*) shrubland. Jarrah (*Eucalyptus marginata*) / exotic trees covers the north-west tip of the Study Area. South-west of the Study Area has Marri Woodland (*Corymbia calophylla*) with some native species of *Morelotia octandra, Mesomelaena tetragona*, *Corynotheca micrantha, Lyginia barbata and Conostylis juncea* understorey. The southern tip of the Study Area is mapped as *Hakea varia* and *Pericalymma ellipticum* indicating the area is waterlogged during winter and / or spring, but the vegetation in this area is classified as *Completed Degraded*.

4.8 Contaminated Sites

A search of DWER's publicly available Contaminated Site Database (accessed 16 September 2023) indicated no contaminated sites within the Study Area.

JDA notes the publicly available database only identifies 3 of the 7 contaminated sites classifications: *Contaminated – restricted use; Contaminated – remediation required*; *and Remediated for restricted use*. The remaining classifications are *Report not substantiated*; *Possibly contaminated – investigation required*, *Not contaminated – unrestricted use;* and *Decontaminated*.

4.9 Aboriginal Heritage

A search of the Aboriginal Heritage Enquiry System (DPLH, 2023b) shows one registered Aboriginal Heritage covers the Study Area, *Southern River* (Site ID: 3511), Figure 9. This site is of 24 km^2. The Aboriginal Heritage Enquiry System (DPLH, 2023b) denotes this area as "*Camp; Creation / Dreaming Narrative; Hunting Place"*.

5. STORMWATER MANAGEMENT

5.1 Design Overview

Local stormwater management is proposed to be consistent with water sensitive design practices and to meet key objectives and criteria as detailed in the LWMS (Environnivate, 2023) and summarised in Table 1.

The stormwater drainage system has been designed based on management of the 'small', minor and major events.

'Small' event management concentrates on the first 15 mm of rainfall (approximately the 1 EY 1 hour event). The first 15 mm of stormwater runoff from impervious surfaces within lots will be retained at-source within soakwells. Stormwater runoff from the road reserve areas will be retained and infiltrated within the vegetated treatment areas.

The minor drainage system is designed as a system of drains, pipes, culverts, kerbs, gutters, etc. and has the capacity to convey stormwater runoff generated by low frequency storms, typically less than the 20% AEP for residential areas.

The major drainage system is defined as the arrangement of roads, drainage reserves and attenuation areas planned to provide safe passage of stormwater runoff from extreme rainfall events (up to the 1% AEP).

The local stormwater management system will consist of ephemeral *Flood Management Area* [FMA] within the POS to retain stormwater runoff up to the critical 1% AEP event and Bio-Retention Area (BRA) within the north-eastern side of the POS to manage the 'small' event.

The BRA and southern part of POS FMA is underlain with a Ø150 subsoil drainage pipe to prevent prolonged ponding and waterlogging. The FMA discharges via a Ø300 outlet pipe to the existing Arabian Court vegetated swale which ultimately outflows to the Wungong River.

The FMA outflows to an existing vegetated swale that discharges to Wungong Brook. The FMA outlet structure is comprised of a bubble up pit with lid level set at the FMA invert (24.40 mAHD). It is connected by a 300 mm pipe that controls flow to pre-development rate by a Ø200 orifice, to a downstream bubble up pit with lid level at 23.53 mAHD in the vegetated swale. The maximum allowable outflow is 120L/s in the 1% AEP and 70L/s in the 20% AEP as outlined in the LWMS (Environnivate, 2023).

Note that if the internal configuration of lots is refined in future, the net developable area must remain as per the existing subdivision area to have negligible impact on the results presented in this UWMP.

5.2 Stormwater Model Parameters

The stormwater management plan for the Study Area is shown on Figure 10.

The stormwater management system has been modelled by JDA using PCSump Version 6.1 (JDA, 2020c) for the 'small' event. An XP-storm model was used for the minor and major events to model stormwater pipe outflow and overland flow from the POS FMA.

Stormwater modelling was conducted based on the methodology in *Australian Rainfall and Runoff* (Ball et al., 2019). The rainfall temporal pattern was assumed spatially uniform across the catchment with storms modelled ranging from 30 minutes to 72 hours. Catchment slopes were calculated from road earthwork levels.

5.2.1 Post Development Drainage Catchments

The post-development drainage catchment is shown on Figure 10.

Catchment A drainage is managed onsite within the FMA in the POS. Catchment B and Catchment C flow to the Lake Road pipe drainage system which discharges to Second Road Main Drain. This has been endorsed by Water

Corporation as part of the LWMS process which confirmed the Lake Road pipe system has sufficient capacity to convey extra flow from Catchment B and Catchment C (Appendix D).

Arabian Court is constructed as a crowned road with the road centreline being a drainage catchment boundary. The northern half of the road contributes to Catchment A with the southern half contributing to Catchment D, which flows into the adjacent vegetated swale along Arabian Court.

A detailed catchment breakdown for Catchment A is shown in Table 9.

TABLE 9: CATCHMENT AREAS

Catchment	Catchment A
Residential Lots (ha)	2.63
Road Reserve (ha)	1.09
POS / Drainage (ha)	0.28
Total	4.01

5.2.2 Hydraulic Conductivity

Structerre (2023) Geotechnical Investigation measured on-site permeability of 20 m/day. This is considered a conservative estimate as it is only representative of the surface sand layer in current pre-development condition.

Brown Geotechnical (2015) however recommended for the Precinct C area that *"Given possible variability in surface conditions due to the presence of fill, prior site disturbance and anticipated reduction in permeability following compaction operations, an average permeability of 5 m/day is suggested for the sand profile in a dense condition."*

Consequently, a saturated hydraulic conductivity of 5 m/day has been used for stormwater modelling, and assumes no underlying low permeability or restrictive layers (ie coffee rock).

Note that areas of imported fill shall be comprised of clean free draining sand with <5% fines and a minimum hydraulic conductivity of 5 m/day.

5.2.3 Loss Model

A breakdown of the rainfall-runoff loss model parameters for each land use is presented in Table 10 below for the land use areas presented in Table 4 and shown in Figure 10.

TABLE 10: CATCHMENT RAINFALL-RUNOFF LOSS MODEL

Land Use	Initial Loss (mm)	Continuing Loss (mm/hr)	Proportional Loss (%)
Residential Lots	15	3	-
Road Reserve	-	-	20
Public Open Space	-	-	90
Drainage	-	-	5

5.2.4 Other Hydraulic Modelling Design Parameters

Other parameters used in PCSump & XP-Storm modelling include:

- Base of aquifer as the base of the superficial aquifer (-19.7 mAHD).
- Design/Maximum groundwater level: 22.5 mAHD.
- BRA invert of 24.20 mAHD.

- BRA side slopes of 1:6.
- FMA invert of 24.40 mAHD.
- FMA side slopes of 1:6.
- Overland Flow Path as v-shape with side slope of 1:10.
- Vegetated Swale as v-shape with side slopes of 1:10.
- Vegetated Swale U/S invert of 24.1 mAHD.
- Vegetated Swale D/S invert of 21 mAHD.
- Wungong River tailwater level of at 22.75 mAHD.

Cross section of the BRA and FMA in the POS is shown on Figure 11.

5.3 Small Event Drainage

The following strategies are proposed for management of the first 15 mm of rainfall ('small' event):

- Residential lots retain and infiltrate the first 15 mm of rainfall from connected impervious areas in soakwells. In residential lots with area less than 350 m^3, soakwells are to be interconnected within the lot to assist in distribution of runoff for more efficient infiltration.
- Stormwater runoff from roads from the first 15 mm of rainfall is piped to or enters through flush kerbing along the POS border to flow into a bio-retention area [BRA] within the POS FMA.
- A Ø150 mm diameter subsoil drainage system is installed beneath the BRA to drain the BRA more effectively during a stormwater event and control groundwater levels. The subsoil drainage system discharges to an existing roadside open drain on the western side of the Arabian Court, that flows through Lot 105 and eventually to the Wungong River.
- The BRA is underlain with amended soils and planted with suitable plant species, consistent with the *Vegetation Guidelines for Biofilters in South-West Western Australia* (Monash University, 2014).

The 'Small' Flood Event Plan is shown on Figure 12 *left*.

5.4 Minor Drainage System

To meet the design criteria for the minor drainage system (for events up to the 20% AEP event), the following strategies are proposed:

- Runoff generated within residential lots in excess of soakwells flows overland via driveways or front of lots into the road drainage network. The pit-pipe road drainage network is sized to manage events up to the 20% AEP.
- Stormwater runoff from roads is conveyed by underground pipe road drainage network and flush kerbing bordering POS to the downgradient POS FMA. The pit-pipe road drainage network is sized to manage events up to the 20% AEP.
- Stormwater runoff that exceeds the capacity of the 'small' event overflows the BRA into the wider POS FMA.
- The FMA is located at the catchment low-point within the POS and provides both infiltration of stormwater, and detention of stormwater prior to discharge into an existing vegetated swale adjacent to Arabian Court, that ultimately discharges to Wungong River. An outlet control structure of a bubble up pit with lid level at 24.40 mAHD with a Ø200 mm diameter orifice in Ø 300 mm outlet pipe controls peak flow to below the pre-development rate of 70 L/s.

- The FMA will have a minimum side slope of 1:6 (v:h) per requirement in City of Armadale (2015) and be planted with appropriate vegetation.

The Minor (20% AEP) Flood Event Plan is shown on Figure 13 *left*.

5.5 Major Drainage System

The major drainage system is designed to manage rainfall events greater than the 20% AEP event up to the 1% AEP event. Key points of the major drainage system strategy are as follows:

- Management includes infiltration of stormwater into in-situ soils and additional sand fill (as in small and minor events) together with runoff from lots (excess of lot soakwells) and road stormwater runoff.
- Road reserves provide flood storage and conveyance. In major storm events, the minor drainage pit and pipe system will be at capacity with excess stormwater bypassing the minor drainage structures and flowing overland within the road carriageway, with roads graded towards the downstream POS FMA.
- The FMA manages up to the 1% AEP flood event via infiltration and detention of stormwater runoff in the POS to below the pre-development rate of 120 L/s, via pipe outflow and overland flow when water level is higher than 24.90 mAHD to the existing vegetated swale adjacent to Arabian Court.
- Minimum habitable building floor levels will have a 300 mm (0.3 m) clearance from the 1% AEP peak top water in the POS FMA, consistent with local government design guidelines.

The Major (1% AEP) Flood Event Plan is shown on Figure 13 *right*.

5.6 Modelling Results

The 'small' event, i.e. the first 15 mm of rainfall, was modelled in PCSump Version 6.1 (JDA, 2020c) with results summarised in Table 11. The provided treatment area exceeds the minimum base area in FAWB (2009) guideline for 2% of the connected impervious area. An indicative BRA area has been shown on Figure 12 *left*.

Modelling results for the minor (20% AEP) and major (1% AEP) events including storage volumes, peak water levels and peak outflows are summarised in Table 12. The results demonstrate the POS design can adequately manage up to the 1% AEP event within the POS boundary, with a defined overflow path to a vegetated swale to Wungong Brook.

TABLE 11: SMALL EVENT MANAGEMENT

Bio-Retention Area (BRA)	BRA
Catchment Details	
Bio-Retention Road Reserve Area Catchment (ha)	1.09
Impervious Catchment Area (ha)	0.87
2% of Impervious Catchment Area (m^2)	174
Bio-Retention Base Area Provided (m^2)	369
Storage Details	
MGL (mAHD)	22.50
BRA Invert (mAHD)	24.20
BRA Base Area (m^2)	369
Storage Depth (m)	0.20
Side Slope (v:h)	1:6
Small Event Management	
Rainfall (mm)	15
Runoff Volume (m^3)	131
Water Depth (m)	0.20
Top Water Level (mAHD)	24.40
Top Water Level Area (m^2)	900
Stored Volume (m^3)	106

TABLE 12: STORMWATER MODELLING RESULTS - MINOR AND MAJOR EVENTS

	FMA
FMA Details	
MGL (mAHD)	22.50
FMA Invert Level (mAHD)	24.40
Side Slope (v:h)	1:6
Outlet BUP Lid Level (mAHD)	24.40
Orifice Invert Level (mAHD)	23.53
Orifice Diameter (mm)	200
20% AEP (Minor)	
Peak Water Level (mAHD)	24.60
Critical Duration (hours)	3
Maximum Depth (m)	0.20
Peak Water Level Area (m^2)	1,656
Peak Water Storage Volume (m^3)	360
Pipe Peak Outflow (L/s)	69
Overland Flow (L/s)	-
Total Peak Outflow (L/s)	69
1% AEP (Major)	
Peak Water Level (mAHD)	24.93
Critical Duration (hours)	6
Maximum Depth (m)	0.53
Peak Water Level Area (m^2)	2,492
Peak Water Storage Volume (m^3)	1,080
Pipe Peak Outflow (L/s)	93
Overland Flow (L/s)	6
Total Peak Outflow (L/s)	99

5.7 Lot Finished Levels Relative to Stormwater

The drainage management criteria for determination of building floor levels shall be a minimum 300 mm above the 1% AEP top water level of the FMA as per the recommendations by City of Armadale (2015).

Finished lot levels range from 25.50 mAHD to 26.93 mAHD, Appendix E, which satisfies the minimum 300 mm separation required to the 1% AEP top water level of the FMA of 24.96 mAHD).

5.8 Water Quality Management

5.8.1 Non-Structural Controls

Non-structural source controls to reduce nutrient export from the site focus on reducing the need for nutrient inputs into the landscape. The following strategies are proposed:

- Local native plants make up a minimum 50% of the planted areas and streetscape treatments. Any non-local species will be selected for drought tolerance and low fertiliser requirements;
- Maintenance practices such as street sweeping to remove sediment build-up, particularly during the development and construction phase (to be coordinated with the City of Armadale); and

5.8.2 Structural Controls

Structural source controls are proposed to complement the non-structural source controls and provide a complete stormwater treatment train.

The *Stormwater Management Manual for Western Australia* (DWER, 2022b) outlines expected pollutant removal efficiencies for various best management practices, including vegetated swales and detention/retention systems. The application of a treatment train approach by using a combination of non-structural and structural measures as outlined in this UWMP will achieve best management practice outcomes for water quality (Table 13).

TABLE 13: BMP WATER QUALITY PERFORMANCE

Parameter	Structural Controls Nutrient Output Reduction[1]	
	Vegetated Swales	Detention/Retention Measures
Total Suspended Solids	60-80%	65-99%
Total Phosphorus	30-50%	40-80%
Total Nitrogen	25-40%	50-70%
Gross Pollutants	-	> 90%

1. Typical Performance Efficiencies via DWER (2022b)

The following structural controls are considered appropriate for the Study Area:

- The use of underground infiltration units (soakwells) within residential lots;
- A bio-retention (vegetated treatment) area within the POS. The FMA, BRA and vegetated swales along Arabian Court will be planted with suitable plant species to assist in water quality improvement. Planting will be consistent with *Vegetation Guidelines for Stormwater Biofilters in the south-west of Western Australia* (Monash University, 2014).
- Verges fronting lots will be landscaped with water-wise low shrub and groundcover planting beneath tree canopy as detailed in the Landscape Concept Plan (Plan E, 2023) presented in the LWMS (Environnivate, 2023).

Stormwater runoff generated from footpaths and driveways in road reserves will generally grade towards verges and infiltrate stormwater from 'small' events at-source. Plant species proposed for verges are robust and can tolerate sporadic runoff during 'small' rainfall events.

5.8.3 Water Quality Treatment Areas

Guidance for design of the treatment bio-retention area and swales are provided in the following guidelines:

- DWER (2017a) *Decision Process for Stormwater Management in Western Australia* – the criteria to capture and treat the first 15 mm of rainfall;
- Payne et al. (2015) *The Adoption Guidelines for Stormwater Biofiltration Systems*;
- *FAWB (2009) Stormwater Biofiltration Systems – Adoption Guidelines;*
- *DoW (2011) Water Sensitive Urban Design – Biofilters; and*
- *Monash University (2014) Vegetation Guidelines for Stormwater Biofilters in the South-West of Western Australia* – for plant selection, density and distribution as appropriate.

The BRA is shown on Figures 10 and 12 *left* with the Landscape Plan from Plan E (2023) in Appendix F.

The BRA is sized to function correctly with a saturated hydraulic conductivity (K_{sat}) of 200 to 300 mm/hr (5 to 7.2 m/day). Research conducted by the Facility for Advancing Water Bio-filtration (FAWB, 2009) indicates that the desired K_{sat} is in the range of 2.5 to 7 m/day, to fulfil the drainage requirements as well as retain sufficient moisture to support the vegetation. The FAWB (2009) research also specifies that for vegetated systems some clogging will occur in the first few years until the vegetation has established and the roots and associated biological activity will maintain the conductivity of the soil media over time.

Guidelines indicate minimum 300 mm of amended soil media is required in all treatment areas, to support vegetation and treat nutrients and that the treatment area of a BRA should be minimum of 2% of the connected impervious areas to provide sufficient treatment capacity. The BRA in the Study Area meets this minimum treatment area requirement.

The minimum specifications for the vegetated treatment area are presented in Table 14.

TABLE 14: MINIMUM SPECIFICATIONS FOR PLANTED BIO-RETENTION AREA

Item	Specification
Amended soil media	• Minimum 300 mm thick. • Hydraulic conductivity between 5 and 7.2 m/day. • PRI >10. • Light compaction only. • Total clay and silt fraction <3% in total (w/w). • Organic matter content <5% (w/w). • Phosphorus content <80 mg3/kg.
Plant selection, planting density and distribution	• As per Vegetation Guidelines for Stormwater Biofilters in the South-West of Western Australia (Monash, 2014). • Tolerant of periodic inundation and extended dry periods. • Preferential selection of endemic and local native species (Monash, 2014).
Maintenance	• 12 months following initial planting.

5.8.4 Flush Kerbing

Flush kerbing bordering POS allows stormwater runoff from frequently occurring 'small' rainfall events to flow directly into POS across grassed verge/areas, maximising infiltration at-source and providing some mechanism for removal of sediment and silt. Footpaths generally surround the central POS. Therefore, flush kerbing is only appropriate adjacent to the roadside swales.

5.8.5 Verge Planting

Verges fronting lots will be installed with package landscaping with low fuel groundcover planting. Stormwater runoff generated from footpaths and driveways in road reserves will generally grade towards verges and infiltrate stormwater from 'small' events at-source. Plant species proposed for verges are detailed in the Landscape Concept Plan (Plan E, 2023) and are robust species that can tolerate sporadic runoff during 'small' rainfall events.

5.8.6 Disease Vector and Nuisance Insect Management

Structural stormwater management systems are designed to minimise the risk of chironomid midge and mosquito breeding. Infiltration, evapotranspiration and drawing down of water via subsoils under the BRA prevents pooling for longer than three days (72 hours) in late spring to early autumn prevents completion of the larval stages of the mosquito life cycle (DWER, 2022b), as per requirement of Department of Health and City of Armadale.

The outlet from the FMA is also set equivalent to the base invert at 24.40 mAHD, so no water is retained in the FMA longer than 12 hours.

6. GROUNDWATER MANAGEMENT

6.1 Groundwater Levels and Management

Groundwater management for the Study Area has been prepared in line with the design criteria presented in the Stormwater Management Manual for Western Australia (DWER, 2022b) and the LWMS (Environnivate, 2023).

For the Study Area, JDA recommends clean sand fill with a minimum saturated hydraulic conductivity of 5 m/day is used to achieve the required separation from finished lot levels and the pre-development AAMGL and MGL.

Proposed finished lot levels across the Study Area, Appendix E, range from 25.50 mAHD in the southeast of the POS to 26.93 mAHD at the balance of Lot 11 in the north with at least a minimum 1.5 m above the pre-development MGL, Figure 7. Subsoil drainage is proposed beneath the central BRA and south of the POS FMA as a contingency measure should groundwater levels rise beneath the FMA. Proposed subsoil drainage, Figure 14, is set a minimum 0.4 m above the pre-development MGL. The proposed subsoil drainage layout within the southern POS FMA is located outside of the Tree Protection Zones (TPZs) of retained trees.

The subsoil drainage system will be located within the road reserve and be beneath the central BRA and southern POS area. It will grade to the southern side of the POS and discharge in the foreshore reserve towards the Wungong River. It will be constructed as a solid section of pipe within the reserve and be located beneath an existing vehicular track so no vegetation clearing is required. The subsoil discharge will flow as shallow sheetflow and is likely to infiltrate before reaching the river.

Lot soakwells should have a minimum 0.5 m clearance from the pre-development MGL.

6.2 Lot Finished Levels Relative to Groundwater

Lot finished levels should be a minimum 1.5 m above the pre-development MGL. Proposed finished lot levels range from 25.50 mAHD to 26.93 mAHD, Appendix E, and a comparison with MGL indicates that all lots have significantly more than 1.5 m separation between finished lot levels and pre-development MGL.

6.3 Groundwater Quality Management

Amended soil with high Phosphorus Retention Index (PRI) will backfill the subsoil pipes in the road reserves to remove nutrients and contaminants from stormwater runoff prior to infiltration to groundwater. Details of the amended soils refer to Section 5.8.3.

A post development groundwater quality monitoring program is also proposed, refer to Section 8.3.

7. WATER EFFICIENCY MEASURES

7.1 Public Open Space (POS)

The POS will incorporate turfed areas, remnant trees and plantings of low water use-vegetation. Mulches and ground-covers will be used to increase the efficiency of irrigation and conserve water. Native species will be used in drainage and other landscaped areas where appropriate, and irrigation system is designed to water wise principles.

The estimated irrigation/POS area within the Study Area is 0.28 ha. Assuming an irrigation rate of 7,500 kL/ha/year and 0.20 ha of these areas require both establishment and ongoing irrigation, the required irrigation volume for these areas is 1,500 kL/year. JDA has applied for a Groundwater Licence with the designated irrigation volume.

A Licence to Construct a Bore has been submitted to DWER as well. The initial purpose of the bore was for dust suppression; however, the same production bore may also be used for irrigation of POS. Water taken from this bore will need to be metered per DWER's metering requirements.

City of Armadale requires the use of a C4 grass type (kikuyu / couch / zoisia) for turf within POS. Turfed areas within the central POS will be above the minor event (20% AEP) flood level. Verges fronting lots will be landscaped with water-wise low shrub and groundcover planting beneath tree canopy. These will be planted by the developer and maintained by the City, with further details to be presented as part the landscape approvals process with the City.

7.2 Residential Lots

To achieve water efficiency targets, households are to be built consistent with current National Construction Code water efficiency standards.

The State Planning Policy 2.9 regarding water resources (WAPC, 2006) requires new developments to employ a total water cycle approach to the consideration of water resources. This section addresses water conservation measures, fit for purpose non-potable supply, and refers to the potable supply strategy and wastewater strategy. JDA notes that a draft State Planning Policy (SPP) 2.9 was released for public comment in September 2021 which amalgamates and synthesises various SPPs into a single planning document including SPP 2.9. The revised SPP 2.9, once published as final, should be used to further inform appropriate water management measures.

Water Conservation initiatives are vital in reducing water demand and can reduce strain or delay timing of potable water supply infrastructure. The Water Conservation Strategy for the development includes:

- Residential zoning with smaller lots to reduce garden (ex-house) use of water;
- Use of water-wise practices at the lot scale, including water efficient fixtures and fittings (WELD rated taps, showerheads, toilets, appliances, rainwater tanks) and water-wise landscaping including native plant species; and
- All dwellings are to be built to 6-star building standards as per the current National Construction Code [NCC]. Note the NCC 2022 was published on 01 October 2022 and incorporates a minimum 7-star energy efficient rating for new dwellings. NCC 2022 will be adopted on 01 May 2023 by the WA Government but there will be transitional period in implementation of the new code with the residential energy efficiency provisions mandatory from 01 May 2025 after which all new dwellings are to be 7-star rated.

Conservation measures aim to reduce scheme water consumption using water efficient appliances and utilising 6-star building and appliance rating schemes towards minimising potable water consumption in the development area within the constraints of the site.

Residents will be encouraged through point-of-sale documentation to install rainwater tanks as part of the domestic water supply scheme to assist in reducing stormwater generation and minimise scheme water importation.

8. UWMP IMPLEMENTATION PLAN

8.1 Construction Management

8.1.1 Dewatering

Dewatering will be required for some elements of subdivision construction including drainage and sewer installation. Given the depth of construction, dewatering will only be in the Superficial Aquifer.

Prior to commencement of dewatering, the construction contractor need to obtain a "Licence to Take Water" if dewatering exemption criteria are not met. This includes a pump rate below 10 L/s over a period of less than 30 days and the volume of water taken over the period does not exceed 25,000 kL.

Dewatering across the development area will be carried out in accordance with the licence conditions. Where possible, construction will be timed to minimise impacts on groundwater and any dewatering requirement.

It is envisioned that residential lots will be connected to sewerage at the earliest opportunity. Should the proposed wastewater pump station and pressure mains not be constructed prior to first flows from the site, temporary sewerage arrangements will be implemented. This will include tankering of sewerage from the site in agreement with Water Corporation and automatic telemetry of sewerage levels to prevent overflows. The sewer system will grade to the pump station located on McNeill Road approximate 900 m south-west of the LSP area.

8.1.2 Acid Sulphate Soils

An ASS investigation will be performed as part of a detailed geotechnical investigation. If ASS is encountered it will be managed in accordance with the applicable DWER Acid Sulphate Guidelines for Identification and Investigation (DER, 2015a) and Treatment and Management (DER, 2015b) of Disturbed Acid Sulphate Soils. Specific methods for treatment and holding times for ASS are specified in these guidelines.

8.1.3 Sediment Control and Dust Suppression

Construction will occur in a manner consistent with the approved Erosion and Sediment Management Plan prepared by Western Environmental (2023). submitted to the City of Armadale by the approved civil contractor.

A Licence to Take Water for dust suppression activities may be required. These types of licences are considered temporary, generally up to 2 years in duration, and may be approved by DWER if the groundwater aquifer is over-allocated.

A Licence to Construct a Bore will also be required. The production bore proposed for POS irrigation may also be used for dust suppression but will need to be meter separately per DWER's metering requirements.

Alternatively, scheme water or water tanking may be required to facilitate dust suppression should an application for a licence to construct a bore not be approved prior to commencement of earthworks.

8.1.4 Vegetation Retention

A Preliminary Tree Assessment was prepared by Aboribus on 18 September 2023 for Lot 102 Arabian Court. The project design team is working in consultation with the City of Armadale in determining which trees are worthy of retention and which can be practically retained. During construction of the works the Developer will ensure the trees agreed for retention are managed in accordance with the recommendation of Appendix C of the Preliminary Tree Assessment (Aboribus, 2023) and Arborist's advice.

8.2 Maintenance

Construction and initial maintenance of the drainage system will initially be the responsibility of the developer but will ultimately by the City of Armadale at the end of the 12 months defects liability period. Table 15 presents the proposed maintenance schedule. During the builders construction phase, the developer will conduct more frequent maintenance of the street drainage, with quarterly street sweeping, inspection of pits, eduction of sediment and rubbish in manholes and removal of debris to prevent blockages.

TABLE 15: MAINTENANCE SCHEDULE FOR DRAINAGE INFRASTRUCTURE

Item	Maintenance Interval		
	Quarterly	Bi-annually	As required
Street Drainage			
Street sweeping to reduce particulate build-up	✓		
Removal of debris to prevent blockages	✓		
Eduction of sediment and rubbish in manholes/GPTs	✓		
Planted Areas (BRAs)			
Inspect for erosion + sediment accumulation		✓	
Assess health of vegetation. Remove dead plants and replace where necessary.		✓	
Removal of sediment and leaf litter layer build up.			✓
Flood Management Areas			
Removal of debris from pipe inlets to prevent blockages	✓		
Use of slow release/low Phosphorus fertilisers in turfed areas.		✓	

8.3 Monitoring Program

The monitoring program has been designed to allow a quantitative assessment of hydrological impacts of the proposed development.

The post-development monitoring program is designed to operate over a 2-year period. The program will be periodically reviewed to ensure suitability and practicality. The program may need to be modified as data is collected to increase or decrease the monitoring effect in a particular area or alter the scope of the program itself.

The proposed post-development monitoring program for the LSP Area has been detailed in the LWMS (Environnivate, 2023) and is summarised below.

Groundwater levels and quality are to be monitored at 1 groundwater monitoring bore, MB5(R), for comparison to pre-development. MB5 was monitored as part of the LWMS pre-development monitoring (September 2014 to September 2022) and is the only LWMS monitoring bore within the Study Area. Pre-development bore locations are shown on Figure 5. The bore will need to be re-drilled for post-development monitoring in adjacent road reserves or the POS and monitoring should commence once more than 80% of the Study Area has been developed to ensure monitoring adequately assesses the hydrological impacts of the proposed development across the LSP area.

Biofilter outflow water quality is to be measured at the biofilter subsoil discharge point, S1.

Infiltration rate is to be measured for the biofilter in the amended soil profile.

Proposed post-development monitoring locations are shown on Figure 14.

Post-development water quality trigger values were calculated as 20% over the maximum reported values and are provided in Table 16.

A summary of the proposed monitoring program and reporting schedule is shown in Table 17 with the frequency of water quality target review and the contingency action plan detailed in Table 18.

All sampling is to be conducted according to Australian Standards and all water quality sample testing is to be conducted by a NATA-approved laboratory.

TABLE 16: GUIDELINE VALUES FOR POST-DEVELOPMENT MONITORING

Parameter		Groundwater Bore
		MB5(R)
pH	Range[1]	4.9 – 5.9
EC (µS/cm)	Min	270
	Max[2]	852
	Median[3]	540
TN (mg/L)	Min	<0.2
	Max[2]	5.4
	Median[3]	1.6
TP (mg/L)	Min	0.18
	Max[2]	5.28
	Median[3]	1.98

1. pH values to be between range provided.
2. 20% applied to present maximum recorded value.
3. Third quartile of pre-development results.

TABLE 17: MONITORING SCHEDULE AND REPORTING

Monitoring Type	Location	Frequency & Timing	Parameter	Reporting	Responsibility
Groundwater Level	MB5(R)	Quarterly for 2 years (Jan, April, July, October)	Water Level (mAHD)	A final report to be provided at the end of the 2-year monitoring period. Report to be provided to DWER and CoA within 3 months of completion of the monitoring period.	Developer
Groundwater Quality	MB5(R)	Quarterly for 2 years (Jan, April, July, October)	In Situ: pH, EC, temp Lab: NOx, TKN, TN, FRP, TP, selected metals		
Biofilter Outflow Quality	Subsoil Outlet (S1)	3 times per year (while flowing) for 2 years.	In Situ: pH, EC, temp Lab: NOx, TKN, TN, FRP, TP, selected metals		
Biofilter Infiltration	Biofilter	Every 12 months for 2 years.	Hydraulic conductivity (m/day)		

TABLE 18: CONTINGENCY PLANNING

Monitoring Type	Criteria for Assessment	Criteria Assessment Frequency	Contingency Action
Groundwater Level	Groundwater levels not to exceed the estimated post-development phreatic line by more than 0.5 m	After each monitoring occasion	1. Review design and operation of subsoil and stormwater drainage system. 2. Perform maintenance as required.
Groundwater Quality	Nutrient concentrations in shallow bores should not exceed 20% of the maximum recorded pre-development level.	Annual review of water quality targets	3. Identify and remove any point sources. 4. Consider reinforcement of Community Education/Awareness program. 5. Review operational and maintenance (e.g. fertilising, cleaning) practices. 6. Consider alterations to POS areas including landscape regimes and soil amendment. 7. Consider modifications to the stormwater system. 8. Consider initiation of community based projects.
Biofilter Outflow Quality	Nutrient concentrations should not exceed the Southern River LWQIP targets.	Annual review of water quality targets	
Biofilter Infiltration	Hydraulic conductivity should remain ⩾2m/day.	After each monitoring occasion	1. Test additional sites per basin to validate results and depth of clogging. 2. Assess results to develop appropriate action to remediate clogged layer. 3. Repeat infiltration testing once remediation measures have been completed. 4. Repeat infiltration testing in 12 months to confirm rates and allow further establishment of vegetation.

8.4 Responsibilities and Funding

The key roles and responsibilities for the implementation of this UWMP area presented in Table 19 below, with details on the maintenance of the surface water treatment structures outlined in Section 8.3.

TABLE 19: ROLES AND RESPONSIBILITIES FOR IMPLEMENTATION OF UWMP

Management Issue	Responsibility and Funding		
	Developer	City of Armadale	Lot Owner
Street Drainage Construction	✓		
Maintenance • Two years, including two winters (period between a successful Practical Completion Inspection and a defects inspection with a written confirmation of City acceptance)	✓		
• Street sweeping and drainage cleaning (eduction of sediment) to be undertaken immediately prior to the end of the 12 month defect liability period inspection.	✓		
• Ongoing (from notification of City acceptance)		✓	
Bio-Retention Area and Flood Management Area Construction	✓		
Maintenance • Two years, including two winters (period between a successful Practical Completion Inspection and a defects inspection with a written confirmation of City acceptance)	✓		
• Ongoing (from notification of City acceptance)		✓	
Street Sweeping • Two years, including two winters (period between a successful Practical Completion Inspection and a defects inspection with a written confirmation of City acceptance)	✓		
• Ongoing (from notification of City acceptance)		✓	
Lot Drainage Installation of underground storage units (e.g. soakwells)			✓

9. REFERENCES

Aboribus (2023) *Preliminary Tree Assessment – Lot 102 Arabian Court, Champion Lakes*.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019, *Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia.*

Bureau of Meteorology [BoM] (2016) *Design Rainfall Data System (2016)*.

BoM (2023) Climate Data Online, Forrestdale (009257) Rainfall Data. Accessed July 2023.

Bowman & Partners Environmental (2021) *Environmental Report Lake Road Precinct C LSP (Lot 101 Lake Road and Lots 102-105 Arabian Court, Champion Lakes).* Report Ref: CG/001/2021 Rev 1. Prepared for Arabian Court Pty Ltd and Masada Property Pty Ltd, August 2021.

Brown Geotechnical (2015) *Precinct C Arabian Court & Lake Road, Champion Lakes Western Australia. Report Ref: 15017.* Prepared for Sureland Development Pty Ltd, May 2015.

City of Armadale (2005) *Town Planning Scheme No. 4 (Local Planning Scheme) FINAL*. Gazetted 19 March 2019.

City of Armadale (2015) *Stormwater Management Handbook*. Last updated 20 May 2015.

Davidson (1995) *Hydrology and Groundwater Resources of the Perth Region Western Australia*. Western Australia Geological Survey, Bulletin 142.

Department of Environment [DoE] (2004) *Perth Groundwater Atlas, Second Edition.*

Department of Environmental Regulation [DER] (2015a) *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes*. Version: Final, June 2005.

DER (2015b) *Treatment and management of soil and water in acid sulfate soil landscapes*. Version: Final, June 2005

Department of Biodiversity, Conservation and Attractions [DBCA] (2018) Geomorphic Wetlands, Swan Coastal Plain.

Department of Planning, Lands and Heritage [DPLH] (2023a) *Map Sheet 24: Forrestdale. Metropolitan Region Scheme Map, 1:25000 Map Series*. Amended to 24 April 2023. Published by the Department of Planning, Lands and Heritage, Perth WA.

DPLH (2023b) Aboriginal Heritage Inquiry System. Accessed 28 July 2023.

Department of Primary Industries and Regional Development [DPIRD] (2022) Pan Evaporation data from Wattleup weather station. Accessed September 2023.

Department of Water [DoW] (2008) 1 m LiDAR Digital Elevation Model (DEM) Dataset.

DoW (2011) *Water Sensitive Urban Design: Biofilters*, June 2011.

DoW (2015) *Selection of future climate projections for Western Australia*. Water Science Technical Series, Report no. WST 72.

Department of Water and Environmental Regulation (2017a) *Decision Process for Stormwater Management in Western Australia,* November 2017.

DWER (2017b) *Acid Sulphate Soil* (A.S.S) *Hazard Mapping*.

DWER (2023) *Contaminated Sites Act 2003 Basic Summary of Records*, *843 Warton Road (ID: 63450)*. Accessed 16 September 2023.

DWER (2022b) Stormwater Management Manual for Western Australia. First published 2004-2007, updated May 2022.

Environnivate (2023) *Arabian Court, Champion Lakes: Lots 101 To 105 Local Water Management Strategy*. Report No. C0122-R01v04, 27 February 2023.

Facility for Advancing Water Bio-filtration [FAWB] (2009) *Guidelines for Soil Filter Media in Bio-retention Systems,* (Version 2.01), Facility for Advancing Water Biofiltration. June 2009.

IPWEA (2017) *Local Government Guidelines for Subdivisional Development Edition 2.3*, November 2017.

JDA (2020c) *PCSump Version 6.1 – USER GUIDE*. JDA Ref: J6216f, February 2020.

Jordan, J.E. (1986) *Environmental Geology Series 1:50,000 Environmental Map – Armadale, Sheets 2033-I and 2133-IV*. Geological Survey of Western Australia.

Luke, G.L, Burke, K.L. & O'Brien, T.M. (1987) *Evaporation data for Western Australia – Resource Management Technical Report No. 65*. Perth: W.A. Department of Agriculture, division of Resource Management. October 1987.

Monash University (2014). *Vegetation Guidelines for Stormwater Bio-filters in the south-west of Western Australia*. November 2014.

NHMRC, NRMMC (2011) *Australian Drinking Wager Guidelines [ADWG] Paper 6 National Water Quality Management Strategy*. Version 3.5. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

Payne, E.G.I., Hatt, B.E., Deletic, A., Dobbie, M.F., McCarthy, D.T. and Chandrasena, G.I. (2015) *Adoption Guidelines for Stormwater Biofiltration Systems*. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

PGV Environmental (2021) *Lots 101 – 105 Arabian Court, Champion Lakes – Morelotia australiensis and Vegetation Survey*. Report No. 10466_003_pvdm, 26 November 2021.

Rowe Group (2023) Lake Road Precinct C Structure Plan: *Lot 101 Lake Road and Lots 102 – 105 Arabian Court, Champion Lakes.* Report No. 9297_21Apr01R_MM_V3, C0122-R01v04, 13 June 2023.

Structerre (2023) *Geotechnical Investigation – Proposed Residential Subdivision Stage 1 – Lot 102 Arabian Court, Champion Lakes,* (Rev 0) dated 18/12/2023.

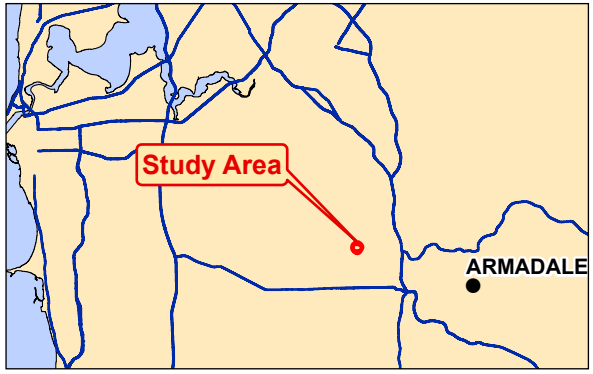
Waters and Rivers Commission [WRC] (1997) *Perth Groundwater Atlas*.

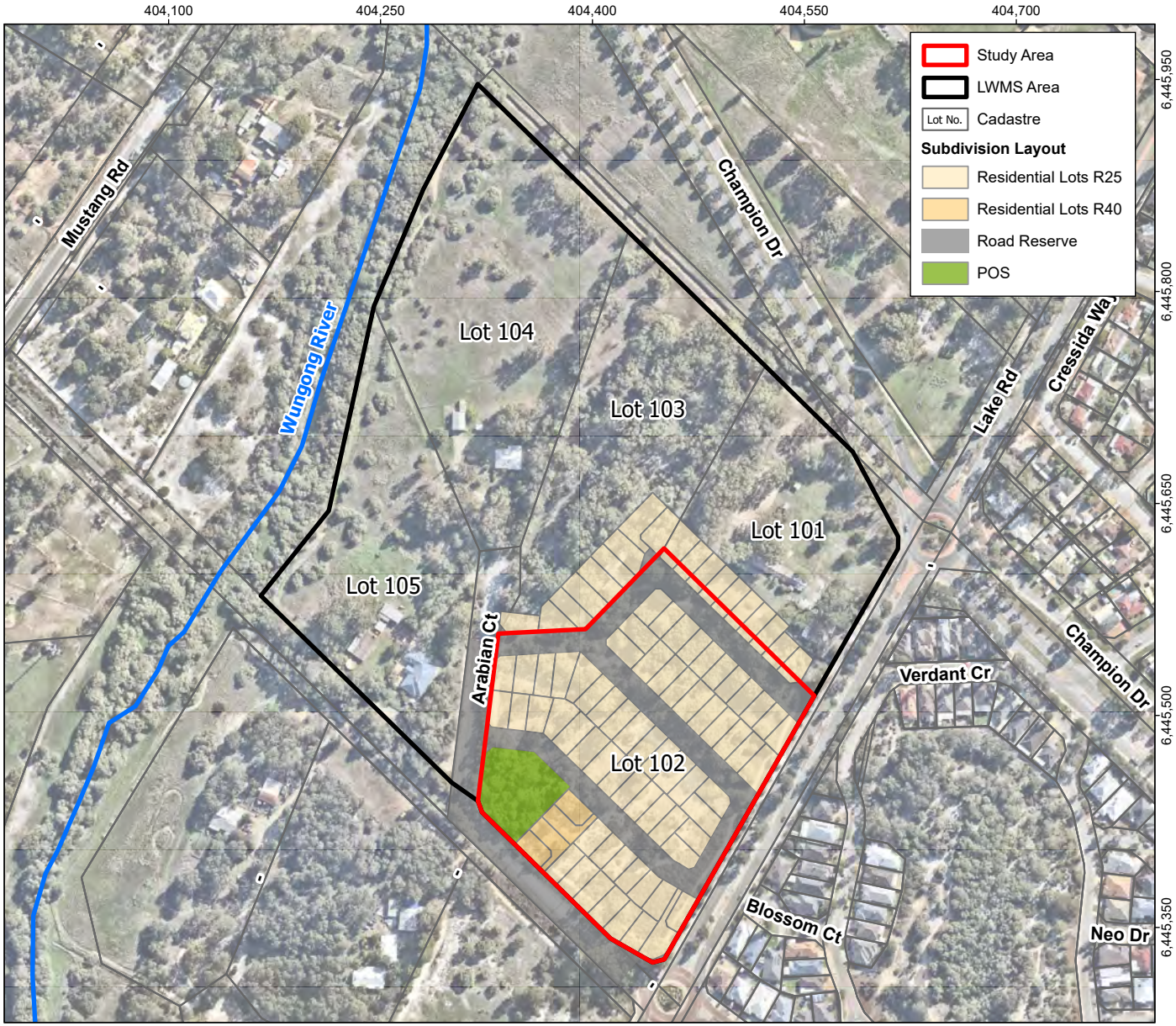
WAPC (2006) *State Planning Policy 2.9 Water Resources*. WA Government Special Gazette 227, 19

WAPC (2008) *Better Urban Water Management*, October 2008.

Western Environmental (2023) *Drainage and Erosion Management Plan.* Report No. A23.064-RPT-EMP, 30 August 2023.

FIGURES





Data Source: Rowe Group (2023); Nearmap Digital Imagery (2023), 30 April 2023.

Coordinate System: GDA 94, Zone 50

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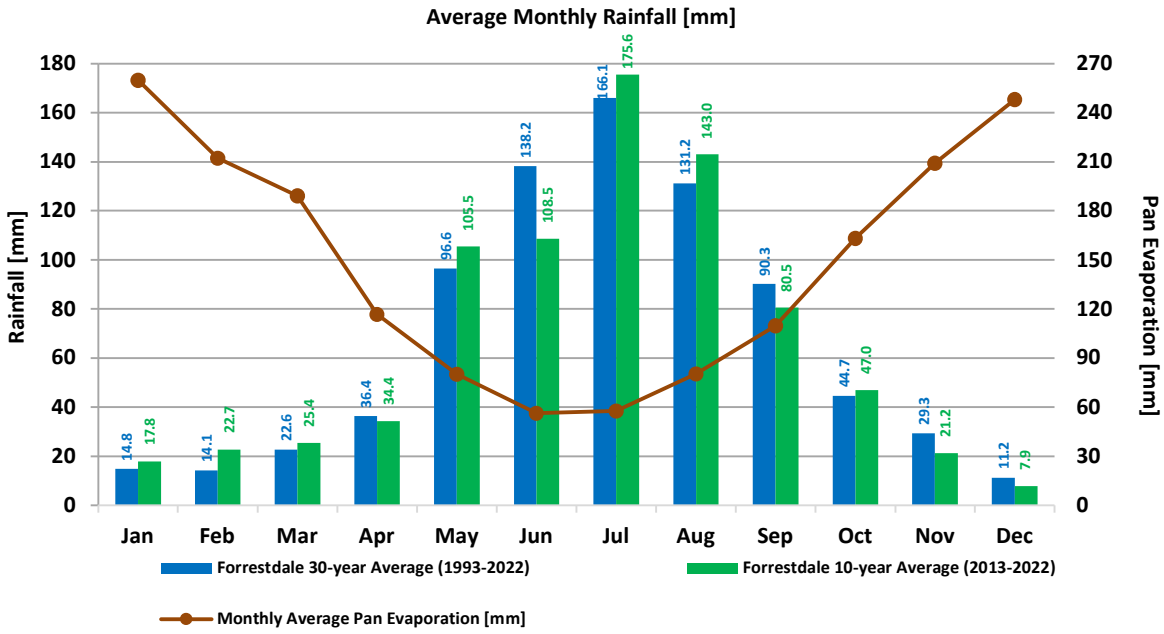
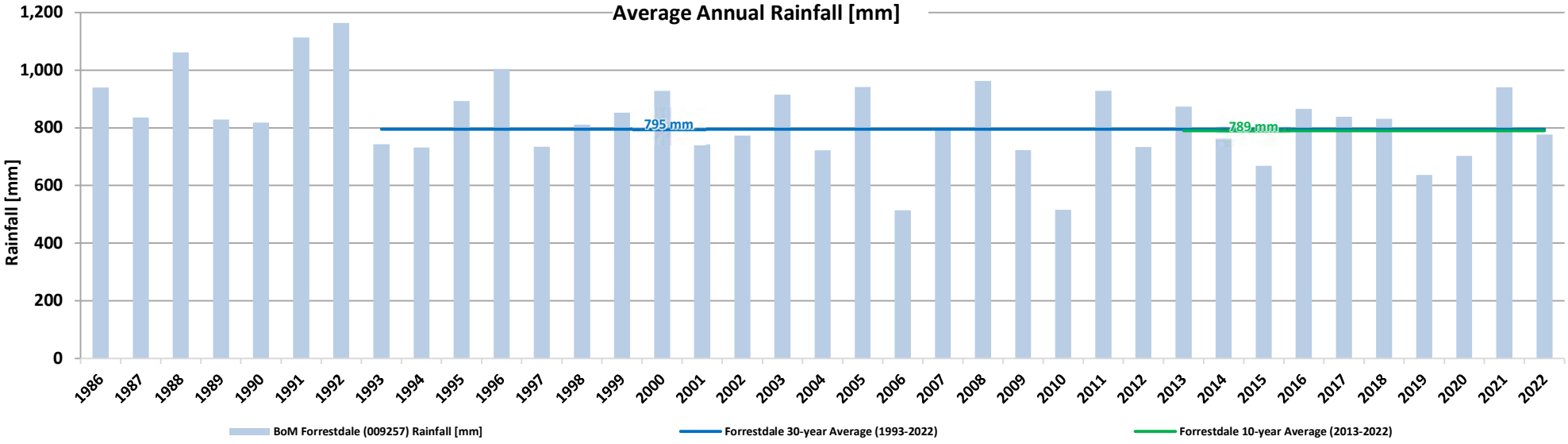
Arabian Court Pty Ltd

Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan

Figure 1: Location and Subdivision Plan





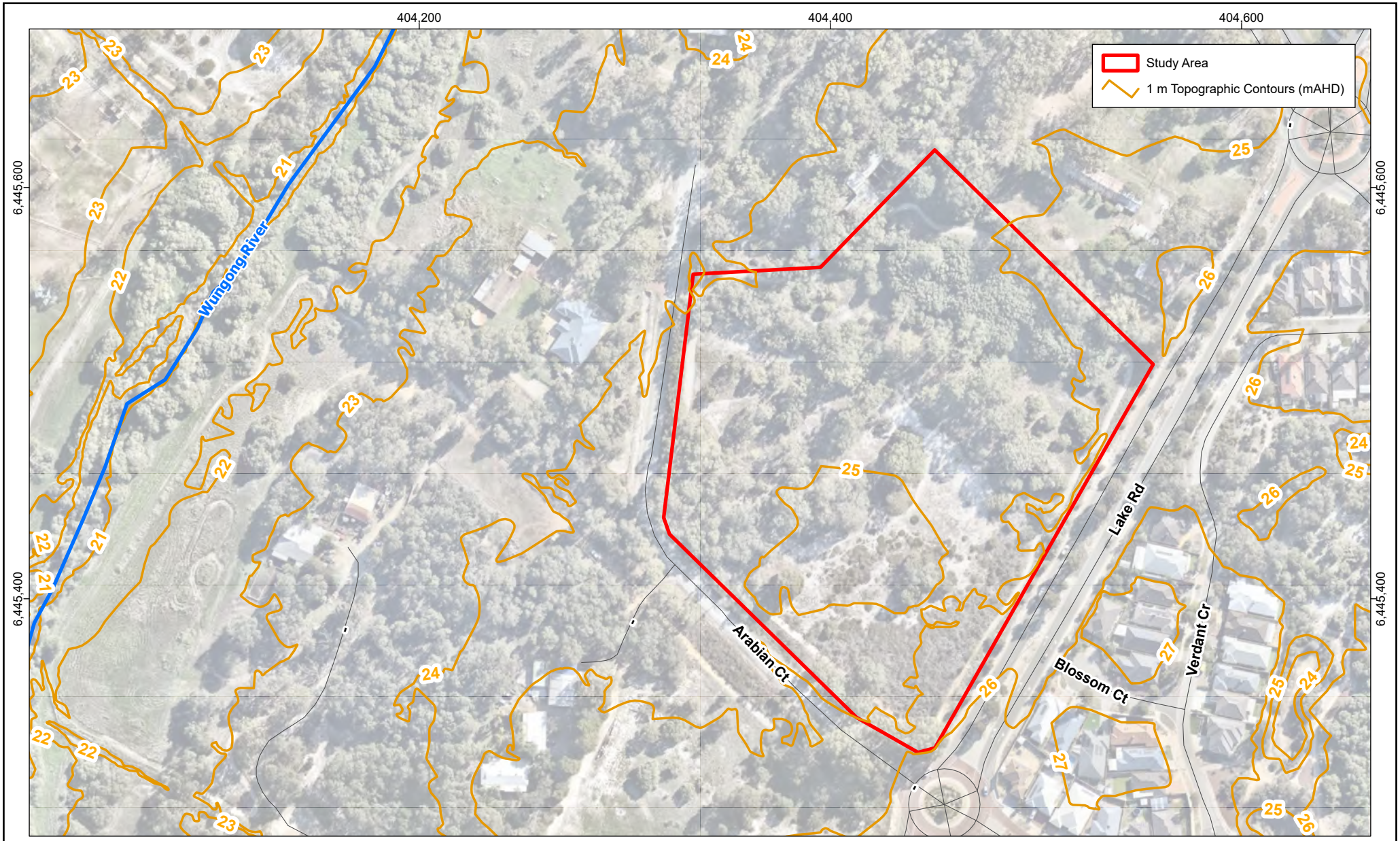
Data Source: Bureau of Meteorology (2023) *Forrestdale (009257)* ; DPIRD (2023) *South Perth Weather Station - Pan Evaporation*

Job No. J7392

Arabian Court Pty Ltd

Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan

Figure 2: Rainfall and Evapoation



Data Source: DoW (2008); Nearmaps (2023)

Coordinate System: GDA 94, Zone 50

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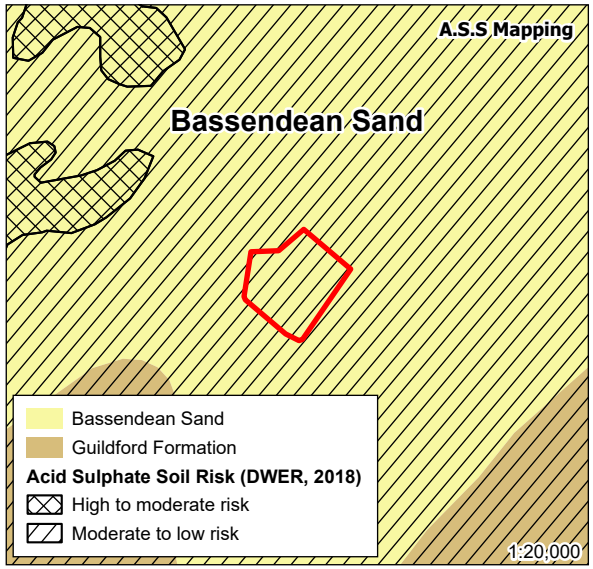
Arabian Court Pty Ltd

Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan

Figure 3: Topography



Lithological Classification

S8 - sand, white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, minor heavy minerals, of eolian origin.

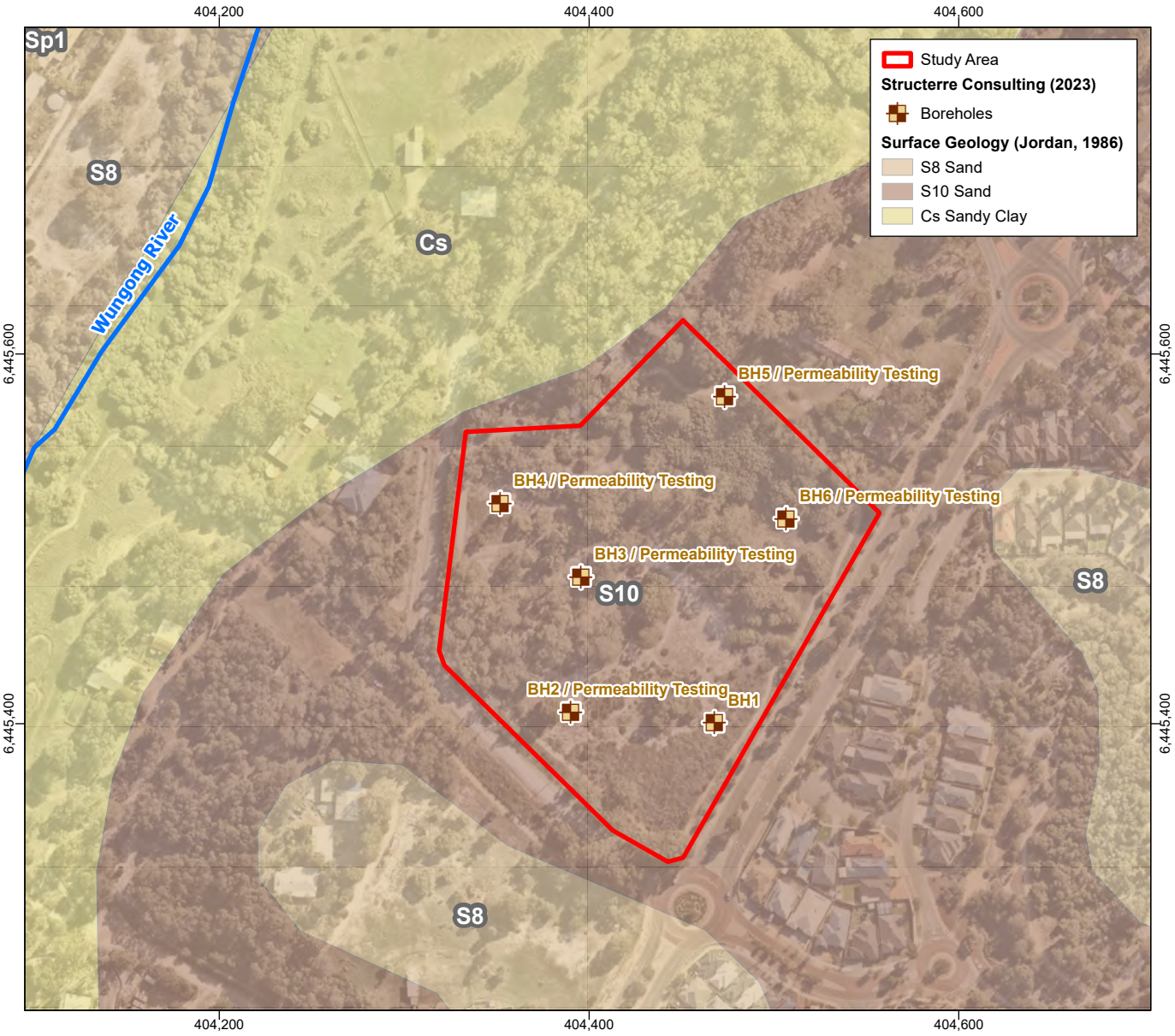
S10 - sand, as S8 over sandy clay to clayey sand of the Guildford Formation, of eolian origin.

Cs - sandy clay, white, grey to brown, fine to coarse, sub-angular to rounded, clay of moderate plasticity; gravel and silt layers near scarp, of alluvial origin.

Surface Geology

Bassendean Sand- Basal conglomerate overlain by dune quartz sand with heavy mineral concentrations

Guildford Formation- Alluvial sand and clay with shallow-marine and estuarine lenses and local basal conglomerate



Data Source: Jordan (1986) Environmental Geology Series *Armadale*; A.S.S Risk Mapping (DWER, 2018); Structeree Consulting (2023); Nearmap (2023).

Coordinate System: GDA 94, Zone 50

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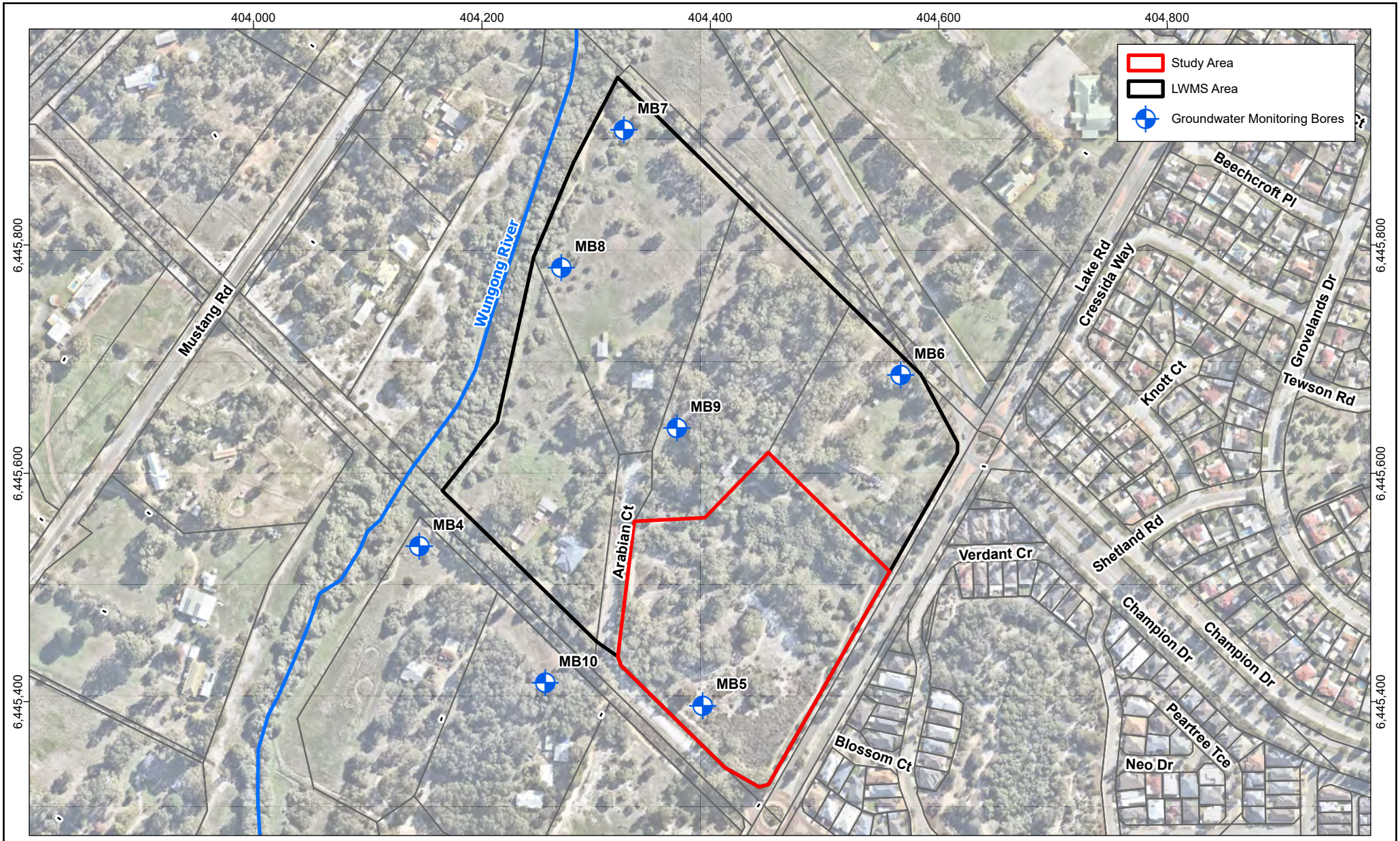
Arabian Court Pty Ltd
Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan
Figure 4: Surface Geology, Geotechnical and A.S.S. Mapping



Data Source: Nearmap (2023): Environnivate (2023)

Coordinate System: GDA 94, Zone 50

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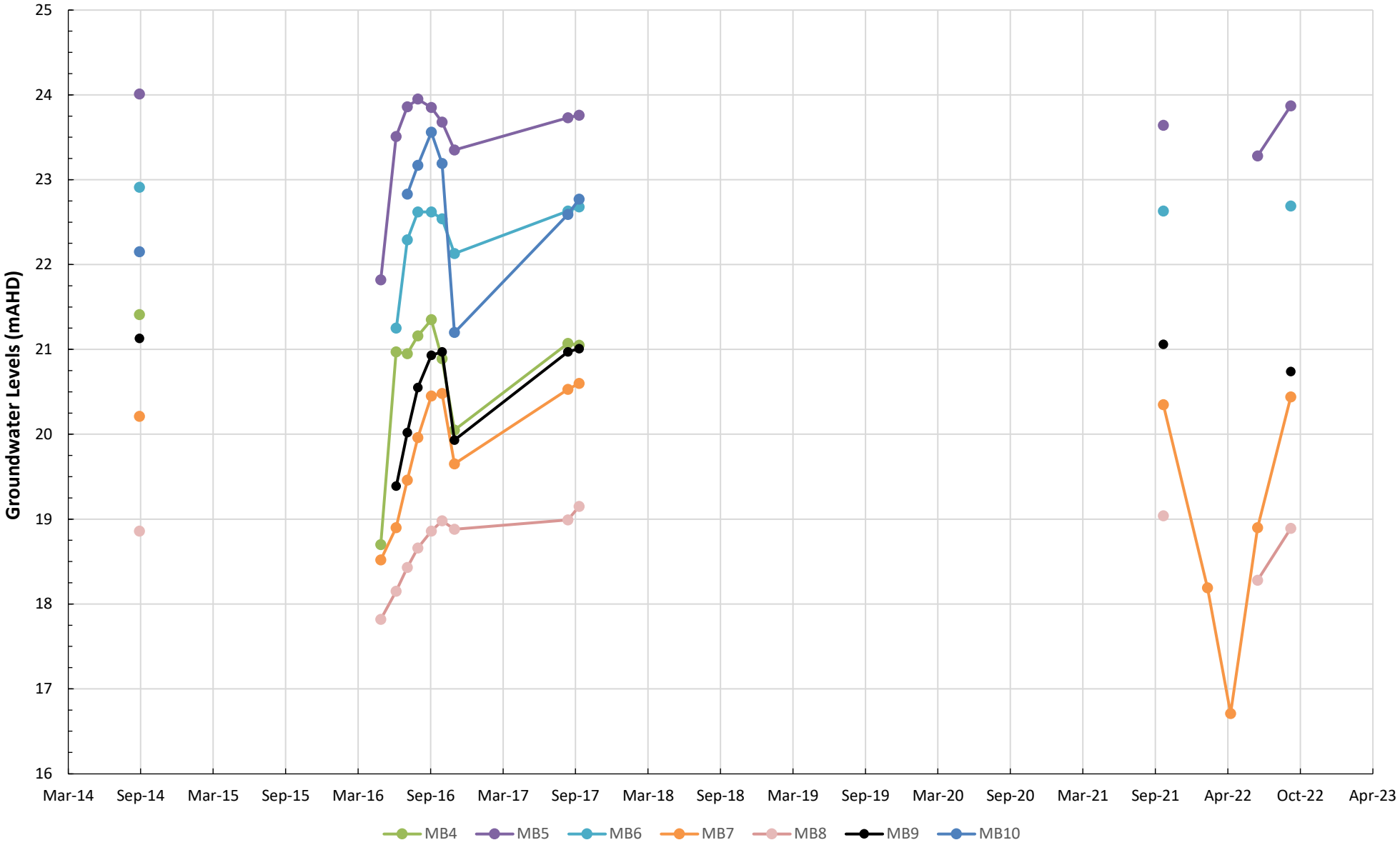
Arabian Court Pty Ltd

Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan

Figure 5: Groundwater Monitoring Bore Locations



Data Source: Environnivate (2023)

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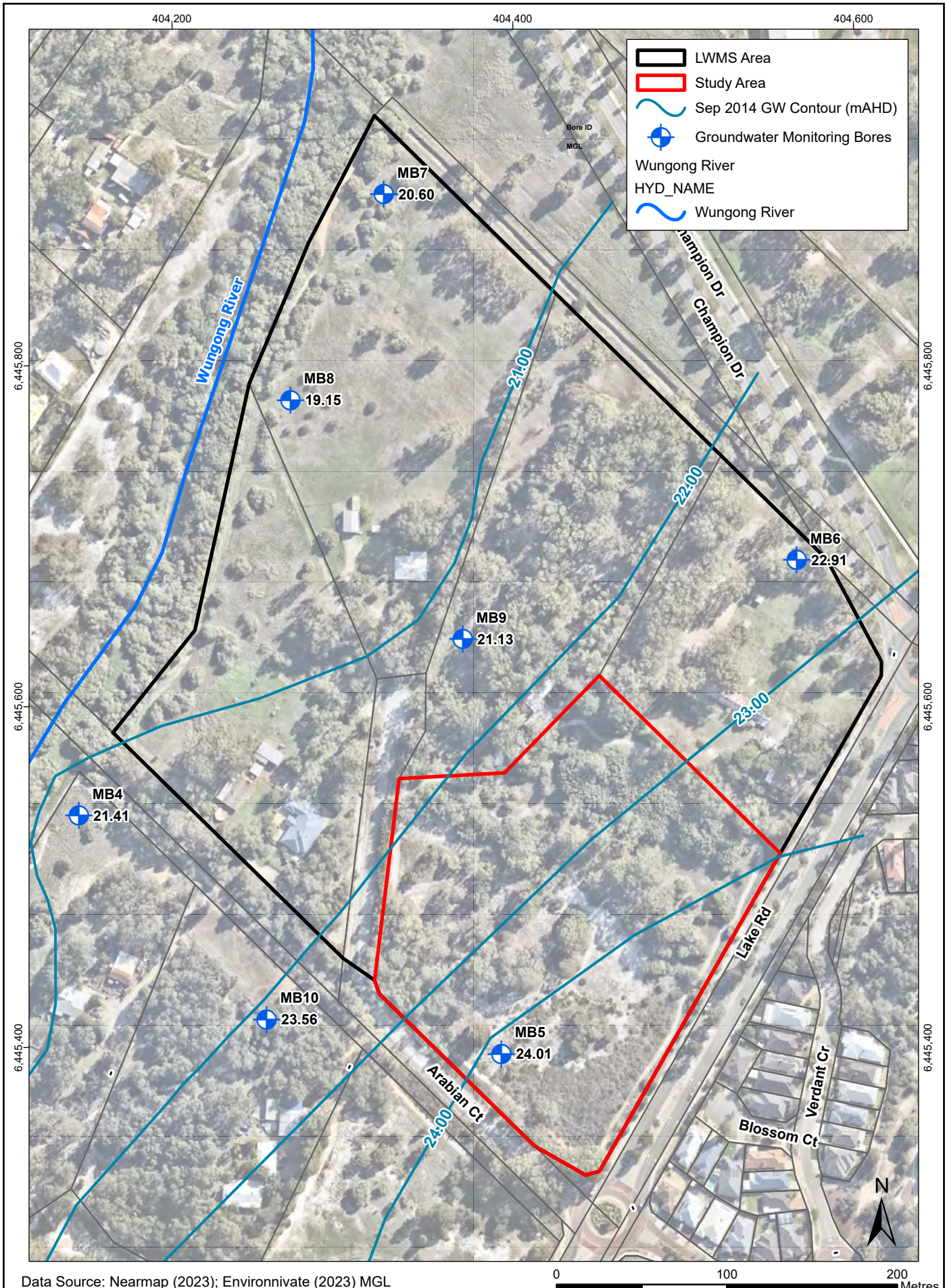
Arabian Court Pty Ltd

Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan

Figure 6: Groundwater Levels, 2014, 2016, 2017, 2021 and 2022



Data Source: Nearmap (2023); Environnivate (2023) MGL

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Job No. J7392
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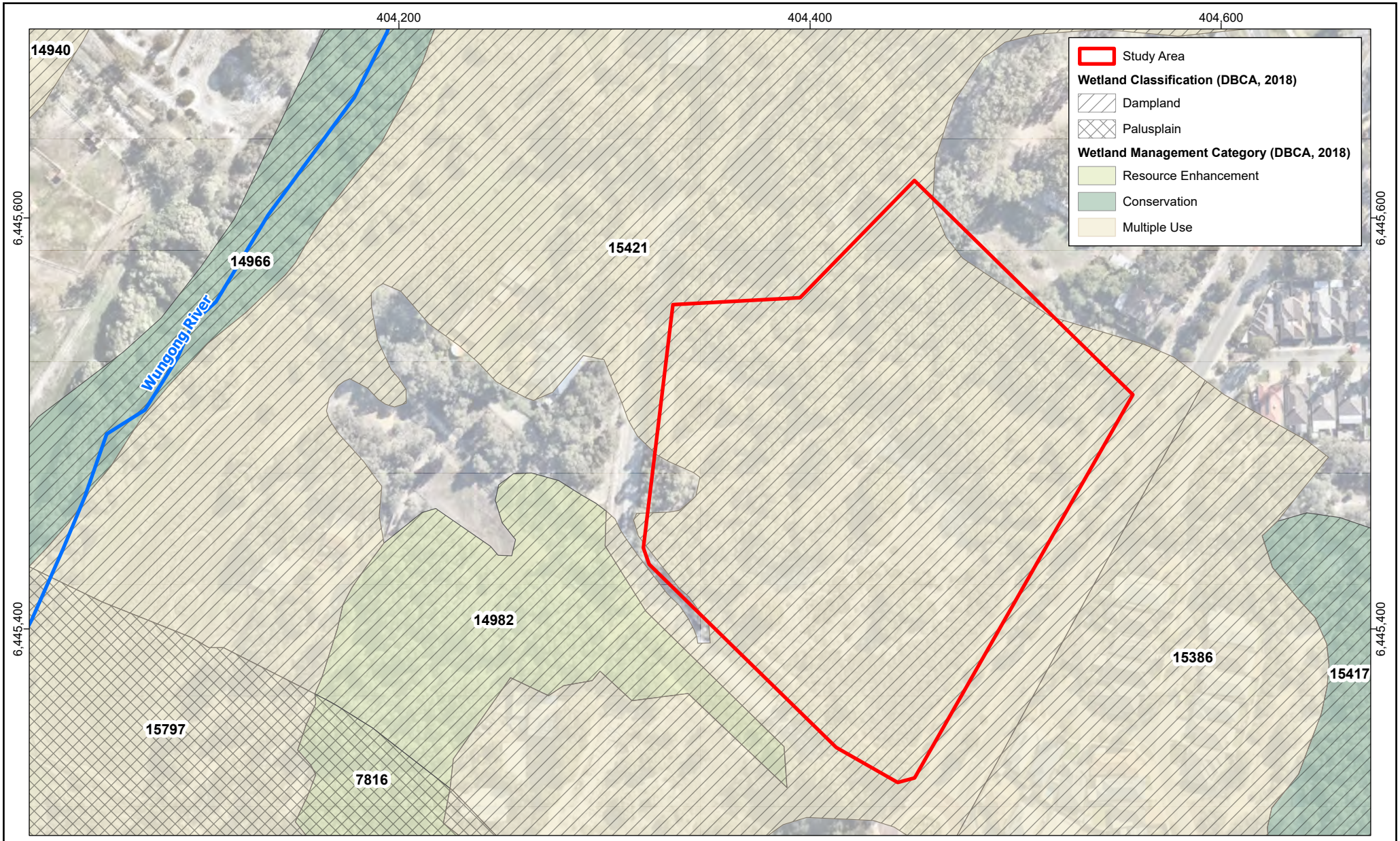
Arabian Court Pty Ltd
Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan
Figure 7: Pre-Development MGL (September 2014 Groundwater Contour)



Data Source: Nearmap (2023); DBCA (2018) *Geomorphic Wetland Mapping - Swan Coastal Plain.*

Coordinate System: GDA 94, Zone 50

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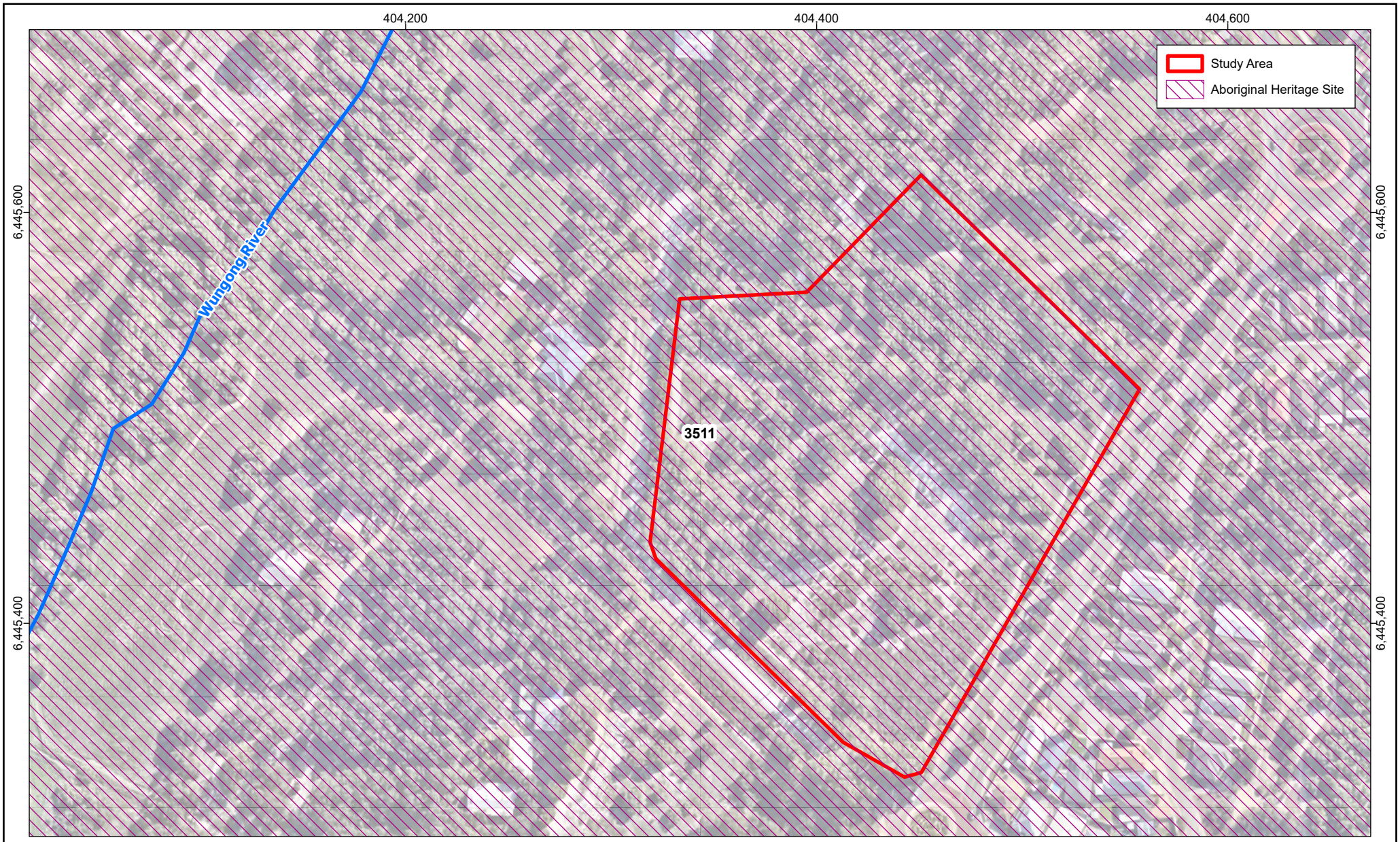
Arabian Court Pty Ltd
Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan

Figure 8: Geomorphic Wetland Mapping



Data Source: Nearmaps (2023); DPLH (2023b).

Coordinate System: GDA 94, Zone 50

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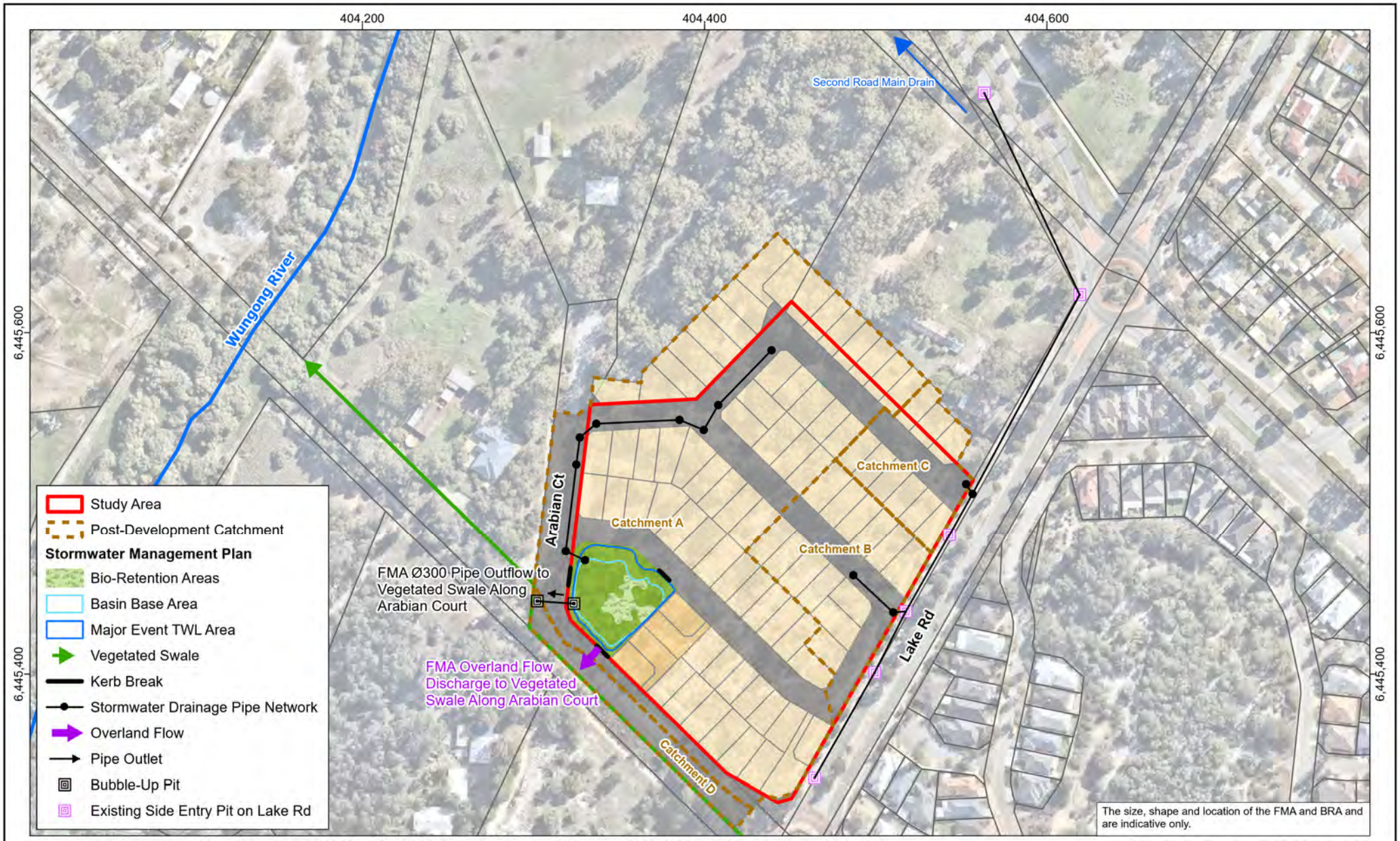
Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan

Figure 9: Aboriginal Heritage



Data Source: Nearmap (2023); Rowe Group (2023); C&W (2023); Plan E (2023); PCSump (2023); XPStorm Modelling Results (2023)

Coordinate System: GDA 94, Zone 50

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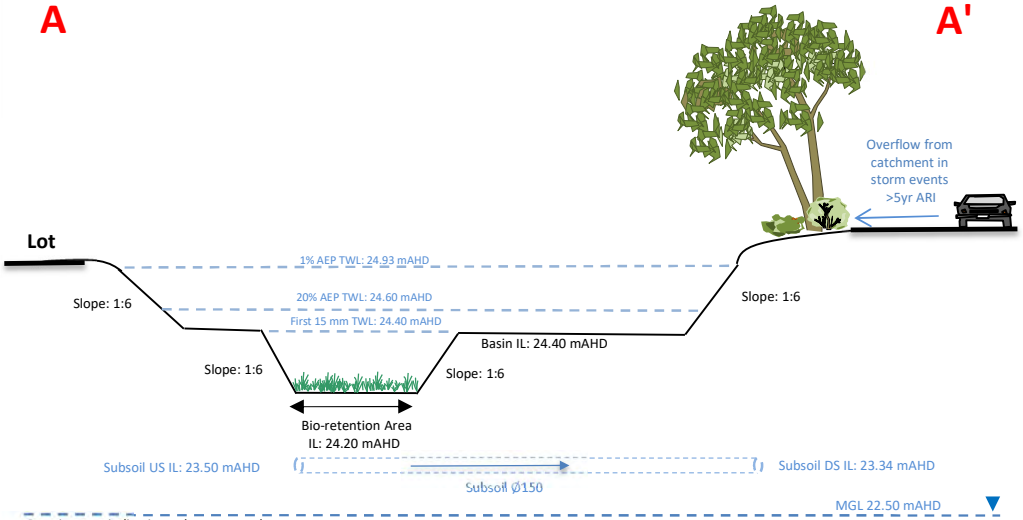
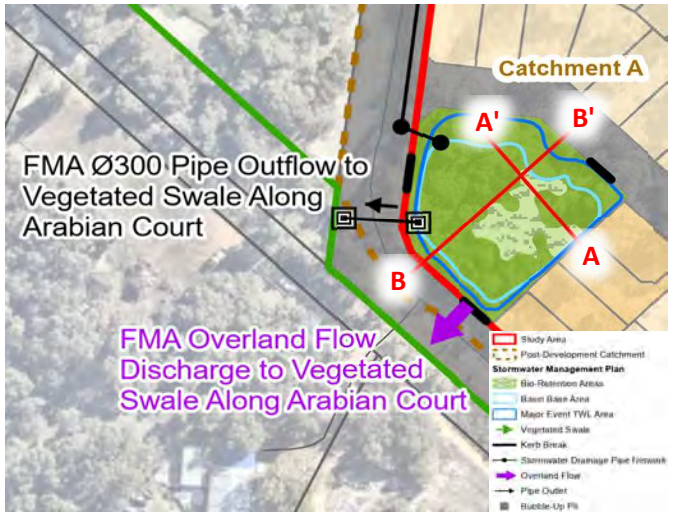
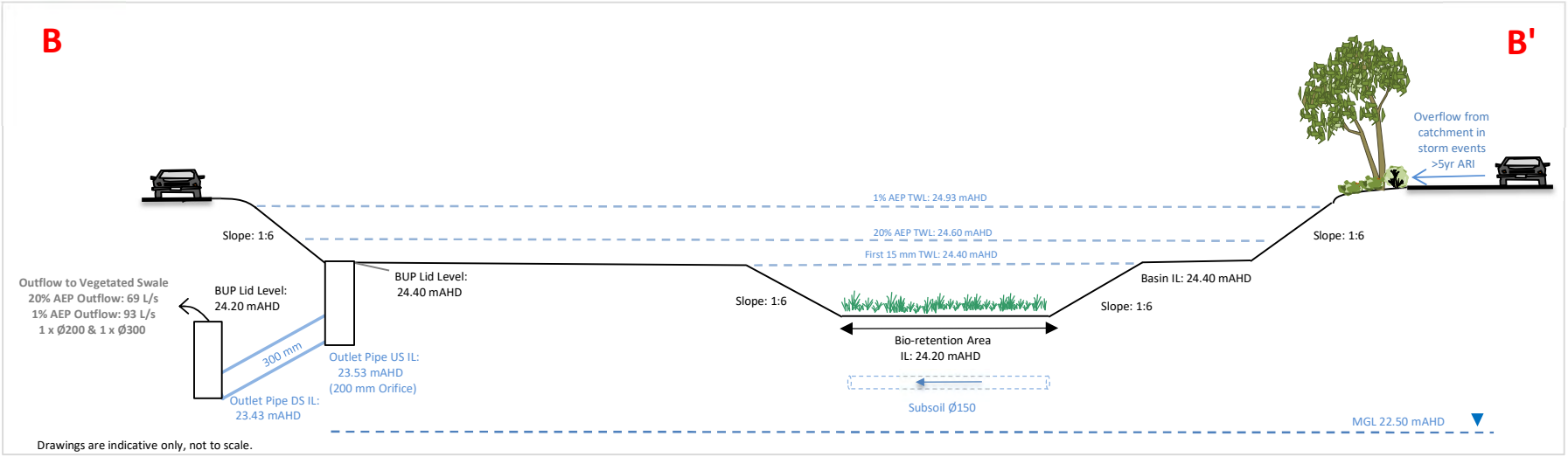
Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan
Figure 10: Stormwater Management Plan







Data Source: PCSump Modelling Results (2023); XPStorm Modelling Results (2023)

Job No. J7392

Arabian Court Pty Ltd

Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan

Figure 11: Drainage Cross Section

Study Area
Post-Development Catchment
Bio-Retention Areas
Kerb Break
Vegetated Swale
Surface Flow Direction

Bio-Retention Area (BRA)	BRA
Catchment Details	
Bio-Retention Road Reserve Area Catchment (ha)	1.09
BRA Invert (mAHD)	24.20
BRA Base Area (m^2)	369
Side Slope (v:h)	1:6
Top Water Level (mAHD)	24.40
Top Water Level Area (m^2)	900
Stored Volume (m^3)	106

Item	Specification
Amended soil media	• Minimum 300 mm thick. • Hydraulic conductivity between 5 and 7.2 m/day. • PRI >10 • Light compaction only. • Total clay and silt fraction <3% in total (w/w). • Organic matter content <5% (w/w). • Phosphorus content <80 mg/kg.
Plant selection, planting density and distribution.	• Tolerant of periodic inundation and extended dry periods. • Preferential selection of endemic and local native species (Monash, 2014). • As per Vegetation Guidelines for Stormwater Biofilters in the South-west of Western Australia (Monash, 2014).
Maintenance	• 24 months following initial planting.

Data Source: Rowe Group (2023); Nearmap (2022); PCSump (2023); C&W (2023); Plan E (2023)

Coordinate System: GDA 94, Zone 50

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Job No. J7392
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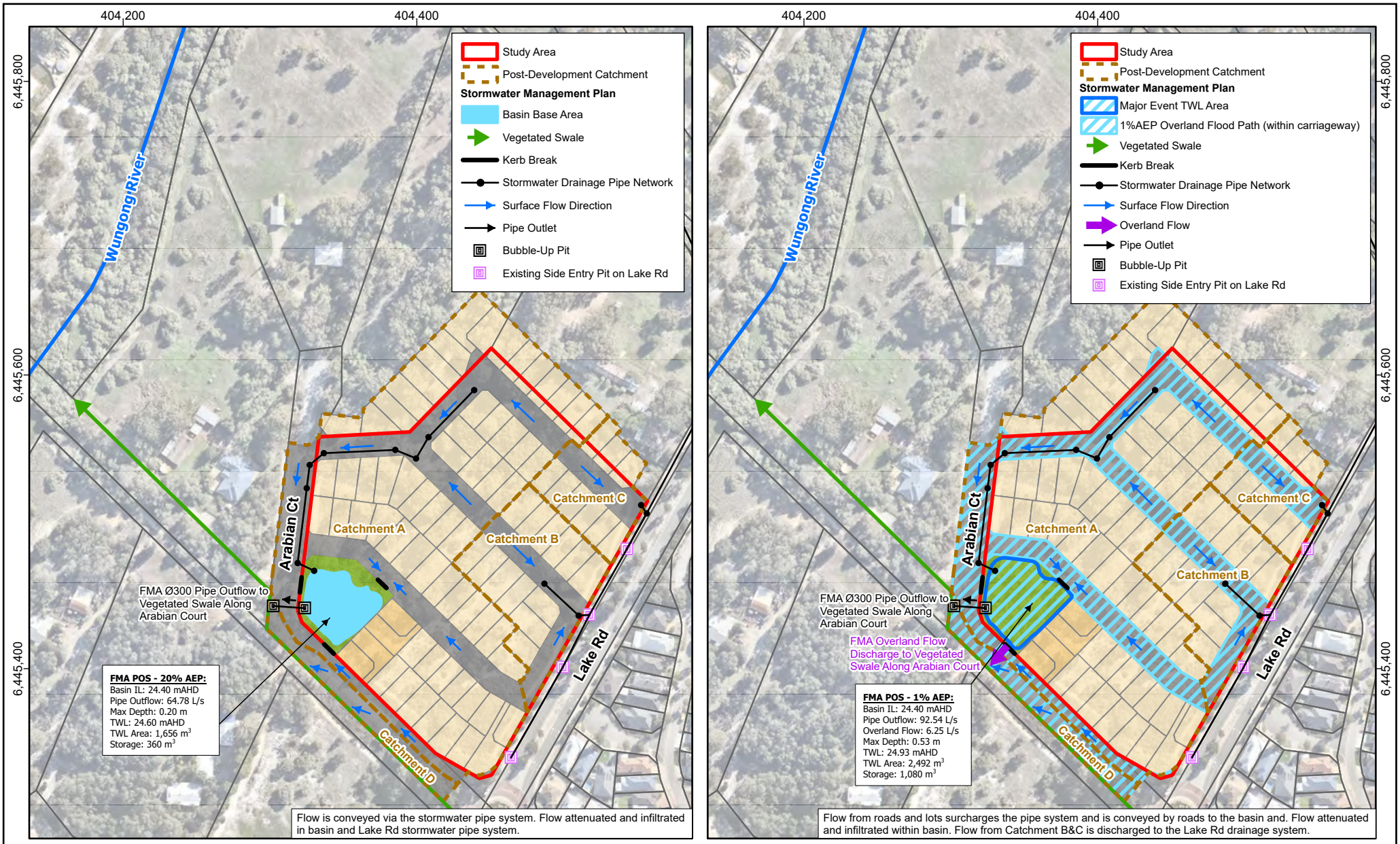
Arabian Court Pty Ltd
Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan
Figure 12: Stormwater Event Plan - Small Event



Data Source: Rowe Group (2023); Nearmap (2023); PCSump (2023); XPStorm (2023); Cossill & Webley (2023); Plan E (2023)

Coordinate System: GDA 94, Zone 50

JDA

Job No. J7392

Scale: 1:3,500 @A4

0 100 200 Metres

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Arabian Court Pty Ltd

Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan

Figure 13: Stormwater Event Plans - Minor & Major Event

Data Source: Nearmap (2023); Rowe Group (2023); C&W (2024); PCSump (2023); XPStorm (2023); Environnivate (2023) MGL: Plan E (2023)

Coordinate System: GDA 94, Zone 50

JDA

Job No. J7392

Scale: 1:2,500 @A4

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Arabian Court Pty Ltd

Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan

Figure 14: Groundwater Management

Data Source: Nearmap (2023); Rowe Group (2023)

Coordinate System: GDA 94, Zone 50

JDA

Job No. J7392
Scale: 1:2,500 @A4

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Arabian Court Pty Ltd
Lot 102 Arabian Court, Champion Lakes: Urban Water Management Plan
Figure 15: Post-Development Monitoring Locations

APPENDIX A

WAPC Subdivision Approval No.162858

Western Australian Planning Commission

Your Ref : 9297

Rowe Group
3/369 Newcastle
NORTHBRIDGE WA 6003

Approval Subject To Condition(s)
Freehold (Green Title) Subdivision

Application No : 162858

Planning and Development Act 2005

Applicant	:	Rowe Group 3/369 Newcastle NORTHBRIDGE WA 6003
Owner	:	Arabian Court Pty Ltd Po Box 1021 EAST VICTORIA PARK WA 6981
Application Receipt	:	3 October 2022

Lot Number	:	102
Diagram / Plan	:	13615
Location	:	
C/T Volume/Folio	:	1607/326
Street Address	:	Lot 102 Arabian Court, Champion Lakes
Local Government	:	City of Armadale

The Western Australian Planning Commission has considered the application referred to and is prepared to endorse a deposited plan in accordance with the plan date-stamped **03 October 2022** once the condition(s) set out have been fulfilled.

This decision is valid for **four years** from the date of this advice, which includes the lodgement of the deposited plan within this period.

The deposited plan for this approval and all required written advice confirming that the requirement(s) outlined in the condition(s) have been fulfilled must be submitted by **29 May 2027** or this approval no longer will remain valid.

140 William Street, Perth, Western Australia 6000, Locked Bag 2506 Perth, 6001
Tel: (08) 6551 8002; Fax: (08) 6551 9001; Infoline: 1800 626 477
e-mail: info@dplh.wa.gov.au; web address http://www. dplh.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

Reconsideration - 28 days

Under section 151(1) of the *Planning and Development Act 2005*, the applicant/owner may, within 28 days from the date of this decision, make a written request to the WAPC to reconsider any condition(s) imposed in its decision. One of the matters to which the WAPC will have regard in reconsideration of its decision is whether there is compelling evidence by way of additional information or justification from the applicant/owner to warrant a reconsideration of the decision. A request for reconsideration is to be submitted to the WAPC on a Form 3A with appropriate fees. An application for reconsideration may be submitted to the WAPC prior to submission of an application for review. Form 3A and a schedule of fees are available on the WAPC website: http://www.dplh.wa.gov.au

Right to apply for a review - 28 days

Should the applicant/owner be aggrieved by this decision, there is a right to apply for a review under Part 14 section 251 of the *Planning and Development Act 2005*. The application for review must be submitted in accordance with part 2 of the *State Administrative Tribunal Rules 2004* and should be lodged within 28 days of the date of this decision to: the State Administrative Tribunal, Level 6, State Administrative Tribunal Building, 565 Hay Street, PERTH, WA 6000. It is recommended that you contact the tribunal for further details: telephone 9219 3111 or go to its website: http://www.sat.justice.wa.gov.au

Deposited plan

The deposited plan is to be submitted to the Western Australian Land Information Authority (Landgate) for certification. Once certified, Landgate will forward it to the WAPC. In addition, the applicant/owner is responsible for submission of a Form 1C with appropriate fees to the WAPC requesting endorsement of the deposited plan. A copy of the deposited plan with confirmation of submission to Landgate is to be submitted with all required written advice confirming compliance with any condition(s) from the nominated agency/authority or local government. Form 1C and a schedule of fees are available on the WAPC website: http://www.dplh.wa.gov.au

Condition(s)

The WAPC is prepared to endorse a deposited plan in accordance with the plan submitted once the condition(s) set out have been fulfilled.

The condition(s) of this approval are to be fulfilled to the satisfaction of the WAPC.

The condition(s) must be fulfilled before submission of a copy of the deposited plan for endorsement.

The agency/authority or local government noted in brackets at the end of the condition(s) identify the body responsible for providing written advice confirming that the WAPC's requirement(s) outlined in the condition(s) have been fulfilled. The written advice of the agency/authority or local government is to be obtained by the applicant/owner. When the written advice of each identified agency/authority or local government has been obtained, it

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should be submitted to the WAPC with a Form 1C and appropriate fees and a copy of the deposited plan.

If there is no agency/authority or local government noted in brackets at the end of the condition(s), a written request for confirmation that the requirement(s) outlined in the condition(s) have been fulfilled should be submitted to the WAPC, prior to lodgement of the deposited plan for endorsement.

Prior to the commencement of any subdivision works or the implementation of any condition(s) in any other way, the applicant/owner is to liaise with the nominated agency/authority or local government on the requirement(s) it considers necessary to fulfil the condition(s).

The applicant/owner is to make reasonable enquiry to the nominated agency/authority or local government to obtain confirmation that the requirement(s) of the condition(s) have been fulfilled. This may include the provision of supplementary information. In the event that the nominated agency/authority or local government will not provide its written confirmation following reasonable enquiry, the applicant/owner then may approach the WAPC for confirmation that the condition(s) have been fulfilled.

In approaching the WAPC, the applicant/owner is to provide all necessary information, including proof of reasonable enquiry to the nominated agency/authority or local government.

The condition(s) of this approval, with accompanying advice, are:

CONDITION(S):

Administrative

1. The plan of subdivision is to be modified in accordance with the plan dated 6 April 2023 (attached);

   a. to relocate the battle-axe legs for lots abutting public open space to the eastern boundary; and
   b. to provide a battle-axe leg to service Lot 61 from the access street to the north.

   (Western Australian Planning Commission)

Drainage and Siteworks

2. Engineering drawings and specifications are to be submitted, approved, and works undertaken in accordance with the approved engineering drawings, specifications and approved plan of subdivision, for grading and/or stabilisation of the site to ensure that:

   a) lots can accommodate their intended use; and

b) finished ground levels at the boundaries of the lot(s) the subject of this approval match or otherwise coordinate with the existing and/or proposed finished ground levels of the land abutting. (Local Government)

3. Prior to the commencement of subdivisional works, an urban water management plan is to be prepared and approved, in consultation with the Department of Water and Environmental Regulation, consistent with any approved Local Water Management Strategy. (Local Government)

4. Engineering drawings and specifications are to be submitted and approved, and works undertaken in accordance with the approved engineering drawings and specifications and approved plan of subdivision, for the filling and/or draining of the land, including ensuring that stormwater is contained on-site, or appropriately treated and connected to the local drainage system. Engineering drawings and specifications are to be in accordance with an approved Urban Water Management Plan (UWMP) for the site, or where no UWMP exists, to the satisfaction of the Western Australian Planning Commission. (Local Government)

5. A management plan detailing how risk of drainage, erosion and sedimentation or other environmental impacts into nearby wetlands and water bodies will be minimised during subdivision is to be:

a) prepared by the landowner/applicant and approved prior to the commencement of subdivisional works; and
b) implemented during subdivisional works.

(Department of Biodiversity, Conservation and Attractions)

6. Prior to the commencement of subdivisional works, the landowner/applicant is to provide a pre-works geotechnical report certifying that the land is physically capable of development or advising how the land is to be remediated and compacted to ensure it is capable of development. In the event that remediation works are required, the landowner/applicant is to provide a post geotechnical report certifying that all subdivisional works have been carried out in accordance with the pre-works geotechnical report. (Local Government).

7. Suitable arrangements being made for connection of the land to the comprehensive district drainage system at the landowner/applicant's cost. (Local Government)

8. Drainage easements and reserves as may be required by the local government for drainage infrastructure being shown on the diagram or plan of survey (deposited plan) as such, granted free of cost, and vested in that local government under Sections 152 and 167 of the *Planning and Development Act 2005*. (Local Government)

9. Suitable arrangements being made with the Water Corporation for the drainage of the land either directly or indirectly into a drain under the control of that body. (Water Corporation).

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Movement Network

10. Engineering drawings and specifications are to be submitted, approved, and subdivisional works undertaken in accordance with the approved plan of subdivision, engineering drawings and specifications, to ensure that those lots not fronting an existing road are provided with frontage to a constructed road(s) connected by a constructed road(s) to the local road system and such road(s) are constructed and drained at the landowner/applicant's cost.

    As an alternative, and subject to the agreement of the Local Government the Western Australian Planning Commission (WAPC) is prepared to accept the landowner/applicant paying to the local government the cost of such road works as estimated by the local government and the local government providing formal assurance to the WAPC confirming that the works will be completed within a reasonable period as agreed by the WAPC. (Local Government)

11. Engineering drawings and specifications are to be submitted and approved, and subdivisional works undertaken for construction of roads in accordance with the approved plan of subdivision, engineering drawings and specifications to ensure that:

    a) street lighting in accordance with dark sky principles is installed on all new subdivisional roads to the standards of the relevant licensed service provider;
    b) roads that have been designed to connect with existing or proposed roads abutting the subject land are coordinated so the road reserve location and width connect seamlessly;
    c) temporary turning areas are provided to those subdivisional roads that are subject to future extension;
    d) eyebrow treatments are provided on the outside of all 90-degree bends for waste collection purposes; and
    e) embayment parking and vehicle barriers are provided within the/abutting the proposed public open space. (Local Government)

12. Engineering drawings and specifications are to be submitted, approved, and subdivisional works undertaken in accordance with the approved plan of subdivision, engineering drawings and specifications, for the provision of shared paths through and connecting to the application area to the satisfaction of the Western Australian Planning Commission. The approved shared paths are to be constructed by the landowner/applicant. (Local Government)

13. Satisfactory arrangements being made with the local government for the cost of upgrading and/or construction of Lake Road and Arabian Court abutting the subject site to an urban standard. (Local Government)

14. All local streets within the subdivision being truncated in accordance with the Western Australian Planning Commission's *Liveable Neighbourhoods* policy. (Local Government)

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15. The proposed access ways being constructed and drained at the landowner/applicant's cost to the specifications of the local government. (Local Government)

16. Pursuant to Section 150 of the *Planning and Development Act 2005* and Division 3 of the *Planning and Development Regulations 2009* a covenant preventing vehicular access onto Lake Road being lodged on the certificate(s) of title of the proposed lots 10, 21,58 and 59 at the full expense of the landowner/applicant. The covenant is to prevent access, to the benefit of the City of Armadale, in accordance with the plan dated 6 April 2023 (attached) and the covenant is to specify:

"*No vehicular access is permitted to and from Lake Road.*" (Local Government)

17. Redundant vehicle crossover(s) to be removed and the kerbing, verge, and footpath (where relevant) reinstated with grass or landscaping to the specifications of the local government. (Local Government)

Public Open Space/Reserves

18. The proposed reserve(s) shown on the approved plan of subdivision being shown on the diagram or plan of survey (deposited plan) as reserve(s) for recreation and vested in the Crown under Section 152 of the *Planning and Development Act 2005*, such land to be ceded free of cost and without any payment of compensation by the Crown. (Local Government)

19. Arrangements being made for the proposed public open space to be developed by the landowner/applicant to a minimum standard and maintained for two summers through the implementation of an approved landscape plan providing for the development and maintenance of the proposed public open space in accordance with the requirements of Liveable Neighbourhoods and to the specifications of the local government. (Local Government)

20. Uniform fencing being constructed along the boundaries of lots abutting public open space and Lake Road. (Local Government)

21. Prior to the commencement of subdivisional works, measures being undertaken to identify any vegetation on the site worthy of retention, including any potential habitat or foraging trees for threatened fauna species, and protection measures implemented to ensure such vegetation is not impacted by subdivisional works. (Local Government).

22. Local Development Plan(s) being prepared and approved for lots 52,53,68,69 and 61 as shown on the plan dated 6 April 2023 (attached) that address the following where relevant:
    a) vehicle access and parking
    b) interface with public open space
    c) interface with Lake Road

(Local Government)

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23. The landowner/applicant shall make arrangements to ensure that prospective purchasers of lots subject of a Local Development Plan are advised in writing that Local Development Plan provisions apply. (Local Government)

Bushfire

24. Information is to be provided to demonstrate that the measures contained in Section 6; Implementation Table of the Bushfire Management Plan by Smith Bushfire Consultants dated 15 May 2023 have been implemented during subdivisional works. This information should include a completed 'Certification by Bushfire Consultant' from the bushfire management plan. (Local Government)

25. A notification, pursuant to Section 165 of the *Planning and Development Act 2005* is to be placed on the certificate(s) of title of the proposed lot(s) with a Bushfire Attack Level(BAL) rating of 12.5 or above, advising of the existence of a hazard or other factor.
Notice of this notification is to be included on the diagram or plan of survey (deposited plan).
The notification is to state as follows:

"This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and may be subject to a Bushfire Management Plan. Additional planning and building requirements may apply to development on this land". (Western Australian Planning Commission)

Utilities

26. Arrangements being made with a licensed water provider for the provision of a suitable water supply service to each lot shown on the approved plan of subdivision. (Water Corporation)

27. Arrangements being made with the Water Corporation for the provision of a sewerage service to each lot shown on the approved plan of subdivision. (Water Corporation)

28. Arrangements being made with a licensed electricity network operator for the provision of an underground electricity distribution system that can supply electricity to each lot shown on the approved plan of subdivision. (Western Power)

29. The transfer of land as a Crown reserve free of cost to Western Power for the provision of electricity supply infrastructure. (Western Power)

ADVICE:

1. Condition 3 has been imposed in accordance with *Better Urban Water Management Guidelines (WAPC 2008).* Further guidance on the contents of urban water management plans is provided in *'Urban Water Management Plans: Guidelines for preparing and complying with subdivision conditions' (Published by the then Department of Water 2008).*

Western Australian Planning Commission

2. In regard to Conditions 10, 11 and 12, the landowner/applicant is advised;

   a. that the road reserves, including the constructed carriageways, laneways, truncations, footpaths/dual use paths and car embayments, are to be generally consistent with the approved plan of subdivision.
   b. to liaise with the City of Armadale in regard to the provision and management of adequate street trees.

3. In regard to Condition 13:

   a. the upgrade of Lake Road is to include the construction of a dual use path and crossing points to the specifications of the City of Armadale.

   b. the upgrade of Arabian Court to an urban standard is to be in a manner sensitive to the adjacent environmental values as set out in the Local Water Management Strategy for the Lake Road Precinct C Structure Plan.
   c.

4. The landowner/applicant and the local government are advised to refer to the Institute of Public Works Engineering Australasia Local Government Guidelines for Subdivisional Development (current edition). The guidelines set out the minimum best practice requirements recommended for subdivision construction and granting clearance of engineering conditions imposed.

5. The landowner/applicant is advised that the Department of Water and Environmental Regulation has prepared dust control guidelines for development sites, which, outline the procedures for the preparation of dust management plans. The dust management plans are generally approved, and their implementation overseen, by the Local Government. Further information on the guidelines can be obtained from the Department of Water and Environmental Regulation's website: www.dwer.wa.gov.au under air quality publications.

6. In regard to Conditions 19 and 21 the landscaping plan and vegetation survey should address the partial retention of existing Marri Trees within the POS in accordance with the Lake Road Precinct C Structure Plan.

7. In regard to Condition 21, appropriate measures shall include the following:

   a) Submission of a detailed site survey identifying any native vegetation on site, including species and size;
   b) Erection of temporary fencing surrounding POS areas prior to commencement of works in accordance with Australian Standard 4970-2009 "Protection of trees on development sites"; and
   c) Authorised removal of vegetation is to be carried out in accordance with Department of Environment requirements; in particular, no burning of cleared vegetation is to occur without prior approval of the City. In general, the City favours on-site mulching over burning.

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8. In regard to Conditions 26 and 27, the landowner/applicant shall make arrangements with the Water Corporation for the provision of the necessary services. On receipt of a request from the landowner/applicant, a Land Development Agreement under Section 83 of the *Water Services Act 2012* will be prepared by the Water Corporation to document the specific requirements for the proposed subdivision.

9. In regard to Condition 28, Western Power provides only one underground point of electricity supply per freehold lot.

10. The applicant/landowner is advised that pursuant to the *Commonwealth Telecommunications Act 1997* there will generally be a requirement for the installation of fibre-ready telecommunications infrastructure. Exemptions can be sought for certain types of development. Further information is available from the Australian Government Department of Infrastructure, Transport, Regional Development and Communications website at: www.infrastructure.gov.au

11. Acid sulfate soils (ASS) risk mapping indicates that the site is located within an area identified as representing a moderate to low risk of ASS occurring within 3 metres of the natural soil surface. Please refer to Department of Water and Environmental Regulation's (DWER) acid sulfate soil guidelines for information to assist with the management of ground and/or groundwater disturbing works: https://www.der.wa.gov.au/your-environment/acid-sulfate-soils/69-acidsulfatesoils-guidelines.

12. This property is on a site where records confirm there is a history of military activities that have resulted in residual UXO. A possibility exists that dangerous items of UXO may still be found on this site. Contact police if a suspicious item that may be UXO is found. Visit www.defence.gov.au/uxo for further information.

Ms Sam Fagan
Secretary
Western Australian Planning Commission
30 May 2023

Enquiries : Jas Lapinski (Ph 6551 9563)

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APPENDIX B

Geotechnical Investigation
(Structerre, 2023)

Doc GE2.1.2

GEOTECHNICAL INVESTIGATION

For: Arabian Court Pty Ltd Atf Arabian Court Unit Trust

Project Address: Proposed Residential Subdivision Stage 1 – Lot 102 Arabian Court, Champion Lakes

Project Number: D325928

Job Number: J445074

Revision Number: 0

Date: 18/12/2023

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ABN 71 349 772 837 Zemla Pty Ltd ACN 008 966 283 as trustee for the Young Purich and Higham Unit Trust trading as Structerre Consulting Engineers

1. PROJECT DETAILS

1.1. Introduction

At the request of Arabian Court Pty Ltd Atf Arabian Court Unit Trust, Structerre Consulting Engineers (Structerre) have conducted a Geotechnical Investigation at Proposed Residential Subdivision Stage 1 – Lot 102 Arabian Court, Champion Lakes, WA. The purpose of the investigation was to provide the following for residential subdivision purposes:

- An assessment of subsurface soil profile and groundwater conditions across the proposed area of development;
- Site classification in accordance with AS 2870-2011 Residential Slabs and Footings;
- Wind Classification in accordance with AS 4055-2012 Wind Loads for Housing;
- Recommendations for stormwater drainage design;
- Recommendations on earthworks and site preparation; and
- Provision of a footing detail considering anticipated surface movement and sand pad thickness.

Terms of reference for this investigation were presented in a Structerre Consulting proposal reference Q103634 (dated 15 November 2023), which was submitted to and accepted by Arabian Court Pty Ltd Atf Arabian Court Unit Trust.

1.2. Site Description

The site is located at Lot 102 Arabian Court, Champion Lakes, City of Armadale. Arabian Court lies to the southwest and west of the site, Lake Road to the east and rural properties to the north and northeast.

The site is generally flat and level as is the surrounding topography. At the time of the field investigation the site was natural bushland covered with scattered trees, shrubs and grasses.

1.3. Field Investigation – Scope of Works

The field investigation was carried out on 6 December 2023 and comprised:

- 6 x Sample Retrieval Probes (SRP) to a depth of 2.5m over the site for material assessment and soil profiling;
- 5 x In-situ percolation tests to determine the permeability of the materials within the upper 1.0m; and
- 6 x Perth Sand Penetrometer (PSP) tests in accordance with AS 1289.6.3.3-1997 to a depth of 1.0m for evaluation of relative densities of the upper layers.

The borehole test locations are shown on the attached site plan in Appendix 1.

Suitably qualified geotechnical personnel from Structerre supervised the fieldwork and all fieldwork, interpretation and terminology used in this report are in accordance with the guidelines presented in AS1726-2017 Geotechnical Site Investigations.

2. DESK STUDY

2.1. Geological Setting

The Armadale sheet 1: 50,000 Environmental Geology Series (Part Sheets 2033 I and 2133 IV, 1986) prepared by the Geological Survey of Western Australia indicates that the following geological layers underlie the site:

- SAND (S8) – white to pale grey at surface, yellow at depth, fine to medium grained, moderately sorted, subangular to subrounded, minor heavy minerals of eolian origin (Bassendean Sand, Qpb), underlain by
- Clayey SAND (Sc) – silty in part, pale grey to brown, medium to coarse-grained, poorly sorted, subangular to rounded, frequent heavy minerals, rare feldspar, of alluvial origin (Guildford Formation Qpa).
- Sandy CLAY (Cs) – white-grey to brown, fine to coarse grained, subangular to rounded sand, clay of moderate plasticity, gravel and silt layers near scarp (Guildford Formation, Qpa).

2.2. Ground Surface and Groundwater Level

The Perth Groundwater Atlas (Waters & Rivers Commission) indicates the ground surface level at this site was approximately 25.0m Australian Height Datum (AHD).

The 2019 groundwater level at the site was approximately 22.5m AHD and the historical maximum was indicated to be approximately 23.5m. It should be noted that the groundwater levels can vary significantly due to seasonal variation and the data from the recorded maximum levels should be used only as a guide.

2.3. Earthquake Coefficient

In accordance with AS 1170.4-2007 Structural Design Actions the site is located within an area with an earthquake acceleration coefficient of 0.10.

2.4. Wind Classification

In accordance with AS 4055-2012 Wind Loads for Housing, wind classification of this site falls within the non-cyclonic “N1-N2” category.

2.5. Potential Acid Sulphate Soils

Information from the publicly available Landgate website indicates that part of the site lies within a zone of Class 2 (moderate to low risk of Acid Sulfate Soils (ASS) occurring within 3m of the natural soil surface).

3. RESULTS OF THE INVESTIGATION

3.1. Subsurface Soil Profile

The subsurface soil profile presented below was determined from the ground conditions encountered within the boreholes and through the interpretation of the PSP test results:

Table 1 – Subsurface Soil Profile

Depth to Base of Strata (m)	Material Description
0.2	Topsoil
1.3 -2.5+	NATURAL: SAND (fine to medium grained), non-plastic, loose grading to dense
1.3 – 1.8+	NATURAL: Clayey Sandy GRAVEL (fine to medium grained), high plasticity – BH1 to BH4 only
Not Penetrated (>2.5m)	NATURAL: SAND (fine to medium grained), non-plastic, loose grading to dense – BH5 & BH6

The soils encountered are consistent with the expected site conditions as predicted from the Environmental Geology Map. It is important to note that there may be pockets of fill on site that are deeper than that encountered by the investigation boreholes. The subsurface soil conditions encountered are presented in the bore logs, within Appendix 3.

3.2. Groundwater

Groundwater was not encountered in any of the boreholes during or immediately after drilling. However, based on the Perth Groundwater Atlas, the groundwater is expected to be encountered approximately 2.0m below the existing ground level or at 1.3m, above the more cohesive materials.

3.3. Percolation Testing

Percolation testing of the in-situ soils was undertaken in five locations. Results of the testing are summarised below:

Table 2 – In Situ Percolation Test Results

Test Location	Testing Depth	Soil Type	Permeability
BH2	0.75 - 1.0m	SAND	>20.0m/day*
BH3	0.75 - 1.0m	SAND	>20.0m/day*
BH4	0.75 - 1.0m	SAND	>20.0m/day*
BH5	0.75 - 1.0m	SAND	>20.0m/day*
BH6	0.75 - 1.0m	SAND	>20.0m/day*

*Permeability exceeded maximum reading on apparatus in accordance with AS 1547:2000.

3.4. Laboratory Test Results

Selected soil samples were tested for Atterberg Limits.

3.4.1. Atterberg Limits

Atterberg Limits were tested by Structerre's in-house NATA accredited laboratory. Results of the testing are summarised below:

Table 3 – Atterberg Limit Test Results

Sample	Test Hole	Depth (m)	Soil Description	Liquid Limit % AS1289 3.1.2	Plastic Limit % AS1289 3.2.1	Plasticity Index % AS1289 3.3.1	Linear Shrinkage % AS1289 3.4.1
1	BH3	1.5-2.5	Clayey, sandy GRAVEL	58	18	40	16

Test results indicate that the underlying natural clayey sandy gravel has high shrink swell capacity or degree of expansion.

A copy of the laboratory testing report is presented in Appendix 4.

4. GEOTECHNICAL CONSTRUCTION CONSIDERATIONS

4.1. Site Classification

AS 2870-2011 Residential Slabs and Footings provides guidance on site classification for residential slabs and footing design based on the expected ground surface movement and depth of expected moisture changes.

Based on results of this investigation the site has variable thickness in sand cover overlying the clayey soils which in turn provides some variation in the classification as presented. The site can be classified as Class “A” provided that all unsuitable materials are removed and replaced with engineer-controlled sand fill materials in accordance with earthwork recommendations outlined in Section 4.3 in this report.

4.2. Drainage

The site is suitable for on-site disposal of stormwater runoff subject to the proposed development. For on-site disposal of stormwater runoff, soakwells of sufficient sizes are required, and should be positioned a minimum of 1.2m or the depth of soakwell (whichever is greater) from any proposed or existing foundations (including those beyond the boundaries of the site) to minimise the risk of differential settlement.

To aid with the design of on-site stormwater drainage, groundwater levels and field permeability results are presented in Section 3 of this report.

4.3. Earthworks

All earthworks shall be undertaken in accordance with AS 3798-2007 Guidelines on earthworks for commercial and residential developments and are to include the following:

- All unsuitable materials to be stripped and removed from the site. Unsuitable materials include topsoils and vegetation, any uncontrolled filling and deleterious and organic materials exposed during the stripping process.
- It is considered that the near surface sand materials will require improvement. Therefore, it is proposed to rake to a depth of approximately 0.5m to ensure potentially unsuitable materials are removed, (tree roots and tree stumps), prior to proof compacting the surface. Any surplus sand material can be stockpiled for reuse, provided it is dry, free from clay/silt (i.e. <5%), organic and deleterious materials.
- It is considered that the stripped topsoils may be reused as structural filling at depth if adequately screened and blended with clean sand at a ratio of 1:1, however it is recommended this not be placed in the upper 0.6m profile to finished design levels as not to impact surface drainage.
- A minimum of 1.5m of sand cover is to be provided or maintained above the reactive (clayey) material to achieve Class “A” Lots.
- Proof compact the exposed surface. The compaction requirements are set out in Table 4, as per AS 3798-2007:

Table 4 – Compaction Requirements

Item	Application	Minimum relative compaction, %	
		Minimum density ratio (Standard Compaction Effort) (Cohesive soils)	Minimum density index (Cohesionless soils)
1	Residential - lot, fill, house, sites	95	70
2	Fill to support pavements a) General fill	95	70
	Subgrade (to a depth of 0.3m)	98	75

- After excavation and proof compaction, the excavated base is to be assessed and approved by a representative from this office prior to backfilling. At this stage it can be assessed whether any further materials need to be removed or whether further compaction of the base is required.
- The ground level should be built up to design levels with any suitable stockpiled sand (cut from site) and import fill, as required. The imported fill should consist of free draining sand with not more than 5% passing a 75µm sieve and be free of organic matter and other deleterious materials.
- The fill materials should be placed in layers not exceeding 300mm loose thickness and compacted to achieve a minimum 7 PSP blows over the interval 150 – 450mm, 9 PSP blows over the interval 450 – 750mm and 11 PSP blows over the interval 750 -1050mm.
- A minimum of 1.5m of non-reactive sand cover above any reactive (clayey) material is required to provide Class “A” Lots. Sand cover less than 1.5m and greater than 0.6m in thickness will result in Class “S” Lots as defined in AS2870.
- After remedial earthworks have been completed, the earthworks should be inspected and approved by a representative from this office.

It is considered that standard medium sized earthmoving equipment would be appropriate for the proposed development. The near surface ground was generally competent and should not pose an issue to site traffic movements. The material encountered on site can be deemed as ‘easy’ to excavate with medium sized earthwork equipment (i.e. a 20t excavator). Should excavations be required below groundwater level, dewatering will be necessary.

4.4. Indicative California Bearing Ratio (CBR)

The indicative California Bearing Ratio (CBR) value of the subgrade material, following earthworks can be estimated from the site investigation results and would be appropriate for preliminary design purposes. The indicative value is shown in Table 5:

Table 5 – Indicative CBR Values

Material	Indicative CBR (%)	Compaction
SAND (In situ or Imported Fill)	12	95% of MMDD*

* Implies the maximum dry density ratio using Modified compaction in accordance with AS 1289 5.2.1-2003.

4.5. Retaining Walls

Retaining walls proposed to be installed at the site will likely support sandy soils. Where imported granular backfill is to be used in conjunction with retaining walls, the geotechnical properties will vary depending upon the nature of the granular materials imported.

For cohesion-less free draining sand, the following parameters can be used as a guide for design purposes:

- Angle of internal friction, Ø = 33^{O}
- Coefficient of active earth pressure K_a = 0.29
- Coefficient of passive earth pressure K_p = 3.39
- At rest coefficient of earth pressure K_0 = 0.46
- Bulk density 18 kN/m^3

Retaining structures should be designed in accordance with AS 4678-2002 Earth Retaining Structures. Where significant eccentric and/or horizontal loading is applied, further assessment will be required. Additionally, hand held compaction equipment is utilised within 2.0m of the walls, to reduce the potential increase in lateral pressure on the retaining wall.

Retaining wall design should ensure adequate drainage to the rear of the wall. It is recommended that the drainage comprises free draining sand and weepholes that are interconnected with a suitable sized perforated drainage pipe.

Experience indicates that excavation immediately in front of retaining walls (i.e. due to service installation) may cause movement to the wall to occur. This can lead to cracking of adjoining structures and needs to be accounted for in the design and construction sequencing of the new works.

4.6. Recommended Footings for Residential Construction (Full Masonry)

Recommended footings for full masonry residential construction within the scope of AS2870 on Class “A” sites will be subject to the thickness of non-reactive (sand) cover above the clayey soils underlying the site at completion of the earthworks.

A Structerre “B1” footing and slab will be applicable for Class “A” Lots with between 1.5m and 1.8m of sand cover, a Structerre “A” footing and slab will be applicable for Lots with between 1.8m and 2.3m of sand cover and a Structerre “D10” footing and slab for Lots with in excess of 2.3m of sand cover above the reactive clay soils.

5. CONCLUSIONS

A site investigation has been carried out at the site of the proposed residential development to assess the geotechnical conditions. Parameter and design recommendations are incorporated in the body of the report. The following conclusions have been drawn from the site investigation:

- The average subsurface soil profile encountered comprised topsoil to 0.2m, overlying SAND to a depth of between 1.3m to 1.8m, overlying clayey sandy gravel (BH1 – BH4) only and underlain by SAND to the investigated depth of 2.5m.
- Groundwater or perched water was not encountered across the site to the depth of 2.5m.
- It is considered that the site is suitable for on-site drainage.
- The developed Lots can be classified as Class “A” in accordance with AS 2870-2011 subject to providing and or maintaining adequate sand cover (>1.5m) above the underlying reactive clayey sandy gravel deposits within the site, provided that the recommended earthworks are undertaken.
- Footing recommendations for Class A sites will be subject to the sand caver above the reactive clayey soils at completion of the works, ranging from Structerre B1 (1.5m to 1.8m) Structerre A (1.8m to 2.3m) and Structerre D10 (>2.3m).
- The full scope of the recommended earthworks is presented in Section 4.3, but generally comprises:
    - Stripping of topsoil and unsuitable materials
    - Proof compaction of the base
    - Placement of sand fill to required design levels
    - Compaction to final level

6. LIMITATION OF FIELD INVESTIGATIONS

This report has been prepared in accordance with generally accepted consulting practice for Arabian Court Pty Ltd Atf Arabian Court Unit Trust using information supplied at the time and for the project specific requirements as understood by Structerre. To the best of our knowledge the information contained in this report is accurate at the date of issue, however it should be emphasised that any changes to ground conditions and/or the proposed structures may invalidate the recommendations given herein.

The conclusions and recommendations in this report are based on the site conditions revealed through selective point sampling, representing the conditions of the site in total, although the area investigated represents only a small portion of the site. The actual characteristics may vary significantly between successive test locations and sample intervals other than where observations, explorations and investigations have been made.

The materials and their geotechnical properties presented in this report may not represent the full range of materials and strengths that actually exist on site and the recommendations should be regarded as preliminary in nature. Allowances should be made for variability in ground conditions and any consequent impact on the development. Structerre accepts no responsibility and shall not be liable for any consequence of variations in ground conditions.

If ground conditions encountered during construction are different to that described in this report, this office should be notified immediately.

For and behalf of

STRUCTERRE CONSULTING

Margie Mortera
Geotechnical Assistant

Checked By: David Harding
Employee Title: Geotechnical Supervisor

Authorised By: Mel Castle
Employee Title: Division Manager - Geotechnical

Job #	Revision	Authored	Checked	Authorised
J445074	0	MM	DH	MC

7. REFERENCES

Department of Water – Perth Groundwater Atlas

Geological Survey of Western Australia 1:50,000 Environmental Geology Series

AS 1170.4-2007 Structural design actions – Earthquake actions in Australia

AS 1289.3.1.2-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the liquid limit of a soil

AS 1289.3.2.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the plastic limit of a soil

AS 1289.3.3.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Calculation of the plasticity index of a soil

AS 1289.3.4.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the linear shrinkage of a soil

AS 1289.6.3.3-1997 Methods of testing soils for engineering purposes – Soil strength and consolidation tests – Determination of the penetration resistance of a soil – Perth sand penetrometer test

AS 1726-2017 Geotechnical site investigation

AS 2870-2011 Residential slabs and footings

AS 3798-2007 Guidelines on earthworks for commercial and residential developments

AS 4055-2012 Wind loads for housing

APPENDIX 1 – SITE LOCATION MAP

Note: Showing approximate test locations only

LEGEND

BH Borehole

Depths of Non-reactive Material

STRUCterre consulting

Zemla Pty Ltd (ABN 71 349 772 837) ATF the Young Purich and Higham Unit Trust trading as Structerre Consulting

1 ERINDALE ROAD, BALCATTA, WA 6021
TEL 9205 4500 FAX 9205 4501 EMAIL: wageotecheng@structerre.com.au

PROJECT:	Proposed Residential Subdivision Stage 1 - Lot 102 Arabian Court, Champion Lakes
PROJECT #:	D325928
JOB #:	J445074
CLIENT:	**Arabian Court Pty Ltd Atf Arabian Court Unit Trust**
SCALE:	NTS
TITLE:	Geotechnical Investigation Site Plan
DATE:	06 Dec '23
DRAWN BY:	MM
CHECKED BY:	DH

Note: Showing approximate test locations only

LEGEND

BH Borehole

STRUCterre consulting

Zemla Pty Ltd (ABN 71 349 772 837) ATF the Young Purich and Higham Unit Trust trading as Structerre Consulting

1 ERINDALE ROAD, BALCATTA, WA 6021
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PROJECT:	Proposed Residential Subdivision Stage 1 - Lot 102 Arabian Court, Champion Lakes
PROJECT #:	D325928
JOB #:	J445074
CLIENT:	**Arabian Court Pty Ltd Atf Arabian Court Unit Trust**
SCALE:	NTS
TITLE:	Geotechnical Investigation Site Plan
DATE:	06 Dec '23
DRAWN BY:	MM
CHECKED BY:	DH

DOC: GE:3.001

APPENDIX 2 – SITE PHOTOS

PHOTO 1

PHOTO 2

STRUCterre consulting

Zemla Pty Ltd (ABN 71 349 772 837) ATF the Young Purich and Higham Unit Trust trading as Structerre Consulting

1 ERINDALE ROAD, BALCATTA, WA 6021
TEL 9205 4500 FAX 9205 4501 EMAIL: wageotecheng@structerre.com.au

PROJECT:	Proposed Residential Subdivision Stage 1 - Lot 102 Arabian Court, Champion Lakes
PROJECT #:	D325928
JOB #:	J445074
CLIENT:	**Arabian Court Pty Ltd Atf Arabian Court Unit Trust**
SCALE:	NTS
TITLE:	Site Photographs
DATE:	06 Dec '23
DRAWN BY:	MM
CHECKED BY:	DH

PHOTO 3 - Sample taken at BH1

PHOTO 4 - Sample taken at BH5

STRUCterre consulting

Zemla Pty Ltd (ABN 71 349 772 837) ATF the Young Purich and Higham Unit Trust trading as Structerre Consulting

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TEL 9205 4500 FAX 9205 4501 EMAIL: wageotecheng@structerre.com.au

PROJECT:	Proposed Residential Subdivision Stage 1 - Lot 102 Arabian Court, Champion Lakes
PROJECT #:	D325928
JOB #:	J445074
CLIENT:	**Arabian Court Pty Ltd Atf Arabian Court Unit Trust**
SCALE:	NTS
TITLE:	Site Photographs
DATE:	06 Dec '23
DRAWN BY:	MM
CHECKED BY:	DH

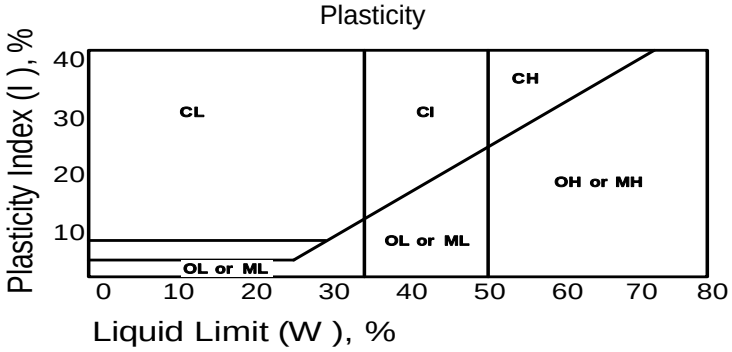
APPENDIX 3 – BORELOGS AND BORELOG TERMINOLOGY

BOREHOLE TERMINOLOGY

Particle Size Distribution

Major Division	Subdivision	Size
Boulders		>200mm
Cobbles		200 - 63mm
Gravel	Coarse	63 - 20mm
	Medium	20- 6mm
	Fine	6 - 2.36mm
Sand	Coarse	2.36 - 0.6mm
	Medium	0.6 - 0.2mm
	Fine	0.2 - 0.075mm

Plasticity



Consistency of Cohesive Soils

Term	Undrained Strength Su (kPa)	Field Guide
Very Soft	< 12	Exudes between the fingers when squeezed in hand
Soft	12 - 25	Can be moulded by light finger pressure
Firm	25 - 50	Can be moulded by strong finger pressure
Stiff	50 - 100	Cannot be moulded by Fingers. Can be indented by thumb.
Very Stiff	100 - 200	Can be indented by thumb nail
Hard	> 200	Can be indented with difficulty by thumb nail.
Friable	-	Crumbles or powders when scraped by thumbnail

Consistency/Density of Non-Cohesive Soils

Term	Density Index (%)	SPT "N" Value Comparison
Very Loose	< 15	0 - 4
Loose	15 - 35	4 - 10
Medium Dense	35 - 65	10 - 30
Dense	65 - 85	30 - 50
Very Dense	> 85	> 50

Moisture Content

D	Dry
M	Moist
W	Wet
S	Saturated

Minor Components

Term	Assessment Guide	Proportion of Minor Component In:
Trace	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component	Coarse grained soils: < 5 % Fine grained soils: <15%
With	Presence easily detected by feel or eye, soil properties little different to general properties of primary component	Coarse grained soils: 5 - 12 % Fine grained soils: 15 - 30%

Soil Legend

FILL	CLAY	GRAVEL	CONCRETE
TOPSOIL	SILT	LIMESTONE	COMBINATIONS
PEAT	SAND	BEDROCK	eg: Clay, Silty, Sandy

USCS

GW	Well graded gravel	SC	Clayey sand	OL	Organic low plasticity silt	CL	Low plasticity clay
GP	Poorly graded gravel	SM	Silty sand	ML	Low plasticity silt	CI	Intermediate plasticity clay
SW	Well graded sand			MH	High plasticity silt	CH	High plasticity clay
SP	Poorly graded sand			OH	Organic high plasticity silt	PT	Peat

DOC:GE:3.003

WA | QLD | NSW | VIC

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ABN 71 349 772 837 Zemla Pty Ltd ACN 008 966 283 as trustee for the Young Purich and Higham Unit Trust trading as Structerre Consulting Engineers

STRUCterre consulting engineers

Project Proposed Residential Subdivision Stage 1 - Lot 102 Arabian Court, Champion Lakes

Client Arabian Court Pty Ltd Atf Arabian Court Unit Trust

Test No. **BH01**

Project No.	D325928	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	404444
Job No.	J445074	**Date**	06/12/2023	**Hole Dia.**	65mm	**Northing**	6445357

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey/brown (Bassendean Sand)	L				D	
1								
		GC: Clayey Sandy GRAVEL: fine to medium grained, high plasticity, orange/brown (Guildford Formation)					M	
2		Terminated at 2.50 m						
3								

Remarks

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

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ABN 71 349 772 837 Zemla Pty Ltd ACN 008 966 283 as trustee for the Young Purich and Higham Unit Trust trading as Structerre Consulting Engineers

STRUCterre consulting engineers

Project Proposed Residential Subdivision Stage 1 - Lot 102 Arabian Court, Champion Lakes

Client Arabian Court Pty Ltd Atf Arabian Court Unit Trust

Test No. **BH02**

Project No.	D325928	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	404397
Job No.	J445074	**Date**	06/12/2023	**Hole Dia.**	65mm	**Northing**	6445408

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, pale grey/ brown (Bassendean Sand)	L - MD				D	
1								
2		GC: Clayey Sandy GRAVEL: fine to medium grained, high plasticity, orange/brown (Guildford Formation)					M	
		Terminated at 2.50 m						
3								

Remarks

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

STRUCterre consulting engineers

Project Proposed Residential Subdivision Stage 1 - Lot 102 Arabian Court, Champion Lakes

Client Arabian Court Pty Ltd Atf Arabian Court Unit Trust

Test No. **BH03**

Project No.	D325928	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	404403
Job No.	J445074	**Date**	06/12/2023	**Hole Dia.**	65mm	**Northing**	6445474

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, pale grey/ brown (Bassendean Sand)	L					
1			D				D	
2		GC: Clayey Sandy GRAVEL: fine to medium grained, high plasticity, orange/brown (Guildford Formation)					M	
		Terminated at 2.50 m						
3								

Remarks

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

STRUCterre consulting engineers

Project Proposed Residential Subdivision Stage 1 - Lot 102 Arabian Court, Champion Lakes

Client Arabian Court Pty Ltd Atf Arabian Court Unit Trust

Test No. **BH04**

Project No.	D325928	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	404344
Job No.	J445074	**Date**	06/12/2023	**Hole Dia.**	65mm	**Northing**	6445497

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, pale grey/ brown (Bassendean Sand)	L - MD				D	
1								
		GC: Clayey Sandy GRAVEL: fine to medium grained, high plasticity, orange/brown (Guildford Formation)					M	
		Terminated at 1.60 m						
2								
3								

Remarks

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

STRUCterre consulting engineers

Project Proposed Residential Subdivision Stage 1 - Lot 102 Arabian Court, Champion Lakes

Client Arabian Court Pty Ltd Atf Arabian Court Unit Trust

Test No. **BH05**

Project No.	D325928	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	404366
Job No.	J445074	**Date**	06/12/2023	**Hole Dia.**	65mm	**Northing**	6445520

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Bassendean Sand)	L - MD				D	
1								
2								
		Terminated at 2.50 m						
3								

Remarks

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

STRUCterre consulting engineers

Project Proposed Residential Subdivision Stage 1 - Lot 102 Arabian Court, Champion Lakes

Client Arabian Court Pty Ltd Atf Arabian Court Unit Trust

Test No. **BH06**

Project No.	D325928	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	404415
Job No.	J445074	**Date**	06/12/2023	**Hole Dia.**	65mm	**Northing**	6445495

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Bassendean Sand)	L				D	
1								
2								
		Terminated at 2.50 m						
3								

Remarks

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

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APPENDIX 4 – LABORATORY TEST RESULTS

Sample No.	**38318**	**Client**	Geotechnical
Job No.	J445074	**Project**	Lot 1, #102 Arabian Court, Champion Lakes

Laboratory testing carried out at Malaga Laboratory 44 Crocker Dr Malaga WA 6090

SAMPLE DETAILS

BH No. / Depth	BH3 1.5M-2.5M	Sampling Method	Client
Sample History	50°C Oven Dried	Sample Preparation	AS 1289 1.1

ATTERBERG LIMITS

Description	Method	Result (%)
Liquid Limit	AS 1289.3.1.2	58
Plastic Limit	AS 1289.3.2.1	18
Plasticity Index	AS 1289.3.3.1	40
Linear Shrinkage	AS 1289.3.4.1	16
Nature of Shrinkage		Curling

PARTICLE SIZE DISTRIBUTION

Method: AS 1289.3.6.1
Description: Particle size distribution by sieve analysis

Sieve Size (mm)	% Passing
19.0	100
2.36	56
0.425	42
0.075	24

AS 1726:2017 Clause 6.1
Material Description: Clayey, sandy GRAVEL
AS Group Symbol: GC

Accredited for compliance with ISO/IEC 17025
WORLD RECOGNISED ACCREDITATION
STRUCTERRE CONSULTING ENGINEERS BALCATTA LABORATORY ACCREDITATION NUMBER 18742

Jacob Pritchard
Authorized Signatory

Laboratory Supervisor

Date: 14-Dec-23

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ABN 71 349 772 837 Zemla Pty Ltd ACN 008 966 283 as trustee for the Young Purich and Higham Unit Trust trading as Structerre Consulting Engineers

APPENDIX C

DWER Licence to Take Water
(GWL209729)

Government of **Western Australia**
Department of **Water and Environmental Regulation**

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Arabian Court Pty Ltd		
Description of Water Resource	Perth Perth - Superficial Swan	**Annual Water Entitlement**	1,500kL
Location of Water Source	LOT 102 ON PLAN 13615 - Volume/Folio 1607/326 - Lot 102		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Irrigation of public open space	LOT 102 ON PLAN 13615 - Volume/Folio 1607/326 - Lot 102
Duration of Licence	From 26 February 2024 to 25 February 2034	

This Licence is subject to the following terms, conditions and restrictions:

1. The annual water year for water taken under this licence is defined as 1 April to 31 March.

2. The licensee shall not use water for sprinkler irrigation between 9 am and 6 pm except for the establishment of newly planted areas. For newly planted areas water may be used within these hours for a period of up to 28 consecutive days, commencing from the date of planting.

3. Between 1 June and 31 August in any year, the licence-holder must not water a lawn, garden, or grass-covered area ("turf") by reticulation, provided always that this restriction shall not apply to watering with a hand held hose; or watering, by way of reticulation: newly planted areas for a period of up to 28 days from the date of planting; for renovating turf; or for maintenance of reticulation systems.

End of terms, conditions and restrictions

APPENDIX D

Water Corporation Endorsement Confirmation Letter (Environnivate, 2023)

From:	Scott Wills
To:	James Wegner; Kanex Kanagaratnam
Cc:	troyb@cosweb.com.au
Subject:	Second Road Main Drain, Champion Lakes
Date:	Wednesday, 25 January 2023 4:54:00 PM
Attachments:	Water Corp Catchment.pdf 6483-00-710_D.pdf Lake Road Champion Lakes.pdf image001.png image002.png

---

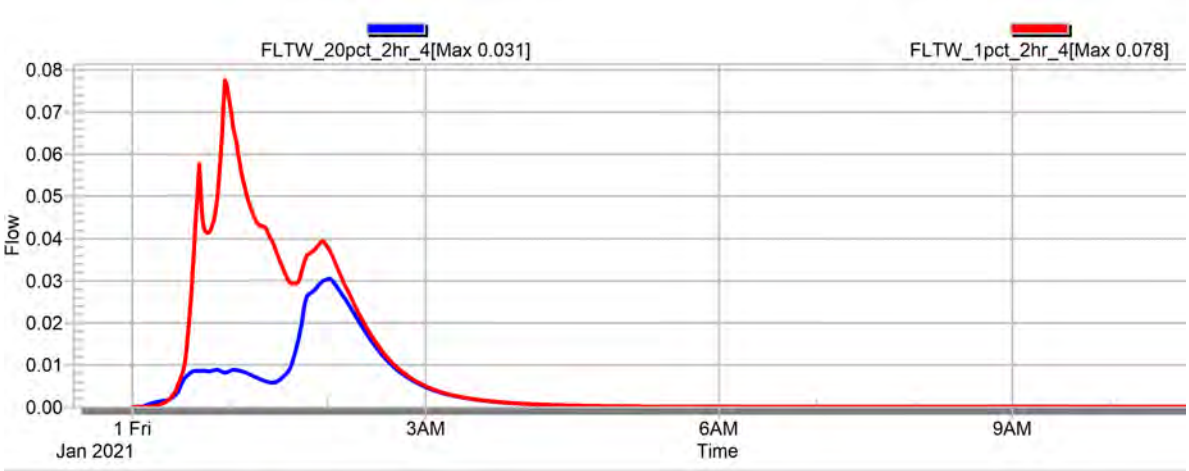
Hi James and Kanex,

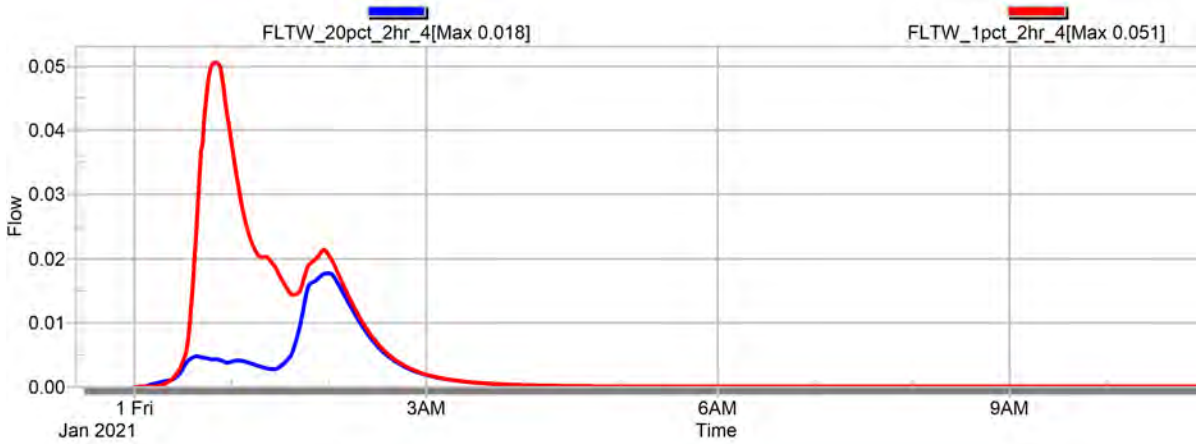
I have prepared an LWMS for five lots located between Arabian Court and Champion Drive, Champion Lakes on behalf of a new proponent. I am aware that Water Corporation advise to the previous proponent (Development Engineers Consultants on behalf of Sureland Property, 2017) was that the land is located outside of the Second Road MD declared drainage catchment and therefore cannot discharge into the Second Road Main Drain. Please refer to the attached figure. On this basis we have designed the catchment to discharge to Wungong River.

However, the civil engineering design has identified a significant level difference between the Estate and Lake St, which will result in a poor interface. As such the civil engineers (Cossill & Webley) have identified a small road area to drain out to Lake St which will eliminate much of the level difference (refer catchment 'A1' shaded red on drawing 6483-00-71_D). This catchment provides the benefit of:

- Removes the need for a retaining wall along the boundary of Lot 102 (or reduces the boundary wall height)
- Improves the ability to facilitate an emergency fire access (between Lot 102 and Lake Road)
- Assists in the pedestrian movement between the development area of Lot 102 and the shared path proposed along Lake Road

The Lake St drainage system discharges to Second Road MD as shown in the attached drainage drawings. We have confirmed that the Lake St pipe system will have capacity to convey the flow from the development, with the two outflow hydrographs from Catchment A1 shown below.



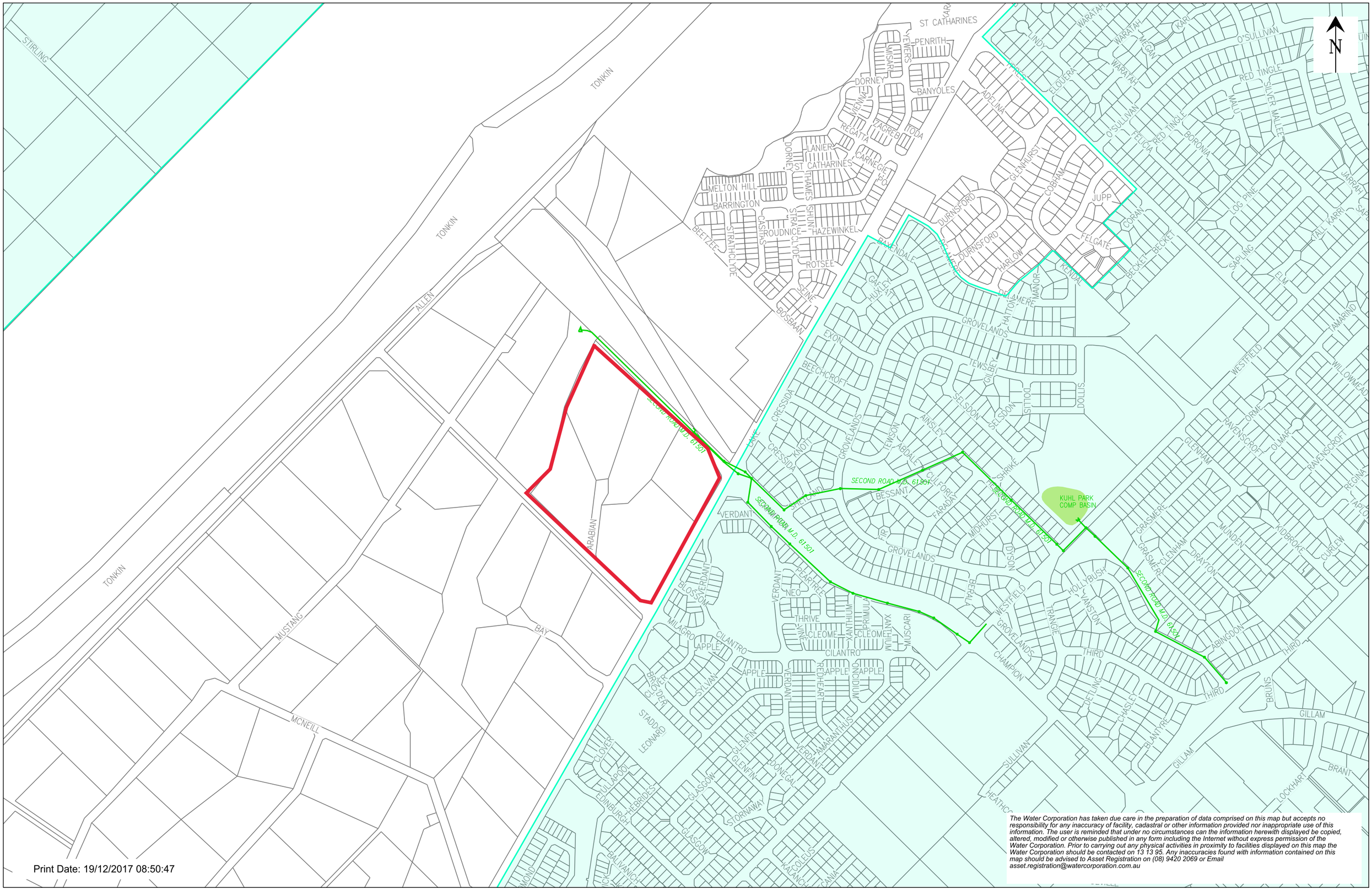


The City of Armadale are generally supportive of this option to improve the Lake St interface. Can you please advise if the additional catchment area for Lake St can be considered, and if so any additional details you require to make an assessment.

Kind regards,
Scott

Scott Wills
0414 346 065
ENVIRONNIVATE

https://environnivate.com.au



Print Date: 19/12/2017 08:50:47

Title: DL

Scale 1:8000

0m 90m 180m 270m 360m

Projection: MGA Zone 50 (m)

Author: DL

WUNGONG RIVER FLOW CHANNEL

WUNGONG RIVER FLOW CHANNEL

LOT 105

LOT 104

LOT 103

LOT 102

LOT 101

ONE WAY CROSSFALL INTO SWALE LOCATED WITHIN THE ROAD RESERVE

ARABIAN COURT

BAY COURT

NO PIPE AND PIT NETWORK KERB BREAK AT POS TO ALLOW RUNNOFF TO INFILTRATE

CROWNED ROAD. HALF THE CARRIDGEWAY CROSSFALL INTO SWALE LOCATED WITHIN THE ROAD RESERVE

LAKE ROAD

LEGEND

- CATCHMENT A
- CATCHMENT A1
- CATCHMENT B
- CATCHMENT C
- CATCHMENT D

REV	DATE	DRN	CKD	APP	AMENDMENT
D	16.01.23	ARH	TB		DRAINAGE CATCHMENTS UPDATED
C	04.08.21	ARH	TB	T. BOEKEMAN	LAYOUT AND CATCHMENTS UPDATED
B	23.06.21	ARH			LOT LAYTOUT UPDATED
A	16.06.21	DPM			ISSUED FOR APPROVAL

N

1:1000 0m 20 40 60m

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: CELCIUS PROPERTY GROUP PTY LTD

APPROVED: 16.01.23

DESIGNED: DPM

SCALE: 1:1000

PROJECT: LAKE ROAD, CHAMPION LAKES - STAGE 00

TITLE: STORMWATER DRAINAGE CATCHMENT PLAN SHEET 1 OF 1

WAPC No.: TBC

DRAWING No.: 6483-00-710

REVISION: D

ORIGINAL SIZE: A1

P:\6483 Arabian Court Champion Lakes\6483-00\Acad\6483-00-710.dwg, 16/01/2023 1:43:25 PM, AlistairH, Digital Signing PDF.pc3, 1:1, - CW Reference

From:	Kanex Kanagaratnam
To:	Scott Wills; James Wegner
Subject:	RE: Second Road Main Drain, Champion Lakes
Date:	Tuesday, 7 February 2023 11:46:17 AM
Attachments:	image001.png image002.png Water Corp Catchment.pdf 6483-00-710_D.pdf Lake Road Champion Lakes.pdf

Hi Scott,

Apologies for the delay in responding.

The Corporation has no objection to Catchment A1 (shown in red shade in the attached 6483-00-710) discharging to the local drain in Lake Street.

Regards,

Kanex Kanagaratnam
Principal Engineer
Drainage & Liveable Communities
Water Corporation
T: (08) 9420 2733

From: Scott Wills <scott@environnivate.com.au>
Sent: Monday, 6 February 2023 3:04 PM
To: James Wegner <James.Wegner@watercorporation.com.au>; Kanex Kanagaratnam <Kanex.Kanagaratnam@watercorporation.com.au>
Subject: RE: Second Road Main Drain, Champion Lakes

Hi Gents,

Just following up to find out when you will be able to respond to my query below.

Regards,
Scott

From: Scott Wills
Sent: Wednesday, January 25, 2023 4:55 PM
To: James Wegner <James.Wegner@watercorporation.com.au>; Kanex Kanagaratnam <Kanex.Kanagaratnam@watercorporation.com.au>
Cc: troyb@cosweb.com.au
Subject: Second Road Main Drain, Champion Lakes

Hi James and Kanex,

I have prepared an LWMS for five lots located between Arabian Court and Champion Drive, Champion Lakes on behalf of a new proponent. I am aware that Water Corporation advise to the previous proponent (Development Engineers Consultants on behalf of Sureland Property, 2017) was that the land is located outside of the Second Road MD declared drainage catchment and therefore cannot discharge into the Second Road Main Drain. Please refer to the attached figure. On this basis we have designed the catchment to discharge to Wungong River.

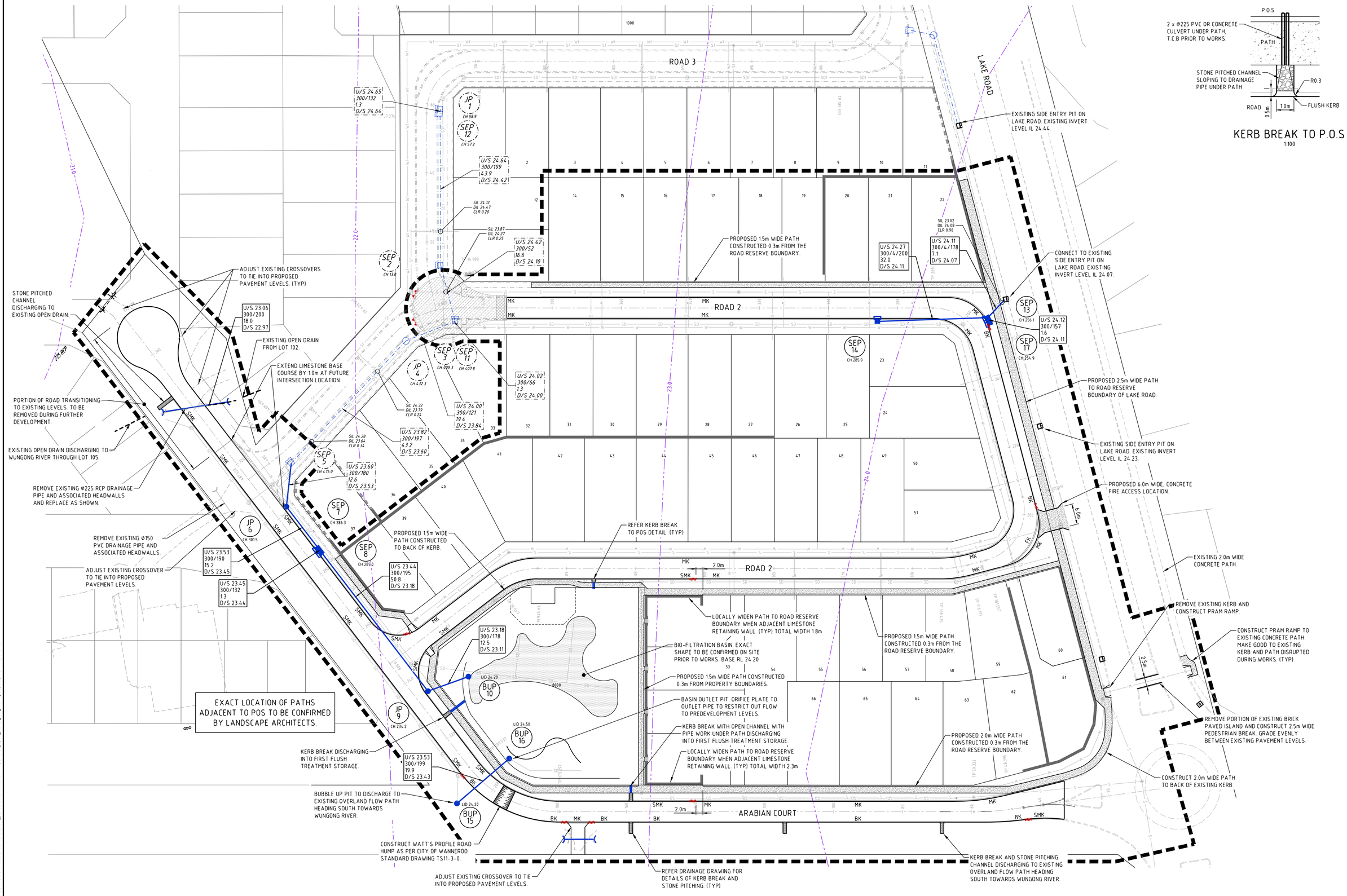
However, the civil engineering design has identified a significant level difference between the Estate and Lake St, which will result in a poor interface. As such the civil engineers (Cossill & Webley) have identified a small road area to drain out to Lake St which will eliminate much of the level difference (refer catchment 'A1' shaded red on drawing 6483-00-71_D). This catchment provides the benefit of:

- Removes the need for a retaining wall along the boundary of Lot 102 (or reduces the boundary wall height)
- Improves the ability to facilitate an emergency fire access (between Lot 102 and Lake Road)
- Assists in the pedestrian movement between the development area of Lot 102 and the shared path proposed along Lake Road

The Lake St drainage system discharges to Second Road MD as shown in the attached drainage drawings. We have confirmed that the Lake St pipe system will have capacity to convey the flow from the development, with the two

APPENDIX E

Earthworks & Subsoil Drainage Plans
(Cossill & Webley, 2023)



KERB BREAK TO P.O.S

1:100

REV	DATE	DRN	CKD	APP	AMENDMENT
A	06.10.23	AC	TB		ISSUED FOR APPROVAL

BEFORE YOU DIG www.byda.com.au

1:100 0m 2 4 6

1:500 0m 10 20 30

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: CELCIUS PROPERTY GROUP PTY LTD

APPROVED: 06.10.23

DESIGNED: AC

SCALE: 1:100 1:500

PROJECT: LAKE ROAD, CHAMPION LAKES - STAGE 01

TITLE: ROADWORKS AND STORMWATER DRAINAGE SHEET 1 OF 1

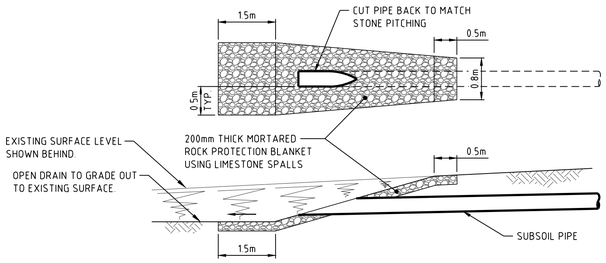
WAPC No. 162858

DRAWING No. 6483-01-610

REVISION A

ORIGINAL SIZE A1

P:\6483 Arabian Court Champion Lakes\6483-01\Acad\6483-01-610.dwg, 5/10/2023 10:25:05 AM, anthonyc, Digital Signing PDF.pc3, 1:1, - CW Reference



SUBSOIL OUTLET DETAIL

N.T.S

LAKE ROAD

ROAD 2

ROAD 2

ARABIAN COURT

SLOTTED PIPE
U/S 24.00
150/355
63.9
D/S 23.82

SLOTTED PIPE
U/S 23.65
150/61
17.0
D/S 23.37

SLOTTED PIPE
U/S 23.40
150/308
33.9
D/S 23.29

SLOTTED PIPE
U/S 23.76
150/301
108.3
D/S 23.40

SLOTTED PIPE
U/S 23.82
150/348
20.9
D/S 23.76

SLOTTED PIPE
U/S 23.50
150/154
32.4
D/S 23.29

SLOTTED PIPE
U/S 23.29
150/275
13.8
D/S 23.24

SLOTTED PIPE
U/S 23.24
150/288
14.4
D/S 23.19

SLOTTED PIPE
U/S 23.08
150/488
19.5
D/S 23.04

SLOTTED PIPE
U/S 23.90
150/119
97.6
D/S 23.08

SOLID PIPE
U/S 23.04
150/642
25.7
D/S 23.00

SOLID PIPE
U/S 23.00
150/688
48.1
D/S 22.93

SOLID PIPE
U/S 22.93
150/654
72.0
D/S 22.82

SUBSOIL DRAINAGE TO DISCHARGE TO OPEN DRAIN FOR OVERLAND FLOW TOWARDS WUNGONG RIVER.

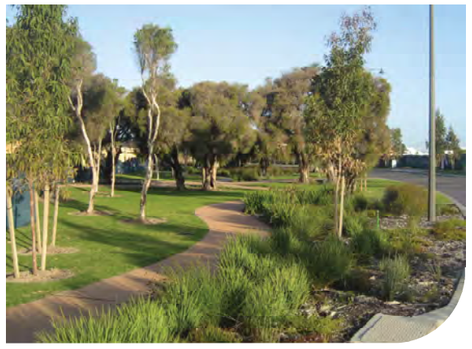
CONSTRUCT SMALL OPEN DRAIN GRADING FROM PROPOSED SUBSOIL PIPE INVERT LEVEL DOWN TO EXISTING SURFACE LEVEL. EXACT LOCATION AND EXTENT TO BE CONFIRMED ON SITE.

LAKE ROAD, CHAMPION LAKES - STAGE 01
SUBSOIL DRAINAGE ALTERNATIVE LAYOUT
6483-01 28.02.24

APPENDIX F

Landscape Plan (Plan E, 2023)

INSPRIATION IMAGERY



NOTE: CIVIL ENGINEERS ARE REVIEWING THE ABILITY TO SHIFT THE ROAD PAVEMENT IN THE AIM TO RETAIN TREES ALONG PERIPHERY OF POS. PRELIMINARY ADVICE INDICATES THAT THIS ROAD EDGE CAN MOVE A FEW METERS HOWEVER CURRENT DESIGN IS SHOWN INDICATING WORST CASE SCENARIO OF TREE REMOVAL

LEGEND

01 SHADE STRUCTURE, SEATING AND VIEWING AREA

02 PATHWAY AROUND PERIPHERY OF OPEN SPACE WITH POTENTIAL FEATURE PAVING.

03 MULCH ONLY AROUND TRANSFORMER

04 IRRIGATED GARDEN BEDS PLANTED WITH LOW SHRUBS, GROUNDCOVERS & SCATTERED TREES.

05 IRRIGATED TURF WITH LARGE EXISTING TREES.

06 TRANSFORMER PAD SITE

07 RECON LIMESTONE BLOCK RETAINING WALL

BOULDER RETAINING TO SOFTEN EDGE OF BASIN AND HELP ABSORB LEVELS AROUND RETAINED TREES

STONE PITCHING FOR OVERLAND FLOWS INTO POS

NON-IRRIGATED BIORETENTION BASIN WITH SWALE PLANT SPECIES

NON-IRRIGATED TUBESTOCK PLANTING & 100MM PINE BARK MULCH

EXISTING TREES TO RETAIN. TPZ'S TO BE PROVIDED IN DETAIL DESIGN

NEW SHADE TREES TO ACCOUNT FOR TREES THAT NEED TO BE REMOVED

POSSIBLE TREES TO BE REMOVED DUE TO LEVEL CHANGE (WITH TREE TAG NUMBER)

TREES IDENTIFIED AS 'QUESTIONABLE' DUE TO POOR HEALTH OR HABIT - REFER ARBORIBUS REPORT (WITH TREE TAG NUMBER). TREES TO BE ASSESSED FURTHER FOR FINAL RETENTION VALUE

1:1 YEAR FLOOD EVENT
VOLUME= 132M³ 200 MM DEEP
AREA= 809M²
NOTE: EARTHWORKS TO BE COMPLETED AROUND EXISTING TREES

1:5 YEAR FLOOD EVENT
VOLUME= 366M³ 250 MM DEEP
AREA= 2043M²
NOTE: EARTHWORKS TO BE COMPLETED AROUND EXISTING TREES

1:100 YEAR FLOOD EVENT
VOLUME= 972M³ 530 MM DEEP
AREA= 2777M²

ARABIAN COURT, CHAMPION LAKES

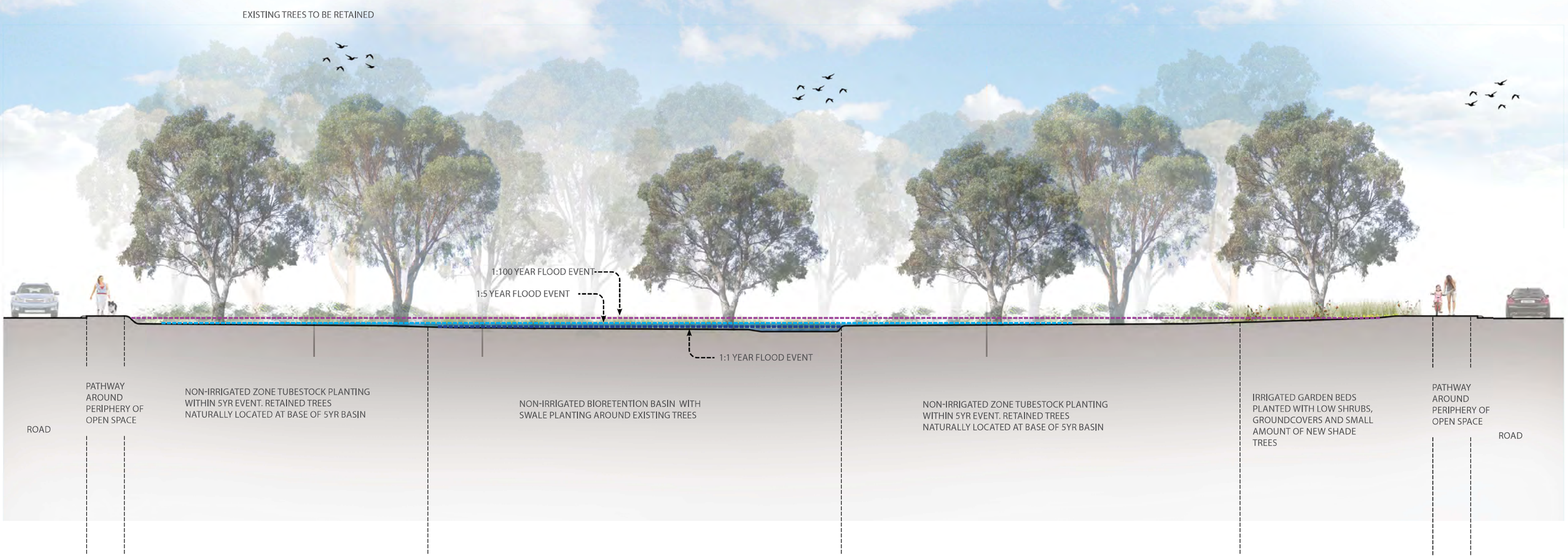
STAGE 1 POS CONCEPT PLAN
DECEMBER 2023

JOB NO. 2012502
1:400 @ A3

C1.101 REV B

0 2 4 8 12 20

PLAN E
LANDSCAPE ARCHITECTS
L1, 278 RAILWAY PDE, WEST LEEDERVILLE WA 6007
T: (08) 9388 9566 E: mail@plane.com.au



SECTION A-A

ARABIAN COURT, CHAMPION LAKES

STAGE 1 POS CONCEPT SECTION
DECEMBER 2023

JOB NO. 2012502
1:200 @ A3

C1.102 REV B

0 1 2 4 6 10

PLAN E
LANDSCAPE ARCHITECTS
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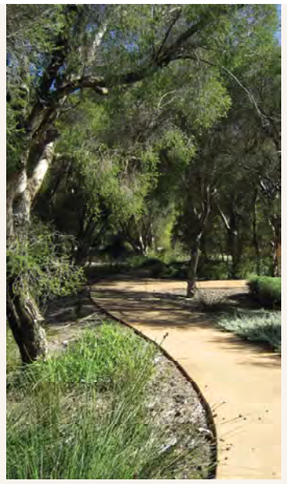
INSPRIATION IMAGERY - POS



ARABIAN COURT, CHAMPION LAKES

STAGE 1 POS CONCEPT IMAGERY
DECEMBER 2023

JOB NO. 2012502 C1.103 REV B

PLAN E
LANDSCAPE ARCHITECTS
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PLANT SPECIES: DRAINAGE BASIN AND SWALE AREAS PLANTS MANAGED TO MAX HEIGHT 500MM (1YR-5YR EVENTS)


BAUMEA ACUTA


CENTELLA ASIATICA


DAMPIERA LINEARIS


FICINIA NODOSA


ISOLEPSIS CURNUA


LEPIDOSPERMA SQAUMATA


LOBELIA ANCEPS


LOMANDRA PRIESSII


MELALEUCA SCABRA


PATTERSONIA JUNCEA


SCHOENUS CLANDESTINUS


SCHOENUS SUBFASCICULARIS


TRICOSTULARIA NEESII

PLAN E
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