

Appendix 1

Feature Survey

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CONTOUR INTERVAL: 0.25m

NOTE: Only trees withe trunk diameter greater or equal to 0.3m were surveyed.

Existing boundaries have been extracted from Landgate's Spatial Cadastral Database, which is only a model of the cadastre. The depicted boundary locations are a graphical representation only and as they have not been re-established by survey. MNG does not guaranteed the position unless stated otherwise.
Re-establishment of lot boundaries by a Licensed Surveyor is recommended for any works on or about a boundary.
This note is an integral part of this plan.

Surface features and levels have been surveyed to meet the requested scope of works accuracy. The surface may be contoured to depict topography or defined only by spot heights. For clarity on hard copy some level information is not shown, refer to 3D digital file.
Above ground indicators (markers) of underground services are located where visible.
Third parties utilising this information should confirm the capture accuracies meet requirements prior to use.
This note is an integral part of this plan.

Rev.	Description	Drawn	Date	Checked
B	Additional Trees as Identified by the Arborist Added / DTM Updated	ASO	28/09/2023	MBW
A	Initial Issue	ASO	06/07/2023	MBW

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Surveyor:- ASO
Survey Date:- 28/09/2023
Precal/Cad:- LANDGATE

N

FEATURE SURVEY
LOT 102 BUSSELL HWY
COWARAMUP

CLIENT:
GOLDFIELDS GROUP

The contents of this plan are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should satisfy themselves of this plans currency by contacting the McMullen Nolan Group.

SCALE 1:1200 @ A1
0 15 30 45 60 120
ALL DISTANCES ARE IN METRES
For a true to scale reproduction of this plan, plot it to A1 with the Paging Scaling set to None.

The boundaries shown on this plan were not re-established as part of this survey, therefore this plan does not guarantee their accuracy. Existing easements, encumbrance or interest are not depicted and a title search is recommended to obtain this information. Re-establishment of the cadastral boundaries is recommended for any proposed works on or near existing boundaries.

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Project Mngr.	Matthew Webb	Datum	MRCG94 / AHD

105705 - DE - 004 - B
Job Number | Type | Plan Number | Revision

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ROAD FEATURES
- Traffic Junction Box
- Traffic Signals - 1 Aspect
- Traffic Signals - 2 Aspect
- Traffic Signals - 3 Aspect
- Traffic Signals - 4 Aspect
- Pedestrian Signals
- Sign On One Pole
- Sign Multiple Poles
- Overhead Sign
- Traffic Controller Box
- Finger Sign
- Traffic Earth Pit
- Police Traffic Camera
- Guide Post
- Km Marker
- Traffic Count

ELECTRICAL
- Earth Pit
- Electrical Pillar
- Electrical Dome
- Light Pole - Directional
- Power Pole
- Transformer Single Pole
- Stay Pole
- Steel Wire Anchor
- High Mast Lighting
- Electrical Cable Marker
- MRWA Cable Marker
- MRWA Electrical Cable Box
- Electrical Cable Pit/Box
- MRWA Distribution Board
- High Tension Power Pole
- Electrical Supply Pole
- Ground Floodlight
- MRWA Electrical Manhole
- Meter Box
- Power Meter Box
- Electrical Transformer
- MRWA Light Pole
- MRWA Multiple Light Pole

COMMUNICATION
- Telstra Pit
- Telstra Pillar
- Telstra Marker
- Telstra Pole
- Telephone Booth
- Emergency Phone
- Antenna
- Telstra Elevated Joint
- Cable Marker (Optus)
- Telstra Tower
- Communication Manhole

WATER
- Water Meter
- Water Stop Valve
- Hydrant (Ground Level)
- Hydrant (Pillar)
- Water Bore
- Stand Pipe
- Reticulation Sprinkler
- Reticulation Control Valve
- Well
- Water Main Marker
- Water Tap
- Flushing Point
- Air Valve
- Peizometer
- Hydrant Booster Box

GAS
- Gas Marker
- Gas Valve
- Gas Test Valve
- LPG Tank
- Gas Test Pit
- Gas Manhole

DRAINAGE
- Invert Level
- Overt Level
- Flood Level
- Water Line
- Flood Level Indicator
- Storm Water Grate
- Drainage Gully
- Drainage Manhole
- Drainage Headwall

SEWER
- Sewer Vent
- Sewer Line Marker
- Sewer Inspection Shaft
- Sewer Inspection Opening
- Sewer Manhole

RAIL
- Rail Traffic Signals
- Rail Traffic Control Box
- Rail Telephone Box
- Rail Cable Pit
- Rail Cable Marker
- Rail SLK Post
- Manhole - Rail Cable

STRUCTURE
- Deck Level
- Floor Level
- Column Centre

GENERAL
- Clothes Hoist
- Air Conditioner
- Marker Unk/Undefined
- Undefined Manhole
- Control Of Access Sign
- Count Station
- Advertising Sign
- Windmill
- Stock Trough
- Litter Bin
- Mail Box
- Parking Meter
- Bus Stop
- Ticket Machine
- Borehole
- Flag Pole
- Bollard
- Fuel Bowser
- Underground Filler
- Diesel Tank
- Oil Main Marker
- Security Post
- Tank

GROUND FEATURES
- Natural Surface
- Aerial Survey Marker

VEGETATION
- Tree Details - Canopy & Trunk
- Tree 0.1m-0.3m Trunk Diameter
- Tree 0.3m-0.5m Trunk Diameter
- Tree 0.5m-1.0m Trunk Diameter
- Tree > 1.0m Trunk Diameter
- Bush
- Die Back Area - Marker
- Nesting Tree
- Tree Trunk / Stump
- Grass Tree

SURVEY CONTROL
- Star Iron Picket
- Trig Point
- SSM
- Bench Mark
- Photo Point
- Cadastral Peg/Post
- Reference Peg
- Alignment Control
- Spring Head Nail
- Spike
- TBM
- Peg Placed / Found

ROAD FEATURES
- Edge Of Bitumen
- Road Shoulder
- Edge Of Unsealed Road
- On Road
- Centre Of Road
- Kerb Top
- Kerb Bottom
- Cattle Grid
- Centre Of Driveway
- Edge Of Driveway
- Pedestrian Ramp
- Pedestrian Crosswalk
- Track
- Parking Bay
- Line Markings 1m Line & 1m Gap
- Line Markings 1m Line & 3m Gap
- Line Markings 3m Line & 9m Gap
- Lane Marking (9m*3m GAP)
- Lane Markings - Audible
- Shared Pathway - Guide Line 900mm*300mm GAP
- Footpath/Shared Path - Give Way 200mm*200mm GAP
- Giveway/Hold/Turn Lines 600mm*600mm GAP
- Double Barrier Line
- Overtaking Lane Left
- Overtaking Lane Right
- Single Solid Line
- Arrow Straight
- Arrow Straight/Left
- Arrow Straight/Right
- Arrow Left
- Arrow Right
- Arrow 3 Ways
- Arrow Right & Left
- Arrow U-Turn
- Arrow Merge
- Painted Lettering On Seal
- Painted Bicycle Traffic Signal Detector
- Guardrail - W Beam
- Guardrail - Thrie
- Barrier Concrete
- Barrier Steel Rope
- Barrier - Single Rail
- Barrier - Double Rail
- Barrier Triple Rail
- Bridge Barrier - (All Types)
- Bridge Expansion Joints
- Bridge - Outside Of Deck
- Soffit String

STRUCTURE
- Bridge
- Abutment
- Columns
- Piers
- Underpass
- Ramp
- Steps/Stairs
- Edge Of Concrete
- Bus Shelter
- Memorial
- Ruin
- Building / Structure
- Awning
- Shed
- Verandah
- Door Opening
- Window
- Roof Gutter Line
- Roof Ridge Line
- Top Of Wall
- Brick Wall
- Concrete Wall
- Livestock Grid

GROUND FEATURE
- Major Contour
- Minor Contour
- Bank Bottom
- Bank Top
- Line Of Levels
- Levee Top
- Levee Bottom
- Rock Outcrop
- Ridge Line
- Borrow Pit
- Earthworks Area
- Ground Subsidence
- Rock Pitching

VEGETATION
- Tree Line/Canopy
- Bush Line
- Hedge
- Garden Bed
- Lawn Area
- Vineyard
- Plantation
- Orchard
- Nursery
- Market Garden
- Recreational Area
- Trunk Circumference Circle
- Tree-line Face Of Trunks

ELECTRICAL
- Varible Message Sign
- Electrical Structure String
- Overhead Powerlines - Null Height
- Overhead Powerlines - True Height
- High Tension Power Lines - Null Height
- High Tension Power Lines - True Height

COMMUNICATION
- Unidentifed Service Pit
- Telstra Cable
- Amcom Cable

WATER
- Water Pipe

GAS
- Gas Line

DRAINAGE
- Drainage Pipe
- Drainage Culvert
- Floodway
- Drain
- Edge Of Drain
- Sump
- Waters Edge
- Swamp
- Dam
- Edge Of Creek/Water
- Centre Of Channel
- Wet Area
- Flood Level Line
- Waterways Cross Section

SEWER
- Sewer Pressure Main
- Sewer Pipe

RAIL
- Railway Platform
- On Rail
- Rail Boom Gate
- Rail Underground Cable
- Dual Gauge Rail
- Narrow Gauge Rail
- Cross Setion - Rail
- Standard Gauge Rail
- Rail U/G Cable

CADASTRAL
- MNG Precal/Re Established
- (SCDB) - State Cadastral Data Base
- Cadastre By Others

GENERAL
- Swimming Pool
- Tank Perimeter
- Mine Shaft
- Mine Workings
- Koppa Logging Fence
- Fence/Gate
- Wall
- Top Of Barrier / Wall etc
- Retaining Wall
- Boundary Line
- Footpath
- Gas Cylinder/Tank
- Brick Paving
- Bike Rack
- Bench Seating
- Handrail

UNDERGROUND SERVICES

UNDERGROUND SERVICES - inDIRECT MEASUREMENT - CLASS B

(PZA)	Underground Amcom/Vocus Cable
(PZC)	Underground Drainage Pipe
(PZE)	Underground Electrical Cable
(PZF)	Underground Western Power Comms
(PZG)	Underground Gas Line
(PZH)	Underground MRWA Comms
(PZI)	Underground MRWA Power
(PZJ)	Underground NBN Comms
(PZK)	Underground TPG /Pipe Networks
(PZN)	Underground Next Gen Comms
(PZO)	Underground Optus Fibre_Optic
(PZP)	Underground Optus Copper
(PZR)	Underground Rail Services
(PZS)	Underground Sewer Pipe
(PZT)	Underground Telstra Copper
(PZU)	Underground Unknown Service
(PZV)	Underground Telstra Optic_Fibre
(PZW)	Underground Water Pipe
(PZX)	Underground Reticulation Pipe
(PZZ)	Abandoned Service

(MAIN ROADS - SURFACE LOCATION) - CLASS B
POINT MEASRUED AT GROUND LEVEL DIRECTLY ABOVE TRACED SERVICE

HA	AMCOM/VOCUS Cable - Surface Location
HC	Drainage Pipe / Stormwater - Surface Location
HE	Electrical Cable - Surface Location
HF	Western Power Communication - Surface Location
HG	Gas Line - Surface Location
HH	MRWA Communication - Surface Location
HI	MRWA Power - Surface Location
HJ	Underground NBN Fibre - Surface Location
HK	Underground TPG/Pipe Networks Surface Location
HN	Next Gen Communication - Surface Location
HO	Optus Optic_Fibre - Surface Location
HP	Optus Copper - Surface Location
HR	Rail Services - Surface Location
HS	Sewer Pipe - Surface Location
HT	Telstra Copper - Surface Location
HU	Unknown Service - Surface Location
HV	Telstra Optic_Fibre - Surface Location
HW	Water Pipe - Surface Location
HX	Reticulation - Surface Location
HZ	Abandoned Service - Surface Location

UNDERGROUND SERVICES

UNDERGROUND SERVICES DIRECT MEASUREMENT - CLASS A

(PQA)	Underground Amcom/Vocus Cable
(PQC)	Underground Drainage Pipe
(PQE)	Underground Electrical Cable
(PQF)	Underground Western Power Comms
(PQG)	Underground Gas Line
(PQH)	Underground MRWA Comms
(PQI)	Underground MRWA Power
(PQJ)	Underground NBN Comms
(PQK)	Underground TPG /Pipe Networks
(PQN)	Underground Next Gen Comms
(PQO)	Underground Optus Fibre_Optic
(PQP)	Underground Optus Copper
(PQR)	Underground Rail Services
(PQS)	Underground Sewer Pipe
(PQT)	Underground Telstra Copper
(PQU)	Underground Unknown Service
(PQV)	Underground Telstra Optic_Fibre
(PQW)	Underground Water Pipe
(PQX)	Underground Reticulation Pipe
(PQZ)	Abandoned Service

(MAIN ROADS - UNVERIFIED, NO MEASURMENT) DBYD COMPILED - CLASS C AND D

QA	AMCOM/VOCUS Cable - Unverified, No Measurement
QC	Drainage Pipe / Stormwater - Unverified, No Measurement
QE	Electrical Cable - Unverified, No Measurement
QF	Western Power Communication - Unverified, No Measurement
QG	Gas Line - Unverified, No Measurement
QH	MRWA Communication - Unverified, No Measurement
QI	MRWA Power- Unverified, No Measurement
QJ	Underground NBN Comms - Unverified, No Measurement
QK	Underground TPG/Pipe Networks - Unverified, No Measurement
QN	Next Gen Communication - Unverified, No Measurement
QO	Optus Optic_Fibre - Unverified, No Measurement
QP	Optus Copper - Unverified, No Measurement
QT	Telstra Copper - Unverified, No Measurement
QV	Telstra Optic_Fibre - Unverified, No Measurement
QR	Rail Services - Unverified, No Measurement
QS	Sewer Pipe - Unverified, No Measurement
QU	Unknown Service - Unverified, No Measurement
QW	Water Pipe - Unverified, No Measurement
QX	Reticulation - Unverified, No Measurement
QZ	Abandoned Service - Unverified, No Measurement

Rev.	Description	Drawn	Date	Checked
H	U/G Services Amended	SAH	30/10/2020	TKI

SCALE 1:1000 @ A3

0 10 20 30 40 50

ALL DISTANCES ARE IN METRES

For a true to scale reproduction of this plan, plot it to A3 with the Paging Scaling set to None.

The contents of this plan are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should satisfy themselves of this plans currency by contacting the McMullen Nolan Group.

Surveyor:- MNG
Survey Date:- 30/06/2020
Precal/Cad:- 30/06/2020

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N

The boundaries shown on this plan were not re-established as part of this survey, therefore this plan does not guarantee their accuracy. Existing easements, encumbrance or interest are not depicted and a title search is recommended to obtain this information. Re-establishment of the cadastral boundaries is recommended for any proposed works on or near existing boundaries.

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McMULLEN NOLAN GROUP
FEATURE SURVEY - GENERAL LEGEND

CLIENT: N/A

Project Mngr	Datum
MNG Group	LOCAL

95465 - DOC - 012 - H
Job Number | Type | Plan Number | Revision

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Appendix 2

Certificate of Title

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WESTERN AUSTRALIA

TITLE NUMBER	
Volume	Folio
2543	**484**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 102 ON DEPOSITED PLAN 36365

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

SOUTHFIELD HOLDINGS PTY LTD OF POST OFFICE BOX 77, COTTESLOE
INTRICATE HOLDINGS PTY LTD OF 22 PRINCES STREET, COTTESLOE
AS TENANTS IN COMMON IN EQUAL SHARES

(T N441460) REGISTERED 22/9/2016

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required. Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	DP36365
PREVIOUS TITLE:	1684-80
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF AUGUSTA MARGARET RIVER

LANDGATE COPY OF ORIGINAL NOT TO SCALE 07/11/2023 02:54 PM Request number: 65826741

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Appendix 3

Environmental Assessment Report

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Environmental Assessment Report

Lot 102 Bussell Highway, Cowaramup

27 October 2023

Prepared for:
Goldfields Cowaramup Pty. Ltd.
Att: Gareth Wilson



Limitations Statement

This report has been prepared in accordance with the Agreement between Ecosystem Solutions Pty Ltd and Goldfields Cowaramup Pty. Ltd. (**"Client"**). It has been solely prepared for a Local Planning Scheme Amendment Request at Lot 102 Bussell Highway, Cowaramup (**"Site"**).

Information

In undertaking this work the authors have made every effort to ensure the accuracy of the information used. Unless otherwise stated in the report, Ecosystem Solutions Pty Ltd has not independently verified such information and cannot guarantee its accuracy or completeness.

Conclusions

Within the limitations imposed by the scope of work, preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable ecological consultants under similar circumstances. No other warranty, expressed or implied, is made.

Reliance

This report is solely for the use of the Client and any reliance on this report by third parties will be at such party's sole risk. This report must only be presented in full and may not be used to support any other purpose than those set out in the report and the Agreement, except where prior written approval with comments are provided by Ecosystem Solutions Pty Ltd. All intellectual property rights in documents created by Ecosystem Solutions Pty Ltd remain the property of Ecosystem Solutions Pty Ltd.

Other parties should not rely on the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters. Ecosystem Solutions Pty Ltd accepts no Liability, or responsibility whatsoever for or in respect of any use or reliance upon this report and its supporting material subsequently used by others. Please note that the contents of this report may not be directly applicable towards another organisation's needs and may not contain sufficient information for purposes of other parties or for other uses.

Ecosystem Solutions Pty Ltd will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of this report.

Document Control

Goldfields Cowaramup Pty. Ltd.

Lot 102 Bussell Highway, Cowaramup

Version	Revision	Purpose	Author	Reviewer	Submitted	
					Form	Date
Report	Rev A	Draft	KP/HD	GM	Electronic (email)	10/05/2023
Report	Rev B	Initial Report	KP/HD	GM	Electronic (email)	31/07/2023
Report	Rev C	Comments from GW	KP	GM	Electronic (email)	15/09/2023
Report	Rev D	Comments from GW	KP	GM	Electronic (email)	26/09/2023
Report	Rev E	Updated SP	KP	GM	Electronic (email)	27/10/2023

Filename: \\ecoserver\projects\projects\231484 lot 102 bussell highway, cowaramup bmp & f&f survey\reports\lot 102 bussell highway, cowaramup environmental assessment report revd.docx

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1 Executive Summary

This report details the results of a flora, fauna and vegetation assessment at Lot 102 Bussell Highway, Cowaramup (hereafter referred to as the Site, Figure 1), to inform and facilitate a local structure plan amendment and subdivision application for the lot. The assessment has included a desktop review, reconnaissance survey for flora and vegetation (as per (Environmental Protection Authority, 2016)) and a basic survey for fauna (as per (Environmental Protection Authority, 2020)), including two dawn, two dusk and two nocturnal surveys. The scope of the field surveys is defined as being the Site (19.64 ha), with the desktop study area defined as being the Site with a 10 km buffer area for database searches and 100 m for landscape mapping. The proposed cross overs onto Memorial Drive and Sunset Drive were also surveyed. The Site was visited from May to July 2023 to complete the field surveys.

No significant flora, fauna or vegetation was observed within the Site. Signs of Black Cockatoos and Western Ringtail Possums were observed within the survey area, with one Western Ringtail Possum observed within a neighbouring lot.

Just under 1.2 ha of remnant native vegetation, in degraded condition, remains within the Site. Of this, it is proposed that approximately 0.39 ha is retained, 0.38 ha is also retained, but modified to a low threat state to satisfy bushfire requirements, with the remaining 0.42 ha cleared for the construction of roads, future houses and other infrastructure.

2 Introduction

Ecosystem Solutions were contracted by Goldfields Cowaramup Pty Ltd to survey Lot 102 Bussell Highway, Cowaramup (hereafter called the "Site") within the Shire of Augusta-Margaret River. A survey was undertaken to assess the vegetation condition and document the presence and distribution of flora and fauna on the Site to support a proposed structure plan amendment and residential subdivision of the Site, generally as envisaged on the attached draft Concept Plan (Figure 1).

The fauna species specifically targeted are signs or suitable habitat of the Western Ringtail Possum (*Pseudocheirus occidentalis*) and Black Cockatoo Species (*Zanda baudinii, Z. latirostris and Calyptorhynchus banksii subsp. naso*), as well as any other conservation significant fauna likely to occur within the Site.

The flora elements specifically targeted include Threatened and Priority species and Threatened and Priority Ecological Communities. A flora survey was not conducted in the optimal time for all plant identification, however the degraded nature of the Site and current land use means that it is highly unlikely that any conservation significant flora occur within the Site.

This flora and fauna assessment was limited to observing species present during the time of the surveys.



Figure 1 Proposed Strucuture Plan for Lot 102 Bussell Highway, Cowaramup

3 Site Details

The Site is zoned as 'Future development' and 'Residential' under the Shire of Augusta-Margaret River Local Planning Scheme 1 and is within the Development Contribution Area. The Site currently has an approved Local Structure Plan. The Site is bound by Sunset Drive to the west, Memorial Drive to the north and Bussell Highway to the east (Figure 1).

The land is currently used for agricultural purposes, for livestock grazing. The Lot is 19.64 ha in area and includes a predominately cleared area of vegetation with scattered trees in the north west corner of the Lot. Part of this vegetated area is envisaged to be retained in an area of Public Open Space (Figure 1), subject to this environmental review and final subdivision design.

The surrounding landscape includes 'Priority agriculture' lots to the south and further east and west of the Site and 'General Agriculture' to the north and east. Residential and future development lots and pockets of remnant vegetation are to the north, east and west of the Lot, which make up parts of the Cowaramup townsite. Parks and recreation lots are scattered throughout the Cowaramup townsite, with the closest reserves to the west of Sunset Drive, to the north of Memorial Drive and east of Bussell Highway.

The Site sits at approximately 130 m AHD with a gentle slope up to 135 m AHD to the east and south-east and gentle slope down to 125 m AHD in the south-west.

4 Flora and Vegetation

4.1 Desktop analysis

The desktop investigation used datasets available from government sources and Ecosystem Solutions own databases to map environmental parameters onto the study area. Information sourced included the following:

- Department of Biodiversity Conservation and Attractions' NatureMap for Threatened and Priority Flora and wetland mapping.
- Department of Agriculture, Water and of the Environments', Environment Protection and Biodiversity Conservation (EPBC) Protected Matters Search Tool
- Department of Primary Industries and Regional Developments', Soil Subsystem mapping
- Department of Water and Environmental Regulations', Acid Sulphate Soils risk (DWER_052) and Environmentally Sensitive Areas mapping
- Department of Planning, Lands and Heritages', Aboriginal Heritage Places mapping

Environmental aspects included in this investigation are as follows:

- Soil landscape systems
- Presence of potential Acid Sulphate Soils (ASS)
- Regional vegetation complexes
- Presence of Environmentally Sensitive Areas (ESA's)
- Hydrology and categorised wetlands
- Presence of conservation significant flora
- Presence of threatened and priority ecological communities.
- Presence of Aboriginal Heritage Places

4.1.1 Soil Landscape

Soil-Landscape systems are areas with recurring patterns of landforms, soils and vegetation and are used by the Department of Agriculture to maintain a consistent approach to land resource surveys. The Department of Primary Industries and Regional Development (DPIRD) Natural Resource Information (WA) database was used to identify the soil and vegetation mapping within the Site, including a 100m buffer around the Site.

The Site is located within the Leeuwin Zone (216) which is between Eagle Bay and Leeuwin (DPIRD-017). This zone is defined as Leeuwin Block (tectonic geology), moderately dissected lateritic plateau on granite. Colluvial soils in the valleys. On the western margin the granite is overlain by Tamala Limestone and there are some coastal dunes (DPIRD, 2023).

This zone is further classified into soil systems. The Site is solely situated on the Cowaramup Uplands System (216Co) (DPIRD-064), which is described as Lateritic plateau, in the Leeuwin Zone. Sandy gravel, loamy gravel, and grey sandy duplex. Jarrah-marri Forest. (DPIRD, 2023).

These systems are further classified into soil subsystems. The Site is on two soil subsystems (DPIRD-027), and they are and described as (Figure 2):

- Cowaramup wet flats phase (216CoCOw) - Poorly drained flats and slight depressions with pale grey mottled (Mungite).
- Cowaramup flats phase (216CoCO1) - Flats (0-2% gradient) with gravelly duplex (Forest Grove) and pale grey mottled (Mungite) soils.

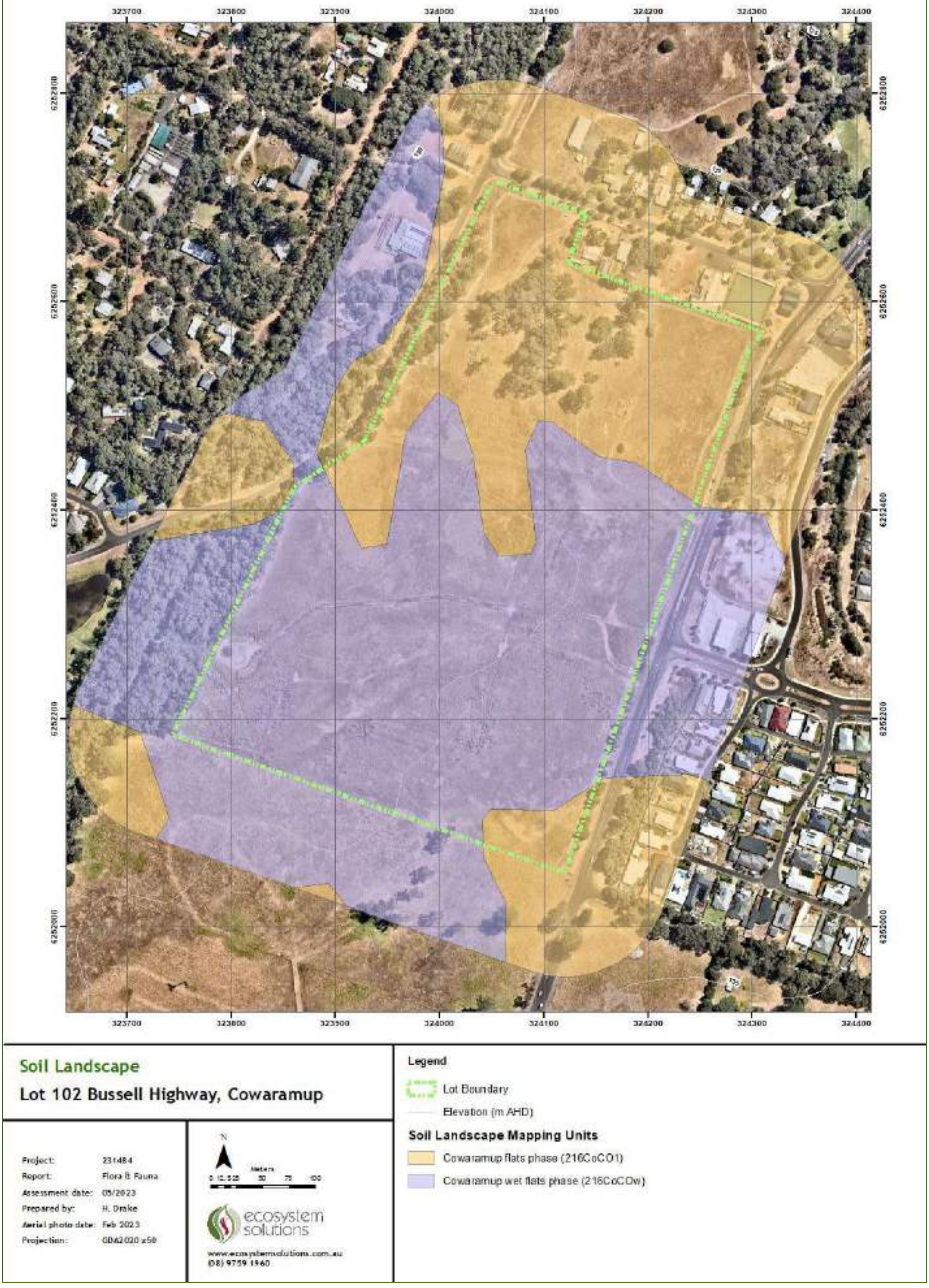


Figure 2 Soil Landscape for Lot 102 Bussell Highway, Cowaramup

4.1.2 Acid Sulphate Soils

Acid Sulfate Soils (ASS) are naturally occurring soils, sediments and peats that contain iron sulphides. When exposed to air (oxygen), these sediments can form sulfuric acid and release metals (including arsenic) into the soil profile. The release of these substances has potential to cause significant environmental and economic impacts by contaminating soil and groundwater. These soils are predominantly found in low-lying land bordering the coast, estuarine or saline wetlands, and freshwater ground water dependent wetlands throughout the State.

The Department of Water and Environmental Regulation (DWER, 2017) developed a map, Acid Sulfate Soil Risk Maps across the State, indicating risk level of ASS materials based on the likelihood of ASS materials occurring within soil profiles. For the Site the Lower South West map (DWER-052) was used to determine the likelihood of ASS within the Site.

This mapping indicates an area of Risk Class 2 (approximately 1241 m^2 / 12.41 ha) within the southern two thirds of the Site (DWER-052) (Figure 3). This Risk Class 2 area does also occur within 100m of the Site on the northern third on the western boundary (Figure 3). Risk Class 2 indicates a moderate to low-risk likelihood of ASS occurring within 3m of natural soil surface but a high to moderate risk of ASS beyond 3m of natural soil surface.

If there is any disturbance greater than 100m^3 required of the Risk Class 2 area, with excavation proposed below the water table, than an Acid Sulfate Soil Management Plan should be prepared and implemented with actions to mitigate the potential impacts provided in the 'Treatment and management of soils and water in acid sulfate soil landscapes' (Department of Environment Regulation, 2015).

There is another ASS Risk Class 2 outside the Lot Boundary 120m to the north-east.

Further assessment of the potential for Acid Sulphate Soils within the Site and any management required will be provided in the Engineering Servicing Report.

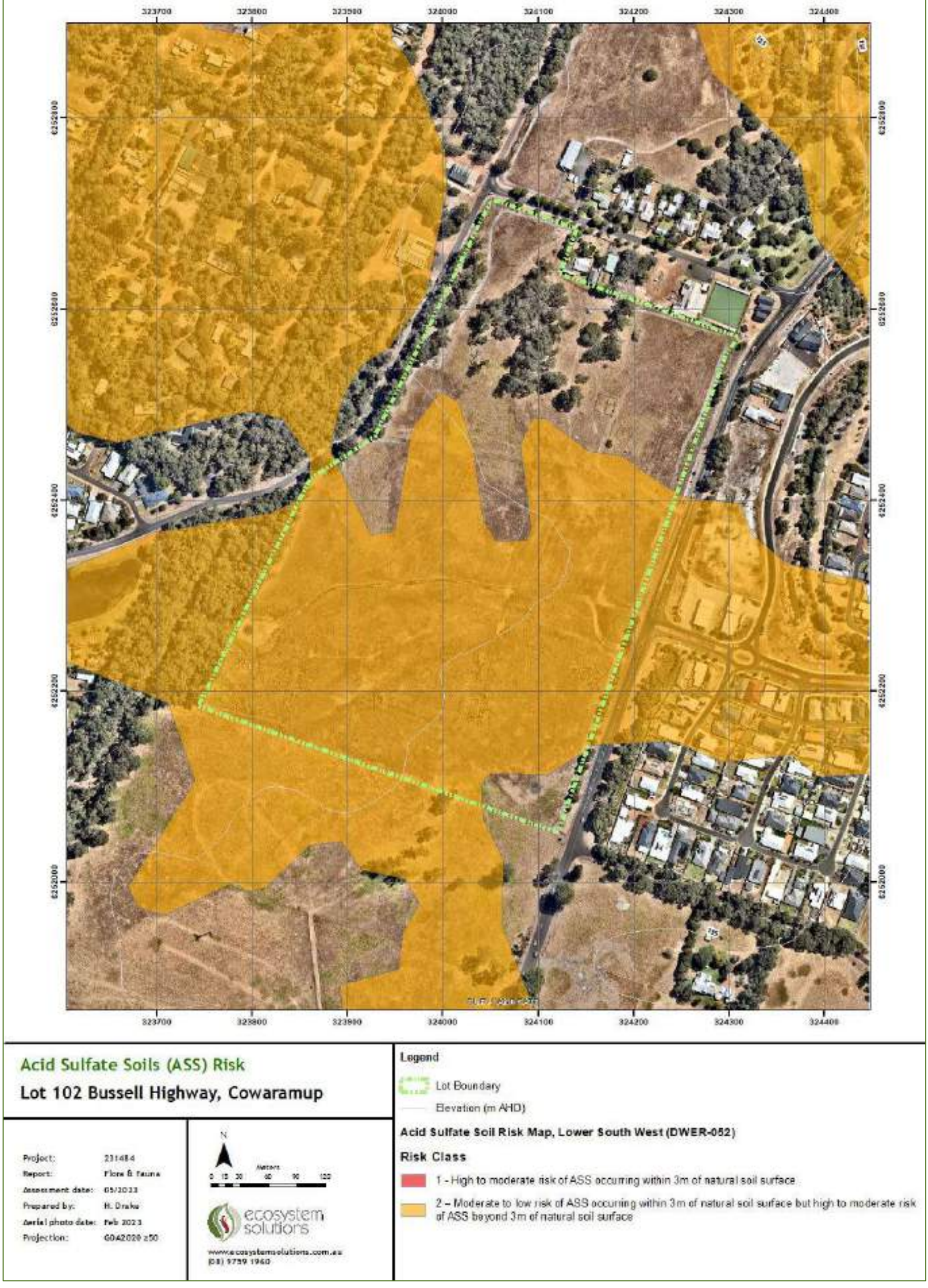


Figure 3 Acid Sulphate Soil (ASS) Risk Map for Lot 102 Bussell Highway, Cowaramup

4.1.3 Regional Vegetation Complexes

The vegetation complex mapping of (Havel & Mattiske, 2000) identifies two vegetation complex classes within the Site, including a 100m buffer around the Site (Figure 4):

- Cowaramup Uplands (C2) - Open Forest of *Eucalyptus marginata* subsp. *marginata-Corymbia calophylla-Banksia grandis* on lateritic uplands in perhumid and humid zones.
- Cowaramup Valleys (Cw2) - Woodland of *Eucalyptus marginata* subsp. *marginata-Corymbia calophylla* on slopes and low woodland of *Melaleuca preissiana-Banksia littoralis* on depressions in perhumid and humid zones.

The 2018 South West Vegetation Complex Statistics (Government of Western Australia, 2019) for these vegetation associations are shown in Table 1. The National Objectives and Targets for Biodiversity Conservation 2001-2005 (Commonwealth of Australia, 2001) aims to retain and protect those vegetation communities with below 30% remaining.

The Cowaramup Uplands is above the National Target with 32.45% remaining from pre-European extent, however that is only 2.45% above the 30% remaining threshold. Approximately 38% of the Cowaramup Uplands is within the Shire of Augusta-Margaret River and less than 5% is protected under conservation. Molloy *et al.* (2007) designed an addendum to complement guidelines to provide additional data to aid and improve Local Government capacity to conserve biodiversity. The addendum developed ecological criteria for assessing the biodiversity conservation value of natural areas. This vegetation class meets criterion 1a iv) and 1a v) and is close to the criterion target threshold for 1a ii).

The Cowaramup Valleys is below the National Target with less than 30% of pre-European extent remaining. Approximately 42% of this extent is within the Shire of Augusta-Margaret River and less than 3.5% within secure lands on conservation. Under the ecological criteria of Molloy et al. (2007) the vegetation complex class meets criterion 1a ii), 1a iv) and 1a v), with less than 1500 ha of its pre-European extent remaining and less than 10% protected.

Table 1 Vegetation Complex Statistics (Government of Western Australia, 2019)

Vegetation Complex Class	Pre-European Remaining (ha)	Pre-European Extent Remaining (%)	Extent within Shire of Augusta-Margaret River (%)	Extent within lands secure of conservation (IUCN I-IV) (ha)	Extent within lands secure of conservation (IUCN I-IV) (%)
Cowaramup Uplands (C2)	4,442.60	32.45	37.99	661.13	4.83
Cowaramup Valleys (Cw2)	1,352.26	20.32	42.20	225.85	3.39

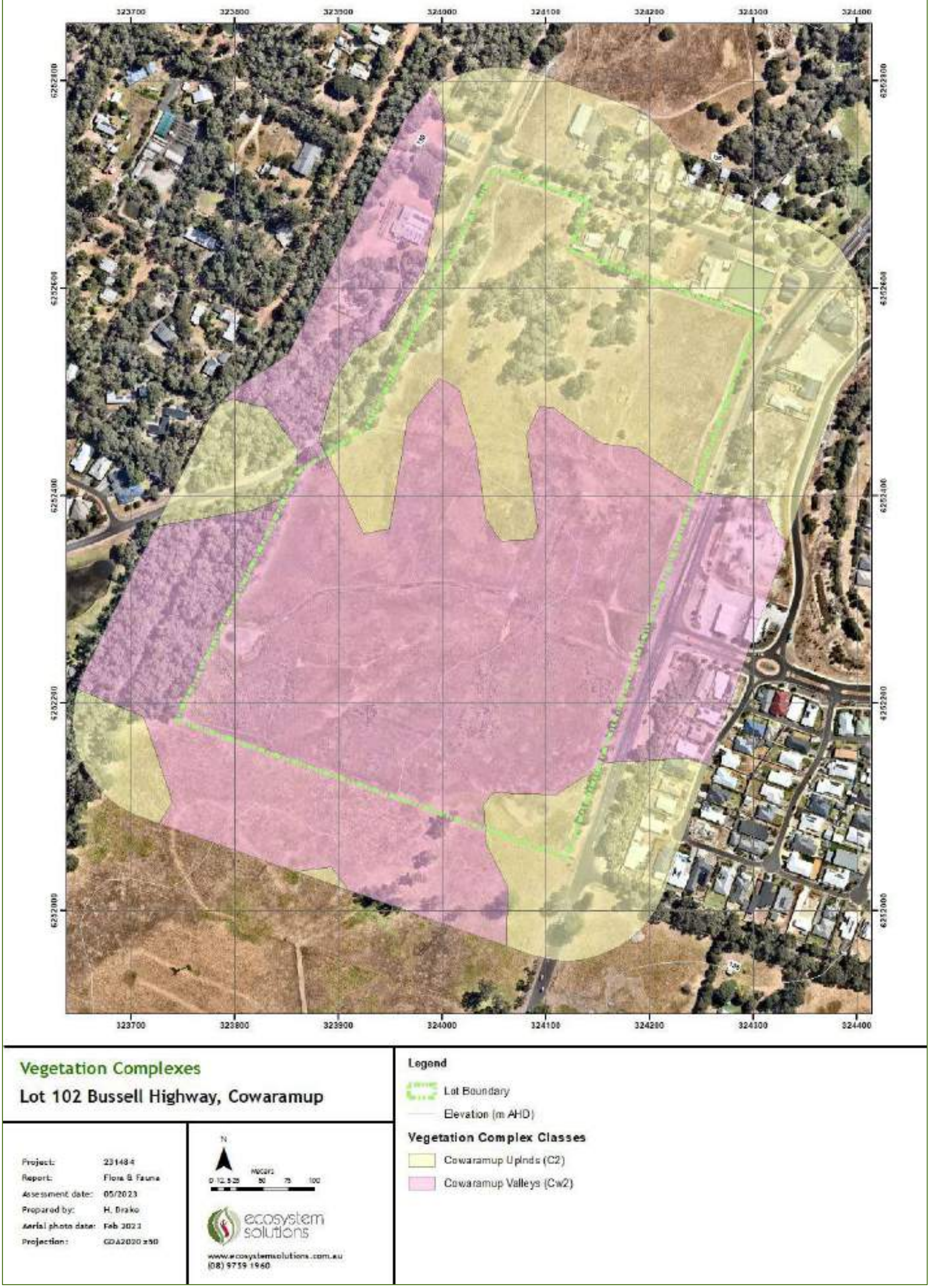


Figure 4 Vegetation Complexes for Lot 102 Bussell Highway, Cowaramup

4.1.4 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are classes or areas of native vegetation, where the exemptions for clearing vegetation under the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (Clearing Regulations) do not apply. ESAs include but are not limited to declared World Heritage properties, defined wetlands, and buffer area, threatened flora and buffer, Threatened Ecological Communities, a Bush Forever Site and lakes, wetlands and fringing native vegetation covered under Environmental Protection Policies (e.g., Swan Coastal Plain Lakes).

A search of the Department of Water and Environmental Regulation's Clearing Regulations – Environmentally sensitive areas mapping indicated that there is no ESA within or around the Site (DWER-046).

4.1.5 Hydrology and Wetlands

Wetlands include areas of seasonally or permanently waterlogged soils, or inundated land, with fresh or saline, flowing, or static water (Wetlands Advisory Committee, 1977). They are important as they support a large proportion of the States flora and fauna.

DBCA manages and protects Ramsar wetlands, which are of international importance, listed under the Ramsar Convention. There are no Ramsar wetlands within or in close proximity to the Site (DBCA-010)

The Site is located within the Wilyabrup Brook catchment (DWER-028). The Wilyabrup Brook is a minor river that has tributaries that are around the Site, with one intersecting the southern half of the Site (DWER-031) (Figure 5). Wilyabrup Brook has a total stream length of nearly 20 km, flowing northwest to an estuary located between Yallingup and Gracetown (Green & Donohue, 2015). The river itself is 850m from the Site boundary.

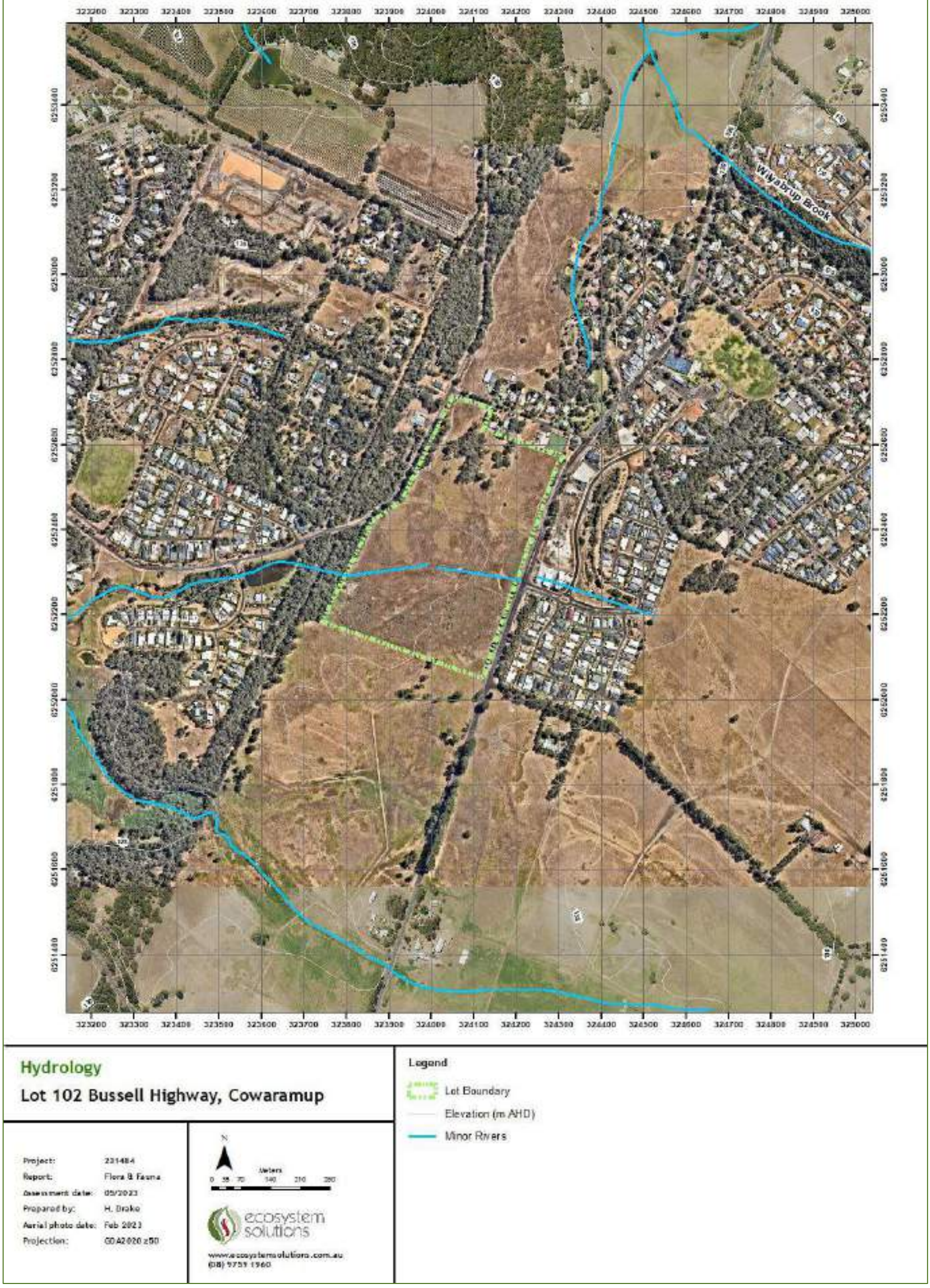


Figure 5 Hydrology Map for Lot 102 Bussell Highway, Cowaramup

4.1.6 Threatened and Priority Flora

Extracts from the following databases have been obtained, using a 10 km buffer, to determine if records of any conservation listed flora species are known within the boundary or surrounding the Site:

- NatureMap database showing listed species under the *Biodiversity Conservation (BC) Act 2016* managed by Department of Biodiversity, Conservation and Attractions (DBCA), provided in Appendix A.
- Protected Matters Search Tool (PMST) showing species listed under the commonwealth *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999* (Appendix B).
- Department Biodiversity, Conservation and Attractions Threatened and Priority Flora database search providing to ascertain if there are any records of threatened or priority flora within a locality (DBCA, 2023). Specific locality information for threatened flora is regarded as confidential therefore has not be provided in this report.

Database search results have been summarised in Table 2, Section 4.3.1.

Flora species are protected based on their conservation status. DBCA recognises threats of extinction and consequently applies regulations towards population and species protection. Protected species are gazetted under the *Biodiversity Conservation Act (2016),* and it is an offence to "take" or damage rare flora without Ministerial approval. The act defines "to take" as "… to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means" (Government of Western Australia, 2010).

Appendix C presents the definitions for conservation status under the *BC Act* 2016, which was previously the *Wildlife Conservation Act 1950*, and *EPBC Act 1999*.

4.1.7 Threatened and Priority Ecological Communities

An ecological community is a naturally occurring biological assemblage that occurs in a particular type of habitat. A Threatened Ecological Community (TEC) is one which is found to fit into one of the following categories: Presumed Totally Destroyed; Critically Endangered; Endangered, or Vulnerable.

Possible TECs that do not meet survey criteria are added to the Department of Parks and Wildlife's Priority Ecological Community Lists, under Priority 1, 2 and 3. These are ranked in order of priority for survey and/or definition of the community type and evaluation of its conservation status.

The database searches from the Protected Matters Search Tool (PMST) and Department Biodiversity, Conservation and Attractions (DBCA) Communities Data have identified the following TEC as likely to occur (Site occurs within the buffer area of the TECs only):

- Banksia woodlands of the Swan Coastal Plain ecological community (Endangered), and

- Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain ecological community (Critically Endangered).

4.1.8 Aboriginal Heritage

Department of Planning, Lands and Heritage (DPLH) developed a data set containing places within Western Australia that have been reported to the Registrar of Aboriginal Sites as possible sites within the meaning of the Aboriginal Heritage Act 1972 (AHA). This includes Registered Sites (those that meet criteria of Section 5 of AHA), Lodged places (those yet to be formally assessed against Section 5 criteria) and Stored data (places to which Section 5 of AHA does not apply). This data is the same as that accessed through the Aboriginal Heritage Inquiry System (AHIS).

A search of the Aboriginal Heritage Places (DPLH-001) dataset identified no Aboriginal Heritage Places within the Site. One Aboriginal Heritage Place was identified in close proximity to the Site. The Cowaramup Sale Yards Camp and Corroboree Grounds (Place 25909) is a ceremonial, historical, and camp Aboriginal Heritage Place and is located on the western side of Sunset Drive.

The DPLHs' Aboriginal Heritage Survey dataset (DPLH-080) was also accessed to determine if the Site was included in Aboriginal Heritage Survey Area information from Heritage Survey Reports submitted to the Department. The search identified the Site is within four Aboriginal Heritage Survey Areas:

- Survey Report ID 27843, Section 16 Research Plan for Test-Excavation of Selected Sites, Leeuwin Region, Western Australia (2013).
- Survey Report ID 102074, Western Australia Regional Forest Agreement Aboriginal Consultation Project. Vol.1. Nov.1997 (2020).
- Survey Report ID 102073, Western Australia Regional Forest Agreement Aboriginal Consultation Project. Vol.2. Nov.1997 (2020)
- Survey Report ID 101971, National Estates Grants Programme Aboriginal Sites in the Lower Southwest Heritage Study. July 1995 (2004).

4.2 Survey Method

A targeted flora and vegetation survey has been completed across the entire Site, consistent with the Technical Guidance for Flora and Vegetation Surveys (Environmental Protection Authority, 2016). The Site was surveyed on 25 May 2023 by staff members from Ecosystem Solutions (Table 2).

Table 2 Flora Project Team and Licencing

Team member	Role	Qualifications	Flora Licence Number
Kelly Paterson	Project Manager / Plant identifications	B.Sc. Hons. Nat Rs Mgmt.	FB62000182 TFL 54-2021
Dani Cuthbert	Team member	Dip Bus & Dip TM	N/A
Hayley Drake	Team member	B.Sc. Cons & Wildlife Bio and Molecular Bio	FB62000348

The Site was walked in a systematic manner to cover the entire area. The survey included targeted searches for significant flora and vegetation communities identified in the desktop analysis and one floristic sampling relevé within the Site, to document and understand the floristics, vegetation communities and condition of the survey area. The vegetation communities have been determined according to Keighery, 1994, adapted from Muir (1977) and Aplin (1979). Vegetation condition has been assessed using the Keighery (1994) scale, provided in Table 4. Additional data including introduced flora were also recorded when opportunistically observed (Table 5). Recordings were marked by using Global Positioning System (GPS) and ArcPad© (Version 8- ESRI). Field observations were analysed and mapped also with ArcGis (ArcMap V10.6.1©).

4.3 Results

4.3.1 Threatened, Priority and Significant Flora

A total of six Threatened (T) species and 34 Priority (P) species have been identified within a 10 km radius of the Site according to the BC Act. Five Endangered (E) species and one vulnerable (V) species under the EPBC Act. (Appendix A & B). The results for all database searches are summarised in Table 3.

The likelihood of the species occurring within the Site is determined based on known distribution, last known records and the habitat expected within the Site or buffer area.

There were no Threatened flora species recorded during the field surveys. While the flora survey was not conducted during the optimal time for plant identification (Spring), the Site is disturbed, with partial clearing and heavy grazing resulting in a very sparse understorey. It is unlikely that any conservation significant flora species are present within the Site.

Table 3 Conservation significant flora species recorded within 10 km of the Site.

Species	Conservation Status*	Life Form	Habitat / Known Distribution	Likelihood of occurrence within the Site	Data Source
Banksia mimica	T/EN	Shrub	Flat to gentle slopes on grey and white sand in open woodlands (Kelly *et al*. 1999, Williams *et al*. 2001).	Unlikely, habitat not present.	PMST
Banksia nivea subsp. uliginosa	T/EN	Shrub	Sandy clay, gravel. Occurs in two areas, near Busselton and Scott River Plain on clay over laterite in thick scrub, in winter wet southern ironstones.	Unlikely, habitat not present.	PMST
Caladenia excelsa	T/EN	Herb	White, grey, or brown sands, sandy loams, loam, clay, laterite, and granite. Hilltops, ridges, slopes, swales, and low plains in deep pale yellow or grey sandy soils.	Unlikely, due to degraded nature of the Site.	TPFL, WAHerb, NatureMap
Caladenia huegelii	T/EN	Herb	Grey or brown sand, clay loam. Current distribution confined to Dunsborough and north of Busselton.	Unlikely, due to degraded nature of the Site.	PMST
Gastrolobium papilio	T/EN	Shrub	Sandy clay over ironstone and laterite. Flat plains. Species is restricted to Hithergreen and Walsall area in Busselton.	Unlikely, habitat not present.	PMST
Drakaea micrantha	T/VU	Herb	White - grey sand.	Unlikely, habitat not present.	NatureMap, PMST
Netrostylis sp. Nannup (P.A. Jurjevich 1133)	P1	Sedge	Creeklines, valley floor, damp, and low-lying areas (Florabase).	Unlikely, habitat not present.	WAHerb, NatureMap
Andersonia sp. Echidna (A.R. Annels ARA 5500)	P2	Shrub	Grey over white sand (Florabase).	Unlikely, habitat not present.	WAHERB, NatureMap
Boronia sp. Leeuwin	P2	Herb	White sand, gravelly laterite. Seasonally swampy heaths. Known from populations in Augusta and Scott River region.	Unlikely, habitat not present.	TPFL, WAHerb, NatureMap
Gastrolobium whicherense	P2	Shrub	Red-grey sandy clay over quartzite. Steep westerly slopes.	Unlikely, habitat not present.	WAHerb, NatureMap
Leptomeria furtiva	P2	Shrub	Grey or black peaty sand. Winter-wet flats.	Unlikely, habitat not present.	WAHerb, NatureMap

Species	Conservation Status*	Life Form	Habitat / Known Distribution	Likelihood of occurrence within the Site	Data Source
Thysanotus sp. Badgingarra (E.A. Griffin 2511)	P2	Herb	Grey sand with lateritic gravel	Unlikely, habitat not present.	WAHerb, NatureMap
Xyris maxima	P2	Shrub	Seasonally wet black peaty sand -brown sandy loam, drainage flats.	Unlikely, habitat not present.	WAHerb, NatureMap
Acacia inops	P3	Shrub	Grey-Black peaty sand, clay, swamps, creeks. Grows along watercourses and swamps.	Unlikely, habitat not present.	WAHerb, TPFL, NatureMap
Boronia capitata subsp. *gracilis*	P3	Shrub	White/grey or black sand. Winter-wet swamps, hillslopes	Unlikely, habitat not present.	WAHerb, NatureMap
Caladenia abbreviata	P3	Herb	Sand, sand dunes	Unlikely, habitat not present.	TPFL, WAHerb, NatureMap
Chamaescilla gibsonii	P3	Herb	Clay to sandy clay, winter wet flats, shallow water-filled claypans.	Unlikely, habitat not present.	WAHerb, NatureMap
Cyathochaeta teretifolia	P3	Herb	Grey sand, sandy clay. Swamps, creek edges.	Unlikely, habitat not present.	WAHerb, NatureMap
Dampiera heteroptera	P3	Herb/ Shrub	Sandy - Grey sandy clay/grey-brown sandy loam soils. Swampy areas.	Unlikely, habitat not present.	WAHerb, NatureMap
Gastrolobium formosum	P3	Shrub	Clay brown loams, along river backs or in swamps.	Unlikely, habitat not present.	WAHerb, TPFL, NatureMap
Grevillea brachystylis subsp. brachystylis	P3	Shrub	Black sand/brown sandy loam/ sandy clay/white-grey clay sand. Seasonally inundated/swampy situations.	Unlikely, habitat not present.	WAHerb, NatureMap
Grevillea bronwenae	P3	Shrub	White -Grey sand over laterite/brown sand/loam, lateritic loams. Hillslopes, seasonally inundated/creekline areas. Known location <0.8km from the Site.	Unlikely, habitat not present.	WAHerb, NatureMap

Species	Conservation Status*	Life Form	Habitat / Known Distribution	Likelihood of occurrence within the Site	Data Source
Grevillea manglesioides subsp. ferricola	P3	Shrub	Red sandy clay over ironstone/gravelly grey, brown sandy loam/brown clay to sandy clay. Winter wet flats.	Unlikely, habitat not present.	WAHerb, NatureMap
Johnsonia inconspicua	P3	Herb	White-grey or black sand. Sedgeland and banksia or jarrah woodland. Low dunes, winter-wet flats.	Unlikely, habitat not present.	TPFL, WAHerb, NatureMap
Lasiopetalum laxiflorum	P3	Shrub	Grey-brown clayey loam occasionally over laterite/gravel	Unlikely, habitat not present.	WAHerb, NatureMap
Lepyrodia heleocharoides	P3	Herb	Moist peaty sand. Dry or seasonally inundated heath or woodland, swamps.	Unlikely, habitat not present.	WAHerb, NatureMap
Netrostylis sp. Blackwood River (A.R. Annels 3043)	P3	Sedge	Loam soil in damp and wet areas, in or adjacent to creeklines.	Unlikely, habitat not present.	WAHerb, NatureMap
Pimelea ciliata subsp. longituba	P3	Shrub	Grey sand over clay, loam.	Unlikely, habitat not present.	WAHerb, NatureMap
Pultenaea pinifolia	P3	Shrub	Loams or clay, floodplains, swampy areas.	Unlikely, habitat not present.	TPFL, WAHerb, NatureMap
Stylidium lowrieanum	P3	Herb	Sand or sandy loam over limestone. Eucalypt or Agonis woodland, forest, scrub.	Unlikely, habitat not present.	WAHerb, NatureMap
Synaphea decumbens	P3	Shrub	Sand over laterite.	Unlikely, due to degraded nature of the Site.	WAHerb, NatureMap
Acacia flagelliformis	P4	Shrub	Sandy soils and winter-wet areas.	Unlikely, habitat not present.	WAHerb, NatureMap
Acacia tayloriana	P4	Shrub	Grey or yellow/orange sandy soils, lateritic gravel, clay loam. Winter wet areas.	Unlikely, habitat not present.	WAHerb, NatureMap

Species	Conservation Status*	Life Form	Habitat / Known Distribution	Likelihood of occurrence within the Site	Data Source
Banksia sessilis var. *cordata*	P4	Shrub	White/grey sand. Coastal limestone.	Unlikely, habitat not present.	TPFL, WAHerb, NatureMap
Drosera fimbriata	P4	Herb	White/grey/black sand/ granite. Hillslope/flat	Unlikely, habitat not present.	WAHerb, NatureMap
Franklandia triaristata	P4	Shrub	Variable soil, brown-grey clay over white or grey sand, white /grey sand, or brown gravel soils common on slope but also found on flats. Known locations in Margaret River, east of Busselton, Nannup, and South of Bunbury.	Unlikely, due to degraded nature of the Site.	WAHerb, NatureMap
Gahnia sclerioides	P4	Sedge	Loam, sandy soils. Moist shaded situations.	Unlikely, habitat not present.	NatureMap
Gonocarpus pusillus	P4	Herb	Grey sandy clay. Winter wet swamps.	Unlikely, habitat not present.	WAHerb, NatureMap
Thysanotus isantherus	P4	Herb	Granite/ dry grey loam over laterite/ clay-loam on granite/ grey sand over gneiss. Jarrah/Marri woodland/ open mixed shrubland/heath.	Unlikely. Specimens from the area previously lodged as T *isantherus* have been confirmed to be T *tenellus*. T *isantherus* is currently only known from the south coast, with the closest record being approximately 280 km away at Bow Bridge.	WAHerb
Thysanotus glaucus	P4	Herb	White, grey, brown, or yellow sand, sandy gravel.	Unlikely, habitat not present and degraded nature of the Site.	TPFL, NatureMap

* BC Act: T = Threatened, P = Priority / EPBC Act: CR = Critically Endangered, EN = Endangered, VU = Vulnerable

4.3.2 Vegetation Communities

A relevé was completed within the only area of remnant vegetation on Site which has understorey vegetation (Figure 6 & 7, Appendix D).

During the Site assessment, vegetation within the relevé was observed to comprise of a single vegetation community (described according to Keighery, 1994, adapted Muir, 1977, and Aplin, 1979) (Figure 6):

- *Corymbia calophylla* (Marri) and *Eucalyptus marginata* (Jarrah) open forest.

The species identified within the relevé are characteristic of the Cowaramup Uplands (C2) vegetation complex as described by Havel and Mattiske (2000) as described in Section 4.1.3:

- Cowaramup Uplands (C2) - Open Forest of *Eucalyptus marginata* subsp. *marginata-Corymbia calophylla-Banksia grandis* on lateritic uplands in perhumid and humid zones.

The Site does not have characteristics of any Threatened Ecological Communities identified in the desktop analysis.

A full species list has been provided of those observed within the Site and along the road reserve along Sunset Drive (Appendix E). There were 17 naturally occurring flora species identified within the Site, with a total of 34 including the neighbouring road reserve.



Figure 6 Vegetation Community Map for Lot 102 Bussell Highway, Cowaramup

4.3.3 Vegetation Condition

Using the scale of condition developed by Keighery (1994, Table 4), vegetation within the Site and proposed cross overs was ranked from degraded to completely degraded (Figure 7).

Vegetation in Completely Degraded condition represents the greatest area of the Site at approximately 19.35 ha or 95.5% of the Site (Table 4, Figure 7). The structure of the vegetation is no longer intact and has been cleared and grazed of almost all native vegetation, with a few isolated trees remaining over sown pasture grass and weed species. The area is currently being used for cattle grazing.

An area of Degraded vegetation represents just under 5% of the total area surveyed at approximately 1.01 ha (Table 4, Figure 7). This area contains an area of remnant forest vegetation that has been largely cleared of native understory with a few native shrub and tree species remaining. This area is also currently being used for cattle grazing. Along with grazing from cattle and rabbits, other disturbance factors include past clearing, weeds, and logging. Weed species opportunistically observed in this area include two declared pests described below.

There were 31 introduced flora species, weeds, opportunistically observed while the Site and road reserve along Sunset Drive was walked (Table 5). Not all individual plants and weeds were recorded, and this number should be considered an underestimate. Abundance and density of these weeds were also not recorded. Of these species three are declared pests, *Asparagus asparagoides* (Bridal Creeper), *Orobanche minor (*Lesser Broomrape) *and Zantedeschia aethiopica* (Arum Lily). There are also two Weed of National Significance (WoNS), *Asparagus asparagoides* (Bridal Creeper) and *Genista monspessulana* (Cape Broom) (Government of Western Australia, 2023).

Table 4 Keighery Condition Scale (Keighery, 1994)

Category	Description	Area
Pristine	Pristine or nearly so, no obvious signs of destruction.	Not observed within the surveyed area.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. For example, damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle track.	Not observed within the surveyed area.
Very Good	Vegetation structure altered, No obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging, and grazing.	Not observed within the surveyed area.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate to it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback, and grazing.	0.13 ha, 0.62%
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration, but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback, and grazing.	1.11 ha, 5.37%
Completely Degraded	The structure of the vegetation in no longer intact and the area is completely or almost completely without native species. These areas are often described as “parkland cleared” with the flora composing weed or crop species with isolated native trees or shrubs.	19.44 ha, 94%

Table 5 Introduced flora species opportunistically identified within the Site and road reserve, including status (Government of Western Australia, 2023), ecological impact and invasiveness (DBCA, 2014).

Species Name	Common Name	Status[1]	Ecological Impact[2]	Invasiveness[2]
Acacia iteaphylla	Flinders Range wattle	N/A	Unknown	Rapid
Acacia longifolia	Sydney Golden Wattle	N/A	Unknown	Moderate
Acacia melanoxylon	Australian Blackwood	N/A	Medium	Slow
Arctotheca calendula	Cape Weed	N/A	Medium	Moderate
Asparagus asparagoides	Bridal Creeper	Declared Pest & WoNS	High	Rapid
Avena sp.	Oat species	N/A	High	Rapid
Briza maxima	Blowfly Grass	N/A	Unknown	Rapid
Cenchrus clandestinus	Kikuyu	N/A	High	Rapid
Chamaecytisus palmensis	Tagasaste	N/A	High	Rapid
Coprosma repens	Mirror Plant	N/A	Unknown	Moderate
Cotula turbinata	Funnel Weed	N/A	Unknown	Rapid
Cynodon dactylon	Couch	N/A	High	Rapid
Eucalyptus sp. (Planted)	N/A	N/A	N/A	N/A
Erodium sp.	Stork's-bill	N/A	Unknown	Moderate
Eryngium sp. (bonariensis)	Fleabane	N/A	Unknown	Rapid
Freesia sp.	Freesia	N/A	High	Rapid
Genista monspessulana	Cape Broom	WoNS	Unknown	Rapid
Hypochaeris radicata	Flat Weed	N/A	Medium	Rapid
Juncus microcephalus	South American rush	N/A	Low	Rapid
Lupinus sp. (angustifolius)	Lupin	N/A	Medium	Unknown
Mentha pulegium	Pennyroyal	N/A	High	Rapid
Olea europaea	Olive	N/A	High	Moderate
Orobanche minor	Lesser Broomrape	Declared Pest	Unknown	Rapid
Paspalum dilatatum	Paspalum	N/A	High	Rapid
Plantago (lanceolata)	Plantain	N/A	High	Unknown
Romulea rosea	Guildford Grass	N/A	High	Unknown
Rumex sp.	Dock	N/A	Unknown	Unknown
Solanum nigrum	Black Berry Nightshade	N/A	Unknown	Moderate
Sonchus sp.	Sowthistle	N/A	Medium	Rapid
Watsonia sp.	Bugle Lily	N/A	High	Moderate
Zantedeschia aethiopica	Arum Lily	Declared Pest	High	Moderate

[1] Western Australian Organism List (WAOL) for declared pests in WA as per Department of Primary Industries and Regional Development and Biosecurity and Agriculture Management Act 2007 (Government of Western Australia, 2023).
[2] Ecological Impact and invasiveness ratings as per Department of Parks and Wildlife Southwest Region Species Prioritisation Process (DBCA 2014).

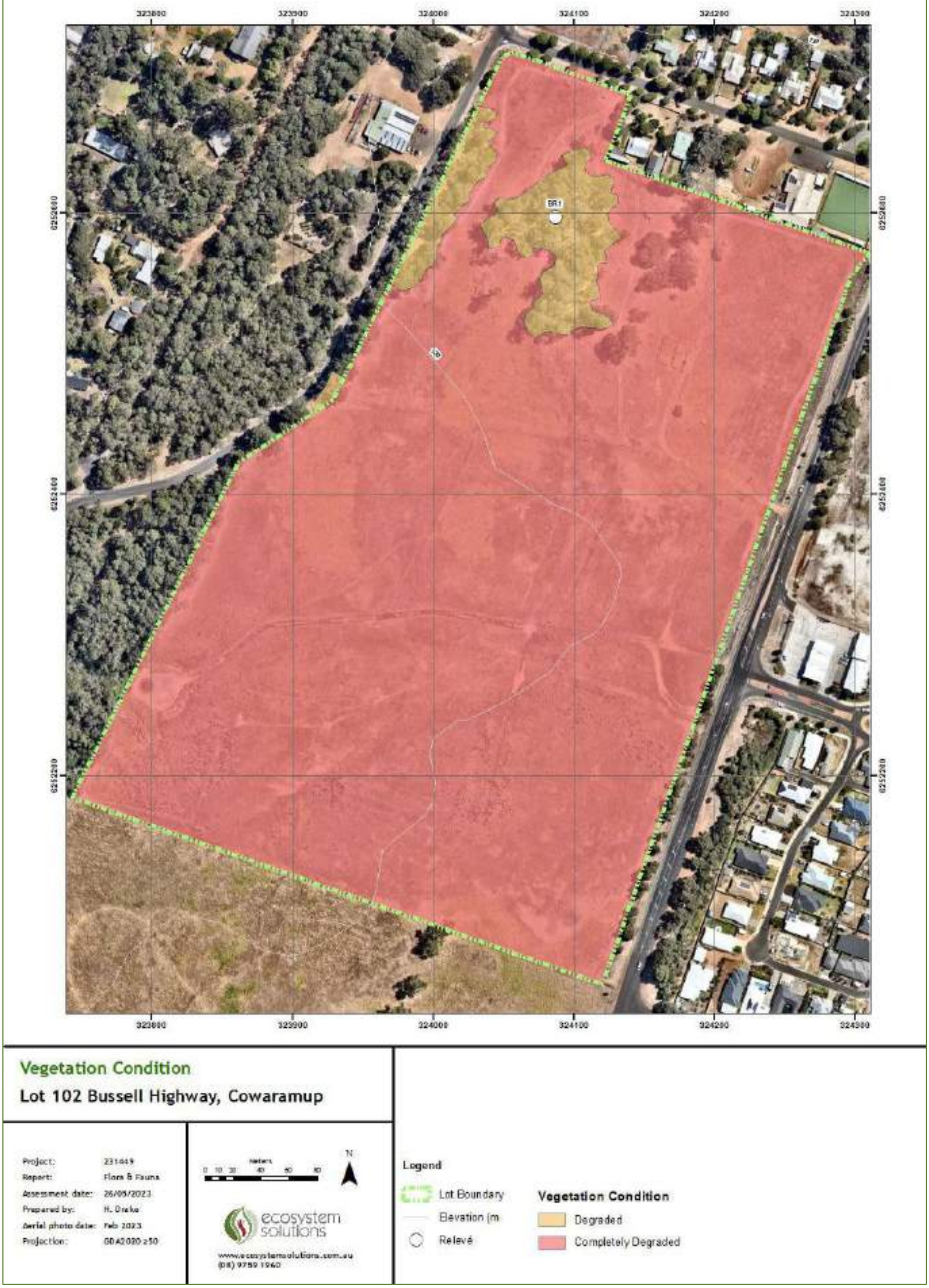


Figure 7 Vegetation Condition Map for Lot 102 Bussell Highway, Cowaramup

5 Fauna

5.1 Desktop Analysis

The conservation status of fauna within WA is determined by two acts of legislation, the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the State Western Australian Biodiversity Conservation Act 2016 (WA) (BC Act). The conservation codes for fauna under the BC Act are presented in Appendix C. These categories are consistent with the International Union for Conservation of Nature (IUCN) classifications and link into a global ranking system for taxa at risk of extinction.

A desktop study and analysis of the records of NatureMap and the Protected Matters Search Tool (Appendix A & B) were made to determine the presence or likely presence of fauna or fauna assemblages within the Site. The analysis primarily targeted terrestrial threatened vertebrate species listed under the Biodiversity Conservation Act 2016 (WA) and Environmental Protection Biodiversity Conservation Act 1999 (Commonwealth). A list of fauna expected to occur within a 10-kilometre radius of the Site was compiled from searches conducted on the DBCA database (NatureMap) and the Commonwealth EPBC Protected Matters Search Tool (Table 6).

Marine species and freshwater fish have been excluded due to the location of the Site. Invertebrates have also been excluded as this is a specialist area not covered under the Scope of this report.

The NatureMap Database identified eight Threatened (T) species, which are rare or are likely to become extinct, four Priority (P) listed species and one Conservation Dependent (CD) species within a 10 km radius of the Site. The Protected Matters Search Tool identified seven Threatened (T) species, within a 10 km radius of the Site. One of which is a Critically endangered (CR) species, four Endangered (EN) species and two Vulnerable (VU) species.

Review of the database searches and the expected vegetation communities and vegetation condition of the Site indicate the conservation significant fauna species likely to be within or utilising the Site include *Pseudocheirus occidentalis* (Western Ringtail Possum). The three Black Cockatoo species, *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo), *Zanda baudinii* (Baudin's Cockatoo) and *Zanda latirostris* (Carnaby's Cockatoo) or habitat of the species are also likely to occur within the area.

Other conservation significant fauna may use the Site however these have not been specifically targeted under the scope of this report.

Table 6 Conservation significant fauna species recorded within 10 km of the Site.

Species	Conservation Status*	Habitat	Likelihood of occurrence within the Site	Data Source
Pseudocheirus occidentalis Western Ringtail Possum	T/CR	Coastal Areas of Peppermint woodland and peppermint woodland and peppermint / tuart associations.	Likely.	PMST Naturemap
Bettongia penicillata ogilbyi Woylie	T/EN	Open forest and woodland with low understory of woody scrub. Woodlands and adjacent heaths with a dense understorey of shrubs. Tall eucalypt forest and woodland, dense myrtaceous shrubland, kwongan or mallee heath.	Unlikely, habitat not present.	PMST Naturemap
Botaurus poiciloptilus Australasian Bittern	T/EN	Wetlands with tall, dense vegetation, favours permanent and seasonal freshwater habitats, dominated by sedges rushes and reeds, growing over a muggy or peaty substrate.	Unlikely, habitat not present.	PMST
Psophodes nigrogularis nigrogularis *Western Heath Whipbird*	T/EN	Occurs in heath-like thicket associations on coastal dunes and in low, dense mallee woodland or shrubland with understorey of dense, stunted shrubs. Preferred habitat is thicket, 2-3m high of varied floristic composition.	Unlikely, habitat not present.	Naturemap
Zanda baudinii (Listed as *Calyptorhynchus baudinii*) Baudin's Cockatoo	T/EN	Dense Jarrah, Karri, and Marri forests. Species nest in large hollows in these species.	Likely.	PMST Naturemap
Zanda latirostris (Listed as *Calyptorhynchus latirostris*) Carnaby's Cockatoo	T/EN	Dense Jarrah, Karri, and Marri forests. Species nest in large hollows in these species.	Likely.	PMST Naturemap
Calyptorhynchus banksii naso Forest Red-tailed Black Cockatoo	T/VU	Dense Jarrah, Karri, and Marri forests. Species nest in large hollows in these species.	Likely.	PMST Naturemap
Dasyurus geoffroii Western Quoll, Chuditch	T/VU	Variety, most dense in riparian jarrah forests. Require large, unfragmented habitats.	Unlikely, habitat not present.	PMST Naturemap
Setonix brachyurus Quokka	T/VU	Mainly dense riparian vegetation, other areas with dense vegetated understory with proximity to freshwater.	Unlikely, habitat not present.	Naturemap

Species	Conservation Status*	Habitat	Likelihood of occurrence within the Site	Data Source
Hydromys chrysogaster Rakali	P4	Found near permanent fresh or brackish waters.	Unlikely, habitat not present.	Naturemap
Isoodon fusciventer Quenda	P4	Forest, woodland, shrub, and heath, usually in sandy soils with dense healthy vegetation in lower stratum.	Possible within road verge, unlikely within the Site due to lack of understorey.	Naturemap
Falsistrellus mackenziei Western False Pipistrelle, Western Falsistrelle	P4	Wet sclerophyll forests of Karri, Jarrah, and Tuart eucalypts. Roost in hollows in old trees, branches, and stumps.	Unlikely, habitat not present.	Naturemap
Notamacropus irma Western Brush Wallaby	P4	Some areas of mallee and heathland. Uncommon in wet sclerophyll forests.	Unlikely, habitat not present.	Naturemap
Phascogale tapoatafa subsp. *wambenger* South-western Brush-tailed Phascogale	CD	Highly arboreal, prefers open forest with sparse groundcover.	Possible.	Naturemap

* BC Act: T = Threatened, P = Priority; CD = Conservation Dependent / EPBC Act: Cr = Critically Endangered, EN= Endangered, VU = Vulnerable

5.2 Survey Method

Ecosystem Solutions conducted a Level 1 fauna survey, consistent with the EPA's Technical Guidance: Terrestrial Fauna Surveys (2020). This method specifies a minimum requirement of a desktop study to gather information on the subject site and a reconnaissance survey to verify the accuracy of the background study and delineate fauna and faunal assemblages.

This survey has minimal impact on the fauna within the property and provides sufficient data on the presence and relative abundance and distribution of taxa. During the field surveys, the habitat within the survey area was assessed to determine its potential suitability to host any of the anticipated threatened or rare species.

With the species in Table 6 in mind, the survey method included the following:

- Satellite Image of the Site was acquired.
- Direct observations of fauna and signs of fauna were recorded using a Trimble Global Positioning System (GPS) and ArcPad© (Version 8- ESRI). Field observations were analysed and mapped with ArcGis (ArcMap V10.6.1©).
- **Roosting survey:** two dawn and two dusk surveys were completed, to record observations of any Black Cockatoos as they leave from or return to roost sites.

  For dawn surveys the Site was attended at least one hour prior to sunrise and monitored for a minimum of two hours. For dusk surveys the Site was attended at least one hour prior to sunset and monitored for a minimum of two hours. The total time allocated for this targeted search is a minimum of eight hours over four days, which aligns with the recommended survey effort for Black Cockatoos (Department of the Environment, Water, Heritage, and the Arts, 2017). This survey ensures optimal opportunity to observe flocks leaving or returning to roost.

  The Site was monitored for birds and their calls using audio and visual observations. Potential roosting trees were inspected via a physical inspection for hollows or signs of Black Cockatoo usage. A flock count was conducted of any observed roost sites.
- **Nocturnal survey:** a spotlight survey was conducted while walking through the Site to detect nocturnal species. This occurred over two non-consecutive nights, post sunset until after or close to last light with a total survey time of approximately 8 hours. The canopy of trees was rigorously observed for eye shine to detect fauna with a spotlight and head torch. The presence of Western Ringtail Possums or any other conservation listed species was recorded. A 40 w LightForce hand-held spotlight was used with white light to observe nocturnal mammals. Observations were recorded using GPS and ArcPad©.

Non-consecutive nocturnal surveys are conducted to better understand the extent of the Western Ringtail Possum home range, as an individuals may stay in close proximity for a few nights if particularly good foraging habitat is present.

- **Habitat tree survey**: recorded all suitable hollow bearing trees, deemed as those greater than 30 cm DBH, recorded with a GPS, noting the tree species, height and presence or likelihood of hollows. A broad assessment of tree health including signs of plant disease has also been made.

  All hollows were inspected for any signs of use by Black Cockatoos. These include wear around the hollow, chewing, scarring and scratch marks on the trunks or branches. Old or recent evidence of cockatoo's feeding or roosting sites (feathers, droppings etc.) were also searched for with an assessment of potential hollows recorded.

  Not all hollows recorded will be suitable for use by Black Cockatoos. The entrance to a hollow must be a minimum diameter of at least 100 mm to be suitable for Black Cockatoo species (Saunders, 1982) and between 2-10m in height, with an average between 5-7m (Saunders, 1979).

  Tree hollows can also be used as rest sites by Western Ringtail Possums and other species, their potential use was also noted. Tree hollows are important across the range of the species and hollow abundance has been positively correlated with possum abundance (Department of Parks and Wildlife, 2014). In the Jarrah Forest, tree hollows can comprise more than 70% of the rest sites.

- **Habitat assessment**: a day survey was completed to record the presence of flora known to be foraging species for Western Ringtail Possums and Black Cockatoos, with an assessment of area and quality of vegetation. Actual foraging evidence observed or any other secondary signs of fauna (e.g., scats, diggings, dreys, nests, burrows, feeding signs) were noted.

  The Black Cockatoo foraging quality assessment score has been determined based on methodology provided in the Referral Guideline for three WA threatened black cockatoo species (Appendix H) (DAWE, 2022).

- The survey's protocol is also consistent with the requirements outlined in the Development Planning Guidelines for Western Ringtail Possums (CALM 2003, now DBCA).

- The referral guidelines for the three threatened black cockatoo species (Department of Agriculture, Water and The Environment, 2022) outline requirements for appropriate level of surveys for these species. This survey's intensity and design comply with these guidelines.

5.3 Results

The Site was surveyed for fauna over one day, two dusk and two-night surveys from May to July 2023 by staff members from Ecosystem Solutions (Table 7).

Kelly Paterson (B.Sc. Hons. Nat Rs Mgmt.), Dani Cuthbert (Dip Bus & Dip TM) and Hayley Drake (B.Sc. Cons & Wildlife Bio and Molecular Bio) conducted a day survey on the 25 May 2023. The Site was traversed in a systematic manner, focussing on the vegetated areas. Dawn and dusk surveys were conducted by Gary McMahon (B.Sc. M. Env Mgmt., PG Dip Bushfire CEnvP) and Dani Cuthbert for any sign of Black Cockatoos, Western Ringtail Possums or other conservation listed species, as described in Table 7.

Table 7 Fauna survey times and observations

Survey Type	Personnel	Date and Time	Sunrise / Sunset Time	Observations
Day	KP, DC & HD	25 May 2023	N/A	No animals of conservation significance were directly observed; however, signs were identified. Multiple scats were observed in two locations within the Site. Two potential dreys were also observed at other locations within the Site. Marked *Corymbia calophylla* nuts were observed within the Site and along the road reserve along Sunset Drive. Non-conservation significant fauna observed within the Site include *Barnardius zonarius* (Australian Ringneck), *Cracticus torquatus* (Grey Butcherbird), *Gymnorhina tibicen* (Magpie), *Phylidonyris novaehollandiae* (New Holland Honeyeater). Rabbit scats were also observed.
Dawn #1	DC	27 June 2023 6:00 am to 8:15 am	First Light 6:57 am Sunrise 7:25 am	7.10 am - Cockatoos heard to the north west of the Site. 7.15 am - Cockatoos heard to the north of the Site. No significant fauna observed within the Site. Other fauna observed includes Magpies, Kookaburra and Rabbits.
Dawn #2	DC	28 June 2023 6:00 am to 8:15 am	First Light 6:57 am Sunrise 7:25 am	No Black Cockatoos or other significant fauna observed.

Survey Type	Personnel	Date and Time	Sunrise / Sunset Time	Observations
Dusk/Nocturnal #1	GM	20 July 2023 4:27 pm to 8:20 pm	Sunset 5:31 pm Last light 5:58 pm	7:40 pm – No WRP observed within the Site. One WRP observed in a tree within the neighbouring property to the north. No Black Cockatoos or other significant fauna observed.
Dusk/Nocturnal #2	GM	23 July 2023 4:30 pm to 8.00 pm	Sunset 5:33 pm Last light 6:00 pm	No WRP, Black Cockatoos or other significant fauna observed.

While no other animals of conservation significance were observed, either directly or through signs, the lack of this data should not be taken directly as an indication that those species are absent from the Site.

5.3.1 Black Cockatoos

The Site is located within the South Coast, Region 4, as defined by the Referral Guidelines for the three Black Cockatoo Species (DAWE, 2022). This region supports Jarrah (*Eucalyptus marginata*) Marri (*Corymbia calophylla*) Forest as well as Karri (*E. diversicolor*) and areas of low heath. Foraging resources are available for all three Black Cockatoo species. The region also includes critical breeding habitat for Carnaby's Cockatoo and Baudin's Cockatoo.

The surveys occurred within the South Coast foraging period for all three Black Cockatoo species and the breeding period for Forest Red-tailed Black Cockatoo.

During the day survey there was one location within the Site where secondary signs, distinctively marked Marri nuts, of Black Cockatoos were observed (Figure 9) Two other locations of marked Marri nuts was also observed within the road reserve along Sunset Drive that was also surveyed (Figure 9). No Black Cockatoos were observed within the Site during the dawn and dusk surveys. During the first dawn survey (Table 7) Black Cockatoos were heard from the north and northwest of the Site, however not from within the Site itself. This suggests that Black Cockatoos are utilising the area, however they are not currently utilizing the Site for roosting.

Habitat trees on the Site that had a diameter at breast height (DBH) over 30 cm and have the potential to be suitable to support nesting of Black Cockatoo species were recorded. A total of 141 habitat trees with a DBH over 30 cm were observed within the Site and within the proposed Sunset Drive crossover, concentrated in the north western corner, (Figure 10 & Appendix F) of which:

- 139 of the habitat trees recorded are within the Site and the other two trees are within the road reserve, within the proposed Sunset Drive crossover. It should be noted that the number of trees in

the Arborist report will not be consistent with the habitat trees, as there were additional trees within the Site that were species not suitable for forming hollows, or with a DBH of less than 30 cm.

- One tree had a hollow observed, however this was too small for use by Black Cockatoos. The remaining trees were not observed to have hollows.
- 134 trees are Marri (95%), two trees are Jarrah (1.4%), five trees are dead (3.5%).
- Four trees were showing some signs of stress (1.87%), potential plant disease, with dead and senescing observed of some branches.

The vegetated areas of the Site are suitable foraging habitat for Black Cockatoos, containing Marri and Jarrah vegetation, which is the primary food source for Baudin's and Forest Red-tailed Black Cockatoos.

The Site abuts the Wadandi track and other small areas of remnant native vegetation to the west. Vast expanses of forest are available within the Leeuwin Naturaliste National Park, located approximately 6km to the west, as well as State Forest blocks to the east and south, representing suitable foraging habitat for all three Black Cockatoo species. There have been no identified Black Cockatoo breeding sites within the surrounding area (DBCA-063). The Site is within the buffer of two known Black Cockatoo roosting sites (DBCA-064).

The foraging quality scoring assessment is summarised in Table 8. The Site has a foraging quality score of 10 for all three Black Cockatoo species. This is the highest foraging score obtainable.

Table 8 Foraging quality scoring assessment (DAWE, 2022)

Attribute	Baudin's	Carnaby's	Forest Red-tailed
Starting score	**10**	**10**	**10**
Foraging potential	The Site represents foraging habitat and signs of feeding debris were observed. **Score - No change**	The Site represents foraging habitat and signs of feeding debris were observed. **Score - No change**	The Site represents foraging habitat and signs of feeding debris were observed. **Score - No change**
Connectivity	There is suitable foraging habitat within 12km of the Site. Including pockets of remnant vegetation and areas under conservation such as North East Margaret River State Forest, Leeuwin-Naturaliste National Park, and Wooditjup National Park. **Score - No change**	There is suitable foraging habitat within 12km of the Site. Including pockets of remnant vegetation and areas under conservation such as North East Margaret River State Forest, Leeuwin-Naturaliste National Park, and Wooditjup National Park. **Score - No change**	There is suitable foraging habitat within 12km of the Site. Including pockets of remnant vegetation and areas under conservation such as North East Margaret River State Forest, Leeuwin-Naturaliste National Park, and Wooditjup National Park. **Score - No change**
Proximity to breeding	The distribution map (Map 2 DAWE, 2022) for the species shows the Site is within the known breeding range for Baudin's. **Score- No change**	The distribution map (Map 3, DAWE, 2022) for the species show the Site is within the breeding range for Carnaby's. **Score - No change**	The distribution map (Map 4, DAWE 2022) for the species shows the Site is within a likely to occur for Forest Red-tailed. **Score- No change**
Proximity to roosting	The distribution map (Map 2 DAWE, 2022) show the Site is within the known range for Baudin's. However, no roosting sites data publicly available for the species. **Score- No change**	The distribution map (Map 3, DAWE, 2022) show the Site is within the known range for Carnaby's. There are 34 roosting sites (buffered) within 20km of the Site, with two roost site buffers overlapping the Site (DBCA-064). **Score - No change**	The distribution map show (Map 4, DAWE 2022) the Site is within a likely to occur for Forest Red-tailed. However, no roosting sites data publicly available for the species. **Score- No change**
Impact from significant plant disease	Only minor evidence of plant disease observed within the Site. **Score - No change**	Only minor evidence of plant disease observed within the Site. **Score - No change**	Only minor evidence of plant disease observed within the Site. **Score - No change**
Total score	**10**	**10**	**10**
Appraisal	The Site includes only scattered *Corymbia calophylla* and *Eucalyptus marginata* in a degraded condition. There are other larger areas of more suitable foraging habitat within proximity to the Site. No evidence was able to be provided to suggest that the Site is more than 12 km for breeding habitat or 20km from known roosting sites. However, data availability is limited.		

5.3.2 Western Ringtail Possums

The Site is located within the known distribution for Western Ringtail Possums, as shown by the Western Ringtail Possum (*Pseudocheirus occidentalis*) Recovery Plan (Department of Parks and Wildlife, 2014). DBCA database records include a record from the road verge directly adjacent to the Site from 2019. The Site is outside the three key management areas, being located south west of the Swan Coastal Plain key management area. According to Shedley & Williams (2014) there are scattered occurrences of Western Ringtail Possums around Margaret River, with lower density populations associated with Jarrah and Marri Forest.

An assessment of habitat for the Western Ringtail Possum on the southern Swan Coastal Plain (Binningup to Dunsborough) by Shedley & Williams (2014) aims to identify and classify habitat that would support viable populations of Western Ringtail Possums according to soil landscape and vegetation. The area of proposed clearing and modification is predominately in Cowaramup flats phase (216CoCO1) with a habitat quality score of 3 (out of 6 classifications) which is defined as having medium habitat suitability and expected density of 2-5 Western Ringtail Possums per hectare.

There are two potential dreys and multiple scats (secondary signs) of Western Ringtail Possums recorded during the day survey (Figure 8 & 9). As Western Ringtail Possums reside in tree hollows as well as dreys, the habitat tree survey, shown in Figure 10 and discussed in section 5.3.1, can be used to determine potential rest sites and habitat for Western Ringtail Possums. Three trees were observed to have hollows (One deemed potential and two considered unsuitable for Black Cockatoos) that may represent rest sites for Western Ringtail Possums (Figure 10).

Only one Western Ringtail Possum was observed during the first nocturnal survey. The Western Ringtail Possum was within the neighbouring property, 20 Memorial Drive, Cowaramup, in a tree along the lot boundary of the Site (Figure 9).

Western Ringtail Possums predominately forage on the leaves of myrtaceous plants, being Peppermint, Marri and Jarrah and a range of shrub species (Department of Parks and Wildlife, 2014). All vegetated areas of the Site represent suitable foraging habitat for Western Ringtail Possums.

Western Ringtail Possums have an approximate home range of less than 5 hectares and approximately 2.7 hectares in the Jarrah Forest (Wayne *et al.*, 2005). Due to the fragmented nature of the Site, it is likely that the survey area is part of their home range and is connected to areas which contain much larger areas of remnant vegetation.

While the Site is outside the Swan Coastal Plain, it can be considered Area 3 – Supporting habitat according to the Significant Impact Guidelines for Western Ringtail Possums on the Swan Coastal Plain (Department of the Environment, Water, Heritage, and the Arts, 2009). A significant impact is deemed possible if the clearing is greater than 0.5 ha.



Figure 8 *Scat observed underneath canopy of Agonis flexuosa clump on Site*

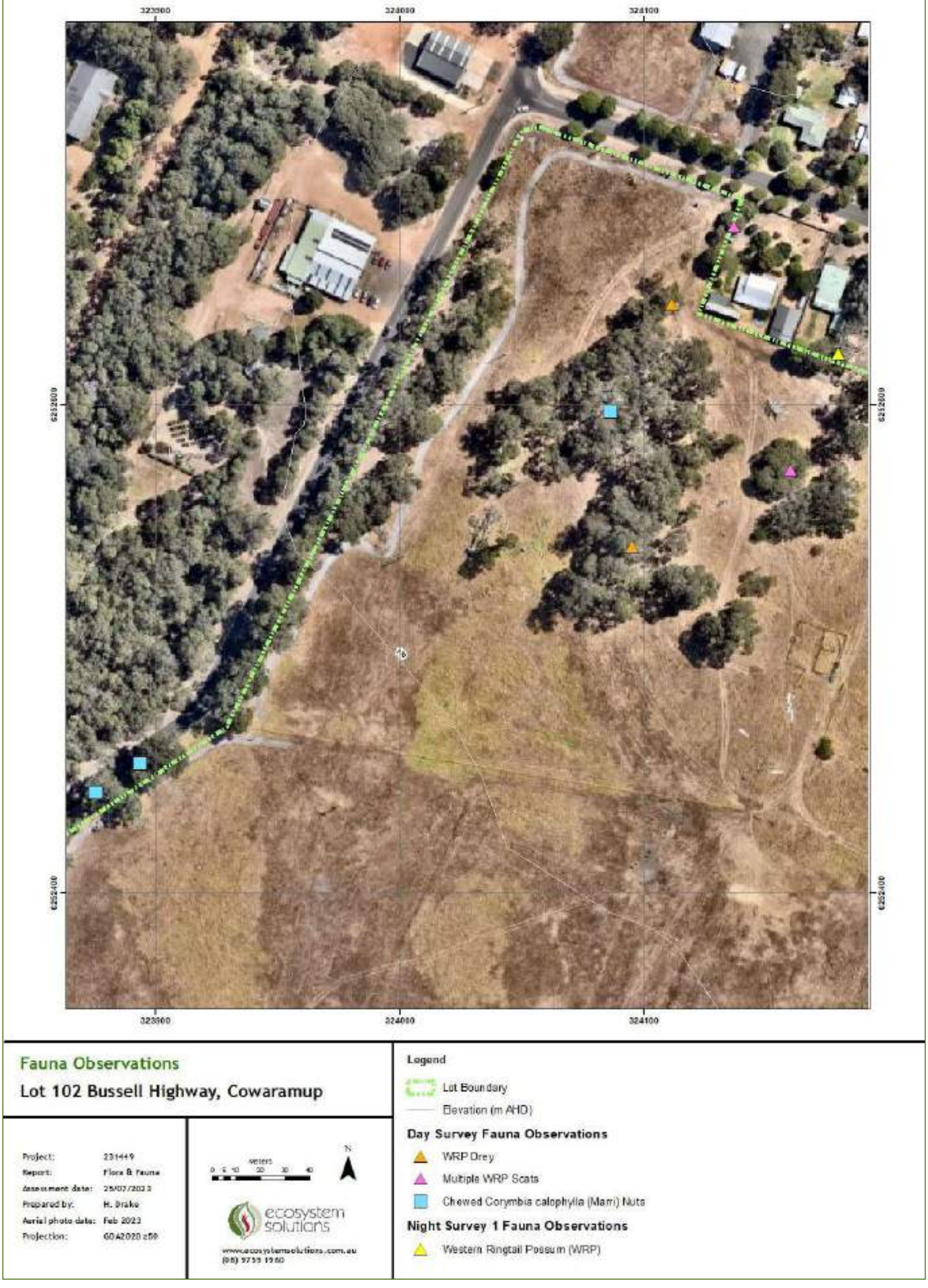


Figure 9 Fauna Observations Map for Lot 102 Bussell Highway, Cowaramup



Figure 10 Habitat Trees Map for Lot 102 Bussell Highway, Cowaramup

6 Proposed Vegetation Management

The total area of remnant vegetation within the Site is currently just under 1.2 ha in size. The proposed subdivision concept has been designed to retain areas of natural vegetation within the development within public open space. Other areas will be modified to Asset Protection Zone standards as required under the Bushfire Management Plan, with the largest and healthiest trees retained. Small areas will require clearing of all native vegetation to facilitate roads, residential dwellings, and other infrastructure. The Tree Clearing Plans below detail the trees within the Site that will be retained, those that may require removal and those that are proposed to be cleared as part of this development (Figures 11 & 12).

The proposed vegetation management across the remnant vegetation of the Site is illustrated spatially in Figure 13 below. A summary of the areas for each proposed management are provided in Table 9.

Table 9 Areas of proposed management of remnant vegetation at Lot 102 Bussell Highway, Cowaramup

Type of modification	Area (ha)
Retention	0.39
Modification	0.67
Clearing	0.13
Total	1.19



Figure 11 Tree Clearing Plan for Lot 102 Bussell Highway, Cowaramup



Figure 12 Tree Clearing Plan for Lot 102 Bussell Highway, Cowaramup – Sunset Drive Crossover



Figure 13 Proposed management of remnant vegetation at Lot 102 Bussell Highway, Cowaramup

7 Survey Constraints

Survey limitations are summarised in Table 9 and 10 below:

Table 10 Summary of flora survey limitations

Constraint	Impact	Comment
Availability of contextual information at a regional and local scale	Nil	Broad scale vegetation and soil mapping data were available. DBCA, NatureMap and PMST database extracts for conservation significant flora and ecological communities were obtained. A search of relevant databases also occurred.
Competency / experience of the survey team	Nil	The ecologist leading the field survey has conducted numerous flora surveys across the southwest of WA and has over 10 years' experience. The ecologist completing the flora identifications has over 10 years' experience identifying Western Australian flora, specialising in southwest flora. Any potential conservation significant flora have been submitted to the Western Australian Herbarium for identification.
Proportion of flora recorded and/or collected, any identification issues	Nil	A focus was placed on identifying any potential conservation significant flora species, with these collections all identified to species level. Specimens that were not potentially conservation significant species have been identified to genus level, or species where this can be easily ascertained.
Was the appropriate area fully surveyed (effort and extent)	Nil	One relevé was conducted within the only remaining area of remnant vegetation on the Site which contained an understorey. Other remnant vegetation included scattered trees only. All areas of remnant vegetation were surveyed on foot for Conservation Significant vegetation communities and flora species.
Access restrictions within the survey area	Nil	All parts of the Site were accessible by vehicle and foot.
Survey timing, rainfall, season of survey	Moderate	The survey was conducted in Autumn which is not the optimal time to observe all conservation significant flora species. Given the heavily grazed and modified nature of the remnant vegetation, it is considered unlikely that any conservation significant flora species will be located within the survey area.
Inconsistent flowering habit of some species	Moderate	Some species do not flower every season and may require environmental triggers to promote flowering such as rainfall, fire, presence of suitable pollinators etc.

Constraint	Impact	Comment
Disturbance that may have affected the results of the survey, such as fire, flood or clearing	Nil	There were no recent disturbances that constrained the survey of the Site.

Table 11 Summary of fauna survey limitations

Constraint	Impact	Comment
Availability of data and information	Nil	DBCA, NatureMap and PMST database extracts for conservation significant fauna were obtained.
Competency / experience of the survey team, including experience in the bioregion surveyed	Nil	The ecologist leading the field surveys has conducted numerous fauna surveys across the southwest of Western Australia and has over 20 years' experience.
Scope of the survey, e.g., where faunal groups were excluded from the survey	Minor	This survey focussed on birds, mammals, and other vertebrate species. Aquatic species were not included as habitat was not present. Invertebrates were not included in the scope of this survey.
Timing, weather, and season	Minor	The surveys were conducted in Autumn, with September being an optimum time for bird and mammal surveys in the southwest. Weather conditions did not impact surveys.
Timing Western Ringtail Possums (WRP) may arise from rest sites & likelihood of rest sites being located outside the Site	Moderate	As WRP use up to 2-7 rest sites at any one time and up to 20 throughout the year there is potential that they are not observed on Site at the time of survey, even though they are utilising the Site. The time WRP arise from a rest Site is also variable and may prevent WRP being observed during survey.
Disturbance that may have affected results, e.g., fire, flood	Nil	There were no disturbances that constrained the survey of the Site.
The proportion of fauna identified, recorded, or collected	Nil	Any potential conservation significant fauna species observed during the surveys have been identified.
Determination of hollow suitability from the ground	Nil	Factors including entrance size, hollow depth, floor, and orientation of the hollow are important factors to nesting hollow suitability and which are difficult to assess from the ground. Therefore, there is potential for the number of hollows recorded to be an over estimation of those suitable as nesting hollows.
Adequacy of the survey intensity and proportion of survey achieved, e.g., the extent to which the area was surveyed	Nil	All areas of remnant vegetation of the Site were surveyed on foot for Conservation Significant fauna species, during day, dawn, and dusk / nocturnal surveys.

Constraint	Impact	Comment
Access problems	Nil	All parts of the Site were accessible by vehicle and foot.

8 Significance

The EPBC Act considers matters of 'National Environmental Significance', including species listed as threatened (including critically endangered, endangered, and vulnerable categories). The Act also considers actions that may have any potential negative impacts on Matters of National Significance. These are referred to as 'Significant Impacts'.

A proposal that is likely to result in a 'Significant Impact' to a threatened species has been determined against the following guidelines for Black Cockatoos and Western Ringtail Possum:

- Matters of National Environmental Significance – Significant impact guidelines 1.1 *Environmental Protection and Biodiversity Conservation Act 1999*, Australian Government, Department of Environment, 2013.
- Referral guidelines for 3 WA threatened black cockatoo species: Carnaby's Cockatoo (*Zanda latirostris)*, Baudin's Black Cockatoo (*Zanda baudinii)* and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii* subsp. *naso),* Department of Agriculture, Water, and the Environment (DAWE), 2022.
- Significant impact guidelines for the vulnerable Western Ringtail Possum (*Pseudocheirus occidentalis*) in the southern Swan Coastal Plain, Western Australia, nationally threatened species, and ecological communities, EPBC policy statement 3.10, Department of Environment, Water, Heritage, and the Arts, 2009[3]

Table 12 and Table 13 discuss the referral triggers and the likely impact on Black Cockatoos and Western Ringtail Possums respectively.

[3] The Site is outside the Swan Coastal Plain and there are no relevant referral guidelines for the survey area in relation to Western Ringtail Possums. It is noted that this document includes the previous listing of Vulnerable for the species instead of the current listing of Critically Endangered.

Table 12 Referral thresholds for Black Cockatoos

Attribute	Referral threshold & Reason	Threshold triggered by this proposal?
Breeding	**Threshold:** Any loss of / impact upon known, suitable or potential nesting trees, and the habitat around these trees, is highly likely to require a referral to the minister. **Reason:** Clearing of breeding habitat is a known threat to the three species[a] as a lack of tree hollows is a limiting factor. Habitat loss, habitat degradation, lack of recruitment, fire and competition are causing the scarcity of nesting resource[b].	**There is minimal impact expected.** The Site includes trees with hollows which are either not suitable for Black Cockatoos or there is no evidence of use. A total of 141 trees had a DBH greater than 30 cm, of these: • 1 had hollows, but they were unsuitable and • 140 trees were recorded to have adequate DBH but no hollow/s. The number of the trees could be retained, including within areas of Public Open Space, the road reserve and within private lots. A focus should be placed on retaining the largest and healthiest of the potential nesting trees. The final number of trees that will require removal will be determined at subdivision stage. Although only minimal impact is expected, the loss or impact to any potential nesting tree (with DBH >500mm) is highly likely to require referral to the minister.
Night roosting habitat	**Threshold:** Removal of any part of a known night roosting site is likely to require referral to the minister. **Reason:** Clearing of night roosting habitat is a known threat to the three species.	**There is minimal impact expected.** Night roosting was not observed within the Site or within the road reserve along Sunset Drive.
High-quality native	**Threshold:** Loss of greater than or equal to **1 ha** of foraging habitat scoring 5-10 using the foraging quality scoring tool is likely to require	**There is minimal impact expected.** The area of vegetation within the survey area that is proposed to be

Attribute	Referral threshold & Reason	Threshold triggered by this proposal?
foraging habitat	referral to the minister. Foraging habitat quality is determined using the foraging quality scoring tool (Appendix H) and considers context i.e., proximity of the impact site to important attributes. **Reason**: Clearing of foraging habitat is a known threat to the three species. Habitat loss, habitat modification, climate change and fire are increasingly causing the scarcity of foraging resources. These resources are critical at all stages of life for the species.	cleared or managed is high-quality foraging habitat, with a score of 10 for all three species. The total amount of clearing and modification required under this proposal is expected to be 0.8 ha or less, as a substantial amount of the existing remnant vegetation will be retained within Public Open Space or the existing road verges. If the amount of vegetation clearing or modification increases to over 1 ha of high quality foraging vegetation, it is likely to require referral to the minister.
Lower-quality native foraging habitat	**Threshold:** Loss of greater than or equal to 10 ha of foraging habitat scoring 0-4 using the foraging quality scoring tool is likely to require referral to the minister. Foraging habitat quality is determined using the foraging quality scoring tool (Appendix H) and takes into account context i.e., proximity of the impact site to important attributes. **Reason**: Clearing of foraging habitat is a known threat to the three species. Habitat loss, habitat modification, climate change and fire are increasingly causing the scarcity of foraging resources. These resources are critical at all stages of life for the species.	**Not applicable.** There is no lower quality foraging habitat recorded within the survey area on the Site.
Exotic foraging habitat	**Threshold:** Loss of greater than or equal to 1 ha of predominantly exotic habitat (e.g., Cape Lilac trees and pine trees) known to be utilised by black cockatoos is likely to require a referral to the minister.	**Not applicable.** There is no loss of exotic habitat on the Site.

Attribute	Referral threshold & Reason	Threshold triggered by this proposal?
	Reason: Clearing of exotic foraging habitat is a known threat to the three species, noting that its value in comparison to native habitat depends upon the context	
A referral under the EPBC Act is likely to be required, as there is proposed removal of potential nesting trees (DBH >300mm).		

Table 13 Actions likely to have a significant impact on Western Ringtail Possums

Actions likely to have a significant impact	Is this action likely under this proposal?
Clearing in a remnant habitat patch that is greater than 0.5 hectares in size.	**There is no significant impact expected.** The total amount of clearing for this proposal will be 0.8 ha or less, however of this 0.38 will be modified to Asset Protection Zone standards, with the biggest and healthiest trees retained. Only 0.42 ha is proposed to be completely cleared, which is under the referral threshold, and therefore referral is not recommended.
Clearing of more than 50% of a remnant patch that is between 0.1 and 0.5 ha (Core habitat/Primary corridors) or 0.2 and 0.5 ha in size (Supporting Habitat).	**There is no significant impact expected.** The Site is considered to be Supporting Habitat and is connected to areas which contain much larger areas of remnant vegetation, and is well under 50% of the total remnant patch.
Fragmentation of existing habitat linkages[4].	**There is no significant impact expected.** This proposal will not cause significant fragmentation, due to the areas of remnant vegetation around the Site.
A referral under the EPBC Act is not recommended for this Site as less than 0.5 ha of habitat is proposed to be cleared as part of this proposal. If the area of proposed clearing becomes greater than 0.5 ha, referral may be required.	

[4] Habitat linkage means any continuous native or exotic vegetation that allows animals to move between areas. These can be as fine scale as canopy cover between neighboring trees.

9 Conclusions and Recommendations

9.1 Conservation Significant Flora

- There were no Threatened Flora or conservation significant flora identified within the Site.
- A spring flora survey has not been conducted, however due to the degraded nature of the Site it is highly unlikely that any conservation significant flora are present.
- A referral under the EPBC Act is not recommended.

9.2 Vegetation

- There were no Threatened Ecological Communities observed within the Site.
- Just under 1.2 ha of remnant vegetation remains within the Site.
- One vegetation complex was identified - Cowaramup Uplands (C2) which is described as open forest of *Eucalyptus marginata* subsp. *marginata*, *Corymbia calophylla*, *Banksia grandis* on lateritic uplands in peri humid and humid zones.
- Completely degraded vegetation represents the greatest area of the Site at 19.35 ha or 95.5% of the Site (Figure 7). This area has been cleared of almost all native vegetation with a few isolated trees remaining over sown pasture grass species. The Site is currently being used for grazing. An area of degraded vegetation represents just under 5% of the total Site at 1.01 ha. It is intended that Public Open Space will retain some areas of this vegetation.
- 31 introduced flora species, weeds, were opportunistically observed while surveying the Site and road reserve.
- The subdivision concept plan has been designed to retain approximately 0.39 ha of the remnant vegetation, with an additional 0.38 ha also retained, but in a modified state with the largest and healthiest trees retained. The area of remnant vegetation to be cleared is 0.42 ha.

9.3 Acid Sulphate Soils

- An area of Acid Sulfate Soil Risk Class 2 is present across the south of the Site, as well as in proximity to the western boundary. Risk Class 2 indicates a moderate to low-risk likelihood of ASS occurring within 3m of natural soil surface but a high to moderate risk of ASS beyond 3m of natural soil surface (DWER-052).
- If there is any disturbance greater than 100m^3 required of the Risk Class 2 area, with excavation proposed below the water table, then an Acid Sulfate Soil Management Plan should be prepared and implemented with actions to mitigate the potential impacts provided in the 'Treatment and management of soils and water in acid sulfate soil landscapes' (DER, 2015).
- Additional information on the potential for and any management of Acid Sulphate Soils within the Site will be provided in the Engineering Servicing Report.

9.4 Black Cockatoos

- No Black Cockatoos were observed within the Site. No signs of nesting or roosting were evident at the time of survey. Calls were heard during the first dawn survey however these were north and north west of the Site.
- A total of 141 trees with a diameter at breast height >30cm were identified on the Site and within the proposed crossover onto Sunset Drive. One tree contained hollows that were unsuitable (Figure 9 & 10).
- As the area of remnant vegetation to be cleared is small and most of the remnant vegetation will be retained within Public Open Space or the existing road reserve, it is unlikely this proposal will significantly impact the local Black Cockatoo population. Although only minimal impact is expected, a referral under the EPBC Act is highly likely as a number of potential nesting trees require removal as part of the application. If an area of native foraging habitat greater than 1 ha is proposed to be cleared, referral to the minister is also likely to be required.

9.5 Western Ringtail Possums

- No Western Ringtail Possums were observed within the Site.
- One Western Ringtail Possum was observed along the lot boundary, within the neighbouring property. Two dreys and multiple scats were observed within the Site.
- The area of remnant vegetation to be cleared is small and a significant amount of the remnant vegetation will be retained, including within Public Open Space. It is unlikely this proposal will significantly impact WRP populations. A referral under the EPBC Act is not recommended, however if the total area of proposed clearing increases to greater than 0.5 ha, referral to the minister may be required.

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Appendix A NatureMap Extract

Naturemap Extract of Flora Recorded within 10km of the Site (DBCA, 2023)

Taxon	EPBC Status	WA Status
Acacia flagelliformis		4
Acacia inops		3
Acacia tayloriana		4
Andersonia sp. Echidna (A.R. Annels ARA 5500)		2
Banksia sessilis var. cordata		4
Boronia anceps		3
Boronia capitata subsp. gracilis		3
Boronia sp. Leeuwin (J. Scott 235)		2
Caladenia abbreviata		3
Caladenia excelsa	T	EN
Caladenia excelsa	T	
Chamaescilla gibsonii		3
Cyathochaeta teretifolia		3
Dampiera heteroptera		3
Drakaea micrantha	T	EN
Drosera fimbriata		4
Franklandia triaristata		4
Gahnia sclerioides		4
Gastrolobium formosum		3
Gastrolobium whicherense		2
Gonocarpus pusillus		4
Grevillea brachystylis subsp. brachystylis		3
Grevillea bronweniae		3
Grevillea manglesioides subsp. ferricola		3
Johnsonia inconspicua		3
Lasiopetalum laxiflorum		3
Leptomeria furtiva		2
Lepyrodia heleocharoides		3
Netrostylis sp. Blackwood River (A.R. Annels 3043)		3
Netrostylis sp. Nannup (P.A. Jurjevich 1133)		1
Pimelea ciliata subsp. longituba		3
Pultenaea pinifolia		3
Stylidium lowrieanum		3
Synaphea decumbens		3
Thysanotus glaucus		4

Taxon	EPBC Status	WA Status
Thysanotus sp. Badgingarra (E.A. Griffin 2511)		2
Xyris maxima		2

Naturemap Extract of Fauna Recorded within 10km of the Site (DBCA, 2023)

Taxon	Common Name	Class	WA Status	EPBC Status
Actitis hypoleucos	Common Sandpiper	Bird	MI	MI
Ardenna carneipes	Flesh-footed Shearwater	Bird	VU	MI
Austroassiminea letha	Cape Leeuwin freshwater snail	Invertebrate	VU	
Bettongia penicillata ogilbyi	Woylie, Brush-tailed Bettong	Mammal	CR	EN
Calidris ruficollis	Red-necked Stint	Bird	MI	MI
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	Bird	VU	VU
Calyptorhynchus baudinii	Baudin's Cockatoo	Bird	EN	EN
Calyptorhynchus latirostris	Carnaby's Cockatoo	Bird	EN	EN
Calyptorhynchus sp. 'white-tailed black cockatoo'	White-tailed Black Cockatoo	Bird	EN	
Calyptorhynchus sp. 'white-tailed black cockatoo'	White-tailed Black Cockatoo	Bird	EN	EN
Caretta caretta	Loggerhead Turtle	Reptile	EN	EN
Charadrius leschenaultii	Greater Sand Plover, Large Sand Plover	Bird	VU	MI
Dasyurus geoffroii	Chuditch, Western Quoll	Mammal	VU	VU
Engaewa pseudoreducta	Margaret River Burrowing Crayfish	Invertebrate	CR	CR
Engaewa reducta	Dunsborough Burrowing Crayfish	Invertebrate	EN	CR
Falsistrellus mackenziei	Western False Pipistrelle, Western Falsistrelle	Mammal	P4	
Geotria australis	Pouched Lamprey	Fish	P3	
Hydromys chrysogaster	Water-Rat, Rakali	Mammal	P4	
Hydroprogne caspia	Caspian Tern	Bird	MI	MI
Isoodon fusciventer	Quenda, Southwestern Brown Bandicoot	Mammal	P4	
Notamacropus irma	Western Brush Wallaby	Mammal	P4	
Pandion haliaetus	Osprey	Bird	MI	MI
Phascogale tapoatafa wambenger	South-western Brush-tailed Phascogale, Wambenger	Mammal	CD	

Pseudocheirus occidentalis	Western Ringtail Possum, Ngwayir	Mammal	CR	CR
Psophodes nigrogularis	Western Whipbird	Bird	EN or P4	
Psophodes nigrogularis nigrogularis	Western Whipbird (Western Heath)	Bird	EN	EN
Setonix brachyurus	Quokka	Mammal	VU	VU
Thalassarche cauta cauta	Shy Albatross	Bird	VU	MI
Thalassarche chlororhynchos	Atlantic Yellow-nosed Albatross	Bird	VU	MI
Thalassarche melanophris	Black-browed Albatross	Bird	EN	MI
Thalasseus bergii	Crested Tern	Bird	MI	MI
Thinornis rubricollis	Hooded Plover, Hooded Dotterel	Bird	P4	
Westralunio carteri	Carter's Freshwater Mussel	Invertebrate	VU	VU

Appendix B Protected Matters Search Tool Extract

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 02-May-2023

Summary

Details

- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat

Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	16
Listed Migratory Species:	8

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	11
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	1
Nationally Important Wetlands:	None
EPBC Act Referrals:	4
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Status of Conservation Dependent and Extinct are not MNES under the EPBC Act. Number is the current name ID.		
Scientific Name	Threatened Category	Presence Text
BIRD		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat may occur within area
Zanda baudinii listed as Calyptorhynchus baudinii Baudin's Cockatoo, Baudin's Black-Cockatoo, Long-billed Black-cockatoo [87736]	Endangered	Breeding known to occur within area
Zanda latirostris listed as Calyptorhynchus latirostris Carnaby's Black Cockatoo, Short-billed Black-cockatoo [87737]	Endangered	Species or species habitat known to occur within area
CRUSTACEAN		
Engaewa pseudoreducta Margaret River Burrowing Crayfish [82674]	Critically Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
MAMMAL		
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat may occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat may occur within area
PLANT		
Banksia mimica Summer Honeypot [82765]	Endangered	Species or species habitat may occur within area
Banksia nivea subsp. uliginosa Swamp Honeypot [82766]	Endangered	Species or species habitat may occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat may occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat may occur within area
Gastrolobium papilio Butterfly-leaved Gastrolobium [78415]	Endangered	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		

Scientific Name	Threatened Category	Presence Text
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area

Extra Information

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

RFA Name	State
South West WA RFA	Western Australia

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Busselton to Flinders Bay Rails to Trails Project, WA	2013/6835	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Not controlled action (particular manner)			
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of

- World and National Heritage properties,
- Wetlands of international and national importance;
- Commonwealth and State/Territory reserves,
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities, and
- other information that may be useful as an indicator of potential habitat value

2 DISCLAIMER

This report is not intended to be definitive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans. State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if listed point, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells by an automated process using polygon capture techniques (i.e. two kilometre grid cells, alpha hull and convex hull), or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrant;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group using the Resource Information tool for the currency of the information

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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Appendix C Conservation Codes for WA Flora and Fauna

Conservation Code	Category
Threatened species (T)	Listed by order of the Minister as Threatened in the category of critically endangered, endangered, or vulnerable under Section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act). ***Threated fauna*** is that subset of 'Specially Protected Fauna' listed under Schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna. ***Threatened flora*** is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threated Flora. The Assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below
Critically endangered species (CR)	Threatened species considered to be *"facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the criteria set out in the ministerial guidelines"*. Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.
Endangered species (EN)	Threatened species considered to be *"facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines"*. Listed as endangered under Section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

Conservation Code	Category
Vulnerable species (VU)	Threatened species considered to *be "facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines"*. Listed as endangered under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.
Extinct species (EX)	Species where *"there is no reasonable doubt that the last member of the species has died"*, and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act). Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.
Extinct in the wild species (EW)	Species that *"is known only to survive in cultivation, captivity or as a naturalised population well outside its part range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form"*, and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act). Currently there are no threated fauna or flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.
Specially protected species	Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection. Species that are listed as threatened species (critically endangered, endangered, or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

Conservation Code	Category
Migratory species (MI)	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (Section 15 of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and the Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements of treaties, excluding species that are listed as Threated species. Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.
Species of special conservation interest (conservation dependent fauna) (CD)	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act). Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.
Other specially protected species (S)	Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act). Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

Conservation Code	Category
Priority species (P)	Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Assessment of Priority codes in based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.
Priority 1 (P1) - Poorly-known species	Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g., agricultural, or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases, or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
Priority 2 (P2) - Poorly-known species	Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g., national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

Conservation Code	Category
Priority 3 (P3) - Poorly-known species	Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
Priority 4 (P4) - Rare, Near Threatened and other species in need of monitoring	(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Appendix D Relevé Field Sheet

STRUCTURAL VEGETATION, FLORA – Relevé				SITE_ID: BR1
Date: 25/05/23	**GPS:** 33°51'8.176"S 115°5'54.683"E			**Photo No.:**1-4 (Below)
Recorder: KL	**Structural Community Type:** *Corymbia calophylla, Eucalyptus marginata* open forest, over *Corymbia calophylla* scattered low trees, over **Genista monspessulana* scattered tall shrubs, over **Genista monspessulana, Hakea lissocarpha* open shrubland, over **Genista monspessulana, Hakea lissocarpha, Styphelia propinqua* low open shrubland, over *Netrostylis* sp. Jarrah Forest, *Juncus pallidus* scattered tussock sedgeland, and **Hypochaeris radicata, *Plantago (lanceolata), Opercularia hispidula,* open tussock herbland, and mixed annual grasses, **Briza maxima, *Avena* sp. closed grassland.			
Location: Northern remnant tree clump				
Condition: Degraded	**Disturbance factors:** Past clearing, grazing (rabbits and cattle), weeds, logging			
Aspect: South west			**Slope:** Moderate	
Geology: Laterite			**Rock:** 20-50	
Soil Colour: Dark brown			**Soil Type:** Loam	
Litter (% cover & depth): 80%, 2cm, ++ organic matter			**Bare Ground (% cover):** 5%	
Hydrology: Good drainage			**Topographic position:** Upland	

Layer	Height (m)	Cover	Plant Species (Dominant 3 first)
Tree (T2)	**10-30**	30-70	*Corymbia calophylla, Eucalyptus marginata*
Tree (T3)	**< 10**	<2	*Corymbia calophylla*
Shrub (S1)	**> 2**	<2	**Genista monspessulana* (One large patch plus scattered)
Shrub (S2)	**1-2**	2-10	**Genista monspessulana, Hakea lissocarpha*
Shrub (S3)	**0-1**	2-10	**Genista monspessulana, Hakea lissocarpha, Styphelia propinqua, Kingia australis, Hakea amplexicaulis, Hovea elliptica, Hovea chorizemifolia, *Acacia melanoxylon, Xanthorrhoea* sp.*(gracilis)*
Sedge/Rush (VR)		<2	*Netrostylis* sp. Jarrah Forest, *Juncus pallidus*
Herb (H)		10-30	**Hypochaeris radicata, *Plantago (lanceolata), Opercularia hispidula, *Lupinus* sp. *(angustifolius), *Erodium* sp., **Romulea rosea, *Orobanche minor, *Rumex* sp.
Grass (G)		>70	Mixed annual grasses – Sterile, **Briza maxima, *Avena* sp.
Other (climbers) (C)		<2	**Asparagus asparagoides*

*** = Introduced, () = Tentative identification**
Surrounding Plants: **Acacia longifolia, Agonis flexuosa, Xylomelum occidentale*



Photo 1 Relevé 1 - Eastern aspect



Photo 2 Relevé 1 – Northern Aspect



Photo 3 Relevé 1 - Western aspect



Photo 4 Relevé 1 – Southern aspect

Appendix E Native Species List

Taxon Name	Within Site	Road Reserve
Acacia myrtifolia		X
Acacia sp. *(browniana/gilbertii)*		X
Adenanthos (barbiger / sp. Whicher Range)		X
Agonis flexuosa	X	X
Anarthria prolifera		X
Billardiera floribunda		X
Corymbia calophylla	X	X
Cyathochaeta avenacea	X	X
Eucalyptus marginata		X
Hakea amplexicaulis	X	X
Hakea lissocarpha	X	
Hibbertia (hypericoides)		X
Hovea chorizemifolia	X	
Hovea elliptica	X	X
Juncus pallidus	X	
Kennedia coccinea		X
Kingia australis	X	X
Lepidosperma (squamatum)	X	X
Leucopogon verticillatus		X
Lomandra pauciflora		X
Lomandra (preissii/purpurea)		X
Lomandra sp.		X
Marianthus/Billardiera sp.		X
Mesomelaena tetragona	X	X
Netrostylis sp. Jarrah Forest	X	X
Opercularia hispidula	X	X
Patersonia sp.		X
Scaevola calliptera		X
Styphelia propinqua	X	X
Taxandria parviceps	X	X
Tetrarrhena laevis		X
Viminaria juncea		X
Xanthorrhoea sp.*(gracilis)*	X	
Xylomelum occidentale	X	X

() = Tentative identification

Appendix F Habitat Trees

DBH (cm)	Species	Height (m)	Notes	Easting	Northing
71	Corymbia calophylla	16	No hollows observed	115° 5' 53.052" E	33° 51' 9.906" S
90	Corymbia calophylla	14	No hollows observed. Leaning but stable.	115° 5' 53.754" E	33° 51' 10.284" S
50	Corymbia calophylla	22	No hollows observed	115° 5' 54.200" E	33° 51' 10.543" S
96	Corymbia calophylla	22	No hollows observed	115° 5' 54.222" E	33° 51' 10.550" S
90	Corymbia calophylla	22	No hollows observed	115° 5' 54.294" E	33° 51' 10.637" S
>30	Corymbia calophylla	20	No hollows observed. Starting to senesce	115° 5' 54.467" E	33° 51' 10.597" S
>30	Corymbia calophylla	22	No hollows observed	115° 5' 54.567" E	33° 51' 10.644" S
>30	Corymbia calophylla	24	No hollows observed. Dead branches	115° 5' 54.758" E	33° 51' 10.748" S
>30	Corymbia calophylla	24	No hollows observed. Starting to senesce	115° 5' 55.820" E	33° 51' 10.630" S
>30	Corymbia calophylla	10	No hollows observed	115° 5' 55.770" E	33° 51' 10.867" S
133	Corymbia calophylla	24	No hollows observed	115° 5' 56.508" E	33° 51' 11.036" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 57.761" E	33° 51' 9.503" S
118	Corymbia calophylla	24	No hollows observed	115° 5' 58.401" E	33° 51' 9.391" S
>30	Corymbia calophylla	24	No hollows observed	115° 5' 58.466" E	33° 51' 9.258" S
>30	Corymbia calophylla	25	No hollows observed	115° 5' 58.592" E	33° 51' 8.556" S
>30	Corymbia calophylla	24	No hollows observed	115° 5' 58.614" E	33° 51' 8.448" S
>30	Corymbia calophylla	25	No hollows observed	115° 5' 58.938" E	33° 51' 8.185" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 58.675" E	33° 51' 8.110" S
>30	Corymbia calophylla	25	No hollows observed	115° 5' 58.880" E	33° 51' 7.796" S
>30	Corymbia calophylla	20	No hollows observed. Potential drey at top of tree	115° 5' 55.543" E	33° 51' 6.817" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 55.399" E	33° 51' 6.864" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 55.428" E	33° 51' 6.965" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 55.043" E	33° 51' 7.400" S
>30	Corymbia calophylla	19	No hollows observed	115° 5' 55.154" E	33° 51' 7.375" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 55.305" E	33° 51' 7.318" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 55.230" E	33° 51' 7.519" S
>30	Corymbia calophylla	21	No hollows observed	115° 5' 55.403" E	33° 51' 7.541" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 55.755" E	33° 51' 7.764" S
>30	Corymbia calophylla	22	No hollows observed	115° 5' 55.914" E	33° 51' 7.804" S
>30	Corymbia calophylla	10	No hollows observed	115° 5' 56.072" E	33° 51' 8.020" S
>30	Corymbia calophylla	8	No hollows observed. Starting to senesce	115° 5' 55.745" E	33° 51' 8.041" S
>30	Corymbia calophylla	10	No hollows observed	115° 5' 55.647" E	33° 51' 7.944" S
>30	Corymbia calophylla	12	No hollows observed	115° 5' 55.417" E	33° 51' 7.854" S
>30	Dead	10	No hollows observed	115° 5' 55.431" E	33° 51' 7.832" S
>30	Corymbia calophylla	12	No hollows observed	115° 5' 54.985" E	33° 51' 7.688" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 54.881" E	33° 51' 7.710" S
>30	Eucalyptus marginata	18	No hollows observed	115° 5' 54.729" E	33° 51' 7.649" S

DBH (cm)	Species	Height (m)	Notes	Easting	Northing
>30	Corymbia calophylla	16	No hollows observed	115° 5' 54.521" E	33° 51' 7.681" S
>30	Corymbia calophylla	8	No hollows observed	115° 5' 54.351" E	33° 51' 7.836" S
>30	Corymbia calophylla	15	No hollows observed	115° 5' 54.665" E	33° 51' 7.966" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 54.675" E	33° 51' 7.987" S
>30	Corymbia calophylla	16	No hollows observed	115° 5' 54.654" E	33° 51' 8.052" S
>30	Corymbia calophylla	15	No hollows observed	115° 5' 54.287" E	33° 51' 8.009" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 54.434" E	33° 51' 8.128" S
>30	Corymbia calophylla	16	No hollows observed	115° 5' 54.650" E	33° 51' 8.167" S
>30	Corymbia calophylla	16	No hollows observed	115° 5' 54.956" E	33° 51' 8.081" S
>30	Corymbia calophylla	15	No hollows observed	115° 5' 55.053" E	33° 51' 8.131" S
>30	Corymbia calophylla	20	Unsuitable hollow	115° 5' 55.244" E	33° 51' 8.347" S
>30	Corymbia calophylla	10	No hollows observed	115° 5' 55.410" E	33° 51' 8.200" S
>30	Corymbia calophylla	12	No hollows observed	115° 5' 55.446" E	33° 51' 8.286" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 55.579" E	33° 51' 8.264" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 55.935" E	33° 51' 8.322" S
>30	Corymbia calophylla	19	No hollows observed	115° 5' 56.378" E	33° 51' 8.524" S
>30	Corymbia calophylla	141	No hollows observed	115° 5' 56.724" E	33° 51' 8.642" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 56.166" E	33° 51' 8.786" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 55.788" E	33° 51' 8.866" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 55.712" E	33° 51' 8.855" S
>30	Corymbia calophylla	21	No hollows observed	115° 5' 55.291" E	33° 51' 8.642" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 54.812" E	33° 51' 8.675" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 54.791" E	33° 51' 8.509" S
>30	Dead	7	No hollows observed	115° 5' 54.758" E	33° 51' 8.524" S
>30	Corymbia calophylla	9	No hollows observed	115° 5' 54.708" E	33° 51' 8.524" S
>30	Corymbia calophylla	12	No hollows observed	115° 5' 54.398" E	33° 51' 8.635" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 54.546" E	33° 51' 8.833" S
>30	Corymbia calophylla	146	No hollows observed	115° 5' 54.683" E	33° 51' 8.898" S
>30	Corymbia calophylla	10	No hollows observed	115° 5' 54.913" E	33° 51' 8.984" S
>30	Corymbia calophylla	16	No hollows observed	115° 5' 55.007" E	33° 51' 9.046" S
>30	Corymbia calophylla	16	No hollows observed	115° 5' 55.374" E	33° 51' 9.002" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 55.485" E	33° 51' 9.006" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 55.601" E	33° 51' 9.053" S
>30	Corymbia calophylla	19	No hollows observed	115° 5' 56.040" E	33° 51' 8.981" S
>30	Eucalyptus marginata	9	No hollows observed	115° 5' 56.058" E	33° 51' 9.582" S
117	Corymbia calophylla	20	No hollows observed	115° 5' 55.482" E	33° 51' 9.416" S
>30	Corymbia calophylla	10	No hollows observed	115° 5' 55.035" E	33° 51' 9.146" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 54.974" E	33° 51' 9.334" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 54.938" E	33° 51' 9.427" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 55.241" E	33° 51' 9.629" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 55.385" E	33° 51' 9.712" S

DBH (cm)	Species	Height (m)	Notes	Easting	Northing
>30	Corymbia calophylla	18	No hollows observed	115° 5' 55.741" E	33° 51' 9.852" S
>30	Corymbia calophylla	16	No hollows observed	115° 5' 55.788" E	33° 51' 10.093" S
>30	Corymbia calophylla	15	No hollows observed	115° 5' 55.251" E	33° 51' 9.852" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 55.219" E	33° 51' 9.838" S
>30	Corymbia calophylla	16	No hollows observed	115° 5' 55.226" E	33° 51' 9.906" S
>30	Dead	10	No hollows observed	115° 5' 54.891" E	33° 51' 9.812" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 54.607" E	33° 51' 9.708" S
>30	Corymbia calophylla	17	No hollows observed	115° 5' 54.701" E	33° 51' 10.252" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 54.765" E	33° 51' 10.288" S
>30	Corymbia calophylla	12	No hollows observed	115° 5' 54.845" E	33° 51' 10.277" S
>30	Corymbia calophylla	19	No hollows observed	115° 5' 54.971" E	33° 51' 10.360" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 55.313" E	33° 51' 10.464" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 54.996" E	33° 51' 10.446" S
>30	Corymbia calophylla	12	No hollows observed	115° 5' 54.909" E	33° 51' 10.262" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 54.866" E	33° 51' 10.270" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 54.809" E	33° 51' 10.223" S
>30	Corymbia calophylla	15	No hollows observed	115° 5' 53.891" E	33° 51' 8.722" S
>30	Corymbia calophylla	17	No hollows observed	115° 5' 53.952" E	33° 51' 8.297" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 54.114" E	33° 51' 7.796" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 53.703" E	33° 51' 7.886" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 53.549" E	33° 51' 7.886" S
>30	Corymbia calophylla	19	No hollows observed	115° 5' 53.556" E	33° 51' 8.099" S
>30	Dead	10	No hollows observed	115° 5' 53.595" E	33° 51' 8.236" S
>30	Dead	7	No hollows observed	115° 5' 53.534" E	33° 51' 8.300" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 53.235" E	33° 51' 8.437" S
>30	Corymbia calophylla	12	No hollows observed	115° 5' 53.145" E	33° 51' 8.596" S
>30	Corymbia calophylla	11	No hollows observed	115° 5' 53.207" E	33° 51' 8.617" S
>30	Corymbia calophylla	10	No hollows observed	115° 5' 53.210" E	33° 51' 8.671" S
>30	Corymbia calophylla	12	No hollows observed	115° 5' 53.019" E	33° 51' 8.995" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 51.795" E	33° 51' 8.347" S
>30	Corymbia calophylla	12	No hollows observed	115° 5' 51.511" E	33° 51' 8.146" S
>30	Corymbia calophylla	16	No hollows observed	115° 5' 51.493" E	33° 51' 8.034" S
>30	Corymbia calophylla	14	No hollows observed	115° 5' 51.806" E	33° 51' 8.020" S
>30	Corymbia calophylla	16	No hollows observed	115° 5' 52.116" E	33° 51' 7.850" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 52.397" E	33° 51' 7.735" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 52.371" E	33° 51' 7.714" S
>30	Corymbia calophylla	6	No hollows observed	115° 5' 52.548" E	33° 51' 7.328" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 52.685" E	33° 51' 7.166" S
>30	Corymbia calophylla	22	No hollows observed	115° 5' 52.728" E	33° 51' 7.037" S
>30	Corymbia calophylla	17	No hollows observed	115° 5' 52.739" E	33° 51' 6.929" S
>30	Corymbia calophylla	15	No hollows observed	115° 5' 52.847" E	33° 51' 6.814" S

DBH (cm)	Species	Height (m)	Notes	Easting	Northing
>30	Corymbia calophylla	14	No hollows observed	115° 5' 52.980" E	33° 51' 6.763" S
>30	Corymbia calophylla	16	No hollows observed. Leaning on 3335, potentially unstable	115° 5' 52.739" E	33° 51' 6.569" S
>30	Corymbia calophylla	16	No hollows observed	115° 5' 52.793" E	33° 51' 6.446" S
>30	Corymbia calophylla	16	No hollows observed	115° 5' 52.951" E	33° 51' 5.816" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 52.044" E	33° 51' 6.907" S
>30	Corymbia calophylla	19	No hollows observed	115° 5' 52.015" E	33° 51' 7.087" S
>30	Corymbia calophylla	19	No hollows observed	115° 5' 51.554" E	33° 51' 8.754" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 51.529" E	33° 51' 9.114" S
>30	Corymbia calophylla	15	No hollows observed	115° 5' 51.111" E	33° 51' 9.010" S
>30	Corymbia calophylla	18	No hollows observed	115° 5' 51.111" E	33° 51' 9.110" S
>30	Corymbia calophylla	12	No hollows observed	115° 5' 50.892" E	33° 51' 9.100" S
>30	Corymbia calophylla	17	No hollows observed	115° 5' 50.816" E	33° 51' 9.161" S
>30	Corymbia calophylla	10	No hollows observed	115° 5' 50.838" E	33° 51' 9.197" S
>30	Corymbia calophylla	8	No hollows observed	115° 5' 50.885" E	33° 51' 9.190" S
>30	Corymbia calophylla	16	No hollows observed	115° 5' 51.029" E	33° 51' 9.406" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 50.852" E	33° 51' 9.395" S
>30	Corymbia calophylla	20	No hollows observed	115° 5' 50.805" E	33° 51' 9.355" S
>30	Corymbia calophylla	7	No hollows observed	115° 5' 50.654" E	33° 51' 9.539" S
>30	Corymbia calophylla	11	No hollows observed	115° 5' 50.489" E	33° 51' 9.557" S
>30	Corymbia calophylla	14	No hollows observed	115° 5' 50.471" E	33° 51' 9.524" S
>30	Corymbia calophylla	10	No hollows observed	115° 5' 52.361" E	33° 51' 6.094" S
>30	Corymbia calophylla	14	No hollows observed	115° 5' 52.209" E	33° 51' 6.151" S

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Appendix 4

Local Water Management Strategy

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Lot 102 Bussell Hwy, Cowaramup

Local Water Management Strategy

October 2023



Goldfields Cowaramup

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Executive Summary

Hyd2o was commissioned by Goldfields Cowaramup to prepare this Local Water Management Strategy (LWMS) to support the local structure plan for Lot 102 Bussell Hwy Cowaramup.

The local structure planning area (herein referred to as the site) is within the town of Cowaramup within the Shire of Augusta-Margaret River, located approximately 260 km south-west of Perth and 12 km north of Margaret River. The site has an approximate area of 19.6 ha and is bound by Memorial Drive to the north, Sunset Drive to the west, Bussell Hwy to the east, and rural land to the south. The proposed development consists of residential lots of various densities, POS and vegetation retention areas, and associated roads.

Understanding key hydrological considerations has informed the development of the structure plan and this LWMS for the site. A summary of the key elements of the water management strategy are detailed in the following table.

The site is located immediately south west of the existing Cowaramup town centre. Typical of the surrounding area, the site has low relief and is underlain by soils with limited infiltration resulting in the formation of perched groundwater tables in winter. The site provides a flow path from east to west across the site for upstream developed areas and receives drainage from Bussell Hwy.

Stormwater management within the site will be undertaken using water sensitive design practices. A treatment train approach to water quality management will be implemented to improve water quality outcomes for the site in comparison to current use, including:

- Provision of lot connections, and use of subsoil drainage to minimise fill importation.
- A combination of pipes, swales (living streams), and road reserves to convey and provide safe passage for the local site and regional upstream flows.
- Distributed vegetated detention/bioretention areas for water quality treatment.
- Landscaped POS area to assist with flood management during larger storm events.
- A range of residential zonings and POS landscape approaches to reduce nutrients.
- Minimising POS water use with any turf areas irrigated using local groundwater.

These measures represent best practice as detailed in the Stormwater Management Manual for Western Australia (Department of Water and Environmental Regulation, 2022), and have been selected and designed with consideration of the sites existing environment. The sites strategy has been informed through discussion with key agencies and is underpinned by field investigation and monitoring outcomes.

This LWMS has been prepared considering previous planning for the site and its surrounds and has been prepared in accordance with the principles, objectives, and key criteria of Better Urban Water Management (Western Australian Planning Commission, 2008).

Implementation of the strategy will be undertaken in accordance with Better Urban Water Management through the development and implementation of Urban Water Management Plans for individual stages of development within the site. An LWMS checklist to assist in the review of this document is included as Appendix A.

Local Water Management Strategy Summary

Strategy Elements	LWMS Method & Approach
Water Use Sustainability	
Water Efficiency	• Reduce consumptive use through adoption of waterwise practices. • 6 Star Building Standards (water efficient fixtures and fittings). • Use of native plantings in POS areas with minimal areas of turf.
Water Supply	• Lots: Water Corporation IWSS. Rainwater Tanks optional (not mandated) • POS: Irrigation Bore / Wet well
Wastewater	• Water Corporation reticulated sewerage.
Stormwater	
Ecological Protection (15 mm Event)	▪ Treatment of the initial 15 mm event on site and any subsoil flows via vegetated detention/bioretention areas ▪ 15mm event storage volume of 1061 m^3 to be provided for this purpose including treatment of Bussell Hwy runoff. Refined modelling to be undertaken at UWMP stage.
Serviceability (20% Annual Exceedance Probability Event)	• Piped drainage system to be sized to convey 20% AEP event. ▪ 20% AEP local flood storage volume (3233 m^3) and area (7861 m^2) provided in POS to attenuate local flows (inclusive of 15mm areas).
Flood Protection (1% Annual Exceedance Probability Event)	• Regional flow paths and flow rates consistent with pre development • Overland flows paths provided within road reserves identified for safe conveyance of flows exceeding pipe drainage system capacity. • 1% AEP local flood storage volume (6589 m^3) and area (8850 m^2) provided in structure plan and POS design to attenuate flow consistent with predevelopment flows (inclusive of 15mm volumes and areas). • Minimum habitable floor levels to be 0.5m above the 1% AEP flood levels.
Groundwater	
Fill & Subsoil Drainage	• Fill to provide clearance above groundwater and any perched system above clay soils. • Subsoil to control any groundwater rise post development within fill above existing clay layer where required.
ASS & Contamination	• Further ASS investigations to be investigated as a separate process and reported in UWMP.

1 Introduction

Hyd2o was commissioned by Goldfields Coraramup to prepare this Local Water Management Strategy (LWMS) to support the proposed local structure plan for Lot 102 Bussell Hwy Cowaramup (herein referred to as the site).

The site is located approximately 260 km south west of Perth and 12 km north of Margaret River in the town of Cowaramup, Shire of Augusta-Margaret River (Figure 1). The site has an approximate area of 19.6 ha and is bound by Memorial Drive to the north, Miamup Road and Sunset Drive to the west, Bussell Hwy to the east, and existing rural land to the south. The site is located immediately south west of the existing town centre.

This document provides an integrated total water cycle management approach to the development, with an assessment of the pre-development environment, development of water use sustainability initiatives, a stormwater management strategy, a groundwater management strategy and a plan for implementation of subdivision plans.

This LWMS has been prepared considering previous planning for the site and its surrounds conducted as part of the original Cowaramup Country Development Guide Plan (Shire of Augusta & Margaret River, 2007) and has been prepared in accordance with the principles, objectives, and key criteria of Better Urban Water Management (Western Australian Planning Commission, 2008).

This document provides the outcomes of site-specific investigations related to groundwater and surface water and provides a clear vision in terms of adopting best management practises to achieve water sensitive design.

A copy of the BUWM (WAPC, 2008) LWMS Checklist is included as Appendix A to assist local government and the Department of Water and Environmental Regulation (DWER) in review of this document.

1.1 Planning Background

The urban water management planning process for the site is shown in Table 1. This LWMS supports the proposed local structure plan for the site.

Table 1: Integrated Planning and Urban Water Management Process

Planning Phase	Planning Document	Urban Water Management Document and Status
Local	Local Structure Plan Lot 102 Bussel Hwy Cowaramup	Lot 102 Bussell Hwy Cowaramup Local Water Management Strategy **THIS DOCUMENT**
Subdivision	Subdivision Application	Urban Water Management Plan (for individual subdivision applications) **FUTURE PREPARATION**

1.2 Key Documents and Previous Studies

This LWMS uses the following key documents to define its principles, criteria, and objectives:

- Stormwater Management Manual for WA (DWER, 2022)
- Decision Process for Stormwater Management in WA (DWER, 2017)
- Better Urban Water Management (WAPC, 2008)
- Servicing Report Lot 102 Bussell Highway, Cowaramup (JDSi Consulting Engineers,2023).
- Report on Geotechnical & Initial Acid Sulphate Soil Investigation – Proposed Subdivision Lots 101 & 102 Bussell Highway Cowaramup WA, (Douglas Partners, 2008)
- Country Vines Estate, Cowaramup Stages 2 and 3 - Stormwater Modelling Infrastructure Services Report (Wood & Grieves Engineers, 2016).

2 Proposed Development

The local structure plan prepared by Rowe Group for the site is shown in Figure 2 and Appendix B.

Consideration of the predevelopment environment of the site, its existing constraints and opportunities, and interfacing with existing areas has guided the development of this plan. The design includes consideration of existing infrastructures such as the existing sewer which runs across the site.

The proposed development consists of residential lots of various densities, public open spaces including vegetation retention areas, and road reserves. POS areas will ultimately be designed with multiple use characteristics to also provide a stormwater management function. Details of the sizing and proposed location of the stormwater management areas are presented in Section 6.

3 Pre-Development Environment

3.1 Site Conditions

The site is located on Bussell Hwy immediately south of the Cowaramup town centre. It has an area of 19.6 ha and is bound by Memorial Drive to the north, Miamup Road and Sunset Drive to the west, Bussell Hwy to the east, and existing rural land to the south.

An aerial photograph showing existing land use within the site is presented in Figure 3, and site feature survey included as Appendix C. The site is predominately cleared pasture and used for cattle grazing. The site has existing urban development located to the north, west, and east, with rural land to the south.

Topographically the site grades broadly from north east to south west with elevations ranging from approximately 132 mAHD at the north eastern corner to approximately 126 mAHD towards the south western corner of the site.

3.2 Geotechnical

Cowaramup-Mentelle 1:50,000 Environmental Geology sheet 1930-III and part of 1830-II (Hall, Marnham, & Langford, 2000), maps the site as predominantly being:

- CoC/PmLE (Leeuwin Complex): Colluvial undivided slopes silty or gravelly sand over mottled sandy clay underlain by Leeuwin Complex; and
- CoAd: Alluvial; Drainage depression; including seasonally active channels; formed in weathered bedrock and slope deposits; silty clayey sand.

A geotechnical field investigation undertaken by Douglas Partners in early May 2008 is included as Appendix D. This investigation was conducted over the site and also the area east of Bussell Highway and included a total excavation of 47 test pits with Perth Sand Penetrometer (PSP) and Dynamic Cone Penetrometer (DCP) testing at each site. Test locations are shown in Figure 4.

Douglas Partners (2008) identified two primary soil profiles, split between a northern half and a southern half of the site, described as follows:

Northern Half of Site - General Soil Profile

- **Topsoil:** Dark grey/grey and brown silty sandy topsoil with 0.1m depth.
- **Sand:** Medium dense, light brown and light grey-brown, fine to medium grained sand with remnants of clay, underlying the topsoil to depths 0.4m - 3.3m.
- **Gravelly Clayey Sand / Clayey Sand:** Medium dense, light brown mottled orange, fine to medium grained clayey sands
- **Ironstone:** Medium to high strength, red-brown ironstone, underlying sand and clayey sand at depths 0.5m - 3.3m.
- **Gravelly Sandy Clay / Sandy Clay:** Stiff, light grey-blue and grey, medium plasticity, sandy clay with variable fractions of lateritic gravel at depths ranging 0.1m-2.5m
- **Granite:** Relatively very high strength weathered granite at depths 3.4 m - 4.1 m.

Southern Half of Site - General Soil Profile

- **Topsoil:** Brown silty and sandy topsoil to a depth of 0.1m.
- **Sand:** Medium dense, brown and grey sand with a variating clay layer, silt and gravel to depths recorded between 0.7m and the test pit terminations depth (2.5m).
- **Gravelly Clayey Sand / Clayey Sand:** Medium dense light grey and occasionally grey clayey sand grading to sandy clay with variating amounts of gravel at depths of 1.0m to test pit termination depth.

Due to the soil profile found across the site, Douglas Partners (2008) considered the site to have low permeability for stormwater disposal purposes, and on-site stormwater disposal using soakwells and infiltration basins generally not suitable without the importation of considerable sand fill.

3.2.1 Acid Sulphate Soils

Acid Sulphate Soil (ASS) is the common name given to naturally occurring soil and sediment containing iron sulfides. These naturally occurring iron sulfides are generally found in a layer of waterlogged soil or sediment and are benign in their natural state. When disturbed and exposed to air, however, they oxidise and produce sulfuric acid, iron precipitates, and concentrations of dissolved heavy metals such as aluminium, iron and arsenic. Release of acid and metals as a result of the disturbance of ASS can cause significant harm to the environment and infrastructure.

Acid Sulphate Soil (ASS) mapping in the vicinity of the site is shown in Figure 4. Published acid sulphate risk mapping indicates no ASS risk detected in the northern area of the site. The southern area of the site is mapped as moderate to low risk of ASS occurring within 3 m of natural soil surface.

Douglas Partners (2008) reported the results of an initial ASS investigation which included both screen and laboratory testing. Based on the results of the investigation, it was determined that acid sulphate soils above the action criterion had been identified beneath the site at depths of between 0.5 m and 2.5 m. It is therefore considered that the risk of acid sulphate soils at the site is high within 3.0 m of the existing surface.

Management of ASS will be addressed at subdivision stage, with details regarding outcomes to be included as part of the Urban Water Management Plan (UWMP). This is further discussed in Section 7.1.

3.3 Contaminated Sites

A search of the Department of Water and Environmental Regulation's Contaminated Sites database indicates no known contaminated areas within the site or surrounding area.

3.4 Wetland

According to SLIP Leeuwin Naturaliste and Donnybrook to Nannup Geomorphic Wetlands dataset, a small area of a long linear Palusvale wetland extends into the site adjacent to the existing site pond in the south western corner of the site (Figure 5). This area totals only approximately 250 m^2. The remainder of the site contains no mapped wetlands.

3.5 Surface Water

A surface water plan for the site is shown in Figure 6.

The site contains a waterway/drain which runs from east to west across the site into an existing excavated pond in the south western corner. Once the pond fills, water then exists the site on the southern end of the pond toward a larger storage structure located downstream of the Wadandi Walk/Cycle Track (formerly Rails to Trails).

Subcatchments of the site are shown on Figure 6 together with the main culvert locations and infrastructure sizings. The majority of the site flows to the main existing waterway/drain, with drainage enhanced via a number of excavated secondary shallow drains in the site.

The site receives flow from an upstream catchment, including runoff from an area of the estate located on the eastern side of Bussell Hwy and also from a section of Bussell Hwy itself. The estate stormwater is managed in a bioretention area on the southern side of Bussell Hwy for small events, prior to discharging via a spillway to the culverts under Bussell Hwy during larger events. No compensation of flows from the estate in larger events therefore occurs prior to discharge into the site.

Stormwater planning for the remainder of the estate to the east is detailed in Wood & Grieve Engineers (2016) Country Vines Estate, Cowaramup Stages 2 and 3 - Stormwater Modelling Infrastructure Services Report. This detailed that no further development areas will discharge stormwater into the site, with stormwater to be diverted north as shown in Figure 6. Extracts from previous stormwater planning via Wood and Grieve (2016) are contained as Appendix E.

To estimate current flows from the site to the downstream environment an XP-Storm model was developed, inclusive of the upstream catchment contribution. Modelling results are shown in Table 2. The model estimated the 1% Annual Exceedance Probability (AEP) flow from the site and its upstream catchment to be 0.58 m^3/s. Note that the model's upstream catchment flow contribution of 0.44 m^3/s via the culvert under Bussell Highway was found to broadly align with the previous Wood & Grieve Engineers (2016) estimate (0.39 m^3/s).

Flow estimates were also verified via the capacity of the existing infrastructure, with culverts upstream and downstream of the site found to have capacities broadly in accordance with estimated flows. Estimated culvert capacities are shown in Figure 6.

The 1% AEP flow estimate of 0.58 m^3/s is therefore adopted for this LWMS as the basis for determining post development storage requirements for the site in Section 6.

Table 2. Surface Water Flow Rates at Key Locations

Location	Modelled Existing 1% AEP Flow Estimate (m^3/s)
Culverts Under Bussell Hwy	0.44
Site Outflow (South Western Corner)	0.58

3.5.1 Surface Water Quality

Water quality sampling was undertaken at the site during winter 2023 on two occasions (15 June and 31 August). Samples were undertaken via grab sampling at four locations including inflows and outflows from the site, and at the sites existing pond, and a location downstream of the site on the same waterway/drain to assist with water quality characterisation.

Samples were sent to a NATA approved laboratory for analysis of physical parameters (temperature, electrical conductivity, pH), total nitrogen, total Kjeldahl nitrogen, ammonia, nitrate, nitrite, total phosphorus, filterable reactive phosphorus, heavy metals (arsenic, cadmium, chromium, copper, nickel, lead, mercury, and zinc), and cations.

Surface water quality results for individual sites are detailed in Appendix F with laboratory reports included in Appendix G. The results are summarised in Table 3.

A summary of water quality monitoring results is provided as follows in comparison to ANZECC (2000) guidelines for lowland rivers in the southwest of Australia.

- Mean pH of the site ranged from 6.8 to 7.05 indicating neutral conditions and was within the ANZECC guideline range of 6.5-8.0.
- Mean electrical conductivity (EC) varied between a minimum of 290 uS/cm at the outflow and a maximum of 340 uS/cm at the inflow. The inflow EC was marginally above the ANZECC (2000) guideline range of 120-300 uS/cm.
- Mean total nitrogen (TN) ranged from 0.51 to 1.04 mg/L across the tested sites, with all sites lower than the ANZECC (2000) guideline of 1.2 mg/L. It was noted that TN concentrations decreased as water moved downstream through the site.
- Total phosphorus (TP) was recorded as below 0.05 mg/L for three of the sampled sites which is lower than the ANZECC (2000) guideline of 0.065 mg/L, with the exception of one sample recording 0.09 mg/L at the site outflow location.

Most metals sampled (arsenic, cadmium, chromium, nickel, lead, and mercury) were generally below the laboratory limit of detection. The average concentration of zinc across all sites was 0.0044 mg/L which meets the ANZECC 95% trigger value for the protection of freshwater species. Mean concentrations of copper were recorded as 0.0011 mg/L which also meets the ANZECC 95% trigger value for the protection of freshwater species.

Table 3. Surface Water Quality Winter 2023 Sampling

Parameter	Site & Mean Parameter Values			
	SW1 Site Inflow	**SW2** Site Pond	**SW3** Site Outflow	**SW4** Downstream
Physical Parameters				
pH	6.90	7.05	6.90	6.80
Electrical Conductivity (uS/cm)	340	300	290	310
Nutrients				
Total Nitrogen (mg/L)	1.04	0.73	0.76	0.51
Ammonia as N (mg/L)	0.01	0.01	0.01	0.01
Nitrate as N (mg/L)	0.78	0.44	0.3	0.18
Nitrite as N (mg/L)	0.01	0.01	0.01	0.01
TKN as N (mg/L)	0.22	0.29	0.45	0.33
Total Phosphorus (mg/L)	0.05	0.05	0.09	0.05
FRP (mg/L)	0.01	0.01	0.01	0.01
Metals				
Arsenic (ug/L)	0.001	0.001	0.001	0.001
Cadmium (ug/L)	0.0001	0.0001	0.0001	0.0001
Chromium (ug/L)	0.001	0.001	0.001	0.001
Copper (ug/L)	0.0014	0.001	0.001	0.001
Mercury (ug/L)	0.0005	0.00005	0.00005	0.00005
Nickel (ug/L)	0.001	0.001	0.001	0.001
Lead (ug/L)	0.001	0.001	0.001	0.001
Zinc (ug/L)	0.0102	0.00235	0.00175	0.00345
Cations				
Calcium (mg/L)	21.00	16.00	14.00	16.00
Magnesium (mg/L)	6.80	6.90	6.85	7.10
Potassium (mg/L)	2.85	2.90	3.30	3.10
Sodium (mg/L)	26.00	28.00	29.00	29.00
Hardness as CaCO3 (mg/L)	81.00	68.00	63.50	69.50

3.6 Groundwater

No existing DWER groundwater mapping covers the site area.

Hyd2o has received advice from both DWER and Shire of Augusta-Margaret River that no groundwater level monitoring is required to inform the planning process and this LWMS. This advice was based on consideration that post development site levels will be primarily determined by the depth of permeable soils on the site above less permeable strata.

Geotechnical reporting by Douglas Partners (2008) provided details of the surface sand layers within the site above less permeable strata which could indicate areas of possible perching, particularly areas where clays and ironstone are present.

Figure 7 details the elevations of the base of the sand layer across the site based on Douglas Partners (2008). These depths below natural surface can be seen to be quite variable ranging from 0.2m below surface in areas adjacent to the current waterway/drain to in excess of 2 m in areas near the southern boundary.

Hyd2o conducted a further field investigation on 15 June 2023, with details of tested sites shown in Figure 7. Some areas of perching were found with groundwater at these locations found to range from 0.35 to 1.4 m below natural surface, with the shallower groundwater depth associated with the areas adjacent to the existing drain/waterway.

These observations were consistent with Douglas Partners (2008), and DWER advice that the site levels will be primarily determined by the depth of permeable soils on the site above less permeable strata.

3.7 Nutrient Input Assessment for Current Land Use

The Urban Nutrient Decision Outcomes (UNDO) model is a conceptual decision support tool developed by DWER that evaluates nutrient reduction decisions for urban developments in south-west Western Australia. It is designed for ease-of-use by urban development proponents and for assessment by local and state government authorities.

The tool was developed to assess the nutrient impacts of urban development in a consistent and scientifically rigorous manner, and improve scientific understanding relating to nutrient issues, and efficiencies in the investment to manage nutrients. The tool is web-based, and provides users with the ability to implement a range of structural or non-structural design options to evaluate and reduce nutrients exported from an urban development.

Modelling outputs of the site's existing land use using UNDO are detailed in Appendix H.

The results indicate nutrient inputs of 1,476 kg/yr of TN and 262 kg/yr of TP to the environment annually based on typical nutrient application rate estimates. The resultant nutrient export was 132 kg/yr of TN and 1.9 kg/yr of TP. These export estimate considers soil types, groundwater gradients, and depth to groundwater in its calculation.

Estimates of post development nutrient input and export rates following land use change are addressed in Section 6.3.

4 Design Criteria

Key design criteria for the site are shown in Table 4 and have been established consistent with criteria specified in the key reference documents previously detailed in Section 1.2. These design criteria are used in Sections 5, 6 and 7 together with the identified constraints and opportunities of the predevelopment environment (Section 3) to establish the water management strategy for the site.

Table 4: Key Urban Water Management Design Objectives

Management Elements	Objectives
Water Use Sustainability	
Water Efficiency	▪ Reduce consumptive use through adoption of waterwise practices.
Water Supply	▪ Apply a "fit for purpose" water supply strategy, and minimise potable water use where drinking quality water is not essential.
Wastewater	▪ Provide a wastewater system which meets agency needs.
Stormwater	
Ecological Protection	▪ Water quality management via treatment of the initial 15 mm event via vegetated detention/bioretention. ▪ Use non structural controls to improve water quality.
Serviceability	▪ Design road drainage system for roads to be passable in the 20% AEP event. ▪ Provide 20% AEP event storage areas to attenuate local stormwater runoff post development.
Flood Protection	▪ Overland flows paths in road reserves for safe conveyance of flows exceeding pipe drainage system capacity. ▪ Provide 1% AEP local flood storage areas to attenuate post development flow from the site to predevelopment rates. ▪ Minimum habitable floor levels to be 0.5m above the 1% AEP flood levels.
Groundwater	
Fill Requirement & Subsoil Drainage	▪ Imported fill to be minimised. ▪ Provide subsoil drainage where required to control any post development groundwater rise. ▪ Establish development levels with acceptable clearance above post development groundwater levels.
Acid Sulphate Soils	▪ Management of Acid Sulphate Soils to be handled as a separate process.

5 Water Use Sustainability Initiatives

5.1 Water Efficiency Measures

Development of the site will lead to an increased demand of water for residential use and irrigation of gardens and POS/drainage areas. Water conservation measures will be implemented to reduce scheme water consumption within the development will be consistent with Water Corporation's "Waterwise" land development criteria including:

- Promotion of use of waterwise practices including water efficient fixtures and fittings (taps, showerheads, toilets, rainwater tanks, waterwise landscaping).
- Use of native plants in POS and drainage landscaped area with minimal turf.

5.2 Water Supply

The Water Corporation service the Cowaramup area via the supply main from Margaret River, which passes the southern boundary of the site, before extending east along Wirring Road to the Wirring Road Supply Tank. Potable water supply to future homes in the site will be via extension of this system. Connection to this system will be designed, approved and constructed in accordance with standard Water Corporation requirements.

Rainwater tanks will not be mandated but are recognised as a non-potable source which individual owners may wish to integrate as part of their domestic water supply scheme to minimise scheme water importation.

The Department of Water and Environmental Regulation's online Water Register (DWER, 2023) indicates the surface water resource (Busselton Coast, Wilyabrup Subarea) as being fully allocated. The local groundwater resource (Combined Leeuwin Superficial / Fractured Rock Aquifer) is specified as having limited information, however based on existing groundwater licences in the immediate vicinity of the site in this aquifer, it is considered likely water at the site can be resourced from the Combined Leeuwin Superficial / Fractured Rock Aquifer. Extracts from DWER's Water Register are contained in Appendix I showing the distribution of licencing in this aquifer in close proximity to the site.

The subdivision application area contains a number of distributed POS areas (Figure 2), with three of these proposed to be used for stormwater management (treatment and flood storage) and flow conveyance. This will consist of an integrated swale/living stream, and landscaped vegetated detention/bioretention and flood storage areas for management of events up to the 1% AEP event.

Indicative landscape concept plans are contained as Appendix J. The landscape design aims to minimising POS water use, with any turf area irrigation proposing to use local groundwater via a shallow bore or wet well installation. The preferred supply method will be developed in consultation with the Shire of Augusta-Margaret River during the detailed POS design phase.

Details of calculations for stormwater volumes used to inform landscape planning are contained in Chapter 7.

Further refinement and provision of landscape design plans will occur at UWMP stage prior to POS construction as engineering and landscape detailed design is progressed.

Detailed landscape plans and detailed engineering for POS will be provided to the Shire of Augusta-Margaret River for approval during the detailed planning phase of POS areas.

Any groundwater licence required for long term irrigation of POS will be ultimately transferred to the Shire of Augusta-Margaret River upon handover of POS areas.

5.3 Wastewater Management

Wastewater management will be via deep sewerage. The Water Corporation operates a gravity sewerage network in the area around the site. Connection of the site to this system will be designed, approved and constructed in accordance with standard Water Corporation requirements.

6 Stormwater Management

Stormwater management for the site will be undertaken consistent with DWER and Shire of Augusta - Margaret River water sensitive design practices. Key elements of the stormwater management system for the site are as follows:

- Landforms to be retained to maximise retained vegetation and minimise imported fill.
- Road and lot runoff will be managed via a piped system and conveyed to vegetated detention/bioretention and flood storage areas for water quality treatment and attenuation to ensure post development flow rates from the site are maintained at existing levels.
- Vegetated detention/bioretention areas sized to manage 15 mm rainfall events for water quality treatment.
- The flood route for upstream catchments to be maintained and storages designed to accommodate current inflows.
- Swales/living streams to be provided in linear POS areas where possible to assist in providing conveyance and providing water quality treatment for upstream inflows.

Post development catchments for the site for stormwater modelling are shown in Figure 8, based on the proposed LSP and existing topography. A total of 9 catchments were identified inclusive of 3 upstream catchments. With regard to the external catchments, it is important to note that Catchment A1 has an existing constructed bioretention storage prior to flow discharging via a spillway to culverts under Bussell Hwy and into the site.

No current management of flows from Catchments A2 and A3 occur prior to their discharge into the site. These areas are therefore required to be managed via the sites flood storage.

Note that the stormwater management approach and modelling in this LWMS has taken into consideration the previous hydraulic modelling and designs undertaken for upstream Lot 101 (Wood & Grieve Engineers, 2016; Cardno, 2009), and used this information to inform the strategy presented in this report.

6.1 Stormwater Modelling

Stormwater modelling for the vegetated detention/bioretention and flood storage areas was performed using XP-Storm. The design rainfall storms modelled in XP-Storm were based on methodology in Australian Rainfall and Runoff (AR&R) (Ball et al, Australia, 2016). All design rainfall and temporal patterns were imported into the model using the ARR Data Hub. Rainfall was assumed to be spatially uniform across the catchment.

Storm durations modelled ranged from 30 minutes to 72 hours and all ensembles were run for each storm to determine critical design events. Various runoff coefficients applied to different land uses for each of the AEP's modelled were determined using Hyd2o's CUURV runoff rate calculator as detailed in Appendix K.

Modelled flood storage volumes, areas, and flood rises are detailed in Table 5 and Figure 9 showing the indicative extent of inundation in POS areas for stormwater management of events up to 1% AEP.

XP-Storm modelling outputs are contained in Appendix L, with landscape plans detailing the integration of these results with POS design shown in Appendix J.

6.1.1 Ecological Protection (63.2% AEP)

Stormwater management results for ecological protection based on the 15mm event (~1 year, 1 hour) are provided in Table 5 and Figure 9 detailing storage requirements for water quality treatment consistent with DWER requirements (DWER, 2017).

The volumes and areas specified for each catchment are proposed to be managed via vegetated detention/bioretention systems to provide treatment prior to offsite discharge of small events. Design of these vegetated water quality control measures undertaken in accordance with Shire of Augusta Margaret River requirements during detailed design and documented in the Uran Water Management Plan.

The design of these areas will consider underlying soil permeabilities and site conditions to ensure the areas will not retain standing stormwater for long periods.

6.1.2 Serviceability (20%AEP)

Modelled storage volumes, areas, and flood rises for the 20% AEP event are detailed in Table 5. The total area required for the storages to manage the 20% AEP event is approximately 7861 m^2 with a total storage volume of approximately 7861 m^3.

6.1.3 Flood Protection (1% AEP)

Table 5 and Figure 9 detail the results of modelling for the 1% AEP event and show the extent of inundation for the proposed storage basin in the south western POS. The total area within the site required for flood storage up to the 1% AEP event is approximately 8850 m^2 with a total storage volume of approximately 6589 m^3.

Modelling shows the 3hr event as the critical duration, and all flows for this event pass through the system in 12 hours. This meets the WAPC (2008) criteria for no standing water to be present for 96 hours following a storm event to reduce health risks from mosquitoes.

Note that the storage shapes shown in Figure 9 are indicative only for determination of area requirements, and representation of storage areas required in relation to POS areas allocated in the structure plan. The final flood attenuation area configuration (side slopes etc.) and exact locations will be documented in UWMP's and will be dependent on final earthworks, drainage, and road design levels for the development.

Minor changes (refinements) in catchment areas shown in this report are therefore considered likely to occur as detailed design proceeds, and stormwater modelling will be updated accordingly during the UWMP process.

Table 5. Stormwater Modelling Results

Catchment	Catchment D/E Biofilter	Catchment B/G Biofilter	Catchment C/F (& External A) Biofilter & Storage
Residential R60 (ha) (1% AEP 78%; 20% AEP 73%; 15mm 67%)	-	2.13	-
Residential R30 (ha) (1% AEP 78%; 20% AEP 73%; 15mm 67%)	0.72	0.14	0.79
Residential R25 (ha) (1% AEP 78%; 20% AEP 73%; 15mm 67%)	1.25	0.94	3.17
Residential R12.5 (ha) (1% AEP 66%; 20% AEP 51%; 15mm 46%)	1.46	-	2.22 (1.62)
Roads (ha) (1% AEP 83%; 20% AEP 69%; 15mm 63%)	1.18	0.73	1.88 (2.95)
POS / Landscape (ha) (1% AEP 15%; 20% AEP 3%; 15mm 1%)	1.17	0.58	1.25 (0.39)
Rural (ha) (1% AEP 15%; 20% AEP 3%; 15mm 1%)	-	-	- (1.28)
Total Catchment Area (ha)	5.78	4.52	9.32 (6.24)
15 mm Event EIA (ha)	2.74	2.60	4.86 (2.62)
20% AEP EIA (ha)	3.05	2.88	5.38 (2.93)
1% AEP EIA (ha)	3.65	3.18	6.29 (3.76)
Existing Peak Discharge (m^3/s) 1% AEP	-	-	0.58 (site plus upstream)
Storage Characteristics			
Nominal Basin Invert (mAHD)	128.3	129.6	biofilter 127.1 flood storage 127.4
Base Area (m^2)	850	800	biofilter 2000 flood storage 5525
Batter Slopes (1:v)	biofilter 1:0	biofilter 1:0	biofilter 1:0 flood storage1:6
Nominal Modelled Outlet	weir @ 0.3m depth + subsoil	weir @ 0.3m depth + subsoil	600 mm outlet pipe @ 0.3m depth + subsoil
Vegetated Detention/Bioretention Area 63% AEP Event (~15mm)			
Flood Rise (m)	0.29	0.29	0.29
Base Area (m^2)	850	800	2000
TWL Area (m^2)	850	800	2000
Volume (m^3)	246	231	584
20% AEP Event			
Flood Rise (m)	Overflow to site flood storage area	Overflow to site flood storage area	0.67
Volume (m^3)			2756
TWL Area (m^2)			6211
Critical Storm (hr)			3
Peak Discharge Rate (m^3/s)			0.24
1% AEP Event			
Flood Rise (m)	Overflow to site flood storage area	Overflow to site flood storage area	1.17
Volume (m^3)			6112
TWL Elevation (mAHD)			128.3
TWL Area (m^2)			7200
Critical Storm (hr)			3
Peak Discharge Rate (m^3/s)			0.58

6.2 Water Quality Treatment

This LWMS proposes a treatment train approach to water quality management, including:

- **Non-Structural Controls**
  Planning: Lot product, POS and storage locations and configuration
  Landscape: Native plantings, WSUD integration
  Maintenance: Storage areas, street sweeping, manhole eduction
  Monitoring: Post development program and review process
- **Structural Controls**
  Vegetated detention/bioretention storages to provide 15mm event treatment

These measures represent known best management practice as detailed in the Stormwater Management Manual for Western Australia (DWER, 2022). Table 6 details a summary from (DWER, 2022) of expected pollutant removal efficiencies for various WSUD measures in relation to water quality design criteria.

While (DWER, 2022) does not provide expected pollutant removal efficiencies for all BMP's, application of a treatment train approach with a combination of the measures detailed will therefore achieve the design objectives for water quality as detailed in Better Urban Water Management (WAPC, 2008).

Vegetated detention/bioretention areas will be sized to treat the first 15mm in accordance with agency requirements (DWER, 2017). Areas and volumes are detailed in Table 5.

Table 6: BMP Water Quality Performance in Relation to Design Criteria

Parameter	Criteria via WAPC (2008) (removal as compared to a development with no WSUD)	Nutrient Output Reduction	
		Vegetated Detention/ Bioretention Systems	Detention/ Retention Storages
Total Suspended Solids	80%	60-80%	65-99%
Total Phosphorus	60%	30-50%	40-80%
Total Nitrogen	45%	25-40%	50-70%
Gross Pollutants	70%	-	>90%

6.3 Nutrient Input Assessment for Proposed Land Use

Post development UNDO modelling of the site is detailed in Appendix M, showing the impact land use change will have with respect to nutrient application and export. Modelling was performed on the local structure plan shown in Figure 2.

The modelling results indicate land use change will result in nutrient inputs of 1,145 kg/yr for TN and 249 kg/yr TP post development. Compared to existing land use (previously detailed in Section 3.7) this results in a 331 kg/yr (22%) reduction in TN input and 13 kg/yr (5%) reduction in TP input annually.

The resultant nutrient export, inclusive of water sensitive urban design, was 36 kg/yr of TN and 7 kg/yr export of TP following development. This represents a 96 kg/yr reduction in TN export and a 5 kg/yr increase in TP export to the environment post development.

These exports are considered likely to be overestimated as not all water sensitive design water quality treatment measures have been included in the UNDO modelling process.

7 Groundwater Management Strategy

The engineering servicing report is contained as Appendix N.

Earthworks for the site will comprise of cut to fill operations, and imported fill where required to achieve clearance to groundwater and flood routing to suit the final development layout.

Give the underlying soil strata, subsoil drainage will be incorporated to assist and control the groundwater levels throughout the sit+e where necessary.

Water quality aspects of groundwater management will be achieved via the distributed vegetated detention/bioretention areas in POS areas to treat stormwater runoff prior to infiltrating or flowing off site.

Final finished lot levels are a detailed design issue to be addressed during the preparation of detailed engineering design drawings and preparation of the UWMP and will be ultimately submitted for council approval at that stage.

7.1 Acid Sulphate Soils

Based on the outcomes of the initial ASS investigation, Douglas Partners (2008) recommended that further detailed investigations for acid sulphate soils, targeting areas of proposed excavations and dewatering be undertaken prior to the commencement of works. The results of these detailed investigations would then form the basis of an acid sulphate soil management plan.

Management of ASS will be addressed as a separate study to the LWMS process, with details regarding the outcomes to be included as part of the Urban Water Management Plan (UWMP).

All assessment and management of ASS will be conducted in accordance with the Acid Sulphate Soil Guideline Series documentation (Department of Environmental Regulation, 2015a & b).

8 Urban Water Management Plans

Consistent with processes defined in WAPC (2008), an Urban Water Management Plan (UWMP) will be developed and submitted to support a subdivision application for the site.

The UWMP will address:

- Demonstrated compliance with LWMS criteria and objectives to the satisfaction of the Shire of Augusta-Margaret River and DWER.
- Agreed/approved measures to achieve water conservation and efficiencies of water use.
- Detailed stormwater management design including the size, location and design of public open space areas, integrating major and minor flood management capability.
- Management of groundwater levels including proposed cut/fill level earthworks, and any subsoil drainage inverts (if/where required).
- Specific structural and non-structural BMPs and treatment trains to be implemented including their function, location, maintenance requirements, expected performance and agreed ongoing management arrangements.
- Management of subdivisional works
- Implementation plan including roles, responsibilities, funding and maintenance arrangements.
- Specific monitoring and reporting to be undertaken consistent with the monitoring program defined in the LWMS.
- Contingency plans (where necessary).

More detail on stormwater storage integration with POS aeras will be provided during the development of the UWMP, including refinement of stormwater modelling, preparation of mor detailed landscape plans (species selection and treatments), and detailed engineering design drawings.

Preparation of the UWMP will be the responsibility of the developer.

9 Monitoring

9.1 Pre Development Monitoring

Hyd2o has received previous advice from both DWER and Shire of Augusta-Margaret River that no groundwater monitoring is required to inform the planning process and this LWMS. This advice was based on consideration that post development site levels will be primarily determined by the depth of permeable soils on the site above less permeable strata.

Notwithstanding some field investigations were conducted by Hyd2o to inform this LWMS as previous described in Chapter 3, including surface water sampling to inform the setting of baseline water quality conditions.

No further monitoring is therefore considered to be required to inform development.

9.2 Post Development Monitoring

Post development monitoring is proposed to operate over a two year period to primarily assess the overall performance of the stormwater system and storage areas. This period of post development monitoring is considered appropriate given the scale of the development to assess the functioning of the stormwater management system.

A standardised proforma will be used to assess performance against design intent. The proforma will consider processes such as vegetation health, scour, erosion, deposition, water levels, and retention periods in all stormwater storage areas.

The program will be conducted as a series of visual inspections to consider processes such as erosion and deposition, vegetation health and water levels and retention periods within vegetated detention/bioretention storages. The inspection will also view outflow areas from the storages for evidence of erosion and scour particularly in relation to surrounding lands. Observations will be used to determine maintenance requirements. Typical items to be monitored are provided in Table 7, with the proposed monitoring locations indicated in Figure 10.

Water quality sampling at key locations is also recommended to be undertaken should water be present within storages, or as inflows or outflows at the time of visual inspection.

Assessment of monitoring outcomes and system performance will be undertaken as part of an annual review and reporting process. Should the system not be functioning in accordance with design a contingency action plan will be implemented. A contingency action plan is shown in Table 8. Actioning of contingencies will be based on comparing monitoring results against trigger values based on predevelopment monitoring outcomes.

The program may need to be modified as data is collected, to increase or decrease the monitoring effort in a particular area or to alter the scope of the program itself. Any modification to the program would be identified through review of collected data and would require the agreement of all parties (DWER, SoAM, and developer).

This program should operate for the first two years following construction with monitoring undertaken a minimum of four times annually.

Table 7. Post Development Monitoring Schedule

Monitoring	Method	Frequency and Timing
Piped System	• Inspect for sedimentation • Identify areas where piped drainage system capacity may be exceeded within monitoring period	Quarterly for 2 years
Storage Areas	• Inspect for erosion and deposition • Assess peak levels against original design, and review any evidence of overtopping • Assess vegetation health • Assess litter content • Assess standing water	
Receiving Environments	• Review frequency of offsite discharge • Assess status of receiving environment • Erosion and/or blockage presence	
Water Quality Sampling	• Grab samples for testing of physical parameters, nutrient and metals. Sample site inflow & outflow, storages & their outflows	Twice annually during winter for 2 years

Table 8: Contingency Planning

Monitoring Type	Criteria for Assessment	Criteria Assessment Frequency	Contingency Action
			1. Assess if an isolated, development area or regional occurrence. 2. Determine if due to the development or other external factors. 3. Perform appropriate contingency action as required (examples provided below) 4. Record and report any breach and action taken. 5. If necessary, inform residents of any required works and their purpose. 6. Inform and provide monitoring data to DWER and local government upon breach of any trigger value(s).
Surface Water Quality	**Overall Water Quality** Water quality discharging from the Study Area significantly greater than: a) Mean predevelopment surface water quality existing the site (via Table 3) TN : 0.8 mg/l TP : 0.1 mg/l b) Typical urban stormwater quality on the Swan Coastal Plain (Martens et al 2004) TN : 1.1 mg/l TP : 0.2 mg/l **BMP Performance** Comparison of water quality inflow and outflow parameters.	Annual Review	1. Identify and remove any point sources of pollution. 2. Review operational and maintenance (e.g. fertilising) practices. 3. Consider alterations to POS areas including landscape regimes and soil amendment. 4. Consider modifications to the stormwater system. 5. Consider initiation of community based projects.

10 Implementation

Table 9 details the roles, responsibilities, and funding to implement the LWMS.

Should the LWMS require any deviations to the strategy detailed in this document, this will require the agreement of all parties (DWER, Shire of Augusta-Margaret River, and developer).

Operation and maintenance of the stormwater management system will initially be the developer's responsibility, ultimately reverting to the Shire following handover.

Details of maintenance responsibilities will be further outlined at UWMP stage. The schedule for maintenance works will be consistent with typical requirements of the Shire of Augusta-Margaret River for stormwater management.

Table 9: Implementation Roles and Responsibilities

Implementation Action	Responsibility & Funding	
	Developer	**Shire of Augusta-Margaret River**
Preparation of UWMP	☑	
Review & Approval of UWMP		☑
Post Development Monitoring Program	☑	
Construction of Stormwater System	☑	
Operation & Maintenance		
a) Prior to Handover	☑	
b) Following Handover		☑

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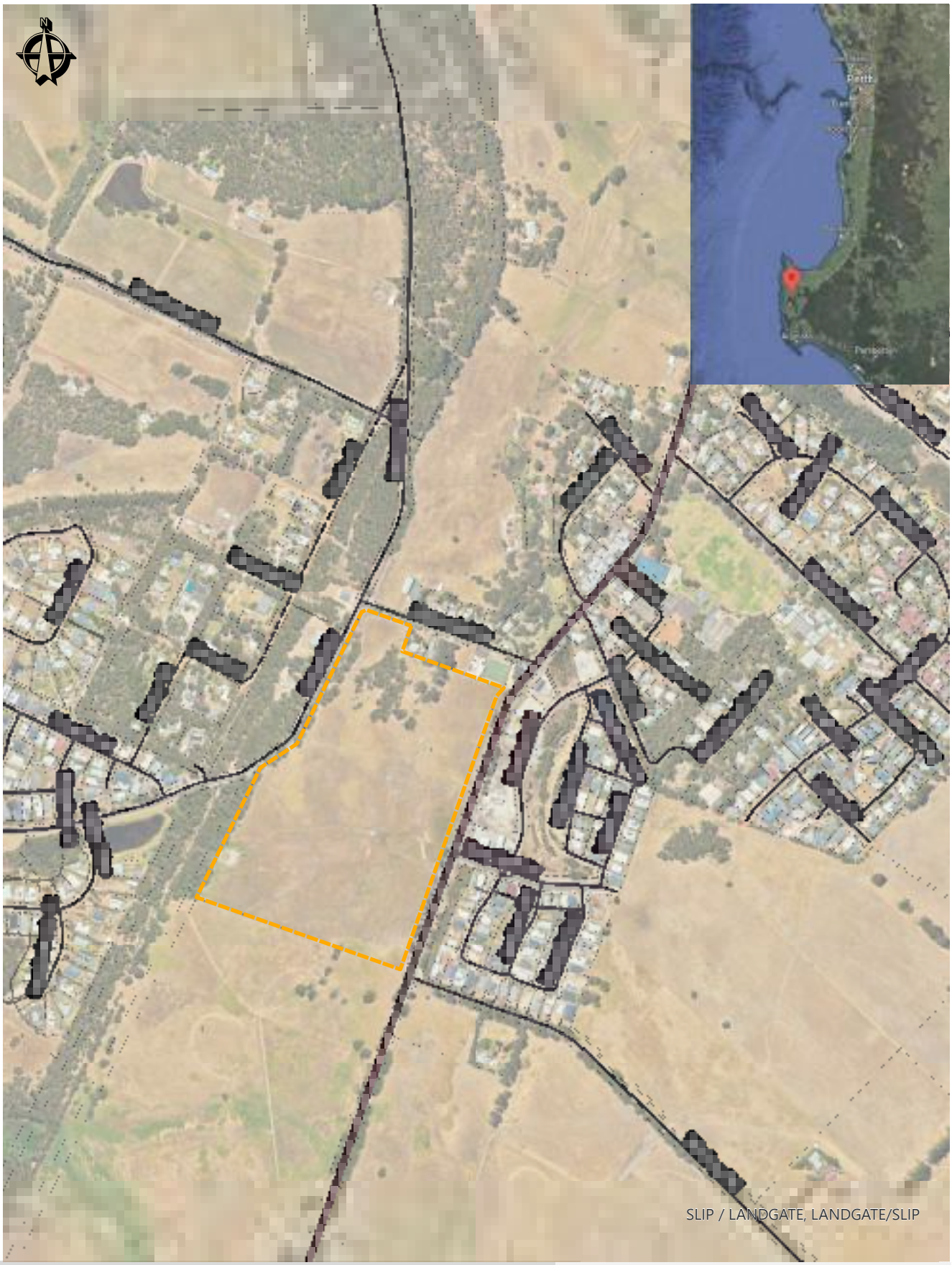
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FIGURES

Date: 11/10/2023 Job No. H23019



Site

0 75 150 225 300 Meters

hyd2o

Lot 102 Bussell Hwy Cowaramup LWMS

Location Plan

Figure 1

Date: 11/10/2023 Job No H23019



Source: Rowe Group 2023

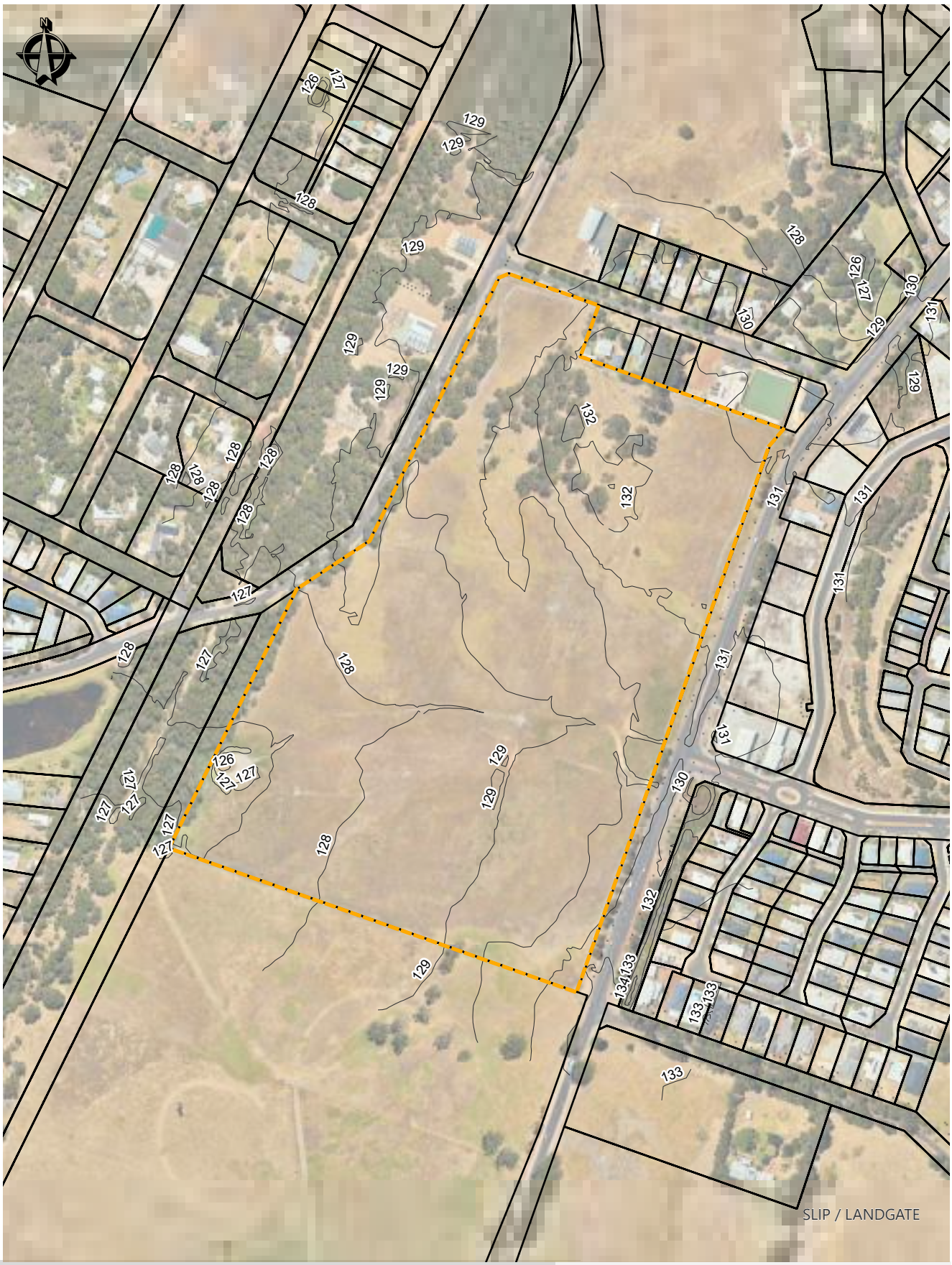
hyd2o

Lot 102 Bussell Hwy Cowaramup LWMS

Local Structure Plan

Figure 2

Date: 11/10/2023 Job No. H23019



Site

1m Topographical Contours

0 30 60 90 120 Meters

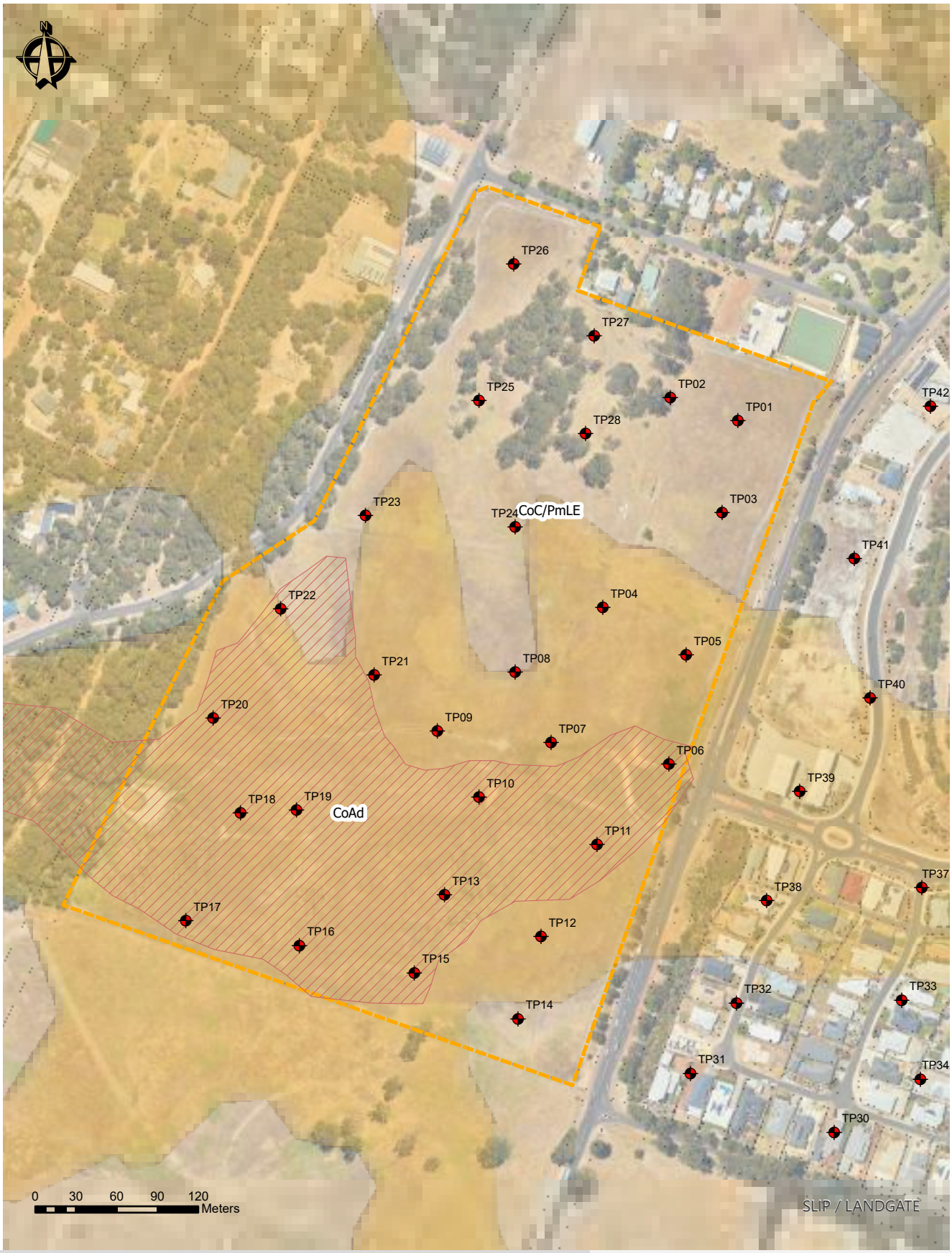
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Lot 102 Bussell Hwy Cowaramup LWMS

Site Conditions

Figure 3

Date: 11/10/2023 Job No. H23019



Site

Geotech Test Pits
(Douglas Partners, 2008)

Moderate to low
ASS risk within 3m

CoAd : Alluvial. Drainage depression; includes seasonally active channels; formed in weathered bedrock and slope deposits; silty clayey sand

Remainder of Site : CoC/PmLE
Colluvial undivided slopes silty or gravelly sand over mottled sandy clay, underlain by Leeuwin Complex

hyd2o

Lot 102 Bussell Hwy Cowaramup LWMS

Geotechnical Plan

Figure 4

Date: 11/10/2023 Job No. H23019



Site

Geomorphic Wetlands
Leeuwin Naturaliste Ridge and Donnybrook to Nannup - Unreviewed (DBCA-043)

Palusvale

0 75 150 225 300
Meters

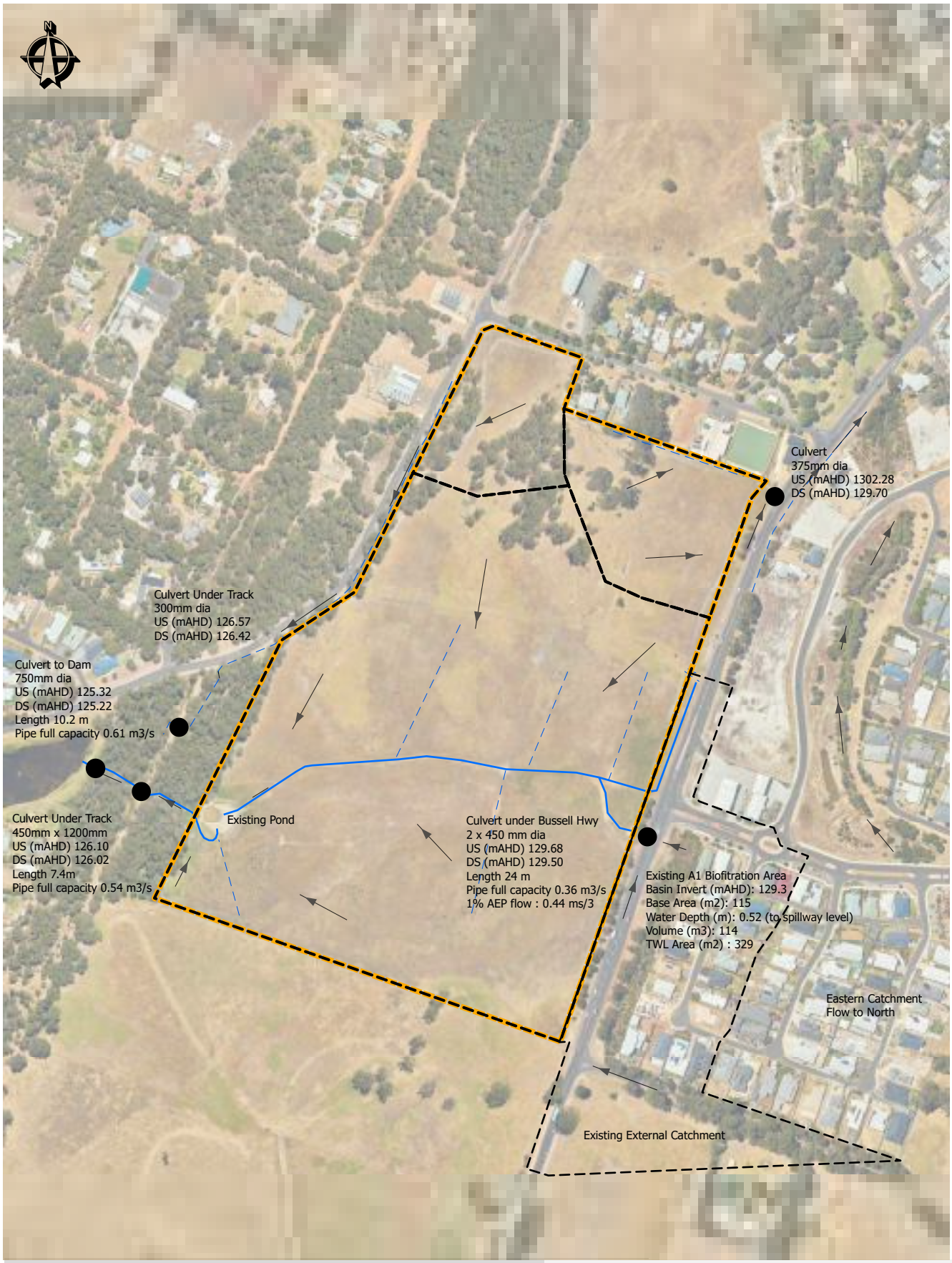
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Lot 102 Bussell Hwy Cowaramup LWMS

Wetland Plan

Figure 5

Date: 11/10/2023 Job No. H23019



Site

Existing Catchments

Flow Direction

Watercourse/Drains

Culverts

0 40 80 120 160 Meters

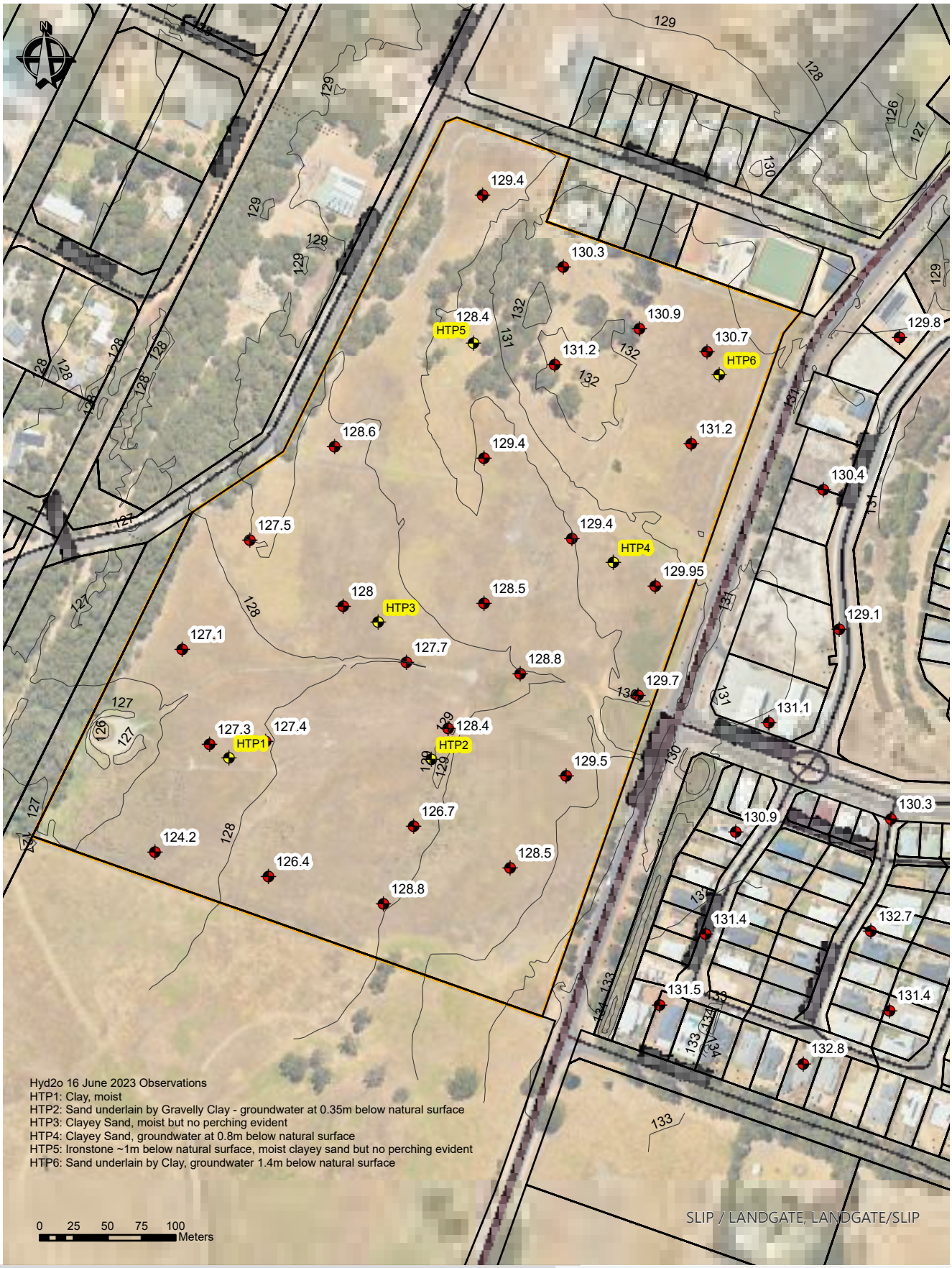
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Lot 102 Bussell Hwy Cowaramup LWMS

Surface Water Plan

Figure 6

Date: 10/10/2023 Job No. H23019



LWMS Site Boundary

Hyd2o Test Locations 16 June 2023

Elevation at Base of Sand Layer (mAHD)
(via Douglas Partners Test Pits)

1m Topographical Contours

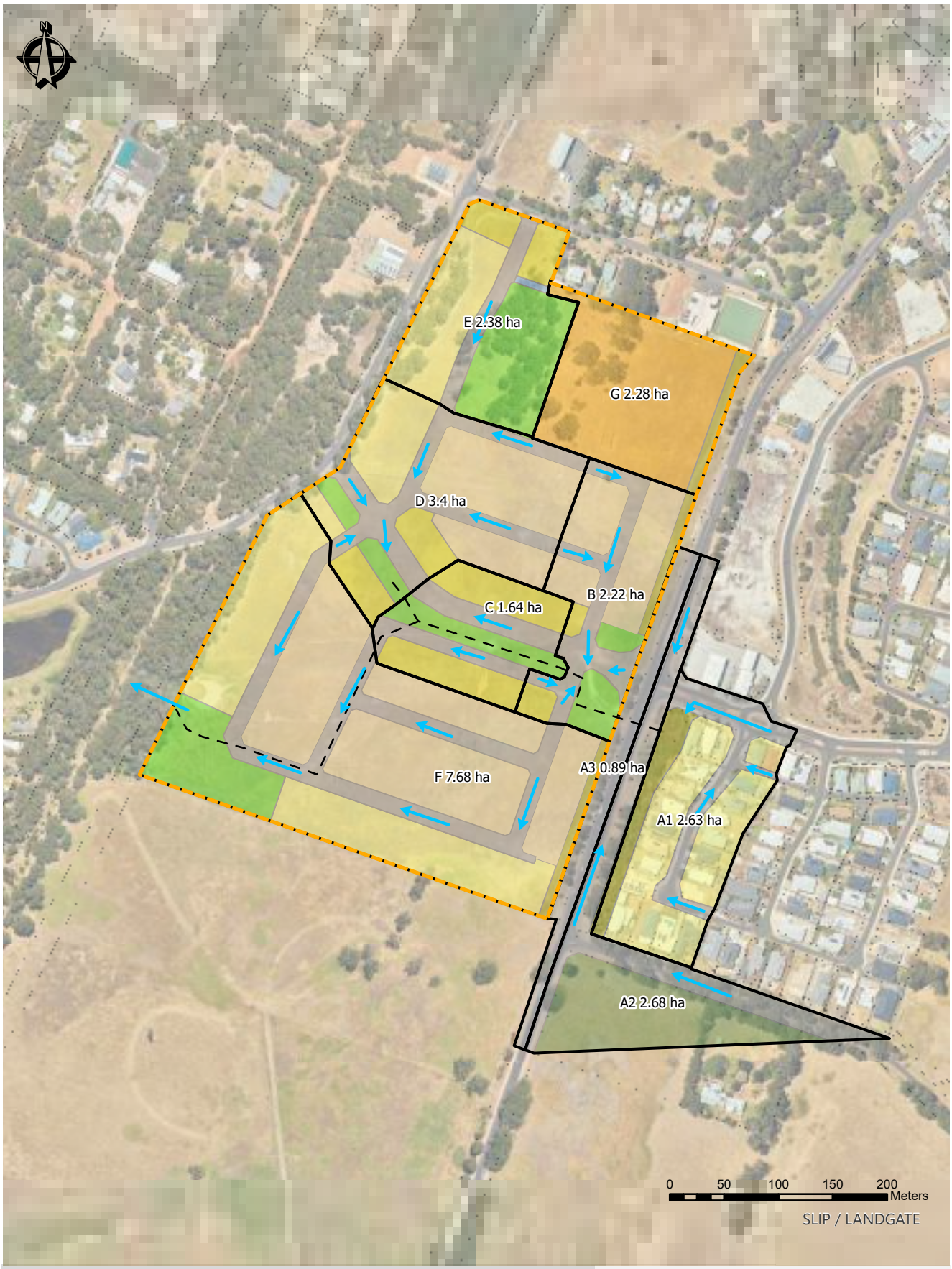
hyd2o

Lot 102 Bussell Hwy Cowaramup LWMS

Groundwater Plan

Figure 7

Date: 20/10/2023 Job No. H23019



LWMS Site Boundary
Catchments
Key Drainage Flowpath
Existing Culvert
Flow Direction

Landscape Buffer
POS
Road Reserve
Shared Access Easement

R12.5 Lot
R25 Lot
R30 Lot
R60 Lot
Rural

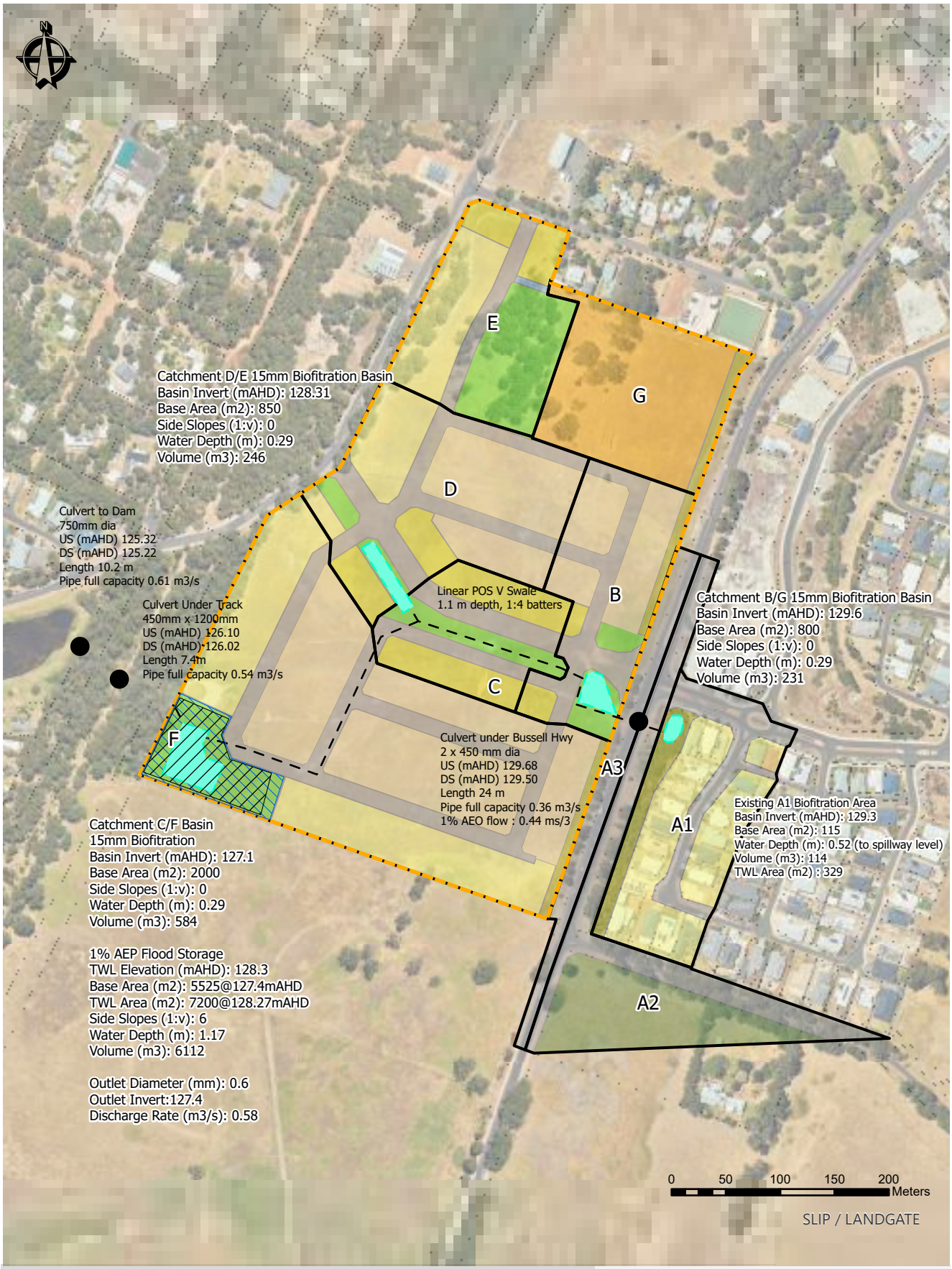
hyd2o

Lot 102 Bussell Hwy Cowaramup LWMS

Catchment Plan

Figure 8

Date: 20/10/2023 Job No. H23019



LWMS Site Boundary
Catchments
1%AEP Flood Storage
20%AEP Flood Storage
Biofiltration Areas
Key Drainage Routes
Landscape Buffer
POS
Road Reserve
Shared Access Easement
Existing Culvert
Flow Direction
R12.5 Lot
R25 Lot
R30 Lot
R60 Lot
Rural

hyd2o

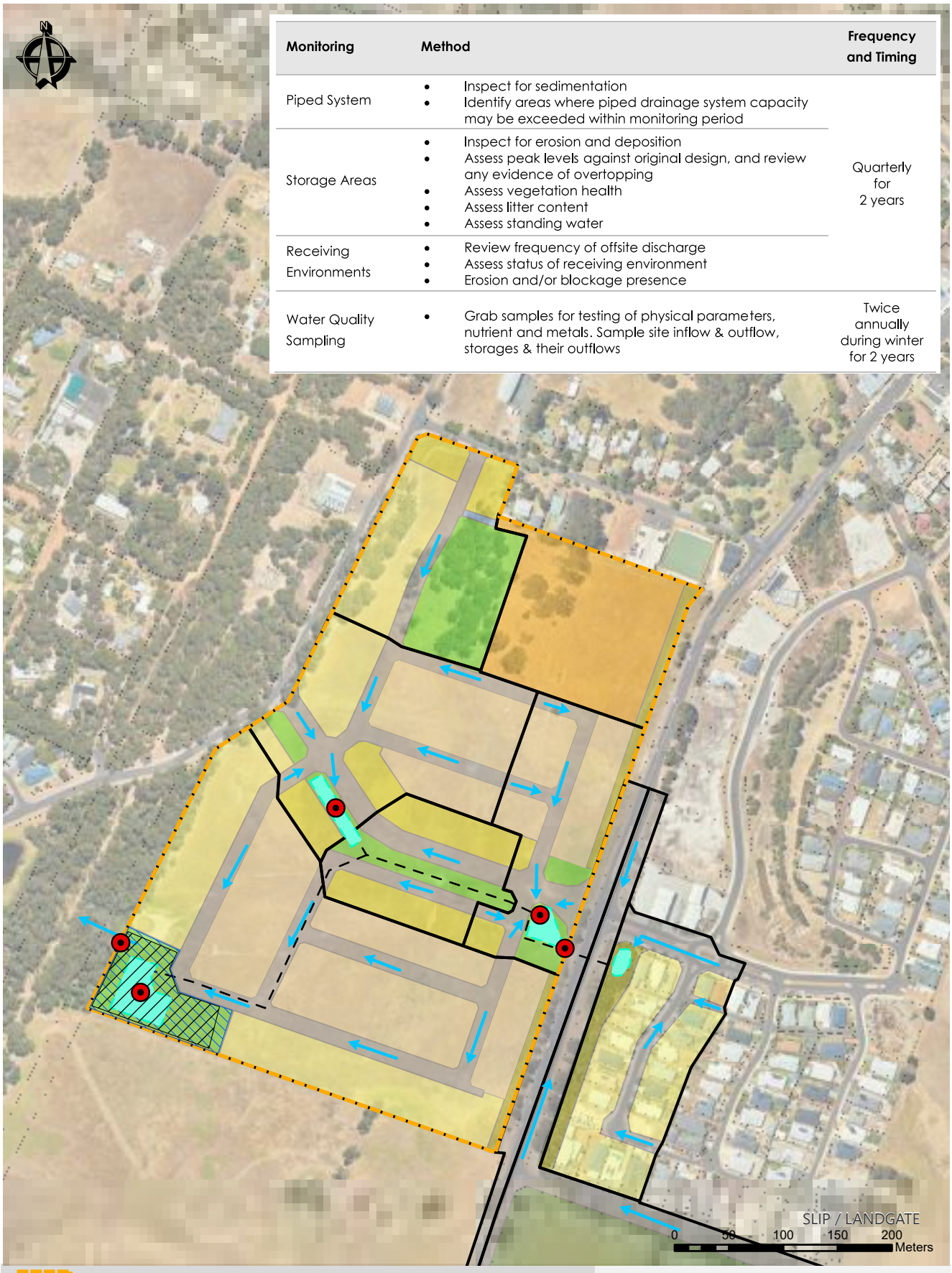
Lot 102 Bussell Hwy Cowaramup LWMS

Stormwater Event Plan

Figure 9

Date: 20/10/2023 Job No. H23019

Monitoring	Method	Frequency and Timing
Piped System	• Inspect for sedimentation • Identify areas where piped drainage system capacity may be exceeded within monitoring period	Quarterly for 2 years
Storage Areas	• Inspect for erosion and deposition • Assess peak levels against original design, and review any evidence of overtopping • Assess vegetation health • Assess litter content • Assess standing water	
Receiving Environments	• Review frequency of offsite discharge • Assess status of receiving environment • Erosion and/or blockage presence	
Water Quality Sampling	• Grab samples for testing of physical parameters, nutrient and metals. Sample site inflow & outflow, storages & their outflows	Twice annually during winter for 2 years



LWMS Site Boundary
Catchments
1%AEP Flood Storage
20%AEP Flood Storage
Biofiltration Areas
Key Drainage Routes
Landscape Buffer
POS
Road Reserve
Shared Access Easement
Rural
Proposed Monitoring Locations
R12.5 Lot
R25 Lot
R30 Lot
R60 Lot

hyd2o

Lot 102 Bussell Hwy Cowaramup LWMS

Post Development Monitoring Plan

Figure 10

APPENDIX A
LWMS Checklist

Better Urban Water Management LWMS Checklist

Local Water Management Strategy Item	Deliverable	✓	Comments
Executive summary			
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Design elements and requirements for BMP's and critical control points	☑	Executive Summary & Section 4
Introduction			
Total water cycle management - principles and objectives Planning background Previous studies		☑	Introduction, Sections 1.1 & 1.2
Proposed development			
Structure plan, zoning and land use Key landscape features Previous land use	Site context plan Structure plan	☑	Section 1, 2, & 3. Figure 1, Figure 2, Figure 3
Landscape - proposed POS areas, POS credits, water source, bore(s), lake details (if applicable), irrigation areas	Landscape plan	☑	Stormwater Areas and Volumes to inform POS credits in Section 6 & Figures 9. Water availability identified in Section 5.2. Landscape Plan in Appendix J
Design criteria			
Agreed design objective and source of objective		☑	Section 4
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		☑	Section 3 & Figures 3-7
Site conditions- existing topography/ contours, aerial photo underlay, major physical features	Site condition plan	☑	Section 3.1, Figure 3
Geotechnical - topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geotechnical plan	☑	Section 3.2, Figure 4
Environmental- areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental plan plus supporting data where appropriate	☑	Sections 3.3-3.4, Figure 5
Surface water- topography, 100 year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface water plan	☑	Section 3.5, Figure 6
Groundwater - topography, pre development groundwater levels and water quality, test bore locations	Groundwater plan plus details of groundwater monitoring and testing	☑	Section 3.6, Figure 7
Water use sustainability initiatives			
Water efficiency measures- private and public open spaces including method of enforcement		☑	Section 5.1
Water supply (fit- for-purpose strategy), agreed actions and implementation. If non-potable supply, support with water balance		☑	Section 5.2
Wastewater management		☑	Section 5.3
Stormwater management strategy			
Flood protection - peak flow rates, volumes and top water levels at control points, 100 year flow paths and 100 year detentions storage areas	100yr event plan Long section of critical points	☑	Section 6 & 6.1-6.3, Figures 8 & 9
Manage serviceability - storage and retention required for the critical 5 year ARI storm events Minor roads should be passable in the 5 year ARI event	5yr event plan	☑	Section 6 & 6.1-6.3, Figures 8 & 9
Protect ecology - detention areas for the 1 yr 1 hr ARI event, areas for water quality treatment and types of (including indicative locations for) agreed structural and non-structural best management practices and treatment trains. Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	1 yr event plan Typical cross sections	☑	Section 6 & 6.1 & 6.3 Figures 8 & 9

Local Water Management Strategy Item	Deliverable	✓	Comments
Groundwater management strategy			
Post development groundwater levels, fill requirements (including existing and likely final surface levels), outlet controls, and subsoil areas/exclusion zones	Groundwater/subsoil plan	☑	Section 7
Actions to address acid sulphate soils or contamination		☑	Section 7
The next stage - subdivision and urban water management plans			
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required prior to detailed design		☑	Section 8
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		☑	Section 9
Implementation			
Developer commitments		☑	Section 10
Roles, responsibilities, funding for implementation		☑	Section 10
Review		☑	Section 10

APPENDIX B

Structure Pan
(Rowe Group, 2023)



\\GRA-FS\DATA\TOWN PLANNING\9000-9999\9729\02 DRAFTING\A-CAD · VR · 2023.10.17

PLAN 1 - STRUCTURE PLAN

LOT 102 BUSSELL HIGHWAY

COWARAMUP

N

0 60 m

SCALE @ A3: 1:2500

9729-LSP-01-D

DRAWN:	VR
DATE CREATED:	2023.10.17
PROJECTION:	MGA50 GDA2020
CADASTRE:	LANDGATE
AERIAL:	MAR 2022

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ROWE GROUP DESIGN

APPENDIX C

Site Feature Survey
(MNG,2023)



CONTOUR INTERVAL: 0.25m

NOTE: Only trees withe trunk diameter greater or equal to 0.3m were surveyed.

Existing boundaries have been extracted from Landgate's Spatial Cadastral Database, which is only a model of the cadastre. The depicted boundary locations are a graphical representation only and as they have not been re-established by survey. MNG does not guaranteed the position unless stated otherwise.
Re-establishment of lot boundaries by a Licensed Surveyor is recommended for any works on or about a boundary.
This note is an integral part of this plan.

Surface features and levels have been surveyed to meet the requested scope of works accuracy. The surface may be contoured to depict topography or defined only by spot heights. For clarity on hard copy some level information is not shown, refer to 3D digital file.
Above ground indicators (markers) of underground services are located where visible.
Third parties utilising this information should confirm the capture accuracies meet requirements prior to use.
This note is an integral part of this plan.

Rev.	Description	Drawn	Date	Checked
A	Initial Issue	ASO	06/07/2023	MBW

Surveyor:- ASO
Survey Date:- 04/07/2023
Precal/Cad:- LANDGATE

SCALE 1:1200 @ A1
0 15 30 45 60 120
ALL DISTANCES ARE IN METRES
For a true to scale reproduction of this plan, plot it to A1 with the Paging Scaling set to None.

The boundaries shown on this plan were not re-established as part of this survey, therefore this plan does not guarantee their accuracy. Existing easements, encumbrance or interest are not depicted and a title search is recommended to obtain this information. Re-establishment of the cadastral boundaries is recommended for any proposed works on or near existing boundaries.

FEATURE SURVEY
LOT 102 BUSSELL HWY
COWARAMUP

CLIENT:
GOLDFIELDS GROUP

The contents of this plan are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should satisfy themselves of this plans currency by contacting the McMullen Nolan Group.

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ABN 90 009 363 311

Project Mngr.	Matthew Webb	Datum	MRCG94 / AHD

105705 - DE - 004 - A
Job Number | Type | Plan Number | Revision

ROAD FEATURES
- Traffic Junction Box
- Traffic Signals - 1 Aspect
- Traffic Signals - 2 Aspect
- Traffic Signals - 3 Aspect
- Traffic Signals - 4 Aspect
- Pedestrian Signals
- Sign On One Pole
- Sign Multiple Poles
- Overhead Sign
- Traffic Controller Box
- Finger Sign
- Traffic Earth Pit
- Police Traffic Camera
- Guide Post
- Km Marker
- Traffic Count

ELECTRICAL
- Earth Pit
- Electrical Pillar
- Electrical Dome
- Light Pole - Directional
- Power Pole
- Transformer Single Pole
- Stay Pole
- Steel Wire Anchor
- High Mast Lighting
- Electrical Cable Marker
- MRWA Cable Marker
- MRWA Electrical Cable Box
- Electrical Cable Pit/Box
- MRWA Distribution Board
- High Tension Power Pole
- Electrical Supply Pole
- Ground Floodlight
- MRWA Electrical Manhole
- Meter Box
- Power Meter Box
- Electrical Transformer
- MRWA Light Pole
- MRWA Multiple Light Pole

COMMUNICATION
- Telstra Pit
- Telstra Pillar
- Telstra Marker
- Telstra Pole
- Telephone Booth
- Emergency Phone
- Antenna
- Telstra Elevated Joint
- Cable Marker (Optus)
- Telstra Tower
- Communication Manhole

WATER
- Water Meter
- Water Stop Valve
- Hydrant (Ground Level)
- Hydrant (Pillar)
- Water Bore
- Stand Pipe
- Reticulation Sprinkler
- Reticulation Control Valve
- Well
- Water Main Marker
- Water Tap
- Flushing Point
- Air Valve
- Peizometer
- Hydrant Booster Box

GAS
- Gas Marker
- Gas Valve
- Gas Test Valve
- LPG Tank
- Gas Test Pit
- Gas Manhole

DRAINAGE
- Invert Level
- Overt Level
- Flood Level
- Water Line
- Flood Level Indicator
- Storm Water Grate
- Drainage Gully
- Drainage Manhole
- Drainage Headwall

SEWER
- Sewer Vent
- Sewer Line Marker
- Sewer Inspection Shaft
- Sewer Inspection Opening
- Sewer Manhole

RAIL
- Rail Traffic Signals
- Rail Traffic Control Box
- Rail Telephone Box
- Rail Cable Pit
- Rail Cable Marker
- Rail SLK Post
- Manhole - Rail Cable

STRUCTURE
- Deck Level
- Floor Level
- Column Centre

GENERAL
- Clothes Hoist
- Air Conditioner
- Marker Unk/Undefined
- Undefined Manhole
- Control Of Access Sign
- Count Station
- Advertising Sign
- Windmill
- Stock Trough
- Litter Bin
- Mail Box
- Parking Meter
- Bus Stop
- Ticket Machine
- Borehole
- Flag Pole
- Bollard
- Fuel Bowser
- Underground Filler
- Diesel Tank
- Oil Main Marker
- Security Post
- Tank

GROUND FEATURES
- Natural Surface
- Aerial Survey Marker

VEGETATION
- Tree Details - Canopy & Trunk
- Tree 0.1m-0.3m Trunk Diameter
- Tree 0.3m-0.5m Trunk Diameter
- Tree 0.5m-1.0m Trunk Diameter
- Tree > 1.0m Trunk Diameter
- Bush
- Die Back Area - Marker
- Nesting Tree
- Tree Trunk / Stump
- Grass Tree

SURVEY CONTROL
- Star Iron Picket
- Trig Point
- SSM
- Bench Mark
- Photo Point
- Cadastral Peg/Post
- Reference Peg
- Alignment Control
- Spring Head Nail
- Spike
- TBM
- Peg Placed / Found

ROAD FEATURES
- Edge Of Bitumen
- Road Shoulder
- Edge Of Unsealed Road
- On Road
- Centre Of Road
- Kerb Top
- Kerb Bottom
- Cattle Grid
- Centre Of Driveway
- Edge Of Driveway
- Pedestrian Ramp
- Pedestrian Crosswalk
- Track
- Parking Bay
- Line Markings 1m Line & 1m Gap
- Line Markings 1m Line & 3m Gap
- Line Markings 3m Line & 9m Gap
- Lane Marking (9m*3m GAP)
- Lane Markings - Audible
- Shared Pathway - Guide Line 900mm*300mm GAP
- Footpath/Shared Path - Give Way 200mm*200mm GAP
- Giveway/Hold/Turn Lines 600mm*600mm GAP
- Double Barrier Line
- Overtaking Lane Left
- Overtaking Lane Right
- Single Solid Line
- Arrow Straight
- Arrow Straight/Left
- Arrow Straight/Right
- Arrow Left
- Arrow Right
- Arrow 3 Ways
- Arrow Right & Left
- Arrow U-Turn
- Arrow Merge
- Painted Lettering On Seal
- Painted Bicycle Traffic Signal Detector
- Guardrail - W Beam
- Guardrail - Thrie
- Barrier Concrete
- Barrier Steel Rope
- Barrier - Single Rail
- Barrier - Double Rail
- Barrier Triple Rail
- Bridge Barrier - (All Types)
- Bridge Expansion Joints
- Bridge - Outside Of Deck
- Soffit String

STRUCTURE
- Bridge
- Abutment
- Columns
- Piers
- Underpass
- Ramp
- Steps/Stairs
- Edge Of Concrete
- Bus Shelter
- Memorial
- Ruin
- Building / Structure
- Awning
- Shed
- Verandah
- Door Opening
- Window
- Roof Gutter Line
- Roof Ridge Line
- Top Of Wall
- Brick Wall
- Concrete Wall
- Livestock Grid

GROUND FEATURE
- Major Contour
- Minor Contour
- Bank Bottom
- Bank Top
- Line Of Levels
- Levee Top
- Levee Bottom
- Rock Outcrop
- Ridge Line
- Borrow Pit
- Earthworks Area
- Ground Subsidence
- Rock Pitching

VEGETATION
- Tree Line/Canopy
- Bush Line
- Hedge
- Garden Bed
- Lawn Area
- Vineyard
- Plantation
- Orchard
- Nursery
- Market Garden
- Recreational Area
- Trunk Circumference Circle
- Tree-line Face Of Trunks

ELECTRICAL
- Varible Message Sign
- Electrical Structure String
- Overhead Powerlines - Null Height
- Overhead Powerlines - True Height
- High Tension Power Lines - Null Height
- High Tension Power Lines - True Height

COMMUNICATION
- Unidentifed Service Pit
- Telstra Cable
- Amcom Cable

WATER
- Water Pipe

GAS
- Gas Line

DRAINAGE
- Drainage Pipe
- Drainage Culvert
- Floodway
- Drain
- Edge Of Drain
- Sump
- Waters Edge
- Swamp
- Dam
- Edge Of Creek/Water
- Centre Of Channel
- Wet Area
- Flood Level Line
- Waterways Cross Section

SEWER
- Sewer Pressure Main
- Sewer Pipe

RAIL
- Railway Platform
- On Rail
- Rail Boom Gate
- Rail Underground Cable
- Dual Gauge Rail
- Narrow Gauge Rail
- Cross Setion - Rail
- Standard Gauge Rail
- Rail U/G Cable

CADASTRAL
- MNG Precal/Re Established
- (SCDB) - State Cadastral Data Base
- Cadastre By Others

GENERAL
- Swimming Pool
- Tank Perimeter
- Mine Shaft
- Mine Workings
- Koppa Logging Fence
- Fence/Gate
- Wall
- Top Of Barrier / Wall etc
- Retaining Wall
- Boundary Line
- Footpath
- Gas Cylinder/Tank
- Brick Paving
- Bike Rack
- Bench Seating
- Handrail

UNDERGROUND SERVICES

UNDERGROUND SERVICES - inDIRECT MEASUREMENT - CLASS B

(PZA)	Underground Amcom/Vocus Cable
(PZC)	Underground Drainage Pipe
(PZE)	Underground Electrical Cable
(PZF)	Underground Western Power Comms
(PZG)	Underground Gas Line
(PZH)	Underground MRWA Comms
(PZI)	Underground MRWA Power
(PZJ)	Underground NBN Comms
(PZK)	Underground TPG /Pipe Networks
(PZN)	Underground Next Gen Comms
(PZO)	Underground Optus Fibre_Optic
(PZP)	Underground Optus Copper
(PZR)	Underground Rail Services
(PZS)	Underground Sewer Pipe
(PZT)	Underground Telstra Copper
(PZU)	Underground Unknown Service
(PZV)	Underground Telstra Optic_Fibre
(PZW)	Underground Water Pipe
(PZX)	Underground Reticulation Pipe
(PZZ)	Abandoned Service

(MAIN ROADS - SURFACE LOCATION) - CLASS B
POINT MEASRUED AT GROUND LEVEL DIRECTLY ABOVE TRACED SERVICE

HA	AMCOM/VOCUS Cable - Surface Location
HC	Drainage Pipe / Stormwater - Surface Location
HE	Electrical Cable - Surface Location
HF	Western Power Communication - Surface Location
HG	Gas Line - Surface Location
HH	MRWA Communication - Surface Location
HI	MRWA Power - Surface Location
HJ	Underground NBN Fibre - Surface Location
HK	Underground TPG/Pipe Networks Surface Location
HN	Next Gen Communication - Surface Location
HO	Optus Optic_Fibre - Surface Location
HP	Optus Copper - Surface Location
HR	Rail Services - Surface Location
HS	Sewer Pipe - Surface Location
HT	Telstra Copper - Surface Location
HU	Unknown Service - Surface Location
HV	Telstra Optic_Fibre - Surface Location
HW	Water Pipe - Surface Location
HX	Reticulation - Surface Location
HZ	Abandoned Service - Surface Location

UNDERGROUND SERVICES

UNDERGROUND SERVICES DIRECT MEASUREMENT - CLASS A

(PQA)	Underground Amcom/Vocus Cable
(PQC)	Underground Drainage Pipe
(PQE)	Underground Electrical Cable
(PQF)	Underground Western Power Comms
(PQG)	Underground Gas Line
(PQH)	Underground MRWA Comms
(PQI)	Underground MRWA Power
(PQJ)	Underground NBN Comms
(PQK)	Underground TPG /Pipe Networks
(PQN)	Underground Next Gen Comms
(PQO)	Underground Optus Fibre_Optic
(PQP)	Underground Optus Copper
(PQR)	Underground Rail Services
(PQS)	Underground Sewer Pipe
(PQT)	Underground Telstra Copper
(PQU)	Underground Unknown Service
(PQV)	Underground Telstra Optic_Fibre
(PQW)	Underground Water Pipe
(PQX)	Underground Reticulation Pipe
(PQZ)	Abandoned Service

(MAIN ROADS - UNVERIFIED, NO MEASURMENT) DBYD COMPILED - CLASS C AND D

QA	AMCOM/VOCUS Cable - Unverified, No Measurement
QC	Drainage Pipe / Stormwater - Unverified, No Measurement
QE	Electrical Cable - Unverified, No Measurement
QF	Western Power Communication - Unverified, No Measurement
QG	Gas Line - Unverified, No Measurement
QH	MRWA Communication - Unverified, No Measurement
QI	MRWA Power- Unverified, No Measurement
QJ	Underground NBN Comms - Unverified, No Measurement
QK	Underground TPG/Pipe Networks - Unverified, No Measurement
QN	Next Gen Communication - Unverified, No Measurement
QO	Optus Optic_Fibre - Unverified, No Measurement
QP	Optus Copper - Unverified, No Measurement
QT	Telstra Copper - Unverified, No Measurement
QV	Telstra Optic_Fibre - Unverified, No Measurement
QR	Rail Services - Unverified, No Measurement
QS	Sewer Pipe - Unverified, No Measurement
QU	Unknown Service - Unverified, No Measurement
QW	Water Pipe - Unverified, No Measurement
QX	Reticulation - Unverified, No Measurement
QZ	Abandoned Service - Unverified, No Measurement

Rev.	Description	Drawn	Date	Checked
H	U/G Services Amended	SAH	30/10/2020	TKI

SCALE 1:1000 @ A3

0 10 20 30 40 50

ALL DISTANCES ARE IN METRES

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The contents of this plan are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should satisfy themselves of this plans currency by contacting the McMullen Nolan Group.

Surveyor:- MNG
Survey Date:- 30/06/2020
Precal/Cad:- 30/06/2020

ISO 9001 - AS/NZS 4801 - ISO 14001
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The boundaries shown on this plan were not re-established as part of this survey, therefore this plan does not guarantee their accuracy. Existing easements, encumbrance or interest are not depicted and a title search is recommended to obtain this information. Re-establishment of the cadastral boundaries is recommended for any proposed works on or near existing boundaries.

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McMULLEN NOLAN GROUP
FEATURE SURVEY - GENERAL LEGEND

CLIENT: N/A

Project Mngr	Datum
MNG Group	LOCAL

95465 - DOC - 012 - H
Job Number | Type | Plan Number | Revision

APPENDIX D

Geotechnical Report
(Douglas Partners, 2008)

Douglas Partners
Geotechnics • Environment • Groundwater

Integrated Practical Solutions

REPORT ON GEOTECHNICAL & INITIAL ACID SULPHATE SOIL INVESTIGATION

PROPOSED SUBDIVISION LOTS 101 & 102 BUSSELL HIGHWAY COWARAMUP, WA

Prepared for
N. I & A EARL

Project 46790
July 2008

Douglas Partners
Geotechnics • Environment • Groundwater

REPORT ON GEOTECHNICAL & INITIAL ACID SULPHATE SOIL INVESTIGATION

PROPOSED SUBDIVISION LOTS 101 & 102 BUSSELL HIGHWAY COWARAMUP, WA

Prepared for
N. I & A EARL

Project 46790
July 2008

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APPENDIX A – Site Plans

APPENDIX B – Results of Field Work

Notes Relating to this Report

APPENDIX C – Geotechnical Laboratory Results

APPENDIX D – Acid Sulphate Soil Laboratory Results and Chain of Custody Report

APPENDIX E – CSRIO Note on Foundation Maintenance

DR:rls
Project No: 46790
17 July 2008

REPORT ON
GEOTECHNICAL AND INITIAL ACID SULPHATE SOIL INVESTIGATION
PROPOSED SUBDIVISION, LOTS 101 & 102 BUSSELL HIGHWAY
COWARAMUP, WA

1. INTRODUCTION

This report presents the results of a geotechnical and initial acid sulphate soil investigation carried out for a proposed residential subdivision of Lots 101 and 102 Bussell Highway in Cowaramup, WA (Refer to Drawing 1). This investigation was requested by Mr. Jon Hines of Cardno BSD acting on behalf of N. I & A Earl and was undertaken in general accordance with Douglas Partners' Pty Ltd (DP) proposal dated 26 February 2008.

The purpose of the investigation is to assess the shallow sub surface conditions beneath the proposed subdivision and thus:

- determine the suitability of the land to support the proposed development;
- provide appropriate site classification in accordance with the requirements of AS2870;
- provide recommendations on improving the site classification;
- provide recommendations on site preparation, compaction, re-use of excavated material for fill and earthworks, if required, so as to allow the development of the site;
- suggest appropriate foundation system(s) for the proposed structures, including the assessment of allowable bearing pressures and likely settlements;
- provide parameters for road pavement design including the California Bearing Ratio (CBR) for the likely subgrade;
- determine the groundwater level at the time of the investigation, if encountered;
- provide comments on drainage;

- assess the suitability of clay within the existing drain for the construction of a series of retention basins;
- assess the excavatability of the shallow soils across the site and at selected locations beneath the proposed sewer alignments (development areas east and west of Bussell Highway as specified by Cardno BSD); and
- assess the risk of acid sulphate soils occurring across the site, and its impact on the proposed development (areas west of Bussell Highway).

Details of the field work programme carried out are presented in this report, together with comments on the issues listed above.

2. PREVIOUS INVESTIGATION

DP undertook a geotechnical and preliminary acid sulphate soil investigation within areas of the eastern part of the site (refer to Drawing 2, Appendix A) in July 2006. The results of this investigation have been reported in Douglas Partners (October 2006), *Report on Geotechnical and Preliminary Acid Sulphate Soil Investigation – Lots 101 & 102 Bussell Highway, Cowaramup*.

The investigation comprised the excavation of 16 test pits with adjacent Dynamic Cone Penetrometer testing. The encountered shallow ground conditions were reported to generally comprise topsoil overlying sand in turn underlain by clayey sand and sandy clay. Shallow cemented materials, including coffee rock and laterite, were also encountered across the site.

Further reference should be made to the abovementioned report for the specific development area depicted on Drawing 2, Appendix A.

3. SITE DESCRIPTION

The site is described as Lots 101 & 102 Bussell Highway, Cowaramup, and comprises a total area of approximately 36 hectares. The site is dissected by Bussell Highway which runs in a north-south direction.

The western portion of the site comprises a rectangular shaped area of approximately 19 hectares and is bounded to the north by Memorial Drive, to the west by Sunset Drive, to the south by existing grazing land and to the east by Bussell Highway (Drawing 2). At the time of the investigation the surface of the western site was covered by green grass with clusters of medium to large trees within the northern parts of the site. Lateritic rocky outcrops where noted amongst the trees in the northern part of the site. A buried optic fibre cable also traverses the site in a north-south direction and generally follows the alignment of the above ground power lines.

The eastern portion of the site comprises a rectangular shaped area of approximately 17 hectares and is bounded to the north by Botrill Street, to the east by existing grazing land, to the south by Wirring Road and to the west by Bussell Highway (Drawing 2). At the time of the investigation the surface of the eastern site was generally covered with green grass. Earthworks were being undertaken within the central and northern parts of the site adjacent to an open drain running though the site.

The Cowaramup Mentelle 1:50 000 Regolith Landform sheet indicates that shallow sub surface conditions beneath the site comprise silty gravelly sand over mottled sandy clay of colluvial origin, in turn underlain by granitic bedrock of the Leeuwin complex. Residual duricrust may also occur.

A survey plan provided by Cardno BSD indicates that the topography across the site generally falls to the west with surface levels generally ranging from 127 m AHD on the western side to 134 m AHD on the eastern side.

The acid sulphate soil risk map (Figure 26 – Dunsborough Acid Sulphate Soils) published by the Western Australian Planning Commission (WAPC) indicates that the site is located within the following risk areas:

- southern portion - moderate to low risk of acid sulphate soils occurring within 3 m of natural soil surface; and
- northern portion - low to no known risk of acid sulphate soils occurring within 3 m of natural soil surface (or deeper).

4. FIELD WORK METHODS

Field work was carried out between 6 and 9 May 2008 and comprised the excavation of 47 test pits with adjacent Perth Sand Penetrometer (PSP) or Dynamic Cone Penetrometer (DCP) tests.

A 28 tonne excavator equipped with a 600 mm wide tiger toothed bucket was used to excavate the test pits to maximum depths of 5.2 m. Representative soil samples were recovered from selected test locations for subsequent laboratory analysis for assessment of geotechnical parameters.

Representative soil samples were recovered from 10 of the 47 test locations from the western side for assessment of acid sulphate soils. Soil samples recovered for the assessment of acid sulphate soils were placed in air tight sample bags and chilled in insulated coolers for transport to the laboratory.

PSP and DCP testing were carried out adjacent to each test location to assess the *in situ* conditions of the shallow ground. This testing was carried out in accordance with the test methods described in AS1289 – 2000.

Each test location was logged in general accordance with AS1726 – 1993 by a suitably experienced representative from Douglas Partners.

Test locations for assessment of excavatability below 2.5 m depth were specified on a plan provided by Cardno BSD in an email dated 29 February 2008 and were understood to comprise the following:

- six test pits (TP6, TP7, TP9, TP17, TP18 and TP19) on the western side to depths of between 3.0 m and 4.0 m; and

- 10 test pits (TP29, TP33, TP35, TP37, TP39, TP40 and TP43 to TP46 inclusive) on the eastern side to depths of between 3.0 m and 5.2 m.

All test locations were located using a hand held GPS and aerial photography and are presented on Drawing 2 in Appendix A. The surface elevation at each test location was interpolated from a contour plan provided by Cardno BSD and are relative to Australian Height Datum (m AHD).

5. FIELD WORK RESULTS

5.1 Ground Conditions

Detailed logs of ground conditions at the test locations and results of field testing are presented in Appendix B, together with notes defining descriptive terms and classification methods. The ground condition varied between test locations across the site, however two general soil profiles can be identified. A summary of the ground conditions is provided below:

Northern and Eastern Parts of the Site (TP1 to TP6, TP8, TP9, TP11, TP21 and TP23 to TP47)

TOPSOIL – dark grey/grey and brown silty sandy topsoil up to 0.1 m depth;

SAND – medium dense, light brown and light grey-brown, fine to medium grained sand with some clay, underlying the topsoil to depths of between 0.4 m and 3.3 m at all test locations, with the exception of TP04, TP21, TP39 and TP43 to TP47;

GRAVELLY CLAYEY SAND / CLAYEY SAND – medium dense, light brown and light brown mottled orange, fine to medium grained clayey sand generally underlying the sandy materials and ironstone. The ironstone was medium to high strength, red-brown at depths of between 0.5 m and 3.3 m. Ironstone thicknesses and refusal depths across the site are further summarised below in Table 1;

IRONSTONE – medium to high strength, red-brown ironstone, underlying sand and clayey sand at depths of between 0.5 m and 3.3 m. Ironstone thicknesses and refusal depths across the site are further summarised below in Table 1;

GRAVELLY SANDY CLAY / SANDY CLAY - stiff, light grey-blue and grey, medium plasticity, sandy clay with variable fractions of lateritic gravel at depths of between 0.1 m and 2.5 m; and

GRANITE – very high strength weathered granite at depths of 3.4 m and 4.1 m at test locations TP17 to TP19, TP33 and TP37 respectively. Depth of refusal on granite is summarised below in Table 2.

The following exceptions to the general profile above were observed:

- light brown, fine to coarse sized, clayey sandy gravel was encountered at test location TP31 at a depth of 0.8 m;
- grey, grey-brown sandy filling with bands of cemented silty sand were encountered at test location TP44 to a depth of 1.5 m; and
- brown cemented silty sand was encountered at test locations TP45 and TP46 at a depth of 0.9 m.

<u>Southwest Part of the Site (TP7, TP10, TP12 to TP20 and TP22)</u>

TOPSOIL – brown silty and sandy topsoil up to 0.1 m depth;

SAND - medium dense, brown and grey sand with varying quantities of clay, silt and gravel underlying the topsoil to depths of between 0.7 m and test pit terminations depths of 2.5 m;

CLAYEY SAND- medium dense light grey and grey clayey sand grading to sandy clay at some locations with varying quantities of gravel between depths of 1.0 m and test pit termination depth;

IRONSTONE- medium to high strength red/brown ironstone at depths of between 0.6 m and 1.0 m at test locations TP10 and TP15. Ironstone thicknesses and refusal depths across the site are further summarised below in Table 1;

The following exceptions to the general profile above were observed:

- loose, dark grey clayey sand with organic matter between depths of 0.1 m and 0.3 m at TP7; and
- stiff light brown sandy clay between depths of 0.3 m to 2.0 m at test locations TP7 and TP18 to TP20.

Table 1 – Summary of Depth to Top of Ironstone and Interpolated Levels

Test Location	Interpolated Surface Level (m AHD)	Depth to top of ironstone (m)	Interpolated Level (m AHD)	Thickness (m)
TP1	131.3	1.3	130.0	0.5
TP2	131.5	Not encountered to a depth of 2.5 m		
TP3	131.5	Not encountered to a depth of 3.0 m		
TP4	130.0	0.8	129.2	0.9
TP5	130.2	Not encountered to a depth of 3.0 m		
TP6	130.0	0.7	129.3	Refusal on ironstone @ 1.0 m
TP7	128.9	Not encountered to a depth of 3.0 m		
TP8	129.0	Not encountered to a depth of 2.5 m		
TP9	128.0	Not encountered to a depth of 3.3 m		
TP10	128.9	0.7	128.2	0.3
TP11	129.8	Not encountered to a depth of 2.5 m		
TP12	129.7	Not encountered to a depth of 2.3 m		
TP13	128.9	Not encountered to a depth of 2.5 m		
TP14	130.0	Not encountered to a depth of 2.5 m		
TP15	128.9	0.6	128.3	Refusal on ironstone @ 1.3 m
TP16	128.4	Not encountered to a depth of 2.5 m		
TP17	127.2	Not encountered to a depth of 3.7 m		
TP18	127.4	Not encountered to a depth of 3.1 m		
TP19	127.8	Not encountered to a depth of 3.3 m		
TP20	127.2	Not encountered to a depth of 3.0 m		
TP21	128.3	Not encountered to a depth of 3.0 m		
TP22	128.2	Not encountered to a depth of 2.3 m		
TP23	129.1	Not encountered to a depth of 3.0 m		
TP24	130.0	Not encountered to a depth of 2.5 m		
TP25	129.8	1.4	128.4	0.2
TP26	129.9	Not encountered to a depth of 3.0 m		
TP27	131.0	0.7	130.3	1.6

TP28	131.4	0.2	131.2	>2.3
TP29	134.5	Not encountered to a depth of 4.0 m		
TP30	133.4	2.3	131.1	Refusal on ironstone @ 2.5 m
TP31	132.0	1.3	130.7	Refusal on ironstone @ 1.5 m
TP32	131.9	1.8	130.1	>0.7 m
TP33	133.2	1.9	131.3	1.1
TP34	133.7	2.3	131.4	>0.2 m
TP35	134.0	1.8	132.2	Refusal on ironstone @ 2.0 m
TP36	133.3	0.5	132.8	Refusal on ironstone @ 1.0 m

Table 1 (continued) – Summary of Depth to Top of Ironstone and Interpolated Levels

Test Location	Inerpolated Surface Level (m AHD)	Depth to top of ironstone (m)	Interpolated Level (m AHD)	Thickness (m)
TP37	132.2	1.9	130.3	0.3
TP38	131.4	Not encountered to a depth of 2.5 m		
TP39	131.2	Not encountered to a depth of 4.0 m		
TP40	131.0	1.9	129.1	Refusal on ironstone @ 2.0 m
TP41	131.0	2.5	128.5	>0.3 m
TP42	130.2	Not encountered to a depth of 2.5 m		
TP43	133.1	0.6	132.5	Refusal on ironstone @ 0.9 m
TP44	134.3	3.5	130.8	0.3
TP45	135.1	2.8	132.3	Refusal on ironstone @ 3.2 m
TP46	133.1	2.5	130.6	Refusal on ironstone @ 2.8m
TP47	131.1	0.4	130.7	Refusal on ironstone @ 0.9m

Notes:
1. Surface level interpolated from a contour plan provided by Cardno BSD.
2. Interpolated ironstone level = interpolated surface level – depth to top of ironstone.

Table 2 – Summary of Depth of Refusal on Granite and Interpolated Level

Test Location	Interpolated Surface Level (m AHD)	Depth of Refusal on Top of Granite (m)	Interpolated Level (m AHD)
TP17	127.2	3.7	123.5
TP18	127.4	3.1	124.3
TP19	127.8	3.3	124.5
TP33	133.2	3.4	129.8
TP37	132.2	4.1	128.1

Notes:
1. Surface level interpolated from a contour plan provided by Cardno BSD.
2. Interpolated granite level = interpolated surface level – depth to top of granite

5.2 Groundwater

At the time of the investigation in May 2008, groundwater seepage, generally above clayey materials was observed in the test pits at depths of between 1.0 m and 3.0 m below the existing surface level.

A summary of depths of seepage and interpolated levels are presented in Table 3.

Table 3 – Summary of Groundwater Seepage Depths and Interpolated Levels

Test Location	Interpolated Surface Level (m AHD)	Depth to GW Seepage (m)	Interpolated Seepage Level (m AHD)
TP1	131.3	No groundwater observed	
TP2	131.5	No groundwater observed	
TP3	131.5	No groundwater observed	
TP4	130.0	No groundwater observed	
TP5	130.2	No groundwater observed	
TP6	130.0	No groundwater observed	
TP7	128.9	1.0 & 2.8	
TP8	129.0	No groundwater observed	
TP9	128.0	2.6	125.4
TP10	128.9	1.8	127.1
TP11	129.8	2	127.8
TP12	129.7	1.8	127.9
TP13	128.9	1.6	127.3
TP14	130.0	1.8	128.2
TP15	128.9	No groundwater observed	
TP16	128.4	1.6	126.8
TP17	127.2	2	125.2
TP18	127.4	2	125.4
TP19	127.8	2.4	125.4
TP20	127.2	2	125.2
TP21	128.3	3	125.3
TP22	128.2	2.4	125.8
TP23	129.1	No groundwater observed	
TP24	130.0	No groundwater observed	
TP25	129.8	No groundwater observed	
TP26	129.9	No groundwater observed	
TP27	131.0	No groundwater observed	
TP28	131.4	No groundwater observed	
TP29	134.5	3.5	131.0
TP30	133.4	No groundwater observed	
TP31	132.0	No groundwater observed	
TP32	131.9	2.5	129.4
TP33	133.2	3.2	130.0
TP34	133.7	No groundwater observed	
TP35	134.0	No groundwater observed	

TP36	133.3	No groundwater observed	
TP37	132.2	2.3	129.9
TP38	131.4	2.1	129.3
TP39	131.2	2.4	128.8
TP40	131.0	1.8	129.2

Notes:
1. Surface level interpolated from a contour plan provided by Cardno BSD.
2. Interpolated seepage level = interpolated surface level – depth of seepage.

Table 3 (continued) – Summary of Groundwater Seepage Depths and Interpolated Levels

Test Location	Interpolated Surface Level (m AHD)	Depth to GW Seepage (m)	Interpolated Seapage Level (m AHD)
TP41	131.0	1.8	129.2
TP42	130.2	No groundwater observed	
TP43	133.1	No groundwater observed	
TP44	134.3	4	130.3
TP45	135.1	No groundwater observed	
TP46	133.1	No groundwater observed	
TP47	131.1	No groundwater observed	

Notes:
1. Surface level interpolated from a contour plan provided by Cardno BSD.
2. Interpolated seepage level = interpolated surface level – depth of seepage.

6. GEOTECHNICAL LABORATORY TESTING

A geotechnical laboratory testing programme was carried out on selected soil samples by a NATA registered laboratory and comprised the determination of:

- particle size distribution on fourteen samples;
- organic content on one sample;
- Atterberg limits and linear shrinkage on eleven samples;
- Maximum modified dry density on three samples; and
- California Bearing Ratio on three samples.

Results of the testing are summarised in Table 4 and test certificates are presented in Appendix C.

Table 4 – Summary of Geotechnical Laboratory Test Results

Test Location	Depth (m)	Soil Type	% fines	d_{10} (mm)	d_{60} (mm)	LL (%)	PL (%)	PI (%)	LS (%)	OMC (%)	MMDD (t/m^3)	CBR (%)	OC (%)
TP4	2.0	SANDY CLAY – with some ironstone cobbles	32	<0.0135	0.65	90	34	56	14.5	-	-	-	-
TP7	0.2	CLAYEY SAND – with some silt and organic matter.	27	<0.0135	0.3	62	40	22	12	-	-	-	12.5
TP7	0.5	GRAVELLY SANDY CLAY – soft, medium plasticity.	30	<0.0135	0.38	42	16	26	11	12.4	1.953	5.0	-
TP10	1.5	SANDY CLAY / CLAYEY SAND – with some fine to coarse sized gravel	33	<0.0135	0.38	45	17	28	11.5	-	-	-	-
TP18	0.6	SANDY CLAY – stiff, medium plasticity	48	<0.0135	0.18	49	17	32	13	14.2	1.858	5.0	-
TP19	0.3	SAND – slightly clayey, with some silt	34	<0.0135	0.2	-	-	-	-	-	-	-	-
TP20	1.0	SANDY CLAY – stiff, medium plasticity with a trace of fine to coarse sized gravel	38	<0.0135	0.4	59	22	37	15	-	-	-	-
TP21	1.5	SANDY CLAY – very stiff, high plasticity with a trace of fine to coarse sized gravel	35	<0.0135	0.4	68	21	47	16	-	-	-	-
TP29	0.5	SAND – with some clay	22	<0.0135	0.32	-	-	-	-	-	-	-	-
TP30	1.0	CLAYEY SAND	27	<0.0135	0.31	30	13	17	6.5	-	-	-	-
TP31	1.0	CLAYEY SANDY GRAVEL – gravel is fine to coarse	22	<0.0135	7.0	-	-	-	-	-	-	-	-

Table 4 (Continued) – Summary of Geotechnical Laboratory Test Results

Test Location	Depth (m)	Soil Type	% fines	d_{10} (mm)	d_{60} (mm)	LL (%)	PL (%)	PI (%)	LS (%)	OMC (%)	MMDD (t/m^3)	CBR (%)	OC (%)
TP39	0.5	SANDY CLAY – stiff, medium plasticity	45	<0.0135	0.2	44	20	24	11	16.4	1.791	4.0	-
TP42	0.5	SANDY CLAY / CLAYEY SAND – stiff, medium plasticity	35	<0.0135	0.28	44	16	28	13	-	-	-	-
TP42	1.5	CLAYEY SAND	23	<0.0135	0.5	42	15	27	9.5	-	-	-	-

Notes:
- The %Fines is the amount of particles smaller than 75 µm;
- A d_{10} of 0.17 mm means that 10 % of the sample particles are finer than 0.17 mm;
- A d_{60} of 0.23 mm means that 10 % of the sample particles are finer than 0.23 mm;
- LL: Liquid Limit;
- PI: Plasticity Index;
- PL: Plastic Limit;
- LS: Linear Shrinkage;
- SIC: Slipped In Cup;
- MMDD: Maximum Modified Dry Density; and
- CBR: California bearing ratio; and

'-' means not tested;

7. ACID SULPHATE SOIL LABORATORY TESTING

Initial acid sulphate soil screening tests were undertaken on all soil samples by the ALS Laboratory Group in accordance with the method as described in Ahern CR., Ahern MR, and Powell B, *Guidelines for Sampling and Analysis of Lowland Acid Sulphate Soils (ASS) in Queensland 1998*, QASSIT, Department of Natural Resource, Resources Sciences Centre, Indooroopilly, Queensland. The screening tests comprised measurement of pH of the soil in water (pH_F) and the pH of the soil after oxidation with a 30 percent solution of peroxide (pH_{FOX}).

Following the screening tests, two selected soil samples per test location were sent to ALS Laboratory Group to undergo the SPOCAS suite of analysis. Samples were selected for analysis with due consideration of the following:

- lowest reported pH_{FOX} within a soil strata at each test location; and
- visual identification of the soils encountered.

The screening results and laboratory testing for the SPOCAS suite are presented in Table D-1 in Appendix D. The detailed laboratory reports and associated chain of custody reports are presented in Appendix D.

8. ENGINEERING EVALUATION AND RECOMMENDATIONS

8.1 Proposed Development

It is understood that the proposed development will comprise the construction of a residential subdivision.

8.2 Site Classification

Results of the field work and laboratory testing indicate that the clayey materials encountered across the site vary from slightly reactive to highly reactive. Furthermore, some areas of the site contain no reactive materials within depths which affect the site classification.

Current classification of the site in accordance with AS2870 for each test location, together with the thickness of filling required to amend the existing classification to a less restrictive classification are given in Table 5. Classification and filling thicknesses given in Table 5 were assessed using the method presented in Kay (1990) based on a design depth of suction change of 1.8 m (McManus, 2004).

Table 5 – Site Classification at each Test Location

Test Location	Current site Classification	Additional Non Reactive Filling Thickness above Existing Ground Level to Achieve a 'Class M' Site [1]	Additional Non Reactive Filling Thickness above Existing Ground Level to Achieve a 'Class S' Site [1]	Additional Non Reactive Filling Thickness above Existing Ground Level to Achieve a 'Class A' Site [1]
TP1	S	-	-	1.2
TP2	S	-	-	1.2
TP3	M	-	0.4	1.5
TP4	S	-	-	1.2
TP5	M	-	0.3	1.6
TP6	S	-	-	1.5
TP7	M	-	0.5	1.8
TP8	S	-	-	1.3
TP9	M	-	0.1	1.5
TP10	S	-	-	1.3
TP11	M	-	0.1	1.5
TP12	A	-	-	-
TP13	A	-	-	-
TP14	A	-	-	-
TP15	S	-	-	1.8
TP16	A	-	-	-
TP17	A	-	-	-
TP18	M	-	0.6	1.8
TP19	M	-	0.3	1.4
TP20	H	0.2	0.7	1.8
TP21	M	-	0.4	1.5
TP22	A	-	-	-
TP23	S	-	-	1.3
TP24	S	-	-	1.2
TP25	S	-	-	0.2
TP26	S	-	-	1.3
TP27	A	-	-	-
TP28	A	-	-	-
TP29	S	-	-	1.8
TP30	S	-	-	1.2
TP31	S	-	-	1.3
TP32	S	-	-	1.3
TP33	A	-	-	1.3
TP34	A	-	-	-
TP35	S	-	-	1.2
TP36	S	-	-	0.8
TP37	A	-	-	-

Test Location	Current site Classification	Additional Non Reactive Filling Thickness above Existing Ground Level to Achieve a 'Class M' Site [1]	Additional Non Reactive Filling Thickness above Existing Ground Level to Achieve a 'Class S' Site [1]	Additional Non Reactive Filling Thickness above Existing Ground Level to Achieve a 'Class A' Site [1]
TP38	S	-	-	1.3
TP39	H	0.1	0.6	1.8
TP40	A	-	-	-
TP41	S	-	-	1.2
TP42	M	-	0.2	1.4
TP43	S	-	-	0.9
TP44	A	-	-	-
TP45	S	-	-	0.6
TP46	S	-	-	0.6
TP47	S	-	-	0.9

Note:
[1] This thickness does not include filling required to replace topsoil and other deleterious materials.

The filling thicknesses given in Table 5 do not include the thickness of additional filling that would be required to replace topsoil. This additional filling thickness will depend on the thickness of soil removed during topsoil stripping operations.

The classification and filling thicknesses given in Table 5 assume that site preparation is carried out as detailed in Section 8.3. Also, it is emphasised that the given classification will need reassessment if bulk earthworks for the proposed development include cutting of the site.

The variation of geotechnical properties over short distances should be avoided beneath the proposed building envelope to minimise the risk of potential differential movements.

8.3 Site Preparation and Compaction

Prior to excavation of foundations and/or placement of fill, all deleterious material, including vegetation and topsoil should be stripped from within each building envelope and either removed from site or stockpiled for possible re-use in landscaping. Topsoil was encountered to depths of up to 0.1 m below the ground level. Organic clayey sand was encountered to a depth of 0.3 m at TP07 and this material should also be excavated.

Tree roots remaining from any clearing operations should be completely removed and the excavation backfilled with suitably compacted ground of similar geotechnical properties as the surrounding soils. As detailed in Section 8.2, owing to the occurrence of reactive material, provision should be taken to minimise disturbance of the natural moisture content balance of the clayey ground shortly prior, during and after the construction of the buildings, in order to minimise ground movement and possible subsequent structural damage.

The results of the investigation suggest that medium to high strength ironstone and high strength granite will be encountered during construction of the residential development (Refer to Tables 1 and 2, Section 5). Consequently, contingency provisions for the excavation of high strength rock would be advisable during the excavation operations across the site. Such provision could include the use of powerful excavators, hydraulic rock breakers or heavy rippers.

If the site is to be filled, prior to placement of filling the subgrade should be proof compacted using a heavy sheepsfoot roller in clayey materials, and a heavy vibrating smooth drum roller in sandy materials. Subgrade should be continually compacted until deformation ceases. Alternatively soft/loose material could be excavated and replaced by a suitable material with similar geotechnical properties to the surrounding material. Care should be taken not to run heavy plant adjacent to existing structures or services.

As noted in Section 8.2, imported filling could be used to improve the site classification. It is recommended that imported filling comprises less than 5% per weight of particles less than 75 microns and no material with a nominal size greater than 150 mm. The filling should be placed at ±2% of its optimum moisture content, in layers not exceeding 300 mm loose thickness and compacted to achieve a dry density ratio of not less than 95% of maximum modified dry density (MMDD). If this material is not available then other materials could be considered provided that their geotechnical properties are determined and implications for site classification and construction are assessed.

If the site is not filled, it is recommended that the foundation material beneath each building envelope and road reserve be compacted to achieve a dry density ratio of not less than 95% MMDD.

Compaction control of natural sand or imported sand filling at the site could be carried out using a Perth Sand Penetrometer. The testing should be carried out in accordance with test method AS 1289.6.3.3. All areas within the proposed building envelopes should be compacted to achieve a minimum blow count of 8 blows per 300 mm penetration to a depth of not less than 1.0 m below foundation level when tested in accordance with the above test method. In accordance with AS1289, the use of PSP is limited to granular soils with a maximum particle size not exceeding 2 mm.

It is recommended that compaction control of clayey materials be carried out using a nuclear surface moisture-density gauge, in accordance with AS1289.5.8.1.

It is emphasised that filling across each building envelope should be carried out so that variation of the ground engineering properties does not occur over short distances.

During construction, some loosening of the surface materials in foundation excavations is expected. Therefore the top 300 mm in the base of any excavation should be re-compacted using a vibratory plate compactor prior to construction of any footings. Confirmation of adequate compaction of should be carried out as suggested above.

8.4 Foundation Design

Shallow foundation systems comprising slab, pad and strip footings founded in the shallow sand or clayey materials should be able to support the proposed structures, providing site preparation is carried out as described in Section 8.3. Footings of buildings covered by AS2870 should be designed to satisfy the requirements of this standard for the appropriate site classification detailed in the previous sections.

It is emphasised that AS2870 applies to single houses, townhouses and the like classified as Class 1 and 10a under the Building Code of Australia. It also applies to light industrial and commercial buildings if they are similar in size, loading and superstructure flexibility. If not the case, footing systems of the proposed buildings should be designed using engineering principles.

For the buildings not covered by AS2870, an allowable bearing pressure of 150 kPa is suggested for foundation design of strip and pad footings. This should ensure that total and differential settlements will be less than 5 mm. It should be noted that the above bearing pressure could be refined and possibly increased once details about the proposed buildings, foundation loads and foundation levels are known.

It should be noted that the above settlement estimate does not incorporate possible movements induced by the seasonal swelling and shrinkage of the reactive clayey materials beneath the site. It is recommended that provision be made for these movements by designing the structures in accordance with the requirements of AS2870.

8.5 Design Parameters for Pavement Design

Subgrade for the proposed pavement across the site comprises sand, clayey sand and sandy clay. The proposed subgrade will also possibly comprise sand filling if the proposed site surface is raised.

Some of the shallow sand contains some fines. Therefore, a subgrade CBR design value of 10% is suggested for pavement constructed on natural sand subgrade, provided the subgrade is compacted to not less than 95% of the maximum modified dry density.

Where clayey sand and sandy clay form the subgrade for the proposed pavement, and where less than 0.5 m of sand exists between the base of the proposed pavement and the top of the sandy clay and clayey sand, a CBR of 4% is suggested for pavement design. However, pavement could be designed using a CBR of 10% if the clayey subgrade is boxed out to a depth of 0.5 m beneath the pavement layers and replaced by suitable clean sand filling compacted to a density ratio of not less than 95% of MMDD. It is emphasised that provision should be made for suitably draining the backfilled excavation so that no water is allowed to pond beneath the pavement layers.

In the event the site surface is raised by filling with clean sand, the proposed pavement should be designed using the CBR of the proposed sand filling. A presumptive CBR value of 12% is suggested for clean sand filling, however, this value should be confirmed prior to pavement

construction once the sand filling material is known and once its CBR is assessed, for instance from laboratory testing.

8.6 Drainage

The clayey materials encountered across the site should be considered to have a low permeability for stormwater disposal purposes. On-site stormwater disposal using soak wells and sumps is generally not suitable across the site, unless an appropriate depth of free draining material exists between the base of soak wells and the top of the clayey material formation.

If the site is filled using free draining sand, on site infiltration of stormwater could be suitable provided a suitable thickness of sand exist over the clay subgrade. Infiltrated water should be expected to pond at the base of the fill onto the clayey subgrade, and provided adequate grades are maintained, migrate horizontally following the topography of the clay subgrade.

The implementation of a suitable drainage strategy is recommended to control this groundwater movement. Such strategy could comprise shaping the clay subgrade in order to direct any perched water into a subsoil drainage network and then directing the water into a suitable outflow.

As noted above, some of the materials underlying the site are reactive and therefore may swell and shrink with moisture variation resulting in surface movement. It is therefore recommended that particular attention be paid to minimise moisture content changes within these clayey materials through the adoption of appropriate measures, such as ensuring that:

- the site is well drained, both during construction and throughout the life of the structures on the site. Excessive drying and wetting of the exposed clayey materials should be minimised. Drying could be avoided by minimising the amount of time during which the base of the excavation is exposed. Surface water should not be allowed to accumulate in footing excavations during construction or near any footing systems of the proposed buildings. Water should therefore be controlled and directed away from foundation excavations and buildings;
- plumbing systems be maintained and repaired to avoid leaks beneath and around structures;
- no large trees be planted or removed adjacent to structures; and

- irregular or excessive watering around the structures is avoided.

For further advice on protecting structures overlying reactive clayey soils, reference should be made to the CSIRO note, entitled 'Foundation Maintenance and Footing Performance: A Homeowner's Guide', which is attached in Appendix E of this report.

8.7 Detention Basins

It is understood that four detention basins are to be constructed within the existing open drain which transects the north eastern part of the site. The basins are for aesthetic purposes. The location of the four basins has been provided by Cardno BSD (Drawing, B6014). The ground properties between the material at the base of the drain and adjacent test pits is anticipated to be of a comparable nature. Thus, an assessment of the suitability of materials for detention basin construction, in the test pits adjacent to the drain, is provided below:

Southern Basin/TP36 and Central Southern Basin/TP40:

- Sand overlying ironstone was encountered at this location, neither of these materials are considered suitable for the construction of a basin embankment or base; and

Central Northern Basin/TP41/46 and Northern Basin/TP42/47 :

- Sand overlying clayey sand and ironstone was encountered at this location, neither of these materials are considered suitable for the construction of a basin embankment or base.

Based on the results of the field work it is considered that the material anticipated to be encountered at the location of the detention basins will not form suitable embankment material. Based on the material encountered within other test locations and laboratory testing reported in Section 5, the sandy clay between depths of 0.4 m and 1.9 m at test location TP18 is considered to be an appropriate material for basin construction.

Clayey materials require strict control of their moisture content in order to enable suitable placement, compaction and minimise post construction swelling or shrinking owing to their reactivity. It is recommended that these materials be placed in layers at close to their optimum

moisture content, not exceeding 200 mm with each layer compacted to achieve a dry density ratio of not less than 95% of MMDD. The use of a sheepsfoot roller is recommended on clayey ground.

9. ACID SULPHATE SOIL EVALUATION

9.1 Assessment Criteria

Screening Testing

The criterion for comparison of the screening tests presented in Table D-1, Appendix D to indicate actual acid sulphate soil (AASS) or potential acid sulphate soil (PASS) are based upon the following guidance specified in the Department of Environment (2006), *ASS Guidelines*, namely:

- $pH_F \leq 4$ strongly indicates oxidation has occurred in the past and that AASS are likely to be present;
- $pH_{FOX} < 3$, plus a pH_{FOX} reading at least one pH unit below the corresponding pH_F, plus a strong reaction with peroxide, strongly indicates the presence of PASS.

Detailed Laboratory Testing

The net acidity, calculated from the results of the titratable actual acidity (TAA) and the peroxide oxidisable sulphur (S_{POS}) testing was compared against the Texture-based acid sulphate soil "Action Criteria" presented in Table 6 of the DEC Guidelines. If the calculated net acidity is greater than the action criterion, it is considered that acid sulphate soils are present and excavations/dewatering within this material would require specific management.

The net acidity is calculated as follows:

Net Acidity ($\%_{sulphur}$) = Spos + TAA + Retained Acidity – ANC/FF

As the subsurface conditions generally comprised sands, clayey sands and sandy clays, the following texture-based action criteria would be applicable:

- for excavation of ASS of less than 1,000 tonnes, a net acidity 0.03 % for sands and 0.06 % for clayey sands and sandy clays; and
- for excavation of ASS of greater than 1,000 tonnes, a net acidity of 0.03 % for sands and 0.03 % for clayey sands and sandy clays.

9.2 Assessment of Analytical Results

Screening Test Results

The screening test results presented in Table D-1, Appendix D indicate the following:

- the results for pH_F are not strongly indicative of actual acid sulphate soils conditions; and
- the results for pH_{FOX} are indicative of PASS beneath the western portion of the site at isolated locations at depths of 2.0 m or greater.

It should be noted that the screening tests undertaken by ALS are indicative only and inferences made from these results should be confirmed by laboratory testing.

Laboratory Results

The results of laboratory testing on selected soil samples are summarised in Table D-1, Appendix D. The results indicate that the calculated net acidity using S_{POS} have exceeded the action criterion of 0.03 % at five of 10 test locations, at depths of between 0.5 m and 2.5 m below the NSL. Net acidities were reported to a maximum of 0.12 % S.

9.3 Conclusions on Acid Sulphate Soil Assessment

Based upon the results of the investigation, it is concluded that acid sulphate soils above the action criterion have been identified beneath the site at depths of between 0.5 m and 2.5 m to a maximum net acidity of 0.12 % S. It is considered, therefore, that the risk of acid sulphate soils above the action criterion is high within 3.0 m of the existing surface.

It is recommended that further detailed investigations for acid sulphate soils, targeted to proposed excavations and dewatering be undertaken prior to the commencement of works. The

results of the detailed investigation would form the basis of an acid sulphate soil management plan.

If dewatering is proposed to be undertaken on the site, the following licences are required from the Department of Water prior to commencement of works:

- 5C Licence to take Groundwater; and
- 26D Licence to Construct or Alter a Well.

As part of the application for the abovementioned licences, assessment of groundwater quality beneath the site in conjunction with further detailed assessment for acid sulphate soils will be required.

10. REFERENCES

Australian Standard AS 2870-1996, Residential Slabs and Footings.

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

Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes

Australian Standard AS 1726-1993, Geotechnical Site Investigations

Australian Standard AS 2159 – 1995, Piling – Design and installation.

Department of Environment (2006), Acid Sulphate Soil Guideline Series Draft Identification and Investigation of Acid Sulphate Soils, Perth Western Australia

McManus (2004) 'The Effect of Thornwaite Index Changes on Ground Movement Predictions in Australian Soils', Proceedings, 9th ANZ Conference on Geomechanics, Auckland, Dr K. McManus, D.Lopes, N.Y. Osman.

Kay, N (1990) 'Use of the Liquid Limit for Characterisation of Expansive Soil Sites', CE 32 No. 3, October 1990

Walsh, P. Fityus, S. Kleeman, P. (1998) 'A Note on the Depth of Design Suction Change for Clays in South Western Australia and South Eastern Queensland', Australian Geomechanics, No. 33, Part 3, pp.37-40

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Reviewed by:





Daniel Reaveley
Geo-Environmental Scientist

pp **Michael Thom**
Principal

APPENDIX A

Site Plans and Test Locations



Fri 11 Jul 08

46790-d01.dgn

PINPOINT CARTOGRAPHICS (08) 9277 7763

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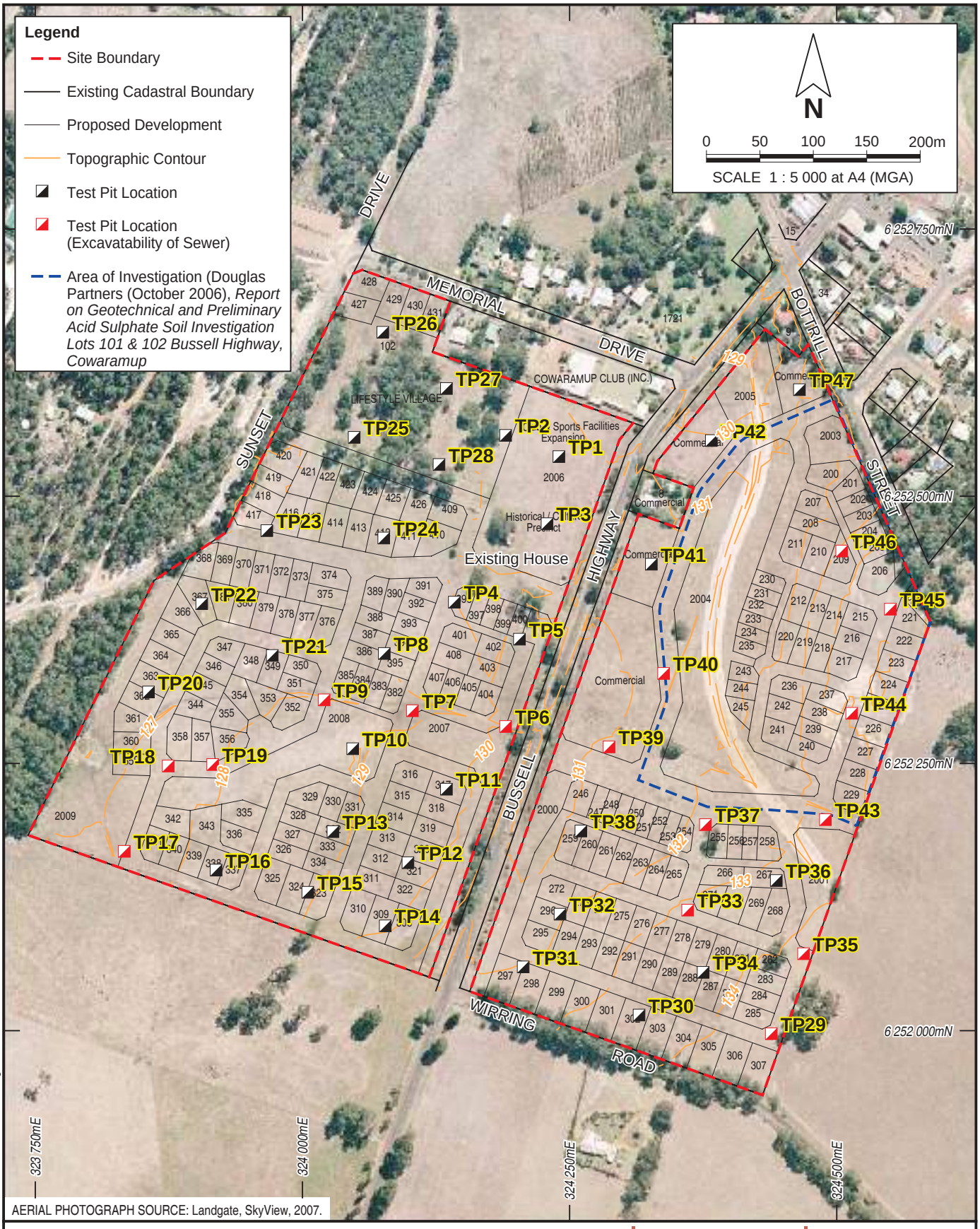
Brisbane, Cairns, Canberra, Darwin, Gold Coast, Melbourne, Minto

Newcastle, Perth, Sydney Sunshine Coast, Townsville, Wollongong, Wyong

Title: GEOTECHNICAL & INITIAL ACID SULPHATE SOIL INVESTIGATION - LOTS 101 & 102 BUSSELL HIGHWAY, COWARAMUP

LOCALITY PLAN

Client: N.I. & A. EARL				Office: PERTH	
Drawn By: R. SHAPLAND	Scale: 1 : 200 000		Project No: 46790	**DRAWING 1**	Revision: A
Approved By: --			Date: 11-07-08		



AERIAL PHOTOGRAPH SOURCE: Landgate, SkyView, 2007.

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Brisbane, Cairns, Canberra, Darwin, Gold Coast, Melbourne, Minto

Newcastle, Perth, Sydney Sunshine Coast, Townsville, Wollongong, Wyong

Title: GEOTECHNICAL & INITIAL ACID SULPHATE SOIL INVESTIGATION - LOTS 101 & 102 BUSSELL HIGHWAY, COWARAMUP

SITE PLAN AND TEST LOCATIONS

Client: N.I. & A. EARL				Office: PERTH	
Drawn By: R. SHAPLAND	Scale: 1 : 5 000		Project No: 46790	**DRAWING 2**	Revision: A
Approved By: --			Date: 11-07-08		

Fri 11 Jul 08

46790-d02.dgn

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APPENDIX B

Results of Fieldwork

Notes Relating to this Report

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NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

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

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, Geotechnical Site Investigations Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00 mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Undrained Shear Strength kPa
Very soft	less than 12
Soft	12—25
Firm	25—50
Stiff	50—100
Very stiff	100—200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT "N" Value (blows/300 mm)	CPT Cone Value (q_c — MPa)
Very loose	less than 5	less than 2
Loose	5—10	2—5
Medium dense	10—30	5—15
Dense	30—50	15—25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

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

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

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

Details of the type and method of sampling are given in the report.

Drilling Methods.

The following is a brief summary of drilling methods currently adopted by the Company and some comments on their use and application.

Test Pits — these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descent into the pit. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) — the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling — the hole is advanced by pushing a 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers — the hole is advanced using 90—115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in

clays and in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling — the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling — similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling — a continuous core sample is obtained using a diamond-tipped core barrel, usually 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" — Test 6.3.1.

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

The test results are reported in the following form.

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

  as 4, 6, 7
  N = 13

- In the case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm

  as 15, 30/40 mm.

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

Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch cone — abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australian Standard 1289, Test 6.4.1.

In the tests, a 35 mm diameter rod with a cone-tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20 mm per second) the information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: —

- Cone resistance — the actual end bearing force divided by the cross sectional area of the cone — expressed in MPa.
- Sleeve friction — the frictional force on the sleeve divided by the surface area — expressed in kPa.
- Friction ratio — the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0—5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0—50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%—2% are commonly encountered in sands and very soft clays rising to 4%—10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:—

q_c (MPa) = (0.4 to 0.6) N (blows per 300 mm)

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:—

q_c = (12 to 18) c_u

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Hand Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150 mm increments of penetration. Normally, there is a depth limitation of 1.2 m but this may be extended in certain conditions by the use of extension rods.

Two relatively similar tests are used.

- Perth sand penetrometer — a 16 mm diameter flat-ended rod is driven with a 9 kg hammer, dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as the Scala Penetrometer) — a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). The test was developed initially for pavement subgrade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms.

Bore Logs

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

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

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

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

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

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

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

- unexpected variations in ground conditions — the potential for this will depend partly on bore spacing and sampling frequency
- changes in policy or interpretation of policy by statutory authorities
- the actions of contractors responding to commercial pressures.

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

Site Anomalies

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

Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section

is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

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

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 131.3m AHD
EASTING: 324240
NORTHING: 6252537
DIP/AZIMUTH: 90°/--

PIT No: TP 01
PROJECT No: 46790
DATE: 6 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
		SAND - medium dense, dark brown, fine to medium grained sand with some silt. Becoming light grey, slightly clayey from 0.2m.		D	0.5				
	0.6	CLAYEY SAND - dense, light grey, fine to medium grained, humid clayey sand.		D	1.0				
	1.3	IRONSTONE - light grey mottled red and orange, medium strength ironstone.		D	1.5				
	1.8	CLAYEY GRAVELLY SAND - medium dense, light grey mottled orange, fine to coarse grained, moist clayey gravelly sand. Gravel is fine to medium sized granite.		D	2.0				
	2.4	GRAVELLY SANDY CLAY - very stiff, light grey mottled orange and red, medium plasticity, gravelly sandy clay. Gravel is fine to coarse sized granite.		D/pp	2.5		pp = 250kPa		
	2.8	Pit discontinued at 2.8m (target depth)							

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 131.5m AHD
EASTING: 324190
NORTHING: 6252557
DIP/AZIMUTH: 90°/--

PIT No: TP 02
PROJECT No: 46790
DATE: 6 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.08	TOPSOIL - dark brown, sandy silty topsoil.							
		SAND - medium dense, dark brown, fine to medium grained, humid sand with roots to 0.4m.							
		becoming light grey-brown and slightly clayey from 0.5 m.							
	0.6	GRAVELLY CLAYEY SAND - dense, light grey-brown mottled orange, fine to coarse grained, moist gravelly clayey sand. Gravel is fine to coarse sized ironstone.		D	1.0				
	1.3	CLAYEY SAND - dense, light grey mottled orange and red, moist clayey sand with some fine gravel.		D	2.0				
	2.5	Pit discontinued at 2.5m (target depth)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3, 4, 5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 131.5m AHD
EASTING: 324229
NORTHING: 6252474
DIP/AZIMUTH: 90°/--

PIT No: TP 03
PROJECT No: 46790
DATE: 6 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, sandy silty topsoil.							
	0.3	SAND - medium dense, grey, fine to medium grained sand with trace of clay.		D	0.2				
		CLAYEY SAND - medium dense, light grey-brown, fine to medium grained, humid clayey sand.		D/B	0.5				
		With some orange mottling from 0.8m.							
1				D	1.0				1
				D	1.5				
2		With some fine to coarse sized ironstone gravel from 1.9m.		D	2.0				2
	2.2	GRAVELLY CLAYEY SAND - medium dense, light grey-brown mottled red & orange, fine to coarse grained, gravelly clayey sand. Gravel is fine to coarse sized ironstone.		D	2.5				
	2.8	GRAVELLY SANDY CLAY - very stiff, light grey-brown mottled red, medium plasticity, moist gravelly sandy clay.							
3	3.0	Gravel is fine to coarse sized ironstone.		D	3.0		pp = 300kPa		3
		Pit discontinued at 3.0m (target depth)							
4									4
5									5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧗ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 130.0m AHD
EASTING: 324142
NORTHING: 6252401
DIP/AZIMUTH: 90°/--

PIT No: TP 04
PROJECT No: 46790
DATE: 6 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty gravelly topsoil.							
		GRAVELLY SAND - medium dense, light brown, fine to medium grained, humid gravelly sand with some silt. Gravel is fine to coarse sized.		D	0.5				
	0.6	CLAYEY SANDY GRAVEL - medium dense, light brown, fine to coarse sized clayey sandy gravel.							
	0.8	IRONSTONE - red-brown, medium to high strength ironstone.							
1									1
	1.7	CLAYEY SAND - medium dense, light grey, fine to coarse grained, moist clayey sand.							
2	2.0	SANDY CLAY - stiff, light grey, medium plasticity, moist, sandy clay with some ironstone cobbles.		D	2.0				2
	2.5	Pit discontinued at 2.5m (target depth)							
3									3
4									4
5									5

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 130.2m AHD
EASTING: 324203
NORTHING: 6252366
DIP/AZIMUTH: 90°/--

PIT No: TP 05
PROJECT No: 46790
DATE: 6 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - brown, sandy silty topsoil.							
	0.25	SAND - medium dense, brown, fine to medium grained, humid sand with some silt.							
		CLAYEY SAND - medium dense, light grey-brown with some orange mottling, fine to medium grained, humid clayey sand.		B	0.5				
	1			D	1.0				
		Becoming moist, fine to coarse, clayey sand with decreasing clay content from 1.3 m.		D	1.5				
	1.8	CLAYEY SAND / SANDY CLAY - very stiff, blue-grey, fine to medium grained, moist clayey sand/sandy clay.		D	2.0				
	2			D	2.5				
		Increasing clay content with depth.							
	3			D	3.0		pp = 250kPa		
	3.0	Pit discontinued at 3.0m (target depth)							
	4								
	5								

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧗ Water level

CHECKED
Initials:
Date:

Douglas Partners
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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 130.0m AHD
EASTING: 324190
NORTHING: 6252285
DIP/AZIMUTH: 90°/--

PIT No: TP 06
PROJECT No: 46790
DATE: 6 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.08	TOPSOIL - dark brown, sandy silty topsoil.							
		SILTY SAND - medium dense, brown, fine to medium grained, humid silty sand.		D	0.2				
	0.3	CLAYEY SILTY SAND - medium dense, light brown, fine to medium grained, clayey silty sand.							
		With some fine to coarse gravel from 0.6m.							
	0.7	IRONSTONE - red-brown, high strength ironstone.							
1	1.0	Pit discontinued at 1.0m (due to refusal on ironstone, slow digging)							
	2								
	3								
	4								
	5								

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 128.9m AHD
EASTING: 324103
NORTHING: 6252299
DIP/AZIMUTH: 90°/--

PIT No: TP 07
PROJECT No: 46790
DATE: 6 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, sandy silty topsoil.							
	0.3	CLAYEY SAND - loose, dark grey, fine to medium grained, moist clayey sand with some silt and organic matter.		D	0.2				
		GRAVELLY SANDY CLAY - soft, grey mottled orange, medium plasticity, wet gravelly sandy clay. Sand is fine to medium grained. Gravel is fine to coarse sized. becoming stiff from 0.6 m depth.		B	0.5		pp = 50kPa		
	1.7	SAND - medium dense, blue-grey, fine to coarse grained, wet sand with some clay. with high strength ironstone at 1.7 m over part of the test pit.							
	3.0	Pit discontinued at 3.0m (target depth)		D	3.0				

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 1.0 m and 2.8 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧭ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 129.0m AHD
EASTING: 324077
NORTHING: 6252353
DIP/AZIMUTH: 90°/--

PIT No: TP 08
PROJECT No: 46790
DATE: 6 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
		SAND - loose, light brown, fine to medium grained, humid sand with trace of clay.							
	0.5	CLAYEY SAND - medium, dense, light grey mottled orange, fine to medium grained, moist clayey sand, with some fine to coarse sized gravel.							
	1	becoming dense from 0.9 m.		D	1.5				
	1.9	SAND - medium dense, orange, fine to coarse grained, moist sand with trace of clay and some fine to coarse sized gravel.							
	2.5	Pit discontinued at 2.5m (target depth)		D	2.5				

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧗ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 128.0m AHD
EASTING: 324020
NORTHING: 6252309
DIP/AZIMUTH: 90°/--

PIT No: TP 09
PROJECT No: 46790
DATE: 6 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
	0.3	SAND - medium dense, light brown, fine to medium grained, humid sand with trace of clay.							
		CLAYEY SAND - dense, light grey mottled orange, fine to medium grained, moist clayey sand (weakly iron cemented).							
	1								1
		With some fine sized gravel from 1.5m.							
	1.8	GRAVELLY SANDY CLAY / GRAVELLY CLAYEY SAND - stiff, light brown mottled red, medium plasticity gravelly sand clay/gravelly clayey sand.			2.0		pp = 200kPa		
	2								2
	2.5	SAND - medium dense, light grey, fine to coarse grained, wet sand with trace of clay and some cobbles (<30cm-10cm). Increasing clay content with depth.							
	3								3
	3.3	Pit discontinued at 3.3m (target depth)							
	4								4
	5								5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 2.6 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 128.9m AHD
EASTING: 324047
NORTHING: 6252264
DIP/AZIMUTH: 90°/--

PIT No: TP 10
PROJECT No: 46790
DATE: 6 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
		SAND - medium dense, dark brown, fine to medium grained moist sand with some silt.		D	0.2				
	0.3	SILTY SAND - medium dense, light brown-orange, fine to medium grained, moist sand with trace of clay.		D	0.5				
	0.5	CLAYEY SAND - medium dense, light brown-orange, fine to medium grained, moist clayey sand, with some fine to medium sized gravel.							
	0.7	IRONSTONE - stiff/medium dense, red-brown, high strength ironstone.							
1	1.0	SANDY CLAY / CLAYEY SAND - soft, light grey, fine to medium grained, moist-wet clayey sand/sandy clay with some fine to coarse sized gravel.		D	1.0				1
				D	1.5				
		Sand becoming fine to coarse grained from 1.8 m.							
2				D	2.0				2
				D	2.5				
	2.8	Pit discontinued at 2.8m (due to hole collapsing)							
3				D	3.0				3
4									4
5									5

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 1.8 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 129.8m AHD
EASTING: 324135
NORTHING: 6252226
DIP/AZIMUTH: 90°/--

PIT No: TP 11
PROJECT No: 46790
DATE: 6 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.08	TOPSOIL - dark brown, sandy silty topsoil.							
		SAND - medium dense, brown, fine to medium grained, humid sand with trace of silt.							
	0.3	CLAYEY SAND - medium dense, light grey-brown, fine to medium grained, moist clayey sand. becoming mottled orange with a trace of fine to coarse sized gravel from 0.5 m.							
	1	with medium to high strength ironstone at 1.0 m at one end of the test pit.							
	2.0	SAND - medium dense, light grey, fine to coarse grained, wet sand with trace of clay and fine to coarse sized gravel.							
	2.3	CLAYEY SAND / SANDY CLAY - medium dense/stiff, blue-grey, fine to coarse sized, wet clayey sand/sandy clay.		D	2.5				
	2.5	Pit discontinued at 2.5m (target depth)							
	3								
	4								
	5								

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 2.0 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 129.7m AHD
EASTING: 324099
NORTHING: 6252157
DIP/AZIMUTH: 90°/--

PIT No: TP 12
PROJECT No: 46790
DATE: 6 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - brown, sandy silty topsoil.							
		SAND - medium dense, brown, fine to medium grained, humid sand with trace of silt. Becoming light brown with orange mottling and some clay from 0.3 m. Increasing clay content with depth.							
	1.2	GRAVELLY SAND / SANDY GRAVEL - medium dense, light grey, fine to coarse grained, wet gravelly sand/sandy gravel. Gravel is fine to coarse sized ironstone with some clay.		D	1.8				
	2.0	SAND - medium dense, light grey, fine to coarse grained, wet sand with trace of clay and fine to coarse sized gravel.							
	2.3	Pit discontinued at 2.3m (due to hole collapsing)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3, 4, 5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 1.8 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧭ Water level

CHECKED
Initials:
Date:

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Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 128.9m AHD
EASTING: 324029
NORTHING: 6252186
DIP/AZIMUTH: 90°/--

PIT No: TP 13
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
		SAND - medium dense, dark brown, fine to medium grained, sand with some silt. Becoming light brown and slightly clayey from 0.3 m.		D	0.2				
		With orange mottling and becoming weakly cemented from 0.7 m.		D	1.2				
	1.5	SAND - medium dense, light grey, fine to coarse grained, wet sand with some clay. Clay increasing with depth.							
	2.2	CLAYEY SAND / SANDY CLAY - medium dense/stiff, blue-grey, fine to coarse sized, wet clayey sand/sandy clay.							
	2.5	Pit discontinued at 2.2m (due to hole collapsing)							

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 1.6 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 130.0m AHD
EASTING: 324077
NORTHING: 6252098
DIP/AZIMUTH: 90°/--

PIT No: TP 14
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, sandy silty topsoil.							
		SAND - medium dense, grey, fine to medium grained, humid sand with trace of silt.							
		Becoming brown with some silt from 0.4 m.		D	0.5				
		With bands of weakly cemented silty sand (coffee rock) from 0.6 m-0.8 m. Becoming light brown with trace of silt and clay from 0.7m.							
	1			D	1.0				
		Becoming fine to coarse, wet from 1.3m.							
				D	1.5				
	1.8	SAND - medium denser, light grey, fine to coarse grained, wet sand with some clay.							
	2			D	2.0				
	2.5	Pit discontinued at 2.5m (due to hole collapsing)		D	2.5				
	3								
	4								
	5								

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Free groundwater observed Groundwater seepage at 1.8 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 128.9m AHD
EASTING: 324005
NORTHING: 6252129
DIP/AZIMUTH: 90°/--

PIT No: TP 15
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy topsoil.							
		CLAYEY GRAVELLY SAND - medium dense, light brown, fine to medium grained, clayey gravelly sand with some cobbles (20cm-50cm). Gravel is fine to coarse sized ironstone.		D	0.3				
	0.6	IRONSTONE - red-brown, high strength ironstone.							
	1.3	Pit discontinued at 1.3m (due to refusal on ironstone, slow digging)							

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

Douglas Partners
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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 128.4m AHD
EASTING: 323919
NORTHING: 6252150
DIP/AZIMUTH: 90°/--

PIT No: TP 16
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
		SAND - medium dense, dark brown, fine to medium grained, sand with some silt. Becoming light brown with some clay from 0.3m.		D	0.4				
		With orange mottling from 0.5m.							
	1	Becoming fine to coarse, wet, with a trace of clay from 1.0m.							
		Becoming light grey from 1.4m.		D	1.5				
	2.0	CLAYEY SAND - medium dense, light grey, fine to coarse grained, wet clayey sand.							
	2.5	Pit discontinued at 2.5m (target depth)							

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 1.6 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 127.2m AHD
EASTING: 323833
NORTHING: 6252168
DIP/AZIMUTH: 90°/--

PIT No: TP 17
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
		SAND - medium dense, brown, fine to medium grained, moist sand with trace of silt. Becoming light brown with some clay from 0.3m.		D	0.5				
		With orange mottling and some fine to coarse sized gravel from 0.6m. Gravel is ironstone.		D	1.0				
	1.2	GRAVELLY SAND / SANDY GRAVEL - medium dense, orange-brown, fine to coarse grained, moist gravelly sand/sandy gravel with trace of clay. Gravel is fine to coarse sized ironstone.		D	1.5				
	1.8	SAND - medium dense, light grey, fine to coarse grained, wet sand with some cobbles (10cm-15cm) and trace of clay. Clay content increasing with depth.		D	2.0				
				D	2.5				
	3.0	CLAYEY SAND - medium dense, light grey, fine to coarse grained, wet clayey sand.		D	3.0				
	3.7	GRANITE - high strength, weathered granite.							
	3.8	Pit discontinued at 3.8m (due to refusal on granite and collapsing hole)							

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 2.0 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧭ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 127.4m AHD
EASTING: 323874
NORTHING: 6252248
DIP/AZIMUTH: 90°/--

PIT No: TP 18
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - brown, sandy topsoil.							
		CLAYEY SAND - medium dense, brown-grey, fine grained, moist clayey sand.		B	0.3				
	0.4	SANDY CLAY - stiff, light brown, medium plasticity, moist sandy clay. Sand is fine grained.		B	0.6		pp = 150kPa		
	1.9	SAND - medium dense, light grey, fine to coarse grained, wet sand with trace of clay and some fine to coarse sized gravel and cobbles. Clay increasing with depth.		D	2.0				
	3.1	GRANITE - high strength, weathered granite.							
	3.2	Pit discontinued at 3.2m (due to refusal on granite and collapsing hole)							

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 2.0 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 127.8m AHD
EASTING: 323916
NORTHING: 6252249
DIP/AZIMUTH: 90°/--

PIT No: TP 19
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
		SAND - medium dense, light brown, fine to medium grained, moist sand, slightly clayey with some silt.		D	0.3				
	0.4	SANDY CLAY - stiff, light brown mottled orange, medium plasticity, moist sandy clay.		D	0.5		pp = 200kPa		
	1	Becoming light grey mottled orange with some fine to coarse sized gravel from 1.0 m.							
	1.3	SANDY CLAYEY GRAVEL - dense, red-brown and light grey, fine to coarse sized sandy clayey gravel. Gravel is medium to coarse sized ironstone.							
	2								
	2.4	SAND - medium dense, light grey, fine to coarse grained, wet sand with trace of clay and fine sized gravel and some cobbles.							
	3	Clay content increasing with depth.							
	3.3	GRANITE - high strength, weathered granite.		D	3.3				
	3.4	Pit discontinued at 3.4m (due to refusal on granite and collapsing hole)							
	4								
	5								

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 2.4 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 127.2m AHD
EASTING: 323856
NORTHING: 6252317
DIP/AZIMUTH: 90°/--

PIT No: TP 20
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy topsoil.							
	0.3	CLAYEY SAND - medium dense,light brown, fine to medium grained, moist clayey sand with trace of fine to coarse sized gravel.							
		SANDY CLAY - stiff, light brown, medium plasticity, moist sandy clay.		B	0.5		pp = 150kPa		
		Becoming light grey mottled orange from 0.7 m with trace of fine to coarse sized gravel.							
1				D	1.0		pp = 150kPa		1
		Sand is fine to coarse grained from 1.5m.							
2	2.0	SAND - medium dense, light grey, fine to coarse grained, wet sand with some clay and trace of fine to coarse sized gravel.		D	2.0				2
	2.7	CLAYEY SAND - medium dense, light grey, fine to coarse grained, wet clayey sand.							
3	3.0	Pit discontinued at 3.0m (target depth)							3
4									4
5									5

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 2.0 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧗ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 128.3m AHD
EASTING: 323972
NORTHING: 6252351
DIP/AZIMUTH: 90°/--

PIT No: TP 21
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
	0.3	SAND - medium dense, dark brown-grey, fine to medium grained, moist sand, with some silt.							
		CLAYEY SAND / SANDY CLAY - medium dense, light brown, fine to medium grained, moist clayey sand/sandy clay. Becoming light grey with orange mottling and some fine to coarse sized gravel from 0.5 m.		D	0.5		pp = 200kPa		
1				D	1.0				1
	1.2	SANDY CLAY - very stiff, light grey mottled red, high plasticity sandy clay with a trace of fine to coarse sized gravel.		D	1.5		pp = 300kPa		
	1.6	CLAYEY SAND - medium dense, light brown and light grey, fine to coarse grained, wet clayey sand with some fine to coarse sized gravel.							
2	2.0	GRAVELLY SAND - medium dense, light brown and light grey, fine to coarse grained gravelly sand and clayey sand. Gravel is quartz.		D	2.0				2
	2.3	CLAY - stiff, grey-blue, high plasticity, moist clay with some sand.		D	2.5				
3	3.0	Pit discontinued at 3.0m (target depth)		D	3.0		pp = 150kPa		3
4									4
5									5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 3.0 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 128.2m AHD
EASTING: 323906
NORTHING: 6252400
DIP/AZIMUTH: 90°/--

PIT No: TP 22
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, sandy topsoil.							
		SAND - medium dense, dark grey, fine to medium grained sand with a trace of silt. Becoming light grey from 0.3 m.							
	0.7	CEMENTED SAND - light brown mottled orange, fine to medium grained, humid weakly cemented sand, with trace of clay. Strength increases with depth.		D	1.0				
	2.3	SAND AND CLAYEY SAND - medium dense, light grey, fine to coarse grained, wet sand and clayey sand.							
	2.5	Pit discontinued at 2.5m (target depth)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3, 4, 5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 2.4 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 129.1m AHD
EASTING: 323967
NORTHING: 6252468
DIP/AZIMUTH: 90°/--

PIT No: TP 23
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, sandy topsoil.							
		SAND - medium dense, light grey-brown, fine to medium grained, moist sand, with some clay.							
	0.5	CLAYEY SAND - medium dense, light brown mottled orange, fine grained moist clayey sand.		D	0.5				
	1			D	1.0				
	1.5	CLAYEY SAND - medium dense, light brown-orange, fine to coarse grained, moist clayey sand.		D	1.5				
	2 2.0	GRAVELLY SAND - medium dense, light brown mottled orange, wet gravelly sand with some clay. Gravel is quartz.		D	2.0				
				D	2.5				
	2.8	CLAYEY SAND - medium dense, light grey, fine to coarse grained, wet clayey sand.							
	3 3.0	Pit discontinued at 3.0m (target depth)		D	3.0				
	4								
	5								

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧗ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 130.0m AHD
EASTING: 324076
NORTHING: 6252461
DIP/AZIMUTH: 90°/--

PIT No: TP 24
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, sandy topsoil.							
		SAND - medium dense, grey, fine to medium grained, humid sand with some silt and fine to coarse sized gravel.		D	0.5				
	0.6	CLAYEY SAND - medium dense, light grey-brown, fine to medium grained, moist clayey sand with some fine to coarse sized gravel. becoming mottled orange and weakly cemented from 0.8 m.		D	1.5				
	2.3	SAND - medium dense, light brown-grey, fine to coarse grained, wet sand, with fine to coarse sized gravel.							
	2.5	Pit discontinued at 2.5m (target depth)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3, 4, 5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 129.8m AHD
EASTING: 324048
NORTHING: 6252555
DIP/AZIMUTH: 90°/--

PIT No: TP 25
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, sandy silty topsoil.							
		SAND - medium dense, grey, fine to medium grained, humid sand.							
		Becoming light brown and weakly cemented with trace of clay from 0.6m.		D	1.0				
	1.4	IRONSTONE - red-brown, medium strength ironstone.							
	1.6	CLAYEY SAND / SANDY CLAY - dense, light grey mottled red, fine to medium grained, moist clayey sand/sandy clay.		D	1.8				
	2.5	Pit discontinued at 2.5m (target depth)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3, 4, 5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 129.9m AHD
EASTING: 324075
NORTHING: 6252653
DIP/AZIMUTH: 90°/--

PIT No: TP 26
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
		SAND - medium dense, light brown, fine to medium grained sand with trace of clay.							
	0.5	CLAYEY SAND - medium dense, light brown, fine to medium grained, moist clayey sand.		D	0.5				
				D	0.6				
		becoming dense, mottled orange and weakly cemented from 0.7 m.							
1				D	1.0				1
				D	1.5				
	1.9								
2		CLAYEY GRAVELLY SAND - medium dense, light brown, fine to coarse grained, moist clayey gravelly sand. Gravel is fine to coarse sized ironstone.		D	2.0				2
				D	2.5				
	2.6	GRAVELLY CLAYEY SAND - medium dense, light brown-light grey mottled red and orange, fine to coarse sized, moist gravelly clayey sand. Gravel is fine to coarse sized.							
3	3.0	Pit discontinued at 3.0m (target depth)		D	3.0				3
4									4
5									5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 131.0m AHD
EASTING: 324135
NORTHING: 6252601
DIP/AZIMUTH: 90°/--

PIT No: TP 27
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, sandy topsoil.							
		SANDY GRAVEL - medium dense, light brown, fine to coarse sized, moist sady gravel with trace of silt.		D	0.5				
	0.7	IRONSTONE - red-brown, medium strength ironstone.							
	1			D	1.3				
	2								
	2.3	SANDY CLAY - very stiff, light grey mottled red and orange, high plasticity, sandy clay. Sand is fine grained.							
	2.5	Pit discontinued at 2.5m (target depth)		D	2.5		pp=>400kPa		
	3								
	4								
	5								

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 131.4m AHD
EASTING: 324128
NORTHING: 6252530
DIP/AZIMUTH: 90°/--

PIT No: TP 28
PROJECT No: 46790
DATE: 7 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.1	TOPSOIL - dark grey, sandy silty topsoil.							
	0.2	GRAVELLY SAND - medium dense, light brown, fine to medium grained, humid gravelly sand.							
		CEMENTED SAND / IRONSTONE - red-brown to light grey, moderately cemented sand and high strength ironstone.							
	1	with ironstone boulders from surface to 1.0 m (0.7 m, 0.4 m and 1.3 m diameter).							
	2	Becoming light grey mottled red from 2.3m.							
	2.5	Pit discontinued at 2.5m (target depth)							
	3								
	4								
	5								

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 134.5m AHD
EASTING: 324439
NORTHING: 6251997
DIP/AZIMUTH: 90°/--

PIT No: TP 29
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
		CLAYEY SAND - medium dense, light brown, fine to medium grained, moist clayey sand with some clay.		D	0.5				
	1								1
	2	Clay content increasing with depth.		D	2.0				2
	3	Becoming light grey mottled orange from 2.9m.							3
	3.3	SAND - medium dense, orange, fine to coarse grained, wet sand with trace of clay and cobble (5cm-15cm).							
	3.6	CLAYEY SAND - medium dense, light grey, fine to coarse grained, wet clayey sand.							
	4 4.0	Pit discontinued at 4.0m (target depth)							4
	5								5

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 3.5 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 133.4m AHD
EASTING: 324315
NORTHING: 6252015
DIP/AZIMUTH: 90°/--

PIT No: TP 30
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, sandy silty topsoil.							
		SAND - medium dense, light brown, fine to medium grained, moist sand with some silt.							
	0.6	CLAYEY SAND - medium dense, light brown mottled orange, fine to medium grained, moist clayey sand.		D	1.0				
	2.3	IRONSTONE - red-brown, medium strength ironstone.							
	2.5	Pit discontinued at 2.5m (target depth)							

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧭ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 132.0m AHD
EASTING: 324207
NORTHING: 6252060
DIP/AZIMUTH: 90°/--

PIT No: TP 31
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
		SAND - medium dense, light brown, fine to medium grained, sand with some clay.							
	0.5	CLAYEY SAND - medium dense, light brown mottled orange, fine to medium grained, moist clayey sand.							
	0.8	CLAYEY SANDY GRAVEL - dense light brown, fine to coarse sized, moist, clayey sand gravel.		D	1.0				
	1.3	IRONSTONE - red-brown, high strength ironstone.							
	1.5	Pit discontinued at 1.5m (due to refusal on ironstone, slow digging)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3, 4, 5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 131.9m AHD
EASTING: 324241
NORTHING: 6252109
DIP/AZIMUTH: 90°/--

PIT No: TP 32
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, silty sandy topsoil.							
		SAND - medium dense, light grey-brown, fine to medium grained, moist sand with some clay.							
	0.5	CLAYEY SAND - medium dense, light grey-brown mottled orange, fine to medium grained, moist clayey sand.							
	1.8	IRONSTONE - red-brown, medium to high strength ironstone.							
	2.5	Pit discontinued at 2.5m (target depth)							

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 2.5 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 133.2m AHD
EASTING: 324361
NORTHING: 6252113
DIP/AZIMUTH: 90°/--

PIT No: TP 33
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, silty sandy topsoil.							
		SAND - medium dense, light brown, fine to medium grained, moist sand with some clay and silt.		D	0.4				
	0.5	CLAYEY SAND - medium dense, light brown mottled orange, fine to medium grained, moist clayey sand.							
	1			D	1.0				
		With some fine to coarse sized gravel from 1.6m.							
	1.9	IRONSTONE - red-brown, medium strength ironstone.							
	3.0	SAND - medium dense, light grey, fine to coarse grained, wet sand.							
	3.4	GRANITE - very high strength weathered granite.		D	3.4				
	3.5	Pit discontinued at 3.5m (due to refusal on granite)							

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 3.2 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 133.7m AHD
EASTING: 324375
NORTHING: 6252055
DIP/AZIMUTH: 90°/--

PIT No: TP 34
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, silty sandy topsoil.							
		SAND - medium dense, light brown, fine to medium grained, moist sand with some clay.							
		Becoming light brown mottled orange from 0.7m.							
	2.3	IRONSTONE - red-brown, medium strength ironstone.							
	2.5	Pit discontinued at 2.5m (target depth)							

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 134.0m AHD
EASTING: 324469
NORTHING: 6252072
DIP/AZIMUTH: 90°/--

PIT No: TP 35
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, silty sandy topsoil.							
		SAND - medium dense, light brown, fine to medium grained, moist sand with some clay.							
	0.6	CLAYEY SAND - medium dense, light brown, fine to medium grained, moist clayey sand.							
	1	With trace of fine to coarse sized gravel from 1.5m.							
	1.8	IRONSTONE - red-brown, medium strength ironstone.							
	2 2.0	Pit discontinued at 2.0m (due to refusal on ironstone, slow digging)							
	3								
	4								
	5								

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 133.3m AHD
EASTING: 324443
NORTHING: 6252140
DIP/AZIMUTH: 90°/--

PIT No: TP 36
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, silty sandy topsoil.							
		SAND - medium dense, light brown, fine to medium grained, moist sand with some clay.							
	0.5	IRONSTONE - red-brown, high strength ironstone.							
	1.0	Pit discontinued at 1.0m (due to refusal on ironstone, slow digging)							

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 132.2m AHD
EASTING: 324377
NORTHING: 6252193
DIP/AZIMUTH: 90°/--

PIT No: TP 37
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, silty sandy topsoil.							
		SAND - medium dense, light grey-brown, fine to medium grained, moist sand with some clay.							
	1	With orange mottling from 1.0m.							
		Becoming orange from 1.2m.							
	1.9	IRONSTONE - red-brown, medium strength ironstone.							
	2.2	SAND - medium dense light grey, fine to coarse grained, wet sand.							
	2.5	SANDY CLAY - stiff light grey-blue, medium plasticity, moist sandy clay. Sand is fine to coarse grained.		D	2.6				
	3								
	4								
	4.1	GRANITE - very high strength weathered granite.							
	4.2	Pit discontinued at 4.2m (due to refusal on granite and collapsing hole)							
	5								

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 2.3 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 131.4m AHD
EASTING: 324261
NORTHING: 6252187
DIP/AZIMUTH: 90°/--

PIT No: TP 38
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark brown, sandy silty topsoil.							
		SAND - medium dense, light brown, fine to medium grained, moist sand with some clay.							
	0.5	CLAYEY SAND - medium dense, light brown mottled orange, fine to medium grained, moist clayey sand.							
	1								1
		Becoming light grey and wet from 1.5m.		D	1.5				
	2								2
	2.0	SAND - medium dense, orange, fine to coarse grained, wet sand.							
	2.4								
	2.5	CLAYEY SAND - medium dense, light blue, fine to coarse grained, wet clayey sand.							
		Pit discontinued at 2.5m (target depth)							
	3								3
	4								4
	5								5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 2.1 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧭ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 131.2m AHD
EASTING: 324287
NORTHING: 6252265
DIP/AZIMUTH: 90°/--

PIT No: TP 39
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.1	TOPSOIL - dark grey, silty sandy topsoil.							
		SANDY CLAY - stiff, light brown mottled orange, medium plasticity, sandy clay.		B	0.5		pp=100kPa -150kPa		
	1								1
		With a trace of fine to coarse sized gravel from 1.3m.							
	1.8	GRAVELLY SANDY CLAY - light grey mottled red, medium plasticity, wet gravelly sandy clay. Gravel is fine to coarse sized.		D	2.0				
	2								2
	2.5	SAND - medium dense, light grey, fine to coarse grained, wet sand with some clay and fine to coarse sized gravel. Gravel is quartz.							
	3								3
	3.0	CLAYEY SAND - medium dense, light grey-blue, fine to coarse grained, wet clayey sand.							
	4								4
	4.0	Pit discontinued at 4.0m (target depth)							
	5								5

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 2.4 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧗ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 131.0m AHD
EASTING: 324338
NORTHING: 6252334
DIP/AZIMUTH: 90°/--

PIT No: TP 40
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, silty sandy topsoil.							
		SAND - medium dense, dark brown, fine to medium grained sand with trace of silt. Becoming light brown and moist with some clay from 0.2m. With orange mottling from 0.7m.							
	1.9	IRONSTONE - red-brown, high strength ironstone.							
	2.0	Pit discontinued at 2.0m (due to refusal on ironstone, slow digging)							

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 1.8 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧗ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 131.0m AHD
EASTING: 324326
NORTHING: 6252436
DIP/AZIMUTH: 90°/--

PIT No: TP 41
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, silty sandy topsoil.							
		SAND - medium dense, dark grey, fine to medium grained, humid sand with some silt. Becoming light grey-brown, moist with some clay from 0.3m.							
	0.6	CLAYEY SAND - medium dense, light brown mottled orange, fine to medium grained, moist clayey sand with trace of fine to coarse sized gravel.							
	1.8	SAND -medium dense, light grey, fine to coarse grained, wet sand with trace of fine to coarse sized gravel.							
	2.3	CLAYEY SAND - medium dense, light grey-blue, fine to coarse grained, wet clayey sand.							
	2.5	IRONSTONE - red-brown, high strength ironstone.							
	2.8	Pit discontinued at 2.8m (target depth)							

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 1.8 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 130.2m AHD
EASTING: 324383
NORTHING: 6252552
DIP/AZIMUTH: 90°/--

PIT No: TP 42
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, silty sandy topsoil.							
		SAND - medium dense, grey, fine to medium grained, humid sand with trace of clay.							
	0.4	SANDY CLAY / CLAYEY SAND - stiff, light grey, medium plasticity, moist sandy clay / clayey sand. Sand is fine to medium grained.		D	0.5		pp = 150kPa		
1	1.0	CLAYEY SAND - medium dense, light grey mottled orange and red, fine to medium grained, moist clayey sand.		D	1.5		pp = 100kPa		
2	2.3	SANDY CLAY - stiff, light grey-blue, medium plasticity, moist sandy clay.							
	2.5	Pit discontinued at 2.5m (target depth)		D	2.5		pp = 150kPa		
3									
4									
5									

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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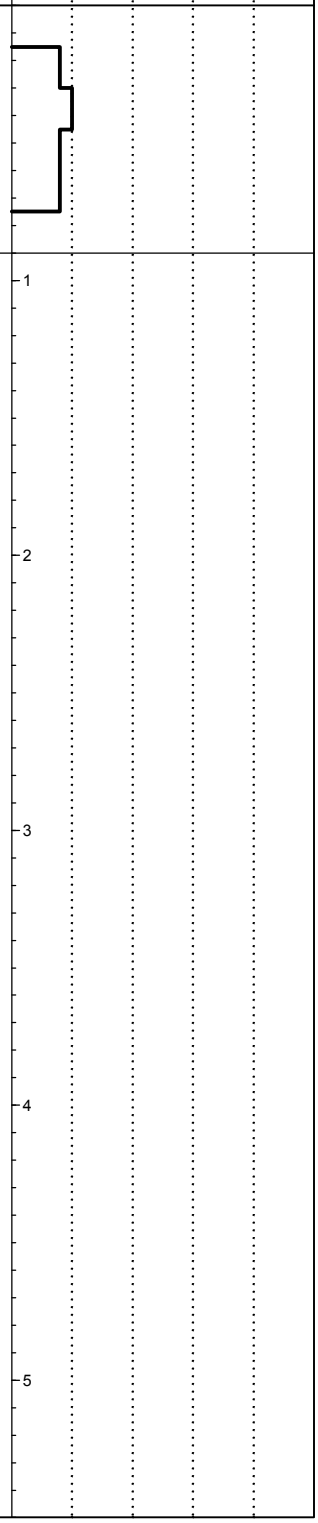
TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 133.1m AHD
EASTING: 324489
NORTHING: 6252197
DIP/AZIMUTH: 90°/--

PIT No: TP 43
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey, silty sandy topsoil.							
		SAND - medium dense, dark brown, fine to medium grained humid sand with some silt. becoming light brown-orange with a trace of silt from 0.3 m.							
	0.6	IRONSTONE - red-brown, high strength ironstone.							
	0.9	Pit discontinued at 0.9m (due to refusal on ironstone, slow digging)							



RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 134.3m AHD
EASTING: 324514
NORTHING: 6252297
DIP/AZIMUTH: 90°/--

PIT No: TP 44
PROJECT No: 46790
DATE: 8 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	SAND (FILLING) - medium dense, grey-grey-brown, fine to medium grained sand with clay.							
	1.5	SAND - medium dense, light grey, fine to medium grained, humid sand with bands of moderately cemented silty sand.							
	1.9	SAND - medium dense, grey, fine to medium grained, sand.							
	3.5	IRONSTONE - red-brown, medium strength ironstone.							
	3.8	SAND - medium dense, light brown, fine to coarse grained, wet sand.							
	4.0	SANDY CLAY - very stiff, light grey-blue, fine to coarse grained sandy clay.			4.1		pp = 250kPa		
	5.2	Pit discontinued at 5.2m (target depth)							

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

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: Groundwater seepage at 4.0 m.

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 135.1m AHD
EASTING: 324550
NORTHING: 6252394
DIP/AZIMUTH: 90°/--

PIT No: TP 45
PROJECT No: 46790
DATE: 9 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.08	TOPSOIL - dark grey, sandy topsoil.							
		SAND - medium dense, grey, fine to medium grained, humid sand. Becoming light grey from 0.3m. Becoming grey-brown from 0.5m.							
	0.9	CEMENTED SILTY SAND - dense, brown, fine to medium grained, moderately cemented silty sand.							
	1.2	CLAYEY SAND - dense, light brown mottled orange, moist clayey sand.							
	2.4	GRAVELLY CLAYEY SAND - medium dense, light brown mottled orange, moist gravelly clayey sand.							
	2.8	IRONSTONE - red-brown, high strength ironstone.							
	3.2	Pit discontinued at 3.2m (due to refusal on ironstone, slow digging)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3, 4, 5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 133.1m AHD
EASTING: 324505
NORTHING: 6252449
DIP/AZIMUTH: 90°/--

PIT No: TP 46
PROJECT No: 46790
DATE: 9 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.08	TOPSOIL - grey, sandy topsoil.							
		SAND - medium dense, grey, fine to medium grained, humid sand. Becoming grey-brown from 0.3m.							
	0.9	CEMENTED SILTY SAND - dense, brown, fine to medium grained, weakly cemented silty sand.							
	1.2	CLAYEY SAND - dense, light grey mottled orange, moist clayey sand. With some fine to coarse sized gravel from 2.5m.							
	2.5	IRONSTONE - red-brown, high strength ironstone.							
	2.8	Pit discontinued at 2.8m (target depth)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3, 4, 5

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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TEST PIT LOG

CLIENT: N. I & A Earl
PROJECT: Lots 101 & 102 Bussell Highway
LOCATION: Cowaramup, WA

SURFACE LEVEL: 131.1m AHD
EASTING: 324465
NORTHING: 6252600
DIP/AZIMUTH: 90°/--

PIT No: TP 47
PROJECT No: 46790
DATE: 9 May 2008
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.08	TOPSOIL - brown, silty sandy topsoil.							
		CLAYEY GRAVELLY SAND - medium dense, orange-brown, fine to medium grained, moist clayey gravelly sand. Gravel is fine to coarse sized.							
	0.4	IRONSTONE - red-brown, high strength ironstone.							
	0.9	Pit discontinued at 0.9m (due to refusal on ironstone, slow digging)							

RIG: Cat 325B Excavator equipped with a 600 mm bucket with tiger teeth. **LOGGED:** R Shapland

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface level interpolated from contour plan provided by Cardno BSD

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧩ Water level

CHECKED
Initials:
Date:

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APPENDIX C

Geotechnical Laboratory Results

Particle Size Distribution & Plasticity Index tests

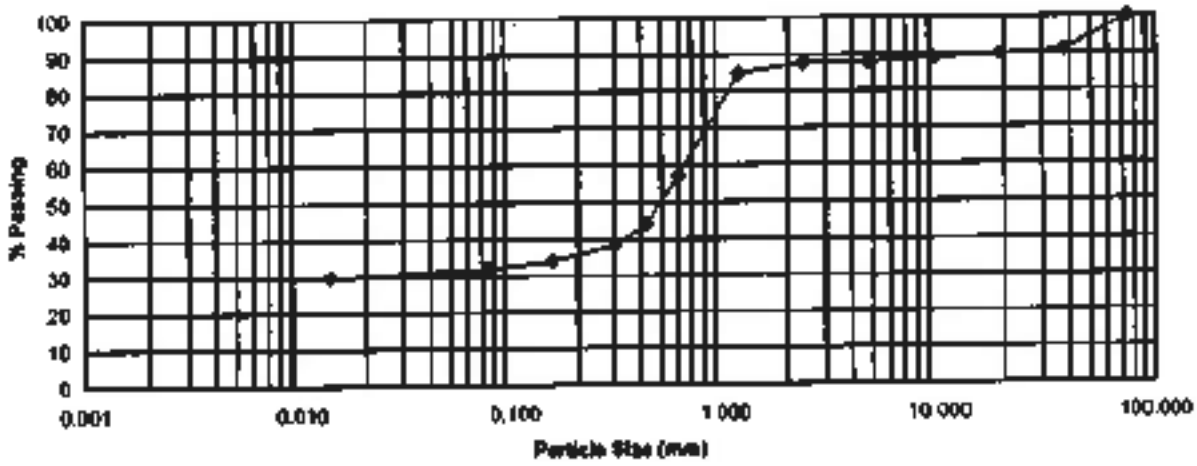
Mining & Civil

Geotest Pty Ltd

unit1/1 Piney Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	60017
Report No:	60017-PO8/1014
Sample No:	P08/1014
Issue Date:	10 June 2008
Sample Location:	TP 4
Depth (m):	2.0

Client: N J & A Earl
Project: Lots 101 & 102 Bussell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1*

Sieve Size (mm)	% Passing
75.0	100
37.5	91
19.0	90
9.5	89
4.75	88
2.36	88
1.18	85
0.600	57
0.425	44
0.300	38
0.150	34
0.075	32
0.0155	30

*Minimum sample mass requirement not met.

Plasticity index tests
Australian Standard 1289

Liquid limit 3.1.1	90	%
Plastic limit 3.2.1	34	%
Plasticity index 3.3.1	56	%
Linear shrinkage 3.4.1	14.5	%

Cracked ☐
Curled ☑

Sampling Procedure: Tested as received

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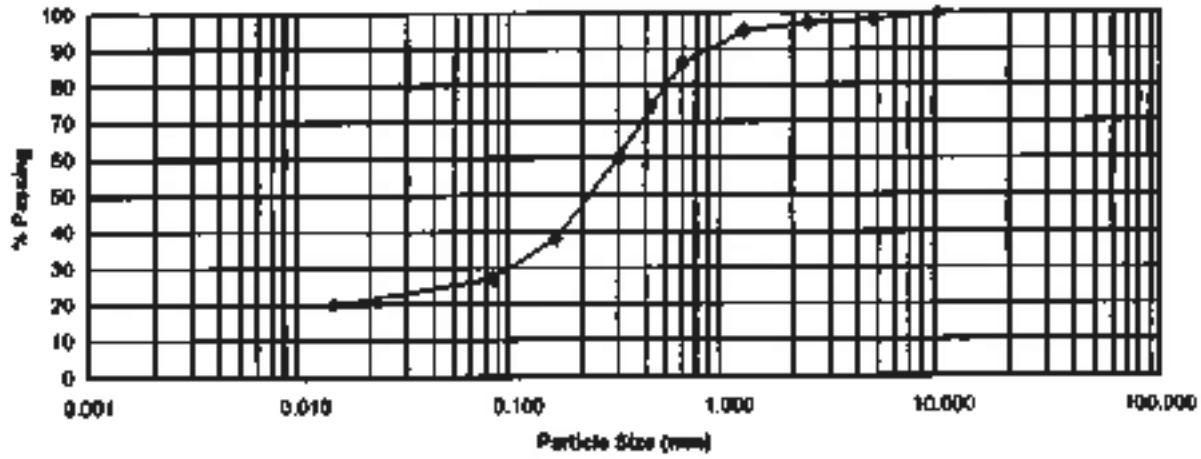
Particle Size Distribution & Plasticity Index tests

Mining & Civil

Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 2822 Fax (08) 9414 2911
Email: kevin@mcgeotest.com.au

Job No:	60017
Report No:	60017-P08/1018
Sample No:	P08/1018
Issue Date:	10 June 2008
Sample Location:	TP 7
Depth (m):	0.2

Client: N I & A Earl
Project: Lots 101 & 102 Bussell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	98
2.36	97
1.18	95
0.600	86
0.425	74
0.300	60
0.150	38
0.075	27
0.0135	20

Plasticity index tests
Australian Standard 1289

Liquid limit 3.1.1	62	%
Plastic limit 3.2.1	40	%
Plasticity index 3.3.1	22	%
Linear shrinkage 3.4.1	12.0	%

Cracked ☐
Curled ☑

Sampling Procedure: Tested as received

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Kevin M Jones

Mining & Civil Geotest Pty Ltd

Ph (08) 9414 8022 Fax (08) 9414 8011

Email kevin@mcgeotest.com.au

Unit 1/1 Pusey Road, JANDAKOT WA 6164

Organic content of Soils
ASTM: D 2974-07a
Test Method C

Job No: 60017

Report No: 60017-P08/1018

Date of issue: 10 June 2008

Client: N I & A Earl

Location: Lots 101 & 102 Bussell Highway Cowaramup

Date tested: 3 June 2008

Tested by: Y Marinovich

Checked: K M Jones

Sample Number	Location and depth (m)	Ash content %	Organic content %
P08/1018	TP 7, 0.2	87.5	12.5

Samples oven dried prior to test
Furnace temperature 440°C

Authorised Signature Kevin M Jones

Particle Size Distribution & Plasticity Index tests

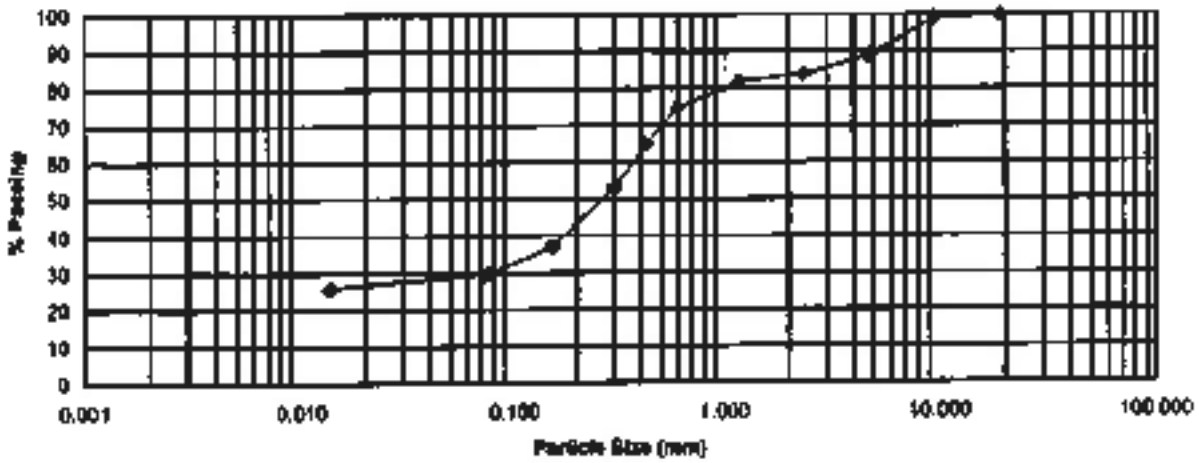
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Geotest Pty Ltd

unit1/1 Pusey Road, Jandakot, WA 6164
Pb (08) 9414 9022 Fax (08) 9414 9011
Email: kevin@mcgeotest.com.au

Job No:	60017
Report No:	60017-PQ8/1008
Sample No:	P08/1008
Issue Date:	10 June 2008
Sample Location:	TP 7
Depth (m):	0.5

Client: N I & A Earl
Project: Lots 101 & 102 Bussell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	99
4.75	89
2.36	84
1.18	82
0.600	75
0.425	65
0.300	53
0.150	37
0.075	30
0.0135	26

Plasticity Index tests
Australian Standard 1289

Liquid limit 3.1.1	42	%
Plastic limit 3.2.1	16	%
Plasticity index 3.3.1	26	%
Linear shrinkage 3.4.1	11.0	%

Cracked ☐
Curled ☑

Sampling Procedure: Tested as received

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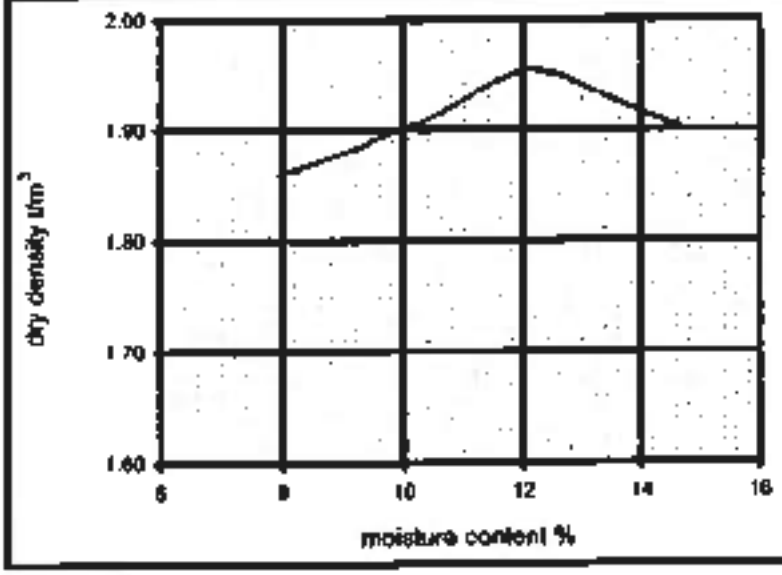
Kevin M Jones

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Unit 1/1 Posey Road, JANDAKOT WA 6164
Ph (08) 9414 5022
Fax (08)9414 5011
Email kevin@mcgeotest.com.au

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

Certificate No:	60017-P08/1008	**Sample No.:**	P08/1008
Client:	N I & A Earl	**Project:**	Lots 101 & 102 Bussell Highway
Location:	TP 7	**Date of issue:**	16 June 2008
Depth (m):	0.5	**Job No:**	60017

Maximum Dry Density t/m^3:	1.953	**Conditions at Test**	
Optimum Moisture Content %:	12.4	Soaking Period (Days)	4
Desired Conditions: %MDD / %OMC	95/100	Surcharge (kg)	4.50
Compactive Effort		Entire Moisture Content %	15.9
Mass of hammer kg	4.9	Entire Moisture Ratio %	128.5
Number of layers	5	Top 30mm Moisture Content %	18.0
Number of blows/layer	18	Top 30mm Moisture Ratio %	145.2
Conditions after Compaction		Swell %	0.5
Dry Density t/m^3	1.863	C.B.R. AT 2.5 mm Penetration	5.0
Moisture Content %	12.0	**Conditions after Soaking**	
Density Ratio %	95.4	Dry Density t/m^3	1.854
Moisture Ratio %	96.5	Moisture Content %	16.2
Soaked / Unsoaked	Soaked	Dry Density Ratio %	94.9
		Moisture Ratio %	130.4



Comments:

Tested as received

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Particle Size Distribution & Plasticity Index tests

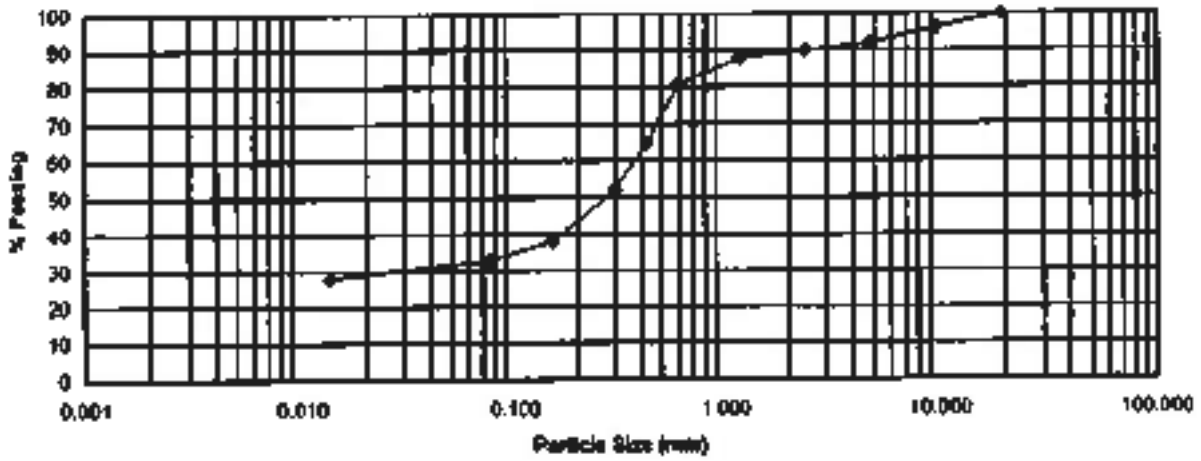
Mining & Civil

Geotest Pty Ltd

unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 9622 Fax (08) 9414 9811
Email: kevin@mcgeotest.com.au

Job No:	60017
Report No:	60017-P08/1015
Sample No:	P08/1015
Issue Date:	10 June 2009
Sample Location:	TP 10
Depth (m):	1.5

Client: N J & A Earl
Project: Lots 101 & 102 Bussell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	96
4.75	92
2.36	90
1.18	88
0.600	81
0.425	65
0.300	52
0.150	38
0.075	33
0.0135	28

Plasticity index tests
Australian Standard 1289

Liquid limit 3.1.1	45	%
Plastic limit 3.2.1	17	%
Plasticity index 3.3.1	28	%
Linear shrinkage 3.4.1	11.5	%

Cracked ☐
Curled ☑

Sampling Procedure: Tested as received

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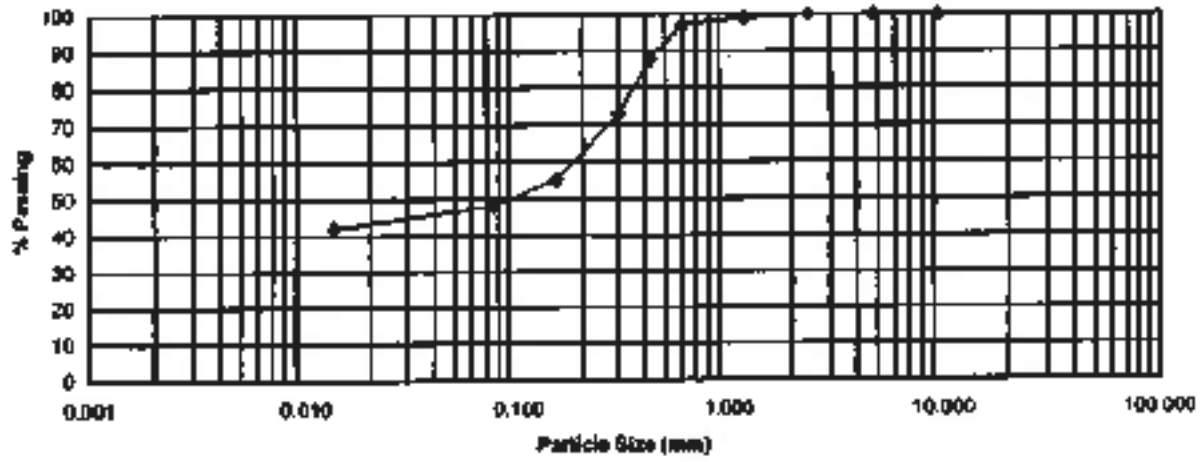
Particle Size Distribution & Plasticity Index tests

Mining & Civil

Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 5022 Fax (08) 9414 5011
Email: kevin@mcgeotest.com.au

Job No:	40017
Report No:	40017-P08/1016
Sample No:	P08/1016
Issue Date:	10 June 2008
Sample Location:	TP 18
Depth (m):	0.6

Client: N I & A Earl
Project: Lots 101 & 102 Bussell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	99
0.600	97
0.425	88
0.300	73
0.150	55
0.075	48
0.0135	42

Plasticity index tests
Australian Standard 1289

Liquid limit 3.1.1	49	%
Plastic limit 3.2.1	17	%
Plasticity index 3.3.1	32	%
Linear shrinkage 3.4.1	13.0	%

Cracked ☐
Curled ☑

Sampling Procedure: Tested as received

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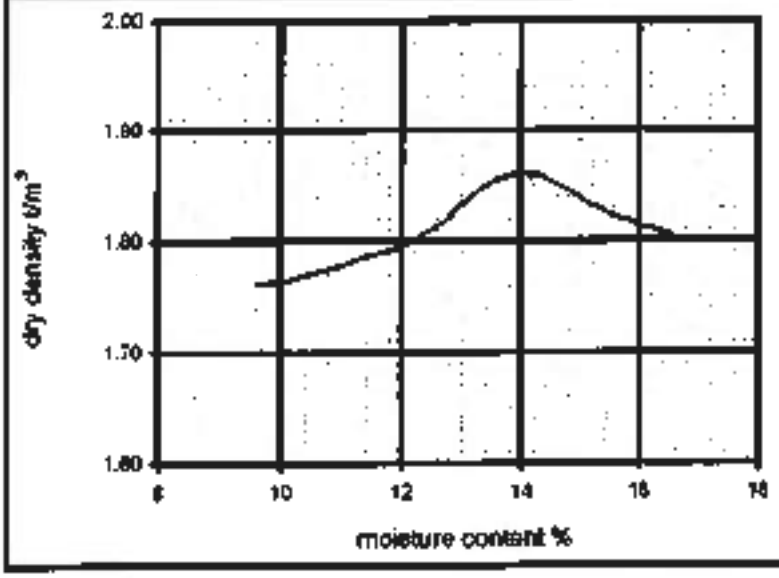
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Civil
Geotest Pty Ltd
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Fax (08)9414 5011
Email kevin@mcgeotest.com.au

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

Certificate No:	60017-P08/1016	Sample No.:	P08/1016
Client:	N I & A Earl	Project:	Lots 101 & 102 Bussell Highway
Location:	TP 18	Date of issue:	10 June 2008
Depth (m):	0.6	Job No:	60017

Maximum Dry Density t/m³:	1.858	**Conditions at Test**	
Optimum Moisture Content %:	14.2	Soaking Period (Days)	4
Desired Conditions: %MDD / %OMC	95/100	Surcharge (kg)	4.50
Compactive Effort		Entire Moisture Content %	17.9
Mass of hammer kg	4.9	Entire Moisture Ratio %	126.0
Number of layers	5	Top 30mm Moisture Content %	18.5
Number of blows/layer	20	Top 30mm Moisture Ratio %	130.5
Conditions after Compaction		Swell %	2.0
Dry Density t/m³	1.770	C.B.R. AT 2.5 mm Penetration	5.0
Moisture Content %	13.9	**Conditions after Soaking**	
Density Ratio %	95.2	Dry Density t/m³	1.736
Moisture Ratio %	98.1	Moisture Content %	18.4
Soaked / Unsoaked	Soaked	Dry Density Ratio %	93.4
		Moisture Ratio %	129.8



Comments:

Tested as received

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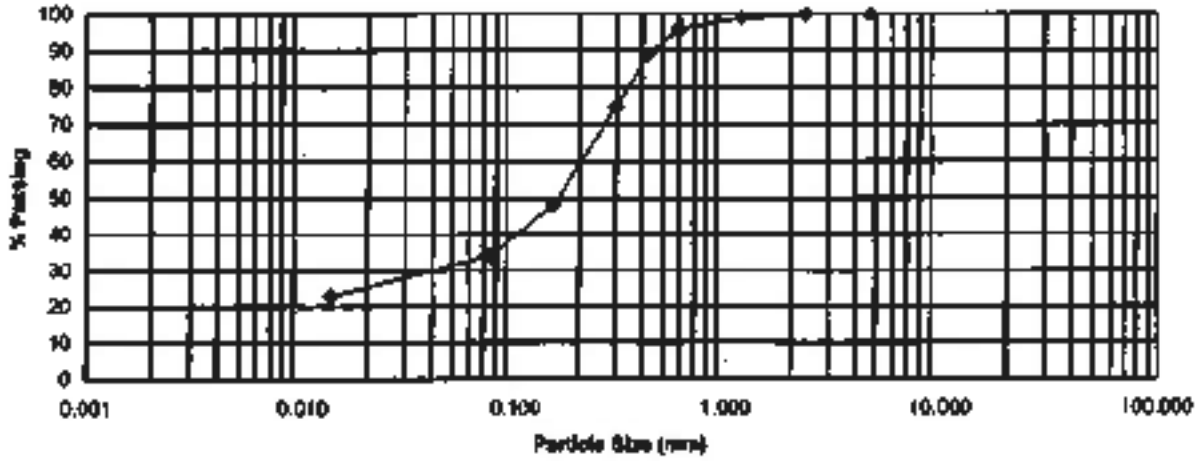
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Particle Size Distribution & Plasticity Index tests

Mining & Civil

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Job No:	60017
Report No:	60017-P08/1020
Sample No:	P08/1020
Issue Date:	10 June 2008
Client:	N I & A Earl
Project:	Lots 101 & 102 Bussell Highway
Location:	Cowaramup
Sample Location:	TP 19
Depth (m):	0.3



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	99
0.600	96
0.425	89
0.300	75
0.150	48
0.075	34
0.0135	23

Plasticity index tests
Australian Standard 1289

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Sampling Procedure: Tested as received

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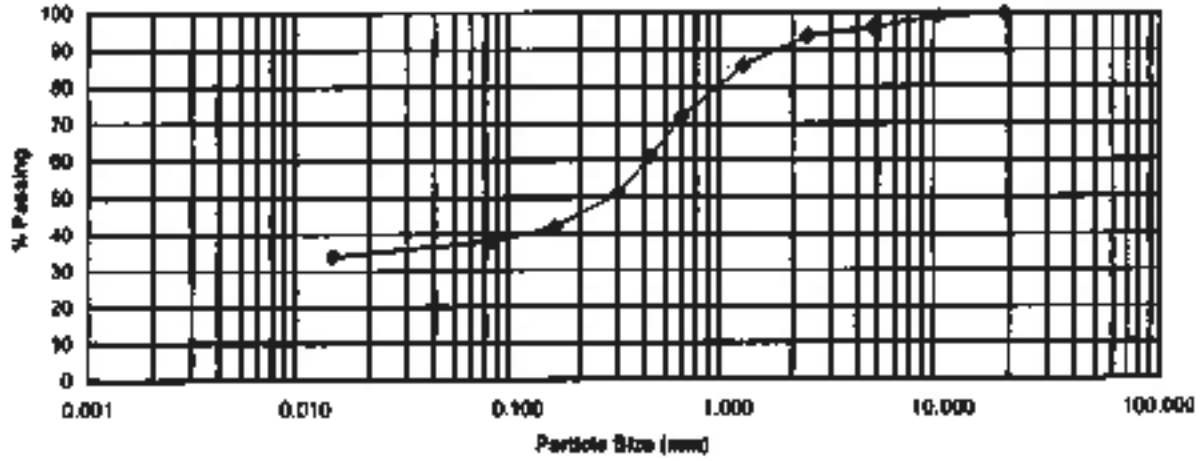
Particle Size Distribution & Plasticity Index tests

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Job No:	60017
Report No:	60017-P08/1019
Sample No:	P08/1019
Issue Date:	10 June 2008
Sample Location:	TP 28
Depth (m):	1.0

Client: N I & A Earl
Project: Lots 101 & 102 Bassell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	99
4.75	96
2.36	94
1.18	86
0.600	72
0.425	61
0.300	51
0.150	42
0.075	38
0.0135	34

Plasticity index tests
Australian Standard 1289

Liquid limit 3.1.1	59	%
Plastic limit 3.2.1	22	%
Plasticity index 3.3.1	37	%
Linear shrinkage 3.4.1	15.0	%

Cracked ☐
Curled ☑

Sampling Procedure: Tested as received

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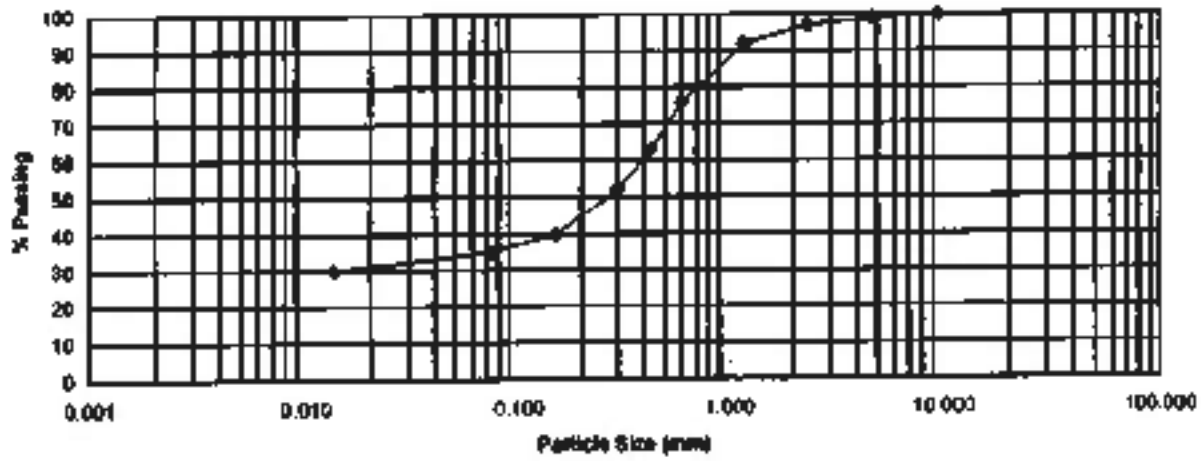
Particle Size Distribution & Plasticity Index tests

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Email: kevin@mcgeotest.com.au

Job No:	60817
Report No:	60817-P06/1017
Sample No:	P06/1017
Issue Date:	30 June 2009
Sample Location:	TP 21
Depth (m):	1.5

Client: N I & A Earl
Project: Lots 101 & 102 Bussell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	99
2.36	97
1.18	92
0.600	76
0.425	63
0.300	52
0.150	40
0.075	35
0.0135	30

Plasticity index tests
Australian Standard 1289

Liquid limit 3.1.1	68	%
Plastic limit 3.2.1	21	%
Plasticity index 3.3.1	47	%
Linear shrinkage 3.4.1	16.0	%

Cracked ☐
Curled ☑

Sampling Procedure: Tested as received

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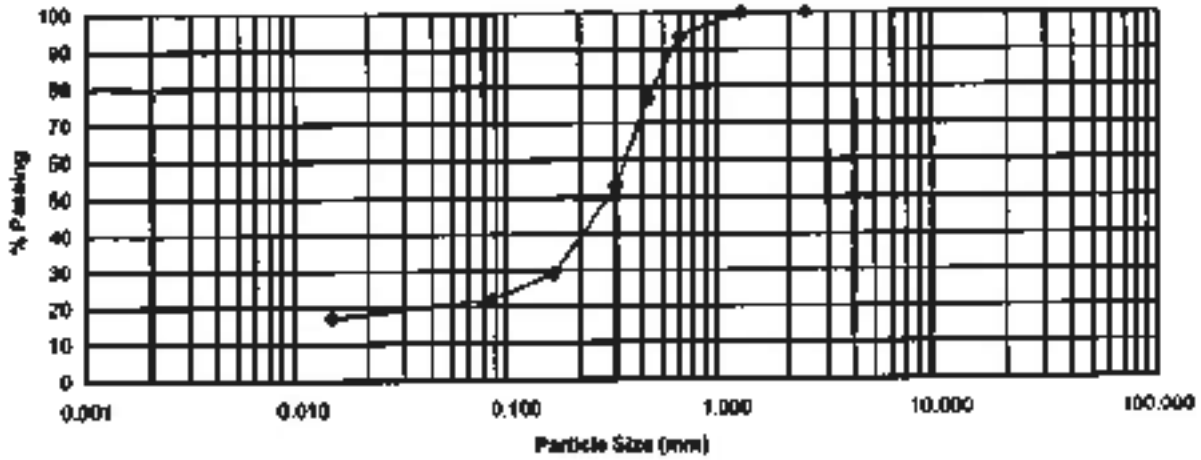
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Job No:	60017
Report No:	60017-PO8/1010
Sample No:	P08/1010
Issue Date:	10 June 2008
Sample Location:	TP 29
Depth (m):	0.5

Client: N J & A Earl
Project: Lots 101 & 102 Bussell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	100
0.600	94
0.425	77
0.300	53
0.150	29
0.075	22
0.0135	17

Plasticity index tests
Australian Standard 1289

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Sampling Procedure: Tested as received

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Particle Size Distribution & Plasticity Index tests

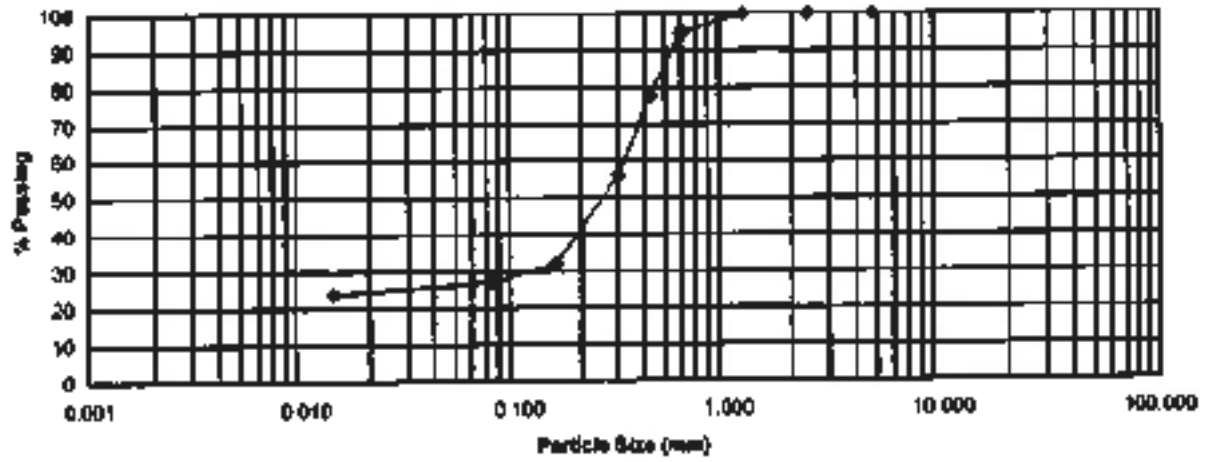
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Job No:	60017
Report No:	60017-POS/1009
Sample No:	POS/1009
Issue Date:	10 June 2009
Sample Location:	TP 30
Depth (m):	1.0

Client: N I & A Earl
Project: Lots 101 & 102 Bussell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	95
0.425	78
0.300	56
0.150	32
0.075	27
0.0135	24

Plasticity index tests
Australian Standard 1289

Liquid limit 3.1.1	30	%
Plastic limit 3.2.1	13	%
Plasticity index 3.3.1	17	%
Linear shrinkage 3.4.1	6.5	%

Cracked ☐
Curled ☑

Sampling Procedure: Tested as received

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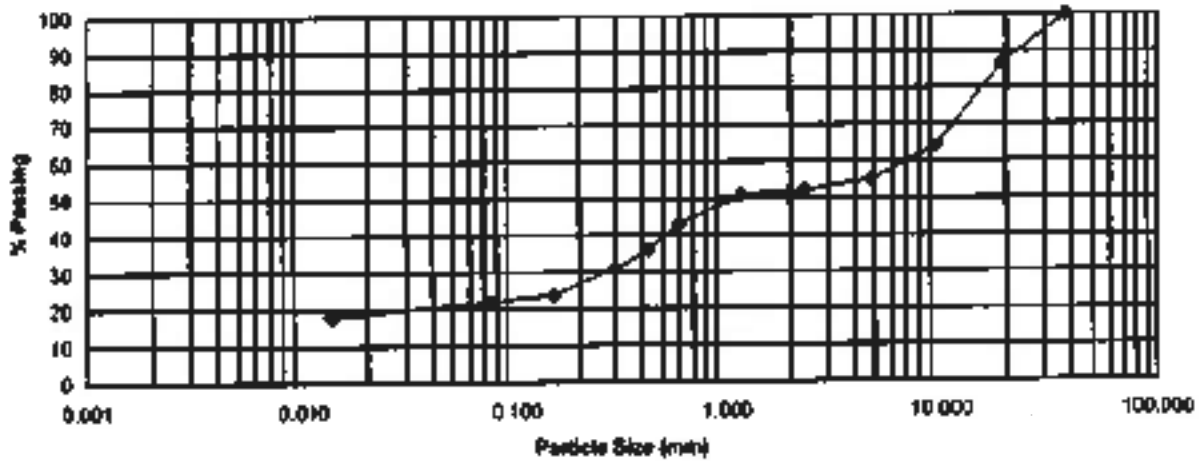
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Job No:	60017
Report No:	60017-PC08/1011
Sample No:	PC08/1011
Issue Date:	10 June 2008
Sample Location:	TP31
Depth (m):	1.0

Client: N I & A Earl
Project: Lots 101 & 102 Bussell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1*

Sieve Size (mm)	% Passing
75.0	
37.5	100
19.0	87
9.5	64
4.75	55
2.36	52
1.18	51
0.600	43
0.425	36
0.300	31
0.150	24
0.075	22
0.0135	18

*Minimum sample mass requirement not met.

Plasticity index tests
Australian Standard 1289

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐
Curled ☐

Sampling Procedure: Tested as received

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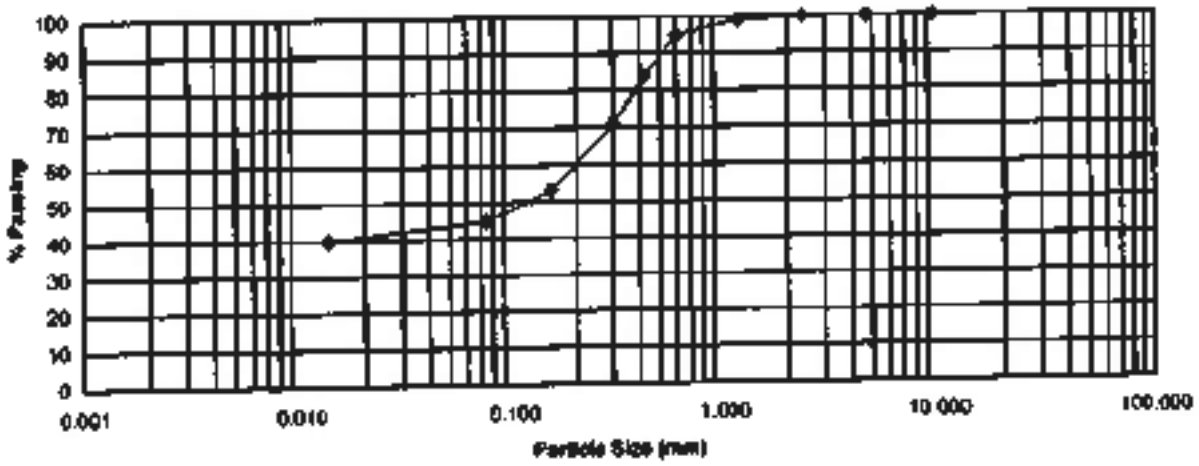
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Job No:	60017
Report No:	60017-P08/1007
Sample No:	P08/1007
Issue Date:	10 June 2008
Sample Location:	TP 39
Depth (m):	0.5

Client: N I & A Earl
Project: Lots 101 & 102 Bussell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.16	100
1.18	99
0.600	95
0.425	84
0.300	71
0.150	53
0.075	45
0.0135	40

Plasticity index tests
Australian Standard 1289

Liquid limit 3.1.1	44	%
Plastic limit 3.2.1	20	%
Plasticity index 3.3.1	24	%
Linear shrinkage 3.4.1	11.0	%

Cracked ☐
Curled ☑

Sampling Procedure: Tested as received

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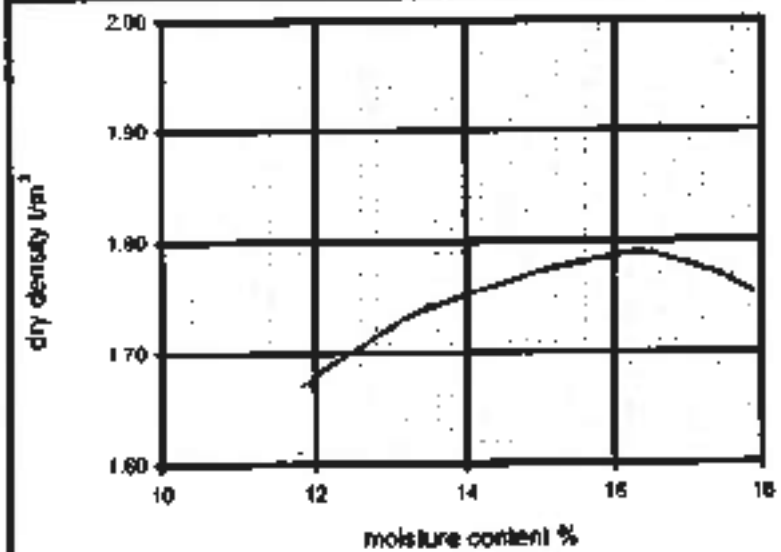
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Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

Certificate No:	60017-P08/1007	Sample No.:	P08/1007
Client:	N I & A Earl	Project:	Lots 101 & 102 Bussell Highway
Location:	TP 39	Date of Issue:	10 June 2008
Depth (m):	0.5	Job No:	60017

Maximum Dry Density t/m^3:	1.791	Conditions at Test	
Optimum Moisture Content %:	16.4	Soaking Period (Days)	4
Desired Conditions: %MDD / %OMC	95/100	Surcharge (kg)	4.50
Compactive Effort		Entire Moisture Content %	19.0
Mass of hammer kg	4.9	Entire Moisture Ratio %	115.7
Number of layers	5	Top 30mm Moisture Content %	22.0
Number of blows/layer	20	Top 30mm Moisture Ratio %	134.4
Conditions after Compaction		Swell %	2.0
Dry Density t/m^3	1.706	C.B.R. AT 2.5 mm Penetration	4.0
Moisture Content %	16.0	Conditions after Soaking	
Density Ratio %	95.2	Dry Density t/m^3	1.672
Moisture Ratio %	97.6	Moisture Content %	20.1
Soaked / Unsoaked	Soaked	Dry Density Ratio %	93.4
		Moisture Ratio %	122.8



Comments:

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MDD-CBR Aug – Aug 2006

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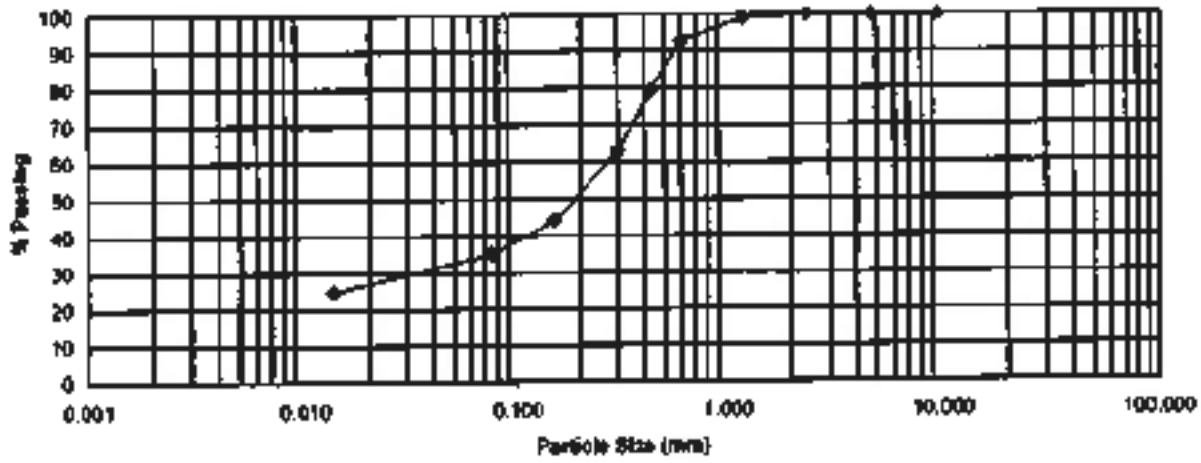
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Particle Size Distribution & Plasticity Index tests

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Job No:	60017
Report No:	60017-P08/1012
Sample No:	P08/1012
Issue Date:	10 June 2008
Sample Location.	TP 42
Depth (m):	0.5

Client: N I & A Earl
Project: Lots 101 & 102 Bussell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	99
0.600	93
0.425	79
0.300	63
0.150	44
0.075	35
0.0135	25

Plasticity Index tests
Australian Standard 1289

Liquid limit 3.1.1	44	%
Plastic limit 3.2.1	16	%
Plasticity index 3.3.1	28	%
Linear shrinkage 3.4.1	13.0	%

Cracked ☐
Curled ☑

Sampling Procedure: Tested as received

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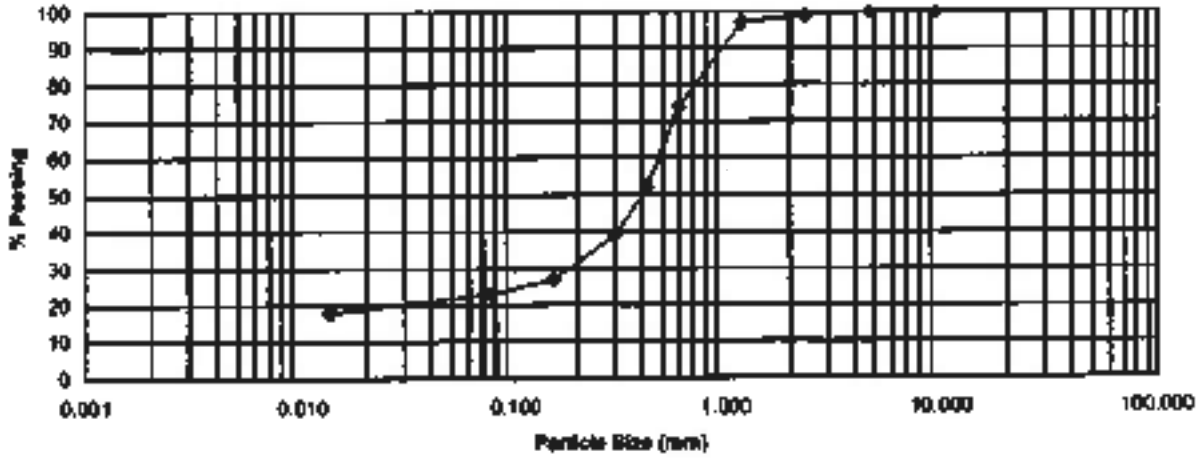
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Job No:	60017
Report No:	60017-P08/1013
Sample No:	P08/1013
Issue Date:	10 June 2008
Sample Location:	TP 42
Depth (m):	1.5

Client: N I & A Earl
Project: Lots 101 & 102 Bussell Highway
Location: Cowaramup



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	99
1.18	97
0.600	74
0.425	52
0.300	39
0.150	27
0.075	23
0.0135	18

Plasticity index tests
Australian Standard 1289

Liquid limit 3.1.1	42	%
Plastic limit 3.2.1	15	%
Plasticity Index 3.3.1	27	%
Linear shrinkage 3.4.1	9.5	%

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Sampling Procedure: Tested as received

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APPENDIX D

Acid Sulphate Soil Laboratory Results
Chain of Custody Reports

Table D-1 – Summary of Screening and SPOCAS Results

Test Location	Sample ID	Depth (m)	Soil Description	Screening Tests[1]				SPOCAS Suite of Testing							
				pH_F	pH_{FOX}	Reaction Strength	Δ pH[2]	pH_{KCl}	pH_{OX}	TAA[3] (%S)	TPA[4] (%S)	S_{POS}[5] (%S)	N_{RASS} (%S)	ANC[7] (%S)	Net[8] Acidity (%S)
Assessment Criteria				**≤4**	**<3**		**>1**								**>0.03**
TP3	1	0.5	CLAYEY SAND – light grey-brown	6.8	5.0	Slight	**1.8**	-	-	-	-	-	-	-	-
TP3	2	1	CLAYEY SAND – light grey-brown mottled orange	6.1	4.5	Slight	**1.6**	6.0	4.5	<0.02	<0.02	<0.02	NR	NR	<0.02
TP3	4	2	CLAYEY SAND – light grey-brown mottled orange	6.1	4.7	Slight	**1.4**	-	-	-	-	-	-	-	-
TP3	5	2.5	GRAVELLY CLAYEY SAND – light grey-brown mottled red & orange	5.5	4.9	Slight	**0.6**	-	-	-	-	-	-	-	-
TP3	6	3	GRAVELLY SANDY CLAY – light grey-brown mottled red	4.9	4.6	Slight	**0.3**	5.1	4.2	0.02	0.04	<0.02	NR	NR	0.02
TP5	7	0.5	CLAYEY SAND – light grey-brown mottled orange	6.2	5.1	Slight	**1.1**	-	-	-	-	-	-	-	-
TP5	8	1	CLAYEY SAND – light grey-brown mottled orange	5.9	5.0	Slight	**0.9**	5.8	4.9	<0.02	<0.02	<0.02	NR	NR	<0.02
TP5	9	1.5	CLAYEY SAND – light grey-brown mottled orange	6.0	4.9	Slight	**1.1**	-	-	-	-	-	-	-	-
TP5	10	2	CLAYEY SAND/SANDY CLAY – blue-grey	5.5	3.6	Slight	**1.9**	-	-	-	-	-	-	-	-
TP5	11	2.5	CLAYEY SAND/SANDY CLAY – blue-grey	5.6	**2.8**	Moderate	**2.8**	5.4	4.5	<0.02	<0.02	<0.02	NR	NR	0.02
TP5	12	3	CLAYEY SAND/SANDY CLAY – blue-grey	5.7	3.0	Slight	**2.7**	-	-	-	-	-	-	-	-
TP10	13	0.5	SILTY SAND – light brown-orange	5.4	4.2	Slight	**1.2**	5.4	4.6	**0.03**	0.04	<0.02	NR	NR	**0.03**

Test Location	Sample ID	Depth (m)	Soil Description	Screening Tests[1]				SPOCAS Suite of Testing							
				pH_F	pH_{FOX}	Reaction Strength	Δ pH[2]	pH_{KCl}	pH_{OX}	TAA[3] (%S)	TPA[4] (%S)	S_{POS}[5] (%S)	N_{RASS} (%S)	ANC[7] (%S)	Net[8] Acidity (%S)
Assessment Criteria				**≤4**	**<3**		**>1**								**>0.03**
TP10	14	1	SANDY CLAY/CLAYEY SAND – light grey	5.6	4.4	Slight	**1.2**	-	-	-	-	-	-	-	-
TP10	15	1.5	SANDY CLAY/CLAYEY SAND – light grey	5.4	4.0	Slight	**1.4**	-	-	-	-	-	-	-	-
TP10	16	2	SANDY CLAY/CLAYEY SAND – light grey	4.9	**2.8**	Extreme	**2.1**	5.5	4.6	<0.02	0.03	<0.02	NR	NR	0.02
TP10	17	2.5	SANDY CLAY/CLAYEY SAND – light grey	5.1	**2.3**	Slight	**2.8**	-	-	-	-	-	-	-	-
TP10	18	3	SANDY CLAY/CLAYEY SAND – light grey	5.4	3.1	Slight	**2.3**	-	-	-	-	-	-	-	-
TP14	19	0.5	SAND – brown	5.9	4.9	Moderate	1	5.3	3.6	**0.04**	0.07	<0.02	NR	NR	**0.05**
TP14	20	1	SAND – light brown	6.0	5.0	Slight	1	-	-	-	-	-	-	-	-
TP14	21	1.5	SAND – light brown	6.0	5.1	Slight	0.9	-	-	-	-	-	-	-	-
TP14	22	2	SAND – light grey	5.9	4.6	Slight	**1.3**	5.8	2.0	<0.02	<0.02	<0.02	NR	NR	<0.02
TP14	23	2.5	SAND – light grey	5.8	4.8	Slight	1	-	-	-	-	-	-	-	-
TP17	25	0.5	SAND – light brown	5.7	4.8	Slight	0.9	5.8	4.2	<0.02	<0.02	<0.02	NR	NR	<0.02
TP17	26	1	SAND – light brown mottled orange	5.8	4.7	Slight	**1.1**	-	-	-	-	-	-	-	-
TP17	27	1.5	SAND – light brown mottled orange	5.9	4.9	Slight	1	-	-	-	-	-	-	-	-
TP17	28	2	SAND – light grey	6.0	4.9	Slight	**1.1**	-	-	-	-	-	-	-	-
TP17	29	2.5	SAND – light grey	5.9	3.1	Slight	**2.8**	5.9	4.2	<0.02	<0.02	0.02	NR	NR	0.03[10]
TP17	30	3	CLAYEY SAND – light grey	5.9	3.9	Slight	**2**	5.8	4.9	<0.02	<0.02	<0.02	NR	NR	<0.02
TP20	31	0.5	SANDY CLAY – light brown	5.5	4.4	Slight	**1.1**	5.2	4.4	**0.04**	0.04	<0.02	NR	NR	**0.05**
TP20	32	1	SANDY CLAY – light brown	4.7	3.6	Slight	**1.1**	-	-	-	-	-	-	-	-
TP20	33	1.5	SANDY CLAY – light brown	4.5	3.4	Slight	**1.1**	4.9	4.1	**0.04**	0.05	<0.02	NR	NR	**0.04**
TP20	34	2	SAND – light grey	5.0	4.3	Slight	0.7	-	-	-	-	-	-	-	-

Test Location	Sample ID	Depth (m)	Soil Description	Screening Tests[1]				SPOCAS Suite of Testing							
				pH_F	pH_{FOX}	Reaction Strength	Δ pH[2]	pH_{KCl}	pH_{OX}	TAA[3] (%S)	TPA[4] (%S)	S_{POS}[5] (%S)	N_{RASS} (%S)	ANC[7] (%S)	Net[8] Acidity (%S)
Assessment Criteria				**≤4**	**<3**		**>1**								**>0.03**
TP20	35	2.5	SAND – light grey	5.3	4.3	Slight	1	5.3	5.0	<0.02	0.02	<0.02	NR	NR	<0.02
TP20	36	3	CLAYEY SAND – light grey	5.2	4.3	Slight	0.9	5.4	5.1	<0.02	<0.02	<0.02	NR	NR	<0.02
TP21	37	0.5	CLAYEY SAND/SANDY CLAY – light grey mottled orange	5.2	4.1	Slight	**1.1**	-	-	-	-	-	-	-	-
TP21	38	1	CLAYEY SAND/SANDY CLAY – light grey mottled orange	4.8	3.7	Slight	**1.1**	5.1	4.4	0.02	0.04	<0.02	NR	NR	0.03[10]
TP21	39	1.5	SANDY CLAY – light grey mottled red	4.9	3.6	Slight	**1.3**	-	-	-	-	-	-	-	-
TP21	40	2	CLAYEY SAND – light brown & light grey	5.0	4.6	Slight	0.4	5.5	4.9	<0.02	0.02	<0.02	NR	NR	<0.02
TP21	41	2.5	CLAY – grey-blue	5.3	**2.6**	Slight	**2.7**	4.7	4.2	**0.06**	0.12	**0.06**	NR	NR	**0.12**
TP21	42	3	CLAY – grey-blue	5.4	4.5	Slight	0.9	-	-	-	-	-	-	-	-
TP23	43	0.5	CLAYEY SAND – light brown mottled orange	5.3	4.2	Moderate	**1.1**	-	-	-	-	-	-	-	-
TP23	44	1	CLAYEY SAND – light brown mottled orange	5.4	4.4	Slight	1	5.4	4.5	<0.02	<0.02	**0.04**	NR	NR	**0.05**
TP23	45	1.5	CLAYEY SAND – light brown-orange	5.5	4.5	Slight	1	-	-	-	-	-	-	-	-
TP23	46	2	GRAVELLY SAND – light brown mottled orange	5.6	4.8	Slight	0.8	5.8	4.7	<0.02	<0.02	0.02	NR	NR	0.03[10]
TP23	47	2.5	GRAVELLY SAND – light brown mottled orange	4.9	4.8	Slight	0.1	-	-	-	-	-	-	-	-
TP23	48	3	CLAYEY SAND – light grey	4.6	4.5	Slight	0.1	5.3	4.6	<0.02	0.02	<0.02	NR	NR	<0.02
TP26	49	0.5	CLAYEY SAND – light brown	5.2	4.6	Slight	0.6	-	-	-	-	-	-	-	-
TP26	50	1	CLAYEY SAND – light brown mottled orange	5.4	4.8	Slight	0.6	5.6	4.8	<0.02	<0.02	<0.02	NR	NR	<0.02

Test Location	Sample ID	Depth (m)	Soil Description	Screening Tests[1]				SPOCAS Suite of Testing							
				pH_F	pH_{FOX}	Reaction Strength	Δ pH[2]	pH_{KCl}	pH_{OX}	TAA [3] (%S)	TPA[4] (%S)	S_{POS} [5] (%S)	N_{RASS} (%S)	ANC[7] (%S)	Net [8] Acidity (%S)
Assessment Criteria				**≤4**	**<3**		**>1**								**>0.03**
TP26	51	1.5	CLAYEY SAND – light brown mottled orange	5.6	4.7	Slight	0.9	-	-	-	-	-	-	-	-
TP26	52	2	CLAYEY GRAVELLY SAND – light brown	5.5	4.6	Slight	0.9	5.7	4.9	<0.02	<0.02	<0.02	NR	NR	<0.02
TP26	53	2.5	CLAYEY GRAVELLY SAND – light brown	5.6	4.8	Slight	0.8	-	-	-	-	-	-	-	-
TP26	54	3	GRAVELLY CLAYEY SAND – light brown mottled red & orange	5.6	4.6	Slight	1	5.8	5.0	<0.02	<0.02	<0.02	NR	NR	<0.02
TP28	55	0.5	CEMENTED SAND – red-brown to light grey	6.4	5.3	Slight	**1.1**	-	-	-	-	-	-	-	-
TP28	56	1	CEMENTED SAND – red-brown to light grey	6.2	5.0	Slight	**1.2**	6.2	5.7	<0.02	<0.02	<0.02	NR	NR	<0.02
TP28	57	1.5	CEMENTED SAND – red-brown to light grey	6.0	4.9	Slight	**1.1**	-	-	-	-	-	-	-	-
TP28	58	2	CEMENTED SAND – red-brown to light grey	5.4	4.6	Slight	0.8	-	-	-	-	-	-	-	-
TP28	59	2.5	CEMENTED SAND – light grey mottled red	4.8	4.4	Slight	0.4	5.1	4.5	0.02	0.02	0.02	NR	NR	0.04[10]

Notes:

1. Screening Tests undertaken by ALS Laboratory Group
2. **Δ pH** – pH_F - pH_{FOX}
3. TAA – titratable actual acidity
4. TPA – titratable peroxide acidity;
5. Spos – peroxide oxidisable sulphur
6. N_{RASS} – retained acidity (reported for pHkCl < 4.5)
7. ANC – acid neutralising capacity (reported for pHkCl > 6.5).
8. Net Acidity = TAA + Spos + NASS – ANC/FF
9. NR – Not Reported
10. Net acidity not considered to be above action criterion given results for TAA and Spos are either equal to, or below the laboratory limit of reporting.

\- Sample not selected for analysis.

Matrix:	SOIL		**Sample Type:**
Workgroup:	EP0802889		**ALS Sample number:**
Project name/number:	46790		**Sample date:**
			Client sample ID (1st):
			Client sample ID (2nd):
			Site:
			Purchase Order:

Analyte grouping/Analyte	CAS Number	Units	LOR
EA037: Ass Field Screening Analysis			
pH (F)		pH Unit	0.1
pH (Fox)		pH Unit	0.1
Reaction Rate		-	1

REG	REG	REG	REG	REG
EP0802889001	EP0802889002	EP0802889003	EP0802889004	EP0802889005
06/05/2008	06/05/2008	06/05/2008	06/05/2008	06/05/2008
1	2	4	5	6
74483	74483	74483	74483	74483
6.8	**6.1**	**6.1**	**5.5**	**4.9**
5.0	**4.5**	**4.7**	**4.9**	**4.6**
Slight	**Slight**	**Slight**	**Slight**	**Slight**

REG	REG	REG	REG	REG
EP0802889006	EP0802889007	EP0802889008	EP0802889009	EP0802889010
06/05/2008	06/05/2008	06/05/2008	06/05/2008	06/05/2008
7	8	9	10	11
74483	74483	74483	74483	74483
6.2	**5.9**	**6.0**	**5.5**	**5.6**
5.1	**5.0**	**4.9**	**3.6**	**2.8**
Slight	**Slight**	**Slight**	**Slight**	**Moderate**

REG	REG	REG	REG	REG
EP0802889011	EP0802889012	EP0802889013	EP0802889014	EP0802889015
06/05/2008	06/05/2008	06/05/2008	06/05/2008	06/05/2008
12	13	14	15	16
74483	74483	74483	74483	74483
5.7	**5.4**	**5.6**	**5.4**	**4.9**
3.0	**4.2**	**4.4**	**4.0**	**2.8**
Slight	**Slight**	**Slight**	**Slight**	**Extreme**

REG	REG	REG	REG	REG
EP0802889016	EP0802889017	EP0802889018	EP0802889019	EP0802889020
06/05/2008	06/05/2008	07/05/2008	07/05/2008	07/05/2008
17	18	19	20	21
74483	74483	74483	74483	74483
5.1	**5.4**	**5.9**	**6.0**	**6.0**
2.3	**3.1**	**4.9**	**5.0**	**5.1**
Slight	**Slight**	**Moderate**	**Slight**	**Slight**

REG	REG	REG	REG	REG
EP0802889021	EP0802889022	EP0802889023	EP0802889024	EP0802889025
07/05/2008	07/05/2008	07/05/2008	07/05/2008	07/05/2008
22	23	25	26	27
74483	74483	74483	74483	74483
5.9	**5.8**	**5.7**	**5.8**	**5.9**
4.6	**4.8**	**4.8**	**4.7**	**4.9**
Slight	**Slight**	**Slight**	**Slight**	**Slight**

REG	REG	REG	REG	REG
EP0802889026	EP0802889027	EP0802889028	EP0802889029	EP0802889030
07/05/2008	07/05/2008	07/05/2008	07/05/2008	07/05/2008
28	29	30	31	32
74483	74483	74483	74483	74483
6.0	**5.9**	**5.9**	**5.5**	**4.7**
4.9	**3.1**	**3.9**	**4.4**	**3.6**
Slight	**Slight**	**Slight**	**Slight**	**Slight**

REG	REG	REG	REG	REG
EP0802889031	EP0802889032	EP0802889033	EP0802889034	EP0802889035
07/05/2008	07/05/2008	07/05/2008	07/05/2008	07/05/2008
33	34	35	36	37
74483	74483	74483	74483	74483
4.5	**5.0**	**5.3**	**5.2**	**5.2**
3.4	**4.3**	**4.3**	**4.3**	**4.1**
Slight	**Slight**	**Slight**	**Slight**	**Slight**

REG	REG	REG	REG	REG
EP0802889036	EP0802889037	EP0802889038	EP0802889039	EP0802889040
07/05/2008	07/05/2008	07/05/2008	07/05/2008	07/05/2008
38	39	40	41	42
74483	74483	74483	74483	74483
4.8	**4.9**	**5.0**	**5.3**	**5.4**
3.7	**3.6**	**4.6**	**2.6**	**4.5**
Slight	**Slight**	**Slight**	**Slight**	**Slight**

REG	REG	REG	REG	REG
EP0802889041	EP0802889042	EP0802889043	EP0802889044	EP0802889045
07/05/2008	07/05/2008	07/05/2008	07/05/2008	07/05/2008
43	44	45	46	47
74483	74483	74483	74483	74483
5.3	**5.4**	**5.5**	**5.6**	**4.9**
4.2	**4.4**	**4.5**	**4.8**	**4.8**
Moderate	**Slight**	**Slight**	**Slight**	**Slight**

REG	REG	REG	REG	REG
EP0802889046	EP0802889047	EP0802889048	EP0802889049	EP0802889050
07/05/2008	07/05/2008	07/05/2008	07/05/2008	07/05/2008
48	49	50	51	52
74483	74483	74483	74483	74483
4.6	**5.2**	**5.4**	**5.6**	**5.5**
4.5	**4.6**	**4.8**	**4.7**	**4.6**
Slight	**Slight**	**Slight**	**Slight**	**Slight**

REG	REG	REG	REG	REG
EP0802889051	EP0802889052	EP0802889053	EP0802889054	EP0802889055
07/05/2008	07/05/2008	07/05/2008	07/05/2008	07/05/2008
53	54	55	56	57
74483	74483	74483	74483	74483
5.6	**5.6**	**6.4**	**6.2**	**6.0**
4.8	**4.6**	**5.3**	**5.0**	**4.9**
Slight	**Slight**	**Slight**	**Slight**	**Slight**

REG	REG
EP0802889056	EP0802889057
07/05/2008	07/05/2008
58	59
74483	74483
5.4	**4.8**
4.6	**4.4**
Slight	**Slight**

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CHAIN OF CUSTODY DESPATCH SHEET

Project Name: Lots 101 & 102 Bussell Hwy Cowaramup
Project No: 46740
DP Contact Person: Mabel F Shepherd
Prior Storage: esky / fridge / shelved (circle) Freezer

To: ALS Laboratory Group
10 Hod Way, Malaga, WA 6090
Ph: 9209 7655
Attn: Michael Sharp

	Sample ID	Sampling Time / Date	Sample Type S-Soil W-Water	Preservation	Lab ID	Analyses: EA055											NOTES
1	1	6/5/08	S	Ice from		✓											
2	2	"	"	"		✓											
3	3	"	"	"		✓ SMK											
4	4	"	"	"		✓											
5	5	"	"	"		✓											
6	6	"	"	"		✓											
7	7	"	"	"		✓											
8	8	"	"	"		✓											
9	9	"	"	"		✓											
10	10	"	"	"		✓											
11	11	"	"	"		✓											
12	12	"	"	"		✓											
	PQL (S)																
	PQL (W)																

Environmental Division
Perth
Work Order
EP0802889
Telephone : +61-8-9209 7655

PQL = practical quantification limit, *As per Laboratory Method Detection Limit

Sampled By: [signature]
Received By: [signature]
Received By:
Received By:

Relinquished By: [signature]
Relinquished By:
Relinquished By:
Relinquished By:

Sign: [signature]
Sign: [signature]
Sign:
Sign:

Date/Time: 26/5/08 10.00am
Date/Time: 26/5/08 13:26
Date/Time:
Date/Time:

** IMPORTANT: PLEASE SIGN AND DATE TO ACKNOWLEDGE RECEIPT OF SAMPLES AND RETURN BY EMAIL **

Send Results to:
Douglas Partners Pty Ltd
36 O'Malley Street
OSBORNE PARK 6017
Ph: (08) 9204 3511
Fax: (08) 9204 3522

Douglas Partners
Geotechnics · Environment · Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project Name: Lots 101 + 102 Bussell Hwy Cowaramup
Project No: 46740
DP Contact Person: Robert Stafford
Prior Storage: esky / fridge / shelved (circle) Freezer

To: ALS Laboratory Group
10 Hod Way, Malaga, WA 6090
Ph: 9209 7655
Attn: Michael Sharp

	Sample ID	Sampling Time / Date	Sample Type S-soil W-water	Preservation	Lab ID	Analytes: EA055											NOTES
12	13	6/5/08	S	Ice		✓											
13	14					✓											
14	15					✓											
15	16					✓											
16	17					✓											
17	18					✓											
18	19	21/5/08				✓											
19	20					✓											
20	21					✓											
21	22					✓											
22	23					✓											
	24					✓	EA055		DUP								
	PQL(S)																
	PQL(W)																

PQL = practical quantification limit. *As per Laboratory Method Detection Limit

Sampled By: [signature] Relinquished By: [signature] Sign: [signature] Date/Time: 26/5/08 10.00am
Received By: [signature] Relinquished By: Sign: Date/Time: 26/5/08 12.26
Received By: Relinquished By: Sign: Date/Time:
Received By: Relinquished By: Sign: Date/Time:

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Fax: (08) 9204 3522

Douglas Partners

CHAIN OF CUSTODY DESPATCH SHEET

Project Name: Lots 101 + 102 Bussell Hwy, Cowaramup
Project No: 46790
DP Contact Person: Robert Shepherd
Prior Storage: (esky) / fridge / shelved (circle) Freezer

To: ALS Laboratory Group
10 Hod Way, Malaga, WA 6090
Ph: 9209 7655
Attn: Michael Sharp

	Sample ID	Sampling Time / Date	Sample Type S-soil W-water	Preservation	Lab ID	Analytes: EA055											NOTES
23	25	7/5/08	S	Ice Pack		✓											
24	26					✓											
25	27					✓											
26	28					✓											
27	29					✓											
28	30					✓											
29	31					✓											
30	32					✓											
31	33					✓											
32	34					✓											
33	35					✓											
34	36					✓											
	PQL (S)																
	PQL (W)																

PQL = practical quantitation limit. *As per Laboratory Method Detection Limit

Sampled By: [signature]
Received By: [signature]
Received By:
Received By:

Relinquished By: [signature] Sign: [signature] Date/Time: 26/5/08 10:00am
Relinquished By: Sign: [signature] Date/Time: 26/5/08 13:28
Relinquished By: Sign: Date/Time:
Relinquished By: Sign: Date/Time:

** IMPORTANT: PLEASE SIGN AND DATE TO ACKNOWLEDGE RECIEPT OF SAMPLES AND RETURN BY EMAIL **

Send Results to:

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36 O'Malley Street
OSBORNE PARK 6017

Ph: (08) 9204 3511
Fax: (08) 9204 3522

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CHAIN OF CUSTODY DESPATCH SHEET

Project Name: Lots 101 & 102 Bussell Hwy, Cowaramup
Project No: 46790
DP Contact Person: Robert Shepherd
Prior Storage: (esky) / fridge / shelved (circle) Freezer

To: ALS Laboratory Group
10 Hod Way, Malaga, WA 6090
Ph: 9209 7655
Attn: Michael Sharp

	Sample ID	Sampling Time / Date	Sample Type S-soil W-water	Preservation	Lab ID	Analytes: E903	NOTES
35	36	7/5/08	S	Ice		✓	
36	38					✓	
37	39					✓	
38	40					✓	
39	41					✓	
40	42					✓	
41	43					✓	
42	44					✓	
43	45					✓	
44	46					✓	
45	47					✓	
46	49					✓	
	PQL (S)						
	PQL (W)						

PQL = practical quantification limit. *As per Laboratory Method Detection Limit

Sampled By: [signature] Relinquished By: [signature] Sign: [signature] Date/Time: 26/5/08 10:00am
Received By: [signature] Relinquished By: Sign: [signature] Date/Time: 26/5/08 13:26
Received By: Relinquished By: Sign: Date/Time:
Received By: Relinquished By: Sign: Date/Time:

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36 O'Malley Street
OSBORNE PARK 6017
Ph: (08) 9204 3511
Fax: (08) 9204 3522

Douglas Partners
Environment · Engineering · Consultancy

CHAIN OF CUSTODY DESPATCH SHEET

Project Name: Lots 101 + 102 Bussell Hwy, Cowaramup
Project No: 46740
DP Contact Person: Adele F Stapland
Prior Storage: esky / fridge / shelved (circle) Freezer

To: ALS Laboratory Group
10 Hod Way, Malaga, WA 6090
Ph: 9209 7655
Attn: Michael Sharp

	Sample ID	Sampling Time / Date	Sample Type S-soil W-water	Preservation	Lab ID	Analytes: 8903					59	Extra	TPH	BTEX			NOTES
47	49	23/5/08	S	Ice/Ice		✓					(59)	Extra	TPH	BTEX			
48	50					✓											
49	51					✓											
50	52					✓											
51	53					✓											
52	54					✓											
53	55					✓											
54	56					✓											
55	57					✓											
56	58					✓											
57	59					✓											
58	60					✓											
	PQL (S)																
	PQL (W)																

PQL = practical quantitation limit, *As per Laboratory Method Detection Limit

Sampled By:	Relinquished By:	Sign:	Date/Time:	26/5/08 10:00am
Received By:	Relinquished By:	Sign:	Date/Time:	26/5/08 13:26
Received By:	Relinquished By:	Sign:	Date/Time:	
Received By:	Relinquished By:	Sign:	Date/Time:	

** IMPORTANT: PLEASE SIGN AND DATE TO ACKNOWLEDGE RECIEPT OF SAMPLES AND RETURN BY EMAIL **

Send Results to:

Douglas Partners Pty Ltd
36 O'Malley Street
OSBORNE PARK 6017

Ph: (08) 9204 3511
Fax: (08) 9204 3522

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order	: **EP0803118**		
Client	: **DOUGLAS PARTNERS PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: MR ROBERT SHAPLAND	Contact	: Michael Sharp
Address	: 36 O'MALLEY STREET OSBORNE PARK WA 6017	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: shaplandr@douglaspartners.com.au	E-mail	: michael.sharp@alsenviro.com
Telephone	: +61 08 9204 3511	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9204 3522	Facsimile	: +61-8-9209 7600
Project	: Ex EP0802889 46790	Page	: 1 of 3
Order number	: 76313		
C-O-C number	: ----	Quote number	: EP2008DOUPARWA0084 (EN-020-08 BQ)
Site	: ----		
Sampler	: ----	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 06-JUN-2008	Issue Date	: 06-JUN-2008 13:44
Client Requested Due Date	: 13-JUN-2008	Scheduled Reporting Date	: **13-JUN-2008**

Delivery Details

Mode of Delivery	: Samples on hand	Temperature	: Ambient
No. of coolers/boxes	: NIL	No. of samples received	: 26
Sercurity Seal	: Intact.	No. of samples analysed	: 26

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Requested Deliverables
- Samples received in appropriately pretreated and preserved containers.
- Please see scanned COC for sample discrepencies: extra samples , samples not received etc.
- **Samples received in appropriately pretreated and preserved containers.**
- **Sample(s) have been received within recommended holding times.**
- **pH analysis should be conducted within 6 hours of sampling.**
- Analytical work for this work order will be conducted at ALS Environmental Perth.
- Please direct any turnaround / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Sample Receipt (SamplesPerth@alsenviro.com)
- Sample Disposal - Aqueous (14 days), Solid (90 days) from date of completion of Work Order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	SOIL - EA029-WA WA - SPOCAS
EP0803118-001	06-MAY-2008 15:00	2	✓
EP0803118-002	06-MAY-2008 15:00	6	✓
EP0803118-003	06-MAY-2008 15:00	8	✓
EP0803118-004	06-MAY-2008 15:00	11	✓
EP0803118-005	06-MAY-2008 15:00	13	✓
EP0803118-006	06-MAY-2008 15:00	16	✓
EP0803118-007	06-MAY-2008 15:00	19	✓
EP0803118-008	06-MAY-2008 15:00	22	✓
EP0803118-009	06-MAY-2008 15:00	25	✓
EP0803118-010	06-MAY-2008 15:00	29	✓
EP0803118-011	06-MAY-2008 15:00	30	✓
EP0803118-012	06-MAY-2008 15:00	31	✓
EP0803118-013	06-MAY-2008 15:00	33	✓
EP0803118-014	06-MAY-2008 15:00	35	✓
EP0803118-015	06-MAY-2008 15:00	36	✓
EP0803118-016	06-MAY-2008 15:00	38	✓
EP0803118-017	06-MAY-2008 15:00	40	✓
EP0803118-018	06-MAY-2008 15:00	41	✓
EP0803118-019	06-MAY-2008 15:00	44	✓
EP0803118-020	06-MAY-2008 15:00	46	✓
EP0803118-021	06-MAY-2008 15:00	48	✓
EP0803118-022	06-MAY-2008 15:00	50	✓
EP0803118-023	06-MAY-2008 15:00	52	✓
EP0803118-024	06-MAY-2008 15:00	54	✓
EP0803118-025	06-MAY-2008 15:00	56	✓
EP0803118-026	06-MAY-2008 15:00	59	✓

Requested Deliverables

ACCOUNTS PAYABLE (WA)

- A4 - AU Tax Invoice	Email	dpperth@douglaspartners.com.au

MR ROBERT SHAPLAND

- *AU Certificate of Analysis - NATA	Email	shaplandr@douglaspartners.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep)	Email	shaplandr@douglaspartners.com.au
- *AU QC Report ¿ DEFAULT (Anon QC Rep) - NATA	Email	shaplandr@douglaspartners.com.au
- A4 - AU Sample Receipt Notification - Environmental	Email	shaplandr@douglaspartners.com.au
- Default - Chain of Custody	Email	shaplandr@douglaspartners.com.au
- EDI Format - ENMRG	Email	shaplandr@douglaspartners.com.au
- EDI Format - ESDAT	Email	shaplandr@douglaspartners.com.au
- EDI Format - XTab	Email	shaplandr@douglaspartners.com.au

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EP0803118**	Page	: 1 of 8
Client	: **DOUGLAS PARTNERS PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: MR ROBERT SHAPLAND	Contact	: Michael Sharp
Address	: 36 O'MALLEY STREET OSBORNE PARK WA 6017	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: shaplandr@douglaspartners.com.au	E-mail	: michael.sharp@alsenviro.com
Telephone	: +61 08 9204 3511	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9204 3522	Facsimile	: +61-8-9209 7600
Project	: Ex EP0802889 46790	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: 76313		
C-O-C number	: ----	Date Samples Received	: 06-JUN-2008
Sampler	: ----	Issue Date	: 16-JUN-2008
Site	: ----		
		No. of samples received	: 26
Quote number	: EN-020-08 BQ	No. of samples analysed	: 26

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Stacey Hawkins	Senior Chemist - Acid Sulphate Soils	Perth Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: 2	6	8	11	13
				Client sampling date / time: 06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00
				EP0803118-001	EP0803118-002	EP0803118-003	EP0803118-004	EP0803118-005
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**6.0**	**5.1**	**5.8**	**5.4**	**5.4**
pH OX (23B)	----	0.1	pH Unit	**4.5**	**4.2**	**4.9**	**4.5**	**4.6**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**4**	**15**	**4**	**7**	**19**
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**6**	**24**	**6**	**9**	**25**
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**2**	**8**	<2	**2**	**6**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	**0.02**	<0.02	<0.02	**0.03**
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	**0.04**	<0.02	<0.02	**0.04**
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	**0.04**	<0.02	<0.02	**0.04**
Peroxide Sulfur (23De)	----	0.02	% S	<0.02	**0.04**	<0.02	**0.02**	**0.04**
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	**0.02**	<0.02	**0.02**	**0.03**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	**15**	<10	**16**	**20**
Liming Rate	----	1	kg CaCO3/t	<1	**1**	<1	**1**	**2**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	**0.02**	<0.02	**0.02**	**0.03**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	**15**	<10	**16**	**20**
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	**1**	<1	**1**	**2**

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: 16	19	22	25	29
				Client sampling date / time: 06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00
				EP0803118-006	EP0803118-007	EP0803118-008	EP0803118-009	EP0803118-010
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.5**	**5.3**	**5.8**	**5.8**	**5.9**
pH OX (23B)	----	0.1	pH Unit	**4.6**	**3.6**	**2.0**	**4.2**	**4.2**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**6**	**24**	**2**	**3**	**2**
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**18**	**42**	**4**	**6**	**11**
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**12**	**18**	<2	**2**	**8**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	**0.04**	<0.02	<0.02	<0.02
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	**0.03**	**0.07**	<0.02	<0.02	<0.02
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	**0.03**	<0.02	<0.02	<0.02
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S	**0.02**	<0.02	<0.02	<0.02	**0.03**
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	**0.02**
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	<10	<10	**14**
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	**0.02**	<0.02	<0.02	<0.02	<0.02
Peroxide Calcium (23Wh)	----	0.02	% Ca	**0.03**	<0.02	<0.02	<0.02	<0.02
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	**0.03**	<0.02	<0.02	<0.02	<0.02
Peroxide Magnesium (23Tm)	----	0.02	% Mg	**0.03**	<0.02	<0.02	<0.02	<0.02
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.02**	**0.05**	<0.02	<0.02	**0.03**
Net Acidity (acidity units)	----	10	mole H+ / t	**15**	**30**	<10	<10	**17**
Liming Rate	----	1	kg CaCO3/t	**1**	**2**	<1	<1	**1**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.02**	**0.05**	<0.02	<0.02	**0.03**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**15**	**30**	<10	<10	**17**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**1**	**2**	<1	<1	**1**

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: 30	31	33	35	36
				Client sampling date / time: 06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00
				EP0803118-011	EP0803118-012	EP0803118-013	EP0803118-014	EP0803118-015
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.8**	**5.2**	**4.9**	**5.3**	**5.4**
pH OX (23B)	----	0.1	pH Unit	**4.9**	**4.4**	**4.1**	**5.0**	**5.1**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**2**	**24**	**27**	**12**	**7**
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**9**	**26**	**33**	**13**	**12**
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**7**	**2**	**6**	<2	**5**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	**0.04**	**0.04**	<0.02	<0.02
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	**0.04**	**0.05**	**0.02**	<0.02
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	**0.02**	**0.04**	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S	<0.02	**0.03**	**0.04**	<0.02	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	**0.02**	<0.02	<0.02	<0.02
Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	**0.02**	<0.02	<0.02	<0.02
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	<0.02	<0.02	**0.03**	<0.02
Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	<0.02	<0.02	**0.03**	<0.02
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	**0.05**	**0.04**	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	**10**	**30**	**24**	**12**	<10
Liming Rate	----	1	kg CaCO3/t	<1	**2**	**2**	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	**0.05**	**0.04**	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**10**	**30**	**24**	**12**	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	**2**	**2**	<1	<1

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: 38	40	41	44	46
				Client sampling date / time: 06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00
				EP0803118-016	EP0803118-017	EP0803118-018	EP0803118-019	EP0803118-020
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.1**	**5.5**	**4.7**	**5.4**	**5.8**
pH OX (23B)	----	0.1	pH Unit	**4.4**	**4.9**	**4.2**	**4.5**	**4.7**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**15**	**6**	**38**	**10**	**3**
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**24**	**14**	**78**	**9**	**5**
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**9**	**8**	**40**	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.02**	<0.02	**0.06**	<0.02	<0.02
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	**0.04**	**0.02**	**0.12**	<0.02	<0.02
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	**0.06**	<0.02	<0.02
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)	----	0.02	% S	**0.03**	<0.02	**0.08**	**0.05**	**0.03**
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	**0.06**	**0.04**	**0.02**
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	**38**	**23**	**16**
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	<0.02	**0.03**	<0.02	<0.02
Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	<0.02	**0.03**	**0.06**	**0.03**
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	<0.02	**0.04**	**0.03**
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	<10	**21**	**13**
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	<0.02	**0.03**	**0.02**
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	<0.02	**0.08**	<0.02	<0.02
Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	<0.02	**0.09**	**0.02**	<0.02
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	<10	**16**	**12**
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	<0.02	**0.02**	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.03**	<0.02	**0.12**	**0.05**	**0.03**
Net Acidity (acidity units)	----	10	mole H+ / t	**21**	<10	**75**	**34**	**19**
Liming Rate	----	1	kg CaCO3/t	**2**	<1	**6**	**2**	**1**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.03**	<0.02	**0.12**	**0.05**	**0.03**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**21**	<10	**75**	**34**	**19**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**2**	<1	**6**	**2**	**1**

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: 48	50	52	54	56
				Client sampling date / time: 06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00
				EP0803118-021	EP0803118-022	EP0803118-023	EP0803118-024	EP0803118-025
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.3**	**5.6**	**5.7**	**5.8**	**6.2**
pH OX (23B)	----	0.1	pH Unit	**4.6**	**4.8**	**4.9**	**5.0**	**5.7**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**10**	**6**	**5**	**4**	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**13**	**8**	<2	**4**	<2
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**2**	**2**	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	**0.02**	<0.02	<0.02	<0.02	<0.02
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	**0.02**
Peroxide Sulfur (23De)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	**0.02**
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	**11**	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**11**	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: 59	----	----	----	----
				Client sampling date / time: 06-MAY-2008 15:00	----	----	----	----
				EP0803118-026	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.1**	----	----	----	----
pH OX (23B)	----	0.1	pH Unit	**4.5**	----	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**13**	----	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**15**	----	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**2**	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	**0.02**	----	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	**0.02**	----	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	----	----	----	----
Peroxide Sulfur (23De)	----	0.02	% S	**0.02**	----	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	**0.02**	----	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	**13**	----	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	----	----	----	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	----	----	----	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	----	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	----	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	----	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	----	----	----	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	----	----	----	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	----	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	----	----	----	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	**0.04**	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	**26**	----	----	----	----
Liming Rate	----	1	kg CaCO3/t	**2**	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.04**	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**26**	----	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	**2**	----	----	----	----

Luke Jones

From: Stacey Hawkins
Sent: Friday, 6 June 2008 10:02 AM
To: Samples Perth
Subject: FW: SPOCAS Suite of Testing - ALS Work Order EP 0802889
Attachments: EP0802889_COC.pdf; PO - ALS Spocas.pdf

Stacey Hawkins
Senior Chemist - Acid Sulfate Soils
ALS Laboratory Group
Environmental Division
Perth, Western Australia
Phone. +61 8 92097655
Fax: +61 8 92097600
www.alsglobal.com

From: Rob Shapland [mailto:Rob.Shapland@douglaspartners.com.au]
Sent: Friday, 6 June 2008 9:56 AM
To: Stacey Hawkins
Subject: SPOCAS Suite of Testing - ALS Work Order EP 0802889

Hi Stacey,

Please find attached purchase order number 76313 to undertake the SPOCAS suite of analysis on the following sample ID's under work order EP 0802889:

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Luke Jones Ken
6/6/08 10:02

Environmental Division
Perth
Work Order
EP0803118

Telephone +61-8-9209 7655

Best regards,

Environmental Division

QUALITY CONTROL REPORT

Work Order	: **EP0803118**	Page	: 1 of 9
Client	: **DOUGLAS PARTNERS PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: MR ROBERT SHAPLAND	Contact	: Michael Sharp
Address	: 36 O'MALLEY STREET OSBORNE PARK WA 6017	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: shaplandr@douglaspartners.com.au	E-mail	: michael.sharp@alsenviro.com
Telephone	: +61 08 9204 3511	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9204 3522	Facsimile	: +61-8-9209 7600
Project	: Ex EP0802889 46790	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 06-JUN-2008
Sampler	: ----	Issue Date	: 16-JUN-2008
Order number	: 76313		
		No. of samples received	: 26
Quote number	: EN-020-08 BQ	No. of samples analysed	: 26

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Stacey Hawkins	Senior Chemist - Acid Sulphate Soils	Perth Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA029-A: pH Measurements (QC Lot: 676469)									
EP0803118-001	2	EA029: pH KCl (23A)	----	0.1	pH Unit	6.0	6.0	0.0	0% - 20%
		EA029: pH OX (23B)	----	0.1	pH Unit	4.5	4.4	0.0	0% - 20%
EP0803118-011	30	EA029: pH KCl (23A)	----	0.1	pH Unit	5.8	5.7	0.0	0% - 20%
		EA029: pH OX (23B)	----	0.1	pH Unit	4.9	4.9	0.0	0% - 20%
EA029-A: pH Measurements (QC Lot: 676470)									
EP0803118-021	48	EA029: pH KCl (23A)	----	0.1	pH Unit	5.3	5.2	0.0	0% - 20%
		EA029: pH OX (23B)	----	0.1	pH Unit	4.6	4.7	0.0	0% - 20%
EA029-B: Acidity Trail (QC Lot: 676469)									
EP0803118-001	2	EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	4	3	0.0	No Limit
		EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	6	6	0.0	No Limit
		EA029: Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	2	2	0.0	No Limit
EP0803118-011	30	EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	2	2	0.0	No Limit
		EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	9	9	0.0	No Limit
		EA029: Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	7	7	0.0	No Limit
EA029-B: Acidity Trail (QC Lot: 676470)									
EP0803118-021	48	EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	0.02	0.02	0.0	No Limit
		EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	10	10	0.0	No Limit
		EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	13	13	0.0	No Limit
		EA029: Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	2	3	0.0	No Limit
EA029-C: Sulfur Trail (QC Lot: 676469)									
EP0803118-001	2	EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA029-C: Sulfur Trail (QC Lot: 676469) - continued									
EP0803118-001	2	EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.02	0.03	0.0	No Limit
		EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	12	20.5	No Limit
EP0803118-011	30	EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA029-C: Sulfur Trail (QC Lot: 676470)									
EP0803118-021	48	EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA029-D: Calcium Values (QC Lot: 676469)									
EP0803118-001	2	EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	0.03	0.0	No Limit
		EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	0.02	0.0	No Limit
		EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	12	17.2	No Limit
EP0803118-011	30	EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	<0.02	0.0	No Limit
		EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA029-D: Calcium Values (QC Lot: 676470)									
EP0803118-021	48	EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	<0.02	0.0	No Limit
		EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA029-E: Magnesium Values (QC Lot: 676469)									
EP0803118-001	2	EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA029-E: Magnesium Values (QC Lot: 676469) - continued									
EP0803118-001	2	EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	11	11.2	No Limit
EP0803118-011	30	EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA029-E: Magnesium Values (QC Lot: 676470)									
EP0803118-021	48	EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA029-H: Acid Base Accounting (QC Lot: 676469)									
EP0803118-001	2	EA029: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA029: Net Acidity (sulfur units)	----	0.02	% S	<0.02	0.02	0.0	No Limit
		EA029: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	0.02	0.0	No Limit
		EA029: Liming Rate	----	1	kg CaCO3/t	<1	1	0.0	No Limit
		EA029: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	1	0.0	No Limit
		EA029: Net Acidity (acidity units)	----	10	mole H+ / t	<10	16	44.8	No Limit
		EA029: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	16	44.8	No Limit
EP0803118-011	30	EA029: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA029: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA029: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA029: Net Acidity (acidity units)	----	10	mole H+ / t	10	<10	0.0	No Limit
		EA029: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	10	<10	0.0	No Limit
EA029-H: Acid Base Accounting (QC Lot: 676470)									
EP0803118-021	48	EA029: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA029: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA029: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA029: Net Acidity (acidity units)	----	10	mole H+ / t	11	12	0.0	No Limit
		EA029: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	11	12	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA029-B: Acidity Trail (QCLot: 676469)								
EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	----	----	----	----
EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029-B: Acidity Trail (QCLot: 676470)								
EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	----	----	----	----
EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029-C: Sulfur Trail (QCLot: 676469)								
EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	----	----	----	----
EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.02	----	----	----	----
EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	----	----	----	----
EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	----	----	----	----
EA029-C: Sulfur Trail (QCLot: 676470)								
EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	----	----	----	----
EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.02	----	----	----	----
EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	----	----	----	----
EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	----	----	----	----
EA029-D: Calcium Values (QCLot: 676469)								
EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	----	----	----	----
EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	----	----	----	----
EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	----	----	----	----
EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	----	----	----	----
EA029-D: Calcium Values (QCLot: 676470)								
EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	----	----	----	----
EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	----	----	----	----
EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	----	----	----	----
EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	----	----	----	----
EA029-E: Magnesium Values (QCLot: 676469)								

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EA029-E: Magnesium Values (QCLot: 676469) - continued								
EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	----	----	----	----
EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	----	----	----	----
EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	----	----	----	----
EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	----	----	----	----
EA029-E: Magnesium Values (QCLot: 676470)								
EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	----	----	----	----
EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	----	----	----	----
EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	----	----	----	----
EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	----	----	----	----

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) Results are required to be reported.**

Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: **EP0803118**	Page	: 1 of 8
Client	: DOUGLAS PARTNERS PTY LTD	Laboratory	: Environmental Division Perth
Contact	: MR ROBERT SHAPLAND	Contact	: Michael Sharp
Address	: 36 O'MALLEY STREET OSBORNE PARK WA 6017	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: shaplandr@douglaspartners.com.au	E-mail	: michael.sharp@alsenviro.com
Telephone	: +61 08 9204 3511	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9204 3522	Facsimile	: +61-8-9209 7600
Project	: Ex EP0802889 46790	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 06-JUN-2008
Sampler	: ----	Issue Date	: 16-JUN-2008
Order number	: 76313		
		No. of samples received	: 26
Quote number	: EN-020-08 BQ	No. of samples analysed	: 26

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-A: pH Measurements								
80* dried soil								
2,	6,	**06-MAY-2008**	**09-JUN-2008**	06-MAY-2009	✓	**10-JUN-2008**	07-SEP-2008	✓
8,	11,							
13,	16,							
19,	22,							
25,	29,							
30,	31,							
33,	35,							
36,	38,							
40,	41,							
44,	46,							
48,	50,							
52,	54,							
56,	59							
EA029-B: Acidity Trail								
80* dried soil								
2,	6,	**06-MAY-2008**	**09-JUN-2008**	06-MAY-2009	✓	**10-JUN-2008**	07-SEP-2008	✓
8,	11,							
13,	16,							
19,	22,							
25,	29,							
30,	31,							
33,	35,							
36,	38,							
40,	41,							
44,	46,							
48,	50,							
52,	54,							
56,	59							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-C: Sulfur Trail							
80* dried soil							
2, 6, 8, 11, 13, 16, 19, 22, 25, 29, 30, 31, 33, 35, 36, 38, 40, 41, 44, 46, 48, 50, 52, 54, 56, 59	**06-MAY-2008**	**09-JUN-2008**	06-MAY-2009	✓	**10-JUN-2008**	07-SEP-2008	✓
EA029-D: Calcium Values							
80* dried soil							
2, 6, 8, 11, 13, 16, 19, 22, 25, 29, 30, 31, 33, 35, 36, 38, 40, 41, 44, 46, 48, 50, 52, 54, 56, 59	**06-MAY-2008**	**09-JUN-2008**	06-MAY-2009	✓	**10-JUN-2008**	07-SEP-2008	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-E: Magnesium Values							
80* dried soil							
2, 6, 8, 11, 13, 16, 19, 22, 25, 29, 30, 31, 33, 35, 36, 38, 40, 41, 44, 46, 48, 50, 52, 54, 56, 59	**06-MAY-2008**	**09-JUN-2008**	06-MAY-2009	✓	**10-JUN-2008**	07-SEP-2008	✓
EA029-F: Excess Acid Neutralising Capacity							
80* dried soil							
2, 6, 8, 11, 13, 16, 19, 22, 25, 29, 30, 31, 33, 35, 36, 38, 40, 41, 44, 46, 48, 50, 52, 54, 56, 59	**06-MAY-2008**	**09-JUN-2008**	06-MAY-2009	✓	**10-JUN-2008**	07-SEP-2008	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-G: Retained Acidity							
80* dried soil							
2, 6, 8, 11, 13, 16, 19, 22, 25, 29, 30, 31, 33, 35, 36, 38, 40, 41, 44, 46, 48, 50, 52, 54, 56, 59	**06-MAY-2008**	**09-JUN-2008**	06-MAY-2009	✓	**10-JUN-2008**	07-SEP-2008	✓
EA029-H: Acid Base Accounting							
80* dried soil							
2, 6, 8, 11, 13, 16, 19, 22, 25, 29, 30, 31, 33, 35, 36, 38, 40, 41, 44, 46, 48, 50, 52, 54, 56, 59	**06-MAY-2008**	**09-JUN-2008**	06-MAY-2009	✓	**10-JUN-2008**	07-SEP-2008	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	3	26	**11.5**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	2	26	**7.7**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	SOIL	Ahern et al 2004 - a suspension peroxide oxidation method following the 'sulfur trail' by determining the level of 1M KCL extractable sulfur and the sulfur level after oxidation of soil sulphides. The 'acidity trail' is followed by measurement of TAA, TPA and TSA. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.

Preparation Methods	Method	Matrix	Method Descriptions
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW 846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Duplicate outliers occur.**
- **For all matrices, no Laboratory Control outliers occur.**
- **For all matrices, no Matrix Spike outliers occur.**

Regular Sample Surrogates

- **For all regular sample matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

- **No Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- **No Quality Control Sample Frequency Outliers exist.**

APPENDIX E

CSRIO Note on Foundation Maintenance

Foundation Maintenance and Footing Performance:
A Homeowner's Guide

CSIRO

BTF 18
replaces
Information
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to restore equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways.

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar yielding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

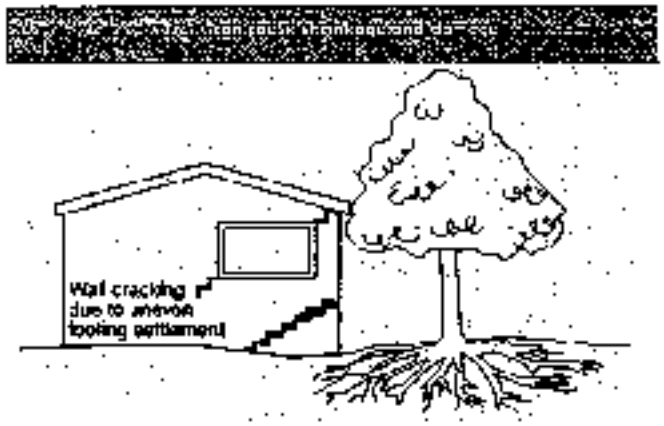
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly arched. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the stepping is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In that case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

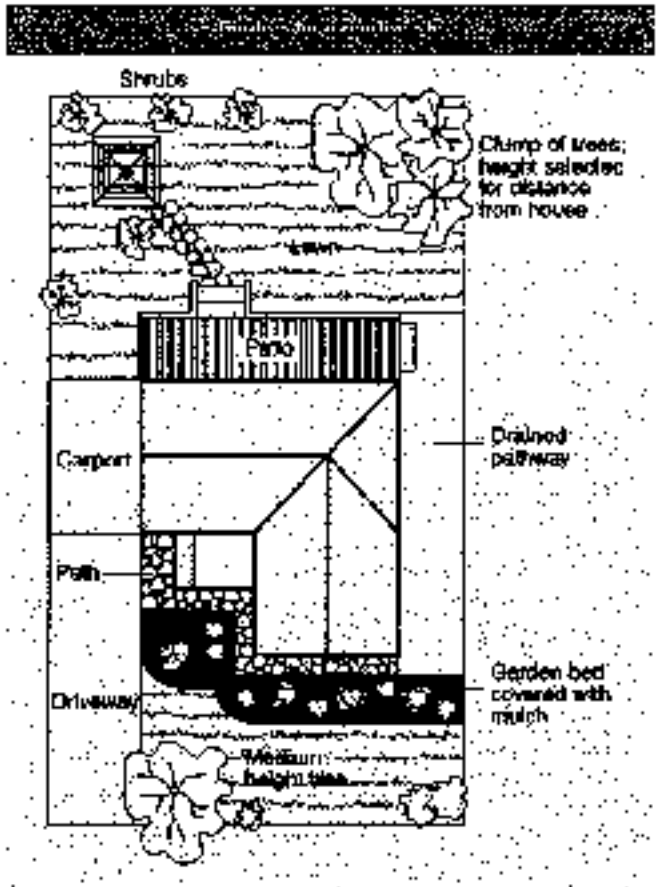
It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can cause in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the emergence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the tolerant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens may also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of wet/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lever FAIB, MIAMA, Partner, Construction Diagnostics.

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an authoritative treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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APPENDIX E

Previous Stormwater Modelling Extracts

A1 (ha)			
road	verge	lots	grass
0.222	0.333	0.138	0.347

A1 External (ha)			
road	verge	lots	grass
0.673	1.009	4.767	1.176

A2 (ha)			
road	verge	lots	grass
0.578	0.867	3.467	1.799

A3 (ha)			
road	verge	lots	grass
0.184	0.276	1.406	0.668

B1 External (ha)			
road	verge	lots	grass
0.154	0.231	0	1.62

B Road (ha)			
road	verge	lots	grass
0.509	0.339	0	0

A External (ha)			
road	verge	lots	grass
0.167	0.251	2.179	26.11

B External (ha)			
road	verge	lots	grass
0.483	0.725	0	1.121

B (ha)			
road	verge	lots	grass
0.597	0.895	4.438	0.74

BUSSELL HIGHWAY

BOTTRILL STREET

South Basin & Weir

Legend

Basin

Gross pollutant trap

Swale

Proposed lot boundaries

Drainage alignment

Existing streams

Drainage reserve

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

PROJECT: Cowaramup Country Estate

DRAWING TITLE: FIGURE 1 : Catchment Areas

PRINCIPAL: N., A., & I. Earl

This drawing has been prepared in accordance with Cardno WA Quality Management System 1 and is the property of Cardno (WA) Pty Ltd and should not be used without permission. The drawing should be read only with dimensions and not be scaled.

Scale 1:4,000 (0 50 100 200 300 400 500 600 Metres)

Cardno

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Project Number	Drawing Number	Revision	Original
W9036	SK01	00	A3

Designed DTF Checked SCR Date 10/06/09
Drawn DTF Approved SCR Sheet 1 of 1
Local Authority Shire of Augusta - Margaret River

EXISTING NATURAL LANDSCAPE ENHANCED WATER COURSE

EXISTING CULVERTS

INSTALL ROCKPITCHED WEIR

EXISTING STORMWATER BASIN

A1 (ha)			
road	verge	lots	grass
0.222	0.333	0.138	0.347

A1 External (ha)			
road	verge	lots	grass
0.673	1.009	4.767	1.176

EXISTING FLOOD ROUTE OVERFLOW LEVEL = 129.43

BUSSELL HIGHWAY

BOTTRILL STREET

INSTALL ROCKPITCHED WEIR

A2 (ha)			
road	verge	lots	grass
0.578	0.867	3.467	1.799

EXISTING TEMPORARY STORMWATER BASIN

PROPOSED DISCHARGE TO TEMPORARY BASIN

EXISTING LIVING STREAM

A3 (ha)			
road	verge	lots	grass
0.184	0.276	1.406	0.668

B1 External (ha)			
road	verge	lots	grass
0.154	0.231	0	1.62

PROPOSED STAGE 2 STORMWATER BASIN.
IL=131.2
OVERFLOW TO LIVING STREAM = 132.0
SLOW RELEASE = DN100 PIPE TO LIVING STREAM

PROPSOED STORMWATER CONNECTION FOR COMMECIAL LOTS AND ROAD

B Road (ha)			
road	verge	lots	grass
0.509	0.339	0	0

A External (ha)			
road	verge	lots	grass
0.167	0.251	2.179	26.11

EXISTING FLOOD ROUTE OVERFLOW LEVEL = 131.13

EXISTING CULVERT

STAGE 1

STAGE 2

STAGE 3

PROPOSED STAGE 3 STORMWATER BASIN WITH WEIR OVERFLOW TO EXISTING CULVERT AND LIVING STREAM

PROPOSED PIPE DISCHARGE FROM STAGE 2

FUTURE LIVING STREAM AND COMPENSATION SYSTEM TO REFLECT EXISTING NATURAL WATER COURSE

ULTMATE STORMWATER MANAGEMENT PLAN TO ALSO REPRESENT THIS AREA

B External (ha)			
road	verge	lots	grass
0.483	0.725	0	1.121

EXISTING STORMWATER BASIN

B (ha)			
road	verge	lots	grass
0.597	0.895	4.438	0.74

STORMWATER MANAGEMENT CONFIGURATION UPDATED NOVEMBER 2016 BY WOOD AND GRIEVE ENGINEERS (BUSSELTON)

Legend
- Basin
- Gross pollutant trap
- Swale
- Road traffic treatment
- Drainage alignment
- Living stream
- Drainage reserve

PROJECT: Cowaramup Country Estate

PRINCIPAL:

Scale 1:4,000 (0 50 100 200 300 400 500 600 Metres)

Cardno
CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Project Number: V9036 | Drawing Number: SK01 | Revision: 00 | Original: A3

Designed: DTF | Checked: SCR | Date: 10/06/09
Drawn: DTF | Approved: SCR | Sheet 1 of 1
Local Authority: Shire of Augusta - Margaret River

FOR CONTINUATION REFER TO DRAWING B6014-001 D1

STANDARD EARTHWORKS NOTES:

1. ALL EARTHWORKS AS SHOWN ON THIS DRAWING SHALL BE COMPLETED WITHOUT VARIATION JUST TO THE PRINTOUT.
2. DRAINAGE AND SLOPING SHALL BE ESTABLISH TO AVOID UNKNOWN SUBSURFACE AT TIMES WATER PONDING. PLANT SHALL NOT BE USED OF TRAVEL ABOUT. FINAL ORIENTATION NOT TO BE ALTERED.
3. ANY UNKNOWN VEGETATION INCLUDING ANY EXISTING UNDERGROUND TANKS WITHIN THE SITE SHALL BE REMOVED AT NO COST TO THE SUPERVISOR OR THE SUPERVISOR AND NATIVE VEGETATION NOT TO BE REMOVED. ANY REMOVED AND DAMAGED VEGETATION NOT TO BE REMOVED. ANY REMOVED AND DAMAGED COMPACTION TESTS AS SPECIFIED IN THE SPECIFICATION.
4. THE CONTRACTOR SHALL MINIMISE DUST, AND NOISE, MAINTAINING CLEAN ROADS AND ANY OTHER INCONVENIENCE THROUGH WATER USAGE ON SITE, WITHOUT VARIATION COST TO THE PRINCIPAL.
5. CONTRACTOR SHALL PROOF CONSTRUCT TO MINIMUM DEPTH -
   - 0.4m ALL AREAS PRIOR TO PLACING OF FILL
   - OR ANY SLIP AREAS AFTER CONSTRUCTION OF CUT, AND PRIOR TO PLACING TOPSOIL, COMPACTION SHALL BE NOT LESS THAN 95% MAXIMUM DRY DENSITY (STANDARD).
6. PLACING OF FILL SHALL NOT COMMENCE UNTIL CLEARING/GRUBBING HAS BEEN COMPLETED AND APPROVED.
7. ALL CUT, FILL AREAS AND BATTERS SHALL BE PLACED AND COMPACTED AS SPECIFIED. FINAL COMPACTED MATERIAL SHALL NOT CONTAIN LUMPS GREATER THAN 100mm DIAMETER. ALL LOOSE MATERIAL SHALL BE REMOVED FROM SITE.
   ALL CUT, FILL AND BATTER SLOPES TO BE GRADED TO A SMOOTH FINISH. BATTER HOLDS AND TRIMMED SHALL BE CARRIED OUT.
8. CUT SHALL BE MADE AND COMPACTED TO THE APPROVED FINAL GRADE AS SHOWN ON THE APPROVED PLAN(S) OR TOPSOIL LEVELS.
9. WHERE THERE IS AN APPARENT CHANGE IN SOIL TYPE, A SOIL ENGINEER SHALL BE CONSULTED. THE CONTRACTOR SHALL HAVE THE APPROPRIATE TESTS CARRIED OUT TO DETERMINE SUBSOIL CONDITIONS AND ENSURE THAT EXCESSIVE SETTLEMENT DOES NOT OCCUR.
10. BATTERS TO RETAINING LEVELS SHALL NOT EXCEED 1 IN 4 SLOPE (GENERALLY AND 1 IN 6 FOR AREAS UNLESS OTHERWISE SHOWN.
11. ANY CONTRACTOR SHALL RESPONSIBLE FOR ANY POS FENCE AND OTHER IMPROVEMENTS WITHIN OR ADJACENT THE LIMITS OF WORKS. ANY ALTERATION OF APPROPRIATELY 50mm BETWEEN TOP OF SOIL AND THE BOTTOM LEVEL IS REQUIRED FOR THE ON REQUIRED WORKS REQUIRED SHALL BE CARRIED OUT TO SUPERVISOR.
12. THE LANDSCAPED SHALL DRAWN WITH NOTES SHALL TAKE THE PRECEDENCE.
13. THE CONTRACTOR SHALL AND NOTIFY TO ASSESSMENT OF ANY EXISTING UTILITIES WITHIN AND AROUND THE PERIMETER OF THE SITE. IN THE UNKNOWN WORKS OF LOCATE THESE PRIOR TO STARTING THE WORKS.

SPECIFIC EARTHWORKS NOTES:

1. THE CONTRACTOR SHALL ASSESS FOR AND CARRY OUT STABILISATION OF ALL EARTHWORKS LOTS AND POS. AREAS INCLUDES DRAINAGE SWALES AND ANY UNDERMINED AREAS AND CANTILEVER RETAINING WALL SLOPE SITES. USING HYDROMULCH WITH SEED MIXES AS ALL INTENDED WITH THE IMPLEMENTATION OF SAID.
2. THE CONTRACTOR IS TO FILL CHANNEL WITH APPROVED GRANULAR MATERIAL AS APPROVED BY THE SUPERINTENDENT.
3. EARTHWORKS RETAINING STRUCTURES ARE TO BE EXCAVATED AS SHOWN.
4. THE CONTRACTOR SHALL ADD VARIATION THE ADJACENT PROPERTY.
5. REFER TO NOTES ON EARTHWORKS AND ASSOCIATED DRAWINGS.

REFER TO B6014-001-D1 FOR NOTES AND LEGEND.

Date	rev	ACTIVITY - REVISION DESCRIPTION	dsgn	drwn	chkd	advsd
23-08-24	A	OVERALL WITH CONSTRUCTION NOTE AND NP 01 REVISED				
		AND DOWNSTREAM HEADWALL AND NOTE ADDED	JRW	JRW		
31-08-24	B	TRAILS, EARTHWORKS AND FENCING ADDED, ISSUED FOR AS CUT D				
		CHAT CUT / SWALES NEW PRELIMINARY ONLY TO BE FINALISED	JRW	JRW		
26-09-24	C	RUSSELL HWY INTERSECTION, SLIP LANE & DRAINAGE ADDED	JRW	JRW		
09-10-24	D	UPDATED PER RFI RESPONSE & LOT 211	JRW	JRC		

PROJECT: COWARAMUP COUNTRY ESTATE - STAGE 1

DRAWING TITLE: ROADWORKS, EARTHWORKS & DRAINAGE - SHT 2 OF 2

PREPARED: N. A. & I. EARL

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N

A1

Cardno

Date: 27-08-24 | Scale: 1:1000 @ A1
Designed: JRW | Checked:
Drawn: DAR/JRW | Approved:
Local Authority: | Sheet: 01 of 01 Sheets
Project Phase Plan Number: B6014-001-D2 | Revision: J

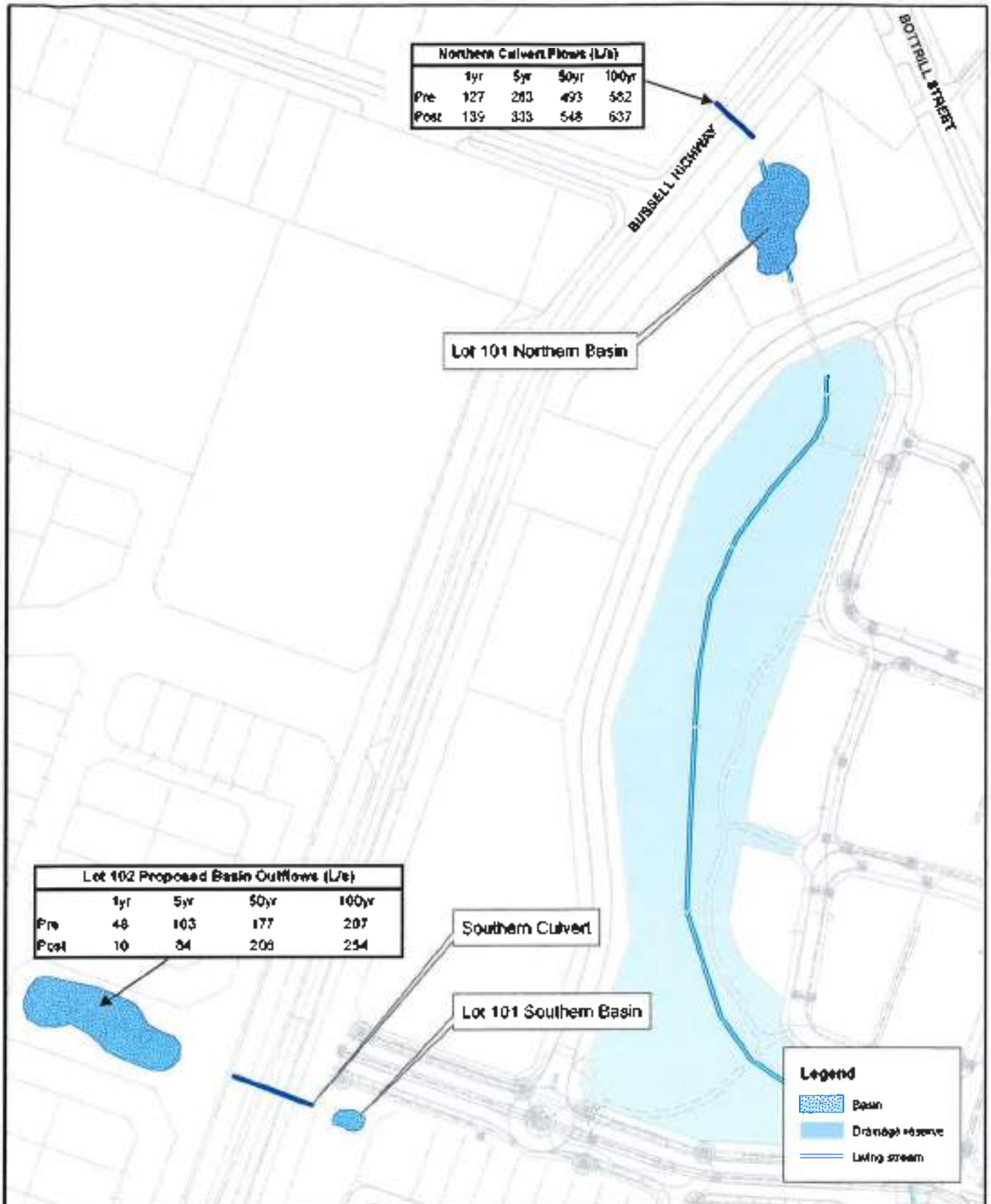
WGE Stormwater Modelling Calibration Results
Basis of Calibration = Cardno Report 4th September 2009 Ref V9035-SCR-90020.20

	Design Storm Event			
Northern Culvert	1yr	5 yr	50yr	100yr
Initial Design Results (Cardno)				
Pre Development	127	283	493	582
Post Development (not including stage 2 or 3)	139	333	548	637
WGE Modelling Results Oct 2016				
Post Development Calibration (not including stage 2 or 3)	266	393		583
Post Development (including stage 2 and 3)	266	394		583

Note: Flows are in litres/second

	Design Storm Event			
Southern Culvert	1yr	5yr	50yr	100yr
Initial Design Results (Cardno)				
Pre Development	48	103	177	207
Post Development	10	84	206	254
WGE Modelling Results Oct 2016				
Post Development Calibration (not including stage 2 or 3)	39	72		390
Post Development (including stage 2 and 3)	39	72		390

Note: Flows are in litres/second



Cardno

Scale 1:2,000 0 15 30 60 90 120 150 Metres

Project: Cornerstone Country Estate

Drawing Title: FIGURE 2 : Proposed Basin Location and Conceptual Layout

Prepared by: N. A. & I Bell

Project Number V9815 Original A4

Drawing Number SK02 Revision 00

Date 18/8/09

APPENDIX F

Surface Water Quality Monitoring Data

H23019 Lot 102 Bussell Hwy Cowaramup

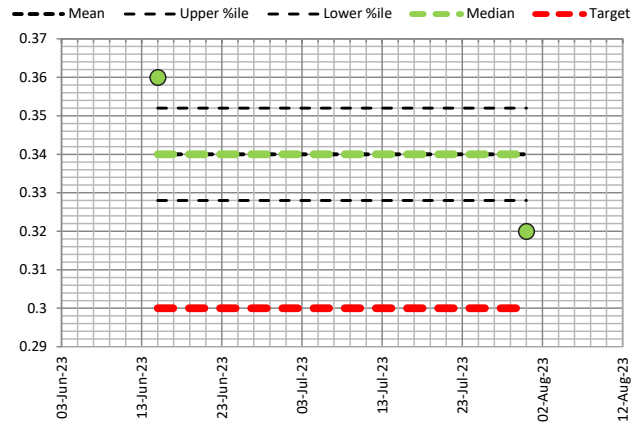
SW1 Inflow to Site
Downstream of Culvert at Bussell Highway

Easting	324187	Data Analysis Period Start Date	1/01/2016
Northing	6252245	Data Analysis Period End Date	28/09/2023

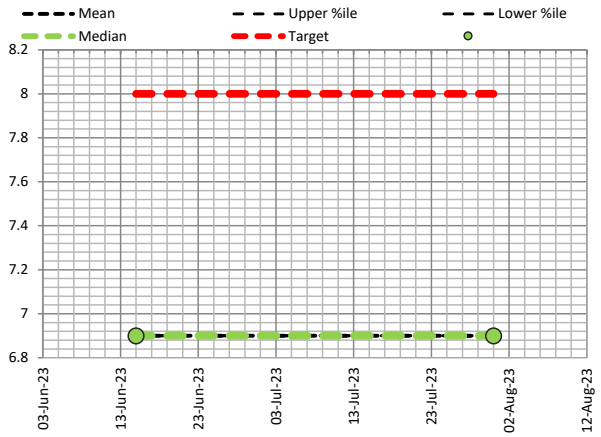
Report Date : 10/10/2023

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
Q	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	1	15.70	15.70	15.70	**15.70**	15.70	15.70		0
EC	Electrical Conductivity	mS/cm	2	0.32	0.33	0.34	**0.34**	0.35	0.36	0.30	2
DO	Dissolved Oxygen	mg/L	1	5.27	5.27	5.27	**5.27**	5.27	5.27		0
DO %	Dissolved Oxygen	%	1	52.80	52.80	52.80	**52.80**	52.80	52.80		0
pH	pH	pH	2	6.90	6.90	6.90	**6.90**	6.90	6.90	8.00	0
ORP	Oxidation Reduction Potential	mV	1	134.10	134.10	134.10	**134.10**	134.10	134.10		0
TUR	Turbidity	NTU	0	0.00	0.00	0.00	**0.00**	0.00	0.00	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TN	Total Nitrogen	mg/L	2	0.77	0.88	1.04	**1.04**	1.19	1.30	1.20	1
TKN	Total Kjeldahl Nitogen	mg/L	2	0.19	0.20	0.22	**0.22**	0.24	0.25		0
NH_3-N	Ammonia as N	mg/L	2	0.01	0.01	0.01	**0.01**	0.01	0.01		0
NO_2-N	Nitrate as N	mg/L	2	0.56	0.65	0.78	**0.78**	0.91	1.00		0
NO -N	Nitrite as N	mg/L	2	0.01	0.01	0.01	**0.01**	0.01	0.01		0
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	**0.05**	0.05	0.05	0.07	0
FRP	Filterable Reactive Phosphorous	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.04	0
As	Arsenic	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100		0
Cu	Copper	mg/L	2	0.00110	0.00122	0.00140	**0.00140**	0.00158	0.00170	0.00140	1
Pb	Lead	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Ni	Nickel	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.01100	0
Zn	Zinc	mg/L	2	0.00840	0.00912	0.01020	**0.01020**	0.01128	0.01200	0.00800	2
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ca	Calcium	mg/L	2	19.00	19.80000	21.00	**21.00**	22.20000	23.00		0
Mg	Magnesium	mg/L	2	6.40	6.56000	6.80	**6.80**	7.04000	7.20		0
K	Potassium	mg/L	2	2.70	2.76000	2.85	**2.85**	2.94000	3.00		0
Na	Sodium	mg/L	2	25.00	25.40000	26.00	**26.00**	26.60000	27.00		0
CaCO3	Hardness as CaCO3	mg/L	2	75.00	77.40000	81.00	**81.00**	84.60000	27.00		0

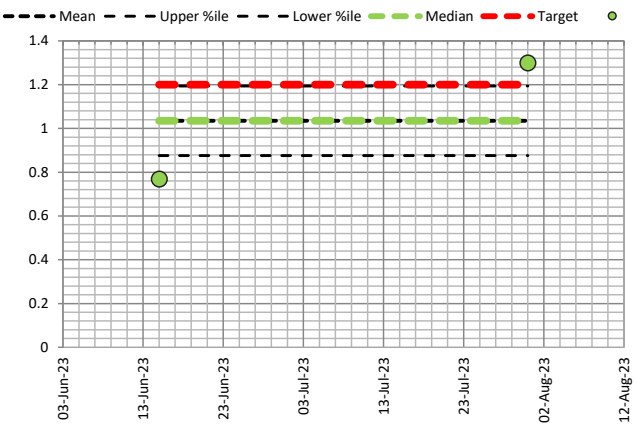
Electrical Conductivity



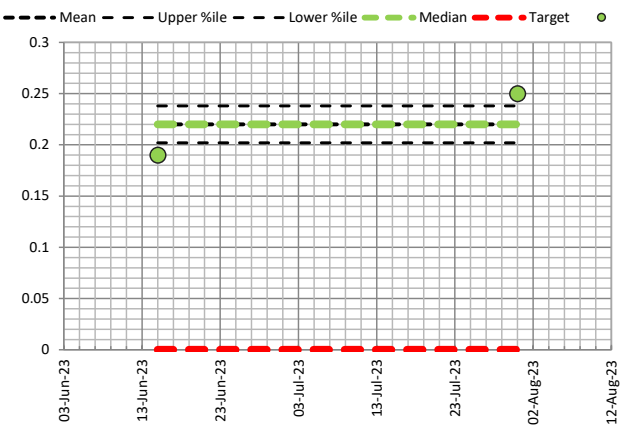
pH



Total Nitrogen



Total Kjeldahl Nitogen



H23019 Lot 102 Bussell Hwy Cowaramup

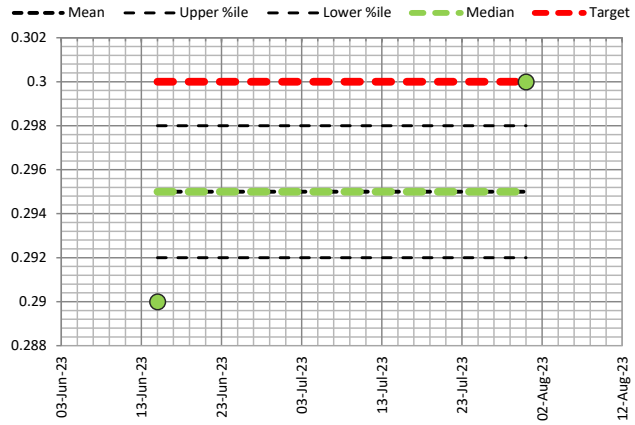
SW2 Site Pond

Easting	323800	Data Analysis Period Start Date	1/01/2016
Northing	6252252	Data Analysis Period End Date	28/09/2023

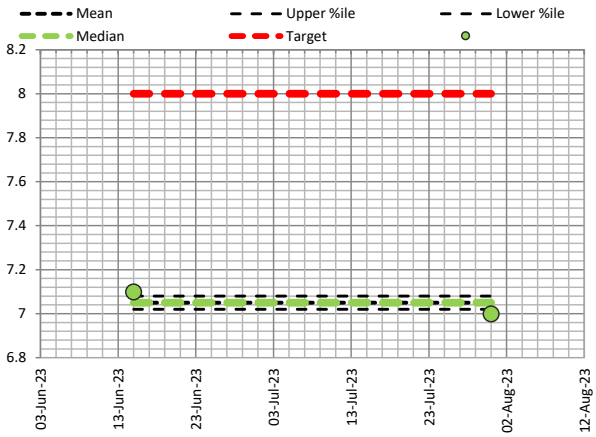
Report Date : 10/10/2023

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
Q	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	1	15.30	15.30	15.30	**15.30**	15.30	15.30		0
EC	Electrical Conductivity	mS/cm	2	0.29	0.29	0.30	**0.30**	0.30	0.30	0.30	0
DO	Dissolved Oxygen	mg/L	1	6.49	6.49	6.49	**6.49**	6.49	6.49		0
DO %	Dissolved Oxygen	%	1	65.60	65.60	65.60	**65.60**	65.60	65.60		0
pH	pH	pH	2	7.00	7.02	7.05	**7.05**	7.08	7.10	8.00	0
ORP	Oxidation Reduction Potential	mV	1	143.60	143.60	143.60	**143.60**	143.60	143.60		0
TUR	Turbidity	NTU	0	0.00	0.00	0.00	**0.00**	0.00	0.00	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TN	Total Nitrogen	mg/L	2	0.71	0.72	0.73	**0.73**	0.74	0.75	1.20	0
TKN	Total Kjeldahl Nitogen	mg/L	2	0.25	0.27	0.29	**0.29**	0.31	0.33		0
NH3-N	Ammonia as N	mg/L	2	0.01	0.01	0.01	**0.01**	0.01	0.01		0
NO_3-N	Nitrate as N	mg/L	2	0.42	0.43	0.44	**0.44**	0.44	0.45		0
NO_2-N	Nitrite as N	mg/L	2	0.01	0.01	0.01	**0.01**	0.01	0.01		0
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	**0.05**	0.05	0.05	0.07	0
FRP	Filterable Reactive Phosphorous	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.04	0
As	Arsenic	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100		0
Cu	Copper	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00140	0
Pb	Lead	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Ni	Nickel	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.01100	0
Zn	Zinc	mg/L	2	0.00160	0.00190	0.00235	**0.00235**	0.00280	0.00310	0.00800	0
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ca	Calcium	mg/L	2	15.00	15.40000	16.00	**16.00**	16.60000	17.00		0
Mg	Magnesium	mg/L	2	6.60	6.72000	6.90	**6.90**	7.08000	7.20		0
K	Potassium	mg/L	2	2.70	2.78000	2.90	**2.90**	3.02000	3.10		0
Na	Sodium	mg/L	2	27.00	27.40000	28.00	**28.00**	28.60000	29.00		0
CaCO3	Hardness as CaCO3	mg/L	2	67.00	67.40000	68.00	**68.00**	68.60000	29.00		0

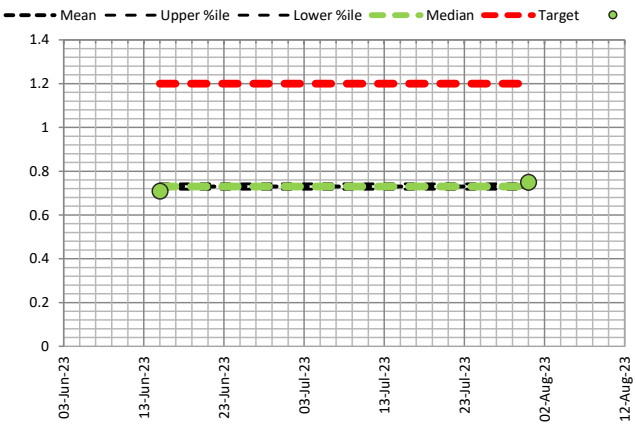
Electrical Conductivity



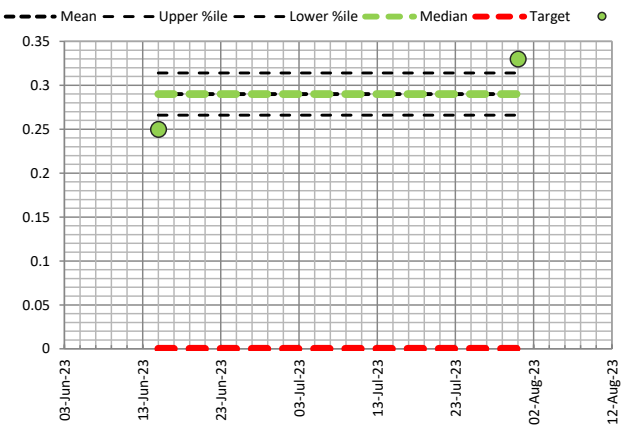
pH



Total Nitrogen



Total Kjeldahl Nitogen



FieldDAE

H23019 Lot 102 Bussell Hwy Cowaramup

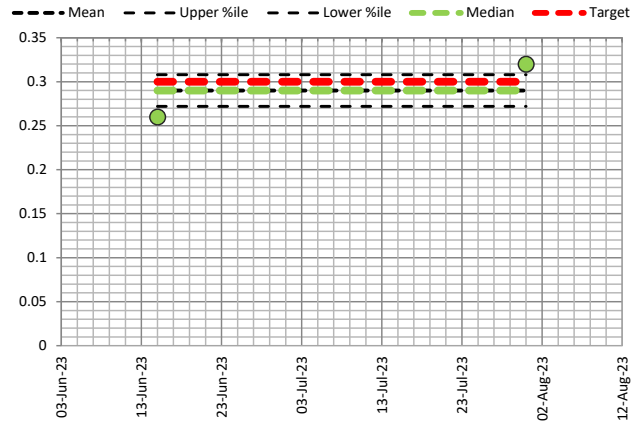
SW3 Outflow from Site
Discharge from Site Pond

Easting	323783	Data Analysis Period Start Date	1/01/2016
Northing	6252264	Data Analysis Period End Date	28/09/2023

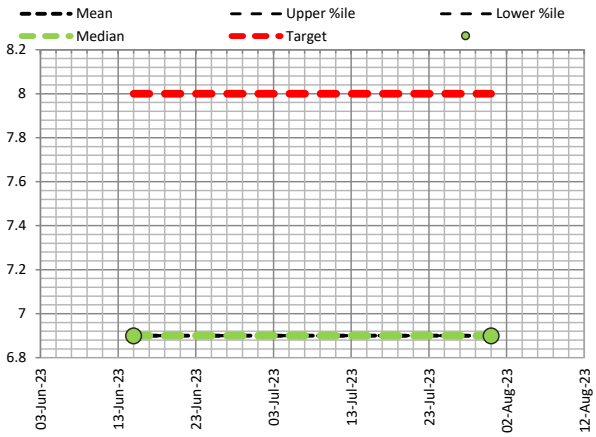
Report Date : 10/10/2023

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
Q	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	1	15.60	15.60	15.60	**15.60**	15.60	15.60		0
EC	Electrical Conductivity	mS/cm	2	0.26	0.27	0.29	**0.29**	0.31	0.32	0.30	1
DO	Dissolved Oxygen	mg/L	1	5.75	5.75	5.75	**5.75**	5.75	5.75		0
DO %	Dissolved Oxygen	%	1	57.80	57.80	57.80	**57.80**	57.80	57.80		0
pH	pH	pH	2	6.90	6.90	6.90	**6.90**	6.90	6.90	8.00	0
ORP	Oxidation Reduction Potential	mV	1	134.50	134.50	134.50	**134.50**	134.50	134.50		0
TUR	Turbidity	NTU	0	0.00	0.00	0.00	**0.00**	0.00	0.00	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TN	Total Nitrogen	mg/L	2	0.74	0.75	0.76	**0.76**	0.76	0.77	1.20	0
TKN	Total Kjeldahl Nitogen	mg/L	2	0.40	0.42	0.45	**0.45**	0.48	0.50		0
NH3-N	Ammonia as N	mg/L	2	0.01	0.01	0.01	**0.01**	0.01	0.01		0
NO_3-N	Nitrate as N	mg/L	2	0.27	0.28	0.30	**0.30**	0.32	0.33		0
NO_2-N	Nitrite as N	mg/L	2	0.01	0.01	0.01	**0.01**	0.01	0.01		0
TP	Total Phosphorous	mg/L	2	0.05	0.06	0.09	**0.09**	0.11	0.12	0.07	1
FRP	Filterable Reactive Phosphorous	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.04	0
As	Arsenic	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100		0
Cu	Copper	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00140	0
Pb	Lead	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Ni	Nickel	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.01100	0
Zn	Zinc	mg/L	2	0.00170	0.00172	0.00175	**0.00175**	0.00178	0.00180	0.00800	0
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ca	Calcium	mg/L	2	14.00	14.00000	14.00	**14.00**	14.00000	14.00		0
Mg	Magnesium	mg/L	2	6.20	6.46000	6.85	**6.85**	7.24000	7.50		0
K	Potassium	mg/L	2	3.10	3.18000	3.30	**3.30**	3.42000	3.50		0
Na	Sodium	mg/L	2	26.00	27.20000	29.00	**29.00**	30.80000	32.00		0
CaCO3	Hardness as CaCO3	mg/L	2	60.00	61.40000	63.50	**63.50**	65.60000	32.00		0

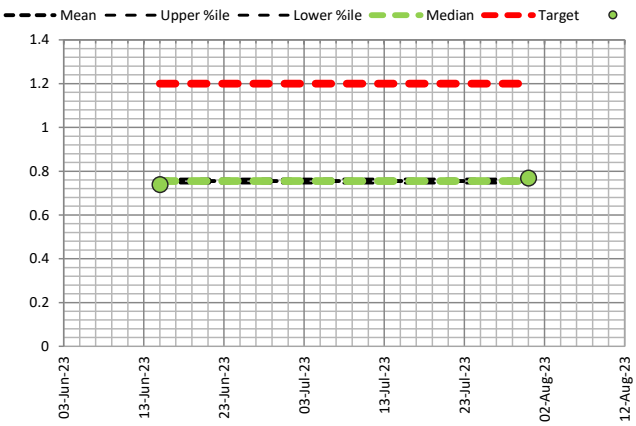
Electrical Conductivity



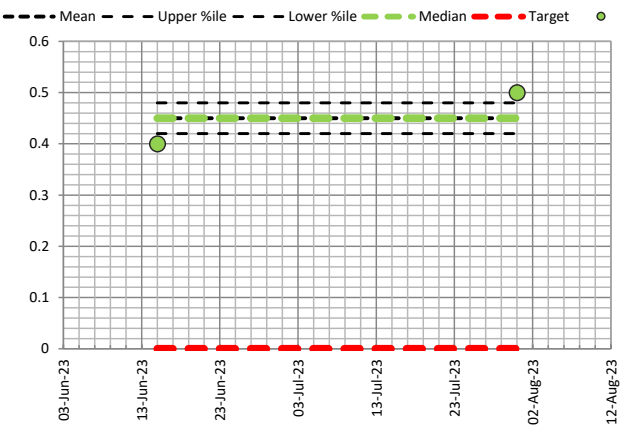
pH



Total Nitrogen



Total Kjeldahl Nitogen



FieldDAE

H23019 Lot 102 Bussell Hwy Cowaramup

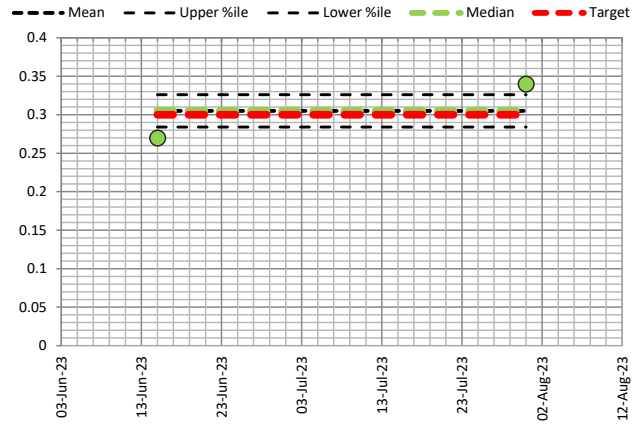
SW4 Creek Flow Downstream of Site
Upstream of Lake Located Downstream of Site

Easting	323687	Data Analysis Period Start Date	1/01/2016
Northing	6252304	Data Analysis Period End Date	28/09/2023

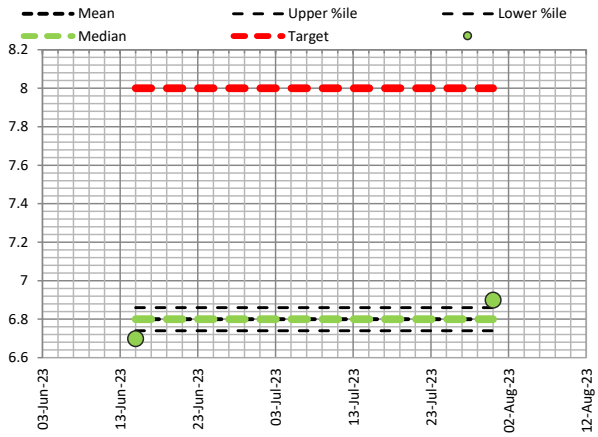
Report Date : 10/10/2023

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
Q	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	1	14.50	14.50	14.50	**14.50**	14.50	14.50		0
EC	Electrical Conductivity	mS/cm	2	0.27	0.28	0.31	**0.31**	0.33	0.34	0.30	1
DO	Dissolved Oxygen	mg/L	1	3.33	3.33	3.33	**3.33**	3.33	3.33		0
DO %	Dissolved Oxygen	%	1	32.80	32.80	32.80	**32.80**	32.80	32.80		0
pH	pH	pH	2	6.70	6.74	6.80	**6.80**	6.86	6.90	8.00	0
ORP	Oxidation Reduction Potential	mV	1	145.80	145.80	145.80	**145.80**	145.80	145.80		0
TUR	Turbidity	NTU	0	0.00	0.00	0.00	**0.00**	0.00	0.00	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TN	Total Nitrogen	mg/L	2	0.44	0.47	0.51	**0.51**	0.55	0.58	1.20	0
TKN	Total Kjeldahl Nitogen	mg/L	2	0.28	0.30	0.33	**0.33**	0.36	0.38		0
NH3-N	Ammonia as N	mg/L	2	0.01	0.01	0.01	**0.01**	0.01	0.01		0
NO_3-N	Nitrate as N	mg/L	2	0.15	0.16	0.18	**0.18**	0.19	0.20		0
NO_2-N	Nitrite as N	mg/L	2	0.01	0.01	0.01	**0.01**	0.01	0.01		0
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	**0.05**	0.05	0.05	0.07	0
FRP	Filterable Reactive Phosphorous	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.04	0
As	Arsenic	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.02400	0
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	**0.00010**	0.00010	0.00010	0.00020	0
Cr	Chromium	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100		0
Cu	Copper	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00140	0
Pb	Lead	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.00340	0
Ni	Nickel	mg/L	2	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	0.01100	0
Zn	Zinc	mg/L	2	0.00230	0.00276	0.00345	**0.00345**	0.00414	0.00460	0.00800	0
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	**0.00005**	0.00005	0.00005	0.00060	0
Ca	Calcium	mg/L	2	14.00	14.80000	16.00	**16.00**	17.20000	18.00		0
Mg	Magnesium	mg/L	2	6.40	6.68000	7.10	**7.10**	7.52000	7.80		0
K	Potassium	mg/L	2	3.00	3.04000	3.10	**3.10**	3.16000	3.20		0
Na	Sodium	mg/L	2	27.00	27.80000	29.00	**29.00**	30.20000	31.00		0
CaCO3	Hardness as CaCO3	mg/L	2	62.00	65.00000	69.50	**69.50**	74.00000	31.00		0

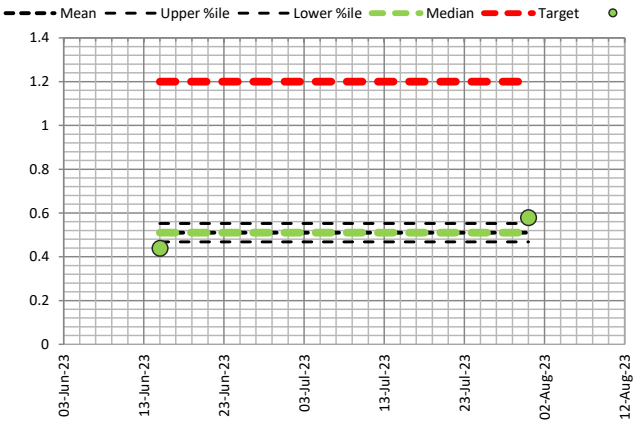
Electrical Conductivity



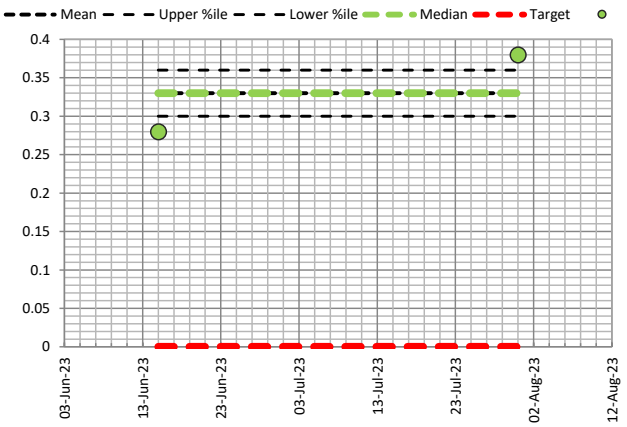
pH



Total Nitrogen



Total Kjeldahl Nitogen



APPENDIX G
Laboratory Reports

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph +61 8 9317 2505 fax +61 8 9317 4163
lab@mpl.com.au
www.mpl.com.au

Certificate of Analysis PEF1123

Client Details

Client	Hyd2O
Contact	Brian Lau
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H22013 - Lot 102 Bussel Hwy, Cowaramup
Number of Samples	4 Surface Water
Date Samples Received	16/06/2023
Date Samples Registered	16/06/2023

Analysis Details

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

Report Details

Date Results Requested by	23/06/2023
Date of Issue	23/06/2023

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

Authorisation Details

Results Approved By	Heram Halim, Operations Manager Lien Tang, Assistant Operations Manager Michael Mowle, Inorganics Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PEF1123

Samples in this Report

Envirolab ID	Sample ID		Matrix	Date Sampled	Date Received
PEF1123-01	OUTFLOW	(SW3)	Surface Water	15/06/2023	16/06/2023
PEF1123-02	OUTFLOW2	(SW4)	Surface Water	15/06/2023	16/06/2023
PEF1123-03	Lake	(SW2)	Surface Water	15/06/2023	16/06/2023
PEF1123-04	INFLOW1	(SW1)	Surface Water	15/06/2023	16/06/2023

Certificate of Analysis PEF1123

Acid Extractable Metals (Surface Water)

			(SW3)	(SW4)	(SW2)	(SW1)
Envirolab ID	**Units**	**PQL**	PEF1123-01	PEF1123-02	PEF1123-03	PEF1123-04
Your Reference			OUTFLOW	OUTFLOW2	Lake	INFLOW1
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023
Phosphorus	mg/L	0.050	0.12	<0.050	<0.050	<0.050

Certificate of Analysis PEF1123

Dissolved Low Level Metals (Surface Water)

			(SW3)	(SW4)	(SW2)	(SW1)
Envirolab ID	**Units**	**PQL**	PEF1123-01	PEF1123-02	PEF1123-03	PEF1123-04
Your Reference			OUTFLOW	OUTFLOW2	Lake	INFLOW1
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	<1.0	1.0	<1.0	1.7
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	<1.0	<1.0	<1.0
Lead	µg/L	1.0	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	1.7	4.6	3.1	12

Certificate of Analysis PEF1123

Inorganics - Physical Parameters (Surface Water)

			(SW3)	(SW4)	(SW2)	(SW1)
Envirolab ID	**Units**	**PQL**	PEF1123-01	PEF1123-02	PEF1123-03	PEF1123-04
Your Reference			OUTFLOW	OUTFLOW2	Lake	INFLOW1
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023
pH	pH units		6.9	6.7	7.1	6.9
Electrical Conductivity	µS/cm	2.0	260	270	290	360

Certificate of Analysis PEF1123

Inorganics - Ionic Balance and Indexes (Surface Water)

			(SW3)	(SW4)	(SW2)	(SW1)
Envirolab ID	**Units**	**PQL**	PEF1123-01	PEF1123-02	PEF1123-03	PEF1123-04
Your Reference			OUTFLOW	OUTFLOW2	Lake	INFLOW1
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023
Calcium	mg/L	0.50	14	14	17	19
Magnesium	mg/L	0.50	6.2	6.4	6.6	6.4
Potassium	mg/L	0.50	3.5	3.0	3.1	2.7
Sodium	mg/L	0.50	26	27	27	27
Hardness as CaCO3	mg/L	3.0	60	62	69	75

Certificate of Analysis PEF1123

Inorganics - Nutrients (Surface Water)

			(SW3)	(SW4)	(SW2)	(SW1)
Envirolab ID	**Units**	**PQL**	PEF1123-01	PEF1123-02	PEF1123-03	PEF1123-04
Your Reference			OUTFLOW	OUTFLOW2	Lake	INFLOW1
Date Sampled			15/06/2023	15/06/2023	15/06/2023	15/06/2023
Ammonia as N	mg/L	0.0050	0.014	<0.0050	0.0057	0.0069
Nitrate as N	mg/L	0.0050	0.33	0.15	0.45	0.56
Nitrate as NO3 by calculation	mg/L	0.020	1.4	0.66	2.0	2.5
Nitrite as N	mg/L	0.0050	0.0076	<0.0050	0.0062	0.0091
Nitrite as NO2 by calculation	mg/L	0.020	0.025	<0.020	0.020	0.030
NOx as N	mg/L	0.0050	0.33	0.15	0.46	0.57
TKN as N by calculation	mg/L	0.10	0.40	0.28	0.25	0.19
Organic Nitrogen by calc.	mg/L	0.10	0.39	0.28	0.24	0.19
Total Nitrogen	mg/L	0.10	0.74	0.44	0.71	0.77
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
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Certificate of Analysis PEH0085

Client Details

Client	Hyd2O
Contact	Andre Righetti
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H23019 - Lot 102 Bussel Hwy, Cowaramup
Number of Samples	4 Surface Water
Date Samples Received	01/08/2023
Date Samples Registered	01/08/2023

Analysis Details

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

Report Details

Date Results Requested by	08/08/2023
Date of Issue	07/08/2023

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

Authorisation Details

Results Approved By	Heram Halim, Operations Manager Michael Mowle, Inorganics Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PEH0085

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PEH0085-01	SW1	Surface Water	31/07/2023	01/08/2023
PEH0085-02	SW2	Surface Water	31/07/2023	01/08/2023
PEH0085-03	SW3	Surface Water	31/07/2023	01/08/2023
PEH0085-04	SW4	Surface Water	31/07/2023	01/08/2023

Certificate of Analysis PEH0085

Acid Extractable Metals (Surface Water)

Envirolab ID	Units	PQL	PEH0085-01	PEH0085-02	PEH0085-03	PEH0085-04
Your Reference			SW1	SW2	SW3	SW4
Date Sampled			31/07/2023	31/07/2023	31/07/2023	31/07/2023
Phosphorus	mg/L	0.050	<0.050	<0.050	<0.050	<0.050

Certificate of Analysis PEH0085

Dissolved Low Level Metals (Surface Water)

Envirolab ID	Units	PQL	PEH0085-01	PEH0085-02	PEH0085-03	PEH0085-04
Your Reference			SW1	SW2	SW3	SW4
Date Sampled			31/07/2023	31/07/2023	31/07/2023	31/07/2023
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0
Copper	µg/L	1.0	1.1	<1.0	<1.0	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	<1.0	<1.0	<1.0	<1.0
Lead	µg/L	1.0	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	8.4	1.6	1.8	2.3

Certificate of Analysis PEH0085

Inorganics - Physical Parameters (Surface Water)

Envirolab ID	Units	PQL	PEH0085-01	PEH0085-02	PEH0085-03	PEH0085-04
Your Reference			SW1	SW2	SW3	SW4
Date Sampled			31/07/2023	31/07/2023	31/07/2023	31/07/2023
pH	pH units		6.9	7.0	6.9	6.9
Electrical Conductivity	µS/cm	2.0	320	300	320	340

Inorganics - Ionic Balance and Indexes (Surface Water)

Envirolab ID	Units	PQL	PEH0085-01	PEH0085-02	PEH0085-03	PEH0085-04
Your Reference			SW1	SW2	SW3	SW4
Date Sampled			31/07/2023	31/07/2023	31/07/2023	31/07/2023
Calcium	mg/L	0.50	23	15	14	18
Magnesium	mg/L	0.50	7.2	7.2	7.5	7.8
Potassium	mg/L	0.50	3.0	2.7	3.1	3.2
Sodium	mg/L	0.50	25	29	32	31
Hardness as CaCO3	mg/L	3.0	87	67	67	77

Certificate of Analysis PEH0085

Inorganics - Nutrients (Surface Water)

Envirolab ID	Units	PQL	PEH0085-01	PEH0085-02	PEH0085-03	PEH0085-04
Your Reference			SW1	SW2	SW3	SW4
Date Sampled			31/07/2023	31/07/2023	31/07/2023	31/07/2023
Ammonia as N	mg/L	0.0050	<0.0050	0.013	0.0082	<0.0050
Nitrate as N	mg/L	0.0050	1.0	0.42	0.27	0.20
Nitrate as NO3 by calculation	mg/L	0.020	4.6	1.8	1.2	0.89
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	1.0	0.42	0.28	0.20
TKN as N by calculation	mg/L	0.10	0.25	0.33	0.50	0.38
Organic Nitrogen by calc.	mg/L	0.10	0.25	0.32	0.49	0.38
Total Nitrogen	mg/L	0.10	1.3	0.75	0.77	0.58
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050

APPENDIX H

UNDO Modelling – Existing Land Use

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

Project:	Lot 102 Bussell Hwy, Cowaramup LWMS Predev	Date:	10/10/2023
		Version:	Version 1.2.0.19289

Subregion name: **Predevelopment Land**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	0	0.00	0.00	0.00
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	100	19.60	1373.96	258.72
Public open space	0	0.00	0.00	0.00
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
19.60	100

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
1476.47	261.66

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
132.34	1.94

Rural living

Landuse	Percent (%)	Area (ha)
Unrestricted	100	19.60
No livestock	0	0.00
No clearing apart from the housing pad	0	0.00

Total area (ha)	Total percent (%)
19.60	100

Nitrogen input (kg)	Phosphorus input (kg)
1373.96	258.72

Note: Commercial horticultre is not permitted in the rural living zone, due to spray drift buffers.

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**No**
Soil type	**Treeton Hills**	**Does subregion contain onsite sewage diposal system?**	**No**
Depth to groundwater (m)	**1**		
Groundwater slope (%)	**1**		
Soil PRI	**27.0**		

Note: Please attach the results of soil tests to this report when submitting.

Summary: Nutrient stripping devices

Treatment Name	Size (m²)	Treated area (ha)	Treating	N removed (kg/yr)	P removed (kg/yr)
Load removed				**0.00**	**0.00**
Net export				**132.34**	**1.94**

Summary: Nutrient load exports

Region	Area (ha)	P export (kg/yr)	N export (kg/yr)
Predevelopment Land	19.60	1.94	132.34

PRE-TREATMENT LOAD (kg/yr)		LOAD REMOVED (kg/yr)		NET LOAD EXPORT (kg/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
132.34	**1.94**	**0.00**	**0.00**	**132.34**	**1.94**

APPENDIX I

DWER Water Register Extracts

Date : 10/10/2023 Job No: H23019



APPENDIX J

Landscape Concept Plan
(South West Landscape
Collective, 2023)



TREES WITHIN ROAD RESERVES ARE TO BE REMOVED. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

VEGETATION TO BE MODIFIED IN ACCORDANCE WITH THE BUSHFIRE MANAGEMENT PLAN. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

LANDSCAPED MOUNDS PLANTED WITH LOW THREAT NATIVE SPECIES AND TALL NATIVE TREES THROUGH LINEAR POS TO ENHANCE RURAL LANDSCAPE AESTHETIC

: TREES WITHIN INTERSECTION ALIGNMENT AND SIGHTLINES TO BE REMOVED. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

1.0m HIGH LANDSCAPED MOUNDING WITH POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

SEATING NODE WITH SHELTER AT FOCAL POINT OF LINEAR POS WITH VIEWS UP AND DOWN THE POS CORRIDOR

SMALL POCKET OF TURF PROVIDING INFORMAL ACTIVE RECREATION SPACE FOR RESIDENTS ON SOUTHERN SIDE OF DEVELOPMENT.

LANDSCAPED MOUNDS PLANTED WITH LOW THREAT NATIVE SPECIES AND TALL NATIVE TREES THROUGH LINEAR POS TO ENHANCE RURAL LANDSCAPE AESTHETIC

FOOTPATH CONNECTION TO WADANDI TRAIL REGIONAL TRAIL NETWORK

SEATING NODE WITH OUTLOOK OVER BASIN TO WADANDI TRAIL RESERVE BEHIND.

CATCHMENT C/ F BASIN TO PROVIDE 2,000sqm OF BIOFILTRATION BASIN AREA. LANDSCAPED WITH NATIVE LOW RUSHES AND SEDGES FOR NUTRIENT STRIPPING AND FILTRATION. TALL NATIVE TREE PLANTING TO SURROUNDING EDGES / BATTERS TO HELP SHADE OUT WEEDS AND PROVIDE WIND BREAK FROM PREVAILING SOUTH-WESTERLY WINDS

1 IN 100 YEAR FLOOD STORAGE AREA TO BE LANDSCAPED WITH LOW THREAT PLANTING AND MULCH WITH CLUMPS OF TALL NATIVE TREES AT MIN 5.0m CANOPY SEPARATION AND MAX. 15% CANOPY COVER TO APZ STANDARDS

MULCH ONLY OR GRAVEL MAINTENANCE ACCESS TO ALONG POS BOUNDARY INTERFACE WITH AGRICULTURAL LOT AND WADANDI TRAIL RESERVE

NEW INTERSECTION ON MEMORIAL DRIVE WILL REQUIRE REMOVAL OF 2 x EXISTING TREES. NEW STREET TREES TO BE INSTALLED IF SIGHTLINES PERMIT, SUBJECT TO DETAILED DESIGN

CONCRETE FOOTPATHS PROVIDING WALKING CIRCUITS THROUGH / AROUND RETAINED VEGETATION WHILE PROVIDING MAINTENANCE ACCESS AND EDGING TO PROTECT EXISTING RETAINED TREES

EXISTING TREES IN GOOD CONDITION TO BE RETAINED AND PROTECTED WITH MULCH AND LOW THREAT UNDERSTOREY PLANTING TO PROTECT INTO THE FUTURE. TOTAL AREA TO BE LESS THAN 0.25HA. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

20.0m WIDE SEPARATION REQUIRED BETWEEN CLUMPS OF RETAINED TREES FOR BUSHFIRE EXCLUSION. CORRIDOR TO PROVIDE POS AMENITIES INCLUDING PLAYGROUND AND PICNIC SHELTER

2.5m WIDE DUAL USE PATH THROUGH CENTRE OF 10.0m WIDE LANDSCAPE BUFFER PROVIDING CONNECTION TO COWARAMUP TOWN CENTRE

EXISTING TREES IN GOOD CONDITION TO BE RETAINED AND PROTECTED WITH MULCH AND LOW THREAT UNDERSTOREY PLANTING TO PROTECT INTO THE FUTURE

WA PEPPERMINT PLANTING AT MIN. 5.0m BETWEEN CANOPIES TO DEVELOPMENT BOUNDARY FOR ADDITIONAL SCREENING. MUST BE LESS THAN 15% CANOPY COVER TOTAL

SINGLE DENSE ROW OF WA PEPPERMINT TREES TO BUSSELL HWY BOUNDARY ON 1.0m HIGH EARTH BUND WITH UNDERSTOREY PLANTING TO APZ REQUIREMENTS

LANDSCAPED MEDIAN WITH TALL NATIVE TREES ON EITHER SIDE TO CREATE GRAND AVENUE ALONG MAIN THROUGH ROAD

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

1.0m HIGH LANDSCAPED MOUNDING WITH POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

BIOFILTRATION BASIN AT ENTRY TO BE LANDSCAPED AS ENTRY FEATURE / WETLAND WITH TALL NATIVE TREE PLANTING TO PRONOUNCE SUBDIVISON ENTRY WITH FEATURE POS PLANTING UNDERSTOREY IN ROAD VERGE

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

MAINTENANCE ACCESS TRACK ENTRY POINT WITH BOLLARDS OR GATE TO SoAMR REQUIREMENTS

VERGE LANDSCAPING BY LOT OWNERS TO SoAMR STANDARDS

STREET TREE PLANTING AT 1 x TREE PER LOT OR 2 x TREES PER CORNER LOT UTILISING LOCAL NATIVE TREE SPECIES

WA PEPPERMINT PLANTING AT MIN. 5.0m BETWEEN CANOPIES TO DEVELOPMENT BOUNDARY FOR ADDITIONAL SCREENING. MUST BE LESS THAN 15% CANOPY COVER TOTAL

SINGLE DENSE ROW OF WA PEPPERMINT TREES TO BUSSELL HWY BOUNDARY ON 1.0m HIGH EARTH BUND WITH UNDERSTOREY PLANTING TO APZ REQUIREMENTS

3.0m WIDE GRAVEL MAINTENANCE ACCESS TRACK THROUGH 10.0m WIDE BUSSELL HWY VISUAL LANDSCAPE BUFFER

10.0m WIDE LANDSCAPE BUFFER TO SOUTHERN BOUNDARY AS VISUAL TRANSITION FROM AGRICULTURAL TO RESIDENTIAL LAND

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 01 CATCHMENT B/G BIOFILTRATION BASIN
- 02 LINEAR POS SWALE WITH 1 IN 4 BATTERS
- 03 CATCHMENT D/E BIOFILTRATION BASIN
- 04 CATCHMENT C/F BIOFILTRATION BASIN AND 1 IN 100 YR FLOOD STORAGE AREA
- 05 OPEN TURF AREAS FOR INFORMAL ACTIVE RECREATION
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- IRRIGATED TURF AREA
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SWALE AND BIOFILTRATION PLANTING AREAS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- EXISTING SURVEYED TREE TO BE RETAINED
- EXISTING SURVEYED TREE TO BE REMOVED
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- LANDSCAPE BUFFER SCREEN TREE PLANTING
- POS NATIVE DRAINAGE TREE PLANTING

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.
2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.
3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

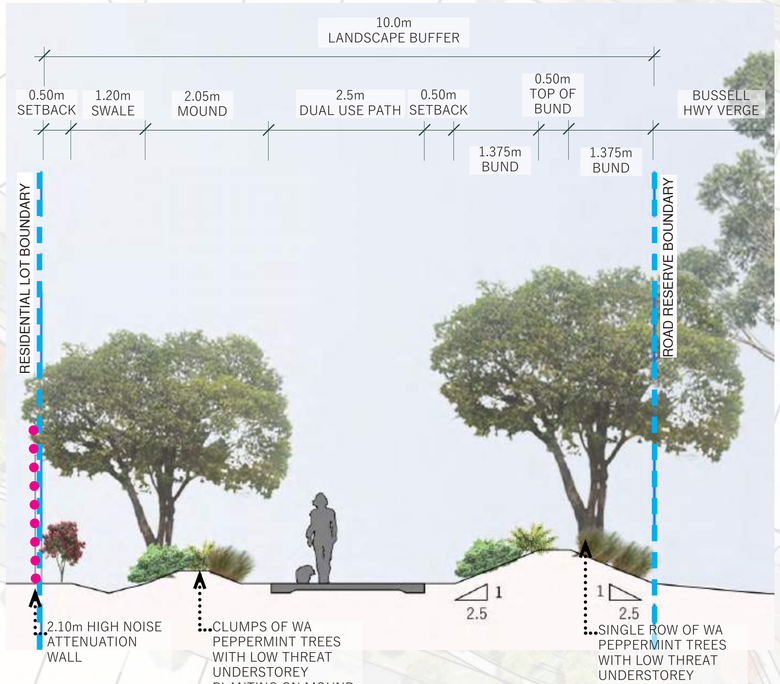
LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - OVERALL SITE PLAN

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-001

SCALE: 1:1500@ A1

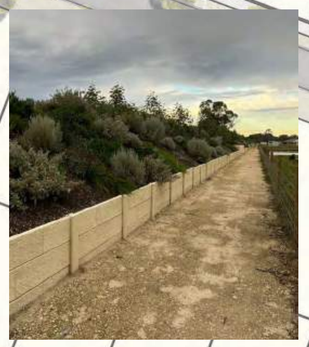
SW LANDSCAPE COLLECTIVE



SCALE **1 : 50 @**

SECTION F - BUSSELL HWY LANDSCAPE BUFFER





EXAMPLE PHOTO: EXAMPLE
BUND AND MOUND PLANTING



2.1m HIGH NOISE ATTENUATION WALL TO REAR OF LOTS ADJACENT BUSSELL HWY

2.5m WIDE DUAL USE PATH THROUGH CENTRE OF 10.0m WIDE LANDSCAPE BUFFER PROVIDING CONNECTION TO COWARAMUP TOWN CENTRE

SHALLOW SWALE CONNECTING THROUGH FROM LANDSCAPE BUFFER TO BIOFILTRATION BASIN

WA PEPPERMINT PLANTING AT MIN. 5.0m BETWEEN CANOPIES TO DEVELOPMENT BOUNDARY FOR ADDITIONAL SCREENING. MUST BE LESS THAN 15% CANOPY COVER TOTAL

SINGLE DENSE ROW OF WA PEPPERMINT TREES TO BUSSELL HWY BOUNDARY ON 1.0m HIGH EARTH BUND WITH UNDERSTOREY PLANTING TO APZ REQUIREMENTS

SEATING NODE FOR PASSIVE RECREATION

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

1.0m HIGH LANDSCAPED MOUNDING WITH POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

NEW INTERSECTION AND ROUND-ABOUT SUBJECT TO DETAILED DESIGN AND MRWA APPROVALS

POS LANDSCAPING PLANTING TO ENTRY ROAD VERGES WITH FEATURE AVENUE STREET TREE PLANTING BEHIND TO CREATE PRONOUNCED INFORMAL ENTRY STATEMENT

BIOFILTRATION BASIN AT ENTRY TO BE LANDSCAPED AS ENTRY FEATURE / WETLAND WITH TALL NATIVE TREE PLANTING TO PRONOUNCE SUBDIVISON ENTRY WITH FEATURE POS PLANTING UNDERSTOREY IN ROAD VERGE

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

SHALLOW SWALE CONNECTING THROUGH FROM LANDSCAPE BUFFER TO BIOFILTRATION BASIN

MAINTENANCE ACCESS TRACK ENTRY POINT WITH BOLLARDS OR GATE TO SoAMR REQUIREMENTS

WA PEPPERMINT PLANTING AT MIN. 5.0m BETWEEN CANOPIES TO DEVELOPMENT BOUNDARY FOR ADDITIONAL SCREENING. MUST BE LESS THAN 15% CANOPY COVER TOTAL

SINGLE DENSE ROW OF WA PEPPERMINT TREES TO BUSSELL HWY BOUNDARY ON 1.0m HIGH EARTH BUND WITH UNDERSTOREY PLANTING TO APZ REQUIREMENTS

3.0m WIDE GRAVEL MAINTENANCE ACCESS TRACK THROUGH 10.0m WIDE BUSSELL HWY VISUAL LANDSCAPE BUFFER

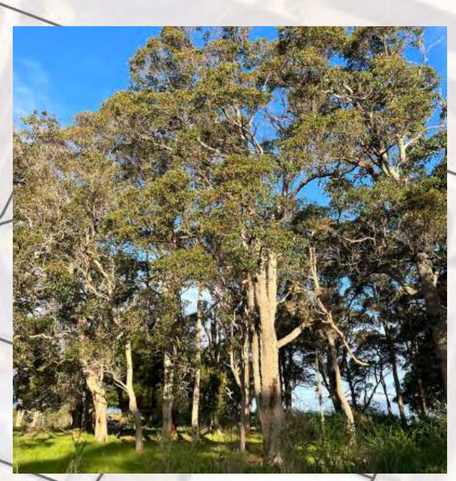
2.1m HIGH NOISE ATTENUATION WALL TO REAR OF LOTS ADJACENT BUSSELL HWY



SITE PHOTO: EXAMPLE MATURE TREES ON SITE ENHANCE NATURAL / RURAL AESTHETIC



SITE PHOTO: EXAMPLE MATURE TREES ON SITE ENHANCE NATURAL / RURAL AESTHETIC



SITE PHOTO: EXAMPLE MATURE TREES ON SITE ENHANCE NATURAL / RURAL AESTHETIC

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 01 CATCHMENT B/G BIOFILTRATION BASIN
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- IRRIGATED TURF AREA
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SWALE AND BIOFILTRATION PLANTING AREAS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- LANDSCAPE BUFFER SCREEN TREE PLANTING
- POS NATIVE DRAINAGE TREE PLANTING
- EXISTING SURVEYED TREE TO BE RETAINED
- EXISTING SURVEYED TREE TO BE REMOVED
- 2.1m HIGH NOISE ATTENUATION WALL TO REAR OF LOTS ADJACENT BUSSELL HWY

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.

2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.

3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

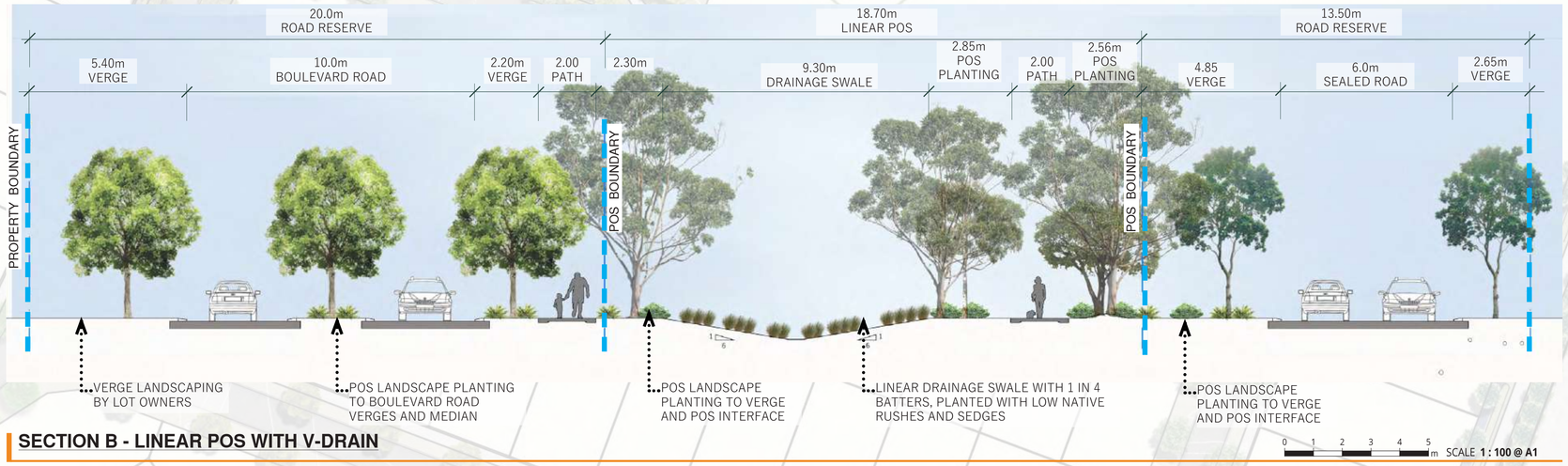
LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - ENTRY POS AND LANDSCAPE BUFFER DETAIL PLANS

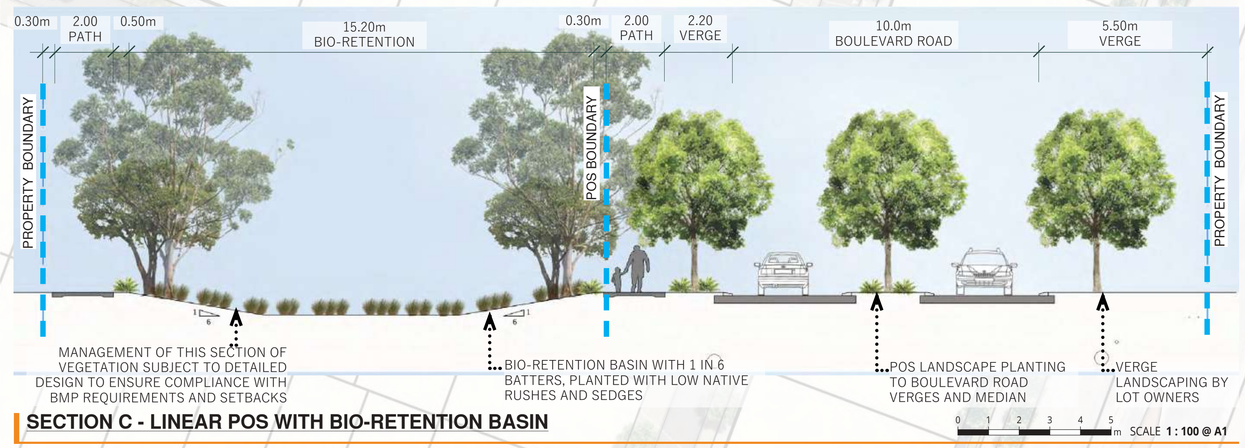
CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-002

SCALE: 0 5 10 15 20 25 m
SCALE **1 : 500 @ A1**

SW LANDSCAPE COLLECTIVE



SECTION B - LINEAR POS WITH V-DRAIN



SECTION C - LINEAR POS WITH BIO-RETENTION BASIN

. TREES WITHIN INTERSECTION ALIGNMENT AND SIGHTLINES TO BE REMOVED. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

FEATURE TALL NATIVE AVENUE STREET TREE PLANTING IN LANDSCAPED MEDIAN

1.0m HIGH LANDSCAPED MOUNDING WITHIN POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

MANAGEMENT OF THIS SECTION OF VEGETATION SUBJECT TO DETAILED DESIGN TO ENSURE COMPLIANCE WITH BMP REQUIREMENTS AND SETBACKS

SEATING NODE WITH SHELTER AT FOCAL POINT OF LINEAR POS WITH VIEWS UP AND DOWN THE POS CORRIDOR

POS LANDSCAPE PLANTING PROVIDING BUFFER TO PRIVATE LOT

SEATING NODE ADJACENT TO TURF AREA FOR PASSIVE RECREATION AND SURVEILLANCE

SMALL POCKET OF TURF PROVIDING INFORMAL ACTIVE RECREATION SPACE FOR RESIDENTS ON SOUTHERN SIDE OF DEVELOPMENT.

SEATING NODE ADJACENT TO TURF AREA FOR PASSIVE RECREATION AND SURVEILLANCE

1.0m HIGH LANDSCAPED MOUNDING WITHIN POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO SHADE FOOTPATH AND REINFORCE RURAL LANDSCAPE AESTHETIC

LANDSCAPED MEDIAN WITH TALL NATIVE TREES ON EITHER SIDE TO CREATE GRAND AVENUE ALONG MAIN THROUGH ROAD

DECIDUOUS POS FEATURE TREE AT FOCAL FROM BUSSELL HIGHWAY ENTRY AND FOR PASSIVE SOLAR PROTECTION FOR SHELTER / SEATING NODE

SEATING NODE WITH SHELTER AT FOCAL POINT OF LINEAR POS WITH VIEWS UP THE POS CORRIDOR AND FROM MAIN ENTRY OFF BUSSELL HIGHWAY

1.0m HIGH LANDSCAPED MOUNDING WITHIN POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO SHADE FOOTPATH AND REINFORCE RURAL LANDSCAPE AESTHETIC

LOW THREAT POS LANDSCAPE PLANTING TO VERGES OF LINEAR POS IN ACCORDANCE WITH APZ STANDARDS

SUNSET DRIVE

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.

2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.

3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 02 LINEAR POS SWALE WITH 1 IN 4 BATTERS
- 03 CATCHMENT D/E BIOFILTRATION BASIN
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- IRRIGATED TURF AREA
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SWALE AND BIOFILTRATION PLANTING AREAS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- LANDSCAPE BUFFER SCREEN TREE PLANTING
- POS NATIVE DRAINAGE TREE PLANTING

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - LINEAR POS DETAIL PLAN

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-003

SCALE: 0 5 10 15 20 25 m
SCALE 1 : 500 @ A1

SW LANDSCAPE COLLECTIVE



EXAMPLE PHOTO: EXISTING MATURE VEGETATION RETAINED IN MEDIANS AND VERGES

SEATING NODE BENEATH SHADE OF EXISTING TREE CANOPY

LANDSCAPED MOUNDS PLANTED WITH LOW THREAT NATIVE SPECIES AND TALL NATIVE TREES THROUGH LINEAR POS TO ENHANCE RURAL LANDSCAPE AESTHETIC

CONCRETE HALF-COURT SPACE AS LOW COST AND LOW MAINTENANCE ACTIVITY SPACE ADJACENT PLAYGROUND TO CATER FOR OLDER AGE GROUPS

STREET TREE PLANTING IN VERGE OF POS TO MATCH OPPOSITE VERGE WITH LOW THREAT PLANTING AND MULCH FINISH BENEATH

UTILISE EXISTING OPEN AREA FOR IRRIGATED TURF SPACE FOR ACTIVE RECREATION AND CONNECTING TO PLAY AND COURT SPACE

LANDSCAPED MOUNDS PLANTED WITH LOW THREAT NATIVE SPECIES AND TALL NATIVE TREES THROUGH LINEAR POS TO ENHANCE RURAL LANDSCAPE AESTHETIC

SEATING NODE OPENING TO TURF AREA FOR PASSIVE OUTLOOK AND SURVEILLANCE

E

05

E

CLUMPS OF TALL NATIVE TREE PLANTINGS WITH POS LANDSCAPE SPECIES PLANTING BENEATH AS NODES OF SCREENING AND HABITAT. TO BE COMPLIANT TO APZ STANDARDS

3.0m WIDE MULCH ONLY MAINTENANCE EDGE TO LARGE AREA OF EXISTING TREES TO BE RETAINED.

MULCH AND LOW THREAT UNDERSTOREY PLANTING TO ASSIST IN PROTECTING EXISTING TREE ROOTS AND IMPROVE OVERALL TREE HEALTH

CONCRETE FOOTPATHS PROVIDING WALKING CIRCUITS THROUGH / AROUND RETAINED VEGETATION WHILE PROVIDING MAINTENANCE ACCESS AND EDGING TO PROTECT EXISTING RETAINED TREES

EXISTING TREES IN GOOD CONDITION TO BE RETAINED AND PROTECTED WITH MULCH AND LOW THREAT UNDERSTOREY PLANTING TO PROTECT INTO THE FUTURE. TOTAL AREA TO BE LESS THAN 0.25HA

ADDITIONAL PLANTING OF MARRI, JARRAH AND WA PEPPERMINTS AS SUCCESSION PLANTING IN OPEN AREAS

PICNIC SETTING OPEN TO PLAYGROUND AND HALF COURT AREA

SHADE SAILS OVER PLAY SPACE FOR SUN PROTECTION AND SHADE

20.0m WIDE SEPARATION REQUIRED BETWEEN CLUMPS OF RETAINED TREES FOR BUSHFIRE EXCLUSION. LOW THREAT PLANTING ONLY TO OCCUR

PLAYGROUND TO PROVIDE VARIETY FOR ALL AGES AND ACCESSIBILITY WITH COMBINATION OF OFF-THE-SHELF AND NATURE PLAY EQUIPMENT / PIECES

PICNIC SHELTER AND SETTING / SEATING TO BE PROVIDED ADJACENT PLAYGROUND

CONCRETE FOOTPATHS PROVIDING WALKING CIRCUITS THROUGH / AROUND RETAINED VEGETATION WHILE PROVIDING MAINTENANCE ACCESS AND EDGING TO PROTECT EXISTING RETAINED TREES

CLUMPS OF TALL NATIVE TREE PLANTINGS WITH POS LANDSCAPE SPECIES PLANTING BENEATH AS NODES OF SCREENING AND HABITAT. TO BE COMPLIANT TO APZ STANDARDS

EXISTING TREES IN GOOD CONDITION TO BE RETAINED AND PROTECTED WITH MULCH AND LOW THREAT UNDERSTOREY PLANTING TO PROTECT INTO THE FUTURE. TOTAL AREA TO BE LESS THAN 0.25HA

CONCRETE FOOTPATHS PROVIDING WALKING CIRCUITS THROUGH / AROUND RETAINED VEGETATION WHILE PROVIDING MAINTENANCE ACCESS AND EDGING TO PROTECT EXISTING RETAINED TREES



EXAMPLE PHOTO: LOW THREAT PLANTING BENEATH RETAINED EXISTING TREES

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 05 OPEN TURF AREAS FOR INFORMAL ACTIVE RECREATION
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- IRRIGATED TURF AREA
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- EXISTING SURVEYED TREE TO BE RETAINED
- EXISTING SURVEYED TREE TO BE REMOVED

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.

2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.

3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - NORTHERN ACTIVE POS DETAIL PLAN

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-004

SCALE: 0 2 4 6 8 10 m
SCALE 1 : 250 @

SW LANDSCAPE COLLECTIVE

WADANDI TRAIL

0.3m RETAINING WALL WITH LOW THREAT PLANTING ABOVE TO PROVIDE BAL SETBACK TO PRIVATE LOTS. MANAGEMENT OF THIS SECTION OF VEGETATION SUBJECT TO DETAILED DESIGN TO ENSURE COMPLIANCE WITH BMP REQUIREMENTS AND SETBACKS

FOOTPATH CONNECTION TO WADANDI TRAIL REGIONAL TRAIL NETWORK

POS LANDSCAPE PLANTING AND NATIVE TREES PROVIDE SEPARATION AND SCREENING TO PRIVATE LOT

CATCHMENT C/ F BASIN TO PROVIDE 2,000sqm OF BIOFILTRATION BASIN AREA. LANDSCAPED WITH NATIVE LOW RUSHES AND SEDGES FOR NUTRIENT STRIPPING AND FILTRATION. TALL NATIVE TREE PLANTING TO SURROUNDING EDGES / BATTERS TO HELP SHADE OUT WEEDS AND PROVIDE WIND BREAK FROM PREVAILING SOUTH-WESTERLY WINDS

FEATURE DECIDUOUS POS TREE PLANTING PROVIDING SEASONAL COLOUR AND SHADE AT FOCAL POINT

SEATING NODE WITH OUTLOOK OVER BASIN TO WADANDI TRAIL RESERVE BEHIND.



EXAMPLE PHOTO: LOW NATIVE RUSH AND SEDGE PLANTING

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BOLLARDS OR ACCESS GATE TO BE INSTALLED TO SoAMR REQUIREMENTS AND SUBJECT TO DETAILED DESIGN DRAWINGS

10.0m WIDE LANDSCAPE BUFFER TO SOUTHERN BOUNDARY AS VISUAL AND SPRAY DRIFT SCREEN FROM ADJACENT AGRICULTURAL USE.

MULCH ONLY OR GRAVEL MAINTENANCE ACCESS TO ALONG POS BOUNDARY INTERFACE WITH AGRICULTURAL LOT AND WADANDI TRAIL RESERVE

1 IN 100 YEAR FLOOD STORAGE AREA TO BE LANDSCAPED WITH LOW THREAT PLANTING AND MULCH WITH CLUMPS OF TALL NATIVE TREES AT MIN 5.0m CANOPY SEPARATION AND MAX. 15% CANOPY COVER TO APZ STANDARDS



EXAMPLE PHOTO: LOW NATIVE RUSH AND SEDGE PLANTING

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 04 CATCHMENT C/F BIOFILTRATION BASIN AND 1 IN 100 YR FLOOD STORAGE AREA
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SWALE AND BIOFILTRATION PLANTING AREAS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- LANDSCAPE BUFFER SCREEN TREE PLANTING
- POS NATIVE DRAINAGE TREE PLANTING
- EXISTING SURVEYED TREE TO BE RETAINED
- EXISTING SURVEYED TREE TO BE REMOVED

NOTES

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2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.

3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

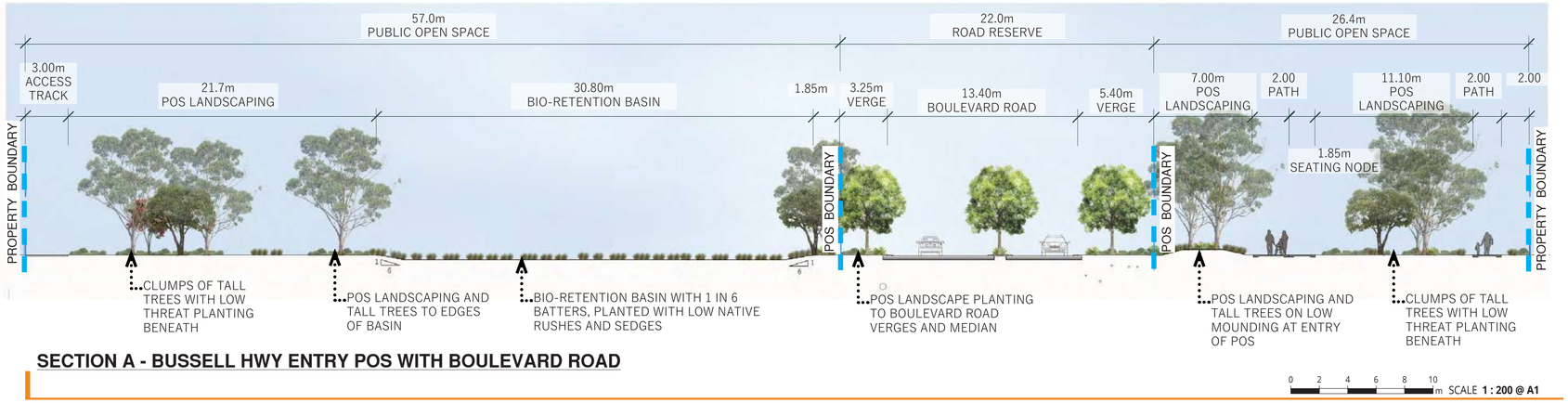
LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - SOUTHERN DRAINAGE POS DETAIL PLAN

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-005

SCALE: 0 2 4 6 8 10 m
SCALE 1 : 250 @

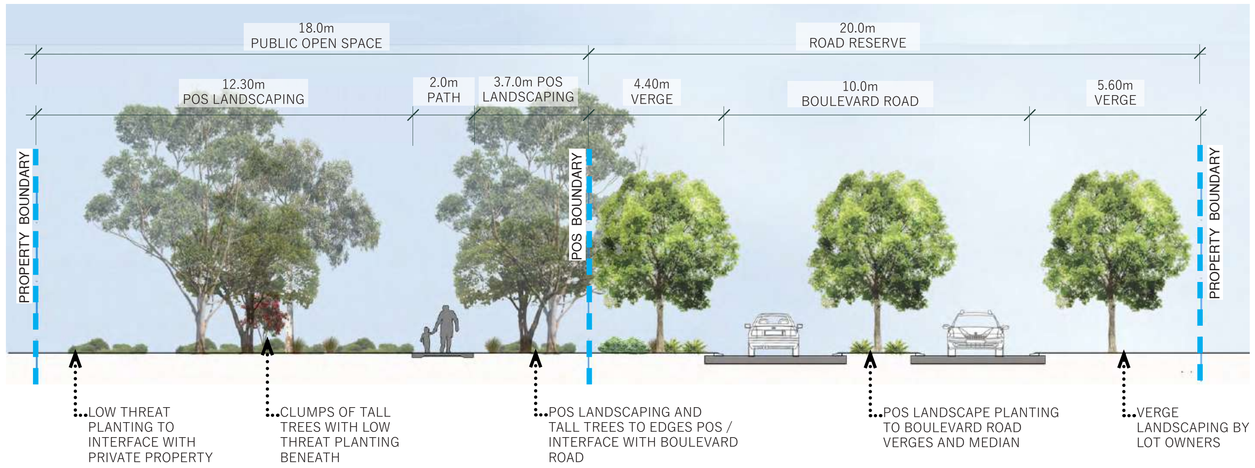
SW LANDSCAPE COLLECTIVE



SECTION A - BUSSELL HWY ENTRY POS WITH BOULEVARD ROAD



EXAMPLE PHOTO: LOW THREAT PLANTING SURROUNDING EXISTING TREES



SECTION D - SUNSET DRIVE LINEAR POS ENTRY

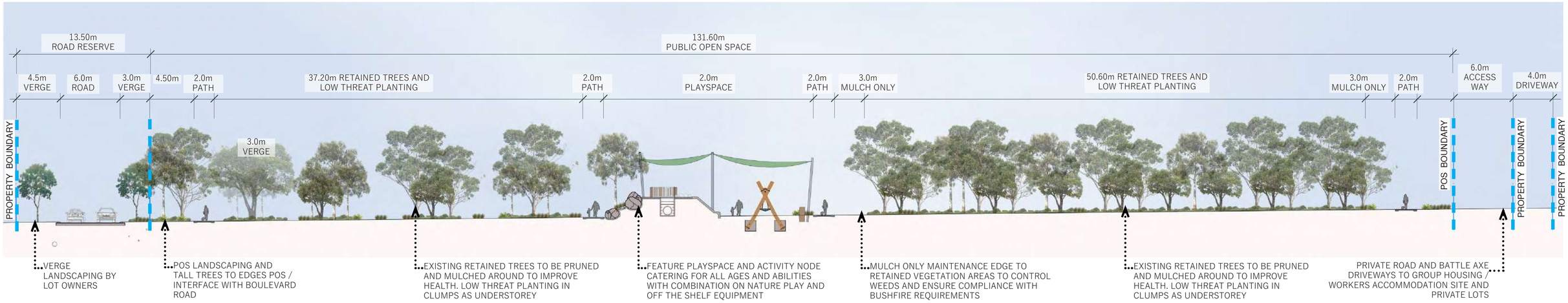
0 1 2 3 4 5 m SCALE 1 : 100 @ A1



EXAMPLE PHOTO: EXISTING TREES RETAINED IN VERGES AND POS



EXAMPLE PHOTO: EXISTING TREES RETAINED TURF POS



SECTION E - NORTHERN POS WITH PLAY SPACE

0 2 4 6 8 10 m SCALE 1 : 200 @ A1

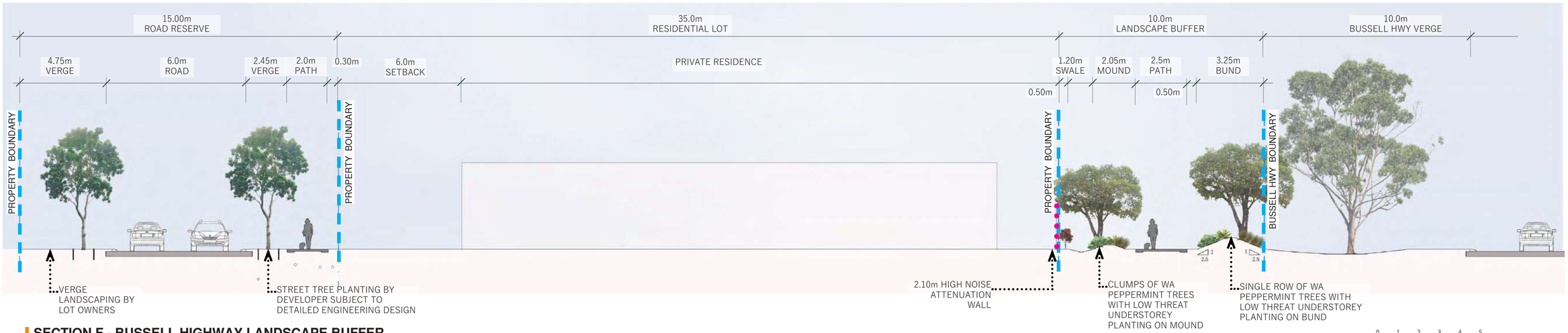
LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - NATURE PLAYGROUND SECTIONS AND IMAGERY

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-006

SCALE: 1:200 @A1

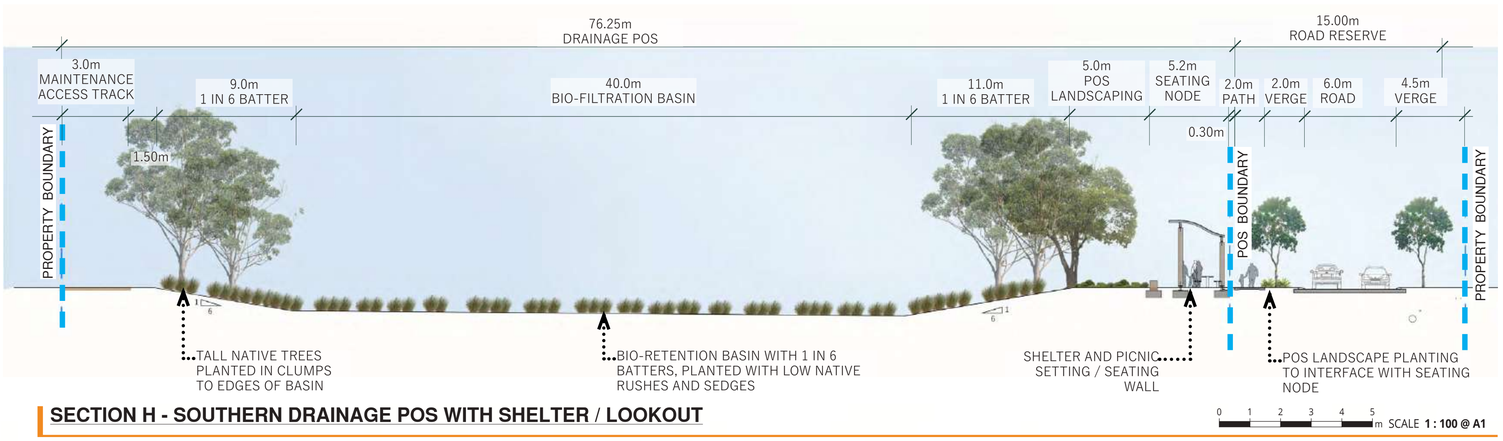
SW LANDSCAPE COLLECTIVE



SECTION F - BUSSELL HIGHWAY LANDSCAPE BUFFER



SECTION G - SOUTHERN LOTS WITH LANDSCAPE TRANSITION BUFFER



SECTION H - SOUTHERN DRAINAGE POS WITH SHELTER / LOOKOUT



EXAMPLE PHOTO: COWARAMUP MAIN STREET FEATURE PLANTING PALETTE



EXAMPLE PHOTO: SIMPLE SEATING NODE IN POS

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE CONCEPT PLAN - TYPICAL SECTIONS

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-007

SCALE: 1:100 @A1

SW LANDSCAPE COLLECTIVE



EXAMPLE RURAL STYLE PINCIC SHELTERS





BENCH SEATING



EXAMPLE NATURE PLAY ELEMENTS



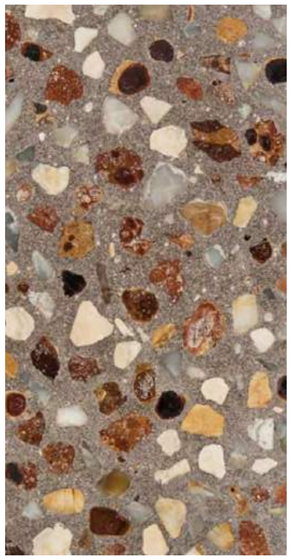




COASTAL LIMESTONESW GRANITE



CUSTOM SITE FURNITURE UTILISING RECYCLED TIMBER MATERIALS



EXPOSED AGG CONCRETE FEATURES



EXISTING SITE LOGS RECYCLED AS POS AND LANDSCAPE FEATURES



EXAMPLE ARTWORK / FEATURE / PLAY ITEMS



COMBINATION OF NATURAL MATERIALS IN SEATING NODES



SIMPLE HALF COURT AND LINEMARKING GAMES



SITE LOGS FOR PLAYGROUND AND LANDSCAPE FEATURES

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE CONCEPT PLAN - HARDSCAPE MATERIAL PALETTE

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-008

SCALE: N/A

SW LANDSCAPE COLLECTIVE

TREE SPECIES

STREET TREES
Agonis flexousa - WA Peppermint
Corymbia calyphylla Grafted Varieties - Marri
Corymbia ficifolia - Red Flowering Gum
Eucalyptus torquata - Coral Gym
Eucalyptus patens - Blackbutt
Hakea laurina - Pin Cushion Hakea

PUBLIC OPEN SPACE TREES
Agonis flexousa - WA Peppermint
Banksia grandis - Bull Banksia
Corymbia calyphylla - Marri
Eucalyptus diversicolour - Karri
Eucalyptus marginata - Jarrah
Eucalyptus patens - Blackbutt
Eucalyptus rudis - River Gum
Melaleuca rhaphiophylla - Swamp Paperbark
Quercus rubra - Red Oak





Agonis flexuosa



Anigozanthus manglessii



Atriplex cinerea



Banksia nivea



Beaufortia squarrosa

LOW THREAT FIRE RESISTANT PLANT SPECIES

SHRUBS AND GRASSES
Anigozanthus manglesii - Red and Green Kangaroo Paw
Atriplex cinerea - Grey Saltbush
Beaufortia squarrosa - Sand Bottlebrush
Calothamnus quadrifidus - Onesided Bottelbrush
Casuarina glauca - Cousin IT
Lepidosperma gladiatum - Coastal Sword Sedge
Olearia axillaris - Coastal Daisy Bush

GROUND COVERS
Banksia nivea - Honeypot Dryandra
Conostylis aculeata - Prickly Conostylis
Eremophila glabra - Emu Bush
Grevillea junipera - Juniper-leaved Grevillea
Hemiandra pungens - Snake bush
Kennedia coccinea - Running Postman
Myoporum parvifolium Creeping Boobialla
Pandorea jasminoides - Star Jasmin
Scaevola aemula - Fairy Fan Flower





Calothamnus quadrifidus



Casuarina Cousin IT



Conostylis aculeata



Ficinia nodosa

FEATURE POS PLANTING SPECIES

TREES
Agonis flexuosa - WA Peppermint Tree
Banksia grandis - Bull Banksia
Hakea lauraina - Pin Cushion Hakea

SHRUBS
Adenanthos cuneatus - Kalbarri Carpet
Anigozanthis flavisua - Yellow Kangaroo Paw
Anigozanthus manglesii - Red and Green Kangaroo Paw
Billardiera fusiformis - Australian Bluebell
Beaufortia squarrosa - Sand Bottlebrush
Calothamnus quadrifidus - Onesided Bottelbrush
Casuarina glauca - Cousin IT
Grevillea olivacea - Olive-Leaved Grevillea
Lepidosperma gladiatum - Coastal Sword Sedge
Lepidosperma Twilight Green
Meebolidna scariosa - Velve Rush
Templetonia retusa - Cockiets Tongue

GROUND COVERS
Banksia nivea - Honeypot Dryandra
Conostylis aculeata - Prickly Conostylis
Grevillea GinGin Gem
Lomandra Seasprayt
Melaleuca heugelli - White Rambler
Myoporum parvifolium Creeping Boobialla
Scaevola crassifolia - Purple Fan Flower





Grevillea Gingin Gem



Grevillea olivacea



Hakea laurina



Juncus pallidus



Lepidosperma gladiatum

DRAINAGE BASIN AND SWALE PLANTING SPECIES

TREES
Melaleuca rhaphiophylla

GROUND COVERS
Baumea juncea
Carex appressa
Ficinia nodosa
Meeboldina scariosa
Juncus pallidus
Scheonoplectus validus





Lomandra longifolia



Meeboldina scariosa



Melaleuca incana nana



Myoproum parvifolium

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE CONCEPT PLAN - SOFTSCAPE MATERIAL PALETTE

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-009

SCALE: N/A

SW LANDSCAPE COLLECTIVE



LEGEND

- SURVEYED TREE LOCATION
  - TREE NUMBER ON ARBORIST REPORT
  - TREE COMMON NAME
  - ASSESSED TREE CONDITION
  - TRUNK DIAMETER (mm)
- TREE CONDITION RATING - GOOD
- TREE CONDITION RATING - FAIR
- TREE CONDITION RATING - POOR
- TREE CONDITION RATING - DEAD

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

STANDARD NOTES

1. **SET OUT & DIMENSIONS.** THE CONTRACTOR SHALL SET OUT ALL PATHS, WALLS, HARD SURFACES AND ELEMENTS EITHER ON SITE PRIOR TO CONSTRUCTION AND SHALL OBTAIN THE SUPERINTENDENTS APPROVAL PRIOR TO WORKS COMMENCING. WRITTEN DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALE. CHECK ALL DRAWING SCALES IN CONJUNCTION WITH DRAWING SIZE.
2. **SERVICES & SITE ASSETS.** THE CONTRACTOR SHALL INVESTIGATE THE NATURE AND LOCATION OF ALL EXISTING SERVICES AND RETAINED SITE ASSETS AFFECTED BY THEIR WORKS. FAILURE TO TAKE DUE CARE SHALL NOT LIMIT THE CONTRACTORS LIABILITIES.
3. **REFERENCE.** THE CONTRACTOR SHALL REFER TO ALL CONTRACT DOCUMENTS, THE SPECIFICATION AND DRAWINGS PRIOR TO AND DURING THE WORKS.
4. **DISCREPANCIES.** NOTIFY SUPERINTENDENT OF ANY SUSPECTED OR KNOWN DISCREPANCIES OR ERRORS PRIOR TO THE ORDERING OF AFFECTED MATERIALS AND OR CONSTRUCTION OF AFFECTED WORKS.
5. **RELEVANT STANDARDS.** THE CONTRACTOR SHALL UNDERTAKE ALL PRICING AND WORKS IN ACCORDANCE WITH CURRENT INDUSTRY BEST PRACTICE AND ALL RELEVANT AUSTRALIAN STANDARDS.
6. **SERVICE LOCATOR.** THE CONTRACTOR SHALL UNDERTAKE A DIAL BEFORE YOU DIG PROCESS PRIOR TO COMMENCING WORKS ON SITE. THE CONTRACTOR SHALL ENGAGE A SERVICE LOCATOR TO MAP THE SPECIFIC LOCATIONS AND DEPTH OF ALL SERVICES AND ADVISE ALL RELEVANT STAFF AND SUBCONTRACTORS IN WRITING PRIOR TO COMMENCING WORKS ON SITE.

SW LANDSCAPE COLLECTIVE

ADDRESS: 4 MAGPIE STREET, MARGARET RIVER WA 6285
EMAIL: ADMIN@SWLANDSCAPE.COM.AU
WEBSITE: WWW.SWLANDSCAPE.COM.AU
PHONE: +61 418 947 889

REV	DATE	BY	ISSUE OR AMENDMENT
D	12.10.23	CE	UPDATED SURVEY INFORMATION
C	09.10.23	CE	ADDITION OF MEMORIAL DRIVE ROAD RESERVE TREES
B	19.09.23	CE	ADDITION OF SUNSET DRIVE ROAD RESERVE TREES
A	13.09.23	CE	ISSUE FOR APPROVAL

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
EXISTING TREE ARBORIST CONDITION SUMMARY

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE
1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER
GFC-01-101

REVISION
D



LEGEND

SURVEYED TREE LOCATION - TREE TO BE RETAINED

SURVEYED TREE LOCATION - TREE TO BE REMOVED

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

STANDARD NOTES

1. **SET OUT & DIMENSIONS.** THE CONTRACTOR SHALL SET OUT ALL PATHS, WALLS, HARD SURFACES AND ELEMENTS EITHER ON SITE PRIOR TO CONSTRUCTION AND SHALL OBTAIN THE SUPERINTENDENTS APPROVAL PRIOR TO WORKS COMMENCING. WRITTEN DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALE. CHECK ALL DRAWING SCALES IN CONJUNCTION WITH DRAWING SIZE.
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4. **DISCREPANCIES.** NOTIFY SUPERINTENDENT OF ANY SUSPECTED OR KNOWN DISCREPANCIES OR ERRORS PRIOR TO THE ORDERING OF AFFECTED MATERIALS AND OR CONSTRUCTION OF AFFECTED WORKS.
5. **RELEVANT STANDARDS.** THE CONTRACTOR SHALL UNDERTAKE ALL PRICING AND WORKS IN ACCORDANCE WITH CURRENT INDUSTRY BEST PRACTICE AND ALL RELEVANT AUSTRALIAN STANDARDS.
6. **SERVICE LOCATOR.** THE CONTRACTOR SHALL UNDERTAKE A DIAL BEFORE YOU DIG PROCESS PRIOR TO COMMENCING WORKS ON SITE. THE CONTRACTOR SHALL ENGAGE A SERVICE LOCATOR TO MAP THE SPECIFIC LOCATIONS AND DEPTH OF ALL SERVICES AND ADVISE ALL RELEVANT STAFF AND SUBCONTRACTORS IN WRITING PRIOR TO COMMENCING WORKS ON SITE.

SW LANDSCAPE COLLECTIVE

ADDRESS: 4 MAGPIE STREET, MARGARET RIVER WA 6285
EMAIL: ADMIN@SWLANDSCAPE.COM.AU
WEBSITE: WWW.SWLANDSCAPE.COM.AU
PHONE: +61 418 947 889

REV	DATE	BY	ISSUE OR AMENDMENT
E	12.10.23	CE	UPDATED SURVEY INFORMATION
D	09.10.23	CE	ADDITION OFMEMORIAL DRIVE ROAD RESERVE TREES
C	22.09.23	CE	ADDITION OF ENGINEERS SIGHTLINE REVIEW
B	19.09.23	CE	ADDITION OF SUNSET DRIVE ROAD RESERVE TREES
A	13.09.23	CE	ISSUE FOR CLIENT REVIEW

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
PRELIMINARY SITE CLEARING / TREE REMOVAL PLAN

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE 1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER GFC-01-102

REVISION E



LEGEND

SURVEYED TREE LOCATION - TREE TO BE RETAINED

SURVEYED TREE LOCATION - TREE TO BE REMOVED

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

STANDARD NOTES

1. **SET OUT & DIMENSIONS.** THE CONTRACTOR SHALL SET OUT ALL PATHS, WALLS, HARD SURFACES AND ELEMENTS EITHER ON SITE PRIOR TO CONSTRUCTION AND SHALL OBTAIN THE SUPERINTENDENTS APPROVAL PRIOR TO WORKS COMMENCING. WRITTEN DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALE. CHECK ALL DRAWING SCALES IN CONJUNCTION WITH DRAWING SIZE.
2. **SERVICES & SITE ASSETS.** THE CONTRACTOR SHALL INVESTIGATE THE NATURE AND LOCATION OF ALL EXISTING SERVICES AND RETAINED SITE ASSETS AFFECTED BY THEIR WORKS. FAILURE TO TAKE DUE CARE SHALL NOT LIMIT THE CONTRACTORS LIABILITIES.
3. **REFERENCE.** THE CONTRACTOR SHALL REFER TO ALL CONTRACT DOCUMENTS, THE SPECIFICATION AND DRAWINGS PRIOR TO AND DURING THE WORKS.
4. **DISCREPANCIES.** NOTIFY SUPERINTENDENT OF ANY SUSPECTED OR KNOWN DISCREPANCIES OR ERRORS PRIOR TO THE ORDERING OF AFFECTED MATERIALS AND OR CONSTRUCTION OF AFFECTED WORKS.
5. **RELEVANT STANDARDS.** THE CONTRACTOR SHALL UNDERTAKE ALL PRICING AND WORKS IN ACCORDANCE WITH CURRENT INDUSTRY BEST PRACTICE AND ALL RELEVANT AUSTRALIAN STANDARDS.
6. **SERVICE LOCATOR.** THE CONTRACTOR SHALL UNDERTAKE A DIAL BEFORE YOU DIG PROCESS PRIOR TO COMMENCING WORKS ON SITE. THE CONTRACTOR SHALL ENGAGE A SERVICE LOCATOR TO MAP THE SPECIFIC LOCATIONS AND DEPTH OF ALL SERVICES AND ADVISE ALL RELEVANT STAFF AND SUBCONTRACTORS IN WRITING PRIOR TO COMMENCING WORKS ON SITE.

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REV	DATE	BY	ISSUE OR AMENDMENT
E	12.10.23	CE	ADDITION OFMEMORIAL DRIVE ROAD RESERVE TREES
D	09.10.23	CE	ADDITION OFMEMORIAL DRIVE ROAD RESERVE TREES
C	22.09.23	CE	ADDITION OF ENGINEERS SIGHTLINE REVIEW
B	19.09.23	CE	ADDITION OF SUNSET DRIVE ROAD RESERVE TREES
A	13.09.23	CE	ISSUE FOR CLIENT REVIEW

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
PRELIMINARY SITE CLEARING / TREE REMOVAL PLAN

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE
1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER
GFC-01-103

REVISION
E

APPENDIX K

CURRV Runoff Rate Calculation

CURRV

Calculator for Urban Runoff Rates & Volumes
20/10/2023

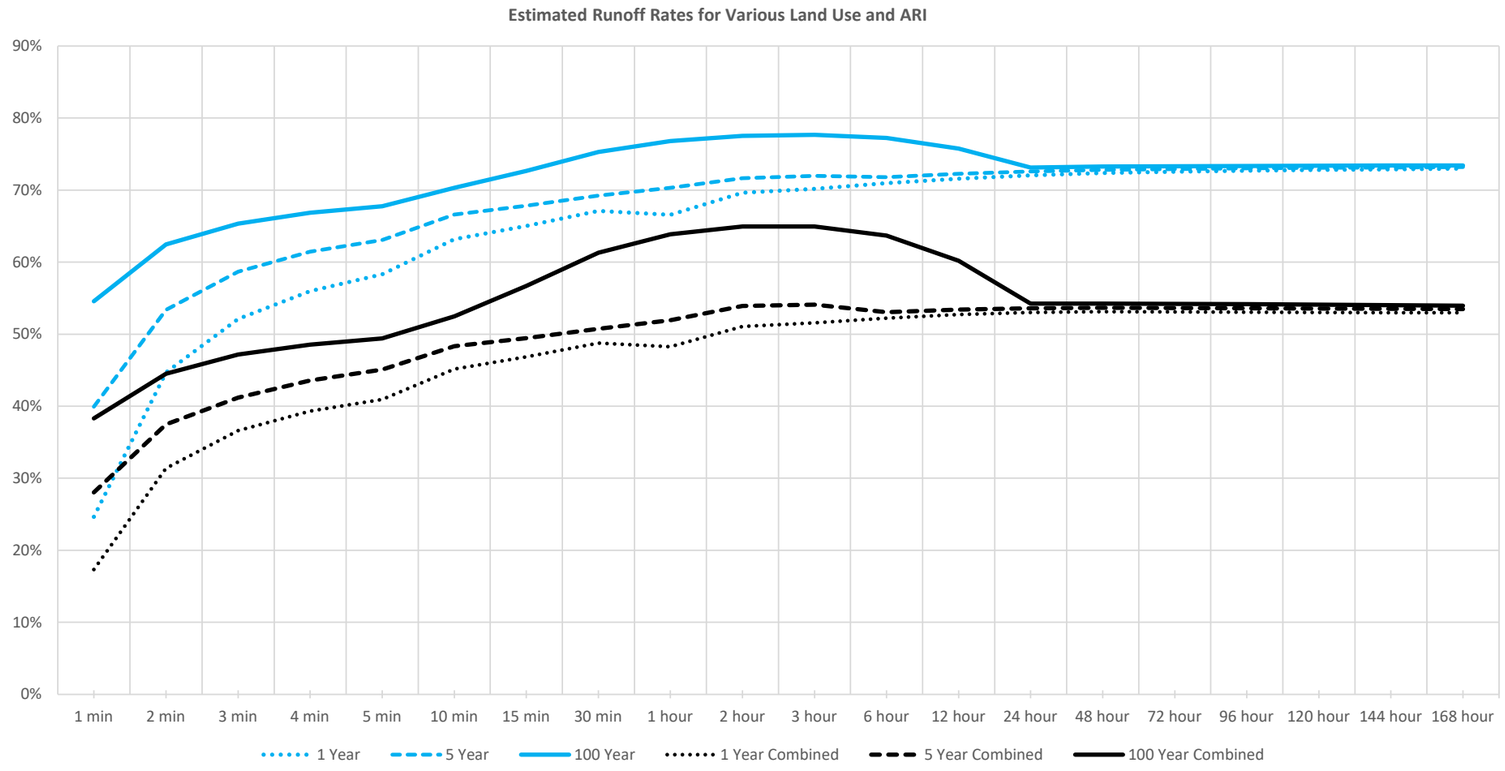
	Land Use Description	Area (ha)	Use in Calc	Imperv Initial Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	Empty (days)	AR&R EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	Comment
1	R12.5 : Residential	3.68	Yes	1.5	24.0	4.9	0.0	1.00	85%	47	13	40	Rainwater tanks assumed non compulsary
2	R25 : Residential	5.36	Yes	1.5	24.0	4.9	0.0	1.00	85%	65	22	13	Rainwater tanks assumed non compulsary
3	R30 : Residential	1.65	Yes	1.5	24.0	4.9	0.0	1.00	85%	65	22	13	Rainwater tanks assumed non compulsary
4	R60 : Residential	2.13	Yes	1.5	24.0	4.9	0.0	1.00	85%	65	22	13	Rainwater tanks assumed non compulsary
5	Roads & Road Reserve	3.79	Yes	1.5	24.0	4.9	0.0	1.00	100%	0	70	30	
6	POS/Landscape	3.00	Yes	1.5	24.0	4.9	0.0	1.00	30%	0	5	95	assume similar EIA/TIA to rural residential
7	Rural (External)	1.28	Yes	1.5	24.0	4.9	0.0	1.00	30%	0	5	95	
8	Roads & Road Reserve (External)	2.95	Yes	1.5	24.0	4.9	0.0	1.00	100%	0	70	30	
9	POS/Landscape (External)	0.39	Yes	1.5	24.0	4.9	0.0	1.00	30%	0	5	95	
10	R12.5 : Residential (External)	1.62	Yes	1.5	24.0	4.9	6.2	1.00	85%	47	13	40	5000 L on site rain tank assumed (slow release)

EIA : Effective Impervious Area, TIA : Total Impervious Area

Land Use Graph Selector **2**

(11 - combined total)

R25 : Residential



Project **Lot 1012 Bussell Hwy Cowaramup LWMS**

Rainfall IFD Data

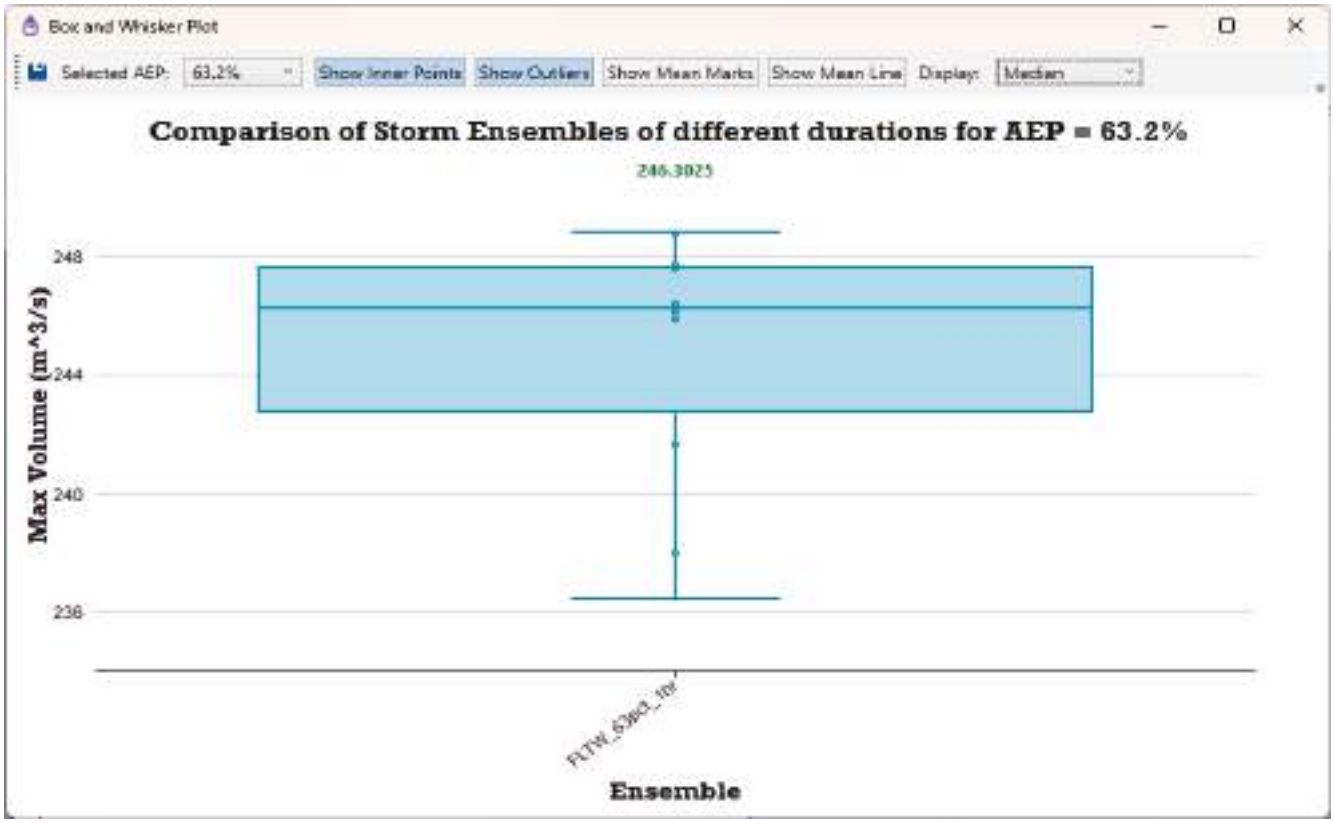
	Duration	Annual Exceedence Probability 63.2%	50%	20%	10%	5%	2%	1%
		1.00	1.44	4.48	10	20	50	100
1	1 min	2.3	2.5	3.3	3.8	4.4	5.1	5.7
2	2 min	3.8	4.2	5.4	6.3	7.3	8.6	9.6
3	3 min	5.1	5.6	7.3	8.5	9.8	11.5	12.9
4	4 min	6.2	6.8	8.9	10.4	11.9	13.9	15.6
5	5 min	7.1	7.8	10.2	12.0	13.7	16.1	17.9
6	10 min	10.3	11.5	15.1	17.6	20.1	23.5	26.2
7	15 min	12.4	13.7	18.1	21.1	24.2	28.3	31.6
8	30 min	16.2	17.9	23.5	27.4	31.5	37.1	41.5
9	1 hour	15.0	22.5	29.3	34.3	39.4	46.6	52.4
10	2 hour	25.7	28.1	36.3	42.4	48.7	57.6	64.8
11	3 hour	29.4	32.1	41.3	48.1	55.1	65.1	73.3
12	6 hour	37.1	40.6	51.8	60.0	68.4	80.5	90.3
13	12 hour	46.7	51.0	65.0	74.9	84.8	99.3	111.0
14	24 hour	57.7	63.1	80.3	92.1	104.0	121.0	135.0
15	48 hour	70.2	76.7	97.0	111.0	124.0	144.0	161.0
16	72 hour	79.1	86.1	108.0	123.0	137.0	159.0	175.0
17	96 hour	87.1	94.6	118.0	133.0	148.0	169.0	186.0
18	120 hour	95.1	103.0	127.0	143.0	158.0	178.0	194.0
19	144 hour	103.0	112.0	137.0	152.0	167.0	187.0	201.0
20	168 hour	112.0	121.0	147.0	162.0	176.0	194.0	207.0

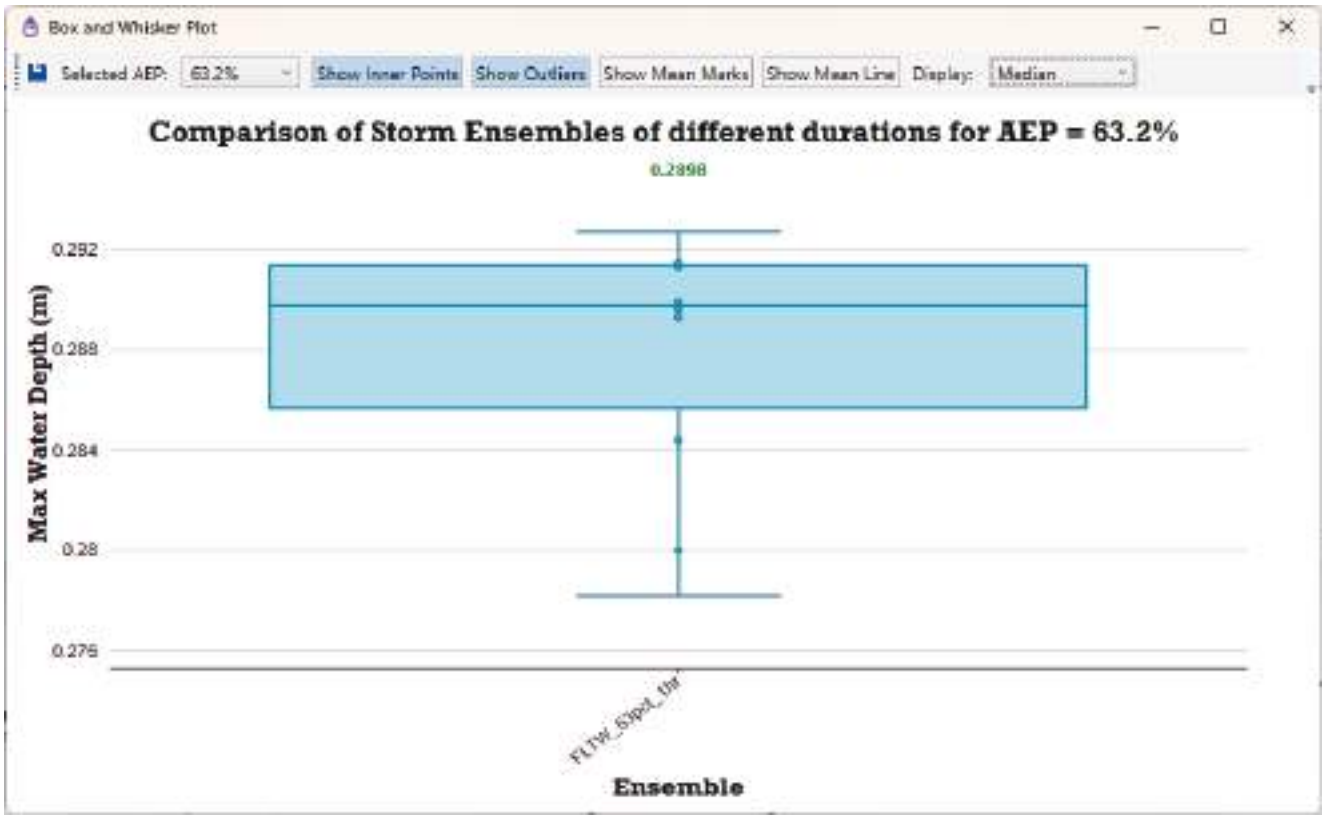
Estimated Runoff Rates

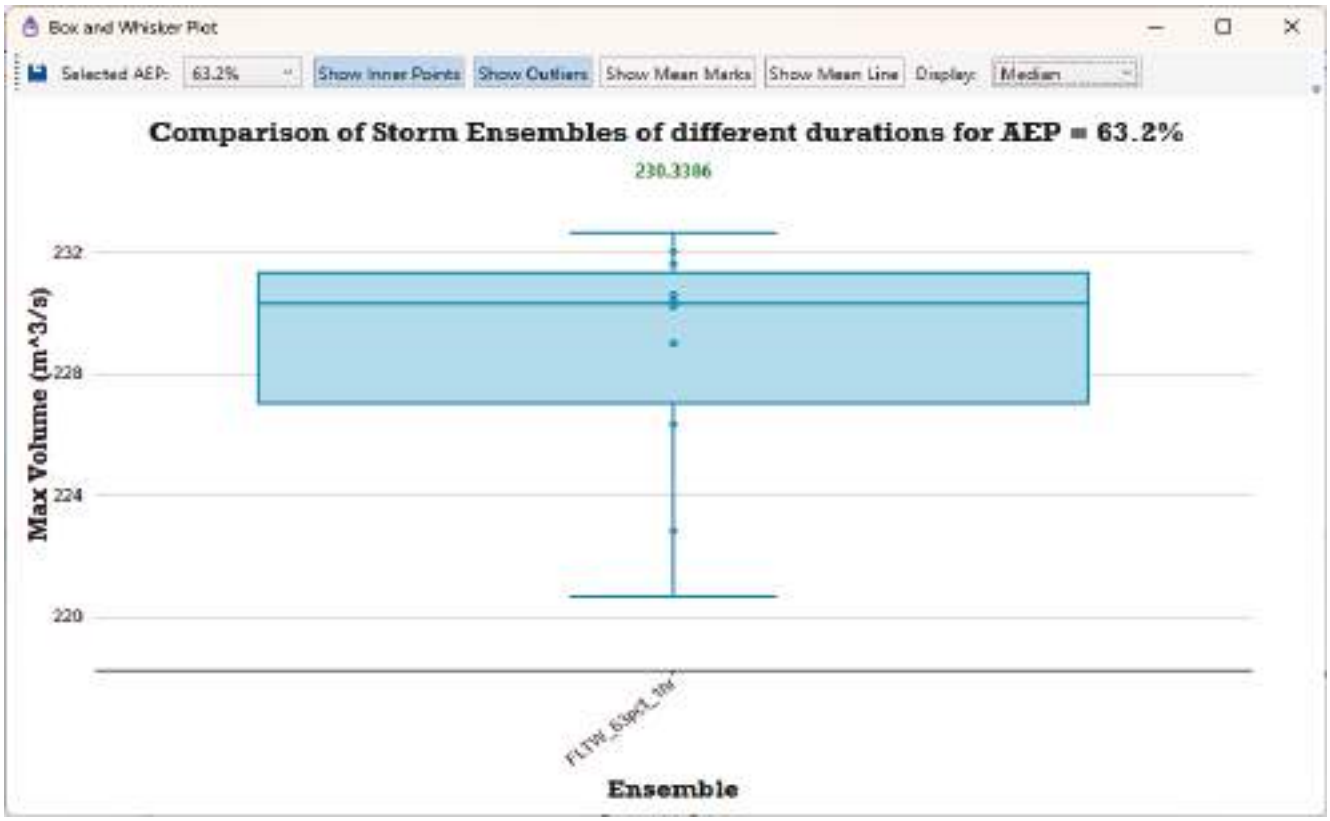
	Annual Exceedence Probability 63.2%	50%	20%	10%	5%	2%	1%
Maximum of All Events	1.00	1.44	4.48	10	20	50	100
R12.5 : Residential	50%	50%	51%	56%	60%	64%	66%
R25 : Residential	73%	73%	73%	74%	75%	77%	78%
R30 : Residential	73%	73%	73%	74%	75%	77%	78%
R60 : Residential	73%	73%	73%	74%	75%	77%	78%
Roads & Road Reserve	69%	69%	69%	74%	77%	81%	83%
POS/Landscape	1%	1%	3%	7%	10%	13%	15%
Rural (External)	1%	1%	3%	7%	10%	13%	15%
Roads & Road Reserve (External)	69%	69%	69%	74%	77%	81%	83%
POS/Landscape (External)	1%	1%	3%	7%	10%	13%	15%
R12.5 : Residential (External)	39%	40%	43%	49%	53%	58%	61%
combined total	**53%**	53%	**54%**	**58%**	60%	63%	**65%**

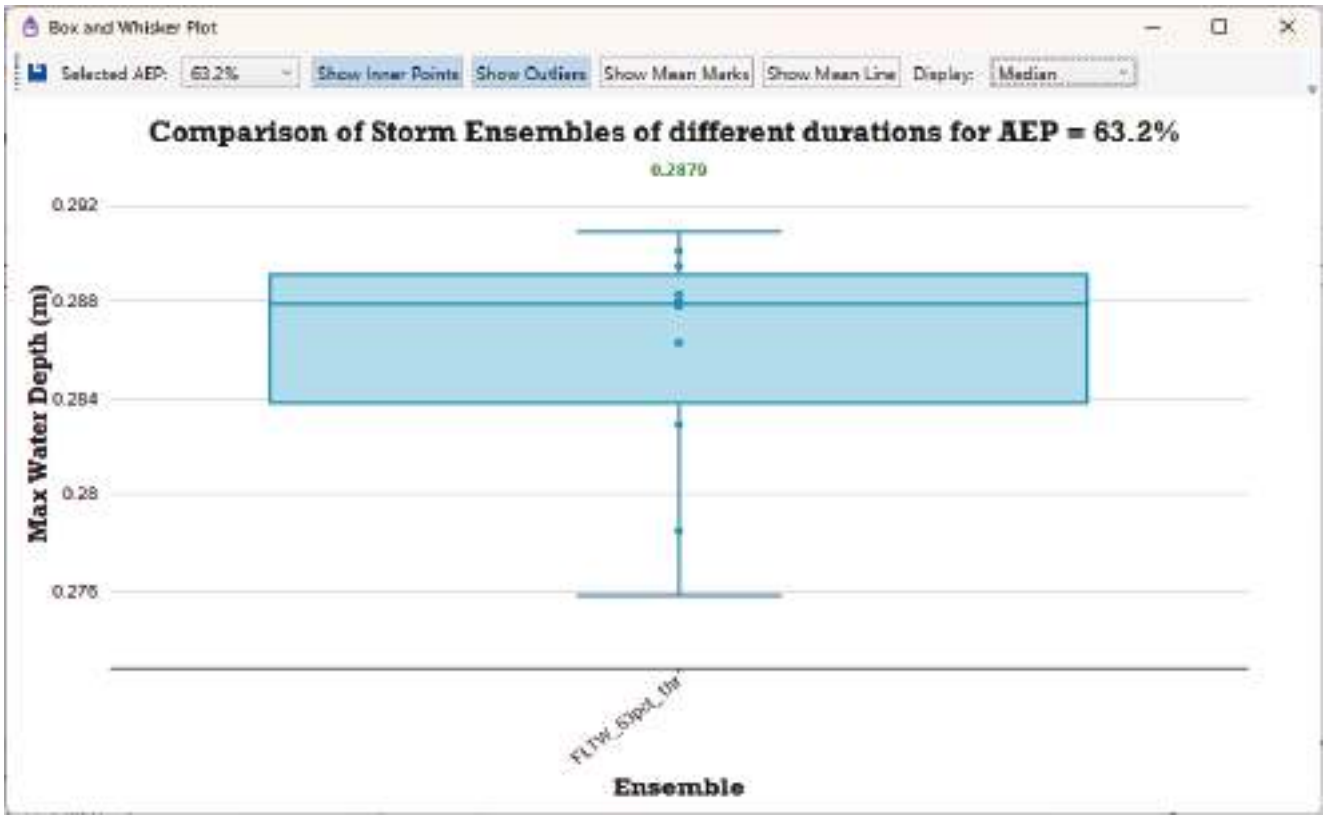
Event Selector	**9**	**1 hour**					
R12.5 : Residential	46%	48%	49%	54%	58%	62%	65%
R25 : Residential	67%	69%	70%	72%	74%	76%	77%
R30 : Residential	67%	69%	70%	72%	74%	76%	77%
R60 : Residential	67%	69%	70%	72%	74%	76%	77%
Roads & Road Reserve	63%	65%	67%	72%	75%	79%	81%
POS/Landscape	1%	1%	2%	6%	9%	12%	14%
Rural (External)	1%	1%	2%	6%	9%	12%	14%
Roads & Road Reserve (External)	63%	65%	67%	72%	75%	79%	81%
POS/Landscape (External)	1%	1%	2%	6%	9%	12%	14%
R12.5 : Residential (External)	24%	33%	38%	45%	50%	55%	59%
combined total	**48%**	51%	**52%**	**56%**	59%	62%	**64%**

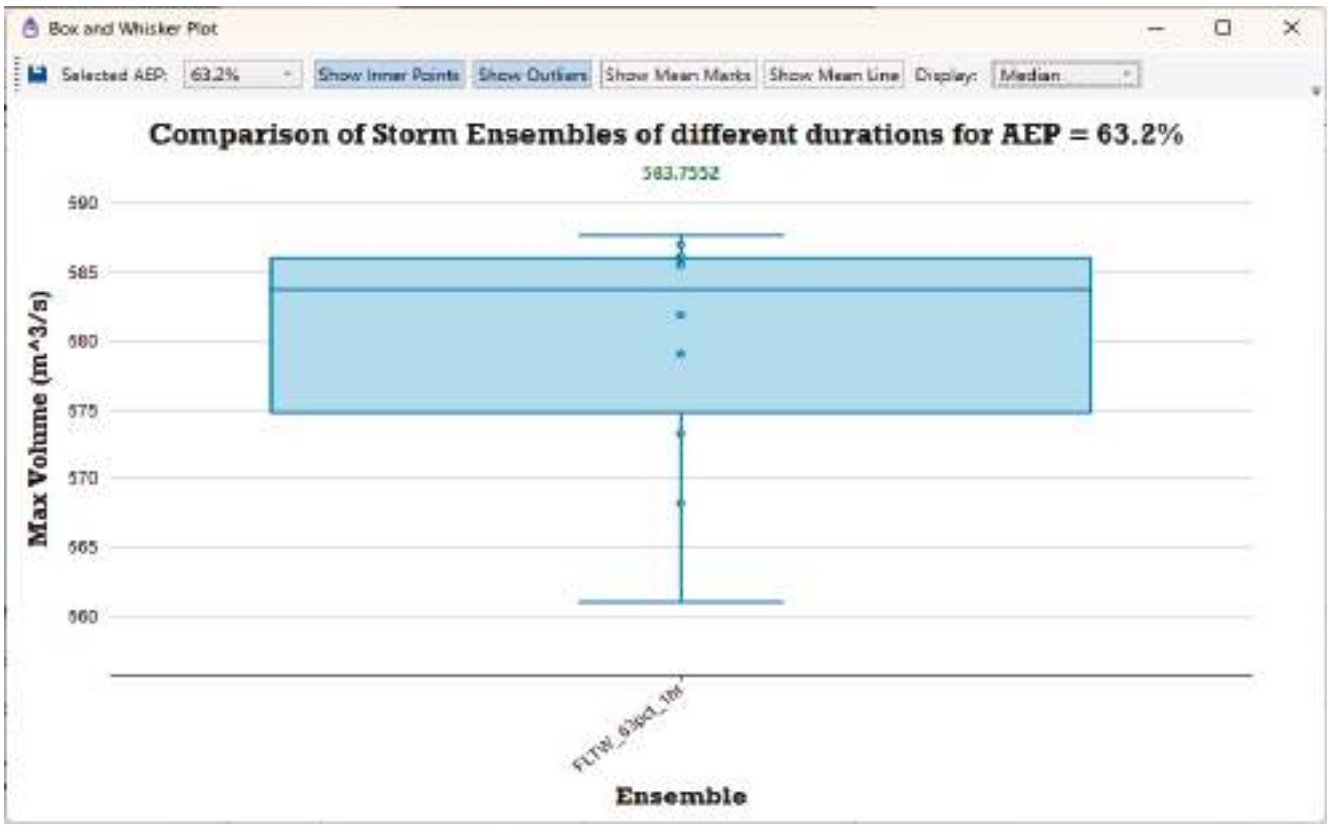
APPENDIX L
XP-Storm Modelling Results

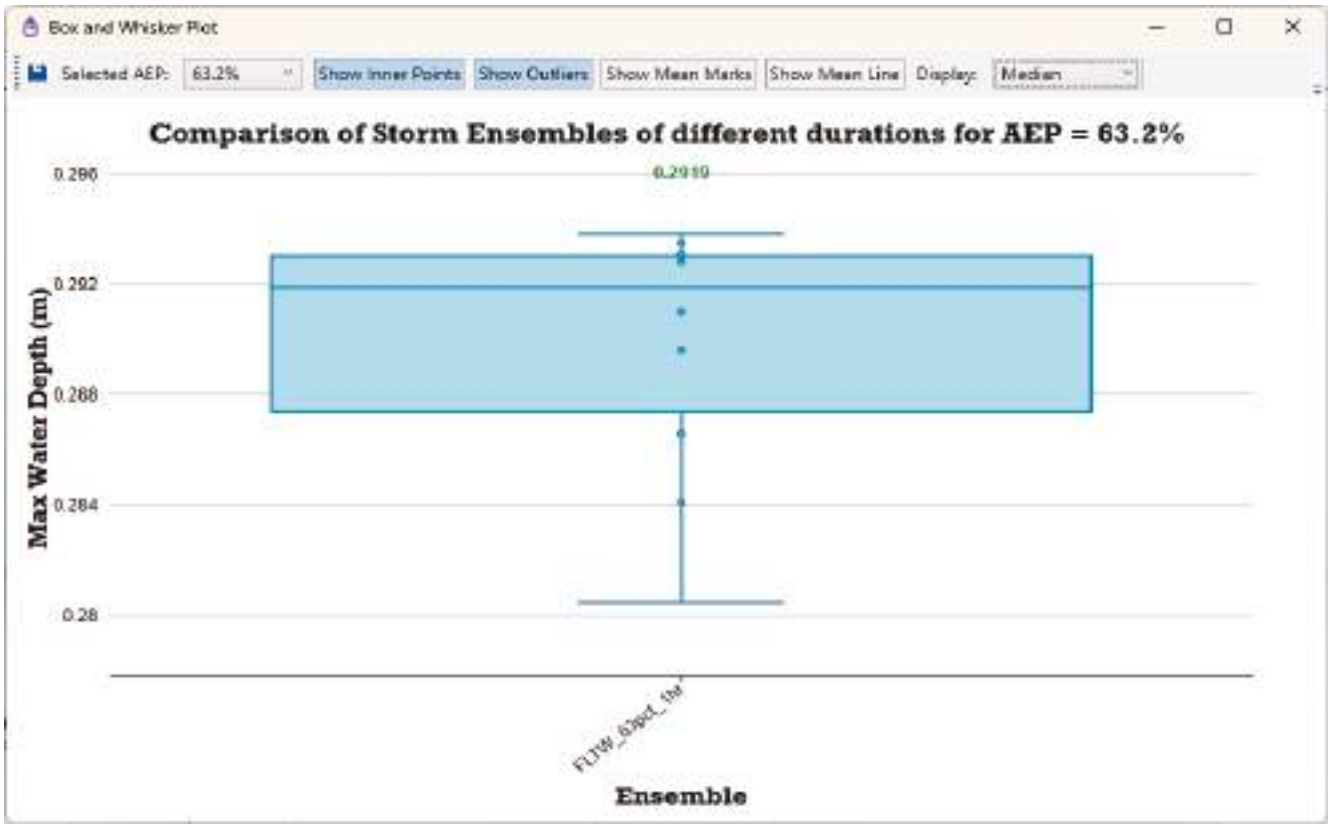

Box and Whisker Plot
Selected AEP: 63.2%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 63.2%
246.3025
248
244
240
236
Max Volume (m^3/s)
FLTW_63pct_1hr
Ensemble

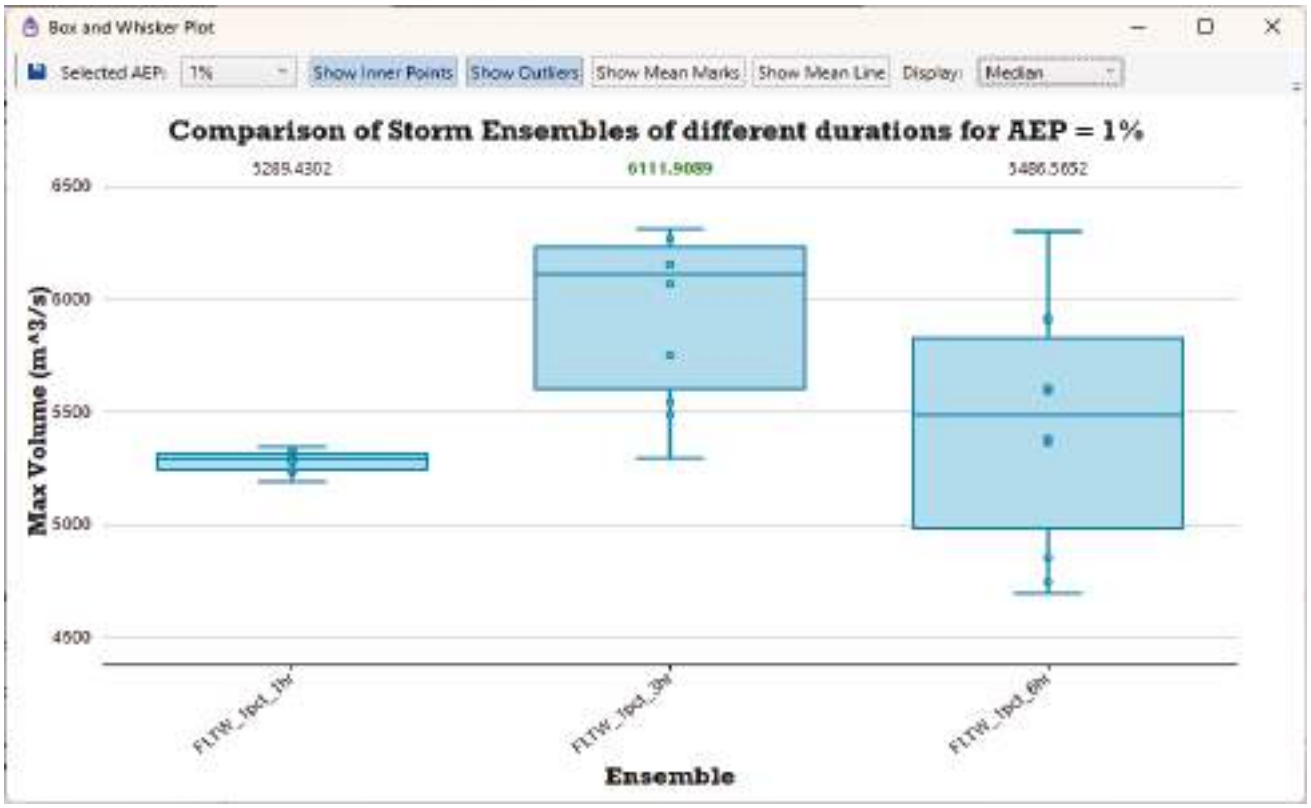

Box and Whisker Plot
Selected AEP: 63.2%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 63.2%
0.2898
0.292
0.288
0.284
0.28
0.276
Max Water Depth (m)
FLTW_63pct_1hr
Ensemble

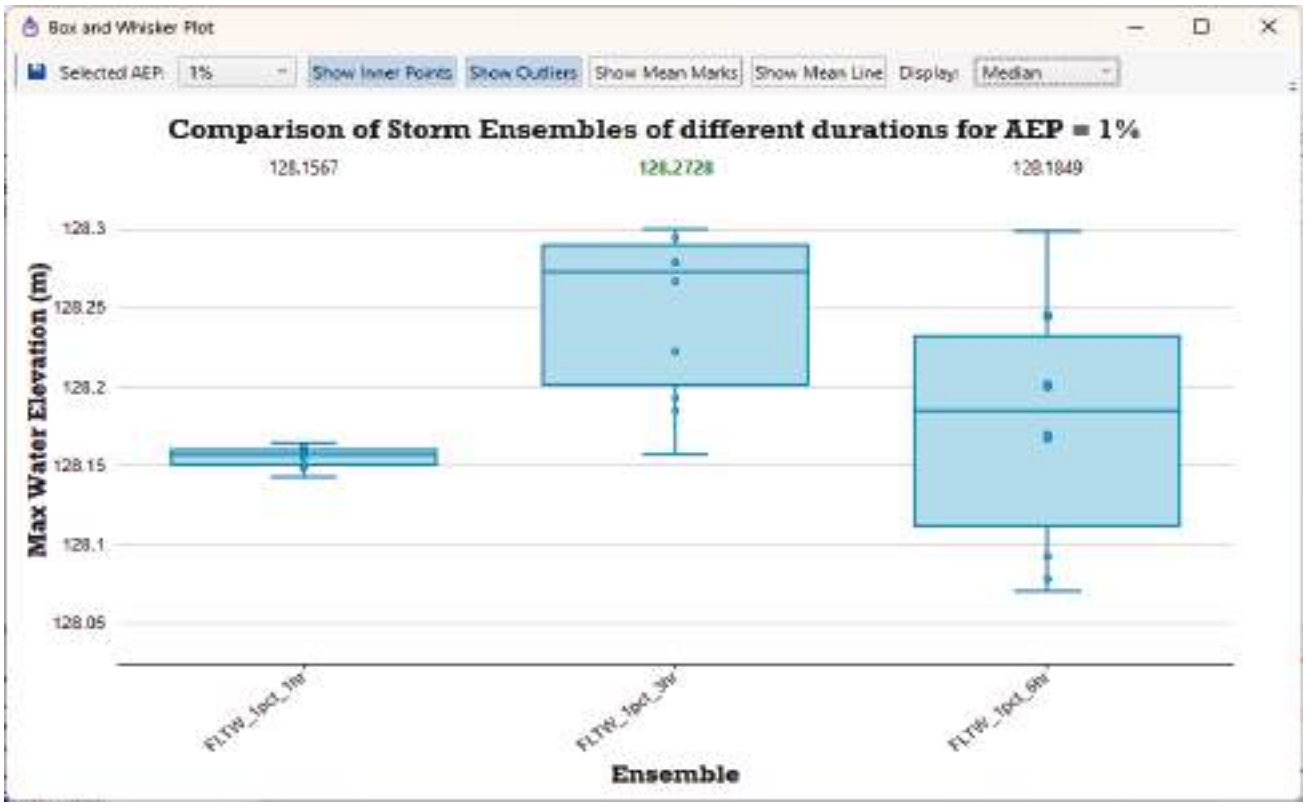

Box and Whisker Plot
Selected AEP: 63.2%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 63.2%
230.3386
232
228
224
220
Max Volume (m^3/s)
FLTW_6Spct_1hr
Ensemble

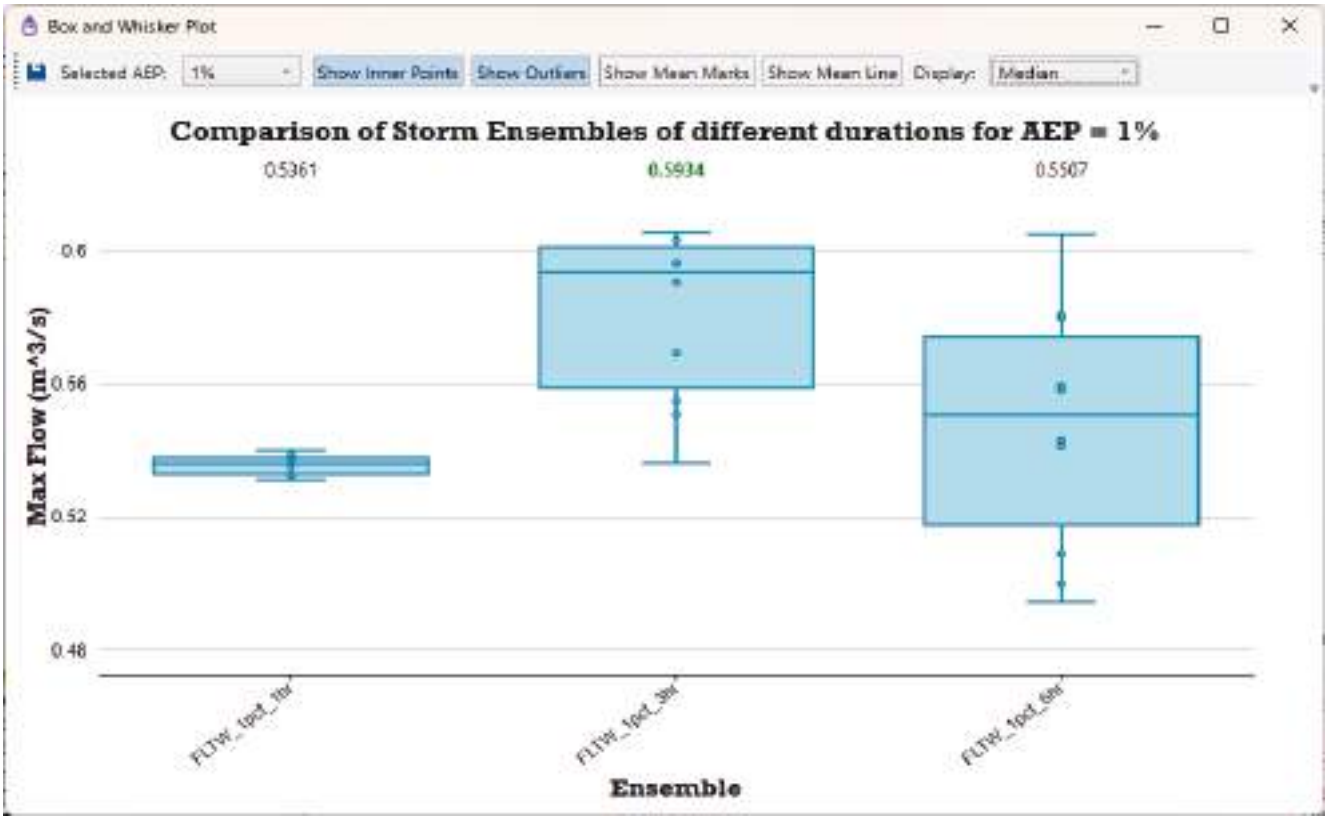

Box and Whisker Plot
Selected AEP: 63.2%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 63.2%
0.2870
0.292
0.288
0.284
0.28
0.276
Max Water Depth (m)
FLTW_6Spct_1hr
Ensemble

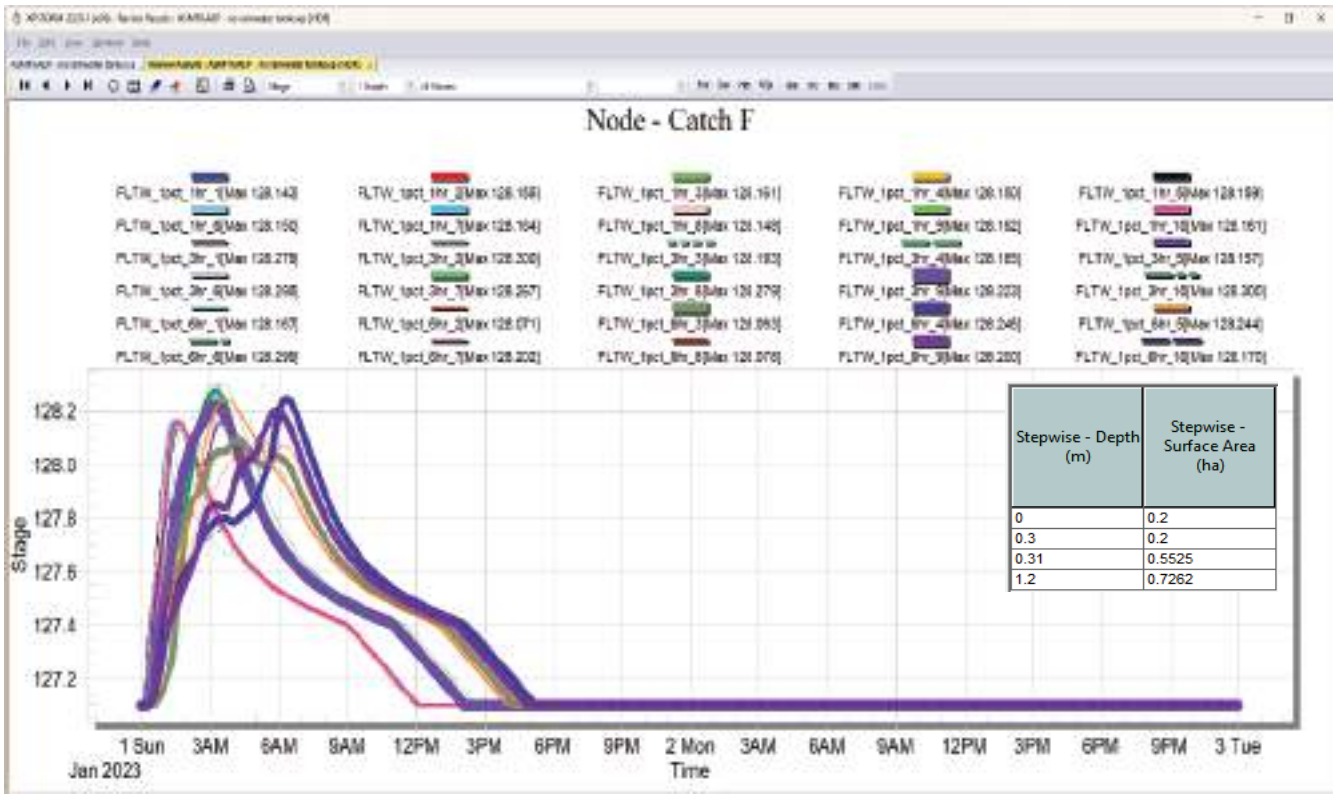

Box and Whisker Plot
Selected AEP:
63.2%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display:
Median
Comparison of Storm Ensembles of different durations for AEP = 63.2%
583.7552
590
585
580
575
570
565
560
Max Volume (m^3/s)
FLTW_63pct_1hr
Ensemble


Box and Whisker Plot
Selected AEP:
63.2%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display:
Median
Comparison of Storm Ensembles of different durations for AEP = 63.2%
0.2919
0.296
0.292
0.288
0.284
0.28
Max Water Depth (m)
FLTW_63pct_1hr
Ensemble


Box and Whisker Plot
Selected AEP: 1%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 1%
5289.4302
6111.9089
5486.5652
6500
6000
5500
5000
4500
Max Volume (m^3/s)
FLTW_1pct_1hr
FLTW_1pct_3hr
FLTW_1pct_6hr
Ensemble


Box and Whisker Plot
Selected AEP: 1%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 1%
128.1567
128.2728
128.1849
128.3
128.25
128.2
128.15
128.1
128.05
Max Water Elevation (m)
FLTW_1pct_1hr
FLTW_1pct_3hr
FLTW_1pct_6hr
Ensemble


Box and Whisker Plot
Selected AEP: 1%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 1%
0.5361
0.5934
0.5507
Max Flow (m^3/s)
0.6
0.56
0.52
0.48
FLTW_1pct_1hr
FLTW_1pct_3hr
FLTW_1pct_6hr
Ensemble


Node - Catch F
Stage
128.2
128.0
127.8
127.6
127.4
127.2
1 Sun
3AM
6AM
9AM
12PM
3PM
6PM
9PM
2 Mon
3AM
6AM
9AM
12PM
3PM
6PM
9PM
3 Tue
Jan 2023
Time
Stepwise - Depth (m)
Stepwise - Surface Area (ha)
0
0.2
0.3
0.2
0.31
0.5525
1.2
0.7262

APPENDIX M

UNDO Modelling – Proposed Land Use

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

Project:	Lot 102 Bussell Hwy, Cowaramup LWMS PostDev	Date:	20/10/2023
		Version:	Version 1.2.0.19289

Subregion name: **Catchment B**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	51	1.10	104.17	27.75
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	17	0.37	14.51	0.44
Road reserve	32	0.69	0.00	0.00

Total area (ha)	Total percent (%)
2.16	11

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
129.96	28.52

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
8.34	1.34

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	0	0.00	0.00	0.00
400-500 m²	12	0.13	8.66	2.21
501-600 m²	88	0.97	95.51	25.54
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
1.09956	51

Nitrogen input (kg)	Phosphorus input (kg)
104.17	27.75

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	45	0.16
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	15	0.05
Sport	0	0.00
Recreation	40	0.15
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
0.37	17

Nitrogen input (kg)	Phosphorus input (kg)
14.51	0.44

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	0.69
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
0.68992	32

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**No**
Soil type	**Treeton Hills**	**Does subregion contain onsite sewage diposal system?**	**No**
Depth to groundwater (m)	**1**		
Groundwater slope (%)	**1**		
Soil PRI	**27.0**		

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Catchment C**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	47	0.74	48.59	12.42
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	24	0.38	17.69	0.55
Road reserve	29	0.45	0.00	0.00

Total area (ha)	Total percent (%)
1.57	8

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
74.48	13.20

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
4.79	0.62

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	0	0.00	0.00	0.00
400-500 m²	99	0.73	47.87	12.23
501-600 m²	1	0.01	0.73	0.19
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
0.73696	47

Nitrogen input (kg)	Phosphorus input (kg)
48.59	12.42

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	50	0.19
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	50	0.19
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
0.38	24

Nitrogen input (kg)	Phosphorus input (kg)
17.69	0.55

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	0.45
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
0.45472	29

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**No**
Soil type	**Treeton Hills**	**Does subregion contain onsite sewage diposal system?**	**No**
Depth to groundwater (m)	**1**		
Groundwater slope (%)	**1**		
Soil PRI	**27.0**		

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Catchment D**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	66	2.33	200.87	52.09
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	6	0.21	9.95	0.31
Road reserve	28	0.99	0.00	0.00

Total area (ha)	Total percent (%)
3.53	18

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
229.27	52.93

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
14.66	2.48

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	0	0.00	0.00	0.00
400-500 m²	17	0.40	25.97	6.63
501-600 m²	55	1.28	126.41	33.81
601-730 m²	0	0.00	0.00	0.00
>730 m²	28	0.65	48.49	11.65
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
2.32848	66

Nitrogen input (kg)	Phosphorus input (kg)
200.87	52.09

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	50	0.11
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	50	0.11
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
0.21	6

Nitrogen input (kg)	Phosphorus input (kg)
9.95	0.31

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	0.99
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
0.98784	28

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**No**
Soil type	**Treeton Hills**	**Does subregion contain onsite sewage diposal system?**	**No**
Depth to groundwater (m)	**1**		
Groundwater slope (%)	**1**		
Soil PRI	**27.0**		

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Catchment E**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	46	1.08	87.84	21.92
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	40	0.94	22.11	0.68
Road reserve	14	0.33	0.00	0.00

Total area (ha)	Total percent (%)
2.35	12

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
122.25	22.95

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
7.84	1.08

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	0	0.00	0.00	0.00
400-500 m²	0	0.00	0.00	0.00
501-600 m²	28	0.30	29.90	8.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	72	0.78	57.94	13.92
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
1.08192	46

Nitrogen input (kg)	Phosphorus input (kg)
87.84	21.92

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	25	0.24
Non-native gardens	0	0.00
Not fertilised	50	0.47
Nature	0	0.00
Sport	0	0.00
Recreation	25	0.24
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
0.94	40

Nitrogen input (kg)	Phosphorus input (kg)
22.11	0.68

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	0.33
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
0.32928	14

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**No**
Soil type	**Treeton Hills**	**Does subregion contain onsite sewage diposal system?**	**No**
Depth to groundwater (m)	**1**		
Groundwater slope (%)	**1**		
Soil PRI	**27.0**		

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Catchment F**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	70	5.35	451.35	114.32
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	12	0.92	38.07	1.16
Road reserve	18	1.38	0.00	0.00

Total area (ha)	Total percent (%)
7.64	39

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
529.40	116.62

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
33.57	5.47

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	0	0.00	0.00	0.00
400-500 m²	0	0.00	0.00	0.00
501-600 m²	41	2.19	216.55	57.91
601-730 m²	0	0.00	0.00	0.00
>730 m²	59	3.16	234.80	56.41
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
5.3508	70

Nitrogen input (kg)	Phosphorus input (kg)
451.35	114.32

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	40	0.37
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	15	0.14
Sport	0	0.00
Recreation	45	0.41
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
0.92	12

Nitrogen input (kg)	Phosphorus input (kg)
38.07	1.16

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	1.38
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
1.37592	18

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**No**
Soil type	**Treeton Hills**	**Does subregion contain onsite sewage diposal system?**	**No**
Depth to groundwater (m)	**1**		
Groundwater slope (%)	**1**		
Soil PRI	**27.0**		

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Catchment G**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	94	2.21	46.41	14.11
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	6	0.14	0.56	0.00
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
2.35	12

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
59.28	14.46

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
3.88	0.70

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	0	0.00	0.00	0.00
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	100	2.21	46.41	14.11

Total area (ha)	Total percent (%)
2.21088	94

Nitrogen input (kg)	Phosphorus input (kg)
46.41	14.11

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	100	0.14
Sport	0	0.00
Recreation	0	0.00
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
0.14	6

Nitrogen input (kg)	Phosphorus input (kg)
0.56	0.00

Soil and drainage information

Type of drainage: **Piped drainage**

Soil type: **Treeton Hills**

Depth to groundwater (m): **1**

Groundwater slope (%): **1**

Soil PRI: **27.0**

Does it contain imported fill? **No**

Does subregion contain onsite sewage diposal system? **No**

Note: Please attach the results of soil tests to this report when submitting.

Summary: Nutrient stripping devices

Treatment	Name	Size (m^2)	Treated area (ha)	Treating	N removed (kg/yr)	P removed (kg/yr)
Biofilter	Catchment B/G Biofilter	800.00	4.51	Sandy soils – Runoff only (full lot connection)	5.66	0.84
Biofilter	Catchment D/E Biofilter	850.00	5.88	Sandy soils – Runoff only (full lot connection)	10.35	1.44
Biofilter	Catchment C/F & External A Biofilter	2000.00	9.21	Sandy soils – Runoff only (full lot connection)	17.94	2.57
Detention / infiltration basin	Detention / infiltration basin 1	7200.00	19.60	Sandy soils – Runoff only (full lot connection)	2.65	0.29

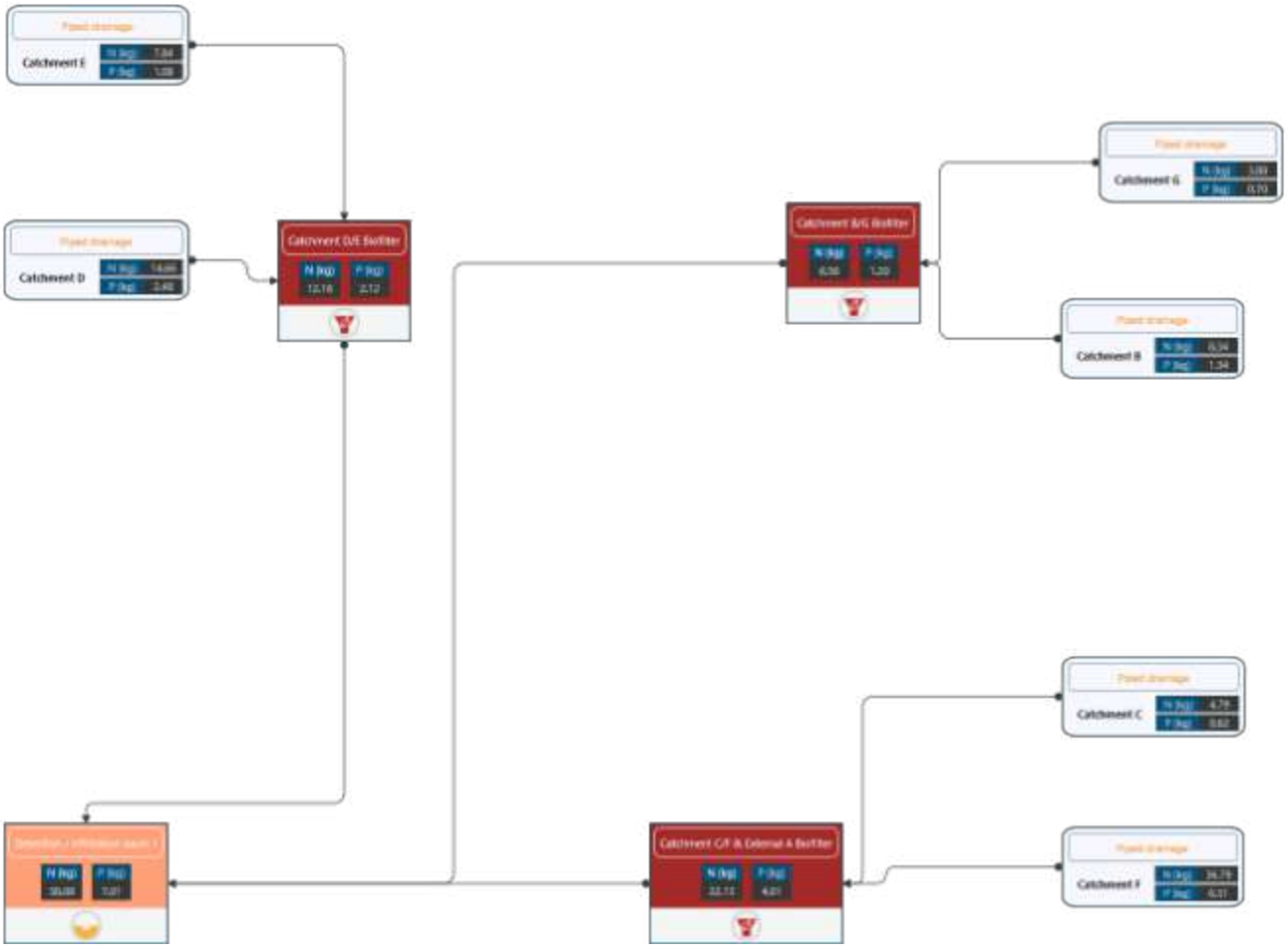
Load removed	**36.61**	**5.14**
Net export	**36.49**	**6.55**

Summary: Nutrient load exports

Region	Area (ha)	P export (kg/yr)	N export (kg/yr)
Catchment B	2.16	1.34	8.34
Catchment C	1.57	0.62	4.79
Catchment D	3.53	2.48	14.66
Catchment E	2.35	1.08	7.84
Catchment F	7.64	5.47	33.57
Catchment G	2.35	0.70	3.88

PRE-TREATMENT LOAD (kg/yr)		LOAD REMOVED (kg/yr)		NET LOAD EXPORT (kg/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
73.09	**11.69**	**36.61**	**5.14**	**36.49**	**6.55**

Treatment diagram



APPENDIX N

Engineering Servicing Report Extracts
(JDSi, 2023)

3 Introduction

Goldfields Group (the Client) have requested JDSi to assess the Engineering constraints and opportunities associated with the development of Lot 102 Bussell Highway, Cowaramup to form part of the Clients due diligence for the development of the Site, refer Figure 1 below.

This report has been based on the subdivisional concept layout, as included in ***Appendix A*****.** Based on this layout and information provided by the Client, the Development will consist of 243 mixed density (R12.5 to R60) residential lots. which consists of the following yields:

- 183 dwellings (R12.5 to R30)
- 60 dwellings (R60) (as per advice from Client, September 2023).

This report covers the engineering infrastructure requirements to service the proposed Development.

JDSi have considered roads, stormwater drainage, wastewater, potable water, power, gas and communication services, with a particular emphasis on the existing service capacity, potential connection locations and the potential infrastructure upgrades required to support the proposed development.

The report has been based on a desktop study of existing services information, a site visit in September 2023, aerial imagery, preliminary advice from various service authorities, industry standards/policies and JDSi's experience. The information is current as of September 2023 and may be subject to change as development progresses in the area.



Figure 1: Site Location

4 Study Area

The Site is bounded by Memorial Drive to the north, Bussell Highway to the east, Sunset Drive to the west and Lot 555 Bussell Hwy to the south.

The Site consists of:

- vacant land formerly used for agricultural (grazing) purposes
- remnant vegetation over the north / north-western portion of the Site,

The Site is within the municipality of the Shire of Augusta Margaret River.

Lot 102 has a land area of 19.64 ha and is currently zoned “Future Development” under the Shire of Augusta / Margaret River TPS.

4.1 Topography

The Site is a largely rectangular shaped parcel of land with surface elevations ranging from approximately 132m AHD in the northeast of the site to 126m AHD in the southwest of the site (Refer *Figure 2*). Surrounding land is higher to the east of Bussell Hwy, up to approximately 140mAHD, generally sloping to the southwest through Lot 102, with adjoining land to the west lower, at approximately 125m AHD.

A feature survey of the site has been undertaken and provided by MNG on 06/07/2023.

A below ground services survey was also undertaken and provided by MNG on 14/07/2023.

A copy of both the feature and existing services surveys are provided in ***Appendix B.***



Figure 2: Site Topography (Water Corporation ESInet Data 2023)

4.2 Geological Setting

Douglas Partners geotechnical report, 2008 states that the Site is located within "the Cowaramup Mentelle 1:50,000 Regolith Landform sheet, which indicates that shallow subsurface conditions beneath the site comprise silty gravelly sand over mottled sandy clay of colluvial origin, in turn underlain by granitic bedrock of the Leeuwin Complex. Residual duricrust may occur."

The geotechnical investigation undertaken by Douglas Partners revealed soil profiles that followed this general description. Sand of variable depth overlies gravelly clayey sand / clayey sand. Duricrust ("ironstone") was encountered in several mid- to upper-slope locations at depths between 0.5m and 3.3m. The ironstone is underlain by variable thickness sandy clay. Granite rock was encountered (refusal) in a cluster of three test pits in the lowest (SW) corner of the site. Depth to granite varied between 3.1 to 3.7m BGL.

4.3 Groundwater

Government groundwater databases are absent for the area.

The Douglas Partners geotechnical investigation was undertaken in May 2008. Although only at the commencement of winter, seepage of groundwater was observed in half (14 of 28) test pits, generally along the interface(s) between sandy and clayey materials. Groundwater seepage was generally greater than 1.5m deep.

It is not expected that groundwater will significantly impact the proposed development. Groundwater levels will need to be further investigated and it is recommended that specialist consultants to be engaged to confirm maximum groundwater levels for the Site and this is considered as part of the drainage, earthworks and design for the development.

Subsoil drainage will be incorporated to assist and control the groundwater levels throughout the site.

4.4 Acid Sulphate Soils

The Douglas Partners geotechnical report indicates that the southern portion of the site has "moderate to low risk of ASS occurring within 3m of the natural soil surface", with the northern portion having "low to no known risk of acid sulphate soils occurring within 3m of the natural soil surface".

5 Stormwater Drainage

Stormwater drainage management for the development will need to be designed and constructed in accordance with Shire of Augusta Margaret River design guidelines and DWER Water Sensitive Urban Design (WSUD guidelines.

Stormwater management for the development will require:

- Demonstration that post-development flow rates do not exceed pre-development flow rates
- Standard pit and pipe drainage systems within the road reserves to convey up to the 20% AEP (1 in 5 yr ARI)
- Clear overland flow path for events greater than the 20% AEP, with a minimum 300mm freeboard to habitable floors
- Detention storage area (basin) in the lowest, southwest portion of the site to reduce peak flow rates to the capacity of downstream facilities
- Subsoil drainage system to be considered in any areas where Average Annual Maximum Groundwater Levels (AAMGL) are within 900mmm of road surface and/or 1200mm of lot pad levels
- Surface and groundwater quality will need to achieve pre-development levels

It is recommended a suitably qualified hydrologist is engaged to assist with the study and preparation of the Urban Water Management Plan.

6 Sewer Reticulation

Water Corporation operates a gravity sewerage network in the area surrounding the Site, with the locations of their existing infrastructure depicted in *Figure 3*. Any connection into this system will need to be designed, approved and constructed in accordance with standard Water Corporation requirements. Any internal plumbing works on the Site will need to meet the requirements of AS3500 'Plumbing and drainage' as documented by the Building Services consultant.

The existing gravity sewerage network is located to the east and southwest of the Site, with an existing Ø225 sewer main passing through the Site. The Ø225 continues to the southwest of the site, to the Type 40 "Smokebush Court" WWPS. The WWPS discharges via a Ø150 pressure main that runs along the western side of Sunset Dr, along Memorial Drive where it joins the Ø150 "Brockman Ed" pressure main, then northward to the Bussell Hwy Cowaramup Type 40 WWPS.

The Bussell Hwy Cowaramup WWPS then discharges via a Ø150 to Ø200 pressure main that travels south along Bussell Hwy through to the Margaret River WWTP. This pressure main passes the eastern boundary of the Site on the western verge of Bussell Hwy, then runs westward along the southern boundary of the Site, before heading south through the adjoining property.

A redundant "disused" pressure main traverses the site. Details of the pressure main are unknown, however it is expected that this main can be removed from the site, or left insitu if deep enough not to cause issue to future residents.

There are six existing connection locations to the existing Ø225 sewer where Ø150 sewer stub lines have previously been installed. These are indicated in *Figure 3* along with their approximate depths as calculated from as-constructed data on Water Corporation's Esinet system.

It must be noted that the subdivision layout shown on the Water Corporation Planning Scheme has been superseded, with the currently proposed subdivisional layout and existing sewer network shown in ***Appendix A.*** The reduced road reserve alignment with the existing sewer triggers additional works to either cut and cap or remove the existing sewer pipes and to remove all access chambers.

Based on preliminary review, the Site is able to be serviced at its current ground level by the revised sewer shown along the proposed internal road network, tying in to the existing Ø225 sewer in the southwest of the site.



Figure 3: Preliminary Sewer Layout (Esinet)

Water Corporation planning for this area (Catchment 0311, Cowaramup SD242) shows the existing Ø225 gravity main extending through the site to the southwest corner. This existing main would service the southern portion of the Site. A Ø150 main is shown to extend from the existing Ø225 in the southwest of the Site, along the unmade road reserve and Sunset Dr then into the Site, to service the northern portion. Refer *Figure 4* and ***Appendix C***.

JDSi understand that this existing sewer will not align efficiently with the proposed layout, and therefore will need to be decommissioned.



Figure 4: Water Corporation Wastewater Planning

A summary of key items from the Water Corporation planning scheme is summarised below:

- Original scheme planning for this catchment (0311) allowed for a Sewer Design Flow (SDF) of 3.1 L/s
- Based on the proposed zoning and lot yield, 243 dwellings (lots) will produce a SDF of around 4.7L/s (assumed “wet ground conditions” as per DS50).
- As a result, the SDF into Smokebush Court WWPS will increase from 20.5 L/s to 22.1 L/s.
- The Ø225 sewer outlet from the Site will cope with all the flow (typically up to around 22 L/S).
- The existing pump rate at Smokebush Court WWPS is 19.4L/s forecast to increase to a long-term pump rate of 27.3L/s. The increased SDF will increase the long-term required pump rate
- It is anticipated that the marginal increase in SDF from the development will not trigger any pump station or pressure main upgrades
- The development can proceed as per the proposal with no anticipated upgrades to the wastewater conveyance network.

It is therefore anticipated that no major external sewer upgrade works will be required to service the Site, noting that the Developer will be responsible for the design and installation of any new reticulation mains required to service the Site.

All new wastewater works installed for the Development will need to be designed and constructed in accordance with Water Corporations guidelines, including the Developers Manual and Design and Construction Requirements for Gravity Sewer Ø150 to SN600 (DS50).

7 Water Reticulation

The Water Corporation owns and maintains the potable water reticulation system in the vicinity of the Site. Any connection into this system will need to be designed, approved and constructed in accordance with standard Water Corporation requirements. It would be expected that a standard development condition addressing the above will be included on any WAPC approval.

The Water Corporation service the Cowaramup area via the supply main from Margaret River, which passes the southern boundary of the Site, before extending east along Wirring Road to the Wirring Road Supply Tank (*Figure 5*). This tank currently has a capacity of 1ML. The reticulation system stems from the Wirring Road Tank.



Figure 5: Existing Water Corporation water supply infrastructure (Esinet)

Based on the Water Corporation Esinet data the reticulation network near the site consists of an existing Ø250 P-12 water reticulation main running along Roy Earl Dr to the east of the Site and eastern side of Bussell Hwy. A Ø250 P-12 main runs along Sunset Drive on the western side of the Site. A Ø200 P-12 main is located on the northern side of the site, along Memorial Dr. A short section of Ø58 AC main extends south from Memorial Dr along Bussell Hwy, for approximately 100m. Refer to *Figure 6*



Figure 6: Existing Water Corporation surrounding water infrastructure (Esinet)

Formal planning advice received from Water Corporation is summarised below, with a full copy provided in ***Appendix C*.**

- Water Corporation have not yet undertaken detailed water reticulation planning over this subdivision area
- Water Corporation assumes that the existing Ø250mm reticulation main on Roy Earl Drive will be extended along the main subdivision boulevard to interconnect with the existing Ø250 main on Sunset Drive

- Other reticulation mains within the Site would be either 100mm or 150mm in size
- With respect to the water source capacity (Wirring Rd Tank), Water Corporation has timed construction of a new 4ML storage tank for delivery by around 2032, based on a projection of service connections and overall scheme consumption data
- The existing 1ML supply is at increasing risk of breaching during the summer peak periods (Christmas through to March) if even the Lot 102 Stage 1 (65 No.) lots are released ahead of the tank being upgraded
- Water Corporation are monitoring subdivision development, lot release and build rates in the town and will endeavour to time the tank upgrade project accordingly

To provide a potable water supply to the development, suitably qualified persons will be required to design the proposed water reticulation network and submit to the Water Corporation for approval.

Applicable headworks charges will need to be paid by the Developer and these will be determined by the Water Corporation at the time of application.

All water main extensions required for the development site will be laid within the existing and proposed road reserves, on the correct alignment and in accordance with the Utility Providers Code of Practice and Water Corporations Water Reticulation Pipelines DN250 and Smaller (DS63). These mains can then be used to provide both potable and fire water connections to each lot, noting that flow and pressure checks will need to be done as part of any assessment of fire water supply for commercial or multi-storey residential developments.



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Appendix 5

Bushfire Management Plan

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Bushfire Management Plan Coversheet

This Coversheet and accompanying Bushfire Management Plan has been prepared and issued by a person accredited by Fire Protection Association Australia under the Bushfire Planning and Design (BPAD) Accreditation Scheme.

Bushfire Management Plan and Site Details

Site Address / Plan Reference: Lot 102 Bussell Highway		
Suburb: Cowaramup	**State:** WA	**P/code:** 6284
Local government area: Shire of Augusta Margaret River		
Description of the planning proposal: Structure Plan Amendment		
BMP Plan / Reference Number: 231484	**Version:** Rev D	**Date of Issue:** 27/10/2023
Client / Business Name: Goldfields C/- Gareth Wilson		

Reason for referral to DFES	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?	☑	☐
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the BPC elements)?	☐	☑
Is the proposal any of the following special development types (see SPP 3.7 for definitions)?		
Unavoidable development (in BAL-40 or BAL-FZ)	☐	☑
Strategic planning proposal (including rezoning applications)	☑	☐
Minor development (in BAL-40 or BAL-FZ)	☐	☑
High risk land-use	☐	☑
Vulnerable land-use	☐	☑

If the development is a special development type as listed above, explain why the proposal is considered to be one of the above listed classifications (E.g. considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

Note: The decision maker (e.g. local government or the WAPC) should only refer the proposal to DFES for comment if one (or more) of the above answers are ticked "Yes".

BPAD Accredited Practitioner Details and Declaration

Name	Accreditation Level	Accreditation No.	Accreditation Expiry
Gary McMahon	Level 3	35078	11/2023
Company Ecosystem Solutions		**Contact No.** (08) 9759 1960	

I declare that the information provided within this bushfire management plan is to the best of my knowledge true and correct

Signature of Practitioner  **Date** 27/10/2023

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Bushfire Management Plan

Lot 102 Bussell Highway, Cowaramup

10 October 2023

Prepared for:

Goldfields

Att: Gareth Wilson



Limitations Statement

This report has been prepared in accordance with the Agreement between Ecosystem Solutions Pty Ltd and Goldfields Att: Gareth Wilson ("**Client**"). It has been solely prepared for Bushfire Management Plan to progress a structure plan amendment at Lot 102 Bussell Highway, Cowaramup ("**Site**").

Information

In undertaking this work the authors have made every effort to ensure the accuracy of the information used. Unless otherwise stated in the report, Ecosystem Solutions Pty Ltd has not independently verified such information and cannot guarantee its accuracy or completeness.

Conclusions

Within the limitations imposed by the scope of work, preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable bushfire consultants under similar circumstances. No other warranty, expressed or implied, is made.

Reliance

This report is solely for the use of the Client and any reliance on this report by third parties will be at such party's sole risk. This report must only be presented in full and may not be used to support any other purpose than those set out in the report and the Agreement, except where prior written approval with comments are provided by Ecosystem Solutions Pty Ltd. All intellectual property rights in documents created by Ecosystem Solutions Pty Ltd remain the property of Ecosystem Solutions Pty Ltd.

Other parties should not rely on the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters. Ecosystem Solutions Pty Ltd accepts no Liability, or responsibility whatsoever for or in respect of any use or reliance upon this report and its supporting material subsequently used by others. Please note that the contents of this report may not be directly applicable towards another organisation's needs and may not contain sufficient information for purposes of other parties or for other uses.

Ecosystem Solutions Pty Ltd will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of this report.

Other limitations

The measures contained in this report cannot guarantee that a structure or building will not be damaged or would survive a bushfire event on every occasion. This is due to the degree of vegetation management,

the unpredictable nature of fire behaviour (knowledge in this field continues to develop) and the unpredictable nature of extreme weather conditions.

The growth, planting or removal of vegetation, poor maintenance of any fire prevention/mitigation measures, addition of structures not included in this report, or other activity can and will change the bushfire threat to all properties detailed in this report. The implementation of fire precautions will depend on the actions of the landowner or occupiers of the land, over which Ecosystem Solutions Pty Ltd has no control. Should changes be made to the Site, a new Bushfire Management Plan is required.

Ecosystem Solutions Pty Ltd accepts no Liability, including Liability for any Loss in connection with:

- a Claim, damage, or injury to property, or persons caused by fire;
- further growth, planting, or removal of vegetation on the Site;
- poor maintenance of any fire protection measures;
- additional structures not included in this assessment; or
- any other activity that may change the bushfire threat level.

The Client and owner of the Site each acknowledge that they have been made aware of the exclusions above and that such exclusion of Liability is reasonable in all the circumstances.

This report is valid for a period of two years only from the date of its issue. All BAL ratings identified in this report are indicative and are required to be verified at the time of construction of individual buildings to ensure appropriate setbacks identified in the Site/building have been achieved.

STATEMENT OF CONFORMITY – PLANNING AND DEVELOPMENT ACT 2005





Gary McMahon
B.Sc. M. Env Mgmt. PG Dip Bushfire Protection. C.EnvP, BPAD Level 3 (35078)

The signatory declares that this Bushfire Management Plan meets the requirements of State Planning Policy 3.7 and the Guidelines for Planning in Bushfire Prone Areas V1.4.

DISCLAIMER

**All capitalised terms used in the Limitations Statement above that are not defined are defined in the Agreement between Ecosystem Solutions Pty Ltd and the Client.*

*** The limitations above are subject to any relevant rights or remedies that the Client may be entitled to under legislation, including Schedule 2 of the Competition and Consumer Act 2010 (Cth).*

Document Control

Client - Goldfields

Site – Lot 102 Bussell Highway, Cowaramup

Version	Revision	Purpose	Author	Reviewer	Submitted	
					Form	Date
Report	Rev A	Initial Report	KP (BPAD 38253 – Level 2) / DC (BPAD 48409 – Level 2)	GM (BPAD 35078 – Level 3)	Electronic (email)	15/09/2023
Report	Rev B	Goldfields Comments	DC (BPAD 48409 – Level 2)	GM (BPAD 35078 – Level 3)	Electronic (email)	26/09/2023
Report	Rev C	Method 2 Calculation	DC (BPAD 48409 – Level 2)	GM (BPAD 35078 – Level 3)	Electronic (email)	10/10/2023
Report	Rev C	Updated Landscape Masterplan	KP (BPAD 38253 – Level 2)	GM (BPAD 35078 – Level 3)	Electronic (email)	27/10/2023

Filename: Z:\PROJECTS\231484 Lot 102 Bussell Highway, Cowaramup BMP & F&F Survey\Reports\Lot 102 Bussell Highway, Cowaramup BMP Rev C.docx

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1 Proposal

This Bushfire Management Plan (BMP) has been prepared for Lot 102 Bussell Highway, Cowaramup (hereafter referred to as the 'Site') by Ecosystem Solutions Pty Ltd, Dani Cuthbert (Dip TM, Dip. BM, BPAD 48409 – Level 2) and Kelly Paterson (B.Sc Hons, Nat Rs Mgmt., BPAD 38253 – Level 2). An assessment of the proposal against the requirements for *State Planning Policy (SPP) 3.7* and *Guidelines for Planning in Bushfire Prone Areas* (Guidelines, WAPC, V 1.4 December 2021) is included.

The Site is located within the Shire of Augusta-Margaret River. The Cowaramup town centre is to the north east of the Site. The Site is located within a bushfire prone area, as declared by *State Planning Policy 3.7* (Figure 1). The majority of the Site has been cleared for agricultural purposes, with a small number of remnant trees concentrated within the north of the Lot. An Environmental Assessment Report (Ecosystem Solutions, unpublished report, September 2023) has been prepared and should be read in conjunction with this BMP.

The proposal is to progress a structure plan amendment of the Site for future urban development, with the proposed structure plan provided in Figure 2.

The purpose of this BMP is to detail the fire management methods and requirements that will be implemented as part of the structure plan amendment for the Site. The aim of the BMP is to reduce the threat to residents and fire fighters in the event of a fire within or near the Site, through assessment against the four Bushfire Protection criteria.



Figure 1 Extract Map of Bushfire Prone Areas for Lot 102 Bussell Highway, Cowaramup, within the blue polygon, accessed 04 May 2023



Figure 2 Proposed Structure Plan for Lot 102 Bussell Highway, Cowaramup

2 Bushfire Assessment Results

2.1 Assessment Inputs

A Site inspection was conducted on 25th May 2023 by Kelly Paterson and Dani Cuthbert, for the purpose of determining the Bushfire Attack Level, for the purposes of determining the Bushfire Attack Level.

All vegetation within 150 m of the Site was classified and the slope under the vegetation determined in accordance with AS 3959-2018, shown in the photos below with map provided in Figure 4 for the current vegetation and Figure 5 for post development.

There are two methods to conduct BAL Assessments under AS3959-2018:

- Method 1 – a simplified method that involved five procedural steps to determine BAL and is subject to limitations on the circumstance in which it can be used.
- Method 2 – a detailed procedure using calculations to determine BAL where a more specific result is sought or where the Site conditions are outside the scope of the simplified procedure.

A Method 2 approach was conducted for Plot 3 – Class A Forest Downslope 1 degree. A Method 2 approach provides a more detailed and accurate assessment of the BAL rating to account for variations in fire runs, slope and flame width which would result in moderated bushfire behaviour compared to the standard Method 1 approach. The default elements used in a Method 1 calculation were used in this situation, apart from the slope, which was measure on site using a Nikon Forestry Pro, resulting in a downslope of 1 degree. This is discussed in more detail below.

Plot	1	**Vegetation Classification or Exclusion Clause – Predevelopment**	Class A Forest Upslope/Flat
Plot	1	**Vegetation Classification or Exclusion Clause – Post Development**	Excluded S 2.2.3.2 (e) or (f)
			
Photo ID: 1			Photo ID: 2
Description / Justification for Classification:			Trees 10 to 30 m high with more than 30% canopy cover over an unmanaged understory. This vegetation is within a proposed Public Open Space and a road reserve. The vegetation within the road reserve will be removed for the establishment of a public road. The vegetation within the Public Open Space will be established in a low fuel state by the developer and will continue to be managed to the standards of an Asset Protection Zone in perpetuity by the Shire of Augusta Margaret River, detailed in Section 3.2, and excluded as low fuel vegetation in Figure 4 – Post Development Vegetation Classification.

Plot	2	**Vegetation Classification or Exclusion Clause - Predevelopment**	Class A Forest Upslope/Flat
Plot	2	**Vegetation Classification or Exclusion Clause – Post Development**	Class A Forest Upslope/Flat / Excluded S 2.2.3.2 (e) or (f)
			
Photo ID: 3			Photo ID: 4
Description / Justification for Classification:			Trees 10 to 30 m high with more than 30% canopy cover over an unmanaged understory. As illustrated in the Post Development Map (Figure 5), the area of this plot that is located with the Sunset Drive road reserve is outside the control of the Developer and will therefore remain as Class A Forest post development. The vegetation within the proposed lots will be modified and maintained to the standards of an Asset Protection Zone by the Developer until individual lots are sold, when this will become the responsibility of the individual landowners.

Plot	3	**Vegetation Classification or Exclusion Clause - Predevelopment**	Class A Forest Downslope 1 degree (Method 2)
Plot	3	**Vegetation Classification or Exclusion Clause – Post Development**	Class A Forest Downslope 1 degree (Method 2)/ Excluded S 2.2.3.2 (e) or (f)
			
Photo ID: 5			Photo ID: 6
Description / Justification for Classification:			Trees 10 to 30 m high with more than 30% canopy cover over an unmanaged understory. As illustrated in the Post Development Map (Figure 5), the area of this plot that is located with the Sunset Drive road reserve is outside the control of the Developer and will therefore remain as Class A Forest post development. This portion of the vegetation has the Method 2 calculation applied. The vegetation within the proposed lots will be modified and maintained to the standards of an Asset Protection Zone by the Developer until individual lots are sold, when this will become the responsibility of the individual landowners.

Plot	4	**Vegetation Classification or Exclusion Clause - Predevelopment**	Class A Forest Downslope > 0 to 5 degrees
Plot	4	**Vegetation Classification or Exclusion Clause – Post Development**	Excluded S 2.2.3.2 (c), (e) or (f)
			
Photo ID: 7			Photo ID: 8
			
Photo ID: 9			Photo ID: 10
Description / Justification for Classification:			Trees 10 to 30 m high with more than 30% canopy cover over an unmanaged understory. Vegetation modification within this plot is required to establish some areas to APZ standards, allowing exclusion under S 2.2.3.2 (f). Two small section of vegetation will be retained and excluded under S 2.2.3.2 (c), being multiple areas of vegetation less than 0.25 ha in area and not within 20 m of a future habitable building or each other, or other areas of vegetation being classified. The Site Tree Clearing Plan (Appendix D) shows the vegetation that will be removed to achieve these setbacks. Areas where vegetation has been removed will be maintained to the standards of an Asset Protection Zone by the Developer until the public open space is ceded to the Shire of Augusta Margaret River, when this will become the Shire's responsibility in perpetuity. A dwelling setback line will be

	established to ensure that no dwellings are constructed within 20 m of the retained vegetation, ensuring this exclusion remains valid in perpetuity.

Plot	5	**Vegetation Classification or Exclusion Clause - Predevelopment**	Class B Woodland Upslope/Flat
Plot	5	**Vegetation Classification or Exclusion Clause – Post Development**	Excluded S 2.2.3.2 (e) or (f)
			
Photo ID: 11			Photo ID: 12
			
Photo ID: 13			Photo ID: 14
Description / Justification for Classification:			Scattered trees up to 20m in height, with a canopy cover of less than 30%, with an open grass understory. Vegetation will be removed by the Developer as per the Site Tree Clearing Plan (Appendix D), therefore is excluded under S 2.2.3.2 (e) or (f) post development.

Plot	6	**Vegetation Classification or Exclusion Clause - Predevelopment**	Class A Forest Upslope/Flat
Plot	6	**Vegetation Classification or Exclusion Clause - Post Development**	Class A Forest Upslope/Flat
			
Photo ID: 15			Photo ID: 16
Description / Justification for Classification:			Trees 10 to 30 m high with more than 30% canopy cover over an unmanaged understory. This vegetation is located outside of the subject site, therefore will remain as Class A Forest Upslope/Flat Post Development.

Plot	7	**Vegetation Classification or Exclusion Clause - Predevelopment**	Class A Forest Upslope/Flat
Plot	7	**Vegetation Classification or Exclusion Clause - Post Development**	Class A Forest Upslope/Flat
			
Photo ID: 17			Photo ID: 18
Description / Justification for Classification:			Trees 10 to 30 m high with more than 30% canopy cover over an unmanaged understory. This vegetation is located outside of the subject site, therefore will remain as Class A Forest Upslope/Flat Post Development.

Plot	8	**Vegetation Classification or Exclusion Clause - Predevelopment**	Class A Forest Upslope/Flat
Plot	8	**Vegetation Classification or Exclusion Clause - Post Development**	Class A Forest Upslope/Flat
			
Photo ID: 19			Photo ID: 20
Description / Justification for Classification:			Trees 10 to 30 m high with more than 30% canopy cover over an unmanaged understory. This vegetation is located outside of the subject site, therefore will remain as Class A Forest Upslope/Flat Post Development.

Plot	9	**Vegetation Classification or Exclusion Clause - Predevelopment**	Class A Forest Upslope/Flat
Plot	9	**Vegetation Classification or Exclusion Clause - Post Development**	Class A Forest Upslope/Flat
			
Photo ID: 21			Photo ID: 22
Description / Justification for Classification:			Trees 10 to 30 m high with more than 30% canopy cover over an unmanaged understory. This vegetation is located outside of the subject site, therefore will remain as Class A Forest Upslope/Flat Post Development.

Plot	10	**Vegetation Classification or Exclusion Clause - Predevelopment**	Class G Grassland >0 to 5 degrees
Plot	10	**Vegetation Classification or Exclusion Clause – Post Development**	Class G Grassland >0 to 5 degrees / Excluded S 2.2.3.2 (e) or (f)
 Photo ID: 23			 Photo ID: 24
 Photo ID: 25			
Description / Justification for Classification:			Unmanaged grasses including scattered paddock trees, with a canopy cover of less than 10%. The Vegetation Classification – Post Development map takes into account the post development firebreak category of the lots, with those being Residential under 4,000m^2, requiring grasses to be maintained at under 10cm in height, therefore these areas are excluded in the post development map.

Plot	11	**Vegetation Classification or Exclusion Clause - Predevelopment**	Class G Grassland Upslope/Flat
Plot	11	**Vegetation Classification or Exclusion Clause – Post Development**	Class G Grassland Upslope/Flat or Excluded S 2.2.3.2 (e) or (f)



Photo ID: 26



Photo ID: 27



Photo ID: 28



Photo ID: 29

Description / Justification for Classification:	Unmanaged grasses, including scattered paddock trees with a canopy cover of less than 10%. The Vegetation Classification – Post Development map takes into account the post development firebreak category of the lots, with those being Residential under 4,000m^2, requiring grasses to be maintained at under 10cm in height, therefore these areas are excluded in the post development map. The Landscape Masterplan (Appendix E) has informed the post-development vegetation classification, with small areas within POS 1, 2, 3 and 4 retaining a Class G Grassland classification. The remainder of these areas will be managed in a non-vegetated or low threat state in perpetuity, and have been excluded under S 2.2.3.2 (e) or (f) in the post development vegetation classification mapping. The areas within the neighbouring rural lots remain as Class G – Grassland post development.

Plot	12	**Vegetation Classification or Exclusion Clause - Predevelopment**	Excluded S 2.2.3.2 (a), (e) or (f)
Plot	12	**Vegetation Classification or Exclusion Clause – Post Development**	Excluded S 2.2.3.2 (a), (e) or (f)



Photo ID: 30



Photo ID: 31



Photo ID: 32



Photo ID: 33



Photo ID: 34

Description / Justification for Classification:	Areas greater than 100m from the Site are excluded under S 2.2.3.2 (a). Non-vegetated areas, including bare earth, roads and buildings, are excluded under S 2.2.3.2 (e). Low threat vegetation including grasses managed at under 10cm in height, managed lawns, gardens and nature strips are excluded under S 2.2.3.2 (f). The Vegetation Classification – Post Development Map excludes grassland within the Site, as these areas must be managed under 10cm in height under the All Lots 4000m^2 and under category of the Shire of Augusta Margaret River's Firebreak Notice and Bushfire Information. The Developer is responsible for maintaining all grasses at under 10cm in height until individual lots are sold, when this will become the responsibility of the individual landowners. The Public Open Spaces, Drainage Reserves and Landscape buffers within the Site will be established in a low fuel state, as described in Section 3.2.

2.1.1 Method 2 Calculation

The following data was used for the Method 2 calculations for Plot 3.

Climate data

- The default Fire Danger Index for Western Australia (Table 2.1 – AS 3959 – 2018) of 80 was used in this calculation.
- 45km/h wind speed default was used in this calculation.

Vegetation Classification

The vegetation classification determines which bushfire model is more appropriate for the vegetation and the surface and overall fuel loads.

- The default AS3959-2018 measurements for Class A Forest were used in this assessment, including 25 t/ha for surface fuel load and 35 t/ha for overall fuel load.

Effective Slope

The slope under the vegetation was taken in the field using the Nikon Forestry Pro.

- The slope under the vegetation within Plot 3 was measured at 1 degree downslope.

Flame Width

The default AS 3959-2018 Flame Width of 100m was used in this Method 2 calculation.

Elevation of receiver

The default AS3959-2018 elevation of receiver was using in this Method 2 calculation.

Flame Length

The resultant flame length from the above inputs is assessed as 21 m, which is less than the BAL-29 distance of 23 m. Therefore the BAL-29 setback distance for any dwelling in proximity to Plot 3 will not have flame contact.



FLAMESOL
FPA AUSTRALIA

Calculated October 6, 2023, 3:40 pm (MDc v.4.9)

Lot 102 Bussell Highway

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	80	Rate of spread	2.57 km/h
Vegetation classification	Forest	Flame length	20.91 m
Understorey fuel load	25 t/ha	Flame angle	52 °, 61 °, 68 °, 72 °, 74 ° & 81 °
Total fuel load	35 t/ha	Elevation of receiver	8.24 m, 9.140000000000001 m, 9.69 m, 9.94 m, 10.05 m & 10.32 m
Vegetation height	n/a	Fire intensity	46,500 kW/m
Effective slope	1 °	Transmissivity	0.861, 0.838, 0.8090000000000001, 0.783, 0.77 & 0.714
Site slope	0 °	Viewfactor	0.6085, 0.4541, 0.3079, 0.2096, 0.1702 & 0.0459
Flame width	100 m	Minimum distance to < 40 kW/m²	17 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	22.6 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	32 m
Flame temperature	1,090 K	Minimum distance to < 12.5 kW/m²	42.6 m
		Minimum distance to < 10 kW/m²	50.8 m

Rate of Spread - Mcarthur, 1973 & Noble et al., 1980

Flame length - NSW Rural Fire Service, 2001 & Noble et al., 1980

Elevation of receiver - Douglas & Tan, 2005

Flame angle - Douglas & Tan, 2005

Radiant heat flux - Drysdale, 1999, Sullivan et al., 2003, Douglas & Tan, 2005

Figure 3 FlameSol Method 2 Calculations for Plot 3

Figure 4
Vegetation Classification - Current Extent
Lot 102 Bussell Highway, Cowaramup

Project:	231484
Report:	BMP
Assessment date:	25/05/2023
Prepared by:	D Cuthbert
Accreditation level:	Level 2
Accreditation number:	48409
Accrediation expiry:	Feb 2024
Aerial photo date:	Feb 2023
Projection:	GDA2020 z50

N

Meters
0 15 30 60 90 120

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- 150m Assessment Area
- 100m Assessment Area
- Lot Boundary
- Residential Lots
- Public Open Space
- Landscape Transition Area
- Elevation (m AHD)
- Photo Points

Vegetation Classification

- Plot 1, Class A Forest Upslope/Flat
- Plot 2, Class A Forest Upslope/Flat
- Plot 3, Class A Forest Downslope 1 Degree
- Plot 4, Class A Forest Downslope >0 to 5 degrees
- Plot 5, Class B Woodland Upslope/Flat
- Plot 6, Class A Forest Upslope/Flat
- Plot 7, Class A Forest Upslope/Flat
- Plot 8, Class A Forest Upslope/Flat
- Plot 9, Class A Forest Upslope/Flat
- Plot 10, Class G Grassland Downslope >0 to 5 degrees
- Plot 11, Class G Grassland Upslope/Flat
- Plot 12, Excluded S 2.2.3.2 (a)
- Plot 12, Excluded S 2.2.3.2 (e) or (f)

Figure 5
Vegetation Classification - Post Extent
Lot 102 Bussell Highway, Cowaramup

Project:	231449
Report:	BMP
Assessment date:	25/05/2023
Prepared by:	D Cuthbert
Accreditation level:	Level 2
Accreditation number:	48409
Accrediation expiry:	Feb 2024
Aerial photo date:	Feb 2023
Projection:	GDA2020 z50

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- 150m Assessment Area
- 100m Assessment Area
- Lot Boundary
- Residential Lots
- Public Open Space
- Landscape Transition Area
- Elevation (m AHD)
- Photo Points

Vegetation Classification

- Plot 1, Excluded S 2.2.3.2 (e) or (f)
- Plot 2, Class A Forest Upslope/Flat
- Plot 2, Excluded S 2.2.3.2 (e) or (f)
- Plot 3, Class A Forest Downslope 1 degree
- Plot 3, Excluded S 2.2.3.2 (e) or (f)
- Plot 4, Excluded S 2.2.3.2 (c)
- Plot 4, Excluded S 2.2.3.2 (e) or (f)
- Plot 5, Excluded S 2.2.3.2 (e) or (f)
- Plot 6, Class A Forest Upslope/Flat
- Plot 7, Class A Forest Upslope/Flat
- Plot 8, Class A Forest Upslope/Flat
- Plot 9, Class A Forest Upslope/Flat
- Plot 10, Excluded S 2.2.3.2 (e) or (f)
- Plot 10, Class G Grassland Downslope >0 to 5 degrees
- Plot 11, Class G Grassland Upslope/Flat
- Plot 11, Excluded S 2.2.3.2 (e) or (f)
- Plot 12, Excluded S 2.2.3.2 (a)
- Plot 12, Excluded S 2.2.3.2 (e) or (f)

2.2 Assessment Outputs

The results from the Site assessment are provided in Table 1. The Determined Bushfire Attack Level (highest BAL) for the Site has been determined in accordance with clause 2.5 of AS 3959- 2018 with map provided based on the Post Development Vegetation (Figure 5) in Figure 6 and detailed BAL Contour map provided in Figure 7.

Table 1 Site Assessment Result – Post Development

Method 1 BAL Determination				
Fire Danger Index - 80 (AS 3959-2018 Table 2.1)				
Plot	Vegetation Classification	Maximum effective Slope Under the Classified Vegetation (degrees)	Required Separation Distance to the Classified Vegetation (metres)	Bushfire Attack Level
1	Class A Forest	Upslope/Flat	N/A – Excluded post development under S 2.2.3.2 (e) or (f)	
2	Class A Forest	Upslope/Flat	21m*	BAL-29
3	Class A Forest	Downslope 1 Degree	23m* (Method 2)	BAL-29
4	Class A Forest	Downslope >0 to 5	N/A - Excluded post development under S 2.2.3.2 (c)	
5	Class B Woodland	Upslope/Flat	N/A - Excluded post development under S 2.2.3.2 (e) or (f)	
6	Class A Forest	Upslope/Flat	21m*	BAL-29
7	Class A Forest	Upslope/Flat	21m*	BAL-29
8	Class A Forest	Upslope/Flat	21m*	BAL-29
9	Class A Forest	Upslope/Flat	21m*	BAL-29
10	Class G Grassland	Downslope >0 to 5	9m*	BAL-29
11	Class G Grassland	Upslope/Flat	8m*	BAL-29
12	Excluded S 2.2.3.2 (a), (c), (e) & (f)	N/A	N/A	BAL-LOW
Determined Bushfire Attack Level				BAL-29**

* This separation distance must be managed to the standards in the Guidelines for Planning in Bushfire Prone Areas as an Asset Protection Zone.

** A lower BAL rating may be achieved based on an increased separation distance from the classified vegetation, depending on the location of the dwelling within the Lot. This determination has been found using the worst-case scenario based on the plan. A detailed BAL assessment will be required prior to the construction of any dwelling with a copy of this Bushfire Management Plan required to allow exclusion of the required plots and knowledge of the Method 2 assessment applied..

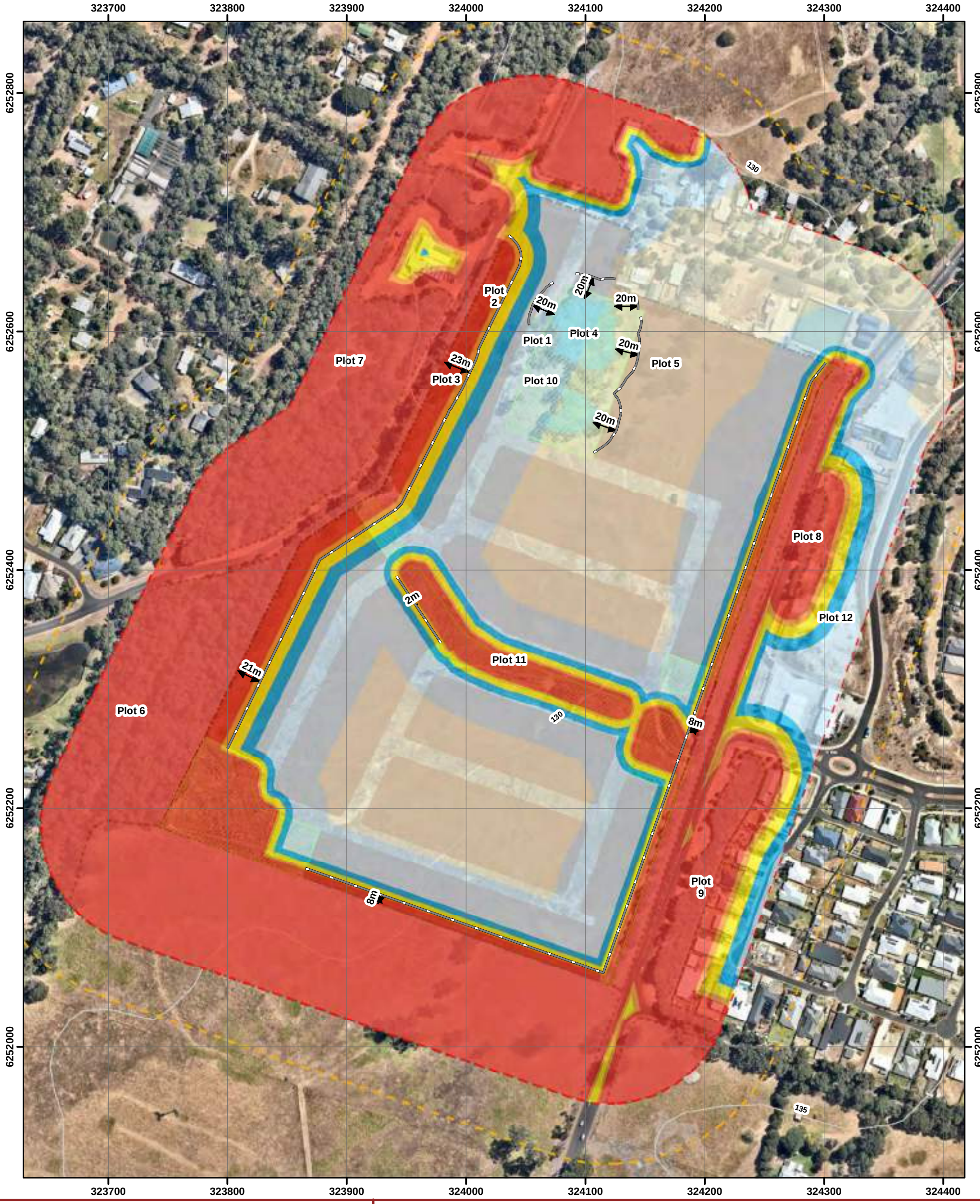


Figure 6
BAL Contour Map

Lot 102 Bussell Highway, Cowaramup

Project:	231449
Report:	BMP
Assessment date:	25/05/2023
Prepared by:	D Cuthbert
Accreditation level:	Level 2
Accreditation number:	48409
Accrediation expiry:	Feb 2024
Aerial photo date:	Feb 2023
Projection:	GDA2020 z50

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- 150m Assessment Area
- 100m Assessment Area
- Lot Boundary
- Residential Lots
- Public Open Space
- Landscape Transition Area
- Elevation (m AHD)
- Excluded S 2.2.3.2 (c)
- Classified Vegetation
- Habitable Building Setback Line
- Distance

Indicative BAL Rating

- BAL-LOW
- BAL-12.5
- BAL-19
- BAL-29
- BAL-40
- BAL-FZ

Figure 7
BAL Contour Map - detailed view

Lot 102 Bussell Highway, Cowaramup

Project:	231449
Report:	BMP
Assessment date:	25/05/2023
Prepared by:	D Cuthbert
Accreditation level:	Level 2
Accreditation number:	48409
Accrediation expiry:	Feb 2024
Aerial photo date:	Feb 2023
Projection:	GDA2020 z50

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- 100m Assessment Area
- Lot Boundary
- Residential Lots
- Public Open Space
- Landscape Transition Area
- Elevation (m AHD)
- Excluded S 2.2.3.2 (c)
- Classified Vegetation
- Habitable Building Setback Line
- Distance

Indicative BAL Rating
- BAL-LOW
- BAL-12.5
- BAL-19
- BAL-29
- BAL-40
- BAL-FZ

3 Environmental Considerations

3.1 Native Vegetation – modification and clearing

Lot 102 Bussell Highway, Cowaramup is predominately cleared, with a small area of remnant trees to the north of the lot. The tree clearing plan shows the extent of the proposed vegetation modification. Some areas of vegetation will be retained in Public Open Space (POS), these areas will be less than 0.25ha in area, and separated by 20m from each other, and any other areas of classified vegetation, and from any future habitable building, allowing for exclusion under S 2.2.3.2 (c). Other areas of existing vegetation within the POS will be managed in a low fuel state in perpetuity. Some vegetation modification is proposed within the future lots, including the modification of vegetation within Plots 2, 3 and 5 to the standards of an Asset Protection Zone (Appendix B). The condition of this vegetation is detailed in the Environmental Assessment Report that has been prepared by Ecosystem Solutions (unpublished report, October 2023), and the Tree Inspection and Recommendations Report prepared by South West Tree Services (unpublished report, August 2023). These reports are to be read in conjunction with this BMP.

Establishment of an Asset Protection Zone does not mean the removal of all vegetation within this area, trees can be retained if the trunks at maturity are 6 metres from all elevations from the building, branches at maturity do not touch or overhang the building, lower branches are removed to a height of 2 metres above the ground or surface vegetation and canopy cover is less than 15%, with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy. Shrubs and ground covers can also be retained if they are managed to APZ requirements.

This bushfire assessment assumes that relevant government approvals for any vegetation modification will be achieved prior to the commencement of any clearing.

The Site and the surrounding 150m buffer have been assessed for environmental values using a simple desktop review (Table 2). The Protected Matters Search Tool and public state databases, searched 25th May 2023, identifies conservation significant flora, fauna, and vegetation with a number of threatened flora and fauna species or species habitat that may occur in the area.

Table 2 Significant environmental values identified within the Site

Environmental Value	Yes or No	If Yes - describe
Conservation Covenants (DPIRD-023)	No	Not applicable
Bushfire Forever Sites (DOP-071)	No	Not applicable
Conservation Category Wetlands and Buffer (DBCA-010, DBCA-017, DBCA-019 or DBCA-043)	No	Not applicable
Threatened Ecological Communities (TECs) (DBCA-038)	No	Nil
Threatened Flora (DBCA-036)	Yes	A number of Threatened flora species or species habitat are known to occur in the area.
Threatened Fauna (DBCA-037)	Yes	A number of Threatened fauna species or species habitat are known to occur in the area including: • Western Ringtail Possum (*Pseudocheirus occidentalis* – Critically Endangered); and • Black Cockatoo species (Calyptorhynchus banksii naso – Vulnerable, Calyptorhynchus baudinii – Endangered & Calyptorhynchus latirostris – Endangered).
Environmentally Sensitive Area (DWER-046)	No	Nil
Significant through Local Planning or Biodiversity Strategy	No	Not applicable

3.2 Re-vegetation / Landscape Plans

A Landscape Masterplan has been prepared (Appendix E) and has informed the classification and exclusion of vegetation within the Site. Most of the land that will become drainage reserves, public open space and landscape buffers has been excluded under S 2.2.3.2 (e), being non vegetated areas, or (f), being vegetation that is low threat and/or managed to the standards of an APZ in perpetuity.

A small area within POS 5 will be excluded under S 2.2.3.2 (c), being two areas of vegetation that are less than 0.25 ha in area and not within 20m of the Site, or each other, or other areas of vegetation being classified.

The planted areas of the drainage swales are classified as Class G Grassland, as they include native sedge and grass species that exceed 50cm in height on maturity. Non-vegetated or low threat buffers are provided around these vegetated areas, to ensure that adjacent lots can still achieve a BAL-29 or lower rating, with a small are immediately abutting POS 3 resulting in a 2 metre rear setback for some adjacent lots.

Any revegetation or vegetation that is not managed to the standards dictated in the Landscape Masterplan in perpetuity, is likely to increase the BAL ratings throughout the Site. Management of the vegetation within the Site to the standards of the Landscape Masterplan, as required by this Bushfire Management Plan, is also ensured using Model Condition (F7) to ensure that the BAL Contour Map prepared prior to development is still valid and that Site conditions have not changed, at the post development/issuing of titles.

4 Assessment Against the Bushfire Protection Criteria

4.1 Compliance with the Acceptable Solutions for each Element

Bushfire Protection Criteria – Element 1 - Location	
Intent: To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk of bushfire to facilitate the protection of people, property, and infrastructure.	
Acceptable Solution	Assessment Statements
A1.1 Development location The strategic planning proposal, subdivision and development application is located in an area that is or will, on completion, be subject to either a moderate or low bushfire hazard level, or BAL–29 or below.	**Compliance with this element is achieved.** The BAL Contour for the Site (Figure 6 & 7) shows the area where a BAL-29 or lower rating can be achieved. Areas available for the construction of a habitable dwelling within the residential lots are confined to areas that are BAL-29 or lower. There are areas of BAL-40 and BAL-FZ that encroach the Site due to vegetation that is outside the lot boundary, and therefore outside of the control of the Developer. These BAL-40 and BAL-FZ are within the landscape buffer on the eastern lot boundary and the landscape transition area on the southern boundary. The western portion of the Site requires a habitable building setback line, to ensure habitable dwellings are located in an area of BAL-29 or lower. A habitable building setback of 20 m is also required from the vegetation within the northern public open space, to ensure this vegetation can be excluded under S 2.2.3.2 (c). Residential lots to the south of POS 3, within the western half of the Site, are also subject to a 2 m habitable setback line, due to Class G Grassland within the POS. The entire Site will be established and maintained to APZ standards by the developer, with grasses maintained

Bushfire Protection Criteria – Element 1 - Location	
	under 10cm in height as per the Shire of Augusta-Margaret River's Firebreak and Fuel Hazard Reduction Notice (*which may be subject to review from time to time)* until they are sold, when ongoing maintenance will become the responsibility of the individual landowners. The establishment and ongoing management of vegetation within the drainage basins, landscape buffers, POS and any other public areas must be to the standards of the Landscape Masterplan (Appendix E). Management of these areas to the level described in the Landscape Masterplan and this BMP is also ensured using Model Condition (F7) (Compliance Certificate), which ensures that the BAL Contour Map (Figures 6 & 7) remains valid and that Site conditions have not changed, at the post-development/issuing of titles.

Bushfire Protection Criteria – Element 2 – Siting and Design	
Intent: To ensure that the siting and design of development minimises the level of bushfire impact.	
Acceptable Solution	Assessment Statements
A2.1 Asset Protection Zone (APZ) Every habitable building is surrounded by, and every proposed lot can achieve, an APZ depicted on submitted plans, which meets the following requirements: • Width: Measured from any external wall or supporting post or column of the proposed building, and of sufficient size to ensure the potential radiant heat impact of a bushfire does not exceed 29kW/m² (BAL-29) in all circumstances. • Location: the APZ should be contained solely within the boundaries of the lot on which the building is situated, except in instances where the neighbouring lot or lots will be	**Compliance with this element is achieved.** Asset Protection Zones surrounding each habitable building will be established and maintained in perpetuity to meet the criterial in the Guidelines (Appendix B) with the following minimum distances required to achieve BAL-29; • 23 m to the Class A Forest Downslope 1 degree (Method 2); • 21m to the Class A Forest Upslope/Flat; and • 8m to the Class G Grassland Upslope/Flat Depending on the final lot layout, some APZs may overlap lot boundaries. It is a condition of this BMP that residential lots are established and maintained to APZ standards in perpetuity, ensuring that any

managed in a low-fuel state on an ongoing basis, in perpetuity. • Management: the APZ is managed in accordance with the requirements of 'Standards for Asset Protection Zones.' (Appendix B).	overlapping APZs will be managed in a low threat state in perpetuity. Establishment and management of the Site to APZ standards is the responsibility of the developers, including management of grasses at under 10cm in height, until individual lots are sold. Management for each lot to APZ standards will then become the responsibility of the individual landowner in perpetuity. Establishment and management of the Public Open Spaces and Drainage Reserves will occur in accordance with the Landscape Masterplan (Appendix E) for a period of two years by the developer. After this period, the land will be ceded to the Crown and vested to the Shire of Augusta Margaret River, with ongoing management in perpetuity the responsibility of the Shire of Augusta Margaret River. Landscape buffers and the landscape transition area will also be established in accordance with the Landscape Masterplan by the Developer. These areas will become the responsibility of individual lot owners when they are sold. In addition to the requirements of the Guidelines, the Shire of Augusta Margaret River's Firebreak Notice and Bushfire Information (*which may be subject to review from time to time)* must be complied with, including maintaining grasses at under 10cm in height.

Bushfire Protection Criteria – Element 3 – Vehicular Access	
Intent: To ensure that the vehicular access serving a subdivision/development is available and safe during a bushfire event.	
Acceptable Solution	Assessment Statements
A3.1 Public Roads Public roads are to meet the minimum technical requirements in Table 6, Column 1 (Appendix C). The trafficable (carriageway/ pavement) width is to be in accordance with the relevant class of road in the Local Government Guidelines for Subdivisional Development (IPWEA Subdivision Guidelines), Liveable Neighbourhoods, Austroad standards and/or any applicable standards for the local government.	**Compliance with this element can be achieved.** The developer will construct public roads to meet the requirements of the relevance class of road in the Local Government Guidelines for Subdivisional Developments, Liveable Neighbourhoods, Austroads standards and/or applicable standards for the local government. Existing public roads in proximity to the Site are in good condition.

Bushfire Protection Criteria – Element 3 – Vehicular Access	
A3.2a Multiple access routes Public road access is to be provided in two different directions to at least two different suitable destinations with an all-weather surface (two-way access). If the public road access to the subject site is via a no-through road which cannot be avoided due to demonstrated site constraints, the road access is to be a maximum of 200 metres from the subject lot(s) boundary to an intersection where two-way access is provided. The no-through road may exceed 200 metres if it is demonstrated that an alternative access, including an emergency access way, cannot be provided due to site constraints and the following requirements are met: • The no-through road travels towards a suitable destination; and • The balance of the no-through road, that is greater than 200 metres from the subject site, is wholly within BAL-LOW, or is within a residential built-out area.	**Compliance with this element is achieved.** All proposed lots will have two access/egress routes from the lot boundary. The internal road network will allow two-way access for all lots via various public roads, which connect to both the Margaret River and Busselton townships. The Concept Plan, Figure 1, shows access roads which will be used to connect the lots within the development to the public road network, ensuring multiple access routes. Alternatively, the public road network can be used to access an alternative location in the event of a bushfire. No no-through roads are proposed as part of this development. If the subdivision is to be staged, the stages are to be designed to ensure all lots within each stage have two access and egress routes via the public road network.
A3.2a Emergency Access Way	**Not applicable to this Site.** No Emergency access ways are proposed or required as part of this development.

Bushfire Protection Criteria – Element 3 – Vehicular Access	
A3.3 Through-roads All public roads should be through roads. No-through roads should be avoided and should only be considered as an acceptable solution where: • It is demonstrated that no alternative road layout exists due to site constraints; and • The no-through road is a maximum length of 200 metres to an intersection providing two-way access unless it satisfies the exemption provisions in A3.2a of this table. A no-through road is to meet all the following requirements: • Requirements of a public road (Table 6, Column 1) (Appendix C); and • Turn-around area as shown in Figure 24 (Appendix C)	**Compliance with this element can be achieved.** All proposed roads will be through roads, providing all lots with two access and egress routes as detailed in A3.2a above. If the subdivision is to be staged, the stages are to be designed to ensure all lots within each stage have two access and egress routes via the public road network.

Bushfire Protection Criteria – Element 3 – Vehicular Access

A3.4a Perimeter roads

A perimeter road is a public road and should be provided for greenfield or infill development where 10 or more lots are being proposed (including as part of a staged subdivision) with the aim of:

- Separating areas of classified vegetation under AS3959, which adjoin the subject site, from the proposed lot(s); and
- Removing the need to battle-axe lots that back onto areas of classified vegetation.
- A perimeter road is to meet the requirements contained in Table 6, Column 1 (Appendix C).

A perimeter road may not be required where;

- The adjoining classified vegetation is Class G Grassland;
- Lots are zoned for rural living or equivalent;
- It is demonstrated that it cannot be provided due to site constraints; or
- All lots have frontage to an existing public road.

Compliance with this element can be achieved.

Lots to the west abut classified vegetation within the Sunset Drive road reserve, however as the vegetation also abuts Sunset Drive, a perimeter road is not required. Lots within the western area are designed to avoid battle-axe lots, and whilst they don't directly abut an existing public road, Sunset Drive provides a road to defend the back of the lots in the event of a bushfire.

It is noted that the surrounding area to the north, south and east are predominately existing lots or cleared farmland, classified as low threat vegetation or Class G Grassland, therefore perimeter roads are not required in these areas.

A perimeter road will be constructed to the standards of a Public Road, as per Table 6, Column 1 (Appendix C).

Bushfire Protection Criteria – Element 3 – Vehicular Access	
A3.4b Fire Service Access Route Where proposed lots adjoin classified vegetation under AS3959 (excluding Class G Grassland)', and a perimeter road is not required in accordance with A3.4a, a fire service access route can be considered as an acceptable solution to provide firefighter access, where access is not available, to the classified vegetation. A fire service access route is to meet all the following requirements: • Requirements in Table 6, Column 3; • Be through-routes with no dead-ends; • Linked to the internal road system at regular intervals, every 500 metres; must be signposted; no further than 500 metres from a public road; if gated, gates must open the required trafficable width and can be locked by the local government and/or emergency services, if keys are provided for each gate; and • Turn-around areas designed to accommodate type 3.4 fire appliances and to enable them to turn around safely every 500 metres	**Not applicable to this Site.** No Fire Service Access Routes are proposed or required as part of this development.

Bushfire Protection Criteria – Element 3 – Vehicular Access	
A3.5 Battle-axe access legs Where it is demonstrated that a battle-axe cannot be avoided due to the site constraints, it can be considered as an acceptable solution. There are no battle-axe technical requirements where the point of the battle-axe access leg joins the effective area of the lot, is less than 50 metres from a public road in a reticulated area. In circumstances where the above condition is not met, or the battle-axe is in a non-reticulated water area, the battle-axe is to meet all the following requirements: • Requirements in Table 6, Column 4; and • Passing bays every 200 metres with a minimum length of 20 metres and a minimum additional trafficable surface width of two metres (i.e., the combined trafficable width of the passing bay and constructed driveway to be a minimum six metres).	**Compliance with this element is achieved** The subdivision concept plan includes three battle-axe legs, which are under 50 m from a public road, and will be in a reticulated water supply area.

Bushfire Protection Criteria – Element 4 - Water	
Intent: To ensure that water is available to the subdivision, development, or land use to enable people, property, and infrastructure to be defended from bushfire.	
Acceptable Solution	Assessment Statements
A4.1 Identification of future water supply Evidence that a reticulated or non-reticulated water supply for bushfire fighting can be provided at the subdivision and/or development application stage, in accordance with the specifications of the relevant water supply authority or the requirements of Schedule 2.	**Compliance with this element is achieved.** The Site will be reticulated. Reticulated water will be supplied in accordance with the Water Corporation's No. 63 Water Reticulation Standards by the Developer. Water Hydrants will be supplied in accordance with Water Corporations Requirements by the Developer.

4.2 Performance Based Solutions

The Site assessment was conducted in accordance with AS 3959-2018 Simplified Procedure (Method 1). The Proposal meets all the compliance requirements for the four Bushfire Protection Criteria Elements. There are no performance-based solutions proposed.

4.3 Summary of the Assessment Outcomes

This plan provides acceptable solutions and responses to the performance criteria outlined in the *Guidelines for Planning in Bushfire Prone Areas* (WAPC, Dec 2021).

The layout and design of the development is such that no structure will be required to be exposed to a radiant heat flux in excess of 29kW/m^2 (BAL-29) provided the management as outlined in this Plan is adopted.

Any class 1, 2, 3 or associated 10a structures that are to be constructed, or additions planned to existing dwellings, shall be designed, and built to conform with Australian Standards AS 3959-2018:

- BAL-29: sections 3 & 7;
- BAL-19: sections 3 & 6; and
- BAL 12.5: sections 3 & 5.

A summary of the Bushfire Management Strategies to be implemented is provided in Figure 8. An individual BAL assessment may achieve a lower BAL rating, based on the exact location of a dwelling within a lot and classified vegetation.

Spatial representation of the proposed risk management measures



The lot layout will be designed to ensure any dwellings eventuating within a Lot can achieve a BAL-29 or lower rating.
There will be no dwellings constructed in areas above BAL-29, or within 20m of the two areas of vegetation less than 0.25 ha in area within the POS, represented by the Habitable Building Setback Line.

A Landscape Masterplan (LMP) has been prepared to ensure that the vegetation within the areas of Public Open Space and Drainage Reserves is maintained to an appropriate level in perpetuity, as to not increase the BAL rating of the proposed lots. The Developer will establish and maintain the areas of Public Open Space and Drainage Reserves according to the LMP for a minimum of two years, when these areas will be ceded to the Crown and vested to the Shire of Augusta Margaret River, who will be the party responsible for maintaining these areas to the standard required in the LMP in perpetuity.

The developer will maintain all lots in a low fuel state until lots are sold, where it is the responsibility of the Landowner.

Public Roads will be constructed according to the Guidelines.

Reticulated water and fire hydrants will be provided in accordance with the Water Corporations No. 63 Water Reticulation Standard.

Establishment of the Site in a low fuel state and the design of the lot layout, water supply and public roads is the responsibility of the developer.

Legend

- Lot Boundary
- Habitable Building Setback Line
- Residential Lots
- Public Open Space
- Landscape Transition Area
- Elevation (m AHD)
- Distance
- Excluded S 2.2.3.2 (c)

PROPERTY / ASSESSMENT DETAILS

Property Address: Lot 102 Bussell Highway, Cowaramup
Project No: 231484
Prepared by: K Paterson
Accreditation Level: Level 2
Accreditation Number: 38253
Accreditation Expiry Date: 02/24

N

0 25 50 100
Meters

ecosystem solutions
www.ecosystemsolutions.com.au
(08) 9759 1960

5 Responsibilities for Implementation and Management of the Required Bushfire Measures

The responsibilities for the Developer and Local Government are outlined in Table 3 and Table 4, respectively.

Table 3 Developer Responsibilities

Number	Action	Due	Completed
1	Design the lot layout to ensure any dwellings eventuating within the Site can achieve a BAL-29 or lower rating.	At Subdivision application stage	☐
2	Design the road layout to ensure each lot is provided two access and egress routes	At Subdivision application stage	☐
3	Design all roads to the standards of Element 3 in accordance with the relevant class of road in the Local Government Guidelines for Subdivisional Development, Liveable Neighbourhoods, Austroad standards and/or any applicable standards for the local government area.	At Subdivision application stage	☐
4	Design the reticulated water and fire hydrants in accordance with the Water Corporation's No. 63 Water Reticulation Standards.	At Subdivision application stage	☐
5	Prepare a Local Development Plan with the appropriate Habitable Building Exclusion from the boundaries as detailed in Figure 8 – Bushfire Management Strategies, to ensure any dwelling constructed within the lot is BAL-29 or lower.	At Subdivision application stage, and prior to lot settlement.	☐

Number	Action	Due	Completed
6	Establish and maintain the public open space and drainage reserves in accordance with the Landscape Masterplan, after a period of two years the land will be ceded to the Crown and vested to the Shire of Augusta Margaret River, with management responsibilities handed over to the Shire of Augusta Margaret River	Post Planning approval and prior to lot sale / until handover to the Shire of Augusta Margaret River	☒
7	Establish and maintain the Landscape buffers and landscape transition areas in accordance with the Landscape Masterplan, with management responsibilities handed over to the Landowner when lots are sold.	Post planning approval and prior to lot sale	
8	Establish and maintain the vegetation within all future residential lots in a low threat state, to Asset Protection Zone standards, until individual lots are sold, when this will become the responsibility of the individual land owners.	Post planning approval and prior to lot sale	
9	Maintain all grass in a low threat with grass under 10 cm, until the lots are sold, when this will become the responsibility of the individual land owners.	Post planning approval and prior to lot sale	
10	Provide a copy and obtain endorsement of this Bushfire Management Plan by those with responsibility under this plan including Builders, Landowners/Occupiers and City of Busselton.	Post planning approval and prior to lot sale	☐
11	Place a notice on the Certificate of Title, advising of the existence of this Bushfire Management Plan and associated maintenance obligations.	Creation of titles and deposited plan	☐

Table 4 Shire of Augusta Margaret River's Responsibilities

Number	Action	Due
1	Monitor landowner compliance with the annual firebreak notice.	Ongoing
2	Maintain areas of Public Open Space and Drainage Reserves in accordance with the Landscape Masterplan in perpetuity.	Two years post planning approval – once responsibility is transferred from the developer.

Table 5 Landowner Responsibilities

Number	Action	Due
1	Maintain their lot to Asset Protection Zone standards, with grass under 10 cm in height, year-round.	Ongoing
2	Maintain landscape buffers and landscape transition areas within their lot according to the Landscape Masterplan, in perpetuity.	Ongoing

6 Glossary

All weather surface: Compacted gravel surface to the standard prescribed in the Austroads Guide to Pavement Technology as a minimum. An all-weather surface does not need to be sealed.

AS 3959: Australian Standard 3959 Construction of Buildings in Bushfire-Prone Areas.

Asset Protection Zone (APZ): A low fuel area immediately surrounding a building.

BAL: Bushfire Attack Level (BAL) as set out in the Australian Standard 3959 Construction of Buildings in Bushfire-Prone Areas (AS 3959), as referenced in the Building Code of Australia (as amended).

BAL Assessment: An assessment prepared in a manner and form set out in AS 3959 to determine a BAL. It is strongly recommended that BAL assessments are prepared by accredited Level 1 BAL Assessors, unless otherwise exempted in these Guidelines.

BAL Contour Map: A BAL Contour Map is a scale map of the subject lot/s illustrating the potential radiant heat impact and associated indicative BAL ratings in reference to any classified vegetation remaining within 100 metres of the assessment area after the development is complete. The intent of the BAL contour map is to identify land suitable for development based on the indicative BAL rating. It is strongly recommended that BAL Contour Maps are prepared by an accredited Bushfire Planning Practitioner.

Bushfire: An unplanned fire burning in vegetation. A generic term which includes grass fires, forest fires and scrub fires both with and without a suppression objective.

Bushfire hazard: The potential or existing flammability of vegetation that, in association with topography and slope, when ignited may cause harm to people and/or damage property and/or infrastructure.

Bushfire Hazard Level (BHL) assessment: A BHL assessment provides a measure of the likely intensity of a bushfire and the likely level of a bushfire attack on a Site determined by categorising and mapping land as having a low, moderate, or extreme Bushfire Hazard Level in accordance with the methodology set out in the Guidelines. It is strongly recommended that Bushfire Hazard Level assessments are prepared by an accredited Bushfire Planning Practitioner.

Bushfire Management Plan (BMP): A document that sets out short, medium and long term risk management strategies for the life of the development. It is strongly recommended that Bushfire Management Plans are prepared by accredited Bushfire Planning Practitioners in accordance with the requirements set out in the Guidelines on behalf of the landowner/proponent with the assistance of the responsible authority for emergency services where required.

Bushfire Planning Practitioner: A person who holds Level Two or Level Three accreditation under the

Western Australian Bushfire Association Framework.

Bushfire prone area: An area that has been designated by the Fire and Emergency Services Commissioner under s. 18P of the Fire and Emergency Services Act 1998 as an area that is subject, or likely to be subject, to bushfires. Such areas are identified on the Map of Bush Fire Prone Areas and can be found on the Department of Fire and Emergency Services website.

Bushfire Protection Criteria: A performance-based system of assessing bushfire risk management measures contained in the Guidelines and applied to all strategic planning proposals, subdivisions, and development applications.

Bushfire risk: The chance of a bushfire igniting, spreading, and causing damage to people, property, and infrastructure.

Bushfire risk management: Means the application of the bushfire protection criteria contained in the Guidelines.

Carriageway: Means a portion of a road that is improved, designed or ordinarily used for vehicular traffic, and includes the shoulders, and areas, including embayments, at the side or centre of the carriageway, used for the stopping or parking of vehicles; and, where a road has 2 or more of those portions divided by a medium strip, the expression means each of those portions, separately.

Development application: An application for approval to carry out development or change a land use under either a local planning scheme or region planning scheme. This includes local development plans but excludes application for single houses and ancillary dwellings on a lot or lots less than 1,100m^2.

Decision-maker: The Minister for Planning, State Administrative Tribunal, Western Australian Planning Commission, Development Assessment Panel, any other State decision-making authorise, and/or the relevant local government and their delegates that make decisions regarding the application of these Guidelines.

Defendable Space: A three-metre-wide area adjacent to a building that is kept free from vegetation (excluding groundcovers and grasses) and provides a relatively safe space from which firefighters and appropriately prepared homeowners may defend the property.

Guidelines: Refers to the Guidelines for Planning in Bushfire Prone Areas (WAPC 2015), as amended.

IPWEA Subdivision Guidelines: Refers to the Local Government Guidelines for Subdivisional Development (Institute of Public Works Engineering Australasia, WAPC, 2017).

Site: The entirety of the land subject to the planning proposal. This includes lot(s) affected by the proposal.

Trafficable: Can be travelled upon by vehicles at the posted speed limit.

Traversable: Means can be moved over safely by a vehicle.

Two-way access: Vehicular access from a site in two different directions to at least two different destinations.

WAPC: Western Australian Planning Commission.

Weight Capacity: Applied to the trafficable surface construction, including all bridges or culvers on the site and access routes.

Appendix A Shire of Augusta Margaret River Firebreak Notice and Bushfire Information

Firebreak Notice Requirements and Bushfire Information

2023–24



amrshire.wa.gov.au

Firebreak Notice Requirements

Important Dates

Fire Control Officers

Permits to Burn

Firebreak Notice Requirements

This document contains the requirements from the Firebreak Notice (the Notice) along with other bushfire information for property owners and occupiers.

All land is to be maintained from **30 November 2023** up to and including **12 May 2024** as specified in the Notice. Properties subject to an approved Bushfire Management Plan must comply with the requirements of their Plan.

APPOINTMENTS AND INSPECTIONS

Owners and occupiers who would like an early inspection by appointment, for reasons including biosecurity, locked gates, and dangerous animals, or for explanation on the requirements of the Notice, should contact Ranger Services on (08) 9780 5695 by **1 November 2023**. Where inspections by appointment are not requested, Rangers are appointed as Bush Fire Control Officers with the power to enter land under the *Bush Fires Act 1954* and will be inspecting properties for compliance without further notice from **1 December 2023**.

VARIATIONS

Where compliance with the Notice is not practical due to environmental considerations or site specific constraints such as water course or steep gradients, owners may apply to the Shire of Augusta Margaret River for a **Variation to the Notice.** Variations must provide an alternative means of meeting the objectives of the Notice, including bushfire risk mitigation and property access, taking into account site specific constraints and advantages. Not all properties will be able to accommodate Variations.

Applications must be completed via the form online at amrshire.wa.gov.au/fire-break-notice. A $30 fee will apply unless applications are submitted before **1 November 2023** in which case they are processed free of charge.

COMPLIANCE

People who do not comply with the Notice or a Variation to the Notice may be issued with a modified penalty of $250 or prosecuted with a penalty up to $5,000. The Shire of Augusta Margaret River may carry out the required work on the land at cost to the owner/occupier.

Definitions

For the purpose of the Notice the following definitions apply:

Asset Protection Zone (APZ) means an area of land within 20 metres from the external walls of any habitable building. The fuel loading (flammable material) in the APZ is to be reduced and maintained to less than 2 tonnes per hectare. Trees must not be closer than 2 metres to a building, and trees must not overhang a building within 4 metres of the external roof. **APZ requirements apply to all properties (excluding vacant lots), regardless of size, and must be maintained all year round.**

Bushfire Management Plan (BMP) is a plan prepared specifically for a property in satisfaction of a development approval or subdivision condition. Properties subject to an approved BMP must comply with the requirements of their plan in addition to the requirements of the Notice.

PLEASE NOTE

- At the Shire of Augusta Margaret River's discretion, Variations may recognise alternate methods and requirements for compliance in an approved Bushfire Management Plan.

Driveway/Access Way means the access route from a road reserve to a habitable building. This should be a minimum of 4 metres wide up to a maximum of 6 metres wide with a minimum 4 metre vertical clearance to allow emergency vehicles to access your property.

Firebreak means an area of land that has been cleared of all trees, bushes, grasses, and any other object or thing which may be flammable, leaving a bare surface to a width specified under the table on page 4, and with a 4 metre high vertical clearance.

Plantation means any area of planted pines, eucalypt, hardwood or softwood trees exceeding 3 hectares in area.

Trafficable means a firm, stable surface capable of allowing a 4WD fire appliance to enter, exit and turn any corner (10 metre radius) without reversing.

Summary of Firebreak Notice Requirements

All landowners/occupiers must carry out fire prevention work in accordance with the requirements of the Notice on or before **30 November 2023**. All land is to be maintained up to and including **12 May 2024**.

Property Type	Firebreak Requirements
All Lots 4000m² and under	• 2 metre wide firebreaks around all piles of garden refuse and/or wood stacks
Residential/ Rural Residential Lots 4001m² and over	• 3 metre wide trafficable firebreaks within 10 metres of all internal boundaries • 2 metre wide firebreaks around all piles of garden refuse/wood stacks, fuel and fodder
Rural Lots (excluding plantations, vineyards, orchards and olive groves)	• 3 metre wide trafficable firebreak required within 100 metres of an internal boundary that abuts a road reserve • Where land is actively grazed or maintained to less than 10cm, a 2 metre firebreak is required • 2 metre wide firebreaks around all piles of garden refuse/wood stacks, fuel and fodder
Plantations	• 10 metre wide internal firebreak around each cell or block - 3 metres must be trafficable • 2 metre wide firebreaks around all piles of garden refuse/wood stacks, fuel and fodder
Vineyards, Orchards and Olive Groves	• 5 metre wide internal firebreak around each cell or block - 3 metres must be trafficable • 2 metre wide firebreaks around all piles of garden refuse/wood stacks, fuel and fodder

Please Note:

Asset Protection Zone (APZ) requirements apply to all properties (excluding vacant lots), regardless of size, and must be maintained all year round.

Clearing in excess of the requirements of the Notice or a BMP will be required to comply with the Local Planning Scheme and Clearing Regulations and may require a Permit.

Asset Protection Zone (APZ)	Grass slashed/ mowed to less than 10cm	Driveway/ Access way	Gutters and rooftops free of debris
✓	✓	✓	✓
✓	Vacant/ cleared land that is not being actively grazed	✓	✓
✓	Vacant/ cleared land that is not being actively grazed	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓



Can We Access Your Property?

DID YOU KNOW?

In order for fire appliances to access your property safely, internal firebreaks must be 3 metres wide and have at least 4 metres vertical clearance. Fire appliances must be able to fit through gates on your property. The average fire appliance is 9 metres in length.

DON'T FUEL FIRES

× Don't have thick vegetation near your home.

✓ Clear all flammable material from around all structures.

✓ Store firewood, timber, petrol, kerosene and all flammable liquids well away from the house.

✓ Clear all dead leaves out of gutters regularly.

✓ Remove dead trees and branches which, when burning, could drop on your roof.

✓ Rake up leaves, twigs and dead material regularly.

✓ Burn off dry grass and vegetation at the approved times and in the approved manner or consider using alternative methods to burning.

Residents can dispose of up to 2 cubic metres of uncontaminated green waste per visit to the David Road Recycling and Waste Management Facility. Open 7 days a week from 8am to 4pm. Visit amrshire.wa.gov.au/greenwaste for more information.

Important Dates

Firebreak Notice Requirements on Private Property to be completed

Firebreaks must be installed on or before 30 November 2023
Firebreaks must be maintained up to and including 12 May 2024
APZs must be maintained all year round

RESTRICTED BURNING PERIOD - Spring/Summer

Permits Required
9 November 2023 to 22 December 2023

PROHIBITED BURNING PERIOD

Burning Prohibited
23 December 2023 to 14 March 2024

RESTRICTED BURNING PERIOD - Autumn

Permits Required
15 March 2024 to 12 May 2024

Please note, these dates can change at short notice due to variable weather conditions. Always call your area Fire Control Officer (FCO) or the Shire Rangers to check prior to lighting up.

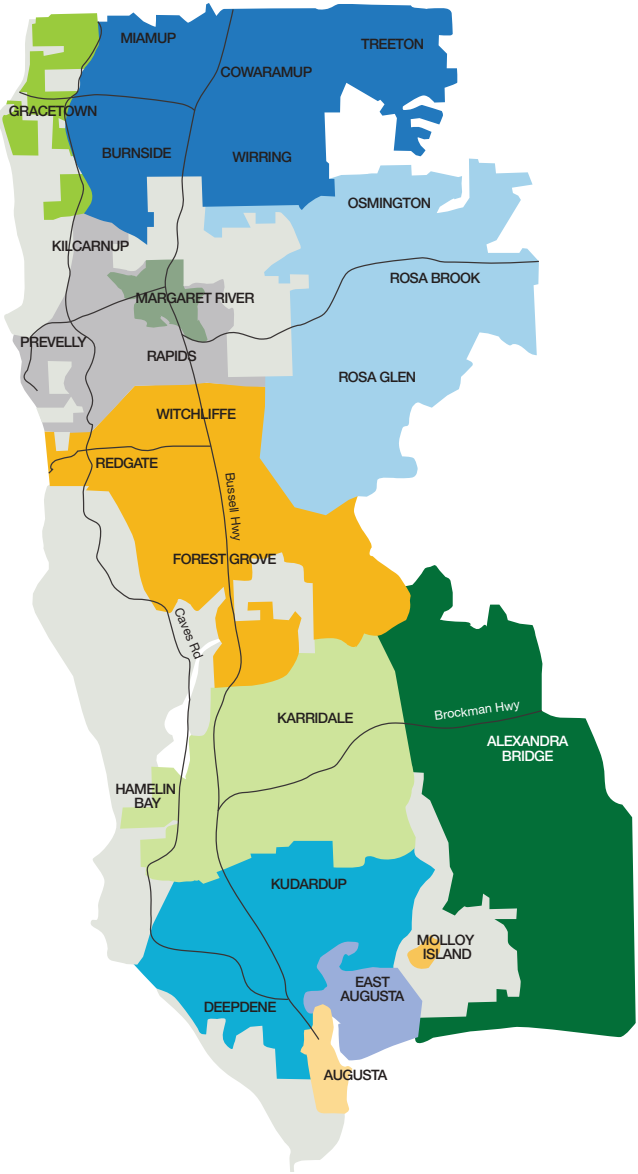
Prohibited Burning
Burning is prohibited on days where the Fire Danger Rating (FDR) is **HIGH** or above. FDRs change daily and can be checked online at emergency.wa.gov.au or contact Shire Rangers on (08) 9780 5695.

Total Fire Ban (TFB)
A TFB may be declared by the DFES Commissioner at any time. If declared, you must not light any fire or undertake any activity that may cause a fire.

Harvest and Vehicle Movement Ban (HVMB)
A HVMB may be declared by the Shire separately, or in conjunction with, a TFB, at any time. If declared, the use of engines, vehicles, plant or machinery are prohibited at particular times of the day.

Register for HVMB SMS Notifications
To register, please provide your first name, surname and mobile phone number via the form online at amrshire.wa.gov.au/fire-bans

Fire Control Officer Area Map



Fire Control Officer Contact Details

Brigade	Fire Control Officer(s)
Alexandra Bridge	**Alexandra Bridge** Tony Mostert: 0428 461 388
Augusta	**Augusta** Brendan Jordan: 0477 970 415
Cowaramup	**Burnside** Tim Garstone: 0428 555 292 **Cowaramup** Ian Earl: 0418 932 847 **Miamup** Billy Pascoe: 0405 965 447 **Treeton** Geoff Jenkins: 0407 776 920 **Wirring** Ryan Leenman: 0415 045 877
East Augusta	**East Augusta** Frank Bartoll: 0458 582 350
Gracetown	**Gracetown** Peter Delfs: 0427 555 491
Karridale	**Hamelin Bay** Simon Hanson: 0428 147 001 **Karridale** Paul Vanzetti: 0447 929 057
Kudardup	**Deepdene** Scott Hamilton: 0427 778 840 **Kudardup** Matthew Nield: 0427 772 719
Margaret River	**Margaret River** Garth Baxter: 0407 755 253
Molloy Island	**Molloy Island** Peter Nash: 0428 955 633
Rosa Brook	**Osmington** Shaun Palmer: 0448 979 041 **Rosa Brook** Mark Ridge: 0408 945 684 **Rosa Glen** Andrew Newnham: 0491 313 968
Wallcliffe	**Kilcarnup** Mark Boyd: 0418 810 327 **Prevelly** Jenny Colquhoun: 0458 231 272 **Rapids** David Kelly: 0428 387 286
Witchcliffe	**Forest Grove** Matt Holland: 0438 005 615 **Redgate** Richard Nash: 0419 951 511 **Witchcliffe** Diane Holland: 0427 930 735

General Information

UPDATE: These requirements have recently changed due to Australian wide standards.

BURNING OF GARDEN REFUSE

RESTRICTED BURNING PERIOD - Spring/Summer

You may burn one small heap of up to 1 cubic metre of garden refuse during the Spring/Summer Restricted Burning Period without a Permit. It cannot be lit before 6pm and must be fully extinguished by 11pm. A courtesy call to your area Fire Control Officer (FCO) is recommended.

RESTRICTED BURNING PERIOD - Autumn

A Permit is required to burn all garden refuse during the Autumn Restricted Burning Period.

Burning is PROHIBITED on days where the Fire Danger Rating is HIGH or above.

WOOD/SOLID FUEL BBQS AND PIZZA OVENS

The use of wood/solid fuel BBQs and pizza ovens is prohibited on days where the Fire Danger Rating is HIGH or above. The use of any wood/solid fuel BBQ or pizza oven is prohibited during a TOTAL FIRE BAN (TFB).

CAMPFIRES AND FIREPITS

Campfires and firepits are NOT permitted;

- at any time during the PROHIBITED Burning Period,
- on days where the Fire Danger Rating is HIGH or above,
- on public land, unless purpose built campfire pits have been provided by the owner of the land and permission to use them has been given by the landowner.

Campfires and firepits are permitted on private property during the RESTRICTED Burning Periods without a Permit, but cannot be lit before 6pm and must be fully extinguished by 11pm. A Permit is required outside of these times. Consent from the landowner must be given (and proof of consent available if requested by an Authorised Person).

You MUST check the Burning Period dates and the Fire Danger Rating (FDR) before lighting up. Please note, the FDR changes regularly and the Important Dates listed on page 7 can also change. For the current Fire Danger Rating visit www.emergency.wa.gov.au or contact Shire Rangers on (08) 9780 5695.

Permits to Burn

A Permit to burn is required during the RESTRICTED Burning Periods.

To obtain a Permit, contact your area FCO by referring to the FCO map in this booklet. Where the FCO is unavailable the Chief Bush Fire Control Officer or the Shire Rangers can also issue Permits. **Please allow up to 72 hours for an FCO to attend your property to assess your Permit application.**

When contacting the FCO to request a Permit, please have the following information ready to provide;

- the size of your burn,
- what you are burning,
- the address of the burn,
- the name and contact number of the Permit holder.

You must notify your adjoining landowners 24 hours in advance of your intention to burn.

Prior to burning, you MUST register your Permit with the Shire Rangers, DBCA and DFES. To do this call the numbers on the Permit and have your Permit handy as the operator will need the Permit details. If you leave a message, please state the **Permit number, property details, Permit holders name, phone number** and **time/date** of intention to burn.

Failure to;

- obtain a Permit,
- comply with all Permit conditions,
- burn without a Permit, or
- burn in contravention to any information provided in the Notice,

may result in a modified penalty of $250 and up to $5,000 should legal action be undertaken.

BE PREPARED!

The preparedness of your property can make all the difference between minor damage and devastation.

For advice on preparing your property for the fire season, please call your local Bushfire Ready Facilitator Gordon Temby (North) on 0419 954 658 or Shire Rangers on (08) 9780 5695.

Key Contacts

FIREBREAKS, INSPECTIONS AND VARIATIONS

Shire Rangers
(08) 9780 5695
Ranger Coordinator
0457 511 430

BURNING AND PERMITS

Fire Control Officers
See page 9 for contact details

OTHER CONTACTS

Chief Bush Fire Control Officer
0419 525 843

Deputy Chief Bush Fire Control Officer
0419 628 465

DFES Emergency Info Line
13 DFES (133 337)
Follow DFES on Twitter and Facebook
or listen to ABC Radio South West WA

DIAL 000

TO REPORT ALL FIRES OR LIFE THREATENING EMERGENCIES

PO Box 61, Margaret River, Western Australia 6285
T (08) 9780 5695 | F (08) 9757 2512
amrshire@amrshire.wa.gov.au | **amrshire.wa.gov.au**

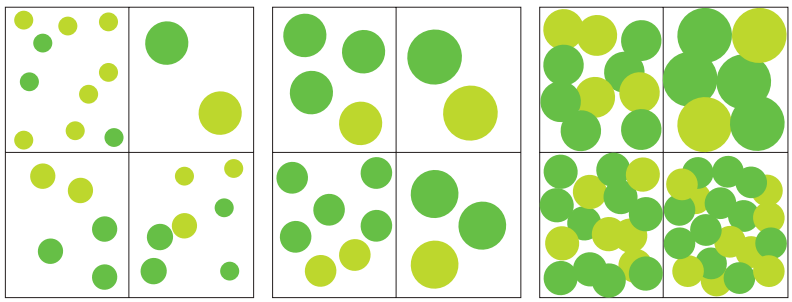
FSC www.fsc.org
MIX
Paper from responsible sources
FSC® C111891

Appendix B Asset Protection Zone Standards



ELEMENT 2: SITING AND DESIGN OF DEVELOPMENT

SCHEDULE 1: STANDARDS FOR ASSET PROTECTION ZONES

OBJECT	REQUIREMENT
Fences within the APZ	• Should be constructed from non-combustible materials (for example, iron, brick, limestone, metal post and wire, or bushfire-resisting timber referenced in Appendix F of AS 3959).
Fine fuel load (Combustible, dead vegetation matter <6 millimetres in thickness)	• Should be managed and removed on a regular basis to maintain a low threat state. • Should be maintained at <2 tonnes per hectare (on average). • Mulches should be non-combustible such as stone, gravel or crushed mineral earth or wood mulch >6 millimetres in thickness.
Trees* (>6 metres in height)	• Trunks at maturity should be a minimum distance of six metres from all elevations of the building. • Branches at maturity should not touch or overhang a building or powerline. • Lower branches and loose bark should be removed to a height of two metres above the ground and/or surface vegetation. • Canopy cover within the APZ should be <15 per cent of the total APZ area. • Tree canopies at maturity should be at least five metres apart to avoid forming a continuous canopy. Stands of existing mature trees with interlocking canopies may be treated as an individual canopy provided that the total canopy cover within the APZ will not exceed 15 per cent and are not connected to the tree canopy outside the APZ. **Figure 19:** Tree canopy cover – ranging from 15 to 70 per cent at maturity  15% 30% 70%
Shrub* and scrub* (0.5 metres to six metres in height). Shrub and scrub >6 metres in height are to be treated as trees.	• Should not be located under trees or within three metres of buildings. • Should not be planted in clumps >5 square metres in area. • Clumps should be separated from each other and any exposed window or door by at least 10 metres.
Ground covers* (<0.5 metres in height. Ground covers >0.5 metres in height are to be treated as shrubs)	• Can be planted under trees but must be maintained to remove dead plant material, as prescribed in 'Fine fuel load' above. • Can be located within two metres of a structure, but three metres from windows or doors if >100 millimetres in height.



ELEMENT 2: SITING AND DESIGN OF DEVELOPMENT

SCHEDULE 1: STANDARDS FOR ASSET PROTECTION ZONES

OBJECT	REQUIREMENT
Grass	• Grass should be maintained at a height of 100 millimetres or less, at all times. • Wherever possible, perennial grasses should be used and well-hydrated with regular application of wetting agents and efficient irrigation.
Defendable space	• Within three metres of each wall or supporting post of a habitable building, the area is kept free from vegetation, but can include ground covers, grass and non-combustible mulches as prescribed above.
LP Gas Cylinders	• Should be located on the side of a building furthest from the likely direction of a bushfire or on the side of a building where surrounding classified vegetation is upslope, at least one metre from vulnerable parts of a building. • The pressure relief valve should point away from the house. • No flammable material within six metres from the front of the valve. • Must sit on a firm, level and non-combustible base and be secured to a solid structure.

** Plant flammability, landscaping design and maintenance should be considered – refer to explanatory notes*

Appendix C Vehicular Access Technical Standards



Table 6: Vehicular access technical requirements

TECHNICAL REQUIREMENTS	1 Public roads	2 Emergency access way[1]	3 Fire service access route[1]	4 Battle-axe and private driveways[2]
Minimum trafficable surface (metres)	In accordance with A3.1	6	6	4
Minimum horizontal clearance (metres)	N/A	6	6	6
Minimum vertical clearance (metres)	4.5			
Minimum weight capacity (tonnes)	15			
Maximum grade unsealed road[3]	As outlined in the IPWEA Subdivision Guidelines	1:10 (10%)		
Maximum grade sealed road[3]		1:7 (14.3%)		
Maximum average grade sealed road		1:10 (10%)		
Minimum inner radius of road curves (metres)		8.5		

Notes:

[1] To have crossfalls between 3 and 6%.

[2] Where driveways and battle-axe legs are not required to comply with the widths in A3.5 or A3.6, they are to comply with the Residential Design Codes and Development Control Policy 2.2 Residential Subdivision.

[3] Dips must have no more than a 1 in 8 (12.5% -7.1 degree) entry and exit angle.



EXPLANATORY NOTES

E3.6 Private driveways

In areas serviced by reticulated water, where the road speed limit is not greater than 70 km/h, and where the distance from the public road to the further part of the habitable building is no greater than 70 metres, emergency service vehicles typically operate from the street frontage.

In the event the habitable building cannot be reached by hose reel from the public road, then emergency service vehicles will need to gain access within the property. Emergency service vehicles will also need to gain access within the property, where access to reticulated water (fire hydrants) is not possible. In these situations, the driveway and battle-axe (if applicable) will need to be wide enough for access for an emergency service vehicle and a vehicle to evacuate.

Turnaround areas should be available for both conventional two-wheel drive vehicles of residents and Type 3.4 fire appliances. Turn-around areas should be located within 30 metres of habitable buildings. Circular and loop driveway design may also be considered.

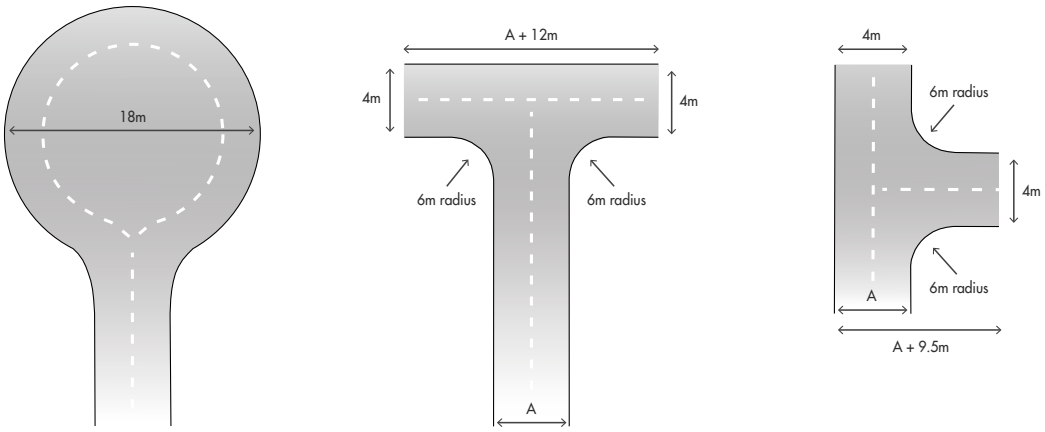


Figure 28: Design requirements for a turn-around area for a private driveway or battle-axe

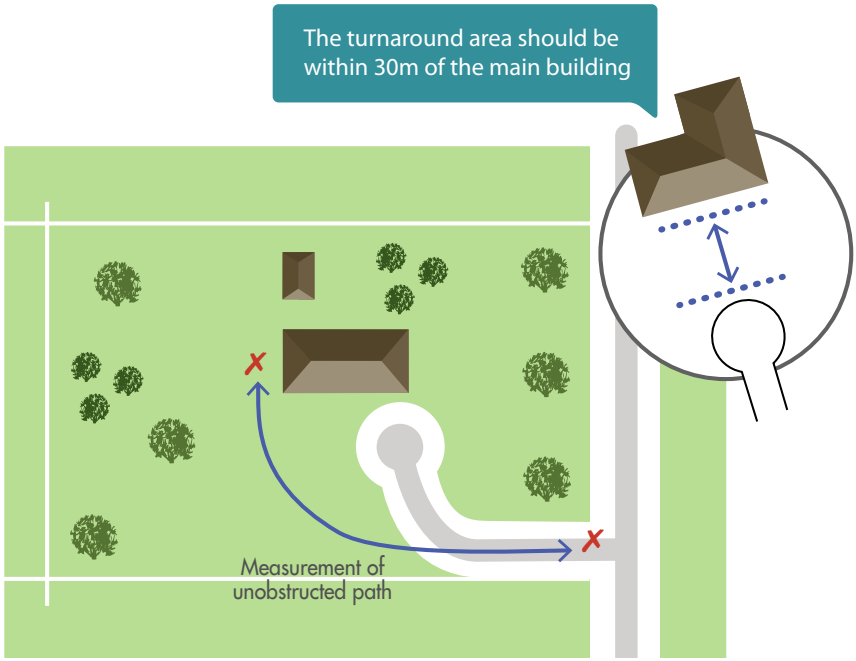


Figure 29: Design requirements for a private driveway where required under A3.6



SCHEDULE 2: WATER SUPPLY DEDICATED FOR BUSHFIRE FIREFIGHTING PURPOSES

2.1 Water supply requirements

Water dedicated for firefighting should be provided in accordance with Table 7 below, and be in addition to water required for drinking purposes.

Table 7: Water supply dedicated for bushfire firefighting purposes

PLANNING APPLICATION	NON-RETICULATED AREAS
Development application	10,000L per habitable building
Structure Plan / Subdivision: Creation of 1 additional lot	10,000L per lot
Structure Plan / Subdivision: Creation of 3 to 24 lots	10,000L tank per lot **or** 50,000L strategic water tank
Structure Plan / Subdivision: Creation of 25 lots or more	50,000L per 25 lots or part thereof Provided as a strategic water tank(s) or 10,000L tank per lot

2.2 Technical requirements

2.2.1 Construction and design

An above-ground tank and associated stand should be constructed of non-combustible material. The tank may need to comply with AS/NZS 3500.1:2018.

Below ground tanks should have a 200mm diameter access hole to allow tankers or emergency service vehicles to refill direct from the tank, with the outlet location clearly marked at the surface. The tank may need to comply with AS/NZS 3500.1:2018. An inspection opening may double as the access hole provided that the inspection opening meets the requirements of AS/NZS 3500.1:2018. If the tank is required under the BCA as part of fire hydrant installation, then the tank will also need to comply with AS 2419.

Where an outlet for an emergency service vehicle is provided, then an unobstructed, hardened ground surface is to be supplied within four metres of any water supply.

2.2.2 Pipes and fittings

All above-ground, exposed water supply pipes and fittings should be metal. Fittings should be located away from the source of bushfire attack and be in accordance with the applicable section below, unless otherwise specified by the local government.

2.2.2.1 Fittings for above-ground water tanks:

- Commercial land uses: 125mm Storz fitting; or
- Strategic water tanks: 50mm or 100mm (where applicable and adapters are available) male camlock coupling with full flow valve; or
- Standalone water tanks: 50mm male camlock coupling with full flow valve; or
- Combined water tanks: 50mm male camlock coupling with full flow valve or a domestic fitting, being a standard household tap that enables an occupant to access the water supply with domestic hoses or buckets for extinguishing minor fires.

2.2.2.2 Remote outlets

In certain circumstances, it may be beneficial to have the outlet located away from the water supply. In such instances in which a remote outlet is to be used, the applicant should consult the local government and DFES on their proposal.

Appendix D Tree Clearing Plan

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LEGEND

SURVEYED TREE LOCATION - TREE TO BE RETAINED

SURVEYED TREE LOCATION - TREE TO BE REMOVED

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

STANDARD NOTES

1. **SET OUT & DIMENSIONS.** THE CONTRACTOR SHALL SET OUT ALL PATHS, WALLS, HARD SURFACES AND ELEMENTS EITHER ON SITE PRIOR TO CONSTRUCTION AND SHALL OBTAIN THE SUPERINTENDENTS APPROVAL PRIOR TO WORKS COMMENCING. WRITTEN DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALE. CHECK ALL DRAWING SCALES IN CONJUNCTION WITH DRAWING SIZE.
2. **SERVICES & SITE ASSETS.** THE CONTRACTOR SHALL INVESTIGATE THE NATURE AND LOCATION OF ALL EXISTING SERVICES AND RETAINED SITE ASSETS AFFECTED BY THEIR WORKS. FAILURE TO TAKE DUE CARE SHALL NOT LIMIT THE CONTRACTORS LIABILITIES.
3. **REFERENCE.** THE CONTRACTOR SHALL REFER TO ALL CONTRACT DOCUMENTS, THE SPECIFICATION AND DRAWINGS PRIOR TO AND DURING THE WORKS.
4. **DISCREPANCIES.** NOTIFY SUPERINTENDENT OF ANY SUSPECTED OR KNOWN DISCREPANCIES OR ERRORS PRIOR TO THE ORDERING OF AFFECTED MATERIALS AND OR CONSTRUCTION OF AFFECTED WORKS.
5. **RELEVANT STANDARDS.** THE CONTRACTOR SHALL UNDERTAKE ALL PRICING AND WORKS IN ACCORDANCE WITH CURRENT INDUSTRY BEST PRACTICE AND ALL RELEVANT AUSTRALIAN STANDARDS.
6. **SERVICE LOCATOR.** THE CONTRACTOR SHALL UNDERTAKE A DIAL BEFORE YOU DIG PROCESS PRIOR TO COMMENCING WORKS ON SITE. THE CONTRACTOR SHALL ENGAGE A SERVICE LOCATOR TO MAP THE SPECIFIC LOCATIONS AND DEPTH OF ALL SERVICES AND ADVISE ALL RELEVANT STAFF AND SUBCONTRACTORS IN WRITING PRIOR TO COMMENCING WORKS ON SITE.

SW LANDSCAPE COLLECTIVE

ADDRESS: 4 MAGPIE STREET, MARGARET RIVER WA 6285
EMAIL: ADMIN@SWLANDSCAPE.COM.AU
WEBSITE: WWW.SWLANDSCAPE.COM.AU
PHONE: +61 418 947 889

REV	DATE	BY	ISSUE OR AMENDMENT
E	12.10.23	CE	UPDATED SURVEY INFORMATION
D	09.10.23	CE	ADDITION OFMEMORIAL DRIVE ROAD RESERVE TREES
C	22.09.23	CE	ADDITION OF ENGINEERS SIGHTLINE REVIEW
B	19.09.23	CE	ADDITION OF SUNSET DRIVE ROAD RESERVE TREES
A	13.09.23	CE	ISSUE FOR CLIENT REVIEW

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
PRELIMINARY SITE CLEARING / TREE REMOVAL PLAN

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE 1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER GFC-01-102

REVISION E



LEGEND

SURVEYED TREE LOCATION - TREE TO BE RETAINED

SURVEYED TREE LOCATION - TREE TO BE REMOVED

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
PRELIMINARY SITE CLEARING / TREE REMOVAL PLAN

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE
1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER
GFC-01-103

REVISION
E

Appendix E Landscape Masterplan



TREES WITHIN ROAD RESERVES ARE TO BE REMOVED. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

VEGETATION TO BE MODIFIED IN ACCORDANCE WITH THE BUSHFIRE MANAGEMENT PLAN. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

LANDSCAPED MOUNDS PLANTED WITH LOW THREAT NATIVE SPECIES AND TALL NATIVE TREES THROUGH LINEAR POS TO ENHANCE RURAL LANDSCAPE AESTHETIC

: TREES WITHIN INTERSECTION ALIGNMENT AND SIGHTLINES TO BE REMOVED. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

1.0m HIGH LANDSCAPED MOUNDING WITH POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

SEATING NODE WITH SHELTER AT FOCAL POINT OF LINEAR POS WITH VIEWS UP AND DOWN THE POS CORRIDOR

SMALL POCKET OF TURF PROVIDING INFORMAL ACTIVE RECREATION SPACE FOR RESIDENTS ON SOUTHERN SIDE OF DEVELOPMENT.

LANDSCAPED MOUNDS PLANTED WITH LOW THREAT NATIVE SPECIES AND TALL NATIVE TREES THROUGH LINEAR POS TO ENHANCE RURAL LANDSCAPE AESTHETIC

FOOTPATH CONNECTION TO WADANDI TRAIL REGIONAL TRAIL NETWORK

SEATING NODE WITH OUTLOOK OVER BASIN TO WADANDI TRAIL RESERVE BEHIND.

CATCHMENT C/ F BASIN TO PROVIDE 2,000sqm OF BIOFILTRATION BASIN AREA. LANDSCAPED WITH NATIVE LOW RUSHES AND SEDGES FOR NUTRIENT STRIPPING AND FILTRATION. TALL NATIVE TREE PLANTING TO SURROUNDING EDGES / BATTERS TO HELP SHADE OUT WEEDS AND PROVIDE WIND BREAK FROM PREVAILING SOUTH-WESTERLY WINDS

1 IN 100 YEAR FLOOD STORAGE AREA TO BE LANDSCAPED WITH LOW THREAT PLANTING AND MULCH WITH CLUMPS OF TALL NATIVE TREES AT MIN 5.0m CANOPY SEPARATION AND MAX. 15% CANOPY COVER TO APZ STANDARDS

MULCH ONLY OR GRAVEL MAINTENANCE ACCESS TO ALONG POS BOUNDARY INTERFACE WITH AGRICULTURAL LOT AND WADANDI TRAIL RESERVE

NEW INTERSECTION ON MEMORIAL DRIVE WILL REQUIRE REMOVAL OF 2 x EXISTING TREES. NEW STREET TREES TO BE INSTALLED IF SIGHTLINES PERMIT, SUBJECT TO DETAILED DESIGN

CONCRETE FOOTPATHS PROVIDING WALKING CIRCUITS THROUGH / AROUND RETAINED VEGETATION WHILE PROVIDING MAINTENANCE ACCESS AND EDGING TO PROTECT EXISTING RETAINED TREES

EXISTING TREES IN GOOD CONDITION TO BE RETAINED AND PROTECTED WITH MULCH AND LOW THREAT UNDERSTOREY PLANTING TO PROTECT INTO THE FUTURE. TOTAL AREA TO BE LESS THAN 0.25HA. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

20.0m WIDE SEPARATION REQUIRED BETWEEN CLUMPS OF RETAINED TREES FOR BUSHFIRE EXCLUSION. CORRIDOR TO PROVIDE POS AMENITIES INCLUDING PLAYGROUND AND PICNIC SHELTER

2.5m WIDE DUAL USE PATH THROUGH CENTRE OF 10.0m WIDE LANDSCAPE BUFFER PROVIDING CONNECTION TO COWARAMUP TOWN CENTRE

EXISTING TREES IN GOOD CONDITION TO BE RETAINED AND PROTECTED WITH MULCH AND LOW THREAT UNDERSTOREY PLANTING TO PROTECT INTO THE FUTURE

WA PEPPERMINT PLANTING AT MIN. 5.0m BETWEEN CANOPIES TO DEVELOPMENT BOUNDARY FOR ADDITIONAL SCREENING. MUST BE LESS THAN 15% CANOPY COVER TOTAL

SINGLE DENSE ROW OF WA PEPPERMINT TREES TO BUSSELL HWY BOUNDARY ON 1.0m HIGH EARTH BUND WITH UNDERSTOREY PLANTING TO APZ REQUIREMENTS

LANDSCAPED MEDIAN WITH TALL NATIVE TREES ON EITHER SIDE TO CREATE GRAND AVENUE ALONG MAIN THROUGH ROAD

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

1.0m HIGH LANDSCAPED MOUNDING WITH POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

BIOFILTRATION BASIN AT ENTRY TO BE LANDSCAPED AS ENTRY FEATURE / WETLAND WITH TALL NATIVE TREE PLANTING TO PRONOUNCE SUBDIVISON ENTRY WITH FEATURE POS PLANTING UNDERSTOREY IN ROAD VERGE

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

MAINTENANCE ACCESS TRACK ENTRY POINT WITH BOLLARDS OR GATE TO SoAMR REQUIREMENTS

VERGE LANDSCAPING BY LOT OWNERS TO SoAMR STANDARDS

STREET TREE PLANTING AT 1 x TREE PER LOT OR 2 x TREES PER CORNER LOT UTILISING LOCAL NATIVE TREE SPECIES

WA PEPPERMINT PLANTING AT MIN. 5.0m BETWEEN CANOPIES TO DEVELOPMENT BOUNDARY FOR ADDITIONAL SCREENING. MUST BE LESS THAN 15% CANOPY COVER TOTAL

SINGLE DENSE ROW OF WA PEPPERMINT TREES TO BUSSELL HWY BOUNDARY ON 1.0m HIGH EARTH BUND WITH UNDERSTOREY PLANTING TO APZ REQUIREMENTS

3.0m WIDE GRAVEL MAINTENANCE ACCESS TRACK THROUGH 10.0m WIDE BUSSELL HWY VISUAL LANDSCAPE BUFFER

10.0m WIDE LANDSCAPE BUFFER TO SOUTHERN BOUNDARY AS VISUAL TRANSITION FROM AGRICULTURAL TO RESIDENTIAL LAND

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 01 CATCHMENT B/G BIOFILTRATION BASIN
- 02 LINEAR POS SWALE WITH 1 IN 4 BATTERS
- 03 CATCHMENT D/E BIOFILTRATION BASIN
- 04 CATCHMENT C/F BIOFILTRATION BASIN AND 1 IN 100 YR FLOOD STORAGE AREA
- 05 OPEN TURF AREAS FOR INFORMAL ACTIVE RECREATION
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- IRRIGATED TURF AREA
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SWALE AND BIOFILTRATION PLANTING AREAS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- EXISTING SURVEYED TREE TO BE RETAINED
- EXISTING SURVEYED TREE TO BE REMOVED
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- LANDSCAPE BUFFER SCREEN TREE PLANTING
- POS NATIVE DRAINAGE TREE PLANTING

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.
2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.
3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

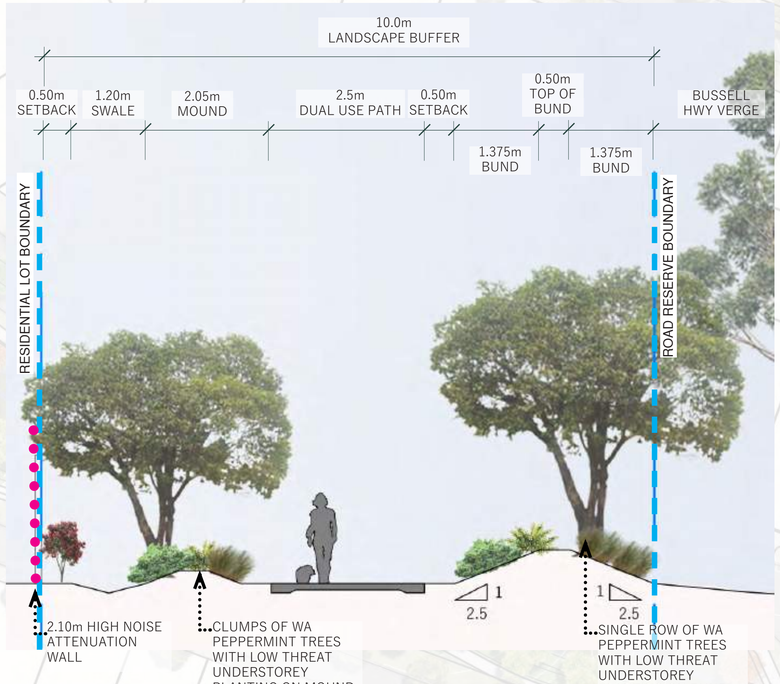
LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - OVERALL SITE PLAN

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-001

SCALE: 1:1500@ A1

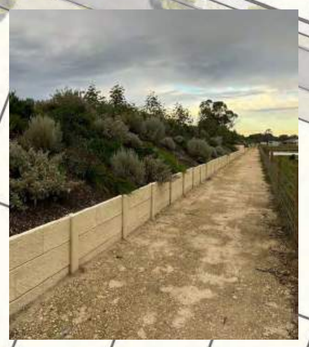
SW LANDSCAPE COLLECTIVE



SCALE **1 : 50 @**

SECTION F - BUSSELL HWY LANDSCAPE BUFFER





EXAMPLE PHOTO: EXAMPLE
BUND AND MOUND PLANTING



2.1m HIGH NOISE ATTENUATION WALL TO REAR OF LOTS ADJACENT BUSSELL HWY

2.5m WIDE DUAL USE PATH THROUGH CENTRE OF 10.0m WIDE LANDSCAPE BUFFER PROVIDING CONNECTION TO COWARAMUP TOWN CENTRE

SHALLOW SWALE CONNECTING THROUGH FROM LANDSCAPE BUFFER TO BIOFILTRATION BASIN

WA PEPPERMINT PLANTING AT MIN. 5.0m BETWEEN CANOPIES TO DEVELOPMENT BOUNDARY FOR ADDITIONAL SCREENING. MUST BE LESS THAN 15% CANOPY COVER TOTAL

SINGLE DENSE ROW OF WA PEPPERMINT TREES TO BUSSELL HWY BOUNDARY ON 1.0m HIGH EARTH BUND WITH UNDERSTOREY PLANTING TO APZ REQUIREMENTS

SEATING NODE FOR PASSIVE RECREATION

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

1.0m HIGH LANDSCAPED MOUNDING WITH POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

NEW INTERSECTION AND ROUND-ABOUT SUBJECT TO DETAILED DESIGN AND MRWA APPROVALS

POS LANDSCAPING PLANTING TO ENTRY ROAD VERGES WITH FEATURE AVENUE STREET TREE PLANTING BEHIND TO CREATE PRONOUNCED INFORMAL ENTRY STATEMENT

BIOFILTRATION BASIN AT ENTRY TO BE LANDSCAPED AS ENTRY FEATURE / WETLAND WITH TALL NATIVE TREE PLANTING TO PRONOUNCE SUBDIVISON ENTRY WITH FEATURE POS PLANTING UNDERSTOREY IN ROAD VERGE

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

SHALLOW SWALE CONNECTING THROUGH FROM LANDSCAPE BUFFER TO BIOFILTRATION BASIN

MAINTENANCE ACCESS TRACK ENTRY POINT WITH BOLLARDS OR GATE TO SoAMR REQUIREMENTS

WA PEPPERMINT PLANTING AT MIN. 5.0m BETWEEN CANOPIES TO DEVELOPMENT BOUNDARY FOR ADDITIONAL SCREENING. MUST BE LESS THAN 15% CANOPY COVER TOTAL

SINGLE DENSE ROW OF WA PEPPERMINT TREES TO BUSSELL HWY BOUNDARY ON 1.0m HIGH EARTH BUND WITH UNDERSTOREY PLANTING TO APZ REQUIREMENTS

3.0m WIDE GRAVEL MAINTENANCE ACCESS TRACK THROUGH 10.0m WIDE BUSSELL HWY VISUAL LANDSCAPE BUFFER

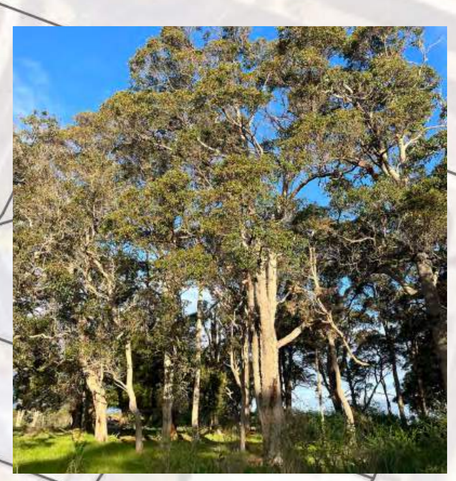
2.1m HIGH NOISE ATTENUATION WALL TO REAR OF LOTS ADJACENT BUSSELL HWY



SITE PHOTO: EXAMPLE MATURE TREES ON SITE ENHANCE NATURAL / RURAL AESTHETIC



SITE PHOTO: EXAMPLE MATURE TREES ON SITE ENHANCE NATURAL / RURAL AESTHETIC



SITE PHOTO: EXAMPLE MATURE TREES ON SITE ENHANCE NATURAL / RURAL AESTHETIC

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 01 CATCHMENT B/G BIOFILTRATION BASIN
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- IRRIGATED TURF AREA
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SWALE AND BIOFILTRATION PLANTING AREAS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- LANDSCAPE BUFFER SCREEN TREE PLANTING
- POS NATIVE DRAINAGE TREE PLANTING
- EXISTING SURVEYED TREE TO BE RETAINED
- EXISTING SURVEYED TREE TO BE REMOVED
- 2.1m HIGH NOISE ATTENUATION WALL TO REAR OF LOTS ADJACENT BUSSELL HWY

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.

2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.

3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

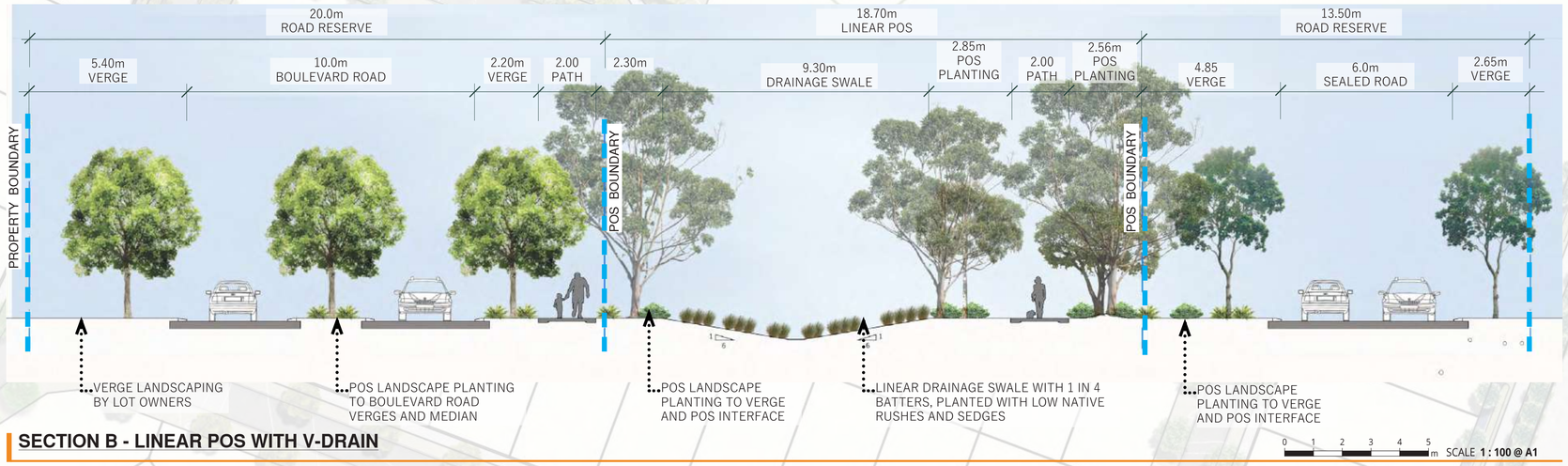
LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - ENTRY POS AND LANDSCAPE BUFFER DETAIL PLANS

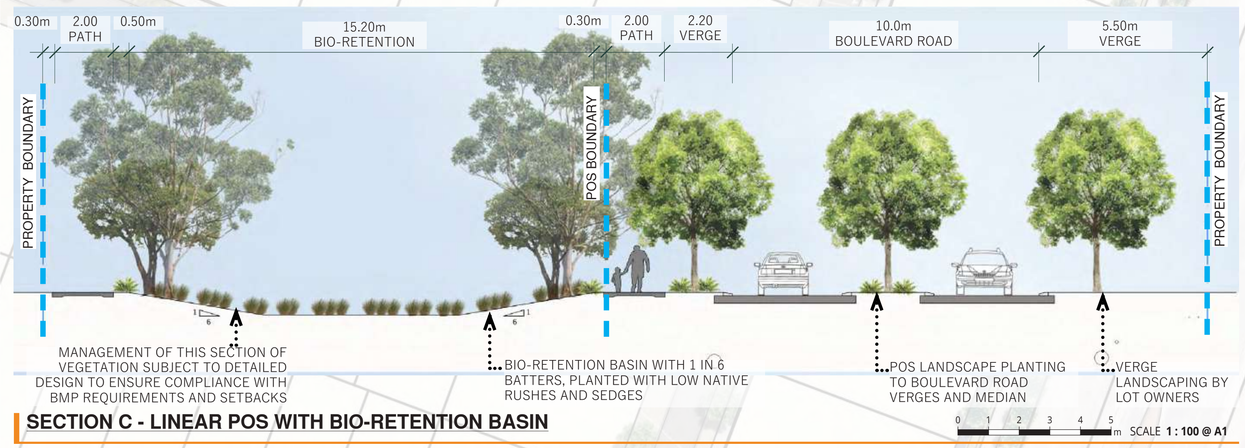
CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-002

SCALE: 0 5 10 15 20 25 m
SCALE **1 : 500 @ A1**

SW LANDSCAPE COLLECTIVE



SECTION B - LINEAR POS WITH V-DRAIN



SECTION C - LINEAR POS WITH BIO-RETENTION BASIN

. TREES WITHIN INTERSECTION ALIGNMENT AND SIGHTLINES TO BE REMOVED. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

FEATURE TALL NATIVE AVENUE STREET TREE PLANTING IN LANDSCAPED MEDIAN

1.0m HIGH LANDSCAPED MOUNDING WITHIN POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

MANAGEMENT OF THIS SECTION OF VEGETATION SUBJECT TO DETAILED DESIGN TO ENSURE COMPLIANCE WITH BMP REQUIREMENTS AND SETBACKS

SEATING NODE WITH SHELTER AT FOCAL POINT OF LINEAR POS WITH VIEWS UP AND DOWN THE POS CORRIDOR

POS LANDSCAPE PLANTING PROVIDING BUFFER TO PRIVATE LOT

SEATING NODE ADJACENT TO TURF AREA FOR PASSIVE RECREATION AND SURVEILLANCE

SMALL POCKET OF TURF PROVIDING INFORMAL ACTIVE RECREATION SPACE FOR RESIDENTS ON SOUTHERN SIDE OF DEVELOPMENT.

SEATING NODE ADJACENT TO TURF AREA FOR PASSIVE RECREATION AND SURVEILLANCE

1.0m HIGH LANDSCAPED MOUNDING WITHIN POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO SHADE FOOTPATH AND REINFORCE RURAL LANDSCAPE AESTHETIC

LANDSCAPED MEDIAN WITH TALL NATIVE TREES ON EITHER SIDE TO CREATE GRAND AVENUE ALONG MAIN THROUGH ROAD

DECIDUOUS POS FEATURE TREE AT FOCAL FROM BUSSELL HIGHWAY ENTRY AND FOR PASSIVE SOLAR PROTECTION FOR SHELTER / SEATING NODE

SEATING NODE WITH SHELTER AT FOCAL POINT OF LINEAR POS WITH VIEWS UP THE POS CORRIDOR AND FROM MAIN ENTRY OFF BUSSELL HIGHWAY

1.0m HIGH LANDSCAPED MOUNDING WITHIN POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO SHADE FOOTPATH AND REINFORCE RURAL LANDSCAPE AESTHETIC

LOW THREAT POS LANDSCAPE PLANTING TO VERGES OF LINEAR POS IN ACCORDANCE WITH APZ STANDARDS

SUNSET DRIVE

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.

2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.

3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 02 LINEAR POS SWALE WITH 1 IN 4 BATTERS
- 03 CATCHMENT D/E BIOFILTRATION BASIN
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- IRRIGATED TURF AREA
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SWALE AND BIOFILTRATION PLANTING AREAS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- LANDSCAPE BUFFER SCREEN TREE PLANTING
- POS NATIVE DRAINAGE TREE PLANTING

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - LINEAR POS DETAIL PLAN

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-003

SCALE: 0 5 10 15 20 25 m
SCALE 1 : 500 @ A1

SW LANDSCAPE COLLECTIVE



EXAMPLE PHOTO: EXISTING MATURE VEGETATION RETAINED IN MEDIANS AND VERGES

SEATING NODE BENEATH SHADE OF EXISTING TREE CANOPY

LANDSCAPED MOUNDS PLANTED WITH LOW THREAT NATIVE SPECIES AND TALL NATIVE TREES THROUGH LINEAR POS TO ENHANCE RURAL LANDSCAPE AESTHETIC

CONCRETE HALF-COURT SPACE AS LOW COST AND LOW MAINTENANCE ACTIVITY SPACE ADJACENT PLAYGROUND TO CATER FOR OLDER AGE GROUPS

STREET TREE PLANTING IN VERGE OF POS TO MATCH OPPOSITE VERGE WITH LOW THREAT PLANTING AND MULCH FINISH BENEATH

UTILISE EXISTING OPEN AREA FOR IRRIGATED TURF SPACE FOR ACTIVE RECREATION AND CONNECTING TO PLAY AND COURT SPACE

LANDSCAPED MOUNDS PLANTED WITH LOW THREAT NATIVE SPECIES AND TALL NATIVE TREES THROUGH LINEAR POS TO ENHANCE RURAL LANDSCAPE AESTHETIC

SEATING NODE OPENING TO TURF AREA FOR PASSIVE OUTLOOK AND SURVEILLANCE

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CLUMPS OF TALL NATIVE TREE PLANTINGS WITH POS LANDSCAPE SPECIES PLANTING BENEATH AS NODES OF SCREENING AND HABITAT. TO BE COMPLIANT TO APZ STANDARDS

3.0m WIDE MULCH ONLY MAINTENANCE EDGE TO LARGE AREA OF EXISTING TREES TO BE RETAINED.

MULCH AND LOW THREAT UNDERSTOREY PLANTING TO ASSIST IN PROTECTING EXISTING TREE ROOTS AND IMPROVE OVERALL TREE HEALTH

CONCRETE FOOTPATHS PROVIDING WALKING CIRCUITS THROUGH / AROUND RETAINED VEGETATION WHILE PROVIDING MAINTENANCE ACCESS AND EDGING TO PROTECT EXISTING RETAINED TREES

EXISTING TREES IN GOOD CONDITION TO BE RETAINED AND PROTECTED WITH MULCH AND LOW THREAT UNDERSTOREY PLANTING TO PROTECT INTO THE FUTURE. TOTAL AREA TO BE LESS THAN 0.25HA

ADDITIONAL PLANTING OF MARRI, JARRAH AND WA PEPPERMINTS AS SUCCESSION PLANTING IN OPEN AREAS

PICNIC SETTING OPEN TO PLAYGROUND AND HALF COURT AREA

SHADE SAILS OVER PLAY SPACE FOR SUN PROTECTION AND SHADE

20.0m WIDE SEPARATION REQUIRED BETWEEN CLUMPS OF RETAINED TREES FOR BUSHFIRE EXCLUSION. LOW THREAT PLANTING ONLY TO OCCUR

PLAYGROUND TO PROVIDE VARIETY FOR ALL AGES AND ACCESSIBILITY WITH COMBINATION OF OFF-THE-SHELF AND NATURE PLAY EQUIPMENT / PIECES

PICNIC SHELTER AND SETTING / SEATING TO BE PROVIDED ADJACENT PLAYGROUND

CONCRETE FOOTPATHS PROVIDING WALKING CIRCUITS THROUGH / AROUND RETAINED VEGETATION WHILE PROVIDING MAINTENANCE ACCESS AND EDGING TO PROTECT EXISTING RETAINED TREES

CLUMPS OF TALL NATIVE TREE PLANTINGS WITH POS LANDSCAPE SPECIES PLANTING BENEATH AS NODES OF SCREENING AND HABITAT. TO BE COMPLIANT TO APZ STANDARDS

EXISTING TREES IN GOOD CONDITION TO BE RETAINED AND PROTECTED WITH MULCH AND LOW THREAT UNDERSTOREY PLANTING TO PROTECT INTO THE FUTURE. TOTAL AREA TO BE LESS THAN 0.25HA

CONCRETE FOOTPATHS PROVIDING WALKING CIRCUITS THROUGH / AROUND RETAINED VEGETATION WHILE PROVIDING MAINTENANCE ACCESS AND EDGING TO PROTECT EXISTING RETAINED TREES



EXAMPLE PHOTO: LOW THREAT PLANTING BENEATH RETAINED EXISTING TREES

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 05 OPEN TURF AREAS FOR INFORMAL ACTIVE RECREATION
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- IRRIGATED TURF AREA
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- EXISTING SURVEYED TREE TO BE RETAINED
- EXISTING SURVEYED TREE TO BE REMOVED

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.

2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.

3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - NORTHERN ACTIVE POS DETAIL PLAN

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-004

SCALE: 0 2 4 6 8 10 m
SCALE 1 : 250 @

SW LANDSCAPE COLLECTIVE

WADANDI TRAIL

0.3m RETAINING WALL WITH LOW THREAT PLANTING ABOVE TO PROVIDE BAL SETBACK TO PRIVATE LOTS. MANAGEMENT OF THIS SECTION OF VEGETATION SUBJECT TO DETAILED DESIGN TO ENSURE COMPLIANCE WITH BMP REQUIREMENTS AND SETBACKS

FOOTPATH CONNECTION TO WADANDI TRAIL REGIONAL TRAIL NETWORK

POS LANDSCAPE PLANTING AND NATIVE TREES PROVIDE SEPARATION AND SCREENING TO PRIVATE LOT

CATCHMENT C/ F BASIN TO PROVIDE 2,000sqm OF BIOFILTRATION BASIN AREA. LANDSCAPED WITH NATIVE LOW RUSHES AND SEDGES FOR NUTRIENT STRIPPING AND FILTRATION. TALL NATIVE TREE PLANTING TO SURROUNDING EDGES / BATTERS TO HELP SHADE OUT WEEDS AND PROVIDE WIND BREAK FROM PREVAILING SOUTH-WESTERLY WINDS

FEATURE DECIDUOUS POS TREE PLANTING PROVIDING SEASONAL COLOUR AND SHADE AT FOCAL POINT

SEATING NODE WITH OUTLOOK OVER BASIN TO WADANDI TRAIL RESERVE BEHIND.



EXAMPLE PHOTO: LOW NATIVE RUSH AND SEDGE PLANTING

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BOLLARDS OR ACCESS GATE TO BE INSTALLED TO SoAMR REQUIREMENTS AND SUBJECT TO DETAILED DESIGN DRAWINGS

10.0m WIDE LANDSCAPE BUFFER TO SOUTHERN BOUNDARY AS VISUAL AND SPRAY DRIFT SCREEN FROM ADJACENT AGRICULTURAL USE.

MULCH ONLY OR GRAVEL MAINTENANCE ACCESS TO ALONG POS BOUNDARY INTERFACE WITH AGRICULTURAL LOT AND WADANDI TRAIL RESERVE

1 IN 100 YEAR FLOOD STORAGE AREA TO BE LANDSCAPED WITH LOW THREAT PLANTING AND MULCH WITH CLUMPS OF TALL NATIVE TREES AT MIN 5.0m CANOPY SEPARATION AND MAX. 15% CANOPY COVER TO APZ STANDARDS



EXAMPLE PHOTO: LOW NATIVE RUSH AND SEDGE PLANTING

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 04 CATCHMENT C/F BIOFILTRATION BASIN AND 1 IN 100 YR FLOOD STORAGE AREA
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SWALE AND BIOFILTRATION PLANTING AREAS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- LANDSCAPE BUFFER SCREEN TREE PLANTING
- POS NATIVE DRAINAGE TREE PLANTING
- EXISTING SURVEYED TREE TO BE RETAINED
- EXISTING SURVEYED TREE TO BE REMOVED

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.

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3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

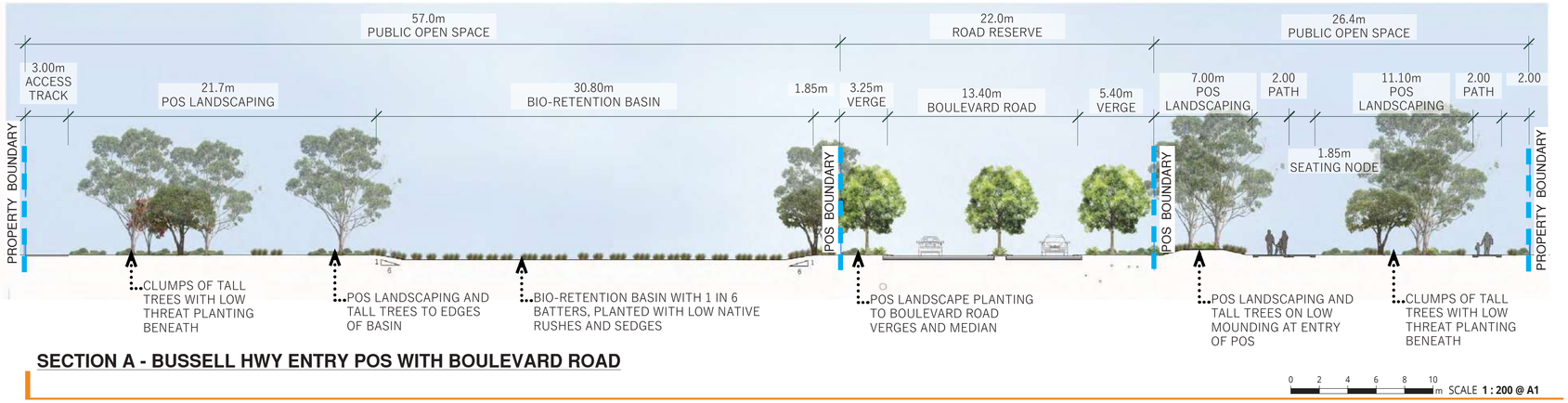
LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - SOUTHERN DRAINAGE POS DETAIL PLAN

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-005

SCALE: 0 2 4 6 8 10 m
SCALE 1 : 250 @

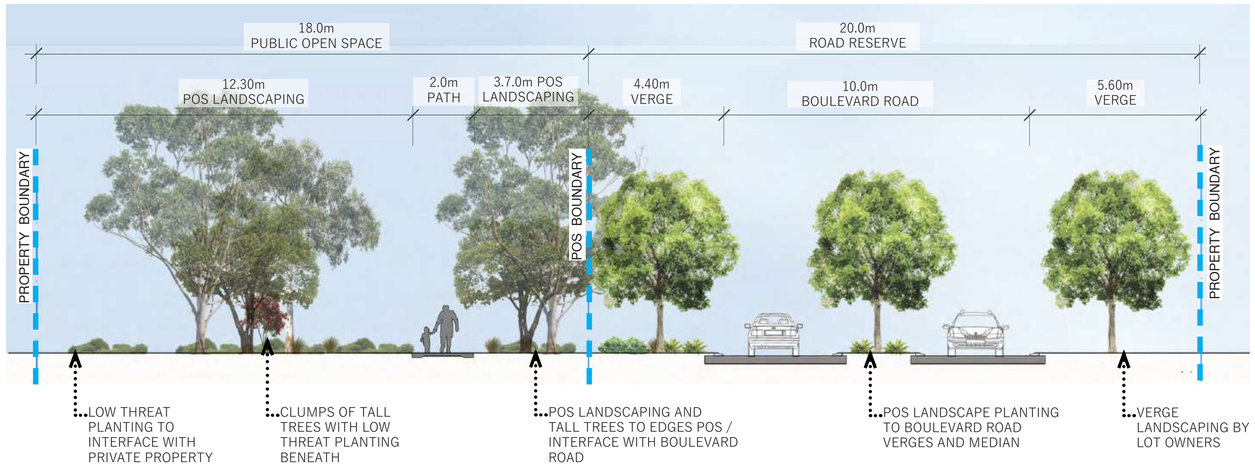
SW LANDSCAPE COLLECTIVE



SECTION A - BUSSELL HWY ENTRY POS WITH BOULEVARD ROAD



EXAMPLE PHOTO: LOW THREAT PLANTING SURROUNDING EXISTING TREES



SECTION D - SUNSET DRIVE LINEAR POS ENTRY

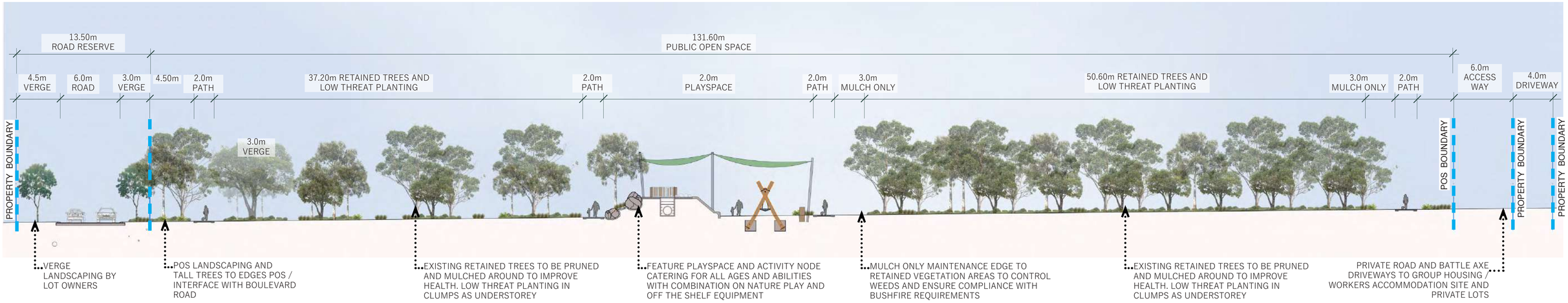
0 1 2 3 4 5 m SCALE 1 : 100 @ A1



EXAMPLE PHOTO: EXISTING TREES RETAINED IN VERGES AND POS



EXAMPLE PHOTO: EXISTING TREES RETAINED TURF POS



SECTION E - NORTHERN POS WITH PLAY SPACE

0 2 4 6 8 10 m SCALE 1 : 200 @ A1

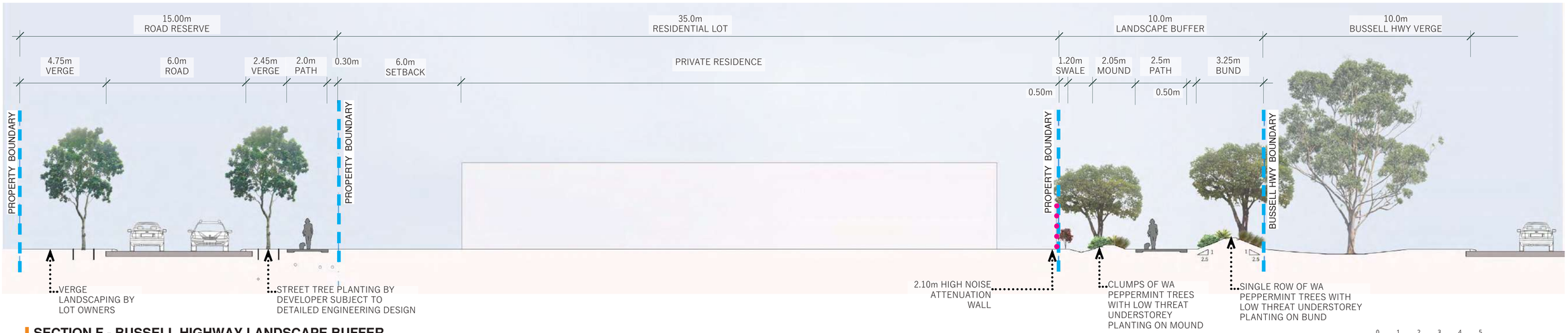
LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - NATURE PLAYGROUND SECTIONS AND IMAGERY

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-006

SCALE: 1:200 @A1

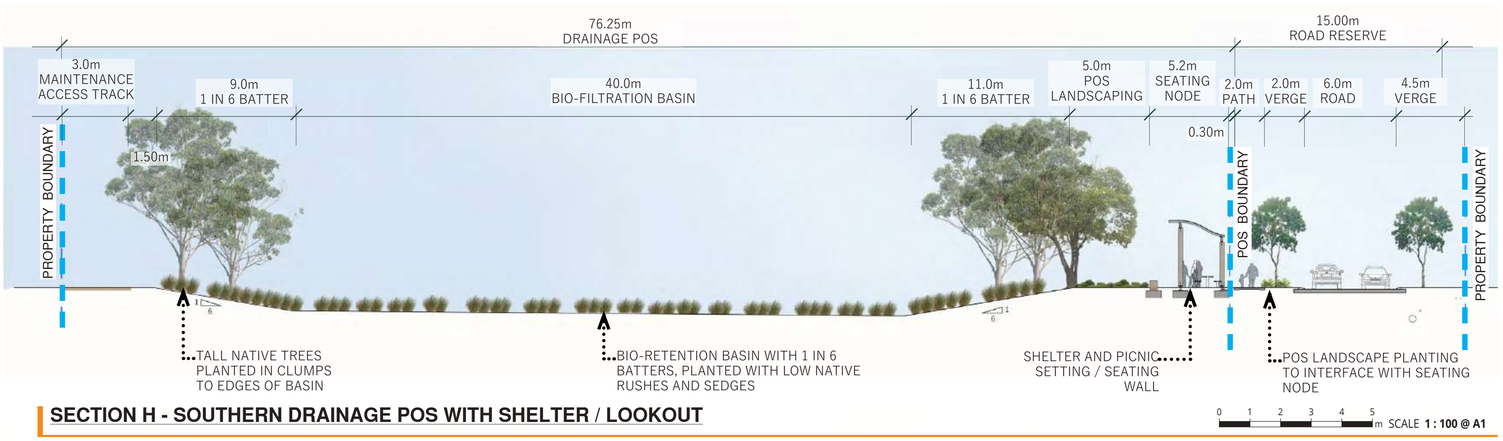
SW LANDSCAPE COLLECTIVE



SECTION F - BUSSELL HIGHWAY LANDSCAPE BUFFER



SECTION G - SOUTHERN LOTS WITH LANDSCAPE TRANSITION BUFFER



SECTION H - SOUTHERN DRAINAGE POS WITH SHELTER / LOOKOUT



EXAMPLE PHOTO: COWARAMUP MAIN STREET FEATURE PLANTING PALETTE



EXAMPLE PHOTO: SIMPLE SEATING NODE IN POS

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE CONCEPT PLAN - TYPICAL SECTIONS

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-007

SCALE: 1:100 @A1

SW LANDSCAPE COLLECTIVE



EXAMPLE RURAL STYLE PINCIC SHELTERS





BENCH SEATING



EXAMPLE NATURE PLAY ELEMENTS



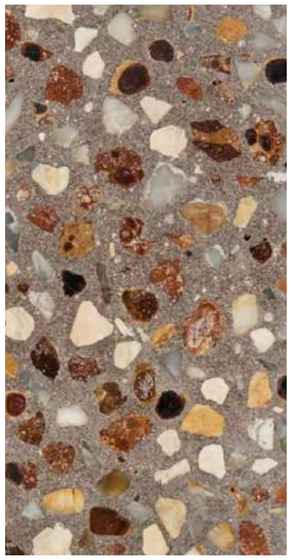




COASTAL LIMESTONESW GRANITE



CUSTOM SITE FURNITURE UTILISING RECYCLED TIMBER MATERIALS



EXPOSED AGG CONCRETE FEATURES



EXISTING SITE LOGS RECYCLED AS POS AND LANDSCAPE FEATURES



EXAMPLE ARTWORK / FEATURE / PLAY ITEMS



COMBINATION OF NATURAL MATERIALS IN SEATING NODES



SIMPLE HALF COURT AND LINEMARKING GAMES



SITE LOGS FOR PLAYGROUND AND LANDSCAPE FEATURES

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE CONCEPT PLAN - HARDSCAPE MATERIAL PALETTE

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-008

SCALE: N/A

SW LANDSCAPE COLLECTIVE

TREE SPECIES

STREET TREES
Agonis flexousa - WA Peppermint
Corymbia calyphylla Grafted Varieties - Marri
Corymbia ficifolia - Red Flowering Gum
Eucalyptus torquata - Coral Gym
Eucalyptus patens - Blackbutt
Hakea laurina - Pin Cushion Hakea

PUBLIC OPEN SPACE TREES
Agonis flexousa - WA Peppermint
Banksia grandis - Bull Banksia
Corymbia calyphylla - Marri
Eucalyptus diversicolour - Karri
Eucalyptus marginata - Jarrah
Eucalyptus patens - Blackbutt
Eucalyptus rudis - River Gum
Melaleuca rhaphiophylla - Swamp Paperbark
Quercus rubra - Red Oak





Agonis flexuosa



Anigozanthus manglessii



Atriplex cinerea



Banksia nivea



Beaufortia squarrosa

LOW THREAT FIRE RESISTANT PLANT SPECIES

SHRUBS AND GRASSES
Anigozanthus manglesii - Red and Green Kangaroo Paw
Atriplex cinerea - Grey Saltbush
Beaufortia squarrosa - Sand Bottlebrush
Calothamnus quadrifidus - Onesided Bottelbrush
Casuarina glauca - Cousin IT
Lepidosperma gladiatum - Coastal Sword Sedge
Olearia axillaris - Coastal Daisy Bush

GROUND COVERS
Banksia nivea - Honeypot Dryandra
Conostylis aculeata - Prickly Conostylis
Eremophila glabra - Emu Bush
Grevillea junipera - Juniper-leaved Grevillea
Hemiandra pungens - Snake bush
Kennedia coccinea - Running Postman
Myoporum parvifolium Creeping Boobialla
Pandorea jasminoides - Star Jasmin
Scaevola aemula - Fairy Fan Flower





Calothamnus quadrifidus



Casuarina Cousin IT



Conostylis aculeata



Ficinia nodosa

FEATURE POS PLANTING SPECIES

TREES
Agonis flexuosa - WA Peppermint Tree
Banksia grandis - Bull Banksia
Hakea lauraina - Pin Cushion Hakea

SHRUBS
Adenanthos cuneatus - Kalbarri Carpet
Anigozanthis flavisua - Yellow Kangaroo Paw
Anigozanthus manglesii - Red and Green Kangaroo Paw
Billardiera fusiformis - Australian Bluebell
Beaufortia squarrosa - Sand Bottlebrush
Calothamnus quadrifidus - Onesided Bottelbrush
Casuarina glauca - Cousin IT
Grevillea olivacea - Olive-Leaved Grevillea
Lepidosperma gladiatum - Coastal Sword Sedge
Lepidosperma Twilight Green
Meebolidna scariosa - Velve Rush
Templetonia retusa - Cockiets Tongue

GROUND COVERS
Banksia nivea - Honeypot Dryandra
Conostylis aculeata - Prickly Conostylis
Grevillea GinGin Gem
Lomandra Seasprayt
Melaleuca heugelli - White Rambler
Myoporum parvifolium Creeping Boobialla
Scaevola crassifolia - Purple Fan Flower





Grevillea Gingin Gem



Grevillea olivacea



Hakea laurina



Juncus pallidus



Lepidosperma gladiatum

DRAINAGE BASIN AND SWALE PLANTING SPECIES

TREES
Melaleuca rhaphiophylla

GROUND COVERS
Baumea juncea
Carex appressa
Ficinia nodosa
Meeboldina scariosa
Juncus pallidus
Scheonoplectus validus





Lomandra longifolia



Meeboldina scariosa



Melaleuca incana nana



Myoproum parvifolium

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE CONCEPT PLAN - SOFTSCAPE MATERIAL PALETTE

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-009

SCALE: N/A

SW LANDSCAPE COLLECTIVE



LEGEND

- SURVEYED TREE LOCATION
  - TREE NUMBER ON ARBORIST REPORT
  - TREE COMMON NAME
  - ASSESSED TREE CONDITION
  - TRUNK DIAMETER (mm)
- TREE CONDITION RATING - GOOD
- TREE CONDITION RATING - FAIR
- TREE CONDITION RATING - POOR
- TREE CONDITION RATING - DEAD

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

STANDARD NOTES

1. **SET OUT & DIMENSIONS.** THE CONTRACTOR SHALL SET OUT ALL PATHS, WALLS, HARD SURFACES AND ELEMENTS EITHER ON SITE PRIOR TO CONSTRUCTION AND SHALL OBTAIN THE SUPERINTENDENTS APPROVAL PRIOR TO WORKS COMMENCING. WRITTEN DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALE. CHECK ALL DRAWING SCALES IN CONJUNCTION WITH DRAWING SIZE.
2. **SERVICES & SITE ASSETS.** THE CONTRACTOR SHALL INVESTIGATE THE NATURE AND LOCATION OF ALL EXISTING SERVICES AND RETAINED SITE ASSETS AFFECTED BY THEIR WORKS. FAILURE TO TAKE DUE CARE SHALL NOT LIMIT THE CONTRACTORS LIABILITIES.
3. **REFERENCE.** THE CONTRACTOR SHALL REFER TO ALL CONTRACT DOCUMENTS, THE SPECIFICATION AND DRAWINGS PRIOR TO AND DURING THE WORKS.
4. **DISCREPANCIES.** NOTIFY SUPERINTENDENT OF ANY SUSPECTED OR KNOWN DISCREPANCIES OR ERRORS PRIOR TO THE ORDERING OF AFFECTED MATERIALS AND OR CONSTRUCTION OF AFFECTED WORKS.
5. **RELEVANT STANDARDS.** THE CONTRACTOR SHALL UNDERTAKE ALL PRICING AND WORKS IN ACCORDANCE WITH CURRENT INDUSTRY BEST PRACTICE AND ALL RELEVANT AUSTRALIAN STANDARDS.
6. **SERVICE LOCATOR.** THE CONTRACTOR SHALL UNDERTAKE A DIAL BEFORE YOU DIG PROCESS PRIOR TO COMMENCING WORKS ON SITE. THE CONTRACTOR SHALL ENGAGE A SERVICE LOCATOR TO MAP THE SPECIFIC LOCATIONS AND DEPTH OF ALL SERVICES AND ADVISE ALL RELEVANT STAFF AND SUBCONTRACTORS IN WRITING PRIOR TO COMMENCING WORKS ON SITE.

SW LANDSCAPE COLLECTIVE

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WEBSITE: WWW.SWLANDSCAPE.COM.AU
PHONE: +61 418 947 889

REV	DATE	BY	ISSUE OR AMENDMENT
D	12.10.23	CE	UPDATED SURVEY INFORMATION
C	09.10.23	CE	ADDITION OF MEMORIAL DRIVE ROAD RESERVE TREES
B	19.09.23	CE	ADDITION OF SUNSET DRIVE ROAD RESERVE TREES
A	13.09.23	CE	ISSUE FOR APPROVAL

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
EXISTING TREE ARBORIST CONDITION SUMMARY

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE
1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER
GFC-01-101

REVISION
D



LEGEND

SURVEYED TREE LOCATION - TREE TO BE RETAINED

SURVEYED TREE LOCATION - TREE TO BE REMOVED

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

STANDARD NOTES

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REV	DATE	BY	ISSUE OR AMENDMENT
E	12.10.23	CE	UPDATED SURVEY INFORMATION
D	09.10.23	CE	ADDITION OFMEMORIAL DRIVE ROAD RESERVE TREES
C	22.09.23	CE	ADDITION OF ENGINEERS SIGHTLINE REVIEW
B	19.09.23	CE	ADDITION OF SUNSET DRIVE ROAD RESERVE TREES
A	13.09.23	CE	ISSUE FOR CLIENT REVIEW

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
PRELIMINARY SITE CLEARING / TREE REMOVAL PLAN

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE 1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER GFC-01-102

REVISION E



LEGEND

SURVEYED TREE LOCATION - TREE TO BE RETAINED

SURVEYED TREE LOCATION - TREE TO BE REMOVED

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

STANDARD NOTES

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
PRELIMINARY SITE CLEARING / TREE REMOVAL PLAN

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE
1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER
GFC-01-103

REVISION
E

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Appendix 6

Noise Management Plan

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PO Box 717
Hillarys WA 6923
T: 9401 7770
www.lgacoustics.com.au

Structure Plan Transportation Noise Assessment

Lot 102 Bussell Highway, Cowaramup

Reference: 23078214-01

Prepared for:
Goldfields

Reference: 23078214-01

Lloyd George Acoustics Pty Ltd
ABN: 79 125 812 544

PO Box 717
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Date	Rev	Description	Author	Verified
3-Oct-23	0	Issued to Client	Matt Moyle	Terry George
18-Oct-23	1	Finalised with Masterplan	Matt Moyle	Terry George

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Figure 5-3: Noise Mitigation – Ground Floor Level 12

Figure 5-4: Noise Mitigation – Upper Floor Level 13

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1. INTRODUCTION

It is proposed to subdivide land at Lot 102 Bussell Highway, Cowaramup (refer *Figure 1-1*) with the proposed structure plan shown in *Figure 1-2*. The site adjoins Bussell Highway, which is considered a 'Strategic Freight/Major Traffic Route as shown on PlanWA Maps, such that a noise assessment is required in accordance with *State Planning Policy No. 5.4 Road and Rail Noise*, being the subject of this report.



Figure 1-1: Subdivision Location (Source: DPLH PlanWA)

Appendix B contains a description of some of the terminology used throughout this report.



Figure 1-2: Concept Masterplan

2. CRITERIA

The criteria relevant to this project is provided in *State Planning Policy No. 5.4 Road and Rail Noise* (hereafter referred to as SPP 5.4) produced by the Western Australian Planning Commission (WAPC). SPP 5.4 is supported by the *Road and Rail Noise Guidelines* (the Guidelines) and the Department of Planning, Lands and Heritage mapping. The objectives of SPP 5.4 are to:

- Protect the community from unreasonable levels of transport noise;
- Protect strategic and other significant freight transport corridors from incompatible urban encroachment;
- Ensure transport infrastructure and land-use can mutually exist within urban corridors;
- Ensure that noise impacts are addressed as early as possible in the planning process; and
- Encourage best practice noise mitigation design and construction standards.

Table 2-1 sets out noise targets that are to be achieved by proposals under which SPP 5.4 applies. Where the targets are exceeded, an assessment is required to determine the likely level of transport noise and management/mitigation required.

Table 2-1: Noise Targets for Noise Sensitive Land-Use

Scenario	Outdoor Noise Target		Indoor Noise Target	
Noise-sensitive land-use and/or development	55 dB $L_{Aeq(Day)}$	50 dB $L_{Aeq(Night)}$	40 dB $L_{Aeq(Day)}$ (Living and Work Areas)	35 dB $L_{Aeq(Night)}$ (Bedrooms)

Notes:

- Day period is from 6am to 10pm and night period from 10pm to 6am.
- The outdoor noise target is to be measured at 1-metre from the most exposed, habitable[1] facade of a noise sensitive building.
- For all noise-sensitive land-use and/or development, indoor noise targets for other room usages may be reasonably drawn from Table 1 of Australian Standard/New Zealand Standard AS/NZS 2107:2016 *Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors* (as amended) for each relevant time period.
- Outdoor targets are to be met at all outdoor areas as far as is reasonable and practicable to do so using the various noise mitigation measures outlined in the Guidelines.

The application of SPP 5.4 is to consider anticipated traffic volumes for the next 20 years from when the noise assessment has been undertaken.

[1] A habitable room is defined in State Planning Policy 3.1 as a room used for normal domestic activities that includes a bedroom, living room, lounge room, music room, sitting room, television room, kitchen, dining room, sewing room, study, playroom, sunroom, gymnasium, fully enclosed swimming pool or patio.

3. METHODOLOGY

Noise measurements and modelling have been undertaken in accordance with the requirements of SPP 5.4 and associated Guidelines, as described in *Section 3.1* and *Section 3.2*.

3.1. Site Measurements

Noise monitoring was undertaken on site using a Ngara Noise Data Logger (S/N: 8780F4) (refer *Figure 3-1*). The logger was programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. The logger complies with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The logger was field calibrated before and after the measurement session and found to be accurate to within ± 1 dB. Lloyd George Acoustics holds current laboratory calibration certificate for the logger.

The microphone was approximately 1.4 metres above existing ground level and approximately 10 metres from the edge of Bussell Highway main carriageway. The measurements were recorded between 29 August 2023 and 5 September 2023.



Figure 3-1: Photograph of Noise Logger on Site

3.2. Noise Modelling

The computer program *SoundPLAN 8.2* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms, modified to reflect Australian conditions. The modifications included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Class 1 and 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two source heights at 1.5 metres and 3.6 metres above road level;
- A -0.8 dB correction has been applied to the lower level heavy vehicle noise source and -8.0 dB to the higher level noise source based on the *Transportation Noise Reference Book*; Paul Nelson (1987), so as to provide consistent results with the CoRTN algorithms.

Predictions are made at heights of 1.4 metres above ground floor level for single storey buildings and 4.2 metres above ground floor level for possible first floors of double storey buildings. The noise is predicted at 1-metre from an assumed building façade, resulting in a + 2.5 dB correction due to reflected noise. It is noted that the structure plan does not provide precise lot layouts, and also includes a portion of land for R60 (grouped housing). As such, only indicative housing envelopes are included in the model to provide some noise mitigation options.

Various input data are included in the modelling and these are discussed in *Section 3.2.1* to *Section 3.2.5*.

3.2.1. Ground Topography

Topographical data was provided by the design team including survey information for the existing site, and surrounding area topography. In the absence of design levels for the structure plan cells, the existing terrain has been assumed at this stage.

Indicative building outlines have been included as these can provide barrier attenuation when located between a source and a receiver, in much the same way as a hill or wall. All buildings are assumed to be single storey with heights of 3.5 metres. This means where modelling is undertaken to a possible upper floor, the noise is predicting above these building outlines.

3.2.2. Road Surface

The corrections applied for different road surface finishes are provided in *Table 3-1*.

Table 3-1: Noise Relationship Between Different Road Surfaces

Chip Seal				Asphalt			
14mm	10mm	5mm	Slurry	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	+1.0 dB	0.0 dB	-0.2 dB	-1.5 dB	-2.5 dB

The existing road surface is 14mm chip seal and assumed to remain unchanged into the future.

3.2.3. Vehicle Speed

The existing posted speed is 60 km/hr and assumed to remain unchanged into the future.

3.2.4. Traffic Volumes

Existing traffic volumes were obtained from Main Roads WA Traffic Map. Forecast 2043 traffic volumes were determined by way of a 1.2% growth rate per annum, as advised by Main Roads WA (Scott Hazebroek, Traffic Modelling Analyst, Reference: #42668). The existing and forecast volumes were determined as presented *Table 3-2* and used in the noise modelling. Note that the percentage heavy vehicles are assumed to be the same in the future as existing.

Table 3-2: Traffic Information Used in Noise Modelling

Parameter	Scenario	
	Existing – 2023	Future – 2043
	Both Directions	Both Directions
24-hour Volume	8,124	10,313
% Heavy	12.8	12.8

3.2.5. Ground Absorption

The ground absorption has been assumed to be 0.0 (0%) for the roads, 0.5 (50%) outside of the roads and 1.0 (100%) for public open spaces, noting that 0.0 represents hard reflective surfaces such as water and 1.0 represents absorptive surfaces such as grass.

4. RESULTS

4.1. Noise Monitoring

The results of the noise monitoring are summarised in *Table 4-1* and shown graphically in *Figure 4-1*.

Table 4-1: Measured Average Noise Levels at Logger

Date	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
Wednesday, 30 August 2023	68.0	65.3	67.0	53.2
Thursday, 31 August 2023	68.4	64.9	66.5	54.9
Friday, 1 September 2023	70.0	66.0	67.7	54.3
Monday, 4 September 2023	68.1	65.7	67.3	57.0
Average	**68.6**	**65.5**	**67.1**	**54.9**

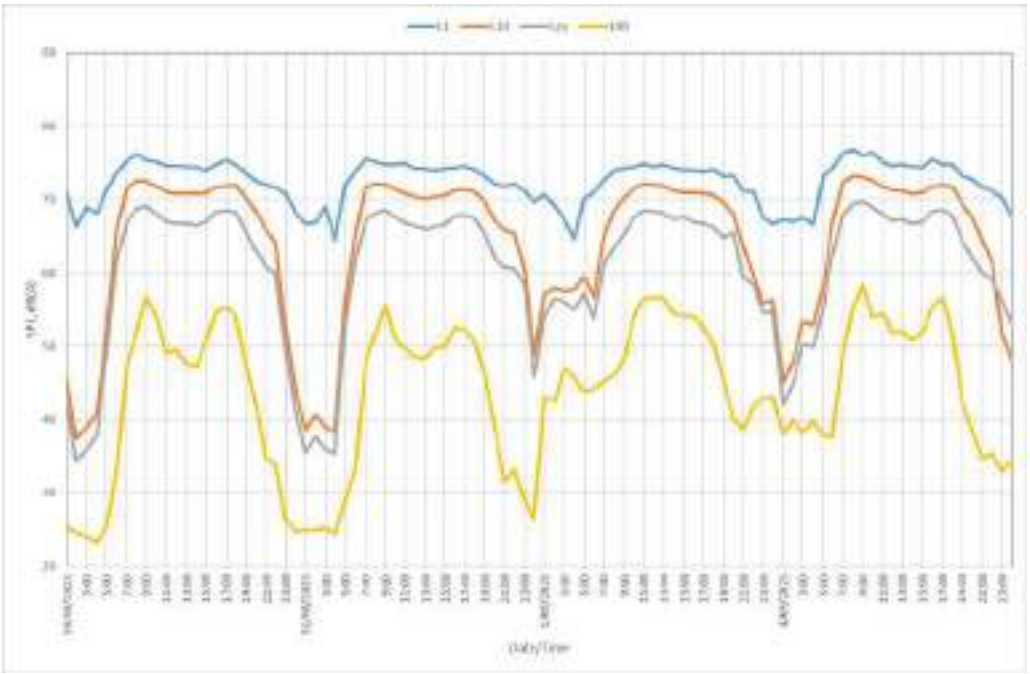
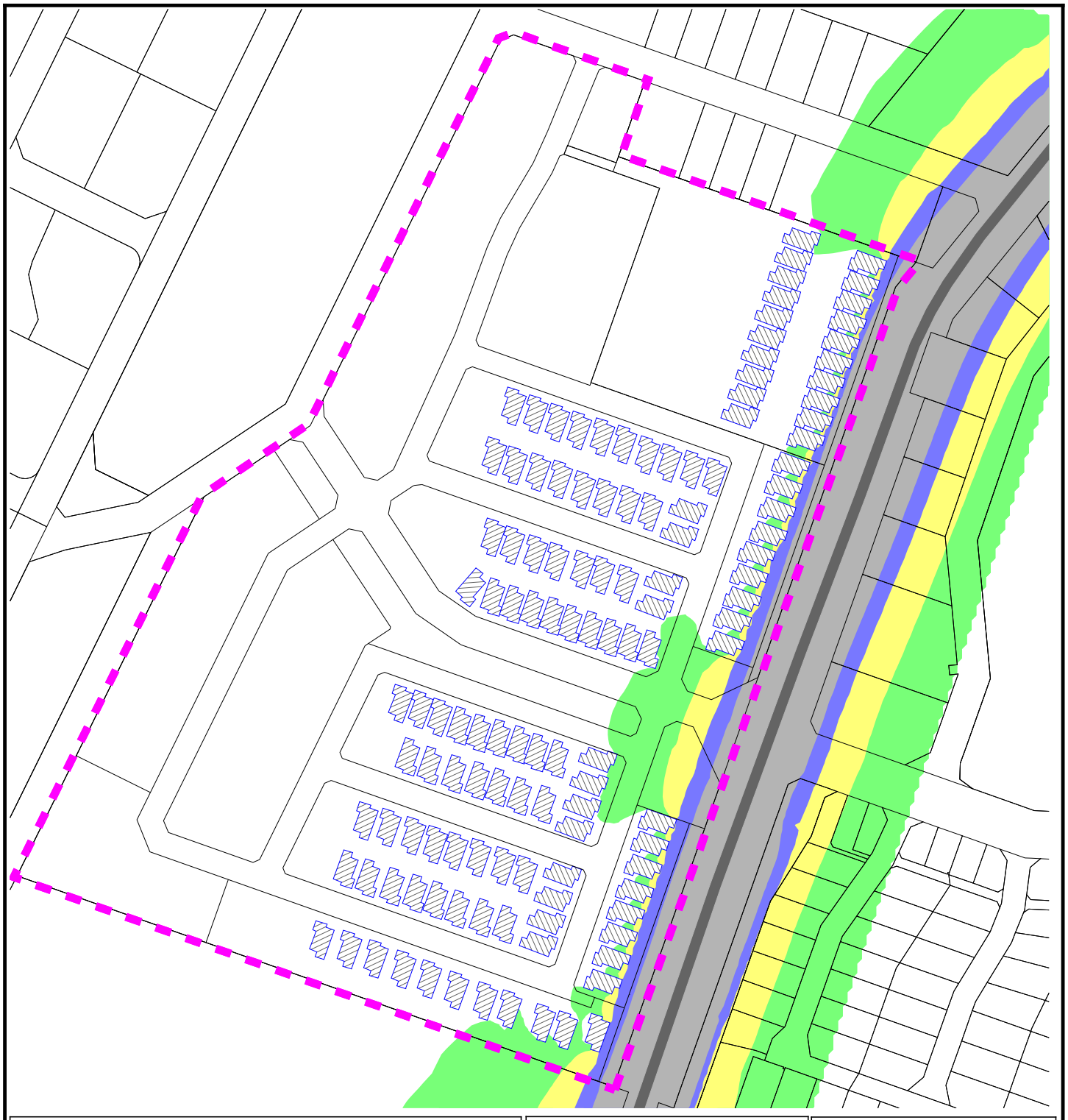


Figure 4-1: Hourly Noise Measurement Results at Noise Logger

The average difference between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 12.6 dB and this same difference has been assumed to exist in future years. As the difference between these two parameters is more than 5 dB, it is the daytime noise that will dictate compliance or otherwise (refer *Section 2*).

4.2. Noise Modelling

The noise model was initially set-up for existing conditions and calibrated to the noise measurement location. The model is then updated to include the proposed subdivision, indicative buildings and future traffic volumes, maintaining the same model calibration. The results of the noise modelling are provided as noise contour plots in *Figure 4-2* and representing ground floor noise levels.



Lot 102 Bussell Highway, Cowaramup
Future Noise Level Contours

$L_{Aeq(Day)}$ Noise Level Contours Based on Future Conditions Ground Floor Level

SoundPlan v8.2
CoRTN Algorithms

22 September 2023

Signs and symbols

- Indicative Building
- Bussell Hwy
- Subject Site

N

Noise levels $L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

Lloyd George Acoustics
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HILLARYS WA 6923
(08) 9401 7770

Length Scale 1:3500

0 20 40 80 120 160 m

Figure 4-2

5. ASSESSMENT

The objectives of SPP 5.4 are to achieve:

- Indoor noise levels specified in *Table 2-1* in noise-sensitive areas (e.g. bedrooms and living rooms of houses); and
- A reasonable degree of acoustic amenity for outdoor living areas on each residential lot.

Where the outdoor noise targets of *Table 2-1* are achieved, no further noise controls are necessary. With reference to *Section 4.2*, it is evident the outdoor noise target will be exceeded at some lots.

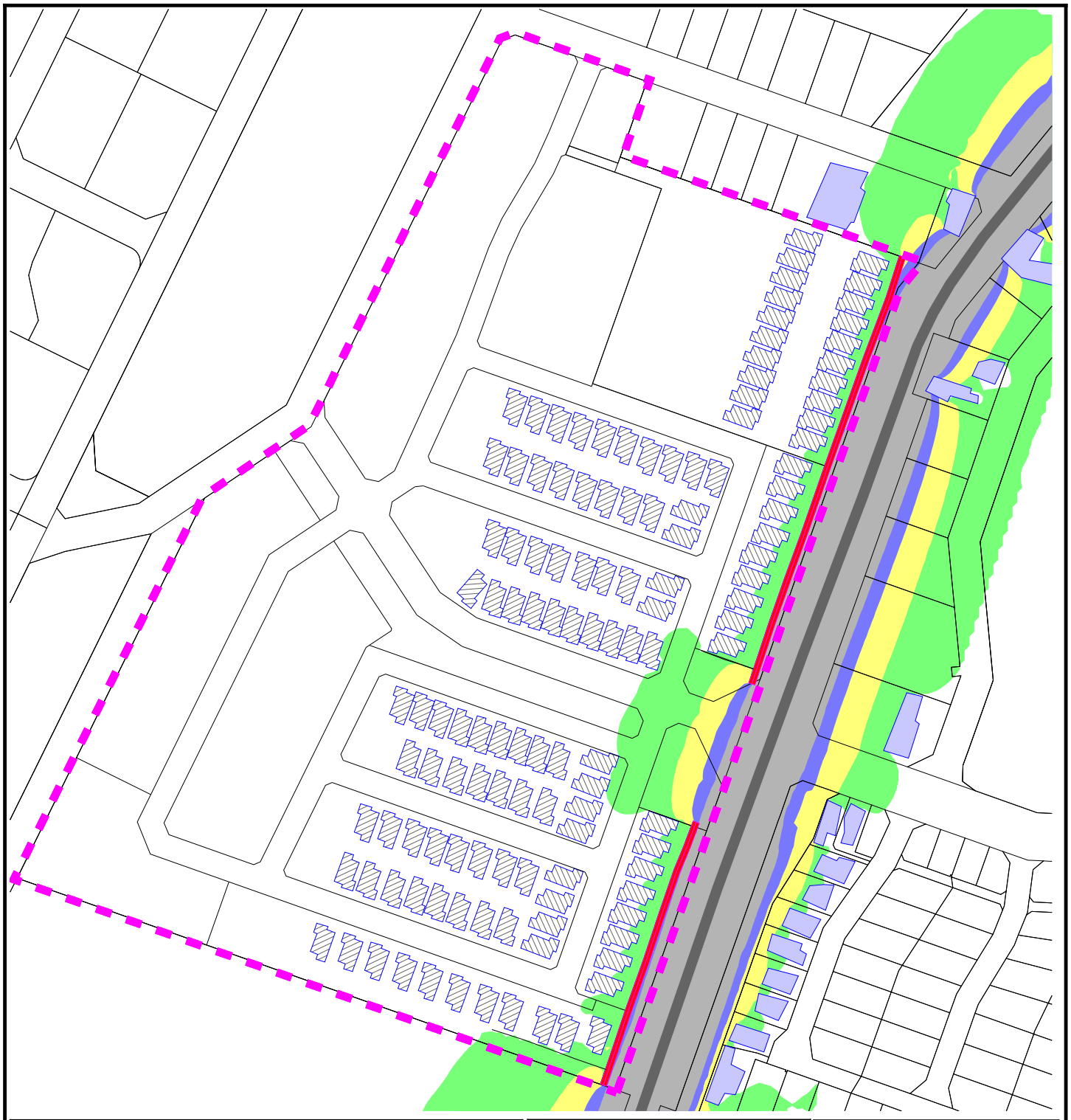
It should be noted that to mitigate noise to below the outdoor noise target is not considered reasonable or practicable. With reference to the various Exposure Levels, these are:

- Exposure A – 56 to 58 dB $L_{Aeq(Day)}$;
- Exposure B – 59 to 62 dB $L_{Aeq(Day)}$;
- Exposure C – 63 to 66 dB $L_{Aeq(Day)}$.

Without any mitigation (i.e. no noise walls) the worst case levels will be within Exposure C for future houses closest to the transport corridor. As such, a 2.0m high noise bund or wall meets the minimum requirements for mitigation, particularly where outdoor living areas are positioned facing the corridor. Where the barrier is to be a wall, construction is to be solid, free of gaps and constructed of a material having a minimum surface mass of 15 kg/m^2. The noise contours with such a barrier (bund is shown on figures, but a wall would be equivalent) are demonstrated in *Figure 5-1* and *Figure 5-2* for ground and upper floors, respectively.

In addition to a noise wall, quiet House Packages are required to dwellings on lots shown on *Figure 5-3* and *Figure 5-4*, being for ground floor and first floor levels respectively. Note that the buildings shown are indicative only, and a precise lot layout and finished lot levels should be made available for a finalised assessment of the barrier and to inform a local development plan. *Appendix A* provides the Quiet House Packages, as taken from the SPP 5.4 Guidelines.

Alternatives to the provided Packages can be accepted if supported by a report from a suitably qualified acoustical consultant (member firm of the Association of Australasian Acoustical Consultants (AAAC)) once the specific house plans for the lot are available. In addition, each of these lots will require a notification on title in accordance with SPP 5.4.



Lot 102 Bussell Highway, Cowaramup
Future Noise Level Contours with 2m Bund

$L_{Aeq(Day)}$ Noise Level Contours Based on Future Conditions Ground Floor Level

Bund Height Relative to Existing Ground Level

SoundPlan v8.2
CoRTN Algorithms

29 September 2023

Signs and symbols

- Indicative Building
- Existing building
- Bussell Hwy
- Subject Site
- 2m High Noise bund

N

Noise levels $L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

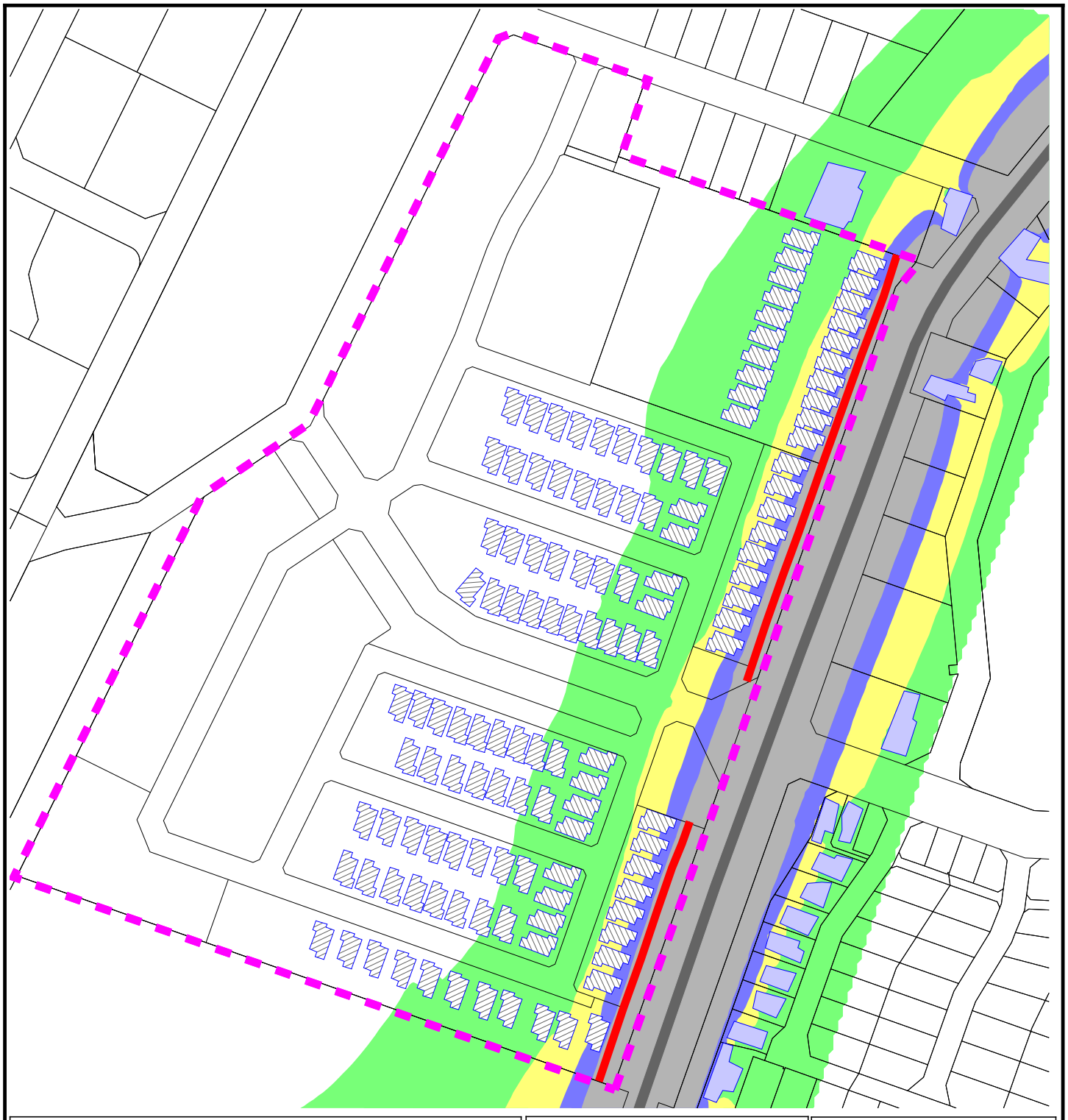
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(08) 9401 7770

Length Scale 1:3500

0 20 40 80 120 160 m

Figure 5-1



Lot 102 Bussell Highway, Cowaramup
Future Noise Level Contours with 2m Bund

$L_{Aeq(Day)}$ Noise Level Contours Based on Future Conditions Upper Floor Level

Bund Height Relative to Existing Ground Level

SoundPlan v8.2
CoRTN Algorithms

29 September 2023

Signs and symbols

- Indicative Building
- Existing building
- Bussell Hwy
- Subject Site
- 2m High Noise Bund

N

Noise levels $L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

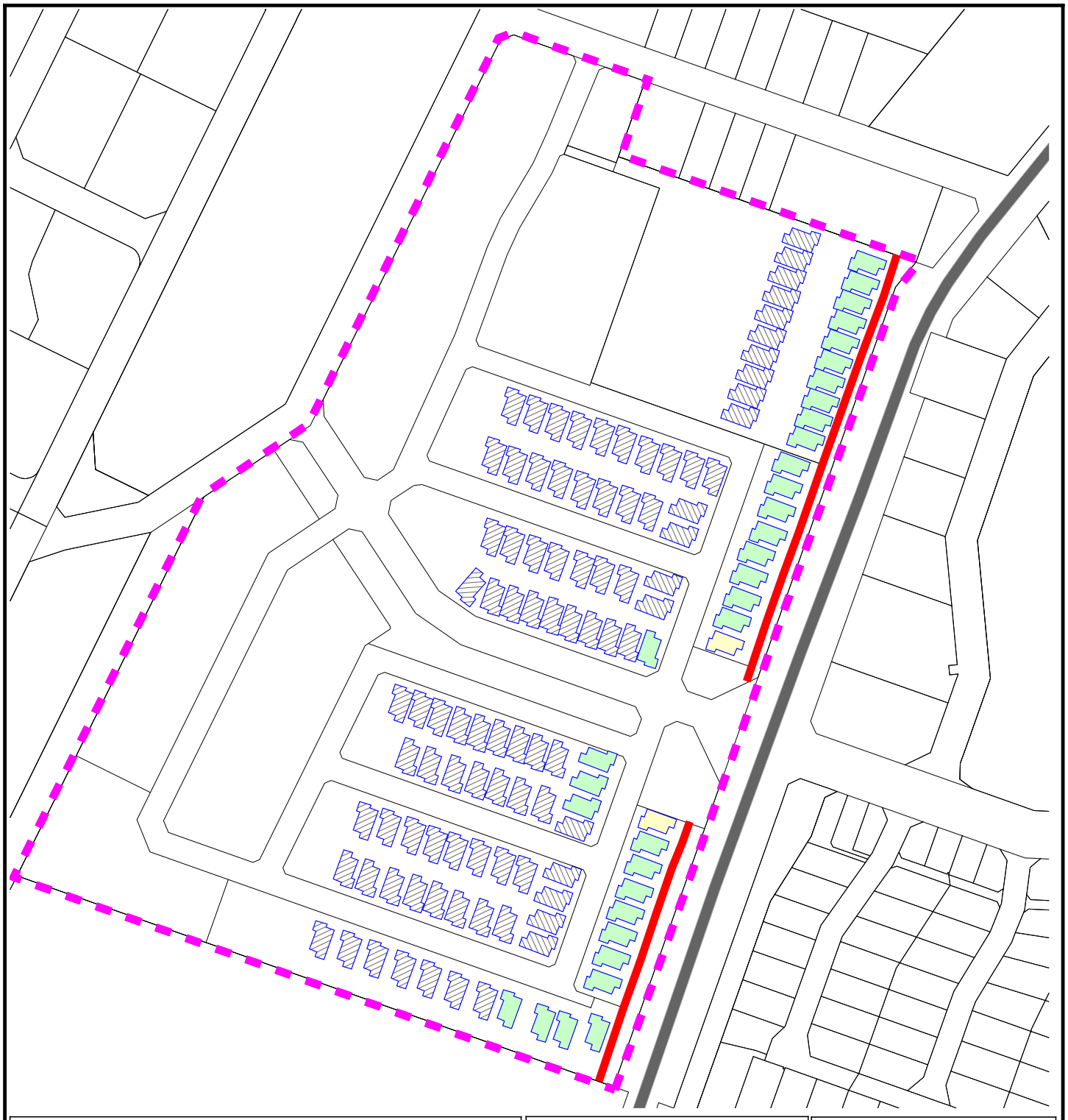
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0 20 40 80 120 160 m

Figure 5-2



Lot 102 Bussell Highway, Cowaramup
Mitigation Packages with 2m Bund

Based on Future Conditions
Ground Floor Level

Bund Height Relative to Existing Ground Level

SoundPlan v8.2

29 September 2023

Signs and symbols

- Package A
- Package B
- Bussell Hwy
- Subject Site
- 2.4m High Wall

N

Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

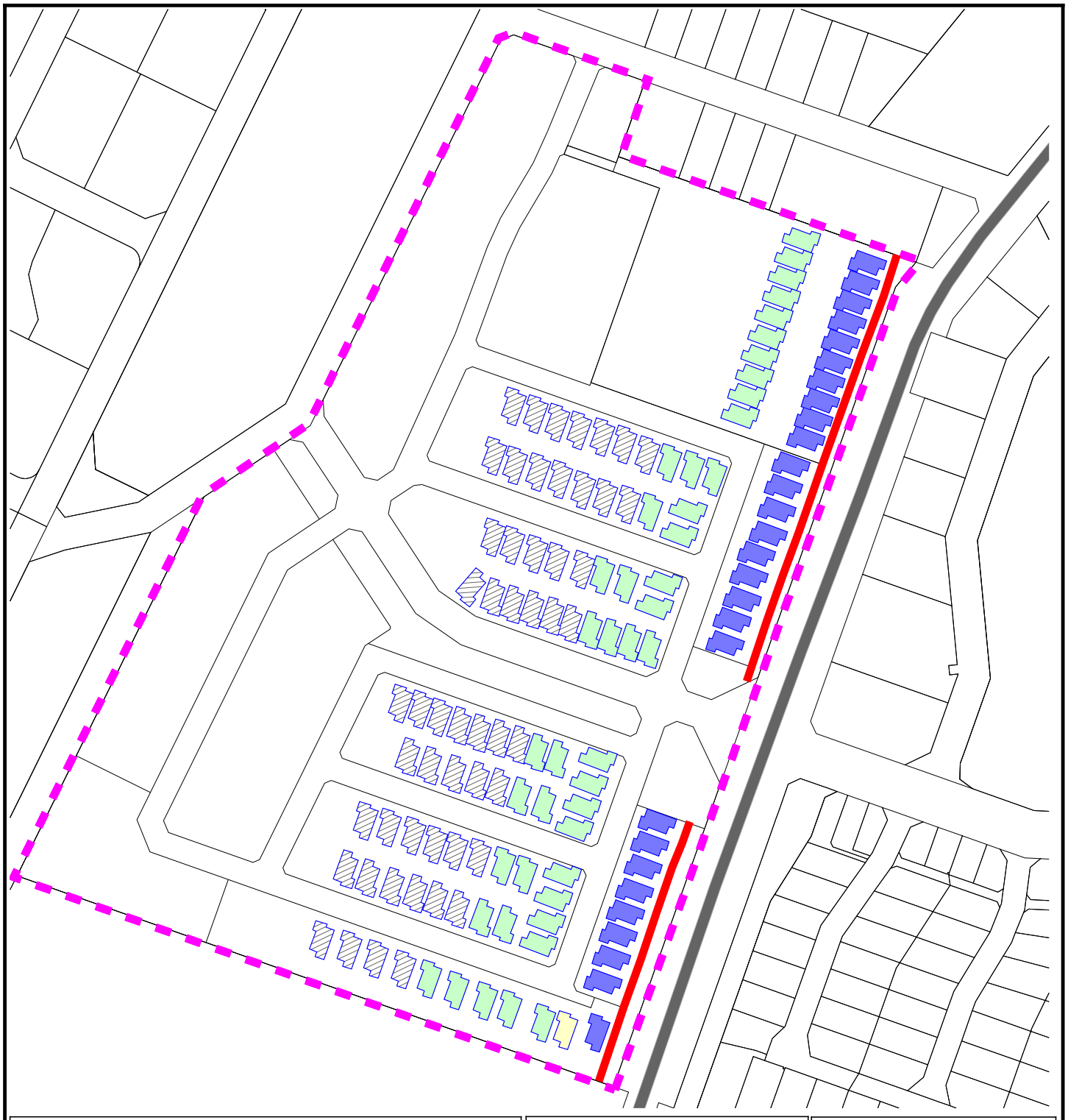
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(08) 9401 7770

Length Scale 1:3500

0 20 40 80 120 160 m

Figure 5-3



Lot 102 Bussell Highway, Cowaramup
Mitigation Packages with 2m Bund

Based on Future Conditions
Upper Floor Level

Bund Height Relative to Existing Ground Level

SoundPlan v8.2

29 September 2023

Signs and symbols

- Package A
- Package B
- Package C
- Bussell Hwy
- Subject Site
- 2m High Bund

N

Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

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Length Scale 1:3500

0 20 40 80 120 160 m

Figure 5-4

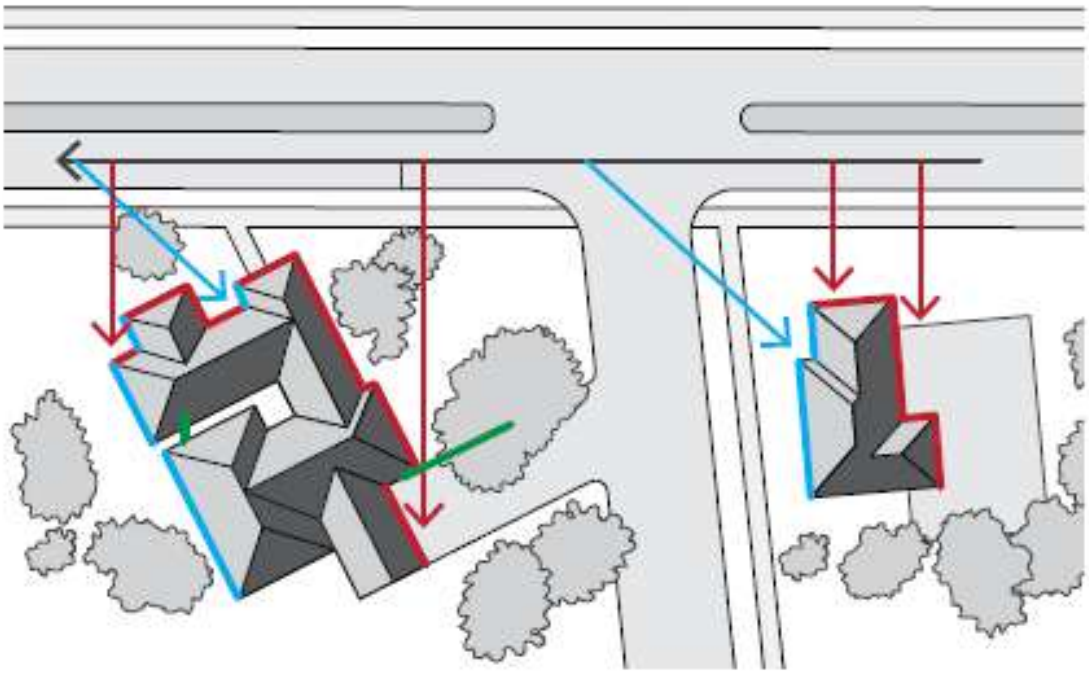
Appendix A – Quiet House Packages

The packages and information provided on the following pages are taken from *Road and Rail Noise Guidelines* (September 2019).

Where outdoor and indoor noise levels received by a noise-sensitive land-use and/or development exceed the policy's noise target, implementation of quiet house requirements is an acceptable solution.

With regards to the packages, the following definitions are provided:

- **Facing** the transport corridor (red): Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular (at a 90 degree angle) to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).
- **Side-on** to transport corridor (blue): Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line, at any angle, can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).
- **Opposite** to transport corridor (green): Neither 'side on' nor 'facing', as defined above.



Quiet House Package A

56-58 dB $L_{Aeq(Day)}$ & 51-53 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): – Sliding or double hung with minimum 10mm single or 6mm-12mm-10mm double insulated glazing; – Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$): – Sealed awning or casement windows with minimum 6mm glass.	• Up to 40% floor area ($R_w + C_{tr} \geq 25$): – Sliding or double hung with minimum 6mm single or 6mm-12mm-6mm double insulated glazing; • Up to 60% floor area ($R_w + C_{tr} \geq 28$); • Up to 80% floor area ($R_w + C_{tr} \geq 31$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	No specific requirements	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.	• Doors to achieve $R_w + C_{tr} \geq 25$: – 35mm Solid timber core hinged door and frame system certified to R_w 28 including seals; – Glazed sliding door with 10mm glass and weather seals.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less.	
	Opposite	No specific requirements	
External Walls	All	• $R_w + C_{tr} \geq 45$: – Two leaves of 90mm thick clay brick masonry with minimum 20mm cavity; or – Single leaf of 150mm brick masonry with 13mm cement render on each face; or – One row of 92mm studs at 600mm centres with: ▪ Resilient steel channels fixed to the outside of the studs; and ▪ 9.5mm hardboard or fibre cement sheeting or 11mm fibre cement weatherboards fixed to the outside; ▪ 75mm thick mineral wool insulation with a density of at least 11kg/m^3; and ▪ 2 x 16mm fire-rated plasterboard to inside.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: • Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2 metres height above ground level.	

Quiet House Package B

59-62 dB $L_{Aeq(Day)}$ & 54-57 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): – Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): – Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): – Sliding or double hung with 6mm-12mm-10mm double insulated glazing; – Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$); • Up to 80% floor area ($R_w + C_{tr} \geq 34$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass.	• Doors to achieve $R_w + C_{tr} \geq 28$: – 40mm Solid timber core hinged door and frame system certified to R_w 32 including seals; – Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: – Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester (24kg/m³). Resilient ties used where required to connect leaves. – Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m³). – Single leaf of 220mm brick masonry with 13mm cement render on each face. – 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. – Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m³) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: – Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling with R3.0+ fibrous insulation.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2.4 metres height above ground level.	

Quiet House Package C

63-66 dB $L_{Aeq(Day)}$ & 58-61 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 20% floor area ($R_w + C_{tr} \geq 31$): – Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 40% floor area ($R_w + C_{tr} \geq 34$): – Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): – Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): – Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Not recommended.	• Doors to achieve $R_w + C_{tr} \geq 30$: – Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass; – 40mm Solid timber core side hinged door, frame and seal system certified to R_w 32 including seals. Any glass inserts to be minimum 6mm.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: – Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m³). Resilient ties used where required to connect leaves. – Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m³). – Single leaf of 220mm brick masonry with 13mm cement render on each face. – 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. – Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m³) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 40$: – Concrete or terracotta tile roof with sarking, or metal sheet roof with foil backed R2.0+ fibrous insulation between steel sheeting and roof battens; – R3.0+ insulation batts above ceiling; – 2 x 10mm plasterboard ceiling or 1 x 13mm sound-rated plasterboard affixed using steel furring channel to ceiling rafters.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2.4 metres height above ground level.	

Mechanical Ventilation requirements

In implementing the acceptable treatment packages, fresh air requirements of the National Construction Code must be satisfied on the basis of windows closed. Whilst not the only solution, the most common is mechanical ventilation / air-conditioning is installed with the following considerations:

- Acoustically rated openings and ductwork to provide a minimum sound reduction performance of R_w 40 dB into sensitive spaces;
- Evaporative systems require attenuated ceiling air vents to allow closed windows;
- Refrigerant based systems need to be designed to achieve National Construction Code fresh air ventilation requirements;
- Openings such as eaves, vents and air inlets must be acoustically treated, closed or relocated to building sides facing away from the corridor where practicable.

Notification

Notifications on title advise prospective purchasers of the potential for noise impacts from major transport corridors and help with managing expectations.

The Notification is to state as follows:

This lot is in the vicinity of a transport corridor and is affected, or may in the future be affected, by road and rail transport noise. Road and rail transport noise levels may rise or fall over time depending on the type and volume of traffic.

Appendix B – Terminology

The following is an explanation of the terminology used throughout this report:

- **Decibel (dB)**

The decibel is the unit that describes the sound pressure levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

- **A-Weighting**

An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A, dB.

- **L_{eq}**

The L_{eq} level represents the average noise energy during a measurement period.

- **L_1**

The L_1 level represents the noise level exceeded for 1 percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

- **L_{10}**

The L_{10} level represents the noise level exceeded for 10 percent of the measurement period and is considered to represent the “intrusive” noise level.

- **L_{90}**

The L_{90} level represents the noise level exceeded for 90 percent of the measurement period and is considered to represent the “background” noise level.

- **$L_{Aeq(Day)}$**

The $L_{Aeq(Day)}$ level is the logarithmic average of the L_{Aeq} levels from 6.00am to 10.00pm.

- **$L_{Aeq(Night)}$**

The $L_{Aeq(Night)}$ level is the logarithmic average of the L_{Aeq} levels from 10.00pm to 6.00am.

- **$L_{A10,18hour}$**

The $L_{A10,18hour}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00am and midnight.

- **$L_{Aeq,24hour}$**

The $L_{Aeq,24hour}$ level is the logarithmic average of the L_{Aeq} levels from over an entire day.

- **Noise-sensitive land use and/or development**

Land-uses or development occupied or designed for occupation or use for residential purposes (including dwellings, residential buildings or short-stay accommodation), caravan park, camping ground, educational establishment, child care premises, hospital, nursing home, corrective institution or place of worship.

- **R_w**

This is the weighted sound reduction index. It is a single number rating determined by moving a grading curve in integral steps against the laboratory measured transmission loss until the sum of the deficiencies at each one-third-octave band, between 100 Hz and 3.15 kHz, does not exceed 32 dB. The higher the R_w value, the better the acoustic performance.

- **C_{tr}**

This is a spectrum adaptation term for airborne noise and provides a correction to the R_w value to suit source sounds with significant low frequency content such as road traffic or home theatre systems. A wall that provides a relatively high level of low frequency attenuation (i.e. masonry) may have a value in the order of – 4 dB, whilst a wall with relatively poor attenuation at low frequencies (i.e. stud wall) may have a value in the order of -12 dB.

- **About the Term 'Reasonable'**

An assessment of reasonableness should demonstrate that efforts have been made to resolve conflicts without comprising on the need to protect noise-sensitive land-use activities. For example, have reasonable efforts been made to design, relocate or vegetate a proposed noise barrier to address community concerns about the noise barrier height? Whether a noise mitigation measure is reasonable might include consideration of:

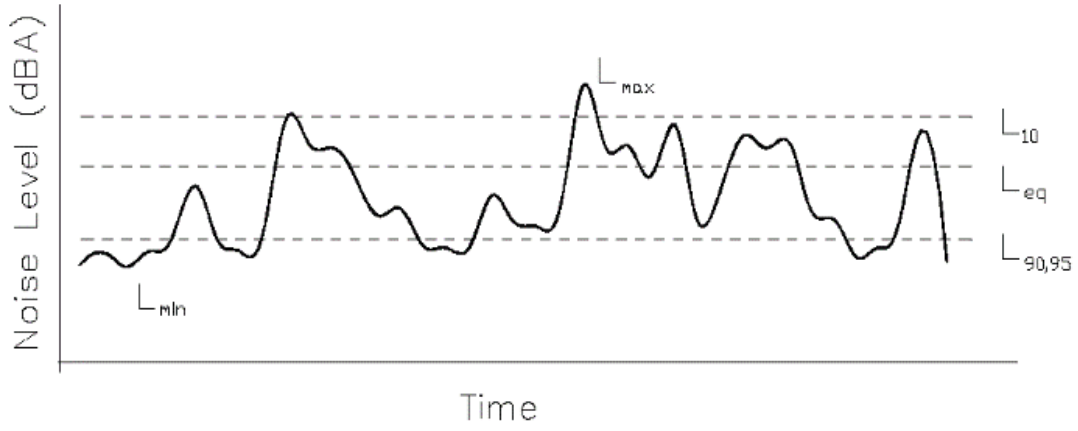
- The noise reduction benefit provided;
- The number of people protected;
- The relative cost vs benefit of mitigation;
- Road conditions (speed and road surface) significantly differ from noise forecast table assumptions;
- Existing and future noise levels, including changes in noise levels;
- Aesthetic amenity and visual impacts;
- Compatibility with other planning policies;
- Differences between metropolitan and regional situations and whether noise modelling requirements reflect the true nature of transport movements;
- Ability and cost for mobilisation and retrieval of noise monitoring equipment in regional areas;
- Differences between Greenfield and infill development;
- Differences between freight routes and public transport routes and urban corridors;
- The impact on the operational capacity of freight routes;
- The benefits arising from the proposed development;
- Existing or planned strategies to mitigate the noise at source.

- **About the Term 'Practicable'**

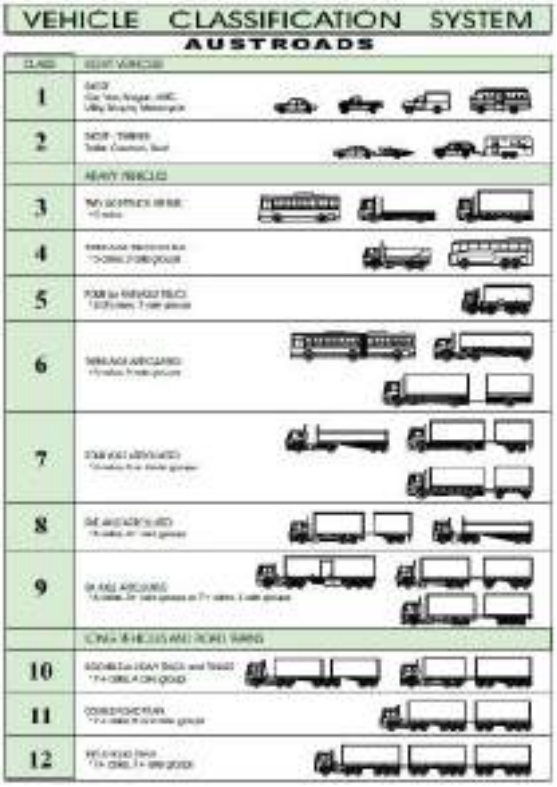
'Practicable' considerations for the purposes of the policy normally relate to the engineering aspects of the noise mitigation measures under evaluation. It is defined as "reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge" (*Environmental Protection Act 1986*). These may include:

- Limitations of the different mitigation measures to reduce transport noise;
- Competing planning policies and strategies;
- Safety issues (such as impact on crash zones or restrictions on road vision);
- Topography and site constraints (such as space limitations);
- Engineering and drainage requirements;
- Access requirements (for driveways, pedestrian access and the like);
- Maintenance requirements;
- Bushfire resistance or BAL ratings;
- Suitability of the building for acoustic treatments.

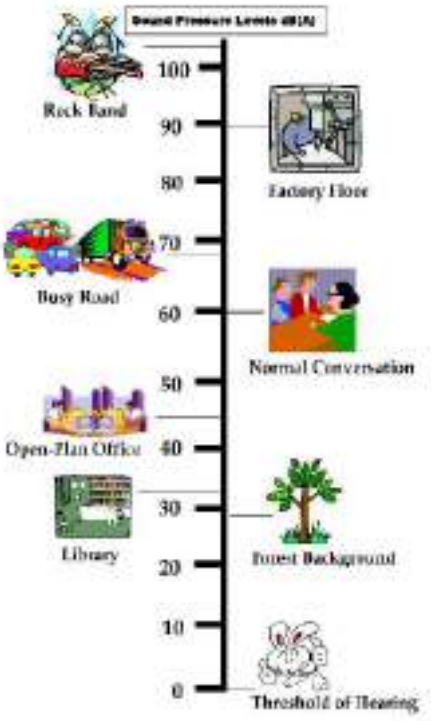
- **Chart of Noise Level Descriptors**



- **Austroads Vehicle Class**



- **Typical Noise Levels**





Appendix 7

Master Plan

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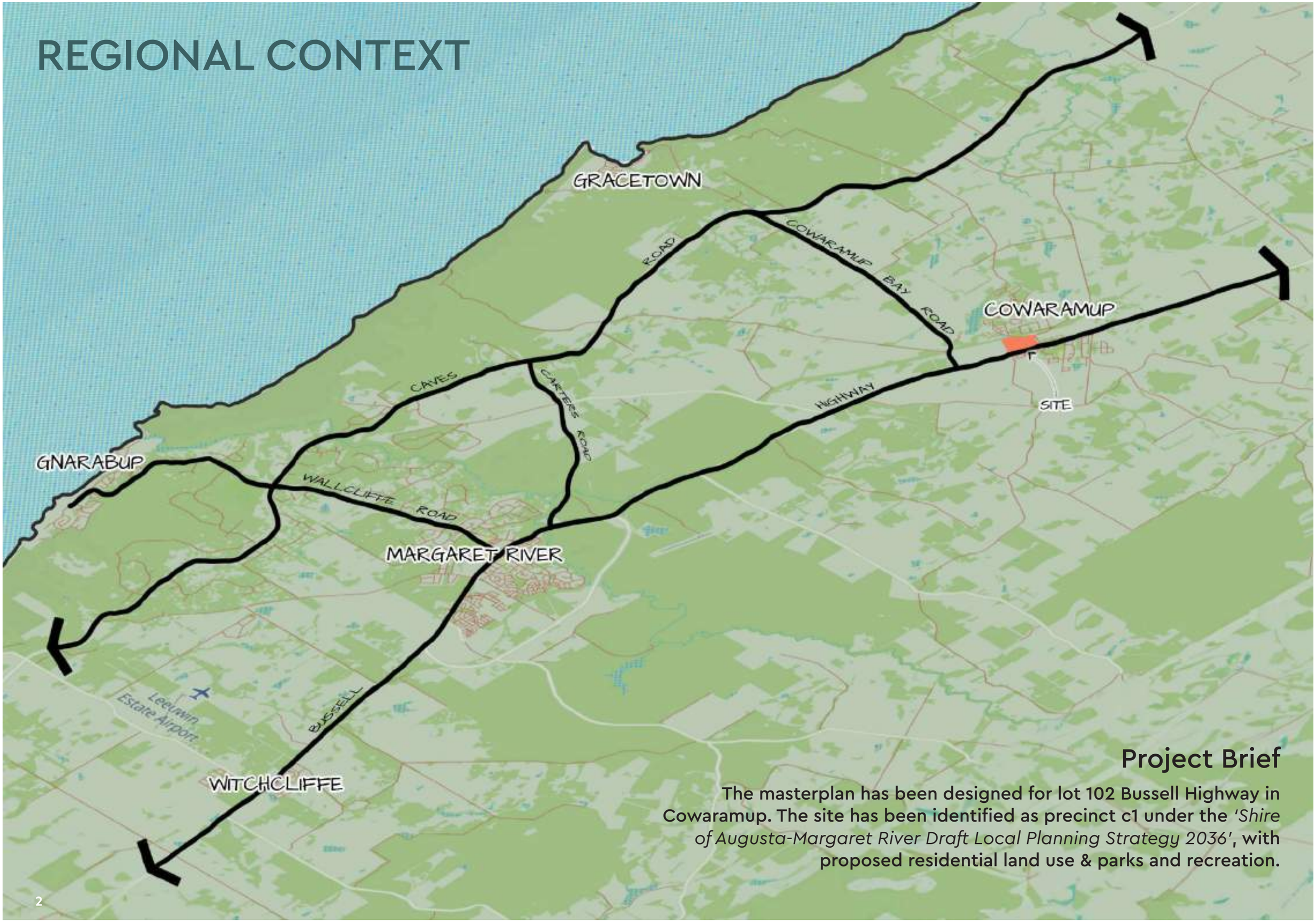
MASTERPLAN DESIGN REPORT

LOT 102 BUSSELL HIGHWAY
COWARAMUP
SHIRE OF AUGUSTA-MARGARET RIVER



ROWE GROUP DESIGN

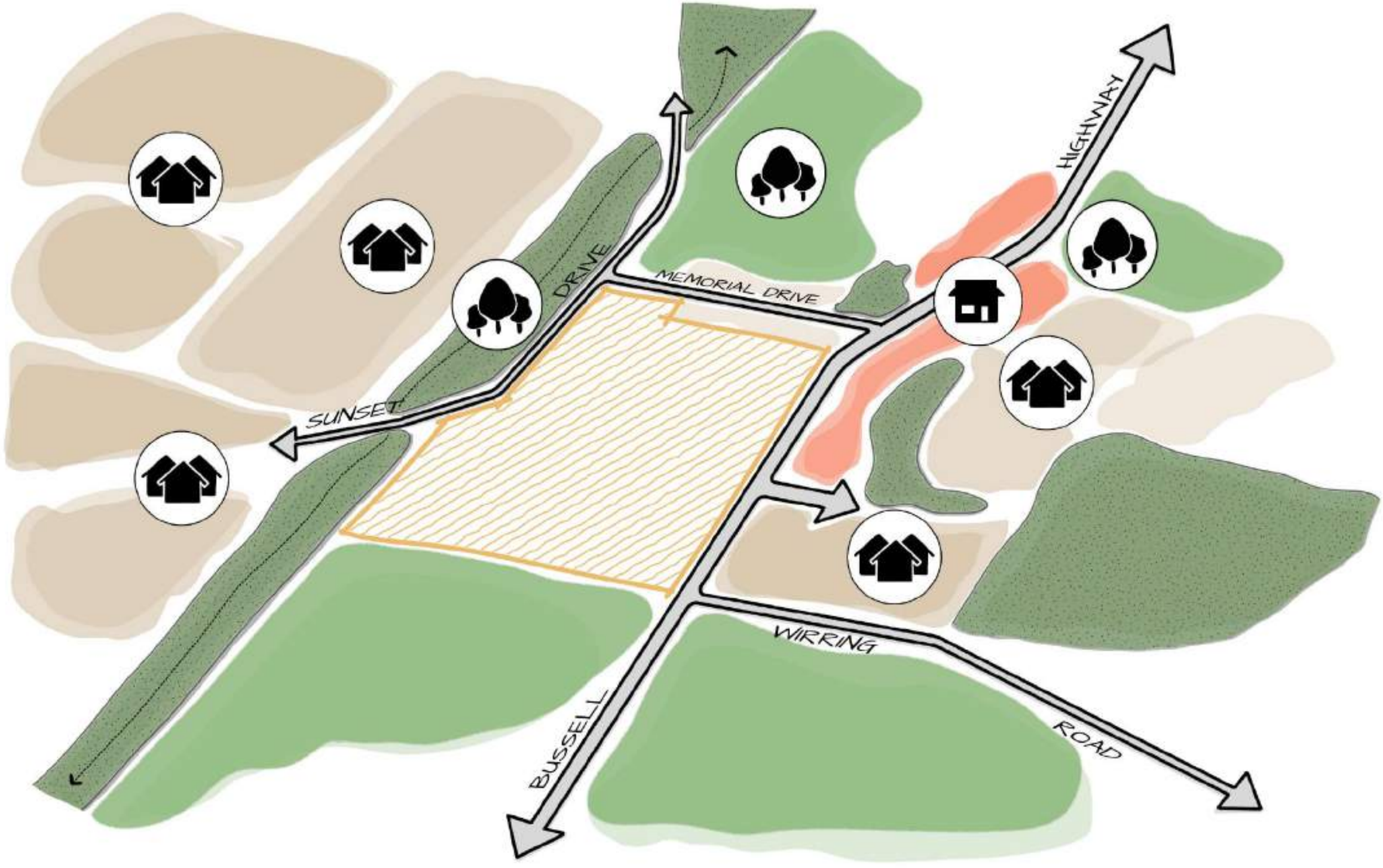
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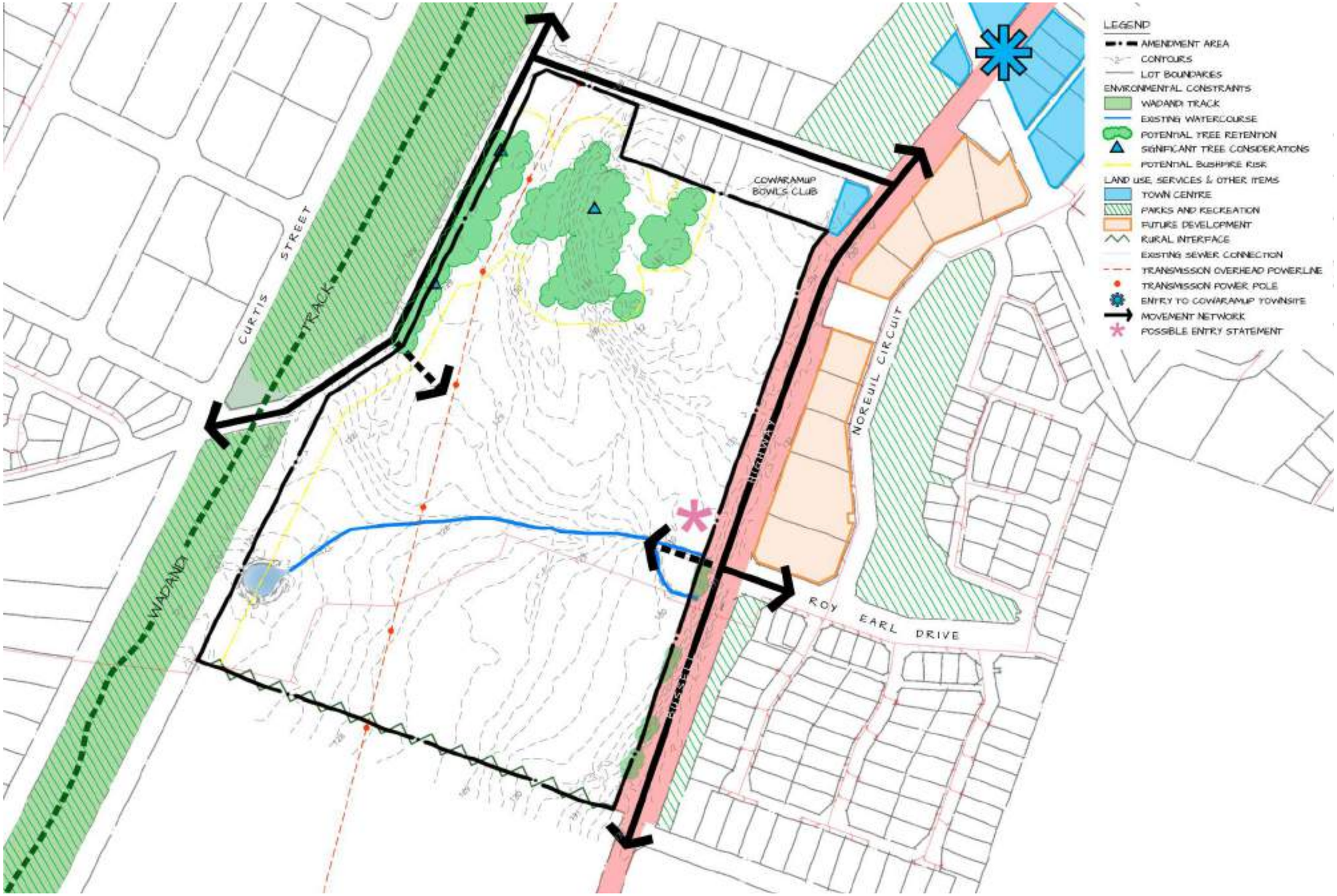
Project Brief

The masterplan has been designed for lot 102 Bussell Highway in Cowaramup. The site has been identified as precinct c1 under the *'Shire of Augusta-Margaret River Draft Local Planning Strategy 2036'*, with proposed residential land use & parks and recreation.

LOCAL CONTEXT

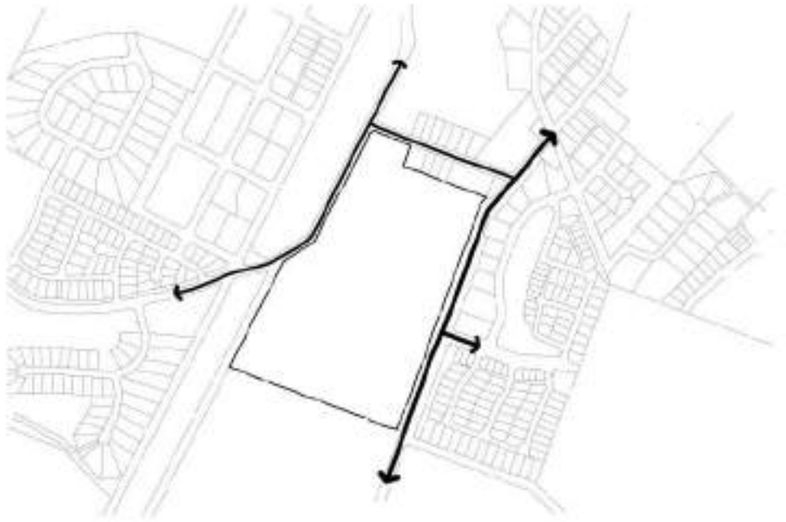


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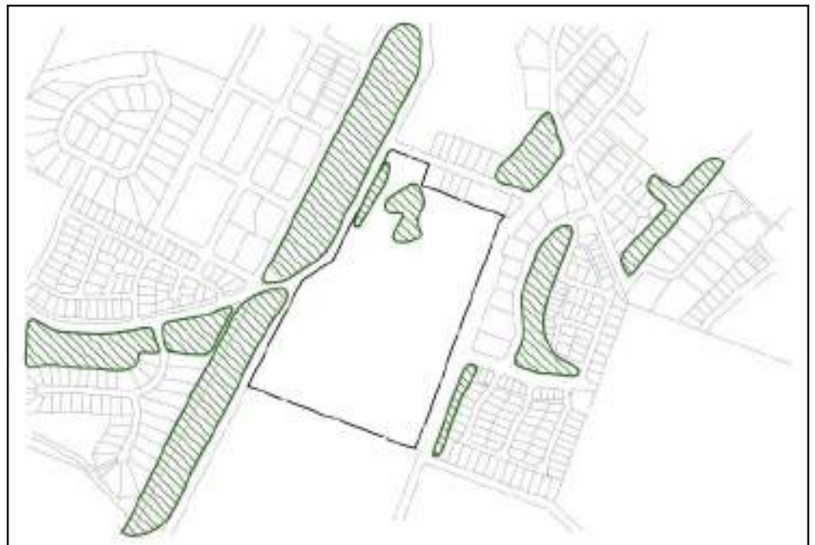


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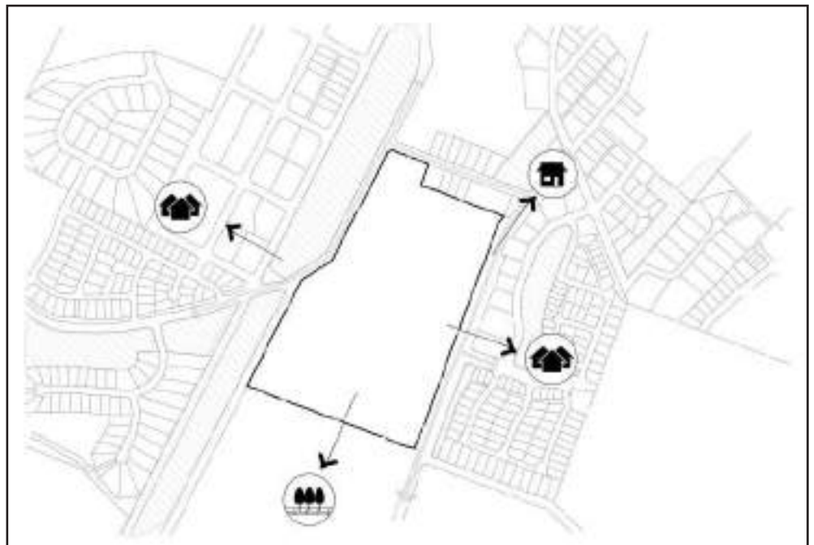
EXISTING ROAD NETWORK



EXISTING GREEN NETWORK

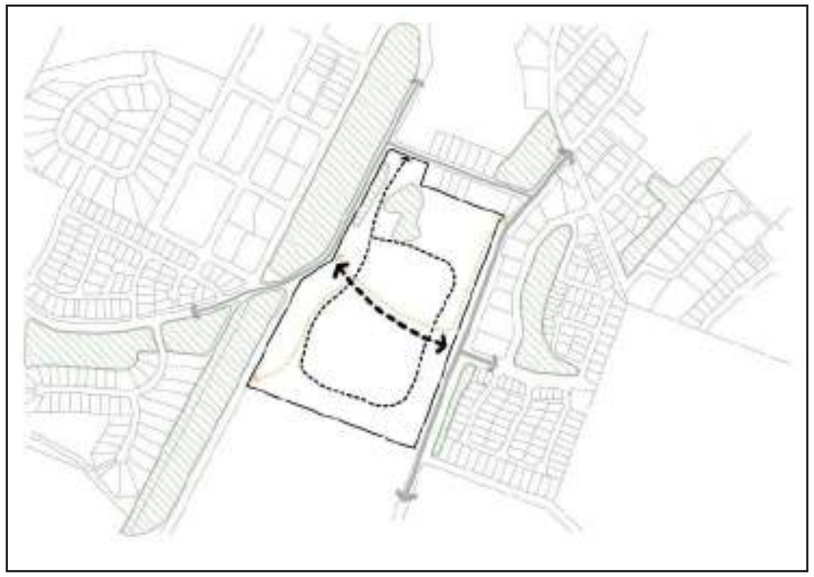


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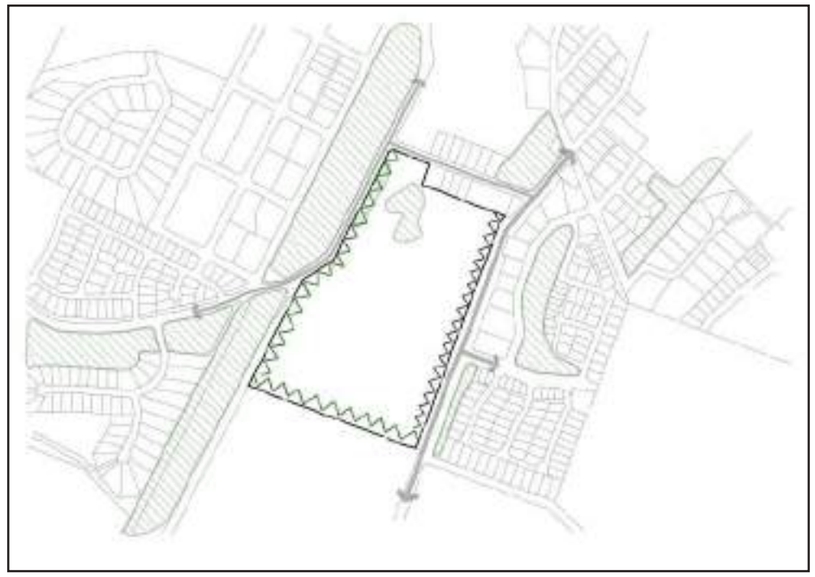


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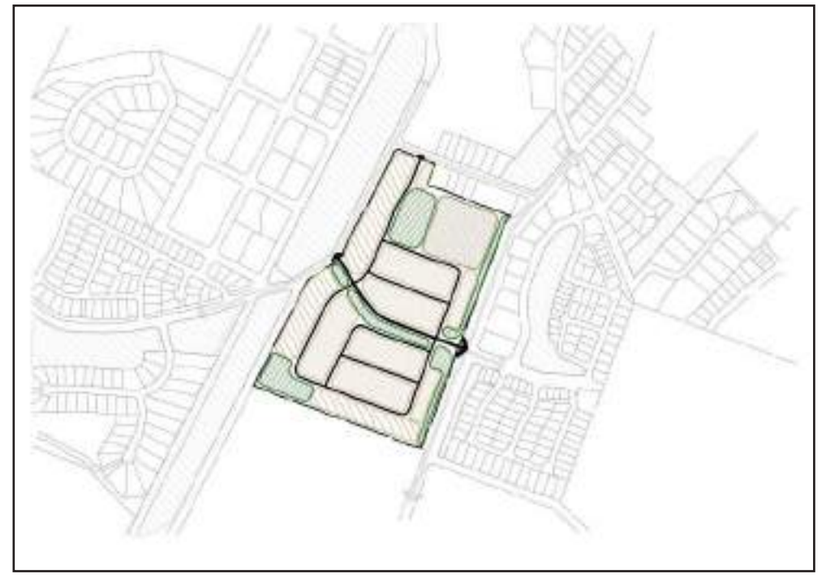
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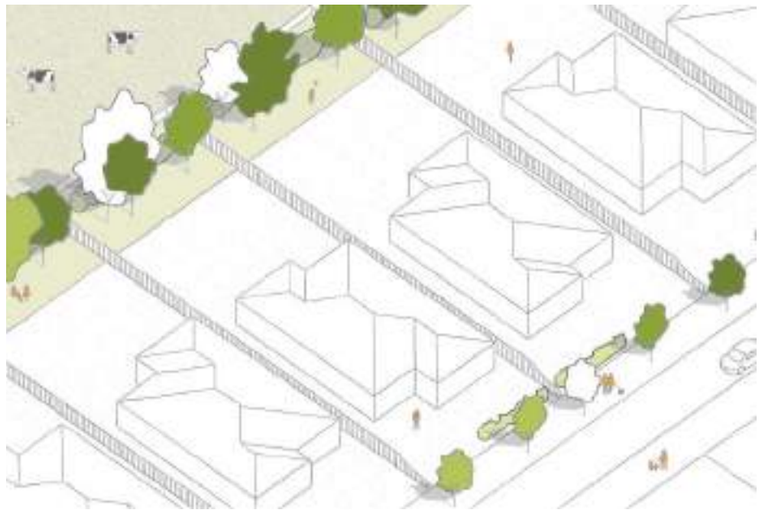
INTERFACE CONSIDERATIONS



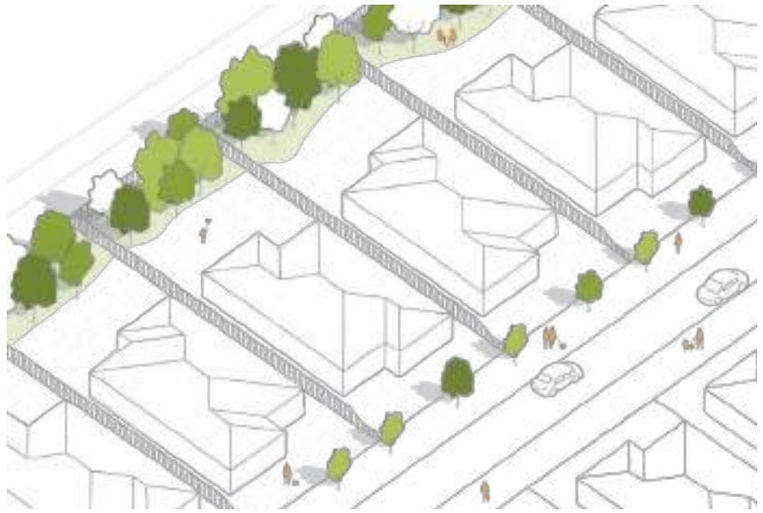
PROPOSAL



DESIGN CONSIDERATIONS



Landscape Transition Interface
along rural land



Retained Vegetation at Back of Lots
along Sunset Drive



Increased tree canopy.
Public Open Space + Street Trees

PROPOSAL



DESIGN CONSIDERATIONS

- East-West link – connecting Bussel Highway to Sunset Drive to relieve traffic through Memorial Drive.
- Pedestrian connections – High level of pedestrian networks throughout site connecting to town centre and to Wadandi Track.
- Linear Public Open Space provides memorable entry experience while the street network engages with the open space to recognise the Cowaramup neighbourhood character.
- Houses are designed to front streets and overlook open space to maximise opportunities for passive surveillance of the public realm.
- Water management is integrated into open spaces providing pedestrian movement and visual relief from the urban environment.
- Northern Public Open Space designed to retain existing trees while providing a high level of amenity.
- Larger transition lots, rural style fencing and landscape buffer respect rural character to the South and West along the Wadandi track.
- Landscape buffer alongside Bussell highway providing a noise barrier and visual screening.
- Southern Gateway – entry POS and roundabout provide a sense of arrival to south of Cowaramup.



Appendix 8

Transport Impact Assessment

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Goldfields

Lot 102 Bussell Highway, Cowaramup

Transport Impact Assessment

October 2023

Project Code: 07060

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Version Control and Approval

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B – FINAL DRAFT	04 October 2023	Richard Spencer	Richard Spencer	Tim Judd
C – FINAL ISSUE	18 October 2023	Richard Spencer	Richard Spencer	Tim Judd

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1 Introduction

1.1 Background

Phil Jones Associates (PJA) has been commissioned by Goldfields Cowaramup Pty Ltd to prepare this Transport Impact Assessment (TIA) for the proposed development of Lot 102 Bussell Highway located in Cowaramup, within the Shire of Augusta-Margaret River Local Government area, Western Australia.

The site is subject to an existing Local Structure Plan approval (2008) for mixed use residential and community development, and it is intended that this Transport Impact Assessment will support an application for an amended and updated Structure Plan and also satisfy the requirements for the Subdivision planning stage, which will be a concurrent process.

This Transport Assessment has been prepared in accordance with the Western Australian Planning Commission (WAPC) Transport Impact Assessment Guidelines Volume 2 – Planning Schemes, Structure Plans & Activity Centre Plans and Volume 3 - Subdivision (2016), which are the most appropriate levels of TIA for this stage of the development.

The location of Lot 102 Bussell Highway (the Site) in relation to the immediate surrounding road network is shown on **Figure 1-1.**

Figure 1-1: Site Location



Source – NearMap 2023

1.2 Prior Structure Plan Assessment

1.2.1 The Site was previously approved as part of a Local Structure Plan in 2008 for development comprising 124 lots, a lifestyle village and Club & Sports Facilities Expansion area. The Site is zoned for future development under the Shire of Augusta-Margaret River Local Planning Scheme No.1

1.2.2 As part of the above approval, an assessment of development generated traffic was undertaken in January 2007, the 'Cowaramup Country Estate Traffic Study'. This study fails to meet the current requirements of the WAPC TIA guidelines. As such, this updated TIA draws on any appropriate information and expands as required to meet the current WAPC TIA requirements of the Structure Plan and the Sub-Division stages of assessment (a concurrent process for this application).

1.3 Subdivision Proposal

This proposal, which is being presented in parallel with a Structure Plan amendment, forms an updated residential only development. The site concept plan (Appendix A) proposes a residential development with public open space of up to 2.58 hectares will be provided across a total of approximately 12.90 hectares of developable land area.

Based on the site concept plan (12.90ha of developable area), the potential yield of the site comprises:

- R12.5 – R30 Residential Lots = **183 lots**
- R60 Residential Lots = **60 lots**
- **Total = 243 Lots**



1.4 Summary of TIA

In accordance with WAPC Guidelines for Transport Impact Assessments, this report sets out the details of the proposed MRS amendment, the key transport issues and impacts related to the development of the Site from a residential and recreational and community perspective including the current level of accessibility by road, public transport, cycle and on foot and sets recommendations to explore the potential for improving these to a suitable level where required and appropriate.

This Transport Assessment has been prepared with sufficient detail and analysis to support an application for a revised Structure Plan & subsequent Staged subdivision submission of up to 140 residential units based on the existing configuration of the road network intersections at a design year horizon of 2032 and up to 160 residential units based on the minor capacity upgrade of the Memorial Drive eastbound approach to Bussell Highway/Memorial Drive intersection at a design year horizon of 2033.

This TIA also explores the proposed modifications to the surrounding transport networks including local and state Government projects and initiatives such as the planned upgrade of the Bussell Highway/Memorial Drive intersection and the Bussell Highway/Roy Earl Drive intersection upgrade to four-way single lane roundabout control.

This TIA ultimately demonstrates that assuming the provision of a new 'link road' across the site between Sunset Drive and Bussell Highway together with a new four-way roundabout access onto Bussell Highway at the Roy Earl Drive intersection, the upgraded road network will be able to support the full 243 residential units proposed at this site in the 2036 design horizon.

The assumed new roundabout intersection at Bussell Highway/Roy Earl Drive, which may ultimately provide access to the development site, is predicted to operate with no issues with respect to traffic queuing and delays for any movement in the AM and PM peak periods under a 2036 design horizon with full development generated traffic.

1.5 Regional and Local Policy Context

Leewin-Naturaliste Sub-Regional Strategy (amended May 2019)

Cowaramup is recognised as a 'Town' within the Leewin-Naturaliste Strategy Plan and is also identified as a 'Village with Enclaves' under State Planning Policy 6.1.

The Sub-Regional Strategy also recognises that:

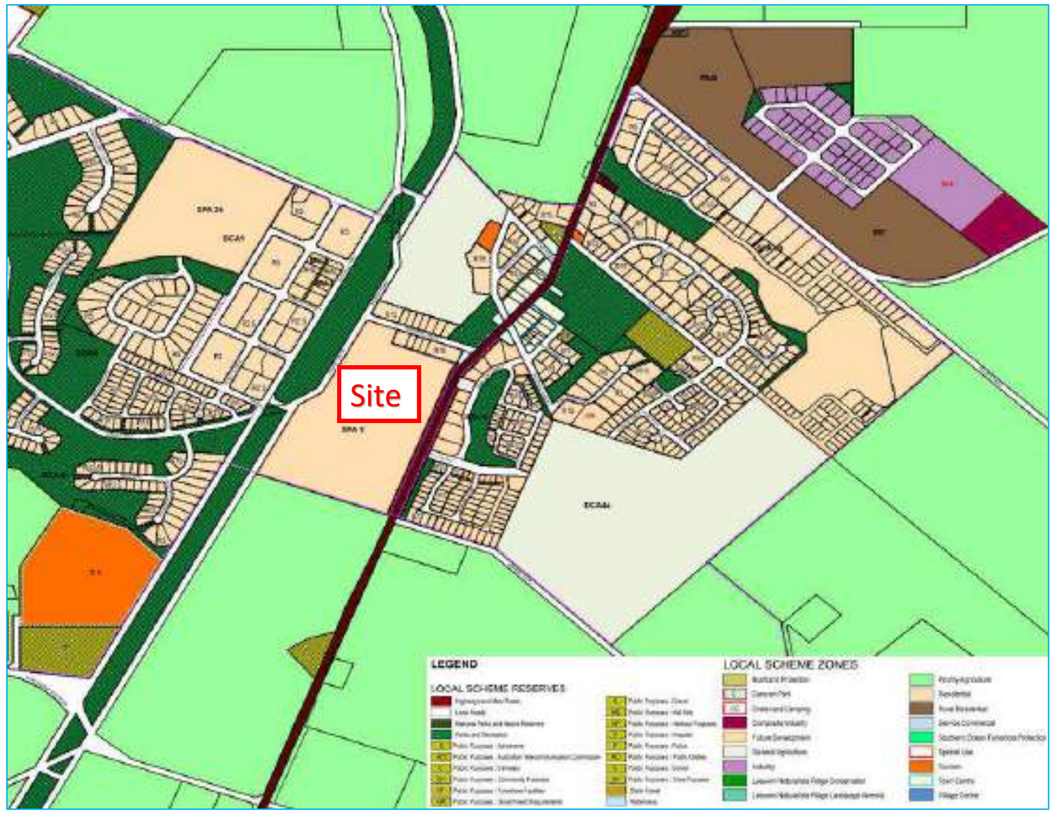
> *There is land identified for 'Future Development' in the Local Planning Strategy surrounding the existing urban area providing opportunities for continued growth and expansion for up to another 15 years, depending on demand.*

In terms of significant infrastructure projects in the vicinity of Cowaramup, the Sub-Regional strategy confirms that:

> *The alignment of a potential bypass route for Cowaramup townsite will be an important factor in the extent of future development to the east of the townsite.*

Shire of Augusta-Margaret River Local Planning Scheme No.1 (Map 08)

Under the provisions of the Shire of Augusta-Margaret River Local Planning Scheme No.1, the Site area (SPA 9) is zoned as 'Residential'. The Scheme recognises that Cowaramup has nearly doubled in size since 2011 and retains the capacity of strong growth over the planning period.



The Site, which is the subject of this Transport Impact Assessment is also recognised in the Scheme as 'Planning Precinct C1' with a current zoning of 'Future Development' and a proposed land use as 'Residential R10 – R30, Parks and Recreation, with the possibility for civic use.'

Other nearby proposed residential land uses recognised in the Local Planning Scheme include C3 and C5 (yet to be developed) and C2 (currently under construction).



Current Urban Growth Area		
Planning Precinct	Precinct Planning Requirements	
C1	**Proposed Land Use:** Residential **Current Zoning:** Future Development **Proposed Use:** Residential R10 – R30, Parks and Recreation, with possibility for civic use	**Development Timeframe:** Short Term **Structure Planning Status/Required:** Structure Plan Endorsed **Estimated Lot Yield:** 124
	Planning matters to be addressed: Need to provide attractive entrance to Cowaramup from the south and buffers to adjoining agricultural land.	

Source: Shire of Augusta-Margaret Rive Local Planning Scheme No.1

2 Existing Situation

2.1 Existing Site Context and Land Uses

The proposed development site (the Site) is located on the fringe of Cowaramup Town Centre, on the western side of Bussell Highway and to the south of Memorial Drive. The site is currently vacant bush/scrub land with informal vehicle access points along its length.

The Site is bounded by Memorial Drive, a small number of existing residential lots and Cowaramup District Social Club to its north, Bussell Highway to the east, vacant land to the south and Sunset Drive the west.

Cowaramup is located approximately 12 kilometres north of the town of Margaret River in West Australia's South West Region. The town has a population of around 1,000 people and is known for its picturesque rural setting, historic buildings, and charming country feel.

Cowaramup is situated in the heart of a prime agricultural region, and it is surrounded by rolling hills, vineyards and farms. The town is also located near some of the Western Australia's most beautiful beaches, making it a popular destination for tourists seeking a mix of natural beauty, rural charm and seaside relaxation.

The location of the Site is illustrated in **Figure 2-1.**

Figure 2-1: Site Location



2.2 Existing Road Network

Bussell Highway

The Site is located to west of Bussell Highway, which is within the care and control of Main Roads WA - South West Region and is classified under the Main Roads WA Road Hierarchy as a Primary Distributor. Bussell Highway provides the main north/south vehicle link between Busselton and Margaret River and onward to Augusta in the south.

In the vicinity of the Site, Bussell Highway is a single carriageway sealed road, typically 7.0m wide pavement, with a posted speed limit of 60km/hr past the Site frontage reducing to 40km/hr as it passes through the centre of Cowaramup. Alongside the Site adjacent to Bussell Highway, there are currently no footpaths or on road cycle facilities. To the north and south of

Cowaramup, Bussell Highway incrementally increases posted speed limit to 60km/hr, 80km/hr and then 110km/hr along the inter-town sections of the highway.

Memorial Drive and Sunset Drive

Memorial Drive abuts the northern flank of the site and runs between Bussell Highway and Sunset Drive/Miamup Road. Memorial Drive forms a priority controlled T-intersection with Bussell Highway and is classified under the Main Roads WA Road Hierarchy as a 'Local Distributor' road (**Figure 2-2**), which provides the main vehicle link to the residential development on the west side of Cowaramup town centre via Sunset Drive and onward to the farming and wine regions.

There is a single footpath on the northern side of Memorial Drive and an informal, unsealed footpath on the western side of Sunset Drive as it flanks the Site.

Road Hierarchy:

Figure 2-2 shows the layout and classification of the roads surrounding the site, including the primary road network.

Figure 2-2: Main Roads WA Functional Road Hierarchy



Road classifications are defined in the Main Roads Functional Hierarchy as follows:

Primary Distributors (light blue): Form the regional and inter-regional grid of MRWA traffic routes and carry large volumes of fast-moving traffic. Some are strategic freight routes, and all are National or State roads. They are managed by Main Roads.

Local Distributors (orange): Carry traffic within a cell and link District Distributors at the boundary to access roads. The route of the Local Distributor discourages through traffic so that the cell formed by the grid of District Distributors only carries traffic belonging to or serving the area. These roads should accommodate buses but discourage trucks. They are managed by Local Government.

Access Roads (grey): Provide access to abutting properties with amenity, safety and aesthetic aspects having priority over the vehicle movement function. These roads are bicycle and pedestrian friendly. They are managed by Local Government.

Speed Zoning:

Figure 2-3 shows the zoning of speeds on the roads surrounding the site. The mapping shows the Cowaramup town centre section of Bussell Highway is posted as a 40km/hr speed zone, with a staggered 60km/hr limit at each end leading into 110km/hr speed zones further out past Treeton Road to the north and Wirring Road to the south.

Figure 2-3: Main Roads WA Speed Classifications



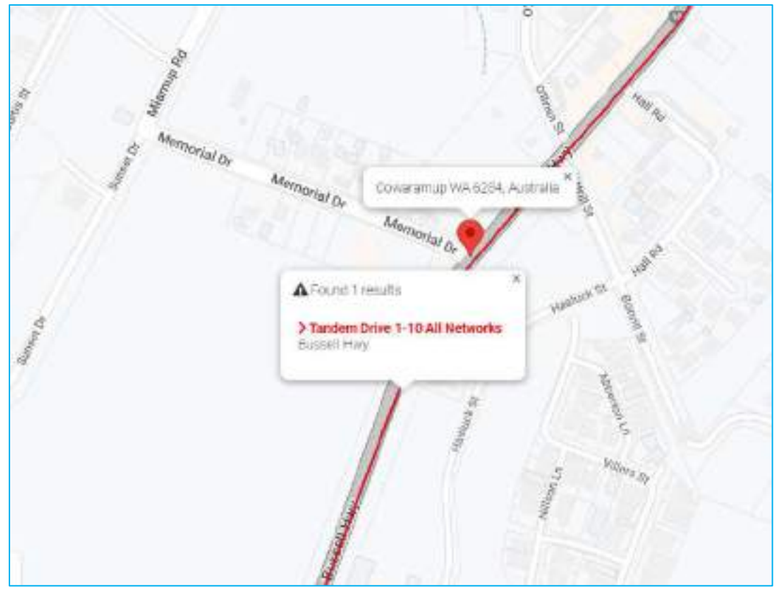


2.3 Existing RAV Network

Bussell Highway, through Cowaramup forms part of Main Road WA's Restricted Access Vehicle Network up to level 4. The RAV 4 network generally permits heavy vehicles with the following specifications:

- Gross Vehicle Mass (GVM) up to 88.5 tonnes.
- Overall vehicle length including any trailers is limited to 27.5. metres and maximum width of 2.5 metres (without an oversize / over mass permit).

Figure 2-4: Existing RAV Network



2.4 Existing Traffic Volumes

2.4.1 Traffic volume data has been obtained for Bussell Highway, south of Memorial Drive, from the Main Roads WA Traffic Map. The available data from 2018 (Site 52860) shows that Bussell Highway carries up to 8,100 vehicles per day during the week (14.4% heavy vehicles), reducing to approximately 6,500 vehicles per day on weekends (8.5% heavy vehicles).

The 85th percentile speed of traffic passing this location on Bussell Highway is 60.3 km/hr northbound and 68.9km/hr southbound on weekdays, against a posted speed limit of 60km/hr.

PJA has undertaken independent and fully classified turning traffic counts at the following intersections on Wednesday 31 May 2023.

- Memorial Drive / Sunset Drive / Miamup Road – 3-way priority controlled intersection
- Bussell Highway / Memorial Drive – 3-way priority controlled intersection
- Bussell Highway / Roy Earl Drive – 3-way priority controlled intersection

The recoded traffic volumes (total vehicles) at each of the above intersections during the AM and PM peak hour periods are presented on the following **Figure 2-5 to Figure 2-7.**

2.5 Existing Key Intersections

The following key intersections are located within a 1km radius of the site. The following intersections are likely to experience the greatest proportion of vehicle activity as a result of the proposed development, and this Transport Impact Assessment will quantify and discuss the relative level of impact associated with the development traffic generation.

North of the Site:

Memorial Drive / Sunset Drive / Miamup Road – 3-way priority controlled intersection is located adjacent to the northern boundary of the Site and provides the main vehicle link to the residential development on the west side of Cowaramup town centre via Sunset Drive and Miamup Road and onward to the farming and wine regions.

Figure 2-5: 2023 Existing Traffic Volumes – Sunset Dr/Miamup Dr/Memorial Dr Intersection



Key:

X = AM Peak

(X) = PM Peak

North-East of Site:

Bussell Highway / Memorial Drive – 3-way priority controlled intersection is located adjacent to the north east corner of the Site and provides the main vehicle access to Bussell Highway, Cowaramup Town Centre and onward to the areas of Margaret River (south) and Busselton to the north.

Figure 2-6: 2023 Existing Traffic Volumes – Bussell Hwy/Memorial Dr Intersection



Key:

X = AM Peak
(X) = PM Peak

East of Site:

Bussell Highway / Roy Earl Drive – 3-way priority controlled intersection is located adjacent to the eastern boundary flank of the Site and provides the main vehicle access to an existing sub-division of land which was part of the original Stage 1 of development of the 2008 Structure Plan approval. This intersection was upgraded in 2015 to its current layout at the beginning of the build-out of the sub-division.

Figure 2-7: 2023 Existing Traffic Volumes – Bussell Hwy/Roy Earl Dr Intersection



Key:

X = AM Peak
(X) = PM Peak

This transport impact assessment examines the future operational capacity of these three existing intersections and determines the relative level of impact as a result of the proposed development traffic and other surrounding developments at the appropriate design years and reports on their capability to accommodate future development generated traffic within acceptable standard criteria.

2.6 Existing Pedestrian / Cycle Networks

Existing pedestrian / cycle networks are illustrated in **Figure 2-8** . Alongside the eastern frontage of Site, there are currently no footpaths or on road cycle facilities on Bussell Highway.

There is a single footpath on the northern side of Memorial Drive and an informal, unsealed footpath on the western side of Sunset Drive as it flanks the Site, which may be shared by pedestrians and cyclists (if they have the ability to be able to use an unsealed footpath), however neither of these road feature on road cycle facilities.

Wadandi Track – Cowaramup

The Wadandi Track is a shared path which starts at Cowaramup at the intersection of Sunset Drive / Memorial Drive, at the north-west corner of the Site. This section of the Wadandi Track runs between Cowaramup and Sebbes Road (11km) and provides recreational and commuting access between Cowaramup, Margaret River (links with Prevelly Cycle Track) and onward to Witchcliffe. The trail passes through natural bushland, vineyards and farmland to provide bike riders and walkers with a diverse landscape to enjoy.

The Wadandi Track showcases the heritage of the former Busselton to Flinders Bay Railway including the industries and communities which it served from 1884 to 1957. Open to walkers and cyclists, the track allows people to experience the diversity of the Margaret River Region including the rich local history, Aboriginal and heritage values, natural environment and local industries.

Figure 2-8: Existing pedestrian / cycle networks



Figure 2-9: The Wadandi Track



2.7 Existing Public Transport

Due to its regional location and its presence as a gateway town to Margaret River by vehicle, Cowaramup does not have a regular scheduled public bus service. TransRegional does not operate in Cowaramup or the surrounding towns.

The closest Transwa coach service to Cowaramup is the **SW1** service which stops at Margaret River (Charles West Avenue stop) and runs from East Perth to Augusta and Pemberton (return) via Bunbury and Augusta. The service operates on Sundays and Tuesdays to Pemberton and seven days a week to/from Augusta.

Figure 2-10: SW1 Transwa Coach Service.

SW1 East Perth to Augusta and Pemberton via Bunbury and Augusta

New Timetable (Effective 24/10/2022)

313/255	271S	271 315/253	277	279	
Mon	Sun	Tue,Thu	Sun to Fri	Fri	From Perth
PM 01:00	PM 12:15	PM 12:15	AM 9:00	PM 4:00	East Perth Terminal
1:25	12:40	12:45	9:30	4:45	Cockburn Central (Stand No. 7)
2:10	1:25	1:30	10:15	5:30	Mandurah Train Station
2:23	1:38	1:43	10:28	5:43	Falcon (Miami Shopping Centre)
– –	– –	– –	– –	6:15 ↓ 6:45	Settlers Roadhouse
3:15	2:30	2:35	11:20	7:05	Australind (Mulgara Street)
3:30 ↓ 3:45	2:40 ↓ 2:45	2:45 ↓ 3:15	11:30 ↓ PM 12:05	7:15 ↓ 7:20	Bunbury Passenger Terminal
4:09	3:09	3:39	12:29	7:38	Capel (Information bay)
4:28	3:28	3:58	12:48	7:57	Busselton (adjacent Albert Street Square)
– –	3:45 ↓ 4:15	– –	– –	– –	Siesta Park Roadhouse
4:56	4:26	4:26	1:16	8:25	Dunsborough (Seymour Boulevard)
5:05	4:35	4:35	1:25	8:34	Yallingup (Hall)
5:45	5:15	5:15	2:05	9:14	Margaret River (Charles West Avenue stop)
6:05	5:35	5:35	2:25	9:34	Karridale (bus shelter)
6:15	5:45	5:45	2:35	9:45	Augusta (opposite newsagency)
	Sun 6:52	Tue 6:52			Nannup (Adam Street opposite Shire)
	7:50	7:50			Pemberton (Visitor Centre)

Source: Transwa

2.8 Crash Assessment

A search of the Main Roads WA Reporting Centre for crash data has been undertaken. This search covered all recorded traffic crashes for the most recently available five-year reporting period between 1 January 2018 and 31 December 2022 for the following roads:

- Bussell Highway, between Treeton Road and Cowaramup Bay Road.
- Memorial Drive, between Bussell Highway and Sunset Drive.
- Sunset Drive, between Memorial Drive and Brockman Road

The results are summarised below in **Table 2-1 and 2-3.**

Table 2-1: Crash Data for Bussell Highway, between Treeton Road and Cowaramup Bay Road

Type of Crash	Fatal	Hospital	Medical	Major PDO*	Minor PDO*	Total
Rear End	-	-	1	4	2	**-**
Sideswipe	-	-	-	2	1	**-**
Hit Object	-	-	-	-	-	**-**
Hit Pedestrian	-	-	-	-	1	**-**
Head On	-	-	-	-	-	**-**
Right Angle	-	-	2	-	-	**-**
Other	-	-	-	2	-	**-**
Total	**-**	**-**	**-**	**-**	**-**	**-**

**Property Damage Only*

Of the above recorded 15 crashes on this section of Bussell Highway, 12 involved property damage only with no injuries or medical requirements reported. One crash involved a vehicle hitting a pedestrian under minor severity circumstances. Three crashes involved medical attention being required, one of which reported as a rear-end shunt in the town centre and two reported as right-angle type crashes at the intersection of Bussell Highway/Cowaramup Bay Road and Bussell Highway/Wiring Road, both of which involved a vehicle failing to give-way to traffic on Bussell Highway. No crashes were recorded as occurring at the intersection of Bussell Highway/Memorial Drive in the past five year period.

No crashes have been recorded as occurring on the section of Memorial Drive between Bussell Highway and Sunset Drive.

Table 2-2: Crash Data for Sunset Drive, between Memorial Drive and Brockman Road

Type of Crash	Fatal	Hospital	Medical	Major PDO*	Minor PDO*	Total
Rear End	-	-	-	-	-	**-**
Sideswipe	-	-	-	-	-	**-**
Hit Object	-	-	-	-	-	**-**
Hit Pedestrian	-	-	-	-	-	**-**
Head On	-	-	-	-	-	**-**
Right Angle	-	-	1	1	1	**-**
Other	-	-	-	-	-	**-**
Total	**-**	**-**	**-**	**-**	**-**	**-**

**Property Damage Only*

Of the above recorded three crashes on this section of Sunset Drive, one resulted in medical attention being required from a right-angle type of crash at the intersection with Memorial Drive which involved an intoxicated driver. The remaining two crashes incurred property damage only, one at the same intersection and the other at Sunset Drive/Curranwong Street intersection.

3 Proposed Subdivision Internal Transport Network

3.1 Proposed Residential Development

Under the provisions of the Shire of Augusta-Margaret River Local Planning Scheme No.1, the Site area (SPA 9) is zoned as 'Residential'.

Based on the site concept masterplan, **Figure 3-1** the proposed residential development consists of a total of 243 dwellings across 12.90 hectares of developable land including approximately 2.58 hectares of public open space.

Table 3-1: Proposed Development Summary

Land Use	Yield
Residential (R12.5 – R30)	183 Lots
Residential (R60)	60 Lots
Public Open Space	2.58 hectares

3.2 Proposed Access Arrangements

The Site currently has no formalised vehicle access with only informal unsealed gated access points along its length. The proposed site concept masterplan sets out the primary future vehicle access directly from Bussell Highway via an upgraded intersection at Roy Earl Drive, a four-arm single lane roundabout. Secondary vehicle access roads are proposed from Sunset Drive and Memorial Drive in the form of priority controlled 'T' intersections.

It is recognised that Main Roads WA and the Shire of Augusta-Margaret River have developed future proposals relating to the upgrade of Bussell Highway/Roy Earl Drive and Bussell Highway/Memorial Drive in the form of a four-way single lane roundabout. This Transport Impact Assessment includes consideration of this assumed future upgrade within the analysis of the surrounding road network in the context of the expected impact of the proposed development.

Pedestrian and cycle access from the Site is proposed via the vehicle access points at Sunset Drive, Memorial Drive and Bussell Highway. The proposed access arrangements are shown in **Figure 3-1.**

3.3 Road Cross Sections

As shown on **Figure 3-1 ,** there is one proposed Neighbourhood Connector Road. This will feature a 17.6m wide road reserve and footpaths on both sides of the road as per the requirement of *Liveable Neighbourhoods*. In accordance with Liveable Neighbourhoods criteria, the internal road reserve through the site can be configured at 17.6m assuming no on-street cycle lanes, no on-street parking on the southern side due to POS and indented on-street parking on the northern verge. Included in this can be a reduced verge width on the southern at 3.1m. The remaining Local Access Roads will include a 15.4m wide road reserve with at least one footpath on one side of the roads as per current guidelines. Laneway access to properties will have a 6m wide road reserve.

Neighbourhood Connector Road

Local Access Road

Figure 3-1: Site Concept Masterplan



3.4 Roads & Intersection Controls

Internal Site Intersections:

Due to the low volume and low speed residential nature of the proposed development area, all intersections within the Site are intended to be constructed as priority-controlled T-intersections. The only exceptions are both four-way intersections formed at the north-south street intersection points where they cross the main east-west street between Sunset Drive and Bussell Highway.

However, it is a recommendation of this report that both of these four-way intersections should be designed as raised plateaus assuming a design speed of 20km/h and posted as such. These raised plateaus would reduce the requirements for Safe Intersection Stopping Distance (SISD) and form appropriate 'gateways' into the residential development. These intersections will require signage (Give-Way or Stop) on the approaches, and in this case the north-south approaches are preferred.

Sunset Drive/Site Access:

The development proposes a site access intersection onto Sunset Drive which takes the form of a three-way priority control. With respect to the location of the intersection on Sunset Drive, locating it on the outside of the bend, as shown in the Site Concept Masterplan, affords it good sight lines to and from the intersection as the roadway bends away from the tree line on the east side.

A desktop appraisal of Sunset Drive shows the bend has a radius of approximately 50m. Putting the intersection either side of that bend will reduce the sight distance to/from the intersection. The current sight distance on the bend is approximately 150m to the South and approximately 150m+ to the North. In accordance with Austroads Guidance, the required Stopping Intersection Sight Distance (SISD) for 70km/h design speed (60km/hr posted + 10km/hr) on Sunset Drive is 150m, which is therefore acceptable. The proposed sight lines are shown on the 'Sunset Drive Sight Lines Plan' at **Appendix C** of this report.

Should the proposed site access intersection be located at the most western extent of the site adjacent to Sunset Drive, the sight distances would be 150m+ to the south and 105m to the north. Thus, the north direction would have insufficient sight distance. The same issue occurs if the intersection were considered to be relocated north of the bend. Therefore, in summary it is recommend retaining the intersection onto Sunset Drive in the location shown on the current Site Concept Plan (i.e. on the outside of the bend) to maximise SISD and stay within acceptable levels.

Memorial Drive/Site Access:

The development proposes a site access intersection onto Memorial Drive which takes the form of a three-way priority control. Liveable Neighbourhoods gives guidance for same side intersections, and this is 40m CL to CL (Table 5 of Element 2), which is achievable in relation to the adjacent intersection of Sunset Dr/Miamup Dr/Memorial Drive.

The required Stopping Intersection Sight Distance (SISD) for a 60km/h design speed (Memorial Drive = 50km/hr posted + 10km/hr) is 123m. A desktop appraisal of this proposed site access intersection in terms of SISD indicates acceptable levels will be achievable on Memorial Drive to the east in relation to Austroads Guidance. The level of available SISD should be checked again and confirmed as achievable at the later detailed intersection design stages.

Bussell Highway/Roy Earl Drive/Site Access:

The proposed roundabout design included in the developer's Site Concept Masterplan (**Figure 3-2**) has been developed based optimising the proposed MRWA draft roundabout design in four key areas being Road Reserve, Roundabout Central Island Radius, Central Hatch Line Marking and Speed Reduction Measures. The optimised roundabout has been tested for the appropriate design vehicles. Section 4.2 of this report discusses these areas of the design in greater detail. The developer's proposed roundabout design shown at **Figure 3-2** optimises the design with the intention of reducing the size, cost and third party land required for construction of this intersection.

Figure 3-2: Proposed Roundabout Design – Bussell Highway

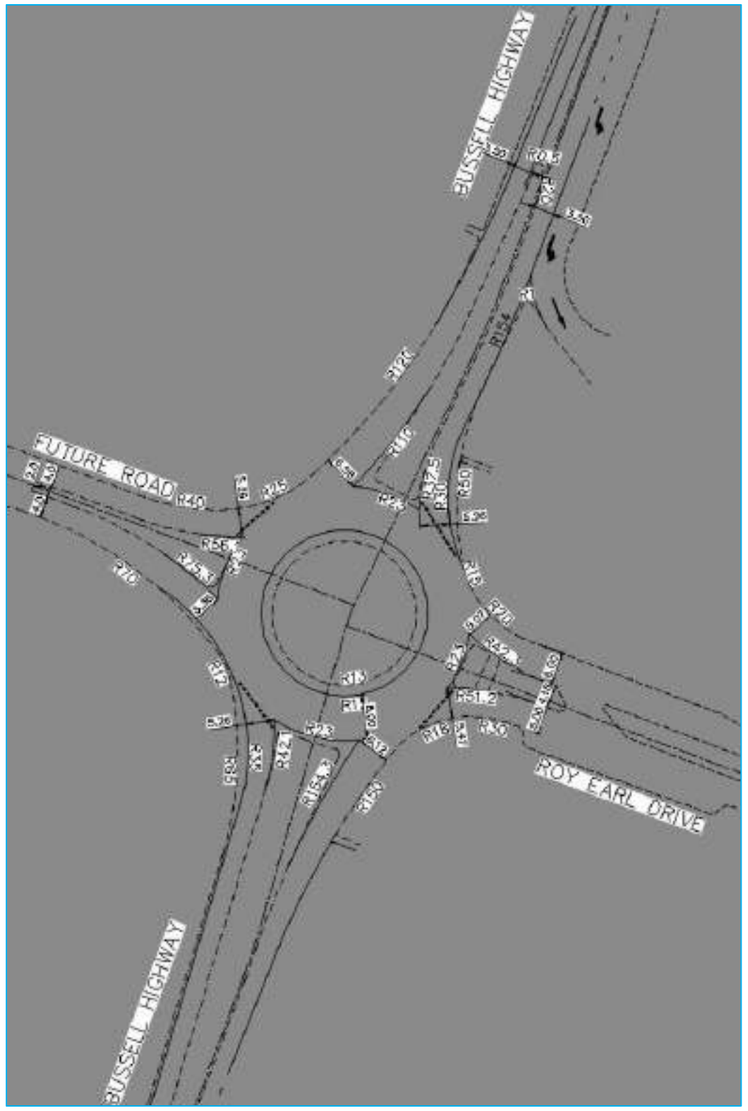


Figure 3-3: Swept Path Analysis of 26m B-Double Combination

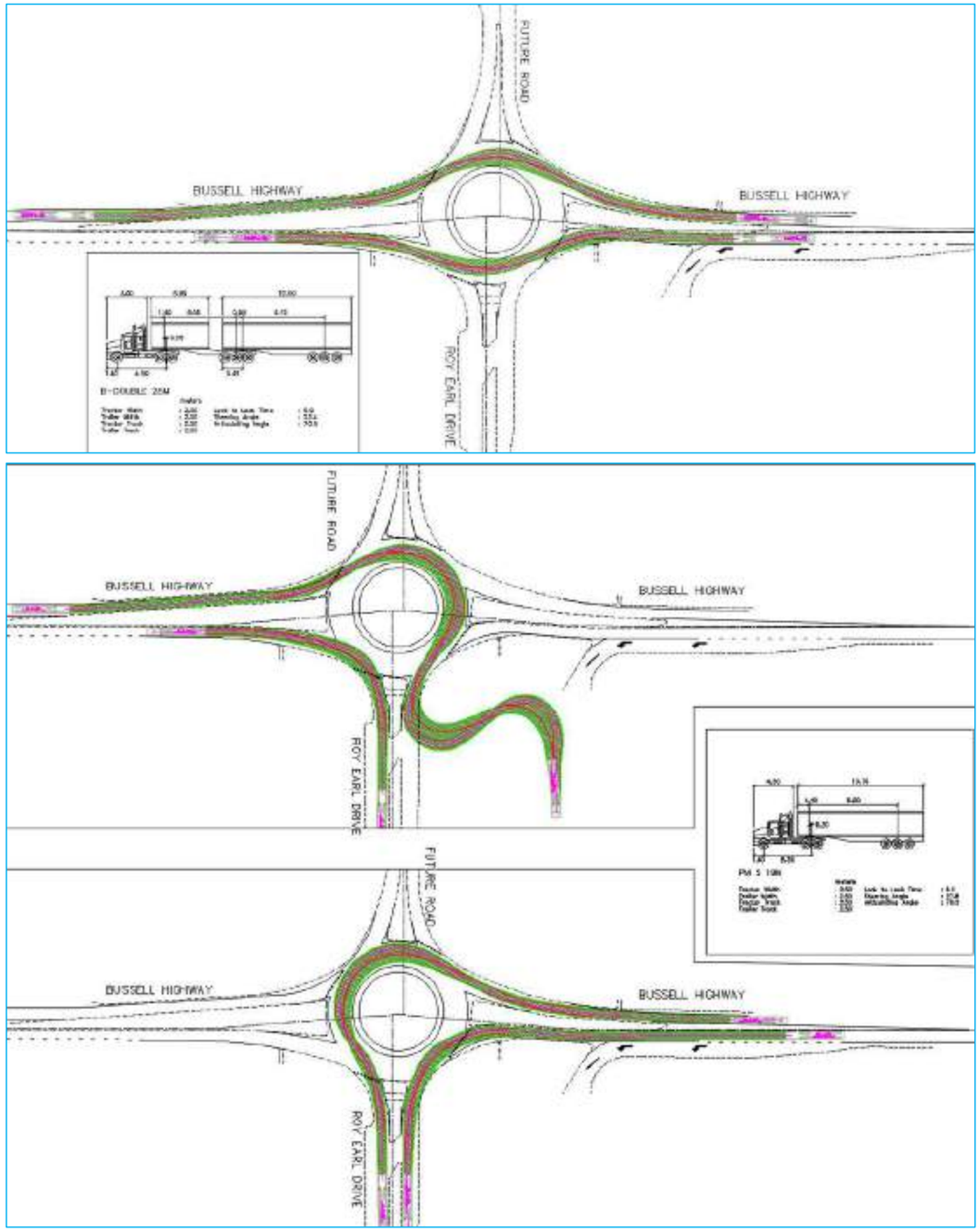
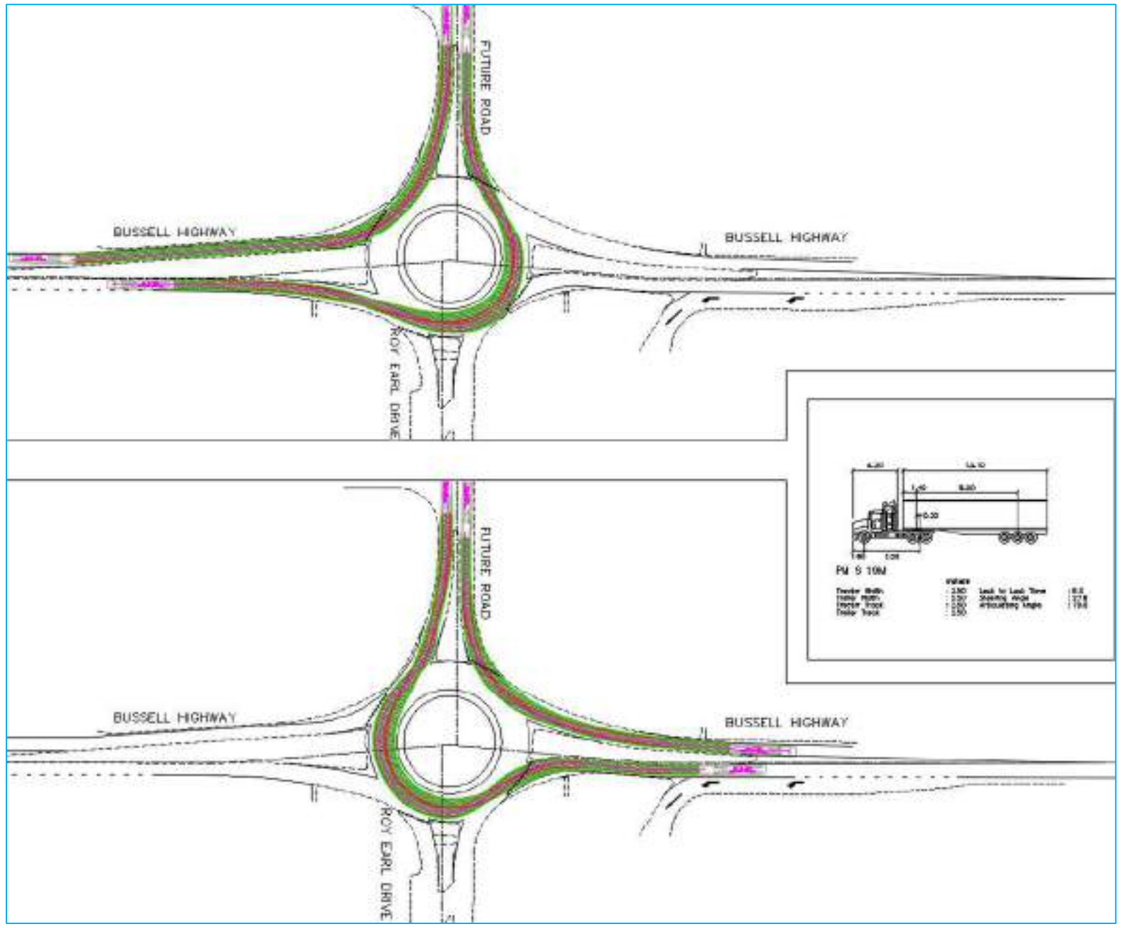


Figure 3-4: Swept Path Analysis of 19m Prime Mover and Semi-Trailer



3.5 Pedestrian and Cycle Access

Pedestrian and cyclist access across the Site has not yet been fully defined. However, it should be provided in accordance with the requirements of the guidance for *Liveable Neighbourhoods*, as per the following.

According to the WAPC Liveable Neighbourhoods Policy, shared paths and footpaths are proposed along all Neighbourhood Connector roads (2-2.5m wide). Dropped kerb crossings will be provided as appropriate, including at intersections. Cyclists can either use the footpaths, or cycle on the quiet streets within the proposed development.

Following these guidelines, the proposed pedestrian and cyclist facilities aim to provide a permeable road network within the subject site to create excellent opportunities for the provision of good pedestrian facilities that maximise the use of non-motorised transport modes. Section 5 of this report discuss access to Cowaramup Town Centre, Cowaramup Primary School and recommends improvements along walking and cycle routes where necessary.

3.6 Public Transport

No public transport routes or bus stops will be provided within the Site.

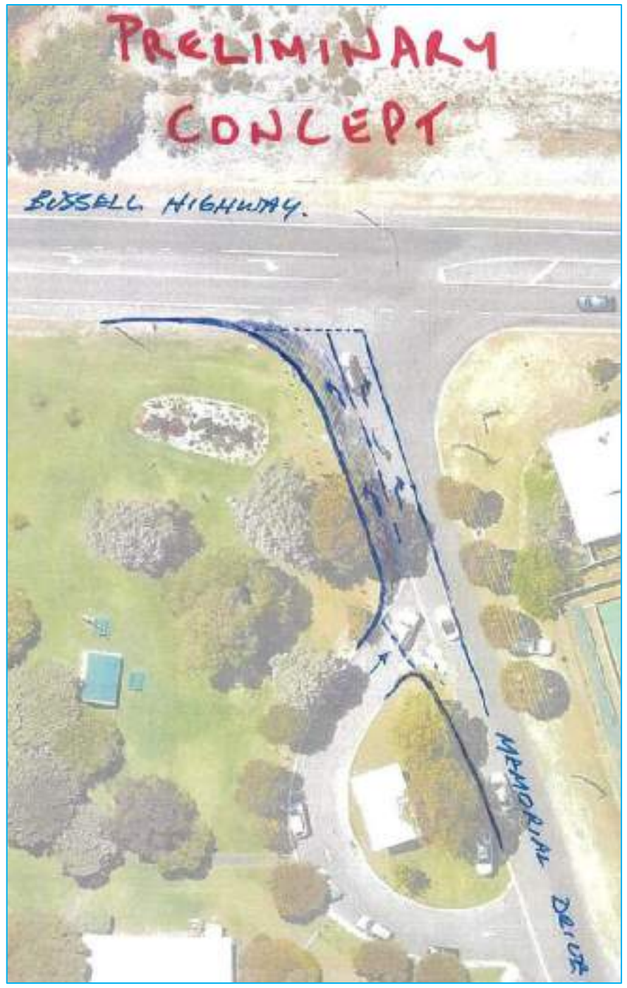
4 Changes to the External Transport Network

4.1 Bussell Highway / Memorial Drive Intersection Upgrade

PJA is aware of a proposed future upgrade to the intersection of Bussell Highway / Memorial Drive located adjacent to the north-east corner of the Site. It is understood that Main Roads WA currently has a developer contribution scheme which requires future developments in the area, which have an impact on this intersection, to help fund the improvements.

PJA has contacted MRWA to request details of the intersection upgrade and at the time of writing this report it is understood that the upgrade comprises the minor widening of Memorial Drive for a short section near its intersection with Bussell Highway to create a two-lane approach featuring a new left turn only lane and a separate right turn only lane. An extract of the preliminary sketch concept design is shown in **Figure 4-1** below for reference.

Figure 4-1: Preliminary Concept – Bussell Hwy/Memorial Drive Intersection



4.2 Bussell Highway / Roy Earl Drive Intersection Upgrade

Main Roads WA has developed a draft intersection configuration at Bussell Highway/Roy Earl Drive, which has been developed in response to the residential structure plan proposals of Lot 102 Bussell Highway and Lot 500 Wirring Road with the intention of establishing an acceptable form of intersection which serves the requirements of these future developments and the future growth of the surrounding area including the future function and operation of Bussell Highway. This draft roundabout design will be included within consideration of site access options analysed within the scenarios included in this Transport Impact Assessment.

An extract of Main Roads WA's draft roundabout design is shown on **Figure 4-2** below for reference.

Figure 4-2: Main Roads WA's Draft Roundabout Concept – Bussell Hwy/Roy Earl Drive/Site Access



An initial appraisal of the draft MRWA roundabout design has been undertaken and reported on below in terms of four key areas, which if addressed are likely to optimise the design and reduce the size, cost and third party land required for construction on this intersection.

Road Reserve: The MRWA draft design does not maximise the position the roundabout toward the east side of the Bussell Hwy road reserve. This is perhaps due to an intention to reduce any impact on existing underground services. However, there is some scope to reposition the roundabout to the eastern side whilst still allowing a pedestrian crossing point across Roy Earl Drive.

Roundabout Central Island Radius: The MRWA draft design shows a central island radius of 20m, which is based on MRWA standard drawing 200331-0194-6. 20m refers to the minimum radius for a double road-train. However, there is a permitted provision allowing the central island to potentially reduce in size where design vehicle through movements only

are required, which is the case in this instance. Therefore, it is recommended that the roundabout design is initially based on a 14mR central island radius (applicable for a 19m semi-trailer) and then test the geometry using swept paths of a double road-train (27.5m) travelling north/south and a 19m semi-trailer turning right in & right out of the service station and proposed site access. This will determine the ideal circulating carriageway width. The central island radius can be adjusted to suit if required.

Central Hatch Line Marking: The MRWA draft design retains the wide central hatch line markings which currently separate northbound and southbound movements on Bussel Hwy in the vicinity of Roy Earl Drive, presumably to tie into existing road features. However, this line marking is only currently required to develop the existing channelised right turn lane (CHR) into Roy Earl Drive under the existing T-intersection layout. The roundabout design can omit this wide central hatch marking on the approach roads and instead include double-barrier white lines, with x2, 3.5m wide lanes (one lane in each direction). This benefit could be considered marginal. However, it helps to reduce third party land required for the construction of this roundabout.

No Speed Reduction Measures Required: The MRWA draft design is located within an existing 60km/hr speed limit zone. Therefore, in accordance with Austroads Guide to Road Design Part 4B Tabel 4.1, no speed reduction measures are required i.e. no reverse curves or long median islands etc. This particularly applies in the southbound direction on Bussell Highway, where the left turn deceleration lane (to the service station) does not need to curve away from the eastern side and can be on a straighter alignment. The approach road entry path radii for the northbound and southbound movements (and side-roads) can be determined using Austroads Guide to Road Design Part 4B, Table 4.2 and Figure 4.5 for a single lane roundabout. This should reduce the curved alignment of the approach roads and help to reduce third party land required for the construction of this roundabout.

The proposed roundabout design included in the developer's Site Concept Masterplan (Section 3.4) has been developed based on the above optimised principles and tested for the design vehicles mentioned above.

4.3 Bussell Highway Improvements – North of Cowaramup

To the north of Cowaramup, there have been relatively recent improvements to Bussell Highway. Specifically, road shoulders along Bussell Highway were widened in 2021 between Treeton Road and Peake Street. In addition, a dedicated right turning lane from Bussell Highway into Treeton Road was constructed. According to Main Roads WA, these upgrades improved safety, provided smoother journeys and give better access into Treeton Road.

4.4 Changes to Pedestrian Network

There has been a recent footpath upgrade, constructed in May 2023, on the western side of Bussell Highway surrounding the south-east corner of the Bussell Highway / Memorial Drive intersection and extends approximately 60 metres to the south of the intersection.

It is a recommendation of this report that investigations be undertaken to explore the potential for extending the above existing footpath network on the western side of Bussell Highway (approximately 500m) to link in with the proposed pedestrian connections on the eastern flank of the Site and the internal footpath network. If feasible, this would encourage trips on foot, bicycle and micro-mobility to the local centre of Cowaramup and help reduce the reliance on private vehicle modes for short trips. The funding mechanism for which these improvements could be budgeted, would be with Main Roads WA.

4.5 Changes to Cycle Network

WABN Grants

The Shire of Augusta-Margaret River is set to benefit from funding as part of the WA Bicycle Network (WABN) Grants Program. Department of Transport (DoT) announced the Shire will receive over $500,000 between 2023 and 2025 for the design and construction of new shared pedestrian/bike paths.

The latest round of funding will see five projects delivered within the shire that will help improve the safety, connectivity and accessibility of active travel networks. It will be used towards the design and construction of shared paths in Witchcliffe, Augusta, Cowaramup and Margaret River.

Successful projects include Cape Leeuwin Trail shared path (funding towards the progression of trail design and implementation, subject to council approval and further engagement with Traditional Custodians), Redgate Road shared path, Hillview Road shared path, Tingle Avenue shared path and Duggan Drive shared path.

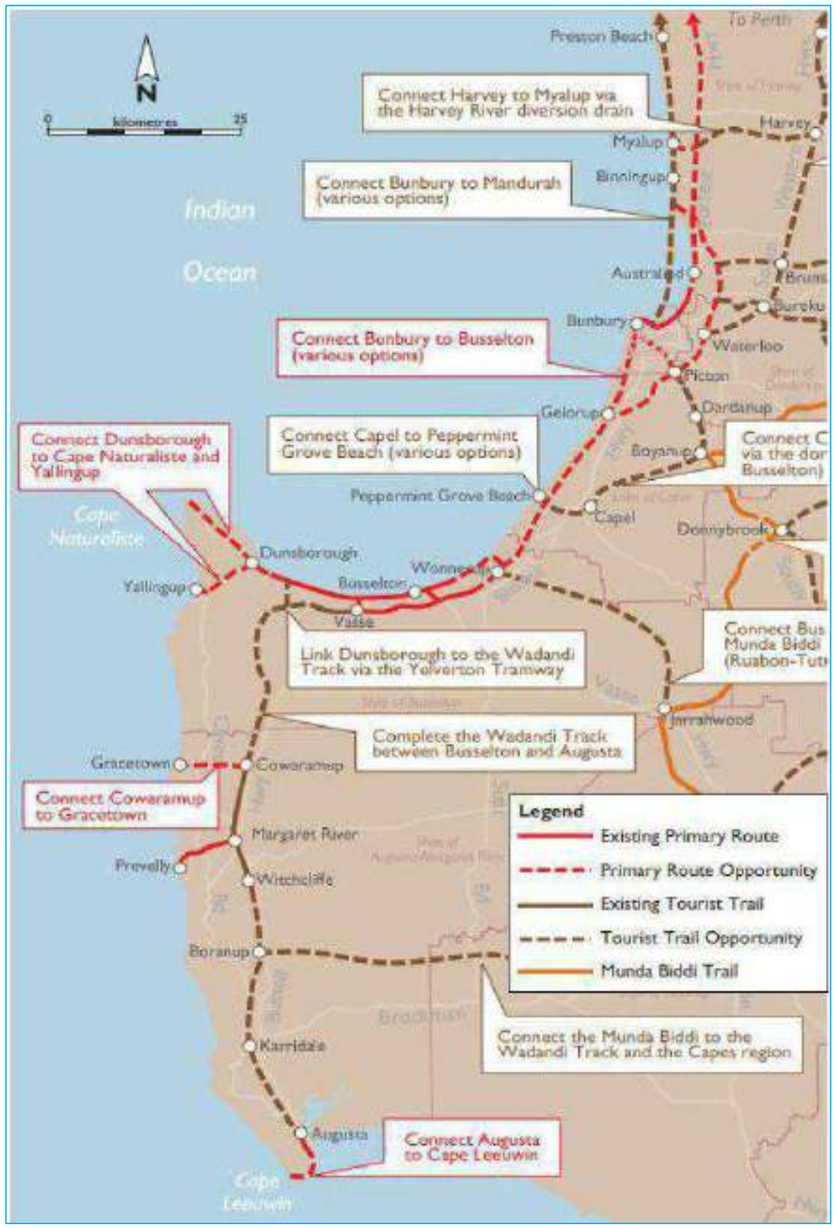
Leeuwin-Naturaliste 2050 Cycling Strategy

The Leeuwin-Naturaliste 2050 Cycling Strategy details the future cycling plans within the region focused on connecting, enhancing and extending the region's cycling infrastructure through the development of an interconnected network of off-road shared paths and trails, protected on-road bike lanes and low-stress residential streets.

Within the Cowaramup area, the keys cycling link proposed are as follows:

- a primary route linking Gracetown to the Wadandi Track along Cowaramup Bay Road - performing a similar function to the Margaret River-Prevelly Shared Path.
- a secondary route along the main street of Cowaramup (extending from Waverley Road to Roy Earl Drive) providing people with access to Cowaramup shops and community facilities.
- a secondary route along Memorial Drive providing a safe link between the Cowaramup town centre and the town's western residential area.
- two local route loops providing residents of east and west Cowaramup with access to higher-order cycling facilities.

Figure 4-3: Proposed Inter-Regional Cycling Connections near Cowaramup



4.6 Changes to Public Transport Network

PJA has contacted the Public Transport Authority to request confirmation of any future plans from the regional public transport provider (TransRegional) in connection with providing new scheduled bus services or school services within Cowaramup and adjoining towns.

The PTA has confirmed that Regional Town Bus Services have no short-term plans to provide local bus routes in Cowaramup. The PTA notes that they may assess the viability of local public transport services for Margaret River within the next five year period. However, this would be dependent on population and residential growth.

5 Integration with Surrounding Area

5.1 Surrounding Attractors / Generators

To the north-east of the Site is the town centre of Cowaramup (approximately 600m from the centre of the Site) and includes facilities such as a church, shops, cafes, bakeries, gift shops, agricultural supplies and food and beverage outlets. Recreational and civic land uses including Pioneer Park, the Cowaramup District Hall, Cowaramup Oval, Skate Park, BMX Track, Basketball Court and Tennis Court.

Cowaramup Primary School is located approximately 1.0km north east of the centre of the development site off Waverley Road, which is likely to generate trips from the proposed development site by walking, cycle and by private vehicle.

Closer to the Site (300m from its centre) is the Cowaramup District Social Club including lawn bowls facility and a distillery and tavern on the eastern side of Bussell Highway. Cowaramup Community Men's Shed and the Volunteer Fire Station is located to the north-west of the site on the western side of Sunset Drive.

Due to the regional location of Cowaramup, on the primary link road of Bussell Highway, significant attractors such as Margaret River located approximately 10-minute drive south and the City of Busselton approximately 30 minutes by car to the north-east are factors in generators of vehicle trips from the Site for employment and recreation.

5.2 Proposed Changes to Surrounding Land Uses

Under the provisions of the Shire of Augusta-Margaret River Local Planning Scheme No.1, the proposed changes to the surrounding land uses include two large areas of land zoned 'Rural Residential' to the north-east of the Site off Treeton Road, together with an adjoining area zoned for 'Industry' and 'Corporate Industry'.

To the south-west of the site, off Cowaramup Bay Road, there is an area of land (T1) zoned for 'Tourism' with an adjoining area of land zoned (SP) as 'Public Purposes: Shire Purposes'.

To the west of the site, off Brockman Road, there is a large area of land (SPA 34) zoned 'Residential', which is currently under the early stages of construction. The proposed development traffic generated by this development will be included in the assessment of intersections within this report.

In addition, immediately adjacent to the eastern end of Roy Earl Drive there is a large area of land designated in the LPS as DCA4a. Pursuant to the provision of the Shire of Augusta-Margaret River Local Planning Scheme No. 1, the Site is zoned 'General Agriculture', as shown in **Figure 5-1**. A Request to Amend LPS 1 (Amendment 76) was lodged in June 2022, seeking to rezone the land to 'Future Development'. The potential for this site to be rezoned as 'Future Development', including the resultant development traffic generation will be included in the assessment existing and future intersections within this report.

Figure 5-1: Shire of Augusta-Margaret River LPS 1



5.3 Travel Desire Lines

Pedestrian / Cycling

The travel desire lines between the proposed Site and the major attractors in Cowaramup (schools, parks and town centre shopping areas) will mainly be via the existing paths in the wider area that connect back to the new footpath network to be created within the proposed development.

As mentioned in Section 4.4, the existing short section of footpath on the western side of Bussell Highway (south of Memorial Drive) would not be sufficient to connect into the proposed pedestrian links on the eastern flank of the Site. It is a recommendation of this report that investigations be undertaken to explore the potential for extending the existing footpath network on the western side of Bussell Highway (approximately 500m) to link in with the proposed pedestrian connections on the eastern flank of the Site and the internal footpath network. If feasible, this would encourage trips on foot, bicycle and micro-mobility to the local centre of Cowaramup and help reduce the reliance on private vehicle modes for short trips. The funding mechanism for which these improvements could be budgeted, would be with Main Roads WA.

This would represent a significant improvement to pedestrian connections with the town centre and its major attractors.

The existing cycling environment on Bussell Highway, along the eastern flank of the site, is poor with only sealed shoulders with edge lines representing an informal and unsuitable provision with a sub-standard width for cyclists of approximately 1.0m and a prevailing speed limit of 60km/hr. It is however anticipated that the majority of the cycle trips to/from the development site would take place via the internal site road onto Memorial Drive which is more appropriate for cycling of most abilities with a 50km/speed limit and an integrated cycling environment. In addition, footpaths connect through Pioneer Park to link with the town centre, which cyclists are legally permitted to use.

To the north of Memorial Drive on Bussell Highway, these sealed shoulders transform into wider offsets and whilst not specifically signed as 'cycle lanes', the width and style of provision lends itself to encourage cycle modes into and out of the town centre. The speed limit of Bussell Highway in this location (north of Memorial Drive) also reduces to 40km/hr which is conducive to the provision of a good cycling environment and adds to the attractiveness of trips by cycle to/from the town centre.

Figure 5-2: Bussell Highway Looking North at Memorial Drive Intersection



Figure 5-3: Bussell Highway Looking North at the Commencement of Existing 40km/hr Speed Zone (north of Memorial Drive)



It is a recommendation of this report that the relocation of the beginning/end of the 40km/hr speed zone on Bussell Highway be investigated by Main Roads WA (in consultation with Shire of AMR) to extend south of Memorial Drive to include the intersection and improve the cycling environment for cyclists joining Bussell Highway from Memorial Drive with a destination in the town centre.

To the west of the site, the 'Wadandi Track', is a shared path starting at the intersection of Sunset Drive / Memorial Drive (north-west corner of the Site). This section of the Wadandi Track runs between Cowaramup and Sebbes Road (11km) and provides recreational and commuting cycle access between Cowaramup, Margaret River (links with Prevelly Cycle Track) and onward to Witchcliffe.

Motor Vehicle

The street network within the proposed development has not yet been constructed. The development site is proposed to be accessed directly from Bussell Highway (primary access) Memorial Drive and Sunset Drive (secondary access points). Direct property access in the form of driveway/crossovers is not proposed from Bussell Highway. All direct property access will be facilitated from the internal road network of the Site. The vehicular connections from Memorial Drive and Sunset Drive will distribute the proposed development generated traffic amongst the surrounding streets and further afield making use of the traffic carrying capacity of the surrounding street network.

Public Transport

There are no public transport services being planned within the proposed development area and as previously mentioned in Section 2.7, mainly due to its regional location and its presence as a gateway town to Margaret River by vehicle, Cowaramup does not have a regular scheduled public bus service. TransRegional does not operate in Cowaramup or the surrounding towns. The PTA has confirmed that Regional Town Bus Services have no short-term plans to provide local bus routes in Cowaramup. The PTA notes that they may assess the viability of local public transport services for Margaret River within the next five years however, this would be dependent on population and residential growth.

5.4 Level of Overall Accessibility and Integration

When the Site is fully developed, it will form part of a wholly integrated residential / rural-residential area with appropriate connections to the regional road network, including Bussell Highway, Caves Road and linkages to coastal towns and areas.

The existing footpath provision immediately surrounding the site for pedestrians is poor and it is recommended that investigations be undertaken to explore the potential for extending the existing footpath network surrounding the site. Similarly, the existing cycle provision is poor and this report recommends exploration of speed reduction remedial measures to improve the safety and environment for cyclists on trips to/from Cowaramup town centre. The mechanism for speed reduction approval and implementation rests with Main Roads WA for Bussell Highway.

The provision of public transport services in Cowaramup is non-existent and it is recommended that PTA investigate the future possibility of providing a regional scheduled public bus services to serve Cowaramup and adjoining towns including a link to Busselton. This would help to address the future sustainability of the development site, particularly in consideration of large areas of land within Cowaramup currently zoned for future residential and rural-residential development which could take advantage of a regular public transport service.

6 Analysis of Internal Transport Networks

The proposed residential development (Lot 102 Bussell Highway) land is currently undeveloped and does not generate traffic onto the existing road network in its own right. However, given the previously approved Local Structure Plan (2008) for this site, it is worth establishing that there is an acceptance by the planning and road authorities that the site is capable of generating new traffic and that a level of impact is considered acceptable. The 2008 Structure Plan included 124 lots, a lifestyle village and Club & Sports Facilities Expansion area.

However, given the length of time since the adopted LSP was approved, this assessment undertakes a new analysis of the impact of the currently proposed residential development, specifically the impact of the generated traffic on the road network.

6.1 Subdivision Generated Traffic

6.1.1 The details of the vehicular traffic expected to be generated by the proposed development at Lot 102 Bussell Highway is calculated and set out in Section 7.3 of this report. The subdivision site is expected to generate a total of 195 two-way vehicle trips in the AM peak hour and the same in the PM peak hour. This equates to approximately 1,950 trips per day. Given the scale of the proposed development and that it will be only a residential land use, it is expected that all of these vehicle trips would be externally distributed onto the adjacent street network.

6.2 Non-Subdivision Traffic (Through Traffic)

6.2.1 Based on 'Scenario Two' it is expected that through traffic within the proposed development area will be present due to the road connection constructed between Sunset Drive and Bussell Highway which will encourage an estimated 70% of existing traffic volume to/from Sunset Drive to be diverted from Memorial Drive and thereby provide some 'relief' to the operation of the Bussell Highway/Memorial Drive intersection. This effect will be mainly due to the greater operating capacity and priorities which the proposed Bussell Highway roundabout will provide for traffic entering and exiting Bussell Highway into the development site and to destinations further west on Sunset Drive and Miamup Road. This effect on existing traffic volumes and routes has been factored into this assessment and represents a worst case assessment in terms of the operation of the future roundabout intersection.

6.3 Design Traffic Flows

6.3.1 The design traffic flows represent the volume used to design the internal road network by adding extraneous traffic (through traffic) to subdivision generated traffic. It is estimated that a total of 470 vehicles per hour (two-way) in the busiest peak hour would utilise the connecting road across the site between Sunset Drive and Bussell Highway.

6.3.2 The remaining side roads within the site are expected to provide access only to the subdivision lots and the maximum anticipated two-way trips within these internal roads is up to 50 vehicles in the peak hour. Through traffic on these side roads is forecast to be negligible and would not carry more than 500 vehicles per day.

6.4 Access to Frontage Properties

Through the development of the assessment parameters in Section 7 of this report, it has been determined that the 'link road' across the site between Sunset Drive and Bussell Highway could carry up to a total of 470 vehicles per hour in the busiest peak hour period and the internal side roads may carry up to 50 vehicles per hour. However, the reality is likely to be less than this.

This means that the 'link road' could be expected to carry up to a total 4,700 vehicles per day and the side roads up to 500 vehicle movements per day. Therefore, in accordance with the criteria given in Liveable Neighbourhoods Element 2, frontage access to properties on the link road and any other internal side roads would be acceptable.

6.5 Pedestrian / Cycle Networks

As the internal link road across the site and the internal side road are anticipated to have relatively low volumes of traffic, it is considered that none of the proposed roads within the site would be difficult for pedestrians and cyclists to cross.

This is in line with Table 4 of the *WA Transport Impact Assessment Guidelines Volume 2,* which has been reproduced below. This states that for a two-lane undivided road, the ability of most pedestrians to cross would only be affected if there are more than 1,100 vehicles per hour (two-way).

The remaining 'access roads' within the site are intended to be 2 lane undivided with up to an anticipated total of 50 two-way vehicle trips within the AM peak hour and as such the ability of most pedestrians to cross would only be affected if there are more than 1,100 vehicles per hour on these types of roads.

Table 6-1: Traffic Volumes Affecting Pedestrian Crossing Amenity

Road cross-section	Traffic volume affecting ability of pedestrians to cross (vehicles per hour – two-way)
2 lane undivided	1,100 vph
2 lane divided (or with pedestrian refuse islands)	2,800 vph
4 lane undivided (without pedestrian refuge islands)	700 vph
4 lane divided (or with pedestrian refuge islands)	1,600 vph

Pedestrian ramps will be provided at every internal intersection within the subdivision site, and in addition safe crossing facilities will be considered at intervals of no greater than 100 metres for the Neighbourhood Connector road which runs through the site between Sunset Drive and Bussell Highway.

6.6 Safe Walk / Cycle to School Assessment

There are no proposed schools within the subdivision area. Cowaramup Primary School is located approximately 1.0km walking distance north east of the centre of the development site off Waverley Road, which is likely to generate trips from the proposed development site by walking and cycle (and by private vehicle). Due to its rural location, this is the only primary school in close proximity to the development site (three other primary schools are located in Margaret River) and Cowaramup Primary School is likely to include the entire development in its catchment, particularly for walking and cycle modes of travel.

The most likely walk and cycle route to Cowaramup Primary School is shown on **Figure 6-1** in **blue**. These routes will begin either at Memorial Drive or Bussell Highway, with a potential secondary route (pink) for the southern half of the development site via Roy Earl Drive, Hasluck Street and Hall Road.

Currently there is no footpath along the eastern flank of the development site adjacent to Bussell Highway which would be a pedestrian desire line to/from Cowaramup Primary School. In addition, the eastern side of Pioneer Park would form a desire line adjacent to Bussell Highway where there is currently only a grassed surface and the lack of a footpath in this location may encourage pedestrians to walk on the sealed edge of Bussell Highway. Within the centre of Cowaramup there is an existing children's crossing which is manned by crossing wardens during school peak periods, which provides an excellent provision to cross Bussell Highway along this route to school.

The secondary route (pink) would involve crossing Bussell Highway via the proposed roundabout intersection using a two-stage crossing with pedestrians required to cross one lane of traffic at a time at the pedestrian refuge islands. At the northern end of this route, at Hall Road, would require a footpath to effectively link up with the existing footpath running through Cowaramup Recreation Reserve. All routes to school cross two-lane undivided side roads, and the low traffic volume nature of these roads (less than 1,100vph) are not considered to cause a barrier to walk to/from school.

Children cycling to Cowaramup Primary School may legally use existing footpaths along the above routes and will benefit from any new footpath sections installed to enhance these routes.

It is a recommendation of this report that investigations be undertaken to explore the potential for extending the existing footpath network in the areas shown in **Figure 6-1 .** If feasible, this would encourage trips on foot to the local centre of Cowaramup and to the Primary School, thereby reduce the reliance on private vehicle modes for short trips. The funding mechanisms for which these improvements could be budgeted, would be with Main Roads WA and the Shire of Augusta Margaret River.

Figure 6-1: Walk/Cycle Routes to Cowaramup Primary School



Further afield, Margaret River High School (12.0 km south) and Busselton Senior High School (36.0 km north) are unlikely to attract trips by walking and cycle from Cowaramup and will mainly involve vehicle based trips. Despite this, Margaret River is accessible by cycle from Cowaramup via the Wadandi Track, which is largely an off-road shared path and mainly unsealed for much of its length and perhaps is best suited to fair weather times of year. The Wadandi Track crosses busy and high speed roads such as Cowaramup Bay Road, Burnside Road and Carters Road before arriving in Margaret River at Walcliffe Road. The length of journey, unsealed nature of this track and various road crossing points does not encourage regular commuting trips by cycle to Margaret River High School. Any improvements to the surface of the track and safer crossing points is not considered to overcome the biggest barrier to cycling to Margaret River which is the distance involved in a two-way trip for High School commuters. As such this assessment does not encourage and rely on these types of trips.

6.7 Pedestrian Permeability and Efficiency

The walkable catchment is simply a technique for comparative evaluation of how easy it is to move through an urban area in order to get to and from these centres or facilities. These maps are the best estimates of walkability, and as such are an indication of energy efficiency.

Walkable catchment calculations are expressed as the actual area in a five-minute walking distance as a percentage of the theoretical area in a five-minute walking distance. The theoretical five-minute walking distance is shown as a circle with a radius of about 400 m drawn around any particular centre. This is an area of 50 ha. When calculating a ten-minute walking distance, the radius used is about 800 m, resulting in a circle area with an area of 200 ha. The higher the percentage the better the walkability and hence the likely energy efficiency of any urban area. A good target for a walkable catchment is to have 60 per cent of the area in a five-minute walking distance, or ten minutes in the case of stations.

Given the size of the development site (10.90 Ha) and the rural location with relatively sparse housing density, this assessment will focus on an 800 metre walking distance measured from the centre of Cowaramup, or ten minute walking distance.

The purple shaded area shown on **Figure 6-2** , shows that approximately 60% of the subdivision area is within 800 metres (ten minute waking time) of the centre of Cowaramup. This means that the majority of retail, recreational and community uses within Cowaramup are within a ten minute walk time of approximately 60% of the subdivision. Cowaramup Primary School is located just outside of 800m of the centre of the site.

Figure 6-2: Walkable Catchment Area



Area of Subdivision with 800m (ten minute walking time) of Cowaramup centre.

6.8 Access to Public Transport

As mentioned in Section 4.6 of this report, PJA has contacted the Public Transport Authority to request confirmation of any future plans from the regional public transport provider (TransRegional) in connection with providing new scheduled bus services or school services within Cowaramup and adjoining towns.

The PTA has confirmed that Regional Town Bus Services have no short-term plans to provide local bus routes in Cowaramup. The PTA notes that they may assess the viability of local public transport services for Margaret River within the next five years however, this would be dependent on population and residential growth.

7 Analysis of External Transport Networks – Assessment Parameters

7.1 Assessment Years and Time Periods

In accordance with the WAPC Transport Impact Assessment Guidelines – Volume 3 Subdivision, the assessment years will generally be the year of full development of the subdivision plus the assessment year adopted for the structure plan. 10 years after full opening of the sub-division is suggested for the post full subdivision development assessment.

Where there is no prior structure plan assessment (which is the case in this instance), a more detailed assessment of the post full development scenario is required to determine the potential medium to longer term impacts of the subdivision on the surrounding transport networks and of the development of the surrounding area on the subdivision itself.

The proposed development is estimated to be fully built out by 2026. This brings the 10 years post build out scenario to approximately 2036 and to accord with strategic road network forecast scenarios, the traffic impact assessment analyses have been based on a 2036 timeframe.

The assessment time periods are broadly in keeping with typical residential development AM and PM peak periods and in consideration of the peak periods on the surrounding road network, the times periods will be 8AM to 9AM and 3:30PM to 4:30PM on weekdays. Weekend peak periods in Cowaramup and surrounding areas include lower levels of background traffic and as such weekend time periods and peaks will not be included in this assessment.

7.2 Background Traffic

7.2.1 PJA commissioned new turning traffic count surveys at the following intersections surrounding the development site on Wednesday 31 May 2023 for the durations of 6am to 9am and 3pm to 6pm. This covers a range either side of the demonstrated peak periods derived from available traffic data of Bussell Highway from the Main Roads WA traffic map.

- Memorial Drive / Sunset Drive / Miamup Road – 3-way priority controlled intersection.
- Bussell Highway / Memorial Drive – 3-way priority controlled intersection
- Bussell Highway / Roy Earl Drive – 3-way priority controlled intersection

7.3 Subdivision Traffic Generation

The traffic generation rates in **Table 6-1** sourced from the WAPC Guidelines, have been used to calculate an estimate of the traffic generated in the AM and PM peak periods by the proposed residential development. Given the location of the Site, with the majority of trips expected by private vehicle, the below trip rates are considered robust, with no reductions applied to account for linked or internal trips.

Table 7-1: WAPC Trip Generation Rates

Land Use	AM Peak Hour		PM Peak Hour	
	IN	OUT	IN	OUT
Residential	0.2 trips per dwelling	0.6 trips per dwelling	0.5 trips per dwelling	0.3 trips per dwelling

Table 7-2 summarises the trip volumes derived from the adopted generation rates.

Table 7-2: Proposed Development Traffic Generation

No of Units	AM Peak Hour		PM Peak Hour	
	IN	OUT	IN	OUT
243	49	146	122	73

The site is expected to generate a total of 195 two-way vehicle trips in the AM peak hour and the same in the PM peak hour. This equates to approximately 1,950 trips per day. Given the scale of the proposed development and that it will be only residential in nature, it is expected that all of these vehicle trips would be externally distributed onto the adjacent street network.

Sections 6.6, 6.7 and 6.8 discuss the assumed composition and assignment of development generated traffic across the assessment scenarios tested as part of this TIA.

7.4 Future Year Traffic Growth

Interrogation of the Main Roads WA traffic map shows a 24 hour count site (No. 51099) on Bussell Highway – south of Metricup. Traffic data for this site is available between the years of 2011 to 2021. Analysis of the increasing traffic volumes over this period, shows an average 3.5% growth rate of traffic on Bussell Highway per annum. This growth rate will be applied to the background 2023 traffic volumes on Bussell Highway up to the design horizon of 2036 for assessment purposes.

Traffic growth on the relevant side roads of Memorial Drive and Sunset Drive surrounding the Site has been assumed to be a nominal 2% increase per annum, which is robust.

7.5 Committed Development Traffic Generation

To the west of the proposed development site there are three committed residential developments which are currently under construction and are not yet generating residential traffic. Once these three developments are fully built out and generating traffic it is estimated (as a robust assessment) that up to 70% of the combined traffic from each site would be directed toward Bussell Highway via a combination of Sunset Drive, Miamup Road and Memorial Drive. These committed developments are comprised of the following yields:

- Site 1 – Off Brockman Road (37 new dwellings)
- Site 2 – Off Brockman Road North (40 new dwellings)
- Site 3 – Off Pioneer Road (40 new dwellings)

The Shire of Augusta Margaret River has confirmed that there are no traffic reports available for Site No.1, 2 and 3. In the absence of this information, the traffic generation rates shown in **Table 6-3**, sourced from the WAPC Guidelines, have been used to calculate an estimate of the committed development traffic generation in the AM and PM peak periods. The below trip rates are considered robust, with no reductions applied to account for linked or internal trips.

Table 7-3: WAPC Trip Generation Rates

Land Use	AM Peak Hour		PM Peak Hour	
	IN	OUT	IN	OUT
Residential	0.2 trips per dwelling	0.6 trips per dwelling	0.5 trips per dwelling	0.3 trips per dwelling

Table 7-2 summarises the trip volumes derived from the adopted generation rates.

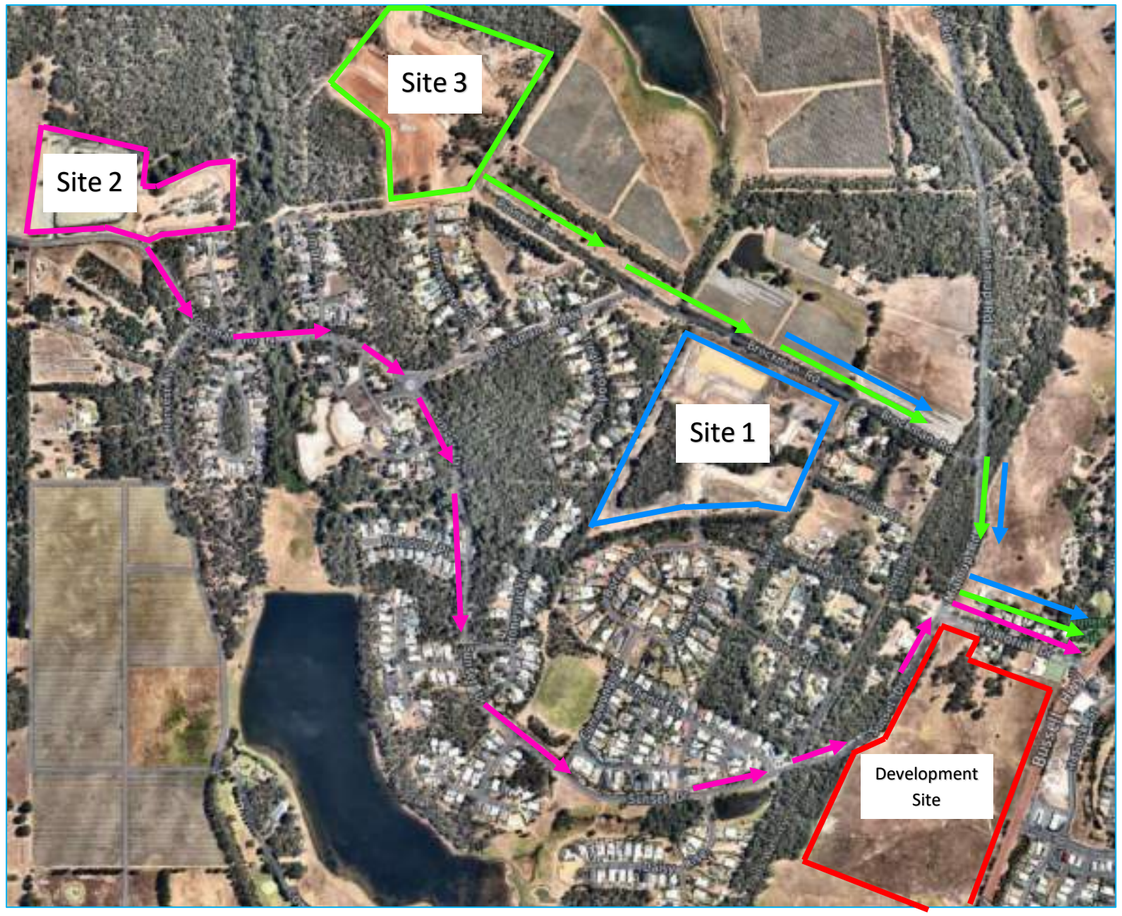
Table 7-4: Committed Development Traffic Generation

No of Units	AM Peak Hour		PM Peak Hour	
	IN	OUT	IN	OUT
Site 1 (37 Units)	8	22	19	11
Site 2 (40 Units)	8	24	20	12
Site 3 (40 Units)	8	24	20	12
Total	**24**	**70**	**59**	**35**

The combination of Sites 1, 2 and 3 are expected to generate a total of an additional 94 two-way vehicle trips in the AM peak hour and the same in the PM peak hour on the surrounding road network. This equates to approximately 940 trips per day. These additional trips (not captured within local traffic counts) have been added to this transport assessment to ensure a robust estimation of future traffic conditions when undertaking intersection analysis.

Figure 7-1 shows the assignment of the committed development traffic generated by each site, based on a robust estimation that up to 70% of the combined traffic from each site would be directed to/from Bussell Highway via a combination of Sunset Drive, Miamup Road and Memorial Drive.

Figure 7-1: Committed Developments West of Subject Site:



7.6 Structure Plan Traffic Generation & Assignment: (Lot 500 Wirring Road)

General:

To the east of the terminating road of Roy Earl Drive is a large parcel of land, known as Lot 500 Wirring Road, which is subject to a Structure Plan application (July 2022) for 350 residential units and a retirement village. The proposed structure plan traffic generation from this site will be assigned to the surrounding road network via the site access roads in the proportions shown on **Figure 7-4 and Figure 6-5**. These proportions have been extracted from the Transport Impact Assessment (July 2022) supplied within the Structure Plan application documentation.

Figure 7-2: Lot 500 Wirring Road – Structure Plan Area



Structure Plan Development:

The proposed local structure plan comprises the following land uses:

- Approximately 350 residential lots with densities between R10 and R25
- A retirement village development site (R60); and
- Roads and public open space

Access Arrangements:

The proposed Site access arrangement is shown in Figure 3-2 and summarised below:

- Access 1 – Roy Earl Drive
- Access 2 – Duggan Drive
- Access 3 – Lions Drive
- Access 4 – Waverley Road
- Access 5 – Wirring Road
- Access 6 & 7 – Potential future road connections

Figure 7-3: Proposed Structure Plan Access Locations



Structure Plan Development Traffic Generation:

Table 7-5 summarises the trip volumes extracted from the Transport Impact Assessment (July 2022) from the Structure Plan application documentation. The adopted traffic generation rates are from **Table 7-2.**

Table 7-5: Structure Plan Traffic Generation (Lot 500 Wirring Road)

No of Units	AM Peak Hour		PM Peak Hour	
	IN	OUT	IN	OUT
Residential 350 Lots (R10 – R25)	69	197	224	126
Retirement Village (R60)	4	6	7	6
Total	76	205	231	133

Structure Plan Traffic Assignment:

The overall trip distribution used for the development traffic are detailed in **Figure 6-4 and Figure 6-5,** for inbound and outbound trips respectively. The development distribution considers the following:

- Location of the development and access roads relative to the surrounding area.
- Driver behaviour based on the local and arterial road network.

Figure 7-4: Development Trip Distribution Inbound



Figure 7-5: Development Trip Distribution Outbound



The potential impact of this proposed residential site in terms of its future traffic generation will be included in the assessment existing and future intersections within this report.

7.7 Lot 102 Bussell Highway - Traffic Assessment Scenarios Considered for Comparison.

In order to establish the relative impact of the proposed residential development on the operation of the surrounding road infrastructure, three assessment scenarios have been undertaken as part of this Transport Impact Assessment. It is essential to understand the scope and capability of the existing road network and its intersections to establish if the proposed development of 243 residential lots would theoretically require new access from Bussell Highway and, if required, to what degree the proposed development (subject Site) would necessitate a new roundabout access to be built from Bussell Highway. As part of this, the capability of the existing road network including the capacity of existing intersections to accommodate new development traffic (within acceptable performance) from the site will be established.

Therefore, the following traffic assessment scenarios have been included in this TIA:

- **Scenario One – Operation of Existing Road Intersections:**
  comprising:
  Scenario One A – '2036 Baseline Without Development'
  - 2036 Background Traffic Volumes at existing intersections only.
  - All committed development traffic. (Not included: Lot 500 Wirring Road – east of Roy Earl Drive).
  - Assumed minor capacity improvement to Bussell Highway/Memorial Drive T-intersection.

  Scenario One B – '2036 With Development'
  - 2036 Background Traffic Volumes at existing intersections only
  - All committed development traffic. (Not included: Lot 500 Wirring Road – east of Roy Earl Drive).
  - Full build out of 243 lots at 102 Bussell Highway (the subject site).
  - Vehicle access to site from only Sunset Drive and Memorial Drive.
  - Assumed minor capacity improvement to Bussell Highway/Memorial Drive T-intersection.

- **Scenario Two – '2036 With Development'**
  (Operation of Existing Road Intersections and Future Roundabout Intersection at Roy Earl Drive):
  comprising:
  - 2036 Background Traffic Volumes
  - All committed development traffic
  - Inclusion of Lot 500 Wirring Road, structure plan development traffic (Section 6.6).
  - Full build out of 243 lots at 102 Bussell Highway (the subject site).
  - Assumed new four-arm, single lane roundabout intersection to access the Site at Bussell Highway/Roy Earl Drive/Site Access (site masterplan proposal).
  - Vehicle access to site from Bussell Highway, Sunset Drive and Memorial Drive.
  - Assumed minor capacity improvement to Bussell Highway/Memorial Drive T-intersection.
  - Assumed redistribution of background traffic, including relief of Memorial Drive, due to the new link road through the site between Sunset Drive and Bussell Highway.

7.8 Scenario One A – '2036 Baseline Without Development'

Under this baseline scenario of assessment, the following three existing intersections (refer to Section 2.4 for details), has been tested to determine their predicted future operational capacity results without any Lot 102 development traffic generation added into the road network. However, future traffic generated by committed development (Section 6.5) has been added to the growthed 2036 background traffic volumes under this scenario :

- Memorial Drive / Sunset Drive / Miamup Road – 3-way priority controlled intersection
- Bussell Highway / Memorial Drive – 3-way priority controlled intersection
  (including assumed minor capacity improvement to Memorial Drive)
- Bussell Highway / Roy Earl Drive – 3-way priority controlled intersection

The results of this scenario assessment for the above intersections are contained in Section 8.5 of this report.

7.9 Scenario One B – '2036 With Development'

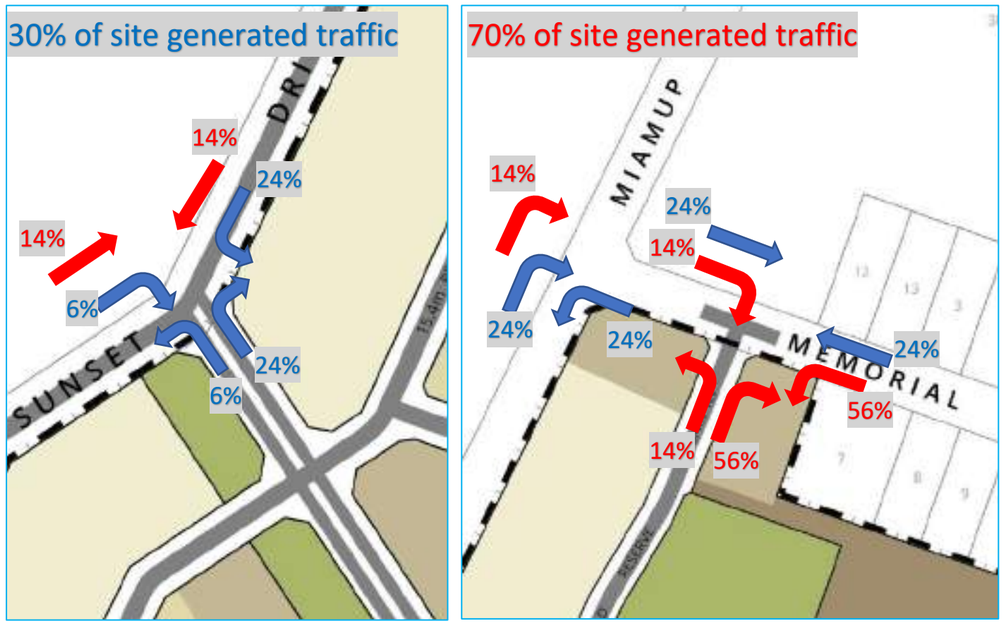
Traffic Distribution:

Under this assessment scenario, the existing intersections listed in section 6.8 above, will be tested with the addition of the distribution of Lot 102 development generated trips to and from the site. The development generated trips will be split across two access roads leading to Sunset Drive and Memorial Drive only. Under this scenario, no vehicle access is proposed to/from Bussell Highway. The majority of traffic from both site access roads will converge onto Memorial Drive and ultimately arrive at the intersection with Bussell Highway. This equates to 80% of development generated traffic travelling through the Bussell Highway/Memorial Drive intersection (arrivals and departures) and the remaining 20% travelling to/from the west of the site via Sunset Drive. As part of this scenario, two 'sensitivity tests' will determine the acceptable future year and quantum of staged development which would theoretically be permissible prior to any access being required to the site directly from Bussell Highway.

Under this scenario, for the purposes of estimating development generated vehicle movements, the directional traffic distribution shown on the plans at **Figure 7-6** have been assumed based on the site access onto Sunset Drive and Memorial Drive and the relative attractiveness of each access road from within the site and the adjacent local roads. Under this Scenario One B site access arrangement (no direct access onto Bussell Hwy) the majority of development generated traffic (70%) expected to use the Memorial Drive access for trips to/from the site and 30% using the Sunset Drive access under this scenario. Ultimately 80% of total generated traffic is assumed to travel to/from Bussell Highway using Memorial Drive under this Scenario One B.

The proportions of externally distributed traffic have been based on the distance between towns to the south such as Margaret River, Busselton to the north and coastal towns and regions to the west. Using a basic gravity model, this has been adjusted for the attractiveness of each area and the hierarchy of the surrounding road network, with Bussell Highway prioritised as the most attractive route and Sunset Drive favoured as the route to/from Caves Road and the western coastal areas.

Figure 7-6: Scenario One B – Development Traffic Distribution at Site Access Points (Sunset Dr and Memorial Dr)



It should be noted that the above proportional splits equate to a combined total of 80% of all development traffic using Memorial Drive and its intersection with Bussell Highway.

Figure 7-7: Scenario One B – Development Traffic Distribution at Bussell Hwy/Memorial Dr Intersection



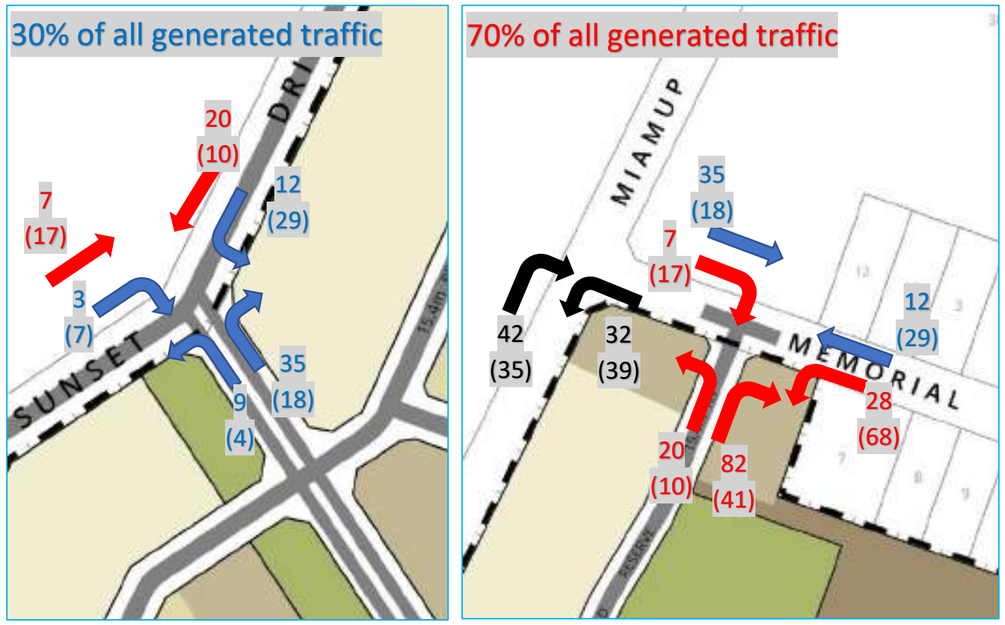
Figure 7-8: Scenario One B – Development Traffic Distribution at Bussell Hwy/Roy Earl Dr Intersection



7.10 Scenario One B – '2036 With Development' - Development Traffic Assignment

Under the assessment of only existing intersections on the surrounding road network (Scenario One), the assignment of trips to and from the site onto the surrounding road network is based on the proportion distribution set out in Section 6.9. **Figure 7-9** to **Figure 7-11** show the assignment of development generated traffic based on these proportions.

Figure 7-9: Scenario One B – Development Traffic Assignment at Site Access Points (Sunset Dr and Memorial Dr)



Key:
X = AM Peak
(X) = PM Peak

Figure 7-10: Scenario One B – Development Traffic Assignment at Bussell Hwy/Memorial Dr Intersection



Key:
X = AM Peak
(X) = PM Peak

Figure 7-11: Scenario One B – Development Traffic Assignment at Bussell Hwy/Roy Earl Dr Intersection



Source – NearMap 2023

7.11 Scenario Two – '2036 With Development'

Traffic Distribution:

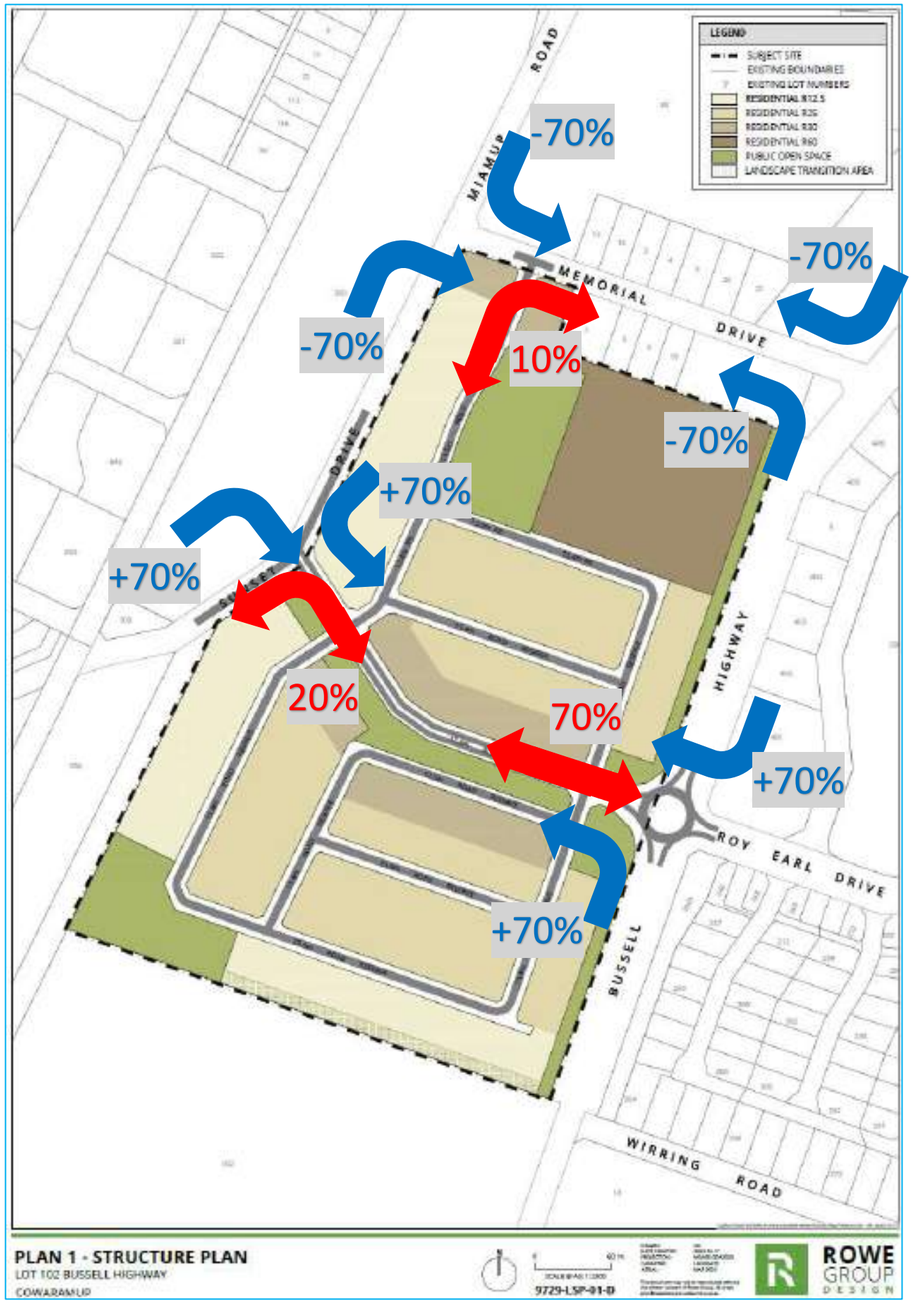
Under the assumed inclusion of the new roundabout site access intersection on Bussell Highway at the intersection with Roy Earl Drive (Scenario Two), the distribution of trips to and from the site will be split across three site access roads comprising Bussell Highway, Sunset Drive and Memorial Drive.

Scenario Two also includes assessment of the existing intersections (included in Scenario One) based upon the redistribution of traffic volumes at these intersections due to the new 'link' road through the subject site. Under this scenario, an element of through traffic (background traffic) will travel between Sunset Drive and Bussell Highway which would otherwise have utilised Memorial Drive. For the purposes of testing a robust assessment, the redistribution of background traffic to/from Sunset Drive and Bussell Highway will be assumed to be 70% via the 'link' road. Thereby, 30% of background traffic will remain on Memorial Drive.

Under this scenario, the majority of development generated traffic from the subject site (70%) will be assumed to access/exit the site directly to/from Bussell Highway, with 10% using Memorial Drive to access Bussell Highway as the less attractive access option under this scenario. These assumptions are based upon the same distribution criteria defined in Scenario One. The remaining 20% of development generated traffic is assumed to exit onto Sunset Drive and travel west along the route to/from Caves Road and the western coastal areas.

Figure 7-12 shows diagrammatically the percentage splits of development generated traffic across the three access intersections and also defines the assumed basic redistribution of background traffic due to the new 'link' road across the site between Sunset Drive and Bussell Highway. As a result, it is expected that Memorial Drive will experience 'relief' in terms of reduced background traffic numbers along its length and at the Bussell Highway/Memorial Drive intersection in terms of turning movements.

Figure 7-12: Scenario Two – Development Traffic Distribution at Three Access Intersections Background Traffic Redistribution.



Key:

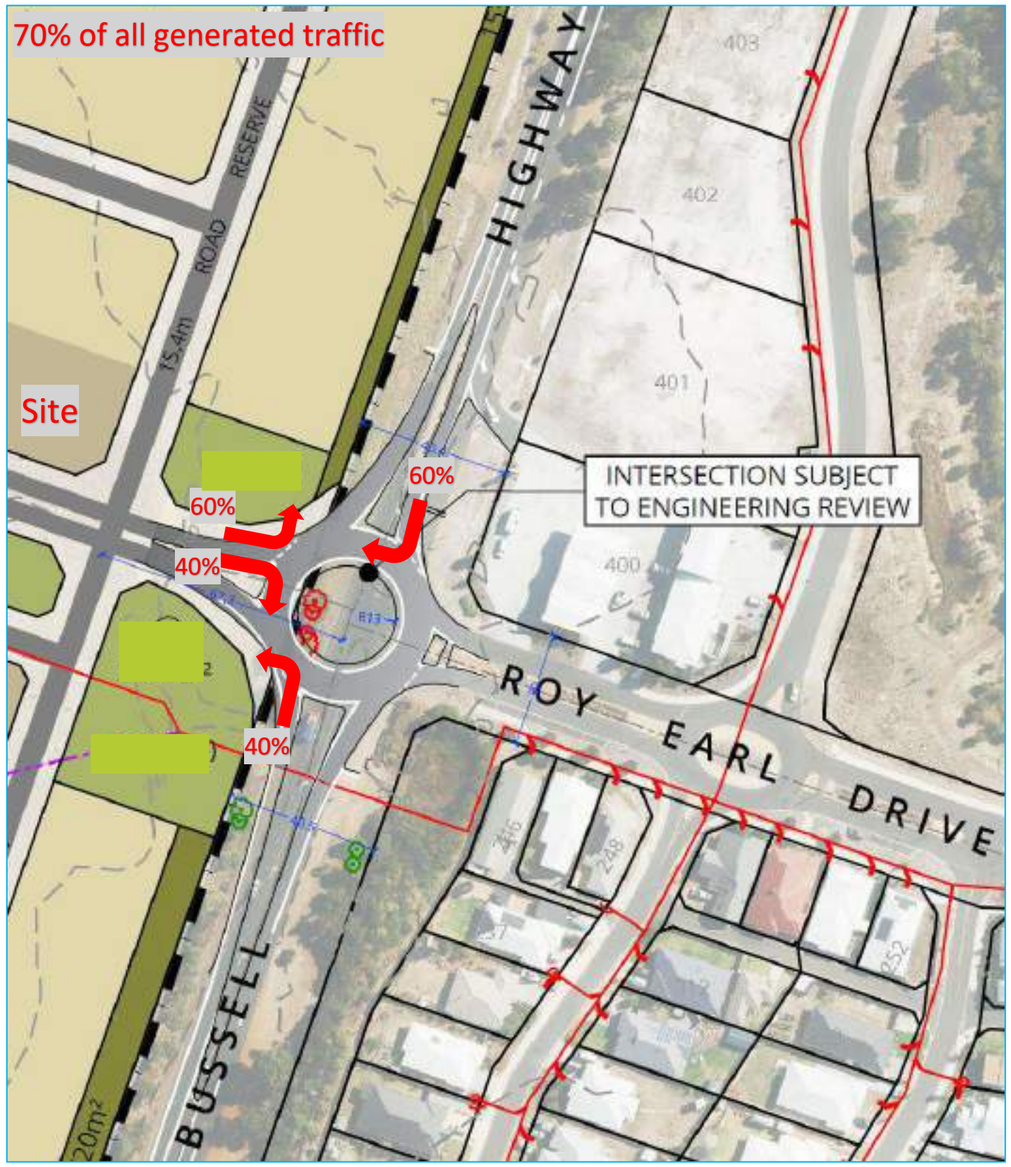
Development Generated Traffic Assignment

Redistribution of Background Traffic Due to New 'Link' Road.

Figure 7-13: Scenario Two – 10% Development Traffic Distribution at Bussell Hwy/Memorial Dr Intersection



Figure 7-14: Scenario Two – 70% Development Traffic Distribution at Bussell Hwy/Roy Earl Dr/Site Access Roundabout

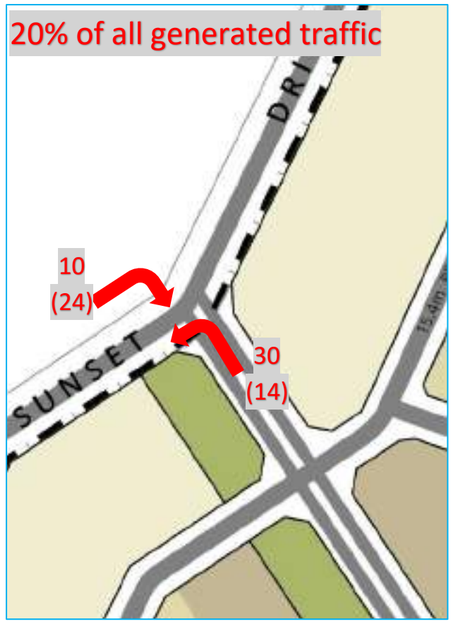


7.12 Scenario Two – '2036 With Development'

Development Traffic Assignment:

Under the assumed inclusion of the new roundabout site access intersection on Bussell Highway at the intersection with Roy Earl Drive (Scenario Two), the assignment of trips to and from the site onto the surrounding road network is based on the proportional distribution set out in Section 6.11. **Figure 7-15 to Figure 7-17** show the assignment of development generated traffic based on these proportions and the Scenario Two road network layout.

Figure 7-15: Scenario Two – Development Traffic Assignment at Site Access Points (Sunset Dr and Memorial Dr)



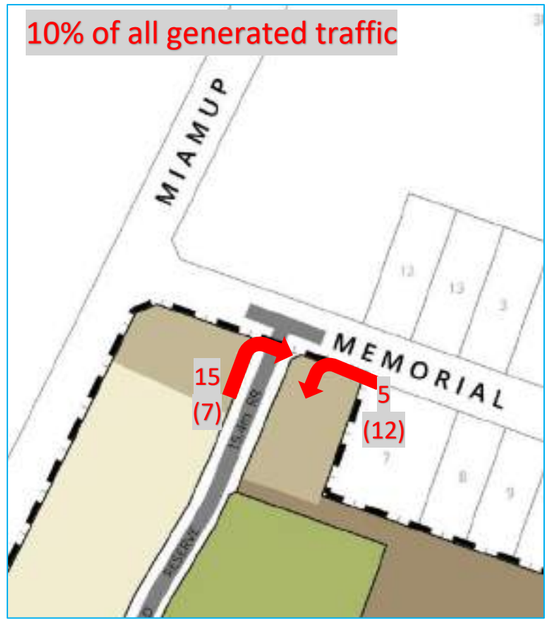
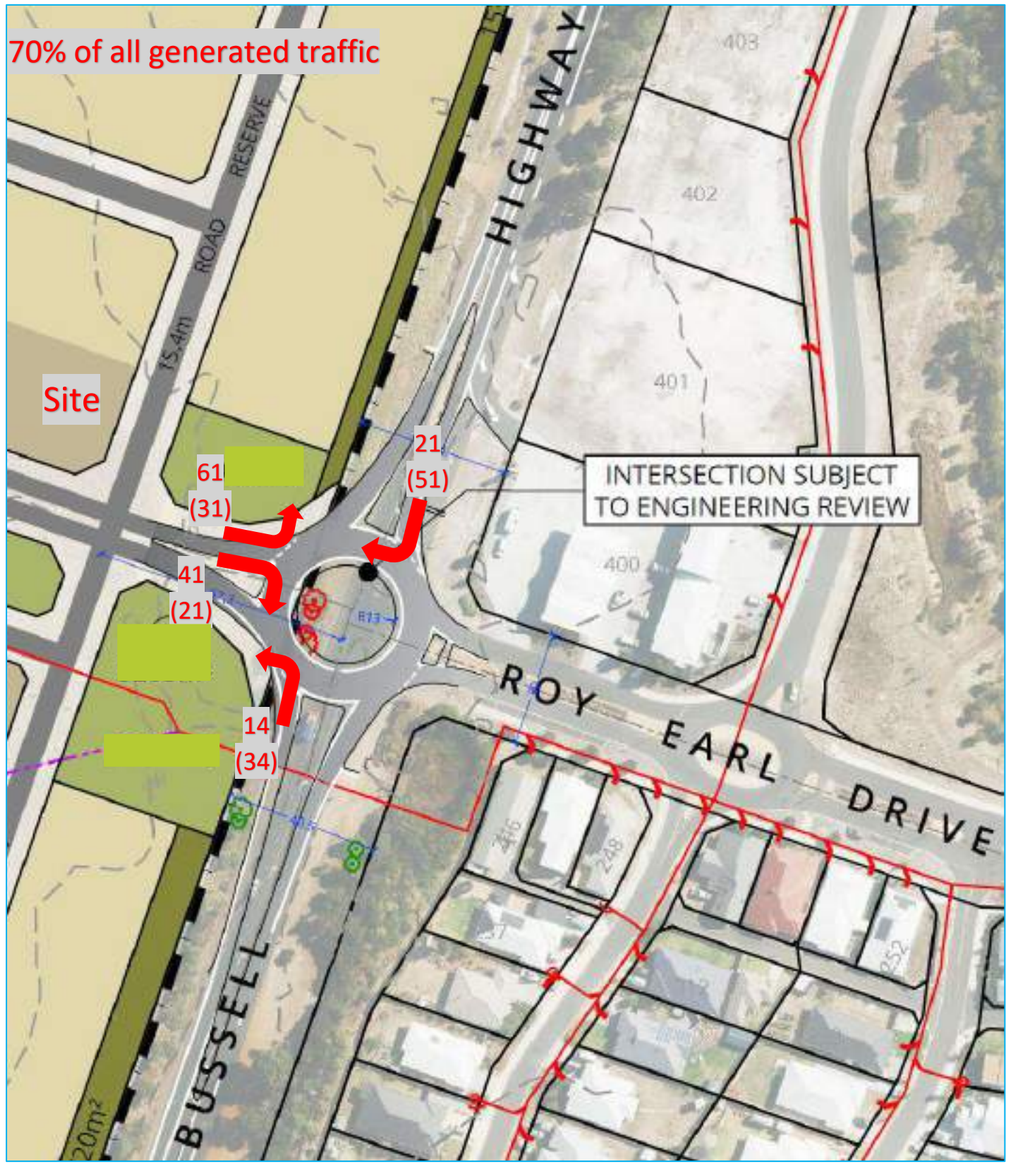


Figure 7-16: Scenario Two – 10% Development Traffic Assignment at Bussell Hwy/Memorial Dr Intersection



Key:
X = AM Peak
(X) = PM Peak

Figure 7-17: Scenario Two – 70% Development Traffic Assignment at Bussell Hwy/Roy Earl Dr/Site Access Roundabout



Key:
X = AM Peak
(X) = PM Peak

8 Analysis of External Transport Networks

8.1 Introduction

This section of the TIA presents the steps undertaken to analyse the transport networks and intersections surrounding the proposed subdivision under three assessment scenarios. Section 6 of this TIA report sets outs in detail the assessment parameters assumed for each traffic scenario tested.

8.2 Extent of Intersection Analysis

For the purposes of this Transport Impact Assessment, three separate main scenarios (including two sensitivity tests) have been analysed in order to establish the relative impact of the proposed residential development on the operation of the surrounding road infrastructure. As part of this, the capability of the existing road network including the capacity of existing intersections to accommodate new development traffic (within acceptable performance criteria) from the site will be established.

Section 6.7 of this report details the assumptions and inclusions of each scenario in terms of traffic generation and traffic growth. In summary the scenarios tested are as follows.

Existing Road Network Intersections:

1. **Scenario One A '2036 Baseline Without Development' – Operation of Existing Road Intersections.**
   - No site access from Bussell Highway. Access only from Sunset Drive and Memorial Drive.

2. **Scenario One B '2036 With Development' – Operation of Existing Road Intersections.**
   - Inclusive of 243 Residential Units Generated Traffic + Committed Development.
   - This scenario assumes inclusion of the minor capacity upgrade to Memorial Drive.
   - No site access from Bussell Highway. Access only from Sunset Drive and Memorial Drive.

   Sensitivity Test No. 1: '2032 With Development'
   – Inclusive of 140 Residential Units + Committed Development.
   - This sensitivity test assumes exclusion of the minor capacity upgrade to Memorial Drive.

   Sensitivity Test No. 2: '2033 With Development'
   – Inclusive of 160 Residential Units + Committed Development.
   - This sensitivity test assumes inclusion of the minor capacity upgrade to Memorial Drive.

Proposed Roundabout and Road Network Intersections:

3. **Scenario Two '2036 With Development' – Operation of Existing Road Intersections and Future Roundabout Intersection at Roy Earl Drive.**
   - Inclusive of 243 Residential Units Generated Traffic + Committed Development Traffic + Structure Plan Traffic.
   - Site access assumed from Bussell Highway, Sunset Drive and Memorial Drive.

8.3 Design Traffic Flows on External Road Network

Scenario One A '2036 Baseline Without Development' – Operation of Existing Road Intersections:

The scope of the traffic assessment for Scenario One A includes the following three intersections at **Figure 8-1 to Figure 8-3** with the following combination of traffic volumes combining to a design horizon of 2036. This scenario establishes the extent to which the existing intersections surrounding the site are likely to operate in terms of their capacity in 2036 without the inclusion of the traffic predicted to be generated by the Lot 102 Bussell Highway site.

- **Scenario One A – '2036 Baseline Without Development', comprising**:
  2023 Base Traffic + 13 Year Traffic Growth to 2036 + All Committed Development Traffic (excluding Lot 500 Wirring Rd)

Scenario One A combined traffic flows at the 2036 design horizon are shown on the following **Figure 8-1 to Figure 8-3.**

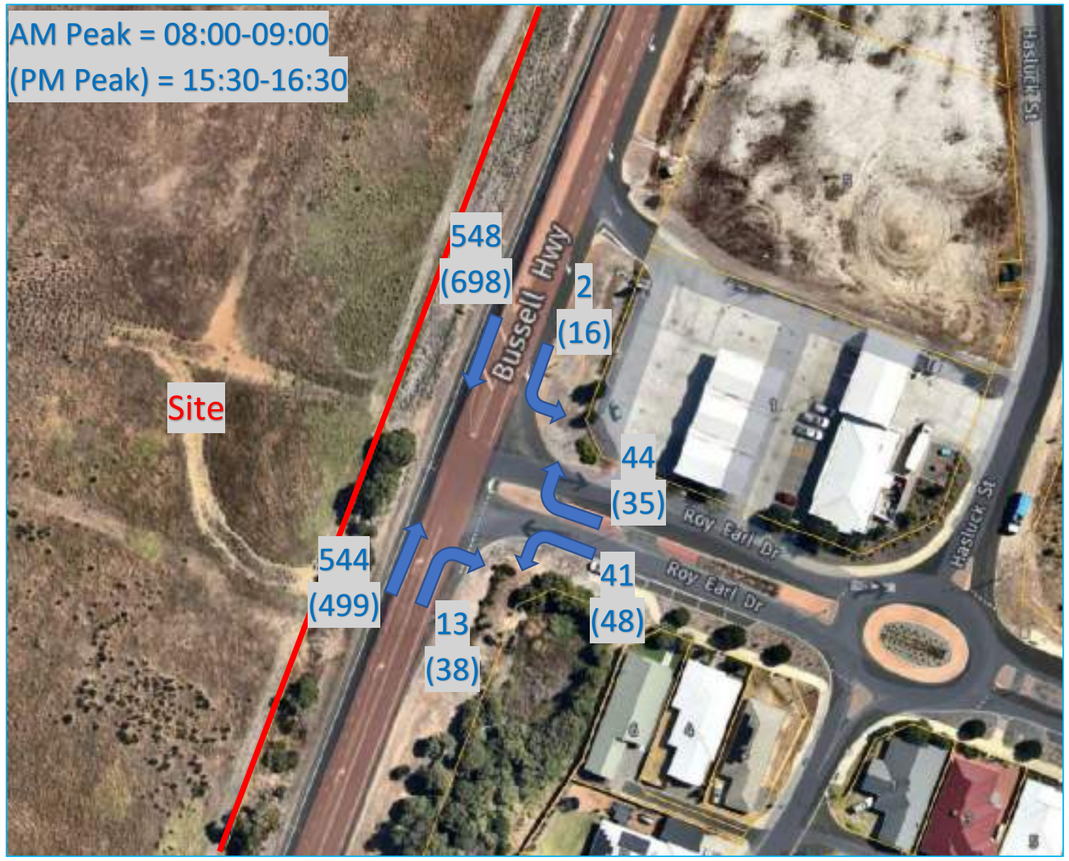
Figure 8-1: Design Traffic Flows - Scenario One A '2036 Without Development'



Figure 8-2: Design Traffic Flows - Scenario One A '2036 Baseline Without Development'



Figure 8-3: Design Traffic Flows - Scenario One A '2036 Baseline Without Development'



Scenario One B '2036 With Development' – Operation of Existing Road Intersections:

The scope of the traffic assessment for Scenario One B includes the following three intersections with the following combination of traffic volumes combining to a design horizon of 2036. This scenario establishes the extent to which the existing intersections surrounding the site may be able to accommodate the additional traffic predicted to be generated by the Lot 102 Bussell Highway site, within recognised acceptable levels of intersection operation.

- **Scenario One B – '2036 With Development', comprising**:
  2023 Base Traffic + 13 Year Traffic Growth to 2036 + All Committed Development Traffic (excluding Lot 500 Wirring Rd) + Development Generated Traffic (the site).

Scenario One B combined traffic flows at the 2036 design horizon are shown on the following **Figure 8-4 to Figure 8-7 .**

Figure 8-4: Design Traffic Flows - Scenario One B '2036 With Development'



Figure 8-5: Design Traffic Flows - Scenario One B '2036 With Development'

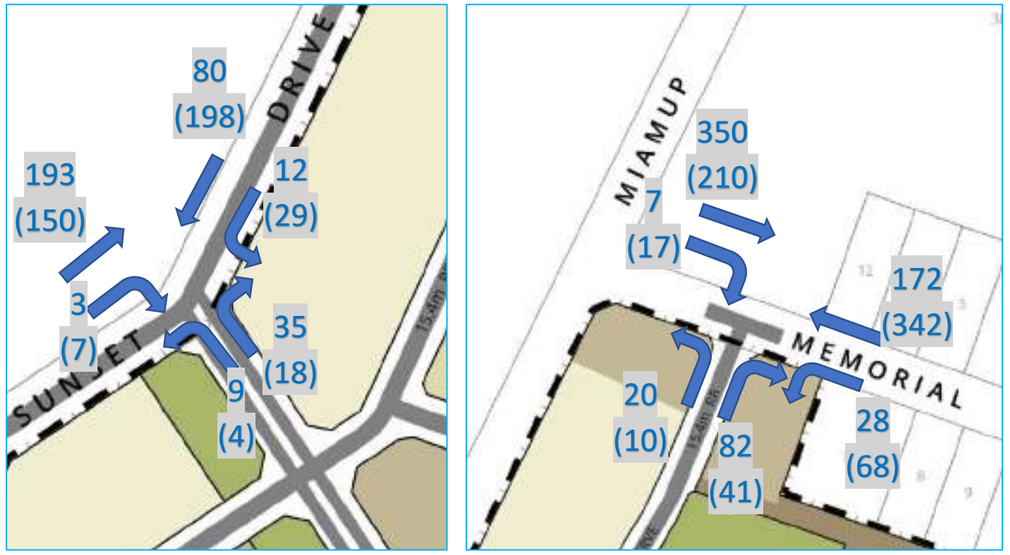


Figure 8-6: Design Traffic Flows - Scenario One B '2036 With Development'



Figure 8-7: Design Traffic Flows - Scenario One B '2036 With Development'



Scenario Two: Operation of Existing Road Intersections and Future Roundabout Intersection at Roy Earl Drive:

The scope of the traffic assessment for Scenario Two includes the following three intersections with the following combination of traffic volumes combining to a design horizon of 2036. This scenario includes an assessment of a new roundabout intersection at Bussell Hwy/Roy Earl Drive/Site Access and the redistribution of background traffic due to the 'link road' through the site between Sunset Drive and Bussell Highway. These intersections have been tested with the following combination of traffic volumes combining to a design horizon of 2036.

- **Scenario Two – 2036 'With Development', comprising:**
  (2023 Base Traffic + 13 Year Traffic Growth to 2036 + Redistributed Base Traffic due to new roundabout + Committed Development Traffic + Structure Plan Generated Traffic (Lot 500 Wirring Road) + Development Generated Traffic (the site).

Scenario Two combined traffic flows at the 2036 design horizon are shown on the following **Figure 8-8 to Figure 8-11**.

As part of this scenario, the proposed site access intersections at Memorial Drive and Sunset Drive have also been analysed for their operational capacity and delay. The 2036 traffic volumes at these site access intersections are shown in **Figure 8-8**.

Figure 8-8: Design Traffic Flows - Scenario Two '2036 With Development'

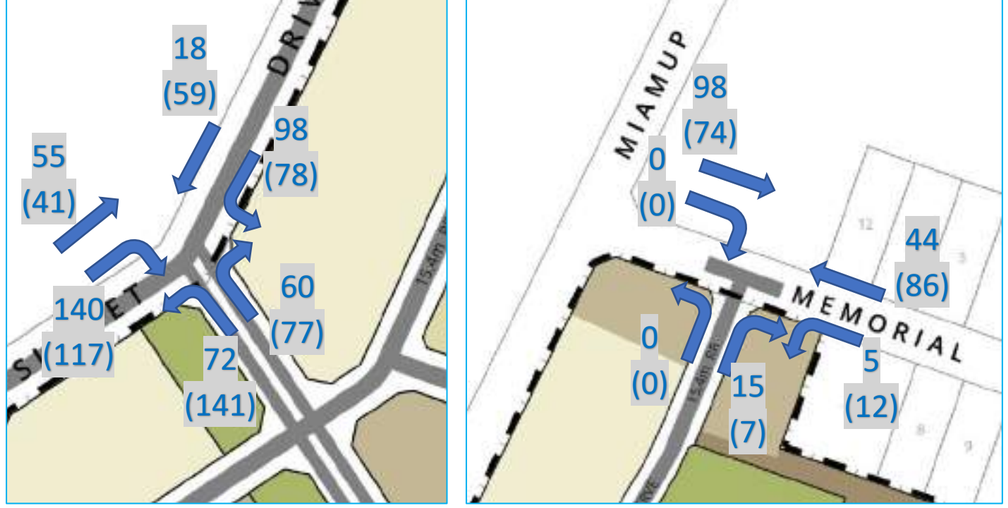


Figure 8-9: Design Traffic Flows - Scenario Two '2036 With Development'



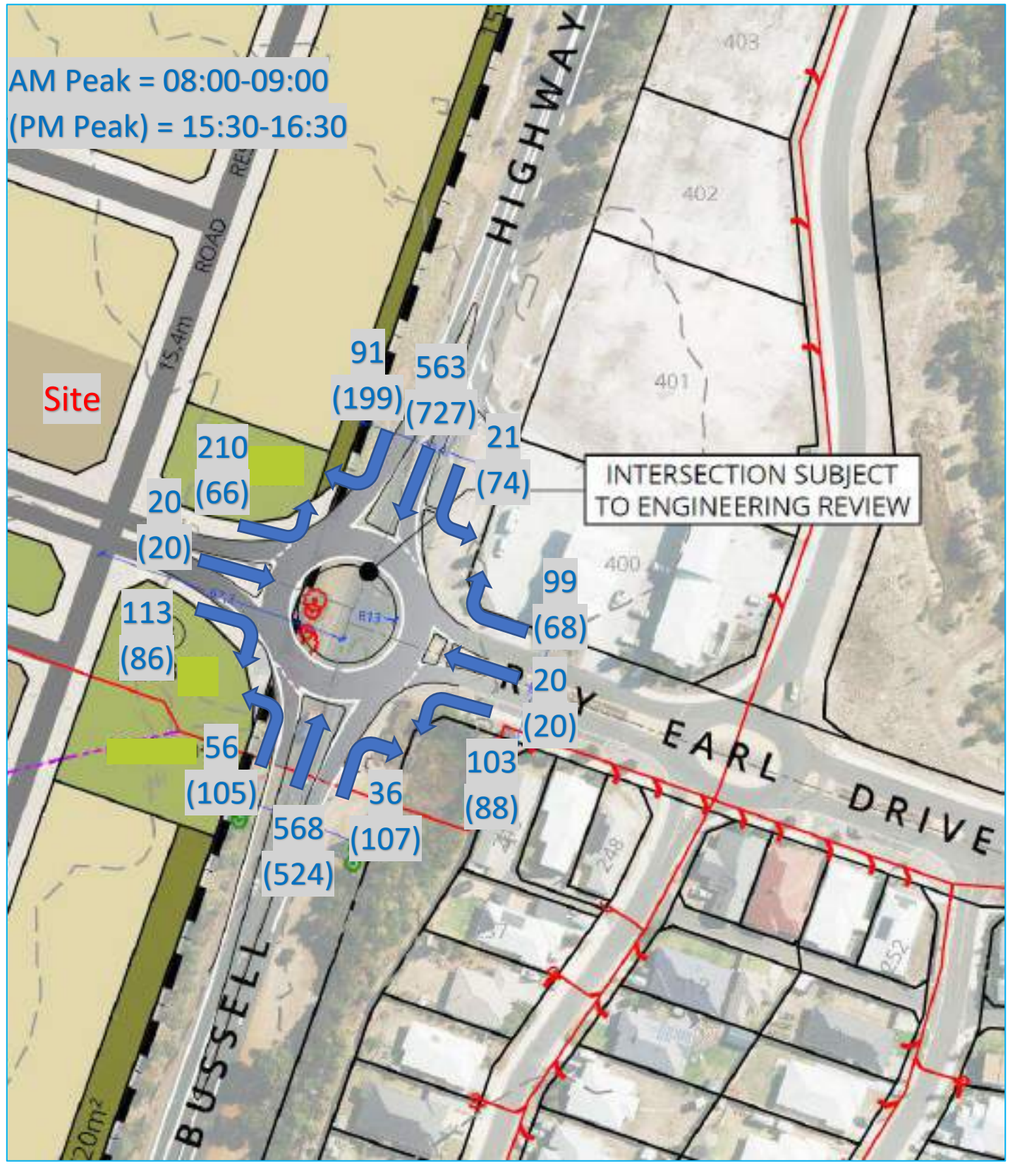
Key:
X = AM Peak
(X) = PM Peak

Figure 8-10: Design Traffic Flows - Scenario Two '2036 With Development'



Key:
X = AM Peak
(X) = PM Peak

Figure 8-11: Design Traffic Flows - Scenario Two '2036 With Development'



Key:

X = AM Peak

(X) = PM Peak

8.4 Impact on Intersections

Across each of the following three assessment scenarios, the SIDRA Intersection capacity results for each approach are presented in the form of Degree of Saturation (DOS), Average Delay, Level of Service (LOS) and 95th Percentile Queue. These characteristics are defined as follows:

- **Degree of Saturation (DOS)**: is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The theoretical intersection capacity is exceeded for an un-signalised intersection where DOS > 0.80;
- **95% Queue:** is the statistical estimate of the queue length up to or below which 95% of all observed queues would be expected;
- **Average Delay:** is the average of all travel time delays for vehicles through the intersection. An unsignalised intersection is considered to be operated at capacity where the average delay exceeds 40 seconds for any movement; and
- **Level of Service (LOS)**: is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers.

8.5 Assessment Results - Scenario One A '2036 Baseline Without Development'

Under Scenario One A, the following intersections have been assessed in SIDRA Intersection and the results are presented in **Table 8-1 to Table 8-3 :**

- Memorial Drive / Sunset Drive / Miamup Road – 3-way priority controlled intersection.
- Bussell Highway / Memorial Drive – 3-way priority controlled intersection.
  (including assumed minor capacity improvement to Memorial Drive)
- Bussell Highway / Roy Earl Drive – 3-way priority controlled intersection.

Table 8-1: Scenario One A – Capacity Results - Memorial Drive / Sunset Drive / Miamup Road Intersection

Lane	AM Peak				PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Memorial Drive / Sunset Drive / Miamup Road – 2036 Without Development (Scenario One A)								
Sunset Dr South Approach								
Through/Right	0.126	6.0	A	4.6	0.088	5.9	A	3.1
Memorial Rd East Approach								
Left	0.039	4.6	A	1.2	0.119	4.6	A	4.0
Right	0.089	5.7	A	2.2	0.107	5.4	A	2.7
Miamup Rd North Approach								
Through/Left	0.082	5.6	A	0.0	0.068	5.3	A	0.0
Intersection	**0.126**	**5.7**	**A**	**4.6**	**0.119**	**5.9**	**A**	**4.0**

Analysis of the Memorial Drive / Sunset Drive / Miamup Road – three-way priority controlled intersection at the 2036 design horizon, without any development traffic added from Lot 102 Bussell Highway shows that there are predicted to be no issues with respect to traffic queuing and delays for any movement in both the AM and PM peak periods. All parameters of this capacity assessment are within recognised thresholds for acceptable intersection operation with the intersection predicted to operate around 13% of its theoretical maximum in both peak periods and negligible vehicle queues.

Table 8-2: Scenario One A – Capacity Results: Bussell Highway / Memorial Drive Intersection

Lane	AM Peak				PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Bussell Highway / Memorial Drive – 2036 Without Development (Scenario One A)								
Bussell Hwy South Approach								
Through/Left	0.366	1.7	A	0.0	0.328	2.0	A	0.0
Bussell Hwy North Approach								
Through	0.306	0.1	A	0.0	0.418	0.2	A	0.0
Right	0.120	6.6	A	3.7	0.122	6.1	A	3.8
Memorial Rd West Approach								
Left	0.251	7.8	A	7.8	0.102	6.6	A	3.0
Right	0.509	29.1	D	15.3	0.596	39.2	E	17.6
Intersection	**0.509**	**29.1**	**D**	**15.3**	**0.596**	**39.2**	**E**	**17.6**

Analysis of the Bussell Highway / Memorial Drive – three-way priority controlled intersection at the 2036 design horizon, without any development traffic added from Lot 102 Bussell Highway shows that there is predicted to be no issues with respect to traffic queuing and delay in the AM peak period, however the PM peak period is predicted to operate at capacity given the Memorial Drive right turn movement will experience delays of 40 seconds, the WAPC threshold for which an intersection can be said to operate at capacity. Predicted vehicle queue lengths on Memorial Drive are expected to be in the order of 18m in the PM peak. In summary, this intersection would not theoretically be capable of supporting any additional traffic movements on Memorial Drive at the 2036 design horizon.

Table 8-3: Scenario One A – Capacity Results - Bussell Highway / Roy Earl Drive Intersection

Lane	AM Peak				PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Bussell Highway / Roy Earl Drive – 2036 Without Development (Scenario One A)								
Bussell Hwy South Approach								
Through	0.347	1.3	A	0.0	0.318	1.3	A	0.0
Right	0.019	8.9	A	0.5	0.073	10.9	B	1.9
Roy Earl Drive East Approach								
Left	0.065	8.1	A	1.6	0.099	10.1	B	2.4
Right	0.276	28.8	D	6.9	0.315	40.5	E	7.3
Bussell Hwy North Approach								
Left	0.001	5.6	A	0.0	0.009	5.6	A	0.0
Through	0.338	0.1	A	0.0	0.431	0.2	A	0.0
Intersection	**0.338**	**28.8**	**D**	**6.9**	**0.431**	**40.5**	**E**	**7.3**

Analysis of the existing Bussell Highway / Roy Earl Drive – three-way priority controlled intersection at the 2036 design horizon, without any development traffic added from Lot 102 Bussell Highway shows that there is predicted to be no issues with respect to traffic queuing and delay in the AM peak period, however the PM peak period is predicted to operate at capacity given the Roy Earl Drive right turn movement will experience delays of over 40 seconds, the WAPC threshold for which an intersection can be said to operate at capacity. Predicted vehicle queue lengths on Roy Earl Drive as expected to be in the order of 7m in the PM peak. In summary, this intersection would not theoretically be capable of supporting any additional traffic movements on Roy Earl Drive at the 2036 design horizon.

8.6 Assessment Results - Scenario One B '2036 With Development'

Under Scenario One B, the following intersections have been assessed in SIDRA Intersection with full development of 243 residential units and committed development. The results are presented in **Table 8-4 to Table 8-6:**

- Memorial Drive / Sunset Drive / Miamup Road – 3-way priority controlled intersection.
- Bussell Highway / Memorial Drive – 3-way priority controlled intersection. (including assumed minor capacity improvement to Memorial Drive)
- Bussell Highway / Roy Earl Drive – 3-way priority controlled intersection.

Table 8-4: Scenario One B – Capacity Results - Memorial Drive / Sunset Drive / Miamup Road Intersection

Lane	AM Peak				PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Memorial Drive / Sunset Drive / Miamup Road – 2036 With Development (Scenario One B)								
Sunset Dr South Approach								
Through/Right	0.152	6.1	A	5.7	0.111	5.9	A	4.0
Memorial Rd East Approach								
Left	0.060	4.6	A	1.9	0.145	4.6	A	5.0
Right	0.092	5.9	A	2.3	0.111	5.6	A	2.8
Miamup Rd North Approach								
Through/Left	0.082	5.6	A	0.0	0.068	5.3	A	0.0
Intersection	**0.152**	**5.9**	**A**	**5.7**	**0.145**	**5.9**	**A**	**5.0**

Analysis of the Memorial Drive / Sunset Drive / Miamup Road – three-way priority controlled intersection at the 2036 design horizon, with development traffic added from Lot 102 Bussell Highway shows that there are predicted to be no issues with respect to traffic queuing and delays for any movement in both the AM and PM peak periods. All parameters of this capacity assessment are within recognised thresholds for acceptable intersection operation with the intersection predicted to operate around 15% of its theoretical maximum in both peak periods and negligible vehicle queues.

Table 8-5: Scenario One B – Capacity Results - Bussell Highway / Memorial Drive Intersection

Lane	AM Peak				PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Bussell Highway / Memorial Drive – 2036 With Development (Scenario One B)								
Bussell Hwy South Approach								
Through/Left	0.376	1.8	A	0.0	0.349	2.2	A	0.0
Bussell Hwy North Approach								
Through	0.306	0.1	A	0.0	0.418	0.2	A	0.0
Right	0.152	6.8	A	4.7	0.308	7.1	A	11.6
Memorial Rd West Approach								
Left	0.334	8.1	A	12.2	0.138	6.6	A	4.1
Right	0.782	44.3	E	31.4	0.974	111.4	F	53.3
Intersection	**0.782**	**44.3**	**E**	**31.4**	**0.974**	**111.4**	**F**	**53.3**

Analysis of the Bussell Highway / Memorial Drive – three-way priority controlled intersection at the 2036 design horizon, with development traffic added from Lot 102 Bussell Highway shows that this existing intersection layout is predicted to operate beyond its acceptable spare capacity given the Memorial Drive right turn movement will experience delays of over 40 seconds in the AM and PM peak periods. Predicted vehicle queue lengths on Memorial Drive are expected to be in the order of 31m in the AM peak and 53m in the PM peak with unacceptable delays of 44 seconds and 111 seconds respectively. In summary, this intersection is not theoretically capable of supporting additional traffic movements on Memorial Drive at the 2036 design horizon based on the existing road network.

Table 8-6: Scenario One B – Capacity Results - Bussell Highway / Roy Earl Drive Intersection

Lane	AM Peak				PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Bussell Highway / Roy Earl Drive – 2036 With Development (Scenario One B)								
Bussell Hwy South Approach								
Through	0.357	1.3	A	0.0	0.344	1.3	A	0.0
Right	0.021	9.4	A	0.5	0.085	12.1	B	2.2
Roy Earl Drive East Approach								
Left	0.070	8.6	A	1.7	0.115	11.4	B	2.7
Right	0.319	33.8	D	7.9	0.426	57.5	F	9.7
Bussell Hwy North Approach								
Left	0.001	5.6	A	0.0	0.009	5.6	A	0.0
Through	0.367	0.1	A	0.0	0.477	0.2	A	0.0
Intersection	**0.367**	**33.8**	**D**	**7.9**	**0.477**	**57.5**	**F**	**9.7**

Analysis of the existing Bussell Highway / Roy Earl Drive – three-way priority controlled intersection at the 2036 design horizon, with development traffic added from Lot 102 Bussell Highway shows that there are predicted to be no issues with respect to traffic queuing and delay in the AM peak period. However the PM peak period is predicted to operate beyond its spare capacity given the Roy Earl Drive right turn movement will experience delays of over 40 seconds, the WAPC threshold for which an intersection can be said to operate at capacity. Predicted vehicle queue lengths on Roy Earl Drive are expected to be in the order of 10m in the PM peak and unacceptable delays of 58 seconds. In summary, this intersection would not theoretically be capable of supporting any additional traffic movements on Roy Earl Drive at the 2036 design horizon.

8.7 Sensitivity Test No. 1 - '2032 With 140 Units + Committed Development'

Under this sensitivity test no.1, the existing configuration (without Memorial Drive capacity improvement) of Bussell Highway / Memorial Drive intersection has been assessed for the critical PM Peak in SIDRA Intersection up to a design horizon of 2032 with a development scale of 140 residential units and committed development traffic. This has been undertaken in order to understand if there is scope for a staged level of development traffic to utilise the existing configuration of this intersection prior to site access directly from Bussel Highway being required. The results of this sensitivity test are as follows:

Table 8-7: Sensitivity Test No. 1 – Bussell Highway / Memorial Drive Intersection (Existing Layout)

Lane	PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Bussell Highway / Memorial Drive – 2032 With Development (Sensitivity Test 1 – 140 Units + Committed Dev)				
Bussell Hwy South Approach				
Left	0.315	4.7	A	0.0
Through	0.315	1.3	A	0.0
Bussell Hwy North Approach				
Through	0.384	0.2	A	0.0
Right	0.244	6.3	A	8.2
Memorial Rd West Approach				
Left	0.734	16.4	C	35.5
Right	0.734	43.2	E	35.5
Intersection	**0.734**	**43.2**	**E**	**35.5**

Sensitivity analysis of the existing layout of the Bussell Highway / Memorial Drive three-way priority controlled intersection shows that it could be capable of accommodating the expected traffic generation of up to 140 residential units from the Lot 102 Bussell Highway site at a 2032 design year horizon, at which point this intersection is predicted to experience delays of over 40 seconds on the Memorial Drive eastbound right turn onto Bussell Highway, the WAPC threshold for which an intersection can be said to operate at capacity.

8.8 Sensitivity Test No. 2 - '2033 With 160 Units + Committed Development'

Under this sensitivity test no.2, the proposed minor capacity improvement to the eastbound Memorial Drive approach to the Bussell Highway / Memorial Drive intersection has been included and assessed for the critical PM Peak in SIDRA Intersection up to a design horizon of 2033 with a development scale of 160 residential units and committed development traffic, in order to understand if there is additional scope for a staged level of development traffic to utilise the proposed configuration of this intersection prior to site access directly from Bussel Highway being required. The results of this sensitivity test are as follows:

Table 8-8: Sensitivity Test No. 2 – Bussell Highway / Memorial Drive Intersection (Proposed Improved Layout)

Lane	PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Bussell Highway / Memorial Drive – 2033 With Development (Sensitivity Test 2 – 160 Units + Committed Dev)				
Bussell Hwy South Approach				
Left	0.325	4.7	A	0.0
Through	0.325	1.4	A	0.0
Bussell Hwy North Approach				
Through	0.396	0.2	A	0.0
Right	0.257	6.4	A	8.8
Memorial Rd West Approach				
Left	0.114	6.4	A	3.3
Right	0.692	47.2	E	21.7
Intersection	**0.692**	**47.2**	**E**	**21.7**

Sensitivity analysis of the proposed improved layout of the Bussell Highway / Memorial Drive three-way priority controlled intersection shows that it could be capable of accommodating the expected traffic generation of up to 160 residential units from the Lot 102 Bussell Highway site at a 2033 design year horizon, at which point this intersection is predicted to experience delays of over 40 seconds on the Memorial Drive eastbound right turn onto Bussell Highway, the WAPC threshold for which an intersection can be said to operate at capacity.

8.9 Assessment Results - Scenario Two '2036 With Development'

Under Scenario Two, the following intersections have been assessed in SIDRA Intersection with full development of 243 residential units and committed development. The results are presented in **Table 8-9 to Figure 8-11:**

- Memorial Drive / Sunset Drive / Miamup Road – 3-way priority controlled intersection.
- Bussell Highway / Memorial Drive – 3-way priority controlled intersection. (including assumed minor capacity improvement to Memorial Drive)
- Bussell Highway / Site Access / Roy Earl Drive – 4-way single lane roundabout.
- Sunset Drive / Site Access – 3-way priority controlled intersection.
- Memorial Drive / Site Access – 3-way priority controlled intersection.

Table 8-9: Scenario Two – Capacity Results - Memorial Drive / Sunset Drive / Miamup Road Intersection

Lane	AM Peak				PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Memorial Drive / Sunset Drive / Miamup Road – 2036 With Development (Scenario Two)								
Sunset Dr South Approach								
Through/Right	0.071	3.1	A	2.3	0.070	2.2	A	1.8
Memorial Rd East Approach								
Left	0.013	4.9	A	0.4	0.038	4.8	A	1.1
Right	0.026	5.5	A	0.6	0.032	5.4	A	0.8
Miamup Rd North Approach								
Through/Left	0.079	1.7	A	0.0	0.063	1.7	A	0.0
Intersection	**0.079**	**5.5**	**A**	**2.3**	**0.070**	**5.4**	**A**	**1.8**

Analysis of the Memorial Drive / Sunset Drive / Miamup Road – three-way priority controlled intersection at the 2036 design horizon, with development traffic added from Lot 102 Bussell Highway and the benefit of the 'link road' across the development site, shows that there are predicted to be no issues with respect to traffic queuing and delays for any movement in both the AM and PM peak periods. All parameters of this capacity assessment are within recognised thresholds for acceptable intersection operation with the intersection predicted to operate around 8% of its theoretical maximum in both peak periods and negligible vehicle queues. Under this scenario two, this intersection experience relief over its existing operation due to the redistribution of traffic toward the 'link road'.

Table 8-10: Scenario Two – Capacity Results - Bussell Highway / Memorial Drive Intersection

Lane	AM Peak				PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Bussell Highway / Memorial Drive – 2036 With Development (Scenario Two)								
Bussell Hwy South Approach								
Through/Left	0.441	1.5	A	0.0	0.328	1.6	A	0.0
Bussell Hwy North Approach								
Through	0.364	0.2	A	0.0	0.525	0.4	A	0.0
Right	0.049	7.5	A	1.4	0.077	6.0	A	2.4
Memorial Rd West Approach								
Left	0.110	8.6	A	2.9	0.076	6.9	A	2.1
Right	0.269	33.3	D	6.3	0.311	44.2	E	6.9
Intersection	**0.441**	**33.3**	**D**	**6.3**	**0.525**	**44.2**	**E**	**6.9**

Analysis of the Bussell Highway / Memorial Drive – three-way priority controlled intersection at the 2036 design horizon, with development traffic added from Lot 102 Bussell Highway and the benefit of the 'link road' across the development site, shows that there are predicted to be no issues with respect to traffic queuing and delays for any movement in the AM peak periods. However, in the PM peak period the Memorial Drive right turn is predicted to operate above the threshold of 40 seconds, but with minimal queueing of approximately 7m or one vehicle.

It should be considered that under this Scenario Two assessment, the 'link road' across the development site provides an alternate route for vehicle to access Bussell Highway and it is suggested that in reality the shift of traffic from Memorial Drive to the 'link road' to access Bussell Highway may be greater than the 70% tested in this assessment.

Table 8-11: Scenario Two – Capacity Results - Bussell Highway / Site Access / Roy Earl Drive Roundabout

Lane	AM Peak				PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Bussell Highway / Site Access / Roy Earl Drive Roundabout – 2036 With Development (Scenario Two)								
Bussell Hwy South Approach								
Through/Left/Right	0.565	3.0	A	44.2	0.684	5.8	A	68.7
Roy Earl Drive East Approach								
Through/Left/Right	0.311	9.5	A	16.8	0.426	14.8	B	27.7
Bussell Hwy North Approach								
Through/Left/Right	0.553	3.1	A	45.1	0.832	7.7	A	125.0
Site Access								
Through/Left/Right	0.486	10.8	B	33.8	0.259	9.6	A	15.3
Intersection	**0.565**	**10.8**	**B**	**45.1**	**0.832**	**14.8**	**B**	**125.0**

Analysis of the new Bussell Highway / Site Access / Roy Earl Drive Roundabout – four-way single lane roundabout at the 2036 design horizon, with development traffic added from Lot 102 Bussell Highway and the benefit of the 'link road' across the development site, shows that there are predicted to be no issues with respect to traffic queuing and delays for any movement in the AM and PM peak periods.

All parameters of this capacity assessment are within recognised thresholds for acceptable intersection operation with the intersection predicted to operate around 83% of its theoretical maximum capacity in PM peak period with minimal vehicle delays and manageable vehicle queues of a maximum 125 metres in the southbound direction on Bussell Highway.

Table 8-12: Scenario Two – Capacity Results - Sunset Drive / Site Access Intersection

Lane	AM Peak				PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Sunset Drive / Site Access – 2036 With Development (Scenario Two)								
Sunset Dr South Approach								
Through/Right	0.124	4.7	A	4.6	0.102	4.9	A	3.7
Site Access East Approach								
Left	0.048	4.6	A	1.5	0.096	4.8	A	3.1
Right	0.063	5.7	A	1.5	0.080	5.6	A	2.0
Sunset Dr North Approach								
Through/Left	0.067	4.7	A	0.0	0.075	3.3	A	0.0
Intersection	**0.124**	**5.7**	**A**	**4.6**	**0.102**	**5.6**	**A**	**3.7**

Table 8-13: Scenario Two – Capacity Results - Memorial Drive / Site Access Intersection.

Lane	AM Peak				PM Peak			
	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)	Degree of Saturation	Average Delay (s)	Int. Level of Service	95th %ile Q (m)
Memorial Drive / Site Access – 2036 With Development (Scenario Two)								
Site Access South Approach								
Left	0.001	4.7	A	0.0	0.001	4.8	A	0.0
Right	0.014	5.1	A	0.3	0.007	5.2	A	0.2
Memorial Dr East Approach								
Through/Left	0.027	0.5	A	0.0	0.054	0.6	A	0.0
Memorial Dr West Approach								
Through/Right	0.055	0.0	A	0.1	0.041	0.1	A	0.1
Intersection	**0.055**	**5.1**	**A**	**0.3**	**0.054**	**5.2**	**A**	**0.2**

Analysis of the proposed secondary site access intersections at Memorial Drive and Sunset Drive (above) at the 2036 design horizon, with development traffic added from Lot 102 Bussell Highway shows that there are predicted to be no issues with respect to traffic queuing and delays for any movement in both the AM and PM peak periods. All parameters of this capacity assessment are within recognised thresholds for acceptable intersection operation.

8.10 Summary of Intersection Assessment Results

Three separate main scenarios (including two sensitivity tests) have been analysed in order to establish the relative impact of the proposed residential development on the operation of the surrounding road infrastructure. A summary of the results and key findings of the intersection assessment in given below

1. **Scenario One A '2036 Baseline Without Development' – Operation of Existing Road Intersections.**
   (no site access from Bussell Highway. Access only from Sunset Drive and Memorial Drive)

The existing intersection of Memorial Drive / Sunset Drive / Miamup Road is predicted to operate under capacity with no issues for any movement in both the AM and PM peak periods at the 2036 design horizon.

During the PM peak period, the existing intersections of Bussell Highway/Memorial Drive and Bussell Highway/Roy Earl Drive are predicted to operate at capacity at the 2036 design horizon. This is based on the parameters given the WAPC for which an intersection can be said to operate at capacity. These intersections would not theoretically be capable of supporting any additional traffic movements on Memorial Drive and Roy Earl Drive at the 2036 design horizon.

2. **Scenario One B '2036 With Development' – Operation of Existing Road Intersections.**
   - Inclusive of 243 Residential Units Generated Traffic + Committed Development Traffic.
   - no site access from Bussell Highway. Access only from Sunset Drive and Memorial Drive.

The existing intersection of Memorial Drive / Sunset Drive / Miamup Road is predicted to continue operating under capacity with no issues for any movement in both the AM and PM peak periods at the 2036 design horizon with development.

During the AM and PM peak periods, the existing intersections of Bussell Highway/Memorial Drive is predicted to operate beyond acceptable capacity limits at the 2036 design horizon and will experience delays of well over 40 seconds. During the PM peak period, the existing intersections of Bussell Highway/Roy Earl Drive is also predicted to operate beyond acceptable capacity limits at the 2036 design horizon and will experience delays of well over 40 seconds. These intersections would not theoretically be capable of supporting the additional traffic movements on Memorial Drive and Roy Earl Drive at the 2036 design horizon based upon this scenario and the surrounding network of existing intersections.

Sensitivity Test No. 1: '2032 With Development'
– Inclusive of 140 Residential Units Generated Traffic + Committed Development.
- This sensitivity test assumes exclusion of the minor capacity upgrade to Memorial Drive.

Sensitivity analysis of the existing layout of the Bussell Highway / Memorial Drive three-way priority controlled intersection shows that it could be capable of accommodating the expected traffic generation of up to 140 residential units from the Lot 102 Bussell Highway site at a 2032 design year horizon, at which point this intersection is predicted to experience delays of over 40 seconds on the Memorial Drive eastbound right turn onto Bussell Highway, the WAPC threshold for which an intersection can be said to operate at capacity.

Sensitivity Test No. 2: '2033 With Development'
– Inclusive of 160 Residential Units Generated Traffic + Committed Development.
- This sensitivity test assumes inclusion of the minor capacity upgrade to Memorial Drive.

Sensitivity analysis of the proposed improved layout of the Bussell Highway / Memorial Drive three-way priority controlled intersection shows that it could be capable of accommodating the expected traffic generation of up to 160 residential units from the Lot 102 Bussell Highway site at a 2033 design year horizon, at which point this intersection is predicted to experience delays of over 40 seconds on the Memorial Drive eastbound right turn onto Bussell Highway, the WAPC threshold for which an intersection can be said to operate at capacity.

3. **Scenario Two '2036 With Development' – Operation of Existing Road Intersections and Future Roundabout Intersection at Roy Earl Drive.**
   - Inclusive of 243 Residential Units Generated Traffic + Committed Development Traffic + Structure Plan Traffic.
   - site access assumed from Bussell Highway, Sunset Drive and Memorial Drive)

Under Scenario Two, the existing intersection of Memorial Drive / Sunset Drive / Miamup Road is predicted to continue operating under capacity with no issues for any movement in both the AM and PM peak periods at the 2036 design horizon with full development.

During the PM peak period the Memorial Drive right turn is predicted to operate above the threshold of 40 seconds, but with minimal queueing of approximately 7m or one vehicle. It should be considered that under this Scenario Two assessment, the 'link road' across the development site provides an alternate route for vehicles (from Memorial Drive and to the west of the township) to access Bussell Highway and it is suggested that in reality the shift of traffic from Memorial Drive to the 'link road' to access Bussell Highway may be greater than the 70% tested in this assessment.

Analysis of the new Bussell Highway / Site Access / Roy Earl Drive Roundabout – four-way single lane roundabout shows that there are predicted to be no issues with respect to traffic queuing and delays for any movement in the AM and PM peak periods.

Analysis of the proposed secondary site access intersections at Memorial Drive and Sunset Drive shows that there are predicted to be no issues with respect to traffic queuing and delays for any movement in both the AM and PM peak periods.

8.11 Pedestrian / Cycle Networks

This analysis focuses on the operation and safety of the external pedestrian/cycle networks including which roads could potentially be difficult for pedestrians and cyclists to cross, identifying where safe crossing facilities should be provided and indicating where safe crossing facilities are proposed.

The key roads focussed on under this assessment of pedestrian and cycle networks are Memorial Drive and Bussell Highway, as these are the roads which pedestrians and cyclists from the site are likely to use and cross when navigating routes to the town centre retail, recreational, community and educational facilities within a five to ten minute walk of the site.

Memorial Drive:

In terms of Memorial Drive, the predicted redistribution of traffic as a result providing a 'link road' through the Lot 102 site between Sunset Drive and Bussell Highway is expected to reduce vehicle trips on Memorial Drive by up to 70%. Memorial Drive is an undivided two-lane road which in 2036 with full development build out is predicted to carry relatively low levels

of traffic, which will be significantly below the upper thresholds recognised as affecting the ability of pedestrians to cross such road types.

In 2036, Memorial Drive is anticipated to carry 110 two-way vehicle trips within the AM peak hour and as such the ability of most pedestrians to cross would only be affected if there are more than 1,100 vehicles per hour on these types of roads. As such the amenity and safety of pedestrians and cyclists using or crossing Memorial Drive is unlikely to be materially affected by the proposed development generated traffic.

Traffic Volumes Affecting Pedestrian Crossing Amenity

Road cross-section	Traffic volume affecting ability of pedestrians to cross (vehicles per hour – two-way)
2 lane undivided	1,100 vph
2 lane divided (or with pedestrian refuse islands)	2,800 vph
4 lane undivided (without pedestrian refuge islands)	700 vph
4 lane divided (or with pedestrian refuge islands)	1,600 vph

Bussell Highway:

Whilst the attractors for pedestrians and cyclists generated by the proposed development to cross Bussell Highway are limited, i.e. BP service station, The West Winds Distillery & Tavern and a potential walk route to Cowaramup Primary School via Hasluck Street (an alternative route is available using Bussell Highway and crossing in the town centre) this assessment considers the ability of future pedestrians and cyclists to cross Bussell Highway.

In 2036 with full development build out, the predicted two-way traffic volume on Bussell Highway is expected to be around 1,300 vehicles per hour in the PM, based on a robust traffic growth rate, and therefore may begin to affect the ability of pedestrians or cyclists to cross. However, the proposed site access roundabout with Roy Earl Drive incorporates pedestrian refuge islands at this intersection. These facilities at the intersection will assist pedestrians to cross Bussell Highway by only navigating one stream of traffic at a time. The upper threshold of a two-lane divided road with pedestrian refuge islands is 2,800 vehicles per hour. The 2036 traffic volume on Bussell Highway is significantly less than this upper threshold which applies at the proposed roundabout intersection.

All other routes to school which cross two-lane undivided side roads carry less than 1,100vph and are not considered to cause a barrier to walk to/from school. It is a recommendation of this report that investigations be undertaken to explore the potential for extending the existing footpath network in the areas shown in Section 8.6 of this report. If feasible, this would encourage trips on foot to the local centre of Cowaramup and to the Primary School, thereby reduce the reliance on private vehicle modes for short trips. The funding mechanisms for which these improvements could be budgeted, would be with Main Roads WA and the Shire of Augusta Margaret River.

9 Safety Issues

9.1 Existing Safety Issues

Section 2.8 of this TIA gives a detailed account of the crash statics for the following three sections of road surrounding the proposed development site. The study area covered all recorded traffic accidents for the most recently available five-year reporting period between 1 January 2018 and 31 December 2022 for the following roads:

- Bussell Highway, between Treeton Road and Cowaramup Bay Road (15 crashes recorded).
- Memorial Drive, between Bussell Highway and Sunset Drive (No crashes recorded).
- Sunset Drive, between Memorial Drive and Brockman Road (3 crashes recorded).

Whilst the recorded crashes (18 in total) occurred over a large study area, none of the crash locations and crash types suggest a particular trend inherent with any particular location. Only four of the recorded crashes involved medical attention being required, with the remaining crashes involving property damage only (PDO). No fatal crashes were recorded across the study area.

Along the section of Bussell Highway, between Treeton Road and Cowaramup Bay Road, three crashes involved medical attention being required, one of which reported as a rear-end shunt in the town centre and two reported as right-angle type crashes at the intersection of Bussell Highway/Cowaramup Bay Road and Bussell Highway/Wiring Road, both of which were report as involving a vehicle failing to give-way to traffic on Bussell Highway.

No crashes were recorded as occurring at the intersection of Bussell Highway/Memorial Drive in the past five year period.

No crashes have been recorded as occurring on the section of Memorial Drive between Bussell Highway and Sunset Drive.

Of the three crashes recorded on Sunset Drive, one resulted in medical attention being required from a right-angle type of crash at the intersection with Memorial Drive which involved an intoxicated driver.

9.2 Impact of the Sub-Division on Safety Issues

Given the relatively low number of crashes recorded over a particularly large study area and the low proportion of medical treatment required outcomes, it is reasonable to assume that whilst the proposed development will contribute to increased traffic volumes in future years (in addition to committed residential developments and proposed structure plan areas), there is a low likelihood that the Lot 102 Bussell Highway development will increase the chances of regular crashes occurring.

In terms of the proposed modifications to the Bussell Highway intersection with Roy Earl Drive, specifically the future operation of a new single lane roundabout to serve access into the Lot 102 site and other developments, it is a recommendation of this report that Road Safety Audits be undertaken by an accredited Road Safety Team at the various stages of the design and approval process to address any deficiencies with the existing road network and/or implications connected with the proposed roundabout design for all road users. This is likely to be a requirement of Main Roads WA's standard design and construction process in the likely event that MRWA project manages the design and construction of this asset.

10 Conclusions

In accordance with WAPC Guidelines for Transport Impact Assessments, this report sets out the details of the proposed MRS amendment, the key transport issues and impacts related to the development of the Site from a residential and recreational and community perspective including the current level of accessibility by road, public transport, cycle and on foot and sets recommendations to explore the potential for improving these to a suitable level where required and appropriate.

This Transport Assessment has been prepared with sufficient detail and analysis to support an application for a revised Structure Plan & subsequent Staged subdivision submission of up to 140 residential units based on the existing configuration of the road network intersections at a design year horizon of 2032 and up to 160 residential units based on the minor capacity upgrade of the Memorial Drive eastbound approach to Bussell Highway/Memorial Drive intersection at a design year horizon of 2033.

This TIA also explores the proposed modifications to the surrounding transport networks including local and state Government projects and initiatives such as the planned upgrade of the Bussell Highway/Memorial Drive intersection and the Bussell Highway/Roy Earl Drive intersection upgrade to four-way single lane roundabout control.

This TIA ultimately demonstrates that assuming the provision of a new 'link road' across the site between Sunset Drive and Bussell Highway together with a new four-way roundabout access onto Bussell Highway at the Roy Earl Drive intersection, the upgraded road network will be able to support the full 243 residential units proposed at this site in the 2036 design horizon.

The assumed new roundabout intersection at Bussell Highway/Roy Earl Drive, which may ultimately provide access to the development site, is predicted to operate with no issues with respect to traffic queuing and delays for any movement in the AM and PM peak periods under a 2036 design horizon with full development generated traffic.

The following conclusions and recommendations have been made regarding the proposed development with respect to this TIA:

10.1 Overall Integration with Surrounding Attractors / Generators

The proposed site integrates well with the existing and proposed land uses immediately surrounding the site which consists primarily to the north-east (of the site), the town centre of Cowaramup (approximately 600m from the centre of the site) and includes facilities such as a church, shops, cafes, bakeries, gift shops, agricultural supplies and food and beverage outlets. Recreational and civic land uses including Pioneer Park, the Cowaramup District Hall, Cowaramup Oval, Skate Park, BMX Track, Basketball Court and Tennis Court.

Cowaramup Primary School is located approximately 1.0km north east of the centre of the development site off Waverley Road, which is likely to generate trips from the proposed development site by walking, cycle and by private vehicle.

Closer to the site (300m from its centre) is the Cowaramup District Social Club including lawn bowls facility and a distillery and tavern on the eastern side of Bussell Highway. Cowaramup Community Men's Shed and the Volunteer Fire Station is located to the north-west of the site on the western side of Sunset Drive.

Due to the regional location of Cowaramup, on the primary link road of Bussell Highway, significant attractors such as Margaret River located approximately 10 minute drive south and the City of Busselton approximately 30 minutes by car to the north-east are factors in generators of vehicle trips from the site for employment and recreation.

When the land is fully developed, the site will form part of a wholly integrated residential suburban area with appropriate and ideal vehicular connections to the primary and regional road network, including Bussell Highway and Caves Road providing an excellent level of vehicular access to and from the site.

10.2 Road Network Accessibility

The site is well located in relation to the existing local and primary state road network and is well positioned to take primary access from Bussell Highway. This will provide enhanced access to the local and primary state road network and access to employment areas and the wider strategic road network.

In relation to the internal site road network accessibility, due to the relatively low volume and low speed residential nature of the proposed development area, all intersections within the area are intended to be constructed as priority-controlled T-intersections. The only exceptions are both four-way intersections formed at the north-south street intersection points where they cross the main east-west street between Sunset Drive and Bussell Highway.

However, it is a recommendation of this report that both of these four-way intersections should be designed as raised plateaus assuming a design speed of 20km/h and posted with advisory signage as such. These raised plateaus would reduce the requirements for Safe Intersection Stopping Distance (SISD) and form appropriate 'gateways' into the residential development. These intersections will require signage (Give-Way or Stop) on the approaches, and in this case the north-south approaches are preferred.

Sunset Drive/Site Access:

The development proposes a site access intersection onto Sunset Drive which takes the form of a three-way priority control. With respect to the location of the intersection on Sunset Drive, locating it on the outside of the bend, as shown in the Site Concept Masterplan, affords it good sight lines to and from the intersection as the roadway bends away from the tree line on the east side.

Memorial Drive/Site Access:

The development proposes a site access intersection onto Memorial Drive which takes the form of a three-way priority control. Liveable Neighbourhoods gives guidance for same side intersections, and this is 40m CL to CL (Table 5 of Element 2), which is achievable in relation to the adjacent intersection of Sunset Dr/Miamup Dr/Memorial Drive.

Bussell Highway/Roy Earl Drive/Site Access:

The proposed roundabout design included in the developer's Site Concept Masterplan has been developed based optimising the proposed MRWA draft roundabout design in four key areas being Road Reserve, Roundabout Central Island Radius, Central Hatch Line Marking and Speed Reduction Measures. The optimised roundabout has been tested for the appropriate design vehicles. Section 4.2 of this report discusses these areas of the design in greater detail.

The developer's proposed roundabout design optimises the design with the intention of reducing the size, cost and third party land required for construction of this intersection.

10.3 Pedestrian and Cycle Accessibility

The site currently has poor accessibility in relation to the existing footpath network and non-existent provision on Bussell Highway, which is required to be improved. Alongside the eastern frontage of site, there are currently no footpaths or on road cycle facilities on Bussell Highway.

There is a single footpath on the northern side of Memorial Drive and an informal, unsealed footpath on the western side of Sunset Drive as it flanks the site, which may be shared by pedestrians and cyclists, however neither of these road feature on road cycle facilities.

It is a recommendation of this report that investigations be undertaken to explore the potential for extending the above existing footpath on the western side of Bussell Highway (approximately 500m) to link in with the proposed pedestrian connections on the eastern flank of the site and the internal footpath network. If feasible, this would encourage trips on foot and bicycle to the local centre of Cowaramup and help reduce the reliance on private vehicle modes for short trips. The funding mechanism for which these improvements could be budgeted, would be with Main Roads WA.

Approximately 60% of the subdivision area is within 800 metres (ten minute waking time) of the centre of Cowaramup. This means that the majority of retail, recreational and community uses within Cowaramup are within a ten minute walk time of approximately 60% of the subdivision. Cowaramup Primary School is located just outside of 800m of the centre of the site.

The Shire of Augusta-Margaret River is set to benefit from funding as part of the WA Bicycle Network (WABN) Grants Program. Department of Transport (DoT) announced the Shire will receive over $500,000 between 2023 and 2025 for the design and construction of new shared pedestrian/bike paths.

The Leeuwin-Naturaliste 2050 Cycling Strategy details the future cycling plans within the region focused on connecting, enhancing and extending the region's cycling infrastructure through the development of an interconnected network of off-road shared paths and trails, protected on-road bike lanes and low-stress residential streets.

Within the Cowaramup area, the keys cycling link proposed are as follows:

- a primary route linking Gracetown to the Wadandi Track along Cowaramup Bay Road - performing a similar function to the Margaret River-Prevelly Shared Path.
- a secondary route along the main street of Cowaramup (extending from Waverley Road to Roy Earl Drive) providing people with access to Cowaramup shops and community facilities.
- a secondary route along Memorial Drive providing a safe link between the Cowaramup town centre and the town's western residential area.
- two local route loops providing residents of east and west Cowaramup with access to higher-order cycling facilities.

The development site is well placed to take advantage of the DoT's WABN grants program facilitated by Shire of Augusta-Margaret River and the Long-Term future strategy for the cycling network (Leeuwin Naturaliste 2050 Cycling Strategy) which would improve and encourage trips by cycle for commuting and recreational purposes.

10.4 Public Transport Accessibility

Due to its regional location and its presence as a gateway town to Margaret River by vehicle, Cowaramup does not have a regular scheduled public bus service. TransRegional does not operate in Cowaramup or the surrounding towns.

The closest Transwa coach service to Cowaramup is the **SW1** service which stops at Margaret River (Charles West Avenue stop) and runs from East Perth to Augusta and Pemberton (return) via Bunbury and Augusta. The service operates on Sundays and Tuesdays to Pemberton and seven days a week to/from Augusta.

PJA has contacted the Public Transport Authority to request confirmation of any future plans from the regional public transport provider (TransRegional) in connection with providing new scheduled bus services or school services within Cowaramup and adjoining towns.

The PTA has confirmed that Regional Town Bus Services have no short-term plans to provide local bus routes in Cowaramup. The PTA notes that they may assess the viability of local public transport services for Margaret River within the next five years however, this would be dependent on population and residential growth. This would help to address the future sustainability of the development site, particularly in consideration of large areas of land within Cowaramup currently zoned for future residential and rural-residential development which could take advantage of a regular public transport service.

10.5 Road Safety Considerations

The crash statics for the following three sections of road surrounding the proposed development site have been investigated. The study area covered all recorded traffic accidents for the most recently available five-year reporting period between 1 January 2018 and 31 December 2022 for the following roads:

- Bussell Highway, between Treeton Road and Cowaramup Bay Road (15 crashes recorded).
- Memorial Drive, between Bussell Highway and Sunset Drive (No crashes recorded).
- Sunset Drive, between Memorial Drive and Brockman Road (3 crashes recorded).

Whilst the recorded crashes (18 in total) occurred over a large study area, none of the crash locations and crash types suggest a particular trend inherent with any particular location. Only four of the recorded crashes involved medical attention being required, with the remaining crashes involving property damage only (PDO). No fatal crashes were recorded across the study area.

Along the section of Bussell Highway, between Treeton Road and Cowaramup Bay Road, three crashes involved medical attention being required, one of which reported as a rear-end shunt in the town centre and two reported as right-angle type crashes at the intersection of Bussell Highway/Cowaramup Bay Road and Bussell Highway/Wiring Road, both of which were report as involving a vehicle failing to give-way to traffic on Bussell Highway.

No crashes were recorded as occurring at the intersection of Bussell Highway/Memorial Drive in the past five year period.

No crashes have been recorded as occurring on the section of Memorial Drive between Bussell Highway and Sunset Drive.

Of the three crashes recorded on Sunset Drive, one resulted in medical attention being required from a right-angle type of crash at the intersection with Memorial Drive which involved an intoxicated driver.

In terms of the proposed modifications to the Bussell Highway intersection with Roy Earl Drive, specifically the future operation of a new single lane roundabout to serve access into the Lot 102 site and other developments, it is a recommendation of this report that Road Safety Audits be undertaken by an accredited Road Safety Team at the various stages of the design and approval process to address any deficiencies with the existing road network and/or implications connected with the proposed roundabout design for all road users.

The existing cycling environment on Bussell Highway, along the eastern flank of the site, is poor with only sealed shoulders with edge lines representing an informal and unsuitable provision with a sub-standard width for cyclists of approximately 1.0m and a prevailing speed limit of 60km/hr. It is however anticipated that the majority of the cycle trips to/from the development site would take place via the internal site road onto Memorial Drive which is more appropriate for cycling of most abilities with a 50km/speed limit and an integrated cycling environment. In addition, footpaths connect through Pioneer Park to link with the town centre, which cyclists are legally permitted to use.

It is a recommendation of this report that the relocation of the beginning/end of the 40km/hr speed zone on Bussell Highway be investigated by Main Roads WA (in consultation with Shire of AMR) to extend south of Memorial Drive to include the intersection and improve the cycling environment for cyclists joining Bussell Highway from Memorial Drive with a destination in the town centre.

10.6 Analysis of the External Transport Network

Three separate main scenarios (including two sensitivity tests) have been analysed in order to establish the relative impact of the proposed residential development on the operation of the surrounding road infrastructure. A summary of the results and key findings of the intersection assessment in given below

4. **Scenario One A '2036 Baseline Without Development' – Operation of Existing Road Intersections.**
   (no site access from Bussell Highway. Access only from Sunset Drive and Memorial Drive)

The existing intersection of Memorial Drive / Sunset Drive / Miamup Road is predicted to operate under capacity with no issues for any movement in both the AM and PM peak periods at the 2036 design horizon.

During the PM peak period, the existing intersections of Bussell Highway/Memorial Drive and Bussell Highway/Roy Earl Drive are predicted to operate at capacity at the 2036 design horizon. This is based on the parameters given the WAPC for which an intersection can be said to operate at capacity. These intersections would not theoretically be capable of supporting any additional traffic movements on Memorial Drive and Roy Earl Drive at the 2036 design horizon.

5. **Scenario One B '2036 With Development' – Operation of Existing Road Intersections.**
   - Inclusive of 243 Residential Units Generated Traffic + Committed Development Traffic.
   - no site access from Bussell Highway. Access only from Sunset Drive and Memorial Drive.

The existing intersection of Memorial Drive / Sunset Drive / Miamup Road is predicted to continue operating under capacity with no issues for any movement in both the AM and PM peak periods at the 2036 design horizon with development.

During the AM and PM peak periods, the existing intersections of Bussell Highway/Memorial Drive is predicted to operate beyond acceptable capacity limits at the 2036 design horizon and will experience delays of well over 40 seconds. During the PM peak period, the existing intersections of Bussell Highway/Roy Earl Drive is also predicted to operate beyond acceptable capacity limits at the 2036 design horizon and will experience delays of well over 40 seconds. These intersections would not theoretically be capable of supporting the additional traffic movements on Memorial Drive and Roy Earl Drive at the 2036 design horizon based upon this scenario and the surrounding network of existing intersections.

Sensitivity Test No. 1: '2032 With Development'
– Inclusive of 140 Residential Units Generated Traffic + Committed Development.
- This sensitivity test assumes exclusion of the minor capacity upgrade to Memorial Drive.

Sensitivity analysis of the existing layout of the Bussell Highway / Memorial Drive three-way priority controlled intersection shows that it could be capable of accommodating the expected traffic generation of up to 140 residential units from the Lot 102 Bussell Highway site at a 2032 design year horizon, at which point this intersection is predicted to experience delays of over 40 seconds on the Memorial Drive eastbound right turn onto Bussell Highway, the WAPC threshold for which an intersection can be said to operate at capacity.

Sensitivity Test No. 2: '2033 With Development'
– Inclusive of 160 Residential Units Generated Traffic + Committed Development.
- This sensitivity test assumes inclusion of the minor capacity upgrade to Memorial Drive.

Sensitivity analysis of the proposed improved layout of the Bussell Highway / Memorial Drive three-way priority controlled intersection shows that it could be capable of accommodating the expected traffic generation of up to 160 residential units from the Lot 102 Bussell Highway site at a 2033 design year horizon, at which point this intersection is predicted to experience delays of over 40 seconds on the Memorial Drive eastbound right turn onto Bussell Highway, the WAPC threshold for which an intersection can be said to operate at capacity.

6. **Scenario Two '2036 With Development' – Operation of Existing Road Intersections and Future Roundabout Intersection at Roy Earl Drive.**
   - Inclusive of 243 Residential Units Generated Traffic + Committed Development Traffic + Structure Plan Traffic.
   - site access assumed from Bussell Highway, Sunset Drive and Memorial Drive)

Under Scenario Two, the existing intersection of Memorial Drive / Sunset Drive / Miamup Road is predicted to continue operating under capacity with no issues for any movement in both the AM and PM peak periods at the 2036 design horizon with full development.

During the PM peak period the Memorial Drive right turn is predicted to operate above the threshold of 40 seconds, but with minimal queueing of approximately 7m or one vehicle. It should be considered that under this Scenario Two assessment, the 'link road' across the development site provides an alternate route for vehicles (from Memorial Drive and to the west of the township) to access Bussell Highway and it is suggested that in reality the shift of traffic from Memorial Drive to the 'link road' to access Bussell Highway may be greater than the 70% tested in this assessment.

Analysis of the new Bussell Highway / Site Access / Roy Earl Drive Roundabout – four-way single lane roundabout shows that there are predicted to be no issues with respect to traffic queuing and delays for any movement in the AM and PM peak periods.

Analysis of the proposed secondary site access intersections at Memorial Drive and Sunset Drive shows that there are predicted to be no issues with respect to traffic queuing and delays for any movement in both the AM and PM peak periods.

Appendix A TIA Checklist

Item	Provided	Comments/Proposals
Summary	Y	
Introduction / Background	Y	
Structure Plan Proposal		
Regional context	Y	
Proposed land uses	Y	
Table of land uses and quantities	Y	
Major attractors / generators	Y	
Specific issues	Y	
Existing Situation		
Existing land uses within structure plan	Y	
Existing land uses within 800m of structure plan area	Y	
Existing road network within structure plan area	Y	
Existing pedestrian / cycle network within structure plan area	Y	
Existing public transport services within structure plan area	Y	
Existing road network within 2 (or 5) km of structure plan area	Y	
Traffic flows on roads within structure plan area (PM and/or AM peak hours)	Y	
Existing pedestrian / cycle networks within 800m of structure plan area.	Y	
Existing public transport services within 800m of structure plan area.	Y	
Proposed Internal Transport Networks		
Changes / additions to existing road network or proposed new road network	Y	
Road reservation widths	Y	
Road cross-sections & speed limits	Y	
Intersection controls	Y	
Pedestrian / cycle networks and crossing facilities	Y	
Changes to External Transport Networks		
Road network	Y	
Intersection controls	Y	
Pedestrian/cycle networks and crossing facilities	Y	
Public transport services	Y	
Integration with surrounding area		
Trip attractors / generators within 800 metres	Y	
proposed changes to land uses within 800 metres	Y	
travel desire lines from development to these attractors/ generators	Y	
adequacy of external transport networks	Y	
deficiencies in external transport networks	Y	
remedial measures to address deficiencies	Y	
Analysis of internal transport networks		
assessment years	Y	
time periods	Y	
Structure plan generated traffic	Y	
Extraneous (through) traffic	Y	
Design traffic flows (that is, total traffic)	Y	
Road cross-sections	Y	
Intersection controls	Y	
Access strategy	Y	
Pedestrian / cycle networks	Y	
Safe routes to schools	Y	
Pedestrian permeability & efficiency	Y	
Access to public transport	Y	
Analysis of external transport networks		
Extent of analysis	Y	
Base flows for assessment year(s)	Y	
Total traffic flows	Y	
Road cross-sections	Y	
Intersection layouts and controls	Y	
Pedestrian / cycle networks	Y	
Conclusions	Y	

Appendix B Site Concept Masterplan

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PLAN 1 - STRUCTURE PLAN

LOT 102 BUSSELL HIGHWAY

COWARAMUP

N

0 60 m

SCALE @ A3: 1:2500

9729-LSP-01-D

DRAWN:	VR
DATE CREATED:	2023.10.17
PROJECTION:	MGA50 GDA2020
CADASTRE:	LANDGATE
AERIAL:	MAR 2022

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ROWE GROUP DESIGN

\\GRA-FS\DATA\TOWN PLANNING\9000-9999\9729\02 DRAFTING\A-CAD · VR · 2023.10.17

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Appendix C Sunset Drive Sight Lines Plan

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0 5 10 20 30m
SCALE 1:500 @ ORIGINAL SHEET SIZE A1

WARNING
BEWARE OF UNDERGROUND SERVICES
BEFORE YOU DIG www.byda.com.au
The location of underground cables are approximate only and their exact position should be checked on site. No guarantee is given that all existing cables and services are shown. Locate all underground cables and services before commencement of work. Refer to Work Health and Safety (General) Regulations 2022.

REV	DATE	DRAWN	CHECKED	APPROVED	
A	22.09.23	AP			ISSUED FOR INFORMATION

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JDSi CONSULTING ENGINEERS

CLIENT:
GOLDFIELDS COWARAMUP PTY. LTD.

PROJECT:
LOT 102 BUSSELL HIGHWAY COWARAMUP

DRAWING TITLE:
SUNSET DRIVE SIGHT LINES PLAN

DRAWN: A. PANZICH		WAPC No.	
DESIGNED: A. PANZICH		SCALE @ A1: 1:500	
PROJECT MANAGER: R. MARTIN		DATUM: AHD	CO-ORDS: MRCG94
JDSi PROJECT No.: JDS232176.0	DRAWING No.: SK002		REVISION: A

Plotted By: APanzich Plot Date: 22/09/23 - 10:39 Cad File: I:\JDS232176\JDS232176.0\02 CIVIL\Drawings\Sketches\JDS232176.0_SK002.dwg

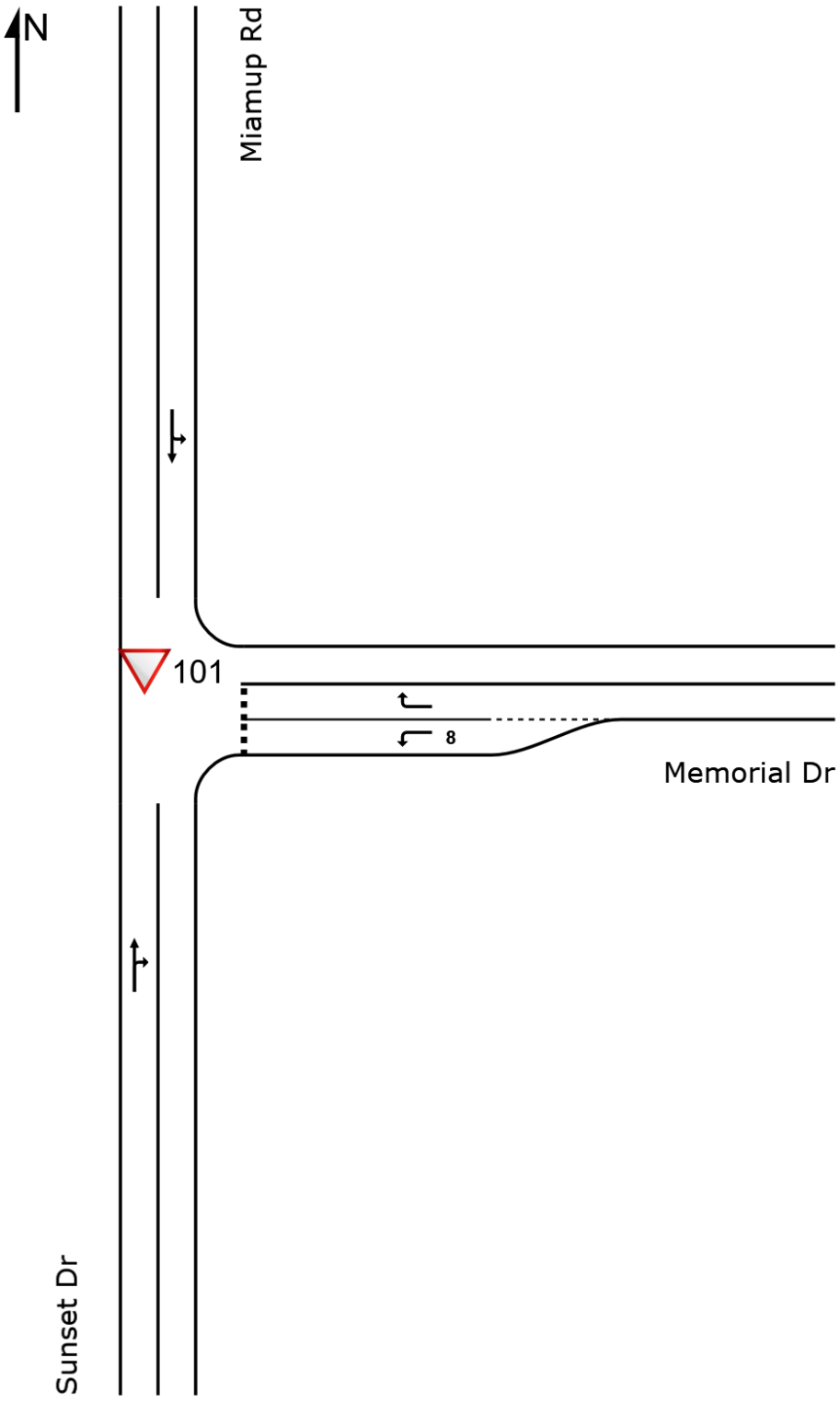
Appendix D SIDRA Intersection Assessment Results

SITE LAYOUT

Site: 101 [Memorial Dr/Sunset Dr 2036 AM - WO Dev (Site Folder: Scenario 1a)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.

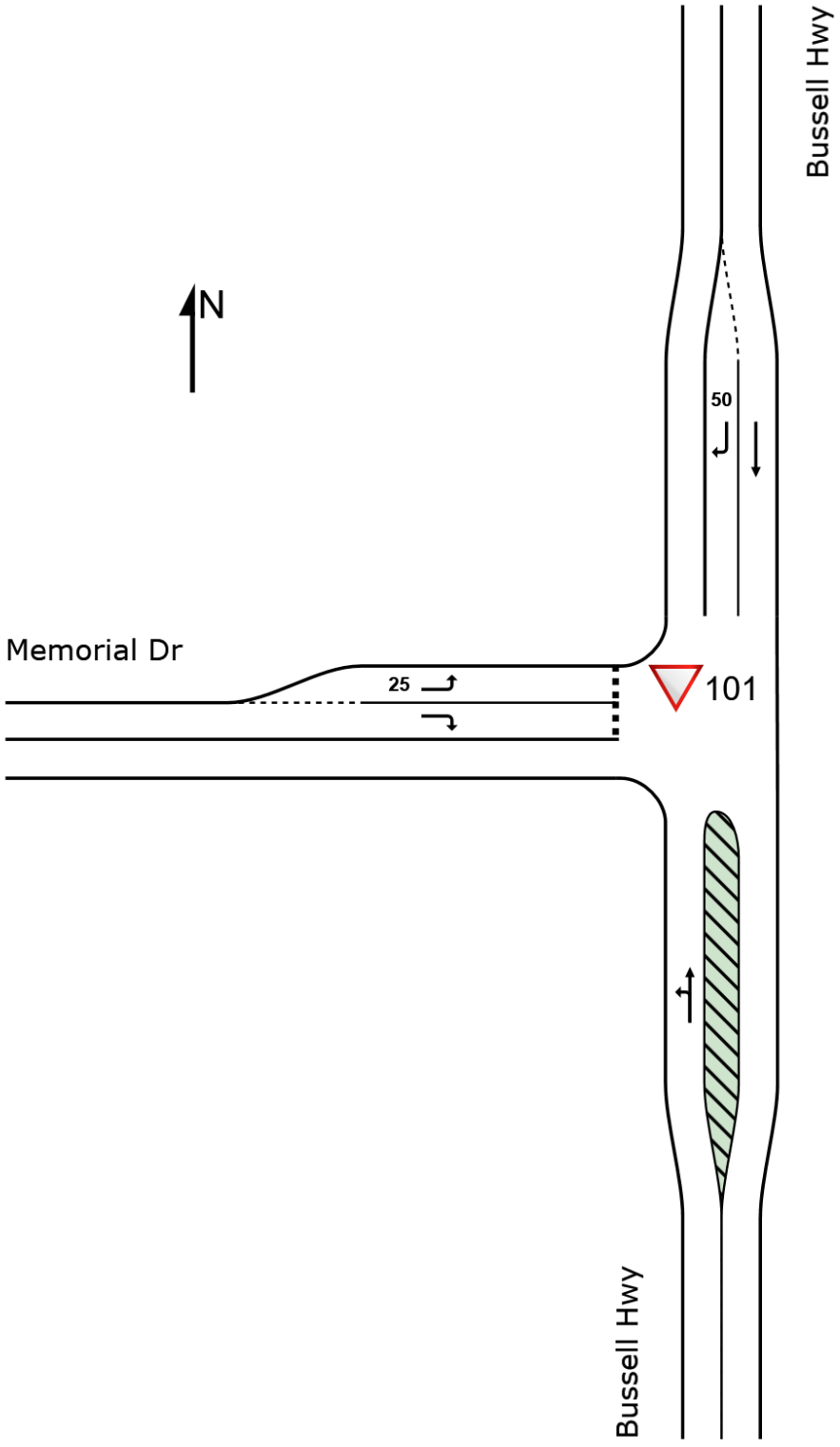


SITE LAYOUT

Site: 101 [Memorial Dr/Bussell 2036 AM - WO Dev (Site Folder: Scenario 1a)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.

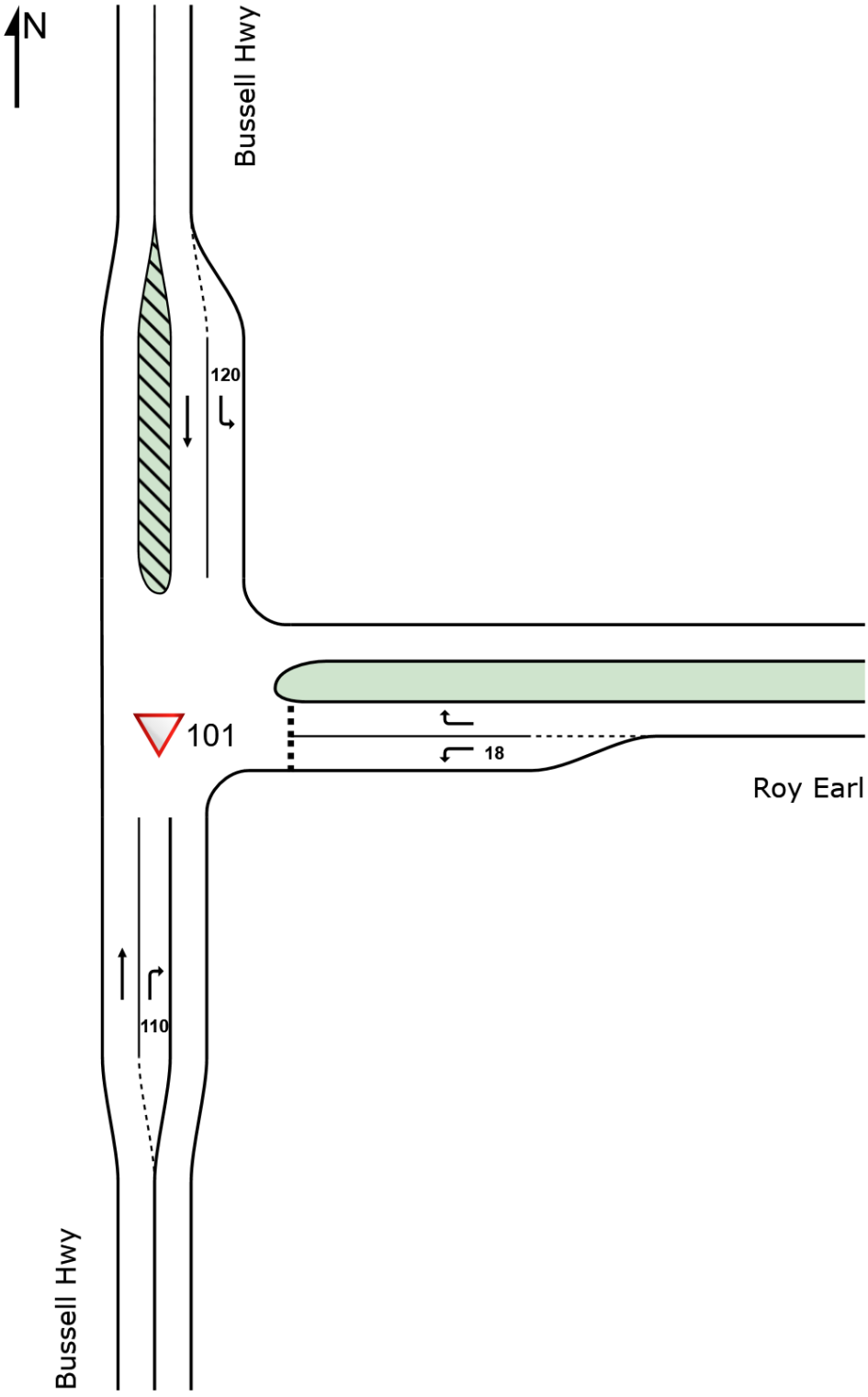


SITE LAYOUT

Site: 101 [Roy Earl/Bussell 2036 AM - WO Dev (Site Folder: Scenario 1a)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



LANE SUMMARY

Site: 101 [Memorial Dr/Sunset Dr 2036 AM - WO Dev (Site Folder: Scenario 1a)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Sunset Dr															
Lane 1	197	3.0	197	3.0	1565	0.126	100	6.0	LOS A	0.6	4.6	Full	500	0.0	0.0
Approach	197	3.0	197	3.0		0.126		6.0	NA	0.6	4.6				
East: Memorial Dr															
Lane 1	63	3.0	63	3.0	1611	0.039	100	4.6	LOS A	0.2	1.2	Short	8	0.0	NA
Lane 2	89	3.0	89	3.0	1008	0.089	100	5.7	LOS A	0.3	2.2	Full	500	0.0	0.0
Approach	153	3.0	153	3.0		0.089		5.2	LOS A	0.3	2.2				
North: Miamup Rd															
Lane 1	148	3.0	148	3.0	1818	0.082	100	5.6	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	148	3.0	148	3.0		0.082		5.6	NA	0.0	0.0				
All Vehicles	498	3.0	498	3.0		0.126		5.6	NA	0.6	4.6				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Sunset Dr

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	1	196	197	3.0	1565	0.126	100	NA	NA
Approach	1	196	197	3.0		0.126			

East: Memorial Dr

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	63	-	63	3.0	1611	0.039	100	0.0	2
Lane 2	-	89	89	3.0	1008	0.089	100	NA	NA
Approach	63	89	153	3.0		0.089			

North: Miamup Rd

Mov. From N	L2	T1	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	147	1	148	3.0	1818	0.082	100	NA	NA
Approach	147	1	148	3.0		0.082			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	498	3.0	0.126

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Sunset Dr				
Lane 1	0.0	0.0	0.0	0.0
East: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Miamup Rd				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr/Sunset Dr 2036 PM - WO Dev (Site Folder: Scenario 1a)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Sunset Dr															
Lane 1	140	3.0	140	3.0	1599	0.088	100	5.9	LOS A	0.4	3.1	Full	500	0.0	0.0
Approach	140	3.0	140	3.0		0.088		5.9	NA	0.4	3.1				
East: Memorial Dr															
Lane 1	192	3.0	192	3.0	1604	0.119	100	4.6	LOS A	0.5	4.0	Short	8	0.0	NA
Lane 2	115	3.0	115	3.0	1070	0.107	100	5.4	LOS A	0.4	2.7	Full	500	0.0	0.0
Approach	306	3.0	306	3.0		0.119		4.9	LOS A	0.5	4.0				
North: Miamup Rd															
Lane 1	124	3.0	124	3.0	1822	0.068	100	5.3	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	124	3.0	124	3.0		0.068		5.3	NA	0.0	0.0				
All Vehicles	571	3.0	571	3.0		0.119		5.2	NA	0.5	4.0				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Sunset Dr

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	1	139	140	3.0	1599	0.088	100	NA	NA
Approach	1	139	140	3.0		0.088			

East: Memorial Dr

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	192	-	192	3.0	1604	0.119	100	0.0	2
Lane 2	-	115	115	3.0	1070	0.107	100	NA	NA
Approach	192	115	306	3.0		0.119			

North: Miamup Rd

Mov. From N	L2	T1	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	118	6	124	3.0	1822	0.068	100	NA	NA
Approach	118	6	124	3.0		0.068			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	571	3.0	0.119

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Sunset Dr				
Lane 1	0.0	0.0	0.0	0.0
East: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Miamup Rd				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr/Bussell 2036 AM - WO Dev (Site Folder: Scenario 1a)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1	628	11.5	628	11.5	1715	0.366	100	1.7	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	628	11.5	628	11.5		0.366		1.7	NA	0.0	0.0				
North: Bussell Hwy															
Lane 1	504	15.3	504	15.3	1650	0.306	100	0.1	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	106	3.0	106	3.0	887	0.120	100	6.6	LOS A	0.5	3.7	Short	50	0.0	NA
Approach	611	13.2	611	13.2		0.306		1.3	NA	0.5	3.7				
West: Memorial Dr															
Lane 1	224	3.0	224	3.0	892	0.251	100	7.6	LOS A	1.0	7.8	Short	25	0.0	NA
Lane 2	107	3.0	107	3.0	211	0.509	100	29.1	LOS D	2.0	15.3	Full	500	0.0	0.0
Approach	332	3.0	332	3.0		0.509		14.6	LOS B	2.0	15.3				
All Vehicles	1571	10.3	1571	10.3		0.509		4.3	NA	2.0	15.3				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	L2 W	T1 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	62	566	628	11.5	1715	0.366	100	NA	NA
Approach	62	566	628	11.5		0.366			

North: Bussell Hwy

Mov. From N To Exit:	T1 S	R2 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	504	-	504	15.3	1650	0.306	100	NA	NA
Lane 2	-	106	106	3.0	887	0.120	100	0.0	1
Approach	504	106	611	13.2		0.306			

West: Memorial Dr

Mov.	L2	R2	Total	%HV		Deg.	Lane	Prob.	Ov.

From W To Exit:	N	S			Cap. veh/h	Satn v/c	Util. %	SL Ov. %	Lane No.
Lane 1	224	-	224	3.0	892	0.251	100	0.0	2
Lane 2	-	107	107	3.0	211	0.509	100	NA	NA
Approach	224	107	332	3.0		0.509			
	Total	%HV	Deg.Satn (v/c)						
All Vehicles	1571	10.3		0.509					

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate sec	Capacity veh/h	Deg. Satn veh/h	Min. Delay v/c	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
West: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr/Bussell 2036 PM - WO Dev (Site Folder: Scenario 1a)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1	565	10.6	565	10.6	1724	0.328	100	2.0	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	565	10.6	565	10.6		0.328		2.0	NA	0.0	0.0				
North: Bussell Hwy															
Lane 1	691	15.3	691	15.3	1650	0.418	100	0.2	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	119	3.0	119	3.0	973	0.122	100	6.1	LOS A	0.5	3.8	Short	50	0.0	NA
Approach	809	13.5	809	13.5		0.418		1.1	NA	0.5	3.8				
West: Memorial Dr															
Lane 1	104	3.0	104	3.0	1021	0.102	100	6.6	LOS A	0.4	3.0	Short	25	0.0	NA
Lane 2	98	3.0	98	3.0	164	0.596	100	39.2	LOS E	2.3	17.6	Full	500	0.0	0.0
Approach	202	3.0	202	3.0		0.596		22.4	LOS C	2.3	17.6				
All Vehicles	1577	11.1	1577	11.1		0.596		4.1	NA	2.3	17.6				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	L2 W	T1 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	105	460	565	10.6	1724	0.328	100	NA	NA
Approach	105	460	565	10.6		0.328			

North: Bussell Hwy

Mov. From N To Exit:	T1 S	R2 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	691	-	691	15.3	1650	0.418	100	NA	NA
Lane 2	-	119	119	3.0	973	0.122	100	0.0	1
Approach	691	119	809	13.5		0.418			

West: Memorial Dr

Mov.	L2	R2	Total	%HV		Deg.	Lane	Prob.	Ov.

From W To Exit:	N	S			Cap. veh/h	Satn v/c	Util. %	SL Ov. %	Lane No.
Lane 1	104	-	104	3.0	1021	0.102	100	0.0	2
Lane 2	-	98	98	3.0	164	0.596	100	NA	NA
Approach	104	98	202	3.0		0.596			
	Total	%HV	Deg.Satn (v/c)						
All Vehicles	1577	11.1		0.596					

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate sec	Capacity veh/h	Deg. Satn veh/h	Min. Delay v/c	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
West: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Roy Earl/Bussell 2036 AM - WO Dev (Site Folder: Scenario 1a)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1	573	15.3	573	15.3	1650	0.347	100	1.3	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	14	3.0	14	3.0	713	0.019	100	8.9	LOS A	0.1	0.5	Short	110	0.0	NA
Approach	586	15.0	586	15.0		0.347		1.5	NA	0.1	0.5				
East: Roy Earl															
Lane 1	43	3.0	43	3.0	668	0.065	100	8.1	LOS A	0.2	1.6	Short	18	0.0	NA
Lane 2	46	3.0	46	3.0	168	0.276	100	28.8	LOS D	0.9	6.9	Full	500	0.0	0.0
Approach	89	3.0	89	3.0		0.276		18.8	LOS C	0.9	6.9				
North: Bussell Hwy															
Lane 1	2	3.0	2	3.0	1818	0.001	100	5.6	LOS A	0.0	0.0	Short	120	0.0	NA
Lane 2	577	12.4	577	12.4	1704	0.338	100	0.1	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	579	12.4	579	12.4		0.338		0.1	NA	0.0	0.0				
All Vehicles	1255	12.9	1255	12.9		0.347		2.1	NA	0.9	6.9				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	573	-	573	15.3	1650	0.347	100	NA	NA
Lane 2	-	14	14	3.0	713	0.019	100	0.0	1
Approach	573	14	586	15.0		0.347			

East: Roy Earl

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	43	-	43	3.0	668	0.065	100	0.0	2
Lane 2	-	46	46	3.0	168	0.276	100	NA	NA
Approach	43	46	89	3.0		0.276			

North: Bussell Hwy									
Mov. From N To Exit:	L2 E	T1 S	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	2	-	2	3.0	1818	0.001	100	0.0	2
Lane 2	-	577	577	12.4	1704	0.338	100	NA	NA
Approach	2	577	579	12.4		0.338			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	1255	12.9	0.347

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate sec	Capacity veh/h	Deg. Satn veh/h	Min. Delay v/c	Merge Delay sec	sec
There are no Exit Short Lanes for Merge Analysis at this Site.												

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
East: Roy Earl				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

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LANE SUMMARY

Site: 101 [Roy Earl/Bussell 2036 PM - WO Dev (Site Folder: Scenario 1a)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1	525	15.3	525	15.3	1650	0.318	100	1.3	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	40	3.0	40	3.0	545	0.073	100	10.9	LOS B	0.3	1.9	Short	110	0.0	NA
Approach	565	14.4	565	14.4		0.318		2.0	NA	0.3	1.9				
East: Roy Earl															
Lane 1	51	3.0	51	3.0	512	0.099	100	10.1	LOS B	0.3	2.4	Short	18	0.0	NA
Lane 2	37	3.0	37	3.0	117	0.315	100	40.5	LOS E	1.0	7.3	Full	500	0.0	0.0
Approach	87	3.0	87	3.0		0.315		22.9	LOS C	1.0	7.3				
North: Bussell Hwy															
Lane 1	17	3.0	17	3.0	1818	0.009	100	5.6	LOS A	0.0	0.0	Short	120	0.0	NA
Lane 2	735	12.4	735	12.4	1704	0.431	100	0.2	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	752	12.2	752	12.2		0.431		0.3	NA	0.0	0.0				
All Vehicles	1404	12.5	1404	12.5		0.431		2.4	NA	1.0	7.3				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	525	-	525	15.3	1650	0.318	100	NA	NA
Lane 2	-	40	40	3.0	545	0.073	100	0.0	1
Approach	525	40	565	14.4		0.318			

East: Roy Earl

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	51	-	51	3.0	512	0.099	100	0.0	2
Lane 2	-	37	37	3.0	117	0.315	100	NA	NA
Approach	51	37	87	3.0		0.315			

North: Bussell Hwy									
Mov. From N To Exit:	L2 E	T1 S	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	17	-	17	3.0	1818	0.009	100	0.0	2
Lane 2	-	735	735	12.4	1704	0.431	100	NA	NA
Approach	17	735	752	12.2		0.431			
	Total	%HV	Deg.Satn (v/c)						
All Vehicles	1404	12.5		0.431					

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate sec	Capacity veh/h	Deg. Satn veh/h	Min. Delay v/c	Merge Delay sec	sec
There are no Exit Short Lanes for Merge Analysis at this Site.												

Variable Demand Analysis

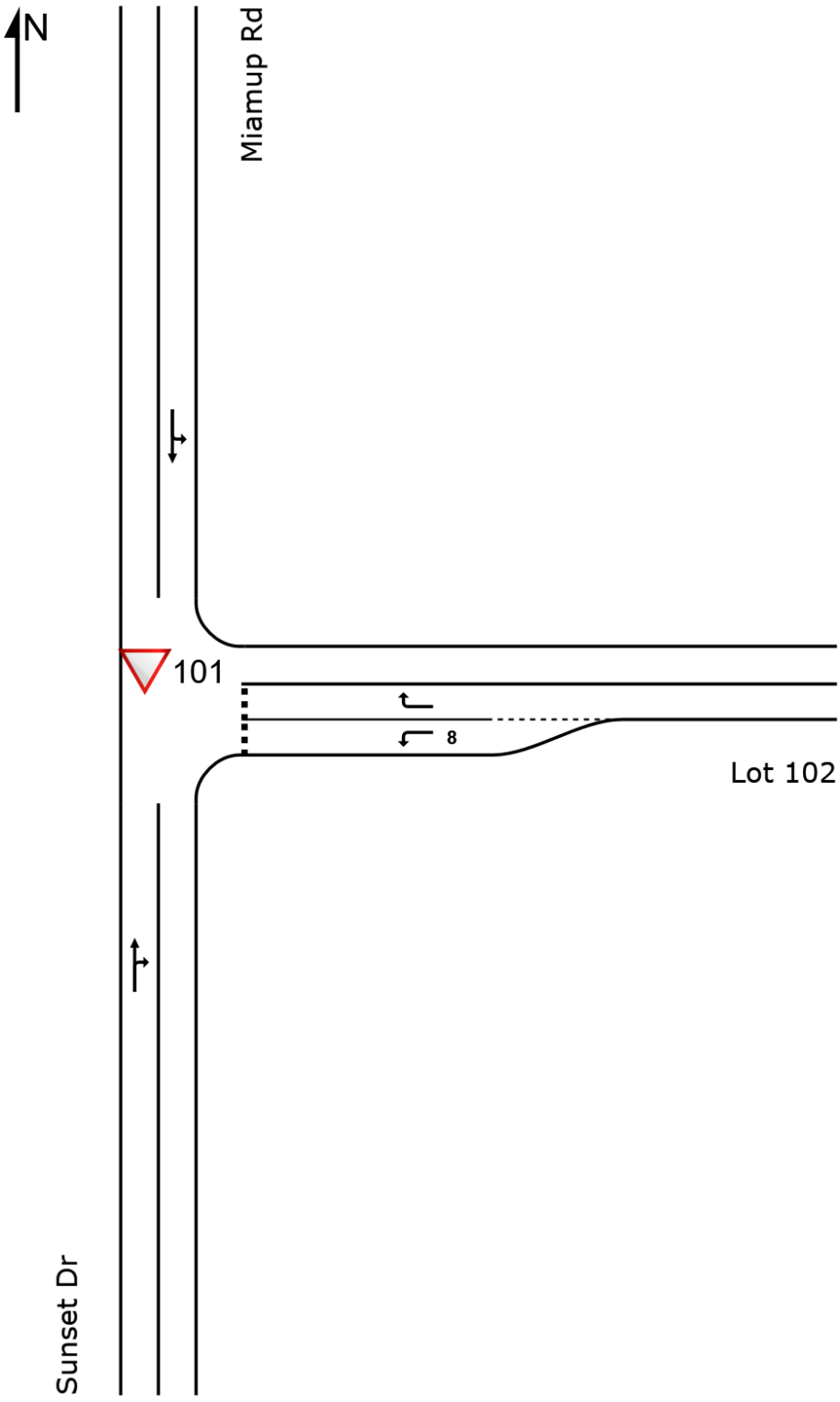
	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
East: Roy Earl				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

SITE LAYOUT

Site: 101 [Sunset Dr Access 2036 AM - with Dev (Site Folder: Sceanrio 1b)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.

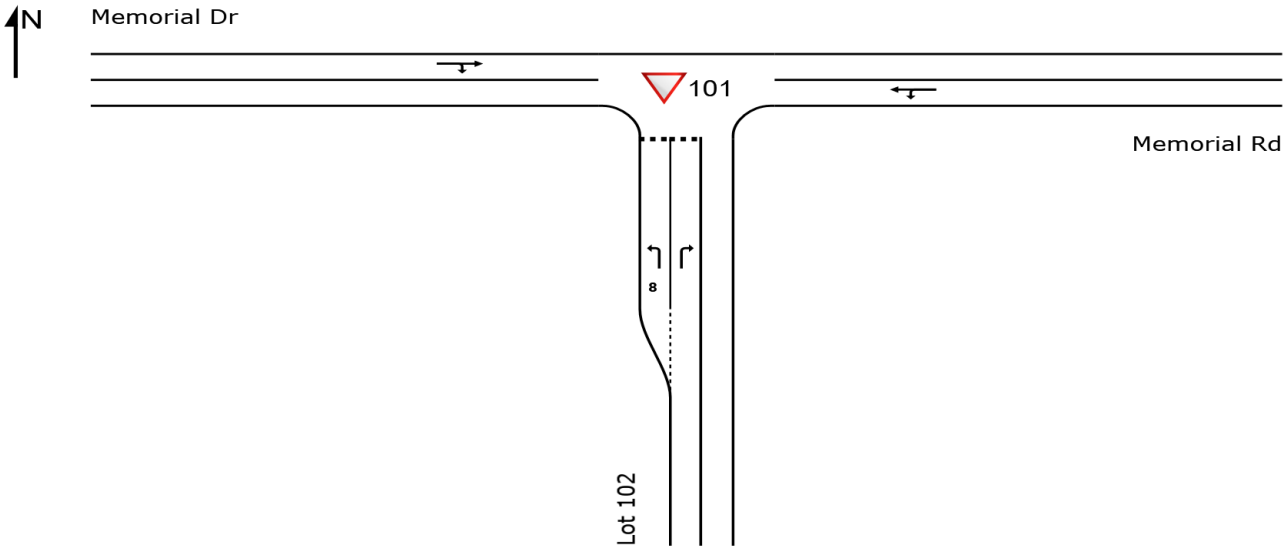


SITE LAYOUT

Site: 101 [Memorial Dr Access 2036 AM - with Dev (Site Folder: Sceanrio 1b)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



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Project: C:\PJA\Phil Jones Associates\SharedData - 07172 Lot 102 Bussell Highway, Cowaramup\4. Technical\4.3 Analysis\4.3.1 Transport \07172_M_01_A_Lot 102 Bussell Hwy.sip9

LANE SUMMARY

Site: 101 [Sunset Dr Access 2036 AM - with Dev (Site Folder: Sceanrio 1b)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Sunset Dr															
Lane 1	206	3.6	206	3.6	1875	0.110	100	1.2	LOS A	0.0	0.2	Full	500	0.0	0.0
Approach	206	3.6	206	3.6		0.110		1.2	NA	0.0	0.2				
East: Lot 102															
Lane 1	9	3.0	9	3.0	1507	0.006	100	4.8	LOS A	0.0	0.2	Short	8	0.0	NA
Lane 2	38	3.0	38	3.0	984	0.039	100	5.7	LOS A	0.1	0.9	Full	500	0.0	0.0
Approach	47	3.0	47	3.0		0.039		5.5	LOS A	0.1	0.9				
North: Miamup Rd															
Lane 1	97	3.0	97	3.0	1900	0.051	100	0.7	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	97	3.0	97	3.0		0.051		0.7	NA	0.0	0.0				
All Vehicles	351	3.3	351	3.3		0.110		1.7	NA	0.1	0.9				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Sunset Dr

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	203	3	206	3.6	1875	0.110	100	NA	NA
Approach	203	3	206	3.6		0.110			

East: Lot 102

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	9	-	9	3.0	1507	0.006	100	0.0	2
Lane 2	-	38	38	3.0	984	0.039	100	NA	NA
Approach	9	38	47	3.0		0.039			

North: Miamup Rd

Mov. From N	L2	T1	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	13	84	97	3.0	1900	0.051	100	NA	NA
Approach	13	84	97	3.0		0.051			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	351	3.3	0.110

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Sunset Dr				
Lane 1	0.0	0.0	0.0	0.0
East: Lot 102				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Miamup Rd				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Sunset Dr Access 2036 PM - with Dev (Site Folder: Sceanrio 1b)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Sunset Dr															
Lane 1	165	3.6	165	3.6	1852	0.089	100	1.4	LOS A	0.1	0.4	Full	500	0.0	0.0
Approach	165	3.6	165	3.6		0.089		1.4	NA	0.1	0.4				
East: Lot 102															
Lane 1	4	3.0	4	3.0	1355	0.003	100	5.2	LOS A	0.0	0.1	Short	8	0.0	NA
Lane 2	19	3.0	19	3.0	906	0.021	100	6.1	LOS A	0.1	0.5	Full	500	0.0	0.0
Approach	23	3.0	23	3.0		0.021		5.9	LOS A	0.1	0.5				
North: Miamup Rd															
Lane 1	239	3.0	239	3.0	1900	0.126	100	0.7	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	239	3.0	239	3.0		0.126		0.7	NA	0.0	0.0				
All Vehicles	427	3.2	427	3.2		0.126		1.3	NA	0.1	0.5				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Sunset Dr

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	158	7	165	3.6	1852	0.089	100	NA	NA
Approach	158	7	165	3.6		0.089			

East: Lot 102

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	4	-	4	3.0	1355	0.003	100	0.0	2
Lane 2	-	19	19	3.0	906	0.021	100	NA	NA
Approach	4	19	23	3.0		0.021			

North: Miamup Rd

Mov. From N	L2	T1	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	31	208	239	3.0	1900	0.126	100	NA	NA
Approach	31	208	239	3.0		0.126			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	427	3.2	0.126

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Sunset Dr				
Lane 1	0.0	0.0	0.0	0.0
East: Lot 102				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Miamup Rd				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr/Sunset Dr 2036 AM - with Dev (Site Folder: Sceanrio 1b)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Sunset Dr															
Lane 1	238	3.0	238	3.0	1565	0.152	100	6.1	LOS A	0.7	5.7	Full	500	0.0	0.0
Approach	238	3.0	238	3.0		0.152		6.1	NA	0.7	5.7				
East: Memorial Dr															
Lane 1	97	3.0	97	3.0	1611	0.060	100	4.6	LOS A	0.2	1.9	Short	8	0.0	NA
Lane 2	89	3.0	89	3.0	970	0.092	100	5.9	LOS A	0.3	2.3	Full	500	0.0	0.0
Approach	186	3.0	186	3.0		0.092		5.2	LOS A	0.3	2.3				
North: Miamup Rd															
Lane 1	148	3.0	148	3.0	1818	0.082	100	5.6	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	148	3.0	148	3.0		0.082		5.6	NA	0.0	0.0				
All Vehicles	573	3.0	573	3.0		0.152		5.7	NA	0.7	5.7				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Sunset Dr

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	1	237	238	3.0	1565	0.152	100	NA	NA
Approach	1	237	238	3.0		0.152			

East: Memorial Dr

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	97	-	97	3.0	1611	0.060	100	0.0	2
Lane 2	-	89	89	3.0	970	0.092	100	NA	NA
Approach	97	89	186	3.0		0.092			

North: Miamup Rd

Mov. From N	L2	T1	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	147	1	148	3.0	1818	0.082	100	NA	NA
Approach	147	1	148	3.0		0.082			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	573	3.0	0.152

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Sunset Dr				
Lane 1	0.0	0.0	0.0	0.0
East: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Miamup Rd				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr/Sunset Dr 2036 PM - with Dev (Site Folder: Sceanrio 1b)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Sunset Dr															
Lane 1	177	3.0	177	3.0	1599	0.111	100	5.9	LOS A	0.5	4.0	Full	500	0.0	0.0
Approach	177	3.0	177	3.0		0.111		5.9	NA	0.5	4.0				
East: Memorial Dr															
Lane 1	233	3.0	233	3.0	1604	0.145	100	4.6	LOS A	0.7	5.0	Short	8	0.0	NA
Lane 2	115	3.0	115	3.0	1036	0.111	100	5.6	LOS A	0.4	2.8	Full	500	0.0	0.0
Approach	347	3.0	347	3.0		0.145		4.9	LOS A	0.7	5.0				
North: Miamup Rd															
Lane 1	124	3.0	124	3.0	1822	0.068	100	5.3	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	124	3.0	124	3.0		0.068		5.3	NA	0.0	0.0				
All Vehicles	648	3.0	648	3.0		0.145		5.3	NA	0.7	5.0				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Sunset Dr

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	1	176	177	3.0	1599	0.111	100	NA	NA
Approach	1	176	177	3.0		0.111			

East: Memorial Dr

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	233	-	233	3.0	1604	0.145	100	0.0	2
Lane 2	-	115	115	3.0	1036	0.111	100	NA	NA
Approach	233	115	347	3.0		0.145			

North: Miamup Rd

Mov. From N	L2	T1	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	118	6	124	3.0	1822	0.068	100	NA	NA
Approach	118	6	124	3.0		0.068			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	648	3.0	0.145

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Sunset Dr				
Lane 1	0.0	0.0	0.0	0.0
East: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Miamup Rd				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr Access 2036 AM - with Dev (Site Folder: Sceanrio 1b)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Lot 102															
Lane 1	21	3.0	21	3.0	1388	0.015	100	5.1	LOS A	0.1	0.4	Short	8	0.0	NA
Lane 2	86	3.0	86	3.0	749	0.115	100	7.3	LOS A	0.4	2.8	Full	500	0.0	0.0
Approach	107	3.0	107	3.0		0.115		6.9	LOS A	0.4	2.8				
East: Memorial Rd															
Lane 1	211	3.0	211	3.0	1899	0.111	100	0.7	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	211	3.0	211	3.0		0.111		0.7	NA	0.0	0.0				
West: Memorial Dr															
Lane 1	376	3.6	376	3.6	1869	0.201	100	0.1	LOS A	0.1	0.5	Full	500	0.0	0.0
Approach	376	3.6	376	3.6		0.201		0.1	NA	0.1	0.5				
All Vehicles	694	3.3	694	3.3		0.201		1.3	NA	0.4	2.8				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Lot 102

Mov. From S To Exit:	L2 W	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	21	-	21	3.0	1388	0.015	100	0.0	2
Lane 2	-	86	86	3.0	749	0.115	100	NA	NA
Approach	21	86	107	3.0		0.115			

East: Memorial Rd

Mov. From E To Exit:	L2 S	T1 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	29	181	211	3.0	1899	0.111	100	NA	NA
Approach	29	181	211	3.0		0.111			

West: Memorial Dr

Mov. From W	T1	R2	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	368	7	376	3.6	1869	0.201	100	NA	NA
Approach	368	7	376	3.6		0.201			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	694	3.3	0.201

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Lot 102				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
East: Memorial Rd				
Lane 1	0.0	0.0	0.0	0.0
West: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr Access 2036 PM - with Dev (Site Folder: Sceanrio 1b)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Lot 102															
Lane 1	11	3.0	11	3.0	1172	0.009	100	5.8	LOS A	0.0	0.3	Short	8	0.0	NA
Lane 2	43	3.0	43	3.0	703	0.061	100	7.6	LOS A	0.2	1.5	Full	500	0.0	0.0
Approach	54	3.0	54	3.0		0.061		7.2	LOS A	0.2	1.5				
East: Memorial Rd															
Lane 1	432	3.0	432	3.0	1896	0.228	100	0.8	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	432	3.0	432	3.0		0.228		0.8	NA	0.0	0.0				
West: Memorial Dr															
Lane 1	239	3.6	239	3.6	1796	0.133	100	0.7	LOS A	0.2	1.3	Full	500	0.0	0.0
Approach	239	3.6	239	3.6		0.133		0.7	NA	0.2	1.3				
All Vehicles	724	3.2	724	3.2		0.228		1.3	NA	0.2	1.5				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Lot 102

Mov. From S To Exit:	L2 W	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	11	-	11	3.0	1172	0.009	100	0.0	2
Lane 2	-	43	43	3.0	703	0.061	100	NA	NA
Approach	11	43	54	3.0		0.061			

East: Memorial Rd

Mov. From E To Exit:	L2 S	T1 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	72	360	432	3.0	1896	0.228	100	NA	NA
Approach	72	360	432	3.0		0.228			

West: Memorial Dr

Mov. From W	T1	R2	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	221	18	239	3.6	1796	0.133	100	NA	NA
Approach	221	18	239	3.6		0.133			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	724	3.2	0.228

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Lot 102				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
East: Memorial Rd				
Lane 1	0.0	0.0	0.0	0.0
West: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr/Bussell 2036 AM - with Dev (Site Folder: Sceanrio 1b)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1	645	11.2	645	11.2	1718	0.376	100	1.8	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	645	11.2	645	11.2		0.376		1.8	NA	0.0	0.0				
North: Bussell Hwy															
Lane 1	504	15.3	504	15.3	1650	0.306	100	0.1	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	132	3.0	132	3.0	866	0.152	100	6.8	LOS A	0.6	4.7	Short	50	0.0	NA
Approach	636	12.8	636	12.8		0.306		1.5	NA	0.6	4.7				
West: Memorial Dr															
Lane 1	298	3.0	298	3.0	892	0.334	100	8.1	LOS A	1.6	12.2	Short	25	0.0	NA
Lane 2	157	3.0	157	3.0	201	0.782	100	44.3	LOS E	4.1	31.4	Full	500	0.0	0.0
Approach	455	3.0	455	3.0		0.782		20.6	LOS C	4.1	31.4				
All Vehicles	1736	9.6	1736	9.6		0.782		6.6	NA	4.1	31.4				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	L2 W	T1 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	79	566	645	11.2	1718	0.376	100	NA	NA
Approach	79	566	645	11.2		0.376			

North: Bussell Hwy

Mov. From N To Exit:	T1 S	R2 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	504	-	504	15.3	1650	0.306	100	NA	NA
Lane 2	-	132	132	3.0	866	0.152	100	0.0	1
Approach	504	132	636	12.8		0.306			

West: Memorial Dr

Mov.	L2	R2	Total	%HV		Deg.	Lane	Prob.	Ov.

From W To Exit:	N	S			Cap. veh/h	Satn v/c	Util. %	SL Ov. %	Lane No.
Lane 1	298	-	298	3.0	892	0.334	100	0.0	2
Lane 2	-	157	157	3.0	201	0.782	100	NA	NA
Approach	298	157	455	3.0		0.782			
	Total	%HV	Deg.Satn (v/c)						
All Vehicles	1736	9.6	0.782						

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate sec	Capacity veh/h	Deg. Satn veh/h	Min. Delay v/c	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
West: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr/Bussell 2036 PM - with Dev (Site Folder: Sceanrio 1b)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1	603	10.2	603	10.2	1730	0.349	100	2.2	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	603	10.2	603	10.2		0.349		2.2	NA	0.0	0.0				
North: Bussell Hwy															
Lane 1	691	15.3	691	15.3	1650	0.418	100	0.2	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	285	3.0	285	3.0	926	0.308	100	7.1	LOS A	1.5	11.6	Short	50	0.0	NA
Approach	976	11.7	976	11.7		0.418		2.2	NA	1.5	11.6				
West: Memorial Dr															
Lane 1	141	3.0	141	3.0	1021	0.138	100	6.6	LOS A	0.5	4.1	Short	25	0.0	NA
Lane 2	123	3.0	123	3.0	126	0.974	100	111.4	LOS F	7.0	53.3	Full	500	0.0	0.0
Approach	264	3.0	264	3.0		0.974		55.5	LOS F	7.0	53.3				
All Vehicles	1843	10.0	1843	10.0		0.974		9.9	NA	7.0	53.3				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	L2 W	T1 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	143	460	603	10.2	1730	0.349	100	NA	NA
Approach	143	460	603	10.2		0.349			

North: Bussell Hwy

Mov. From N To Exit:	T1 S	R2 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	691	-	691	15.3	1650	0.418	100	NA	NA
Lane 2	-	285	285	3.0	926	0.308	100	0.0	1
Approach	691	285	976	11.7		0.418			

West: Memorial Dr

Mov.	L2	R2	Total	%HV		Deg.	Lane	Prob.	Ov.

From W To Exit:	N	S			Cap. veh/h	Satn v/c	Util. %	SL Ov. %	Lane No.
Lane 1	141	-	141	3.0	1021	0.138	100	0.0	2
Lane 2	-	123	123	3.0	126	0.974	100	NA	NA
Approach	141	123	264	3.0		0.974			
	Total	%HV	Deg.Satn (v/c)						
All Vehicles	1843	10.0		0.974					

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate sec	Capacity veh/h	Deg. Satn veh/h	Min. Delay v/c	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
West: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Roy Earl/Bussell 2036 AM - with Dev (Site Folder: Sceanrio 1b)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1	589	15.3	589	15.3	1650	0.357	100	1.3	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	14	3.0	14	3.0	660	0.021	100	9.4	LOS A	0.1	0.5	Short	110	0.0	NA
Approach	603	15.0	603	15.0		0.357		1.5	NA	0.1	0.5				
East: Roy Earl															
Lane 1	43	3.0	43	3.0	618	0.070	100	8.6	LOS A	0.2	1.7	Short	18	0.0	NA
Lane 2	46	3.0	46	3.0	145	0.319	100	33.8	LOS D	1.0	7.9	Full	500	0.0	0.0
Approach	89	3.0	89	3.0		0.319		21.6	LOS C	1.0	7.9				
North: Bussell Hwy															
Lane 1	2	3.0	2	3.0	1818	0.001	100	5.6	LOS A	0.0	0.0	Short	120	0.0	NA
Lane 2	626	12.4	626	12.4	1704	0.367	100	0.1	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	628	12.4	628	12.4		0.367		0.2	NA	0.0	0.0				
All Vehicles	1321	12.9	1321	12.9		0.367		2.2	NA	1.0	7.9				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	589	-	589	15.3	1650	0.357	100	NA	NA
Lane 2	-	14	14	3.0	660	0.021	100	0.0	1
Approach	589	14	603	15.0		0.357			

East: Roy Earl

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	43	-	43	3.0	618	0.070	100	0.0	2
Lane 2	-	46	46	3.0	145	0.319	100	NA	NA
Approach	43	46	89	3.0		0.319			

North: Bussell Hwy									
Mov. From N To Exit:	L2 E	T1 S	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	2	-	2	3.0	1818	0.001	100	0.0	2
Lane 2	-	626	626	12.4	1704	0.367	100	NA	NA
Approach	2	626	628	12.4		0.367			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	1321	12.9	0.367

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h sec	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
East: Roy Earl				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

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LANE SUMMARY

Site: 101 [Roy Earl/Bussell 2036 PM - with Dev (Site Folder: Sceanrio 1b)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1	567	15.3	567	15.3	1650	0.344	100	1.3	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	40	3.0	40	3.0	472	0.085	100	12.1	LOS B	0.3	2.2	Short	110	0.0	NA
Approach	607	14.5	607	14.5		0.344		2.0	NA	0.3	2.2				
East: Roy Earl															
Lane 1	51	3.0	51	3.0	440	0.115	100	11.4	LOS B	0.4	2.7	Short	18	0.0	NA
Lane 2	37	3.0	37	3.0	86	0.426	100	57.5	LOS F	1.3	9.7	Full	500	0.0	0.0
Approach	87	3.0	87	3.0		0.426		30.8	LOS D	1.3	9.7				
North: Bussell Hwy															
Lane 1	17	3.0	17	3.0	1818	0.009	100	5.6	LOS A	0.0	0.0	Short	120	0.0	NA
Lane 2	813	12.4	813	12.4	1704	0.477	100	0.2	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	829	12.2	829	12.2		0.477		0.3	NA	0.0	0.0				
All Vehicles	1524	12.6	1524	12.6		0.477		2.8	NA	1.3	9.7				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	567	-	567	15.3	1650	0.344	100	NA	NA
Lane 2	-	40	40	3.0	472	0.085	100	0.0	1
Approach	567	40	607	14.5		0.344			

East: Roy Earl

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	51	-	51	3.0	440	0.115	100	0.0	2
Lane 2	-	37	37	3.0	86	0.426	100	NA	NA
Approach	51	37	87	3.0		0.426			

North: Bussell Hwy									
Mov. From N To Exit:	L2 E	T1 S	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	17	-	17	3.0	1818	0.009	100	0.0	2
Lane 2	-	813	813	12.4	1704	0.477	100	NA	NA
Approach	17	813	829	12.2		0.477			
	Total	%HV	Deg.Satn (v/c)						
All Vehicles	1524	12.6		0.477					

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate sec	Capacity veh/h	Deg. Satn veh/h	Min. Delay v/c	Merge Delay sec	sec
There are no Exit Short Lanes for Merge Analysis at this Site.												

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
East: Roy Earl				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr/Bussell 2032 PM - with Dev - growth to fail (Site Folder: Scenario 1d)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)
Design Life Analysis: Constant Number of Years = 2

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1	543	10.4	543	10.4	1727	0.315	100	2.1	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	543	10.4	543	10.4		0.315		2.1	NA	0.0	0.0				
North: Bussell Hwy															
Lane 1	633	15.3	633	15.3	1650	0.384	100	0.2	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	245	2.8	245	2.8	1005	0.244	100	6.3	LOS A	1.1	8.2	Short	50	0.0	NA
Approach	878	11.8	878	11.8		0.384		1.9	NA	1.1	8.2				
West: Memorial Dr															
Lane 1	221	2.9	221	2.9	301	0.734	100	29.1	LOS D	4.7	35.5	Full	500	0.0	0.0
Approach	221	2.9	221	2.9		0.734		29.1	LOS D	4.7	35.5				
All Vehicles	1643	10.1	1643	10.1		0.734		5.6	NA	4.7	35.5				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	L2 W	T1 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	122	421	543	10.4	1727	0.315	100	NA	NA
Approach	122	421	543	10.4		0.315			

North: Bussell Hwy

Mov. From N To Exit:	T1 S	R2 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	633	-	633	15.3	1650	0.384	100	NA	NA
Lane 2	-	245	245	2.8	1005	0.244	100	0.0	1
Approach	633	245	878	11.8		0.384			

West: Memorial Dr

Mov.	L2	R2	Total	%HV		Deg.	Lane	Prob.	Ov.

From W To Exit:	N	S			Cap. veh/h	Satn v/c	Util. %	SL Ov. %	Lane No.
Lane 1	117	104	221	2.9	301	0.734	100	NA	NA
Approach	117	104	221	2.9		0.734			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	1643	10.1	0.734

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate sec	Capacity veh/h	Deg. Satn veh/h	Min. Delay v/c	Merge Delay sec	sec
There are no Exit Short Lanes for Merge Analysis at this Site.												

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
West: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0

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MOVEMENT SUMMARY

Site: 101 [Memorial Dr/Bussell 2032 PM - with Dev - growth to fail (Site Folder: Scenario 1d)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)
Design Life Analysis: Constant Number of Years = 2

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Bussell Hwy															
1	L2	All MCs	122	3.6	122	3.6	0.315	4.7	LOS A	0.0	0.0	0.00	0.29	0.00	47.2
2	T1	All MCs	421	12.4	421	12.4	0.315	1.3	LOS A	0.0	0.0	0.00	0.29	0.00	48.3
Approach			543	10.4	543	10.4	0.315	2.1	NA	0.0	0.0	0.00	0.29	0.00	48.0
North: Bussell Hwy															
8	T1	All MCs	633	15.3	633	15.3	0.384	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	39.8
9	R2	All MCs	245	2.8	245	2.8	0.244	6.3	LOS A	1.1	8.2	0.58	0.72	0.58	40.2
Approach			878	11.8	878	11.8	0.384	1.9	NA	1.1	8.2	0.16	0.20	0.16	39.9
West: Memorial Dr															
10	L2	All MCs	117	2.8	117	2.8	0.734	16.4	LOS C	4.7	35.5	0.90	1.37	2.02	32.5
12	R2	All MCs	104	2.9	104	2.9	0.734	43.2	LOS E[11]	4.7	35.5	0.90	1.37	2.02	35.0
Approach			221	2.9	221	2.9	0.734	29.1	LOS D	4.7	35.5	0.90	1.37	2.02	33.7
All Vehicles			1643	10.1	1643	10.1	0.734	5.6	NA	4.7	35.5	0.21	0.39	0.36	41.2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

11 Level of Service is worse than the Level of Service Target specified in the Parameter Settings dialog.

LANE SUMMARY

Site: 101 [Memorial Dr/Bussell 2033 PM - with Dev - growth to fail (Site Folder: Scenario 1d)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)
Design Life Analysis: Constant Number of Years = 3

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1	561	10.4	561	10.4	1727	0.325	100	2.1	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	561	10.4	561	10.4		0.325		2.1	NA	0.0	0.0				
North: Bussell Hwy															
Lane 1	654	15.3	654	15.3	1650	0.396	100	0.2	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	253	2.7	253	2.7	982	0.257	100	6.4	LOS A	1.2	8.8	Short	50	0.0	NA
Approach	906	11.8	906	11.8		0.396		1.9	NA	1.2	8.8				
West: Memorial Dr															
Lane 1	120	2.8	120	2.8	1054	0.114	100	6.4	LOS A	0.4	3.3	Short	6	0.0	NA
Lane 2	106	2.8	106	2.8	154	0.692	100	47.2	LOS E[11]	2.9	21.7	Full	500	0.0	0.0
Approach	226	2.8	226	2.8		0.692		25.6	LOS D	2.9	21.7				
All Vehicles	1694	10.1	1694	10.1		0.692		5.2	NA	2.9	21.7				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

11 Level of Service is worse than the Level of Service Target specified in the Parameter Settings dialog.

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	L2 W	T1 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	126	435	561	10.4	1727	0.325	100	NA	NA
Approach	126	435	561	10.4		0.325			

North: Bussell Hwy

Mov. From N To Exit:	T1 S	R2 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	654	-	654	15.3	1650	0.396	100	NA	NA
Lane 2	-	253	253	2.7	982	0.257	100	0.0	1
Approach	654	253	906	11.8		0.396			

West: Memorial Dr									
Mov. From W To Exit:	L2 N	R2 S	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	120	-	120	2.8	1054	0.114	100	0.0	2
Lane 2	-	106	106	2.8	154	0.692	100	NA	NA
Approach	120	106	226	2.8		0.692			
	Total	%HV	Deg.Satn (v/c)						
All Vehicles	1694	10.1		0.692					

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate sec	Capacity veh/h	Deg. Satn veh/h	Min. Delay v/c	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
West: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

MOVEMENT SUMMARY

Site: 101 [Memorial Dr/Bussell 2033 PM - with Dev - growth to fail (Site Folder: Scenario 1d)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)
Design Life Analysis: Constant Number of Years = 3

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Bussell Hwy															
1	L2	All MCs	126	3.4	126	3.4	0.325	4.7	LOS A	0.0	0.0	0.00	0.29	0.00	47.2
2	T1	All MCs	435	12.4	435	12.4	0.325	1.4	LOS A	0.0	0.0	0.00	0.29	0.00	48.3
Approach			561	10.4	561	10.4	0.325	2.1	NA	0.0	0.0	0.00	0.29	0.00	48.0
North: Bussell Hwy															
8	T1	All MCs	654	15.3	654	15.3	0.396	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	39.8
9	R2	All MCs	253	2.7	253	2.7	0.257	6.4	LOS A	1.2	8.8	0.59	0.73	0.61	40.2
Approach			906	11.8	906	11.8	0.396	1.9	NA	1.2	8.8	0.17	0.20	0.17	39.9
West: Memorial Dr															
10	L2	All MCs	120	2.8	120	2.8	0.114	6.4	LOS A	0.4	3.3	0.47	0.66	0.47	40.7
12	R2	All MCs	106	2.8	106	2.8	0.692	47.2	LOS E[11]	2.9	21.7	0.96	1.17	1.62	29.8
Approach			226	2.8	226	2.8	0.692	25.6	LOS D	2.9	21.7	0.70	0.90	1.01	34.8
All Vehicles			1694	10.1	1694	10.1	0.692	5.2	NA	2.9	21.7	0.18	0.33	0.23	41.4

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

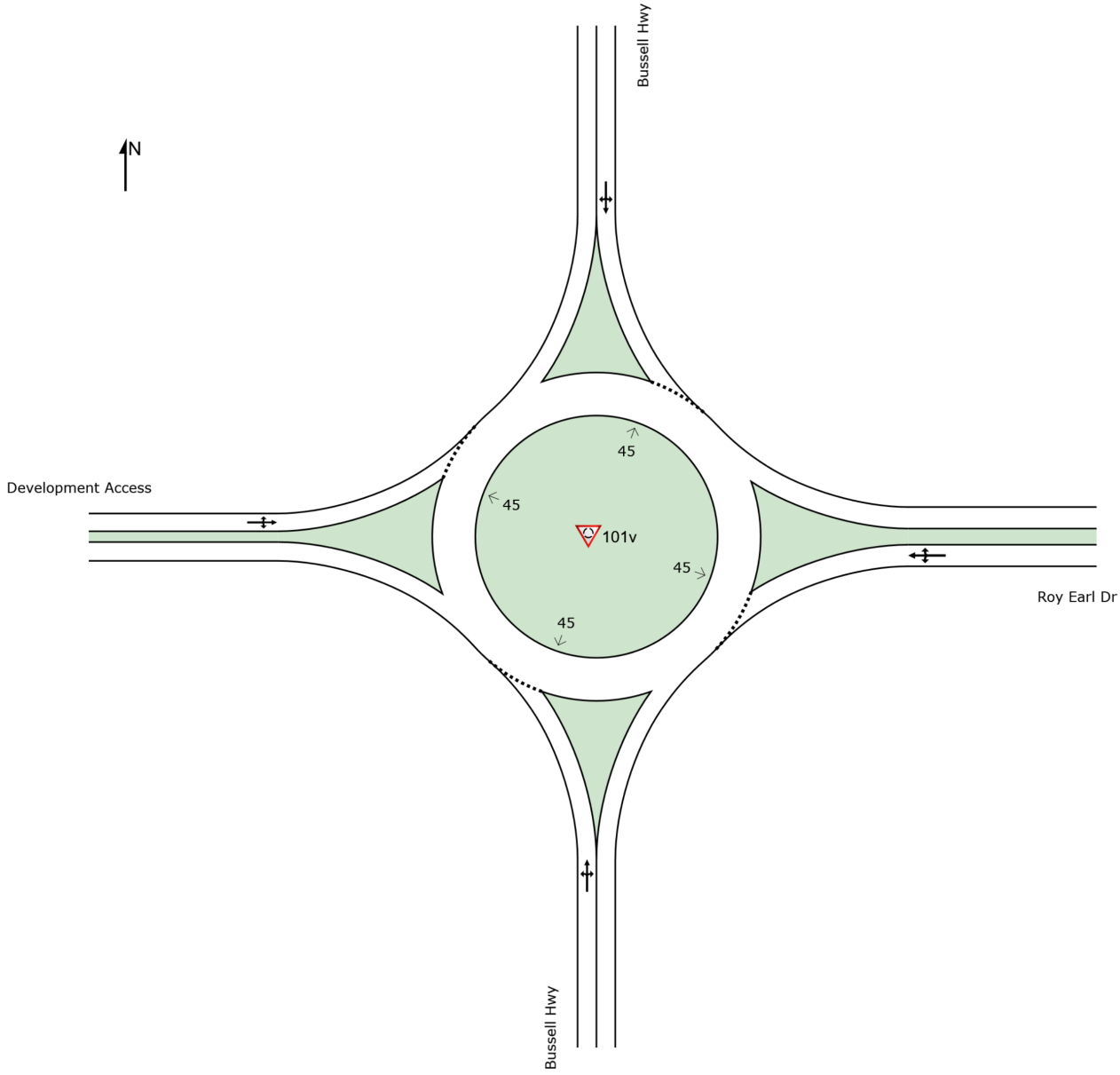
11 Level of Service is worse than the Level of Service Target specified in the Parameter Settings dialog.

SITE LAYOUT

Site: 101v [Roy Earl Dr/Bussell Future AM - with Dev (Site Folder: Scenario 2)]

New Site
Site Category: (None)
Roundabout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



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LANE SUMMARY

Site: 101 [Sunset Dr Access 2036 AM - with Dev (Site Folder: Scenario 2)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Sunset Dr															
Lane 1	205	3.2	205	3.2	1661	0.124	100	4.7	LOS A	0.6	4.6	Full	500	0.0	0.0
Approach	205	3.2	205	3.2		0.124		4.7	NA	0.6	4.6				
East: Lot 102															
Lane 1	76	3.0	76	3.0	1589	0.048	100	4.6	LOS A	0.2	1.5	Short	8	0.0	NA
Lane 2	63	3.0	63	3.0	1004	0.063	100	5.7	LOS A	0.2	1.5	Full	500	0.0	0.0
Approach	139	3.0	139	3.0		0.063		5.1	LOS A	0.2	1.5				
North: Miamup Rd															
Lane 1	122	3.0	122	3.0	1832	0.067	100	4.7	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	122	3.0	122	3.0		0.067		4.7	NA	0.0	0.0				
All Vehicles	466	3.1	466	3.1		0.124		4.8	NA	0.6	4.6				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Sunset Dr

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	58	147	205	3.2	1661	0.124	100	NA	NA
Approach	58	147	205	3.2		0.124			

East: Lot 102

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	76	-	76	3.0	1589	0.048	100	0.0	2
Lane 2	-	63	63	3.0	1004	0.063	100	NA	NA
Approach	76	63	139	3.0		0.063			

North: Miamup Rd

Mov. From N	L2	T1	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	103	19	122	3.0	1832	0.067	100	NA	NA
Approach	103	19	122	3.0		0.067			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	466	3.1	0.124

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Sunset Dr				
Lane 1	0.0	0.0	0.0	0.0
East: Lot 102				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Miamup Rd				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Sunset Dr Access 2036 PM - with Dev (Site Folder: Scenario 2)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Sunset Dr															
Lane 1	166	3.2	166	3.2	1637	0.102	100	4.9	LOS A	0.5	3.7	Full	500	0.0	0.0
Approach	166	3.2	166	3.2		0.102		4.9	NA	0.5	3.7				
East: Lot 102															
Lane 1	148	3.0	148	3.0	1541	0.096	100	4.8	LOS A	0.4	3.1	Short	8	0.0	NA
Lane 2	81	3.0	81	3.0	1016	0.080	100	5.6	LOS A	0.3	2.0	Full	500	0.0	0.0
Approach	229	3.0	229	3.0		0.096		5.1	LOS A	0.4	3.1				
North: Miamup Rd															
Lane 1	139	3.0	139	3.0	1856	0.075	100	3.3	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	139	3.0	139	3.0		0.075		3.3	NA	0.0	0.0				
All Vehicles	535	3.0	535	3.0		0.102		4.6	NA	0.5	3.7				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Sunset Dr

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	43	123	166	3.2	1637	0.102	100	NA	NA
Approach	43	123	166	3.2		0.102			

East: Lot 102

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	148	-	148	3.0	1541	0.096	100	0.0	2
Lane 2	-	81	81	3.0	1016	0.080	100	NA	NA
Approach	148	81	229	3.0		0.096			

North: Miamup Rd

Mov. From N	L2	T1	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	82	57	139	3.0	1856	0.075	100	NA	NA
Approach	82	57	139	3.0		0.075			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	535	3.0	0.102

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Opposing Flow Rate pcu/h	Critical Gap sec	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.												

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Sunset Dr				
Lane 1	0.0	0.0	0.0	0.0
East: Lot 102				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Miamup Rd				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr/Sunset Dr 2036 AM - with Dev (Site Folder: Scenario 2)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Sunset Dr															
Lane 1	121	3.3	121	3.3	1701	0.071	100	3.1	LOS A	0.3	2.3	Full	500	0.0	0.0
Approach	121	3.3	121	3.3		0.071		3.1	NA	0.3	2.3				
East: Memorial Dr															
Lane 1	19	3.0	19	3.0	1484	0.013	100	4.9	LOS A	0.0	0.4	Short	8	0.0	NA
Lane 2	27	3.0	27	3.0	1034	0.026	100	5.5	LOS A	0.1	0.6	Full	500	0.0	0.0
Approach	46	3.0	46	3.0		0.026		5.2	LOS A	0.1	0.6				
North: Miamup Rd															
Lane 1	148	3.0	148	3.0	1883	0.079	100	1.7	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	148	3.0	148	3.0		0.079		1.7	NA	0.0	0.0				
All Vehicles	316	3.1	316	3.1		0.079		2.8	NA	0.3	2.3				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Sunset Dr

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	63	58	121	3.3	1701	0.071	100	NA	NA
Approach	63	58	121	3.3		0.071			

East: Memorial Dr

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	19	-	19	3.0	1484	0.013	100	0.0	2
Lane 2	-	27	27	3.0	1034	0.026	100	NA	NA
Approach	19	27	46	3.0		0.026			

North: Miamup Rd

Mov. From N	L2	T1	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	45	103	148	3.0	1883	0.079	100	NA	NA
Approach	45	103	148	3.0		0.079			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	316	3.1	0.079

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Sunset Dr				
Lane 1	0.0	0.0	0.0	0.0
East: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Miamup Rd				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr/Sunset Dr 2036 PM - with Dev (Site Folder: Scenario 2)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Sunset Dr															
Lane 1	123	3.4	123	3.4	1764	0.070	100	2.2	LOS A	0.2	1.8	Full	500	0.0	0.0
Approach	123	3.4	123	3.4		0.070		2.2	NA	0.2	1.8				
East: Memorial Dr															
Lane 1	57	3.0	57	3.0	1510	0.038	100	4.8	LOS A	0.2	1.1	Short	8	0.0	NA
Lane 2	34	3.0	34	3.0	1054	0.032	100	5.4	LOS A	0.1	0.8	Full	500	0.0	0.0
Approach	91	3.0	91	3.0		0.038		5.0	LOS A	0.2	1.1				
North: Miamup Rd															
Lane 1	118	3.0	118	3.0	1883	0.063	100	1.7	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	118	3.0	118	3.0		0.063		1.7	NA	0.0	0.0				
All Vehicles	332	3.1	332	3.1		0.070		2.8	NA	0.2	1.8				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Sunset Dr

Mov. From S To Exit:	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	81	42	123	3.4	1764	0.070	100	NA	NA
Approach	81	42	123	3.4		0.070			

East: Memorial Dr

Mov. From E To Exit:	L2 S	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	57	-	57	3.0	1510	0.038	100	0.0	2
Lane 2	-	34	34	3.0	1054	0.032	100	NA	NA
Approach	57	34	91	3.0		0.038			

North: Miamup Rd

Mov. From N	L2	T1	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	36	82	118	3.0	1883	0.063	100	NA	NA
Approach	36	82	118	3.0		0.063			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	332	3.1	0.070

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Sunset Dr				
Lane 1	0.0	0.0	0.0	0.0
East: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
North: Miamup Rd				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr Access 2036 AM - with Dev (Site Folder: Scenario 2)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Lot 102															
Lane 1	1	3.0	1	3.0	1554	0.001	100	4.7	LOS A	0.0	0.0	Short	8	0.0	NA
Lane 2	16	3.0	16	3.0	1119	0.014	100	5.1	LOS A	0.0	0.3	Full	500	0.0	0.0
Approach	17	3.0	17	3.0		0.014		5.1	LOS A	0.0	0.3				
East: Memorial Rd															
Lane 1	52	3.0	52	3.0	1903	0.027	100	0.5	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	52	3.0	52	3.0		0.027		0.5	NA	0.0	0.0				
West: Memorial Dr															
Lane 1	104	3.0	104	3.0	1909	0.055	100	0.0	LOS A	0.0	0.1	Full	500	0.0	0.0
Approach	104	3.0	104	3.0		0.055		0.0	NA	0.0	0.1				
All Vehicles	173	3.0	173	3.0		0.055		0.7	NA	0.0	0.3				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Lot 102

Mov. From S To Exit:	L2 W	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	1	-	1	3.0	1554	0.001	100	0.0	2
Lane 2	-	16	16	3.0	1119	0.014	100	NA	NA
Approach	1	16	17	3.0		0.014			

East: Memorial Rd

Mov. From E To Exit:	L2 S	T1 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	5	46	52	3.0	1903	0.027	100	NA	NA
Approach	5	46	52	3.0		0.027			

West: Memorial Dr

Mov. From W	T1	R2	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	103	1	104	3.0	1909	0.055	100	NA	NA
Approach	103	1	104	3.0		0.055			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	173	3.0	0.055

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Lot 102				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
East: Memorial Rd				
Lane 1	0.0	0.0	0.0	0.0
West: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr Access 2036 PM - with Dev (Site Folder: Scenario 2)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Lot 102															
Lane 1	1	3.0	1	3.0	1500	0.001	100	4.8	LOS A	0.0	0.0	Short	8	0.0	NA
Lane 2	7	3.0	7	3.0	1099	0.007	100	5.2	LOS A	0.0	0.2	Full	500	0.0	0.0
Approach	8	3.0	8	3.0		0.007		5.1	LOS A	0.0	0.2				
East: Memorial Rd															
Lane 1	103	3.0	103	3.0	1901	0.054	100	0.6	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	103	3.0	103	3.0		0.054		0.6	NA	0.0	0.0				
West: Memorial Dr															
Lane 1	79	3.0	79	3.0	1907	0.041	100	0.1	LOS A	0.0	0.1	Full	500	0.0	0.0
Approach	79	3.0	79	3.0		0.041		0.1	NA	0.0	0.1				
All Vehicles	191	3.0	191	3.0		0.054		0.6	NA	0.0	0.2				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Lot 102

Mov. From S To Exit:	L2 W	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	1	-	1	3.0	1500	0.001	100	0.0	2
Lane 2	-	7	7	3.0	1099	0.007	100	NA	NA
Approach	1	7	8	3.0		0.007			

East: Memorial Rd

Mov. From E To Exit:	L2 S	T1 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	13	91	103	3.0	1901	0.054	100	NA	NA
Approach	13	91	103	3.0		0.054			

West: Memorial Dr

Mov. From W	T1	R2	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.

To Exit:	E	S							
Lane 1	78	1	79	3.0	1907	0.041	100	NA	NA
Approach	78	1	79	3.0		0.041			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	191	3.0	0.054

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Lot 102				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
East: Memorial Rd				
Lane 1	0.0	0.0	0.0	0.0
West: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr/Bussell 2036 AM - with Dev (Site Folder: Scenario 2)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1	753	12.2	753	12.2	1707	0.441	100	1.5	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	753	12.2	753	12.2		0.441		1.5	NA	0.0	0.0				
North: Bussell Hwy															
Lane 1	601	15.3	601	15.3	1650	0.364	100	0.2	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	36	3.0	36	3.0	727	0.049	100	7.5	LOS A	0.2	1.4	Short	50	0.0	NA
Approach	637	14.6	637	14.6		0.364		0.6	NA	0.2	1.4				
West: Memorial Dr															
Lane 1	77	3.0	77	3.0	698	0.110	100	8.6	LOS A	0.4	2.9	Short	6	0.0	NA
Lane 2	38	3.0	38	3.0	141	0.269	100	33.3	LOS D	0.8	6.3	Full	500	0.0	0.0
Approach	115	3.0	115	3.0		0.269		16.8	LOS C	0.8	6.3				
All Vehicles	1504	12.5	1504	12.5		0.441		2.3	NA	0.8	6.3				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	L2 W	T1 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	20	733	753	12.2	1707	0.441	100	NA	NA
Approach	20	733	753	12.2		0.441			

North: Bussell Hwy

Mov. From N To Exit:	T1 S	R2 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	601	-	601	15.3	1650	0.364	100	NA	NA
Lane 2	-	36	36	3.0	727	0.049	100	0.0	1
Approach	601	36	637	14.6		0.364			

West: Memorial Dr

Mov.	L2	R2	Total	%HV		Deg.	Lane	Prob.	Ov.

From W To Exit:	N	S			Cap. veh/h	Satn v/c	Util. %	SL Ov. %	Lane No.
Lane 1	77	-	77	3.0	698	0.110	100	0.0	2
Lane 2	-	38	38	3.0	141	0.269	100	NA	NA
Approach	77	38	115	3.0		0.269			
	Total	%HV	Deg.Satn (v/c)						
All Vehicles	1504	12.5		0.441					

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate sec	Capacity veh/h	Deg. Satn veh/h	Min. Delay v/c	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
West: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101 [Memorial Dr/Bussell 2036 PM - with Dev (Site Folder: Scenario 2)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Give-Way (Two-Way)

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1	561	11.8	561	11.8	1711	0.328	100	1.6	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	561	11.8	561	11.8		0.328		1.6	NA	0.0	0.0				
North: Bussell Hwy															
Lane 1	866	15.3	866	15.3	1650	0.525	100	0.4	LOS A	0.0	0.0	Full	500	0.0	0.0
Lane 2	75	3.0	75	3.0	973	0.077	100	6.0	LOS A	0.3	2.4	Short	50	0.0	NA
Approach	941	14.3	941	14.3		0.525		0.8	NA	0.3	2.4				
West: Memorial Dr															
Lane 1	72	3.0	72	3.0	942	0.076	100	6.9	LOS A	0.3	2.1	Short	6	0.0	NA
Lane 2	33	3.0	33	3.0	105	0.311	100	44.2	LOS E	0.9	6.9	Full	500	0.0	0.0
Approach	104	3.0	104	3.0		0.311		18.6	LOS C	0.9	6.9				
All Vehicles	1606	12.7	1606	12.7		0.525		2.2	NA	0.9	6.9				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	L2 W	T1 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	37	524	561	11.8	1711	0.328	100	NA	NA
Approach	37	524	561	11.8		0.328			

North: Bussell Hwy

Mov. From N To Exit:	T1 S	R2 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	866	-	866	15.3	1650	0.525	100	NA	NA
Lane 2	-	75	75	3.0	973	0.077	100	0.0	1
Approach	866	75	941	14.3		0.525			

West: Memorial Dr

Mov.	L2	R2	Total	%HV		Deg.	Lane	Prob.	Ov.

From W To Exit:	N	S			Cap. veh/h	Satn v/c	Util. %	SL Ov. %	Lane No.
Lane 1	72	-	72	3.0	942	0.076	100	0.0	2
Lane 2	-	33	33	3.0	105	0.311	100	NA	NA
Approach	72	33	104	3.0		0.311			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	1606	12.7	0.525

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate sec	Capacity veh/h	Deg. Satn veh/h	Min. Delay v/c	Merge Delay sec

There are no Exit Short Lanes for Merge Analysis at this Site.

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
West: Memorial Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101v [Roy Earl Dr/Bussell Future AM - with Dev (Site Folder: Scenario 2)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Roundabout

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1[d]	695	11.0	695	11.0	1229	0.565	100	3.0	LOS A	5.2	44.2	Full	500	0.0	0.0
Approach	695	11.0	695	11.0		0.565		3.0	LOS A	5.2	44.2				
East: Roy Earl Dr															
Lane 1[d]	234	2.0	234	2.0	752	0.311	100	9.5	LOS A	2.4	16.8	Full	500	0.0	0.0
Approach	234	2.0	234	2.0		0.311		9.5	LOS A	2.4	16.8				
North: Bussell Hwy															
Lane 1[d]	711	10.5	711	10.5	1286	0.553	100	3.1	LOS A	5.4	45.1	Full	500	0.0	0.0
Approach	711	10.5	711	10.5		0.553		3.1	LOS A	5.4	45.1				
West: Development Access															
Lane 1[d]	361	2.0	361	2.0	743	0.486	100	10.8	LOS B	4.5	33.8	Full	500	0.0	0.0
Approach	361	2.0	361	2.0		0.486		10.8	LOS B	4.5	33.8				
All Vehicles	2000	8.1	2000	8.1		0.565		5.2	LOS A	5.4	45.1				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

d Dominant lane on roundabout approach

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	L2 W	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	59	598	38	695	11.0	1229	0.565	100	NA	NA
Approach	59	598	38	695	11.0		0.565			

East: Roy Earl Dr

Mov. From E To Exit:	L2 S	T1 W	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	108	21	104	234	2.0	752	0.311	100	NA	NA
Approach	108	21	104	234	2.0		0.311			

North: Bussell Hwy

Mov. From N To Exit:	L2 E	T1 S	R2 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	22	593	96	711	10.5	1286	0.553	100	NA	NA
Approach	22	593	96	711	10.5		0.553			
West: Development Access										
Mov. From W To Exit:	L2 N	T1 E	R2 S	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	221	21	119	361	2.0	743	0.486	100	NA	NA
Approach	221	21	119	361	2.0		0.486			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	2000	8.1	0.565

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
East: Roy Earl Dr				
Lane 1	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
West: Development Access				
Lane 1	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 101v [Roy Earl Dr/Bussell Future PM - with Dev (Site Folder: Scenario 2)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Roundabout

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Bussell Hwy															
Lane 1[d]	775	9.4	775	9.4	1133	0.684	100	5.8	LOS A	8.3	68.7	Full	500	0.0	0.0
Approach	775	9.4	775	9.4		0.684		5.8	LOS A	8.3	68.7				
East: Roy Earl Dr															
Lane 1[d]	185	2.0	185	2.0	435	0.426	100	14.8	LOS B	3.9	27.7	Full	500	0.0	0.0
Approach	185	2.0	185	2.0		0.426		14.8	LOS B	3.9	27.7				
North: Bussell Hwy															
Lane 1[d]	1053	9.4	1053	9.4	1265	0.832	100	7.7	LOS A	15.3	125.0	Full	500	0.0	0.0
Approach	1053	9.4	1053	9.4		0.832		7.7	LOS A	15.3	125.0				
West: Development Access															
Lane 1[d]	181	2.0	181	2.0	700	0.259	100	9.6	LOS A	2.1	15.3	Full	500	0.0	0.0
Approach	181	2.0	181	2.0		0.259		9.6	LOS A	2.1	15.3				
All Vehicles	2194	8.2	2194	8.2		0.832		7.8	LOS A	15.3	125.0				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

d Dominant lane on roundabout approach

Approach Lane Flows (veh/h)

South: Bussell Hwy

Mov. From S To Exit:	L2 W	T1 N	R2 E	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	111	552	113	775	9.4	1133	0.684	100	NA	NA
Approach	111	552	113	775	9.4		0.684			

East: Roy Earl Dr

Mov. From E To Exit:	L2 S	T1 W	R2 N	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	93	21	72	185	2.0	435	0.426	100	NA	NA
Approach	93	21	72	185	2.0		0.426			

North: Bussell Hwy

Mov. From N To Exit:	L2 E	T1 S	R2 W	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	78	765	209	1053	9.4	1265	0.832	100	NA	NA
Approach	78	765	209	1053	9.4		0.832			
West: Development Access										
Mov. From W To Exit:	L2 N	T1 E	R2 S	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	69	21	91	181	2.0	700	0.259	100	NA	NA
Approach	69	21	91	181	2.0		0.259			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	2194	8.2	0.832

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h	Critical Gap pcu/h	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
South: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
East: Roy Earl Dr				
Lane 1	0.0	0.0	0.0	0.0
North: Bussell Hwy				
Lane 1	0.0	0.0	0.0	0.0
West: Development Access				
Lane 1	0.0	0.0	0.0	0.0



Appendix 9

Landscape Master Plan

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TREES WITHIN ROAD RESERVES ARE TO BE REMOVED. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

VEGETATION TO BE MODIFIED IN ACCORDANCE WITH THE BUSHFIRE MANAGEMENT PLAN. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

LANDSCAPED MOUNDS PLANTED WITH LOW THREAT NATIVE SPECIES AND TALL NATIVE TREES THROUGH LINEAR POS TO ENHANCE RURAL LANDSCAPE AESTHETIC

: TREES WITHIN INTERSECTION ALIGNMENT AND SIGHTLINES TO BE REMOVED. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

1.0m HIGH LANDSCAPED MOUNDING WITH POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

SEATING NODE WITH SHELTER AT FOCAL POINT OF LINEAR POS WITH VIEWS UP AND DOWN THE POS CORRIDOR

SMALL POCKET OF TURF PROVIDING INFORMAL ACTIVE RECREATION SPACE FOR RESIDENTS ON SOUTHERN SIDE OF DEVELOPMENT.

LANDSCAPED MOUNDS PLANTED WITH LOW THREAT NATIVE SPECIES AND TALL NATIVE TREES THROUGH LINEAR POS TO ENHANCE RURAL LANDSCAPE AESTHETIC

FOOTPATH CONNECTION TO WADANDI TRAIL REGIONAL TRAIL NETWORK

SEATING NODE WITH OUTLOOK OVER BASIN TO WADANDI TRAIL RESERVE BEHIND.

CATCHMENT C/ F BASIN TO PROVIDE 2,000sqm OF BIOFILTRATION BASIN AREA. LANDSCAPED WITH NATIVE LOW RUSHES AND SEDGES FOR NUTRIENT STRIPPING AND FILTRATION. TALL NATIVE TREE PLANTING TO SURROUNDING EDGES / BATTERS TO HELP SHADE OUT WEEDS AND PROVIDE WIND BREAK FROM PREVAILING SOUTH-WESTERLY WINDS

1 IN 100 YEAR FLOOD STORAGE AREA TO BE LANDSCAPED WITH LOW THREAT PLANTING AND MULCH WITH CLUMPS OF TALL NATIVE TREES AT MIN 5.0m CANOPY SEPARATION AND MAX. 15% CANOPY COVER TO APZ STANDARDS

MULCH ONLY OR GRAVEL MAINTENANCE ACCESS TO ALONG POS BOUNDARY INTERFACE WITH AGRICULTURAL LOT AND WADANDI TRAIL RESERVE

NEW INTERSECTION ON MEMORIAL DRIVE WILL REQUIRE REMOVAL OF 2 x EXISTING TREES. NEW STREET TREES TO BE INSTALLED IF SIGHTLINES PERMIT, SUBJECT TO DETAILED DESIGN

CONCRETE FOOTPATHS PROVIDING WALKING CIRCUITS THROUGH / AROUND RETAINED VEGETATION WHILE PROVIDING MAINTENANCE ACCESS AND EDGING TO PROTECT EXISTING RETAINED TREES

EXISTING TREES IN GOOD CONDITION TO BE RETAINED AND PROTECTED WITH MULCH AND LOW THREAT UNDERSTOREY PLANTING TO PROTECT INTO THE FUTURE. TOTAL AREA TO BE LESS THAN 0.25HA. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

20.0m WIDE SEPARATION REQUIRED BETWEEN CLUMPS OF RETAINED TREES FOR BUSHFIRE EXCLUSION. CORRIDOR TO PROVIDE POS AMENITIES INCLUDING PLAYGROUND AND PICNIC SHELTER

2.5m WIDE DUAL USE PATH THROUGH CENTRE OF 10.0m WIDE LANDSCAPE BUFFER PROVIDING CONNECTION TO COWARAMUP TOWN CENTRE

EXISTING TREES IN GOOD CONDITION TO BE RETAINED AND PROTECTED WITH MULCH AND LOW THREAT UNDERSTOREY PLANTING TO PROTECT INTO THE FUTURE

WA PEPPERMINT PLANTING AT MIN. 5.0m BETWEEN CANOPIES TO DEVELOPMENT BOUNDARY FOR ADDITIONAL SCREENING. MUST BE LESS THAN 15% CANOPY COVER TOTAL

SINGLE DENSE ROW OF WA PEPPERMINT TREES TO BUSSELL HWY BOUNDARY ON 1.0m HIGH EARTH BUND WITH UNDERSTOREY PLANTING TO APZ REQUIREMENTS

LANDSCAPED MEDIAN WITH TALL NATIVE TREES ON EITHER SIDE TO CREATE GRAND AVENUE ALONG MAIN THROUGH ROAD

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

1.0m HIGH LANDSCAPED MOUNDING WITH POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

BIOFILTRATION BASIN AT ENTRY TO BE LANDSCAPED AS ENTRY FEATURE / WETLAND WITH TALL NATIVE TREE PLANTING TO PRONOUNCE SUBDIVISON ENTRY WITH FEATURE POS PLANTING UNDERSTOREY IN ROAD VERGE

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

MAINTENANCE ACCESS TRACK ENTRY POINT WITH BOLLARDS OR GATE TO SoAMR REQUIREMENTS

VERGE LANDSCAPING BY LOT OWNERS TO SoAMR STANDARDS

STREET TREE PLANTING AT 1 x TREE PER LOT OR 2 x TREES PER CORNER LOT UTILISING LOCAL NATIVE TREE SPECIES

WA PEPPERMINT PLANTING AT MIN. 5.0m BETWEEN CANOPIES TO DEVELOPMENT BOUNDARY FOR ADDITIONAL SCREENING. MUST BE LESS THAN 15% CANOPY COVER TOTAL

SINGLE DENSE ROW OF WA PEPPERMINT TREES TO BUSSELL HWY BOUNDARY ON 1.0m HIGH EARTH BUND WITH UNDERSTOREY PLANTING TO APZ REQUIREMENTS

3.0m WIDE GRAVEL MAINTENANCE ACCESS TRACK THROUGH 10.0m WIDE BUSSELL HWY VISUAL LANDSCAPE BUFFER

10.0m WIDE LANDSCAPE BUFFER TO SOUTHERN BOUNDARY AS VISUAL TRANSITION FROM AGRICULTURAL TO RESIDENTIAL LAND

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 01 CATCHMENT B/G BIOFILTRATION BASIN
- 02 LINEAR POS SWALE WITH 1 IN 4 BATTERS
- 03 CATCHMENT D/E BIOFILTRATION BASIN
- 04 CATCHMENT C/F BIOFILTRATION BASIN AND 1 IN 100 YR FLOOD STORAGE AREA
- 05 OPEN TURF AREAS FOR INFORMAL ACTIVE RECREATION
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- IRRIGATED TURF AREA
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SWALE AND BIOFILTRATION PLANTING AREAS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- EXISTING SURVEYED TREE TO BE RETAINED
- EXISTING SURVEYED TREE TO BE REMOVED
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- LANDSCAPE BUFFER SCREEN TREE PLANTING
- POS NATIVE DRAINAGE TREE PLANTING

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.
2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.
3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

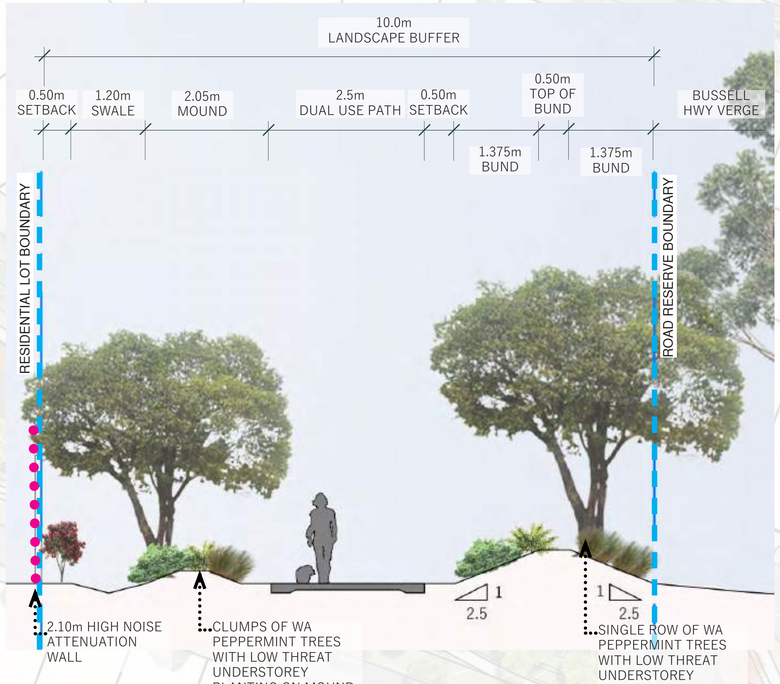
LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - OVERALL SITE PLAN

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-001

SCALE: 1:1500@ A1

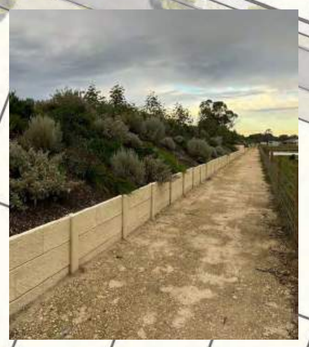
SW LANDSCAPE COLLECTIVE



SCALE **1 : 50 @**

SECTION F - BUSSELL HWY LANDSCAPE BUFFER





EXAMPLE PHOTO: EXAMPLE
BUND AND MOUND PLANTING



2.1m HIGH NOISE ATTENUATION WALL TO REAR OF LOTS ADJACENT BUSSELL HWY

2.5m WIDE DUAL USE PATH THROUGH CENTRE OF 10.0m WIDE LANDSCAPE BUFFER PROVIDING CONNECTION TO COWARAMUP TOWN CENTRE

SHALLOW SWALE CONNECTING THROUGH FROM LANDSCAPE BUFFER TO BIOFILTRATION BASIN

WA PEPPERMINT PLANTING AT MIN. 5.0m BETWEEN CANOPIES TO DEVELOPMENT BOUNDARY FOR ADDITIONAL SCREENING. MUST BE LESS THAN 15% CANOPY COVER TOTAL

SINGLE DENSE ROW OF WA PEPPERMINT TREES TO BUSSELL HWY BOUNDARY ON 1.0m HIGH EARTH BUND WITH UNDERSTOREY PLANTING TO APZ REQUIREMENTS

SEATING NODE FOR PASSIVE RECREATION

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

1.0m HIGH LANDSCAPED MOUNDING WITH POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

NEW INTERSECTION AND ROUND-ABOUT SUBJECT TO DETAILED DESIGN AND MRWA APPROVALS

POS LANDSCAPING PLANTING TO ENTRY ROAD VERGES WITH FEATURE AVENUE STREET TREE PLANTING BEHIND TO CREATE PRONOUNCED INFORMAL ENTRY STATEMENT

BIOFILTRATION BASIN AT ENTRY TO BE LANDSCAPED AS ENTRY FEATURE / WETLAND WITH TALL NATIVE TREE PLANTING TO PRONOUNCE SUBDIVISON ENTRY WITH FEATURE POS PLANTING UNDERSTOREY IN ROAD VERGE

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

SHALLOW SWALE CONNECTING THROUGH FROM LANDSCAPE BUFFER TO BIOFILTRATION BASIN

MAINTENANCE ACCESS TRACK ENTRY POINT WITH BOLLARDS OR GATE TO SoAMR REQUIREMENTS

WA PEPPERMINT PLANTING AT MIN. 5.0m BETWEEN CANOPIES TO DEVELOPMENT BOUNDARY FOR ADDITIONAL SCREENING. MUST BE LESS THAN 15% CANOPY COVER TOTAL

SINGLE DENSE ROW OF WA PEPPERMINT TREES TO BUSSELL HWY BOUNDARY ON 1.0m HIGH EARTH BUND WITH UNDERSTOREY PLANTING TO APZ REQUIREMENTS

3.0m WIDE GRAVEL MAINTENANCE ACCESS TRACK THROUGH 10.0m WIDE BUSSELL HWY VISUAL LANDSCAPE BUFFER

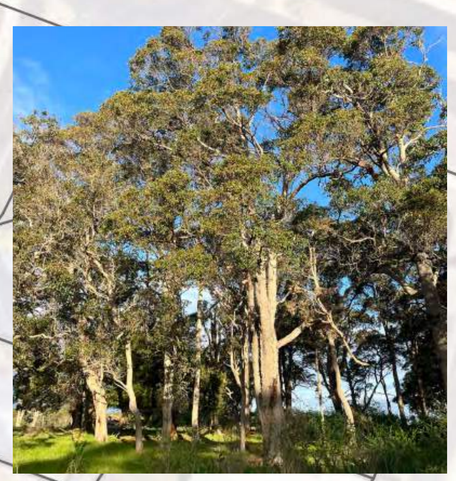
2.1m HIGH NOISE ATTENUATION WALL TO REAR OF LOTS ADJACENT BUSSELL HWY



SITE PHOTO: EXAMPLE MATURE TREES ON SITE ENHANCE NATURAL / RURAL AESTHETIC



SITE PHOTO: EXAMPLE MATURE TREES ON SITE ENHANCE NATURAL / RURAL AESTHETIC



SITE PHOTO: EXAMPLE MATURE TREES ON SITE ENHANCE NATURAL / RURAL AESTHETIC

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 01 CATCHMENT B/G BIOFILTRATION BASIN
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- IRRIGATED TURF AREA
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SWALE AND BIOFILTRATION PLANTING AREAS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- LANDSCAPE BUFFER SCREEN TREE PLANTING
- POS NATIVE DRAINAGE TREE PLANTING
- EXISTING SURVEYED TREE TO BE RETAINED
- EXISTING SURVEYED TREE TO BE REMOVED
- 2.1m HIGH NOISE ATTENUATION WALL TO REAR OF LOTS ADJACENT BUSSELL HWY

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.

2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.

3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

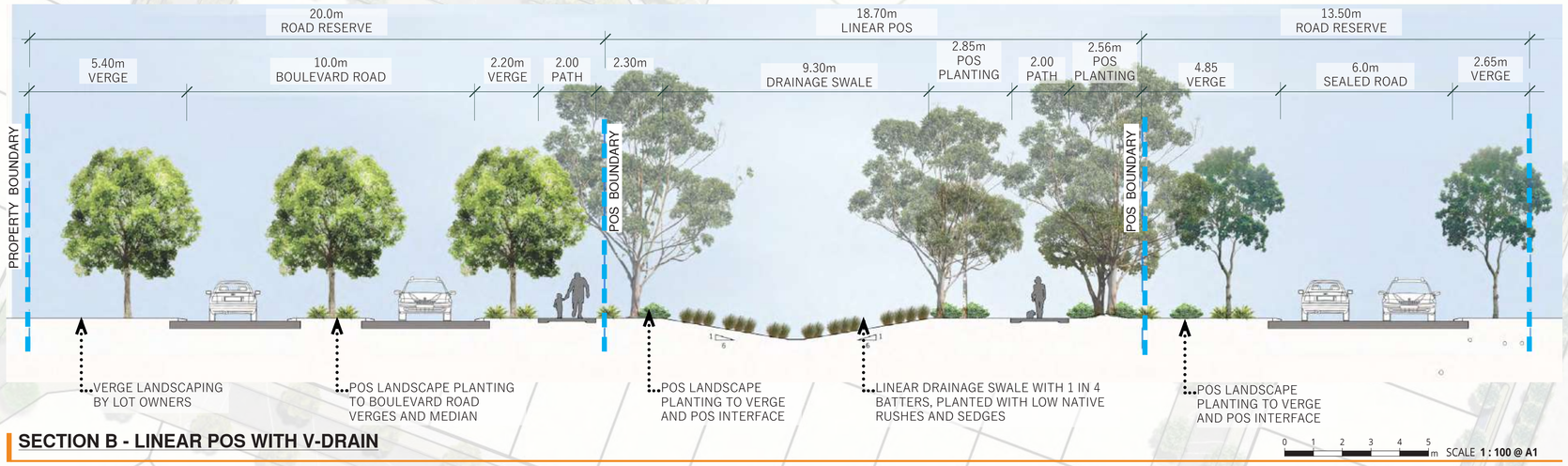
LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - ENTRY POS AND LANDSCAPE BUFFER DETAIL PLANS

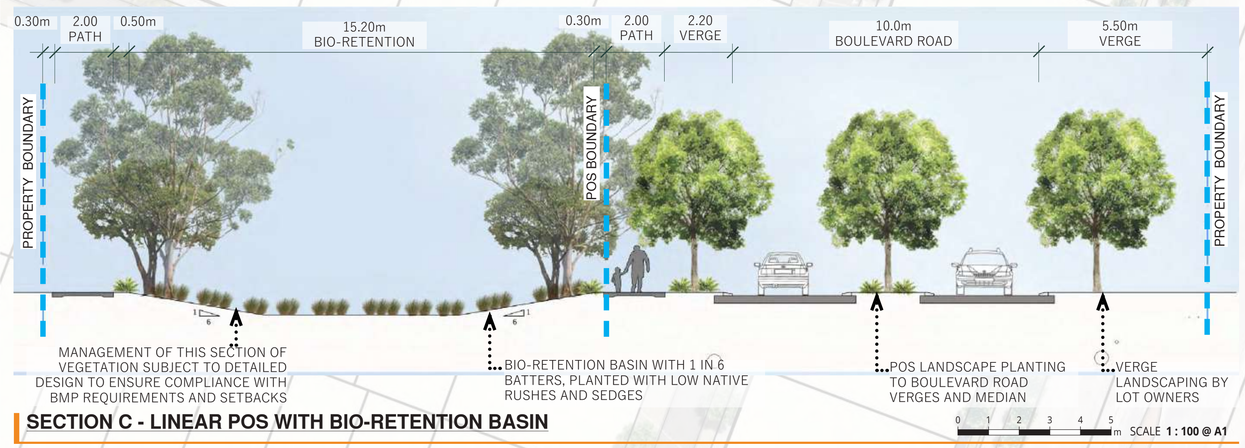
CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-002

SCALE: 0 5 10 15 20 25 m
SCALE **1 : 500 @ A1**

SW LANDSCAPE COLLECTIVE



SECTION B - LINEAR POS WITH V-DRAIN



SECTION C - LINEAR POS WITH BIO-RETENTION BASIN

. TREES WITHIN INTERSECTION ALIGNMENT AND SIGHTLINES TO BE REMOVED. PLEASE REFER TO 'SITE CLEARING / TREE REMOVAL PLANS" GFC-01-002 AND 03 FOR MORE DETAIL.

FEATURE TALL NATIVE AVENUE STREET TREE PLANTING IN LANDSCAPED MEDIAN

1.0m HIGH LANDSCAPED MOUNDING WITHIN POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

OPEN POS AREA WITH LOW THREAT PLANTING TO APZ STANDARDS WITH CLUMPS OF TALL NATIVE TREES TO PRONOUNCE SUBDIVISION ENTRY

MANAGEMENT OF THIS SECTION OF VEGETATION SUBJECT TO DETAILED DESIGN TO ENSURE COMPLIANCE WITH BMP REQUIREMENTS AND SETBACKS

SEATING NODE WITH SHELTER AT FOCAL POINT OF LINEAR POS WITH VIEWS UP AND DOWN THE POS CORRIDOR

POS LANDSCAPE PLANTING PROVIDING BUFFER TO PRIVATE LOT

SEATING NODE ADJACENT TO TURF AREA FOR PASSIVE RECREATION AND SURVEILLANCE

SMALL POCKET OF TURF PROVIDING INFORMAL ACTIVE RECREATION SPACE FOR RESIDENTS ON SOUTHERN SIDE OF DEVELOPMENT.

SEATING NODE ADJACENT TO TURF AREA FOR PASSIVE RECREATION AND SURVEILLANCE

1.0m HIGH LANDSCAPED MOUNDING WITHIN POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO SHADE FOOTPATH AND REINFORCE RURAL LANDSCAPE AESTHETIC

LANDSCAPED MEDIAN WITH TALL NATIVE TREES ON EITHER SIDE TO CREATE GRAND AVENUE ALONG MAIN THROUGH ROAD

DECIDUOUS POS FEATURE TREE AT FOCAL FROM BUSSELL HIGHWAY ENTRY AND FOR PASSIVE SOLAR PROTECTION FOR SHELTER / SEATING NODE

SEATING NODE WITH SHELTER AT FOCAL POINT OF LINEAR POS WITH VIEWS UP THE POS CORRIDOR AND FROM MAIN ENTRY OFF BUSSELL HIGHWAY

1.0m HIGH LANDSCAPED MOUNDING WITHIN POS BOUNDARY AS FEATURE AT ENTRY WITH TALL NATIVE TREES TO SHADE FOOTPATH AND REINFORCE RURAL LANDSCAPE AESTHETIC

LOW THREAT POS LANDSCAPE PLANTING TO VERGES OF LINEAR POS IN ACCORDANCE WITH APZ STANDARDS

SUNSET DRIVE

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.

2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.

3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 02 LINEAR POS SWALE WITH 1 IN 4 BATTERS
- 03 CATCHMENT D/E BIOFILTRATION BASIN
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- IRRIGATED TURF AREA
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SWALE AND BIOFILTRATION PLANTING AREAS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- LANDSCAPE BUFFER SCREEN TREE PLANTING
- POS NATIVE DRAINAGE TREE PLANTING

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - LINEAR POS DETAIL PLAN

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-003

SCALE: 0 5 10 15 20 25 m
SCALE 1 : 500 @ A1

SW LANDSCAPE COLLECTIVE



EXAMPLE PHOTO: EXISTING MATURE VEGETATION RETAINED IN MEDIANS AND VERGES

SEATING NODE BENEATH SHADE OF EXISTING TREE CANOPY

LANDSCAPED MOUNDS PLANTED WITH LOW THREAT NATIVE SPECIES AND TALL NATIVE TREES THROUGH LINEAR POS TO ENHANCE RURAL LANDSCAPE AESTHETIC

CONCRETE HALF-COURT SPACE AS LOW COST AND LOW MAINTENANCE ACTIVITY SPACE ADJACENT PLAYGROUND TO CATER FOR OLDER AGE GROUPS

STREET TREE PLANTING IN VERGE OF POS TO MATCH OPPOSITE VERGE WITH LOW THREAT PLANTING AND MULCH FINISH BENEATH

UTILISE EXISTING OPEN AREA FOR IRRIGATED TURF SPACE FOR ACTIVE RECREATION AND CONNECTING TO PLAY AND COURT SPACE

LANDSCAPED MOUNDS PLANTED WITH LOW THREAT NATIVE SPECIES AND TALL NATIVE TREES THROUGH LINEAR POS TO ENHANCE RURAL LANDSCAPE AESTHETIC

SEATING NODE OPENING TO TURF AREA FOR PASSIVE OUTLOOK AND SURVEILLANCE

E

05

E

CLUMPS OF TALL NATIVE TREE PLANTINGS WITH POS LANDSCAPE SPECIES PLANTING BENEATH AS NODES OF SCREENING AND HABITAT. TO BE COMPLIANT TO APZ STANDARDS

3.0m WIDE MULCH ONLY MAINTENANCE EDGE TO LARGE AREA OF EXISTING TREES TO BE RETAINED.

MULCH AND LOW THREAT UNDERSTOREY PLANTING TO ASSIST IN PROTECTING EXISTING TREE ROOTS AND IMPROVE OVERALL TREE HEALTH

CONCRETE FOOTPATHS PROVIDING WALKING CIRCUITS THROUGH / AROUND RETAINED VEGETATION WHILE PROVIDING MAINTENANCE ACCESS AND EDGING TO PROTECT EXISTING RETAINED TREES

EXISTING TREES IN GOOD CONDITION TO BE RETAINED AND PROTECTED WITH MULCH AND LOW THREAT UNDERSTOREY PLANTING TO PROTECT INTO THE FUTURE. TOTAL AREA TO BE LESS THAN 0.25HA

ADDITIONAL PLANTING OF MARRI, JARRAH AND WA PEPPERMINTS AS SUCCESSION PLANTING IN OPEN AREAS

PICNIC SETTING OPEN TO PLAYGROUND AND HALF COURT AREA

SHADE SAILS OVER PLAY SPACE FOR SUN PROTECTION AND SHADE

20.0m WIDE SEPARATION REQUIRED BETWEEN CLUMPS OF RETAINED TREES FOR BUSHFIRE EXCLUSION. LOW THREAT PLANTING ONLY TO OCCUR

PLAYGROUND TO PROVIDE VARIETY FOR ALL AGES AND ACCESSIBILITY WITH COMBINATION OF OFF-THE-SHELF AND NATURE PLAY EQUIPMENT / PIECES

PICNIC SHELTER AND SETTING / SEATING TO BE PROVIDED ADJACENT PLAYGROUND

CONCRETE FOOTPATHS PROVIDING WALKING CIRCUITS THROUGH / AROUND RETAINED VEGETATION WHILE PROVIDING MAINTENANCE ACCESS AND EDGING TO PROTECT EXISTING RETAINED TREES

CLUMPS OF TALL NATIVE TREE PLANTINGS WITH POS LANDSCAPE SPECIES PLANTING BENEATH AS NODES OF SCREENING AND HABITAT. TO BE COMPLIANT TO APZ STANDARDS

EXISTING TREES IN GOOD CONDITION TO BE RETAINED AND PROTECTED WITH MULCH AND LOW THREAT UNDERSTOREY PLANTING TO PROTECT INTO THE FUTURE. TOTAL AREA TO BE LESS THAN 0.25HA

CONCRETE FOOTPATHS PROVIDING WALKING CIRCUITS THROUGH / AROUND RETAINED VEGETATION WHILE PROVIDING MAINTENANCE ACCESS AND EDGING TO PROTECT EXISTING RETAINED TREES



EXAMPLE PHOTO: LOW THREAT PLANTING BENEATH RETAINED EXISTING TREES

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 05 OPEN TURF AREAS FOR INFORMAL ACTIVE RECREATION
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- IRRIGATED TURF AREA
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- EXISTING SURVEYED TREE TO BE RETAINED
- EXISTING SURVEYED TREE TO BE REMOVED

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.

2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.

3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - NORTHERN ACTIVE POS DETAIL PLAN

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-004

SCALE: 0 2 4 6 8 10 m
SCALE 1 : 250 @

SW LANDSCAPE COLLECTIVE

WADANDI TRAIL

0.3m RETAINING WALL WITH LOW THREAT PLANTING ABOVE TO PROVIDE BAL SETBACK TO PRIVATE LOTS. MANAGEMENT OF THIS SECTION OF VEGETATION SUBJECT TO DETAILED DESIGN TO ENSURE COMPLIANCE WITH BMP REQUIREMENTS AND SETBACKS

FOOTPATH CONNECTION TO WADANDI TRAIL REGIONAL TRAIL NETWORK

POS LANDSCAPE PLANTING AND NATIVE TREES PROVIDE SEPARATION AND SCREENING TO PRIVATE LOT

CATCHMENT C/ F BASIN TO PROVIDE 2,000sqm OF BIOFILTRATION BASIN AREA. LANDSCAPED WITH NATIVE LOW RUSHES AND SEDGES FOR NUTRIENT STRIPPING AND FILTRATION. TALL NATIVE TREE PLANTING TO SURROUNDING EDGES / BATTERS TO HELP SHADE OUT WEEDS AND PROVIDE WIND BREAK FROM PREVAILING SOUTH-WESTERLY WINDS

FEATURE DECIDUOUS POS TREE PLANTING PROVIDING SEASONAL COLOUR AND SHADE AT FOCAL POINT

SEATING NODE WITH OUTLOOK OVER BASIN TO WADANDI TRAIL RESERVE BEHIND.



EXAMPLE PHOTO: LOW NATIVE RUSH AND SEDGE PLANTING

H

H

BOLLARDS OR ACCESS GATE TO BE INSTALLED TO SoAMR REQUIREMENTS AND SUBJECT TO DETAILED DESIGN DRAWINGS

10.0m WIDE LANDSCAPE BUFFER TO SOUTHERN BOUNDARY AS VISUAL AND SPRAY DRIFT SCREEN FROM ADJACENT AGRICULTURAL USE.

MULCH ONLY OR GRAVEL MAINTENANCE ACCESS TO ALONG POS BOUNDARY INTERFACE WITH AGRICULTURAL LOT AND WADANDI TRAIL RESERVE

1 IN 100 YEAR FLOOD STORAGE AREA TO BE LANDSCAPED WITH LOW THREAT PLANTING AND MULCH WITH CLUMPS OF TALL NATIVE TREES AT MIN 5.0m CANOPY SEPARATION AND MAX. 15% CANOPY COVER TO APZ STANDARDS



EXAMPLE PHOTO: LOW NATIVE RUSH AND SEDGE PLANTING

LEGEND

- EXTENT OF PROJECT SITE
- EXTENT OF DETAIL PLANS
- 04 CATCHMENT C/F BIOFILTRATION BASIN AND 1 IN 100 YR FLOOD STORAGE AREA
- PROPERTY BOUNDARY AND PROPOSED NEW LOTS
- NEW SEALED ROADS
- CONCRETE FOOTPATHS
- EXPOSED AGG CONCRETE FOOTPATHS
- MAINTENANCE ACCESS TRACK
- MULCH ONLY
- VERGE LANDSCAPING BY LOT OWNERS
- FEATURE POS LANDSCAPE PLANTING AREA
- LOW THREAT PLANTING TO MANAGED APZ REQUIREMENTS
- SWALE AND BIOFILTRATION PLANTING AREAS
- SEATING NODE / SHADE SHELTERS
- BENCH SEAT / DDA COMPLIANT SEATING
- 10.0m WIDE AGRICULTURAL LANDSCAPE BUFFER
- POS NATIVE FEATURE TREE PLANTING
- POS DECIDUOUS FEATURE TREE PLANTING
- STREET TREE - FEATURE AVENUE NATIVE TREE
- STREET TREE - MAJOR ROAD
- STREET TREE - MINOR ROAD
- LANDSCAPE BUFFER SCREEN TREE PLANTING
- POS NATIVE DRAINAGE TREE PLANTING
- EXISTING SURVEYED TREE TO BE RETAINED
- EXISTING SURVEYED TREE TO BE REMOVED

NOTES

1. ALL NEW LANDSCAPE WORKS SHALL BE COMPLIANT WITH ASSET PROTECTION ZONE AND BUSHFIRE MANAGEMENT PLAN REQUIREMENTS.

2. ALL STREET TREE PLANTING SHALL BE INSTALLED WITH APPROPRIATE ROOT CONTROL BARRIERS.

3. LANDSCAPE DESIGN IS SUBJECT TO CONFIRMATION OF CIVIL DESIGN REQUIREMENTS INCLUDING ROAD ALIGNMENTS AND LOCATION OF SERVICES.

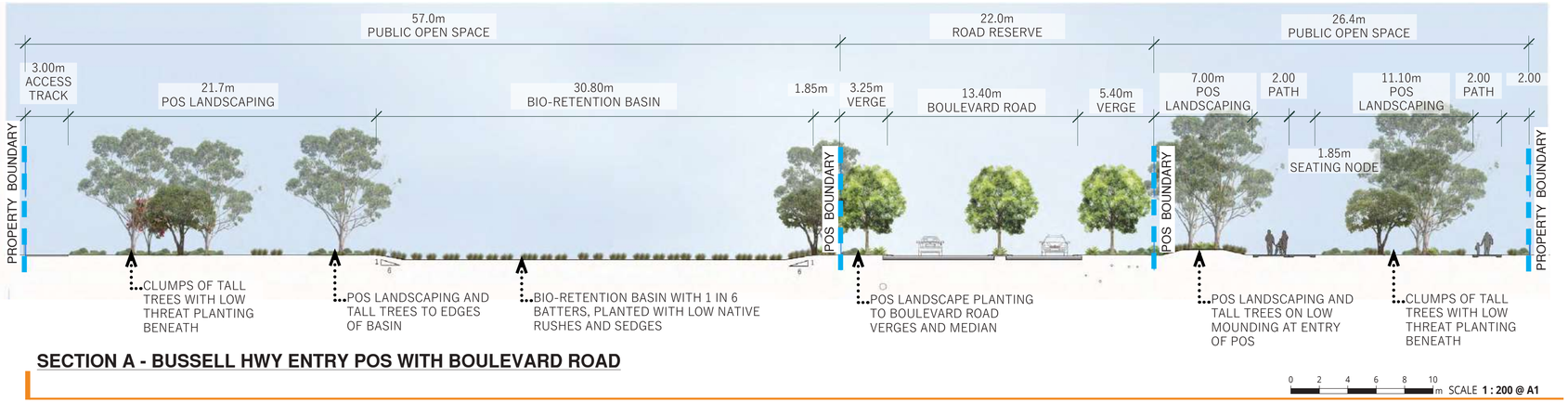
LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - SOUTHERN DRAINAGE POS DETAIL PLAN

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-005

SCALE: 0 2 4 6 8 10 m
SCALE 1 : 250 @

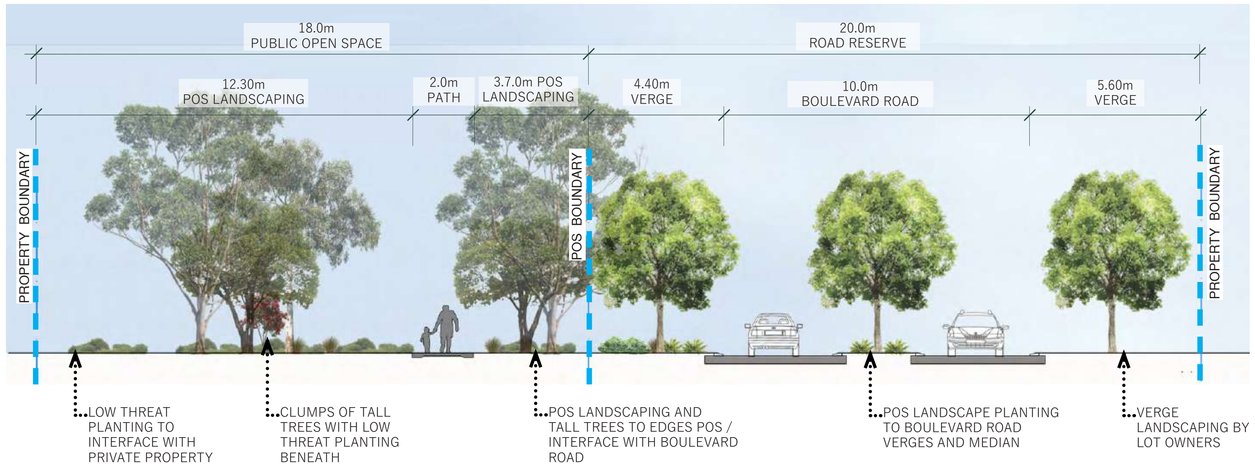
SW LANDSCAPE COLLECTIVE



SECTION A - BUSSELL HWY ENTRY POS WITH BOULEVARD ROAD



EXAMPLE PHOTO: LOW THREAT PLANTING SURROUNDING EXISTING TREES



SECTION D - SUNSET DRIVE LINEAR POS ENTRY

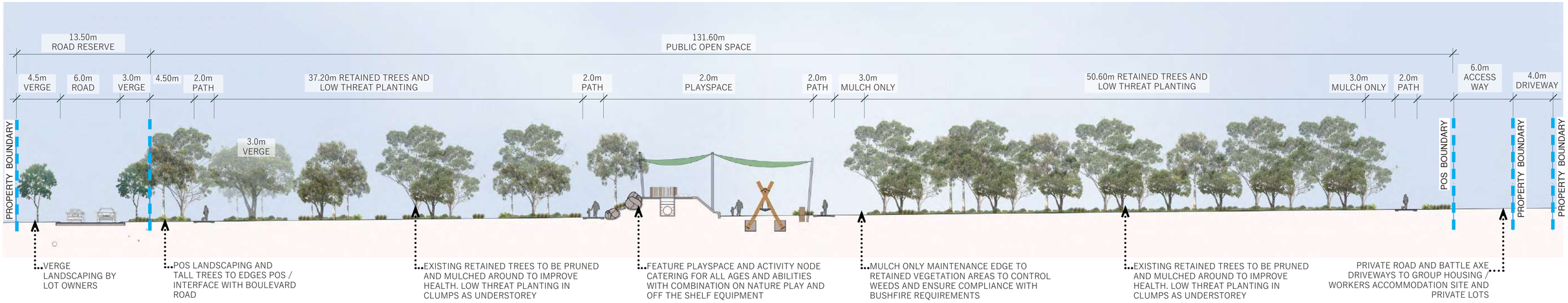
0 1 2 3 4 5 m SCALE 1 : 100 @ A1



EXAMPLE PHOTO: EXISTING TREES RETAINED IN VERGES AND POS



EXAMPLE PHOTO: EXISTING TREES RETAINED TURF POS



SECTION E - NORTHERN POS WITH PLAY SPACE

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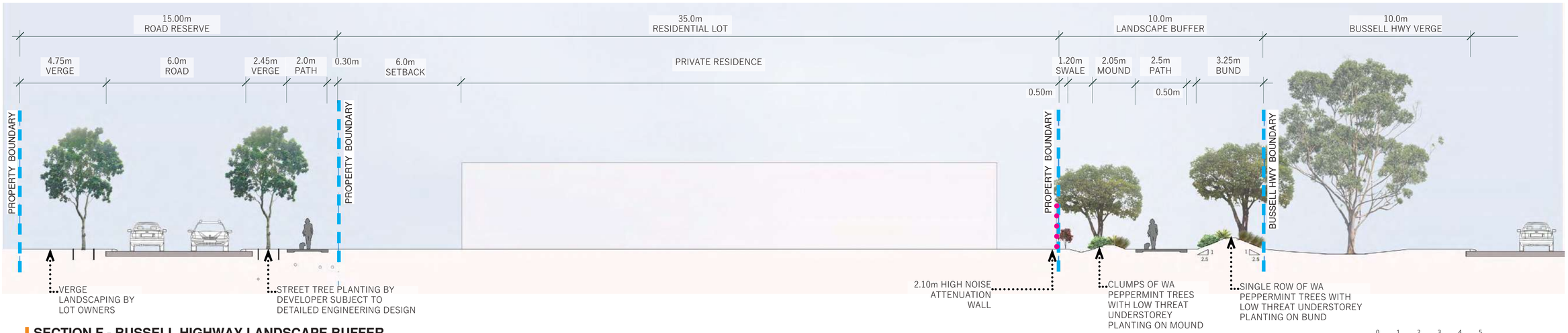
LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE MASTERPLAN - NATURE PLAYGROUND SECTIONS AND IMAGERY

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-006

SCALE: 1:200 @A1

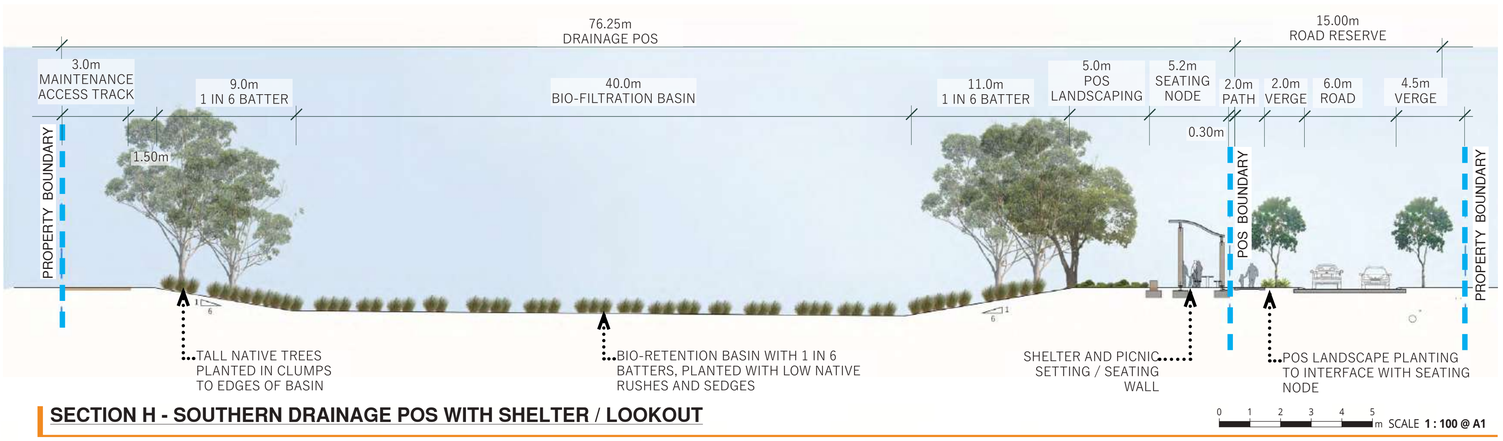
SW LANDSCAPE COLLECTIVE



SECTION F - BUSSELL HIGHWAY LANDSCAPE BUFFER



SECTION G - SOUTHERN LOTS WITH LANDSCAPE TRANSITION BUFFER



SECTION H - SOUTHERN DRAINAGE POS WITH SHELTER / LOOKOUT



EXAMPLE PHOTO: COWARAMUP MAIN STREET FEATURE PLANTING PALETTE



EXAMPLE PHOTO: SIMPLE SEATING NODE IN POS

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE CONCEPT PLAN - TYPICAL SECTIONS

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-007

SCALE: 1:100 @A1

SW LANDSCAPE COLLECTIVE



EXAMPLE RURAL STYLE PINCIC SHELTERS





BENCH SEATING



EXAMPLE NATURE PLAY ELEMENTS



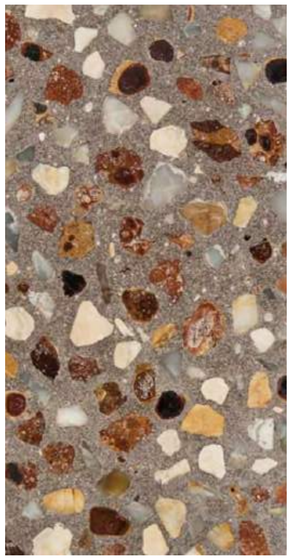




COASTAL LIMESTONESW GRANITE



CUSTOM SITE FURNITURE UTILISING RECYCLED TIMBER MATERIALS



EXPOSED AGG CONCRETE FEATURES



EXISTING SITE LOGS RECYCLED AS POS AND LANDSCAPE FEATURES



EXAMPLE ARTWORK / FEATURE / PLAY ITEMS



COMBINATION OF NATURAL MATERIALS IN SEATING NODES



SIMPLE HALF COURT AND LINEMARKING GAMES



SITE LOGS FOR PLAYGROUND AND LANDSCAPE FEATURES

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE CONCEPT PLAN - HARDSCAPE MATERIAL PALETTE

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-008

SCALE: N/A

SW LANDSCAPE COLLECTIVE

TREE SPECIES

STREET TREES
Agonis flexousa - WA Peppermint
Corymbia calyphylla Grafted Varieties - Marri
Corymbia ficifolia - Red Flowering Gum
Eucalyptus torquata - Coral Gym
Eucalyptus patens - Blackbutt
Hakea laurina - Pin Cushion Hakea

PUBLIC OPEN SPACE TREES
Agonis flexousa - WA Peppermint
Banksia grandis - Bull Banksia
Corymbia calyphylla - Marri
Eucalyptus diversicolour - Karri
Eucalyptus marginata - Jarrah
Eucalyptus patens - Blackbutt
Eucalyptus rudis - River Gum
Melaleuca rhaphiophylla - Swamp Paperbark
Quercus rubra - Red Oak





Agonis flexuosa



Anigozanthus manglessii



Atriplex cinerea



Banksia nivea



Beaufortia squarrosa

LOW THREAT FIRE RESISTANT PLANT SPECIES

SHRUBS AND GRASSES
Anigozanthus manglesii - Red and Green Kangaroo Paw
Atriplex cinerea - Grey Saltbush
Beaufortia squarrosa - Sand Bottlebrush
Calothamnus quadrifidus - Onesided Bottelbrush
Casuarina glauca - Cousin IT
Lepidosperma gladiatum - Coastal Sword Sedge
Olearia axillaris - Coastal Daisy Bush

GROUND COVERS
Banksia nivea - Honeypot Dryandra
Conostylis aculeata - Prickly Conostylis
Eremophila glabra - Emu Bush
Grevillea junipera - Juniper-leaved Grevillea
Hemiandra pungens - Snake bush
Kennedia coccinea - Running Postman
Myoporum parvifolium Creeping Boobialla
Pandorea jasminoides - Star Jasmin
Scaevola aemula - Fairy Fan Flower





Calothamnus quadrifidus



Casuarina Cousin IT



Conostylis aculeata



Ficinia nodosa

FEATURE POS PLANTING SPECIES

TREES
Agonis flexuosa - WA Peppermint Tree
Banksia grandis - Bull Banksia
Hakea lauraina - Pin Cushion Hakea

SHRUBS
Adenanthos cuneatus - Kalbarri Carpet
Anigozanthis flavisua - Yellow Kangaroo Paw
Anigozanthus manglesii - Red and Green Kangaroo Paw
Billardiera fusiformis - Australian Bluebell
Beaufortia squarrosa - Sand Bottlebrush
Calothamnus quadrifidus - Onesided Bottelbrush
Casuarina glauca - Cousin IT
Grevillea olivacea - Olive-Leaved Grevillea
Lepidosperma gladiatum - Coastal Sword Sedge
Lepidosperma Twilight Green
Meebolidna scariosa - Velve Rush
Templetonia retusa - Cockiets Tongue

GROUND COVERS
Banksia nivea - Honeypot Dryandra
Conostylis aculeata - Prickly Conostylis
Grevillea GinGin Gem
Lomandra Seasprayt
Melaleuca heugelli - White Rambler
Myoporum parvifolium Creeping Boobialla
Scaevola crassifolia - Purple Fan Flower





Grevillea Gingin Gem



Grevillea olivacea



Hakea laurina



Juncus pallidus



Lepidosperma gladiatum

DRAINAGE BASIN AND SWALE PLANTING SPECIES

TREES
Melaleuca rhaphiophylla

GROUND COVERS
Baumea juncea
Carex appressa
Ficinia nodosa
Meeboldina scariosa
Juncus pallidus
Scheonoplectus validus





Lomandra longifolia



Meeboldina scariosa



Melaleuca incana nana



Myoproum parvifolium

LOT 102 BUSSELL HWY, COWARAMUP

LANDSCAPE CONCEPT PLAN - SOFTSCAPE MATERIAL PALETTE

CLIENT: GOLDFIELDS COWARAMUP
DATE: 18 OCTOBER 2023
REVISION: A
DWG NO GFC-02-009

SCALE: N/A

SW LANDSCAPE COLLECTIVE



LEGEND

- SURVEYED TREE LOCATION
  - TREE NUMBER ON ARBORIST REPORT
  - TREE COMMON NAME
  - ASSESSED TREE CONDITION
  - TRUNK DIAMETER (mm)
- TREE CONDITION RATING - GOOD
- TREE CONDITION RATING - FAIR
- TREE CONDITION RATING - POOR
- TREE CONDITION RATING - DEAD

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

STANDARD NOTES

1. **SET OUT & DIMENSIONS.** THE CONTRACTOR SHALL SET OUT ALL PATHS, WALLS, HARD SURFACES AND ELEMENTS EITHER ON SITE PRIOR TO CONSTRUCTION AND SHALL OBTAIN THE SUPERINTENDENTS APPROVAL PRIOR TO WORKS COMMENCING. WRITTEN DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALE. CHECK ALL DRAWING SCALES IN CONJUNCTION WITH DRAWING SIZE.
2. **SERVICES & SITE ASSETS.** THE CONTRACTOR SHALL INVESTIGATE THE NATURE AND LOCATION OF ALL EXISTING SERVICES AND RETAINED SITE ASSETS AFFECTED BY THEIR WORKS. FAILURE TO TAKE DUE CARE SHALL NOT LIMIT THE CONTRACTORS LIABILITIES.
3. **REFERENCE.** THE CONTRACTOR SHALL REFER TO ALL CONTRACT DOCUMENTS, THE SPECIFICATION AND DRAWINGS PRIOR TO AND DURING THE WORKS.
4. **DISCREPANCIES.** NOTIFY SUPERINTENDENT OF ANY SUSPECTED OR KNOWN DISCREPANCIES OR ERRORS PRIOR TO THE ORDERING OF AFFECTED MATERIALS AND OR CONSTRUCTION OF AFFECTED WORKS.
5. **RELEVANT STANDARDS.** THE CONTRACTOR SHALL UNDERTAKE ALL PRICING AND WORKS IN ACCORDANCE WITH CURRENT INDUSTRY BEST PRACTICE AND ALL RELEVANT AUSTRALIAN STANDARDS.
6. **SERVICE LOCATOR.** THE CONTRACTOR SHALL UNDERTAKE A DIAL BEFORE YOU DIG PROCESS PRIOR TO COMMENCING WORKS ON SITE. THE CONTRACTOR SHALL ENGAGE A SERVICE LOCATOR TO MAP THE SPECIFIC LOCATIONS AND DEPTH OF ALL SERVICES AND ADVISE ALL RELEVANT STAFF AND SUBCONTRACTORS IN WRITING PRIOR TO COMMENCING WORKS ON SITE.

SW LANDSCAPE COLLECTIVE

ADDRESS: 4 MAGPIE STREET, MARGARET RIVER WA 6285
EMAIL: ADMIN@SWLANDSCAPE.COM.AU
WEBSITE: WWW.SWLANDSCAPE.COM.AU
PHONE: +61 418 947 889

REV	DATE	BY	ISSUE OR AMENDMENT
D	12.10.23	CE	UPDATED SURVEY INFORMATION
C	09.10.23	CE	ADDITION OF MEMORIAL DRIVE ROAD RESERVE TREES
B	19.09.23	CE	ADDITION OF SUNSET DRIVE ROAD RESERVE TREES
A	13.09.23	CE	ISSUE FOR APPROVAL

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
EXISTING TREE ARBORIST CONDITION SUMMARY

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE
1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER
GFC-01-101

REVISION
D



LEGEND

SURVEYED TREE LOCATION - TREE TO BE RETAINED

SURVEYED TREE LOCATION - TREE TO BE REMOVED

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

STANDARD NOTES

1. **SET OUT & DIMENSIONS.** THE CONTRACTOR SHALL SET OUT ALL PATHS, WALLS, HARD SURFACES AND ELEMENTS EITHER ON SITE PRIOR TO CONSTRUCTION AND SHALL OBTAIN THE SUPERINTENDENTS APPROVAL PRIOR TO WORKS COMMENCING. WRITTEN DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALE. CHECK ALL DRAWING SCALES IN CONJUNCTION WITH DRAWING SIZE.
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6. **SERVICE LOCATOR.** THE CONTRACTOR SHALL UNDERTAKE A DIAL BEFORE YOU DIG PROCESS PRIOR TO COMMENCING WORKS ON SITE. THE CONTRACTOR SHALL ENGAGE A SERVICE LOCATOR TO MAP THE SPECIFIC LOCATIONS AND DEPTH OF ALL SERVICES AND ADVISE ALL RELEVANT STAFF AND SUBCONTRACTORS IN WRITING PRIOR TO COMMENCING WORKS ON SITE.

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EMAIL: ADMIN@SWLANDSCAPE.COM.AU
WEBSITE: WWW.SWLANDSCAPE.COM.AU
PHONE: +61 418 947 889

REV	DATE	BY	ISSUE OR AMENDMENT
E	12.10.23	CE	UPDATED SURVEY INFORMATION
D	09.10.23	CE	ADDITION OFMEMORIAL DRIVE ROAD RESERVE TREES
C	22.09.23	CE	ADDITION OF ENGINEERS SIGHTLINE REVIEW
B	19.09.23	CE	ADDITION OF SUNSET DRIVE ROAD RESERVE TREES
A	13.09.23	CE	ISSUE FOR CLIENT REVIEW

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
PRELIMINARY SITE CLEARING / TREE REMOVAL PLAN

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE 1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER GFC-01-102

REVISION E



LEGEND

SURVEYED TREE LOCATION - TREE TO BE RETAINED

SURVEYED TREE LOCATION - TREE TO BE REMOVED

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

STANDARD NOTES

1. **SET OUT & DIMENSIONS.** THE CONTRACTOR SHALL SET OUT ALL PATHS, WALLS, HARD SURFACES AND ELEMENTS EITHER ON SITE PRIOR TO CONSTRUCTION AND SHALL OBTAIN THE SUPERINTENDENTS APPROVAL PRIOR TO WORKS COMMENCING. WRITTEN DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALE. CHECK ALL DRAWING SCALES IN CONJUNCTION WITH DRAWING SIZE.
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PHONE: +61 418 947 889

REV	DATE	BY	ISSUE OR AMENDMENT
E	12.10.23	CE	ADDITION OFMEMORIAL DRIVE ROAD RESERVE TREES
D	09.10.23	CE	ADDITION OFMEMORIAL DRIVE ROAD RESERVE TREES
C	22.09.23	CE	ADDITION OF ENGINEERS SIGHTLINE REVIEW
B	19.09.23	CE	ADDITION OF SUNSET DRIVE ROAD RESERVE TREES
A	13.09.23	CE	ISSUE FOR CLIENT REVIEW

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
PRELIMINARY SITE CLEARING / TREE REMOVAL PLAN

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE
1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER
GFC-01-103

REVISION
E



Appendix 10

Arborist Report

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Tree Inspection and Recommendations

Prepared for:

Lot 102 Bussel Hwy Cowaramup

31 August 2023

Written by Glen Taylor

Certificate III in Arboriculture AHC30810
Certificate IV in Horticulture AHC40410
Quantified Tree Risk Assessment Registration No. 5328

Quantified Tree Risk Assessment

South West Tree Services is a QTRA registered user. The QTRA system applies established and accepted risk management principles to tree safety management. By using a comprehensive range of values, QTRA enables the arborist to identify and analyse the risk from tree failure in 3 key stages:

1) To consider land use in terms of vulnerability to impact and likelihood of occupation
2) To consider the consequences of an impact, taking account of the size of the tree or branch, and
3) To estimate the probability that the tree or branch will fail onto the land use in question. 1/4K unacceptable when imposed on others

The QTRA method provides a framework for the assessment of these primary components of tree failure risk. The input values for these components are set out in broad ranges of Target, Size and Probability of failure. The QTRA assessor estimates values for the tree components and inputs them into the QTRA manual calculator to calculate the risk of harm.

QTRA Advisory Risk Thresholds

Thresholds	Description	Action
	Unacceptable Risks will not ordinarily be tolerated	Control the risk
1/1 000	Unacceptable (where imposed on others) Risks will not ordinarily be tolerated	Control the risk Review the risk
	Tolerable (by agreement) Risks may be tolerated if those exposed to the risk accept it, or the tree has exceptional value	Control the risk unless there is broad stakeholder agreement to tolerate it, or the tree has exceptional value Review the risk
1/10 000	Tolerable (where imposed on others) Risks are tolerable if ALARP	Assess costs and benefits of risk control Control the risk only where a significant benefit might be achieved at a reasonable cost Review the risk
1/1 000 000	Broadly Acceptable Risk is already ALARP	No action currently required Review the risk

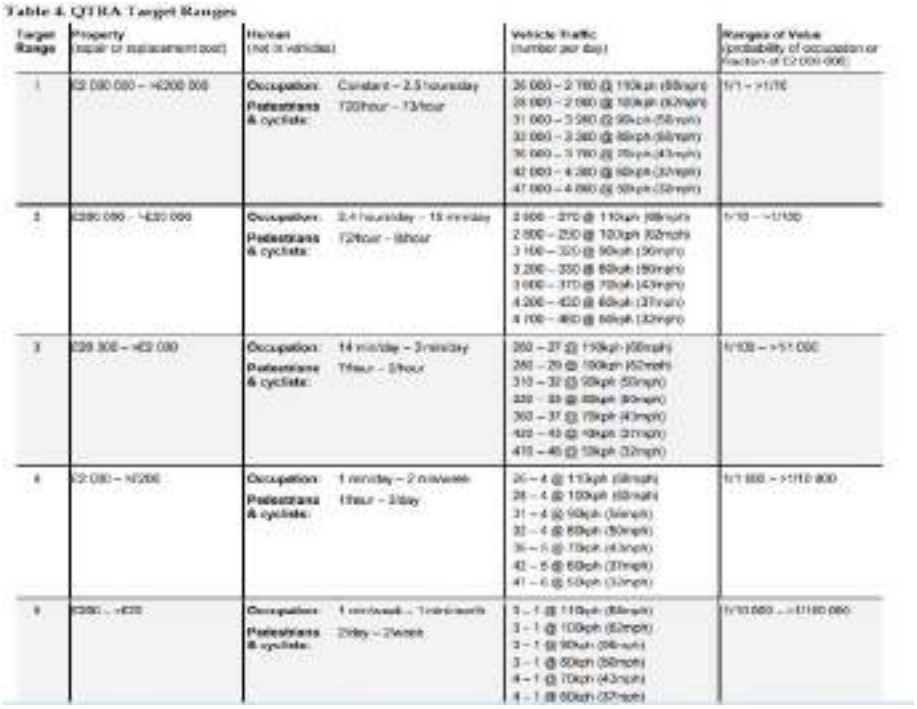


Table 4. QTRA Target Ranges

Target Range	Property (repair or replacement cost)	Human (not in vehicles)	Vehicle Traffic (number per day)	Ranges of Value (probability of occupation or fraction of £2 000 000)
1	£2 000 000 – >£200 000	Occupation: Constant – 2.5 hours/day Pedestrians & cyclists: 120/hour – 1/3/hour	36 000 – 2 160 @ 110kph (68mph) 28 000 – 2 160 @ 100kph (62mph) 31 000 – 3 580 @ 90kph (56mph) 33 000 – 3 380 @ 80kph (50mph) 36 000 – 3 780 @ 70kph (43mph) 42 000 – 4 380 @ 60kph (37mph) 47 000 – 4 880 @ 50kph (32mph)	1/1 – >1/10
2	£200 000 – >£20 000	Occupation: 2.4 hours/day – 15 min/day Pedestrians & cyclists: 12/hour – 1/hour	2 600 – 270 @ 110kph (68mph) 2 500 – 250 @ 100kph (62mph) 3 100 – 320 @ 90kph (56mph) 3 200 – 330 @ 80kph (50mph) 3 000 – 310 @ 70kph (43mph) 4 200 – 420 @ 60kph (37mph) 4 700 – 480 @ 50kph (32mph)	1/10 – >1/100
3	£20 000 – >£2 000	Occupation: 14 min/day – 3 min/day Pedestrians & cyclists: 1/hour – 1/day	260 – 27 @ 110kph (68mph) 250 – 29 @ 100kph (62mph) 310 – 32 @ 90kph (56mph) 320 – 33 @ 80kph (50mph) 300 – 31 @ 70kph (43mph) 420 – 43 @ 60kph (37mph) 470 – 48 @ 50kph (32mph)	1/100 – >1/1 000
4	£2 000 – >£200	Occupation: 1 min/day – 2 min/week Pedestrians & cyclists: 1/hour – 1/day	26 – 4 @ 110kph (68mph) 25 – 4 @ 100kph (62mph) 31 – 4 @ 90kph (56mph) 32 – 4 @ 80kph (50mph) 30 – 5 @ 70kph (43mph) 42 – 6 @ 60kph (37mph) 47 – 6 @ 50kph (32mph)	1/1 000 – >1/10 000
5	£200 – >£20	Occupation: 1 min/week – 1 min/month Pedestrians & cyclists: 2/day – 2/week	3 – 1 @ 110kph (68mph) 3 – 1 @ 100kph (62mph) 3 – 1 @ 90kph (56mph) 3 – 1 @ 80kph (50mph) 4 – 1 @ 70kph (43mph) 4 – 1 @ 60kph (37mph)	1/10 000 – >1/100 000

Quantified Tree Risk Assessment User Manual V5 2.3 – October 2017

Visual Tree Risk Assessment

The assessing arborist uses his skill, experience and knowledge to locate and visual abnormalities upon or surrounding the subject trees.

A visual assessment of predictable symptoms associated with tree failures and/or tree disorders that culminate to form visual tree condition. This process is accepted by professional arborists as being a first measure in the assessment and management of urban trees.

Arborist Disclaimer Statement

Tree safety management is a matter of limiting the risk of significant harm from tree failure whilst maintaining the benefits of trees in our environment.

Arborists recommend measures to enhance the structure, health, stability, and appearance of trees, while attempting to reduce the risk of living near then. Clients may choose to accept or disregard the recommendations made or seek additional advice. The recommendations made are to reduce the risk from living near and around trees and bring the associated risk down to a broadly acceptable range.

Arborists cannot detect every condition that could possibly lead to the structural failure of a tree. Trees are living organisms subject to attack from disease, insects, fungi and bad weather. There are some inherent risks with trees that cannot be predicted with any degree of certainty, even by an arborist. Arborist cannot predict acts of nature including, without limitation, storms, and wind strength, which can cause even a healthy tree to fail.

Arborists cannot guarantee that a tree will be healthy under all circumstances, or for a specified period of time.

Marri Canker Disease

Canker disease is caused by the fungal pathogen *Quambalaria coyrecup* and is contributing to the decline in marri trees *Corymbia calphylla* in the south west of WA. The fungus enters through wounds and cracks in the bark and results in the death of areas of bark and the tissue below, effectively ring barking the limb of the tree from the point of infection.

To reduce introduction of further disease, it is preferred that an EWP (elevated work platform) is used or climbing without spikes to avoid opening wounds in the bark through climbing spikes when pruning trees.

Soil Health

Mulching placed over the soil surface can mitigate trip hazards, improve soil conditions, protect plants from foot traffic and lawn equipment and suppress weeds. Furthermore, mulching increases water availability, improves soil aeration, acts as a pH buffer and increases nutrient availability. Applying a 75 – 100mm layer of mulch within the tree dripline is a simple, cost effective way to improve soil and promote plant growth.

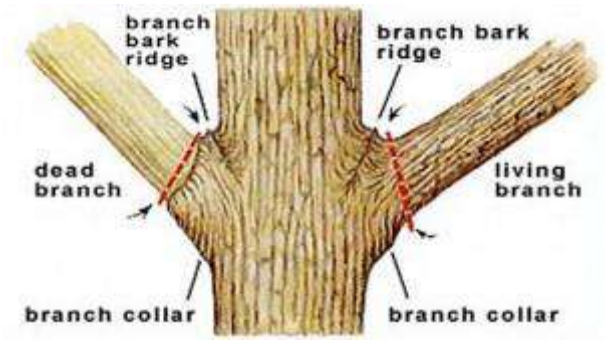
Pruning to Australian standards

Urban trees often require pruning to maintain clearance for utility services and buildings or to improve the safety, structure, health and beauty of a tree.

Outdated pruning techniques such as lopping have been previously used to maintain trees. Study has proven that these pruning techniques were unsuccessful and detrimental to the viability of trees primarily due to inability of the tree to compartmentalise the wound. Lopping is the cutting of branches or stems between branch unions or at internodes on young trees. This is an unacceptable practice for the following reasons:

1. It increases the rate of shoot production and elongation i.e. epicormic growth
2. The resulting regrowth has poor attachment and is prone to failure or collapse
3. The resulting stubs often decay
4. The natural habit and form of the tree is destroyed
5. It reduces the useful life expectancy of the tree
6. It predisposes trees to fungal infection and insect attack
7. It is not economically viable as lopped trees generally required removal or regular maintenance

Pruning specifications



1. **Clearance Pruning**

To reduce or remove branches as required to achieve physical clearance of a certain target. Usually, to maintain distance from utility services wires, gutters or of tree's over the boundaries of neighbouring properties.

2. **Crown Lifting**

Crown lifting involves removing or pruning lower limbs of trees to achieve a certain clearance from the ground/obstacles to eliminate the possibility of contact.

3. **Remedial pruning**

Involves reducing or removing branches as required to correct structural defects and restore a foundation for future growth. Remedial pruning is typically done on mature tree's to repair damages after major failure from storm events, other mechanical damage or previous poor pruning.

4. **Dead Wooding**

The removal of dead, dying, diseased, detached or broken branches is specified to improve crown appearance and long life of the tree. For the purpose of this report, major deadwood is considered limbs of 50mm diameter and above.

Site Overview of Lot 107 Bussell Hwy Cowaramup

The trees on site are predominantly Marri and have symptoms synonymous with Marri cancer infection (Quambalaria coyrecup) or are extremely susceptible to Marri Canker and the following points need to be considered;

1. It is a primary fungal pathogen and causal agent of lesion development (cankers) and eventual dieback in susceptible hosts, specifically *Corymbia calophylla* (Marri).

2. There is currently no proven method of control.

3. Marri canker is readily spread and typically appears where the trees have suffered mechanical damage (i.e. pruning).

4. Good hygiene is imperative to prevent spread of Marri canker.

Summary of Assessment

The site was assessed from observations made from ground level on 28 August 2023.

All trees on site have been identified, measured, and tagged with unique tag numbers (Fig. 1). Tags were fixed on the southern side of each tree at eye level.



Fig. 1

Tree health and structure has been documented for each tree.

All trees have been photographed and locations captured on satellite imagery.

This report has not included a tree risk assessment as usage and occupation rates have not been finalised.

Tree Survey

Tag No	Species	Crown Spread (M)	Tree Height (M)	Trunk Diameter (mm)	Health	Comments
1	Jarrah *Eucalyptus marginata*	5	11	600	Good	Co dominant stems
2	Jarrah *Eucalyptus marginata*	5	6	200	Fair	Unbalanced growth pattern
3	Marri *Corymbia calophylla*	12	22	1100	Poor	Canker infection Exposed heartwood
4	Marri *Corymbia calophylla*	10	20	500	Fair	Minor deadwood
5	Marri *Corymbia calophylla*	14	18	500	Fair	Minor deadwood Bleeding throughout trunk
6	Marri *Corymbia calophylla*	10	22	500	Fair	Unbalanced growth pattern
7	Marri *Corymbia calophylla*	4	12	250	Fair	Unbalanced growth pattern
8	Marri *Corymbia calophylla*	6	17	400	Fair	Sections of exposed heartwood at base of tree
9	Marri *Corymbia calophylla*	9	21	800	Poor	Dead limbs throughout crown Minor exposed heartwood at base
10	Marri *Corymbia calophylla*	2	10	160	Poor	Canopy predominantly dead
11	Marri *Corymbia calophylla*	5	19	250	Fair	
12	Marri *Corymbia calophylla*	15	22	700	Poor	Canker infection throughout tree
13	Marri *Corymbia calophylla*	6	19	500	Fair	Minor deadwood throughout canopy Epicormic growth
14	Marri *Corymbia calophylla*	9	18	550	Poor	Unbalanced growth pattern Canker infection Major deadwood Significant limb failure
15	Marri	11	17	600	Poor	Codominant stems Canker infection

	Corymbia calophylla					**History of significant limb failure**
16	**Marri** *Corymbia calophylla*	**5**	**12**	**400**	**Poor**	**Canker infection** **Dead crown and crown failure**
17	**Marri** *Corymbia calophylla*	**5**	**9**	**300**	**Poor**	**Canker infection throughout crown** **Predominantly dead**
18	**Jarrah** *Eucalyptus marginata*	**6**	**21**	**350**	**Fair**	**Minor deadwood**
19	**Marri** *Corymbia calophylla*	**NA**	**14**	**250**	**Dead**	**Canker infection**
20	**Marri** *Corymbia calophylla*	**2**	**8**	**150**	**Fair**	**Monir deadwood in crown**
21	**Marri** *Corymbia calophylla*	**4**	**16**	**400**	**Fair**	**Exposed heartwood at base of tree**
22	**Marri** *Corymbia calophylla*	**15**	**25**	**1000**	**Poor**	**Evidence of canker infection throughout crown** **Dead sections throughout crown**
23	**Marri** *Corymbia calophylla*	**7**	**18**	**400**	**Fair**	**Dead section in crown**
24	**Marri** *Corymbia calophylla*	**7**	**16**	**400**	**Fair**	**Unbalanced growth patterns**
25	**Jarrah** *Eucalyptus marginata*	**5**	**14**	**170**	**Fair**	
26	**Marri** *Corymbia calophylla*	**10**	**20**	**380**	**Poor**	**Significant dead area in corwn**
27	**Marri** *Corymbia calophylla*	**12**	**24**	**550**	**Poor**	**Canker infection in crown**
28	**Marri** *Corymbia calophylla*	**5**	**9**	**250**	**Fair**	**Top crown cut off previously** **All crown growth epicormic**
29	**Marri** *Corymbia calophylla*	**12**	**22**	**500**	**Fair**	**Co dominant stems**
30	**Marri** *Corymbia calophylla*	**14**	**21**	**600**	**Fair**	**Minor dead wood**
31	**Marri** *Corymbia calophylla*	**11**	**22**	**500**	**Poor**	**Canker infection at base of crown**

32	**Jarrah** *Eucalyptus marginata*	**9**	**14**	**380**	**Fair**	**Minor deadwood throughout crown**
33	**Peppermint tree** *Agonis flexuosa*	**18**	**12**	**Ave. 500**	**Fair**	**10 trunk cluster** **Poor structure** **Some failure at base of tree**
34	**Marri** *Corymbia calophylla*	**7**	**14**	**900**	**Poor**	**Previous significant limb failure**
35	**Marri** *Corymbia calophylla*	**10**	**19**	**650**	**Poor**	**Canker infection in crown**
36	**Marri** *Corymbia calophylla*	**12**	**22**	**800**	**Poor**	**Canker infection in crown**
37	**Marri** *Corymbia calophylla*	**4**	**19**	**420**	**Poor**	**Epicormic growth** **Dead sections throughout crown**
38	**Marri** *Corymbia calophylla*	**14**	**21**	**650**	**Poor**	**Exposed heartwood in trunk** **Canker infection** **Dead wood throughout tree**
39	**Marri** *Corymbia calophylla*	**15**	**16**	**700**	**Poor**	**Exposed heartwood in trunk** **Canker infection** **Dead wood throughout tree**
40	**Marri** *Corymbia calophylla*	**18**	**20**	**1000**	**Fair**	**Minor deadwood throughout tree** **Co dominant stems**
41	**Marri** *Corymbia calophylla*	**18**	**18**	**650**	**Poor**	**Canker infection** **Exposed heartwood in trunk**
42	**Eucalypt** Unidentifiable	**4**	**6**	**250**	**Poor**	**Non-native to this region** **Dead wood throughout crown**
43	**Stone fruit**	**4**	**4**	**300**	**Poor**	**Non-native to this region** **Hollowing in trunk**
44	**Stone fruit**	**5**	**4**	**300**	**Poor**	**Non-native to this region**
45	**Sugar Gum**	**12**	**10**	**450**	**Poor**	**Non-native to this region** **Co dominant stems** **Cross rubbing stems**
46	**Marri** *Corymbia calophylla*	**20**	**24**	**1100**	**Poor**	**Canker infection** **Unbalanced growth pattern** **Dead wood throughout tree**
47	**Ornamental Deciduous**	**7**	**6**	**350**	**Poor**	**Non-native to this region** **Dead and diseased limbs**
48	**Marri** *Corymbia calophylla*	**4**	**8**	**650**	**Poor**	**Exposed heartwood in crown** **Termite activity at base of trunk**
49	**Marri** *Corymbia calophylla*	**6**	**14**	**500**	**Poor**	**Exposed heartwood in crown** **Termite activity at base of trunk**
50	**Marri**	**20**	**25**	**1300**	**Poor**	**Codominant stems**

	Corymbia calophylla					**Canker infection** **Termite activity** **Exposed heartwood in trunk**
51	**Marri** *Corymbia calophylla*	**NA**	**12**	**350**	**Dead**	
52	**Marri** *Corymbia calophylla*	**7**	**19**	**500**	**Poor**	**Canker infection** **Dead wood throughout tree**
53	**Jarrah** *Eucalyptus marginata*	**5**	**10**	**320**	**Poor**	**Co dominant stem** **1 stem dead**
54	**Marri** *Corymbia calophylla*	**14**	**18**	**600**	**Poor**	**Major dead wood throughout tree** **Co dominant stem**
55	**Marri** *Corymbia calophylla*	**6**	**17**	**400**	**Poor**	**Unbalanced growth pattern** **Canker infection** **Multi stems/dead stems**
56	**Marri** *Corymbia calophylla*	**8**	**12**	**250**	**Poor**	**Unbalanced growth pattern**
57	**Marri** *Corymbia calophylla*	**8**	**22**	**450**	**Fair**	**Some evidence of canker infection in crown**
58	**Jarrah** *Eucalyptus marginata*	**9**	**16**	**460**	**Good**	**Minor dead wood**
59	**Jarrah** *Eucalyptus marginata*	**3**	**16**	**200**	**Fair**	**Co dominant stems**
60	**Marri** *Corymbia calophylla*	**9**	**20**	**700**	**Poor**	**Canker infection** **Multi stem** **Significant exposed heart wood**
61	**Marri** *Corymbia calophylla*	**10**	**20**	**600**	**Poor**	**Co dominant stems/dead stems** **Canker infection**
62	**Marri** *Corymbia calophylla*	**2**	**11**	**150**	**Poor**	**Dead wood throughout**
63	**Marri** *Corymbia calophylla*	**3**	**16**	**300**	**Poor**	**Exposed heartwood at base of tree** **Canker infection**
64	**Marri** *Corymbia calophylla*	**7**	**20**	**400**	**Poor**	**Canker infection** **Co dominant stems** **Significant dead stems throughout crown**
65	**Marri**	**3**	**14**	**80**	**Fair**	**Minor dead wood**

	Corymbia calophylla					
66	**Marri** *Corymbia calophylla*	**4**	**15**	**300**	**Poor**	**Dead stems throughout**
67	**Marri** *Corymbia calophylla*	**4**	**14**	**300**	**Poor**	**Dead stems throughout**
68	**Marri** *Corymbia calophylla*	**1**	**10**	**100**	**Poor**	**Epicormic growth** **Exposed heart wood**
69	**Marri** *Corymbia calophylla*	**7**	**17**	**400**	**Poor**	**Exposed and burnt out heart wood** **Significant crown failure** **Codominant stems**
70	**Marri** *Corymbia calophylla*	**NA**	**12**	**200**	**Dead**	
71	**Marri** *Corymbia calophylla*	**10**	**22**	**500**	**Fair**	**Minor dead wood**
72	**Marri** *Corymbia calophylla*	**NA**	**10**	**240**	**Dead**	
73	**Marri** *Corymbia calophylla*	**4**	**16**	**250**	**Fair**	**Unbalanced growth pattern** **Dead stem**
74	**Jarrah** *Eucalyptus marginata*	**3**	**14**	**200**	**Fair**	**Minor dead wood** **Epicormic growth**
75	**Jarrah** *Eucalyptus marginata*	**3**	**14**	**180**	**Fair**	**Minor dead wood** **Epicormic growth**
76	**Marri** *Corymbia calophylla*	**3**	**14**	**200**	**Fair**	**Minor dead wood**
77	**Marri** *Corymbia calophylla*	**3**	**14**	**200**	**Fair**	**Minor dead wood**
78	**Marri** *Corymbia calophylla*	**8**	**18**	**350**	**Fair**	**Minor dead wood**
79	**Jarrah** *Eucalyptus marginata*	**5**	**19**	**350**	**Fair**	**Minor dead wood**
80	**Marri** *Corymbia calophylla*	**6**	**18**	**300**	**Fair**	**Minor dead wood**
81	**Marri**	**10**	**16**	**400**	**Fair**	**Canker infection**

	Corymbia calophylla					**Minor dead wood**
82	**Marri** *Corymbia calophylla*	**4**	**11**	**300**	**Poor**	**Epicormic growth**
83	**Jarrah** *Eucalyptus marginata*	**3**	**14**	**200**	**Poor**	**Epicormic growth**
84	**Marri** *Corymbia calophylla*	**6**	**14**	**450**	**Poor**	**Unbalanced growth pattern Damage to base of tree Exposed heart wood**
85	**Marri** *Corymbia calophylla*	**12**	**18**	**550**	**Fair**	**Minor dead wood**
86	**Marri** *Corymbia calophylla*	**18**	**24**	**1000**	**Poor**	**Significant canker infection Dead wood throughout tree**
87	**Marri** *Corymbia calophylla*	**6**	**21**	**350**	**Poor**	**Unbalanced growth pattern Canker infection**
88	**Marri** *Corymbia calophylla*	**10**	**22**	**600**	**Fair**	**Minor dead wood**
89	**Marri** *Corymbia calophylla*	**8**	**15**	**350**	**Poor**	**Unbalanced growth pattern Epicormic growth**
90	**Jarrah** *Eucalyptus marginata*	**4**	**15**	**250**	**Poor**	**Exposed heart wood at base of tree Predominantly dead crown**
91	**Jarrah** *Eucalyptus marginata*	**NA**	**16**	**250**	**Dead**	
92	**Marri** *Corymbia calophylla*	**9**	**21**	**700**	**Fair**	**Minor dead wood**
93	**Marri** *Corymbia calophylla*	**12**	**24**	**700**	**Fair**	**Minor dead wood**
94	**Marri** *Corymbia calophylla*	**5**	**17**	**350**	**Poor**	**Predominantly dead in crown**
95	**Marri** *Corymbia calophylla*	**NA**	**7**	**200**	**Dead**	
96	**Marri** *Corymbia calophylla*	**8**	**20**	**600**	**Poor**	**Major dead wood Canker infection in trunk**
97	**Marri** *Corymbia calophylla*	**5**	**20**	**300**	**Fair**	**Minor dead wood**
98	**Marri**	**7**	**15**	**280**	**Poor**	**Unbalanced growth pattern**

	Corymbia calophylla					**Canker infection**
99	**Marri** *Corymbia calophylla*	**11**	**22**	**500**	**Fair**	**Minor dead wood**
100	**Marri** *Corymbia calophylla*	**8**	**20**	**400**	**Fair**	**Canker infection** **Unbalanced growth pattern**
101	**Jarrah** *Eucalyptus marginata*	**4**	**12**	**200**	**Fair**	**Minor dead wood**
102	**Marri** *Corymbia calophylla*	**10**	**20**	**600**	**Poor**	**Significant canker infection** **Dead stems**
103	**Marri** *Corymbia calophylla*	**6**	**20**	**500**	**Poor**	**Predominantly dead crown** **Epicormic growth**
104	**Marri** *Corymbia calophylla*	**6**	**18**	**360**	**Fair**	
105	**Marri** *Corymbia calophylla*	**11**	**22**	**700**	**Poor**	**Canker infection** **History of limb failure** **Major dead wood**
106	**Marri** *Corymbia calophylla*	**4**	**11**	**220**	**Poor**	**Unbalanced growth pattern** **Epicormic growth**
107	**Marri** *Corymbia calophylla*	**12**	**24**	**750**	**Poor**	**Canker infection** **Exposed heart wood at base of tree**
108	**Marri** *Corymbia calophylla*	**8**	**16**	**340**	**Fair**	**Unbalanced growth pattern** **Epicormic growth** **Dead wood in crown**
109	**Marri** *Corymbia calophylla*	**10**	**18**	**500**	**Poor**	**Failed at ground level** **Crown resting in neighbouring tree**
110	**Marri** *Corymbia calophylla*	**7**	**17**	**460**	**Poor**	**Canker infection** **Major dead wood**
111	**Marri** *Corymbia calophylla*	**7**	**14**	**300**	**Poor**	**Co dominant stems** **Exposed heart wood at base of trunk**
112	**Marri** *Corymbia calophylla*	**12**	**16**	**450**	**Poor**	**Canker infection** **Major dead wood**
113	**Marri** *Corymbia calophylla*	**8**	**15**	**350**	**Poor**	**Co dominant stems** **I stem has failed**
114	**Marri** *Corymbia calophylla*	**4**	**14**	**350**	**Poor**	**Canker infection** **Crown has failed at canker lesion** **Epicormic growth below lesion**
115	**Marri**	**7**	**12**	**440**	**Poor**	**Canker infection**

	Corymbia calophylla					**Major dead wood**
116	**Marri** *Corymbia calophylla*	**12**	**21**	**750**	**Fair**	**Unbalanced growth pattern** **Minor dead wood**
117	**Marri** *Corymbia calophylla*	**10**	**14**	**400**	**Poor**	**Canker infection** **History of limb failure**
118	**Marri** *Corymbia calophylla*	**10**	**17**	**650**	**Poor**	**Canker infection** **Exposed heart wood at base of trunk**
119	**Marri** *Corymbia calophylla*	**NA**	**8**	**200**	**Dead**	
120	**Marri** *Corymbia calophylla*	**4**	**9**	**420**	**Poor**	**Co dominant stems** **Predominantly dead crown**
121	**Marri** *Corymbia calophylla*	**10**	**17**	**550**	**Poor**	**Canker infection** **Significant limb failure**
122	**Marri** *Corymbia calophylla*	**8**	**15**	**450**	**Poor**	**Canker infection** **Major dead wood**
123	**Marri** *Corymbia calophylla*	**10**	**19**	**600**	**Fair**	**Unbalanced growth pattern** **Exposed heart wood at base of crown** **Limb failure**
124	**Marri** *Corymbia calophylla*	**8**	**15**	**600**	**Poor**	**Canker infection** **Minor dead wood**
125	**Marri** *Corymbia calophylla*	**5**	**14**	**280**	**Poor**	**Canker infection** **Major dead wood** **Significant failure in crown**
126	**Marri** *Corymbia calophylla*	**4**	**10**	**150**	**Poor**	**Canker infection** **Minor dead wood**
127	**Marri** *Corymbia calophylla*	**3**	**8**	**130**	**Poor**	**Unbalanced growth pattern**
128	**Marri** *Corymbia calophylla*	**7**	**9**	**180**	**Poor**	**Exposed heart wood at base od crown** **Canker infection**
129	**Marri** *Corymbia calophylla*	**10**	**20**	**420**	**fair**	**Minor dead wood** **Epicormic growth**
130	**Marri** *Corymbia calophylla*	**12**	**16**	**550**	**Fair**	**Unbalanced growth pattern** **Termite nest at base**
131	**Marri**	**10**	**20**	**500**	**Poor**	**Exposed heart wood** **Unbalanced growth pattern**

	Corymbia calophylla					**Termite nest at base**
132	**Marri** *Corymbia calophylla*	**7**	**14**	**400**	**Poor**	**Failed from base of tree and resting in crown of neighbouring tree**
133	**Marri** *Corymbia calophylla*	**4**	**14**	**440**	**Poor**	**Exposed heart wood at base of trunk Predominantly dead crown**
134	**Marri** *Corymbia calophylla*	**11**	**19**	**500**	**Fair**	**Unbalanced growth pattern Minor dead wood**
135	**Marri** *Corymbia calophylla*	**6**	**19**	**370**	**Poor**	**Canker infection Co dominant stems Significant dead stems**
136	**Marri** *Corymbia calophylla*	**12**	**23**	**1000**	**Poor**	**Canker infection Codominant stems Major dead wood**
137	**Marri** *Corymbia calophylla*	**11**	**20**	**900**	**Poor**	**Canker infection Codominant stems Major dead wood**
138	**Marri** *Corymbia calophylla*	**5**	**14**	**240**	**Fair**	**Epicormic growth Minor dead wood Multi stemmed**
139	**Marri** *Corymbia calophylla*	**9**	**16**	**600**	**Fair**	**Co dominant stems Exposed heart wood in crown**
140	**Marri** *Corymbia calophylla*	**7**	**17**	**500**	**Fair**	**Minor dead wood**
141	**Marri** *Corymbia calophylla*	**10**	**18**	**1000**	**Poor**	**Co dominant stems Exposed heart wood Termite infested Poor structure**
142	**Marri** *Corymbia calophylla*	**NA**	**10**	**210**	**Dead**	
143	**Marri** *Corymbia calophylla*	**12**	**20**	**650**	**Poor**	**Exposed heart wood as base of trunk Canker infection Major dead wood**
144	**Marri** *Corymbia calophylla*	**8**	**16**	**420**	**Fair**	**Unbalanced growth pattern**
145	**Marri** *Corymbia calophylla*	**6**	**13**	**270**	**Fair**	**Minor dead wood**
146	**Marri** *Corymbia calophylla*	**7**	**19**	**600**	**Fair**	**Unbalanced growth pattern**
147	**Marri**	**9**	**17**	**500**	**Poor**	**Canker infection Dead stem**

	Corymbia calophylla					
148	**Marri** *Corymbia calophylla*	**12**	**19**	**600**	**Poor**	**Co dominant stems History of limb failure Major dead wood**
149	**Marri** *Corymbia calophylla*	**8**	**16**	**650**	**Poor**	**Hollowing at base of tree Significant limb failure**
150	**Marri** *Corymbia calophylla*	**12**	**18**	**500**	**Fair**	**Unbalanced growth pattern Co dominant stems**
151	**Marri** *Corymbia calophylla*	**NA**	**10**	**220**	**Dead**	
152	**Marri** *Corymbia calophylla*	**8**	**15**	**500**	**Poor**	**Unbalanced growth pattern Co dominant stems Significant dead stem**
153	**Marri** *Corymbia calophylla*	**8**	**20**	**530**	**Fair**	**Minor dead wood**
154	**Marri** *Corymbia calophylla*	**5**	**14**	**280**	**Fair**	**Unbalanced growth pattern**
155	**Marri** *Corymbia calophylla*	**10**	**20**	**480**	**Poor**	**Dead stems throughout Significant exposed heart wood**
156	**Marri** *Corymbia calophylla*	**3**	**8**	**300**	**poor**	**Co dominant stems Crown failure Canker infection**
157	**Marri** *Corymbia calophylla*	**5**	**10**	**220**	**Fair**	**Minor limb failure**
158	**Marri** *Corymbia calophylla*	**6**	**18**	**300**	**Fair**	**Minor dead wood Minor history of limb failure**
159	**Marri** *Corymbia calophylla*	**8**	**19**	**440**	**Fair**	**Exposed heart wood at base of tree Minor dead wood**
160	**Marri** *Corymbia calophylla*	**4**	**9**	**180**	**Fair**	
161	**Marri** *Corymbia calophylla*	**9**	**16**	**550**	**Poor**	**Canker infection Major dead wood**
162	**Marri** *Corymbia calophylla*	**5**	**14**	**430**	**Poor**	**Canker infection Damaged cambium layer at base of tree**
163	**Marri** *Corymbia calophylla*	**4**	**11**	**340**	**Poor**	**Crown snapped out Epicormic growth in trunk**

Tag No	Species	Crown Spread (M)	Tree Height (M)	Trunk Diameter (mm)	Health	Comments
164	**Queensland Box tree *Lophostemon conferus***	**6**	**5**	**600**	**Good**	
165	**Queensland Box tree *Lophostemon conferus***	**6**	**5**	**600**	**Good**	
166	**Queensland Box tree *Lophostemon conferus***	**4**	**4**	**200**	**Fair**	**Exposed heartwood at base of tree**
167	**Queensland Box tree *Lophostemon conferus***	**6**	**5**	**400**	**Good**	
168	**Queensland Box tree *Lophostemon conferus***	**6**	**5**	**500**	**Good**	**Multi stem**
169	**Queensland Box tree *Lophostemon conferus***	**6**	**5**	**500**	**Good**	
170	**Marri** *Corymbia calophylla*	**6**	**18**	**400**	**Good**	**Minor previous limb failure**
171	**Marri** *Corymbia calophylla*	**10**	**20**	**600**	**Good**	**Minor damage to cambium layer at base of tree**
172	**Marri** *Corymbia calophylla*	**10**	**20**	**360**	**Good**	**Some epicormic growth to lower limbs**
173	**Marri** *Corymbia calophylla*	**7**	**17**	**200**	**Good**	
174	**Marri** *Corymbia calophylla*	**5**	**8**	**300**	**Poor**	**Significant dead stems throughout canopy**

175	**Marri** *Corymbia calophylla*	**16**	**24**	**1200**	**Fair**	**Dead wood in canopy and some diseased limbs**
176	**Marri** *Corymbia calophylla*	**12**	**12**	**600**	**Good**	**Significant lean and unbalanced growth pattern**
178	**Marri** *Corymbia calophylla*	**7**	**14**	**900**	**Poor**	**Dead wood throughout crown**
179	**Marri** *Corymbia calophylla*	**7**	**14**	**500**	**Poor**	**Significant exposed heartwood at base of tree due to previous termite activity**
180	**Marri** *Corymbia calophylla*	**2**	**4**	**170**	**Good**	
181	**Marri** *Corymbia calophylla*	**7**	**6**	**300**	**Fair**	**Unbalanced growth pattern** **Minor exposed heartwood**
182	**Marri** *Corymbia calophylla*	**10**	**11**	**500**	**Good**	**Unbalanced growth pattern**
183	**Marri** *Corymbia calophylla*	**6**	**11**	**400**	**Good**	
184	**Marri** *Corymbia calophylla*	**6**	**11**	**150**	**Good**	
185	**Marri** *Corymbia calophylla*	**12**	**14**	**500**	**Poor**	**Canker infection** **Exposed heartwood and dead stems**
186	**Marri** *Corymbia calophylla*	**10**	**19**	**550**	**Poor**	**Minor exposed heartwood at base of tree** **Significant dead stems throughout canopy** **Cancer infection**
187	**Marri** *Corymbia calophylla*	**8**	**11**	**300**	**Good**	**Major dead wood throughout tree**
188	**Marri** *Corymbia calophylla*	**8**	**4**	**120**	**Good**	
189	**Marri** *Corymbia calophylla*	**7**	**13**	**300**	**Good**	
190	**Marri** *Corymbia calophylla*	**4**	**12**	**300**	**Good**	**Minor dead wood**
191	**Marri** *Corymbia calophylla*	**10**	**14**	**600**	**Poor**	**Significant failure to crown** **Unbalanced growth pattern**

Figure 1: Tree Mapping Areas



Map Printed from FindMaps on Mon Sep 15 08:20:48 AWST 2025

Map 1: Tree Locations 1-30

Legend

Tree Locations 1-30
Tree Locations

Property boundary
Property Boundary



Map Printed from FireMaper on Thu Aug 31 06:26:57 AWST 2023

Map 2: Tree Locations 31-51

Legend

Tree Locations 31-51
Tree Locations

Property boundary
Property Boundary



Map Printed from FireMaps on Thu Aug 31 09:30:34 AWST 2023

Map 3: Tree Locations 52-81

Legend

Tree Locations 52-81
Tree Locations

Property boundary
Property Boundary



Map Printed from FirstMap on Thu Aug 31 06:44:59 AWST 2023

Map 4: Tree Locations 82-113

Legend

Tree Locations 82-113
Tree Locations

Property boundary
Property Boundary



Map Printed from FireMaps on Thu Aug 31 08:49:50 AWST 2023

Map 5: Tree Locations 114-129

Legend

Tree Locations 114-129
Tree Locations

Property Boundary
Property Boundary



Map Printed from FireMaps on Thu Aug 31 11:04:48 AWST 2023

Map 6: Tree Locations 130-163

Legend

Tree Locations 130-163
Tree Locations

Property boundary
Property Boundary



Map Printed from FireMaps on Thu Aug 31 11:09:09 AWST 2023

Map 7: Tree Locations 164-169

Legend

Tree Locations 164-169
Tree Locations

Property Boundary
Property Boundary



Map Printed from FireMaps on Mon Sep 15 08:38:30 AWST 2003

Map 8: Tree Locations 170-191

Legend

Tree Locations 170-191
Tree Locations

Property Boundary
Property Boundary



Map Printed from FloMaps on Fri Oct 20 11:52:30 AWST 2023

1	NW N NE 10°N (T) 33.851776°S, 115.098741°E ±9ft ▲ 473ft	NE SE 90°E (T) 33.851763°S, 115.098840°E ±13ft ▲ 466ft 28 Aug 2023, 12:26:44
2	N NE E 30°NE (T) 33.851865°S, 115.098764°E ±13ft ▲ 480ft	W NW N 295°NW (T) 33.851862°S, 115.098822°E ±13ft ▲ 462ft 28 Aug 2023, 12:30:09
3	NW N NE 13°N (T) 33.851898°S, 115.098780°E ±13ft ▲ 461ft	W NW N 297°NW (T) 33.851960°S, 115.098949°E ±13ft ▲ 469ft 28 Aug 2023, 12:30:37

4	NW N NE 4°N (T) 33.851914°S, 115.096686°E ±13ft 470ft	NE E SE 98°E (T) 33.851867°S, 115.096537°E ±13ft 469ft 28 Aug 2023, 12:31:14
5	N NE E 27°NE (T) 33.851950°S, 115.096682°E ±13ft 484ft	SW W NW 270°W (T) 33.851964°S, 115.096882°E ±13ft 466ft 28 Aug 2023, 12:31:47
6	NW N NE 18°N (T) 33.852033°S, 115.096705°E ±13ft 461ft	S SW W 237°SW (T) 33.851953°S, 115.096864°E ±13ft 471ft 28 Aug 2023, 12:32:31

7	NW N NE 0°N (T) 33.852015°S, 115.098650°E ±13ft ▲ 471ft	E SE S 125°SE (T) 33.851935°S, 115.098591°E ±13ft ▲ 473ft
8	NW N NE 13°N (T) 33.851990°S, 115.098643°E ±13ft ▲ 471ft	NW N NE 346°N (T) 33.852090°S, 115.098652°E ±13ft ▲ 469ft
9	NW N NE 357°N (T) 33.852060°S, 115.098590°E ±13ft ▲ 484ft	E SE S 150°SE (T) 33.851909°S, 115.098555°E ±13ft ▲ 486ft

10	NW N NE 9°N (T) 33.852024°S, 115.098617°E ±13ft ▲ 467ft	W NW N 335°NW (T) 33.852086°S, 115.098618°E ±13ft ▲ 472ft 29 Aug 2023, 12:36:03
11	NW N NE 15°N (T) 33.852029°S, 115.098699°E ±13ft ▲ 475ft	N NE E 61°NE (T) 33.852063°S, 115.098537°E ±13ft ▲ 468ft 29 Aug 2023, 12:41:28
12	W NW N 337°NW (T) 33.852115°S, 115.098755°E ±13ft ▲ 486ft	SW W NW 266°W (T) 33.852147°S, 115.098890°E ±13ft ▲ 458ft 29 Aug 2023, 12:42:11

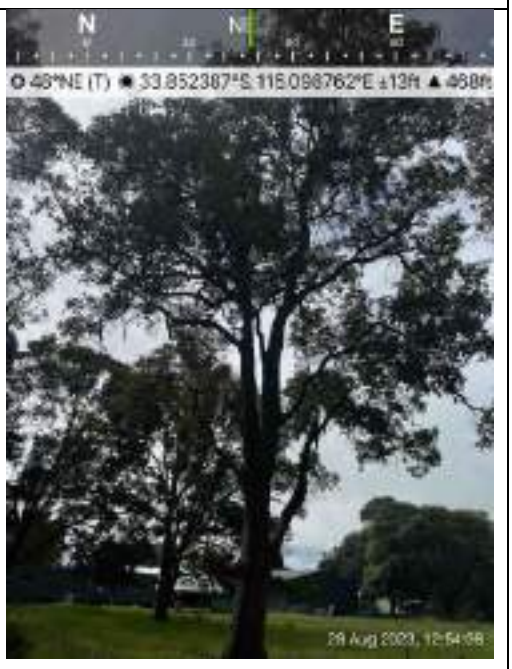
13	W NW N 332°NW (T) 33.852075°S, 115.098827°E ±13ft ▲ 475ft	SE S SW 163°S (T) 33.851945°S, 115.098883°E ±13ft ▲ 470ft 28 Aug 2023, 12:42:43
14	W NW N 330°NW (T) 33.852092°S, 115.098861°E ±13ft ▲ 468ft	NE E SE 106°E (T) 33.851971°S, 115.098832°E ±13ft ▲ 472ft
15	W NW N NE 340°N (T) 33.852162°S, 115.098951°E ±13ft ▲ 485ft	SW W NW 267°W (T) 33.852222°S, 115.099105°E ±13ft ▲ 467ft

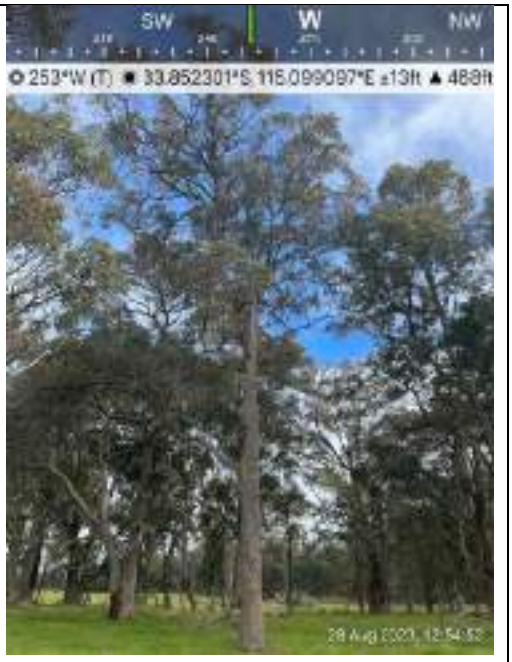
16	N NE E 52°NE (T) 33.852180°S, 115.096818°E ±13ft ▲ 466ft	W NW N 330°NW (T) 33.852242°S, 115.096909°E ±13ft ▲ 471ft 28 Aug 2023, 12:46:30
17	N NE E 37°NE (T) 33.852160°S, 115.096787°E ±13ft ▲ 470ft	S SW W 219°SW (T) 33.852101°S, 115.096828°E ±13ft ▲ 471ft
18	NW N NE 14°N (T) 33.852154°S, 115.096729°E ±13ft ▲ 471ft	SW W NW 257°W (T) 33.852088°S, 115.096844°E ±13ft ▲ 476ft

19	NW N NE E 28°NE (T) 33.852160°S, 115.098718°E ±13ft ▲ 470ft 019	E SE S SW 157°SE (T) 33.852101°S, 115.098684°E ±13ft ▲ 474ft 29 Aug 2023, 12:47:13
20	NW N NE E 21°N (T) 33.852112°S, 115.098627°E ±13ft ▲ 471ft 020	N NE E 61°NE (T) 33.852137°S, 115.098599°E ±13ft ▲ 467ft 29 Aug 2023, 12:47:38
21	NW N NE 10°N (T) 33.852079°S, 115.098571°E ±13ft ▲ 467ft 021	N N E 48°NE (T) 33.852153°S, 115.098547°E ±13ft ▲ 467ft 29 Aug 2023, 12:47:57

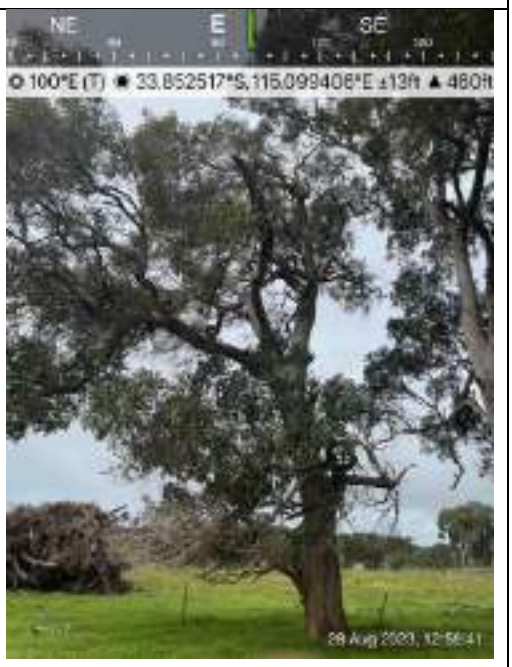
22	NW N NE E 24°NE (T) ● 33.852081°S, 115.098517°E ±13ft ▲ 484ft 027	NE E SE 90°E (T) ● 33.852108°S, 115.098452°E ±13ft ▲ 458ft
23	N NE E 35°NE (T) ● 33.852086°S, 115.098488°E ±13ft ▲ 451ft 023	NW N NE 13°N (T) ● 33.852165°S, 115.098479°E ±13ft ▲ 458ft
24	N NE E 38°NE (T) ● 33.852095°S, 115.098385°E ±13ft ▲ 463ft 024	E SE S 117°SE (T) ● 33.852056°S, 115.098294°E ±13ft ▲ 462ft

25	N NE E 41°NE (T) 33.852156°S, 115.096508°E ±13ft ▲ 459ft 025	N NE E SE 88°E (T) 33.852183°S, 115.098439°E ±13ft ▲ 456ft
26	N NE E 31°NE (T) 33.852159°S, 115.096509°E ±13ft ▲ 453ft 026	S SW W 243°SW (T) 33.852112°S, 115.098629°E ±13ft ▲ 467ft
27	NW N NE E 21°N (T) 33.852193°S, 115.098500°E ±13ft ▲ 458ft 027	E S S 137°SE (T) 33.852101°S, 115.098405°E ±13ft ▲ 454ft

28	NW N NE 20°N (T) 33.852194°S, 115.096518°E ±13ft 458ft 028	S SW W 244°SW (T) 33.852159°S, 115.096549°E ±13ft 464ft
29	N NE E 32°NE (T) 33.852245°S, 115.096715°E ±13ft 464ft 029	W NW N 327°NW (T) 33.852327°S, 115.096800°E ±13ft 465ft 28 Aug 2023, 12:53:35
30	N NE E 38°NE (T) 33.852309°S, 115.096839°E ±13ft 461ft 030	N N E 48°NE (T) 33.852387°S, 115.096762°E ±13ft 458ft 28 Aug 2023, 12:54:08

31	N NE E 43°NE (T) ● 33.852360°S, 115.099894°E ±13ft ▲ 463ft 031	SW W NW 253°W (T) ● 33.852301°S, 115.099097°E ±13ft ▲ 468ft
32	NW N NE 18°N (T) ● 33.852410°S, 115.099067°E ±13ft ▲ 464ft 032	SE S SW W 203°SW (T) ● 33.852282°S, 115.099089°E ±13ft ▲ 464ft
33	N E 48°NE (T) ● 33.852511°S, 115.099270°E ±13ft ▲ 465ft 033	S SW W 235°SW (T) ● 33.852368°S, 115.099440°E ±13ft ▲ 462ft

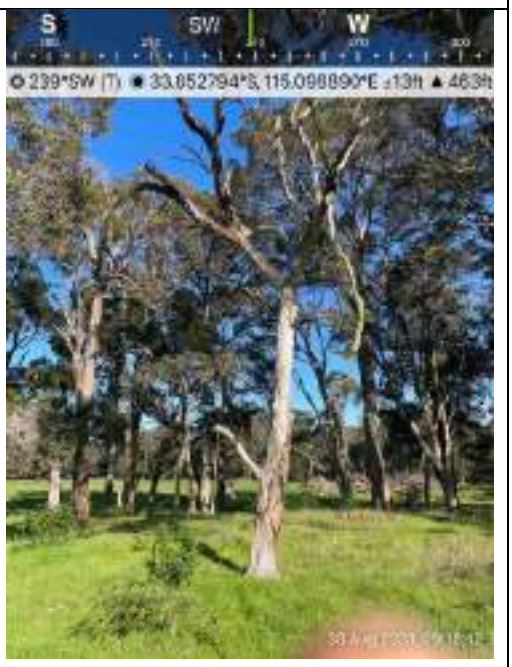
34	N NE E 28°NE (T) ● 33.852263°S, 115.099553°E ±13ft ▲ 486ft 034	NE E SE 81°E (T) ● 33.852293°S, 115.099432°E ±13ft ▲ 459ft 28 Aug 2023, 12:56:53
35	NW N NE E 24°NE (T) ● 33.852154°S, 115.099867°E ±13ft ▲ 483ft 035	NE E SE 93°E (T) ● 33.852170°S, 115.099515°E ±13ft ▲ 464ft 28 Aug 2023, 12:57:25
36	NW N NE E 24°NE (T) ● 33.852265°S, 115.099668°E ±13ft ▲ 459ft 036	N NE E 63°NE (T) ● 33.852320°S, 115.099535°E ±13ft ▲ 463ft

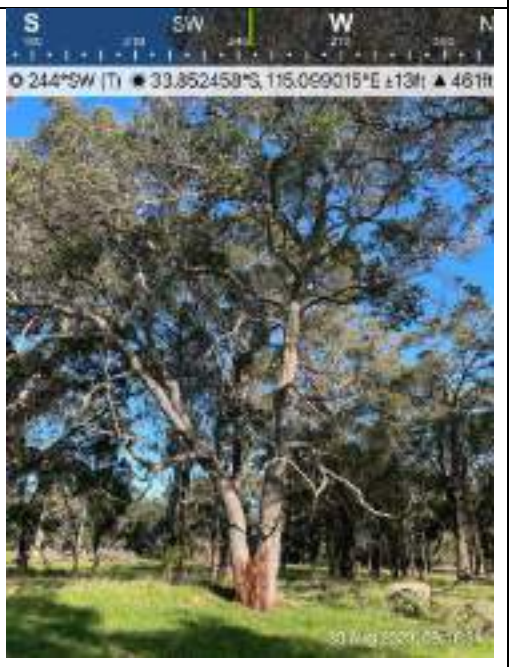
37	N NE E 27°NE (T) ● 33.852338°S, 115.099582°E ±13ft ▲ 483ft 079	NE E SE 109°E (T) ● 33.852303°S, 115.099464°E ±13ft ▲ 472ft
38	NW N NE 10°N (T) ● 33.852372°S, 115.099567°E ±13ft ▲ 486ft 078	NE E SE 83°E (T) ● 33.852359°S, 115.099416°E ±13ft ▲ 472ft
39	N NE E 24°NE (T) ● 33.852570°S, 115.099533°E ±13ft ▲ 485ft 076	NE E SE 100°E (T) ● 33.852517°S, 115.099406°E ±13ft ▲ 480ft

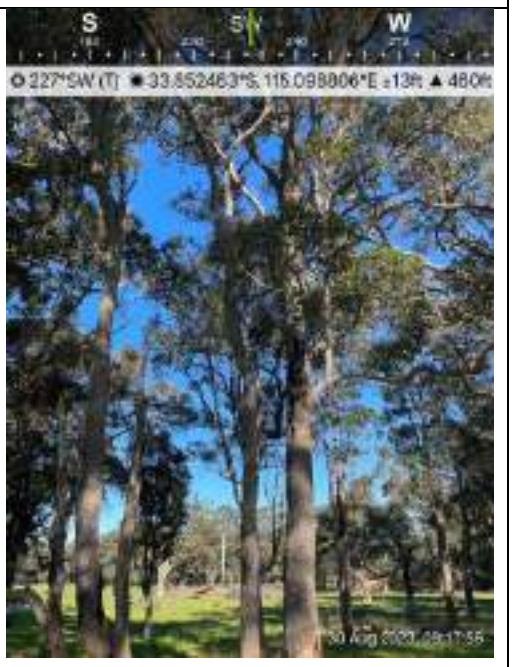
40	N NE E 27°NE (T) ● 33.852625°S, 115.099522°E ±13ft ▲461ft	NE E SE 91°E (T) ● 33.852598°S, 115.099325°E ±13ft ▲471ft
41	W NW N 336°NW (T) ● 33.852667°S, 115.099336°E ±13ft ▲466ft	N NE E SE 69°E (T) ● 33.852644°S, 115.099185°E ±13ft ▲467ft
42	NW N NE E 22°NE (T) ● 33.852786°S, 115.099466°E ±13ft ▲467ft	NE E SE 69°E (T) ● 33.852745°S, 115.099361°E ±13ft ▲472ft

43	NW N NE 354°N (T) 33.852683°S, 115.099204°E ±13ft ▲ 467ft 043	NE E SE 68°E (T) 33.852669°S, 115.099139°E ±13ft ▲ 473ft
44	NW N NE 380°N (T) 33.852760°S, 115.099192°E ±13ft ▲ 468ft 044	NE E SE 80°E (T) 33.852715°S, 115.099116°E ±13ft ▲ 469ft
45	NW N NE 12°N (T) 33.852906°S, 115.099181°E ±13ft ▲ 470ft 045	NE E SE 95°E (T) 33.852850°S, 115.099079°E ±13ft ▲ 468ft

46	NW N NE E 23°NE (T) ● 33.853089°S, 115.099048°E ±13ft ▲ 471ft 046	NE E SE 87°E (T) ● 33.853008°S, 115.098861°E ±13ft ▲ 471ft
47	NW N NE 358°N (T) ● 33.853519°S, 115.099460°E ±13ft ▲ 488ft 047	NE E SE 101°E (T) ● 33.853456°S, 115.099376°E ±13ft ▲ 475ft
48	NW N NE 2°N (T) ● 33.853009°S, 115.098813°E ±13ft ▲ 469ft 048	NE E SE 71°E (T) ● 33.852997°S, 115.098722°E ±13ft ▲ 472ft

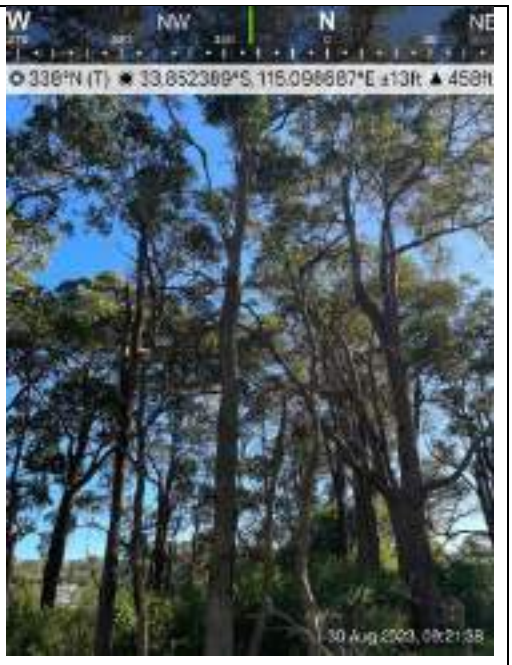
49	NW N NE 11°N (T) ● 33.852967°S, 115.098804°E ±13ft ▲ 470ft 049	E SE S 123°SE (T) ● 33.852906°S, 115.098759°E ±13ft ▲ 473ft
50	NW N NE 18°N (T) ● 33.852961°S, 115.098852°E ±13ft ▲ 475ft 050	SE S SW 177°S (T) ● 33.852761°S, 115.098919°E ±13ft ▲ 474ft
51	NW N NE 353°N (T) ● 33.852811°S, 115.098780°E ±13ft ▲ 465ft 051	S SW W 239°SW (T) ● 33.852794°S, 115.098890°E ±13ft ▲ 463ft

52	NW N NE 340°N (T) 33.852725°S, 115.098787°E ±13ft ▲ 458ft 052	S SW W 245°SW (T) 33.852732°S, 115.098916°E ±13ft ▲ 459ft
53	NW N NE 343°N (T) 33.852657°S, 115.098856°E ±13ft ▲ 454ft 053	S SW W 240°SW (T) 33.852651°S, 115.098968°E ±13ft ▲ 455ft
54	NW N NE 6°N (T) 33.852469°S, 115.098842°E ±13ft ▲ 453ft 054	S SW W 244°SW (T) 33.852459°S, 115.099015°E ±13ft ▲ 461ft

55	NW N NE 13°N (T) 33.852510°S, 115.098725°E ±13ft ▲ 453ft 055	S SW W 229°SW (T) 33.852468°S, 115.098845°E ±13ft ▲ 460ft
56	NW N NE 17°N (T) 33.852489°S, 115.098714°E ±13ft ▲ 457ft 056	S SW W 227°SW (T) 33.852463°S, 115.098806°E ±13ft ▲ 460ft
57	NW N NE 3°N (T) 33.852485°S, 115.098708°E ±13ft ▲ 457ft 057	SE S SW 175°S (T) 33.852368°S, 115.098769°E ±13ft ▲ 455ft

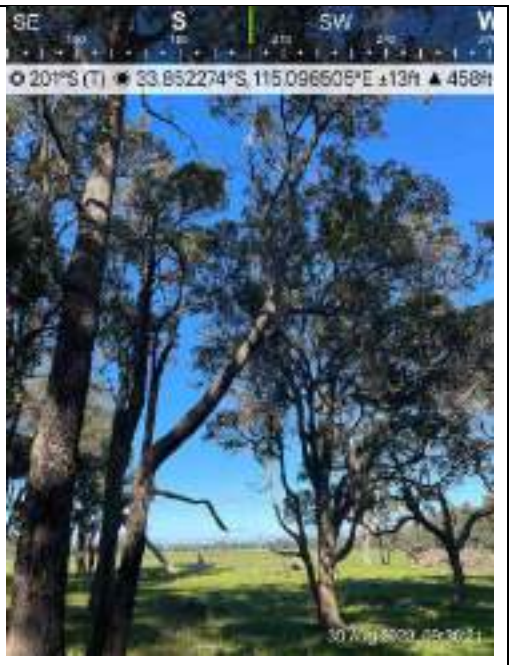
58	NW N NE 349°N (T) 33.852524°S, 115.098620°E ±13ft ▲ 449ft 058	SW W NW 252°W (T) 33.852522°S, 115.098734°E ±13ft ▲ 458ft
59	NW N NE 17°N (T) 33.852500°S, 115.098580°E ±13ft ▲ 453ft 059	S SW W 220°SW (T) 33.852438°S, 115.098709°E ±13ft ▲ 451ft
60	NW N NE 21°N (T) 33.852428°S, 115.098598°E ±13ft ▲ 451ft 060	S SW W 224°SW (T) 33.852361°S, 115.098723°E ±13ft ▲ 446ft

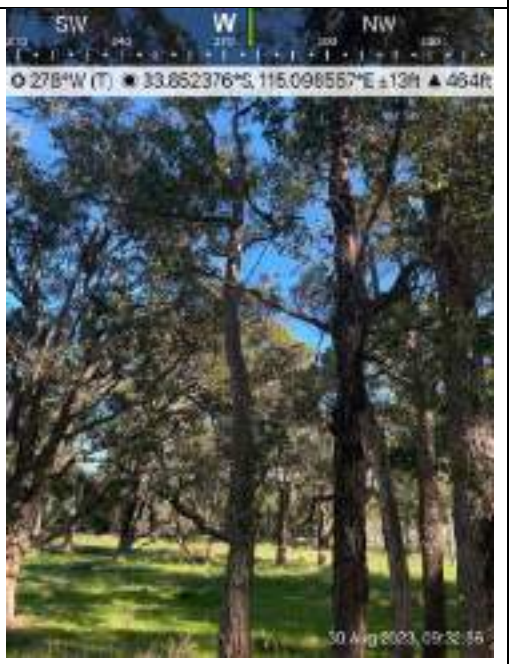
61	NW N NE 5°N (T) 33.852349°S, 115.098605°E ±13ft 454ft 061	SW W NW 275°W (T) 33.852371°S, 115.098728°E ±13ft 453ft
62	NW N NE 1°N (T) 33.852295°S, 115.098656°E ±13ft 461ft 062	SW W NW 253°W (T) 33.852303°S, 115.098696°E ±13ft 461ft
63	NW N NE 356°N (T) 33.852291°S, 115.098633°E ±13ft 455ft 063	NW N NE 15°N (T) 33.852320°S, 115.098593°E ±13ft 452ft

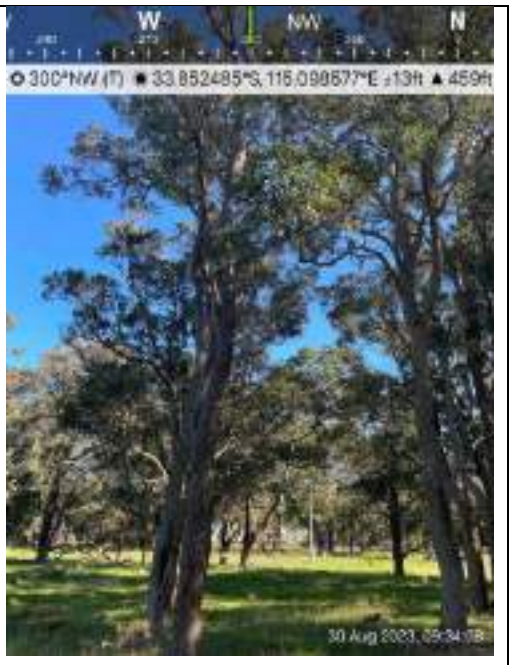
64	NW N NE 354°N (T) 33.852262°S, 115.098666°E ±13ft ▲ 459ft 064	W NW N NE 336°N (T) 33.852389°S, 115.098687°E ±13ft ▲ 458ft
65	NW N NE 5°N (T) 33.852292°S, 115.098678°E ±13ft ▲ 452ft 065	SW W NW 253°W (T) 33.852297°S, 115.098741°E ±13ft ▲ 455ft
66	NW N NE 5°N (T) 33.852268°S, 115.098651°E ±9ft ▲ 482ft 066	NW N NE 342°N (T) 33.852357°S, 115.098579°E ±13ft ▲ 450ft

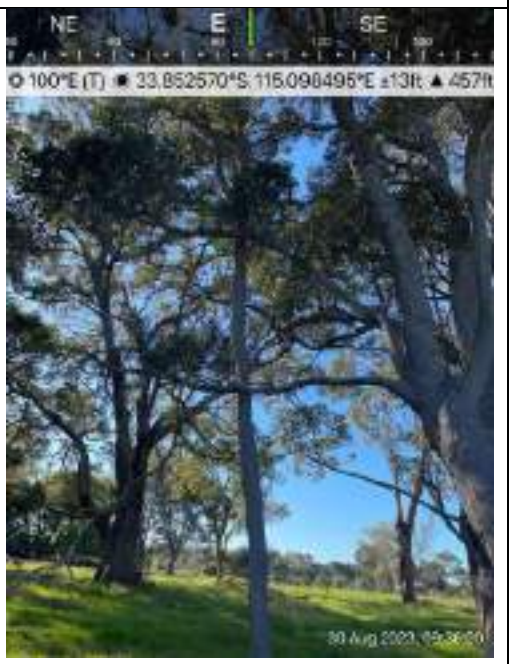
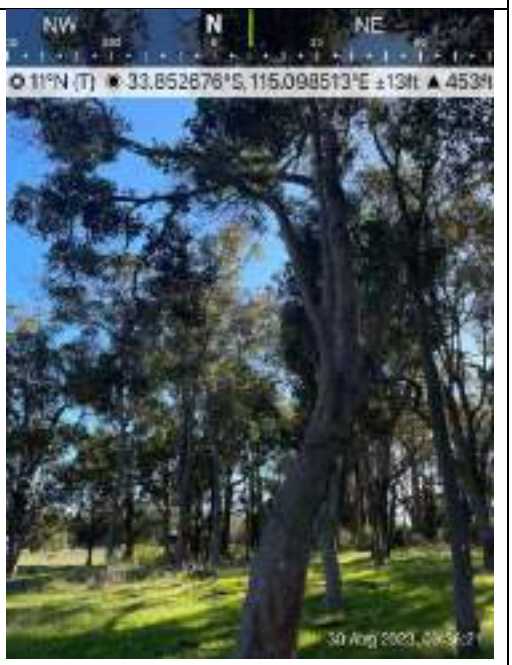
67	NW N NE 5°N (T) 33.852262°S, 115.098515°E ±13ft ▲ 454ft 090	SE S SW W 203°SW (T) 33.852218°S, 115.098584°E ±13ft ▲ 454ft
68	NW N NE 2°N (T) 33.852249°S, 115.098497°E ±13ft ▲ 451ft 090	S SW W 209°SW (T) 33.852219°S, 115.098558°E ±13ft ▲ 461ft
69	NW N NE 8°N (T) 33.852264°S, 115.098494°E ±13ft ▲ 459ft 090	NW N NE 346°N (T) 33.852307°S, 115.098503°E ±13ft ▲ 457ft

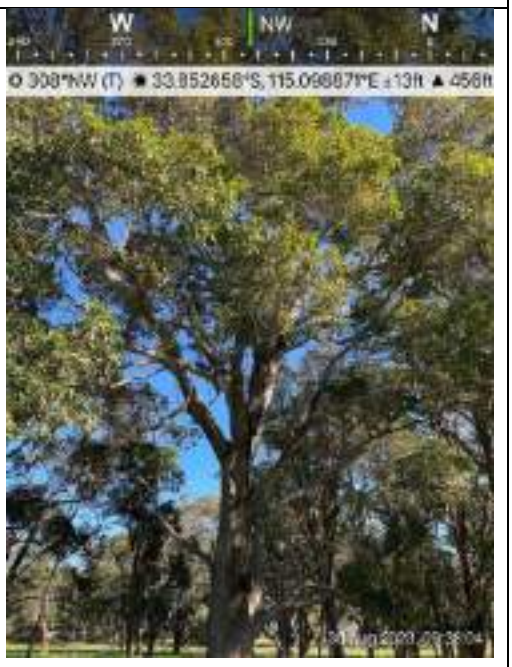
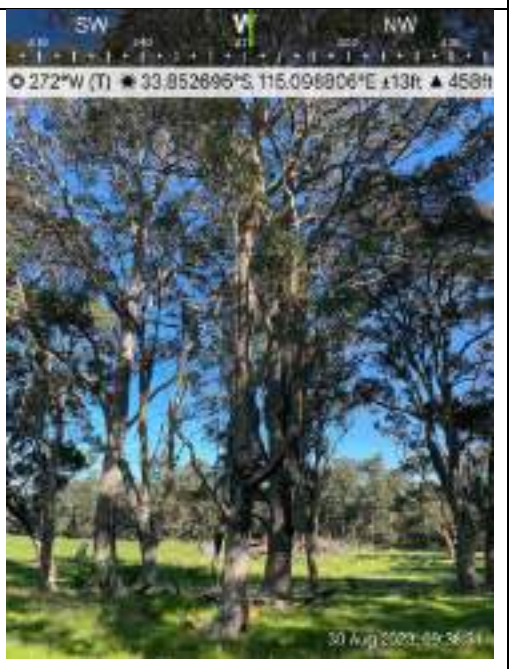
70	NW N NE 358°N (T) 33.852301°S, 115.096513°E ±13ft 454ft	SW W NW 288°W (T) 33.852305°S, 115.096672°E ±13ft 465ft
71	NW N NE 343°N (T) 33.852340°S, 115.096497°E ±13ft 455ft	NW N NE 16°N (T) 33.852295°S, 115.096599°E ±13ft 450ft
72	NW N NE 346°N (T) 33.852365°S, 115.096464°E ±13ft 449ft	N E 48°NE (T) 33.852153°S, 115.096547°E ±13ft 467ft 28 Aug 2023, 12:47:57

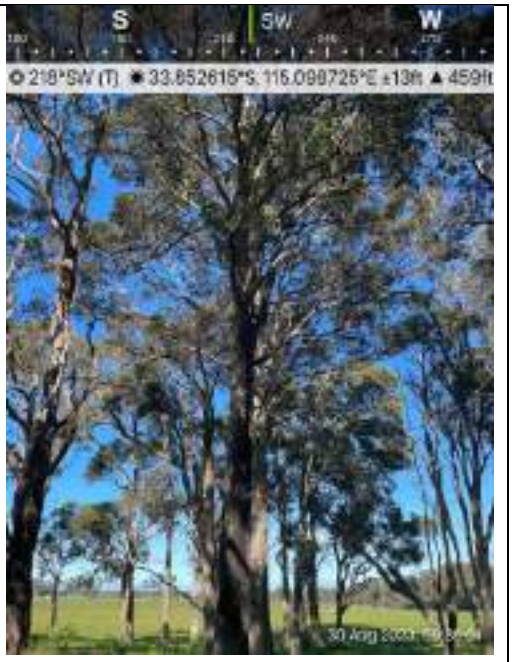
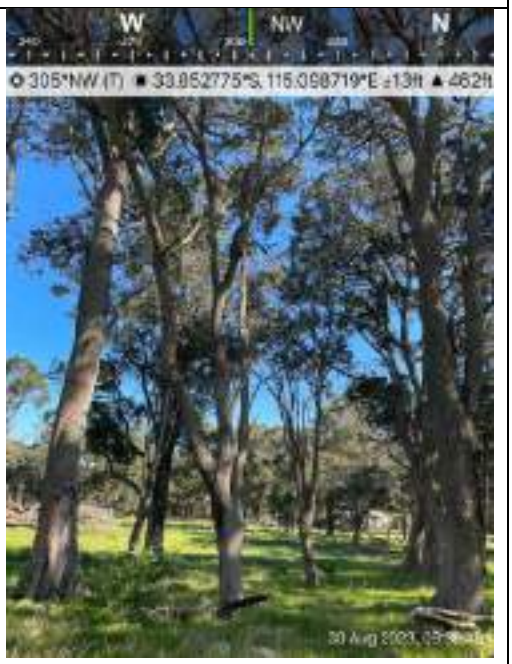
73	NW N NE 19°N (T) 33.852334°S, 115.096471°E ±13ft ▲ 456ft	SE S SW 201°S (T) 33.852274°S, 115.096505°E ±13ft ▲ 458ft
74	NW N NE 10°N (T) 33.852367°S, 115.096530°E ±13ft ▲ 456ft	W NW N 306°NW (T) 33.852412°S, 115.096567°E ±13ft ▲ 460ft
75	NW N NE 4°N (T) 33.852369°S, 115.096546°E ±13ft ▲ 460ft	SW W NW 270°W (T) 33.852385°S, 115.096614°E ±13ft ▲ 461ft

76	NW N NE 13°N (T) 33.852325°S, 115.098536°E ±13ft 454ft 0/6	E SE S 142°SE (T) 33.852300°S, 115.098517°E ±13ft 451ft
77	NW N NE 5°N (T) 33.852367°S, 115.098512°E ±13ft 455ft 0/4	SW W NW 278°W (T) 33.852376°S, 115.098557°E ±13ft 464ft
78	NW N NE 11°N (T) 33.852417°S, 115.098523°E ±13ft 462ft 0/8	SW W NW 290°W (T) 33.852442°S, 115.098628°E ±13ft 463ft

79	NW N NE E 22°NE (T) 33.852450°S, 115.09851°E ±13ft 457ft 079	W NW N 300°NW (T) 33.852485°S, 115.09857°E ±13ft 459ft 30 Aug 2023, 09:34:18
80	NW N NE E 20°N (T) 33.852445°S, 115.09846°E ±13ft 459ft 080	W NW N NE 341°N (T) 33.852504°S, 115.09850°E ±13ft 457ft 30 Aug 2023, 09:34:34
81	NW N NE 8°N (T) 33.852407°S, 115.09838°E ±13ft 459ft 081	SW W NW 259°W (T) 33.852384°S, 115.09851°E ±13ft 482ft

82	N NE E 41°NE (T) ● 33.852575°S, 115.098550°E ±13ft ▲ 454ft 0827	SW W NW 286°W (T) ● 33.852577°S, 115.098636°E ±13ft ▲ 460ft
83	NW N NE 11°N (T) ● 33.852608°S, 115.098560°E ±13ft ▲ 454ft 0835	NE E SE 100°E (T) ● 33.852570°S, 115.098495°E ±13ft ▲ 457ft
84	NW N NE 13°N (T) ● 33.852597°S, 115.098509°E ±13ft ▲ 449ft 0841	NW N NE 11°N (T) ● 33.852676°S, 115.098513°E ±13ft ▲ 453ft

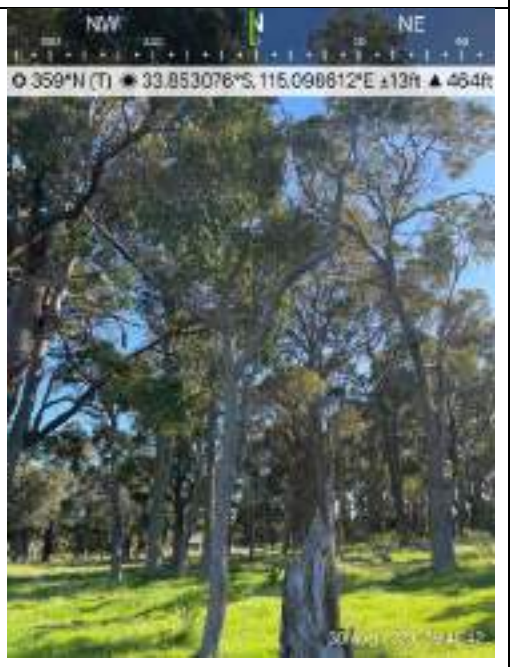
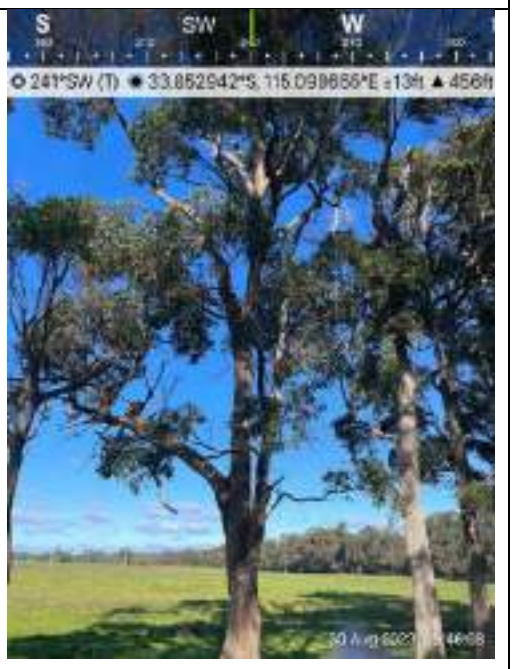
85	NW N NE 20°N (T) 33.852644°S, 115.098571°E ±13ft ▲ 449ft C80	SW W NW 281°W (T) 33.852658°S, 115.098695°E ±13ft ▲ 453ft
86	N NE E 46°NE (T) 33.852590°S, 115.098729°E ±13ft ▲ 455ft C86	W NW N 308°NW (T) 33.852658°S, 115.098671°E ±13ft ▲ 456ft
87	N NE E 28°NE (T) 33.852737°S, 115.098694°E ±13ft ▲ 462ft C87	SW W NW 272°W (T) 33.852695°S, 115.098606°E ±13ft ▲ 458ft

88	NW N NE 17°N (T) 33.852716°S, 115.098847°E ±13ft 466ft 088	S SW W 218°SW (T) 33.852615°S, 115.098725°E ±13ft 459ft
89	NW N NE E 23°NE (T) 33.852732°S, 115.098620°E ±13ft 454ft 089	W NW N 305°NW (T) 33.852775°S, 115.098719°E ±13ft 462ft
90	NW N NE 18°N (T) 33.852700°S, 115.098562°E ±13ft 467ft 090	S SW W 246°SW (T) 33.852657°S, 115.098649°E ±13ft 466ft

91	W N NE E 25°NE (T) 33.852744°S, 115.096513°E ±13ft ▲ 454ft 091	SW W NW 254°W (T) 33.852702°S, 115.096567°E ±13ft ▲ 458ft 30 Aug 2023, 09:40:49
92	NW N NE 18°N (T) 33.852708°S, 115.096435°E ±13ft ▲ 456ft 092	SW W NW 260°W (T) 33.852654°S, 115.096554°E ±13ft ▲ 451ft
93	NW N NE 14°N (T) 33.852753°S, 115.096586°E ±13ft ▲ 456ft 093	NE E SE 78°E (T) 33.852791°S, 115.096432°E ±13ft ▲ 461ft

94	NW N NE 14°N (T) 33.852784°S, 115.098586°E ±13ft ▲ 461ft 094	SW W NW 259°W (T) 33.852753°S, 115.098698°E ±13ft ▲ 460ft
95	NW N NE E 22°NE (T) 33.852864°S, 115.098598°E ±13ft ▲ 459ft 095	SW W NW 257°W (T) 33.852844°S, 115.098658°E ±13ft ▲ 461ft
96	NW N NE 19°N (T) 33.852688°S, 115.098832°E ±13ft ▲ 462ft 096	W NW N 315°NW (T) 33.852968°S, 115.098741°E ±13ft ▲ 469ft

97	N NE E 30°NE (T) ● 33.852921°S, 115.096538°E ±13ft ▲ 461ft 097	SW W NW 287°W (T) ● 33.852920°S, 115.096875°E ±13ft ▲ 464ft
98	NW N NE 16°N (T) ● 33.852898°S, 115.096520°E ±13ft ▲ 464ft 098	S SW W 217°SW (T) ● 33.852800°S, 115.096594°E ±13ft ▲ 462ft
99	N NE E 34°NE (T) ● 33.852870°S, 115.096503°E ±13ft ▲ 463ft 099	SE S SW 173°S (T) ● 33.852748°S, 115.096464°E ±13ft ▲ 458ft

100	NW N NE 2°N (T) 33.852859°S, 115.098481°E ±13ft ▲ 454ft 100	NW N NE 342°N (T) 33.852946°S, 115.098515°E ±13ft ▲ 463ft
101	N E E 44°NE (T) 33.853008°S, 115.098600°E ±13ft ▲ 464ft 101	NW N NE 359°N (T) 33.853076°S, 115.098612°E ±13ft ▲ 464ft
102	NW N NE 13°N (T) 33.853005°S, 115.098521°E ±13ft ▲ 459ft 102	S SW W 241°SW (T) 33.852942°S, 115.098666°E ±13ft ▲ 456ft

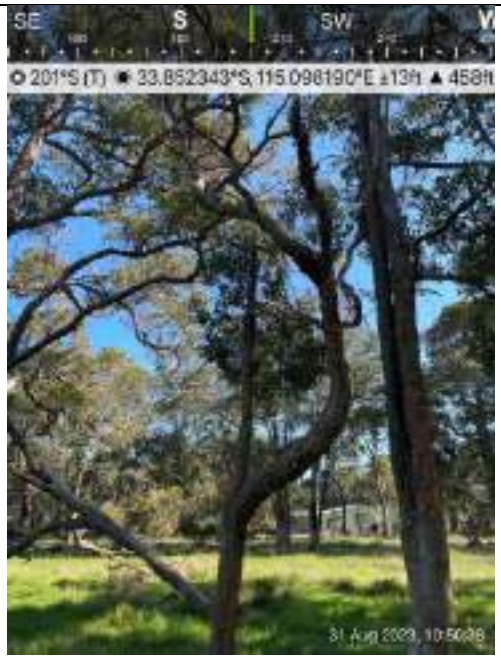
103	NW N NE 9°N (T) 33.852997°S, 115.098470°E ±13ft ▲ 453ft 103	NW N NE 359°N (T) 33.853071°S, 115.098499°E ±13ft ▲ 457ft
104	NW N NE 17°N (T) 33.852980°S, 115.098443°E ±13ft ▲ 457ft 104	E S SW W 207°SW (T) 33.852877°S, 115.098485°E ±13ft ▲ 467ft
105	NW N NE 18°N (T) 33.852960°S, 115.098395°E ±13ft ▲ 461ft 105	NW N NE 356°N (T) 33.853091°S, 115.098413°E ±13ft ▲ 461ft

106	N NE E 35°NE (T) 33.852960°S, 115.098356°E ±13ft ▲ 457ft 106	NE E SE 92°E (T) 33.852962°S, 115.098297°E ±13ft ▲ 458ft
107	N NE E 31°NE (T) 33.852944°S, 115.098365°E ±13ft ▲ 454ft 107	S SW W NW 248°W (T) 33.852899°S, 115.098495°E ±13ft ▲ 458ft
108	NW N NE 11°N (T) 33.852952°S, 115.098348°E ±13ft ▲ 457ft 108	N NE E 33°NE (T) 33.852984°S, 115.098312°E ±13ft ▲ 480ft

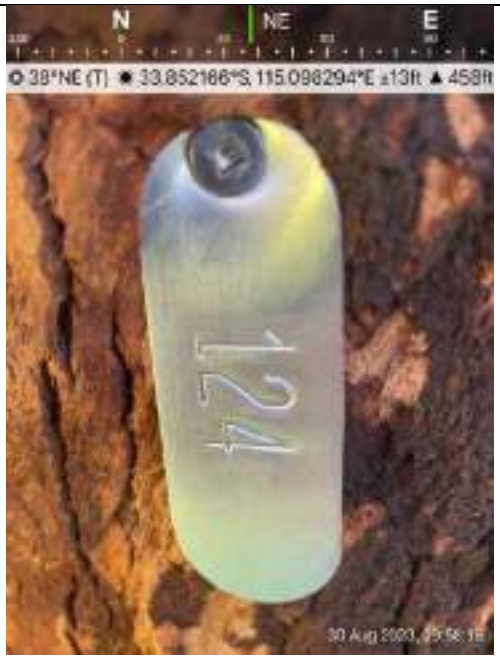
109	NW N NE E 23°NE (T) 33.852908°S, 115.098247°E ±13ft ▲ 458ft 109	N NE E 34°NE (T) 33.853028°S, 115.098255°E ±13ft ▲ 484ft
110	NW N NE 14°N (T) 33.852754°S, 115.098028°E ±13ft ▲ 461ft 110	S SW W NW 247°SW (T) 33.852701°S, 115.098120°E ±13ft ▲ 484ft
111	NW N NE 15°N (T) 33.852804°S, 115.097960°E ±13ft ▲ 457ft	W NW N 311°NW (T) 33.852855°S, 115.098025°E ±13ft ▲ 480ft

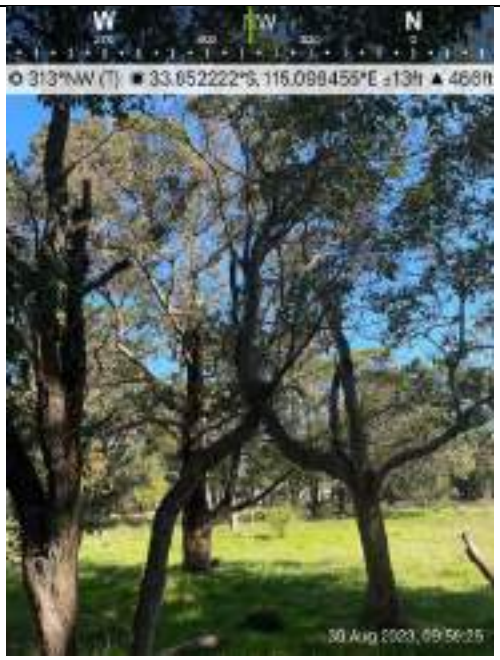
112	N NE E 31°NE (T) 33.852502°S, 115.097990°E ±13ft ▲ 457ft 112	SW W NW 268°W (T) 33.852495°S, 115.098144°E ±13ft ▲ 452ft
113	NW N NE 356°N (T) 33.852417°S, 115.098068°E ±13ft ▲ 458ft 113	S SW W 217°SW (T) 33.852390°S, 115.098126°E ±13ft ▲ 455ft
114	NW N NE E 21°N (T) 33.852412°S, 115.098117°E ±13ft ▲ 444ft 114	SW W NW N 292°W (T) 33.852432°S, 115.098167°E ±13ft ▲ 441ft

115	NW N NE 9°N (T) 33.852419°S, 115.098005°E ±13ft ▲ 445ft 115	SW W NW 254°W (T) 33.852356°S, 115.098127°E ±13ft ▲ 439ft
116	NW N NE 15°N (T) 33.852372°S, 115.098050°E ±13ft ▲ 440ft 116	SW W NW 283°W (T) 33.852358°S, 115.098206°E ±13ft ▲ 446ft
117	NW N NE E 23°NE (T) 33.852505°S, 115.098237°E ±13ft ▲ 445ft 117	S SW W 227°SW (T) 33.852408°S, 115.098302°E ±13ft ▲ 452ft

118	NW N NE E 22°NE (T) 33.852344°S, 115.098230°E ±13ft ▲ 443ft 118	S SW W 222°SW (T) 33.852225°S, 115.098289°E ±13ft ▲ 464ft
119	W NW N 297°NW (T) 33.852295°S, 115.098130°E ±13ft ▲ 461ft 119	SE S SW 201°S (T) 33.852343°S, 115.098190°E ±13ft ▲ 458ft
120	NW N NE 14°N (T) 33.852304°S, 115.098181°E ±13ft ▲ 454ft 120	SW W NW 279°W (T) 33.852306°S, 115.098219°E ±13ft ▲ 448ft

121	NW N NE 20°N (T) 33.852242°S, 115.098151°E ±13ft ▲ 456ft 121	SW W NW 254°W (T) 33.852221°S, 115.098272°E ±13ft ▲ 454ft
122	W N NE E 25°NE (T) 33.852211°S, 115.098092°E ±13ft ▲ 457ft 122	S SW W 211°SW (T) 33.852102°S, 115.098155°E ±13ft ▲ 448ft
123	NW N NE 19°N (T) 33.852214°S, 115.098152°E ±13ft ▲ 456ft 123	SW W NW 282°W (T) 33.852229°S, 115.098346°E ±13ft ▲ 457ft

124	N NE E 38°NE (T) ● 33.852186°S, 115.098294°E ±13ft ▲ 458ft 121	S W W 223°SW (T) ● 33.852091°S, 115.098392°E ±13ft ▲ 459ft
125	N NE E 54°NE (T) ● 33.852173°S, 115.098386°E ±13ft ▲ 460ft 125	NW N NE E 22°NE (T) ● 33.852239°S, 115.098366°E ±13ft ▲ 462ft
126	N NE E 39°NE (T) ● 33.852209°S, 115.098427°E ±13ft ▲ 463ft 126	W NW N 307°NW (T) ● 33.852214°S, 115.098437°E ±13ft ▲ 461ft

127	NW N NE 5°N (T) 33.852200°S, 115.098410°E ±13ft 483ft 127	W NW N 313°NW (T) 33.852222°S, 115.098455°E ±13ft 468ft 30 Aug 2023, 09:56:25
128	NW N NE 10°N (T) 33.852360°S, 115.098515°E ±45ft 593ft 128	SW W NW 290°W (T) 33.852280°S, 115.098504°E ±13ft 458ft
129	NW N NE 1°N (T) 33.852311°S, 115.098472°E ±13ft 457ft 129	W NW N 333°NW (T) 33.852304°S, 115.098510°E ±13ft 449ft

130	W NW N 313°NW (T) ● 33.851622°S, 115.097979°E ±13ft ▲ 452ft 130	SW W NW 266°W (T) ● 33.851619°S, 115.098138°E ±13ft ▲ 454ft
131	NW N NE 8°N (T) ● 33.851808°S, 115.097963°E ±13ft ▲ 461ft 131	W NW N 299°NW (T) ● 33.851821°S, 115.098094°E ±13ft ▲ 455ft
132	W NW N NE 336°N (T) ● 33.851829°S, 115.097898°E ±13ft ▲ 458ft 132	N NE E 33°NE (T) ● 33.851874°S, 115.097869°E ±13ft ▲ 456ft

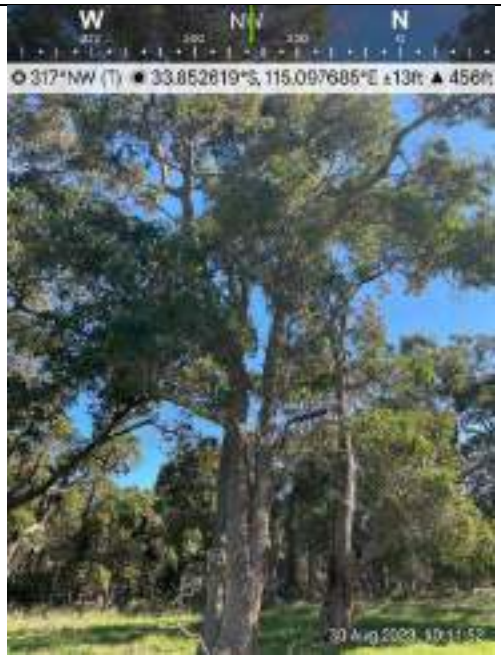
133	W NW N 334°NW (T) 33.851906°S, 115.097965°E ±13ft ▲ 456ft 133	NW N NE 341°N (T) 33.851950°S, 115.097989°E ±13ft ▲ 482ft
134	NW N NE 355°N (T) 33.851891°S, 115.097980°E ±13ft ▲ 456ft 134	W NW N 336°NW (T) 33.851997°S, 115.098078°E ±13ft ▲ 480ft
135	W NW N 323°NW (T) 33.851923°S, 115.097934°E ±13ft ▲ 460ft 135	NE E SE S 113°SE (T) 33.851887°S, 115.097852°E ±13ft ▲ 480ft

136	W NW N NE 339°N (T) 33.851967°S, 115.097941°E ±13ft ▲ 449ft 136	W NW N 317°NW (T) 33.851990°S, 115.098067°E ±13ft ▲ 459ft
137	W NW N 309°NW (T) 33.852048°S, 115.097960°E ±9ft ▲ 458ft 137	W NW N 328°NW (T) 33.852081°S, 115.098023°E ±13ft ▲ 464ft
138	NW N NE 4°N (T) 33.852049°S, 115.097866°E ±13ft ▲ 466ft 138	SE S SW 180°S (T) 33.851942°S, 115.097886°E ±13ft ▲ 457ft

139	NW N NE 7°N (T) 33.851946°S, 115.097735°E ±13ft ▲ 452ft 139	SW W NW 281°W (T) 33.851940°S, 115.097874°E ±13ft ▲ 454ft
140	W NW N NE 338°N (T) 33.851981°S, 115.097726°E ±13ft ▲ 459ft 140	SW W NW 268°W (T) 33.851980°S, 115.097825°E ±13ft ▲ 461ft
141	NW N NE 5°N (T) 33.852106°S, 115.097803°E ±13ft ▲ 459ft 141	W NW N 320°NW (T) 33.852191°S, 115.097942°E ±13ft ▲ 457ft

142	NW N NE 11°N (T) 33.852138°S, 115.097791°E ±13ft 457ft 142	SE S SW 200°S (T) 33.852071°S, 115.097804°E ±13ft 458ft 30 Aug 2023, 10:06:31
143	NW N NE 18°N (T) 33.852147°S, 115.097818°E ±13ft 459ft 143	W NW N 323°NW (T) 33.852219°S, 115.097902°E ±13ft 461ft 30 Aug 2023, 10:06:58
144	NW N NE 341°N (T) 33.852167°S, 115.097782°E ±13ft 456ft 144	W NW N 305°NW (T) 33.852199°S, 115.097827°E ±13ft 459ft

145	NW N NE 1°N (T) 33.852243°S, 115.097675°E ±13ft ▲ 463ft 145	SE S SW 171°S (T) 33.852145°S, 115.097654°E ±13ft ▲ 457ft
146	NW N NE 350°N (T) 33.852267°S, 115.097597°E ±13ft ▲ 465ft 146	S SW W 235°SW (T) 33.852167°S, 115.097678°E ±13ft ▲ 458ft
147	NW N NE 360°N (T) 33.852314°S, 115.097573°E ±13ft ▲ 463ft 147	SW W NW 258°W (T) 33.852271°S, 115.097667°E ±13ft ▲ 457ft

148	W NW N 332°NW (T) 33.852309°S, 115.097675°E ±13ft ▲452ft 148	W NW N 300°NW (T) 33.852382°S, 115.097811°E ±13ft ▲453ft
149	W NW N 333°NW (T) 33.852514°S, 115.097676°E ±13ft ▲455ft 149	SW W NW 280°W (T) 33.852494°S, 115.097714°E ±13ft ▲458ft
150	NW N NE 14°N (T) 33.852542°S, 115.097586°E ±13ft ▲458ft 150	W NW N 317°NW (T) 33.852819°S, 115.097685°E ±13ft ▲456ft

151	NW N NE 18°N (T) 33.852579°S, 115.097500°E ±13ft ▲ 454ft 151	NW N NE 3°N (T) 33.852633°S, 115.097512°E ±13ft ▲ 452ft
152	NW N NE 3°N (T) 33.852539°S, 115.097451°E ±13ft ▲ 454ft 152	SW W NW 253°W (T) 33.852499°S, 115.097529°E ±13ft ▲ 451ft
153	NW N NE 354°N (T) 33.852592°S, 115.097474°E ±13ft ▲ 456ft 153	W NW N 312°NW (T) 33.852630°S, 115.097575°E ±13ft ▲ 457ft

154	NW N NE 9°N (T) 33.852539°S, 115.097389°E ±13ft ▲ 459ft 154	S SW W 237°SW (T) 33.852492°S, 115.097452°E ±13ft ▲ 455ft
155	W NW N NE 338°N (T) 33.852567°S, 115.097379°E ±13ft ▲ 456ft 155	SW W NW 273°W (T) 33.852569°S, 115.097486°E ±13ft ▲ 454ft
156	NW N NE 2°N (T) 33.852609°S, 115.097429°E ±13ft ▲ 454ft 156	NW N NE 355°N (T) 33.852656°S, 115.097467°E ±13ft ▲ 456ft

157	NW N NE 348°N (T) 33.852598°S, 115.097404°E ±13ft ▲ 454ft 157	NW N NE 11°N (T) 33.852636°S, 115.097409°E ±13ft ▲ 455ft
158	NW N NE 352°N (T) 33.852596°S, 115.097369°E ±13ft ▲ 455ft 158	W NW N 308°NW (T) 33.852629°S, 115.097429°E ±13ft ▲ 455ft
159	W NW N 320°NW (T) 33.852635°S, 115.097375°E ±13ft ▲ 455ft 159	W NW N 304°NW (T) 33.852663°S, 115.097467°E ±13ft ▲ 456ft

160	NW N NE 344°N (T) 33.852610°S, 115.097374°E ±13ft ▲ 485ft 160	NW N NE 355°N (T) 33.852663°S, 115.097377°E ±13ft ▲ 467ft
161	NW N NE 8°N (T) 33.852701°S, 115.097365°E ±13ft ▲ 468ft 161	W NW N 331°NW (T) 33.852777°S, 115.097457°E ±13ft ▲ 459ft
162	W NW N NE 340°N (T) 33.852656°S, 115.097267°E ±13ft ▲ 457ft 162	SW W NW 290°W (T) 33.852840°S, 115.097360°E ±13ft ▲ 454ft

163	W NW N 324°NW (T) 33.852684°S, 115.097294°E ±13ft ▲ 458ft 163	W NW N 300°NW (T) 33.852692°S, 115.097377°E ±13ft ▲ 460ft
164	NW N NE 18°N (T) 33.851471°S, 115.099045°E ±45ft ▲ 0ft	SE S SW 198°S (T) 33.851422°S, 115.099137°E ±9ft ▲ 477ft
165	NW N NE 20°N (T) 33.851475°S, 115.099004°E ±13ft ▲ 450ft	SE S SW 200°S (T) 33.851396°S, 115.099046°E ±13ft ▲ 451ft

166	NW N NE 18°N (T) 33.851410°S, 115.098900°E ±13ft ▲ 452ft 166	SE S SW 195°S (T) 33.851356°S, 115.098912°E ±13ft ▲ 457ft
167	NW N NE 6°N (T) 33.851366°S, 115.098690°E ±13ft ▲ 456ft 167	SE S SW W 202°S (T) 33.851271°S, 115.098721°E ±13ft ▲ 459ft
168	NW N NE 16°N (T) 33.851293°S, 115.098485°E ±13ft ▲ 456ft 168	SE S SW W 200°S (T) 33.851200°S, 115.098511°E ±13ft ▲ 459ft

169	NW N NE 3°N (T) 33.851269°S, 115.098389°E ±13ft ▲ 456ft	SE S SW W 201°S (T) 33.851188°S, 115.098413°E ±13ft ▲ 452ft 15 Sep 2023, 10:40:47
170	NW N NE 353°N (T) 33.853595°S, 115.096396°E ±13ft ▲ 449ft	E SE S 150°SE (T) 33.853532°S, 115.096309°E ±13ft ▲ 453ft 15 Sep 2023, 10:44:49
171	W NW N 333°NW (T) 33.853603°S, 115.096447°E ±13ft ▲ 458ft	W NW N 332°NW (T) 33.853694°S, 115.096524°E ±13ft ▲ 458ft

172	NW N NE 357°N (T) ● 33.853585°S, 115.096435°E ±13ft ▲ 459ft	SE S SW 195°S (T) ● 33.853510°S, 115.096370°E ±13ft ▲ 457ft 15 Sep 2023, 10:46:48
173	NW N NE 17°N (T) ● 33.853576°S, 115.096460°E ±13ft ▲ 454ft	SE S SW 185°S (T) ● 33.853499°S, 115.096391°E ±13ft ▲ 460ft
174	NW N NE 359°N (T) ● 33.853550°S, 115.096484°E ±13ft ▲ 446ft	SE S SW 180°S (T) ● 33.853491°S, 115.096421°E ±13ft ▲ 452ft 15 Sep 2023, 10:47:29

175	NW N NE 17°N (T) 33.853531°S, 115.096513°E ±13ft ▲ 456ft	SE S SW 182°S (T) 33.853419°S, 115.096429°E ±13ft ▲ 462ft 15 Sep 2023, 10:47:35
176	NW N NE 348°N (T) 33.853419°S, 115.096804°E ±13ft ▲ 484ft	E S S 138°SE (T) 33.853358°S, 115.096715°E ±13ft ▲ 488ft 15 Sep 2023, 10:48:40
177	W NW N 337°NW (T) 33.853340°S, 115.096761°E ±13ft ▲ 461ft	E SE S 123°SE (T) 33.853289°S, 115.096822°E ±13ft ▲ 461ft

178	W NW N NE 338°N (T) 33.853330°S, 115.096867°E ±13ft ▲ 465ft	N NE E 49°NE (T) 33.853354°S, 115.096805°E ±13ft ▲ 462ft
179	W NW N 335°NW (T) 33.853300°S, 115.096814°E ±13ft ▲ 461ft	NW N NE 4°N (T) 33.853344°S, 115.096832°E ±13ft ▲ 463ft
180	NW N NE 341°N (T) 33.853290°S, 115.096812°E ±13ft ▲ 463ft	NE E SE 85°E (T) 33.853291°S, 115.096800°E ±13ft ▲ 464ft

181	W NW N 303°NW (T) 33.853290°S, 115.096882°E ±13ft ▲ 465ft 181	E SE S 150°SE (T) 33.853271°S, 115.096831°E ±13ft ▲ 482ft 15 Sep 2023, 10:50:34
182	W NW N 309°NW (T) 33.853275°S, 115.096892°E ±13ft ▲ 461ft 182	NE E SE 96°E (T) 33.853286°S, 115.096827°E ±13ft ▲ 488ft
183	NW N NE 349°N (T) 33.853254°S, 115.096845°E ±13ft ▲ 467ft 183	E SE S 145°SE (T) 33.853205°S, 115.096806°E ±13ft ▲ 473ft 15 Sep 2023, 10:51:26

184	W NW N 329°NW (T) 33.853254°S, 115.096889°E ±13ft ▲ 467ft 184	NE E SE S 112°E (T) 33.853249°S, 115.096845°E ±13ft ▲ 462ft
185	W NW N 298°NW (T) 33.853237°S, 115.096915°E ±13ft ▲ 462ft 185	SE S SW 181°S (T) 33.853182°S, 115.096887°E ±13ft ▲ 454ft
186	W NW N 317°NW (T) 33.853232°S, 115.096855°E ±13ft ▲ 460ft 186	E SE S 132°SE (T) 33.853156°S, 115.096751°E ±13ft ▲ 483ft

187	W NW N 299°NW (T) 33.853185°S, 115.096901°E ±13ft ▲452ft 187	E SE S 147°SE (T) 33.853168°S, 115.096862°E ±13ft ▲453ft
188	W NW N 299°NW (T) 33.853191°S, 115.096915°E ±13ft ▲450ft 188	E SE S 146°SE (T) 33.853182°S, 115.096915°E ±13ft ▲452ft
189	W NW N 314°NW (T) 33.853150°S, 115.096925°E ±13ft ▲451ft 189	E SE S 119°SE (T) 33.853161°S, 115.096856°E ±13ft ▲483ft

190	W NW N 303°NW (T) 33.853149°S, 115.096947°E 454ft 190	E SE S 142°SE (T) 33.853126°S, 115.096885°E 462ft
191		

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Appendix 11

Tree Retention Plan

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LEGEND

- SURVEYED TREE LOCATION
  - TREE NUMBER ON ARBORIST REPORT
  - TREE COMMON NAME
  - ASSESSED TREE CONDITION
  - TRUNK DIAMETER (mm)
- TREE CONDITION RATING - GOOD
- TREE CONDITION RATING - FAIR
- TREE CONDITION RATING - POOR
- TREE CONDITION RATING - DEAD

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

STANDARD NOTES

1. **SET OUT & DIMENSIONS.** THE CONTRACTOR SHALL SET OUT ALL PATHS, WALLS, HARD SURFACES AND ELEMENTS EITHER ON SITE PRIOR TO CONSTRUCTION AND SHALL OBTAIN THE SUPERINTENDENTS APPROVAL PRIOR TO WORKS COMMENCING. WRITTEN DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALE. CHECK ALL DRAWING SCALES IN CONJUNCTION WITH DRAWING SIZE.
2. **SERVICES & SITE ASSETS.** THE CONTRACTOR SHALL INVESTIGATE THE NATURE AND LOCATION OF ALL EXISTING SERVICES AND RETAINED SITE ASSETS AFFECTED BY THEIR WORKS. FAILURE TO TAKE DUE CARE SHALL NOT LIMIT THE CONTRACTORS LIABILITIES.
3. **REFERENCE.** THE CONTRACTOR SHALL REFER TO ALL CONTRACT DOCUMENTS, THE SPECIFICATION AND DRAWINGS PRIOR TO AND DURING THE WORKS.
4. **DISCREPANCIES.** NOTIFY SUPERINTENDENT OF ANY SUSPECTED OR KNOWN DISCREPANCIES OR ERRORS PRIOR TO THE ORDERING OF AFFECTED MATERIALS AND OR CONSTRUCTION OF AFFECTED WORKS.
5. **RELEVANT STANDARDS.** THE CONTRACTOR SHALL UNDERTAKE ALL PRICING AND WORKS IN ACCORDANCE WITH CURRENT INDUSTRY BEST PRACTICE AND ALL RELEVANT AUSTRALIAN STANDARDS.
6. **SERVICE LOCATOR.** THE CONTRACTOR SHALL UNDERTAKE A DIAL BEFORE YOU DIG PROCESS PRIOR TO COMMENCING WORKS ON SITE. THE CONTRACTOR SHALL ENGAGE A SERVICE LOCATOR TO MAP THE SPECIFIC LOCATIONS AND DEPTH OF ALL SERVICES AND ADVISE ALL RELEVANT STAFF AND SUBCONTRACTORS IN WRITING PRIOR TO COMMENCING WORKS ON SITE.

SW LANDSCAPE COLLECTIVE

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PHONE: +61 418 947 889

REV	DATE	BY	ISSUE OR AMENDMENT
D	12.10.23	CE	UPDATED SURVEY INFORMATION
C	09.10.23	CE	ADDITION OF MEMORIAL DRIVE ROAD RESERVE TREES
B	19.09.23	CE	ADDITION OF SUNSET DRIVE ROAD RESERVE TREES
A	13.09.23	CE	ISSUE FOR APPROVAL

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
EXISTING TREE ARBORIST CONDITION SUMMARY

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE
1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER
GFC-01-101

REVISION
D



LEGEND

SURVEYED TREE LOCATION - TREE TO BE RETAINED

SURVEYED TREE LOCATION - TREE TO BE REMOVED

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

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REV	DATE	BY	ISSUE OR AMENDMENT
E	12.10.23	CE	ADDITION OFMEMORIAL DRIVE ROAD RESERVE TREES
D	09.10.23	CE	ADDITION OFMEMORIAL DRIVE ROAD RESERVE TREES
C	22.09.23	CE	ADDITION OF ENGINEERS SIGHTLINE REVIEW
B	19.09.23	CE	ADDITION OF SUNSET DRIVE ROAD RESERVE TREES
A	13.09.23	CE	ISSUE FOR CLIENT REVIEW

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
PRELIMINARY SITE CLEARING / TREE REMOVAL PLAN

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE
1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER
GFC-01-103

REVISION
E



LEGEND

SURVEYED TREE LOCATION - TREE TO BE RETAINED

SURVEYED TREE LOCATION - TREE TO BE REMOVED

REFER ARBORIST REPORT BY SOUTH WEST TREE SERVICES - TREE INSPECTION AND RECOMMENDATIONS FOR LOT 102 BUSSELL HIGHWAY, COWARAMUP, DATED 31ST AUGUST 2023

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CLIENT
GOLDFIELDS COWARAMUP

PROJECT
LOT 102 BUSSELL HIGHWAY
COWARAMUP, WA

STAGE OR PHASE
MASTERPLAN

DRAWING TITLE
PRELIMINARY SITE CLEARING / TREE REMOVAL PLAN

DESIGNED BY	CE	APPROVED BY	CE
DRAWING BY	BM	DATE INITIALLY DRAWN	03.08.2023

SCALE 1:500 @ A1
0 5 10 15 20 25 m

DRAWING NUMBER GFC-01-102

REVISION E

Tag No	Species	Crown Spread (M)	Tree Height (M)	Trunk Diameter (mm)	Health	Comments	Retain Tree	Remove Tree	Comments
1	Jarrah - Eucalyptus marginata	5	11	600	Good	Co dominant stems		1	Located in private lot
2	Jarrah - Eucalyptus marginata	5	6	200	Fair	Unbalanced growth pattern		1	Located in private lot
3	Marri - Corymbia calophylla	12	22	1100	Poor	Canker infection Exposed		1	Located in private lot
4	Marri - Corymbia calophylla	10	20	500	Fair	Minor deadwood		1	Located within road access to group housing site
5	Marri - Corymbia calophylla	14	18	500	Fair	Minor deadwood		1	Located on boundary of POS and to achieve bushfire setbacks
6	Marri - Corymbia calophylla	10	22	500	Fair	Unbalanced growth pattern	1		
7	Marri - Corymbia calophylla	4	12	250	Fair	Unbalanced growth pattern	1		
8	Marri - Corymbia calophylla	6	17	400	Fair	Sections of exposed heartwood	1		
9	Marri - Corymbia calophylla	9	21	800	Poor	Dead limbs throughout crown	1		
10	Marri - Corymbia calophylla	2	10	160	Poor	Canopy predominantly dead		1	Poor condition, small tree, safety
11	Marri - Corymbia calophylla	5	19	250	Fair		1		
12	Marri - Corymbia calophylla	15	22	700	Poor	Canker infection throughout tree	1		
13	Marri - Corymbia calophylla	6	19	500	Fair	Minor deadwood throughout	1		
14	Marri - Corymbia calophylla	9	18	550	Poor	Unbalanced growth pattern	1		
15	Marri - Corymbia calophylla	11	17	600	Poor	Codominant stems Canker	1		
16	Marri - Corymbia calophylla	5	12	400	Poor	Canker infection	1		
17	Marri - Corymbia calophylla	5	9	300	Poor	Canker infection	1		
18	Jarrah - Eucalyptus marginata	6	21	350	Fair	Minor deadwood	1		
19	Marri - Corymbia calophylla	NA	14	250	Dead	Canker infection		1	Tree already dead, safety
20	Marri - Corymbia calophylla	2	8	150	Fair	Monir deadwood in crown	1		
21	Marri - Corymbia calophylla	4	16	400	Fair	Exposed heartwood at base of	1		
22	Marri - Corymbia calophylla	15	25	1000	Poor	Evidence of canker infection	1		
23	Marri - Corymbia calophylla	7	18	400	Fair	Dead section in crown	1		
24	Marri - Corymbia calophylla	7	16	400	Fair	Unbalanced growth patterns	1		
25	Jarrah - Eucalyptus marginata	5	14	170	Fair		1		
26	Marri - Corymbia calophylla	10	20	380	Poor	Significant dead area in corwn	1		
27	Marri - Corymbia calophylla	12	24	550	Poor	Canker infection in crown	1		
28	Marri - Corymbia calophylla	5	9	250	Fair	Top crown cut off previously All	1		
29	Marri - Corymbia calophylla	12	22	500	Fair	Co dominant stems	1		
30	Marri - Corymbia calophylla	14	21	600	Fair	Minor dead wood	1		
31	Marri - Corymbia calophylla	11	22	500	Poor	Canker infection at base of crown	1		
32	Jarrah - Eucalyptus marginata	9	14	380	Fair	Minor deadwood throughout		1	Tree located on POS boundary with Group Housing site
33	Peppermint tree - Agonis flexuosa	18	12	Ave. 500	Fair	10 trunk cluster Poor structure		1	Poor structure, not able to achieve clearance to ground if pruned
34	Marri - Corymbia calophylla	7	14	900	Poor	Previous significant limb failure	1		
35	Marri - Corymbia calophylla	10	19	650	Poor	Canker infection in crown		1	Poor condition on boundary of Group Housing Site
36	Marri - Corymbia calophylla	12	22	800	Poor	Canker infection in crown	1		
37	Marri - Corymbia calophylla	4	19	420	Poor	Epicormic growth		1	Poor condition, remove to achieve clearance to other trees
38	Marri - Corymbia calophylla	14	21	650	Poor	Exposed heartwood in trunk	1		
39	Marri - Corymbia calophylla	15	16	700	Poor	Exposed heartwood in trunk		1	Poor condition, remove to achieve clearance for adjacent tree
40	Marri - Corymbia calophylla	18	20	1000	Fair	Minor deadwood throughout	1		
41	Marri - Corymbia calophylla	18	18	650	Poor	Canker infection	1		
42	Eucalypt Unidentifiable	4	6	250	Poor	Non-native to this region	1		
43	Stone fruit	4	4	300	Poor	Non-native to this region		1	Non-native
44	Stone fruit	5	4	300	Poor	Non-native to this region		1	Non-native
45	Sugar Gum	12	10	450	Poor	Non-native to this region Co		1	Non-native
46	Marri - Corymbia calophylla	20	24	1100	Poor	Canker infection Unbalanced	1		

47	Ornamental Deciduous	7	6	350	Poor	Non-native to this region	1		
48	Marri - Corymbia calophylla	4	8	650	Poor	Exposed heartwood in crown		1	Poor condition, on boundary of group housing site
49	Marri - Corymbia calophylla	6	14	500	Poor	Exposed heartwood in crown		1	Poor condition, on boundary of group housing site
50	Marri - Corymbia calophylla	20	25	1300	Poor	Codominant stems Canker		1	Poor condition, on boundary of group housing site
51	Marri - Corymbia calophylla	NA	12	350	Dead			1	Tree already dead
52	Marri - Corymbia calophylla	7	19	500	Poor	Canker infection		1	Poor condition, bushfire setback to group housing site
53	Jarrah - Eucalyptus marginata	5	10	320	Poor	Co dominant stem 1 stem dead		1	Poor condition, bushfire setback to group housing site
54	Marri - Corymbia calophylla	14	18	600	Poor	Major dead wood throughout	1		
55	Marri - Corymbia calophylla	6	17	400	Poor	Unbalanced growth pattern	1		
56	Marri - Corymbia calophylla	8	12	250	Poor	Unbalanced growth pattern		1	Poor condition, smaller tree remove to provide clearance to adajcent trees
57	Marri - Corymbia calophylla	8	22	450	Fair	Some evidence of canker	1		
58	Jarrah - Eucalyptus marginata	9	16	460	Good	Minor dead wood	1		
59	Jarrah - Eucalyptus marginata	3	16	200	Fair	Co dominant stems	1		
60	Marri - Corymbia calophylla	9	20	700	Poor	Canker infection Multi stem	1		
61	Marri - Corymbia calophylla	10	20	600	Poor	Co dominant stems/dead stems	1		
62	Marri - Corymbia calophylla	2	11	150	Poor	Dead wood throughout		1	Poor condition, dead wood througout
63	Marri - Corymbia calophylla	3	16	300	Poor	Exposed heartwood at base of	1		
64	Marri - Corymbia calophylla	7	20	400	Poor	Canker infection Co dominant		1	Poor condition, multi-stemmed
65	Marri - Corymbia calophylla	3	14	80	Fair	Minor dead wood	1		
66	Marri - Corymbia calophylla	4	15	300	Poor	Dead stems throughout	1		
67	Marri - Corymbia calophylla	4	14	300	Poor	Dead stems throughout	1		
68	Marri - Corymbia calophylla	1	10	100	Poor	Epicormic growth Exposed heart	1		
69	Marri - Corymbia calophylla	7	17	400	Poor	Exposed and burnt out heart	1		
70	Marri - Corymbia calophylla	NA	12	200	Dead			1	Tree already dead
71	Marri - Corymbia calophylla	10	22	500	Fair	Minor dead wood	1		
72	Marri - Corymbia calophylla	NA	10	240	Dead			1	Tree already dead
73	Marri - Corymbia calophylla	4	16	250	Fair	Unbalanced growth pattern Dead	1		
74	Jarrah - Eucalyptus marginata	3	14	200	Fair	Minor dead wood Epicormic	1		
75	Jarrah - Eucalyptus marginata	3	14	180	Fair	Minor dead wood Epicormic	1		
76	Marri - Corymbia calophylla	3	14	200	Fair	Minor dead wood	1		
77	Marri - Corymbia calophylla	3	14	200	Fair	Minor dead wood	1		
78	Marri - Corymbia calophylla	8	18	350	Fair	Minor dead wood	1		
79	Jarrah - Eucalyptus marginata	5	19	350	Fair	Minor dead wood	1		
80	Marri - Corymbia calophylla	6	18	300	Fair	Minor dead wood	1		
81	Marri - Corymbia calophylla	10	16	400	Fair	Canker infection Minor dead	1		
82	Marri - Corymbia calophylla	4	11	300	Poor	Epicormic growth		1	Remove to achieve fire separation through POS
83	Marri - Corymbia calophylla	3	14	200	Poor	Epicormic growth		1	Remove to achieve fire separation through POS
84	Marri - Corymbia calophylla	6	14	450	Poor	Unbalanced growth pattern		1	Remove to achieve fire separation through POS
85	Marri - Corymbia calophylla	12	18	550	Fair	Minor dead wood		1	Remove to achieve fire separation through POS
86	Marri - Corymbia calophylla	18	24	1000	Poor	Significant canker infection Dead		1	Remove to achieve fire separation through POS
87	Marri - Corymbia calophylla	6	21	350	Poor	Unbalanced growth pattern		1	Remove to achieve fire separation through POS
88	Marri - Corymbia calophylla	10	22	600	Fair	Minor dead wood		1	Remove to achieve fire separation through POS
89	Marri - Corymbia calophylla	8	15	350	Poor	Unbalanced growth pattern		1	Remove to achieve fire separation through POS
90	Jarrah - Eucalyptus marginata	4	15	250	Poor	Exposed heart wood at base of		1	Remove to achieve fire separation through POS
91	Jarrah - Eucalyptus marginata	NA	16	250	Dead			1	Tree already dead
92	Marri - Corymbia calophylla	9	21	700	Fair	Minor dead wood	1		
93	Marri - Corymbia calophylla	12	24	700	Fair	Minor dead wood		1	Tree already dead
94	Marri - Corymbia calophylla	5	17	350	Poor	Predominantly dead in crown	1		
95	Marri - Corymbia calophylla	NA	7	200	Dead		1		
96	Marri - Corymbia calophylla	8	20	600	Poor	Major dead wood Canker	1		

97	Marri - Corymbia calophylla	5	20	300	Fair	Minor dead wood	1		
98	Marri - Corymbia calophylla	7	15	280	Poor	Unbalanced growth pattern	1		
99	Marri - Corymbia calophylla	11	22	500	Fair	Minor dead wood	1		
100	Marri - Corymbia calophylla	8	20	400	Fair	Canker infection Unbalanced	1		
101	Marri - Corymbia calophylla	4	12	200	Fair	Minor dead wood	1		
102	Marri - Corymbia calophylla	10	20	600	Poor	Significant canker infection Dead	1		
103	Marri - Corymbia calophylla	6	20	500	Poor	Predominantly dead crown	1		
104	Marri - Corymbia calophylla	6	18	360	Fair		1		
105	Marri - Corymbia calophylla	11	22	700	Poor	Canker infection History of limb	1		
106	Marri - Corymbia calophylla	4	11	220	Poor	Unbalanced growth pattern	1		
107	Marri - Corymbia calophylla	12	24	750	Poor	Canker infection	1		
108	Marri - Corymbia calophylla	8	16	340	Fair	Unbalanced growth pattern	1		
109	Marri - Corymbia calophylla	10	18	500	Poor	Failed at ground level		1	Tree already failed at ground, leaning over
110	Marri - Corymbia calophylla	7	17	460	Poor	Canker infection Major dead	1		
111	Marri - Corymbia calophylla	7	14	300	Poor	Co dominant stems		1	Tree within proposed road reserve
112	Marri - Corymbia calophylla	12	16	450	Poor	Canker infection Major dead		1	Tree within proposed road reserve
113	Marri - Corymbia calophylla	8	15	350	Poor	Co dominant stems I stem has		1	Tree within proposed road reserve
114	Marri - Corymbia calophylla	4	14	350	Poor	Canker infection		1	Tree within proposed road reserve
115	Marri - Corymbia calophylla	7	12	440	Poor	Canker infection Major dead		1	Tree within proposed road reserve
116	Marri - Corymbia calophylla	12	21	750	Fair	Unbalanced growth pattern	1		
117	Marri - Corymbia calophylla	10	14	400	Poor	Canker infection History of limb	1		
118	Marri - Corymbia calophylla	10	17	650	Poor	Canker infection	1		
119	Marri - Corymbia calophylla	NA	8	200	Dead			1	Tree within proposed road reserve
120	Marri - Corymbia calophylla	4	9	420	Poor	Co dominant stems		1	Tree within proposed road reserve
121	Marri - Corymbia calophylla	10	17	550	Poor	Canker infection Significant limb		1	Tree within proposed road reserve
122	Marri - Corymbia calophylla	8	15	450	Poor	Canker infection Major dead		1	Tree within proposed road reserve
123	Marri - Corymbia calophylla	10	19	600	Fair	Unbalanced growth pattern		1	Tree within proposed road reserve
124	Marri - Corymbia calophylla	8	15	600	Poor	Canker infection Minor dead		1	Tree within proposed road reserve
125	Marri - Corymbia calophylla	5	14	280	Poor	Canker infection Major dead	1		
126	Marri - Corymbia calophylla	4	10	150	Poor	Canker infection Minor dead		1	Poor condition, smaller tree remove to provide clearance to adajcent trees
127	Marri - Corymbia calophylla	3	8	130	Poor	Unbalanced growth pattern		1	Poor condition, smaller tree remove to provide clearance to adajcent trees
128	Marri - Corymbia calophylla	7	9	180	Poor	Exposed heart wood at base od		1	Poor condition, smaller tree remove to provide clearance to adajcent trees
129	Marri - Corymbia calophylla	10	20	420	fair	Minor dead wood Epicormic	1		
130	Marri - Corymbia calophylla	12	16	550	Fair	Unbalanced growth pattern	1		
131	Marri - Corymbia calophylla	10	20	500	Poor	Exposed heart wood Unbalanced	1		
132	Marri - Corymbia calophylla	7	14	400	Poor	Failed from base of tree and		1	Poor condition, remove for separation to road reserve trees
133	Marri - Corymbia calophylla	4	14	440	Poor	Exposed heart wood at base of		1	Poor condition, remove for separation to road reserve trees
134	Marri - Corymbia calophylla	11	19	500	Fair	Unbalanced growth pattern		1	Large tree in centre of lot
135	Marri - Corymbia calophylla	6	19	370	Poor	Canker infection Co dominant		1	Poor condition, remove for separation to road reserve trees
136	Marri - Corymbia calophylla	12	23	1000	Poor	Canker infection Codominant	1		
137	Marri - Corymbia calophylla	11	20	900	Poor	Canker infection Codominant	1		
138	Marri - Corymbia calophylla	5	14	240	Fair	Epicormic growth Minor dead		1	Remove for separation to road reserve trees
139	Marri - Corymbia calophylla	9	16	600	Fair	Co dominant stems		1	Remove for separation to road reserve trees
140	Marri - Corymbia calophylla	7	17	500	Fair	Minor dead wood		1	Remove for separation to road reserve trees
141	Marri - Corymbia calophylla	10	18	1000	Poor	Co dominant stems Exposed		1	Remove for separation to road reserve trees
142	Marri - Corymbia calophylla	NA	10	210	Dead		1		
143	Marri - Corymbia calophylla	12	20	650	Poor	Exposed heart wood as base of	1		
144	Marri - Corymbia calophylla	8	16	420	Fair	Unbalanced growth pattern		1	Remove for separation to road reserve trees
145	Marri - Corymbia calophylla	6	13	270	Fair	Minor dead wood	1		
146	Marri - Corymbia calophylla	7	19	600	Fair	Unbalanced growth pattern	1		

147	Marri - Corymbia calophylla	9	17	500	Poor	Canker infection Dead stem		1	Remove for separation to road reserve trees
148	Marri - Corymbia calophylla	12	19	600	Poor	Co dominant stems		1	Remove for separation to road reserve trees
149	Marri - Corymbia calophylla	8	16	650	Poor	Hollowing at base of tree		1	Remove for separation to road reserve trees
150	Marri - Corymbia calophylla	12	18	500	Fair	Unbalanced growth pattern Co	1		
151	Marri - Corymbia calophylla	NA	10	220	Dead		1		
152	Marri - Corymbia calophylla	8	15	500	Poor	Unbalanced growth pattern Co		1	Remove for separation to road reserve trees
153	Marri - Corymbia calophylla	8	20	530	Fair	Minor dead wood	1		
154	Marri - Corymbia calophylla	5	14	280	Fair	Unbalanced growth pattern	1		
155	Marri - Corymbia calophylla	10	20	480	Poor	Dead stems throughout		1	Remove for separation to road reserve trees
156	Marri - Corymbia calophylla	3	8	300	poor	Co dominant stems Crown failure		1	Remove for separation to road reserve trees
157	Marri - Corymbia calophylla	5	10	220	Fair	Minor limb failure		1	Remove for separation to road reserve trees
158	Marri - Corymbia calophylla	6	18	300	Fair	Minor dead wood	1		
159	Marri - Corymbia calophylla	8	19	440	Fair	Exposed heart wood at base of	1		
160	Marri - Corymbia calophylla	4	9	180	Fair			1	Remove for separation to road reserve trees
161	Marri - Corymbia calophylla	9	16	550	Poor	Canker infection Major dead		1	Remove for separation to road reserve trees
162	Marri - Corymbia calophylla	5	14	430	Poor	Canker infection		1	Remove for separation to road reserve trees
163	Marri - Corymbia calophylla	4	11	340	Poor	Crown snapped out Epicormic		1	Remove for separation to road reserve trees
164	Queensland Box tree *Lophostemon*	6	5	600	Good		1		
165	Queensland Box tree *Lophostemon*	6	5	600	Good		1		
166	Queensland Box tree *Lophostemon*	4	4	200	Fair	Exposed heartwood at base of		1	In proposed intersection with Memorial Drive
167	Queensland Box tree *Lophostemon*	6	5	400	Good			1	In proposed intersection with Memorial Drive
168	Queensland Box tree *Lophostemon*	6	5	500	Good	Multi stem	1		
169	Queensland Box tree *Lophostemon*	6	5	500	Good		1		
170	Marri - Corymbia calophylla	400	18	6	Good	Minor previous limb failure	1		
171	Marri - Corymbia calophylla	600	20	10	Good	Minor damage to cambium layer	1		
172	Marri - Corymbia calophylla	360	20	10	Good	Some epicormic growth to lower	1		
173	Marri - Corymbia calophylla	200	17	7	Good		1		
174	Marri - Corymbia calophylla	300	8	5	Poor	Significant dead stems	1		
175	Marri - Corymbia calophylla	1200	24	16	Fair	Dead wood in canopy and some	1		
176	Marri - Corymbia calophylla	600	12	12	Good	Significant lean and unbalanced		1	In proposed intersection with Sunset Drive
177	Marri - Corymbia calophylla	600	12	12	Poor	Canker Infection		1	In proposed intersection with Sunset Drive
178	Marri - Corymbia calophylla	900	14	7	Poor	Dead wood throughout crown		1	In proposed intersection with Sunset Drive
179	Marri - Corymbia calophylla	500	14	7	Poor	Significant exposed heartwood at		1	In proposed intersection with Sunset Drive
180	Marri - Corymbia calophylla	170	4	2	Good			1	In proposed intersection with Sunset Drive
181	Marri - Corymbia calophylla	300	6	7	Fair	Unbalanced growth pattern		1	In proposed intersection with Sunset Drive
182	Marri - Corymbia calophylla	500	11	10	Good	Unbalanced growth pattern	1		
183	Marri - Corymbia calophylla	400	11	6	Good			1	In proposed intersection with Sunset Drive
184	Marri - Corymbia calophylla	150	11	6	Good		1		
185	Marri - Corymbia calophylla	500	14	12	Poor	Canker infection		1	In proposed intersection with Sunset Drive
186	Marri - Corymbia calophylla	550	19	10	Poor	Minor exposed heartwood at		1	In proposed intersection with Sunset Drive
187	Marri - Corymbia calophylla	300	11	8	Good	Major dead wood throughout	1		
188	Marri - Corymbia calophylla	120	4	8	Good		1		
189	Marri - Corymbia calophylla	300	13	7	Good		1		
190	Marri - Corymbia calophylla	300	12	4	Good	Minor dead wood	1		
191	Marri - Corymbia calophylla	600	10	14	Poor	Significant crown failure	1		
							108	83	

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Appendix 12

Engineering Servicing Report

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SERVICING REPORT

Lot 102 Bussell Highway, Cowaramup

JDS232176.0 October 2023

Prepared for:

Goldfields Group

JDSi
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DOCUMENT REVIEW				
Revision	**Date Issued**	**Issue Type**	**Written By**	**Approved By**
Rev A	20/09/23	Draft for Review	BW	RM
Rev B	18/10/23	Final	BW	RM

1 Executive Summary

JDSi Consulting Engineers has been engaged by Goldfields Cowaramup Pty Ltd to assess the infrastructure servicing requirements associated with the proposed development of Lot 102 Bussell Highway, Cowaramup (herein referred to as the Site). This report does not address the internal subdivisional, building services or built form development requirements.

The level of investigations are limited to only that required at Structure Plan Level, and it is acknowledged that more detailed investigations will be carried out at the time of land development.

In summary, the report has found that the land identified is suitable for future development with regards to critical infrastructure.

- Stormwater drainage will be designed and managed in accordance with an Urban Water Management Plan (UWMP), which will be prepared prior to development and needs to be approved by the Shire of Augusta Margaret River, in conjunction with Department of Water and Environmental Regulation Authority requirements.
- Sewer infrastructure already services the proposed site. There are no pump stations required to develop this site and all lots will be connected to gravity mains with no impediment.
- Water mains supply is available, and the property is surrounded with existing mains for connection within Bussell Highway and Sunset Drive.
- It is likely that power for the site will be provided from High Voltage and underground power feeders that are present within the property boundary. Prior to development, Western Power will provide updated advice with regards to capacity within the region and connection requirements.
- Reticulated gas is not present within the region, however this is not a critical service and future lot owners will likely provide their own bottled supply if required,
- Communication mains are present adjacent the site. Discussions with NBN indicate there are no major constraints with servicing the site with NBN compliant communications.
- Road access will be provided from 3 existing roads surrounding the site. Direct access onto Bussell highway will provide an ideal connection to handle expected traffic volumes from the site at full development.

The information within this report has been provided by relevant servicing Authorities and high-level investigations by the Project team. Future capacities of networks and availability of services will need to be re-evaluated at the time of ultimate development.

2 Key Objectives

The key objectives of this report are to:

- Review and analyse existing documentation associated with the site
- Summarise any existing infrastructure assets within the vicinity of the site
- Summarise key engineering and servicing constraints and opportunities associated with the proposed development
- Summarise Water Corporation's requirements for sewer and water reticulation and supply to the site
- Summarise Western Power's requirements for electrical reticulation and supply to the site, along with any major forward works on existing infrastructure
- Summarise ATCO's requirement for gas reticulation to the site
- Summarise NBN's servicing and supply requirement for telecommunication to the site
- Summarise Telstra's existing infrastructure supplying and/or impacting the site
- Provide commentary on the overall stormwater drainage strategy for the proposed development
- Provide commentary on potential road upgrades and improvements required to facilitate access to the site

3 Introduction

Goldfields Cowaramup Pty Ltd (Goldfields) have requested JDSi to assess the Engineering constraints and opportunities associated with development of Lot 102 Bussell Highway, Cowaramup.

The high-level investigations are considered appropriate to support the Local Structure Plan submission.

This report has been based on the Structure Plan, as included in ***Appendix A.*** Based on this layout and information provided by the Client, the Development will consist of 243 mixed density (R12.5 to R60) residential lots. which consists of the following yields:

- 183 dwellings (R12.5 to R30)
- 60 dwellings (R60) (as per advice from Client, September 2023).

This report covers the engineering infrastructure requirements to service the proposed Development.

JDSi have considered roads, stormwater drainage, wastewater, potable water, power, gas and communication services, with a particular emphasis on the existing service capacity, potential connection locations and the potential infrastructure upgrades required to support the proposed development.

The report has been based on a desktop study of existing services information, a site visit in September 2023, aerial imagery, preliminary advice from various service authorities, industry standards/policies and JDSi's experience. The information is current as of September 2023 and may be subject to change as development progresses in the area.



Figure 1: Site Location

4 Study Area

The Site is bounded by Memorial Drive to the north, Bussell Highway to the east, Sunset Drive to the west and Lot 555 Bussell Hwy to the south.

The Site consists of:

- vacant land formerly used for agricultural (grazing) purposes
- remnant vegetation over the north / north-western portion of the Site,

The Site is within the municipality of the Shire of Augusta Margaret River.

Lot 102 has a land area of 19.64 ha and is currently zoned “Future Development” under the Shire of Augusta / Margaret River TPS.

4.1 Topography

The Site is a largely rectangular shaped parcel of land with surface elevations ranging from approximately 132m AHD in the northeast of the site to 126m AHD in the southwest of the site (Refer *Figure 2*). Surrounding land is higher to the east of Bussell Hwy, up to approximately 140mAHD, generally sloping to the southwest through Lot 102, with adjoining land to the west lower, at approximately 125m AHD.

A feature survey of the site has been undertaken and provided by MNG on 06/07/2023.

A below ground services survey was also undertaken and provided by MNG on 14/07/2023.

A copy of both the feature and existing services surveys are provided in ***Appendix B.***



Figure 2: Site Topography (Water Corporation ESInet Data 2023)

4.2 Geological Setting

Douglas Partners geotechnical report, 2008 states that the Site is located within "the Cowaramup Mentelle 1:50,000 Regolith Landform sheet, which indicates that shallow subsurface conditions beneath the site comprise silty gravelly sand over mottled sandy clay of colluvial origin, in turn underlain by granitic bedrock of the Leeuwin Complex. Residual duricrust may occur."

The geotechnical investigation undertaken by Douglas Partners revealed soil profiles that followed this general description. Sand of variable depth overlies gravelly clayey sand / clayey sand. Duricrust ("ironstone") was encountered in several mid- to upper-slope locations at depths between 0.5m and 3.3m. The ironstone is underlain by variable thickness sandy clay. Granite rock was encountered (refusal) in a cluster of three test pits in the lowest (SW) corner of the site. Depth to granite varied between 3.1 to 3.7m BGL.

4.3 Groundwater

Government groundwater databases are absent for the area.

The Douglas Partners geotechnical investigation was undertaken in May 2008. Although only at the commencement of winter, seepage of groundwater was observed in half (14 of 28) test pits, generally along the interface(s) between sandy and clayey materials. Groundwater seepage was generally greater than 1.5m deep.

It is not expected that groundwater will significantly impact the proposed development. Groundwater levels will need to be further investigated and it is recommended that specialist consultants to be engaged to confirm maximum groundwater levels for the Site and this is considered as part of the drainage, earthworks and design for the development.

Subsoil drainage will be incorporated to assist and control the groundwater levels throughout the site.

4.4 Acid Sulphate Soils

The Douglas Partners geotechnical report indicates that the southern portion of the site has "moderate to low risk of ASS occurring within 3m of the natural soil surface", with the northern portion having "low to no known risk of acid sulphate soils occurring within 3m of the natural soil surface". If ASS is present, all construction will be in accordance with an approved environmental management plan.



Figure 3: Acid Sulphate Soil Risk Mapping (MNG Access)

5 Stormwater Drainage

Stormwater drainage management for the development will need to be designed and constructed in accordance with Shire of Augusta Margaret River design guidelines and DWER Water Sensitive Urban Design (WSUD) guidelines.

Stormwater management for the development will likely require:

- Demonstration that post-development flow rates do not exceed pre-development flow rates
- Standard pit and pipe drainage systems within the road reserves to convey up to the 20% AEP (1 in 5 yr ARI)
- Clear overland flow path for events greater than the 20% AEP, with a minimum 300mm freeboard to habitable floors
- Detention storage area (basin) in the lowest, southwest portion of the site to reduce peak flow rates to the capacity of downstream facilities
- Subsoil drainage system to be considered in any areas where Average Annual Maximum Groundwater Levels (AAMGL) are within 900mmm of road surface and/or 1200mm of lot pad levels
- Surface and groundwater quality will need to achieve pre-development levels

Drainage connections will be provided to every lot which will collect rainwater and convey runoff downstream to ultimate discharge locations throughout the site.

Due to the low permeability of the subsoil structure, it is envisaged that infiltration of stormwater will not be achieved, instead, any flows leaving the site will be detained and compensated in basins to achieve predevelopment flow rates.

6 Sewer Reticulation

Water Corporation operates a gravity sewerage network in the area surrounding the Site, with the locations of their existing infrastructure depicted in *Figure 3*. Any connection into this system will need to be designed, approved and constructed in accordance with standard Water Corporation requirements. Any internal plumbing works on the Site will need to meet the requirements of AS3500 'Plumbing and drainage' as documented by the Building Services consultant.

The existing gravity sewerage network is located to the east and southwest of the Site, with an existing Ø225 sewer main passing through the Site. The Ø225 continues to the southwest of the site, to the Type 40 "Smokebush Court" WWPS. The WWPS discharges via a Ø150 pressure main that runs along the western side of Sunset Dr, along Memorial Drive where it joins the Ø150 "Brockman Ed" pressure main, then northward to the Bussell Hwy Cowaramup Type 40 WWPS.

The Bussell Hwy Cowaramup WWPS then discharges via a Ø150 to Ø200 pressure main that travels south along Bussell Hwy through to the Margaret River WWTP. This pressure main passes the eastern boundary of the Site on the western verge of Bussell Hwy, then runs westward along the southern boundary of the Site, before heading south through the adjoining property.

A redundant "disused" pressure main traverses the site. It is expected that this main can be removed from the site, or left insitu if deep enough not to cause issue to future residents.

There are six existing connection locations to the existing Ø225 sewer where Ø150 sewer stub lines have previously been installed. These are indicated in *Figure 3* along with their approximate depths as calculated from as-constructed data on Water Corporation's Esinet system.

It must be noted that the subdivision layout shown on the Water Corporation Planning Scheme has been superseded, with the currently proposed subdivisional layout and existing sewer network shown in ***Appendix A.*** The amended road reserve alignment will require the existing sewer infrastructure to be either decommissioned or removed.

Based on preliminary review, the Site can be serviced at its current ground level by the revised sewer shown along the proposed internal road network, tying in to the existing Ø225 sewer in the southwest corner of the site.



Figure 4: Preliminary Sewer Layout (Esinet)

Water Corporation planning for this area (Catchment 0311, Cowaramup SD242) shows the existing Ø225 gravity main extending through the site to the southwest corner. This existing main would service the southern portion of the Site. A Ø150 main is shown to extend from the existing Ø225 in the southwest of the Site, along the unmade road reserve and Sunset Dr then into the Site, to service the northern portion. Refer *Figure 4* and ***Appendix C***.

JDSi understand this existing sewer will not align efficiently with the proposed layout, and therefore will need to be decommissioned.



Figure 5: Water Corporation Wastewater Planning

A summary of key items from the Water Corporation planning scheme is summarised below:

- Original scheme planning for this catchment (0311) allowed for a Sewer Design Flow (SDF) of 3.1 L/s
- The total SDF into Smokebush Court WWPS is 20.5 L/s
- The Ø225 sewer outlet from the Site will cope with all the flow (typically up to around 22 L/S).
- The existing pump rate at Smokebush Court WWPS is 19.4L/s forecast to increase to a long-term pump rate of 27.3L/s.
- It is anticipated that the SDF from the development will not trigger any pump station or pressure main upgrades
- The development can proceed as per the proposal with no anticipated upgrades to the wastewater conveyance network.

It is therefore anticipated that no major external sewer upgrade works will be required to service the Site, noting that the Developer will be responsible for the design and installation of any new reticulation mains required to service the Site.

All new wastewater works installed for the Development will need to be designed and constructed in accordance with Water Corporations guidelines, including the Developers Manual and Design and Construction Requirements for Gravity Sewer Ø150 to SN600 (DS50).

7 Water Reticulation

The Water Corporation owns and maintains the potable water reticulation system in the vicinity of the Site. Any connection into this system will need to be designed, approved and constructed in accordance with standard Water Corporation requirements. It would be expected that a standard development condition addressing the above will be included on any WAPC approval.

The Water Corporation service the Cowaramup area via the supply main from Margaret River, which passes the southern boundary of the Site, before extending east along Wirring Road to the Wirring Road Supply Tank (*Figure 5*). This tank currently has a capacity of 1ML. The reticulation system stems from the Wirring Road Tank.



Figure 6: Existing Water Corporation water supply infrastructure (Esinet)

Based on the Water Corporation Esinet data the reticulation network near the site consists of an existing Ø250 P-12 water reticulation main running along Roy Earl Dr to the east of the Site and eastern side of Bussell Hwy. A Ø250 P-12 main runs along Sunset Drive on the western side of the Site. A Ø200 P-12 main is located on the northern side of the site, along Memorial Dr. A short section of Ø58 AC main extends south from Memorial Dr along Bussell Hwy, for approximately 100m. Refer to *Figure 6*



Figure 7: Existing Water Corporation surrounding water infrastructure (Esinet)

Formal planning advice received from Water Corporation is summarised below, with a full copy provided in ***Appendix C.***

- Water Corporation have not yet undertaken detailed water reticulation planning over this subdivision area
- Water Corporation assumes that the existing Ø250mm reticulation main on Roy Earl Drive will be extended along the main subdivision boulevard to interconnect with the existing Ø250 main on Sunset Drive

- Other reticulation mains within the Site would be either 100mm or 150mm in size
- With respect to the water source capacity (Wirring Rd Tank), Water Corporation has timed construction of a new 4ML storage tank for delivery by around 2032, based on a projection of service connections and overall scheme consumption data
- The existing 1ML supply is at increasing risk of breaching during the summer peak periods (Christmas through to March) if even the Lot 102 Stage 1 (65 No.) lots are released ahead of the tank being upgraded
- Water Corporation are monitoring subdivision development, lot release and build rates in the town and will endeavour to time the tank upgrade project accordingly

To provide a potable water supply to the development, suitably qualified persons will be required to design the proposed water reticulation network and submit to the Water Corporation for approval.

Applicable headworks charges will need to be paid by the Developer and these will be determined by the Water Corporation at the time of application.

All water main extensions required for the development site will be laid within the existing and proposed road reserves, on the correct alignment and in accordance with the Utility Providers Code of Practice and Water Corporations Water Reticulation Pipelines DN250 and Smaller (DS63). These mains can then be used to provide both potable and fire water connections to each lot, noting that flow and pressure checks will need to be done as part of any assessment of fire water supply for commercial or multi-storey residential developments.

Due to the close proximity of existing mains, the development can easily be serviced without any offsite mains upgrades.

8 Power Supply

Western Power owns and operates all electrical supply network assets within the development area and therefore all new electrical supply equipment and cables will need to be installed in accordance with Western Power, WAER (West Australian Electrical Requirements), AS3000 specifications and Standards.

The total load for the ultimate development has been estimated to be 1.32MVA and has been calculated using Western Power's recommended Design After Diversity Maximum Demand (DADMD). The estimated loads are summarised below.

Table 1: Estimated loads.

Load Type	Volume	Load Allowance	kVA Allocated
Residential	183 Dwellings	4.7kVA/dwelling	860 kVA
Group Housing	60 Dwellings	3.1kVA/dwelling	186 kVA
POS	6	30kVA / space	180 kVA
		Total DADMD	**1226 kVA**

The following advice is based on JDSi desktop studies and supporting information obtained from the Western Power NCMT (Network Capacity Mapping Tool) online database. Refer to Figure 8 and **Appendix D.**

Existing HV Overhead and Underground network have been identified within the vicinity of the development, originating from the Margaret River Zone Substation. Margaret River Zone Substation is the closest existing bulk electricity connection, located approximately 11km to the development site. Based on Western Power forecasts remaining capacity for 2028, it is estimated that 15-20MVA is available for this HV feeder nearest to the development site.

The nearest points of connection to the WP distribution network for the site are the identified HV overhead and underground network along Memorial Drive and Wirring Road.

The development will require the removal/relocation of the existing WP infrastructure within and adjacent to unencumber the site and to additionally satisfy the typical WAPC conditions for new developments. The existing infrastructure consists of Overhead HV aerials through the site, Overhead LV aerials and streetlighting adjacent to the development.

The development is estimated to require two 630kVA transformers (2 x 630kVA = 1,260kVA) and two high voltage switchgear kiosks to bring the HV power network into the subdivision.

Please note Western Power cannot reserve network capacity therefore the above advice is current as at the date of this report. Once the Development planning has been finalised it is recommended a formal Design Information Package (DIP) request is submitted to Western Power in order to progress the design of the first stage of the Development.

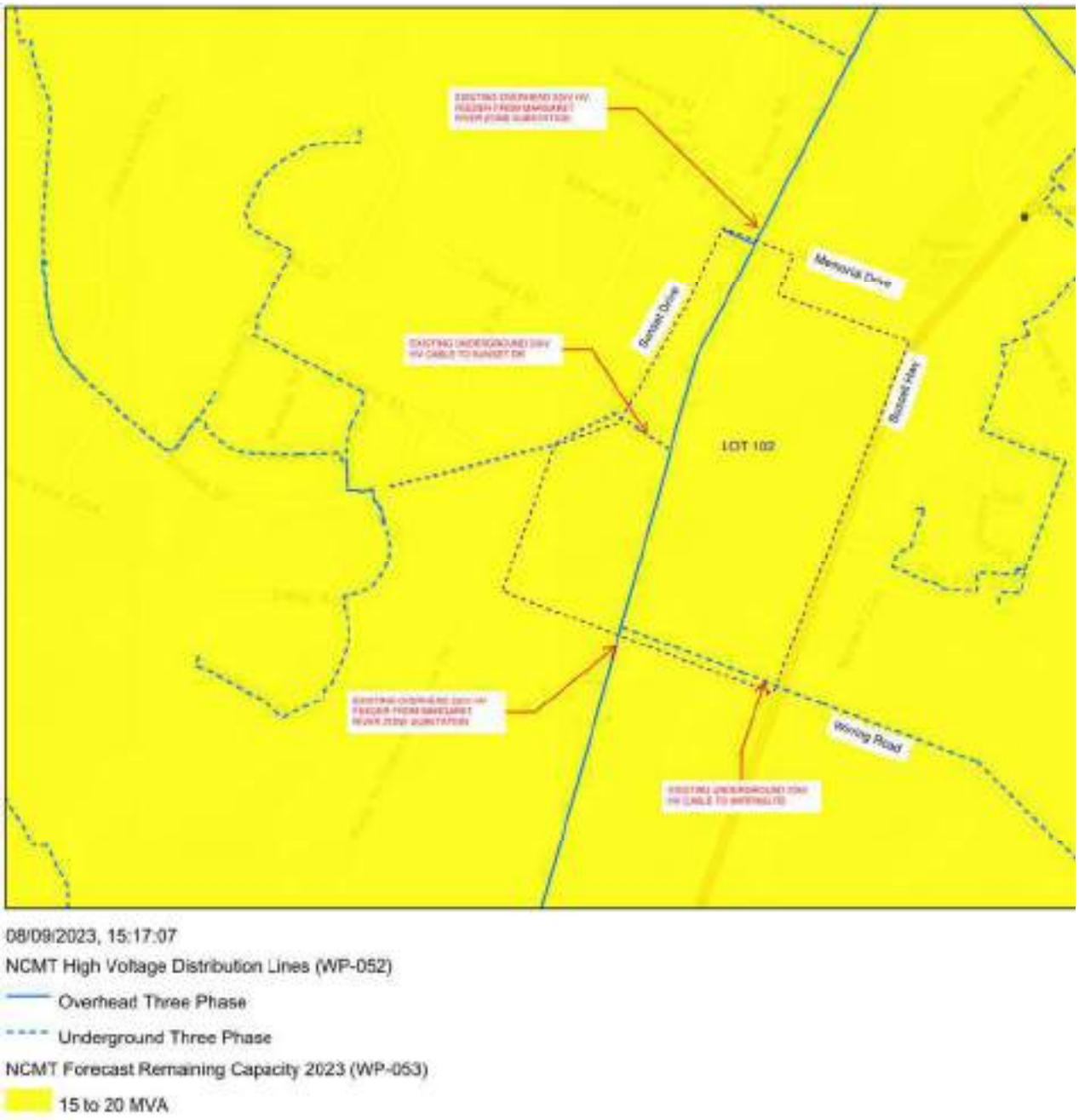


Figure 8: WP NCMT for surrounding area

9 Gas

There is no gas infrastructure within the Cowaramup area.

Advice from ATCO (Sept 2023) is that the nearest, feasible tie-in to the reticulated network is 25km away, in Vasse. Provisional estimates provided by ATCO for this work is from $5.5M to $6.0M in good ground conditions, to approximately $12.0M if rock is encountered. Refer to ***Appendix E*** for the formal ATCO correspondence.

Reticulated gas is not considered to be an essential service and as such is generally not required as a condition of development. Based on the above there does not appear to be any feasible opportunity to

providing reticulated gas infrastructure to the development and lot owners are likely to choose gas bottles for their own supply.

10 Telecommunications

The proposed development will require a fibre ready pit and conduit network to be installed at the Developer's cost. The pit and conduit will be designed in accordance with NBN standards and will be installed in the telecommunications alignment within the internal road reserves. Once installed and inspected, ownership of the pit and conduit network will be transferred to NBN.

10.1 Telstra

Before You Dig Australia (BYDA) information indicates existing communication infrastructure provided by Telstra exists within and adjacent to the Site (***Appendix F***). Optic Fibre cables enter the site on the southern boundary and leave via the northern boundary on Memorial Dr. The cables are approximately 500m in length.

Optic Fibre cables also exist on Roy Earl Dr, on the eastern side of Bussell Hwy. Other Telstra infrastructure exists on the western side of Bussell Hwy adjacent the Site, as well as along Memorial Dr.

Initial advice from Telstra (full correspondence in ***Appendix F***) on the status of the cables within the Site was that they believe "this section has been relocated and cutover into some new network on Bussell Hwy, the fibre through the subdivision does not have any designation therefore…. thinking that it is dead/left insitu."

Further verbal advice, on query of the initial response was that exposing the fibre and testing is the only way to confirm if it is dead or live. A quote needs to be arranged with Telstra for them to investigate and undertake the testing. Telstra could potentially check in the pits to see if it has been cut off, but they cannot confirm the cable status fully without testing.

If the cable is dead, Telstra advise it can likely remain insitu, with it being removed in sections if required to allow for construction of other services, such as deep sewer. If the cable is live, then the asset will be required to be relocated to standard alignments within adjoining road reserves.

10.2 NBN

BYDA suggests limited existing NBN network adjacent the site that would potentially supply the proposed pit and conduit network. However, formal planning advice received from NBN Co is summarised below and indicates a relatively straight forward connection to the existing network is expected. Refer ***Appendix G*** for a full copy of the advice.

- The proposed development in Cowaramup abuts the existing NBN fixed line network footprint so there would likely be no backhaul charges (subject to confirmation of lot count) to service this development with Fibre to the Premises (FttP) services with capacity to cater for residential grade connections.
- If required, NBN can also explore the availability of enterprise grade 1Gbps ethernet services.
- A standard "capped per premises" contribution would apply to service the development (invoiced on a stage-by-stage basis). NBN will review this contribution charge subject to further discussions on the developers' requirements as well as other current and future developments with NBN.
- Under the standard Master Developer Agreement, the developer would be responsible for the design and construct of the pit and pipe to NBN guidelines.
- The NBN advice excludes the cost of moving any existing NBN assets that may need to be relocated to service the development as well as any assets within the development boundary that need to be relocated as part of the site works.

- Before You Dig Australia records will indicate any NBN assets that may clash with the proposed development. NBN could also potentially minimise any of these costs by allowing pit and pipe for the asset relocation to be designed and built under a Master Developer Agreement.

Based on the above advice, there does not appear to be any major constraints with regards to providing communications infrastructure to the development. It should be noted that due to the dynamic nature of NBN's network, infrastructure requirements and connection points referred above may differ when applications are placed in the future.

11 Roadworks

The surrounding road network is under the control of Main Roads WA (Bussell Hwy) and the Shire of Augusta Margaret River (Memorial Dr and Sunset Dr) and as such all works on and abutting the public roads will be subject to their approvals.

As typically conditioned in a WAPC subdivision approval, the roads fronting the development are required to provide suitable access and egress and be designed for the intended traffic volumes. Any new road network will be consistent with standard residential developments including kerbed and asphalted pavements and road cross-sections will be designed to align with the existing landform. In all cases the road cross sections will be designed to cater for utility services on standard verge alignments and appropriate stormwater management strategies.

Any new public roads, parking areas and footpaths will need to be designed in accordance with Shire of Augusta Margaret River standards and guidelines, Local Government Guidelines for Subdivisional Development (IPWEA) and Main Roads WA requirements. Road modifications may be required to cater for vehicle turning movements as defined in AUSTROADS design guidelines.

Main Roads has advised that preference is for a roundabout to be constructed with this development to connect to Bussell Highway and Roy Earl Drive. Timing for construction of the roundabout will be governed by staging of the development and traffic requirements.

Other entry points to the subdivision from existing roads will be the boulevard connection to Sunset Dr and a two-way, single carriageway intersection with Memorial Drive to the north.

12 Disclaimer

JDSi have undertaken this assessment based on a desktop study and liaison with relevant utility providers. Subsequently, assumptions have been made which, if incorrect, have potential to change the assessment and/or recommendations. Major cost implications exist through factors which cannot be assured at this time including upgrading and provision of utility services, WAPC conditions of development, Local Authority Scheme Requirements, ground conditions, timing of adjacent developments, etc.

While JDSi has taken all care in the preparation of the likely development requirements and has noted key assumptions, JDSi accepts no responsibility for the accuracy of this report and provides it only as an indicative summary of engineering requirements.

If any further information is required or should you wish to clarify any issue, please contact our office.

APPENDIX A

STRUCTURE PLAN



\\GRA-FS\DATA\TOWN PLANNING\9000-9999\9729\02 DRAFTING\A-CAD · VR · 2023.10.17

PLAN 1 - STRUCTURE PLAN

LOT 102 BUSSELL HIGHWAY

COWARAMUP

N

0 60 m

SCALE @ A3: 1:2500

9729-LSP-01-D

DRAWN:	VR
DATE CREATED:	2023.10.17
PROJECTION:	MGA50 GDA2020
CADASTRE:	LANDGATE
AERIAL:	MAR 2022

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ROWE GROUP DESIGN

APPENDIX B

FEATURE & EXISTING SERVICES SURVEY



CONTOUR INTERVAL: 0.25m

NOTE: Only trees withe trunk diameter greater or equal to 0.3m were surveyed.

Existing boundaries have been extracted from Landgate's Spatial Cadastral Database, which is only a model of the cadastre. The depicted boundary locations are a graphical representation only and as they have not been re-established by survey. MNG does not guaranteed the position unless stated otherwise.
Re-establishment of lot boundaries by a Licensed Surveyor is recommended for any works on or about a boundary.
This note is an integral part of this plan.

Surface features and levels have been surveyed to meet the requested scope of works accuracy. The surface may be contoured to depict topography or defined only by spot heights. For clarity on hard copy some level information is not shown, refer to 3D digital file.
Above ground indicators (markers) of underground services are located where visible.
Third parties utilising this information should confirm the capture accuracies meet requirements prior to use.
This note is an integral part of this plan.

Rev.	Description	Drawn	Date	Checked
A	Initial Issue	ASO	06/07/2023	MBW

Surveyor:- ASO
Survey Date:- 04/07/2023
Precal/Cad:- LANDGATE

SCALE 1:1200 @ A1
0 15 30 45 60 120
ALL DISTANCES ARE IN METRES
For a true to scale reproduction of this plan, plot it to A1 with the Paging Scaling set to None.

The boundaries shown on this plan were not re-established as part of this survey, therefore this plan does not guarantee their accuracy. Existing easements, encumbrance or interest are not depicted and a title search is recommended to obtain this information. Re-establishment of the cadastral boundaries is recommended for any proposed works on or near existing boundaries.

FEATURE SURVEY
LOT 102 BUSSELL HWY
COWARAMUP

CLIENT:
GOLDFIELDS GROUP

The contents of this plan are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should satisfy themselves of this plans currency by contacting the McMullen Nolan Group.

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ABN 90 009 363 311

Project Mngr.	Matthew Webb	Datum	MRCG94 / AHD

105705 - DE - 004 - A
Job Number | Type | Plan Number | Revision

ROAD FEATURES
- Traffic Junction Box
- Traffic Signals - 1 Aspect
- Traffic Signals - 2 Aspect
- Traffic Signals - 3 Aspect
- Traffic Signals - 4 Aspect
- Pedestrian Signals
- Sign On One Pole
- Sign Multiple Poles
- Overhead Sign
- Traffic Controller Box
- Finger Sign
- Traffic Earth Pit
- Police Traffic Camera
- Guide Post
- Km Marker
- Traffic Count

ELECTRICAL
- Earth Pit
- Electrical Pillar
- Electrical Dome
- Light Pole - Directional
- Power Pole
- Transformer Single Pole
- Stay Pole
- Steel Wire Anchor
- High Mast Lighting
- Electrical Cable Marker
- MRWA Cable Marker
- MRWA Electrical Cable Box
- Electrical Cable Pit/Box
- MRWA Distribution Board
- High Tension Power Pole
- Electrical Supply Pole
- Ground Floodlight
- MRWA Electrical Manhole
- Meter Box
- Power Meter Box
- Electrical Transformer
- MRWA Light Pole
- MRWA Multiple Light Pole

COMMUNICATION
- Telstra Pit
- Telstra Pillar
- Telstra Marker
- Telstra Pole
- Telephone Booth
- Emergency Phone
- Antenna
- Telstra Elevated Joint
- Cable Marker (Optus)
- Telstra Tower
- Communication Manhole

WATER
- Water Meter
- Water Stop Valve
- Hydrant (Ground Level)
- Hydrant (Pillar)
- Water Bore
- Stand Pipe
- Reticulation Sprinkler
- Reticulation Control Valve
- Well
- Water Main Marker
- Water Tap
- Flushing Point
- Air Valve
- Peizometer
- Hydrant Booster Box

GAS
- Gas Marker
- Gas Valve
- Gas Test Valve
- LPG Tank
- Gas Test Pit
- Gas Manhole

DRAINAGE
- Invert Level
- Overt Level
- Flood Level
- Water Line
- Flood Level Indicator
- Storm Water Grate
- Drainage Gully
- Drainage Manhole
- Drainage Headwall

SEWER
- Sewer Vent
- Sewer Line Marker
- Sewer Inspection Shaft
- Sewer Inspection Opening
- Sewer Manhole

RAIL
- Rail Traffic Signals
- Rail Traffic Control Box
- Rail Telephone Box
- Rail Cable Pit
- Rail Cable Marker
- Rail SLK Post
- Manhole - Rail Cable

STRUCTURE
- Deck Level
- Floor Level
- Column Centre

GENERAL
- Clothes Hoist
- Air Conditioner
- Marker Unk/Undefined
- Undefined Manhole
- Control Of Access Sign
- Count Station
- Advertising Sign
- Windmill
- Stock Trough
- Litter Bin
- Mail Box
- Parking Meter
- Bus Stop
- Ticket Machine
- Borehole
- Flag Pole
- Bollard
- Fuel Bowser
- Underground Filler
- Diesel Tank
- Oil Main Marker
- Security Post
- Tank

GROUND FEATURES
- Natural Surface
- Aerial Survey Marker

VEGETATION
- Tree Details - Canopy & Trunk
- Tree 0.1m-0.3m Trunk Diameter
- Tree 0.3m-0.5m Trunk Diameter
- Tree 0.5m-1.0m Trunk Diameter
- Tree > 1.0m Trunk Diameter
- Bush
- Die Back Area - Marker
- Nesting Tree
- Tree Trunk / Stump
- Grass Tree

SURVEY CONTROL
- Star Iron Picket
- Trig Point
- SSM
- Bench Mark
- Photo Point
- Cadastral Peg/Post
- Reference Peg
- Alignment Control
- Spring Head Nail
- Spike
- TBM
- Peg Placed / Found

ROAD FEATURES
- Edge Of Bitumen
- Road Shoulder
- Edge Of Unsealed Road
- On Road
- Centre Of Road
- Kerb Top
- Kerb Bottom
- Cattle Grid
- Centre Of Driveway
- Edge Of Driveway
- Pedestrian Ramp
- Pedestrian Crosswalk
- Track
- Parking Bay
- Line Markings 1m Line & 1m Gap
- Line Markings 1m Line & 3m Gap
- Line Markings 3m Line & 9m Gap
- Lane Marking (9m*3m GAP)
- Lane Markings - Audible
- Shared Pathway - Guide Line 900mm*300mm GAP
- Footpath/Shared Path - Give Way 200mm*200mm GAP
- Giveway/Hold/Turn Lines 600mm*600mm GAP
- Double Barrier Line
- Overtaking Lane Left
- Overtaking Lane Right
- Single Solid Line
- Arrow Straight
- Arrow Straight/Left
- Arrow Straight/Right
- Arrow Left
- Arrow Right
- Arrow 3 Ways
- Arrow Right & Left
- Arrow U-Turn
- Arrow Merge
- Painted Lettering On Seal
- Painted Bicycle Traffic Signal Detector
- Guardrail - W Beam
- Guardrail - Thrie
- Barrier Concrete
- Barrier Steel Rope
- Barrier - Single Rail
- Barrier - Double Rail
- Barrier Triple Rail
- Bridge Barrier - (All Types)
- Bridge Expansion Joints
- Bridge - Outside Of Deck
- Soffit String

STRUCTURE
- Bridge
- Abutment
- Columns
- Piers
- Underpass
- Ramp
- Steps/Stairs
- Edge Of Concrete
- Bus Shelter
- Memorial
- Ruin
- Building / Structure
- Awning
- Shed
- Verandah
- Door Opening
- Window
- Roof Gutter Line
- Roof Ridge Line
- Top Of Wall
- Brick Wall
- Concrete Wall
- Livestock Grid

GROUND FEATURE
- Major Contour
- Minor Contour
- Bank Bottom
- Bank Top
- Line Of Levels
- Levee Top
- Levee Bottom
- Rock Outcrop
- Ridge Line
- Borrow Pit
- Earthworks Area
- Ground Subsidence
- Rock Pitching

VEGETATION
- Tree Line/Canopy
- Bush Line
- Hedge
- Garden Bed
- Lawn Area
- Vineyard
- Plantation
- Orchard
- Nursery
- Market Garden
- Recreational Area
- Trunk Circumference Circle
- Tree-line Face Of Trunks

ELECTRICAL
- Varible Message Sign
- Electrical Structure String
- Overhead Powerlines - Null Height
- Overhead Powerlines - True Height
- High Tension Power Lines - Null Height
- High Tension Power Lines - True Height

COMMUNICATION
- Unidentifed Service Pit
- Telstra Cable
- Amcom Cable

WATER
- Water Pipe

GAS
- Gas Line

DRAINAGE
- Drainage Pipe
- Drainage Culvert
- Floodway
- Drain
- Edge Of Drain
- Sump
- Waters Edge
- Swamp
- Dam
- Edge Of Creek/Water
- Centre Of Channel
- Wet Area
- Flood Level Line
- Waterways Cross Section

SEWER
- Sewer Pressure Main
- Sewer Pipe

RAIL
- Railway Platform
- On Rail
- Rail Boom Gate
- Rail Underground Cable
- Dual Gauge Rail
- Narrow Gauge Rail
- Cross Setion - Rail
- Standard Gauge Rail
- Rail U/G Cable

CADASTRAL
- MNG Precal/Re Established
- (SCDB) - State Cadastral Data Base
- Cadastre By Others

GENERAL
- Swimming Pool
- Tank Perimeter
- Mine Shaft
- Mine Workings
- Koppa Logging Fence
- Fence/Gate
- Wall
- Top Of Barrier / Wall etc
- Retaining Wall
- Boundary Line
- Footpath
- Gas Cylinder/Tank
- Brick Paving
- Bike Rack
- Bench Seating
- Handrail

UNDERGROUND SERVICES

UNDERGROUND SERVICES - inDIRECT MEASUREMENT - CLASS B

(PZA)	Underground Amcom/Vocus Cable
(PZC)	Underground Drainage Pipe
(PZE)	Underground Electrical Cable
(PZF)	Underground Western Power Comms
(PZG)	Underground Gas Line
(PZH)	Underground MRWA Comms
(PZI)	Underground MRWA Power
(PZJ)	Underground NBN Comms
(PZK)	Underground TPG /Pipe Networks
(PZN)	Underground Next Gen Comms
(PZO)	Underground Optus Fibre_Optic
(PZP)	Underground Optus Copper
(PZR)	Underground Rail Services
(PZS)	Underground Sewer Pipe
(PZT)	Underground Telstra Copper
(PZU)	Underground Unknown Service
(PZV)	Underground Telstra Optic_Fibre
(PZW)	Underground Water Pipe
(PZX)	Underground Reticulation Pipe
(PZZ)	Abandoned Service

(MAIN ROADS - SURFACE LOCATION) - CLASS B
POINT MEASRUED AT GROUND LEVEL DIRECTLY ABOVE TRACED SERVICE

HA	AMCOM/VOCUS Cable - Surface Location
HC	Drainage Pipe / Stormwater - Surface Location
HE	Electrical Cable - Surface Location
HF	Western Power Communication - Surface Location
HG	Gas Line - Surface Location
HH	MRWA Communication - Surface Location
HI	MRWA Power - Surface Location
HJ	Underground NBN Fibre - Surface Location
HK	Underground TPG/Pipe Networks Surface Location
HN	Next Gen Communication - Surface Location
HO	Optus Optic_Fibre - Surface Location
HP	Optus Copper - Surface Location
HR	Rail Services - Surface Location
HS	Sewer Pipe - Surface Location
HT	Telstra Copper - Surface Location
HU	Unknown Service - Surface Location
HV	Telstra Optic_Fibre - Surface Location
HW	Water Pipe - Surface Location
HX	Reticulation - Surface Location
HZ	Abandoned Service - Surface Location

UNDERGROUND SERVICES

UNDERGROUND SERVICES DIRECT MEASUREMENT - CLASS A

(PQA)	Underground Amcom/Vocus Cable
(PQC)	Underground Drainage Pipe
(PQE)	Underground Electrical Cable
(PQF)	Underground Western Power Comms
(PQG)	Underground Gas Line
(PQH)	Underground MRWA Comms
(PQI)	Underground MRWA Power
(PQJ)	Underground NBN Comms
(PQK)	Underground TPG /Pipe Networks
(PQN)	Underground Next Gen Comms
(PQO)	Underground Optus Fibre_Optic
(PQP)	Underground Optus Copper
(PQR)	Underground Rail Services
(PQS)	Underground Sewer Pipe
(PQT)	Underground Telstra Copper
(PQU)	Underground Unknown Service
(PQV)	Underground Telstra Optic_Fibre
(PQW)	Underground Water Pipe
(PQX)	Underground Reticulation Pipe
(PQZ)	Abandoned Service

(MAIN ROADS - UNVERIFIED, NO MEASURMENT) DBYD COMPILED - CLASS C AND D

QA	AMCOM/VOCUS Cable - Unverified, No Measurement
QC	Drainage Pipe / Stormwater - Unverified, No Measurement
QE	Electrical Cable - Unverified, No Measurement
QF	Western Power Communication - Unverified, No Measurement
QG	Gas Line - Unverified, No Measurement
QH	MRWA Communication - Unverified, No Measurement
QI	MRWA Power- Unverified, No Measurement
QJ	Underground NBN Comms - Unverified, No Measurement
QK	Underground TPG/Pipe Networks - Unverified, No Measurement
QN	Next Gen Communication - Unverified, No Measurement
QO	Optus Optic_Fibre - Unverified, No Measurement
QP	Optus Copper - Unverified, No Measurement
QT	Telstra Copper - Unverified, No Measurement
QV	Telstra Optic_Fibre - Unverified, No Measurement
QR	Rail Services - Unverified, No Measurement
QS	Sewer Pipe - Unverified, No Measurement
QU	Unknown Service - Unverified, No Measurement
QW	Water Pipe - Unverified, No Measurement
QX	Reticulation - Unverified, No Measurement
QZ	Abandoned Service - Unverified, No Measurement

Rev.	Description	Drawn	Date	Checked
H	U/G Services Amended	SAH	30/10/2020	TKI

SCALE 1:1000 @ A3

0 10 20 30 40 50

ALL DISTANCES ARE IN METRES

For a true to scale reproduction of this plan, plot it to A3 with the Paging Scaling set to None.

The contents of this plan are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should satisfy themselves of this plans currency by contacting the McMullen Nolan Group.

Surveyor:- MNG
Survey Date:- 30/06/2020
Precal/Cad:- 30/06/2020

ISO 9001 - AS/NZS 4801 - ISO 14001
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N

The boundaries shown on this plan were not re-established as part of this survey, therefore this plan does not guarantee their accuracy. Existing easements, encumbrance or interest are not depicted and a title search is recommended to obtain this information. Re-establishment of the cadastral boundaries is recommended for any proposed works on or near existing boundaries.

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ABN 90 009 363 311

McMULLEN NOLAN GROUP
FEATURE SURVEY - GENERAL LEGEND

CLIENT: N/A

Project Mngr	Datum
MNG Group	LOCAL

95465 - DOC - 012 - H
Job Number | Type | Plan Number | Revision

43375 43500 43625 43750 43875

202875 202750 202625 202500 202375 202250 202125

30 500 505 506 551 555 102 12 13 3 4 5 20 21 1721 7 8 9 10 11 6 405 8 404 403 402 401 400 468 467 2016 246 247 248 249 250 251 257 258 259 260 261 262 263 264 265 266 267 268 269 312 311 310 309 308 307 306 305 299 300 301 302 303 304

SUNSET DRIVE

CURTIS STREET

TRAINER STREET

MEMORIAL DRIVE

BUSSELL HIGHWAY

ROY EARL DRIVE

WIRRING ROAD

Sewer Pipe Inverts Derived From Water Corporation Sewer ESInet

Sewer Pipe Inverts Derived From Water Corporation Sewer ESInet

Sewer Pipe Inverts Derived From Water Corporation Sewer ESInet

Please See MNG Locate Report 105705UL-002A For More Information

MNG - UNDERGROUND SERVICES MINI LEGEND

STANDARD SURVEY CLASS A, B & C		BYDA COMPILED - CLASS D	
HA	AMCOM/VOCUS Cable - Underground Location	QA	AMCOM/VOCUS Cable - Unverified, No Measurement
HC	Drainage Pipe / Stormwater - Underground Location	QC	Drainage Pipe / Stormwater - Unverified, No Measurement
HE	Electrical Cable - Underground Location	QE	Electrical Cable - Unverified, No Measurement
HF	Western Power Communication - Underground Location	QF	Western Power Communication - Unverified, No Measurement
HG	Gas Line - Underground Location	QG	Gas Line - Unverified, No Measurement
HH	MRWA Communication - Underground Location	QH	MRWA Communication - Unverified, No Measurement
HI	MRWA Power - Underground Location	QI	MRWA Power- Unverified, No Measurement
HJ	Underground NBN Fibre - Underground Location	QJ	Underground NBN Comms - Unverified, No Measurement
HK	Underground TPG/Pipe Networks - Underground Location	QK	Underground TPG/Pipe Networks - Unverified, No Measurement
HL	Next Gen Communication - Underground Location	QL	Next Gen Communication - Unverified, No Measurement
HO	Optus Optic Fibre - Underground Location	QO	Optus Optic Fibre - Unverified, No Measurement
HP	Optus Copper - Underground Location	QP	Optus Copper - Unverified, No Measurement
HR	Rail Services - Underground Location	QR	Telstra Copper - Unverified, No Measurement
HS	Sewer Pipe - Underground Location	QV	Telstra Optic Fibre - Unverified, No Measurement
HT	Telstra Copper - Underground Location	QR	Rail Services - Unverified, No Measurement
HU	Unknown Service - Underground Location	QS	Sewer Pipe - Unverified, No Measurement
HV	Telstra Optic Fibre - Underground Location	QU	Unknown Service - Unverified, No Measurement
HW	Water Pipe - Underground Location	QX	Water Pipe - Unverified, No Measurement
HZ	Reticulation - Underground Location	QZ	Reticulation - Unverified, No Measurement
	Abandoned Service - Underground Location		Abandoned Service - Unverified, No Measurement

10.00 Ground Level
9.99 Top of Service

Potholed Depth & Location
GPR/EMI Depth & Location

**PLEASE NOTE : HEIGHTS SHOWN ARE TO TOP OF SERVICE.

DISCLAIMERS

Class 2/3 Accuracy Statement
This survey has been completed to CLASS 2/3 Accuracy
Hard Stand Areas are to Class 2 Accuracy
Horizontal Accuracy ± 20mm
Vertical Accuracy ± 20mm
All other Areas are to Class 3 Accuracy
Horizontal Accuracy ± 30mm
Vertical Accuracy ± 50mm
This note is an integral part of this plan

Landgate SCDB only
Existing boundaries have been extracted from Landgate's Spatial Cadastral Database, which is only a model of the cadastre. The depicted boundary locations are a graphical representation only and as they have not been re-established by survey. MNG does not guaranteed the position unless stated otherwise. Re-establishment of lot boundaries by a Licensed Surveyor is recommended for any works on or about a boundary.
This note is an integral part of this plan

GPR/EMI - Class B (MNG LOCATE)
Location and depths of underground services have been determined by ground penetrating radar (gpr) through signal based observations. Measured service contacts are profiled along grid line only. Service identifications are based on information supplied by the contractor and together with their location, should be verified prior to works in the vicinity. Prior to demolition, excavation or construction, users should satisfy themselves to the currency of services, which may have been altered or new services installed on or near the subject site. Refer to the date and method of acquisition
This note is an integral part of this plan.

BYDA - Class C
Provides an interpretation of the approximate location of the utility using available existing records such as BYDA plans or site records along with a visual inspection for of surface features (such as pits and valves covers). Ground Penetrating Radar (GPR), acoustic, photographic and other methods can also be used to obtain proof of the existence of an undefined service that do not utilize physical measurements of tracing that satisfy QL-B or QL-A tolerances. Tolerance: Horizontal +/- 300mm and Zero Vertical

BYDA - Class D
Underground services have been compiled from information obtained from a Before-You-Dig-Australia search.
Service locations have not been verified by MNG. Alignments are indicative only. Prior to demolition, excavation or construction, users should satisfy themselves to the currency of services, which may have been altered or new services installed on or near the subject site. Refer to the date and method of acquisition.
This note is an integral part of this plan

Rev.	Description	Drawn	Date	Checked
A	Initial Issue	DRD	14/07/2023	MBW

ISO 9001 - ISO14001 - ISO45001
Global-Mark.com.au©

Surveyor:- JMG
Survey Date:- 06/06/2023
Precal/Cad:- SCDB

N

LOT 102 BUSSELL HIGHWAY
COWARAMUP
UNDERGROUND SERVICE LOCATION SURVEY

CLIENT:
GOLDFIELDS GROUP

The contents of this plan are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should satisfy themselves of this plans currency by contacting the McMullen Nolan Group.

SCALE 1:1250 @ A1
0 25 50 75 100 125
ALL DISTANCES ARE IN METRES
For a true to scale reproduction of this plan, plot it to A1 with the Paging Scaling set to None.

The boundaries shown on this plan were not re-established as part of this survey, therefore this plan does not guarantee their accuracy. Existing easements, encumbrance or interest are not depicted and a title search is recommended to obtain this information. Re-establishment of the cadastral boundaries is recommended for any proposed works on or near existing boundaries.

MCMULLEN NOLAN GROUP
Level 1, 2 Sabre Crescent
Jandakot, W.A. 6164
PO Box 3526, Success
W.A. 6964, Australia
Offices in: Perth | Melbourne | Kimberley| South West WA
Tel: (08) 6436 1599
Fax: (08) 6436 1500
info@mngsurvey.com.au
www.mngsurvey.com.au
ABN 90 009 363 311

Project Mngr.	Matthew Webb	Datum	MRCG94 / AHD

105705 - DE - 003 - A
Job Number | Type | Plan Number | Revision

APPENDIX C

WATER CORPORATION CORRESPONDENCE & SCHEME PLANNING

Ben Whitfield

From: Brett Coombes <Brett.Coombes@watercorporation.com.au>
Sent: Tuesday, 5 September 2023 1:15 PM
To: Richard Martin
Subject: RE: SF0009564 Stage 2 - Service Feasibility - Lot 102, Bussell Highway , Cowaramup
Attachments: Cowaramup_SD242_WW_Planning-Overall_Sewer_District_Plan_with_Landuse.pdf

Good afternoon Richard,

The Cowaramup SD sewer concept planning is attached, which is relatively straightforward for this site (you might already have seen our sewer planning).

We haven't yet undertaken detailed water reticulation planning over this subdivision area. I believe Cardno did a sewer and water retic layout based on the earlier approved subdivision layout. There is a 250PVC main that currently ends on the eastern side of Bussell Hwy on Roy Earl Drive. At this early stage assume extension of this as 250 (or 200?) along the main subdivision boulevard to eventually interconnect with the 250 main on Sunset Drive. Other minor retic mains along subdivision access roads would be 100mm. Feel free to include a draft water retic plan in any further correspondence with us, or perhaps in the structure plan report or with the subdivision application.

w.r.t to the water source capacity (the existing storage tank) constraint that you were discussing with my colleague Matt Calabro, the Corporation has timed construction of a new 4ML storage tank for delivery by around 2032 based on a projection of service connections and overall scheme consumption data. Release and buildout on all your proposed 65 lots before the tank is constructed will increase the risk breaching the capacity of the current 1ML tank in the summer peak weeks (typically from Christmas through to March). We will monitor subdivision, lot release and build rates in the town and endeavour to time the tank project accordingly.

Regards

Brett Coombes
Senior Planner, Land Use Planning
Development Services
Tel. 9420-3165

From: Richard Martin <richard.martin@jdsi.com.au>
Sent: Friday, 1 September 2023 8:34 AM
To: Matt Calabro <Matt.Calabro@watercorporation.com.au>
Subject: SF0009564 Stage 2 - Service Feasibility - Lot 102, Bussell Highway , Cowaramup

Hi Matt

Attached is the proposed development subdivision plan.

The intention is to commence the first stage of around 65 lots in October next year.

Further to below, we need to prepare an engineering servicing report in the next 2 weeks. Are you able to please advise on water and sewer servicing for this development, and any other potential implication we need to be aware of for full development and commencement date.

Regards,

Richard Martin
DIRECTOR SOUTH WEST

M: 0423 232 963
6/8-10 Prince Street
Busselton WA 6280

www.jdsi.com.au

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From: Matt Calabro <Matt.Calabro@watercorporation.com.au>
Sent: Thursday, 11 May 2023 9:53 AM
To: Richard Martin <richard.martin@jdsi.com.au>
Subject: RE: SF0009564 - Service Feasibility - Lot 102, Bussell Highway , Cowaramup

Hi Richard,

The sooner you can give us Yields and usage requirements for the first stage the better really. Once we have that we will be better able to plan and guide you going forward. Once the first stage has began we will be able to show demand and growth in the area, which will help to reprioritise the water tank.

Regards,

Matt Calabro
Senior Planner – Land Planning
Development Services

E Matt.Calabro@watercorporation.com.au

watercorporation.com.au

From: Richard Martin <richard.martin@jdsi.com.au>
Sent: Wednesday, 10 May 2023 7:03 AM
To: Matt Calabro <Matt.Calabro@watercorporation.com.au>
Cc: Steven Foley <steven.foley@jdsi.com.au>
Subject: FW: SF0009564 - Service Feasibility - Lot 102, Bussell Highway , Cowaramup

Hi Matt,

Further to below, it is the intention of the Developer to start construction on the first stage before the end of next year.

We are currently in planning, so the exact stage sizing and development layout is still being worked on.

Please advise if there is anything formal we need to provide to ensure adequate water supply is planned and provided for next year.

Regards,

Richard Martin
DIRECTOR SOUTH WEST

M: 0423 232 963
6/8-10 Prince Street
Busselton WA 6280

JDSi CONSULTING ENGINEERS

www.jdsi.com.au

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From: Steven Foley <steven.foley@jdsi.com.au>
Sent: Wednesday, 10 May 2023 5:44 AM
To: Richard Martin <richard.martin@jdsi.com.au>
Subject: FW: SF0009564 - Service Feasibility - Lot 102, Bussell Highway , Cowaramup

---

From: Matt Calabro <Matt.Calabro@watercorporation.com.au>
Sent: Thursday, 16 February 2023 3:02 PM
To: Steven Foley <steven.foley@jdsi.com.au>
Subject: RE: SF0009564 - Service Feasibility - Lot 102, Bussell Highway , Cowaramup [Filing cancelled]

Hi Steven,

The new water tank is driven by a demand threshold based on users connected to the network, staging over the next 5-6 years would be ideal and doing so would likely allow the demand and natural growth to trigger the tank to be built a couple years earlier and will also allow us to keep up with the growing water demand.

I would recommend coming to us with the first stage as soon as possible so we can work through the requirements and demands to avoid any potential issues.
Coming to us early for each additionally stage thereafter will help a lot with delivery as well.

Regards,

Matt Calabro
Senior Planner – Land Planning
Development Services

E Matt.Calabro@watercorporation.com.au

watercorporation.com.au

From: Steven Foley <steven.foley@jdsi.com.au>
Sent: Thursday, 16 February 2023 2:06 PM
To: Matt Calabro <Matt.Calabro@watercorporation.com.au>
Cc: Richard Martin <richard.martin@jdsi.com.au>; Jagan Deep Singh <jagan.singh@jdsi.com.au>
Subject: RE: SF0009564 - Service Feasibility - Lot 102, Bussell Highway , Cowaramup

Hi Matt,

Thanks for the advice below.

In regards to the water supply the project is likely to be staged across 5 stages over the next 5-6 years – not sure if that assists with your advice below. Stage 1 water supply to lots for builders would not likely be required until early/mid 2024. This site is zoned and structure plan approved and the developer could lodge a WAPC approval tomorrow for these lots to be developed. Would WC not be obliged/required to find a way to service the initial stage whilst working on the new water tank in the background?

Happy to have a phone hook up or meeting to discuss further.

Regards,

Steven Foley
DIRECTOR

M: 0411 153 087
P: 08 9227 0595
F: 08 9227 8617

Level 1
432 Murray Street
Perth WA 6000

PO Box 7483
Cloisters Square PO
WA 6850

www.jdsi.com.au

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From: Matt Calabro <Matt.Calabro@watercorporation.com.au>
Sent: Thursday, 16 February 2023 11:27 AM
To: Jagan Deep Singh <jagan.singh@jdsi.com.au>
Subject: SF0009564 - Service Feasibility - Lot 102, Bussell Highway , Cowaramup

Hi Jagan,

I have been looking into your Service Feasibility inquiry, apologies for the late reply.

Wastewater Servicing to the area is available and the network has capacity.

Unfortunately Water Servicing to the area is where there is a problem.
Cowaramup is a difficult area to supply Water for at the moment as capacity from the Water Tank has hit its limit.
Cowaramup has experienced significant growth in the past few years resulting in reduced reliability and a high risk of water supply interruption.
There is another large scale development east of this site that has been zoned and is going through Structure Plan submission currently, between both this one and your proposed development he network cannot support this development in its current state.

A new Water Tank project for the town is in the works but will not be delivered until 2030, this will need to be delivered before the development can connect to the scheme.

If you have any further questions please let me know.

Regards,

Matt Calabro
Senior Planner – Land Planning
Development Services

E Matt.Calabro@watercorporation.com.au

watercorporation.com.au

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Water Corporation E-mail – Report any suspicious emails to the WC Cyber Team using our "Report Phishing" button in outlook.

AUTHOR: DEMPSTG0 FILE: J:\Mapping_Tasks\South_West\Wastewater\RITM0668780_Cowaramup_SD242_WWC\Working\Cowaramup_SD242_Overall_Landuse.mxd COORDINATE SYSTEM: GDA 1994 MGA ZONE 50 VERTICAL DATUM: AHD

FILL REQUIRED

COWARAMUP P.S. 2
TIMBER CT
PUMP STN. 'PS2 - 242'
REDUCTION '110 - 113'
SEWER DESIGN FLOW - 13.0 L/s
EXISTING PUMP RATE - 19.9 L/s
LONG TERM PUMP RATE - 17.3 L/s

'0103 - 242'
SDF - 1.2 L/s

'0098 - 242'
SDF - 3.1 L/s

'0154 - 242'
SDF - 4.6 L/s

'0156 - 242'
SDF - 2.4 L/s

'0193 - 242'
SDF - 0.0 L/s

'0257 - 242'
SDF - 3.9 L/s

'0288 - 242'
SDF - 1.8 L/s

'0219 - 242'
SDF - 0.1 L/s

'114 - 242'
SDF - 4.5 L/s

'0310 - 242'
SDF - 0.2 L/s

'402 - 242'
SDF - 1.8 L/s

'64 - 242'
SDF - 1.7 L/s

COWARAMUP P.S. 3
SMOKEBUSH COURT
PUMP STN. 'PS3 - 242'
REDUCTION '110 - 113'
SEWER DESIGN FLOW - 20.5 L/s
EXISTING PUMP RATE - 19.4 L/s
LONG TERM PUMP RATE - 27.3 L/s

COWARAMUP P.S. 1
BUSSELL HWY
PUMP STN. 'PS1 - 242'
REDUCTION '110 - 113'
SEWER DESIGN FLOW - 22.1 L/s
EXISTING PUMP RATE - 22.3 L/s
LONG TERM PUMP RATE - 76.6 L/s

'0024 - 242'
SDF - 2.1 L/s

PRIVATE PS'S
TO BE GRADED OUT
'31 - 242'
SDF - 1.1 L/s

'0311 - 242'
SDF - 3.1 L/s

'0322 - 242'
SDF - 3.0 L/s

'71 - 242'
SDF - 4.0 L/s

AE2722 - 242'
SDF - 1.7 L/s

AE7274 - 242'
SDF - 2.2 L/s

'24 - 242'
SDF - 5.1 L/s

'4 - 242'
SDF - 5.5 L/s

'74 - 242'
SDF - 2.4 L/s

'T6 - 242'
SDF - 0.0 L/s

'T7 - 242'
SDF - 0.3 L/s

EXISTING DN150 AND
PROPOSED DN300 FROM PS 1
BUSSEL HWY DISCHARGE AT
ACCESS CHAMBER 109 LOCATED
AT THE MARGARET RIVER WWTP

COWARAMUP
SD242

COWARAMUP - SD242
Root Node at WWTP is ROOT
Total catchment inflow = 55.5 L/sec
Total injected flow = 0.0 L/sec
Total outflow at root node = 55.5 L/sec

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LEGEND

- Existing Access Chamber
- Proposed Access Chamber
- Existing Vacuum Chamber
- Proposed Vacuum Chamber
- Existing Pump Station
- Proposed Pump Station
- Existing Gravity Sewer
- Proposed Gravity Sewer
- Existing Vacuum Sewer
- Proposed Vacuum Sewer
- Existing Pressure Main
- Proposed Pressure Main
- Node Catchment
- PS and Sewer Catchments
- Sewer District / WWTP Catchment
- Existing Sewered Areas
- Sewered By Private PS
- Parks and Public Open Space
- Bush Forever
- Cut / Fill
- Floodway / Flood Fringe
- Flood Plain

NOTATION

CATCHMENT 'SEWER DISTRICT NUMBER' - 'CATCHMENT NODE'
R15 - 108.4 @75% (W)
'R' CODE ZONING
GROSS AREA (ha)
% OF LAND DEVELOPMENT
(W) - WET CONDITIONS
(D) - DRY CONDITIONS

0 100 200 300 400 500 Metres

DATE	REVISION DESCRIPTION	DRN	APPD
XX/XX	XXXXXXXXXXXXXXXXXXXXX	XX	XX

SHEET INDEX

N

NEXUS No. 124258855
VERSION V1

WATER CORPORATION
ISSUED WITH THE AUTHORITY OF THE MANAGER ASSET PLANNING GROUP
629 NEWCASTLE STREET, LEEDERVILLE 6007 WESTERN AUSTRALIA.
TELEPHONE (08) 9420 2420, FAX (08) 9420 3179

WASTEWATER SCHEME PLANNING SERIES

COWARAMUP - SD242

CONCEPTUAL PLANNING
LONG TERM SCHEME WITH LANDUSE

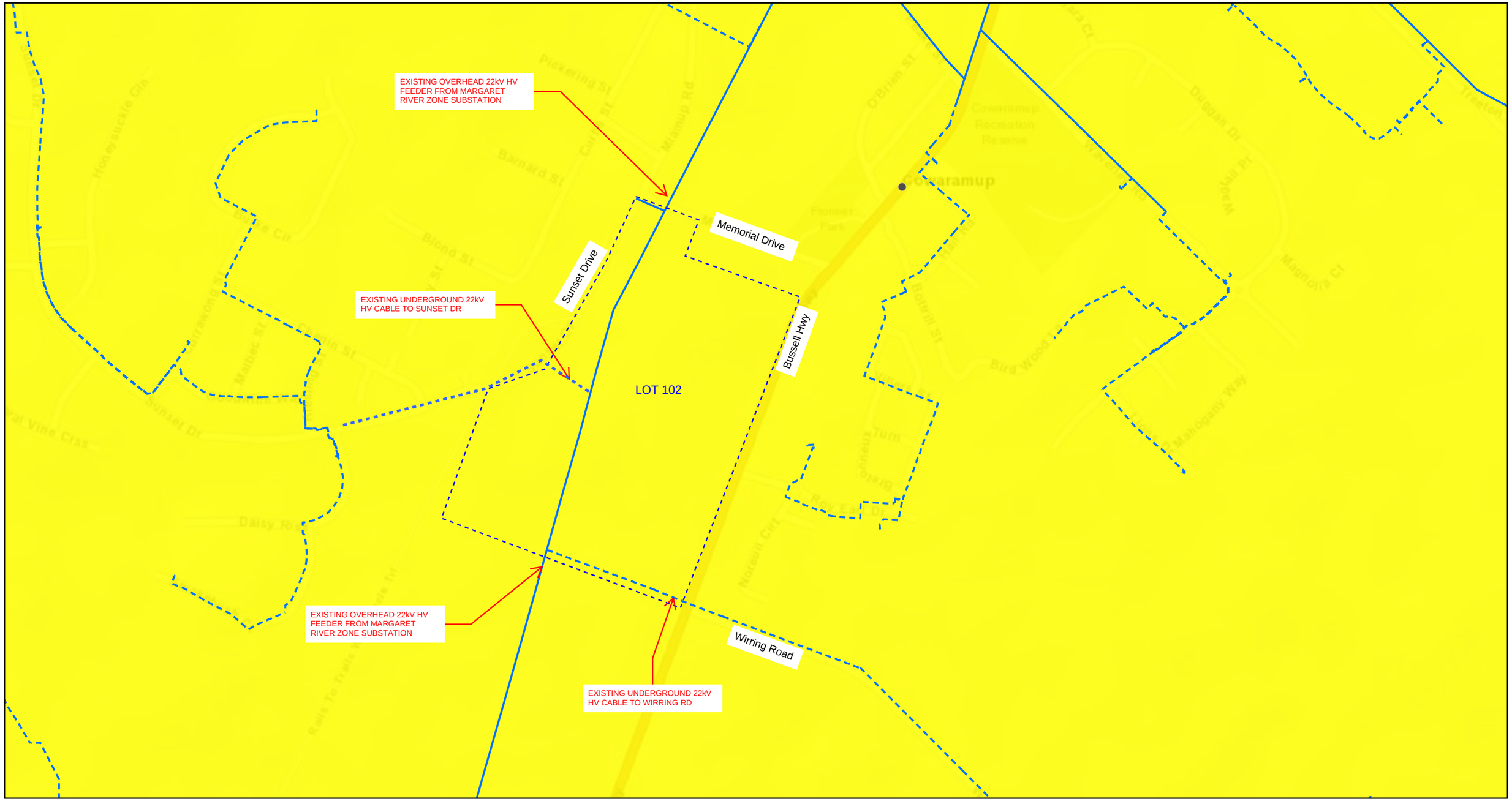
PLANNING BY	COMPILED BY	ACCEPTED BY
APG PLANNERS	W. CALLANAN	C. DELPORT
SCALE	FULL REVIEW	NEXUS FOLDER.
1:7,500	NOVEMBER 2021	59244688

A1

APPENDIX D

WESTERN POWER
NETWORK CAPACITY MAPPING TOOL

Network Capacity Mapping Tool



08/09/2023, 15:17:07

NCMT High Voltage Distribution Lines (WP-052)

Overhead Three Phase

Underground Three Phase

NCMT Forecast Remaining Capacity 2023 (WP-053)

15 to 20 MVA

1:7,644

0 425 850 1,700 ft

0 130 260 520 m

Esri, HERE, Garmin, NGA, USGS

Plans printed from the Network Capacity Mapping Tool (NCMT) are
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APPENDIX E

ATCO GAS CORRESPONDENCE

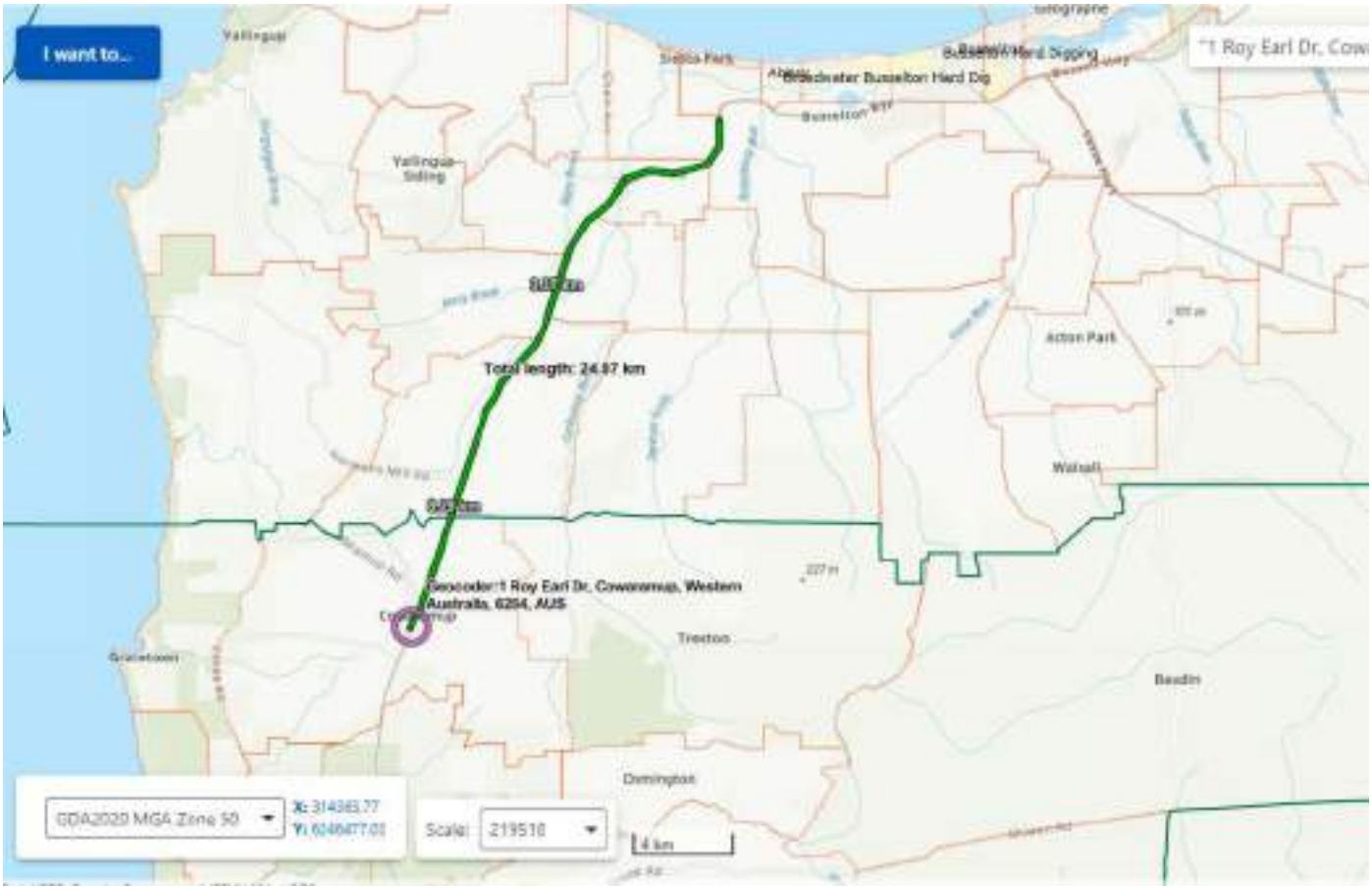
Ben Whitfield

From: Hoyne, Ben <Ben.Hoyne@atco.com>
Sent: Tuesday, 5 September 2023 9:58 AM
To: Brenton Washfold
Subject: RE: Goldfields Cowaramup

Hi Brenton

In my line of work, you win some and, sadly you lose some – LOT 102 BUSSELL HWY, COWARAMUP unfortunately fall in the latter.

As per the screen shot below, the proposed development is ~25km away from the nearest feasible tie-in location (Vasse).



Rough provisional estimate to make this a reality (subject to executive approval) = $5.5-6m. If rock is encountered, you'd be looking at circa ~$12m.

Best regards,
Ben

Benjamin Hoyne
Business Development Lead | Renewable Fuels
ATCO, Gas Division, Australia

P. +61 8 6163 5061 **M.** +61 419 787 599
A. 81 Prinsep Road, Jandakot, Western Australia, 6164
atco.com.au Facebook Twitter LinkedIn

ATCO acknowledges Aboriginal people as the Traditional Custodians of country throughout Australia including Torres Strait Islander peoples.
We pay respect to their cultures, Elders past and present, and in the spirit of reconciliation, we commit to working together for our shared future.

From: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Sent: Tuesday, 5 September 2023 9:09 AM
To: Hoyne, Ben <Ben.Hoyne@atco.com>
Subject: Goldfields Cowaramup

Caution – This email is from an external source. If you are concerned about this message, please report using Phish Alert Button in your Outlook for analysis.
Hi Ben,

I've got another one that's come across my desk. Are you able to provide some advice around the attached site in terms of serviceability requirements i.e. mains extensions, infrastructure upgrades etc?

Thanks,

Brenton Washfold
Senior Civil Engineer

M: 0422 213 753
P: 08 9227 0595
F: 08 9227 8617

U6 / 8-10 Prince St
Busselton WA 6280

Level 1
432 Murray Street
Perth WA 6000

www.jdsi.com.au

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APPENDIX F

TELSTRA CORRESPONDENCE

Ben Whitfield

From: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>
Sent: Tuesday, 19 September 2023 1:13 PM
To: Brenton Washfold
Cc: Richard Martin; Ben Whitfield
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

Will do, thanks Brenton

Regards,
Gavin Vincent
Design & Construction | InfraCo Operations
M 0417983453

To ensure you receive the best customer service, if you cannot contact me, or if you need to lodge a new project or follow up on an existing one please see below for more contact details.

Network Integrity

- Front of House contact - 1800 810 443
- Email new job request - Networkintegrity@team.telstra.com
- In order for you lodge your own projects online, please action via the below link,

https://www.telstra.com.au/forms/request-asset-relocation-or-commercial-works

NBN Co

- If NBN network requires relocation, please contact on 1800 687 626 or email: RelocationWorks@nbnco.com.au

Network Integrity: Working with the civil construction industry to prevent damage to Telstra's underground assets.

General

From: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Sent: Tuesday, September 19, 2023 1:08 PM
To: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>
Cc: Richard Martin <richard.martin@jdsi.com.au>; Ben Whitfield <Ben.Whitfield@jdsi.com.au>
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

[External Email] This email was sent from outside the organisation – be cautious, particularly with links and attachments.

Hi Gavin,

Further to the below, I go on leave tomorrow and am returning on the 27th. In my absence can you please send anything relating to this quote to both Richard and Ben (Cc'd)?

Thanks,

Brenton Washfold
Senior Civil Engineer

M: 0422 213 753
P: 08 9227 0595
F: 08 9227 8617

U6 / 8-10 Prince St
Busselton WA 6280

Level 1
432 Murray Street
Perth WA 6000

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From: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Sent: Tuesday, 19 September 2023 8:11 AM
To: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>; Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

Yes please Gavin

Sent from my Galaxy

-------- Original message --------
From: "Vincent, Gavin" <Gavin.W.Vincent@team.telstra.com>
Date: 19/9/23 8:05 am (GMT+08:00)
To: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

Brenton
Would you like me to proceed with a quote?

Regards,
Gavin Vincent
Design & Construction | InfraCo Operations
M 0417983453

To ensure you receive the best customer service, if you cannot contact me, or if you need to lodge a new project or follow up on an existing one please see below for more contact details.

Network Integrity

- Front of House contact - 1800 810 443
- Email new job request - Networkintegrity@team.telstra.com
- In order for you lodge your own projects online, please action via the below link,

https://www.telstra.com.au/forms/request-asset-relocation-or-commercial-works

NBN Co

- If NBN network requires relocation, please contact on 1800 687 626 or email: RelocationWorks@nbnco.com.au

Network Integrity: Working with the civil construction industry to prevent damage to Telstra's underground assets.

From: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>
Sent: Tuesday, September 19, 2023 7:42 AM
To: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

Brenton
I would need to organise a quote (1 week for that)

Regards,
Gavin Vincent
Design & Construction | InfraCo Operations
M 0417983453

To ensure you receive the best customer service, if you cannot contact me, or if you need to lodge a new project or follow up on an existing one please see below for more contact details.

Network Integrity

- Front of House contact - 1800 810 443
- Email new job request - Networkintegrity@team.telstra.com
- In order for you lodge your own projects online, please action via the below link,

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NBN Co

- If NBN network requires relocation, please contact on 1800 687 626 or email: RelocationWorks@nbnco.com.au

Network Integrity: Working with the civil construction industry to prevent damage to Telstra's underground assets.

From: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Sent: Tuesday, September 19, 2023 7:14 AM
To: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

[External Email] This email was sent from outside the organisation – be cautious, particularly with links and attachments.

Sorry Gavin, how quick do you think you could arrange testing to confirm? And what's the cost for this?

Brenton Washfold
Senior Civil Engineer

M: 0422 213 753
P: 08 9227 0595
F: 08 9227 8617

U6 / 8-10 Prince St
Busselton WA 6280

Level 1
432 Murray Street
Perth WA 6000

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From: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>
Sent: Tuesday, 19 September 2023 6:50 AM
To: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

Brenton
Telstra are happy for it to stay insitu, however if you come across it during your construction then it can be removed in sections.

Regards,
Gavin Vincent
Design & Construction | InfraCo Operations
M 0417983453

To ensure you receive the best customer service, if you cannot contact me, or if you need to lodge a new project or follow up on an existing one please see below for more contact details.

Network Integrity

- Front of House contact - 1800 810 443
- Email new job request - Networkintegrity@team.telstra.com
- In order for you lodge your own projects online, please action via the below link,

https://www.telstra.com.au/forms/request-asset-relocation-or-commercial-works

NBN Co

- If NBN network requires relocation, please contact on 1800 687 626 or email: RelocationWorks@nbnco.com.au

Network Integrity: Working with the civil construction industry to prevent damage to Telstra's underground assets.

General

From: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Sent: Tuesday, September 19, 2023 6:42 AM
To: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

[External Email] This email was sent from outside the organisation – be cautious, particularly with links and attachments.

Ok thanks Gavin. I'll pass this information on to the team.
Is it a requirement to be removed, or we could leave insitu as well, only removing sections if we need to during construction (i.e. for deep sewer trenching etc)?

Brenton Washfold
Senior Civil Engineer

M: 0422 213 753
P: 08 9227 0595
F: 08 9227 8617

U6 / 8-10 Prince St
Busselton WA 6280

Level 1
432 Murray Street
Perth WA 6000

www.jdsi.com.au

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General

From: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>
Sent: Tuesday, 19 September 2023 6:34 AM
To: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

Brenton
Only exposing the fibre and testing will tell, the fibre may be cutoff at the pit locations so that will say its not working.
It can be removed when you do your development works.

Regards,
Gavin Vincent
Design & Construction | InfraCo Operations
M 0417983453

To ensure you receive the best customer service, if you cannot contact me, or if you need to lodge a new project or follow up on an existing one please see below for more contact details.

Network Integrity

- Front of House contact - 1800 810 443
- Email new job request - Networkintegrity@team.telstra.com
- In order for you lodge your own projects online, please action via the below link,

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NBN Co

- If NBN network requires relocation, please contact on 1800 687 626 or email: RelocationWorks@nbnco.com.au

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General

From: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Sent: Tuesday, September 19, 2023 6:32 AM
To: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

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Hi Gavin,

I'll check with the client and come back to you, however we won't be able to arrange in time for completion of our servicing report. Is there any other way to get some more certainty now (any records of this being cut over to Bussell Hwy etc), or only testing will confirm?

Would Telstra require the cable to be removed as part of the development so it does not remain insitu and potentially remain within lots being created?

Thanks,

Brenton Washfold
Senior Civil Engineer

M: 0422 213 753
P: 08 9227 0595
F: 08 9227 8617

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General

From: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>
Sent: Tuesday, 19 September 2023 6:26 AM
To: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

Brenton
I can organise a quote to expose the fibre and then try to test if working or not.

Regards,
Gavin Vincent
Design & Construction | InfraCo Operations
M 0417983453

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NBN Co

- If NBN network requires relocation, please contact on 1800 687 626 or email: RelocationWorks@nbnco.com.au

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General

From: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Sent: Tuesday, September 19, 2023 6:23 AM
To: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

[External Email] This email was sent from outside the organisation – be cautious, particularly with links and attachments.

Hi Gavin,

Thanks very much for the prompt response, much appreciated.

Is there any way to get some more certainty over this as it has the potential to be a show-stopper if it's live and needs to be relocated? And if it is in fact dead but left insitu, would the cable need to be removed as part of this development?

Thanks,

Brenton Washfold
Senior Civil Engineer

M: 0422 213 753
P: 08 9227 0595
F: 08 9227 8617

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General

From: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>
Sent: Monday, 18 September 2023 12:34 PM
To: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Subject: RE: Lot 102 Bussell Hwy, Cowaramup

Brenton
I'm thinking this section has been relocated and cutover into some new network on Bussell Hwy, the fibre through the subdivision does not have any designation therefore I'm thinking that it is dead/left insitu.

Regards,
Gavin Vincent
Design & Construction | InfraCo Operations
InfraCo
M 0417983453

To ensure you receive the best customer service, if you cannot contact me, or if you need to lodge a new project or follow up on an existing one please see below for more contact details.

Network Integrity

- Front of House contact - 1800 810 443
- Email new job request - Networkintegrity@team.telstra.com
- In order for you lodge your own projects online, please action via the below link, https://www.telstra.com.au/forms/request-asset-relocation-or-commercial-works

NBN Co

- If NBN network requires relocation, please contact on 1800 687 626 or email: RelocationWorks@nbnco.com.au

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General

From: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Sent: Monday, September 18, 2023 10:26 AM
To: Vincent, Gavin <Gavin.W.Vincent@team.telstra.com>
Subject: Lot 102 Bussell Hwy, Cowaramup

[External Email] This email was sent from outside the organisation – be cautious, particularly with links and attachments.

Hi Gavin,

Hope you're well.

We're looking into servicing of a development in Cowaramup (concept attached) and from the BYDA information available it appears there may be an optic fibre cable running through the lot (refer attached). Are you able to confirm what this cable is that runs through the site in a north-south direction, and it is still a live feed? If so, are you able to provide any input into what the likely relocation strategy might be?

Apologies for the late notice, but we're looking to finalise a first draft of our report by COB tomorrow, so any info you can provide would be great.

Thanks,

Brenton Washfold
Senior Civil Engineer

M: 0422 213 753
P: 08 9227 0595
F: 08 9227 8617

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APPENDIX G

NBN CORRESPONDENCE

Ben Whitfield

From: Brian O'Keefe <brianokeefe@nbnco.com.au>
Sent: Tuesday, 12 September 2023 2:33 PM
To: Brenton Washfold
Cc: Ben Whitfield; Tricia Butler; Ian McCulloch
Subject: RE: [External] Goldfields Cowaramup - Lot 100 [Commercial - Anyone]

Hi Brenton,

The proposed development in Cowaramup abuts the existing NBN fixed line network footprint so there would likely be no backhaul charges (subject to confirmation of lot count) to service this development with Fibre to the Premises (FttP) services with capacity to cater for residential grade connections. If required, we can also explore the availability of enterprise grade 1Gbps ethernet services.

A standard capped per premises contribution would apply to service the development (invoiced on a stage-by-stage basis). We will review this contribution charge subject to further discussions on the developers' requirements as well as other current and future developments with NBN.

Under our standard Master Developer Agreement, the developer would be responsible for the design and construct of the pit and pipe to NBN guidelines.

This advice excludes the cost of moving any existing NBN assets that may need to be relocated to service the development as well as any assets within the development boundary that need to be relocated as part of the site works. Dial Before You Dig info will indicate any NBN assets that may clash with the proposed development. Further details on asset relocations (including obtaining a quote) can be found at https://www.nbnco.com.au/develop-or-plan-with-the-nbn/commercial-works. We could also potentially minimise any of these costs by allowing pit and pipe for the asset relocation to be designed and built under a Master Developer Agreement.

Hopefully, this covers off the high-level information you're after, but please let me know if you have any further questions.

Kind regards

Brian O'Keefe
Senior Account Manager WA/NT, New Developments
M +61 409 900 712 | **E** brianokeefe@nbnco.com.au
Level 4, 202 Pier St, Perth WA 6000

nbn acknowledges and pays respects to the traditional custodians of all the lands upon which we work.

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From: Brenton Washfold <Brenton.Washfold@jdsi.com.au>
Sent: Thursday, September 7, 2023 1:35 PM
To: Tricia Butler <triciabutler@nbnco.com.au>; Ian McCulloch <ianmcculloch@nbnco.com.au>
Cc: Brian O'Keefe <brianokeefe@nbnco.com.au>; Ben Whitfield <Ben.Whitfield@jdsi.com.au>
Subject: [External] Goldfields Cowaramup - Lot 100

EXTERNAL SENDER – Be cautious opening Links and Attachments

Hi Tricia and Ian,

I have another project we're looking at and I've attached the subdivision concept for reference. Are you able to provide similar advice on this one in terms of existing network in the area, serviceability, infrastructure upgrades, backhaul costs etc?

Thanks,

Brenton Washfold
Senior Civil Engineer

M: 0422 213 753
P: 08 9227 0595
F: 08 9227 8617

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