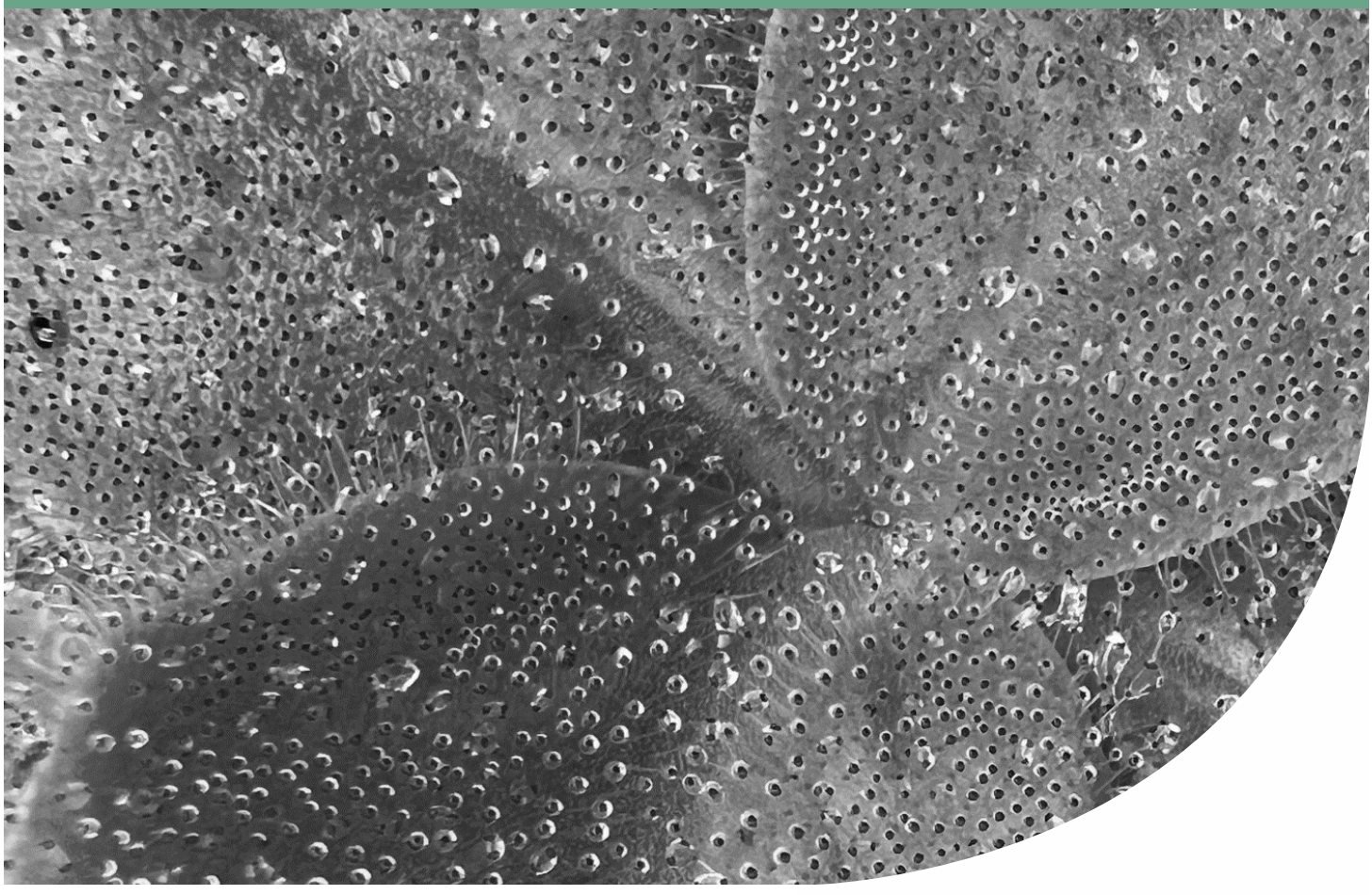
Detailed Flora and Vegetation Assessment

Karnup District Structure Plan

Project No: EP23-018(06)

Prepared for City of Rockingham
June 2024



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Executive Summary

The City of Rockingham engaged Emerge Associates to conduct a detailed flora and vegetation assessment within the District Structure Plan area in Karnup (the 'site').

The assessment included a desktop study of the environmental context of the site and the likelihood of occurrence of threatened and priority flora and ecological communities. Field survey(s) were conducted over 16 days between July and November 2023 during which the composition and condition of vegetation was recorded. Flora and vegetation values were characterised to the standard required of a detailed survey with reference to (EPA 2016b). A portion of the site was accessible and traversed during the surveys. The remainder of the site was viewed from adjacent accessible areas and a determination on values was made, where possible.

Outcomes of the assessment include the following:

- A total of 184 native and 153 non-native (weed) species were recorded.
- No threatened or priority flora species were recorded within the accessible portions of the site.
- Seven declared pest species were recorded (**Asparagus aethiopicus*, **Asparagus asparagoides*, **Gomphocarpus fruticosus*, **Lantana* sp., **Opuntia stricta*, **Moraea flaccida* and **Zantedeschia aethiopica*), of which four ((**A. aethiopicus*, **A. asparagoides, Lantana* sp. and **O. stricta*) are also listed as weeds of national significance.
- A total of 16 vegetation units were recorded over the site, ranging from 'completely degraded' to 'very good' condition. An 'unconfirmed' vegetation unit and condition category was applied to vegetation that could not be viewed from adjacent areas.
- The site contains 12.68 ha of the 'threatened ecological community' (TEC)/'priority ecological community' (PEC) 'banksia woodlands of the Swan Coastal Plain' within three separate patches. An additional 145.40 ha of vegetation across the site has the potential to represent the TEC/PEC. This community is listed as a 'endangered' TEC under the *Environmental Protection and Biodiversity Conservation Act 1999* and a 'priority 3' PEC in Western Australia.
- The site contains 685.12 ha of the 'tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' TEC/PEC. An additional 54.82 ha of vegetation across the site has the potential to represent the TEC/PEC. This community is listed as a 'critically endangered' TEC under the *Environmental Protection and Biodiversity Conservation Act 1999* and a 'priority 3' PEC in Western Australia.
- The site contains 20.53 ha of the State listed 'southern *Eucalyptus gomphocephala-Agonis flexuosa* woodlands' PEC.
- The following flora and vegetation values will require further consideration for any future approvals.
    - The potential presence of threatened and priority flora species within the inaccessible portions of the site.
    - Vegetation mapped as being in 'good' or better condition over the entirety of the site.
    - The confirmed and unconfirmed TECs and PECs mapped over the entirety of the site.

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Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
EPA	Environmental Protection Authority
DBCA	Department of Biodiversity, Conservation and Attractions
DoW	Department of Water (now DWER)
DWER	Department of Water and Environmental Regulation
DPaW	Department of Parks and Wildlife (now DBCA)
WALGA	Western Australia Local Government Association

Table A2: Abbreviations – General terms

General terms	
A	Annual
CCW	Conservation category wetland
CR	Critically endangered
DSP	District structure plan
EN	Endangered
ESA	Environmentally sensitive area
FCT	Floristic community type
IBRA	Interim Biogeographic Regionalisation for Australia
MUW	Multiple use wetland
NVIS	National Vegetation Information System (ESCAVI 2003)
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
P5	Priority 5
PEC	Priority ecological community
P	Perennial
PG	Perennial geophyte
REW	Resource enhancement wetland
T	Threatened
TEC	Threatened ecological communities

General terms	
UFI	Unique feature identifier
VU	Vulnerable

Table A3: Abbreviations – Legislation

Legislation	
BAM Act	*Biosecurity and Agriculture Management Act 2007*
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
BC Act	*Biodiversity Conservation Act 2016*
BC Regs	*Biodiversity Conservation Regulations 2018*

Table A4: Abbreviations – Units of measurement

Units of measurement	
cm	Centimetre
ha	Hectare
km	Kilometre
m	Metre
m^2	Square metre
m AHD	m in relation to the Australian height datum
mm	Millimetre

1 Introduction

1.1 Purpose

Emerge Associates (Emerge) were engaged by City of Rockingham to conduct a detailed flora and vegetation assessment within the Karnup District Structure Plan (DSP) area as shown in **Figure 1** (referred to herein as the 'site').

Flora and vegetation assessments are required to characterise vegetation values and, in particular, confirm the presence or absence of values relevant to environmental approvals process, such as, 'native vegetation', 'threatened' flora, 'priority' flora, 'threatened ecological communities' (TECs), 'priority ecological communities' (PECs) and weeds.

1.2 Legislation and policy

'Native vegetation' is defined by the *Environmental Protection Act 1986* (EP Act) as indigenous aquatic or terrestrial flora. In the *Environmental Factor Guideline – Flora and Vegetation* the EPA further defines it as native vascular flora and defines vegetation as groupings of flora (EPA 2016a). Native vegetation is protected in Western Australia and can't be cleared without a permit or valid exemption. Biological diversity, habitat function, scarcity, association with wetlands and other ecosystem services influence the value placed on native vegetation (DWER 2018a). Planted flora and vegetation are generally not regarded as native vegetation unless required to be established under the EP Act or other written law or regulation.

Flora and ecological communities may be listed as threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (DCCEEW 2021) and the State *Biodiversity Conservation Act 2016* (BC Act) (DBCA 2022c, 2023e). Threatened flora and TECs are classified as either 'critically endangered'(CR), 'endangered' (EN) or 'vulnerable' (VU) (DCCEEW 2021). Commonwealth and/or State ministerial approval is required to impact threatened flora or TECs.

Native flora and ecological communities that are not listed as threatened, but are otherwise considered rare or under threat, may be added to a Department of Biodiversity, Conservation and Attractions (DBCA) priority list (DBCA 2022b, c). 'Priority flora' and PECs are classified as either 'priority 1' (P1), 'priority 2' (P2), 'priority 3' (P3) or 'priority 4' (P4). They do not have direct statutory protection. However, their priority classification is taken into account during State and Local government approval processes.

Flora that are regarded as having negative environmental or economic impacts are often referred to as weeds (DBCA 2023g). Particularly detrimental weed species may be listed as a 'declared pest' pursuant to the State *Biosecurity and Agriculture Management Act 2007* (BAM Act) or as a 'weed of national significance' (WoNS) (DAWE 2021). Management of weeds, declared pests and WoNS may be required during State and Local government approval processes.

Further information on legislation and policy relevant to flora and vegetation assessments is provided in **Appendix A**.

1.3 Scope of work

The Environmental Protection Authority (EPA) *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* establishes standards for the assessment of flora and vegetation in Western Australia (EPA 2016b).

The scope of work was to undertake a detailed and targeted survey with reference to EPA (2016b).

As part of this scope of work, the following tasks were undertaken:

- Desktop study to provide contextual information and determine the likelihood of occurrence of threatened and priority flora or ecological communities.
- Field survey(s) to record flora, vegetation units and vegetation condition.
- Analysis and mapping of contextual information, vegetation units, vegetation condition and threatened and priority flora or ecological communities (if present).
- Documentation of the desktop study, methods, results, discussion and conclusions.

2 Desktop Study

2.1 Site context

2.1.1 Location and extent

The site is located in the City of Rockingham in the Swan Coastal Plain region of Western Australia and extends over 1,657 hectares (ha) as shown in **Figure 1**. The site is bounded by Kwinana Freeway to the east, Stakehill Road to the north, Fletcher Road and Mandurah Road to the west and Paganoni Road to the south.

2.1.2 Climate

The Swan Coastal Plain region of Western Australia experiences a Mediterranean climate of hot dry summers and cool wet winters (BoM 2023). Recent rainfall at the closest weather station to the site has been generally consistent with long term averages **Plate 1** (BoM 2023). Flora and vegetation surveys should be undertaken during the season that is most suitable for detection and identification of the range of flora likely to occur in the area (EPA 2016b). For the south-west botanical province in which the site lies, the primary survey time is spring (September to November) (EPA 2016b).

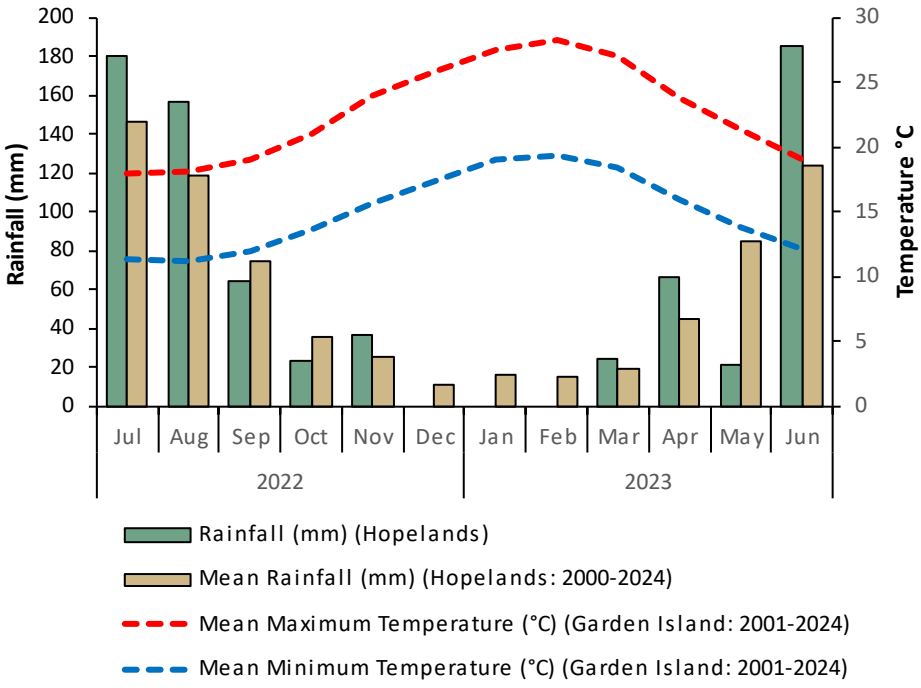

Plate 1: Recent rainfall and long-term mean temperature and rainfall

2.1.3 Geomorphology and soils

The site occurs on the Swan Coastal Plain, which is the geomorphic unit that characterises much of the Perth metropolitan area. The Swan Coastal Plain is approximately 500 km long and 20 to 30 km wide and is roughly bounded by the Indian Ocean to the west and the Darling Scarp to the east. Broadly, the Swan Coastal Plain consists of two sedimentary belts of different origin: its eastern side comprises the Pinjarra Plain which formed from the deposition of alluvial material washed down from the Darling Scarp and its western side comprises three dune systems that run roughly parallel to the Indian Ocean coastline. These dune systems, referred to as Quindalup, Spearwood and Bassendean associations, represent a succession of coastal deposition and, as a result, they contain soils at different stages of leaching and formation (Kendrick *et al.* 1991). The site is located within the Spearwood dune system.

Examination of broad scale soil mapping shows four soil associations as occurring within the site, as described in **Table 1** (Churchward and McArthur 1980). The soil types mapped within the site are shown in **Figure 2**.

Table 1: Broad scale soil mapping within the site (Churchward and McArthur 1980)

Soil association	Location within site	Description
Karrakatta	Majority of the site	Undulating landscape with deep yellow sands over limestone.
Serpentine River	A strip along the north side of the eastern boundary	Poorly drained plain with fine textured alluvial soils.
Yoongarillup	A strip along the south side of the eastern boundary	Plains with low ridges and swales; shallow and brown sands over marine limestone.
Cottesloe	Very small patch in the south west corner	Low hilly landscape with shallow brown sands over limestone, much exposed limestone.

The site is not known to contain any restricted landforms or unique geological features.

2.1.4 Topography

The elevation of the site ranges from 1 metre in relation to the Australian height datum (mAHD) on to 35 mAHD and varies across the site (DoW 2008) (**Figure 2**).

2.1.5 Hydrology and wetlands

Wetlands are areas of seasonally, intermittently or permanently waterlogged land such as poorly drained soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries (Wetlands Advisory Committee 1977). Wetlands can be recognised by the presence of vegetation associated with waterlogging or the presence of hydric soils such as peat, peaty sand or carbonate mud (Hill *et al.* 1996).

Wetlands of national or international significance may be afforded special protection under Commonwealth or international agreements. Review of the *Ramsar List of Wetlands of International Importance* (DBCA 2017) and *A Directory of Important Wetlands in Australia – Western Australia* (DBCA 2018) indicates that no Ramsar or listed 'important wetlands' are located within or near the site.

The Department of Water and Environmental Regulation (DWER) hydrography linear dataset (DWER 2018b) records the following 30 wetland or water related features within the site:

- 14 perennial swamps
- 11 earth dams
- 3 areas subject to inundation
- 2 minor, non-perennial watercourses.

The *Geomorphic Wetlands of the Swan Coastal Plain* dataset maps geomorphic wetland features and classifies them based on their landform shape and water permanence (DBCA 2023a). Each wetland feature is assigned to one of three management categories: 'conservation', 'resource enhancement' and 'multiple use'.

The *Geomorphic Wetlands, Swan Coastal Plain* dataset records six 'conservation' category wetland features (UFIs 6411, 6413, 6414, 6446, 6624, 6636), seven 'resource enhancement' category wetland features (UFIs 6429, 6548, 6625, 6626, 6634, 6638, 6641), and four 'multiple use' category wetland features (UFIs 6426, 6428, 15848, 16501) also occur within the site (DBCA 2023a). One conservation and three resource enhancement wetland features are classified as damplands and the remaining wetland features are all classified as sumplands. The locations of the geomorphic wetlands in the site are shown in **Figure 2**.

2.1.6 Regional vegetation

Native vegetation is described and mapped at different scales to illustrate patterns in its distribution. At a continental scale the *Interim Biogeographic Regionalisation for Australia* (IBRA) divides Australia into floristic subregions (Environment Australia 2000).

The site is contained within the Swan Coastal Plain IBRA region and within the 'SWA02' or Perth subregion. The Perth subregion is characterised by mainly banksia low woodland on leached sands with melaleuca swamps where ill-drained; and woodland of *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah) and *Corymbia calophylla* (marri) on less leached soils (Beard 1990). This subregion is recognised as a biodiversity hotspot and contains a wide variety of endemic flora and vegetation types.

Variations in native vegetation can be further classified based on regional vegetation mapping. Heddle *et al.* (1980) mapping shows the site as comprising four vegetation complexes. The four complexes are described below, with their extent of pre-European vegetation remaining and under conservation (Government of Western Australia 2019), in **Table 3**.

Table 2: Vegetation complex mapping within the site (Heddle et al. 1980)

Vegetation complex	Location within site	Description	Pre-European vegetation (Government of Western Australia 2019)	
			Extent remaining	Extent remaining and protected for conservation purposes[1]
Karrakatta – central south	Majority of the site	Predominantly open forest of *Eucalyptus gomphocephala* (Tuart) - *Eucalyptus marginata* (Jarrah) - *Corymbia calophylla* (Marri) and woodland of *Eucalyptus marginata* (Jarrah) - *Banksia* species.	23.5%	4.6%
Serpentine River	A strip along the north side of the eastern boundary	Closed *Melaleuca* scrub and fringing woodland of *Eucalyptus rudis* (Flooded Gum).	9.8%	2.4%
Yoongarillup	A strip along the south side of the eastern boundary	Woodland of *Eucalyptus gomphocephala* (Tuart) with *Agonis flexuosa* in the second storey.	35.8%	14.1%
Cottesloe – central south	Very small patch in the south west corner	Woodland of *Eucalyptus gomphocephala* and open forest of *Eucalyptus gomphocephala - Eucalyptus marginata - Corymbia calophylla*.	32.2%	10.0%

2.1.7 Threatened and priority flora

The Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) has compiled various datasets relating to 'matters of national environmental significance' (MNES) (DCCEEW 2023). The *Protected Matters Search Tool* provides general guidance on threatened flora listed under the EPBC Act that may occur within a location based on validated records and less reliable unvalidated habitat distribution modelling (DCCEEW 2023).

DBCA's *Threatened and Priority Flora Database* and *WA Herbarium Database* contain records of threatened and priority flora in Western Australia (DBCA 2023f). Searches of these databases provide point data for threatened and priority flora within a location, comprising validated and historical unvalidated records.

The *Protected Matters Search Tool* (DCCEEW 2023) and DBCA's threatened and priority flora databases (reference no. 40-0523FL) identified 13 threatened and 24 priority flora occurring or potentially occurring within a 10 km radius of the site (refer **Appendix B**).

[1]Defined as being listed in the DBCA-legislated lands and waters dataset as either Crown reserves or lands managed under Section 8A of the CALM Act that have an IUCN category of I – IV (Government of Western Australia 2019).

2.1.8 TECs and PECs

The *Protected Matters Search Tool* provides general guidance on TECs listed as CR and EN under the EPBC Act that may occur within a location based on reliable records and less reliable habitat distribution modelling (DCCEEW 2023).

DBCA's *Threatened and Priority Ecological Community buffers and boundaries in WA* dataset contains validated records of TECs and PECs. Searches of this dataset provides buffered polygons of TEC and PEC records.

The *Protected Matters Search Tool* and DBCA's TEC and PEC database (reference no. 22-0523EC) identified 8 TECs and 9 PECs occurring or potentially occurring within a 10 km radius of the site (refer **Appendix C**).

2.1.9 Historical land use

Review of historical images available from 1665 onwards shows that the majority of the site was cleared of native vegetation prior to 1974, likely for grazing and/or cropping uses (WALIA 2023).

The north-eastern portion of the site was cleared for use as a forestry plantation in 1970 and then utilised as a limestone quarry from 2008. The rest of the site has been separated into lots used for rural properties with cropping/grazing paddocks as well as a small commercial quarry in the south. Some remnant vegetation remains in the south-western portion of the site.

2.1.10 Bush Forever

The Government of Western Australia's *Bush Forever* policy is a strategic plan for conserving regionally significant bushland within the Swan Coastal Plain portion of the Perth Metropolitan Region. The objective of *Bush Forever* is to protect representations of all original ecological communities by targeting a minimum of 10% of each vegetation complex for protection (Government of WA 2000). *Bush Forever* sites are representative of regional ecosystems and habitat and have a key role in the conservation of Perth's biodiversity.

Two *Bush Forever* areas occur within the site and a further five occur adjacent to the site. Bush Forever Site 278 (Cassia Drive Bushland) occurs as two parcels within the north-western portion of the site. Bush Forever Site 379 (Anstey Swamp) occurs within the south-western portion of the site and extends to the north-west. Bush Forever Site 395 (Paganoni Swamp and Adjacent Bushland) is adjacent to the south of the site and extends slightly into the south-western boundary of the site. Bush Forever sites 376 and 75 occur adjacent to the north of the site and sites 277 and 394 lie adjacent to the site but are separated by the Kwinana Freeway.

The locations of Bush Forever sites within and adjacent to the site are shown in **Figure 2**.

2.1.11 DBCA managed or legislated land

DBCA has tenure of, or interests in, numerous areas of land across the state for a range of purposes. Tenure categories include national parks, nature reserves, conservation parks, marine parks, marine nature reserves, marine management areas, section 5(1)(g) reserves, state forest and timber reserves. These areas are mapped within the *Legislated Lands and Waters* (DBCA 2023b) and *Lands*

of Interest (DBCA 2022a) datasets. The *Legislated Lands and Waters* (DBCA 2023b) dataset includes lands subject to the *Conservation and Land Management Act 1984* (CALM Act 1984), *Swan and Canning Rivers Management Act 2006* (SCRM Act) and lands identified under the *Land Administration Act 1997* (LA Act). The *Lands of Interest* (DBCA 2022a) dataset includes all other lands of which DBCA is recognised as the manager but is not vested under any act.

A section 5(1)(h) reserve lies on the north-eastern edge of the site associated with forestry or explosive activity. A crown freehold area associated with Bush Forever Site 379 exists on the south-western edge of the site and adjacent to the west edge of the site. Another crown freehold area exists adjacent to the south of the site associated with Bush Forever Site 395. DBCA managed and legislated land is shown in **Figure 3**.

2.1.12 Ecological linkages

Ecological linkages are linear landscape elements that allow the movement of fauna, flora and genetic material between areas of habitat. This exchange of genetic material between vegetation improves the viability of this vegetation by allowing greater access to breeding partners and food sources, refuge from disturbances such as fire and maintenance of genetic diversity of Vegetation units and populations. Ecological linkages are ideally continuous or near-continuous as the more fractured a linkage is, the less ease flora and fauna have in moving within the corridor (Alan Tingay and Associates 1998).

The Perth Biodiversity Project, supported by the Western Australian Local Government Association (WALGA), identified and mapped regional ecological linkages within the Perth Metropolitan Region (WALGA and PBP 2004).

Ecological linkage no. 76, which is associated with Bush Forever sites 379 and 395, occurs in the south-western portion of the site and extends beyond the site in a north-south direction. Ecological linkage no. 81, which is associated with Bush Forever sites 379 and 278, occurs in the north-western portion of the site and extends in a south-east direction. Ecological linkage no. 74 occurs in the north-eastern portion of the site and extends in a north-south direction.

The locations of these linkages and linkages in the wider area of the site are shown in **Figure 3**.

2.1.13 Previous surveys

A number of flora and vegetation assessments have previously been undertaken over portions of the site, including Karnup Station in the south-western corner of the site (360 Environmental 2017)(PGV 2014) and Stakehill Road (PGV 2014; Strategen JBS&G 2021).

During these surveys broad scale mapping of vegetation units and vegetation condition were completed and the 'banksia woodlands of the Swan Coastal Plain' TEC/PEC and the 'tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain' TEC/PEC were identified over portions of the site. No threatened or priority flora species were recorded.

2.2 Likelihood of occurrence

The distribution and habitat preferences of the threatened and priority flora species and ecological communities listed in **Appendix B** and **Appendix C** was reviewed against site context information described in **Section 2.1**. Likelihood of occurrence of threatened and priority flora species and ecological communities within the site was classified as 'high', 'moderate', 'low' or 'negligible' as outlined in **Table 3**.

Table 3: Decision matrix for likelihood of occurrence of threatened and priority flora and ecological communities

		Distribution[1]	
		Reliable record within search area	No reliable record within search area
Habitat	Suitable	High	Nil
	Potentially suitable	Moderate	
	Unsuitable	Negligible	

[1] Reliable record defined as validated, recent (within the last ~40 years) and spatially accurate (refer DBCA search meta data) in order to exclude unverified range or habitat projections.

2.2.1 Threatened and priority flora

A total of 24 threatened and 20 priority flora were classified as having a 'high' or 'moderate' likelihood of occurrence within the site, as outlined in **Table 4**. The complete likelihood of occurrence assessment is provided as **Appendix B**.

Table 4: Threatened or priority flora species with a high or moderate likelihood occurrence in the site

Species	Status		Life strategy	Flowering period	Likelihood of occurrence
	WA	EPBC Act			
Synaphea sp. Serpentine (G.R. Brand 103)	CR	CR	P	Sep-Oct	Moderate
Caladenia huegelii	CR	EN	PG	Sep-early Nov	Moderate
Drakaea elastica	CR	EN	PG	late Sep-Oct/Nov, survey Jul-Aug	High
Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026)	P1	-	P	May or Aug	Moderate
Acacia sp. Binningup (G. Cockerton et al. WB 37784)	P1	-	P	Aug	Moderate
Stachystemon exilis	P1	-	P	Oct-Nov	Moderate
Acacia benthamii	P2	-	P	Aug-Sept	High
Cardamine paucijuga	P2	-	A	Sep-Oct	High
Johnsonia pubescens subsp. *cygnorum*	P2	-	P	Sep	Moderate
Thelymitra variegata	P2	-	P	Jun-Sep	Moderate
Beyeria cinerea subsp. *cinerea*	P3	-	P	May-Oct	High

Table 4: Threatened or priority flora species with a high or moderate likelihood occurrence in the site (cont.)

Species	Status		Life strategy	Flowering period	Likelihood of occurrence
	WA	EPBC Act			
Boronia capitata subsp. *gracilis*	P3	-	P	Jun-Nov	Moderate
Carex tereticaulis	P3	-	P	Sep-Oct	Moderate
Dillwynia dillwynioides	P3	-	P	Aug - Dec	High
Lasiopetalum membranaceum	P3	-	P	Sep-Dec	Moderate
Schoenus capillifolius	P3	-	A	Oct-Nov	High
Sphaerolobium calcicola	P3	-	P	Jun or Sep-Nov	High
Styphelia filifolia	P3	-	P	Feb-Apr	Moderate
Caladenia speciosa	P4	-	PG	Sep-Oct	Moderate
Conostylis pauciflora subsp. *pauciflora*	P4	-	P	Aug-Oct	High
Eucalyptus foecunda subsp. *foecunda*	P4	-	P	Jan-Mar	Moderate
Jacksonia sericea	P4	-	P	Dec-Feb	High
Stylidium longitubum	P4	-	A	Oct-Dec	Moderate
Diuris drummondii	VU	VU	PG	Nov-Jan	High

CR=critically endangered, EN=endangered, VU=vulnerable, P1-P4=Priority 1-Priority 4, P=perennial, PG=perennial geophyte.

2.2.2 TECs and PECs

Four TECs and six PECs were classified as having a 'high' or 'moderate' likelihood of occurrence within the site, as detailed in **Table 5**. The complete likelihood of occurrence assessment is provided as **Appendix C**.

Table 5: Threatened or priority ecological communities with a high or moderate likelihood of occurrence in the site

Community	Status		Likelihood of occurrence
	WA	EPBC Act	
Sedgelands in Holocene dune swales of the southern Swan Coastal Plain (SCP19a)	TEC (CR)	TEC (EN)	High
Woodlands over sedgelands in Holocene dune swales of the southern Swan Coastal Plain (SCP19b)	TEC (CR)	TEC (EN)	High
Herb rich shrublands in clay pans (SCP08)	TEC (VU)	TEC (CR)	High
Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (SCP15)	TEC (VU)	-	Moderate
Banksia woodlands of the Swan Coastal Plain (Banksia WL SCP)	PEC (P3)	TEC (EN)	High

Table 5: Threatened or priority ecological communities with a high or moderate likelihood of occurrence in the site (cont.)

Community	Status		Likelihood of occurrence
	WA	EPBC Act	
Low lying *Banksia attenuata* woodlands or shrublands (SCP21c)	PEC (P3)	TEC (EN)	Moderate
Northern Spearwood shrublands and woodlands (SCP24)	PEC (P3)	-	High
Southern *Eucalyptus gomphocephala - Agonis flexuosa* woodlands (SCP25)	PEC (P3)	-	High
Coastal shrublands on shallow sands (SCP29a)	PEC (P3)	-	High
Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain (tuart woodlands)	PEC (P3)	TEC (CR)	High

3 Methods

3.1 Field survey

Experienced botanists visited the site over 16 days to conduct the field survey: 28 July, 3, 4, 8, 9, 15, 16, 18, 24, 29 and 30 August, 14, 18, 27, 28 September and 30 November 2023. The site was traversed on foot and the composition and condition of vegetation was recorded. Plant specimens were collected where the identity of flora required further confirmation. Photographic images and notes were recorded as required.

3.1.1 Targeted searches

Targeted searches were conducted for threatened and priority flora and ecological communities, with a particular focus on those with a high or moderate likelihood of occurrence (refer **Section 2.2**). Transects for flora were traversed approximately 5 m apart through areas of potentially suitable habitat. Transects and records were marked using a hand-held GPS receiver (±5 m accuracy).

3.1.2 Sampling

Detailed sampling of the vegetation was undertaken using a combination of non-permanent 10 x 10 m quadrats and relevés. The quadrats were established using fence droppers bounded by measuring tape. The relevés were completed over an equivalent 10 x 10 m area without the use of physical markers and were included to provide a more rapid sample of patches of vegetation in poorer condition and/or of smaller size. The position[2] of each sample was recorded with a hand-held GPS receiver (±5 m accuracy).

The data recorded within each sample included:

- site details (site name, site number, observers, date, location)
- environmental information (slope, aspect, bare-ground, rock outcropping, soil type and colour, litter layer, topographical position, time since last fire event)
- biological information (species, plant specimens, vegetation structure, vegetation condition, ‘foliage projective cover’, and disturbance).

Twelve locations were sampled, comprised of eight quadrats and four relevés, as shown in **Figure 3**.

3.1.3 Vegetation condition

The condition of the vegetation was assessed using the Keighery (1994) scale (**Table 6**). For areas where no access was permitted and the vegetation appeared to contain attributes of two condition categories, or the appropriate category could not be determined, a compound condition category was applied. For vegetation in the site containing *Banksia* spp., the condition scale provided in the DoEE (2016) conservation advice for the ‘banksia woodlands of the Swan Coastal Plain TEC’ was applied in addition to the Keighery scale, as shown in **Table 6**.

[2] For quadrats the north-west corner was recorded.

Table 6: Vegetation condition scale applied during the field survey

Category	Definition (Keighery 1994)	Indicator (DoEE 2016)	
		Typical native vegetation composition^	Typical weed cover
Pristine	Pristine or nearly so, no obvious signs of disturbance.	Native plant species diversity fully retained or almost so	Zero or close to
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.	High native plant species diversity	Less than 10%
Very good	Vegetation structure altered 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.	Moderate native plant species diversity	5-20%
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate 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.	Low native plant species diversity	5-50%
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.	Very low native plant species diversity	20-70%
Completely degraded	The structure of the vegetation is 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 comprising weed or crop species with isolated native trees or shrubs.	Very low to no native species diversity	Greater than 70%

^relative to the expected natural diversity for that vegetation.

3.2 Analysis and data preparation

3.2.1 Lot access

Some lots were unable to be accessed during the survey due to lack of permission from landowners (**Figure 1**). Where access was limited, best efforts were made to take accurate data from nearby accessible lots or public roads. The degree of limitation and subsequent changes to data outputs are summarised in **Table 7**.

Table 7: Summary of survey limitations.

Limitation status	Access permitted	Access not permitted	Output
None – attribute confirmed	The survey was sufficient and we are confident of the status of the attribute	Survey from adjacent accessible areas (e.g. road reserves, neighbouring lots with permission to access) was sufficient and we are confident of the status of the attribute	Attribute shown on map without caveat
Minor – attribute not confirmed	The survey was able to determine some information about the attribute but was not conclusive	The survey effort was able to determine some information about the attribute but was not conclusive	Attribute shown on map without caveat. Limitation described in report.
Major – attribute unknown	N/A	Values are unknown	Attribute shown on map as 'status unconfirmed' and described in report.

3.2.2 Flora identification

Flora were identified through comparison with named material and through the use of taxonomic keys. Plant specimens collected during the field survey were dried, pressed and named in accordance with requirements of the Western Australian Herbarium (2023).

Flora was classified as native if indigenous to the IBRA region in which the site occurs. Non-native flora is denoted by '*' in text and raw data. The legal or policy status of flora was denoted using codes outlined in **Appendix A**.

3.2.3 Sampling adequacy

A species accumulation curve was plotted from sample data by generating a trendline (log) in Microsoft Excel. The trendline was forecast to locate the asymptote of the curve (the point at which the curve flattens), which provides an indication of amount of sampling that would be required before it can be assumed few species remain undetected.

Species richness was estimated in PRIMER v6 (Clarke and Gorley 2006). Jacknife1 and Chao2 non-parametric estimators are reported as these are known to perform well in comparison to simulated and real data sets and are also recommended for small sample sizes (Gotelli and Colwell 2011). Differences between recorded and estimated species richness was used to evaluate the adequacy of sampling effort.

3.2.4 Threatened and priority flora confirmation

Threatened and priority flora were confirmed as absent from the site where no significant limitation was identified that could have affected their detection (refer **Section 3.3**).

3.2.5 Vegetation unit identification and description

The vegetation units within the site were identified from the sample data collected during the field survey. The vegetation was described according to the dominant species present using the structural

formation descriptions of the *National Vegetation Inventory System* (NVIS) (NVIS Technical Working Group 2017).

3.2.6 Floristic community type assignment

The identified vegetation units were compared to the regional 'floristic community type' (FCT) dataset *A floristic survey of the southern Swan Coastal Plain* (Gibson *et al.* 1994). Each sample was compared to Gibson *et al.* (1994) separately to limit the influence of spatial correlation when assigning an FCT. FCT analysis was not undertaken for samples located within disturbed vegetation with low native species diversity as the vegetation was considered unlikely to currently represent an FCT.

Sample data (presence/absence) was first reconciled with Gibson *et al.* (1994) by standardising the names of taxa with those used in the earlier study. This was necessary due to changes in nomenclature in the intervening period. Taxa that were only identified to genus level were excluded, while some infra-species that have been identified since 1994 were reduced to species level. The combined dataset was then imported into the statistical analysis package PRIMER v6 (Clarke and Gorley 2006).

A resemblance matrix was generated using the Bray-Curtis distance measure which provided the percentage similarity between all pairs of samples. A cluster analysis was then performed using the resemblance matrix and hierarchical agglomerative clustering, to produce a dendrogram.

Where a sample tended to cluster with a grouping of different FCTs, the resemblance matrix was examined. Ultimately a combination of cluster analysis, resemblance matrix and contextual information relating to the soils, landforms and known FCTs within the region was considered in the final determination of an FCT for vegetation within the site.

3.2.7 TEC and PEC confirmation

Vegetation units were assessed against TEC and PEC diagnostic characteristics and, if available, size and/or vegetation condition thresholds (DBCA 2023c). TECs and PECs were confirmed as absent from the site where no significant limitation was identified that could have affected their detection (refer **Section 3.3**).

3.2.8 Mapping

Environmental features, vegetation units, vegetation condition, threatened or priority flora or ecological communities were mapped on aerial photography using notes and data collected in the field.

3.3 Limitations

It is important to note constraints imposed on assessments and the degree to which these may have limited outcomes. An evaluation of the desktop study and methods applied in the current assessment against standard constraints outlined in the EPA document *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016b) is provided in **Table 8**.

Table 8: Evaluation of assessment against standard constraints outlined in (EPA 2016b)

Constraint	Degree of limitation	Details
Availability of contextual information	No limitation	The broad scale contextual information described in **Section 2.1** is adequate to place the site and vegetation in context.
	No limitation	Regarding assignment of FCTs, the authoritative Gibson *et al.* (1994) dataset was derived from a necessarily limited sample of vegetation from largely publicly owned land which is now more than 30 years out of date. Consequently, it is unknown to what degree official FCTs are an appropriate reference for the biodiverse vegetation across the Swan Coastal Plain. Furthermore, Gibson *et al.* (1994) collected data in the main flowering period (spring) and in many cases sampled plots multiple times to provide a complete species list. The site was sampled multiple times in spring which allowed for comparison with the Gibson *et al.* (1994) dataset.
Experience level of personnel	No limitation	This flora and vegetation assessment was undertaken by a qualified botanists with 5-13 years of botanical experience in Western Australia. Technical review was undertaken by a senior environmental consultant with 13 years' experience in environmental science in Western Australia.
Suitability of timing	No limitation	In Mediterranean climates some flora spend part of their lifecycle as underground storage organs or seed to avoid excessive heat and drought over the summer period. These species, known as 'geophytes' or 'annuals', tend to re-emerge during winter and are often most visible during spring, which is the flowering period for the majority of plant species. Therefore, spring is the optimal time to complete flora and vegetation surveys in the south-west of WA. The survey was conducted in July, August, September and November and thus within the main flowering season. High rainfall was recorded from May to September 2023 in the months preceding the site visits. Therefore, it is likely that many plant species would have been in flower and/or visible at the time of survey. The degraded nature of much of the site limits the potential habitat for native geophytic plants such as orchids and the majority of threatened and priority flora species with potential to occur are perennial species. The survey timing was considered adequate to allow the detection of species for which seasonal timing is critical.
Temporal coverage	No limitation	Detailed flora and vegetation assessments can require multiple visits, at different times of year, and over a period of a number of years, to enable observation of all species present. The site was visited multiple times in July-November 2023. The July and August site visits provided an insight into the vegetation condition and composition out of the main flowering period. Therefore, according to the EPA guidelines this survey is considered to meet the requirements of a 'detailed' survey.

Table 8: Evaluation of assessment against standard constraints outlined in (EPA 2016b) (cont.)

Constraint	Degree of limitation	Details
Spatial coverage and access	No limitation	Site coverage was comprehensive (track logged) where access was possible.
	Limitation	Some portions of the site could not be accessed due to lack of permission from landowners. Consequently, some areas were viewed from a distance or mapped via aerial imagery and assumptions based on surrounding vegetation. These areas could not be searched for threatened and priority flora (see **Figure 1**).
Sampling intensity	No limitation	A total of 337 species were recorded, of which 138 were recorded from twelve sample locations and 199 were recorded opportunistically. Minimum species richness within site is estimated at between 200 (Jacknife1) and 234 (Chao2) species (refer species accumulation curve and estimates shown in **Plate 2**). The number of species recorded in the site is more than the estimates and, combined with the degraded nature of the majority of the site, demonstrates that survey effort was ample to prepare a comprehensive species inventory for the site.
Influence of disturbance	No limitation	Time since fire is greater than 30 years as interpreted from aerial imagery and therefore short-lived species more common after fire may not have been visible.
	No limitation	Historical ground disturbance was evident in parts of the site. The disturbance history of the site was considered when undertaking field sampling.
Adequacy of resources	No limitation	All resources required to perform the survey were available.

4 Results

4.1 Flora

4.1.1 Species inventory

A total of 337 were recorded during the field survey. A summary of legal and policy status of flora records is provided in **Table 9**. A complete species list is provided in **Appendix D**.

Table 9: Summary of legal and policy status of taxa recorded in the site

Status	Unlisted	Threatened	Priority	Declared Pest	Planted	Total
Native	177	0	0	-	7	**184**
Non-native	99	-	-	7	47	**153**
Total	276	0	0	7	54	**337**

Sampling recorded 138 species from 12 samples. A further 199 species were recorded opportunistically across the site. A species accumulation curve derived from sample data is presented in **Plate 2**. Species richness was estimated to be between 200 (Jacknife1) and 234 (Chao2).

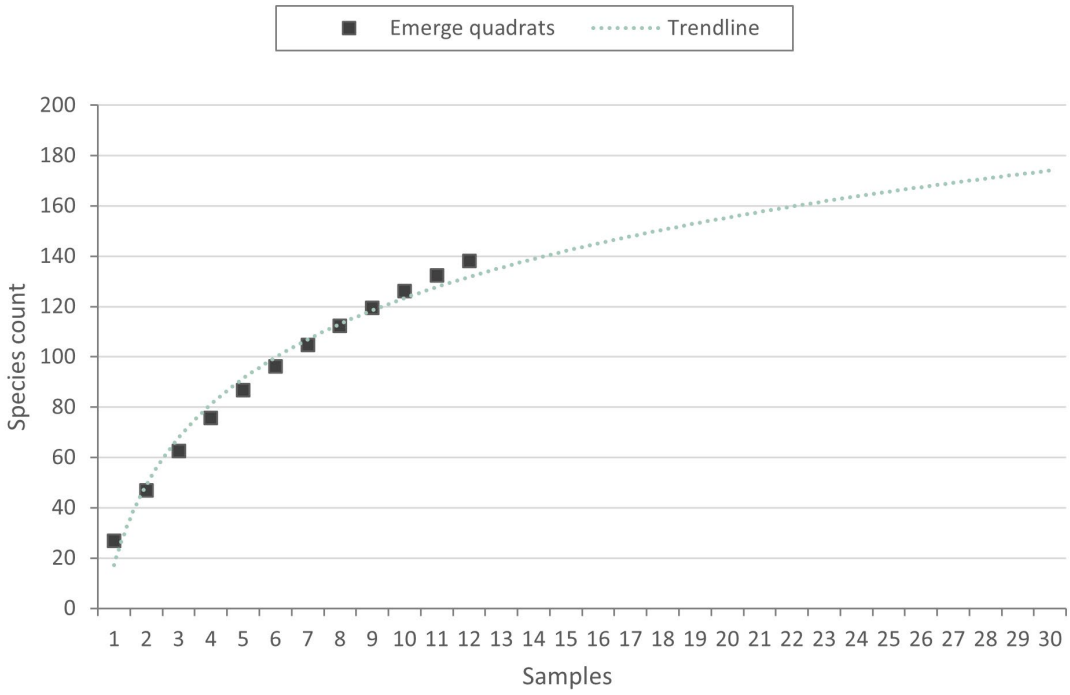

Plate 2: Species accumulation curve derived from sample data (y = 46.128ln(x) + 17.145 R^2 = 0.9808)

4.1.2 Threatened and priority flora

No occurrences of threatened or priority flora species were recorded naturally occurring within the accessible portions of the site. Whilst *Grevillea olivacea* (P4) and *Grevillea curviloba* (T) were recorded, these species were planted and the site is not within the natural range of these species.

The threatened and priority flora species identified in **Section 2.2** are not considered to occur in the accessible portions of the site as no significant limitation affecting their detection was identified (refer **Section 3.3**). The threatened and priority flora species identified in **Section 2.2** may occur within some of the inaccessible portions of the site, as discussed in (refer **Section 3.3**).

4.1.3 Locally and regionally significant flora

Two regionally significant flora species, *Hibbertia cuneiformis* and *Trachymene coerulea,* were recorded within the site. *H. cuneiformis* is listed as significant because the site is at the 'northern or southern limit of its known geographical range' and the species has 'significant populations'. *T. coerulea* is listed as 'significant flora of the Spearwood Dunes in the Perth metropolitan region' as it has 'significant populations' on the Swan Coastal Plain (Government of WA 2000).

4.1.4 Declared pests

Seven species listed as a declared pest (C3) pursuant to the BAM Act were recorded within the site:

- **Asparagus aethiopicus* (Sprenger's asparagus)
- **Asparagus asparagoides* (bridal creeper)
- **Gomphocarpus fruticosus* (narrow-leaved cotton bush)
- **Lantana* sp. (lantana)
- **Moraea flaccida* (one-leafed Cape tulip)
- **Opuntia stricta* (common prickly pear)
- **Zantedeschia aethiopica* (arum lily)

Sprenger's asparagus, bridal creeper, common prickly pear and lantana are listed as weeds of national significance (WoNS).

4.2 Vegetation

4.2.1 Vegetation units

Sixteen vegetation units were identified within the site. A description and the area of each vegetation unit is provided in **Table 10**. The location of each vegetation unit is shown in **Figure 5**. Raw sample data is provided in **Appendix F**.

Table 10: Description and extent of vegetation units identified within the site

Code	Description	Sample/s	Total area (ha)	Proportion of site (%)	Representative photograph
AfB	Low open forest of *Allocasuarina fraseriana* and *Banksia attenuata* and *B. menziesii* over weeds	-	2.40	0.14	
Agfl	Planted *Agonis flexuosa* trees over pasture weeds	-	1.48	0.09	-
Ap	Shrubland of *Acacia pulchella* over pasture weeds	-	32.71	1.97	

Table 10: Description and extent of vegetation units identified within the site (cont.)

Code	Description	Sample/s	Total area (ha)	Proportion of site (%)	Representative photograph
BaBm	Low open woodland of *Banksia menziesii* and *Banksia attenuata* over open mixed shrubland over weeds	-	1.86	0.11	
Cc	Open forest of *Corymbia calophylla* over pasture weeds	-	0.71	0.04	

Table 11: Description and extent of vegetation units identified within the site (cont.)

Code	Description	Sample/s	Total area (ha)	Proportion of site (%)	Representative photograph
Eg	Open to closed forest of *Eucalyptus gomphocephala, Allocasuarina fraseriana* and *Banksia littoralis* over open shrubland of *Xanthorrhoea brunonis* and *X. preissii*, *Macrozamia riedlei, Spyridium globulosum* and *Acacia pulchella* over sedgeland of *Morelotia octandra* and *Desmocladus flexuosus*	Q10	199.1	12.02	
EgB	Open to closed forest of *Eucalyptus gomphocephala* and *Banksia littoralis* and *B. grandis* over forbland of natives and weeds	Q4, Q6, Q7	20.53	1.24	

Table 11: Description and extent of vegetation units identified within the site (cont.)

Code	Description	Sample/s	Total area (ha)	Proportion of site (%)	Representative photograph
EgEm	Open forest of *Eucalyptus gomphocephala* and *Eucalyptus marginata* over open shrubland of *Spyridium globulosum* and *Acacia pulchella* over pasture weeds	-	50.12	3.02	
EgEmAfB	Open forest of *Eucalyptus gomphocephala*, *Eucalyptus marginata, Banksia littoralis* and *Allocasuarina fraseriana* over shrubland of *Macrozamia riedlei* and *Spyridium globulosum* over forbland of *Desmocladus flexuosus*, *Hybanthus calycinus* and *Sowerbaea laxiflora*	Q2, R3, R11	46.26	2.79	

Table 11: Description and extent of vegetation units identified within the site (cont.)

Code	Description	Sample/s	Total area (ha)	Proportion of site (%)	Representative photograph
EgMr	Open forest of *Eucalyptus gomphocephala* over low open forest of *Melaleuca rhaphiophylla* over closed sedgeland of *Gahnia trifida* and forbland of *Centella asiatica, Lobelia anceps* and *Opercularia vaginata*	Q5, Q12	5.02	0.30	
Em	Woodland of *Eucalyptus marginata* over sparse to open shrubland of *Macrozamia riedlei* (or absent) over forbland of weeds	-	20.86	1.26	

Table 11: Description and extent of vegetation units identified within the site (cont.)

Code	Description	Sample/s	Total area (ha)	Proportion of site (%)	Representative photograph
EmAfBa	Scattered *Eucalyptus marginata, Allocasuarina fraseriana* and *Banksia attenuata* and *B. menziesii* over weeds.	-	43.84	2.65	
EmBaBm	Low woodland to open forest of *Eucalyptus marginata, Banksia attenuata* and *Banksia menziesii* over shrubland of *Kunzea glabrescens* and *Hibbertia hypericoides* over forbland of *Dasypogon bromeliifolius*, *Desmocladus flexuosus* and *Morelotia octandra*	Q1	4.58	0.28	

Table 11: Description and extent of vegetation units identified within the site (cont.)

Code	Description	Sample/s	Total area (ha)	Proportion of site (%)	Representative photograph
Mr	Low open forest of *Melaleuca rhaphiophylla* and *Melaleuca teretifolia* over closed sedgeland of *Lepidosperma longitudinale*	Q8, R9	2.34	0.14	
MrKg	Low woodland of *Melaleuca rhaphiophylla* over open to closed shrubland of *Kunzea glabrescens* over forbland of *Dasypogon bromeliifolius* and weeds	-	1.61	0.10	

Table 11: Description and extent of vegetation units identified within the site (cont.)

Code	Description	Sample/s	Total area (ha)	Proportion of site (%)	Representative photograph
Non-native	Areas dominated by non-native species, including horticultural lands	-	1092	65.9	
Unconfirmed	Areas that could not be viewed from adjacent accessible areas or public land	-	111.17	6.71	-
N/A	Bitumen roads	-	20.51	1.24	-

4.2.2 Vegetation condition

The extent of vegetation by condition category is detailed in **Table 11** and shown in **Figure 5**.

Table 11: Extent of vegetation condition categories within the site

Condition category (Keighery 1994)	Total area (ha)	Proportion of site (%)
Pristine	0	0
Excellent	0	0
Very good	5.88	0.35
Good	31.08	1.88
Good - degraded	87.24	5.26
Degraded	309.23	18.66
Completely degraded	1091.99	65.90
Unconfirmed	111.17	6.71
N/A	20.51	1.24

4.2.3 Floristic community types

Vegetation unit **EgB** represents FCT 25 'southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands'. Plant communities **EgMr** and **Mr** were determined to represent FCT 17 '*Melaleuca rhaphiophylla – Gahnia trifida* seasonal wetlands'. Vegetation units **Eg**, **EgEmAfB** and **EmBaBm** represent FCT 21a 'central *Banksia attenuata – Eucalyptus marginata* woodlands', as shown in **Table 12**. The relevant portions of the cluster dendrograms are provided in **Appendix F**.

Other vegetation units were either too degraded to assign an FCT or could not be accessed during the field survey.

Table 12: Vegetation unit FCT classification by sample

Vegetation unit	Sample unit	Most similar Gibson *et al.* (1994) sites	Similarity (%)	Floristic community type (FCT)
EgB	Q4	PAGA-5 (FCT 25)	36	FCT 25: 'southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands'
	Q6	Cool09 (FCT 19)	29	
	Q6^	Cool09 (FCT 19)	29	
		PAGA-6 (FCT 25)	26	
	Q7^	MINN-1 (FCT 25)	30	
		C71-4 (FCT 25)	26	
EgMr	Q5	Cool01 (FCT 17)	44	FCT 17: '*Melaleuca rhaphiophylla – Gahnia trifida* seasonal wetlands'
	Q12	Cool04 (FCT 17)	47	
Mr	Q8	Cool04 (FCT 17)	24	
	R9	Cool11 (FCT 17)	53	

Table 12: Vegetation unit FCT classification by sample (cont.)

Vegetation unit	Sample unit	Most similar Gibson *et al.* (1994) sites	Similarity (%)	Floristic community type (FCT)
Eg	R10	YAN-25 (FCT 28)	27	FCT 21a: 'central *Banksia attenuata – Eucalyptus marginata* woodlands'
	R10^	NEER-11 (FCT 24)	40	
		NEER-6 (FCT 28)	35	
		low12b (FCT 21a)	35	
EgEmAfB	Q2	NINE-1 (FCT 21a)	44	
	Q2^	NINE-1 (FCT 21a)	44	
		SHENT-1 (FCT 28)	42	
	R3	TRIG-6 (FCT 24)	42	
	R3^	NEER-11 (FCT 24)	41	
		SHENT-1 (FCT 28)	40	
		WOODV-2 (FCT 28)	40	
		CORON-2 (FCT 25)	39	
		WELL-2 (FCT 21a)	38	
	R11	YAN-25 (FCT 28)	24	
	R11^	NEER-11 (FCT 24)	36	
		SHENT-1 (FCT 28)	36	
		low04 (FCT 21a)	33	
EmBaBm	Q1	Low10a (FCT 21a)	42	
	Q1^	HARRY-2 (FCT 28)	49	
		WELL-2 (FCT 21a)	47	

Note: ^ shows highest percent similarity to individual Gibson et al. (1994) samples rather than similarity to a cluster of samples.

4.2.4 Threatened and priority ecological communities

The TECs and PECs identified within the site are listed in **Table 13**.

Table 13: TECs and PECs recorded within the site.

Community	Status		Status within the site	Area (ha) within the site
	WA	EPBC Act		
Banksia woodlands of the Swan Coastal Plain (Banksia WL SCP)	PEC (P3)	TEC (EN)	Confirmed	12.68
			Unconfirmed	145.40
Southern *Eucalyptus gomphocephala - Agonis flexuosa* woodlands (SCP25)	PEC (P3)	-	Confirmed	20.53
Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain (Tuart woodlands)	PEC (P3)	TEC (CR)	Confirmed	685.12
			Unconfirmed	54.82

The locations of the TECs and PECs within the site are shown in **Figure 6**.

The structure, composition and patch sizes of a number of areas of vegetation units **EgEmAfB** and **EmBaBm** indicates that they represent the Commonwealth listed 'banksia woodlands of the Swan Coastal Plain' TEC, as outlined in **Table 14**. In addition, portions of vegetation units **AfB**, **Eg, EgAfB**, **EgEmAfB, EmAfBa** and **unconfirmed** vegetation may also represent the 'banksia woodlands of the Swan Coastal Plain' TEC.

Table 14: Criteria for determining presence of banksia woodlands of the Swan Coastal Plain TEC adapted from DoEE (2016)

Criteria	Requirements for meeting criteria	Site implications
1. Must meet key diagnostic characteristics	A variety of factors relating to: Location Soils Structure Composition	Site meets location and soils criteria. The **EgEmAfB** and **EmBaBm** vegetation includes the key diagnostic feature of a tree layer of *Banksia attenuata*, *Banksia menziesii* and *Banksia ilicifolia*. The **EgEmAfB** and **EmBaBm** vegetation within site also meets structure and composition criterion. FCT 21a is identified as one of the FCTs comprising the banksia woodland TEC.
2. Must meet condition thresholds	A patch should at least meet the 'good' condition category (see **Table 5**)	The **EgEmAfB** and **EmBaBm** vegetation exists over four 'patches'. The **EgEmAfB** and **EmBaBm** vegetation is present in 'very good', 'good' and 'degraded' condition, which meets this criterion. The conservation advice indicates that a single patch may include areas of variable condition, meaning parts of the **EgEmAfB** and **EmBaBm** vegetation in 'degraded' condition associated with better condition vegetation may still be considered the TEC.

Table 14: Criteria for determining presence of banksia woodlands of the Swan Coastal Plain TEC adapted from DoEE (2016)

Criteria	Requirements for meeting criteria	Site implications
3. Must meet minimum patch size	Minimum size of patch: Pristine=no minimum size Excellent=0.5 ha Very Good=1 ha Good=2 ha	The **EgEmAfB** vegetation in Lot 146 comprises 5.89 ha in 'very good' condition which meets this criterion. The **EgEmAfB** vegetation in Lot 4 comprises 3.11 ha in 'good' condition which meets this criterion. The **EgEmAfB** vegetation in Lot 172 comprises 1.89 ha in 'good' condition which independently doesn't meet this criterion. However in association with banksia vegetation to the south of the lot in Paganoni Swamp, the **EgEmAfB** vegetation meets this criterion. The **EmBaBm** vegetation in Lot 3 is in 'good' condition and comprises 1.79 ha which independently does not meet this criterion. However in association with the 'good-degraded' vegetation surrounding the lot, the **EmBaBm** vegetation meets this criterion. Some areas shown on **Figure 6** were unconfirmed as they could not be accessed for survey but were contiguous with areas of confirmed banksia vegetation.
4. Must incorporate surrounding context	Breaks (e.g. tracks) < 30 m do not separate vegetation into separate patches Buffer zones may apply (20-50 m recommended from patch edge) The site should be thoroughly sampled (2 surveys in same spring). Survey timing should be appropriate. Surrounding environment should be considered (e.g. connectivity, conservation values, fauna habitat)	Small scale tracks (<30 m wide) exist within the patches. Land surrounding the patch is a combination of rural residential, native vegetation and planted vegetation. This survey was conducted in July-November (within the main flowering season). Thus for a detailed level survey, the survey timing is appropriate. Large areas of intact vegetation exist to the south and west of the site.
Result	The site supports 12.68 ha of the banksia woodlands of the Swan Coastal Plain TEC within three separate patches. An additional 145.40 ha of vegetation across the site that has the potential to represent the TEC.	

DBCA's *Priority Ecological Community* list indicates that the description, area and condition thresholds that apply to the Commonwealth-listed TEC of the same name also apply to the 'banksia woodlands of the Swan Coastal Plain' PEC (DBCA 2022b) . Therefore, total of 12.68 ha of this PEC occurs within the site as shown in **Figure 6**. An additional 145.40 ha could not be confirmed but has the potential to represent the PEC.

The FCT, structure, composition and patch sizes of vegetation units **Eg**, **EgB, EgEmAfB, EgMr** and associated areas indicate that portions of the vegetation represents the Commonwealth listed 'tuart

(*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' TEC, as outlined in **Table 15**.

Table 15: Assessment of site conditions against the tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain TEC criteria (adopted from (DoEE 2019))

Criteria	Requirements for meeting criteria	Site implications
1. Must meet key diagnostic characteristics	Located in appropriate bioregion and landform. At least 2 living established *E. gomphocephala* trees with DBH≥ 15cm present in canopy layer and with <60 m between the outer edges of canopies^ Vegetation structure is a woodland, forest, open forest, open woodland, or mallee (various forms).	Site is located in appropriate bioregion and landform. The patches contains more than two living established *E. gomphocephala* trees with DBH≥ 15cm present in canopy layer and with <60 m between the outer edges of canopies Vegetation within the patch comprises a woodland to open woodland structure.
2. Must meet size threshold	A patch must be larger than 0.5 ha#	The patches are >0.5 ha.
3. Must meet condition thresholds	Patches >5 ha: no condition threshold Patches ≥0.5 – <2 ha: 'very high' or 'high' condition† Patches ≥2 – ≤5 ha: 'very high', 'high' or 'moderate' condition†	The patches range from 0.5 ha to 561.3 ha in size. Those over 5 ha are not subject to condition thresholds. Four patches under 5 ha were not considered to meet the condition threshold. Some areas shown on **Figure 6** were unconfirmed as they could not be accessed for survey but appeared to contain tuart trees based on viewing from adjacent areas but the condition could not be confirmed.
4. Must incorporate surrounding context	Breaks (e.g. tracks, cleared areas) < 30 m do not separate vegetation into separate patches The site should be thoroughly sampled in the appropriate season. Survey timing should be appropriate. Surrounding environment should be considered (e.g. connectivity, conservation values, fauna habitat)	Breaks such as tracks exist within the patch but do not separate the patch. The survey timing was sufficient to determine that the patch represents the TEC.
Result	The site supports 685.12 ha of the tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain TEC. An additional 54.82 ha if the TEC could not be confirmed.	

^Includes dead trees. Where species of dead tree is unclear it is assumed to be *E. gomphocephala* if its canopy is within 60 m of an identified *E. gomphocephala tree*. #Note that a patch comprises a 30 m buffer around the canopy of each *E. gomphocephala* tree, may extend beyond a lot boundary and may include areas of bare ground, waterbodies and hardscape. †Using the condition scale provided in (DoEE 2019).

DBCA's *Priority Ecological Community* list indicates that the description, area and condition thresholds that apply to the Commonwealth-listed TEC of the same name also apply to the 'tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' PEC (DBCA 2022b) . Therefore, total of 685.12 ha of this PEC occurs within the site as shown in **Figure 6**. An additional 54.82 ha pf the PEC could not be confirmed but has the potential to represent the PEC.

The **EgB** vegetation present in the south-western portion of the site represents FCT 25 and thus the 'southern *Eucalyptus gomphocephala-Agonis flexuosa* woodlands' PEC. No condition thresholds apply for this PEC so the **EgB** vegetation in good or better condition is considered to represent this PEC[3]. As such, 20.53 ha of the PEC occurs within the site as shown in **Figure 6**. Additional areas of FCT 25 may occur in inaccessible portions of the site.

No other TECs or PECs occur within the site. The likelihood of occurrence results are provided in **Appendix C**.

[3] 'Good' is considered an appropriate condition threshold to apply where none is specified by TEC/PEC documentation as it represents vegetation with relatively intact structure.

5 Discussion

5.1 Flora

5.1.1 Threatened and priority flora

No threatened or priority flora species were recorded within the accessible portions of the site.

As the timing of the surveys coincided with the main flowering period of the annual or geophytic species with potential to occur in the site, they should have been visible if present. Areas of suitable habitat for these species was searched on multiple occasions during the flowering period (August to and November) but none of the species was recorded. Therefore, it is considered unlikely that they occur in the accessible portions of the site.

The survey was undertaken outside of the main flowering period of priority flora *Eucalyptus foecunda* subsp. *foecunda*, *Jacksonia sericea* and *Styphelia filifolia* but these species are perennial and would be visible at any time of year, even if not flowering. Given that no sterile specimens potentially representing these species were collected, the survey is considered conclusive in determining that none of the species occur in the accessible portions of the site.

Vegetation in good or better condition where access was not permitted may comprise suitable habitat for threatened and priority flora species that could not be verified during the current survey. Those areas that are considered to contain potential habitat that could not be accessed are shown in **Figure 7**.

5.1.2 Declared pests

Seven species listed as declared pests pursuant to the BAM Act were recorded within the site (Sprenger's asparagus, bridal creeper, narrow-leaved cotton bush, lantana, common prickly pear, one-leaf Cape tulip and arum lily). No control category was assigned for these species and their keeping category is listed as 'exempt' under the Act, so no management is required.

5.2 Vegetation

Survey of portions of the site that could not be accessed but could be viewed from adjacent areas was considered to be sufficient to define broad vegetation values despite the inability to walk through the entirety of the vegetation. The vegetation values could not be verified within the portions of the site that could not be viewed from adjacent accessible areas. These areas are largely limited to the north-eastern corner adjacent to Stakehill Road and Kwinana Freeway, some areas in the north-western portion off Cassia Drive and between Fletcher Road and Winery Drive in the western portion of the site. These areas are mapped as 'unconfirmed' vegetation units and condition on **Figure 4** and **Figure 5** respectively.

5.2.1 Vegetation condition

A compound vegetation condition category of 'good – degraded' was included for areas that could not be accessed but appeared to comprise partially intact vegetation. These areas tended to

comprise a relatively intact overstorey and lack of native understorey, which aligns with the 'degraded' condition category. However, as the areas could not be viewed in detail, it is possible that some native understorey species occur but could not be observed from a distance, which would be more indicative of the 'good' category. Thus, these areas were conservatively assessed as being in 'good-degraded' condition. Although not being accessible for traversing, it is considered unlikely that the 'good – degraded' areas would fall outside of these two condition categories due both to the high level of historical disturbance locally and the experience level of the botanists undertaking the survey, who are very familiar with applying the Keighery (1994) scale.

5.2.2 Floristic community assignment

The FCT analysis for vegetation units **EgMr** and **Mr** was clear, with samples clustering with FCT 17 with high similarity.

Samples comprising the **Eg**, **EgBaBm, EgEmAfB** and **EmBaBm** vegetation tended to cluster with a variety of FCTs, including 21a, 24 and 28 as per **Table 11.** The site occurs south of all Gibson *et al.* (1994) FCT 24 and FCT 28 sites and thus occurrence within the site is unlikely. The similarity to these FCTs is likely due to the presence of coastal species that occur throughout the near coastal areas of the SCP. Gibson *et al.* (1994) sites comprising FCT 21a occur close to the southern boundary of the site within Paganoni Swamp and the **Eg**, **EgBaBm, EgEmAfB** and **EmBaBm** vegetation within the site is considered more likely to represent this FCT. Based on the frequency of species, all samples tended to show high similarity to FCT 21a. Whilst tuart and *Allocasuarina fraseriana* are not typical species for FCT 21a, this FCT is noted to sometimes contain both species as dominants (Gibson et al. 1994).

Sample Q6 within the **EgB** vegetation located close to the southern boundary of the site clustered with FCT 19 'sedgelands in Holocene dune swales'. However, it is likely that a small number of species has skewed the analysis for this sample, such as the sedge *Ficinia nodosa* which is limited to a small number of FCTs within the Gibson *et al.* (1994) dataset. The majority of species recorded in Q6 (including tuart) do not occur in Gibson *et al.* (1994) sites representing FCT 19, nor is the sample located in a dune swale. The **EgB** vegetation was considered to represent FCT 25 based on the high individual similarity to Gibson *et al.* (1994) FCT 25 sites and tuart also occurs in 82% of Gibson *et al.* (1994) FCT 25 sites.

5.2.3 Threatened and priority ecological communities

The banksia woodlands of the Swan Coastal Plain ETC/PEC was determined to occur over 12.68 ha of the site, with an additional 145.40 ha potential areas that could not be confirmed due to site access. The potential areas includes vegetation in which *Banksia* spp. were visible from adjacent areas. Some of these areas were contiguous with confirmed areas of the TEC/PEC in the north-western portion of the site, whilst the lots in the north-eastern portion of the site along Amarillo Drive were considered to potentially represent the TEC/PEC as they were conservatively assessed as being in 'good – degraded' condition.

Tuart trees are common throughout the site, both within intact plant communities and scattered though non-native dominated areas and along roadsides. A total of 685.12 ha of the tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain TEC/PEC was confirmed across the site, with an additional 54.82 ha that could not be confirmed due to site access.

This unconfirmed vegetation includes areas where the presence of tuart trees was recorded from adjacent areas, but the condition of the vegetation could not be confirmed.

The presence of the southern *Eucalyptus gomphocephala-Agonis flexuosa* woodlands PEC was determined based on the location of samples Q4, Q6 and Q7 and associated vegetation. Additional areas of the PEC may occur within the inaccessible portions of the site.

6 Conclusions

Outcomes of the assessment include the following:

- A total of 184 native and 153 non-native (weed) species were recorded.
- No threatened or priority flora species were recorded within the accessible portions of the site.
- Seven declared pest species were recorded (Sprenger's asparagus, bridal creeper, narrow-leaved cotton bush, lantana, common prickly pear, one-leaf Cape tulip and arum lily), of which four (Sprenger's asparagus, bridal creeper, lantana and common prickly pear) are also listed as weeds of national significance.
- A total of 16 vegetation units were recorded over the site, ranging from 'completely degraded' to 'very good' condition. An 'unconfirmed' vegetation unit and condition category is included for those areas that could not be viewed from adjacent areas.
- The site contains 12.68 ha of the 'threatened ecological community' (TEC)/'priority ecological community' (PEC) 'banksia woodlands of the Swan Coastal Plain' within three separate patches. An additional 145.40 ha of vegetation across the site has the potential to represent the TEC/PEC. This community is listed as a 'endangered' TEC under the *Environmental Protection and Biodiversity Conservation Act 1999* and a 'priority 3' PEC in Western Australia.
- The site contains 685.12 ha of the 'tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' TEC/PEC. An additional 54.82 ha of vegetation across the site has the potential to represent the TEC/PEC. This community is listed as a 'critically endangered' TEC under the *Environmental Protection and Biodiversity Conservation Act 1999* and a 'priority 3' PEC in Western Australia.
- The site contains 20.53 ha of the State listed 'southern *Eucalyptus gomphocephala-Agonis flexuosa* woodlands' PEC.
- The following flora and vegetation values will require further consideration for any future approvals.
    - The potential presence of threatened and priority flora species within the inaccessible portions of the site.
    - Vegetation mapped as being in 'good' or better condition over the entirety of the site.
    - The confirmed and unconfirmed TECs and PECs mapped over the entirety of the site.

7 References

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7.2 Online references

The online resources that have been utilised in the preparation of this report are referenced in **Section 7.1**, with access date information provided in **Table R 1**.

Table R 1 Access dates for online references

Reference	Date accessed	Website or dataset name
(BoM 2023)	28 June 2023	Climate Data Online
(DBCA 2023e)	28 September 2023	Threatened Ecological Communities
DAWE (2021)	22 May 2024	Weeds of National Significance (WoNS)
DCCEEW (2023)	12 May 2023	Protected Matters Search Tool
DBCA (2023d)	26 July 2023	NatureMap
WALIA (2023)	28 June 2023	Landgate Map Viewer

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Figures

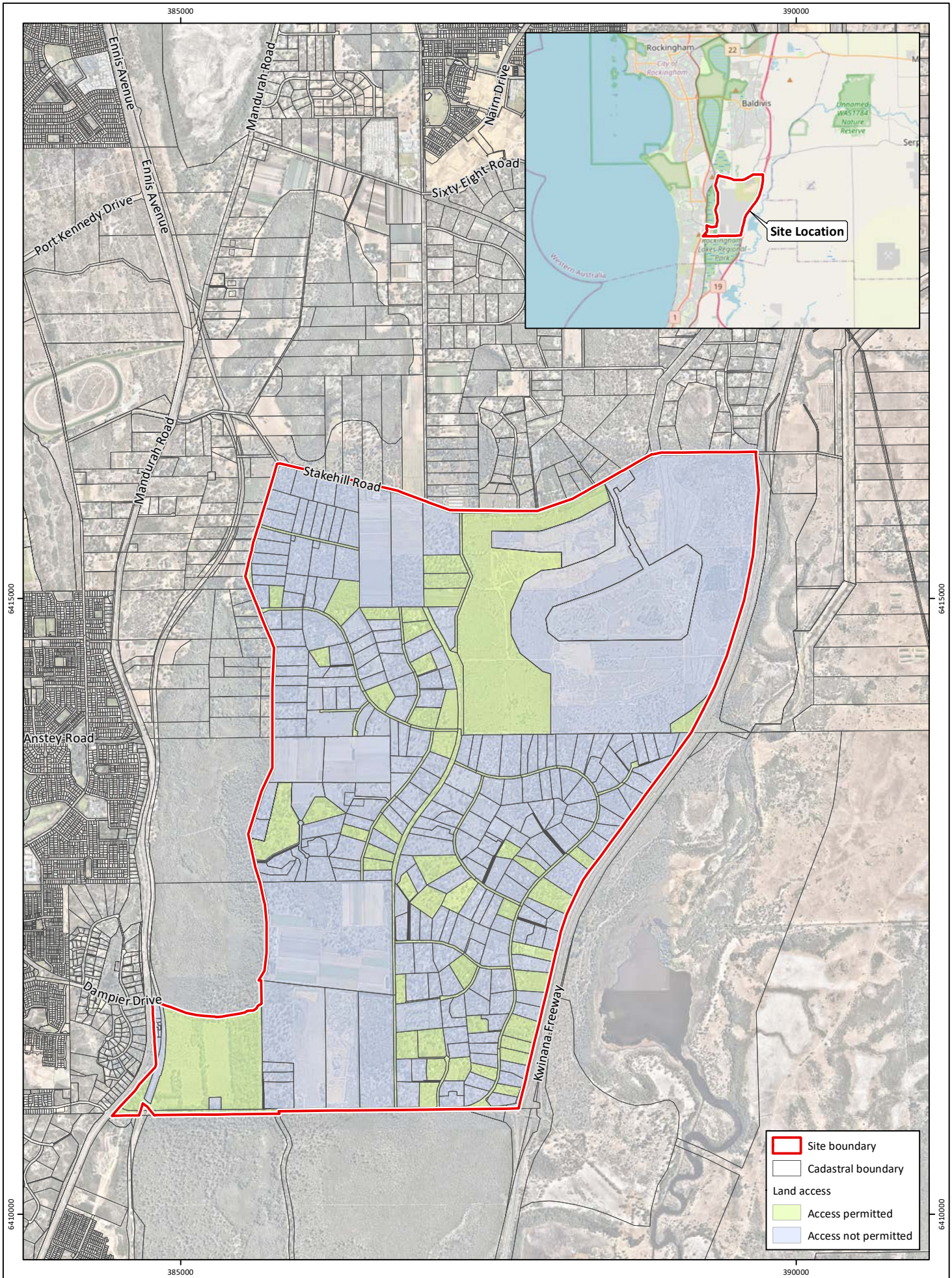

Figure 1: Site Location

Project:	Detailed Flora and Vegetation Assessment Karnup District Structure Plan
Client:	City of Rockingham

Plan Number:	**EP23-018(06)--F52**
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Date:	23/05/2024
Checked:	SKP
Approved:	RAW
Date:	24/05/2024

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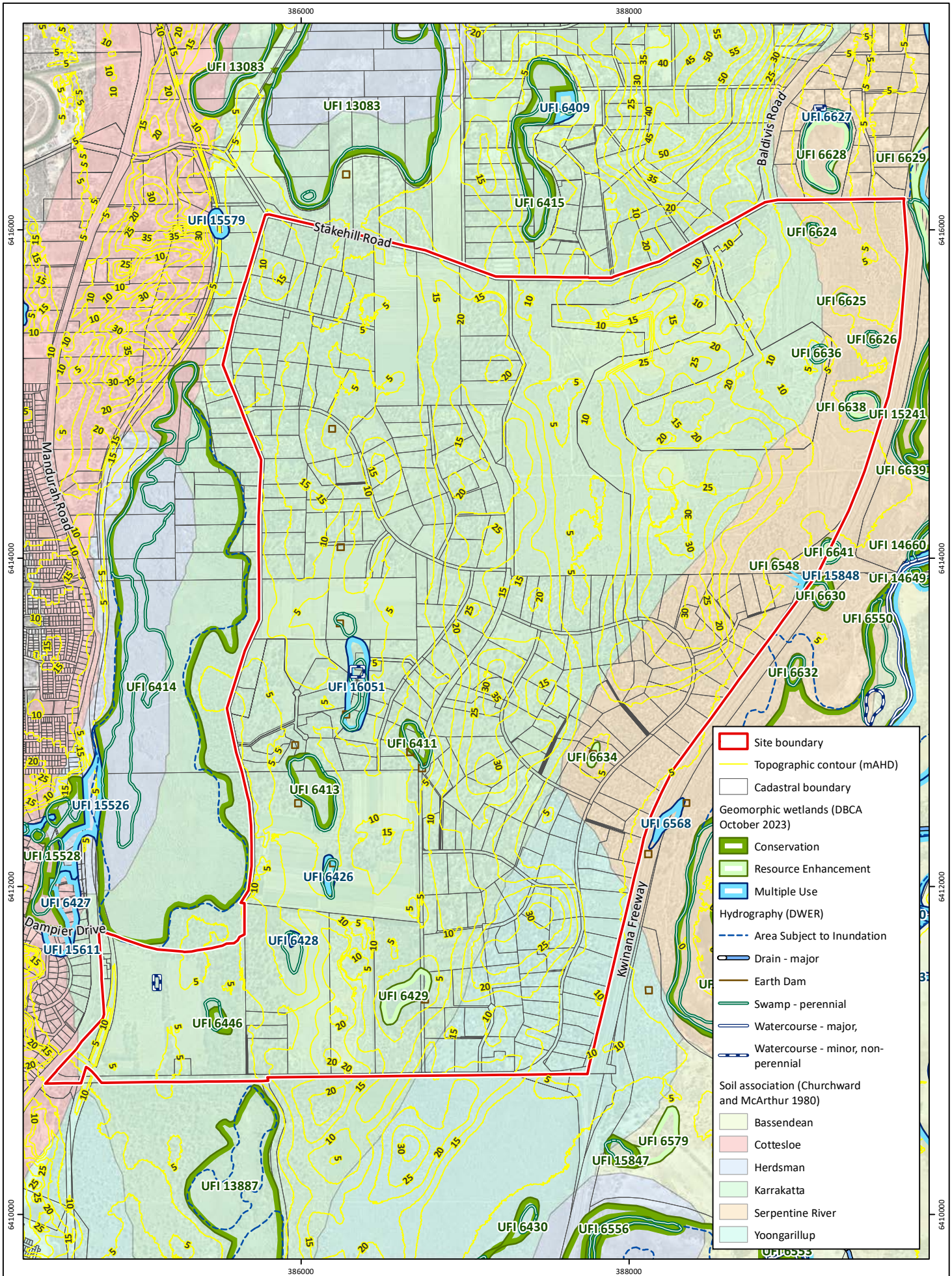

Figure 2: **Hydrography, Soils and Topography**

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Client:	City of Rockingham

Plan Number: EP23-018(06)--F53a

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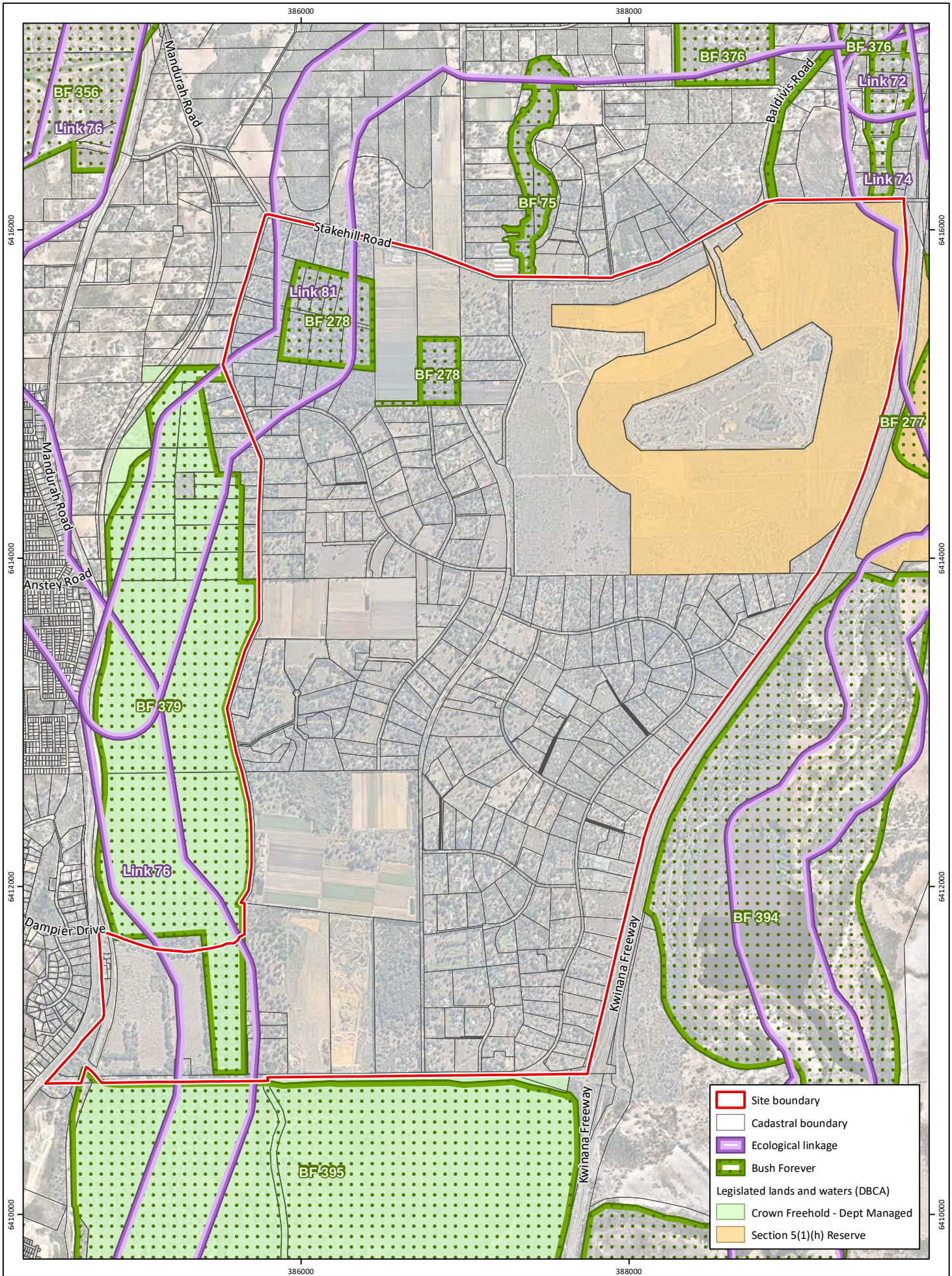

Figure 3: Environmental Features

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Client:	City of Rockingham

Plan Number:	**EP23-018(06)--F54**
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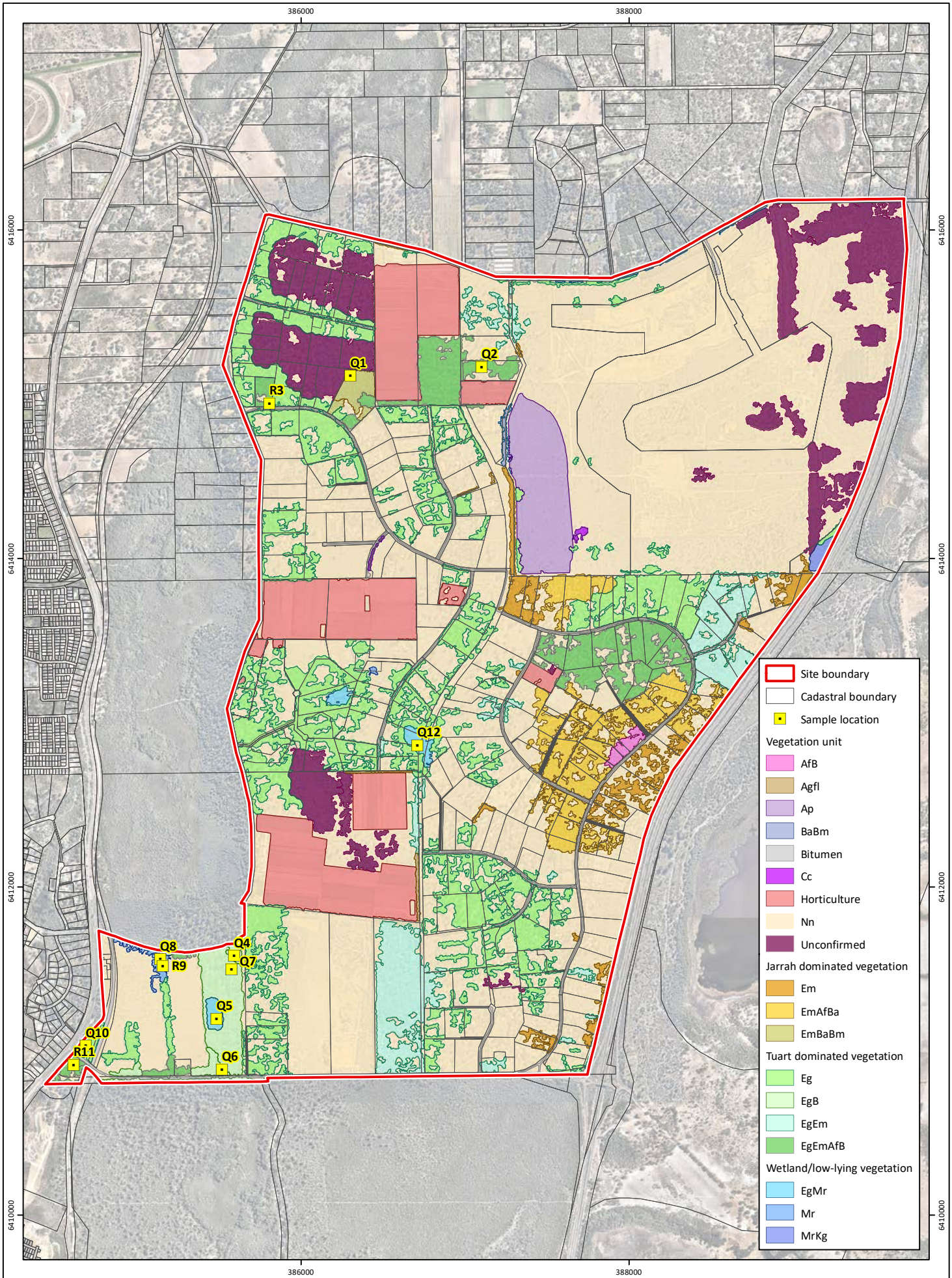

Figure 4: Vegetation Units

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Karnup District Structure Plan

Client: City of Rockingham

Plan Number: EP23-018(06)--F58

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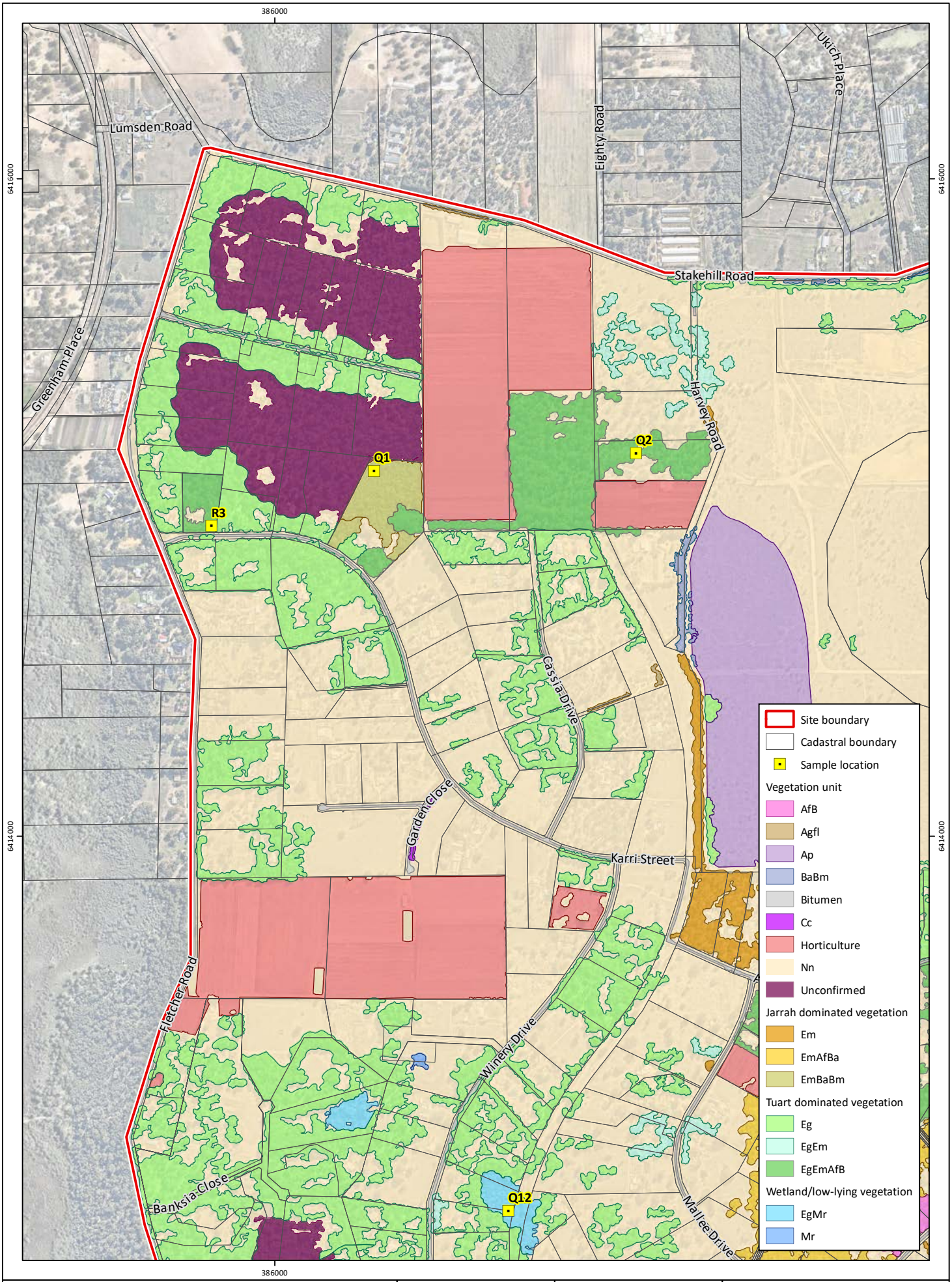

Figure 4a: Vegetation Units

Project:	Detailed Flora and Vegetation Assessment Karnup District Structure Plan
Client:	City of Rockingham

Plan Number: EP23-018(06)--F55

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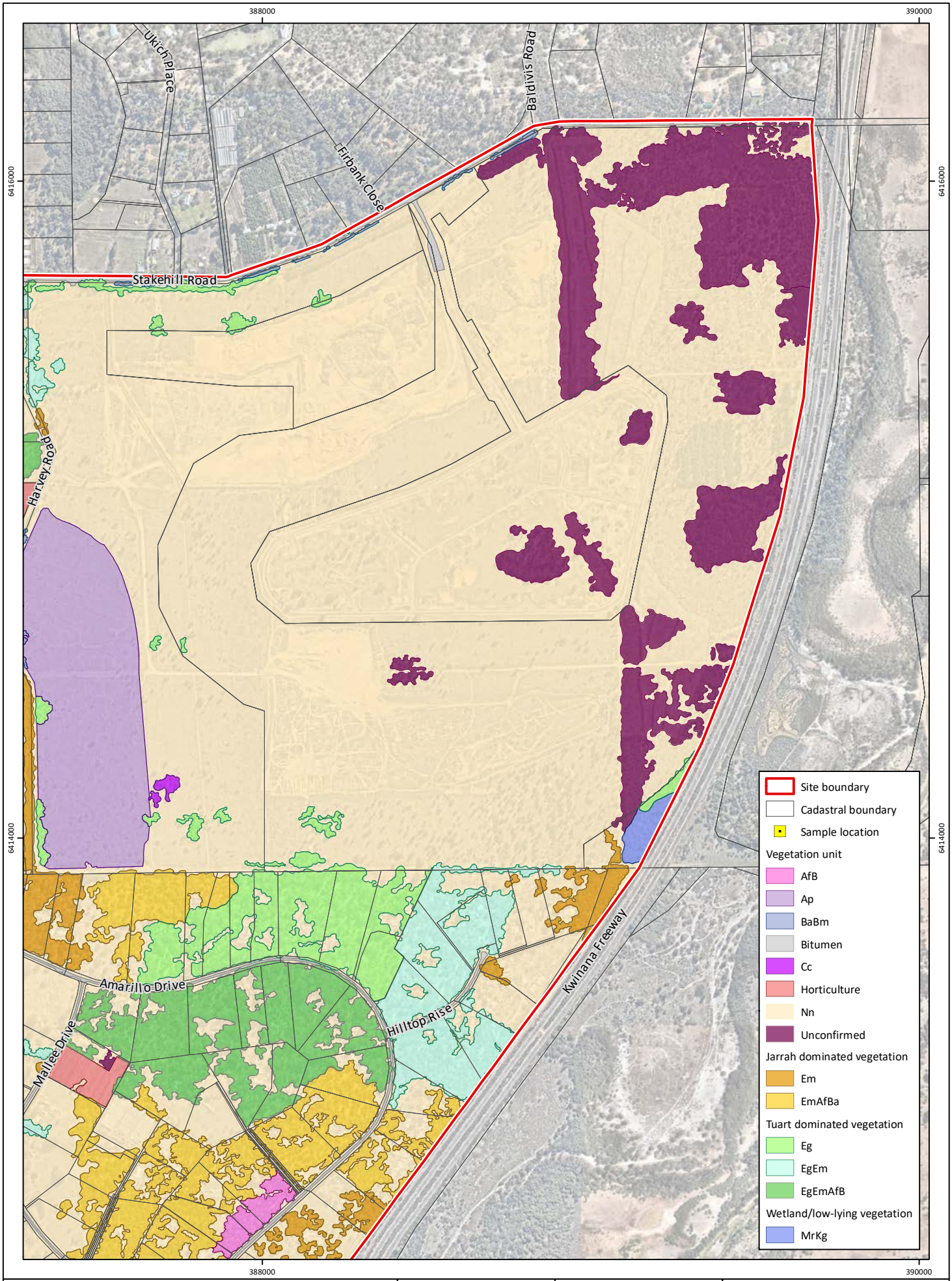

Figure 4b: Vegetation Units

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Karnup District Structure Plan
Client: City of Rockingham

Plan Number: EP23-018(06)--F55

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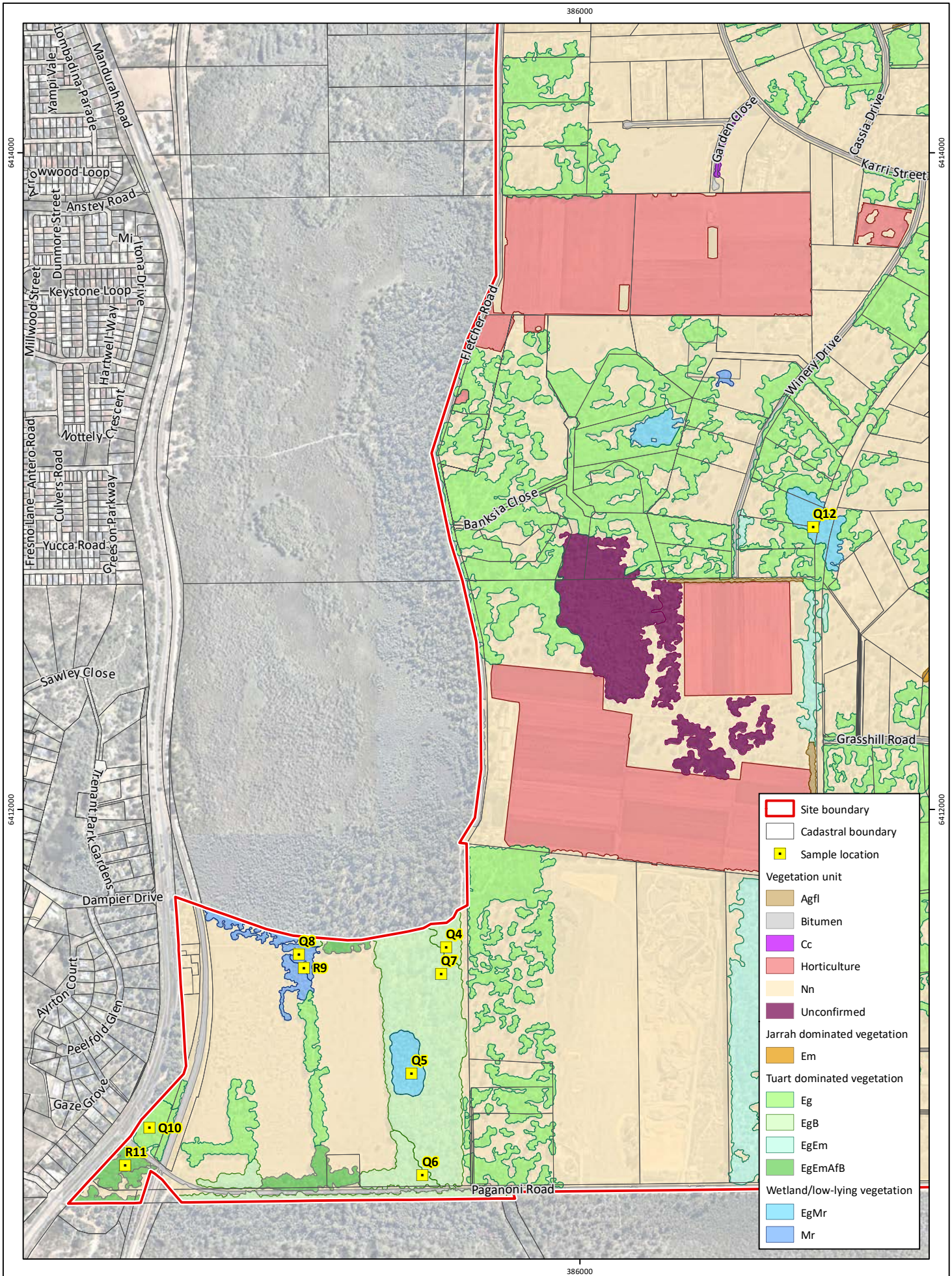

Figure 4c: Vegetation Units

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Client:	City of Rockingham

Plan Number:
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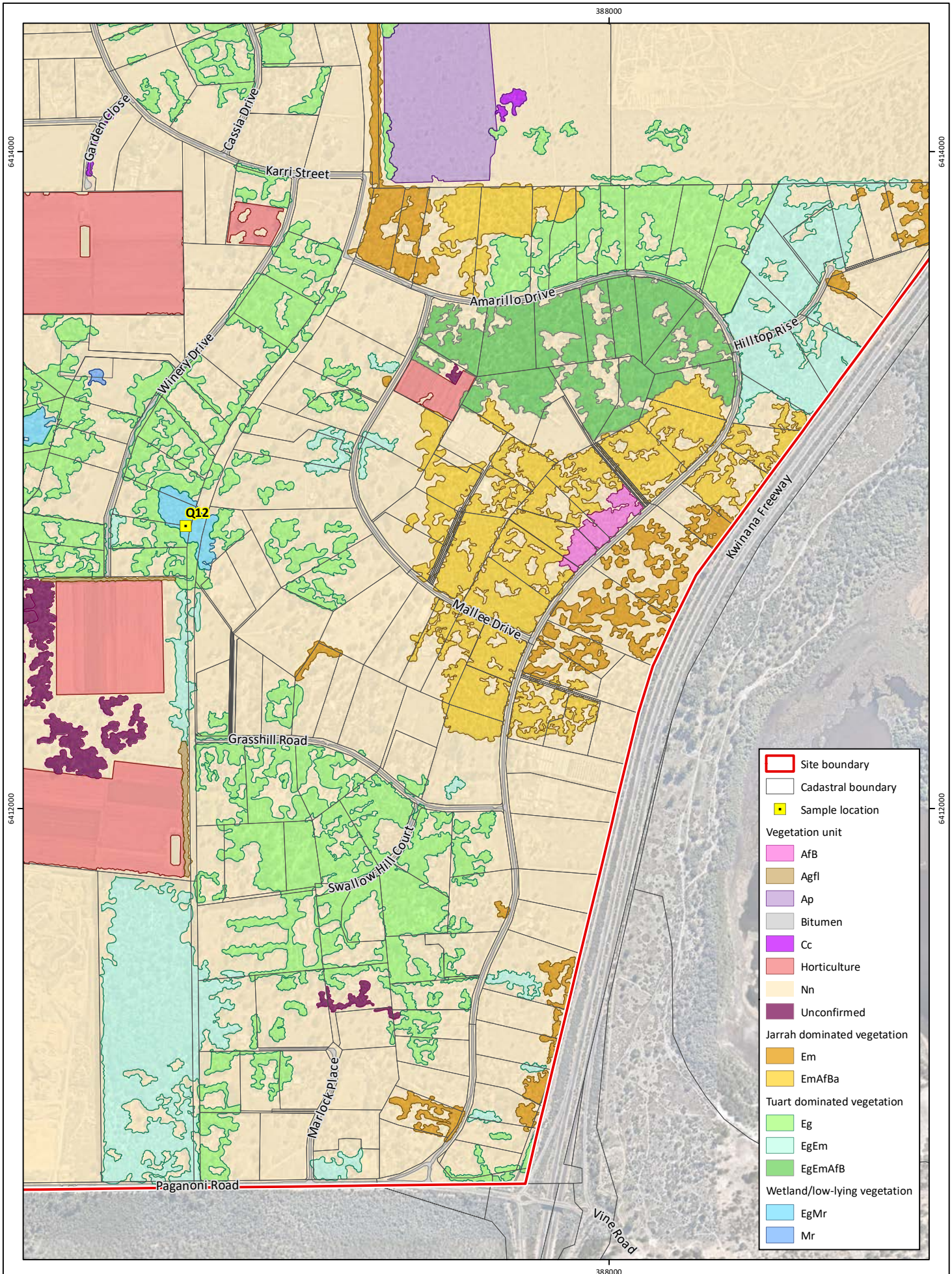

Figure 4d: Vegetation Units

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Karnup District Structure Plan
Client: City of Rockingham

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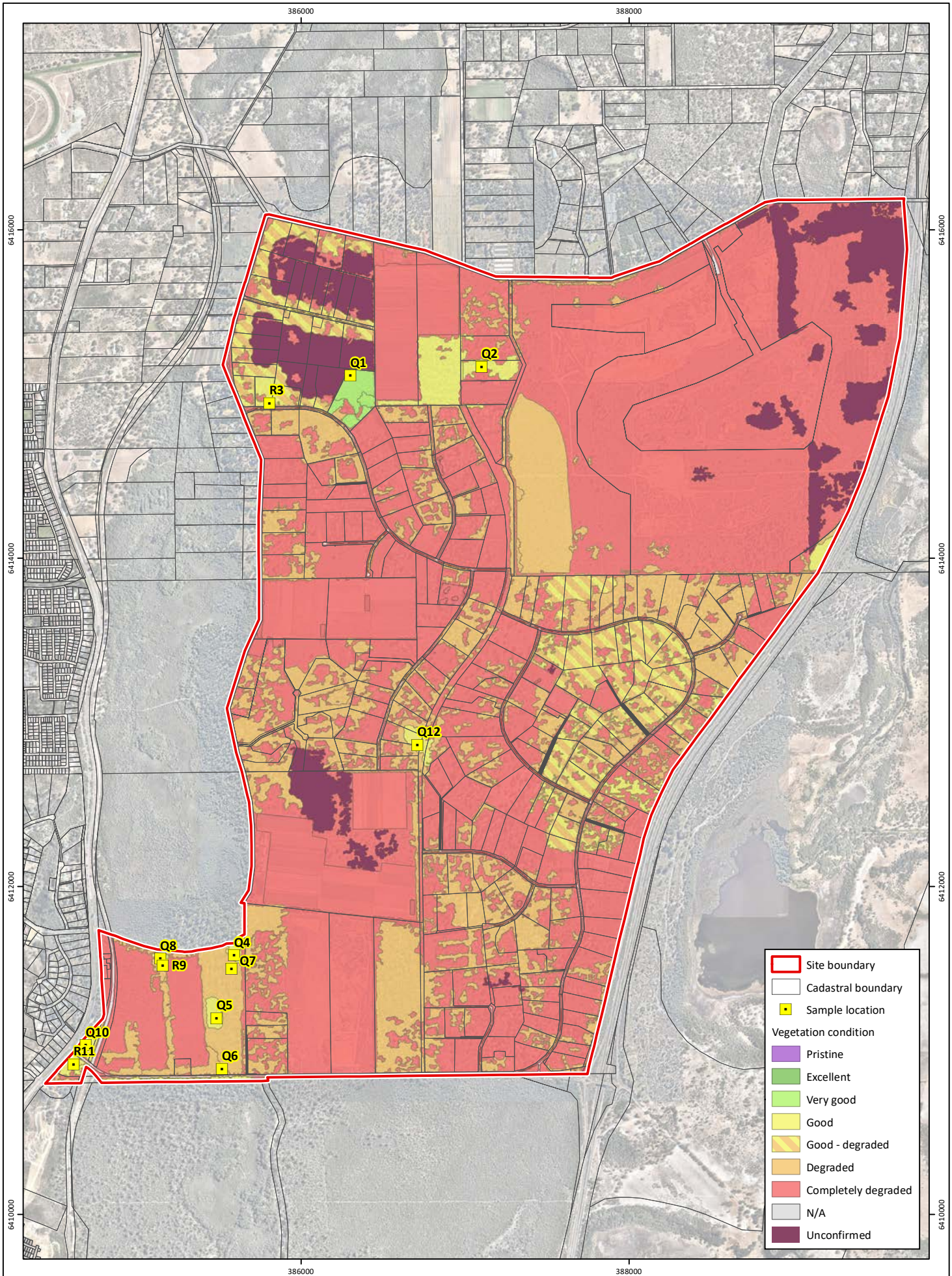

Figure 5: Vegetation Condition

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Karnup District Structure Plan

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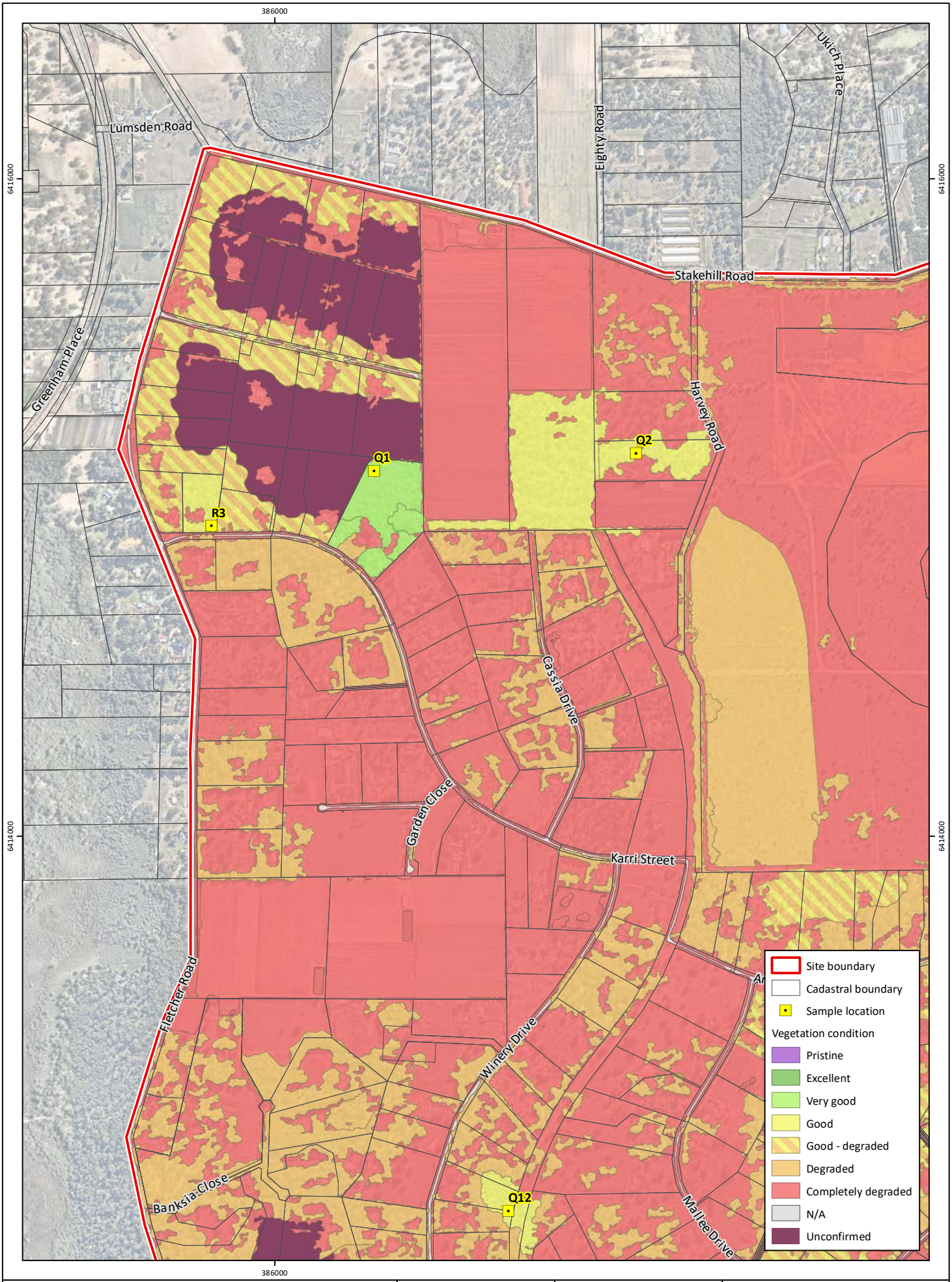

Figure 5a: Vegetation Condition

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Karnup District Structure Plan
Client: City of Rockingham

Plan Number: EP23-018(06)--F56

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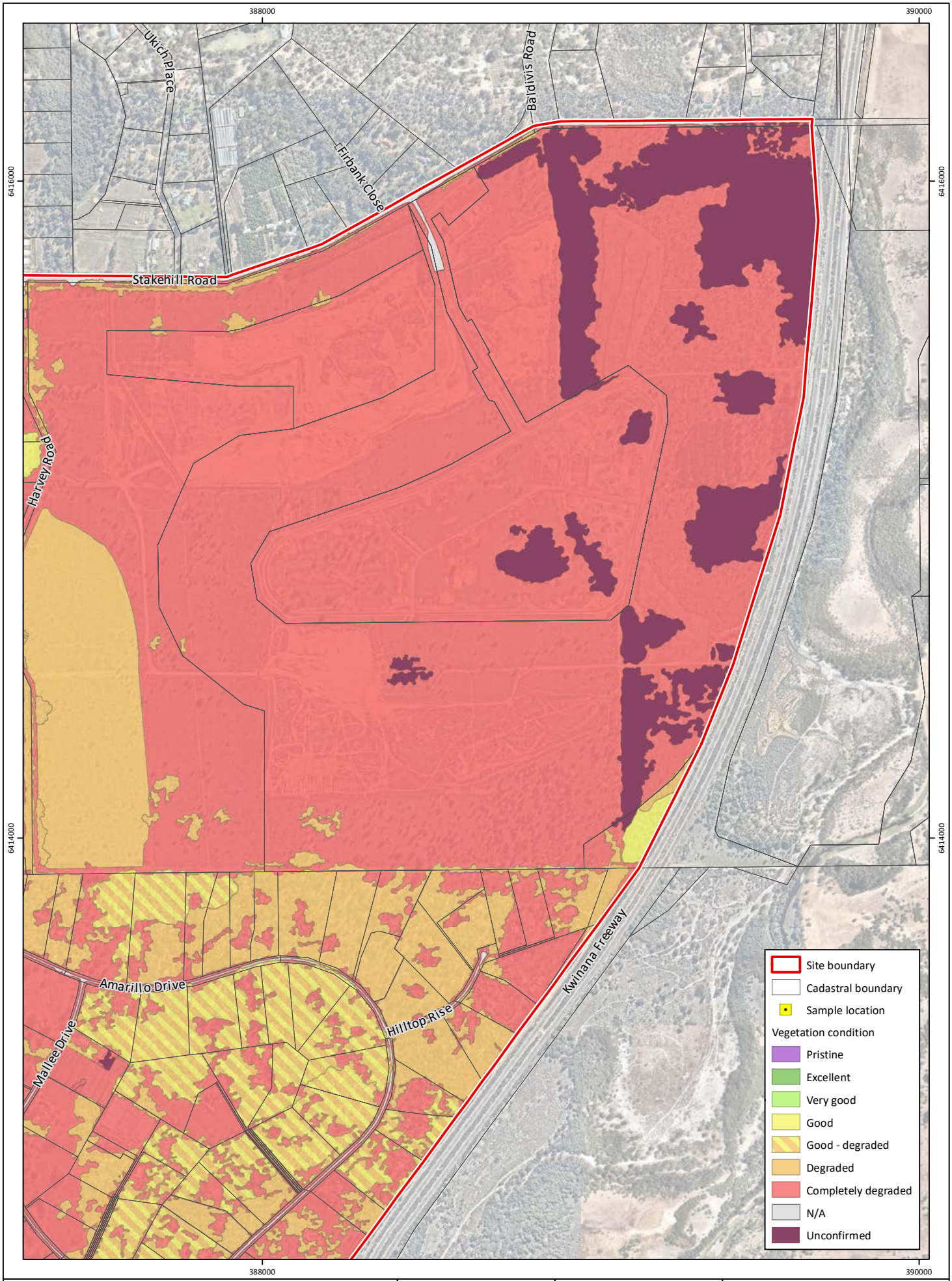

Figure 5b: Vegetation Condition

Project:	Detailed Flora and Vegetation Assessment Karnup District Structure Plan
Client:	City of Rockingham

Plan Number:
EP23-018(06)--F56

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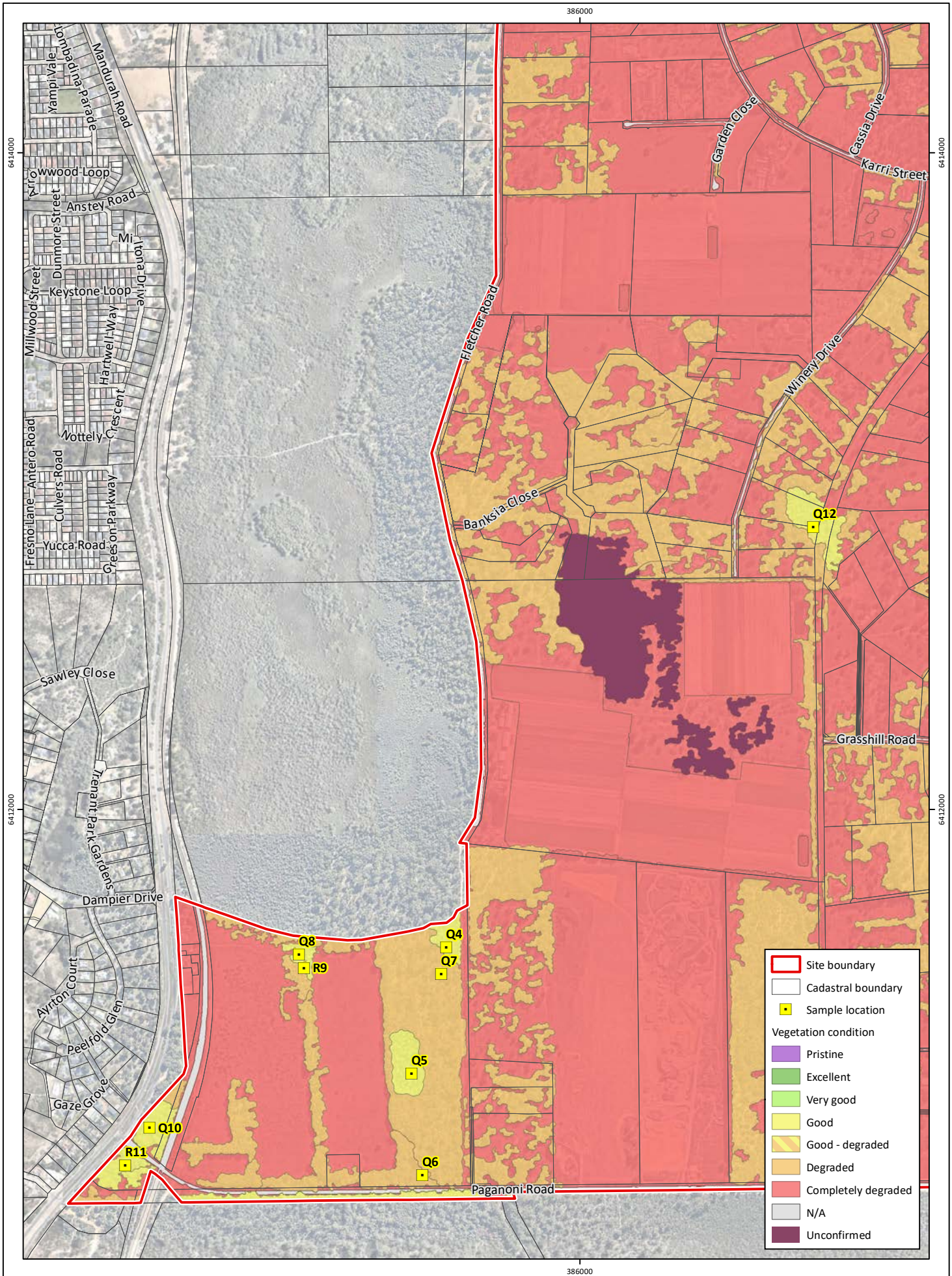

Figure 5c: Vegetation Condition

Project:	Detailed Flora and Vegetation Assessment Karnup District Structure Plan
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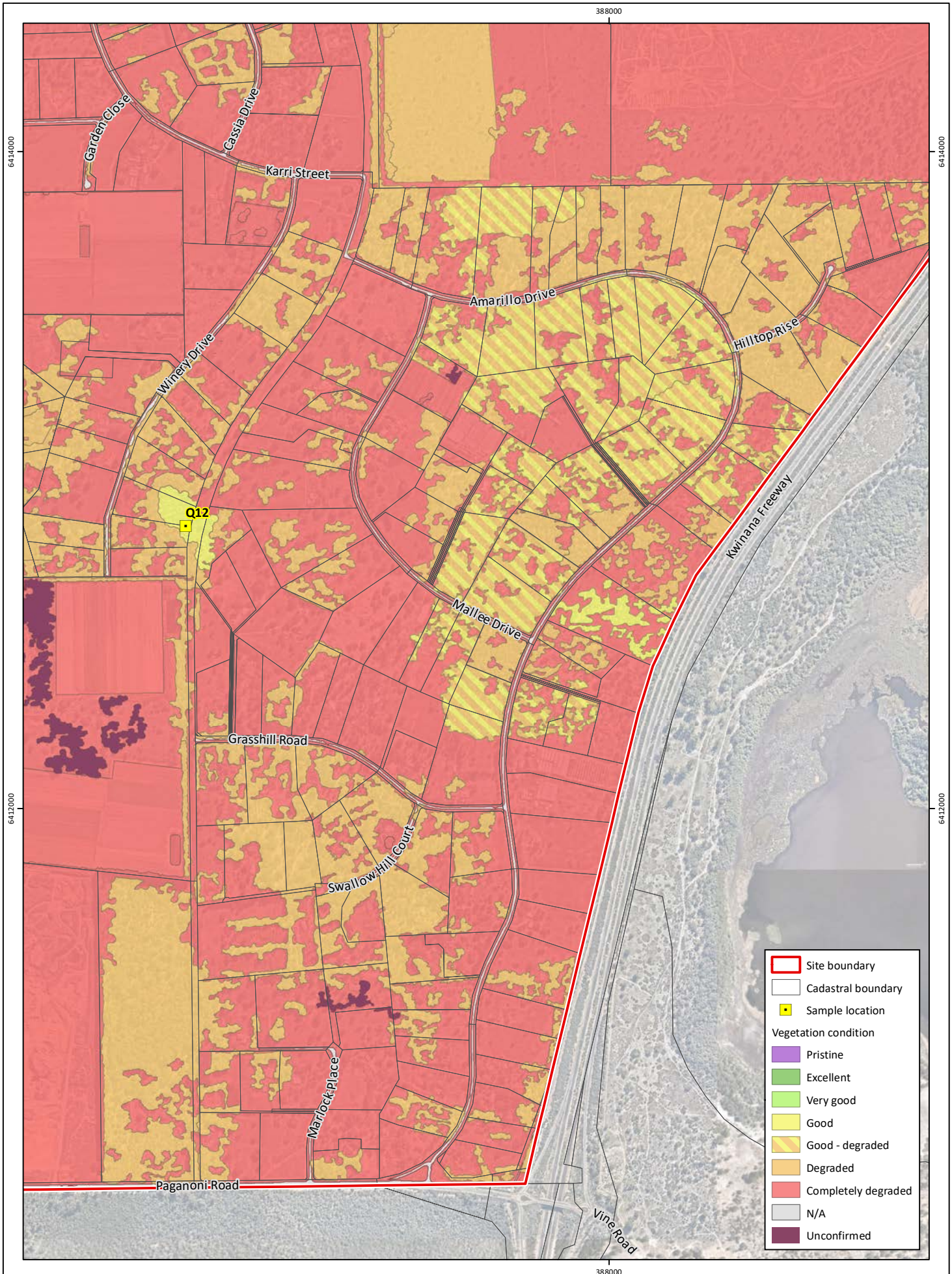

Figure 5d: Vegetation Condition

Project: Detailed Flora and Vegetation Assessment
Karnup District Structure Plan
Client: City of Rockingham

Plan Number: EP23-018(06)--F56

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GDA2020 MGA Zone 50

emerge ASSOCIATES

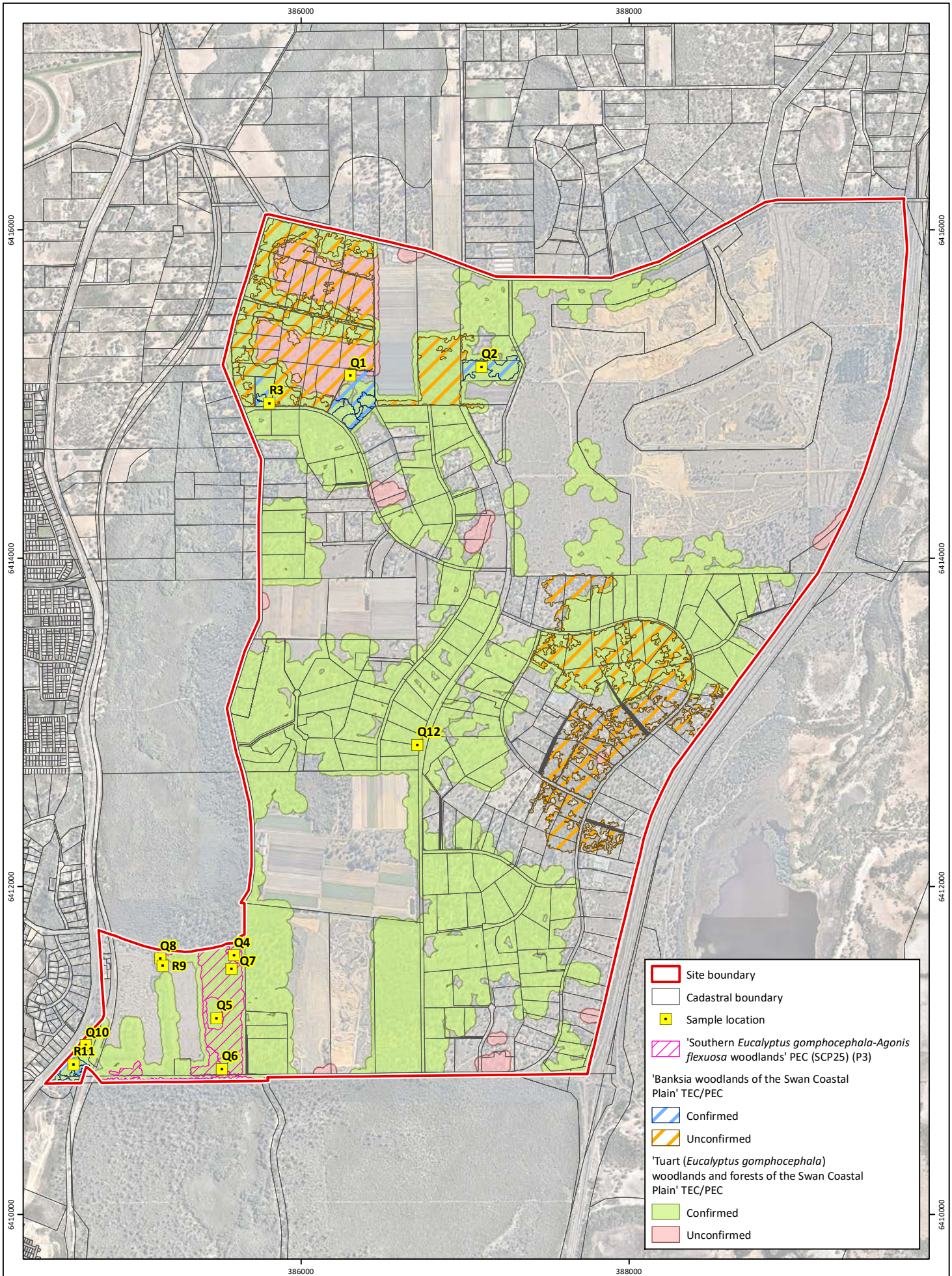

Figure 6: **Threatened and Priority Ecological Communities**

Project: Detailed Flora and Vegetation Assessment
Karnup District Structure Plan

Client: City of Rockingham

Plan Number: EP23-018(06)--F60a
Drawn: GAR
Date: 12/06/2024
Checked: SKP
Approved: RAW
Date: 12/06/2024

N

0 400 800
Metres

Scale: 1:30,000@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

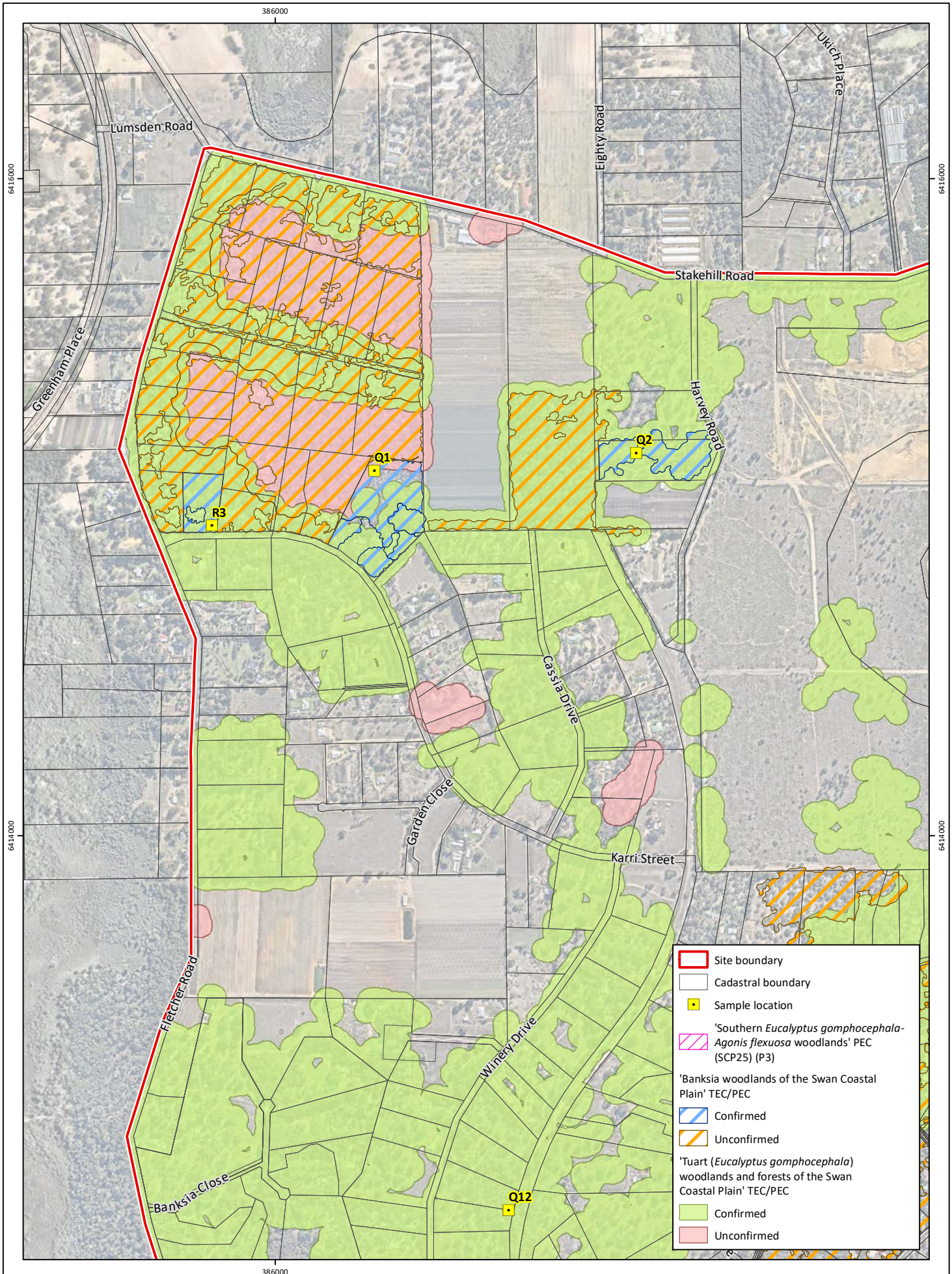

Figure 6a: Threatened and Priority Ecological Communities

Project:	Detailed Flora and Vegetation Assessment Karnup District Structure Plan
Client:	City of Rockingham

Plan Number: EP23-018(06)--F57

Drawn:	GAR
Date:	23/05/2024
Checked:	SKP
Approved:	RAW
Date:	24/05/2024

N

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Metres

Scale: 1:15,000@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

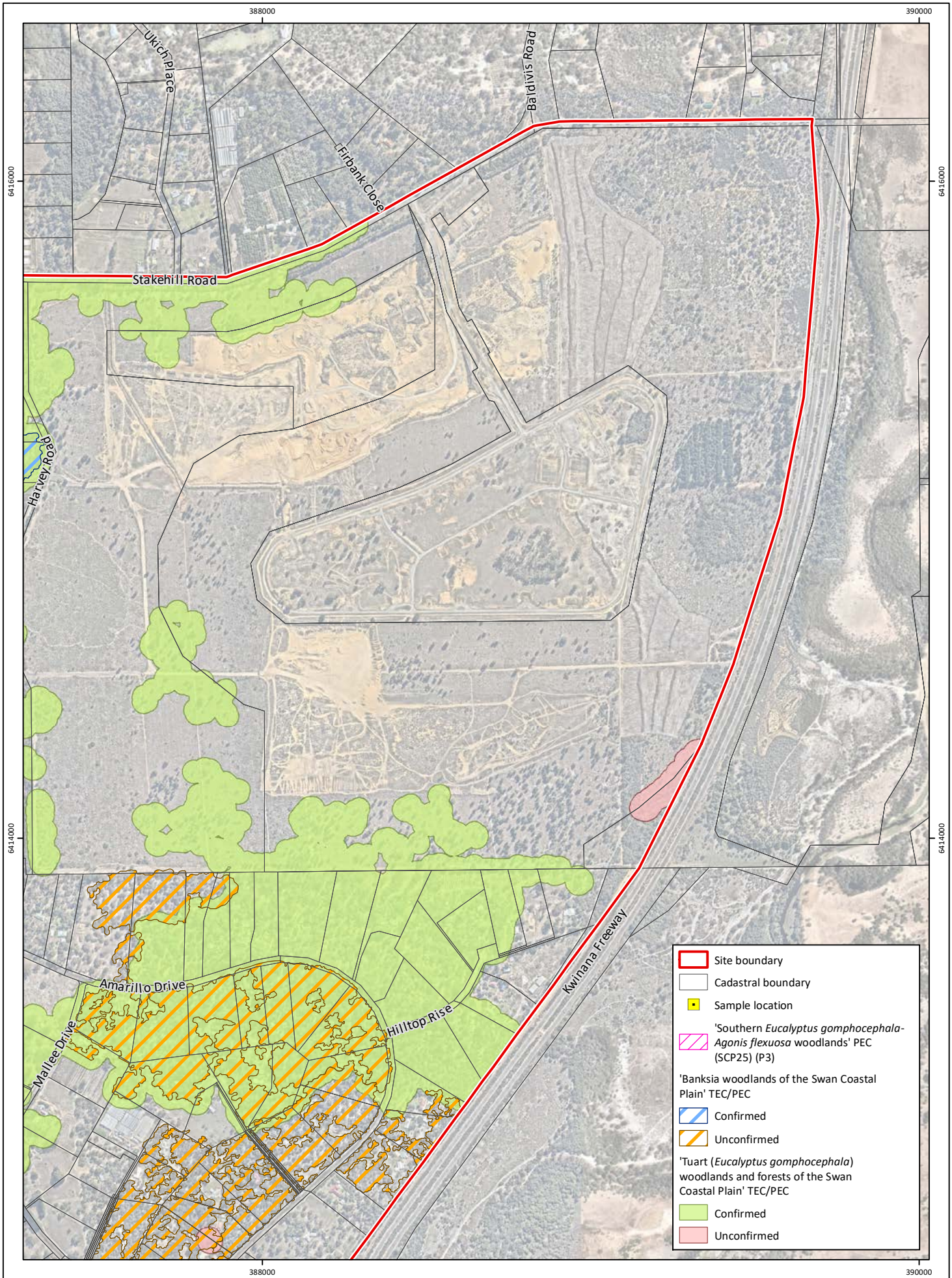

Figure 6b: Threatened and Priority Ecological Communities

Project:	Detailed Flora and Vegetation Assessment Karnup District Structure Plan
Client:	City of Rockingham

Plan Number:
EP23-018(06)--F57

Drawn:	GAR
Date:	23/05/2024
Checked:	SKP
Approved:	RAW
Date:	24/05/2024

N

0 200 400
Metres

Scale: 1:15,000@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

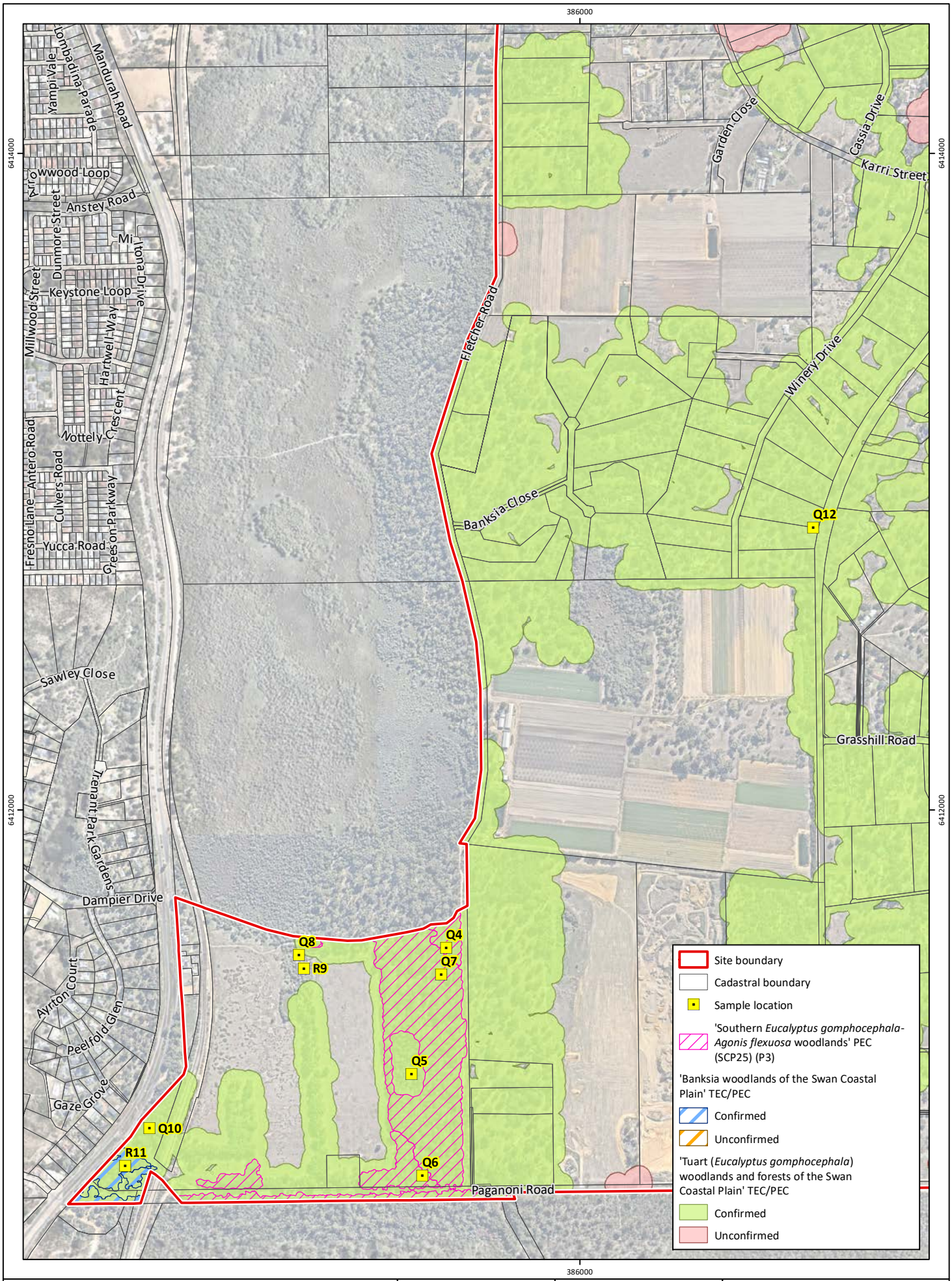

Figure 6c: Threatened and Priority Ecological Communities

Project:	Detailed Flora and Vegetation Assessment Karnup District Structure Plan
Client:	City of Rockingham

Plan Number: EP23-018(06)--F57

Drawn:	GAR
Date:	23/05/2024
Checked:	SKP
Approved:	RAW
Date:	24/05/2024

N

0 200 400
Metres

Scale: 1:15,000@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

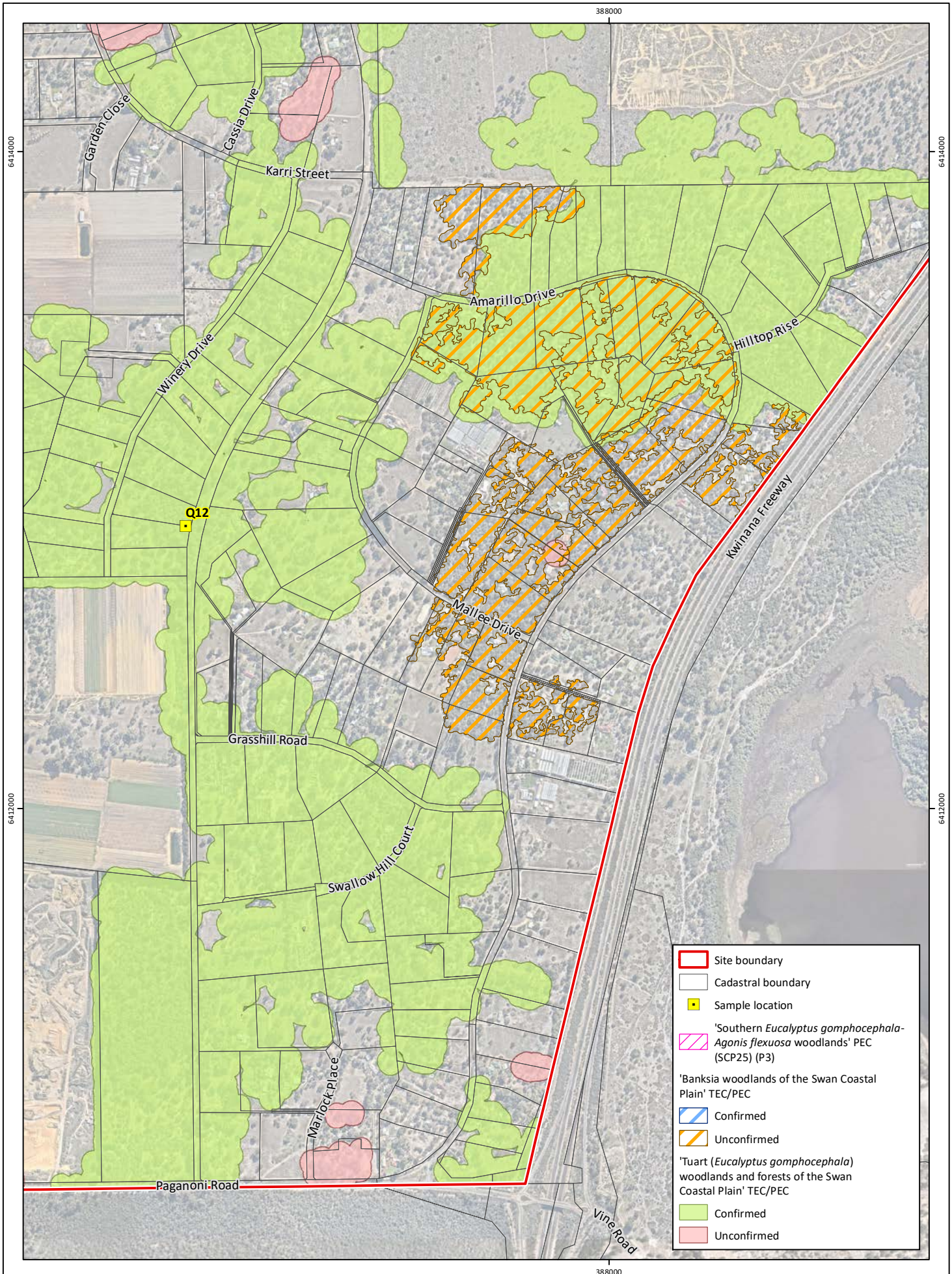

Figure 6d: Threatened and Priority Ecological Communities

Project: Detailed Flora and Vegetation Assessment
Karnup District Structure Plan

Client: City of Rockingham

Plan Number: EP23-018(06)--F57

Drawn:	GAR
Date:	23/05/2024
Checked:	SKP
Approved:	RAW
Date:	24/05/2024

N

0 200 400
Metres

Scale: 1:15,000@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

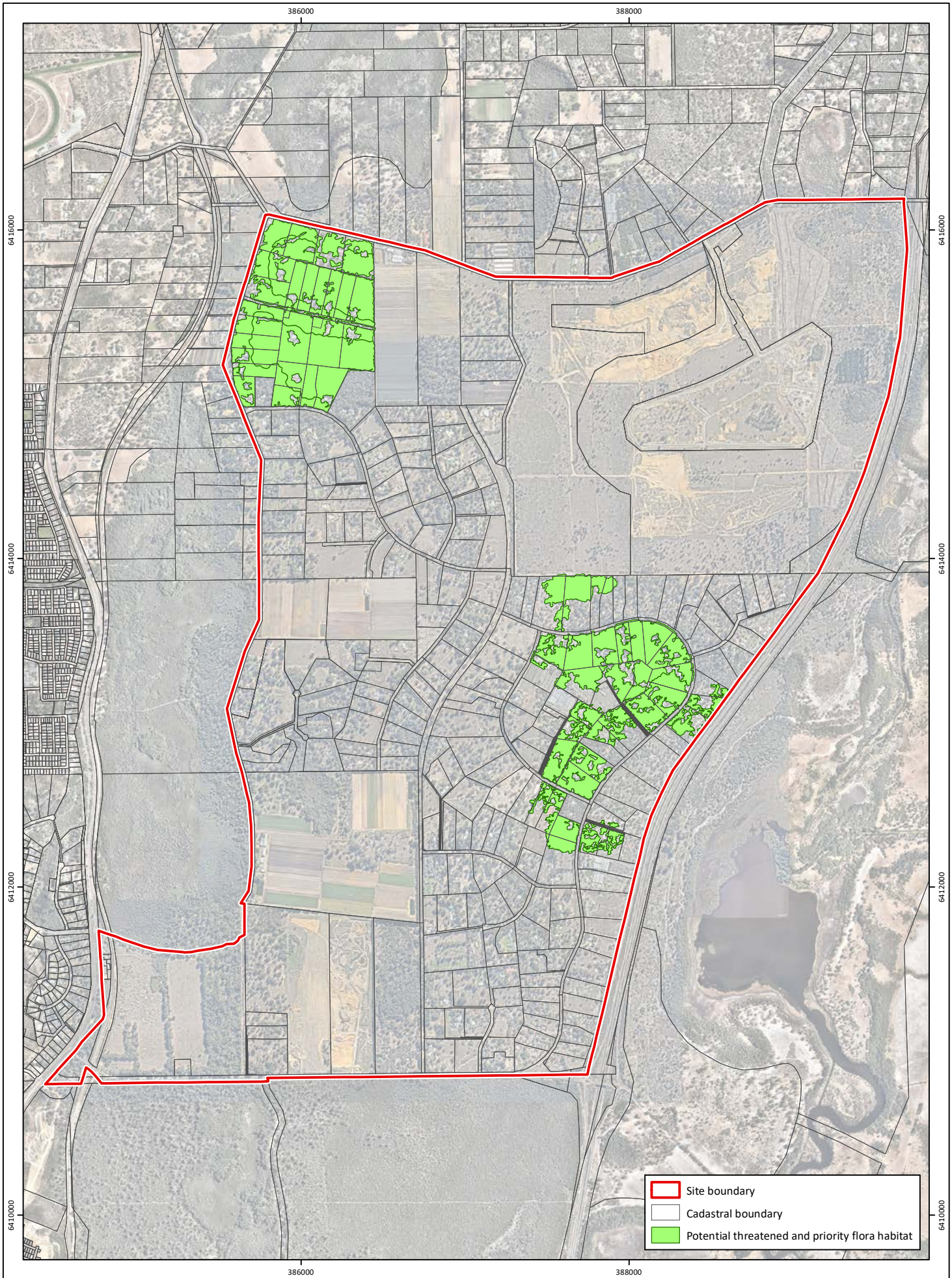

Figure 7: Potential Threatened and Priority Flora Habitat

Project: Detailed Flora and Vegetation Assessment
Karnup District Structure Plan
Client: City of Rockingham

Plan Number:
EP23-018(06)--F69

Drawn:	GAR
Date:	24/05/2024
Checked:	SKP
Approved:	RAW
Date:	24/05/2024

N

0 400 800
Metres

Scale: 1:30,000@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

Appendix A

Additional Information

Conservation Significant Flora and Vegetation

Threatened and priority flora

Flora species considered rare or under threat warrant special protection under Commonwealth and/or State legislation. At the Commonwealth level, flora species can be listed as 'threatened' pursuant to Schedule 1 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In Western Australia, plant taxa may be classed as 'threatened' under the *Biodiversity Conservation Act 2016* (BC Act) which is enforced by Department of Biodiversity Conservation and Attractions (DBCA). Threatened flora species are listed under sections 19(1) and 26(2) of the BC Act and published in the Biodiversity Conservation (Species) Order 2022. It is an offence to 'take' or disturb threatened flora without Ministerial approval. Section 5(1)1 of the Act defines to take as including "… to gather, pluck, cut, pull up, destroy, dig up, remove, harvest or damage flora by any means" or to cause or permit the same to be done.

Threatened flora are assigned categories under the EPBC Act and BC Act according to their conservation status, as outlined in **Table 1**.

Flora species that may be threatened or near threatened but lack sufficient information to be listed under the BC Act may be added to the DBCA's *Priority Flora List* (DBCA 2018b). Priority flora species are considered during State approval processes. Priority flora are assigned categories as listed in **Table 1**.

Table 1: Definitions of threatened and priority flora species pursuant to the EPBC Act and BC Act and on DBCA's Priority Flora List (DBCA 2023b)

Conservation code	Description
EX†	Threatened Flora – Presumed Extinct Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
T^†	Threatened Flora – Extant Taxa which are declared to be likely to become extinct or is rare, or otherwise in need of special protection.
CR^	Threatened Flora – Critically Endangered Taxa which are considered to be facing an extremely high risk of extinction in the wild.
EN^	Threatened Flora – Endangered Taxa which are considered to be facing a very high risk of extinction in the wild.
VU^	Threatened Flora – Vulnerable Taxa which are considered to be facing a high risk of extinction in the wild.
P1	Priority One – Poorly Known Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat e.g. road verges, urban areas, farmland, active mineral leases etc., or the plants are under threat, e.g. from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P2	Priority Two – Poorly Known Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey.
P3	Priority Three – Poorly Known Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but needs further survey.
P4	Priority Four – Rare Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

^pursuant to the EPBC Act, †pursuant to the BC Act, on DBCA's *Priority Flora List*

Threatened and priority ecological communities

'Threatened ecological communities' (TECs) are ecological communities that are rare or under threat and therefore warrant special protection. Selected TECs are afforded statutory protection at a Commonwealth level under section 181 of the EPBC Act. TECs nominated for listing under the EPBC Act are considered by the Threatened Species Scientific Committee and a final decision is made by the Commonwealth Minister for the Environment. Once listed under the EPBC Act, communities are categorised as either 'critically endangered', 'endangered' or 'vulnerable' as defined in **Table 2**. Any action likely to have a significant impact on a community listed under the EPBC Act requires approval from the Minister for the Environment.

In Western Australia TECs are listed under sections 27(1), 31 and 33 of the BC Act. TECs are determined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee (WATECSAC) and endorsed by the State Minister for the Environment. The WATECSAC is an independent group comprised of representatives from organisations including tertiary institutions, the Western Australian Museum and DBCA. The TECs listed under the BC Act are defined in Schedule 1 of the Biodiversity Conservation (Threatened Ecological Communities) Order 2023. State TECs are also acknowledged through other environmental approval processes such as 'environmental impact assessment' pursuant to Part IV of the *Environmental Protection Act 1986* (EP Act) and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

TECs are assigned to one of the categories outlined in **Table 2** according to their level of threat.

Table 2: Categories of threatened ecological communities (English and Blyth 1997; DEC 2009)

Conservation code	Description
PD	Presumably Totally Destroyed An ecological community that has been adequately searched for but for which no representative occurrences have been located.
CE	Critically Endangered An ecological community that has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
E	Endangered An ecological community that has been adequately surveyed and is not critically endangered but is facing a very high risk of total destruction in the near future.
V	Vulnerable An ecological community that has been adequately surveyed and is not critically endangered or endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future.

An ecological community with insufficient information available to be considered a TEC or which are rare but not currently threatened may be listed as a 'priority ecological community' (PEC). PECs are categorised based on a variety of criteria, as described in **Table 3**. Listed PECs are published by DBCA (DBCA 2023a).

Table 3: Categories of priority ecological communities (DEC 2013)

Priority code	Description
P1	Priority One: Poorly known ecological communities Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
P2	Priority Two: Poorly known ecological communities Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
P3	Priority Three: Poorly known ecological communities (i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
P4	Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (i) Rare. Ecological communities known from few occurrences 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 communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for a higher threat category. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
P5	Priority Five: Conservation Dependent ecological communities Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Reporting

Section 43 of the BC Act requires that an occurrence of a threatened species or threatened ecological community is reported to DBCA where the occurrence has been identified as part of field work completed:

- as part of an assessment under Part IV of the *Environmental Protection Act 1986*; or
- in relation to an application for a clearing permit under the *Environmental Protection Act 1986* section 51E(1)(d).

Penalties apply to individuals and organisations that fail to provide accurate reports of threatened species or communities.

The *Biodiversity Conservation Regulations 2018* (BC Regulations 2018) came into effect on January 1 2019. The BC Regulations include provisions for licencing, charges, penalties and other provisions associated with the BC Act.

Weeds

A number of legislative and policy documents exist in relation to weed management at state and national levels. The *Biosecurity and Agriculture Management Act 2007* (BAM Act) is the principle legislation guiding weed management in Western Australia and lists declared pest species. At a national level, the Australian government has compiled a list of 32 Weeds of National Significance (WoNS) (DoEE 2018), of which many are also listed under the BAM Act.

Declared Pests

Part 2.3.23 of the BAM Act requires a person must not; "*a) keep, breed or cultivate the declared pest; b) keep, breed or cultivate an animal, plant or other thing that is infected or infested with the declared pest; c) release into the environment the declared pest, or an animal, plant or other thing that is infected or infested with the declared pest; or d) intentionally infect or infest, or expose to infection or infestation, a plant, animal or other thing with a declared pest*".

Under the BAM Act, all declared pests are assigned a legal status, as described in **Table 7**. Species assigned to the 'declared pest, prohibited - s12' category are placed in one of three control categories, as described in **Table 8**.

The *Biosecurity and Agriculture Management Regulations 2013* specify keeping categories for species assigned to the 'declared pest - s22(2)' category, which relate to the purposes of which species can be kept, as well as the entities that can keep them. The categories are described in **Table 9**.

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act (DPIRD 2020).

Table 4: Legal status of declared pest species listed under the BAM Act (DPIRD 2020)

Category	Description
Declared Pest Prohibited - s12	May only be imported and kept subject to permits. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions.
Declared Pest s22(2)	Must satisfy any applicable import requirements when imported, and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia

Table 5: Control categories of declared pest species listed under the BAM Act (DPIRD 2020)

Category	Description
C1	Exclusion Not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2	Eradication Present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3	Management Established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Table 6: Keeping categories of declared pest species listed under the BAM Act (DPIRD 2020)

Category	Description
Prohibited	Can only be kept under a permit for public display and education purposes, and/or genuine scientific research, by entities approved by the state authority.
Exempt	No permit or conditions are required for keeping.
Restricted	Organisms which, relative to other species, have a low risk of becoming a problem for the environment, primary industry or public safety and can be kept under a permit by private individuals.

Wetland Habitat

Geomorphic wetland types

On the Swan Coastal Plain DBCA (2017) have used the geomorphic wetland classification system developed by Semeniuk (1987) and Semeniuk and Semeniuk (1995) to classify wetlands based on the landform shape and water permanence (hydro-period) as outlined in **Table 10**.

Table 7: Geomorphic Wetlands of the Swan Coastal Plain classification categories (DBCA 2017)

Level of inundation	Geomorphology			
	Basin	Flat	Channel	Slope
Permanently inundated	Lake	-	River	-
Seasonally inundated	Sumpland	Floodplain	Creek	-
Seasonally waterlogged	Dampland	Palusplain	-	Paluslope

Wetland management categories

DBCA maintains the *Geomorphic Wetland of the Swan Coastal Plain* dataset (DBCA 2018a), which also categorises individual wetlands into specific management categories as described in **Table 11**.

Table 8: Geomorphic Wetlands of the Swan Coastal Plain classification categories (DBCA 2017)

Management category	Description of wetland	Management objectives
Conservation (CCW)	Support high levels of attributes	Preserve wetland attributes and functions through reservation in national parks, crown reserves and state owned land. Protection provided under environmental protection policies.
Resource enhancement (REW)	Partly modified but still supporting substantial functions and attributes	Restore wetland through maintenance and enhancement of wetland functions and attributes. Protection via crown reserves, state or local government owned land, environmental protection policies and sustainable management on private properties.
Multiple use (MUW)	Few wetland attributes but still provide important hydrological functions	Use, development and management considered in the context of water, town and environmental planning through land care.

The management categories of wetland features are determined based on hydrological, biological and human use features. The DBCA document *A methodology for the evaluation of specific wetland types on the Swan Coastal Plain, Western Australia* (DBCA 2017) details the methodology by which wetlands on the Swan Coastal Plain are assigned management categories based on a two tiered evaluation system, with preliminary and secondary evaluation stages. The preliminary evaluation aims to identify any features of conservation significance that would immediately place the wetland within the CCW management category. Examples of these significant features include presence on significant wetland lists, presence of TECs or PECs (Priority 1 and 2), presence of threatened flora and

over 90% of vegetation in good or better condition based on the Keighery (1994) scale. If such environmental values are identified the wetland would be categorised as CCW without further evaluation.

Should the preliminary evaluation indicate that no such features occur, the secondary evaluation and site assessment are then applied. In the secondary evaluation, an appropriate management category is determined through the assessment of a range of environmental attributes, functions and values.

Wetland reclassification

DBCA have a protocol for proposing changes to the wetland boundaries and management categories of the existing geomorphic wetland dataset (DEC 2007). The procedure involves a wetland desktop evaluation and site assessment which culminates in a recommended management category. Relevant information should be obtained in the optimal season for vegetation condition and water levels, which is usually spring (DEC 2007). In the case of larger wetlands that have undergone a degree of disturbance, a separate management category may be assigned to parts of the wetland in order to reflect the current values.

References

General references

Department of Biodiversity, Conservation and Attractions (DBCA) 2017, *A methodology for the evaluation of wetlands on the Swan Coastal Plain*, draft prepared by the Wetlands Section of the Department of Biodiversity, Conservation and Attractions and the Urban Water Branch of the Department of Water and Environmental Regulation, Perth.

Department of Biodiversity, Conservation and Attractions (DBCA) 2018a, *Geomorphic Wetlands, Swan Coastal Plain (DBCA-019)*.

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Department of Biodiversity, Conservation and Attractions (DBCA) 2023a, *Priority Ecological Communities for Western Australia Version 35*, Perth.

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Department of Environment and Conservation (DEC) 2009, *Definitions, Categories and Criteria for Threatened and Priority Ecological Communities*, Perth.

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English, V. and Blyth, J. 1997, *Identifying and Conserving Threatened Ecological Communities in the South West Botanical Province*, ANCA National Reserves System Cooperative Program, Project Number N702, Perth.

Keighery, B. 1994, *Bushland Plant Survey: A guide to plant community survey for the community*, Wildflower Society of WA (Inc), Nedlands.

Semeniuk, C. A. 1987, *Wetlands of the Darling System - a geomorphic approach to habitat classification*, Journal of the Royal Society of Western Australia, 69: 95-112.

Semeniuk, C. A. and Semeniuk, V. 1995, *A Geomorphic Approach to Global Classification for Inland Wetlands*, Vegetatio, 118(1/2): 103-124.

Online references

Department of Environment and Energy (DoEE) 2018, Weeds of National Significance, <http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html>.

Department of Primary Industries and Regional Development (DPIRD) 2020, The Western Australian Organism List (WAOL), < https://www.agric.wa.gov.au/bam/western-australian-organism-list-waol>.

Appendix B

Conservation Significant Flora Species and likelihood of Occurrence Assessment

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	CR	CR	P	Low woodland on grey, clayey sand with lateritic pebbles (Pinjarra Plain) near winter wet flats.	Sep-Nov	Negligible
Synaphea sp. Serpentine (G.R. Brand 103)	CR	CR	P	Seasonally damp areas, loam - sand.	Sep-Oct	Moderate
Caladenia huegelii	CR	EN	PG	Well-drained, deep sandy soils in lush undergrowth in a variety of moisture levels.	Sep-early Nov	Moderate
Drakaea elastica	CR	EN	PG	Bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps. Typically in banksia woodland or thickets of Kunzea glabrescens.	late Sep-Oct/Nov, survey Jul-Aug	High
Eucalyptus x balanites	CR	EN	P	Light coloured sandy soils over laterite. Habitat consists of gently sloping heathlands; open mallee woodland over shrubland (Population 2) or heathland with emergent mallees (population 1)	Oct - Feb	Negligible
Verticordia plumosa var. ananeotes	CR	EN	P	Sand in open jarrah woodland or sandy/clay soils with marri.	Nov-Dec	Negligible
Synaphea sp. Pinjarra Plain (A.S. George 17182)	EN	CR	P	White grey clayey sand on edges of seasonally inundated low lying areas.	Sep-Oct	Negligible
Diuris purdiei	EN	EN	PG	Sand to sandy clay soils in areas subject to winter inundation.	late September to mid-October	Negligible
Drakaea micrantha	EN	VU	PG	Open sandy patches often adjacent to winter-wet swamps.	Sept- early Oct	Negligible
Andersonia gracilis	VU	EN	P	Seasonally damp, black sandy clay flats near or on the margins of swamps.	Sep-Nov	Negligible
Banksia mimica	VU	EN	P	Flat to gentle slopes in grey and white sand in open woodlands.	Dec-Jan	Negligible
Diuris drummondii	VU	VU	PG	In low-lying depressions in peaty and sandy clay swamps.	Nov-Jan	High

	WA	EPBC Act				
Diuris micrantha	VU	VU	PG	Dark grey-black sandy clay-loam in winter wet depressions or swamps. Often in shallow standing water.	Aug/Sep-early Oct	Negligible
Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026)	P1	-	P	Grey or black sand over clay. Swampy areas, winter wet lowlands.	May or Aug	Moderate
Acacia sp. Binningup (G. Cockerton et al. WB 37784)	P1	-	P	Woodland and shrubland on sand, often in degraded areas	Aug	Moderate
Stachystemon exilis	P1	-	P	Low lying areas on sand.	Oct-Nov	Moderate
Acacia benthamii	P2	-	P	Sand, typically on limestone breakaways	Aug-Sept	High
Cardamine paucijuga	P2	-	A	Winter wet areas, sand or clay	Sep-Oct	High
Johnsonia pubescens subsp. cygnorum	P2	-	P	Grey white yellow sands on flats and seasonally wet areas.	Sep	Moderate
Thelymitra variegata	P2	-	P	Sandy clay, sand, laterite.	Jun-Sep	Moderate
Beyeria cinerea subsp. cinerea	P3	-	P	Sand, limestone.	May-Oct	High
Boronia capitata subsp. gracilis	P3	-	P	White/grey or black sand in winter-wet swamps, hillslopes.	Jun-Nov	Moderate
Calandrinia oraria	P3	-	A/P	Coastal dunes, in low heath, sand over limestone.	Aug-Oct	Negligible
Carex tereticaulis	P3	-	P	Black peaty sand.	Sep-Oct	Moderate
Dillwynia dillwynioides	P3	-	P	Winter wet depressions on sandy soils	Aug - Dec	High
Lasiopetalum membranaceum	P3	-	P	Sand over limestone	Sep-Dec	Moderate
Pimelea calcicola	P3	-	P	Sand, limestone on coastal ridges.	Sep-Nov	Negligible
Schoenus capillifolius	P3	-	A	Brown mud in claypans.	Oct-Nov	High
Sphaerolobium calcicola	P3	-	P	White-grey-brown sand, sandy clay over limestone, black peaty sandy clay. Tall dunes, winter-wet flats, interdunal swamps, low-lying areas.	Jun or Sep-Nov	High
Styphelia filifolia	P3	-	P	Brown over pale yellow sand.	Feb-Apr	Moderate
Caladenia speciosa	P4	-	PG	White, grey or black sand.	Sep-Oct	Moderate
Conostylis pauciflora subsp. pauciflora	P4	-	P	Grey sand, limestone. Hillslopes, consolidated dunes.	Aug-Oct	High
Eucalyptus foecunda subsp. foecunda	P4	-	P	Sand over limestone. Outcropping limestone.	Jan-Mar	Moderate

	WA	**EPBC Act**				
Eucalyptus rudis subsp. cratyantha	P4	-	P	Loam on flats and hillsides.	Jul-Sep	Negligible
Jacksonia sericea	P4	-	P	Calcareous and sandy soils on Swan Coastal Plain	Dec-Feb	High
Parsonsia diaphanophleba	P4	-	P	Alluvial soils along rivers.	Jan-Feb or Apr-Sep	Negligible
Stylidium longitubum	P4	-	A	Sandy clay, clay. Seasonal wetlands.	Oct-Dec	Moderate

Note: T=threatened, CE=critically endangered, E=endangered, V=vulnerable, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4, P=perennial, PG=perennial geophyte, A=annual. Species considered to potentially occur within the site are shaded green

Appendix C

Conservation Significant Communities and Likelihood of Occurrence Assessment

Code	Community name	TEC/ PEC	Level of significance		Likelihood of occurrence
			State	EPBC Act	
SCP19a	Sedgelands in Holocene dune swales of the southern Swan Coastal Plain	TEC	CR	EN	High
SCP19b	Woodlands over sedgelands in Holocene dune swales of the southern Swan Coastal Plain	TEC	CR	EN	High
SCP08	Herb rich shrublands in clay pans	TEC	VU	CR	High
SCP15	Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain	TEC	VU	-	Moderate
Walyungup Microbial	Microbial community of a coastal saline lake (Lake Walyungup)	PEC	P1	-	Negligible
Banksia WL SCP	Banksia Woodlands of the Swan Coastal Plain ecological community	TECP /PEC	P3	EN	High
SCP21c	Low lying *Banksia attenuata* woodlands or shrublands	TEC/ PEC	P3	EN	Moderate
SCP24	Northern Spearwood shrublands and woodlands	PEC	P3	-	High
SCP25	Southern *Eucalyptus gomphocephala - Agonis flexuosa* woodlands	PEC	P3	-	High
SCP29a	Coastal shrublands on shallow sands	PEC	P3	-	High
SCP29b	Acacia shrublands on taller dunes	PEC	P3	-	Negligible
Tuart woodlands	Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain ecological	TEC/ PEC	P3	CR	High
Coastal Saltmarsh	Subtropical and Temperate Coastal Saltmarsh	TEC/ PEC	PR	VU	Negligible

Note: TEC=threatened ecological community, PEC=priority ecological community, CR=critically endangered, EN=endangered, VU=vulnerable, P3=priority 3

Appendix D

Species List

Family	Status	Species
Aizoaceae		
	*	*Carpobrotus edulis*
		Carpobrotus virescens
Amaryllidaceae		
	*, Pl	*Agapanthus* sp.
Anacardiaceae		
	*	*Schinus terebinthifolia*
Anarthriaceae		
		Lyginia imberbis
Apiaceae		
		Apium prostratum
		Centella asiatica
		Daucus glochidiatus
		Eryngium pinnatifidum subsp. *pinnatifidum ms*
		Xanthosia huegelii
Apocynaceae		
		Alyxia buxifolia
	*, DP	*Gomphocarpus fruticosus*
	*, Pl	*Plumeria sp.*
Araceae		
	*, DP	*Zantedeschia aethiopica*
Araliaceae		
		Trachymene coerulea subsp. *coerulea*
		Trachymene pilosa
Asparagaceae		
		Acanthocarpus preissii
	*, DP, WoNS	*Asparagus aethiopicus*
	*, DP, WoNS	*Asparagus asparagoides*
		Dichopogon capillipes
		Laxmannia squarrosa
		Lomandra caespitosa
		Lomandra maritima
		Lomandra micrantha
		Lomandra preissii
		Lomandra sericea
		Lomandra suaveolens
		Lomandra sp.
		Sowerbaea laxiflora
		Thysanotus patersonii/manglesianus
		Thysanotus sp.
	*, Pl	*Yucca aloifolia*
Asphodelaceae		
	*	*Asphodelus fistulosus*
	*	*Trachyandra divaricata*
Asteraceae		
	*	*Arctotheca calendula*
	*	*Artemisia* sp.
	*	*Cirsium vulgare*

Family	Status	Species
Asteraceae (cont.)	*	*Cotula australis*
	*	*Erigeron bonariensis*
	*	*Erigeron canadensis*
	*	*Erigeron* sp.
	*	*Gazania linearis*
	*	*Hypochaeris glabra*
	*	*Lactuca serriola*
		Lagenophora ?huegelii
		Olearia axillaris
	*	*Osteospermum ecklonis*
		Podolepis gracilis
		Podotheca gnaphalioides
		Rhodanthe citrina
		Senecio pinnatifolius
	*	*Sonchus oleraceus*
	*	*Ursinia anthemoides*
	*	*Asteraceae* sp.
Bignoniaceae		
	*, Pl	*Jacaranda* sp.
Brassicaceae		
	*	*Brassica* sp.
	*	*Heliophila pusilla*
Cactaceae		
	*, DP, WoNS	*Opuntia stricta*
Campanulaceae		
		Lobelia anceps
	*	*Wahlenbergia capensis*
Caryophyllaceae		
	*	*Petrorhagia dubia*
	*	*Stellaria media*
Casuarinaceae		
		Allocasuarina fraseriana
Celastraceae		
		Stackhousia huegelii
Chenopodiaceae		
		Rhagodia baccata
Colchicaceae		
		Burchardia congesta
Convolvulaceae		
	*	*Cuscuta epithymum*
Crassulaceae		
		Crassula colorata
Cupressaceae		
		Callitris preissii
Cyperaceae		
		Baumea articulata
		Baumea juncea
		Cyperaceae sp.

Family	Status	Species
Cyperaceae (cont.)	*	*Cyperus* sp.
		Ficinia nodosa
		Gahnia trifida
		Isolepis sp.
		Lepidosperma calcicola
		Lepidosperma gladiatum
		Lepidosperma longitudinale
		Lepidosperma squamatum
		Machaerina articulata
		Machaerina juncea
		Mesomelaena pseudostygia
		Morelotia octandra
		Schoenus clandestinus
		Schoenus subfascicularis
		Tetraria octandra
Dasypogonaceae		
		Dasypogon bromeliifolius
Dilleniaceae		
		Hibbertia cuneiformis
		Hibbertia hypericoides
		Hibbertia racemosa
	*, Pl	*Hibbertia scandens*
		Hibbertia subvaginata
Droseraceae		
		Drosera erythrorhiza
		Drosera pallida
		Drosera stolonifera
		Drosera sp.
Ericaceae		
		Brachyloma preissii
		Conostephium pendulum
		Leucopogon australis
		Leucopogon sp.
		Styphelia propinqua
Euphorbiaceae		
	*	*Euphorbia paralias*
	*	*Euphorbia peplus*
	*	*Euphorbia terracina*
	*	*Euphorbia* sp.
		Monotaxis grandiflorus
		Ricinocarpos undulatus
	*	*Ricinus communis*
Fabaceae		
		Acacia cochlearis
		Acacia ?cyclops
		Acacia extensa
	*	*Acacia iteaphylla*
		Acacia lasiocarpa

Family	Status	Species
Fabaceae (cont.)		*Acacia ?littorea*
	*	*Acacia longifolia*
	*	*Acacia podalyriifolia*
		Acacia pulchella
		Acacia rostellifera
		Acacia saligna
		Acacia stenoptera
		Acacia sp.
		Bossiaea eriocarpa
	*	*Chamaecytisus palmensis*
	*	*Cytisus proliferus*
		Daviesia divaricata
		Daviesia triflora
	*, Pl	*Erythrina* sp.
		Gastrolobium capitatum
		Gompholobium tomentosum
		Hardenbergia comptoniana
		Hovea trisperma
		Isotropis cuneifolia
		Jacksonia furcellata
		Jacksonia sternbergiana
		Kennedia prostrata
	*	*Lupinus angustifolius*
	*	*Lupinus cosentinii*
	*	*Lupinus luteus*
	*	*Ornithopus compressus*
	*	*Ornithopus sativus*
	*	*Trifolium arvense*
	*	*Trifolium campestre*
	*	*Trifolium* sp.
	*	*Vicia* sp.
Geraniaceae		
	*	*Erodium cicutarium*
	*	*Erodium* sp.
		Geranium solanderi
	*	*Pelargonium capitatum*
Goodeniaceae		
		Scaevola canescens
		Scaevola crassifolia
Haemodoraceae		
		Anigozanthos humilis
		Anigozanthos sp.
		Conostylis aculeata
		Conostylis candicans subsp. *calcicola*
		Phlebocarya ciliata
Hemerocallidaceae		
		Caesia micrantha
		Chamaescilla corymbosa

Family	Status	Species
Hemerocallidaceae (cont.)		*Corynotheca micrantha*
		Dianella revoluta
		Tricoryne elatior
Iridaceae		
	*	*Freesia* sp.
	*	*Gladiolus caryophyllaceus*
	*, DP	*Moraea flaccida*
		Patersonia occidentalis
	*	*Romulea flava*
	*	*Romulea rosea*
	*	*Watsonia meriana var. bulbillifera*
	*	*Iridaceae* sp.
Juncaceae		
		Juncus pallidus
		Juncus sp.
Juncaginaceae		
		Cycnogeton lineare
Lamiaceae		
		Hemiandra pungens
	*, Pl	*Lavandula* sp.
	*	*Mentha* sp.
	*, Pl	*Salva rosmarinus*
	*, Pl	*Westringia fruticosa*
Lauraceae		
		Cassytha racemosa
	*, Pl	*Persea americana*
Loganiaceae		
		Logania vaginalis
Loranthaceae		
		Nuytsia floribunda
Lythraceae		
	*	*Punica granatum*
Macarthuriaceae		
		Macarthuria australis
Malvaceae		
		Alyogyne sp.
	*	*Malva parviflora*
Moraceae		
	*	*Ficus carica*
	*	*Morus nira*
	*	*Morus* sp.
Musaceae		
	*, Pl	*Musa* sp.
Myrtaceae		
	Pl	*Agonis flexuosa*
	Pl	*Beaufortia* sp.
	Pl	*Callistemon phoeniceus*
	*, Pl	*Callistemon* sp.

Family	Status	Species
Myrtaceae (cont.)		*Calothamnus quadrifidus*
	*, Pl	*Chamelaucium uncinatum*
		Corymbia calophylla
	*, Pl	*Corymbia citriodora*
	*, Pl	*Corymbia ficifolia*
	*, Pl	*Corymbia maculata*
		Darwinia citriodora
	*, Pl	*Eucalyptus caesia*
	*, Pl	*Eucalyptus camaldulensis*
	*, Pl	*Eucalyptus ?chapmaniana*
	*, Pl	*Eucalyptus erythrocorys*
		Eucalyptus gomphocephala
	*, Pl	*Eucalyptus grandis*
	*, Pl	*Eucalyptus leucoxylon*
	*, Pl	*Eucalyptus loxophleba*
		Eucalyptus marginata
		Eucalyptus patens
	*, Pl	*Eucalyptus robusta*
		Eucalyptus rudis
		Eucalyptus todtiana
	*, Pl	*Eucalyptus ?victrix*
	*, Pl	*Eucalyptus* sp.
	*	*Gaudium laevigatum*
		Hypocalymma angustifolium
		Kunzea glabrescens
		Melaleuca huegelii
		Melaleuca ?lateritia
	*, Pl	*Melaleuca nesophila*
		Melaleuca preissiana
	*, Pl	*Melaleuca quinquenervia*
		Melaleuca rhaphiophylla
		Melaleuca teretifolia
		Melaleuca thymoides
		Melaleuca sp.
	*, Pl	*Thryptomene saxicola*
Nephrolepidaceae		
	*, Pl	*Nephrolepis* sp.
Nyctaginaceae		
	*, Pl	*Bougainvillea* sp.
Oleaceae		
	*, Pl	*Fraxinus* sp.
	*	*Olea europaea*
Orchidaceae		
		Caladenia flava
		Caladenia latifolia
		Caladenia sp.
	*	*Disa bracteata*
		Diuris corymbosa

Family	Status	Species
Orchidaceae (cont.)		*Microtis media*
		Microtis sp.
		Pterostylis ectypha
		Pterostylis vittata
		Pterostylis sp.
		Thelymitra sp.
Orobanchaceae		
	*	*Orobanche minor*
Oxalidaceae		
	*	*Oxalis pes-caprae*
	*	*Oxalis purpurea*
		Oxalis sp.
Papaveraceae		
	*	*Fumaria capreolata*
	*	*Fumaria densiflora*
Phyllanthaceae		
		Lysiandra calycina
		Poranthera microphylla
Phytolaccaceae		
	*	*Phytolacca octandra*
Pinaceae		
	*, Pl	*Pinus pinaster*
Poaceae		
	*	*Avena barbata*
	*	*Briza maxima*
	*	*Bromus diandrus*
	*	*Cenchrus clandestinus*
	*	*Cenchrus setaceus*
	*	*Cynodon dactylon*
	*	*Ehrharta calycina*
	*	*Ehrharta longiflora*
	*	*Eragrostis curvula*
	*	*Eragrostis* sp.
	*	*Hemarthria uncinata*
	*	*Hyparrhenia hirta*
	*	*Lagurus ovatus*
	*	*Lolium perenne*
		Microlaena stipoides
	*	*Paspalum dilatatum*
	*, Pl	*Sorghum* sp.
	*	*Vulpia* sp.
Polygonaceae		
		Muehlenbeckia adpressa
	*	*Rumex acetosa*
Primulaceae		
	*	*Lysimachia arvensis*

Family	Status	Species
Proteaceae		
	Pl	*Adenanthos sericeus*
		Banksia attenuata
		Banksia blechnifolia
		Banksia grandis
		Banksia ilicifolia
		Banksia littoralis
		Banksia menziesii
		Banksia nivea
	Pl	*Banksia prionotes*
		Banksia sessilis
	*, Pl	*Banksia* sp.
		Conospermum stoechadis
	*, Pl	*Grevillea bipinnatifida*
	Pl	*Grevillea crithmifolia*
	*, Pl	*Grevillea curviloba*
	*, Pl	*Grevillea leucopteris*
	*, Pl	*Grevillea obtusifolia*
	*, Pl	*Grevillea olivacea*
	Pl	*Grevillea preissii*
	*, Pl	*Grevillea synapheae*
		Grevillea vestita
	*, Pl	*Grevillea* sp.
	*, Pl	*Hakea laurina*
		Hakea lissocarpha
	*, Pl	*Hakea petiolaris*
		Hakea prostrata
		Hakea trifurcata
	*, Pl	*Hakea* sp.
		Petrophile linearis
	*, Pl	*Protea* sp.
		Stirlingia latifolia
		Synaphea spinulosa
		Xylomelum occidentale
Restionaceae		
		Desmocladus fasciculatus
		Desmocladus flexuosus
		Hypolaena exsulca
		Hypolaena sp.
		Leptocarpus coangustatus
Rhamnaceae		
		Spyridium globulosum
Rosaceae		
	*, Pl	*Prunus* sp.
Rubiaceae		
		Opercularia hispidula
		Opercularia vaginata

Family	Status	Species
Rutaceae		
	*, Pl	*Citrus x limon*
	*, Pl	*Citrus* sp.
		Clematis sp.
		Diplolaena dampieri
		Philotheca spicata
Santalaceae		
		Exocarpos sparteus
Scrophulariaceae		
	*	*Dischisma arenarium*
		Eremophila glabra
	*, Pl	*Eremophila maculata*
Solanaceae		
	*	*Physalis* sp.
	*	*Solanum nigrum*
Stylidiaceae		
		Stylidium piliferum
Thymelaeaceae		
		Pimelea rosea
Tropaeolaceae		
	*, Pl	*Nastursium* sp.
Typhaceae		
		Typha orientalis
		Typha sp.
Verbenaceae		
	*, DP, WoNS	*Lantana* sp.
Violaceae		
		Pigea calycina
Xanthorrhoeaceae		
		Xanthorrhoea brunonis
		Xanthorrhoea preissii
Zamiaceae		
		Macrozamia riedlei

*=non-native, Pl=planted, DP=declared pest, WoNS=weed of national significance

Appendix E

Sample Data

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q1

Project no.: EP23-018
Date: 28/07/2023, 18/09/2023 **Status** Non-permanent
Author: TAA,TDP Q1: Page 1 of 3

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	386301.5655	NW corner northing:	6415111.653
Altitude (m):	8.4	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	> 5 yrs	Disturbance:	low - weeds
Soil type/texture	sand/	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	20% (leaves,branches,)	Vegetation condition:	very good

Vegetation Sample Data

KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q1

Project no.: EP23-018

Date: 28/07/2023, 18/09/2023 **Status** Non-permanent

Author: TAA,TDP

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia stenoptera	opp
	Allocasuarina fraseriana	5
*	*Arctotheca calendula*	opp
	Banksia attenuata	15
	Banksia menziesii	20
	Banksia nivea	opp
	Bossiaea eriocarpa	opp
	Brachyloma preissii	opp
	Brachyloma preissii	opp
*	*Briza maxima*	1
*	*Briza maxima*	0.1
	Burchardia congesta	0.1
	Caladenia flava	0.1
	Caladenia sp.	0.1
	Chamaescilla corymbosa	1
	Conostylis aculeata	0.1
	Dasypogon bromeliifolius	15
	Daviesia divaricata	opp
	Daviesia divaricata	opp
	Desmocladus flexuosus	30
	Dianella revoluta	0.1
	Drosera erythrorhiza	opp
*	*Ehrharta calycina*	1
*	*Ehrharta calycina*	0.1
	Eucalyptus marginata	15
	Gastrolobium capitatum	opp
	Gompholobium tomentosum	1
	Hakea prostrata	opp
	Hardenbergia comptoniana	opp
	Hibbertia hypericoides	2
	Hovea trisperma	opp
*	*Hypochaeris glabra*	opp
*	*Hypochaeris glabra*	0.1
	Hypolaena exsulca	1

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q1

Project no.: EP23-018

Date: 28/07/2023, 18/09/2023 **Status** Non-permanent

Author: TAA,TDP Q1: Page 3 of 3

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Jacksonia sternbergiana	opp
	Kennedia prostrata	opp
	Kunzea glabrescens	10
	Lagenophora ?huegelii	opp
	Lepidosperma calcicola	opp
	Lomanda caespitosa	opp
	Lomandra preissii	opp
*	*Lysimachia arvensis*	opp
	Macrozamia riedlei	0.5
	Microlaena stipoides	1
	Morelotia octandra	10
	Opercularia vaginata	opp
*	*Oxalis pes-caprae*	opp
	Pigea calycina	0.1
	Pterostylis vittata	0.1
*	*Romulea rosea*	opp
	Scaevola canescens	opp
	Schoenus clandestinus	opp
	Schoenus clandestinus	0.1
	Stylidium piliferum	0.1
	Thysanotus patersonii/manglesianus	opp
	Trachymene pilosa	0.1
*	*Ursinia anthemoides*	opp
	Xanthorrhoea brunonis	opp

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q2

Project no.: EP23-018
Date: 29/08/2023 **Status** Non-permanent
Author: MS,TDP Q2: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	387099.4147	NW corner northing:	6415165.657
Altitude (m):	18	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	mid-slope
Time since fire:	3-5 yrs	Disturbance:	moderate - weeds, tracks
Soil type/texture	sand/loam	Bare ground (%):	20
Rocks (%) and type:	No rocks	Soil colour:	grey/yellow
Litter:	10% (leaves,twigs,)	Vegetation condition:	good

Vegetation Sample Data

KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q2

Project no.: EP23-018

Date: 29/08/2023 **Status** Non-permanent

Author: MS,TDP Q2: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia pulchella	25
	Allocasuarina fraseriana	5
	Anigozanthos humilis	opp
	Banksia attenuata	15
	Brachyloma preissii	2
*	*Briza maxima*	1
	Burchardia congesta	0.1
	Chamaescilla corymbosa	0.1
	Conostephium pendulum	0.1
	Conostylis aculeata	0.1
	Corynotheca micrantha	opp
	Desmocladus flexuosus	0.1
	Drosera pallida	0.1
	Drosera stolonifera	0.1
*	*Ehrharta calycina*	10
	Eucalyptus marginata	15
	Gompholobium tomentosum	0.1
Pl	*Grevillea crithmifolia*	opp
	Hardenbergia comptoniana	0.1
	Heliophylla pusilla	0.1
	Hibbertia hypericoides	25
*	*Hypochaeris glabra*	0.1
	Hypolaena exsulca	2
	Isolepis sp.	0.1
	Jacksonia furcellata	1
	Lepidosperma calcicola	2
	Phlebocarya ciliata	5
	Rhodanthe citrina	0.1
*	*Romulea rosea*	0.1
	Sowerbaea laxiflora	0.1
	Tetraria octandra	1
*	*Ursinia anthemoides*	1
	Xylomelum occidentale	opp

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: R3

Project no.: EP23-018
Date: 29/08/2023 **Status** Non-permanent
Author: MS, R3: Page 1 of 3

Quadrat and landform details

Sample type:	releve	Size:	10 m x 10 m
NW corner easting:	385806.9646	NW corner northing:	6414944.727
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	flat
Time since fire:	> 5 yrs	Disturbance:	high - weeds, clearing
Soil type/texture	loam/sand with organic layer	Bare ground (%):	1
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	10% (leaves,twigs,branches)	Vegetation condition:	degraded-good

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: R3

Project no.: EP23-018
Date: 29/08/2023 **Status** Non-permanent
Author: MS, R3: Page 2 of 3

Species Data
* denotes non-native species

Status	Confirmed name
*	*Acacia iteaphylla*
*	*Acacia longifolia*
	Acacia pulchella
?Pl	*Agonis flexuosa*
	Allocasuarina fraseriana
	Banksia attenuata
	Banksia grandis
	Banksia menziesii
	Burchardia congesta
	Caladenia flava
	Caladenia latifolia
	Caladenia sp.
	Chamaescilla corymbosa
	Conostephium pendulum
	Conostylis aculeata
	Conostylis aculeata
	Corynotheca micrantha
	Cyperaceae sp.
	Desmocladus flexuosus
	Dianella revoluta
*	*Ehrharta calycina*
	Eucalyptus gomphocephala
	Eucalyptus marginata
*	*Euphorbia peplus*
*	*Fumaria capreolata*
*	*Gomphocarpus fruticosus*
	Hardenbergia comptoniana
	Hibbertia hypericoides
*	*Hypochaeris glabra*
	Jacksonia furcellata
	Kennedia prostrata
	Lepidosperma squamatum
	Lomandra maritima
	Lomandra micrantha

Vegetation Sample Data

KARNUP DISTRICT STRUCTURE PLAN

Sample Name: R3

Project no.: EP23-018

Date: 29/08/2023 **Status** Non-permanent

Author: MS, R3: Page 3 of 3

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
*	*Lysimachia arvensis*	
	Macrozamia riedlei	
	Mesomelaena pseudostygia	
*	*Oxalis sp.*	
	Pigea calycina	
	Pterostylis ectypha	
*	*Sonchus oleraceus*	
	Sowerbaea laxiflora	
*	*Trachyandra divaricata*	
	Tricoryne elatior	
*	*Ursinia anthemoides*	
	Xanthorrhoea preissii	

Vegetation Sample Data

KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q4

Project no.: EP23-018

Date: 30/08/2023 **Status** Permanent

Author: MS,TDP Q4: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	385592.4235	NW corner northing:	6411579.679
Altitude (m):	4	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	flat
Time since fire:	3-5 yrs	Disturbance:	high - weeds
Soil type/texture	sand/loam with organic layer	Bare ground (%):	1
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	20% (leaves,logs,branches)	Vegetation condition:	good

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q4

Project no.: EP23-018
Date: 30/08/2023 **Status** Non-permanent
Author: MS,TDP

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia pulchella	1
	Banksia grandis	opp
	Banksia littoralis	50
	Caladenia latifolia	0.1
*	*Carpobrotus edulis*	2
	Desmocladus flexuosus	0.1
	Desmocladus flexuosus	0.1
	Drosera stolonifera	0.1
*	*Ehrharta calycina*	10
	Eucalyptus gomphocephala	20
	Ficinia nodosa	2
	Hardenbergia comptoniana	0.1
*	*Hypochaeris glabra*	0.1
	Lepidosperma longitudinale	20
	Macrozamia riedlei	2
	Opercularia hispidula	2
	Opercularia vaginata	0.1
	Pigea calycina	10
	Rhagodia baccata	0.1
*	*Sonchus oleraceus*	0.1
	Sowerbaea laxiflora	0.1
	Spyridium globulosum	opp
*	*Stellaria media*	0.1
	Trachymene pilosa	0.1
*	*Trifolium campestre*	0.1
*	*Ursinia anthemoides*	0.1

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q5

Project no.: EP23-018
Date: 30/08/2023 **Status** Permanent
Author: MS,TDP Q5: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	385486.3124	NW corner northing:	6411195.396
Altitude (m):	5	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	depression
Time since fire:	> 5 yrs	Disturbance:	moderate - tracks weeds
Soil type/texture	loam/sand with organic layer	Bare ground (%):	1
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	30% (leaves,logs,branches)	Vegetation condition:	good-very good

Vegetation Sample Data

KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q5

Project no.: EP23-018

Date: 30/08/2023 **Status** Non-permanent

Author: MS,TDP

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia saligna	opp
	Apium prostratum	0.1
	Caladenia sp.	0.1
	Centella asiatica	2
	Eucalyptus gomphocephala	20
	Gahnia trifida	80
*	*Hypochaeris glabra*	0.1
	Juncus pallidus	1
	Lepidosperma longitudinale	1
	Lobelia anceps	0.1
	Lobelia anceps	1
	Melaleuca rhaphiophylla	25
	Muehlenbeckia adpressa	opp
	Opercularia hispidula	1
*	*Stellaria media*	0.1
	Unknown (sterile soft grass)	15

Vegetation Sample Data

KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q6

Project no.: EP23-018
Date: 30/08/2023 **Status** Non-permanent
Author: MS,TDP Q6: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	385519.1766	NW corner northing:	6410886.096
Altitude (m):	7	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	> 5 yrs	Disturbance:	high - weeds
Soil type/texture	sand/loam with organic layer	Bare ground (%):	1
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	40% (leaves,twigs,branches)	Vegetation condition:	degraded-good

Vegetation Sample Data

KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q6

Project no.: EP23-018

Date: 30/08/2023 **Status** Non-permanent

Author: MS,TDP

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acanthocarpus preissii	2
	Banksia littoralis	10
*	*Briza maxima*	15
	Cyperaceae sp.	5
	Drosera erythrorhiza	1
*	*Ehrharta calycina*	10
	Eucalyptus gomphocephala	25
*	*Euphorbia sp.*	1
	Ficinia nodosa	2
*	*Fumaria capreolata*	1
	Gahnia trifida	1
	Hardenbergia comptoniana	1
	Pigea calycina	1
	Lepidosperma longitudinale	10
	Opercularia hispidula	10
	Rhagodia baccata	5
	Sowerbaea laxiflora	1
	Trachymene coerulea subsp. coerulea	1
*	*Ursinia anthemoides*	1

Vegetation Sample Data

KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q7

Project no.: EP23-018
Date: 30/08/2023 **Status** Non-permanent
Author: MS,TDP Q7: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	385577.2573	NW corner northing:	6411499.454
Altitude (m):	9	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	> 5 yrs	Disturbance:	high - weeds
Soil type/texture	sand/loam with organic layer	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	30% (leaves,logs,branches)	Vegetation condition:	good

Vegetation Sample Data

KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q7

Project no.: EP23-018

Date: 30/08/2023 **Status** Non-permanent

Author: MS,TDP

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia pulchella	5
	Banksia grandis	5
	Caladenia latifolia	0.5
*	*Carpobrotus edulis*	1
	Cyperaceae sp.	2
	Dichopogon capillipes	1
*	*Ehrharta calycina*	5
	Eucalyptus gomphocephala	25
	Eucalyptus marginata	10
	Hardenbergia comptoniana	3
	Jacksonia furcellata	4
	Macrozamia riedlei	3
	Opercularia hispidula	1
	Opercularia vaginata	1
*	*Oxalis sp.*	1
	Rhagodia baccata	1
	Sowerbaea laxiflora	0.5
	Spyridium globulosum	2
*	*Trifolium campestre*	1
*	*Ursinia anthemoides*	0.5

Vegetation Sample Data

KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q8

Project no.: EP23-018

Date: 30/08/2023 **Status** Non-permanent

Author: MS,TDP Q8: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	385143.9168	NW corner northing:	6411559.148
Altitude (m):	5	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	depression
Time since fire:	no evidence	Disturbance:	low - weeds
Soil type/texture	loam/sand with organic layer	Bare ground (%):	1
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	30% (leaves,twigs,)	Vegetation condition:	very good

Vegetation Sample Data

KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q8

Project no.: EP23-018

Date: 30/08/2023 **Status** Non-permanent

Author: MS,TDP Q8: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
*	*Asparagus asparagoides*	0.1
	Cassytha racemosa	opp
*	*Ehrharta calycina*	1
*	*Erigeron sp.*	0.1
	Ficinia nodosa	1
*	*Ficus carica*	1
*	*Gomphocarpus fruticosus*	0.1
	Lepidosperma longitudinale	99
	Melaleuca rhaphiophylla	opp
	Melaleuca teretifolia	90
	Muehlenbeckia adpressa	1
	Unknown (sterile herb)	0.1

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: R9

Project no.: EP23-018
Date: 14/09/2023 **Status** Non-permanent
Author: MS, R9: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	10 m x 10 m
NW corner easting:	385158.7893	NW corner northing:	6411516.742
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	near saturated	Landform:	depression
Time since fire:	no evidence	Disturbance:	moderate - weeds, tracks
Soil type/texture	loam/	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	black/
Litter:	% (branches,leaves,logs)	Vegetation condition:	very good

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: R9

Project no.: EP23-018
Date: 14/09/2023 **Status** Non-permanent
Author: MS, R9: Page 2 of 2

Species Data
* denotes non-native species

Status	Confirmed name
*	*Asteraceae sp.*
*	*Ehrharta longiflora*
*	*Erigeron sp.*
*	*Fumaria capreolata*
	Gahnia trifida
	Lepidosperma longitudinale
	Lobelia anceps
	Machaerina juncea
	Melaleuca rhaphiophylla
	Muehlenbeckia adpressa
	Rhagodia baccata
*	*Sonchus oleraceus*
*	*Sonchus oleraceus*

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q10

Project no.: EP23-018
Date: 14/09/2023 **Status** Permanent
Author: MS, Q10: Page 1 of 3

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	384687.9785	NW corner northing:	6411031.146
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	depression
Time since fire:	no evidence	Disturbance:	moderate - weeds, tracks
Soil type/texture	loam/ with organic layer	Bare ground (%):	1
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	5% (leaves,twigs,branches)	Vegetation condition:	good-very good

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q10

Project no.: EP23-018
Date: 14/09/2023 **Status** Non-permanent
Author: MS, Q10: Page 2 of 3

Species Data
* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia pulchella	1
	Acacia saligna	opp
	Acanthocarpus preissii	opp
	Allocasuarina fraseriana	5
	Banksia attenuata	opp
	Banksia grandis	opp
	Banksia littoralis	5
*	*Briza maxima*	<1
	Burchardia congesta	<1
	Caladenia flava	opp
	Chamaescilla corymbosa	<1
	Conostylis candicans subsp. calcicola	<1
	Desmocladus flexuosus	10
	Desmocladus flexuosus	<1
	Dianella revoluta	<1
	Dichopogon capillipes	20
	Diplolaena dampieri	<1
	Drosera erythrorhiza	<1
*	*Ehrharta calycina*	3
	Eucalyptus gomphocephala	40
	Hardenbergia comptoniana	<1
*	*Hypochaeris glabra*	1
	Jacksonia furcellata	1
	Lepidosperma squamatum	<1
	Lomandra caespitosa	1
	Lomandra maritima	25
	Macrozamia riedlei	1
	Morelotia octandra	40
	Pigea calycina	opp
	Pimelea rosea	opp
	Poranthera microphylla	<1
	Sowerbaea laxiflora	opp
	Spyridium globulosum	25
*	*Stellaria media*	<1

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q10

Project no.: EP23-018

Date: 14/09/2023 **Status** Non-permanent

Author: MS, Q10: Page 3 of 3

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Trachymene pilosa	<1
	Xanthorrhoea brunonis	1
	Xanthosia huegelii	opp

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: R11

Project no.: EP23-018
Date: 18/09/2023 **Status** Non-permanent
Author: SKP, R11: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	10 m x 10 m
NW corner easting:	384614.8337	NW corner northing:	6410915.55
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	> 5 yrs	Disturbance:	moderate - weeds
Soil type/texture	sand/	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	brown/orange
Litter:	20% (leaves,branches,)	Vegetation condition:	good

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: R11

Project no.: EP23-018
Date: 18/09/2023 **Status** Non-permanent
Author: SKP, R11: Page 2 of 2

Species Data
* denotes non-native species

Status	Confirmed name
	Acacia pulchella
	Acanthocarpus preissii
	Allocasuarina fraseriana
	Alyxia buxifolia
	Banksia attenuata
	Banksia grandis
*	*Briza maxima*
	Burchardia congesta
	Caladenia flava
	Caladenia latifolia
	Chamaescilla corymbosa
	Conospermum stoechadis
	Desmocladus flexuosus
	Dianella revoluta
	Dichopogon capillipes
	Diuris corymbosa
*	*Ehrharta calycina*
	Eucalyptus gomphocephala
	Eucalyptus marginata
*	*Freesia sp.*
*	*Fumaria capreolata*
	Hibbertia hypericoides
	Jacksonia furcellata
	Macrozamia riedlei
	Moraea flaccida
	Morelotia octandra
*	*Pelargonium capitatum*
	Pigea calycina
	Pimelea rosea
	Sowerbaea laxiflora
	Spyridium globulosum
*	*Ursinia anthemoides*
	Xanthorrhoea brunonis

Vegetation Sample Data
KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q12

Project no.: EP23-018
Date: 28/07/2023 **Status** Non-permanent
Author: TAA,TDP Q12: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	386710.3345	NW corner northing:	6412860.095
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	depression
Time since fire:	> 5 yrs	Disturbance:	moderate - tracks weeds
Soil type/texture	loam/sand with organic layer	Bare ground (%):	1
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	25% (leaves,logs,branches)	Vegetation condition:	degraded - good

Vegetation Sample Data

KARNUP DISTRICT STRUCTURE PLAN

Sample Name: Q12

Project no.: EP23-018
Date: 28/07/2023 **Status** Non-permanent
Author: TAA,TDP

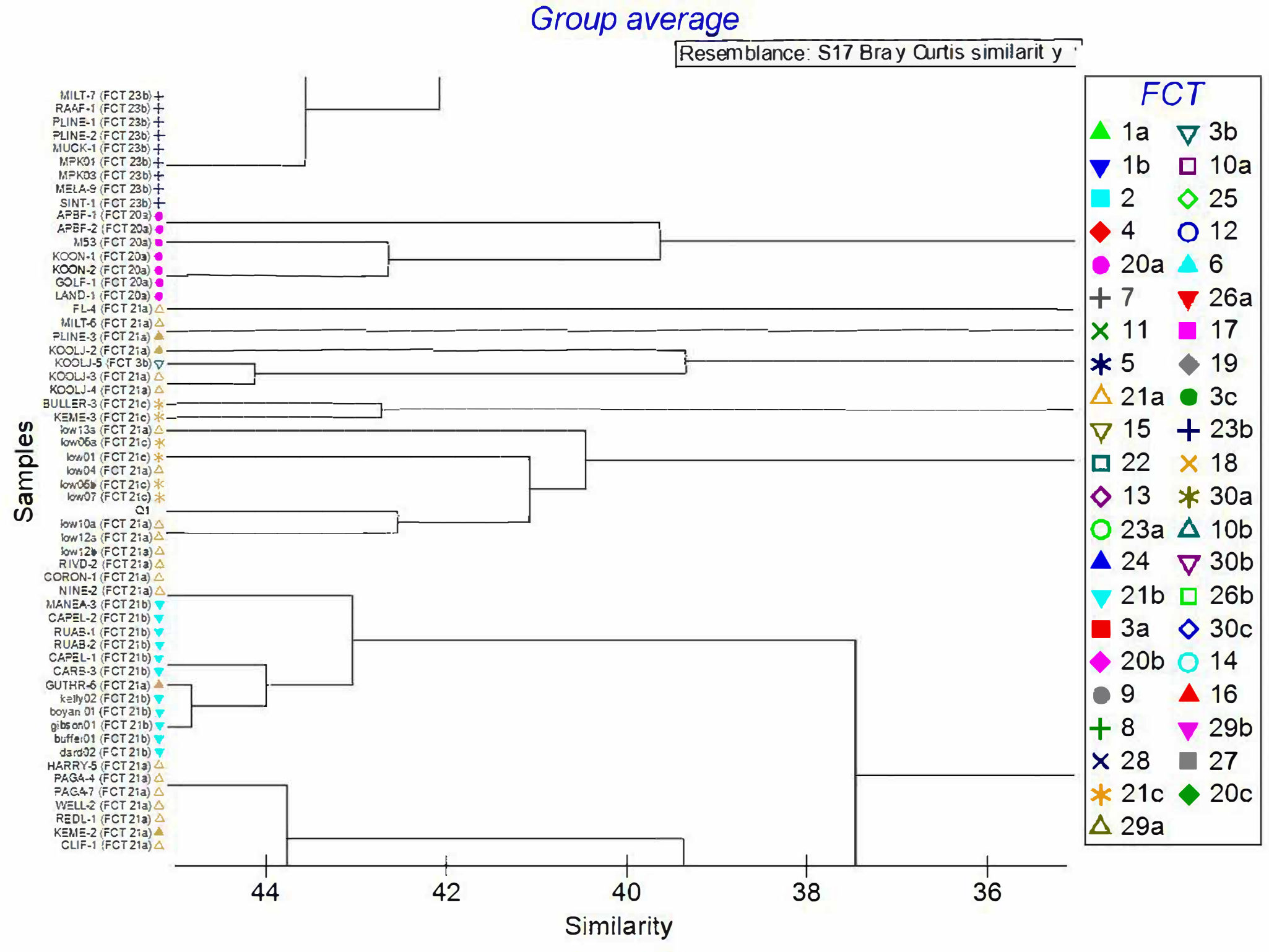
Species Data

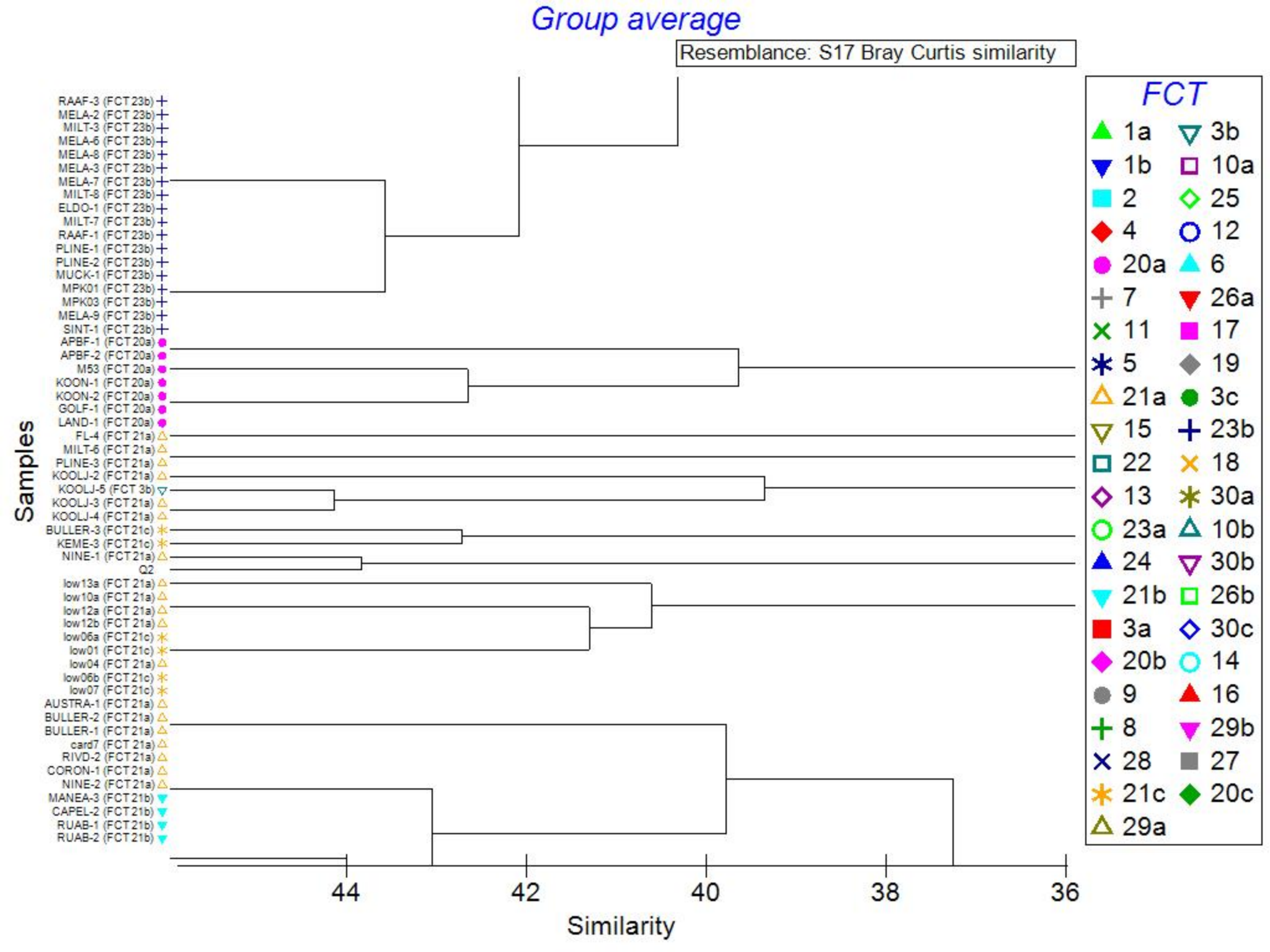
* denotes non-native species

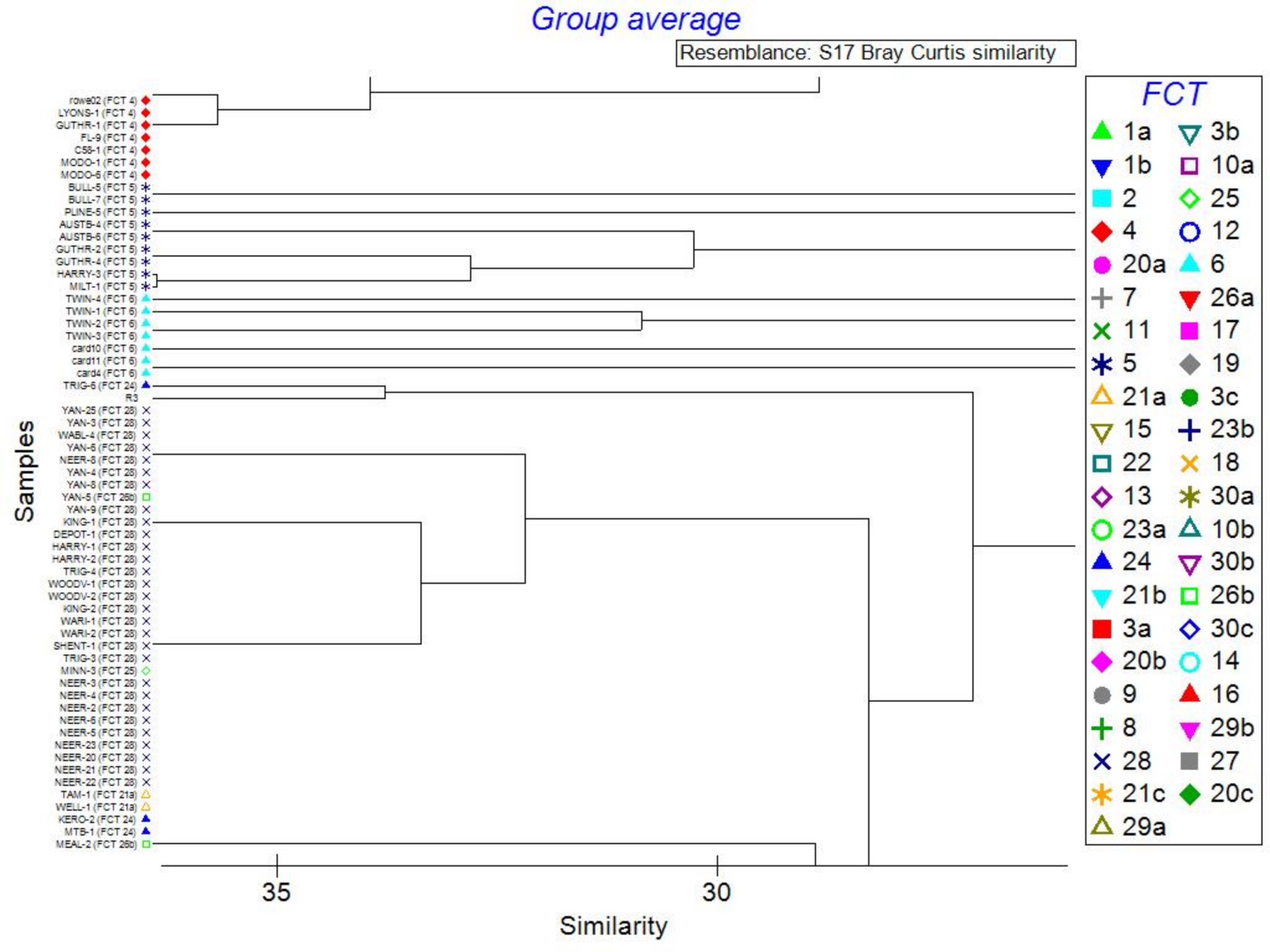
Status	Confirmed name	Cover (%)
	Apium prostratum	2
	Baumea articulata	opp
	Baumea juncea	2
*	*Cenchrus clandestinus*	5
	Centella asiatica	10
	Cirsium vulgare	2
*	*Cuscuta epithymum*	1
*	*Cynodon dactylon*	10
	Eucalyptus gomphocephala	10
	Ficus carica	2
	Gahnia trifida	5
	Hemarthria uncinata	2
	Juncus pallidus	opp
	Lepidosperma longitudinale	10
	Lobelia anceps	opp
	Lobelia anceps	3
	Melaleuca rhaphiophylla	25
*	*Paspalum dilatatum*	5
*	*Schinus terebinthifolia*	5
	Schinus terebinthifolia	opp
*	*Solanum nigrum*	1
	Spyridium globulosum	5

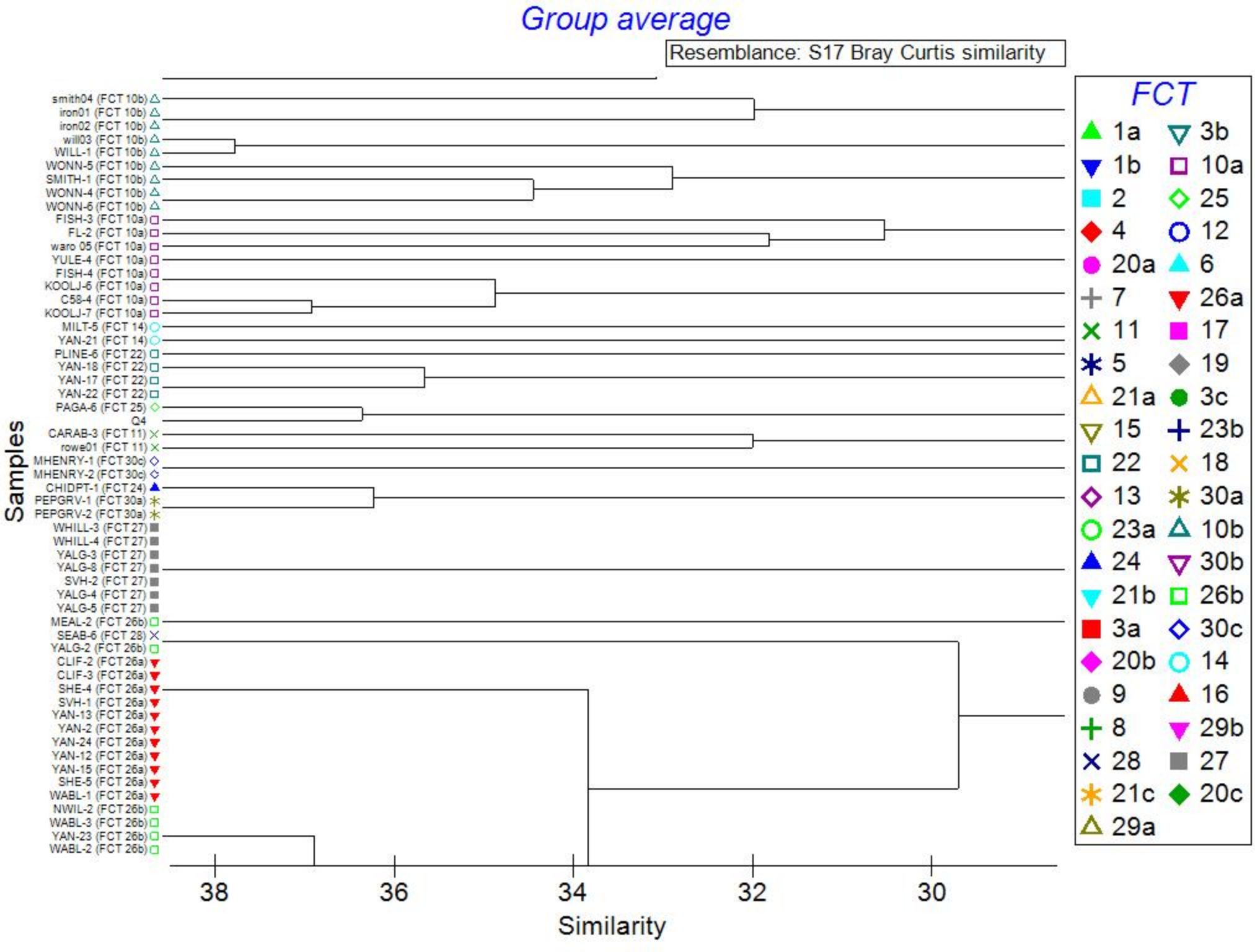
Appendix F

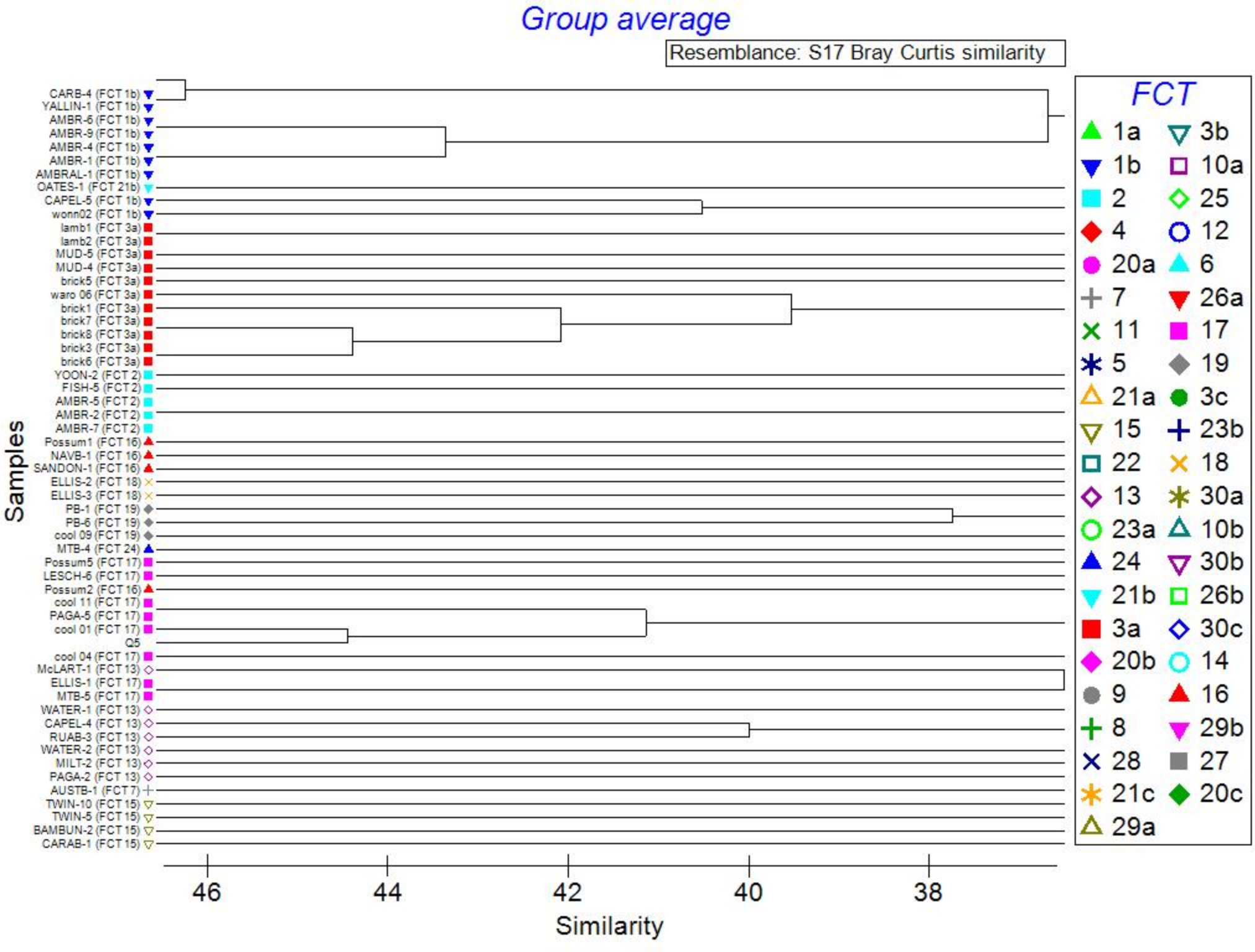
Cluster Dendrograms

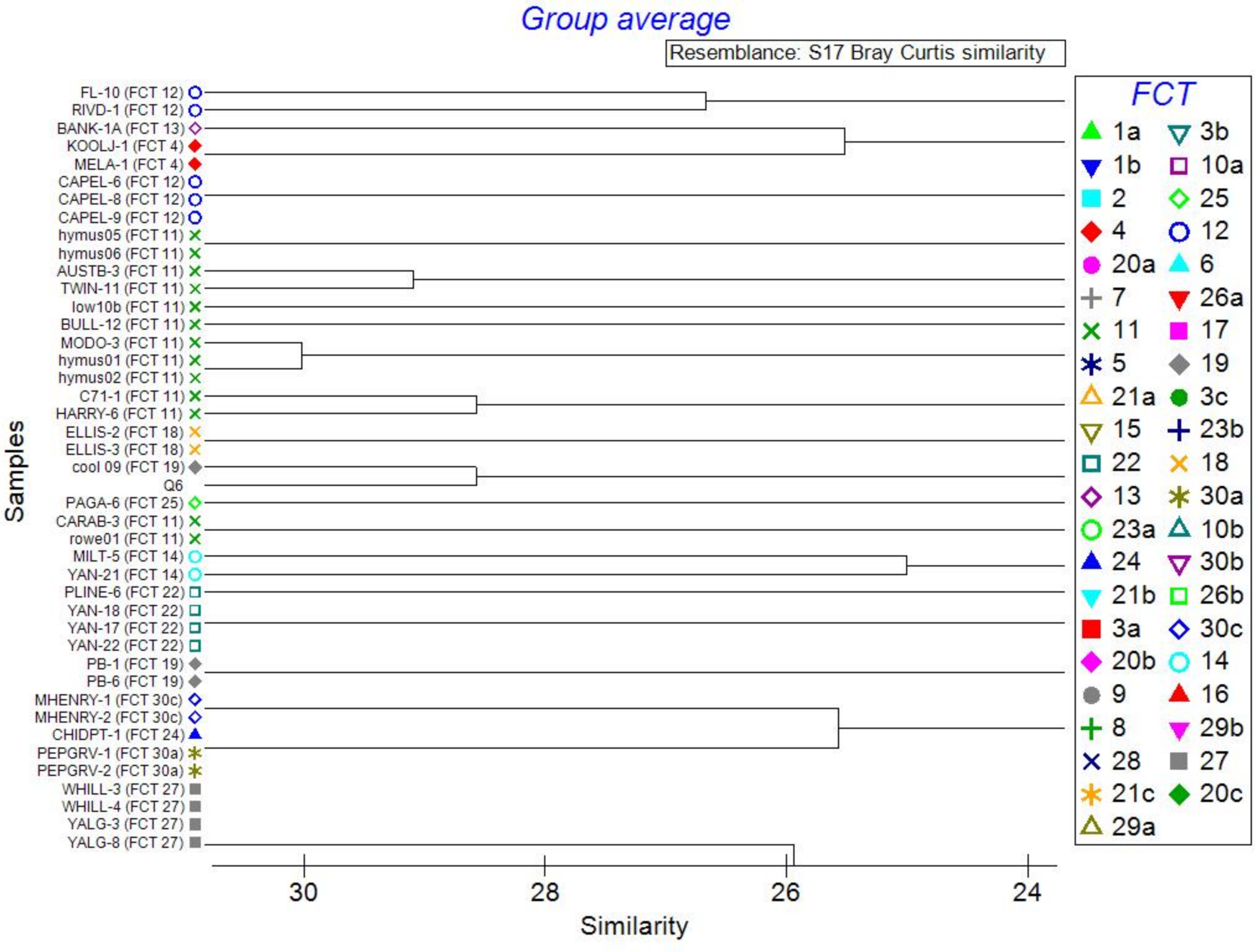

Group average
Resemblance: S17 Bray Curtis similarity
Samples
MILT-7 (FCT 23b)
RAAF-1 (FCT 23b)
PLINE-1 (FCT 23b)
PLINE-2 (FCT 23b)
MUCK-1 (FCT 23b)
MPK01 (FCT 23b)
MPK03 (FCT 23b)
MELA-9 (FCT 23b)
SINT-1 (FCT 23b)
APBF-1 (FCT 20a)
APBF-2 (FCT 20a)
M53 (FCT 20a)
KOON-1 (FCT 20a)
KOON-2 (FCT 20a)
GOLF-1 (FCT 20a)
LAND-1 (FCT 20a)
FL-4 (FCT 21a)
MILT-6 (FCT 21a)
PLINE-3 (FCT 21a)
KOOLJ-2 (FCT 21a)
KOOLJ-5 (FCT 3b)
KOOLJ-3 (FCT 21a)
KOOLJ-4 (FCT 21a)
BULLER-3 (FCT 21c)
KEME-3 (FCT 21c)
low13a (FCT 21a)
low06a (FCT 21c)
low01 (FCT 21c)
low04 (FCT 21a)
low06b (FCT 21c)
low07 (FCT 21c)
Q1
low10a (FCT 21a)
low12a (FCT 21a)
low12b (FCT 21a)
RIVD-2 (FCT 21a)
CORON-1 (FCT 21a)
NINE-2 (FCT 21a)
MANEA-3 (FCT 21b)
CAPEL-2 (FCT 21b)
RUAB-1 (FCT 21b)
RUAB-2 (FCT 21b)
CAPEL-1 (FCT 21b)
CARB-3 (FCT 21b)
GUTHR-6 (FCT 21a)
kelly02 (FCT 21b)
boyan 01 (FCT 21b)
gibson01 (FCT 21b)
buffer01 (FCT 21b)
dard02 (FCT 21b)
HARRY-5 (FCT 21a)
PAGA-4 (FCT 21a)
PAGA-7 (FCT 21a)
WELL-2 (FCT 21a)
REDL-1 (FCT 21a)
KEME-2 (FCT 21a)
CLIF-1 (FCT 21a)
44
42
40
38
36
Similarity
FCT
1a
3b
1b
10a
2
25
4
12
20a
6
7
26a
11
17
5
19
21a
3c
15
23b
22
18
13
30a
23a
10b
24
30b
21b
26b
3a
30c
20b
14
9
16
8
29b
28
27
21c
20c
29a

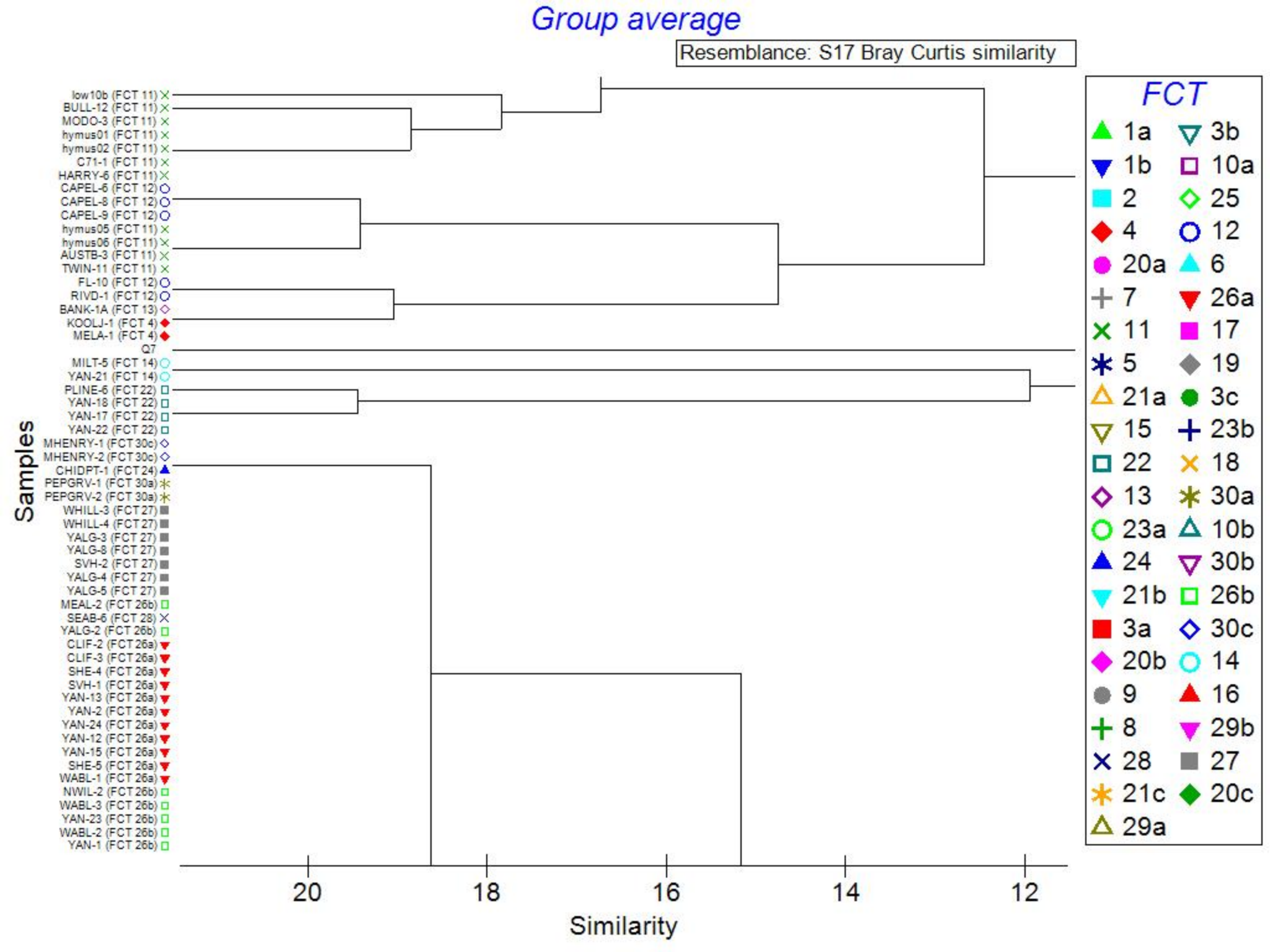

Group average
Resemblance: S17 Bray Curtis similarity
Samples
RAAF-3 (FCT 23b)
MELA-2 (FCT 23b)
MILT-3 (FCT 23b)
MELA-6 (FCT 23b)
MELA-8 (FCT 23b)
MELA-3 (FCT 23b)
MELA-7 (FCT 23b)
MILT-8 (FCT 23b)
ELDO-1 (FCT 23b)
MILT-7 (FCT 23b)
RAAF-1 (FCT 23b)
PLINE-1 (FCT 23b)
PLINE-2 (FCT 23b)
MUCK-1 (FCT 23b)
MPK01 (FCT 23b)
MPK03 (FCT 23b)
MELA-9 (FCT 23b)
SINT-1 (FCT 23b)
APBF-1 (FCT 20a)
APBF-2 (FCT 20a)
M53 (FCT 20a)
KOON-1 (FCT 20a)
KOON-2 (FCT 20a)
GOLF-1 (FCT 20a)
LAND-1 (FCT 20a)
FL-4 (FCT 21a)
MILT-6 (FCT 21a)
PLINE-3 (FCT 21a)
KOOLJ-2 (FCT 21a)
KOOLJ-5 (FCT 3b)
KOOLJ-3 (FCT 21a)
KOOLJ-4 (FCT 21a)
BULLER-3 (FCT 21c)
KEME-3 (FCT 21c)
NINE-1 (FCT 21a)
Q2
low13a (FCT 21a)
low10a (FCT 21a)
low12a (FCT 21a)
low12b (FCT 21a)
low06a (FCT 21c)
low01 (FCT 21c)
low04 (FCT 21a)
low06b (FCT 21c)
low07 (FCT 21c)
AUSTRA-1 (FCT 21a)
BULLER-2 (FCT 21a)
BULLER-1 (FCT 21a)
card7 (FCT 21a)
RIVD-2 (FCT 21a)
CORON-1 (FCT 21a)
NINE-2 (FCT 21a)
MANEA-3 (FCT 21b)
CAPEL-2 (FCT 21b)
RUAB-1 (FCT 21b)
RUAB-2 (FCT 21b)
44
42
40
38
36
Similarity
FCT
1a
3b
1b
10a
2
25
4
12
20a
6
7
26a
11
17
5
19
21a
3c
15
23b
22
18
13
30a
23a
10b
24
30b
21b
26b
3a
30c
20b
14
9
16
8
29b
28
27
21c
20c
29a

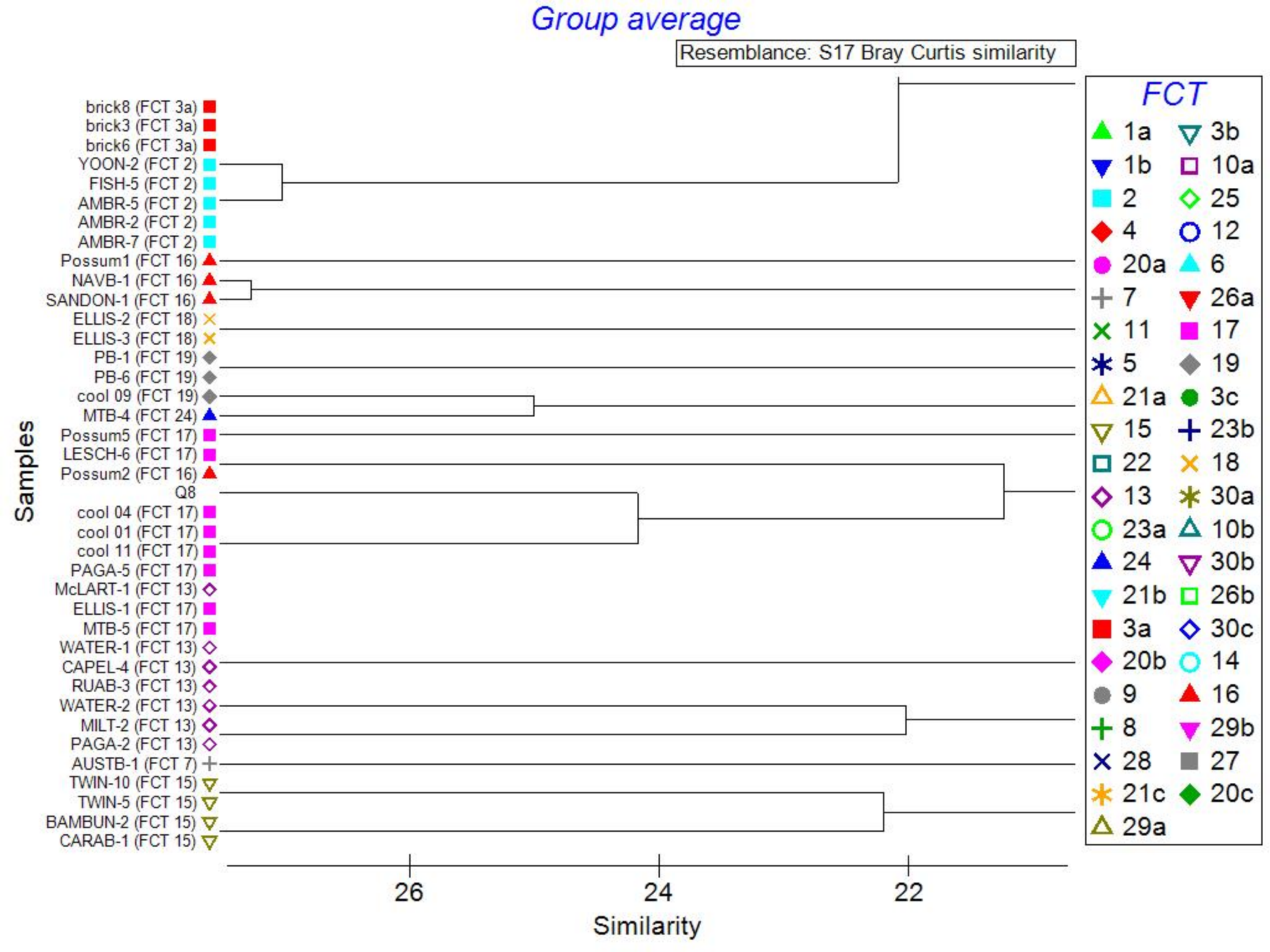

Group average
Resemblance: S17 Bray Curtis similarity
rowe02 (FCT 4)
LYONS-1 (FCT 4)
GUTHR-1 (FCT 4)
FL-9 (FCT 4)
C58-1 (FCT 4)
MODO-1 (FCT 4)
MODO-6 (FCT 4)
BULL-5 (FCT 5)
BULL-7 (FCT 5)
PLINE-5 (FCT 5)
AUSTB-4 (FCT 5)
AUSTB-6 (FCT 5)
GUTHR-2 (FCT 5)
GUTHR-4 (FCT 5)
HARRY-3 (FCT 5)
MILT-1 (FCT 5)
TWIN-4 (FCT 6)
TWIN-1 (FCT 6)
TWIN-2 (FCT 6)
TWIN-3 (FCT 6)
card10 (FCT 6)
card11 (FCT 6)
card4 (FCT 6)
TRIG-6 (FCT 24)
R3
YAN-25 (FCT 28)
YAN-3 (FCT 28)
WABL-4 (FCT 28)
YAN-6 (FCT 28)
NEER-8 (FCT 28)
YAN-4 (FCT 28)
YAN-8 (FCT 28)
YAN-5 (FCT 26b)
YAN-9 (FCT 28)
KING-1 (FCT 28)
DEPOT-1 (FCT 28)
HARRY-1 (FCT 28)
HARRY-2 (FCT 28)
TRIG-4 (FCT 28)
WOODV-1 (FCT 28)
WOODV-2 (FCT 28)
KING-2 (FCT 28)
WARI-1 (FCT 28)
WARI-2 (FCT 28)
SHENT-1 (FCT 28)
TRIG-3 (FCT 28)
MINN-3 (FCT 25)
NEER-3 (FCT 28)
NEER-4 (FCT 28)
NEER-2 (FCT 28)
NEER-6 (FCT 28)
NEER-5 (FCT 28)
NEER-23 (FCT 28)
NEER-20 (FCT 28)
NEER-21 (FCT 28)
NEER-22 (FCT 28)
TAM-1 (FCT 21a)
WELL-1 (FCT 21a)
KERO-2 (FCT 24)
MTB-1 (FCT 24)
MEAL-2 (FCT 26b)
Samples
35
30
Similarity
FCT
1a
3b
1b
10a
2
25
4
12
20a
6
7
26a
11
17
5
19
21a
3c
15
23b
22
18
13
30a
23a
10b
24
30b
21b
26b
3a
30c
20b
14
9
16
8
29b
28
27
21c
20c
29a

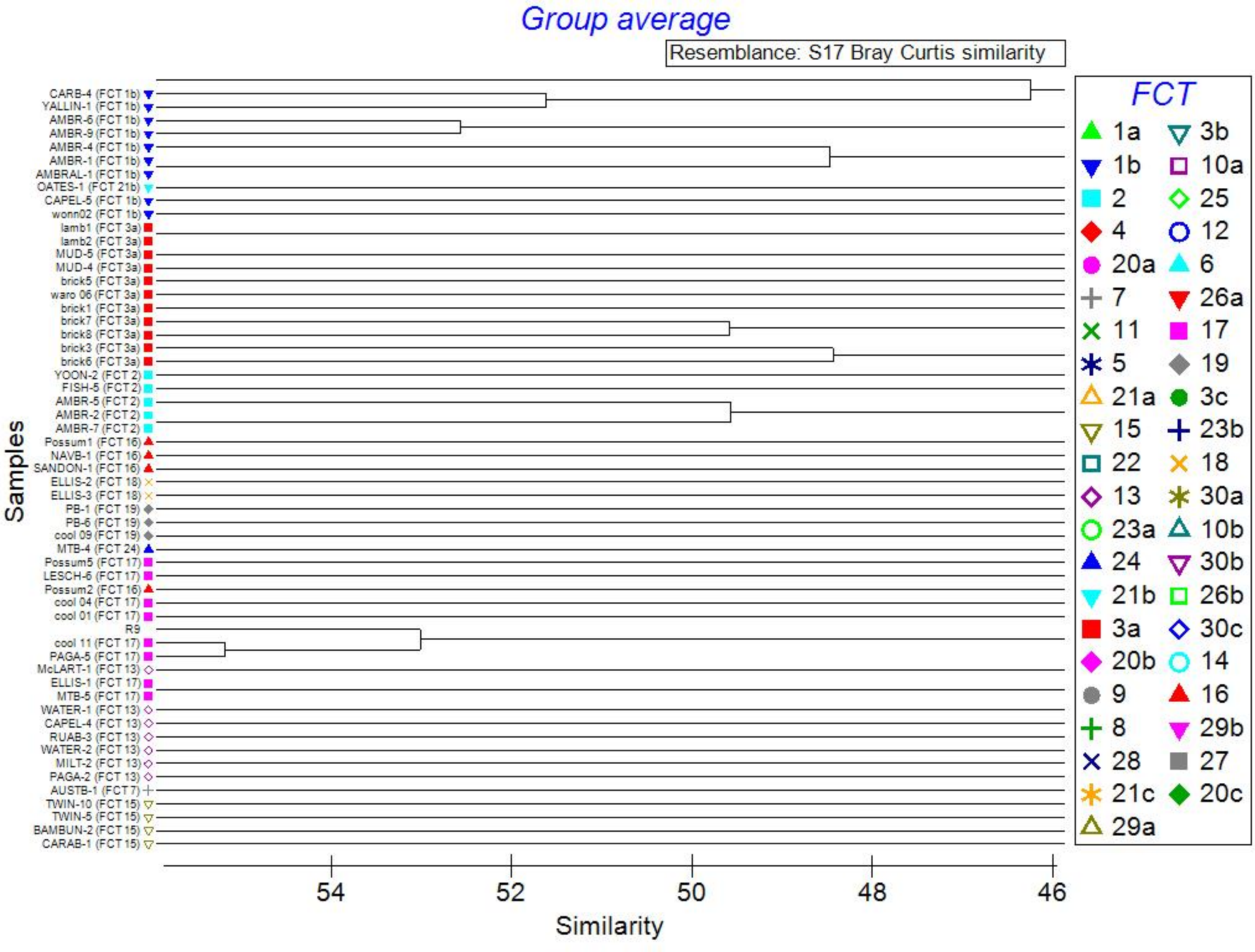

Group average
Resemblance: S17 Bray Curtis similarity
smith04 (FCT 10b)
iron01 (FCT 10b)
iron02 (FCT 10b)
will03 (FCT 10b)
WILL-1 (FCT 10b)
WONN-5 (FCT 10b)
SMITH-1 (FCT 10b)
WONN-4 (FCT 10b)
WONN-6 (FCT 10b)
FISH-3 (FCT 10a)
FL-2 (FCT 10a)
waro 05 (FCT 10a)
YULE-4 (FCT 10a)
FISH-4 (FCT 10a)
KOOLJ-6 (FCT 10a)
C58-4 (FCT 10a)
KOOLJ-7 (FCT 10a)
MILT-5 (FCT 14)
YAN-21 (FCT 14)
PLINE-6 (FCT 22)
YAN-18 (FCT 22)
YAN-17 (FCT 22)
YAN-22 (FCT 22)
PAGA-6 (FCT 25)
Q4
CARAB-3 (FCT 11)
rowe01 (FCT 11)
MHENRY-1 (FCT 30c)
MHENRY-2 (FCT 30c)
CHIDPT-1 (FCT 24)
PEPGRV-1 (FCT 30a)
PEPGRV-2 (FCT 30a)
WHILL-3 (FCT 27)
WHILL-4 (FCT 27)
YALG-3 (FCT 27)
YALG-8 (FCT 27)
SVH-2 (FCT 27)
YALG-4 (FCT 27)
YALG-5 (FCT 27)
MEAL-2 (FCT 26b)
SEAB-6 (FCT 28)
YALG-2 (FCT 26b)
CLIF-2 (FCT 26a)
CLIF-3 (FCT 26a)
SHE-4 (FCT 26a)
SVH-1 (FCT 26a)
YAN-13 (FCT 26a)
YAN-2 (FCT 26a)
YAN-24 (FCT 26a)
YAN-12 (FCT 26a)
YAN-15 (FCT 26a)
SHE-5 (FCT 26a)
WABL-1 (FCT 26a)
NWIL-2 (FCT 26b)
WABL-3 (FCT 26b)
YAN-23 (FCT 26b)
WABL-2 (FCT 26b)
Samples
38
36
34
32
30
Similarity
FCT
1a
3b
1b
10a
2
25
4
12
20a
6
7
26a
11
17
5
19
21a
3c
15
23b
22
18
13
30a
23a
10b
24
30b
21b
26b
3a
30c
20b
14
9
16
8
29b
28
27
21c
20c
29a

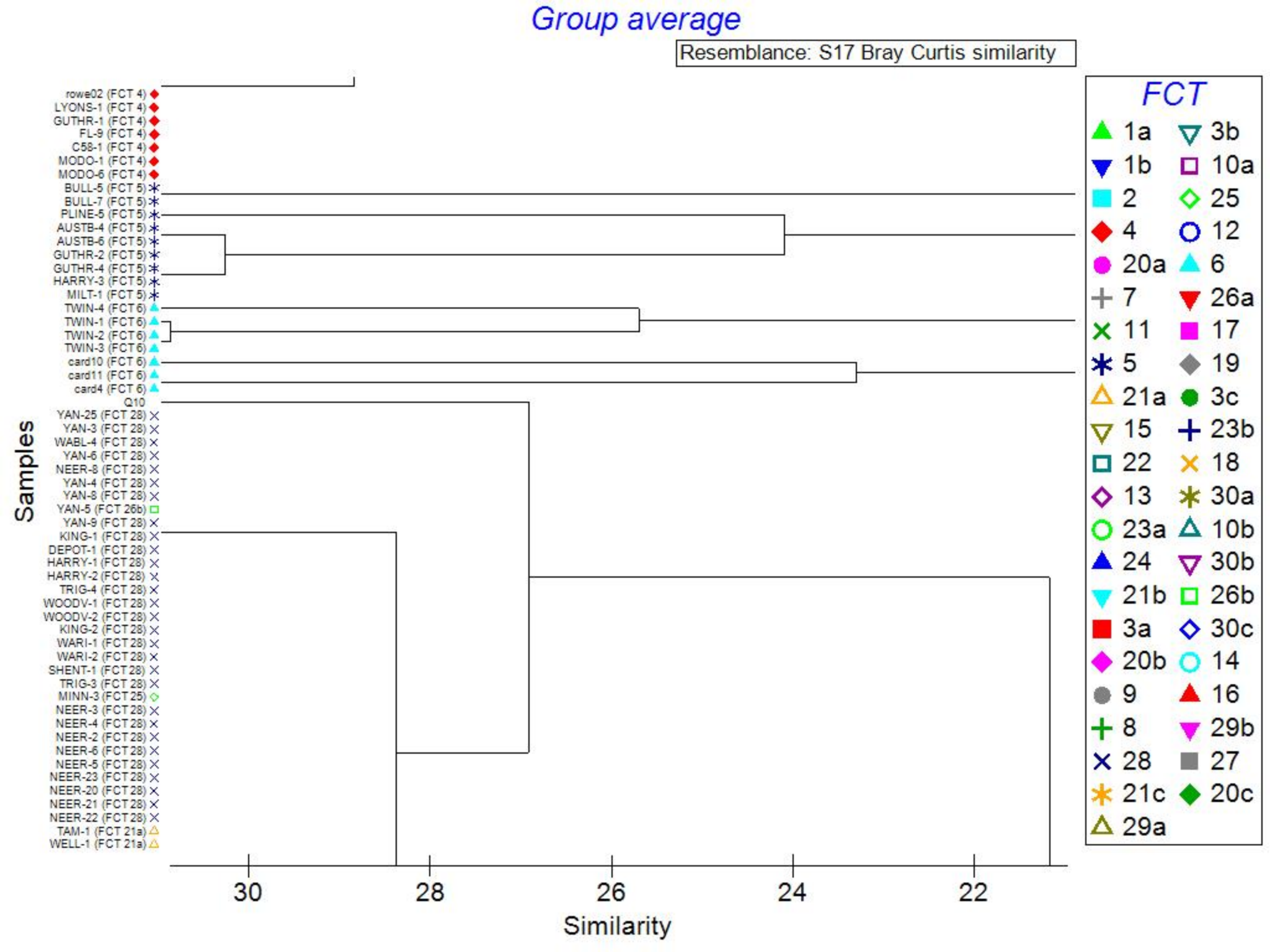

Group average
Resemblance: S17 Bray Curtis similarity
CARB-4 (FCT 1b)
YALLIN-1 (FCT 1b)
AMBR-6 (FCT 1b)
AMBR-9 (FCT 1b)
AMBR-4 (FCT 1b)
AMBR-1 (FCT 1b)
AMBRAL-1 (FCT 1b)
OATES-1 (FCT 21b)
CAPEL-5 (FCT 1b)
wonn02 (FCT 1b)
lamb1 (FCT 3a)
lamb2 (FCT 3a)
MUD-5 (FCT 3a)
MUD-4 (FCT 3a)
brick5 (FCT 3a)
waro 06 (FCT 3a)
brick1 (FCT 3a)
brick7 (FCT 3a)
brick8 (FCT 3a)
brick3 (FCT 3a)
brick6 (FCT 3a)
YOON-2 (FCT 2)
FISH-5 (FCT 2)
AMBR-5 (FCT 2)
AMBR-2 (FCT 2)
AMBR-7 (FCT 2)
Possum1 (FCT 16)
NAVB-1 (FCT 16)
SANDON-1 (FCT 16)
ELLIS-2 (FCT 18)
ELLIS-3 (FCT 18)
PB-1 (FCT 19)
PB-6 (FCT 19)
cool 09 (FCT 19)
MTB-4 (FCT 24)
Possum5 (FCT 17)
LESCH-6 (FCT 17)
Possum2 (FCT 16)
cool 11 (FCT 17)
PAGA-5 (FCT 17)
cool 01 (FCT 17)
Q5
cool 04 (FCT 17)
McLART-1 (FCT 13)
ELLIS-1 (FCT 17)
MTB-5 (FCT 17)
WATER-1 (FCT 13)
CAPEL-4 (FCT 13)
RUAB-3 (FCT 13)
WATER-2 (FCT 13)
MILT-2 (FCT 13)
PAGA-2 (FCT 13)
AUSTB-1 (FCT 7)
TWIN-10 (FCT 15)
TWIN-5 (FCT 15)
BAMBUN-2 (FCT 15)
CARAB-1 (FCT 15)
Samples
46
44
42
40
38
Similarity
FCT
1a
1b
2
4
20a
7
11
5
21a
15
22
13
23a
24
21b
3a
20b
9
8
28
21c
29a
3b
10a
25
12
6
26a
17
19
3c
23b
18
30a
10b
30b
26b
30c
14
16
29b
27
20c

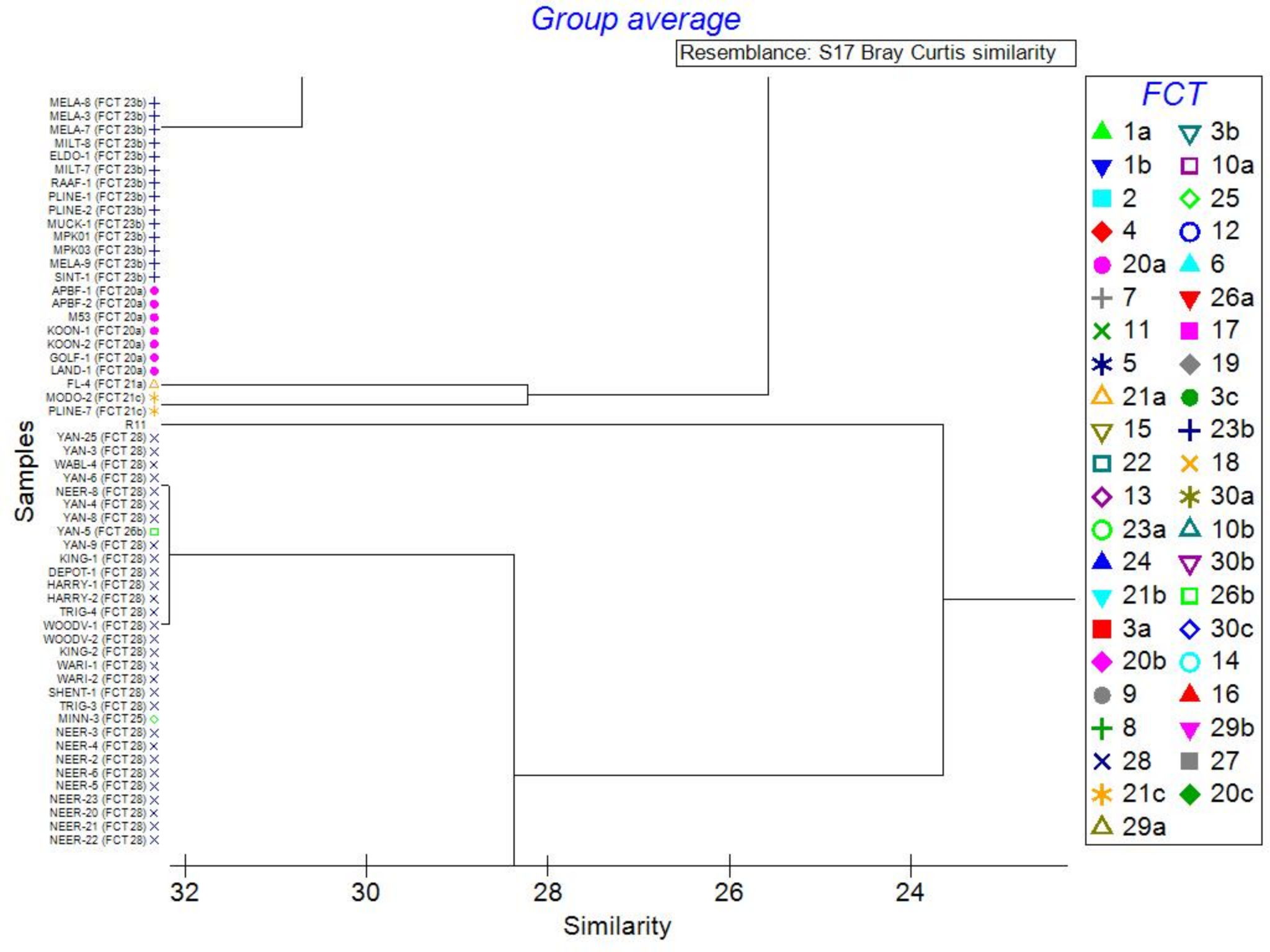

Group average
Resemblance: S17 Bray Curtis similarity
FL-10 (FCT 12)
RIVD-1 (FCT 12)
BANK-1A (FCT 13)
KOOLJ-1 (FCT 4)
MELA-1 (FCT 4)
CAPEL-6 (FCT 12)
CAPEL-8 (FCT 12)
CAPEL-9 (FCT 12)
hymus05 (FCT 11)
hymus06 (FCT 11)
AUSTB-3 (FCT 11)
TWIN-11 (FCT 11)
low10b (FCT 11)
BULL-12 (FCT 11)
MODO-3 (FCT 11)
hymus01 (FCT 11)
hymus02 (FCT 11)
C71-1 (FCT 11)
HARRY-6 (FCT 11)
ELLIS-2 (FCT 18)
ELLIS-3 (FCT 18)
cool 09 (FCT 19)
Q6
PAGA-6 (FCT 25)
CARAB-3 (FCT 11)
rowe01 (FCT 11)
MILT-5 (FCT 14)
YAN-21 (FCT 14)
PLINE-6 (FCT 22)
YAN-18 (FCT 22)
YAN-17 (FCT 22)
YAN-22 (FCT 22)
PB-1 (FCT 19)
PB-6 (FCT 19)
MHENRY-1 (FCT 30c)
MHENRY-2 (FCT 30c)
CHIDPT-1 (FCT 24)
PEPGRV-1 (FCT 30a)
PEPGRV-2 (FCT 30a)
WHILL-3 (FCT 27)
WHILL-4 (FCT 27)
YALG-3 (FCT 27)
YALG-8 (FCT 27)
Samples
30
28
26
24
Similarity
FCT
1a
3b
1b
10a
2
25
4
12
20a
6
7
26a
11
17
5
19
21a
3c
15
23b
22
18
13
30a
23a
10b
24
30b
21b
26b
3a
30c
20b
14
9
16
8
29b
28
27
21c
20c
29a

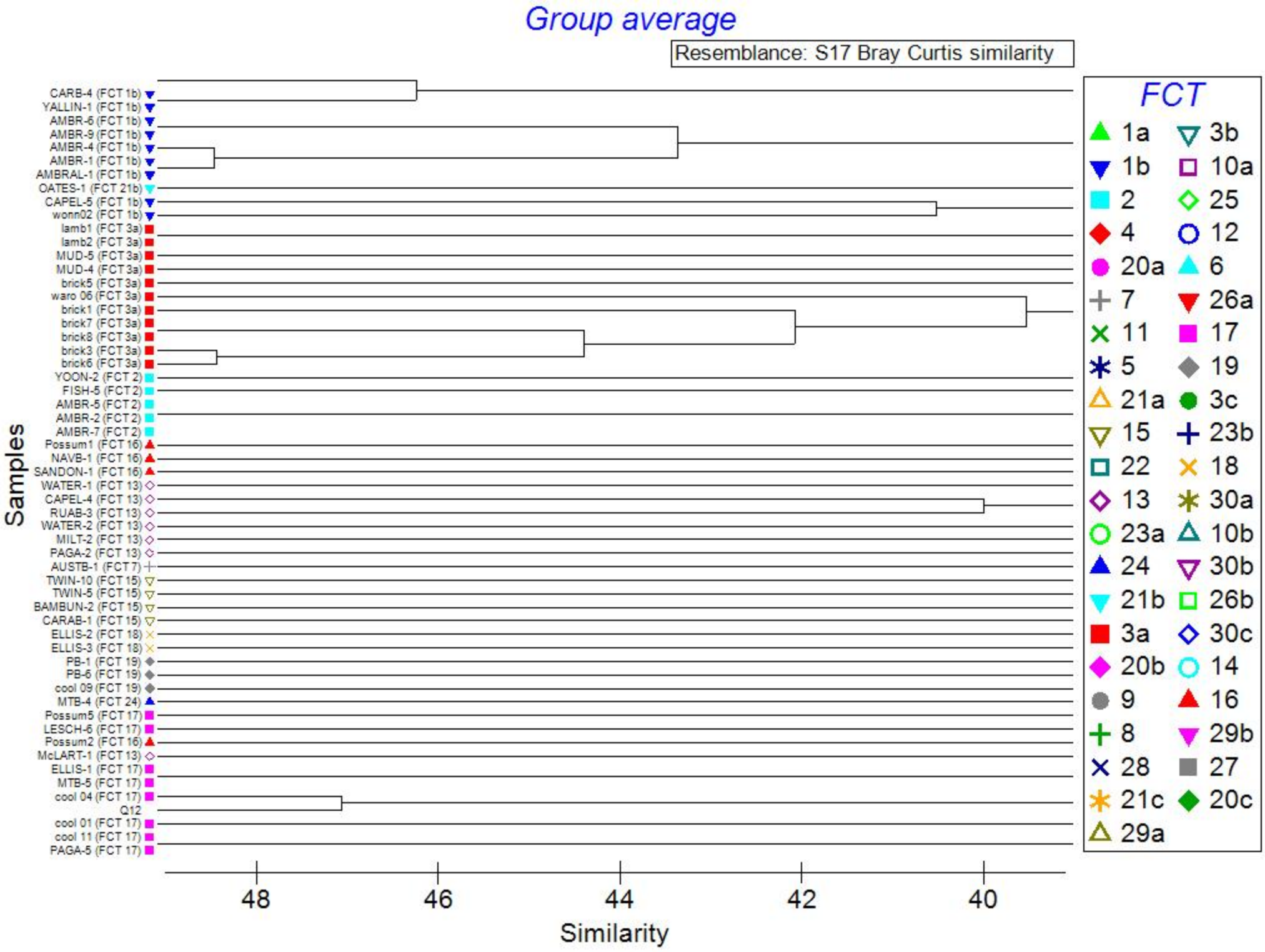

Group average
Resemblance: S17 Bray Curtis similarity
low10b (FCT 11)
BULL-12 (FCT 11)
MODO-3 (FCT 11)
hymus01 (FCT 11)
hymus02 (FCT 11)
C71-1 (FCT 11)
HARRY-6 (FCT 11)
CAPEL-6 (FCT 12)
CAPEL-8 (FCT 12)
CAPEL-9 (FCT 12)
hymus05 (FCT 11)
hymus06 (FCT 11)
AUSTB-3 (FCT 11)
TWIN-11 (FCT 11)
FL-10 (FCT 12)
RIVD-1 (FCT 12)
BANK-1A (FCT 13)
KOOLJ-1 (FCT 4)
MELA-1 (FCT 4)
Q7
MILT-5 (FCT 14)
YAN-21 (FCT 14)
PLINE-6 (FCT 22)
YAN-18 (FCT 22)
YAN-17 (FCT 22)
YAN-22 (FCT 22)
MHENRY-1 (FCT 30c)
MHENRY-2 (FCT 30c)
CHIDPT-1 (FCT 24)
PEPGRV-1 (FCT 30a)
PEPGRV-2 (FCT 30a)
WHILL-3 (FCT 27)
WHILL-4 (FCT 27)
YALG-3 (FCT 27)
YALG-8 (FCT 27)
SVH-2 (FCT 27)
YALG-4 (FCT 27)
YALG-5 (FCT 27)
MEAL-2 (FCT 26b)
SEAB-6 (FCT 28)
YALG-2 (FCT 26b)
CLIF-2 (FCT 26a)
CLIF-3 (FCT 26a)
SHE-4 (FCT 26a)
SVH-1 (FCT 26a)
YAN-13 (FCT 26a)
YAN-2 (FCT 26a)
YAN-24 (FCT 26a)
YAN-12 (FCT 26a)
YAN-15 (FCT 26a)
SHE-5 (FCT 26a)
WABL-1 (FCT 26a)
NWIL-2 (FCT 26b)
WABL-3 (FCT 26b)
YAN-23 (FCT 26b)
WABL-2 (FCT 26b)
YAN-1 (FCT 26b)
Samples
20
18
16
14
12
Similarity
FCT
1a
3b
1b
10a
2
25
4
12
20a
6
7
26a
11
17
5
19
21a
3c
15
23b
22
18
13
30a
23a
10b
24
30b
21b
26b
3a
30c
20b
14
9
16
8
29b
28
27
21c
20c
29a


Group average
Resemblance: S17 Bray Curtis similarity
brick8 (FCT 3a)
brick3 (FCT 3a)
brick6 (FCT 3a)
YOON-2 (FCT 2)
FISH-5 (FCT 2)
AMBR-5 (FCT 2)
AMBR-2 (FCT 2)
AMBR-7 (FCT 2)
Possum1 (FCT 16)
NAVB-1 (FCT 16)
SANDON-1 (FCT 16)
ELLIS-2 (FCT 18)
ELLIS-3 (FCT 18)
PB-1 (FCT 19)
PB-6 (FCT 19)
cool 09 (FCT 19)
MTB-4 (FCT 24)
Possum5 (FCT 17)
LESCH-6 (FCT 17)
Possum2 (FCT 16)
Q8
cool 04 (FCT 17)
cool 01 (FCT 17)
cool 11 (FCT 17)
PAGA-5 (FCT 17)
McLART-1 (FCT 13)
ELLIS-1 (FCT 17)
MTB-5 (FCT 17)
WATER-1 (FCT 13)
CAPEL-4 (FCT 13)
RUAB-3 (FCT 13)
WATER-2 (FCT 13)
MILT-2 (FCT 13)
PAGA-2 (FCT 13)
AUSTB-1 (FCT 7)
TWIN-10 (FCT 15)
TWIN-5 (FCT 15)
BAMBUN-2 (FCT 15)
CARAB-1 (FCT 15)
Samples
26
24
22
Similarity
FCT
1a
3b
1b
10a
2
25
4
12
20a
6
7
26a
11
17
5
19
21a
3c
15
23b
22
18
13
30a
23a
10b
24
30b
21b
26b
3a
30c
20b
14
9
16
8
29b
28
27
21c
20c
29a


Group average
Resemblance: S17 Bray Curtis similarity
CARB-4 (FCT 1b)
YALLIN-1 (FCT 1b)
AMBR-6 (FCT 1b)
AMBR-9 (FCT 1b)
AMBR-4 (FCT 1b)
AMBR-1 (FCT 1b)
AMBRAL-1 (FCT 1b)
OATES-1 (FCT 21b)
CAPEL-5 (FCT 1b)
wonn02 (FCT 1b)
lamb1 (FCT 3a)
lamb2 (FCT 3a)
MUD-5 (FCT 3a)
MUD-4 (FCT 3a)
brick5 (FCT 3a)
waro 06 (FCT 3a)
brick1 (FCT 3a)
brick7 (FCT 3a)
brick8 (FCT 3a)
brick3 (FCT 3a)
brick6 (FCT 3a)
YOON-2 (FCT 2)
FISH-5 (FCT 2)
AMBR-5 (FCT 2)
AMBR-2 (FCT 2)
AMBR-7 (FCT 2)
Possum1 (FCT 16)
NAVB-1 (FCT 16)
SANDON-1 (FCT 16)
ELLIS-2 (FCT 18)
ELLIS-3 (FCT 18)
PB-1 (FCT 19)
PB-6 (FCT 19)
cool 09 (FCT 19)
MTB-4 (FCT 24)
Possum5 (FCT 17)
LESCH-6 (FCT 17)
Possum2 (FCT 16)
cool 04 (FCT 17)
cool 01 (FCT 17)
R9
cool 11 (FCT 17)
PAGA-5 (FCT 17)
McLART-1 (FCT 13)
ELLIS-1 (FCT 17)
MTB-5 (FCT 17)
WATER-1 (FCT 13)
CAPEL-4 (FCT 13)
RUAB-3 (FCT 13)
WATER-2 (FCT 13)
MILT-2 (FCT 13)
PAGA-2 (FCT 13)
AUSTB-1 (FCT 7)
TWIN-10 (FCT 15)
TWIN-5 (FCT 15)
BAMBUN-2 (FCT 15)
CARAB-1 (FCT 15)
Samples
54
52
50
48
46
Similarity
FCT
1a
1b
2
4
20a
7
11
5
21a
15
22
13
23a
24
21b
3a
20b
9
8
28
21c
29a
3b
10a
25
12
6
26a
17
19
3c
23b
18
30a
10b
30b
26b
30c
14
16
29b
27
20c


Group average
Resemblance: S17 Bray Curtis similarity
rowe02 (FCT 4)
LYONS-1 (FCT 4)
GUTHR-1 (FCT 4)
FL-9 (FCT 4)
C58-1 (FCT 4)
MODO-1 (FCT 4)
MODO-6 (FCT 4)
BULL-5 (FCT 5)
BULL-7 (FCT 5)
PLINE-5 (FCT 5)
AUSTB-4 (FCT 5)
AUSTB-6 (FCT 5)
GUTHR-2 (FCT 5)
GUTHR-4 (FCT 5)
HARRY-3 (FCT 5)
MILT-1 (FCT 5)
TWIN-4 (FCT 6)
TWIN-1 (FCT 6)
TWIN-2 (FCT 6)
TWIN-3 (FCT 6)
card10 (FCT 6)
card11 (FCT 6)
card4 (FCT 6)
Q10
YAN-25 (FCT 28)
YAN-3 (FCT 28)
WABL-4 (FCT 28)
YAN-6 (FCT 28)
NEER-8 (FCT 28)
YAN-4 (FCT 28)
YAN-8 (FCT 28)
YAN-5 (FCT 26b)
YAN-9 (FCT 28)
KING-1 (FCT 28)
DEPOT-1 (FCT 28)
HARRY-1 (FCT 28)
HARRY-2 (FCT 28)
TRIG-4 (FCT 28)
WOODV-1 (FCT 28)
WOODV-2 (FCT 28)
KING-2 (FCT 28)
WARI-1 (FCT 28)
WARI-2 (FCT 28)
SHENT-1 (FCT 28)
TRIG-3 (FCT 28)
MINN-3 (FCT 25)
NEER-3 (FCT 28)
NEER-4 (FCT 28)
NEER-2 (FCT 28)
NEER-6 (FCT 28)
NEER-5 (FCT 28)
NEER-23 (FCT 28)
NEER-20 (FCT 28)
NEER-21 (FCT 28)
NEER-22 (FCT 28)
TAM-1 (FCT 21a)
WELL-1 (FCT 21a)
Samples
30
28
26
24
22
Similarity
FCT
1a
3b
1b
10a
2
25
4
12
20a
6
7
26a
11
17
5
19
21a
3c
15
23b
22
18
13
30a
23a
10b
24
30b
21b
26b
3a
30c
20b
14
9
16
8
29b
28
27
21c
20c
29a


Group average
Resemblance: S17 Bray Curtis similarity
MELA-8 (FCT 23b)
MELA-3 (FCT 23b)
MELA-7 (FCT 23b)
MILT-8 (FCT 23b)
ELDO-1 (FCT 23b)
MILT-7 (FCT 23b)
RAAF-1 (FCT 23b)
PLINE-1 (FCT 23b)
PLINE-2 (FCT 23b)
MUCK-1 (FCT 23b)
MPK01 (FCT 23b)
MPK03 (FCT 23b)
MELA-9 (FCT 23b)
SINT-1 (FCT 23b)
APBF-1 (FCT 20a)
APBF-2 (FCT 20a)
M53 (FCT 20a)
KOON-1 (FCT 20a)
KOON-2 (FCT 20a)
GOLF-1 (FCT 20a)
LAND-1 (FCT 20a)
FL-4 (FCT 21a)
MODO-2 (FCT 21c)
PLINE-7 (FCT 21c)
R11
YAN-25 (FCT 28)
YAN-3 (FCT 28)
WABL-4 (FCT 28)
YAN-6 (FCT 28)
NEER-8 (FCT 28)
YAN-4 (FCT 28)
YAN-8 (FCT 28)
YAN-5 (FCT 26b)
YAN-9 (FCT 28)
KING-1 (FCT 28)
DEPOT-1 (FCT 28)
HARRY-1 (FCT 28)
HARRY-2 (FCT 28)
TRIG-4 (FCT 28)
WOODV-1 (FCT 28)
WOODV-2 (FCT 28)
KING-2 (FCT 28)
WARI-1 (FCT 28)
WARI-2 (FCT 28)
SHENT-1 (FCT 28)
TRIG-3 (FCT 28)
MINN-3 (FCT 25)
NEER-3 (FCT 28)
NEER-4 (FCT 28)
NEER-2 (FCT 28)
NEER-6 (FCT 28)
NEER-5 (FCT 28)
NEER-23 (FCT 28)
NEER-20 (FCT 28)
NEER-21 (FCT 28)
NEER-22 (FCT 28)
Samples
32
30
28
26
24
Similarity
FCT
1a
3b
1b
10a
2
25
4
12
20a
6
7
26a
11
17
5
19
21a
3c
15
23b
22
18
13
30a
23a
10b
24
30b
21b
26b
3a
30c
20b
14
9
16
8
29b
28
27
21c
20c
29a


Group average
Resemblance: S17 Bray Curtis similarity
CARB-4 (FCT 1b)
YALLIN-1 (FCT 1b)
AMBR-6 (FCT 1b)
AMBR-9 (FCT 1b)
AMBR-4 (FCT 1b)
AMBR-1 (FCT 1b)
AMBRAL-1 (FCT 1b)
OATES-1 (FCT 21b)
CAPEL-5 (FCT 1b)
wonn02 (FCT 1b)
lamb1 (FCT 3a)
lamb2 (FCT 3a)
MUD-5 (FCT 3a)
MUD-4 (FCT 3a)
brick5 (FCT 3a)
waro 06 (FCT 3a)
brick1 (FCT 3a)
brick7 (FCT 3a)
brick8 (FCT 3a)
brick3 (FCT 3a)
brick6 (FCT 3a)
YOON-2 (FCT 2)
FISH-5 (FCT 2)
AMBR-5 (FCT 2)
AMBR-2 (FCT 2)
AMBR-7 (FCT 2)
Possum1 (FCT 16)
NAVB-1 (FCT 16)
SANDON-1 (FCT 16)
WATER-1 (FCT 13)
CAPEL-4 (FCT 13)
RUAB-3 (FCT 13)
WATER-2 (FCT 13)
MILT-2 (FCT 13)
PAGA-2 (FCT 13)
AUSTB-1 (FCT 7)
TWIN-10 (FCT 15)
TWIN-5 (FCT 15)
BAMBUN-2 (FCT 15)
CARAB-1 (FCT 15)
ELLIS-2 (FCT 18)
ELLIS-3 (FCT 18)
PB-1 (FCT 19)
PB-6 (FCT 19)
cool 09 (FCT 19)
MTB-4 (FCT 24)
Possum5 (FCT 17)
LESCH-6 (FCT 17)
Possum2 (FCT 16)
McLART-1 (FCT 13)
ELLIS-1 (FCT 17)
MTB-5 (FCT 17)
cool 04 (FCT 17)
Q12
cool 01 (FCT 17)
cool 11 (FCT 17)
PAGA-5 (FCT 17)
Samples
48
46
44
42
40
Similarity
FCT
1a
1b
2
4
20a
7
11
5
21a
15
22
13
23a
24
21b
3a
20b
9
8
28
21c
29a
3b
10a
25
12
6
26a
17
19
3c
23b
18
30a
10b
30b
26b
30c
14
16
29b
27
20c