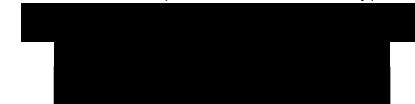


**VEGETATION SURVEY AND SEARCH FOR RARE FLORA
ROADSTONE QUARRY
LOTS 102-104 McLENNAN DRIVE AND GODEL ROAD,
NOWERGUP, CITY OF WANNEROO**

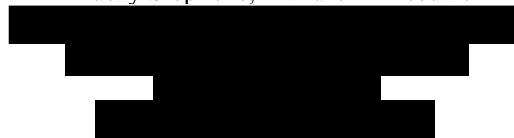


Tuart (*Eucalyptus gomphocephala*) Woodland to Open Forest (**Eg**), behind, and
Perennial Veldtgrass (*Ehrharta calycina*) Closed (to Open) Grassland (**CL**), in front.
Near Waypoint (WP) 961 and western boundary of Lot 104.
Photograph: Pelusey Photography DSC_9137 (50), 16/4/2015

Prepared by
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Prepared for
Lindsay Stephens, Landform Research



27 April 2015

SUMMARY

On 30 April, 14 and 30 May and 6, 11, 13 and 16 June, 2014 botanist Dr A Weston and field assistants surveyed the vegetation of Areas C and D, Roadstone Quarry site, Nowergup, and searched for rare flora there. Areas C and D are adjacent to each other, are in the southern parts of Lots 102 and 103, are south of McLennan Drive and east of Godel Road and are approximately 1 km east-northeast of Lake Nowergup.

On 22 and 31 October 2014 and on 2 March and 16 April 2015 Rd. Weston and assistants surveyed the vegetation of Lot 104 plus parts of Lots 102 and 103. They also searched for rare flora there.

Figure 1 is an aerial photograph showing ten vegetation units with dominants that are native and two with dominants that are not. Shortened names of these units and their assessed conditions [E – Excellent, VG – Very Good, G - Good, D – Degraded, CD – Completely Degraded] are:

Af	E-D	<i>Allocasuarina fraseriana</i> Low Woodland - Open Low Woodland
BC	VG-G	<i>Banksia sessilis</i> Open Tall Scrub – Tall Shrubland over <i>Calothamnus quadrifidus</i> Heaths and Shrublands
BM	E-G	<i>Banksia sessilis</i> Open Tall Scrub – Tall Shrubland, over <i>Melaleuca systema</i> Heaths and Mixed Shrubs
CL	CD	Cleared; assessed condition: Completely Degraded
CL+	CD (-D)	Similar to CL but with more native plants and species
Ed	VG-CD	<i>Eucalyptus decipiens</i> Low Woodland to Open Woodland
Eg	CD(-D)	<i>Eucalyptus gomphocephala</i> Open Forest to Woodland over, mainly, Grasslands to Closed Grasslands of <i>Ehrharta calycina</i> and other alien species
Eg / Em	G-CD	<i>Eucalyptus gomphocephala</i> – <i>E. marginata</i> (mostly dead) Open Forest to Woodland over, mainly, Grasslands to Closed Grasslands of <i>Ehrharta calycina</i> and other alien species
Em	G-D	<i>Eucalyptus marginata</i> (mostly dead) - <i>Allocasuarina fraseriana</i> – <i>Banksia attenuata</i> - <i>Nuytsia floribunda</i> Low Woodland to Open Woodland
M	E	<i>Melaleuca systema</i> Closed to Open Heath over <i>Desmocladius flexuosus</i> Sedgeland to Open Sedgeland (often with <i>Melaleuca huegelii</i> and/or other species of shrubs)
P	CD (-D)	Three pine trees and other, mainly alien, species in part of a cleared area near the north-eastern corner of Lot 102
X	VG-CD	<i>Xanthorrhoea preissii</i> Shrubland to Open Tall Scrub often with <i>Banksia sessilis</i>, <i>Calothamnus quadrifidus</i> or other species of shrubs.

The Floristic Community Types (FCTs) that may be represented in the survey area are, at most, seven: 21a, 23a, 24, 26a, 26b, 27 and 28. It is possible, though unlikely, that the M vegetation east of the centre of Area C is a representation of FCT 26a. Floristically, most of the rest of the survey area is probably FCT 26b, FCT 27 and/or FCT 24.

The Department of Parks and Wildlife (DPaW) (2014a) lists FCT 26a (62. Limestone Ridges SCP 26a) as a Threatened Ecological Community, a listing endorsed by the Western Australian Minister for the Environment. DPaW (2014b) lists FCT 24 as Swan 20. Community Type 24, a Priority 3(i) Ecological

Community. SCPs are more commonly referred to as FCTs and, less commonly, as SCPFCTs and Community Types.

The 168 species and other taxa of vascular plants recorded in the survey area are listed in Appendix B's Table B1. None of the 168 is a Threatened or Priority species or other taxon. But one species, Bridal Creeper (*Asparagus asparagoides*), is a serious environmental weed. A small population of it was found in *Eucalyptus decipiens* Low Woodland in Area C and a few plants of it are in the **Em Vegetation Unit** in the south-western part of Lot 103. Bridal creeper is a Declared Pest in Western Australia and is a Weed of National Significance.

Neither FCT 26a or any other Threatened Ecological Community or species or other taxon of Threatened or Priority Flora was unequivocally identified in the survey area.

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**VEGETATION SURVEY AND SEARCH FOR RARE FLORA
ROADSTONE QUARRY
LOTS 102-104 MCLENNAN DRIVE AND GODEL ROAD,
NOWERGUP, CITY OF WANNEROO**

1.0 INTRODUCTION

On 30 April, 14 and 30 May and 6, 11, 13 and 16 June 2014, botanist A. S. Weston and field assistants surveyed the vegetation of Areas C and D, Roadstone Quarry site, Nowergup, and searched for Threatened and other rare flora there (Weston 2014). Areas C and D are adjacent to each other, are in the southern parts of Lots 102 and 103, are south of McLennan Drive, and are approximately 1 km east-northeast of Lake Nowergup. On 22 and 31 October, 2014 and on 2 March and 16 April, 2015 Dr. Weston and assistants surveyed the vegetation of Lot 104 and parts of Lots 102 and 103, mainly outside Areas C and D, and searched for rare flora there. This report describes the objectives, methods and results of both sets of surveys and searches.

Area D is in Lot 103, which borders Godel Road, and Area C is in Lot 102, on the south side of Lot 101, which borders McLennan Drive. Lots 102-104 are usually referred to in this report as the survey area, especially regarding vegetation, and occasionally as the search area, especially regarding rare flora.

Figure 1 is an aerial photograph of the survey area with boundaries and vegetation units shown on it. Locations of waypoints are also shown on it.

Area C is estimated to comprise approximately 6 ha, Area D is estimated to comprise approximately 3 ha, and the entire survey area is estimated to comprise approximately 66 ha.

The purpose of the survey and searches is to fulfil some of the conditions required for Roadstone Quarries to obtain permission to clear vegetation in parts of the survey area.

2.0 OBJECTIVES

The principal objectives of the vegetation survey are

- to identify, describe and map the vegetation units in the survey area and to assess their condition, and
- to identify the Floristic Community Types (FCTs) in the survey area and assess their significance.

The principal objectives of the flora searches are to find any species of flora there that are classified by the state or federal government as Threatened, Priority or otherwise significant.

3.0 METHODS

Vegetation was surveyed and rare flora plants searched for on 30 April, 14 and 30 May, 6, 11, 13 and 16 June, and 22 and 31 October, 2014 and on 2 March, 2015. J Leithead, E Mueller, G Owen, M Owen, M Pelusey, N Segal and P Spriggins each assisted Dr Weston on one or more of those dates.

3.1 VEGETATION UNITS

The dominant species, crown density of at least the tallest stratum of vegetation and assessed condition of vegetation units were recorded while surveying in the survey area (see Section 4 below, Figure 1 and Appendix E).

3.2 FLORISTIC COMMUNITY TYPES (FCTs)

The preferred and most accurate method of determining the Floristic Community Type (FCT) of a group of plants or stand of vegetation is to use the technique(s) described by Keighery (1994) in her *Bushland Plant Survey; A Guide to Plant Community Survey for the Community* and in the 2002 photocopy of it. The basic, repeatable technique is to record all species of vascular plants in a 100 m² permanent quadrat, the corners of which are marked with fence droppers or other posts or pegs. The recording of species requires at least two visits to the quadrat, ideally in spring at the peak of flowering and several weeks before or after then or at all three times. It also requires the use of standard recording sheets (see Keighery 1994, pp. 18-30) and collection and recording of supplementary information.

The list of species recorded in each quadrat is then compared with the Southern Swan Coastal Plain data set of Gibson *et al.* (1994; see p. 6) to determine which Swan Coastal Plain FCT is closest to it. The preferred method of comparison uses DEND, NNB and other PATN numerical classification techniques based on similarities of sampled quadrat floristic composition to floristic composition of quadrats in the original Swan Coastal Plain (SCP) data set (see, e.g., Griffin 2005, pp. 3, 4).

During visits to the survey area, *Melaleuca huegelii* Thickets and other vegetation on limestone ridges, knolls and slopes were searched for probable or possible FCT 26a assemblages of species, especially those indicated in Appendix B's Tables B1 and B2 and those that might include enough of the 17 high frequency (>80%) FCT 26a species listed in Gibson *et al.* (1994, Table 12) to indicate the possible presence of FCT 26a. FCT 26a is the only Threatened Ecological Community (of flora) that might be in or near the survey area.

At least seven of the 17 high frequency FCT 26a species are ephemeral and not expected to be visible or identifiable at the time of visits to the Nowergup survey area.

Subsequently, on the bases of on-site observations and interpretation of aerial photography, the parts of the survey area most likely to have stands of FCT 26a were identified.

As the field surveys were done at times when most ephemeral species would not be visible or identifiable, other methods of identifying which FCTs are in the survey area were also used. These methods are based only partly upon the placing of 10 m by 10 m quadrats and listing the species of vascular plants in each quadrat. Species of vascular plants in linear and circular relevés were also listed. Specimens of plants not easily identifiable in the field were collected for identification in the Western Australian Herbarium (WAH).

Some of the alternative methods are based upon species lists. Others are based upon information in Gibson *et al.* (1994), especially the maps and species lists in Appendix 1 of that report, the plot (site) names and locations given in the report's Appendix 4, the species group indicated for each species listed in the 1994 report's Table 12, and particular statements in that report about where [floristic] community types were found. The methods based upon species lists differ from each other in the ways the lists are used - in how and with what they are compared. The comparisons involve the following:

- Comparisons with complete lists of species in at least one appropriate original Gibson *et al.* (1994) FCT 26a quadrat and/or a more extensive, though incomplete, list of FCT 26a species, such as the one in Table 12 (Gibson *et al.* 1994; Table B1 in Appendix B of this report indicates each FCT 26a species listed in Table 12 and the species group it is in),
- Comparisons with the list of 17 high-frequency FCT 26a species and 14 other species and additional information - see Table B2 in Appendix B of this report, and
- A Full Gibson Analysis (BSD Consultants 2003) of each of the three Nowergup Area C quadrat species lists - for Quadrats A, B and J - (see Table B3 in Appendix B of this report for each of the lists).

The Appendix B Table B1 list has all 98 species in Table 12's 26a column (Gibson *et al.* 1994, pp. 31-36), and the Table B2 list has all 17 high frequency (in 82%, 91% or 100% of all 11 quadrats) FCT 26a species with entries in Table 12's 26a column.

Appendix C gives more details about the alternative methods.

3.3 FLORA

Attempts were made during field work to record all species of vascular plants seen in the survey area, especially Threatened and Priority Flora taxa and otherwise significant flora taxa, e.g. species listed in *Bush Forever* (2000, Volume 2, Table 13).

The principal taxa (species, subspecies and varieties) searched for are the 45 listed in Appendix A's Table A1. Thirty-two (32) of them are the Threatened (T) and Priority (P1, P2, P3 and P4) Flora taxa in the results of searches of three Department of Parks and Wildlife (DPaW) databases. Thirteen (13) of them are the Threatened (CR, EN, VU) flora taxa in the results of searches of federal Australian Government (2014) databases with the EPBC Act Protected Matters Search Tool.

One of the species, *Dielsia stenostachya*, is listed only in *Bush Forever* (2000, Volume 2, Table 13), as an e species ('taxa endemic to the Swan Coastal Plain').

The information in the table was compiled mainly from the results of the searches of the DPaW databases and from Smith (2013), FloraBase (2014), Grieve (1998), Marchant *et al.* (1987) and Brown *et al.* (2013, 2008, 1998), other references, Western Australian Herbarium (WAH) herbarium specimens and personal observations.

4.0 RESULTS and DISCUSSION

4.1 VEGETATION

4.1.1 Vegetation Type, Association and Complex

The survey area vegetation is mapped by Beard (1979), at a scale of 1:250 000, as Banksia Low Woodland (bLi), with Jarrah-Tuart Woodland more than 1 km east of it and Jarrah-Marri Woodland less than 1 km west of it. Beard (1979, pp. 20, 31) describes the survey area vegetation as belonging to the south-central or Muchea section of Bassendean System vegetation in the Drummond Subdistrict. He does not refer to limestone, limestone vegetation or heath being in this section, the section south of it or the two sections north of it.

The mapping of Shepherd *et al.* (2002) is similar to that of Beard (1979, 1981); it shows the vegetation of the survey area as Low woodland: Banksia (Vegetation Association 949). Beeston *et al.* (2002) note that 40.25% of the pre-European extent of Vegetation Association 949 remains.

Heddle *et al.* (1978) show the survey area as being in an eastern part of the Cottesloe Vegetation Complex – Central and South (52). They describe the native vegetation of this complex as being "heaths on the limestone outcrops" and, on deeper sands, a mosaic of tuart woodland and tuart-jarrah-marri open-forest (Heddle *et al.* 1978, 1980).

4.1.2 Vegetation Units

Distributions of vegetation units are shown in Figure 1, Vegetation Units. Locations of sites and waypoints are also shown there. The map symbols of the vegetation units and the units themselves are listed below. The vegetation structure categories and the six-point condition assessment scale used are defined in Appendix E. Photographs of some of the vegetation units are on the title page and

in Plates 1 to 7. Waypoint numbers, site letters and locations are listed in Appendix D. Only a few of the species found in a vegetation unit are listed below.

Af Plates 1, 2

***Allocasuarina fraseriana* Low Woodland - Open Low Woodland, with a few *Nuytsia floribunda*, *Eucalyptus gomphocephala* and *Eucalyptus tottiana* low trees, over *Banksia sessilis* – *Xanthorrhoea preissii* – *Hakea trifurcata* - *Allocasuarina humilis* Shrubland, over *Hibbertia hypericoides* Open Low Heath, over *Desmocladus fasciculatus* and *D. flexuosus* Sedgeland to Open Sedgeland.**

Also weedy grasses, a few *Calectasia narragara* and *Mesomelaena pseudostygia* plants, a small stand of *Alexgeorgea nitens*, and other species.

Condition: Very Good, Excellent to Good, Good to Degraded

Orange sandy soil. Very little, if any, outcropping limestone.

BC Plate 3

***Banksia sessilis* Open Tall Scrub – Tall Shrubland over *Calothamnus quadrifidus* Open Low Heath – Open Low Shrubland (with *Grevillea vestita* in the southern part of Area C)**

Also weedy grasses and a few *Hakea trifurcata*, *Mesomelaena pseudostygia* and *Banksia sessilis* plants. Other species recorded in Quadrat A are listed in Table B3 Column QA.

Condition: Good to Very Good

Orange sandy soil and scattered outcrops of limestone. Site M (WP 919, 11 June 2014) is a clearing with *Grevillea vestita* and which is surrounded by *Banksia sessilis* Open Tall Scrub to Tall Shrubland.

BM Plates 3, 7

***Banksia sessilis* Open Tall Scrub – Tall Shrubland, over *Melaleuca systema* and Mixed Shrubs (with *Xanthorrhoea preissii*, *Banksia sessilis*, *Hakea trifurcata*) Shrubland to Open Heath, over *Melaleuca systema* - *Hibbertia hypericoides* Open Low Heath**

Also, at least in some stands, *Desmocladus flexuosus*, *Hypochaeris glabra*, *Grevillea preissii*, *Dianella revoluta*, *Melaleuca huegelii* and *Acacia rostellifera* plants.

Condition: Good to Excellent

Orange sandy soil. Increasing amount of outcropping limestone upslope.

CL Plates Title page, 5

Cleared; assessed condition: Completely Degraded

CL+ Plates 2

Similar to CL but with more native plants and species

Ed Plates 1, 4

***Eucalyptus decipiens* Low Woodland to Open Woodland over *Banksia sessilis* - *Xanthorrhoea preissii* – *Allocasuarina humilis* Shrubland to Open Shrubland over *Hibbertia hypericoides* Open Low Heath – Open Low Shrubland**

Also grasses and other established alien species, *Pyrrochis nigricans*, and a few *Mesomelaena pseudostygia* plants.

Condition: Very Good, Good to Very Good, Degraded, Degraded to Completely Degraded

Orange sandy soil. Generally some outcropping limestone.

Eg Plates: Title page, 3

***Eucalyptus gomphocephala* Open Forest to Woodland over, mainly, Grasslands to Closed Grasslands of *Ehrharta calycina* and other, less common alien species of grasses, herbs and shrubs**

Condition: Completely Degraded (to Degraded)

Orange sandy soil. Some outcropping limestone.

Eg / Em Plate 5

***Eucalyptus gomphocephala* – *E. marginata* (mostly dead) Open Forest to Woodland over, mainly, Grasslands to Closed Grasslands of *Ehrharta calycina* and other alien species**

Condition: Completely Degraded to Degraded, (Good)

Mainly orange to yellow sandy soil. Occasional outcropping limestone.

Em Plate 6

***Eucalyptus marginata* (usually dead) - *Allocasuarina fraseriana* – *Banksia attenuata* – *Banksia grandis* - *Nuytsia floribunda* Low Woodland to Open Woodland, over *Xanthorrhoea preissii* – *Macrozamia riedlei* Open Heath to Tall Shrubland, over, mainly, weedy grasses**

Also grasses, other alien herbaceous plants and a few *Acacia pulchella* and *Banksia sessilis* plants.

Condition: Good to Degraded, Degraded

Orange sandy soil. Little or no outcropping limestone.

M Plates 4, 7

***Melaleuca systema* Closed to Open Heath over *Desmocladius flexuosus* Sedgelands to Open Sedgelands (often with *Banksia sessilis*, *Melaleuca huegelii* and/or other species of shrubs)**

Also *Acacia lasiocarpa* var. *lasiocarpa*, *Diplolaena angustifolia*, *Grevillea preissii*, *Hakea costata*, *Hypochaeris glabra*, *Opercularia vaginata*. Other species in Quadrat B are listed in Table B3 Column QB.

Condition: Excellent (to Very Good)

On substrate of more than 70% limestone boulders.

Representative site: Quadrat B (WP 932; 30 April, 16 June 2014)

P Three pine trees and other alien species in part of a cleared area near the north-eastern corner of Lot 102

Condition: Completely Degraded

X Plates 2, 7

***Xanthorrhoea preissii* Shrubland to Open Tall Scrub, often (1) east to north-east of Area C, with native and alien shrubs, and (2) elsewhere, with *Banksia sessilis*, *Calothamnus quadrifidus* or other shrubs.**

Condition: (1) Completely Degraded to Degraded. (2) Good to Degraded

4.1.3 Floristic Community Types (FCTs)

The FCTs that may be represented in the survey area are, at most, seven: 21a, 23a, 24, 26a, 26b, 27 and 28. However, representation there of FCT 28 is doubtful because the Gibson *et al.* (1994) FCT 28 NEER quadrats are on the west side of Wanneroo Road, more than two kilometres from the survey area. Also, FCT 28 is, according to Gibson *et al.* (1994, p. 44), largely made up of woodlands dominated by species of *Banksia* and *Eucalyptus*, but not *E. gomphocephalus*. Gibson *et al.* (1994, Appendix 1) shows the *Banksia attenuata* – dominated FCT 21a and FCT 23a quadrats as Bassendean and further east. The few FCT 21a quadrats north of the Swan River are also shown as further north.

Because a limestone outcrop in the narrow strip of vegetation in Figure 1 nearest the centre of the north-western border of Area C has *Astroloma microcalyx* growing on it, if the vegetation there were in much better condition, its FCT would probably be 27. The figures in the *Astroloma microcalyx* row in Table B2 support this inference.

Gibson *et al.* (1994, p. 43-44) state that FCT 24 and FCT 25 are closely related and that in one of their FCT 25 quadrats *Eucalyptus decipiens*, not *Eucalyptus gomphocephala*, was the dominant. But *Eucalyptus gomphocephala* formed the overstorey nearby, as it does near Areas C and D.

Consequently, it is inferred that (1) a small area of heath vegetation in, around and west of Quadrat (Site) B may be a representation of FCT 26a, and (2) one or more of FCTs 24, 26b and 27 are represented elsewhere in the survey area, including some areas with no outcropping limestone.

4.1.4 Vegetation Condition

Most of the Lot 102 vegetation in and north of Area C is assessed as being in Good to Very Good Condition while most vegetation in the rest of the survey area is assessed as being Good to Completely Degraded. The assessments would be higher if there were fewer environmental weeds there.

Vegetation with very few, if any, native plants (Unit C1) is assessed as Completely Degraded. Weediness is the reason for assessing the condition of the Em vegetation in the south-western corner of Lot 102 and south-eastern corner of Lot 103 as Degraded.

Most, if not all, of the survey area appears to have been unburnt for many years. Even tall, old Balga (*Xanthorrhoea preissii*) plants have unburnt skirts, as shown in Plate 2.

4.2 FLORA

Appendix B's Table B1 lists 168 species and other taxa of vascular plants recorded during the survey. None of them is listed in Table A1, and none is a Threatened, Priority or other significant species.

One small population of Bridal Creeper (*Asparagus asparagoides*) was found in *Eucalyptus decipiens* Low Woodland in the central western part of Area C, and another was found in the south-western part of Lot 103. Bridal creeper is a serious, highly invasive environmental weed. It is a Declared Pest in Western Australia and is one of a few dozen Weeds of National Significance (<http://www.weeds.org.au/WoNS/>) (<https://www.agric.wa.gov.au/declared-plants/bridal-creeper-declared-pest>).

4.3 LIMITATIONS

Earlier, Weston (2003) used a version of this report's Table B2, in Appendix B, as an aid to distinguishing between FCT 26a, FCT 26b and FCT 27, but it was less helpful in 2014, in large part because many annual plants and other ephemeral species were absent or not identifiable. According to Gibson (in Weston and Gibson 1997), FCT 26b and FCT 27 are difficult to distinguish from each other on aerial photography, even on highly magnified stereoscopic pairs of high resolution colour aerial photographs. Probably FCT 26a is also sometimes difficult to distinguish from FCT 26b and FCT 27.

This absence of species is probably at least the principal reason why the species numbers for QA, QB and QJ in Table 1, below, are significantly less than the mean species richness numbers in Table 2.

Table 1 Numbers of Species

Numbers of Species (SPP) listed in G 1994 [Gibson *et al.* (1994, Table 12, Community Type 26a Column)], WG 1997 [Weston and Gibson (1997, Appendix 1)], C/D 2014, N2 [Appendix B, Table B1, C/D '14 and N2 Columns] and QA, QB, QJ [Appendix B, Table B3, QA, QB, QJ Columns] See Appendix B for more details and keys

	G 1994	WG 1997	C/D 2014 + N2 ('14-'15)		QA	QB	QJ
TOTAL SPP	98	225	168		38	36	29
C/D SPP	C/D 35	C/D 65	C/D 132	N2 36	C/D 38	C/D 36	C/D 29

Table 2 Mean Species Richness

Mean quadrat species richness listed in Gibson <i>et al.</i> (1994, Appendix 1)	FCT 24	FCT 26a	FCT 26b	FCT 27
	41.8	50.2	52.7	39

Some herbaceous plants, such as many orchids, flower briefly, then disappear and, furthermore, some do not appear every year. Some plants flower for only one or a few seasons following a hot summer fire, and the incidence of flowering of plants that flower annually may vary from year to year.

Density variations in the understorey, especially under woodland and forest canopies, are often difficult or impossible to recognise or map.

Some plants, especially small sedges, are impossible to identify if they are not in seed.

The paucity of species in a quadrat reduces the reliability of analysing quadrat samples using either a Full Gibson Analysis (BSD Consultants 2003) or a PATN analysis. When a group of species that would be in a quadrat, and sampled, is missing, then analysis of a sample may yield a faulty result.

The sampling done for the original southern Swan Coastal Plains survey was in ‘. . . the least disturbed vegetation available . . .’ (Gibson *et al.* 1994, p. 4).

Griffin (2005) describes a number of other problems in the interpretation of PATN analyses and with the system of Floristic Community Types.

5.0 CONCLUSIONS

Figure 1 is an aerial photograph with boundaries of nine vegetation units and CI shown on it. Shortened names of these units and their assessed conditions [**E** – Excellent, **VG** – Very Good, **G** – Good, **D** – Degraded, **CD** – Completely Degraded] are listed below. Longer names and other details about the units are listed in Section 4.1.2.

Af	E-D	<i>Allocasuarina fraseriana</i> Low Woodland - Open Low Woodland,,
BC	VG-G	<i>Banksia sessilis</i> Open Tall Scrub – Tall Shrubland over <i>Calothamnus quadrifidus</i> Heaths and Shrublands
BM	E-G	<i>Banksia sessilis</i> Open Tall Scrub – Tall Shrubland, over <i>Melaleuca systena</i> Heaths and Mixed Shrubs
CL	CD	Cleared; assessed condition: Completely Degraded
CL+	CD	Similar to CL but with more native plants and species
Ed	VG-CD	<i>Eucalyptus decipiens</i> Low Woodland to Open Woodland
Eg / Em	G-CD	<i>Eucalyptus gomphocephala</i> – <i>E. marginata</i> (mostly dead) Open Forest to Woodland over, mainly, Grasslands to Closed Grasslands of <i>Ehrharta calycina</i> and other alien species
Eg	CD(-D)	<i>Eucalyptus gomphocephala</i> Open Forest to Woodland over, mainly, Grasslands to Closed Grasslands of <i>Ehrharta calycina</i> and other, less common alien species
Em	G-D	<i>Eucalyptus marginata</i> (mostly dead) - <i>Allocasuarina fraseriana</i> – <i>Banksia attenuata</i> – <i>Banksia grandis</i> - <i>Nuytsia floribunda</i> Low Woodland to Open Woodland
M	E	<i>Melaleuca systena</i> Closed to Open Heath over <i>Desmocladus flexuosus</i> Sedgeland to Open Sedgeland (with <i>Melaleuca huegelii</i> and/or other shrubs in some places)
P	CD	Three pine trees and other alien species in part of a cleared area near the north-eastern corner of Lot 102

X ***Xanthorrhoea preissii* Shrubland to Open Tall Scrub, often with *Banksia sessilis*, or other shrubs**
Condition: (1- E to NE of Area C) D-CD. (2- elsewhere) G-D

The Floristic Community Types (FCTs) that may be represented in the survey area are, at most, seven: 21a, 23a, 24, 26a, 26b, 27 and 28. It is possible that the M vegetation unit east of the centre of Area C is a representation of FCT 26a. Floristically, most of the rest of the survey area is, probably, FCT 24, FCT 26b and/or FCT 27.

The Department of Parks and Wildlife (DPaW) (2014a) lists FCT 26a (62. Limestone Ridges SCP 26a) as endorsed by the Western Australian Minister for the Environment, Species & Communities Branch, as a Threatened Ecological Community (correct to May 2014). SCP 26a is also referred to, elsewhere, as an FCT, an SCPFCT and a Community Type. DPaW (2014b) lists FCT 24 as Swan 20. Community Type 24, a Priority 3(i) Ecological Community.

The 168 species and other taxa of vascular plants recorded in the survey area are listed in Appendix B's Table B1 Columns C/D '14 (132 taxa) plus N2 (36 taxa). Taxa recorded in quadrats QA, QB and QJ are listed in Table B2. None of them is a Threatened or Priority taxon.

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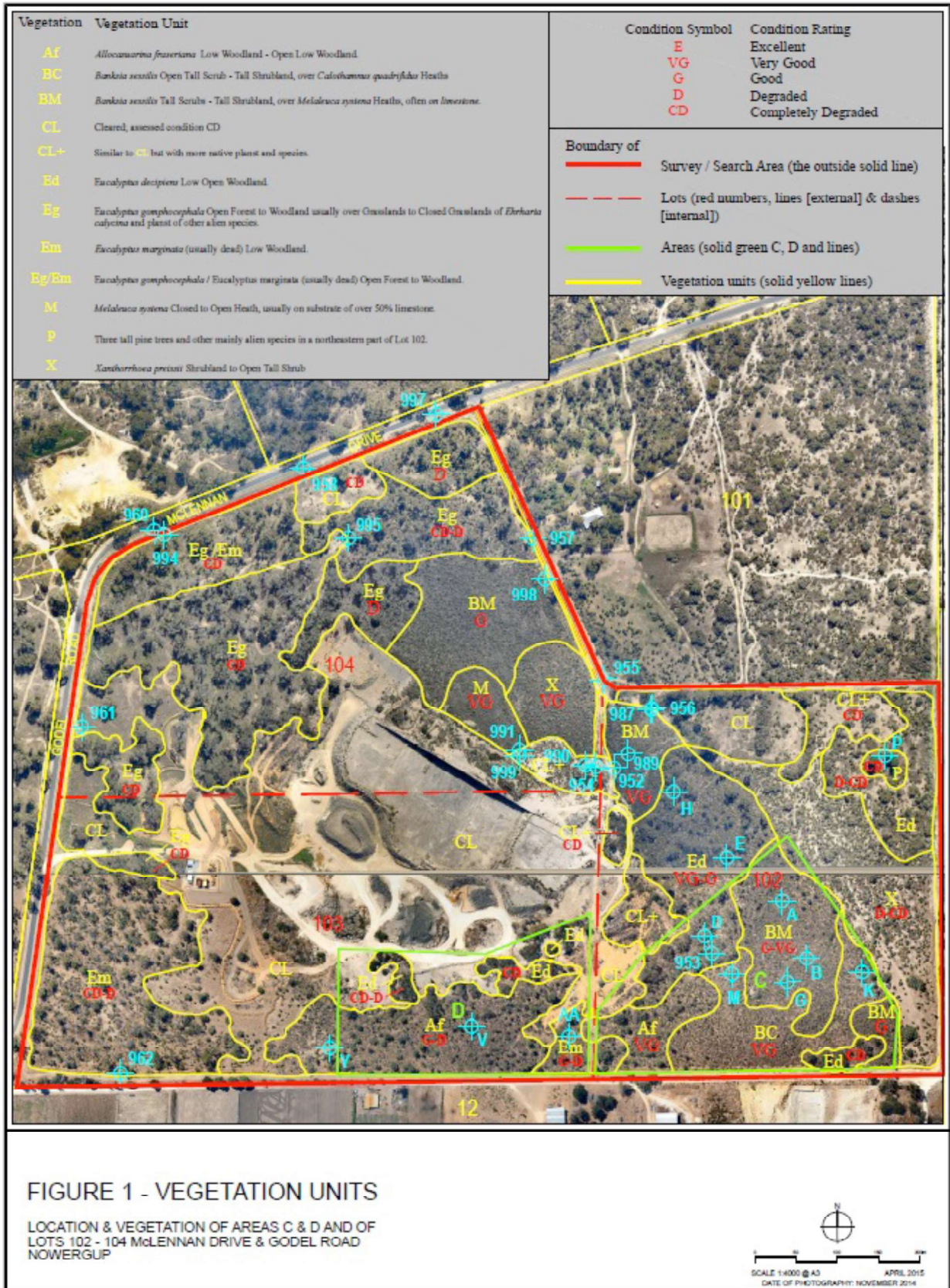
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- A.** *Allocasuarina fraseriana* Low Woodland - Open Low Woodland, with *Nuytsia floribunda* and *Eucalyptus tottiana* low trees, over *Banksia sessilis* – *Xanthorrhoea preissii* – *Hakea trifurcata* Shrubland, over *Hibbertia hypericoides* Open Low Heath, over *Desmocladus fasciculatus* and *D. flexuosus* Sedgelands to Open Sedgelands.
Photo: An enclave of **Unit Af** in **Vegetation Unit X** east of Area C in Lot 102.



- B.** *Allocasuarina fraseriana*, *Nuytsia floribunda*, *Xanthorrhoea preissii* and, in foreground, *Allocasuarina humilis*. **Vegetation Unit Af.** **Photo:** Near Site V, Area D, Lot 103. **Vegetation Unit Ed** in left background.

PLATE 1 *Allocasuarina fraseriana* Low Woodland - Open Low Woodland



A. *Nuytsia floribunda* grove, skirted, long-unburnt *Xanthorrhoea preissii* plants and, in foreground, *Hibbertia hypericoides* shrubs. In **Vegetation Unit Af**, near Site Y, Area D.

Photo: Looking south towards centre of Lot 103's southern boundary.
The long skirt on the *Xanthorrhoea* suggests that it has not been burnt for many years.



B. *Astroloma microcalyx* on limestone and on sand over limestone; in **Vegetation Unit CH+**, in Lot 102 near north-eastern corner of Lot 103.

PLATE 2 **Vegetation Units Af and CH+, and *Astroloma microcalyx***



A. *Banksia sessilis* Open Tall Scrub – Tall Shrubland over *Calothamnus quadrifidus* Heaths.
Vegetation Unit BC. **Photo:** Looking south-west from near WP 987, in Lot 102, over north-east corner of the quarry and the boundary between Lots 102 and 104.



B.– *Banksia sessilis* Open Tall Scrub – Tall Shrubland over *Melaleuca systena*, **M Vegetation Unit** (in foreground), **BM Vegetation Unit** (in most of central part of photo) and **Eg Vegetation Unit** (in background). **Photo:** Looking north-west from northern edge of quarry near WP 991, in Lot 104.

PLATE 3 *Banksia sessilis* Open Tall Scrubs – Tall Shrublands, *Melaleuca systena* Heath and Tuart (*Eucalyptus gomphocephalus*) Woodland



A. *Eucalyptus decipiens* Low Woodland, over *Banksia sessilis* - *Xanthorrhoea preissii* – *Allocasuarina humilis* Shrubland to Open Shrubland over Mixed small shrubs, herbs and graminoids. In Area C near south-east corner of Lot 102.



B. *Diplolaena angustifolia* on limestone in Quadrat (Site) B, **Vegetation Unit M** (a small area, which is mapped as **Vegetation Unit BM**) East of centre of Area C

PLATE 4 *Eucalyptus decipiens* Low Woodland, and *Diplolaena angustifolia*



A. *Eucalyptus gomphocephala* Open Forest to Woodland – with a few *Eucalyptus marginata* (mostly dead) trees – over, mainly, Grasslands to Closed Grasslands of *Ehrharta calycina* and other, less common alien species of grasses, herbs and shrubs. **Vegetation Units Eg / Em and CL. Photo:** Near WP 961, in the western part of Lot 104.



B. *Eucalyptus gomphocephala* – *E. marginata* (many trees, mostly dead) Open Forest to Woodland over, mainly, Grasslands to Closed Grasslands of *Ehrharta calycina* and other alien species. **Vegetation Unit Eg / Em (or Em with a few Tuart trees). Photo:** Near WP 960, in the north-western part of Lot 104.

PLATE 5 *Eucalyptus gomphocephala* and *E. marginata* (mostly dead) Open Forest to Woodland



Eucalyptus marginata (mostly dead) Low Woodland to Open Woodland, with few Tuarts, * *Acacia podalyriifolia*, *Allocasuarina fraseriana*, *Banksia attenuata*, *Banksia grandis* and *Nuytsia floribunda* trees, over, mainly, weedy grasses.

Photo: North-east of WP 962, in southern part of **Em Vegetation Unit**.

PLATE 6 Vegetation Unit Em: *Eucalyptus marginata* - Low Woodland to Open Woodland



A. *Melaleuca systema* Closed Heath in Quadrat on limestone at Waypoint B, in **Vegetation Unit M**.
Photo: Near WP B, east of centre of Area C, Lot 102. Mapped there as in **Vegetation Unit BM**.



A. *Xanthorrhoea preissii* Shrubland to Tall Shrubland with *Banksia sessilis*, *Calothamnus quadrifidus* and other species of shrubs. **Vegetation Unit X**.
Photo: Looking north from near south-eastern corner of Lot 104 and Waypoints 954 and 990.

PLATE 7 *Melaleuca systema* Closed Heath and *Xanthorrhoea preissii* Shrubland to Open Tall Scrub

APPENDIX A

Threatened and Priority Flora and other Significant Flora with Distributions and Habitats which may include the Nowergup Search Area

(based mainly upon printouts of results of DPaW March 2014 database searches and upon EPBC Act Protected Matters Search Tool April 2014 search results)

1.0 TABLE A1

Table A1 lists 45 taxa (species, subspecies and varieties) of flora. Thirty-two (32) of them are the Threatened (T) and Priority (P1, P2, P3 and P4) Flora taxa in the results of searches of three Department of Parks and Wildlife (DPaW) databases. Thirteen (13) of them are the Threatened (CR, EN, VU) flora taxa in the results of searches of federal databases with the EPBC Act Protected Matters Search Tool. One of them, *Dielsia stenostachya*, is listed in *Bush Forever* (2000, Volume 2, Table 13) as an e species ('taxa endemic to the Swan Coastal Plain').

The taxa in the results of DPaW searches of the TPFL and WAHerb databases were recorded within 10 km of a point with the coordinates 31°37'45" S and 115°44'51" E. Target locality names in the DPaW searches of the TPlist database are Mariginiup, Nowergup, Neerabup, Carabooda, Carramar, Tamala, Clarkson, Ridgewood, Merriwa, Mindanie, Jindalee, Butler, Alkimos, Yanchep, Gngangara-Moore and Eglinton.

The EPBC CR, EN and VU taxa were recorded within 10 km of a point in the survey area with the coordinates 31°37'45" S and 115°44'51" E. It is the same point as the one at the centre of the DPaW database searches.

The twelve (12) taxa in the EPBC search results that are not in the DPaW search results are italicised in Table A1. Only *Eucalyptus argutifolia*, which is not italicized in Table A1, is in both sets of search results.

Epiblema grandiflorum var. *cyaneum* and *Anigozanthos viridis* subsp. *terraspectans* are in the EPBC search results. However, Western Australian Herbarium botanists no longer recognise this variety of *Epiblema grandiflorum* or this subspecies of *Anigozanthos viridis* (Thiele 2011). Neither is listed in FloraBase (2014, 2015) as Threatened or Priority.

The taxa listed in Table A1 are the principal, but not only, taxa searched for in the field search area in 2014-2015. The table also provides information about conservation codes, distributions, locality records, growth forms, habitats and flowering times for at least some of these taxa. The information about distributions, localities, growth forms, habitats and flowering times is not always comprehensive, but information about habitat is at least indicative and should help in assessing how likely species of rare flora are to occur in the survey area.

The Table A1 list of taxa was compiled principally from the results of searches of three databases carried out by the Species and Communities Branch of the DPaW in March 2014, and from FloraBase. The three DPaW databases are Threatened and Priority Flora (TPFL), Threatened and Priority Flora List (TPlist) and Western Australian Herbarium Specimen (WAHerb). The point coordinates given to the DPaW as the centre of the databases search area are:

Coordinates: 31°37'45" S and 115°44'51" E

The results of the database searches also provided some information about conservation codes, localities and distributions, habitats and flowering times. Additional information in the table was obtained from examination of herbarium specimens and their labels in the Western Australian Herbarium, consultations with other botanists, information in FloraBase (2014, 2015), Marchant *et al.* (1987), Brown *et al.* (2013), Department of Parks and Wildlife (2013a) and relevant parts of the *Flora of Australia* and *How to Know Western Australian Wildflowers*. These references are listed in the report to which this is Appendix A.

2.0 ATTACHMENT TO APPENDIX A (Follows Table A1)

Extract from the 'Australian Government Department of Environment (DoE) EPBC Act Protected Matters Report' for a 20 km wide circular area centred on Lat. -31°37'45" S and Long. 115°44'51" E (-31.62917 115.7475).

A report was generated by the Department of Environment (2014) EPBC Act Protected Matters Search Tool (<http://www.environment.gov.au/arcgis-framework/apps/pmst/pmst-coordinate.jsf>) for a 20 km wide area centred on a point in the survey area with the coordinates -31°37'45" S and 115°44'51" E. That report lists two threatened ecological communities (Aquatic Root Mat Community in Caves of the Swan Coastal Plain, and Sedgeland in Holocene dune

swales of the southern Swan Coastal Plain) and 13 taxa of Threatened flora. The 13 taxa of Threatened Flora are listed in the Attachment. None of these taxa, except possibly *Eucalyptus argutifolia*, occurs near the search area.

The EPBC “Aquatic Root Mat Community in Caves of the Swan Coastal Plain” threatened ecological community (TEC) is the same as the Department of Parks and Wildlife’s “24. CAVES SCP01 Aquatic Root Mat Community Number 1 of Caves of the Swan Coastal Plain” - which has a “Category of Threat and criteria met under WA criteria” of CR B) i) and CR B) ii) and is on the List of Threatened Ecological Communities endorsed by the Western Australian Minister for the Environment (Department of Parks and Wildlife 2013b). It is probably within and restricted to the LS2 karst belt described by Csaky (2003) in her report on karst hazards in the Wanneroo Area. Her Figure 2.1 shows LS2 karst in the southern half to two-thirds of Area C.

The EPBC “Sedgeland in Holocene dune swales of the southern Swan Coastal Plain” TEC is the same as the Department of Parks and Wildlife’s FCT 19 (“4. SCP19 Sedgeland in Holocene dune swales of the southern Swan Coastal Plain” - which has a “Category of Threat and criteria met under WA criteria” of CR B) ii) and is on the List of Threatened Ecological Communities endorsed by the Western Australian Minister for the Environment Department of Parks and Wildlife 2013b). According to Gibson *et al.* (1994, p. 41), is a wetland community restricted to coastal dune swales south of Perth.

3.0 CONSERVATION CODES DEFINITIONS (summary of definitions in Smith 2013)

T: **Threatened Flora** (Declared Rare Flora – Extant). Listed under Schedule 1 of the Wildlife Conservation (Rare Flora) Notice. [Gazetted]

X: **Presumed Extinct Flora** (Declared Rare Flora – Extinct). Listed under Schedule 2 of the Wildlife Conservation (Rare Flora) Notice. [Gazetted]

<http://dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/84-listing-of-species-and-ecological-communities> should have the Wildlife Conservation (Rare Flora) Notice.

Threatened Flora (Schedule 1) are further recognised by the Department according to their level of threat using IUCN Red List criteria, which are the three EPBC Act Threatened Codes in Appendix A’s Table A1 and its Attachment:

CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild.

EN: Endangered – considered to be facing a very high risk of extinction in the wild.

VU: Vulnerable – considered to be facing a high risk of extinction in the wild.

*Taxa = plural of taxon (a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies, variety or forma). Loosely: = ‘species’

P1: Priority One: Poorly-known species/taxa

Species/Taxa that are known from one or a few collections (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas,

P2: Priority Two: Poorly-known species/taxa

Species/Taxa that are known from one or a few collections, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks,

P3: Priority Three: Poorly-known species/taxa

Species/Taxa that are known from collections from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat.

P4: Priority Four: Rare, Near Threatened and other species/taxa in need of monitoring

(a) Rare. Species/Taxa that are considered to have been adequately surveyed,

(b) Near Threatened. Species/Taxa that are considered to have been adequately surveyed.

(c) Species/Taxa that have been removed from the list of threatened taxa during the past five years for reasons other than taxonomy.

P5: Priority Five: Conservation Dependent species/taxa

Species/Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species/taxa becoming threatened within five years.

4.0 SIGNIFICANCE CODES DEFINITIONS

(from *Bush Forever* 2000, Volume 2, Table 13, pp. 51-55)

d = populations disjunct from their known geographic range;

e = taxa endemic to the Swan Coastal Plain;

p = considered to be poorly reserved (applies to all DRF and Priority taxa);

r = populations at the northern or southern limit of their known geographic range;

s = significant populations;

E = taxa endemic to the Swan Coastal Plain in the Perth Metropolitan Region;

X = taxa considered lost in the Perth Metropolitan Region

5.0 DEFINITION OF *

An asterisk (*) preceding an italicised two-word scientific name indicates that the name is of an established alien species, an environmental weed.