

Addendum to Detailed and Targeted Flora and Vegetation Survey Vasse Diversion Drain Upgrade (Ecoedge, 2020)



Prepared for Water Corporation

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Statement of limitations

Reliance on Data

In the preparation of this report, Ecoedge has relied on data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report. Unless stated otherwise in the report, Ecoedge has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report are based in whole or in part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Ecoedge will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, unavailable, misrepresented or otherwise not fully disclosed to Ecoedge.

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1 Introduction and Background

This report forms an addendum to the report on a survey carried out in 2019 by Ecoedge (Ecoedge 2020) and should be read in conjunction with that report.

In 2019 Water Corporation requested that Ecoedge determine the presence or absence of the Priority one “*Eucalyptus rudis*, *Corymbia calophylla* and *Agonis flexuosa* Closed Low Forest” ecological community within the Development Area Footprint of the Vasse Diversion Upgrade via a Multivariate Variate Analysis (MVA).

Ecoedge determined the community to be present within the Development Area Footprint (DAF) based on an assessment of three quadrats (VASS01, VASS02 and VASS03) installed (for the most part) outside of the DAF in vegetation adjacent and contiguous with DAF vegetation (**Figure 1**). At the time Ecoedge observed the vegetation outside but adjacent to the DAF to be similar to the DAF vegetation but in better condition. Ecoedge considered a survey of this vegetation would yield a more reliable Floristic Community Type (FCT) determination via MVA than the more degraded DAF vegetation.

Water Corporation was concerned that the FCT of the vegetation within the DAF had not been appropriately determined as no vegetation within the DAF had been statistically compared with confirmed “*Eucalyptus rudis*, *Corymbia calophylla* and *Agonis flexuosa* Closed Low Forest” FCT quadrat data.

Water Corporation therefore requested quadrats be installed within the potential Priority Ecological Community (PEC) as identified by Ecoedge within a revised DAF area to address the methodological shortfall.

Water Corporation has also requested a targeted survey for the Federally and State protected perennial grass *Austrostipa bronwenae* in potential habitat within and adjacent to the Swale Drain in the DAF as a new population of this threatened perennial grass species was identified in proximity to the DAF in the 2019 survey.

The field assessment was carried out by Russell Smith (SL flora permit SL012551) and Colin Spencer (SL flora permit FB62000169) on 5 March 2020 in accordance with the Environmental Protection Authority (EPA) Technical Guidance (EPA, 2016).

This report compiles findings of the field assessment.

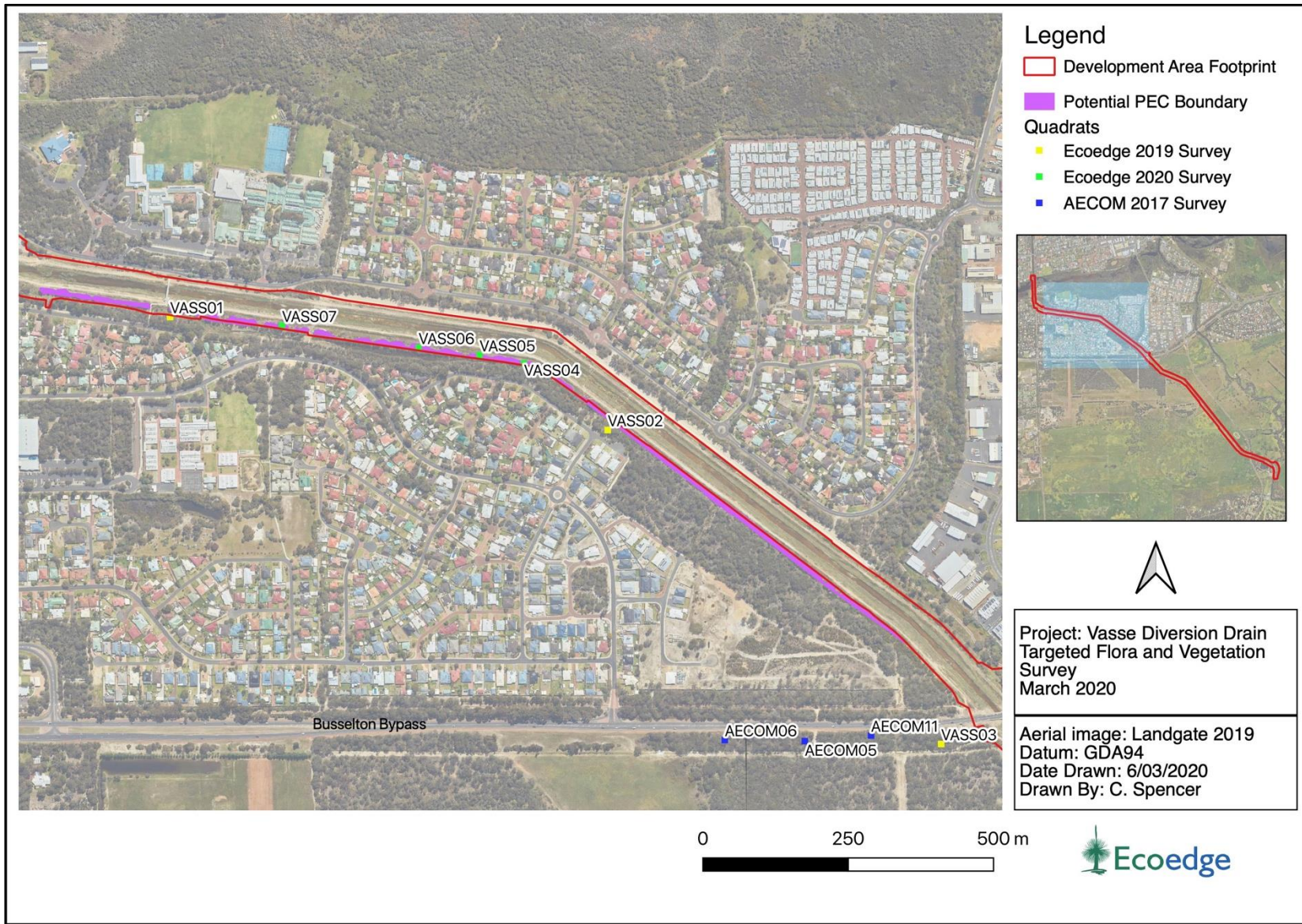


Figure 1. Location of potential priority one ecological community within the DAF.

2 Methods

2.1 Quadrat Survey

Four 10m x 10m quadrats (VASS04, VASS05, VASS06 and VASS07) were installed in vegetation of Degraded to Good condition within the DAF (**Figure 1**) and all vascular species within them were recorded along with an estimate of cover as per EPA (2016).

2.2 Targeted Survey *Austrostipa bronwenae*



Figure 2. *Austrostipa bronwenae*

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* listing: Endangered.
- Western Australian *Biodiversity Conservation Act 2016* listing: Critically endangered.
- Description of taxa: Tufted, perennial grass 90 – 150 cm tall (Williams, 2011).
- Description of habitat: Williams, 2011 describes its preferred habitat as non-saline but seasonally wet grey-brown sandy loam soil containing nodules of Muchea Limestone, at the edge of *Gahnia trifida* sedgeland with *Eucalyptus decipiens* and *Melaleuca viminea*.
- Department of Biodiversity, Conservation and Attraction BCA records: Known from only five populations, Kenwick 1a and 1b, Kemerton 1a and 1b, Bunbury (DPaW 2017), and Busselton.

In spring 2019 Ecoedge provided a specimen of suspected *A bronwenae* found in dampland areas within the “*Eucalyptus rudis*, *Corymbia calophylla* and *Agonis flexuosa* Closed Low Forest” ecological community approximately 100 m south of the DAF to the WA Herbarium to confirm its identification. The specimen was positively identified as a new and significant range extension of *A. bronwenae*.

The same population of three individuals of *A. bronwenae* was visited prior to undertaking survey to confirm characteristics of this species that would assist in a confident out-of-season identification of the species, especially when compared with the similar and co-occurring *A. flavescens*.

At the time of the survey both species had a similar tufted growth habit, similar panicle arrangement, similar sized persistent glumes and no flower or fruit. However, it was considered that the plants could be confidently identified based on other differentiating features.

The main and very apparent difference between the species was the blue green colour of the observed *A. bronwenae* culms and leaf blades versus the consistently light green colour of *A. flavescens* culms and leaf blades, when compared in the field. Other differentiating features include:

- consistently rolled terete leaves of *A. bronwenae* versus the generally consistent flat to rolled leaves of *A. flavescens*
- strongly ribbed abaxial, pubescent leaf surface of *A. flavescens* versus the generally unribbed, glabrous abaxial surface of *A. bronwenae*.

These literature based taxonomical features, together with field-based observations and comparative photographs supporting these observations are provided in **Appendix 1**.

Observations were also noted of its occurring habitat which comprised of *Corymbia calophylla*, *Agonis flexuosa*, *Melaleuca raphiophylla*, *Banksia littoralis* Woodland over *Acacia saligna*, *Hibbertia cuneiformis* and *Xanthorrhoea brunonis* Open Shrubland over *Gahnia trifida*, *Lepidosperma longitudinale*, *Baumea juncea*, *B. arthrophylla* sedgeland.

One of the distinctive taxa co-occurring with *A. bronwenae* is the sedge *Gahnia trifida* (Williams, 2011; DPaW, 2017; C. Spencer, pers. observation). Those areas dominated by this sedge occurring within and adjacent to the DAF were identified and thoroughly searched during the targeted survey. These areas occurred predominantly adjacent to the Swale drain and in vegetation near the New River and the vegetation between Queen Elizabeth Ave and the diversion drain north of College Ave, **Figure 3** and **Figure 4**.



Figure 3. *Lepidosperma gladiatum* and *Gahnia trifida* growing adjacent swale drain.



Figure 4. *Gahnia trifida* near the New River

2.3 Multivariate Analysis of Floristic Quadrat Data

The floristic quadrat data from the four newly installed quadrats (VASS04, VASS05, VASS05, VASS06) together with the three quadrats installed in Very Good to Excellent condition adjacent to the DAF (VASS01, VASS02, VASS03) (Ecoedge, 2020) and from three quadrats placed in the “*Eucalyptus rudis*, *Corymbia calophylla* and *Agonis flexuosa* Closed Low Forest” Priority Ecological Community (PEC) just east of the Survey Area by AECOM (2017) (AECOM5, AECOM6 and AECOM11) were subjected to MVA using the software PATN (Belbin, 2003). In order to determine the relationship of the three quadrats installed within the DAF to the floristic community types derived for the Swan Coastal Plain (SCP) by Gibson *et al.* (1994) (“the SCP Survey”) the ten quadrats from within and adjacent to the DAF were compared to a subset of the Gibson *et al.* 1994 dataset. This dataset comprised 149 quadrats occurring south of Bagieau Road in Myalup, about 45 km north of Bunbury. It was considered that only including quadrats from the Gibson *et al.* 1994 dataset that were sited close to (within 125 km) the Survey Area would lead to a more accurate assignment of the appropriate FCT.

The MVA used two-way classification (Agglomerative Hierarchical Fusion) of the presence/absence data for each quadrat. The flexible UPGMA classification strategy was used ($\beta = -0.1$), together with the Bray-Curtis site similarity measure. The default settings for number of groups to be produced by the classification (i.e. the “cut-off level”) was accepted in each case. The primary output of the classification were dendrograms and a two-way table of taxa and quadrats.

The data from the Gibson *et al.*, 1994 survey dataset had been subject to taxonomic updating. Taxonomic updating of the 25-year-old data was required because many taxonomic changes have taken place since the original survey was carried out (e.g. *Dryandra* to *Banksia*, *Eucalyptus calophylla* to *Corymbia calophylla*, etc.). In addition, there is some uncertainty about the identification of such species as *Thysanotus manglesianus* and *T. patersonii*, where many Swan Coastal Plain specimens have intermediate characteristics between the two. In such cases terms such as ‘*Thysanotus manglesianus/patersonii* complex’ were used.

3 Survey Limitations

Potential limitations with regard to the assessment are addressed in **Table 1**.

Table 1. Limitations of the field survey with regard to assessment adequacy and accuracy.

Aspect	Constraint	Comment
Scope	No	The survey scope was prepared in consultation with WC and was designed to comply with EPA requirements.
Proportion of flora identified	Moderate	The survey was carried out in early March, which is outside the main season for flowering in the south-west of Western Australia. Consequently, the number of herbaceous taxa visible in the quadrats was lower than if a spring survey had been conducted. However, <i>Austrostipa bronwenae</i> , which is a perennial, would have been easily recognizable.
Climatic and seasonal effects	Slight/Moderate	Rainfall for the 2019 wet season at Busselton (1st April – 30 th November) was only 58% of average. Summer rainfall (1 Dec 2019-29 Feb 2020) was also below average (BOM).
Availability of contextual information	Negligible	Comprehensive regional surveys of remnant vegetation, as well as more localized surveys, have been carried out on the southern Swan Coastal Plain.
Completeness of the survey	Slight/Moderate	The whole search area was covered on foot. Most herbaceous species within the quadrats were either not visible or not identifiable.
Skill and knowledge of the botanists	Negligible	The senior field botanist conducting the survey has had extensive experience in botanical surveys in south west Australia over a period of 25 years.

4 Results

4.1 Targeted survey

All potential habitat for *A. bronwenae* was searched **Figure 5**. However, no plants were observed. It is considered that because of its distinctive blue green appearance which sets it apart from the only other co-occurring and similar *Austrostipa* species, *Austrostipa flavescens*, that it would have been observed, had it occurred within the area searched.

4.2 Quadrat Survey and Multivariate Analysis

Details on the four newly installed quadrats (VASS04, VASS05, VASS06, VASS07), which were contained between 10 and 18 species, is presented in **Appendix 2**. This was significantly lower than the 33 to 38 taxa recorded in the three quadrats installed just outside the DAF and reported in Ecoedge (2020). The reasons for this lower species-richness per quadrat are firstly, because the earlier quadrats were installed in Very Good-Excellent condition vegetation compared to the Degraded-Good for the recent quadrats, and secondly, because most annual, or annually-regenerating taxa (such as orchids and *Stylidiaceae*) are either not visible or not identifiable in March.

A portion of the dendrogram produced by the MVA is shown below in **Figure 6**. This demonstrates that the four new quadrats clustered with the AECOM quadrats and the spring quadrats (VASS01, VASS02, VASS03) sited near the DAF (**Figure 1**). They form a separate sub-cluster to the six other quadrats presumably because they lack most of the spring herbaceous species and because of the lower number of species within the quadrats. However, they have much more in common with the AECOM and spring quadrats (VASS01, 02, 03) than they do with any others from the dataset used in the entire MVA.

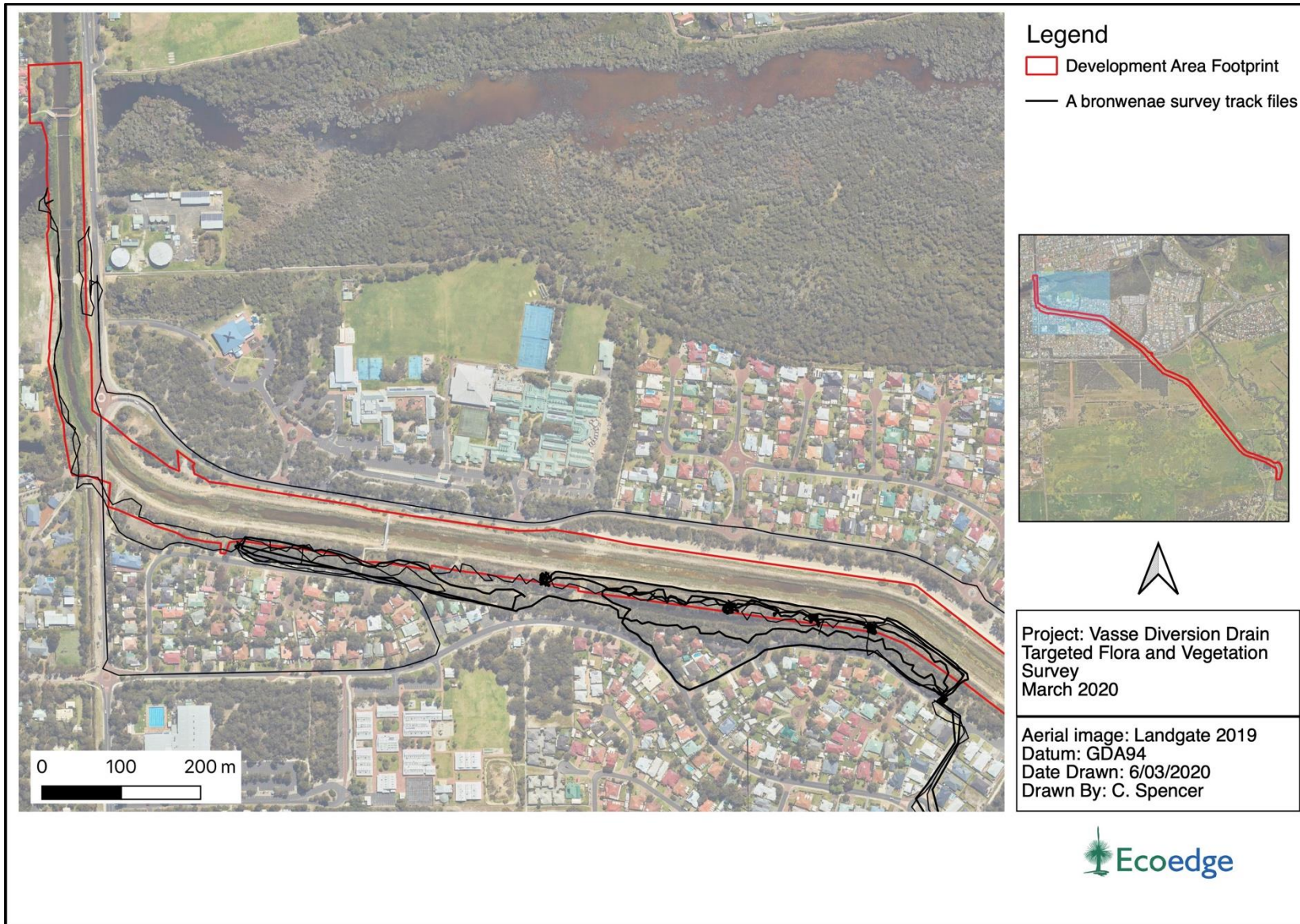


Figure 5. Targeted search for *Austrostipa bronwenae*, (track files include car travel between sites)

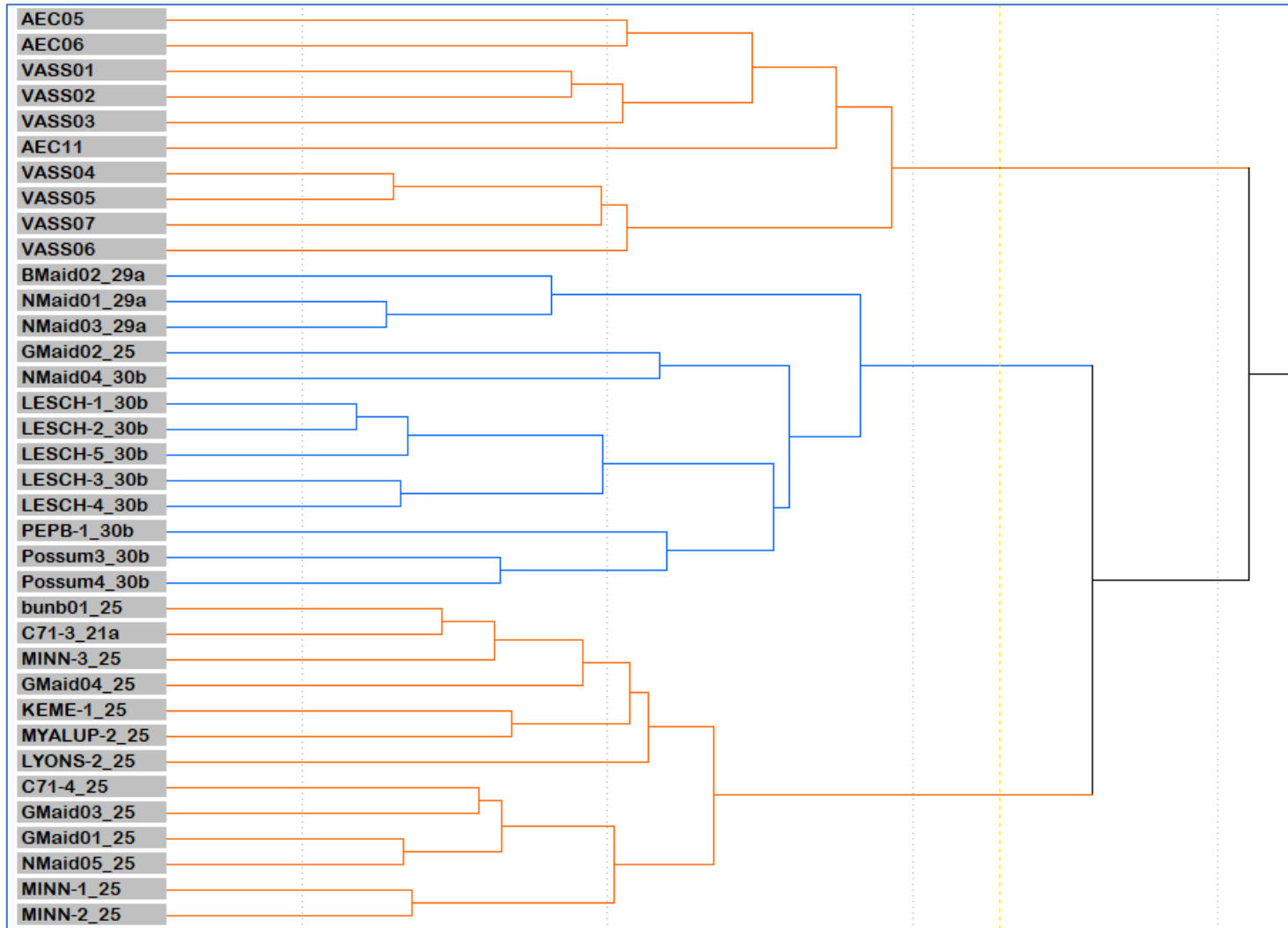


Figure 6. Portion of the dendrogram produced by the MVA of the four DAF quadrats (VASS04-VASS07) when compared to quadrats placed within the “*Eucalyptus rudis*, *Corymbia calophylla* and *Agonis flexuosa* Closed Low Forest” PEC (AEC05, AEC06 & AEC11) (AECOM, 2017) and three quadrats installed near the DAF (VASS01-VASS03) (Ecoedge, 2020).

5 Discussion and conclusions

5.1 Targeted survey

The search of potential habitat for *A. bronwenae* resulted in no plants of this species being found. Possible reasons for this are the history of physical disturbance adjacent to the diversion drain over the last 60 years which has resulted in much of the area being cleared and then re-vegetating (discussed in Ecoedge, 2020). In addition, based on observations by the authors of two nearby populations of *A. bronwenae*, some of the potential habitat was too dry, or had a too heavy cover of the rush *Baumea juncea* to be suitable for *A. bronwenae*.

The same potential habitat was more or less surveyed in 2019 by Ecoedge and whilst the species was not specifically targeted in the 2019 survey it is likely that it would have been observed had it been present.

5.2 Multivariate Analysis

When allowance is made for the time of survey (outside main spring flowering season) and the relatively high level of disturbance, the results of the MVA suggest that the vegetation where the quadrats (VASS04-VASS07) were placed within the DAF is the same vegetation type as that where the quadrats (VASS01-VASS03) reported in Ecoedge (2020) were placed. These quadrats are all similar to vegetation where the three quadrats (AECOM5, AECOM6 and AECOM11) from the AECOM (2017) survey were situated, which is a recognised occurrence of the “*Eucalyptus rudis*, *Corymbia calophylla* and *Agonis flexuosa* Closed Low Forest” PEC.

“*Eucalyptus rudis*, *Corymbia calophylla* and *Agonis flexuosa* Closed Low Forest” is quite a distinctive community in terms of its characteristic shrub and tree species having elements of damplands of heavy soils on the Pinjarra Plain and Abba Plain (e.g. *Eucalyptus rudis*, *Melaleuca raphiophylla*, *Banksia littoralis*, *Hakea varia*) along with taxa characteristic of the Quindalup Dune wetlands (Webb *et al.*, 2009), such as *Spyridium globulosum*, *Acacia littorea* and *Lepidosperma gladiatum*. It is probably this characteristic suite of shrub and tree species, rather than herbaceous species (which largely were not found during the autumn survey reported here) which are the basis for the discrete clustering of the DAF and neighbouring quadrats in the MVA and which separates them from all other floristic community types described by Gibson *et al.* (1994).

Based on the results of the MVA reported here, it is clear that vegetation Unit A, as described in Ecoedge (2020) and in which the four quadrats (VASS04-VASS07) were placed is the PEC “*Eucalyptus rudis*, *Corymbia calophylla* and *Agonis flexuosa* Closed Low Forest”.

6 References

- AECOM (2017). Bussell Highway (Busselton Bypass) Flora and Vegetation Assessment, AECOM Australia Pty Ltd, Unpublished report to Main Roads Western Australia.
- Department of Parks and Wildlife (DPaW) (2017). *Austrostipa bronwenae* Interim Recovery Plan 2017–2022. Interim Recovery Plan No. 381. Department of Parks and Wildlife, Western Australia.
- Environmental Protection Authority of WA (2016). Technical Guidance Flora and Vegetation Surveys for Environmental Impact. EPA, Perth, Western Australia. http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/EPA/Technical/Guidance/FloraandVegetationsurvey_Dec13.pdf
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- Jessop, J., Dashorst, G.R.M., James, F. M. (2006). Grasses of South Australia, An illustrated guide to the native and naturalised species. Wakefield Press, South Australia.
- Webb, A, Keighery, B.J., Keighery, G.J., Longman, V. (2009). The flora and vegetation of the Busselton Plain (Swan Coastal Plain): a report for the Department of Environment and Conservation as part of the Swan Bioplan Project. Dept. of Environment and Conservation, Perth, Western Australia.
- Williams, A.R. (2011). *Austrostipa* (Poaceae) subgenus *Lobatae* in Western Australia. *Telopea*, 13: 177-192.

Appendix 1. Out of season features differentiating between *Austrostipa flavescens* and *A. bronwenae*

Table 1. Differentiating out of season taxonomical descriptions for *A. flavescens* and *A. bronwenae* & field observations (5/03/2020).

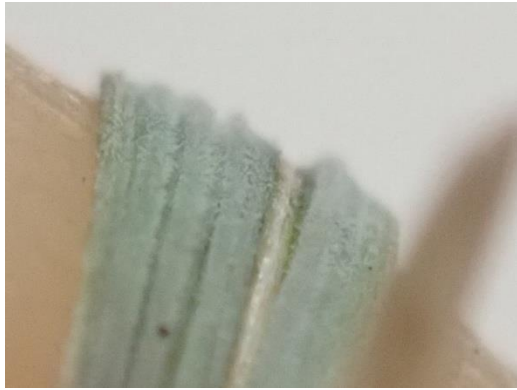
	Taxonomical descriptions		Field observations undertaken	
Species	<i>Austrostipa flavescens</i> Telopea 6: 585 (1996) in (Jessop et al., 2006)	<i>Austrostipa bronwenae</i> (Williams 2011)	<i>Austrostipa. flavescens</i>	<i>Austrostipa bronwenae</i>
Leaf blades	rolled or flat	Terete, rolled or involute	Rolled or flat	rolled
length	8-70 cm	35-45 cm		
width	0.6- 7mm	0.5 – 0.8 mm		
Adaxial surface	Glabrous to scabrid or densely hairy above	Strongly ribbed, pubescent with an even covering of erect hairs 0.03 – 0.6 mm long	Sparse covering of pubescent hairs	pubescent with an even covering of erect hairs 0.03 – 0.6 mm long
Abaxial surface	Glabrous to scabrid or pubescent below.	Not ribbed, glabrous and smooth.	Glabrous and ribbed	Glabrous, not ribbed 'smooth',
Leaf sheaths	Glabrous or minutely pubescent or scabrid, with glabrous or ciliate margins and auricles: ligule 0.3 – 0.6 mm long	Upper leaf sheaths glabrous, but lower sheath margins sometimes with hairs 0.1 – 0.3 mm long. Ligule 0.0-1.0 (-2) mm long, either between asymmetrical sheath lobes (which can be 3-5 mm long), or if absent, then the sheath lobes do not join in the middle of the inside collar region. Auricular region unmarked, or sometimes marked with a darkened spot, glabrous or with a few hairs 0.1 -0.7 mm long.	Symmetrical leaf lobes, ciliate leaf margins.	Asymmetrical leaf lobes. Hairless leaf margins.

Table 2. Images showing out-of-season differentiating features between *A. bronwenae* and *A. flavescens*.

<i>Austrostipa bronwenae</i>	<i>Austrostipa flavescens</i>
 <p data-bbox="331 808 660 842">Blue green – tufted habit</p>	 <p data-bbox="935 808 1264 842">Light green – tufted habit</p>
 <p data-bbox="331 1252 660 1285">Involute, rolled leaf blade</p>	 <p data-bbox="1007 1252 1192 1285">Flat leaf blade</p>
 <p data-bbox="384 1704 612 1738">Terete leaf blade</p>	

Austrostipa bronwenae

Austrostipa flavescens



Ribbed, evenly hairy adaxial leaf surface



Ribbed, glabrous adaxial leaf surface



Smooth, glabrous abaxial leaf surface



Pubescent, ribbed abaxial leaf surface



Assymetrical leaf lobes



Symmetrical leaf lobes

Appendix 2 Quadrat details



Quadrat: VASS04 Date: 5/03/2020

Latitude: 33' 39.930" Longitude: 115' 20.085"

Condition: Degraded

Landscape Position: Plain Soil: Grey-brown loamy sand Litter 80%

SPECIES NAME	COVER
<i>Acacia littorea</i>	1
<i>Lepidosperma longitudinale</i>	1
<i>Acacia saligna</i>	2
<i>Avena barbata</i>	2
<i>Banksia littoralis</i>	2
<i>Ehrharta calycinus</i>	2
<i>Eucalyptus rudis</i>	2
<i>Watsonia meriana</i> var. <i>bulbillifera</i>	2
<i>Kunzea glabrescens</i>	3
<i>Spyridium globulosum</i>	3
<i>Agonis flexuosa</i>	4
<i>Briza maxima</i>	4
<i>Lepidosperma gladiatum</i>	4



Quadrat: VASS05 Dates: 5/03/2020

Latitude: 33' 39.922" Longitude: 115' 20.036"

Condition: Degraded

Landscape Position: Plain Soil: Grey-brown loamy sand Litter 60%

SPECIES NAME	COVER
<i>Acacia saligna</i>	1
<i>Agonis flexuosa</i>	3
<i>Austrostipa flavescens</i>	1
<i>Briza maxima</i>	4
<i>Cynodon dactylon</i>	1
<i>Hardenbergia comptoniana</i>	1
<i>Kunzea glabrescens</i>	3
<i>Lepidosperma gladiatum</i>	4
<i>Spyridium globulosum</i>	1
<i>Watsonia meriana</i> var. <i>bulbillifera</i>	2



Quadrat: VASS06 Dates: 5/03/2020

Latitude: 33' 39.914" Longitude: 115' 19.968"

Condition: Good

Landscape Position: Plain Soil: Grey-brown loamy sand Litter 60%

SPECIES NAME	COVER
<i>Acacia saligna</i>	1
<i>Adenanthos meisneri</i>	1
<i>Agonis flexuosa</i>	4
<i>Agrostocrinum scabrum</i> subsp. <i>scabrum</i>	1
<i>Austrostipa flavescens</i>	2
<i>Avena barbata</i>	2
<i>Baumea juncea</i>	1
<i>Briza maxima</i>	4
<i>Bromus diandrus</i>	2
<i>Conospermum caeruleum</i> subsp. ' <i>Busselton</i> '	1
<i>Dampiera linearis</i>	1
<i>Hibbertia cuneiformis</i>	1
<i>Hypolaena pubescens</i>	1
<i>Kunzea glabrescens</i>	1
<i>Lomandra micrantha</i>	2
<i>Lyginia imberbis</i>	1
<i>Watsonia meriana</i> var. <i>bulbillifera</i>	3



Quadrat: VASS07 Dates: 5/03/2020

Latitude: 33' 39.891" Longitude: 115' 19.817" Condition: Good

Landscape Position: Plain Soil: Grey-brown loamy sand Litter 80%

SPECIES NAME	COVER
<i>Acacia longifolia</i>	1
<i>Acacia saligna</i>	3
<i>Adenanthos meisneri</i>	3
<i>Agonis flexuosa</i>	4
<i>Avena barbata</i>	2
<i>Briza maxima</i>	4
<i>Bromus diandrus</i>	2
<i>Conospermum caeruleum</i> subsp. 'Busselton'	2
<i>Conostylis aculeata</i> subsp. <i>gracilis</i>	1
<i>Corymbia calophylla</i>	3
<i>Ehrharta calycinus</i>	2
<i>Gahnia trifida</i>	1
<i>Hardenbergia comptoniana</i>	1
<i>Jacksonia furcellata</i>	2
<i>Lepidosperma gladiatum</i>	2
<i>Pelargonium capitatum</i>	1
<i>Romulea rosea</i>	1
<i>Spyridium globulosum</i>	1