

New Bridgewater Bridge Project

NATURAL VALUES ASSESSMENT

5th November 2021

For Burbury Consulting



SUMMARY

The proponent, the Department of State Growth of the Tasmanian government, is investigating replacement options for the existing Bridgewater Bridge across the River Derwent from Granton to Bridgewater. The project managers Burbury Consulting engaged North Barker Ecosystem Services (NBES) to undertake a flora and fauna habitat assessment of the project land and to make recommendations to minimise impacts to threatened natural values.

Vegetation

Six native TASVEG vegetation units have been recorded within our investigations:

- AHS saline aquatic herbland 27.34 ha***
- ARS saline sedgeland/rushland* 0.39 ha
- ASF freshwater aquatic sedgeland and rushland** 0.99 ha
- DVG Eucalyptus viminalis grassy forest and woodland 0.62 ha
- NBA Bursaria Acacia woodland and scrub 0.45 ha
- GCL lowland grassland complex 1.26 ha

* Indicates units that correspond to communities listed as threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA).

** Indicates units that correspond to communities listed as threatened under the Tasmanian *Nature Conservation Act 2002* (NCA).

*** Indicates units that correspond to multiple communities listed under the EPBCA and/or NCA.

Threatened Flora

The project land overlaps with occurrences of three species listed as rare under the Tasmanian *Threatened Species Protection Act 1995* (TSPA).

- Austrostipa bigeniculata
 - based on preliminary design considerations, only around 100 m² of a large occurrence (over 10,000 plants) is expected to be impacted by the final design, in addition to scattered locations with low abundances, thus making the expected impact in the order of a couple of hundred plants (with the exact value depending on the relative density within the area of the main occurrence that gets impacted)
- Ruppia megacarpa
- According to Marine Solutions calculations, in the order of 2.01 hectares of potential *Ruppia* spp. (primarily *R. megacarpa*) habitat is likely to be directly and permanently lost within the proposed southern reclamation and under the bridge structure where it crosses the tidal flats either through direct impact (for example, piling) or shading. Due to varied density of *Ruppia* spp. within this area, this is estimated to represent closer to 1.38 hectare of *Ruppia* spp. cover lost (as some parts of the bridge lie over areas with much lower density of the species). Note that this estimate is slightly less than the estimates provided for loss of aquatic vegetation communities or the areas shown on the figures in this report as the *Ruppia* spp. calculations have been based on a more refined boundary of impact *Vittadinia gracilis*
 - project land contains around 28 plants, with 16 plants around the existing highway at Granton and around 12 plants north of the existing bridge, occurring at three locations close to (or identical to) locations at which they

have been reported from in the past – all of the observed plants/locations within the project land are at risk from the extent of permanent works

Two other TSPA rare species, *Schoenoplectus tabernaemontani* and *Vittadinia muelleri*, were observed in our surveys but not within the project land.

Weeds

The project land has been found to support several introduced species, with 140 recorded from the general surveys, including 13 species of weeds declared under the *Tasmanian Weed Management Act 1999*.

Threatened Fauna

The project land is potentially within the range of several threatened fauna but has limited habitat values that could be considered critical to the persistence of species at the local level or higher.

Targeted waterbird and roadkill surveys have helped establish specific mitigation measures and recommendations into potential impacts.

Conclusions and Recommendations

Our results and analyses have established that if our recommendations for mitigation are followed the proposal can proceed without resulting in a significant impact to Matters of National Environmental Significance (MNES) and that it is not likely to have a significant detrimental impact on values listed as threatened under other Acts or considered as conservation significant for other reasons. Largely this is due to the already modified nature of the general landscape and the capacity to avoid, mitigate and offset anticipated impacts to a satisfactory degree.

The following recommendations are made regarding general management of the proposal area and to ensure minimal impacts to conservation significant values.

Native Vegetation

- Concentrate direct and irreversible clearance within areas of non-native vegetation (cleared land) and non-threatened vegetation as much as possible, with particular reference to minimising the final construction footprint (temporary and permanent) within AHS vegetation.
- Apply micro-siting approach (with the aid of an ecologist) to areas of the final footprint within native vegetation – the micro-siting should aim to make minor adjustments to the footprint on the ground by selecting localised areas with relatively less important values (e.g. lower condition areas), as well as maintaining variation within a community across the project land and local areas containing important values.
- In cases of redesign, maximise the proportion of the footprint within non-native (modified) vegetation and avoid threatened and/or native vegetation (as well as habitat for threatened fauna, or locations of threatened flora).
- Clearly demarcate the permitted impact area (project land or outer boundary of disturbance) either in situ and/or clearly on construction plans and specify on all contractor agreements that works, vehicles and materials must be confined within the designated impact area.
- Incorporate rigorous construction controls around sediment displacement and deposition within a Construction Environmental Management Plan, particularly with respect to the AHS community.

- Areas of threatened communities beyond the impact footprint should be designated as exclusion zones and marked on the ground and/or in construction plans to the degree necessary to ensure no inadvertent impacts occur.
- Incorporate a revegetation plan into the post-construction requirements, covering areas where clearance of native vegetation is not required to be a permanent loss (e.g. borrow pits [if required], temporary access routes and temporary construction disturbance footprints). The plan should outline suitable species for revegetation (sourced from the local environment), as well as revegetation specifics, such as seed application rates, use of established plants, specific planting details, *etc.*

Threatened Flora

- It is recommended to exclude as many of the known locations of threatened flora as possible from the impact footprint during the final design phases.
- The general areas around threatened flora locations that are not approved to be impacted should be protected from indirect or inadvertent impacts by designating construction exclusion zones around any known occurrences within 10 m of proposed works – exclusion zones must be specified within the detailed design plans and the exclusions should cover but not be limited to mechanical disturbance, dumping of fill, alteration of drainage patterns and soil compaction. Physical barriers or cordons should be applied as necessary to reinforce the exclusion requirements.

<u>Weeds</u>

- Prepare and implement a stringent project specific Weed Management Plan (which must be linked to contractor requirements within a Construction Environment Management Plan or similar), which amongst other things must adhere to the principles of best practice guidelines and relevant legislation, and contain requirements and prescriptions for:
 - Weed removal and treatment prior to, during, and after civil works.
 - Requirements for wash-down and inspections of all site plant, including earthmoving machinery¹.
 - Specifications around the relocation, importation and reuse of soil and earth during works.
 - Detailed post-works surveys and control, particularly in relation to potential germination of *Amelichloa caudata*, *Galenia pubescens* and *Amsinckia calycina*, as well as consideration of *Amaranthus albus* and *Asphodelus fistulosus*.

Threatened Fauna (excluding waterbirds)

No specific mitigation measures are warranted for the relevant species within the scope of this report (noting the Australian Grayling is outside the scope of this report).

<u>Waterbirds</u>

- Undertake monthly surveys for bird nests from May to February until works commence. Any nest observed within this period should be treated as an exclusion zone and buffered from impacts if possible. Nests that cannot viably be protected from destruction will need to be approved to be taken under permit (for those species protected by the *Wildlife (General) Regulations 2010* (section 5.3).

¹ DPIPWE (2015b); Allen and Gartenstein (2010)

- Within a Soil and Water Management Plan (applied within a Construction Environment Management Plan and completed before works commence), include prescriptions to manage and mitigate sedimentation levels within the aquatic habitats of the River Derwent during (and as a result of) works, particularly in relation to the shallow macrophyte beds adjacent to the causeway. This plan should also mitigate potential impacts from acid sulfate soil.
- Maintain the current structure and position of the causeway regardless of the eventual bridge design. It is understood there is currently no intention to remove the causeway.
- Complete and implement an Artificial Light Management Plan (to take into account light pollution and bird strike mitigation for design considerations with respect to operational lighting of the new crossing and any temporary lighting required during works) it is understood the proponent has engaged a consultant to complete such a plan.

<u>Roadkill</u>

- The final design should favour the presence of continuous structural obstructions along each side and should not include any grassy verges on the new crossing (grassy verges on the terrestrial edges of the adjoining roadways are acceptable).
- Implement location specific roadkill monitoring post-construction, to establish if specific mitigation measures have been beneficial.
- Note aspects of roadkill collisions in relation to the recommended Artificial Light Management Plan.

Consideration of Offsets

- Formalise an offset mechanism and plan for offsetting the loss of AHS vegetation, subject to the final design and the offset requirements from the regulator, with the recommendation being a monetary contribution to conservation projects in the River Derwent, to be managed under the authority of the Derwent Estuary Program. Recommended projects with associated offset value for the AHS (and associated values) include:
 - Construction of a wetland interpretation centre
 - Extension surveys for further patches of AHS vegetation and the key macrophytes that make up the community at this location – including exploration of the potential for *Stuckenia pectinata* in the area
 - Wetland and riparian weed control works
 - Waterbird monitoring and habitat management (primarily weed control)
 - Undertake/commission/sponsor regular rubbish clean-ups along the margins of aquatic habitats around the new crossing for the purposes of maintaining/improving waterbird habitat
- Consider offset recommendations for specific lifeforms (e.g. *Austrostipa bigeniculata* and *Ruppia megacarpa*) if final impacts are greater than expected based on preliminary design considerations.

Project	> New Prideewater Pridee Preject		
Project			
Location	River Derwent, Bridgewater, Tasmania		
Proponent	Department of State Growth		
Project managers	Burbury Consulting: B	ryce Taplin - btaplin@burburyconsulting.com.au	
NBES JOD CODE	BURUU2		
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Field inspections and photos	General flora and faur	na:	
	Richard White and Jar	red Parry	
	Bird surveys:		
	Erin Harris and Richar	d White	
	Sedge extension surve	eys:	
	Andrew North and Ka	ren Ziegler (Derwent); Jared Parry and Erin Harris (Jordan)	
	Spring/summer flora	surveys:	
	Grant Daniels and Jare	ed Parry	
Field dates	General flora and faur	na:	
	- 7-8/4/2020		
	Waterbird surveys:		
	- Periodical from	n 7/4 – 9/12/2020	
	Sedge extension surve	5V2.	
	- 22/5/2020 (De	rwent and lower Jordan by boat)	
	- 25/9/2020 (upper Jordan on foot)		
	Spring/summer flora surveys:		
	- 4/11/2020		
	- 9/12/2020		
Reporting	Grant Daniels		
Mapping	Jacques Demange		
External consultations	Eric Woehler, BirdLife	Tasmania – provision of long-term avifaunal data around	
		project land; additional opinion on avifaunal impacts	
		and mitigation.	
	Sandy Leighton, DSG	and Adam Muyt, GCC – discussion of <i>Galenia pubescens</i>	
		as an emerging priority weed in Tasmania with	
		respect to its occurrence in the project land.	
	Andrew Crane and Cla	are Lond-Caulk, DPIPWE – general discussions of natural	
		values with potential to interact with the proposal.	
Permit to take native flora	DA 18246		
Version	Date	Author / Comment	
Draft 0.1	09/10/2020	Grant Daniels completed preliminary draft for Burbury	
		and ERA comments prior to spring and summer surveys	
Draft 0.2	02/12/2020	Issued partial draft to client as factual report for ECI	
Draft 0.3	11/1/2020	GD and NBES staff completed draft with spring summer	
		results and edits	
Version 1.0	12/1/2021	Grant Daniels delivered to Burbury Consulting	
Version 2.0	25/6/2021GD edits and updates in response		
definition and assessment condition		definition and assessment conditions	
Version 2.1 5/11/2021 GD edits and		GD edits and updates in response to DSG and PM	
		feedback 30/7 and 13/8, MPIS comments 29/10. 5/11	

File Control and Contributors

North Barker Ecosystem Services BUR002: 2021_11_05 v. 2.1



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List of Acronyms

(excluding measurement units and abbreviations defined within figures or tables)

- AHS saline aquatic herbland (TASVEG unit)
- ARS saline sedgeland/rushland (TASVEG unit)
- ASF freshwater aquatic sedgeland and rushland (TASVEG unit)
- DFTD Devil Facial Tumour Disease
- DSEWPaC Department of Sustainability, Environment, Water, Population and Communities
- DPIPWE Department of Primary Industries, Parks, Water and the Environment, Tasmania
- DVG Eucalyptus viminalis grassy forest and woodland (TASVEG unit)
- EPBCA Environment Protection and Biodiversity Conservation Act 1999
- GCL Lowland grassland complex (TASVEG unit)
- LUPAA Land Use Planning and Approvals Act 1993
- MNES Matters of National Environmental Significance
- NBA Bursaria Acacia woodland and scrub (TASVEG unit)
- NBES North Barker Ecosystem Services
- NCA Tasmanian Nature Conservation Act 2002
- NVA Natural Values Atlas database (DPIPWE, Tasmania)
- OAQ water, sea (TASVEG unit)
- SPRAT Species Profile and Threats Database
- TSPA Tasmanian Threatened Species Protection Act 1995

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1 INTRODUCTION

1.1 Background

The proponent, the Department of State Growth of the Tasmanian government, is investigating replacement options for the existing Bridgewater Bridge, which carries the Midland Highway (A1) and the disused Southern Railway Line across the River Derwent estuary from Granton (south) to Bridgewater (north). The crossing currently comprises a purpose-built causeway and a steel truss vertical-lift bridge completed in 1946², both of which filter multilane components of the highway to the north and south into single lanes.

The project managers (Burbury Consulting) engaged North Barker Ecosystem Services (NBES) to undertake a flora and fauna habitat assessment of the project land, and to make recommendations to minimise impacts to threatened natural values, particularly regarding limiting the likelihood of significant impacts to Matters of National Environmental Significance (MNES) protected under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBCA).

1.2 Location and Existing Environment

1.2.1 Location characteristics

The existing Bridgewater Bridge is in the Tasmanian Southeast bioregion and occurs at an intersection of the boundaries of three local government areas: Brighton, Derwent Valley and Glenorchy. Surrounding aquatic areas are part of the River Derwent Marine Conservation Area. The project land and the surrounding local areas have been subject to a long history of human modification and management, including land clearance and conversion, agriculture, urban and industrial use. Local terrestrial habitats have consequently had their natural values reduced and/or restricted with varying apparent levels of human influence. Some components of the aquatic habitats are likely to be novel ecosystems that have colonised human-modified niches such as the causeway and its influence on adjacent sub-tidal flats.

1.2.2 Survey/study area

An extended survey area was initially investigated during the general flora and fauna surveys (with some minor exceptions of parcels for which land access was denied – Figure 1a and 1b), with the current extent of the project land and extent of permanent works areas defined within the initial survey area. It is expected that the chosen design will have a permanent footprint that is smaller than the area defined as the extent of permanent works in this report and will not go beyond the defined boundaries (Figure 1b).

The areas of the River Derwent in and around the project land were the focus of targeted bird surveys (Figure 1b). In addition, extended areas up and down the River Derwent, as well as up the Jordan River to Pontville, were the focus of extension surveys for a threatened sub-aquatic sedge identified during the general surveys (Figures 1c and 1d). Selected areas of the project land were also subject to targeted spring and summer surveys for potential threatened flora and weeds that may not have been detected in the earlier survey effort.

1.2.3 Geology

Soils throughout the terrestrial components of the project land are primarily Cenozoic cover sequences with varied derivations, including Jurassic dolerite (geocode Jd 6001), Quaternary

² Two bridges with different designs were in operation across the span from the causeway and Bridgewater between 1849 and 1946, with a punt in operation between 1829 and 1849

depositions (Qpf 7673) and some elements of Tertiary basalt (Tbs 6594); in addition, a large part of the southern landward edge at Granton is derived from Permian sediment (Pua) as part of the Abels Bay Formation.

The aquatic habitats surrounding the existing bridge and the causeway are based on silt deposition from alluvial flows.

1.2.4 Topography and altitude

The terrestrial components of the project land span from sea level in the lowest points on the River Derwent, to around 15 m asl³ on the margin of Granton in the south, and 35 m around Bridgewater in the north. Bathymetric contours indicate the channel within the River Derwent below the existing bridge is around 5 m at its deepest.

1.2.5 Climate characteristics⁴

Mean rainfall for the area is around 500 mm per annum, with limited seasonal variation in precipitation, but slightly dry autumns relative to other seasons. This coincides with the tail end of the warmest time of year, in which average daily maxima can be in excess of 40 ° C.

2 BOTANICAL SURVEY, ROADKILL, AND FAUNA HABITAT ASSESSMENT

2.1 Background Research – Supporting Data

The following sources were used for biological records from the region to supplement field data collected by NBES:

- Protected Matters database⁵ all matters of national environmental significance that may occur in the area or relate to the area in some way.
- Tasmanian Natural Values Atlas (NVA)⁶ this Department of Primary Industries, Parks, Water and the Environment, Tasmania (DPIPWE) database includes biological records.
- TASVEG 4.0 (and TASVEG Live) digital data this layer has been field-truthed during ground surveys.
- Previous assessments on natural values around the project land (by NBES).
- BirdLife Tasmania for long-term avifaunal data from around the project land⁷, as well as specific consultation with Convenor Eric Woehler.
- Birdata database⁸.
- The Listmap including layers containing annual records of bird roadkill (layers 3004, 3012-14, and 3148).
- Roadkill data supplied by contractors for the Department of State Growth from link 14 Ch 0.00-1.29 (with some adjacent bycatch due to the method).

⁸ Birdlife Australia (2020) available at: https://birdata.birdlife.org.au/

³ Above sea level

⁴ Using climatological data from the nearest weather station at Campania, 42.6867°S 147.4258°E 45m AMSL

⁵ EPBC Act Protected Matters report, (Commonwealth of Australia) – PMST_ Z700NQ

⁶ NVA report_nvr_1_04-Aug-2020 (DPIPWE) – with the database checked manually at later dates for new records

⁷ Includes data not publicly available, from an area defined by a polygon with the following vertices: - 42.7349 147.2138, -42.7511 147.2174, -42.7546 147.2301, -42.7409 147.2441, -42.7348 147.2321, - 42.7349 147.2138

• Data on injured species taken in by Bonorong wildlife rescue and attributed to collisions from the existing bridge area (supplied via email correspondence).

2.2 Survey Timing

Surveys by NBES ecologists commenced in autumn 2020 and concluded in summer 2020, with multi-person field trips varying in duration from 1-2 days undertaken in April, May, September, October and December, in addition to regular periodical bird surveys undertaken by individual observers between April and November; the distribution of survey effort was aligned with optimal survey timing for threatened flora species considered to have a high likelihood of being present (based on habitat and previous records to a radius of 5 km).



Figure 1a: Index of locations of the various survey areas encompassing the main general survey area, targeted bird survey areas, and sedge extension surveys



Figure 1b: Detail of locations of the various survey areas encompassing the main general survey area, targeted bird survey areas, and sedge extension surveys within the lower Jordan River and the lower reaches of the River Derwent



Figure 1c: Detail of location of the sedge extension survey within the upper reaches of the Jordan River



Figure 1d: Detail of location of the sedge extension survey within the upper reaches of the River Derwent

2.3 Flora Field Methods

Flora field data were recorded using handheld non-differential GPS units with average location accuracy < 10 m.

2.3.1 Vegetation mapping

In Tasmania, the primary source on the distribution of vegetation is the statewide TASVEG⁹ mapping database (with TASVEG 4.0 being the latest iteration, and current distribution data available in the TASVEG Live database version). It is standard practice to truth TASVEG data using recent imagery and ground sampling¹⁰.

The image interpretation process for the current proposal involved several satellite images accessed via Google Earth Pro^{11} . The images had a resolution of no more than 2.5 m, with a capture date of 4/12/2019.

Ground sampling was undertaken over the course of all field visits. When a patch was ground sampled, the observer assessed the requisite traits of vegetation structure, floristics, geology and environment to discriminate the patch from any other possible TASVEG units using the descriptions and stepwise keys within the online versions of the current TASVEG companion manual¹². Boundary discrimination was based on image interpretation and aided by point data collected on a hand-held GPS unit. All ground sampling was undertaken during the daytime, mostly in fine weather due to the potential sampling constraints associated with reduced visibility from rain and/or low light.

This combination of image interpretation followed by stratified ground sampling and interpolation is consistent with the DPIPWE guidelines for natural values assessments (section 7, DPIPWE 2015a¹³).

Following ground sampling and the collation of data, TASVEG units observed on site were crossreferenced against all vegetation communities listed as threatened under the Tasmanian *Nature Conservation Act 2002* (NCA) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA).

2.3.2 Floristic surveys, including threatened flora searches

To support the determination of TASVEG units (as per DPIPWE guidelines, 2015a) and provide general floristic data, within each native community at least one full vascular plant species list was taken in representative ¹/₄ ha plots using a Timed Meander Search Procedure¹⁴ (excluding planted ornamentals); this method requires the observer to continue survey effort until survey yields (new species observations) diminish towards zero. Outside the ¹/₄ ha plots, threatened species observations, and observations of additional non-threatened plant species were noted as encountered while traversing the site and while conducting all other observations – where nodes of additional plants were present, additional plots were undertaken. Surveys for the current assessment included 24 floristic plots distributed across the project land. While outside plots, flora survey effort was applied disproportionately within locations considered likely to contain threatened species habitat (based on NBES knowledge and DPIPWE guidelines) or simply contain

⁹ DPIPWE (2013)

¹⁰ TVMMP (2013)

¹¹ Google Earth Pro (2020), August 2020 – DigitalGlobe, TerraMetrics, CNES/ Airbus

¹² Kitchener and Harris (2013)

¹³ DPIPWE (2015a)

¹⁴ Goff *et al.* (1982)

species not noted earlier (based on observations of habitat variation at the sub-community scale). In addition, locations of previous threatened flora observations within the project land (based on NVA observation data) were visited for verification of identification and to establish if the species were still present. Similar to the defined plots, meandering searches within potential threatened species habitat or at previously reported locations, continued until a point in time when it was apparent the likelihood of more observations was too low to warrant further effort.

To further increase the survey effectiveness in capturing threatened flora, the general ground survey in April 2020 was supplemented with targeted spring and summer surveys in October and December to maximise the potential for recording threatened species (based on species known within 5 km), particularly those with narrow windows for identification, such as orchids¹⁵.

In addition, extended areas up and downstream within the River Derwent (undertaken by boat), as well as up the Jordan River (on foot and by boat), were the focus of extension surveys for a threatened sub-aquatic sedge identified during the general surveys.

Declared¹⁶ and environmental weeds, as well as symptomatic evidence of plant pathogens, were searched for and recorded where evident within or close to (such as on an adjacent road) the project land.

Botanical nomenclature follows the current census of Tasmanian plants¹⁷.

2.4 Fauna Field Methods

Observations of habitat suitability for fauna (particularly threatened fauna) were made concurrently with the flora ground surveys across the project land. Particular reference and/or targeted searching was undertaken in relation to:

- The suitability of habitat for, and the presence of dens (including natal dens) of the Tasmanian devil (*Sarcophilus harrisii*), the eastern quoll (*Dasyurus viverrinus*), and spotted-tailed quoll (*Dasyurus maculatus* ssp. *maculatus*);
- Habitat potential and the presence of possible foraging holes (diggings) of the eastern barred bandicoot (*Perameles gunnii* ssp. *gunnii*);
- Habitat mapping and periodical surveys targeted at waterbirds in aquatic habitats around the existing bridge, causeway and River Derwent margins; and
- Roadkill on the existing bridge and causeway (with incidental sightings on roads elsewhere in the survey area).

2.4.1 Waterbird surveys

2.4.1.1 Survey area

The aquatic surrounds of the existing bridge were stratified into 12 zones based on habitat type and location (including a buffer of up to 500 m from the initial project land boundary), with the 6 habitat/location zones on the eastern side of the existing bridge mirrored on the western side (Figure 1b). These 12 zones covered all potential aquatic or sub-aquatic habitat associated with the River Derwent in the local area and included the entire existing bridge and causeway.

¹⁵ Wapstra, M. (2018)

¹⁶ Tasmanian Weed Management Act 1999

¹⁷ de Salas & Baker (2020)

2.4.1.2 Habitat types and locations

- <u>Coastal rushland and sedgeland</u> dominated by aquatic sedges, rushes and grasses, and equivalent to TASVEG units ARS and ASF. Associated with the riparian margins of the River Derwent (and including the adjoining 5 m of water) on the northwest bank (zone 1), the northeast bank (zone 2), the southwest bank (zone 7) and the southeast bank (zone 8).
- <u>Deep water on silt</u> the deepest section of water flowing under the existing bridge through a channel maintained by dredging and subsequently relatively depauperate in macrophytes. Divided into the west (zone 3) and the east side of the existing bridge (zone 4).
- <u>Intertidal macrophytes and seagrass</u> shallow (< 5 m) subtidal zones dominated by *Ruppia* species (and other macrophytes) and aquatic grasses of the Zosteraceae. Found on the west (zone 5) and the east side of the causeway (zone 6).
- <u>Existing bridge</u> the steel truss vertical lift bridge in the northern section of the River Derwent crossing. For the surveys it has been separated into two halves, the western side (zone 9) and the eastern side (zone 10).
- <u>Causeway</u> compiled of soil, stone and clay in the southern section of the River Derwent crossing, where the embankment includes some components of grasses, sedges and rushes associated with the 'coastal rushland and sedgeland'. For the surveys it has been separated into two halves, the western side (zone 11) and the eastern side (zone 12).

2.4.1.3 Timing and conditions

To capture potential seasonal variation in avifaunal use of the site and provide scope to capture breeding attempts, targeted waterbird surveys have been undertaken periodically since mid-April 2020 until mid-December 2020 (with any given week having between 0 and 5 surveys, most weeks having 3 surveys and a maximum time between surveys of 24 days). Overall, 60 surveys were conducted. Survey timing was stratified by time of day (morning – prior to 10 am; midday – between 10 am and 3 pm; evening – after 3 pm) and tidal level (high tide, low tide, rising tide and receding tide – noting that this variable is indicative only as it progressively changes through a survey and influences different parts of the site at different rates), both of which may potentially influence variation in foraging, roosting and nesting behaviour. The total number of surveys completed is distributed evenly across the different combinations of time and day and tide level (Table 1).

	Low tide	High tide	Rising tide	Receding tide
Morning	5	5	5	5
Midday	5	5	5	5
Evening	5	5	5	5

able	1. Number	of surveys	completed	by time	of day	and tide level
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Temperature, windspeed, wind direction and cloud cover were recorded at the start of each survey. Surveys were not conducted when visibility was impaired due to fog or low cloud, nor during rain events or very strong winds (some brief observations were however made in such conditions to supplement our understanding of use of the site in such conditions). Each survey included approximately 2 hours of observation time and included observation of each habitat/location zone.

2.4.1.4 Survey method

For each survey:

- Zones 1, 2, 7 and 8 were observed by meandering transects (15-20 minutes each) along the shorelines and/or margins of the sedges/rushes/grasses.
- All other zones were observed from fixed locations on either the adjacent shoreline or the causeway, with survey length dependent on the levels of abundance and activity but generally requiring less than 15 minutes observation to identify all birds and behaviours for each individual site.

Observations within all zones included noting each species (seen or heard) and their abundance, as well as any evident behaviour and habitat use. Behaviours were classed as: perching (including roosting, in trees, on fallen logs, or man-made objects), foraging (including diving, swimming between dives, grazing, and aerial hunting), breeding (courting, nesting/potential nesting, and observed with young), and loafing (resting, on land or in water). Fly-overs were noted (for example to understand the degree of reliance on the river as a guide for local dispersal) but excluded from habitat use assessments.

2.4.2 Roadkill counts

To supplement the roadkill data from external sources (section 2.1), regular (up to 14 a week) drive-by roadkill surveys have been undertaken on the existing bridge and the causeway since late April 2020 until mid-December 2020. Each survey involved an observer (the driver) in a vehicle travelling at less than 60 km/hr crossing the existing bridge and the causeway at least once and noting any dead or injured animals, recording the species, location on the road (bridge or causeway, west or east), the time, and any other relevant notes. Roadkill surveys were only undertaken during daylight hours and were not undertaken in conditions that markedly limited visibility/detectability and/or safety. Incidental records were noted for roadkill on sections of highway adjacent to the existing bridge and the causeway.

Since commencement, at least two roadkill surveys have been undertaken on most days of the work week, with a minimum separation of one hour between multiple counts on any given day. A total of 373 roadkill surveys were undertaken.

2.5 Limitations

Our assessment is primarily focussed on terrestrial and sub-aquatic elements, with fully aquatic elements the scope of another consulting report.

Due to seasonal variations in detectability and accurate discrimination (*i.e.* identification of closely related species), there may be some herb, orchid and/or graminoid species present in the project land that have been overlooked due to flowering at times of the year other than when the surveys were undertaken, or being absent at the time of surveys due to seasonality and/or the absence of requisite germination triggers. In particular, it is noted that the general surveys undertaken in winter coincided with low detectability of the weed *Lepidium draba*, which is subsequently discussed in the weed results as likely to be more widespread than mapped (this was in part remedied by the summer survey when this species was more detectable).

Some habitats (e.g. coastal rushland and sedgeland) were inaccessible on foot due to inundation, the dense nature of the vegetation, and unstable, boggy ground. In some areas of the bird survey zones, sections of this habitat were noted as up to 100 m wide. Detections of natural values (including birds) in these cases relied on observation from the nearest accessible point and/or

relied on non-visual cues (for birds). The capacity for aural detection was however also limited by ambient levels of traffic noise, especially in the morning and afternoon surveys during peak hour traffic.

The potential for plant seasonality to have impacted the detection probability of threatened species in particular has been considered in the interpretation of results and was mitigated by the number and timing of surveys, in particular the targeted spring and summer surveys. To further mitigate survey limitations, field data from the present study were supplemented with data from the Tasmanian Natural Values Atlas¹⁸, the EPBCA Significant Matters database¹⁹, and the external sources listed in section 2.1. All threatened species known or with potential to occur in the local area (5 km radius of the project land) have thus been considered in terms of habitat suitability on site.

There is a potential for erroneous species identification when conducting roadkill surveys on such a busy thoroughfare where pulling over or slowing down are not always viable options and road regulations and safety are foremost. Furthermore, the degree to which the animal has been runover can make identification infeasible. When conducting roadkill surveys on a bridge surrounded by water there is always the chance that an animal, that has been killed or injured, could go undetected if it has fallen into the water.

Locations of critical elements (e.g. specific survey points, weeds²⁰, evidence of pathogens, threatened species habitat, *etc.*), were recorded with a handheld non-differential GPS with an average accuracy of 3-10 m.

3 BIOLOGICAL VALUES

3.1 Vegetation

Six native TASVEG vegetation units were recorded within our broader survey area:

- AHS saline aquatic herbland*** 27.34 ha
- ARS saline sedgeland/rushland* 0.39 ha
- ASF freshwater aquatic sedgeland and rushland** 0.99 ha
- DVG Eucalyptus viminalis grassy forest and woodland 0.62 ha
- GCL lowland grassland complex 1.26 ha
- NBA Bursaria Acacia woodland and scrub 0.45 ha
- * Indicates units that correspond to communities listed as threatened under the Commonwealth EPBCA.
- ** Indicates units that correspond to communities listed as threatened under the Tasmanian *Nature Conservation Act 2002* (NCA).

*** Indicates units that correspond to multiple communities listed under the EPBCA and/or NCA.

The native units cover 31.05 ha (62.62 %) of the 49.58 ha of terrestrial and sub-aquatic components within the 85.71 ha project land, with the remainder being modified land or water. Native vegetation types are described below within groupings derived from similarities in floristics and

¹⁸ NVA report_nvr_1_04-Aug-2020 (DPIPWE) – with the database checked manually at later dates for new records

¹⁹ EPBC Act Protected Matters Report (Commonwealth of Australia) PMST_Z700NQ

²⁰ Tasmanian Weed Management Act 1999

structure. Vascular plant species lists from sampling points are given in Appendix A. The distribution of TASVEG units recorded within the project land is illustrated in Figures 2a and 2b.

3.1.1 Aquatic habitats

- AHS saline aquatic herbland (NCA and EPBCA listed) 27.34 ha
- ARS saline sedgeland/rushland (EPBCA listed) 0.39 ha
- ASF freshwater aquatic sedgeland and rushland (NCA listed) 0.99 ha

Within the project land, these units occur almost exclusively on the margins of the River Derwent associated with both the natural coastline and the banks of the causeway (Plates 1 - 3, Figures 2a and 2b), with the latter niche likely to have been colonised more extensively since construction of the causeway and the resultant implications for water movement and sediment deposition. Comparison with historical photos shows that change has been marginal over the last 150 years for the rushy and grassy elements, with *Phragmites* appearing to have expanded more in that time than *Juncus* (Plates 4-7); the same photo comparisons are not available for the subtidal macrophyte beds adjacent to the causeway, but it is effectively certain they have greatly expanded since its construction, as the area was unlikely to be as suitable for the presence of the assemblage if water depths and flows prior to the causeway were equivalent to what occurs in the unimpeded sections of the river now.

The subtidal macrophyte beds (Plate 8) have been surveyed during the aquatic investigations for the project and found to be comprised of a mix of *Ruppia* species (*R. megacarpa* and likely *R. polycarpa*), *Lepilaena cylindrocarpa*, *Zostera muelleri*, and several epiphytic or associated macroalgae²¹ - *Stuckenia pectinata* may be present. The assemblage constitutes the TASVEG unit AHS saline aquatic herbland²², which is listed as threatened under the NCA and vulnerable under the EPBCA within the listed ecological community 'subtropical and temperate coastal saltmarsh'.

Phragmites australis is the dominant species within the patches of ASF, with *Juncus pallidus* and *Schoenoplectus pungens* other natives noted within the relatively depauperate patches. Localised patches of *Juncus kraussii* occur within the ASF at a scale too small to practically differentiate as patches of ARS.

The patches of ASF in the River Derwent qualify as listed wetlands under the NCA. A small remnant patch of ASF was mapped near the Black Snake Road underpass at Granton - this appears to be a vestige of a drainage line now mostly subsumed by the surrounding land modifications and subsequently lacks any meaningful value as a wetland (Plate 3). Thus, patches of ASF within the River Derwent meet the definitions of threatened wetlands under the NCA, but the isolated patch at Granton does not.

The examples of ARS within the project land are dominated by 1-2 m tall tussocks of *Juncus kraussii* subsp. *australiensis*, with a variably dense layer of halophytic herbs at ground level, including *Apium prostratum, Lilaeopsis polyantha, Limonium australe* var. *australe, Lobelia anceps, Samolus repens* var. *repens* and *Selliera radicans*.

The patches of ARS within the project land meet the definition for listing under the EPBCA vulnerable ecological community subtropical and temperate coastal saltmarsh; however, as the patches of ARS are so small, their qualification is contingent upon being present within a mosaic of interconnected qualifying vegetation.

²¹ Pers. comm. Tim Alexander, Marine Solutions

²² With the boundary of the unit determined by Mount (2011)

The wetlands and aquatic areas to the west and on the northeast landward corner of the existing bridge constitute part of the River Derwent nationally important wetland. None of the wetland (or River Derwent more broadly) is listed as a RAMSAR site of international importance.



Plate 1: Juncus kraussii dominated saline sedgeland and rushland (ARS) on the southeast margin of the causeway



Plate 2: *Phragmites australis* dominated wetland (freshwater aquatic sedgeland - ASF) on the southwest margin of the project land



Plate 3: *Phragmites australis* dominated patch of a remnant watercourse now lacking wetland values



Plate 4: Southwest corner of causeway shown in photo dated 1870, showing relatively sparse cover of rushes



Plate 5: Southwest corner of causeway in 2020, showing slightly increased cover of *Phragmites* (and more roadside weeds) since 1870



Plate 6: Southeast corner of causeway shown in photo dated 1923, showing relatively sparse cover of rushes



Plate 7: Southeast corner of causeway in 2020, showing slightly increased cover of *Phragmites* (and more roadside weeds) since 1923



Plate 8: Macroalgal growth within the subtidal macrophyte and seagrass beds adjacent to the causeway (May 2020 photo taken from aircraft)



Figure 2a: Distribution of verified native vegetation types within project land (north)

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Figure 2b: Distribution of verified native vegetation types within project land (south)

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3.1.2 Dry forest and woodland or scrub

- DVG Eucalyptus viminalis grassy forest and woodland 0.62 ha
- NBA Bursaria Acacia woodland and scrub 0.45 ha

Within the project land, these units are restricted to a road-cutting embankment to the southwest of the existing part of the highway through Granton (Figure 2b).

The small (0.62 ha) edge of a DVG remnant that falls within the project land is in low-moderate condition (Plate 9), with frequent occurrences of the weedy shrub African boxthorn (*Lycium ferocissimum*). The canopy is dominated by spreading 12-20 m tall *E. viminalis* and occasional *E. pulchella.* The shrub and small tree layers are dominated by *Acacia mearnsii* and *Dodonaea viscosa.* Native grasses dominate the ground layer, particularly *Austrostipa mollis* and *A. scabra.*

The adjacent small patch (0.45 ha) of *Acacia mearnsii* dominated woodland and scrub (Plate 10) is evidently derived from past clearance of a eucalypt community that included a component of *E. amygdalina* and *E. pulchella*. The subcanopy and ground layers are broadly similar to the DVG, with ground hugging shrubs such as *Astroloma humifusum, Einadia nutans, Pultenaea pedunculata*, and grasses and graminoids including *Dianella revoluta, Austrostipa mollis*, and *Rytidosperma setaceum*.

The examples of these communities within the project land do not qualify as threatened communities.



Plate 9: Dry Eucalyptus viminalis woodland above the existing highway at Granton



Plate 10: Clearance derived NBA dominated by Acacia mearnsii above the existing highway at Granton

3.1.3 Grassland

- GCL – lowland grassland complex – 1.26 ha

One small patch (totalling 1.26 ha) of GCL occurs within the project land north of the existing bridge (Figure 2a). Although the general area would have supported an extensive system of grassland and grassy habitats prior to settlement, the current nature of the GCL in the project land suggests it may have been disturbance/clearance derived, rather than remnant, particularly given the paucity of plants from genera such as *Poa* and *Themeda*, and the abundance of non-native species. The GCL is nonetheless dominated at ground level by native wallaby grass (*Rytidosperma*) (Plate 11) and spear grasses of *Austrostipa*, including *A. bigeniculata*, *A. nodosa*, and *A. scabra*. Native herbs include *Senecio quadridentatus* and *Cotula australis*. The GCL within the project land was investigated against all relevant definitions and condition criteria and does not meet the requirements of any threatened community.

Patches of modified land were noted as having seasonal localised dominance of the same suite of species, but not sufficient attributes to consider mapping as GCL on the weight of traits and seasonality.



Plate 11: Disturbance-induced grassland on a roadside cutting north of the existing bridge near Bridgewater

3.2 Threatened and Conservation Significant Flora

3.2.1 Threatened flora

The general surveys documented 216 vascular plant species (including 140 exotics) within the project land (Appendix A). Our surveys confirmed or established the presence of four threatened flora species, with an additional species captured during the aquatic investigations²³; only three of these species are found within the extent of permanent works area (Figures 3a and 3b), with these species marked with asterisks below:

- Austrostipa bigeniculata (TSPA rare)*

²³ Marine Solutions surveys – pers. comm. Tim Alexander

- *Ruppia megacarpa* (TSPA rare)* (Marine Solutions records)
- Vittadinia gracilis (TSPA rare)*
- Schoenoplectus tabernaemontani (TSPA rare) not found within project land (Figure 3c)
- Vittadinia muelleri (TSPA rare) not found within project land

In addition to the threatened flora known within (or close to) the project land, Table 2 lists threatened species with observation records attributed to within a 5 km radius, and discusses the potential for each species to occur within the project land based on habitat and the context of known records.

Table 2: Threatened flora species with observations (Tasmanian Natural Values Atlas) or predicted habitat (EPBCA Protected Matters database) from within a 5 km radius of the site ²⁴

Species	Status ²⁵ TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat ²⁶
	Confirmed as pre	sent in project la	nd (by NBES unless otherwise noted)
<i>Austrostipa bigeniculata</i> doublejointed speargrass	rare/ -	Present	<i>Austrostipa bigeniculata</i> is found mainly in the south-east and Midlands in open woodlands and grasslands, where it is often associated with fertile soils and some level of disturbance (Plate 12).
			The project land contains one large occurrence of this species (with in excess of 10,000 plants estimated to be present). This disturbance-derived patch is a new occurrence (<i>i.e.</i> not recorded by previous observers) but is near known records (including a patch of over 20,000 plants) in the Bridgewater/Brighton area, which broadly speaking is a known stronghold for the species.
<i>Ruppia megacarpa</i> largefruit seatassel	rare/ -	Present	Perennial aquatic herb with rhizomes 0.6 to 1 mm in diameter. In Tasmania it is found growing in estuaries and lagoons along the east and southeast coasts, and brackish lagoons in the Midlands; there is also an historic record from the Tamar estuary in the north. Reported by Marine Solutions as a dominant component of the macrophyte beds adjacent to the causeway.
<i>Vittadinia gracilis</i> woolly new- holland-daisy	rare/ -	Present	<i>V. gracilis</i> occurs in grassland and grassy woodland. Project land contains around 28 plants, with 16 plants around the existing highway at Granton (Plate 13) and around 12 plants north of the existing bridge, occurring at three locations close to (or identical to) locations at which they have been reported from in the past – all of the observed plants/locations within the project land are at risk from the permanent footprint (Figures 3a and 3b).

²⁴ Natural Values Report # 1_04-Aug-2020, DPIPWE, 2020; EPBC Act Protected Matters report PMST_Z700NQ, pers. comm. from Tim Alexander, Marine Solutions

²⁵ Tasmanian *Threatened Species Protection Act 1995,* Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

²⁶ Threatened Species Section (2020)

Species	Status ²⁵ TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat ²⁶				
	Confirmed as present in survey area but excluded project land						
<i>Schoenoplectus tabernaemontani</i> river clubsedge	rare/ -	Present	Not previously known within 500 m of the area. Two records were known within 5 km, on the Jordan River near Pontville, and the River Derwent near Limekiln Point near Granton. Prior to our work these two records were the only NVA observations or herbarium specimens known for this species south of Ross in the Midlands. Our initial ground survey of the project land found a clump of around 30 m ² (50-60 % cover) on the northeast foreshore of the River Derwent (Plate 14). Given the paucity of records in southern Tasmania and the potential limitation of requiring clearance of the occurrence, extension surveys of the River Derwent and Jordan River were undertaken. The River Derwent survey resulted in the discovery of 4 new occurrences, supporting around 150 m ² at in excess of 75 % cover (Plate 15, Figure 3c). No additional occurrence has now been excluded from the project land.				
<i>Vittadinia muelleri</i> narrowleaf new- holland-daisy	rare/ -	Present	<i>Vittadinia muelleri</i> occurs in native grassland and grassy woodland. The species was confirmed as still extant north of the current project land, with several hundred plants observed adjacent to the existing highway around Bridgewater (Plate 16).				
	Previously re	eported from pro	ject land or within 500 m radius				
<i>Austrostipa blackii</i> crested speargrass	rare/ -	Low	The habitat of <i>Austrostipa blackii</i> is poorly understood because of confusion with other species. In its "pure" form (<i>i.e.</i> long coma), <i>A. blackii</i> is a species of very near-coastal sites such as the margins of saline lagoons, creek outfalls and vegetated dunes. Further inland, where it seems to grade into other species, it occurs in open grassy woodlands. Marginally suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.				
<i>Bolboschoenus caldwellii</i> sea clubsedge	rare/ -	Very low	<i>Bolboschoenus caldwellii</i> is widespread in shallow, standing, sometimes brackish water, rooted in heavy black mud. A conspicuous species unlikely to have been overlooked within the survey areas.				
Calocephalus citreus	rare/ -	Very low	<i>Calocephalus citreus</i> inhabits disturbed dry grasslands and is found from a few locations in the south-east of the State.				

Species	Status ²⁵ TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat ²⁶
lemon beautyheads			Marginally suitable habitat is present within the project land but the species has not been observed and is very unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.
<i>Calocephalus lacteus</i> milky beautyheads	rare/ -	Very low	Calocephalus lacteus occurs in open, dry sites in lowland areas of eastern and northern Tasmania and on lower altitudes of the Central Plateau. It requires bare ground for recruitment and may benefit from disturbance. It is often found on roadsides and beside tracks. Marginally suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.
<i>Carex gunniana</i> mountain sedge	rare/ -	None	The habitat of <i>Carex gunniana</i> is poorly understood and highly variable. It includes wet eucalypt forest, sandy heathlands, margins of streams, littoral sands, shingle with seepage, damp grasslands within dry forest and rough pasture. Habitat and land use not considered to be compatible with occurrence of the species.
<i>Dianella amoena</i> grassland flaxlily	rare/ ENDANGERED	Low	<i>Dianella amoena</i> occurs mainly in the northern and southern Midlands, where it grows in native grasslands and grassy woodlands. Marginally suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.
<i>Haloragis aspera</i> rough raspwort	vulnerable/ -	Very low	<i>Haloragis aspera</i> is presumed to occur in wet areas in the eastern part of the State. Habitat and land use not considered to be compatible with occurrence of the species.
<i>Haloragis heterophylla</i> variable raspwort	rare/ -	Low	Haloragis heterophylla occurs in poorly-drained sites (sometimes only marginally so), which are often associated with grasslands and grassy woodlands with a high component of <i>Themeda triandra</i> (kangaroo grass). It also occurs in grassy/sedgy <i>Eucalyptus ovata</i> forest and woodland, shrubby creek lines, and broad sedgy/grassy flats, wet pasture and margins of farm dams. Suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.

Species	Status ²⁵ TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat ²⁶
<i>Hibbertia basaltica</i> basalt guineaflower	endangered/ ENDANGERED	None	Hibbertia basaltica is restricted to areas of basalt between Pontville and Bridgewater in southern Tasmania where it occurs on slopes along the lower reaches of the Jordan River and one of its tributaries, in native grassland dominated by <i>Themeda triandra</i> (kangaroo grass) and <i>Austrostipa</i> (spear grass) species with the occasional <i>Bursaria spinosa</i> (prickly box). Rock cover is high, while soils are shallow clay loams. Slopes vary from 0-15 degrees, and altitude 15-45 m above sea level. Note that a very similar taxon, possibly undescribed or within the concept of <i>H.</i> <i>basaltica</i> , occurs in similar habitat but on Jurassic dolerite in the same part of the State, currently all such sites shown on databases as <i>H. basaltica</i> . Suitable habitat is present within the project land but the species has not been observed and is very unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.
<i>Lepidium hyssopifolium</i> soft peppercress	endangered/ ENDANGERED	Very low	The native habitat of <i>Lepidium hyssopifolium</i> is the growth suppression zone beneath large trees in grassy woodlands and grasslands (e.g. over-mature black wattles and isolated eucalypts in rough pasture). <i>Lepidium hyssopifolium</i> is now found primarily under large exotic trees on roadsides and home yards on farms. It occurs in the eastern part of Tasmania between sea-level to 500 metres above sea level in dry, warm and fertile areas on flat ground on weakly acid to alkaline soils derived from a range of rock types. It can also occur on frequently slashed grassy/weedy roadside verges where shade trees are absent. Suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.
<i>Stuckenia pectinata</i> fennel pondweed	rare/ -	Moderate	Stuckenia pectinata is found in fresh to brackish/saline waters in rivers, estuaries and inland lakes. It forms dense stands or mats, particularly in slow-flowing or static water. The species grows in water of various depth. Not observed within the shallow marginal aquatic habitats captured in our surveys, nor reported by Marine Solutions from the aquatic survey of the AHS community. Has been previously reported from the Derwent Estuary (old NVA and Derwent Estuary Program records) and may be present to a minor degree within the AHS around the causeway given the similarities of non-fertile material with other aquatic macrophytes and the limitations of aquatic surveys.
<i>Triptilodiscus pygmaeus</i> dwarf sunray	vulnerable/ -	Very low	<i>Triptilodiscus pygmaeus</i> grows within grasslands, grassy woodlands or rockplates, with the underlying substrate being mostly Tertiary basalt or Jurassic dolerite. The
Species	Status ²⁵ TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat ²⁶
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			elevation range of recorded sites in Tasmania is 30-470 m above sea level, with an annual rainfall of about 450-600 mm. The species occurs within native grassland dominated by <i>Themeda triandra</i> (kangaroo grass). Habitat and landuse not considered to be compatible with occurrence of the species.
<i>Vittadinia burbidgeae</i> smooth new- holland-daisy	rare/ -	Very low	<i>V. burbidgeae</i> occurs in grassland and grassy woodland. Typically found further north in the Midlands and unlikely to have been overlooked in the project land.
	Prev	viously reported f	from within 5 km radius
<i>Aphelia gracilis</i> slender fanwort	rare/ -	Very low	Aphelia gracilis inhabits damp sandy ground and wet places in the Midlands and north-east of the State. It may readily colonise sites after fire or other disturbance. Typically found further north in the Midlands and unlikely to have been overlooked in the project land.
<i>Asperula scoparia</i> subsp. <i>scoparia</i> prickly woodruff	rare/ -	Low	Asperula scoparia subsp. scoparia is widespread in Tasmania and is mainly found in native grasslands and grassy forests, often on fertile substrates such as dolerite- derived soils. Forested sites are usually dominated by <i>Eucalyptus globulus</i> and <i>E. viminalis</i> (lower elevations) and <i>E. delegatensis</i> (higher elevations). Suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing
<i>Atriplex suberecta</i> sprawling saltbush	vulnerable/ -	Very low	Atriplex suberecta occurs in a wide range of habitats on most soil types, including saline areas, but is most commonly found in disturbed areas. Very unlikely to have been overlooked within the small amount of suitable habitat in the project land.
<i>Brachyscome rigidula</i> cutleaf daisy	vulnerable/ -	Very low	<i>Brachyscome rigidula</i> is found in the Midlands, East Coast and in parts of the eastern Central Highlands of Tasmania, where it occurs in rough pasture, grassland and grassy woodland on dry rocky hills and flats. Typically found further north in the Midlands and unlikely to have been overlooked in the project land.
<i>Caladenia anthracina</i> blacktip spider- orchid	endangered/ CRITICALLY ENDANGERED	None	<i>Caladenia anthracina</i> has a restricted distribution in the Campbelltown/Ross area, occurring in grassy woodland with <i>Acacia dealbata</i> (silver wattle) and bracken on well-drained sandy soil. Two historical sites from the Derwent Valley are presumed extinct.

Species	Status ²⁵ TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat ²⁶
<i>Caladenia caudata</i> tailed spider- orchid	vulnerable/ VULNERABLE	None	Caladenia caudata has highly variable habitat, which includes the central north: <i>Eucalyptus obliqua</i> heathy forest on low undulating hills; the north-east: <i>E. globulus</i> grassy/heathy coastal forest, <i>E. amygdalina</i> heathy woodland and forest, <i>Allocasuarina</i> woodland; and the south-east: <i>E. amygdalina</i> forest and woodland on sandstone, coastal <i>E. viminalis</i> forest on deep sands. Substrates vary from dolerite to sandstone to granite, with soils ranging from deep windblown sands, sands derived from sandstone and well-developed clay loams developed from dolerite. A high degree of insolation is typical of many sites. Habitat and land use not considered to be compatible with occurrence of the species.
<i>Caladenia filamentosa</i> daddy longlegs	rare/ -	None	<i>Caladenia filamentosa</i> occurs in lowland heathy and sedgy eucalypt forest and woodland on sandy soils. Habitat and land use not considered to be compatible with occurrence of the species.
<i>Colobanthus curtisiae</i> grassland cupflower	rare/ VULNERABLE	None	When first described, <i>Colobanthus curtisiae</i> was understood to occur in native grassland and grassy woodland (the type location is a grassy <i>E. pauciflora</i> woodland on a small basalt hill) but also extending to subalpine low vegetation (Ben Lomond area). This species is now known to occur in lowland grasslands and grassy woodlands but is also prevalent on rocky outcrops and margins of forest on dolerite on the Central Highlands (including disturbed sites such as log landings and snig tracks). Typically found further north in the Midlands and unlikely to have been overlooked in the project land.
<i>Cryptandra amara</i> pretty pearlflower	endangered/ -	Very low	<i>Cryptandra amara</i> grows in some of the driest areas of the State and is typically associated with fertile rocky substrates (e.g. basalt). Its habitat ranges from near-riparian rockplates to grasslands or grassy woodlands. Suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.
<i>Desmodium varians</i> slender ticktrefoil	endangered/ -	Very low	<i>Desmodium varians</i> occurs locally in the east of the State, growing in native grassland, or open grassy shrubland or woodland, with <i>Themeda triandra</i> (kangaroo grass) and <i>Poa labillardierei</i> (silver tussockgrass) being the most prominent grasses. Suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to

Species	Status ²⁵ TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat ²⁶
			discrete locations and/or reduced to ground level by grazing or mowing.
<i>Diuris palustris</i> swamp doubletail	endangered/ -	None	<i>Diuris palustris</i> occurs in coastal areas in grassy open eucalypt forest, sedgy grassland and heathland with <i>Leptospermum</i> (teatree) and <i>Melaleuca</i> (paperbark) on poorly- to moderately-drained sandy peat and loams, usually in sites that are wet in winter. Habitat and land use not considered to be compatible with occurrence of the species.
<i>Epilobium pallidiflorum</i> showy willowherb	Rare (delisting pending)/ -	None	<i>Epilobium pallidiflorum</i> occurs in wet places (e.g. natural wetlands amongst forest, margins of <i>Melaleuca ericifolia</i> swamp forest, scrubby-sedgy <i>E. ovata</i> woodland on heavy soils, etc.) mostly in the north and north-west of the State. Highly unlikely to have been overlooked.
<i>Eryngium ovinum</i> blue devil	vulnerable/ -	Very low	<i>Eryngium ovinum</i> occurs in a range of lowland vegetation types most often on fertile heavy clay soils derived from dolerite. Vegetation types include open grasslands usually dominated by <i>Themeda triandra</i> (kangaroo grass), grassy forests and woodlands on slopes, ridges and broad flats, and also roadside verges (representing remnant populations). Suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.
<i>Eucalyptus risdonii</i> risdon peppermint	rare/ -	None	<i>Eucalyptus risdonii</i> is restricted to the greater Hobart area (particularly the Meehan Range), with an outlying population at Mangalore and on South Arm. It occurs on mudstone, with an altitudinal range from near sea level to 150 m above sea level. It can occur as a dominant in low open forest with a sparse understorey on dry, insolated ridgelines and slopes (e.g. with a north-west aspect), and individuals can extend into other forest types typically dominated by <i>E. tenuiramis</i> or <i>E. amygdalina</i> (but occasionally by other species) on less exposed sites. Highly unlikely to have been overlooked.
<i>Glycine latrobeana</i> clover glycine	vulnerable/ VULNERABLE	Very low	<i>Glycine latrobeana</i> occurs in a range of habitats, geologies and vegetation types. Soils are usually fertile but can be sandy when adjacent to or overlaying fertile soils. The species mainly occurs on flats and undulating terrain over a wide geographical range, including near-coastal environments, the Midlands, and the Central Plateau. It mainly occurs in grassy/heathy forests and woodlands and native grasslands. Habitat and landuse not considered to be compatible with occurrence of the species.

Species	Status ²⁵ TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat ²⁶
<i>Gratiola pubescens</i> hairy brooklime	rare/ -	Very low	Gratiola pubescens is most commonly located in permanently or seasonally damp or swampy ground, including the margins of farm dams. Suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.
<i>Lachnagrostis robusta</i> tall blowngrass	rare/ -	Very low	<i>Lachnagrostis robusta</i> occurs in saline situations such as the margins of coastal and inland saline lagoons. Marginal habitat only within project land. Not likely to have been overlooked.
<i>Lepilaena patentifolia</i> spreading watermat	rare/ -	Very low	<i>Lepilaena patentifolia</i> occurs in coastal lagoons, creeks, inlets and estuaries and brackish inland lagoons. Not observed within the shallow marginal aquatic habitats captured in our surveys.
<i>Lythrum salicaria</i> purple loosestrife	vulnerable/ -	None	<i>Lythrum salicaria</i> inhabits swamps, stream banks and rivers mainly in the north and north-east of the State. It can also occur between gaps in <i>Melaleuca ericifolia</i> forest. This species can act as a weed, proliferating along roadsides and other disturbed areas, and, as horticultural strains are in cultivation and birds can disperse seed, some occurrences may not be native. Highly unlikely to have been overlooked.
<i>Olearia hookeri</i> crimsontip daisybush	rare/ -	None	<i>Olearia hookeri</i> is found on dry hills around Hobart in the State's south and along the central east coast. It grows within eucalypt woodlands with a mixed grassy-shrubby understorey, favouring north-north-westerly slopes on mudstone (except for an atypical occurrence on dolerite at Templestowe flats near Seymour). In the south of the State the habitat is dominated by <i>Eucalyptus amygdalina</i> , <i>Eucalyptus risdonii</i> or <i>Eucalyptus tenuiramis</i> , in the central east near Mt Peter the habitat is dominated by <i>Eucalyptus sieberi</i> over a very sparse understorey. Highly unlikely to have been overlooked.
<i>Pellaea calidirupium</i> hotrock fern	rare/ -	None	Pellaea calidirupium is found in inland, rocky habitats in areas of low to moderate rainfall predominantly in the eastern half of Tasmania. It grows in crevices and on ledges on exposed or semi-exposed rock outcrops. A large sterile colony occurs on the bare summit of Casaveen Bluff (east of York Plains), while nearby, on a tributary of the Little Swanport River plants grow under more favourable conditions on a rock ledge within the protection of a rock gully. Habitat and landuse not considered to be compatible with occurrence of the species.

Species	Status ²⁵ TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat ²⁶
<i>Pterostylis ziegeleri</i> grassland greenhood	vulnerable/ VULNERABLE	Very low	Pterostylis ziegeleri is restricted to the east and north of Tasmania. In coastal areas, the species occurs on the slopes of low stabilised sand dunes and in grassy dune swales, while in the Midlands it grows in native grassland or grassy woodland on well-drained clay loams derived from basalt. Suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.
<i>Pultenaea prostrata</i> silky bushpea	vulnerable/ -	Very low	Pultenaea prostrata occurs in grassy woodlands or grasslands, mostly on Tertiary basalt or Quaternary alluvium. Suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.
<i>Ranunculus pumilio var. pumilio</i> ferny buttercup	rare/ -	Very low	Ranunculus pumilio var. pumilio occurs mostly in wet places (e.g. broad floodplains of permanent creeks, "wet pastures") from sea level to altitudes of 800-900 m above sea level. Suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.
<i>Scleranthus diander</i> tufted knawel	vulnerable/ -	Very low	<i>Scleranthus diander</i> is found from the Central Midlands area to Hobart with most of the records from the Ross and Tunbridge areas. This species inhabits grassy woodland and is associated with dolerite and basalt substrates. Typically found further north in the Midlands and unlikely to have been overlooked in the project land.
<i>Scleranthus fasciculatus</i> spreading knawel	vulnerable/ -	Very low	Scleranthus fasciculatus is known from a few locations in the Midlands and south-east. The vegetation at most of the sites is <i>Poa</i> grassland/grassy woodland. <i>Scleranthus</i> <i>fasciculatus</i> appears to need gaps between the tussock spaces for its survival and both fire and stock grazing maintain the openness it requires. Often found in areas protected from grazing such as coarse woody debris. Typically found further north in the Midlands and unlikely to have been overlooked in the project land.
<i>Senecio squarrosus</i> leafy fireweed	rare/ -	Low	<i>Senecio squarrosus</i> occurs in a wide variety of habitats. One form occurs predominantly in lowland damp tussock grasslands. The more widespread and common form occurs mainly in dry forests (often grassy) but extends to wet forests and other vegetation types.

Species	Status ²⁵ TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat ²⁶
			Suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing. Can have prolonged absences when disturbance is lacking in suitable habitat.
<i>Stackhousia subterranea</i> grassland candles	endangered/ -	Very low	Stackhousia subterranea occurs in native grasslands and grassy woodlands/forests, often associated with fertile soils derived from basalt. Themeda triandra (kangaroo grass) is often one of the more prominent grasses. Typically found further north in the Midlands and unlikely to have been overlooked in the project land.
<i>Thesium australe</i> southern toadflax	extinct/ VULNERABLE	None	In Tasmania, <i>Thesium australe</i> is known only from an 1804 collection from the Derwent Valley. Suitable habitat for this species includes grassland and grassy woodland. <i>Thesium australe</i> is presumed extinct in Tasmania.
<i>Uncinia elegans</i> handsome hooksedge	rare/ -	None	<i>Uncinia elegans</i> occurs in a wide range of forest types including wet sclerophyll forest, dry sclerophyll forest and open grassy woodlands. It is most often associated with damp grassy habitats and can occur on disturbed sites. Habitat and landuse not considered to be compatible with occurrence of the species.
<i>Vallisneria australis</i> river ribbons	rare/ -	Very low	<i>Vallisneria australis</i> grows rooted and submerged in flowing freshwater habitats such as major rivers of the Midlands. Not observed within the shallow marginal aquatic habitats captured in our surveys.
<i>Velleia paradoxa</i> spur velleia	vulnerable/ -	Very low	<i>Velleia paradoxa</i> is known from the Hobart and Launceston areas, and the Midlands and the Derwent Valley, where it occurs in grassy woodlands or grasslands on dry sites. It has been recorded up to 550 m above sea level at sites with an annual rainfall range of 450-750 mm. Suitable habitat is present within the project land but the species has not been observed and is unlikely to have been overlooked unless it was low in number, restricted to discrete locations and/or reduced to ground level by grazing or mowing.
<i>Vittadinia cuneata</i> var. <i>cuneata</i> fuzzy new- holland-daisy	rare/ -	None	<i>Vittadinia cuneata</i> var. <i>cuneata</i> occurs in native grassland and grassy woodland. Typically found further north in the Midlands and unlikely to have been overlooked in the project land.
<i>Xanthoparmelia amphixantha</i> lichen	endangered/ -	Very low	<i>Xanthoparmelia amphixantha</i> occurs in the Southern Midlands on stony shallow soils in native grassland. Habitat and landuse not considered to be compatible with occurrence of the species.

Species	Status ²⁵ TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat ²⁶
<i>Xanthoparmelia molliuscula</i> lichen	endangered/ -	Very low	<i>Xanthoparmelia molliuscula</i> occurs on basalt in the Midlands on shallow, stony soils in native grassland. Habitat and landuse not considered to be compatible with occurrence of the species.
<i>Xanthoparmelia vicariella</i> lichen	rare/ -	Very low	<i>Xanthoparmelia vicariella</i> is known only from the Southern Midlands where it occurs on dolerite and basalt boulders in dry woodland and native grassland. Habitat and landuse not considered to be compatible with occurrence of the species.
		Predicted by hal	bitat mapping only
<i>Barbarea australis</i> riverbed wintercress	endangered/ - ENDANGERED	None	Barbarea australis is a riparian species found near river margins, creek beds and along flood channels adjacent to the river. It tends to favour the slower reaches and has not been found on steeper sections of rivers. It predominantly occurs in flood deposits of silt and gravel deposited as point bars and at the margins of base flows, or more occasionally or between large cobbles on sites frequently disturbed by fluvial processes. Some of the sites are a considerable distance from the river, in flood channels scoured by previous flood action, exposing river pebbles. Most populations are in the Central Highlands, but other populations occur in the north-east and upland areas in the central north. Location, habitat and/or landuse not considered to be compatible with occurrence of the species.
<i>Epacris exserta</i> South Esk heath	endangered/ ENDANGERED	None	<i>Epacris exserta</i> occurs along the lower reaches of the South Esk, North Esk and Supply rivers. It is a strictly riparian species that grows in areas subject to periodic inundation, mainly on alluvium amongst dolerite boulders within dense riparian scrub, and occasionally in open rocky sites. It has been recorded from 10-310 m asl. Location, habitat and/or landuse not considered to be compatible with occurrence of the species.
<i>Epacris virgata</i> (Kettering) pretty heath	vulnerable/ ENDANGERED	None	<i>Epacris virgata</i> (Kettering) occurs among foothills in south- eastern Tasmania in dry sclerophyll forest on hilly terrain at elevations of 10-300 m above sea level, mainly on dolerite, though sometimes close to the geological boundary of dolerite and Permian mudstone. It is generally associated with grassy/heathy <i>Eucalyptus ovata</i> woodland/forest but is also occasionally found in grassy/heathy <i>E. pulchella</i> woodland/forest. Location, habitat and/or landuse not considered to be compatible with occurrence of the species.
Leucochrysum albicans var. tricolor	endangered/ ENDANGERED	None	<i>Leucochrysum albicans</i> var. <i>tricolor</i> occurs in the west and on the Central Plateau and the Midlands, mostly on basalt soils in open grassland. This species would have originally

Species	Status ²⁵ TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat ²⁶
grassland paperdaisy			occupied <i>Eucalyptus pauciflora</i> woodland and tussock grassland, though most of this habitat is now converted to improved pasture or cropland.
			Location, habitat and/or landuse not considered to be compatible with occurrence of the species.
<i>Prasophyllum apoxychilum</i> tapered leek- orchid	endangered/ ENDANGERED	None	<i>Prasophyllum apoxychilum</i> is restricted to eastern and north-eastern Tasmania where it occurs in coastal heathland or grassy and scrubby open eucalypt forest on sandy and clay loams, often among rocks. It occurs at a range of elevations and seems to be strongly associated with dolerite in the east and south-east of its range. Location, habitat and/or landuse not considered to be compatible with occurrence of the species.
<i>Pterostylis commutata</i> Midlands greenhood	endangered/ CRITICALLY ENDANGERED	None	<i>Pterostylis commutata</i> is restricted to Tasmania's Midlands, where it occurs in native grassland and <i>Eucalyptus</i> <i>pauciflora</i> grassy woodland on well-drained sandy soils and basalt loams. Location, habitat and/or landuse not considered to be compatible with occurrence of the species.
<i>Xerochrysum</i> <i>palustre</i> swamp everlasting	vulnerable / VULNERABLE	None	Mostly inhabits seasonally swampy environments in lowlands, but highland occurrences on basalt outcrops have also been found. Location, habitat and/or landuse not considered to be compatible with occurrence of the species.



Plate 12: Austrostipa bigeniculata on a roadside cutting north of the existing bridge near Bridgewater (earlier part of project land now excluded)



Plate 13: Vittadinia gracilis adjacent to the existing highway (south of the existing bridge) near Granton



Plate 14: Schoenoplectus tabernaemontani observed on the north-eastern shore of the River Derwent adjacent to the existing Bridgewater Bridge – inset shows detail of fertile material (note this occurrence has now been excised from the project land)



Plate 15: Schoenoplectus tabernaemontani observed during the extension survey on the River Derwent



Figure 3a: Distribution of threatened flora within north of project land (including past local records) (noting that report by Marine Solutions contains current mapping of *Ruppia megacarpa*)



Figure 3b: Distribution of threatened flora within south of project land (including past local records) (noting that report by Marine Solutions contains current mapping of *Ruppia megacarpa*)



Figure 3c: Distribution of Schoenoplectus tabernaemontani (river club sedge) from the River Derwent extension survey



Plate 16: Vittadinia muelleri on a roadside cutting north of the existing bridge near Bridgewater

3.3 Introduced Plants and Plant Pathogens

3.3.1 Weeds

The study area has been found to support several introduced species, with 140 taxa recorded from the general surveys, including 13 species of weeds declared under the *Tasmanian Weed Management Act 1999*, an additional two species of declared weed have been recorded within the site (or close to it) in the past according to NVA data.

The declared weeds observed or previously reported* in the area are (Figures 4a-f):

- African boxthorn Lycium ferocissimum common throughout
- amsinckia *Amsinckia calycina* two adjacent clusters found on the causeway, with over 100 plants (eradicated by NBES during the survey) (Plate 17)
- blackberry *Rubus fruticosus* aggregate common throughout
- boneseed *Chrysanthemoides monilifera* common throughout
- Californian thistle *Cirsium arvense* concentrated patches
- espartillo Amelichloa caudata patchy around Bridgewater side of existing bridge
- fennel Foeniculum vulgare (Plates 18a & 18b) common throughout
- gorse *Ulex europaeus* occasional throughout
- hoary cress/ white weed *Lepidium draba* common throughout
- onion weed Asphodelus fistulosus* past record only, northwest of project land
- Montpellier/canary broom *Genista monspessulana* common throughout
- slender thistle *Carduus pycnocephalus* concentrated patches

- tumbleweed *Amaranthus albus* * past records around northern end of existing bridge
- white horehound *Marrubium vulgare* occasional throughout
- willow Salix x fragilis nothovar fragilis edge of the River Derwent only

Declared weeds (as well as environmental weeds) are common and widespread across the project land, with common occurrences of African boxthorn (Plate 19) and locally dense patches of blackberry and fennel being particularly prominent. The local area is also recognised as supporting a significant component of the only known population of espartillo (*Amelichloa caudata*) within mainland Tasmania; this species was first recorded in the vicinity of the project land in the early 90s and remains extant, with at least three locations in the project land (Plate 20) and around a dozen known from the broader surrounds²⁷ (Figures 4a-f) – to the best of our knowledge no formal eradication attempt has been made for the species prior to this project. A similarly novel Tasmanian weed, tumble weed (*Amaranthus albus*), which has only half a dozen areas of infestation known in Tasmania, has previously been reported from near the project land according to NVA records (Figures 4a-f), but has not been detected recently (including our surveys in which the previous locations were searched – Plate 21) and may not currently be present. An additional high threat weed, amsinckia (*Amsinckia calycina*), was recorded on the causeway during our survey and was removed entirely (by hand) on the day.

In addition to declared weeds, part of the project land near Granton was found to support about 50 plants of coastal galenia (*Galenia pubescens*) (Plate 22), which is a relatively novel weed for mainland Tasmania (known from verges of the Brooker Highway between Granton and Lutana, as well as some periurban and highway locations on the eastern shore, with all other Tasmanian records on Flinders Island) and recognised as a potential high threat emerging weed warranting eradication.



Plate 17: Amsinckia was recorded on the causeway in November 2020 by NBES and hand removed on the day in an attempt at eradication

²⁷ With observations provided to NBES from a recent Eco-works survey by Oliver Strutt





Plates 18a and b: Locally dense infestations of fennel are present throughout the project land



Plate 19: Shrubs of African boxthorn are common within the project land



Plate 20: Green upright clumps are espartillo Amelichloa caudata (photo from EcoWorks)

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Plate 21: The past reported locations of tumbleweed *Amaranthus albus* were searched repeatedly during surveys and not found to support the species – it is considered likely that the habitat has changed markedly since the species occurred at the reported locations (being suspected to be more cultivated and maintained now, and perhaps less suitable for its occurrence)



Plate 22: Coastal galenia control site (pink patches post-treatment) following works undertaken by NBES in the course of this project



Figure 4a: Reference index for maps of distribution of weeds (note that because of the large abundance and diversity of weeds, our weed mapping has been simplified into zones with similar composition and density of species – individual locations where weeds were recorded are also presented, but are not labelled on the maps to improve clarity)



Figure 4b: Distribution of weeds within north of project land



Figure 4c: Distribution of weeds within north of project land



Figure 4d: Distribution of weeds within project land around the northern end of the existing bridge and the causeway



Figure 4e: Distribution of weeds within the project land around the southern end of the existing bridge



Figure 4f: Distribution of weeds within the southern end of the project land

3.4 Fauna of Conservation Significance

3.4.1 General survey observations and habitat assessment

The ground surveys established that the project land contains a limited extent of potential habitat for threatened fauna, on account of being largely non-native habitats in a periurban area and being subject to intensive habitat modification for around 200 years. No ground dens, hollows or nests suitable for threatened fauna were observed nor are likely to have been overlooked. It is considered that for threatened species the site mostly represents an occasional foraging resource and doesn't support any habitat values that are limited in the local area; this particularly applies to the terrestrial habitats, whereas the estuarine habitats around the existing bridge may have more value to particular conservation significant species and contribute to a larger degree to general fauna habitat at the local and regional level, particularly for resident waterbirds (although this may also be subject to seasonality, rather than year-round importance).

3.4.2 Threatened species presence

Widespread ground-dwelling species with relatively broad ecological niches, such as Tasmanian devils and eastern quolls, appear to disperse through the area (based on roadkill records on the NVA) but the project land is unlikely to represent a permanent part of a range for individuals of these species, nor is the location or habitat very suitable for denning based on the available niches, the distance to prey resources and the levels of disturbance.

In terms of threatened birds, a minor amount of planted potential foraging habitat is present in the project land for the swift parrot (Figures 5a-b); observation records however suggest that the species utilises the broader area very infrequently, the frequency of which is unlikely to be measurably impacted by the proposal (Table 3).

Observations of the Australasian bittern are known from the general vicinity of the project land (with the records from the northwest of the site having spatial inaccuracy of 6000 m) and some very small (< 0.5 ha) patches of potential (but suboptimal) habitat are present around the causeway and banks of the River Derwent (Figures 5a-b). Due to the size of the patches and the proximity to disturbance, they are not suitable for nesting or permanent occupation, but may occasionally be used for foraging or shelter. It is thus possible some suboptimal habitat (< 2 ha) for this species will be lost in the proposal, but the potential losses are negligible in relation to the extent of suitable habitat present elsewhere in the River Derwent within 4-5 km, which is greater than 350 ha (Figure 6).

The great crested grebe is an additional threatened waterbird with observations from the vicinity of the project land (including observations during our surveys), however its occurrence around the existing bridge tends to be irruptive and irregular; prior to our surveys there were no reported observations of nesting or breeding behaviour in the area, but we observed in December 2020 two adults birds displaying courtship behaviour adjacent to the project land (within our bird survey zone along the north-eastern shore of the River Derwent), which may be an indication that breeding occurs in the area discreetly (although courting behaviour does not necessarily mean breeding is occurring) – consistent with the reasoning for Australasian bittern habitat, potential nesting habitat losses for the great crested grebe are considered to be minor in relation to the extent of viable habitat present in the broader area.

Several other threatened and/or migratory fauna are identified as having the potential to occur in the project land based on broad scale habitat mapping presented within the EPBC Protected Matters database, or have verified observations within 5 km according to the Tasmanian *Natural Values Atlas* and/or BirdLife data. Table 3 provides a description of the preferred habitat of these species and an assessment of the likelihood of their occurrence.

Table 3: Fauna species of conservation significance known within a 5 km radius of the project land, or with the potential to occur based on habitat mapping 28

Species	Status ²⁹ TSPA / EPBCA	Potential to occur	Observations and preferred habitat ³⁰
	Repo	rted from within	5000 m ³¹
		BIRDS	
<i>Accipiter novaehollandiae</i> grey goshawk	Endangered / -	Very low	The core habitat for this species is generally below 600 m with high priority nesting habitat occurring along watercourses in old growth wet forests ³² . This species inhabits large tracts of wet and swamp forest, particularly patches with closed canopies above an open understorey and with dense stands of prey habitat nearby. Mature blackwood (<i>Acacia</i> <i>melanoxylon</i>) is the preferred nesting tree for this species. There are only two sightings of this species within 5000 m, dated 1905 and 1911. It is highly unlikely that this species will utilise the area due to the absence of suitable foraging and nesting habitat. May be transient in the area.
<i>Alcedo azurea</i> subsp. <i>diemenensis</i> azure kingfisher	Endangered / ENDANGERED	Very low	This species is found along rivers in the south, west, north and northwest of Tasmania with outlying occurrences in the northeast, east, centre and Bass Strait islands. This species occurs in the forested margins of major river systems where it perches on branches overhanging rivers waiting for prey items such as small fish, insects and freshwater crayfish to come down the river. This species nests in holes along the top of riverbanks and is therefore susceptible to clearing and modification of river-side vegetation. There is thought to be fewer than 500 mature individuals left in Tasmania 400+/- 100 (based on Holdsworth et al. 2021) with the overall distribution of Tasmania's azure

²⁸ NVA report_nvr_1_04-Aug-2020, DPIPWE, 2020. EPBC Act Protected Matters Report, Commonwealth of Australia, PMST_Z700NQ

²⁹ Tasmanian Threatened Species Protection Act 1995, Commonwealth Environment Protection and Biodiversity Conservation Act 1999

³⁰ Threatened Species Section (2020)

³¹ Natural Values Report: nvr_1_04_Aug_2020

³² Brereton and Mooney (1994) Conservation of the nesting habitat of the grey goshawk *Accipiter novaehollandiae* in Tasmanian State Forests

Species	Status ²⁹ TSPA / EPBCA	Potential to occur	Observations and preferred habitat ³⁰
			kingfisher reflecting the higher rainfalls in the west and north-west regions of Tasmania.
			Suitable habitat for this species in the project land is very limited, with little vegetation cover. The only recording of this species within 5000 m was along the Jordan River in the early 1900s with a position accuracy of +/- 10,000 m. It is very unlikely that this species is present in the project land.
<i>Aquila audax</i> subsp. <i>fleayi</i> Tasmanian wedge- tailed eagle	Endangered / ENDANGERED	Foraging: Low – moderate Nesting: None	Wedge-tailed eagles' nest in a range of old growth native forests and are dependent on forest for nesting. This species requires large sheltered trees for nesting and is highly sensitive to anthropogenic disturbances during the breeding season. Territories can contain up to five alternate nests usually close to each other but may be up to 1 km apart where habitat is locally restricted. They hunt and scavenge on a wide variety of fauna including fish, reptiles, birds and mammals. Suitable nesting habitat is present within 5000 m of the project land in surrounding gullies. However, the closest eagle nest is 2500 m away, which is a confirmed white-bellied sea-eagle nest to the northwest, well out of the 500 m exclusion zone or 1 km line of sight recommended for development during the breeding season. Whilst there is some chance the species may fly over the area on occasion there are no expected potential impacts to any eagle nests associated with the proposal.
<i>Botaurus poiciloptilus</i> Australasian bittern	- / ENDANGERED	Low - moderate	Australasian bitterns are a highly cryptic species, utilising wetlands and lakes with a dense cover of vegetation. Whilst once common on Tasmania's north/east coasts, the numbers of bitterns in the state during the last two decades have declined significantly in both their range and total due to habitat loss and extended periods of dryness. Small patches of potential habitat for this species are present around the causeway and banks of the River Derwent (Figure 6). Due to the size of the patches and the proximity to disturbance, they are not suitable for nesting or permanent occupation, but may occasionally be used for foraging or shelter. Both an NVA record and Birdlife records are attributed to within the project land on the northwest bank of the river (but with a spatial

Species	Status ²⁹ TSPA / EPBCA	Potential to occur	Observations and preferred habitat ³⁰
			inaccuracy of 6000 m) with the most recent sighting in 2009. It is thus possible some habitat for this species will be lost in the proposal (< 2 ha), but this potential is negligible in relation to the extent of suitable habitat present elsewhere in the River Derwent within 4-5 km, which is > 350 ha.
<i>Haliaeetus leucogaster</i> white-bellied sea- eagle	Vulnerable / MARINE	Foraging: Moderate - high Nesting: Nil	In Tasmania, the white-bellied sea-eagle is restricted to nesting within 5 km of coastlines, major estuaries and inland lakes. They typically build nests in large eucalypt trees, much like the Tasmanian wedge-tailed eagle (<i>Aquila</i> <i>audax fleayi</i>), although their specific nesting requirements aren't as strict as the wedge- tailed eagle, such that they often nest in relatively small and exposed coastal trees (including [in a minority of cases] non-native species [e.g. <i>Pinus radiata</i>]), and are also known to nest occasionally on sea cliffs or even piles of rocks at ground level on islands lacking ground predators (e.g. Ninth Island). Two known white-bellied sea-eagle nests, believed to be from the same breeding pair, are found northwest of the project land, approximately 2500-3000 m away and thus well out of the 500 m exclusion zone or 1 km line of sight recommended for development during the breeding season. It is likely that the species uses the aquatic parts of the project land within a foraging range, and we have observed the use of <i>Pinus</i> <i>radiata</i> trees in the sites northeast as perches. However, there are no potential impacts associated with the proposal to this species' nesting habitat and it is unlikely the general suitability of the area for foraging will be meaningfully impacted by the proposal.
<i>Hirundapus caudacutus</i> white-throated needletail	- / VULNERABLE	Low	The white-throated needletail is a migratory species, breeding in central and north-eastern Asia in Siberia, Mongolia, northern-eastern China and northern Japan. It migrates south through eastern China, Korea and Japan spending its non-breeding season in eastern and south-eastern Australia including Tasmania. This species is almost exclusively aerial, occurring over most types of habitat with a preference to wooded areas, open forests, heathland and rainforests.

Species	Status ²⁹ TSPA / EPBCA	Potential to occur	Observations and preferred habitat ³⁰
			Due to their aerial nature, this species is most likely unaffected by terrestrial habitat alteration outside of its Northern Hemisphere breeding range. It is uncommonly recorded but widespread in Tasmania. Large numbers of this species (in the 1000's) were recorded between the existing Bridgewater Bridge and New Norfolk during 1965 by BirdLife but no observation records have since been made in the area.
<i>Lathamus discolor</i> swift parrot	Endangered / CRITICALLY ENDANGERED	Low	Swift parrots are a migratory species, undertaking annual flights from Tasmania to the mainland of Australia. When in Tasmania they are semi-nomadic, crossing much to the state to coincide with the erratic and patchy flowering patterns of their preferred food plants, <i>Eucalyptus globulus</i> and <i>Eucalyptus</i> <i>ovata</i> . Breeding occurs in hollow-bearing trees within 10 km of flowering food stands. Records on the NVA and from Birdlife indicate that this species has only ever been reported just over a dozen times within 5000 m of the project land, with only one of the sightings occurring after 1998, during 2014 roughly 3000 m away. The small clusters of potential habitat trees for this species in and around the project land consist of planted potential foraging trees <i>(E. globulus</i>) with no breeding potential – they represent an extremely minor potential resource for the species.
<i>Pardalotus quadragintus</i> forty-spotted pardalote	Endangered / ENDANGERED	Nil	This species is endemic to Tasmania and occurs in only a few small areas within the State. It is relatively restricted to dry grassy forest and woodland along the east coast containing mature white gum (<i>Eucalyptus viminalis</i>). It is highly unlikely that this species persists within the area with only three recorded sightings all prior to 1989.
<i>Podiceps cristatus</i> great crested grebe	Vulnerable / -	Moderate (occasional)	This species inhabits wetlands, deep lakes, rivers and swamps and prefers a combination of open water and dense reedbeds. This species is relatively rare in Tasmania but can have minor irruptions and periods of regular sightings in some areas. This happened around the existing Bridgewater Bridge between 2014-2018 (Birdlife and on the NVA), with numerous sightings; the species has also been reported from the area more recently

Species	Status ²⁹ TSPA / EPBCA	Potential to occur	Observations and preferred habitat ³⁰
			(Andrew Crane pers. comm and was observed during our surveys adjacent to the project land at the far eastern end of our bird survey Zone 2. Two great crested grebes were observed swimming together during the last 2 weeks of surveys in December. On one occasion they were observed in a brief courtship display. They were often observed amongst the reeds and there is a possibility they could breed in the reeds discreetly. Due to the separation of this habitat from the project land, the project is not likely to have a direct impact on the likelihood of the species visiting the site periodically and/or potentially breeding.
<i>Thalassarche cauta</i> shy albatross	Vulnerable / ENDANGERED	Nil	Breeds on remote islands off the Tasmanian coast: Albatross Island, Pedra Branca and the Mewstone. Is relatively sedentary, which is unique among albatross, and generally forages close to the colony over continental shelf, with a range of < 200 km. Whilst there is one record of this species attributed to within 500 m of the project land, the estimated accuracy of the position is up to +/- 5000 m and was recorded in 1884. Other than this sighting, this species has not been observed within 5000 m. The next closest sighting of this species was 25 km away with a position accuracy of +/- 18,500 m. It would be an exceptionally rare occurrence for this species to occur on site given its pelagic nature.
<i>Tyto novaehollandiae</i> masked owl	Endangered/ VULNERABLE	Low	Masked owls are a nocturnal species that favour the edges of dry forests, utilising nearby hollows >15 cm in diameter for nesting. Therefore, significant habitat for this species is limited to large eucalypts within dry eucalypt forest in their core range. Their core foraging habitat includes mature native forests and woodlands typically below 600 m altitude as well as mosaics of both native vegetation and agricultural patches. There have been nine recorded sightings of this species occurring within 500 m of the project land between 1975-1981 that were recorded on the NVA and by Birdlife. No suitable hollow-bearing trees exist within the extent of the potential impact or disturbance area. Regardless, given the nearness of the site

Species	Status ²⁹ TSPA / EPBCA	Potential to occur	Observations and preferred habitat ³⁰
			to housing and roads, we consider the chances of this species occurring on the site as low.
		MAMMALS	
<i>Dasyurus maculatus</i> spotted-tail quoll	Rare / VULNERABLE	Very low	The spotted-tail quoll is forest dependent species that occupies a large range of habitats. The species habitat is characterized by high annual rainfall and predictable rain patterns. It forages and hunts on farmland and pasture, travelling up to 20 km at night, and shelters in logs, rocks or thick vegetation.
			Two observations on the NVA are attributed to within 5000 m of the project land, with the most recent sighting being a roadkill incident in early 2020. Based on the lack of suitable available habitat for this species and the project land not being within the core range of an important population, it is unlikely this species will be impacted at a population level.
<i>Dasyurus viverrinus</i> eastern quoll		Low - moderate	The eastern quoll is widespread in Tasmania and was previously widespread in mainland south-eastern Australia but has been effectively extinct there since 1963 (some reintroductions have occurred). Not currently listed as threatened species within Tasmania under the TSPA.
	- / ENDANGERED		Records from the NVA indicate that the eastern quoll occurs in most parts of Tasmania but is recorded infrequently in the wetter western third of the state. The species' distribution is associated with areas of low rainfall and cold winter minimum temperatures. It is found in a range of vegetation types including open grassland (including farmland), tussock grassland, grassy woodland, dry eucalypt forest, coastal scrub and alpine heathland, but is typically absent from large tracts of wet eucalypt forest and rainforest.
			Nine individuals have been recorded within 5000 m of the project land, with four recent roadkill incidences recorded between 2018- 2019, one of which was in the project land. It is likely however these were dispersing individuals rather than residents within the project land. Based on our habitat assessment it is unlikely that alteration of the project land

Species	Status ²⁹ TSPA / EPBCA	Potential to occur	Observations and preferred habitat ³⁰
			will impact the likelihood of presence of the species.
<i>Perameles gunnii</i> eastern barred bandicoot	- / VULNERABLE	Moderate - high	This species originally occurred in native grasslands and grassy woodlands in Tasmania's Midlands. However, it is now rare in the Midlands where most of its habitat has been cleared. Since European settlement, the eastern barred bandicoot has spread into (originally heavily forested) agricultural areas in the state's southeast, northeast and northwest. It favours a mosaic of open grassy areas for foraging and thick vegetation cover for shelter and nesting. Removal of plant cover in agricultural areas is seen as one of the main threats to the species. It is possible that this species uses the project land on occasions as it is able to persist in residential areas with suitable cover and areas of native vegetation. A recent roadkill incident of this species was recorded at Gould's Lagoon, approximately 2 km from the project land. Prior to this incident there were 25 sightings within 5000 m of the site between 1971-2011. Given the tolerance of this species to persist in suburban areas, it is not considered likely that the project land is critical to the persistence of this species at a local level or higher.
<i>Sarcophilus harrisii</i> Tasmanian devil	Endangered / ENDANGERED	Low - moderate	The Tasmanian devil lives in a wide range of habitats across Tasmania, especially in landscapes with a mosaic of pasture and woodland. Populations have declined substantially since the first observations of the infectious cancer Devil Facial Tumour Disease (DFTD). DFTD has now spread across much of Tasmania. The reduced population is also likely to be more sensitive to additional threats such as death by roadkill, competition with cats and foxes, and loss or disturbance of areas surrounding traditional dens where young are raised. The protection of breeding opportunities is particularly important for the species due to the mortalities from demographic pressures. Records of Tasmanian devil are not uncommon in the broader area with one recorded roadkill incident within 500 m of the site during 2016 and 17 other roadkill incidents within 5000 m occurring between

Species	Status ²⁹ TSPA / EPBCA	Potential to occur	Observations and preferred habitat ³⁰
			2012-2020. With the ongoing threat of the road and lack of suitable native habitat, it is unlikely that this disturbed site near a road, railway and residences can function as permanent habitat for this species.
		FISH	
<i>Prototroctes maraena</i> Australian grayling	Vulnerable / VULNERABLE	Low - moderate	This species of fish migrates between fresh and marine environments and is generally found in Tasmania's north, eastern and western rivers with only a few occurrences in Tasmania's south. Little is known about the population size of this species in Tasmania, but it is believed that in recent years its range has reduced substantially.
			The only known records of this species within 5000 m are from 1987 with three individuals being recorded within 200 m of the project land. It is unknown how many targeted surveys have been undertaken in the area since this time. This species is being dealt with in more detail by a separate consultancy focussing on fully aquatic elements.
		REPTILES	
<i>Pseudemoia pagenstecheri</i> tussock skink	Vulnerable / -	Nil	This species occurs in <i>Poa</i> tussock grassland and <i>Themeda</i> grassland without trees. It is a ground dwelling species occurring at a range of elevations. It is typically found in small disconnected patches near Cradle Mountain, in the Midlands and eastern Bass Strait Islands.
			There is only one recorded sighting of this species within 5000 m of the project land, during 2009 along the Jordan River.
AMPHIBIANS			
<i>Litoria raniformis</i> green and gold frog	Vulnerable / VULNERABLE	Nil	In Tasmania, the species occurs in lowland areas in the south-east (where it is very rare) and north, breeding in permanent freshwater or slightly brackish habitats, generally with emergent vegetation. It has declined significantly (over 20 %) in range and abundance over the last 20 years, having disappeared from the Midlands, Derwent Valley, much of the Hobart region and parts of the north-west coast (although historical records are also less common in that region).

Species	Status ²⁹ TSPA / EPBCA	Potential to occur	Observations and preferred habitat ³⁰
			The only known record of this species occurring within 5000 m of the project land was during 1970. Since then, none have been recorded and it is highly unlikely that this species would occur on site based on its currently limited extent in southern Tasmania.
		INVERTEBRAT	ES
<i>Antipodia chaostola</i> chaostola skipper	Endangered/ ENDANGERED	Nil	A medium brown and yellow butterfly, this species is restricted to dry forest and woodland that support sedges from the <i>Gahnia</i> genus. It is found in small isolated populations in south-eastern and eastern Tasmania. This species has never been recorded within 5000 m, however based on range boundaries on the NVA it has the potential to occur. Despite this there is lack of suitable <i>Gahnia</i> habitat for this species on site so it is not expected to occur in the area.
<i>Discocharopa vigens</i> ammonite pinwheel snail	Endangered/ CRITICALLY ENDANGERED	Nil	Endemic to Tasmania, this species of land snail occurs only in the Hobart area. Found only under dolerite rocks within forested habitats, this species is currently restricted to two known extant populations. Within these two populations there is thought to be < 200 individuals coving an area of 2 ha. Only one individual snail has been found within 5000 m, during 2003. No suitable habitat is present within the project land.
Potential to occur based on range boundaries and species habitat ³³			
BIRDS			
<i>Calidris ferruginea</i> curlew sandpiper	- / CRITICALLY ENDANGERED	Nil	The curlew sandpiper was once a common visitor to Tasmania, but their numbers have declined significantly since the 1950's ³⁴ . It frequents intertidal mudflats in sheltered coastal areas, with the most important sites for them in Tasmanian centred on the north and

³³ NVA report_ nvr_1_04-Aug-2020 (DPIPWE); EPBC Act Protected Matters Report, Commonwealth of Australia, PMST_Z700NQ

³⁴ Cooper et al. (2012); Reid and Park (2003)

Species	Status ²⁹ TSPA / EPBCA	Potential to occur	Observations and preferred habitat ³⁰
			east coast of Tasmania ³⁵ . However, they are also occasionally recorded inland, along the open edges of ephemeral and permanent lakes and other water bodies.
			It is unlikely that this species occurs within the project land; they have never been recorded so far up the River Derwent.
Diomedea antipodensis	- / VULNERABLE	Nil	Endemic to New Zealand, the antipodean albatross is a pelagic species that often forages in the south-west Pacific Ocean, Southern Ocean and Tasman Sea.
albatross			Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Diomedea antipodensis gibsoni</i> Gibson's albatross	- / VULNERABLE	Nil	This species breeds only on Adams Island and Auckland Island New Zealand. They typically forage in the Tasman Sea and further south or the mid-Pacific Ocean.
			Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Diomedea</i> <i>epomophora</i> southern royal albatross	- / VULNERABLE	Nil	The majority of the southern royal albatross population nest on the subantarctic Campbell Island.
			Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Diomedea exulans</i> wandering albatross	Endangered / VULNERABLE	Nil	This species has a circumpolar distribution breeding on six subantarctic islands. In Australian territory this species breeds on Macquarie Island and forages in the Australian portions of the Southern Ocean.
			Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Diomedea sanfordi</i> northern royal albatross	- / ENDANGERED	Nil	This species is regularly seen foraging off the waters of Tasmania. It predominately breeds on Chatham Island, New Zealand.
			Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Limosa lapponica bauera</i> bar-tailed godwit	- / VULNERABLE	Nil	In Tasmania, this species is recorded along the north and east coastlines, King Island and the Furneaux Group with the most sightings in the south-east between Orford and Southport Lagoon.

Species	Status ²⁹ TSPA / EPBCA	Potential to occur	Observations and preferred habitat ³⁰
<i>Limosa lapponica menzbieri</i> northern Siberia bar-tailed godwit	- / CRITICALLY ENDANGERED	Nil	Not known to occur in Tasmania, spending the non-breeding season predominantly in the north and north-west of Western Australia and in south-eastern Asia.
<i>Macronectes giganteus</i> southern giant petrel	Vulnerable / ENDANGERED	Nil	This species breeds on six subantarctic and Antarctic islands in Australian Territory. It is a rare visitor to Tasmania. Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Macronectes halli</i> northern giant petrel	Rare / VULNERABLE	Nil	This species breeds in the subantarctic. Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Numenius madagascariensis</i> eastern curlew	Endangered / CRITICALLY ENDANGERED	Nil	Much like the curlew sandpiper, the eastern curlew was once a common visitor to Tasmania, but their numbers have declined significantly since the 1980's ³⁶ . It frequents intertidal mudflats in sheltered coastal areas, with the most important sites for them in Tasmanian centred on the northwest coast of Tasmania ³⁷ . However, they are also occasionally recorded inland, along the open edges of ephemeral and permanent lakes and other water bodies. It is unlikely that this species occurs within the project land.
<i>Pachyptila turtur subantarctica</i> fairy prion	Endangered / VULNERABLE	Nil	In Australia this species breeds on Macquarie Island but forages as a pelagic species around Tasmania. Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Pterodroma leucoptera leucoptera</i> Gould's petrel	- / ENDANGERED	Nil	This species breeds Cabbage Tree and Boondelbah Island off NSW. They are a pelagic species. Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Sternula nereis nereis</i> Australian fairy tern	Vulnerable / VULNERABLE	Nil	This species is found along Australian coastlines from Western Australia to Victoria and in Tasmania. It occurs along isolated sandy inlets, coastal beaches estuaries and saline and freshwater wetlands and lagoons. Unlikely to occur within the project land.

³⁶ Cooper and Clemens et al. (2012); Reid and Park (2003)

³⁷ Bryant (2002)
Species	Status ²⁹ TSPA / EPBCA	Potential to occur	Observations and preferred habitat ³⁰
<i>Thalassarche bulleri</i> Buller's albatross	- / VULNERABLE	Nil	This species breeds in New Zealand and is a relatively common visitor to Australian waters. It is recorded off the coast of Tasmania. Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Thalassarche bulleri platei</i> northern Buller's albatross	- / VULNERABLE	Nil	This species breeds only on Chatham and Three Kings Island in New Zealand. It forages in the Pacific Ocean and Tasman Sea. It is unlikely to occur within the project land.
<i>Thalassarche</i> <i>chrysostoma</i> grey-headed albatross	Endangered / ENDANGERED	Nil	In Australia, this species breeds on the western flanks of Petrel Peak, Macquarie Island. They forage in the Southern Ocean, with most records coming from the south and west of Tasmania. Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Thalassarche impavida</i> Campbell albatross	- / VULNERABLE	Nil	This species breeds only on Campbell Island, New Zealand in the subantarctic. It visits Australian waters and is most commonly seen foraging off Tasmania over oceanic continental slopes. Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Thalassarche melanophris</i> black-browed albatross	Endangered / VULNERABLE	Nil	During the breeding season, this species is mostly confined to the waters surrounding Heard Island, Macquarie Island, McDonald Island and Bishop and Clerk Islets. Due to its pelagic nature, it is unlikely to occur within the project land.
<i>Thalassarche salvini</i> Salvin's albatross	- / VULNERABLE	Nil	This species breeds in the south of New Zealand on Bounty, Snares and Chatham Islands and is a non-breeding visitor to Australian waters, infrequently seen around Tasmania. It is unlikely to occur within the project land.
<i>Thalassarche steadi</i> white-capped albatross	- / VULNERABLE	Nil	This species is an occasional visitor to Tasmanian waters and can sometimes be seen flying along the coastlines though is often mistaken for the shy albatross. It is unlikely to occur within the project land.
<i>Thinornis cucullatus cucullatus</i> hooded plover (eastern)	- / VULNERABLE	Nil	This species is widely distributed in Tasmania and inhabits sandy ocean beaches. This species nests on or near beaches, with nests located on flat beaches above the high tide mark and on the sides of sparsely vegetated dunes. With the lack of suitable habitat near the project land it is unlikely that this species will occur.



Figure 5a: Distribution of potential threatened fauna habitat and observations within the north of the project land



Figure 5b: Distribution of potential threatened fauna habitat and observations within the south of the project land



Figure 6: Distribution of potential habitat for the Australasian bittern within 5 km of the project land

New Bridgevater Bridge Project Flora and Fauna Habitat Assessment





3.4.3 General waterbirds

Although the aquatic habitats around the existing bridge are not recognised internationally as an Important Bird Area for waterbirds³⁸ or a RAMSAR wetland, they are part of the nationally important wetland of the River Derwent (upstream of the existing bridge and east of Dromedary), with the information sheet for that listing³⁹ referring to use by great crested grebes as notable fauna, as well as several other general waterbirds within the section on other fauna, including black swans (*Cygnus atratus*), Pacific black duck (*Anas superciliosa*), musk duck (*Biziura lobata*), Australasian shoveler (*Anas rhynchotis*), white-faced heron (*Egretta novaehollandiae*), chestnut teal (*Anas castanea*), masked lapwing (*Vanellus miles*), great cormorant (*Phalacrocorax carbo*), marsh harrier (*Circus approximans*), silver gull (*Chroicocephalus novaehollandiae*), Eurasian coot (*Fulica atra*), little pied cormorant (*Microcarbo melanoleucos*), great egret (*Ardea alba*), Australian pelican (*Pelecanus conspicillatus*), native hen (*Gallinula mortieri*), and hoary-headed grebe (*Poliocephalus poliocephalus*).

Consistent with the recognition of the area for waterbird habitat, four species are surveyed annually by DPIPWE from south of Dromedary to the causeway (and downstream to Green Point), which is considered to be the most important zone for waterbirds in the River Derwent⁴⁰. Figure 7 shows the annual counts for these species between 1990 and 2020⁴¹. The most abundant species in that time has been the black swan, with relatively high counts in recent years contrasting with the statewide trend for the species. It is suspected that relatively high numbers in the River Derwent may be the result relatively dry conditions in other less stable habitats, including mainland environments⁴². Such trends however have been less apparent in the other target species, which typically have much lower abundances and fluctuations.



Figure 7: Interannual variation in targeted waterbird counts at Bridgewater (DPIPWE data via DEP) (note blue-winged shoveller = Australasian shoveller)

³⁸ Dutson, Garnett and Gole, 2009

³⁹ http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS068

⁴⁰ DEP, State of the Derwent estuary 2020 draft

⁴¹ Source: Wildlife Management Branch, DPIPWE, 2020 via Inger Visby DEP

⁴² DEP, State of the Derwent estuary 2020 draft; Newman and Cooper 2019

The most abundant species observed during our waterbird surveys were Eurasian coot, black swan, silver gull and little black cormorant, with over 1000 individuals of each recorded. The black swan and silver gull were the only species to be observed in every single survey, with the little black cormorant absent in only one survey. Other species recorded frequently (most surveys) were masked lapwing, little pied cormorant, great cormorant, chestnut teal, pacific black duck and Tasmanian native-hen.

Variation in the abundance of some species during the course of the year was apparent. Species that utilised the area in greater numbers during the cooler period (winter) were: Australasian grebe, Australasian shoveler, chestnut teal, Eurasian coot, hoary headed grebe, kelp gull, little pied cormorant, masked lapwing, musk duck, and white-faced heron. Abundance of these species halved during the warmer months. In contrast, species that utilised the site in greater numbers during the warmer months were black swan, little black cormorant, great cormorant, little grassbird and brown falcon, in addition to the summer migrants, welcome swallow and swamp harrier.

Within our survey areas, the northeast of zone 2 (beyond the project land) supported the greatest abundance of birds, primarily because this area is where Eurasian coots were found to consistently loaf or forage, with Eurasian coot being the most abundant species within our survey areas, with some survey counts exceeding 500 individuals across the entire site (*i.e.* all zones).

The existing bridge itself (zones 9 and 10) and the eastern banks of the causeway had the lowest bird abundances. The existing bridge and the causeway (zones 11 and 12) also had the lowest species richness but were used for roosting and perching (including the introduced Common starling *Sturnus vulgaris* on the existing bridge), with the banks of the causeway being a frequent roost for silver gulls and masked lapwings and used for grazing by swans on the eastern side. Welcome swallows were observed building nests on the existing bridge frame structure (as well as three jetties in our survey areas). No other breeding was observed on the existing bridge or other artificial structures, although some elements are suitable breeding sites for gulls and cormorants. In addition, the causeway roosts frequently used by small flocks of silver gulls and masked lapwings included seasonally high proportions of immature birds (particularly the gulls) following breeding elsewhere.

The northern banks of the foreshore (zones 1 and 2) and the southwestern areas (zones 5 and 7) had relatively high species richness (Appendix B), with the rocky margins in the north and shallow subtidal aquatic herbland bordered by rushland in the south providing diverse foraging opportunities. On account of the foraging opportunities, most species recorded in our surveys were found to be foraging (with every species, other than pelicans, observed foraging - Appendix B). Foraging was observed in each of our survey zones except zones 9, 10 and 11 (consisting of the existing bridge itself and western causeway roost site).

The presence of rushes, grasses and sedges in the south (zones 7 and 8) provided birds with sheltering opportunities, as did the bay in the far eastern section of zone 2 (particularly protection from the prevailing NW winds) – these attributes were found to be correlated with breeding behaviours and chick rearing.

Species observed to utilise the surveys areas for breeding were black swan, little grassbird, welcome swallow, Tasmanian native-hen, purple swamphen, and pacific black duck (pacific black duck x mallard hybrid). A pair of great crested grebe were observed courting in zone 2 in late November/early December, but no further definitive evidence of breeding was observed in this species.

Species were predominately observed nesting well beyond the expected extent of permanent works, such as in zone 7 in the reeds and rushes along the southwest bank of the River Derwent,

and zone 2 to the east of the existing bridge along the northern shore. Reeds and rushes within zone 8 were the main breeding habitat near the project land, but based on vegetation traits and shelter, zones 7 and 2 beyond the project land are considered the best breeding sites in the local area.

Consistent with the discussion around the Australasian bittern habitat, the breeding habitats found within and close to the project land are quite minor in extent (< 2 ha) and quality compared to the large, densely vegetated wetlands elsewhere in the River Derwent (> 350 ha) (Figure 6).

The project land also supports small scale habitat elements that receive disproportionate use, such as four large dead trees sitting out from the water, which were the primary roosting spots for ducks, cormorants and gulls (Plate 23).

Based on our observations of habitat use (including with reference to species diversity and abundance), we have identified several fine-scale habitat elements and broader patches within the survey areas that appear to contribute disproportionately to waterbird habitat (Figure 8).



Plate 23: Dead tree habitat on the northwest shore of the bird survey area



Figure 8: Key locations for waterbird use in and around the project land

3.4.4 Roadkill

From the datasets and our surveys, a total of 76 roadkills have been recorded on or around the existing bridge and causeway since 2016⁴³. 11 incidences were recorded by NBES surveys (April – December 2020), 4 by staff at Bonorong (January - November 2020), and 61 by road maintenance contractors (between May 2016 – December 2020). A total of 7 species were conclusively identified from the mortalities and injuries, with two general categories for 'wallaby' and 'unknown' included in the contractor data. 'Unknown' individuals constituted 23 records and 'wallaby' 17 records. Of the 7 species definitively identified within the records, the most frequently recorded species was the black swan, with 19 mortalities (Table 4).

Seasonality is evident within the records. Winter has the highest number of recorded roadkill counts, followed by autumn (Table 4). There were significantly less roadkill incidents during spring than any other season (Table 4) (with a two-factor without replication ANOVA yielding a P-value = <0.05). This is perhaps an even stronger relationship in the context of the greater abundance of swans we recorded in the area in general during the spring and summer surveys. It is likely the disproportionate level of swan roadkill mortalities during winter is directly influenced by the frequency of thick fog events, which are leading to decreased visibly and a subsequent decline in the capacity of swans to avoid traffic. This may have been exacerbated by seasonal habitat changes, with our bird survey observations showing that swans forage more on the edge of the causeway during autumn and winter (when the roadside grasses and herbs are green and succulent) and spend more time away from the road during spring and summer.

Other species that have been recorded dead on the existing bridge or the causeway include: silver gull, Tasmanian Native hen, masked lapwing, European rabbit, common brushtail possum and a dog (Table 4). Our incidental sightings of roadkill from surrounding roads included: kelp gull, Pacific black duck, domestic goose, green rosella, musk lorikeet, Australian magpie, forest raven, common blackbird, echidna, common wombat, southern brown bandicoot, eastern barred bandicoot, and ring-tail possum. In contrast to bridge and causeway roadkill records, incidental sightings increased slightly during the warmer months and included a greater proportion of non-birds.

Across all taxa, almost all the roadkill observations where the precise location is known in relation to the existing bridge and the causeway, were located on the causeway. Only two roadkill carcasses were observed on the existing bridge from within this subset of the data.

Species	Autumn	Spring	Summer	Winter	Total
Black swan	11	0	1	7	19
Tasmanian native hen	0	1	0	3	4
Silver gull	2	0	0	0	2
Masked lapwing	1	0	0	0	1

Table 4: Number of individual species killed each season on the existing Bridgewater bridgeand the causeway between 2016 – 2020.

⁴³ Noting the council data received via the Department of State Growth was not as location specific as the other datasets (*i.e.* it includes animals collected from a broader area than just the existing bridge and causeway)

Brushtail possum	4	0	1	3	8
European rabbit	0	1	0	0	1
Dog	1	0	0	0	1
'Wallaby'	1	0	3	13	17
'Unknown'	7	1	6	9	23
Total	27	3	11	35	76

4 POTENTIAL IMPACTS AND MITIGATION

4.1 Mitigation and Avoidance Through Planning and Design

Due to the location of the existing bridge and adjoining highways, the proponent is somewhat constrained in their ability to relocate components of the project footprint as a measure of avoidance and mitigation of impacts to natural values. The results of our investigations however can nonetheless be used to minimise impacts through other mechanisms, such as construction protocols, post-works management, and design considerations.

4.2 Potential Impact Footprint

Our assessment focusses on terrestrial elements, as purely aquatic elements are the basis of a separate assessment – there is however some unavoidable overlap with sub-aquatic elements and values that straddle the definition of aquatic and non-aquatic – components of the wetland and saltmarsh communities subject to large tidal movements for instance.

Although a design has not been finalised for a permanent works footprint, it can be expected that only a subset of the project land will be permanently altered by the works (*i.e.* the project footprint of the chosen design may be smaller, and impacts in some areas will be temporary). Nonetheless, due to the scale of the development and the nature of the works, it is likely the permanent and temporary works footprint will collectively be proportionately quite large within the project land. The potential extent of permanent works provided for our assessment covers 56.8 ha (with 37.9 ha being terrestrial and the remainder aquatic). This area has been used as the basis for our impact assessments for all values other than a subset of the values for which we have been supplied impact estimates based on preliminary design considerations⁴⁴.

Potential for temporary and indirect impacts are considered where relevant in relation to avoidance and mitigation. Potential indirect impacts from the proposal are likely to be contingent upon the adequacy of management prescriptions and mitigation. They also vary with natural values. For instance, a change in ground cover (e.g. from grassy verge to highway) could have different indirect impacts for weeds (alteration of habitat availability or suitability) to fauna (potential for fragmentation and/or interruption of dispersal, and altered likelihood of road trauma). For this reason, indirect impacts are discussed where relevant within discussion and consideration of different natural values. Due to the reasons outlined above, the project land boundary is considered sufficient to capture indirect impacts, however the potential for indirect impacts to go beyond the project land is considered for all values.

⁴⁴ Email correspondence from Bryce Taplin, Burbury Consulting – 8/6/2021

4.3 Native Vegetation and Ecological Communities

4.3.1 Conservation significant vegetation and ecological communities

- The extent of permanent works area contains and thus has the potential to impact up to 16.08 ha of the EPBCA vulnerable subtropical and temperate coastal saltmarsh community, represented within the project land by the TASVEG units ARS and AHS.
- The extent of permanent works area contains and thus has the potential to impact up to 16.32 ha of the NCA listed wetland community, represented in the project land by the TASVEG units ASF and AHS.
- The extent of permanent works area contains and thus has the potential to impact 12.31 ha of the nationally important wetland area of the River Derwent (which covers a total of 987.16 ha), while all the aquatic components of the works area (18.9 ha) are entirely within the River Derwent Marine Conservation Area.
- The remaining communities within the potential extent of the permanent works area are well reserved at the State and regional level (and not threatened).
- None of the grassland (or grassy communities) within the project land has been found to meet the key definitions and conditional criteria of the critically endangered EPBCA community lowland native grasslands of Tasmania.

4.3.2 Extent of impact

- Overall, the extent of permanent works has the potential to affect a total of six native vegetation units, two of which are components of an NCA listed community, and two that qualify as components of an EPBCA listed community (Table 5).
- The potential extent of impact on this native vegetation is 17.10 ha.
- Proportional losses to individual units are very low at bioregional and statewide levels for ARS, ASF, DVG, GCL and NBA (Table 5).
- Losses for the AHS unit are moderately high at the bioregional level but low/moderate at a statewide level (noting that AHS is not listed as threatened as a standalone community but is a component of the NCA listed wetlands and the EPBCA listed subtropical and coastal saltmarsh).
- Proportional potential losses of the threatened wetland and saltmarsh communities are much lower than the proportional losses of the AHS unit individually (due to additional TASVEG units contributing to the threatened wetland and saltmarsh communities) and considered to be relatively low at the bioregional level and very low at the statewide level (Table 5).
- It can be expected that there will be some scope for revegetation and natural regeneration of native vegetation following works, particularly given the evident history of disturbance-induced grasslands and wetland/saltmarsh macrophyte assemblages colonising parts of the existing environment within the project land following previous works (e.g. the banks of the causeway).

4.3.3 Potential for further mitigation

The proportional bioregional loss (c. 3 %) of AHS will be the most notable impact of the project in relation to native vegetation (albeit native vegetation that is thought to have colonised a man-made environment). The relatively broad distribution of this vegetation type across the southern side of the project land is likely to make complete avoidance infeasible. The primary means of minimising direct impacts to this community should be minimising the permanent and temporary works footprint and associated disturbance within the macrophyte beds. Minimising indirect impacts will require rigorous controls on sediment disruption and deposition, which should be defined within a Construction Environmental Management Plan for the project.

Although the potential losses of other native vegetation communities are not considered to be significant with respect to conservation status and the likelihood of persistence of vegetation communities at a local level and higher (Table 5), the impacts can be further reduced with general mitigation commitments.

Direct and irreversible clearance should be concentrated within the areas of cleared land and non-threatened vegetation as much as possible. Where threatened and/or native vegetation is unavoidable, micro-siting at a local scale may be able to direct impacts into localised areas with less contribution to the overall value (e.g. a rocky area containing minimal vegetation, or a localised area with lower quality vegetation than the surrounds). As well as representative examples of all communities, the project should aim to protect localised variations within units and areas that contain other important values (e.g. threatened flora).

To further minimise net losses, revegetation could be considered as a minor form of mitigation in areas where clearance of native vegetation is not required to be a permanent loss (e.g. borrow pits [if required], temporary access routes and temporary construction disturbance footprints). Suitable species for revegetation should be sourced from the local environment (see species lists in Appendix A). Revegetation specifics, such as seed application rates, use of established plants, specific planting details, *etc.*, are best outlined in a revegetation plan once specific project details, timing, locations, *etc.*, are finalised, and may be included as a requirement in a post-construction management plan. Revegetation of seagrass beds is possible, but the diverse suite of macrophytes that make up the AHS vegetation within the project land includes species with potentially less suitability for revegetation and less established propagation methods at this time.

If further clearance is required due to redesign, to minimise vegetation losses, the proposal should clearly define the extent of clearance required and concentrate the chosen design footprint within areas of already cleared land where possible, as well as avoid impacts to threatened communities (as well as habitat for threatened fauna, or locations of threatened flora).

Prior to the commencement of works, the impact area (project land or outer boundary of disturbance) should be marked (either *in situ* and/or clearly on construction plans) and all contractor agreements should specify that works, vehicles and materials must be confined within the designated impact areas. Areas of threatened communities beyond the impact footprint should be designated as exclusion zones and marked on the ground and/or in construction plans to the degree necessary to ensure no inadvertent impacts occur.

4.3.4 Offset opportunities and priorities for native vegetation

- Although the regional and statewide proportional potential losses of the listed wetland and saltmarsh communities are relatively low, the potential regional proportional loss of the constituent AHS vegetation warrants consideration of offset options – by implementing an offset targeting the AHS vegetation, there will also be offset benefits for the wetland and saltmarsh communities (which by definition include AHS), as well as threatened flora (*Ruppia megacarpa*) and general fauna (particularly waterbirds).
- An effective and plausible mechanism for offsetting the loss of AHS vegetation is a monetary contribution to conservation projects in the River Derwent, to be managed under the authority of the Derwent Estuary Program. Recommended projects with associated offset value for the AHS (and associated values) include:
 - Construction of a wetland interpretation centre

- Extension surveys for further patches of AHS vegetation and the key macrophytes that make up the community at this location – including exploration of the potential for *Stuckenia pectinata* in the area
- Wetland and riparian weed control works
- Waterbird monitoring and habitat management (primarily weed control)
- Undertake/commission/sponsor regular rubbish clean-ups along the margins of aquatic habitats around the new crossing for the purposes of maintaining/improving waterbird habitat

4.3.5 Summary of recommendations for native vegetation

- Concentrate direct and irreversible clearance within areas of non-native vegetation (cleared land) and non-threatened vegetation as much as possible, with particular reference to minimising the final construction footprint (temporary and permanent) within AHS vegetation.
- Apply micro-siting approach (with the aid of an ecologist) to areas of the final footprint within native vegetation – the micro-siting should aim to make minor adjustments to the footprint on the ground by selecting localised areas with relatively less important values (e.g. lower condition areas), as well as maintaining variation within a community across the project land and local areas containing important values.
- In cases of redesign, maximise the proportion of the footprint within non-native (modified) vegetation and avoid threatened and/or native vegetation (as well as habitat for threatened fauna, or locations of threatened flora).
- Clearly demarcate the permitted impact area (project land or outer boundary of disturbance) either in situ and/or clearly on construction plans and specify on all contractor agreements that works, vehicles and materials must be confined within the designated impact area.
- Incorporate rigorous construction controls around sediment displacement and deposition within a Construction Environmental Management Plan, particularly with respect to the AHS community.
- Areas of threatened communities beyond the impact footprint should be designated as exclusion zones and marked on the ground and/or in construction plans to the degree necessary to ensure no inadvertent impacts occur.
- Incorporate a revegetation plan into the post-construction requirements, covering areas where clearance of native vegetation is not required to be a permanent loss (e.g. borrow pits [if required], temporary access routes and temporary construction disturbance footprints). The plan should outline suitable species for revegetation (sourced from the local environment), as well as revegetation specifics, such as seed application rates, use of established plants, specific planting details, *etc*.
- Formalise an offset mechanism and plan for offsetting the loss of AHS vegetation, subject to the final design and the offset requirements from the regulator, with the recommendation being a monetary contribution to conservation projects in the River Derwent, to be managed under the authority of the Derwent Estuary Program. Recommended projects with associated offset value for the AHS (and associated values) include:
 - Construction of a wetland interpretation centre

- Extension surveys for further patches of AHS vegetation and the key macrophytes that make up the community at this location – including exploration of the potential for *Stuckenia pectinata* in the area
- Wetland and riparian weed control works
- Waterbird monitoring and habitat management (primarily weed control)
- Undertake/commission/sponsor regular rubbish clean-ups along the margins of aquatic habitats around the new crossing for the purposes of maintaining/improving waterbird habitat

4.4 Threatened Flora

4.4.1 Potential impacts and context

The following TSPA rare flora can be expected to be at risk within the project land:

- Austrostipa bigeniculata
 - the project land captures one large occurrence of this species, estimated to support over 10,000 plants, with scattered plants elsewhere
 - based on preliminary design considerations, only around 100 m² of the large occurrence is expected to be impacted by the final design, in addition to all of the scattered locations, thus making the expected impact in the order of a couple of hundred plants (with the exact value depending on the relative density within the area of the main occurrence that gets impacted)
 - the Bridgewater/Brighton/Pontville area in general is estimated to contain many 10s of thousands of plants
- Ruppia megacarpa
 - $_{\odot}$ $\,$ dominant component within the macrophyte beds adjacent to the causeway $_{\odot}$
- according to Marine Solutions calculations, in the order of 2.01 hectares of potential *Ruppia* spp. (primarily *R. megacarpa*) habitat is likely to be directly and permanently lost within the proposed southern reclamation and under the bridge structure where it crosses the tidal flats either through direct impact (for example, piling) or shading. Due to varied density of *Ruppia* spp. within this area, this is estimated to represent closer to 1.38 hectare of *Ruppia* spp. cover lost (as some parts of the bridge lie over areas with much lower density of the species). Note that this estimate is slightly less than the estimates provided for loss of aquatic vegetation communities or the areas shown on the figures in this report as the *Ruppia* spp. calculations have been based on a more refined boundary of impact *Vittadinia gracilis*
 - project land contains around 28 plants, with 16 plants around the existing highway at Granton and around 12 plants north of the existing bridge, occurring at three locations close to (or identical to) locations at which they have been reported from in the past – all of the observed plants/locations within the project land are at risk from the permanent footprint but avoidance may be possible during the design phase
 - species is a relatively common component of native roadside remnants throughout the Midlands, with a population of many thousands of plants conceivable – populations in the south are however limited

Table 5: Proportional and quantitative vegetation losses from the potential project footprint (values with asterisks provided by proponent based on preliminary design considerations as per reference in footnote 43 – where expected footprint impact estimates have not been provided, the extent within the extent of permanent works area is taken as potential impact)

	Extent in project land	Extent within potential permanent works area	Potential losses from project footprint	Co	ntext
Community/ unit	Total (ha)	Total (ha)	Total (ha)	Total loss % of extent in bioregion	Total loss % of extent in State
(AHS) saline aquatic herbland	27.34	16.01	2.4 – 3.2*	2.6 – 3.5	0.23 – 0.29
(ARS) saline sedgeland/rushland	0.39	0.06	0.06	0.06	0.01
(ASF) freshwater aquatic sedgeland and rushland	0.99	0.30	0.10*	0.005	0.001
(DVG) Eucalyptus viminalis grassy forest and woodland	0.62	0.20	0.20	0.001	0.0006
(GCL) lowland grassland complex	1.26	0.15	0.15	0.003	0.001
(NBA) <i>Bursaria – Acacia</i> woodland and scrub	0.45	0.35	0.35	0.004	0.002
EPBCA subtropical and temperate coastal saltmarsh (ARS and AHS)	27.72	16.07	2.4 - 3.2*	0.09 – 0.12	0.03 – 0.04
NCA wetlands (ASF and AHS)	28.33	16.31	2.5 – 3.3*	0.09 – 0.11	0.01 – 0.02

The following TSPA rare flora have occurrences close to the project land boundary:

- Schoenoplectus tabernaemontani
 - $\circ~$ the project land previously overlapped with one location of this species supporting around 30 m² (50-60 % cover), but this has been excised from the current proposal (but is still relatively close to the project boundary (< 100 m)
 - the River Derwent survey resulted in the discovery of 4 new occurrences, supporting around 150 m2 at in excess of 75 % cover – it is expected more plants occur between the end of the New Norfolk part of the extension survey and the western edge of the project land
- Vittadinia muelleri
 - several hundred plants observed within the survey area around the existing highway near Bridgewater, north of the project land and not at risk
 - species is a very common component of native roadside remnants in the Midlands and various vegetation types throughout southern Tasmania – it is highly likely the species will be nominated and accepted for delisting from the TSPA in the near future due to the overall size and distribution of its population, and its tendency to persist in (and colonise) human-disturbed environments

4.4.2 Potential for further mitigation

Our current survey coverage is considered to be very good, and based on the timing and extent of surveys, it appears unlikely meaningful occurrences of other species of threatened flora will be recorded within the project land during or in lead up to the project works (Table 2). Based on current observations and the context of each species and their overall populations, the expected losses are expected to be negligible for *Vittadinia gracilis* and *Austrostipa bigeniculata*. Given the ecology of *Ruppia megacarpa* and that the population in the project land is thought to have colonised the causeway since construction, the expected losses of that species are unlikely to compromise the persistence of the population post-works. As such, it appears highly unlikely that the proposal will put at risk the long-term persistence of any threatened flora at the local, bio-regional or statewide level.

Nonetheless, to continue to minimise the direct loss of threatened flora, it is recommended to exclude as many of the known locations as possible from the impact footprint during the final design phases.

In addition to avoiding the direct loss of sites, the general areas around threatened flora not approved to be impacted should be protected from indirect or inadvertent impacts by designating construction exclusion zones around any known occurrences within 10 m of proposed works – exclusion zones must be specified within the detailed design plans and the exclusions should cover but not be limited to mechanical disturbance, dumping of fill, alteration of drainage patterns and soil compaction. Physical barriers or cordons should be applied as necessary to reinforce the exclusion requirements.

4.4.3 Offset opportunities and priorities for threatened flora

- If residual impacts from the chosen design to *Austrostipa bigeniculata* are greater than expected (*i.e.* in the order of several thousands of plants rather than a couple of hundred), it is recommended to consider offset opportunities in the form of propagation and cultivation of replacement plants within roadside areas following works (with precedent for this on the Brighton Bypass). Current levels of expected impacts however do not warrant an offset for this species.

- The recommended offset measures for the AHS community will also address losses of *Ruppia megacarpa*.
- No offsets are considered to be warranted for *Vittadinia gracilis* (nor *V. muelleri* should a change in the project land put that species at risk).
- The extension survey results for *Schoenoplectus tabernaemontani* have demonstrated that impacts to the clump of plants near the project land boundary would not warrant an offset should they be put at risk from a change in the extent of works.

4.5 Weeds

Earthworks associated with clearance and infrastructure construction present a risk of spreading and introducing weeds, both onsite and offsite. Development activities for this proposal may result in the spread of several declared or environmental weeds, including some species with very limited occurrences in Tasmania and several with the capacity to negatively impact environmental and pastoral values. To address this, the proponent has already acted upon a recommendation in an earlier draft and undertaken some targeted primary control of high priority weeds (*Amelichloa caudata* and *Galenia pubescens*) in and around the project land. In addition, NBES eradicated (as best possible with hand removal) *Amsinckia calycina* upon discovery on the causeway in the summer survey. To further limit the potential for weed introduction and dispersal, the following are recommended to comply with DPIPWEs Weed and Disease Planning and Hygiene Guidelines:

- Prepare and implement a stringent project specific Weed Management Plan (which must be linked to contractor requirements within a Construction Environment Management Plan or similar), which amongst other things must adhere to the principles of best practice guidelines and relevant legislation, and contain requirements and prescriptions for:
 - Weed removal and treatment prior to, during, and after civil works.
 - Requirements for wash-down and inspections of all site plant, including earthmoving machinery⁴⁵.
 - Specifications around the relocation, importation and reuse of soil and earth during works.
 - Detailed post-works surveys and control, particularly in relation to potential germination of *Amelichloa caudata*, *Galenia pubescens* and *Amsinckia calycina*, as well as consideration of *Amaranthus albus* and *Asphodelus fistulosus*.

4.6 Threatened Fauna (excluding waterbirds)

4.6.1 Tasmanian devil, spotted-tailed quoll and eastern quoll

4.6.1.1 Context

These species are wide-ranging carnivores, with foraging locations largely driven by prey occurrences rather than habitat types or conditions (more so for the devil than the quolls which can display some stratification of habitat use). Due to the more specific and critical nature of breeding sites (natal dens), these are treated with priority in impact assessments and mitigation measures (where applicable).

⁴⁵ DPIPWE (2015b); Allen and Gartenstein (2010)

4.6.1.2 Site specifics/ existing conditions

The terrestrial components of the site primarily comprise highly modified land, much of which is near a large and busy highway. Only 2.34 ha of the terrestrial component of the project land is native vegetation. Although Tasmanian devil and quolls may occur in modified land, there can be expected in most cases to be a relationship between frequency of occurrence and the presence of native vegetation (due to prey availability and sheltering/denning opportunities). Based on the broader matrix of modified land and our field assessment, these species are expected to be transient/dispersive through the area only.

4.6.1.3 Potential impacts and mitigation

Given the location, the lack of suitability for denning opportunities, and our conclusion that the project land is unlikely to form a core part of a home range for either Tasmanian devil or quolls, potential impacts to these species are considered to be negligible. Thus, no specific mitigation measures are warranted for these species. It is noted however they may benefit from general roadkill mitigation measures should they be applied for other species.

4.6.2 Eastern barred bandicoot

4.6.2.1 Context

This is a moderately common species of mixed modified environments in southeast Tasmania and can be expected to use parts of the project land to varying degrees based on the habitats and known occurrences of the species in the broader local area (e.g. Pontville and Brighton).

4.6.2.2 Site specifics/ existing conditions

Habitat equivalent to (or better than) that within the project land is very abundant (thousands of hectares) within the adjacent local areas of Brighton, Pontville, Dromedary, *etc.*, making the extent of potential habitat within the project land extremely minor in the context of the broader surrounds.

4.6.2.3 Potential impacts and mitigation

It is not conceivable that the project land contains a degree of habitat, nor any specific elements, that could be critical to persistence of the species at the local level or higher. No specific mitigation measures are warranted for this species. It is noted however they may benefit from general roadkill mitigation measures should they applied for other species.

4.6.3 White-bellied sea eagle

4.6.3.1 Context

In Tasmania, the white-bellied sea-eagle is restricted to nesting within 5 km of coastlines, major estuaries and inland lakes. They typically build nests in large eucalypt trees, much like the Tasmanian wedge-tailed eagle (*Aquila audax fleayi*), although their specific nesting requirements are not as strict as that species.

4.6.3.2 Site specifics/ existing conditions

This species has been observed around the project land and can be expected to derive foraging opportunities from the aquatic elements within the River Derwent in particular. No suitable breeding habitat is present within the project land and it is not expected any nesting opportunities will be impacted in nearby areas based on the general absence of suitable habitat. The nearest nests are 2.5 km away to the northwest of the project land, well beyond the 500 m exclusion zone or 1 km line of sight for development during the breeding season.

4.6.3.3 Potential impacts and mitigation

Impact to foraging habitat is negligible given extent of equivalent habitat in the area. No impact is expected to breeding habitat or breeding birds.

No specific mitigation measures are warranted for this species.

4.6.4 Tasmanian wedge-tailed eagle

4.6.4.1 Context

Wedge-tailed eagles' nest in a range of old growth native forests and are dependent on forest for nesting. This species requires large, sheltered trees for nesting and is highly sensitive to anthropogenic disturbances during the breeding season.

4.6.4.2 Site specifics/ existing conditions

The project land can be expected to comprise a minor part of one or more foraging territories for this species. No suitable breeding habitat is present within the project land and it is not expected any nesting opportunities will be impacted in nearby areas based on the general absence of suitable habitat. The nearest modelled suitable habitat is near Forest Road to the south of the river – these areas are adjacent to roads and/or near residential lots and unlikely to be utilised for breeding. The nearest known eagle nests are around 2.5-3 km away, well beyond the 500 m exclusion zone or 1 km line of sight for development during the breeding season.

4.6.4.3 Potential impacts and mitigation

Impact to foraging habitat is primarily to highly modified land which is abundant in the broader area and is therefore negligible. No impact is expected to breeding habitat or breeding birds.

No mitigation measures are warranted for this species.

4.6.5 Australian grayling

4.6.5.1 Context

This species of fish migrates between fresh and marine environments. In Tasmania it is mostly found in rivers in the north, east and west, with only a few occurrences in the south (including the River Derwent).

A separate report by Marine Solutions covers site specifics and the potential impacts and mitigation for this species.

4.6.6 Swift parrot

4.6.6.1 Context

The breeding range of the swift parrot is concentrated along the east and southeast coast of Tasmania and is strongly associated with the distribution of blue gum (*Eucalyptus globulus*), its primary feeding resource⁴⁶. The swift parrot nests in hollows in large eucalypt trees, normally within 10 km of foraging habitat⁴⁷.

⁴⁶ Department of the Environment (2016) *Lathamus discolor* (Swift Parrot), Conservation Advice ⁴⁷ Webb (2008)

4.6.6.2 Site specifics/ existing conditions

The vicinity of the project land is known to be occasionally used by swift parrots, with around a dozen observations of the species documented within 5 km and the location being partly within a Swift Parrot Important Breeding Area (SPIBA) (noting SPIBAs effectively cover the entire known breeding range of the species). It is noted however that only one of the reported sightings within 5 km was made after 1998, with this being made during 2014, roughly 3000 m from the project land.

The project land was found to contain 43 *E. globulus* trees, with less than half being greater than 40 cm diameter at breast height (DBH) and thus considered suitable foraging trees at the time of survey. The remaining trees at the time of survey were of insufficient age/size to constitute viable foraging habitat. All 43 of the *E. globulus* trees were noted as plantings rather than native remnants. No suitable nesting trees were observed within the project land and the potential foraging value of the planted trees was considered to be an extremely minor potential resource.

4.6.6.3 Potential impacts and mitigation

The primary potential impact for this species relates to the potential direct loss of 11 planted trees of sufficient size and age to be considered viable potential foraging habitat. The impact of such a removal, when considered in isolation from any other current or future developments in the area, can be expected to have a negligible impact to the carrying capacity of the population given the paucity of observations in the area and the nature of the habitat. Even on a local scale the planted trees were concluded to be an extremely minor potential foraging resource and it is noted that natural habitats mapped in the broader area⁴⁸ support 112 ha of sub-optimal foraging habitat (low density foraging trees or young *E. globulus* forest) and 118 ha of high-density foraging habitat (*E. globulus* forest)⁴⁹.

There is ample scope for an offset replacement of the lost potential foraging trees post development with new plantings, which could reach equivalent size and value within 15 years. This however is not seen as necessary in the context of the proposal due to the marginal nature of the habitat and the location being used infrequently by the species. In addition, it is noted that Tasmanian blue gums are planted extensively in periurban environments and given the high rates of turnover/removal associated with trees planted around urban residences⁵⁰, the continual removal and replacement of young periurban trees is unlikely to be a factor in the recovery or decline of the swift parrot.

4.6.7 Offsets for threatened fauna

- Based on the anticipated impacts and the assessments provided above⁵¹, offsets are not considered to be warranted for these species of threatened fauna.

⁴⁸ Habitat context area includes habitat within 5 km of project land

⁴⁹ TASVEG mapping, DPIPWE

⁵⁰ Kirkpatrick et al. (2012)

⁵¹ And supported by detailed assessments of Matters of National Environmental Significance in a separate NBES report (June 2021)

4.7 General Waterbirds (including Australasian bittern and great crested grebe)

4.7.1.1 Context

Although none of the project land (or River Derwent) is listed as a RAMSAR site, the wetlands and aquatic habitats to the west and on the northeast landward corner of the existing bridge constitute part of the River Derwent nationally important wetland. The site is well known for attracting large numbers of birds and DPIPWE consider this to be the most important zone for waterbirds in the River Derwent⁵².

Within Tasmania, the Australasian bittern is now found mostly in the north-east and east coast, as well on the islands of Bass Strait, however it can also be found in the upper River Derwent (as well as Lake Crescent and Lake Sorell).

The great crested grebe is relatively rare in Tasmania but can have minor irruptions and periods of regular sightings in some areas. This happened around the existing Bridgewater Bridge between 2014-2018 (Birdlife and on the NVA), with numerous sightings.

4.7.1.2 Site specifics/ existing conditions

Waterbirds were recorded in all the areas surveyed, but they were primarily non-threatened widespread species with relatively broad ecological niches (*i.e.* although they are reliant on aquatic elements, their relationships with particular habitat elements are not overly specific). Nonetheless, the project land was found to be used in various ways by these waterbirds, with nesting, foraging and roosting/loafing all observed by various species. The relatively shallow subtidal areas adjacent to the causeway were found to support high abundances of birds and were associated with both foraging and breeding opportunities.

In terms of nesting observations (in some cases deduced indirectly by behaviour and locations), the following were recorded within the project land:

- black swan (12 nests)
- Tasmanian native hen (2 nests)
- purple swamp hen (3 nests)
- little grassbird (1 nest)
- welcome swallow (2 nests)
- pacific black duck (including hybrids of) (1 nest)

The great crested grebe was the only threatened species observed during our surveys. Although courtship behaviour was observed within the project land, with two birds swimming together during the last 2 weeks of surveys in December and, on one occasion, the birds undertaking a brief courtship display, they were typically observed amongst the reeds beyond the project land, with the possibility they could breed in the reeds discreetly.

The Australasian bittern is known from the general area but only has minor sub-optimal habitat patches within the potential extent of permanent works area.

4.7.1.3 Potential impacts and mitigation

These species are at risk of direct impacts from the proposal in relation to lost or altered habitat, direct impacts to nests during works, light pollution (regarding disorientated birds) and collision mortality from the proposed structure. Our assessment indicates these risks can be mitigated

⁵² DEP, State of the Derwent estuary 2020 draft

and that impacts can be expected to be relatively small in relation to the more extensive areas of habitat in the immediately adjacent areas of the River Derwent that are not at risk from the proposal.

Specifically in relation to direct loss of potential breeding habitat (with a focus on threatened species), the patches of potential (sub-optimal) breeding habitat for the Australasian bittern and the great crested grebe are so small that less than 2 ha are at risk of impacts from the proposal, with in excess of 350 ha of higher quality habitat present in the surrounding 5 km radius of the River Derwent.

With respect to foraging habitat, up to 3.2 ha of sub-tidal macrophyte beds are at risk of impacts from clearance required for the footprint, while tens of hectares of equivalent habitat will remain in the broader area beyond the project land, supported by many hundreds of hectares of potential aquatic foraging habitat of other types (*i.e.* not just macrophyte beds).

<u>Prior to works</u>

The individual nests observed within (/deduced from) our observations (section 4.7.1.2) will not necessarily be present at the point of works, as the species observed will generally rebuild annually. Thus, a pre-works survey is recommended to quantify the number of nests at risk and guide mitigation where possible. Due to variable breeding seasons for the suite of species and their ephemeral nests, the survey will require multiple iterations, with our recommendation being that it should be undertaken monthly from May to February to capture all possible breeding events. Any nest observed within this period can be assessed for viability as an exclusion zone for protection from impacts during works (taking into account the expected length of time the nest will be used for). Nests that cannot viably be protected from destruction will need to be approved to be taken under permit (for those species protected by the *Wildlife (General) Regulations 2010* (section 5.3).

During works

During works, there is a high likelihood that the noise and physical disturbance associated with works will result in the displacement of waterbirds to varying degrees. Some species/individuals with a high tolerance of human activities can be expected to be displaced to only a minor degree and remain active in adjacent parts of the River Derwent, or even remain active within the project land itself but perhaps with altered patterns of behaviour and activity. Given the area is already a highly disruptive environment with the existing levels of traffic noise and frequent recreational boat use, it can be expected that the species and individuals within the area are relatively resilient/adapted to such disturbance. In contrast, more sensitive species (or species/individuals already at their limits of tolerable disturbance) may be displaced beyond the local area and forced to find suitable habitat elsewhere during the period of construction. Given the nature of the waterbird assemblage we have recorded on site and the fact that these species tend to be highly adapted to regional dispersals in relation to habitat and environmental variables (e.g. influxes of birds into Tasmania during mainland droughts, and similar examples within Tasmania), the potential consequences of such movements are not considered likely to have long-term ramifications for the overall populations of the species nor their continued occupation of the local area following works.

The primary potential impacts that are expected during works relate to increased sedimentation and temporary changes in lighting to facilitate works at night. Although it can be expected that changes in sedimentation levels may not be permanent within the area, this (as well as the levels of temporary increase) will need to be managed under specific soil and water prescriptions under a Construction Environment Management Plan and associated documents (e.g. a Soil and Water Management Plan). The subtidal macrophyte beds to the east and west of the causeway will be particularly at risk of impacts from increased sediment, with the potential result being decreased quality of bird foraging habitat in those areas. It is acknowledged however that the construction of the causeway itself in the 1800s (and the associated sediment build-up in those areas in which tidal movements became constrained) is likely to have been the catalyst for the formation of the macrophyte patches and, being colonisers of sediment, they can be expected to be resilient to some level of sediment change as long as the rate of change does not overwhelm the rates of growth and lateral spread.

Potential impacts and mitigation measures around lighting are discussed in relation to operational issues below.

Post-works/ operational period

The existing causeway is not proposed for removal but may be used in construction or design. Alterations that increase waterflow and depth could be expected to displace sediments and potentially disadvantage the macrophyte beds, with subsequent implications for bird habitat. As such, it is ideal that the current structure and position of the causeway will be maintained. This will also maintain (and possibly improve) the current roost sites in this area.

Fragmentation from the new bridge structure has been considered as a potential impact for waterbirds (and other fauna) but is not considered likely to pose a genuine impediment given the nature of the species in the area (specifically their capacity for long-distance flights and natural adaptations to utilising widely dispersed habitat fragments).

During construction and operations, the project land/new crossing may become a source of light pollution that is greater than the existing bridge, which is relatively dimly illuminated. Light can disorientate birds, cause them to change flight patterns, and result in groundings, all of which can result in collisions with vehicles⁵³, with spates of collisions of short-tailed shearwaters known from the Tasman Bridge for instance⁵⁴. Efforts to limit the effects of artificial lights can be expected to reduce the potential for mortalities⁵⁵. The use of different colour lights (green and blue lights are less attractive to migrating birds for example⁵⁶) should be explored as should efforts to shield light emissions. Detailed recommendations can be made when the chosen design is finalised and construction lighting requirements understood. This should be addressed within the Artificial Light Management Plan and implemented within the requirements of the Construction Environment Management Plan, ensuring it adheres the principles and best practices measures within the *National Light Pollution Guidelines for Wildlife including Marine Turtles, Seabirds and Migratory Shorebirds*⁵⁷.

As a general observation, waterbird habitats within the project are prone to high accumulations of non-perishable human rubbish, with subsequent impacts through habitat alteration and risks of ingestion and entanglement. It is possible that the existing bridge and the causeway alter water movement in a way that influences the likelihood of rubbish accumulation in these areas, and that the new bridge could alter this (positively or negatively) – this however will require monitoring post-works (as well as baseline date prior to the works). The value of the aquatic

⁵³ Rodriguez et al. (2014)

⁵⁴ For example see <u>https://www.abc.net.au/news/2019-05-10/record-number-of-mutton-birds-taken-into-care/11100436</u>

⁵⁵ Rodriguez et al. (2014)

⁵⁶ Poot et al. (2008)

⁵⁷ Department of the Environment and Energy (2020)

habitats and shorelines around the project land could be improved for waterbirds through the implementation of regular rubbish clean-ups, which could be supported as an offset mechanism.

4.7.2 Offsets for waterbirds

- The recommended offset measures for the AHS community will also mitigate impacts to waterbirds.

4.7.3 Summary of recommendations for waterbirds

- Undertake monthly surveys for bird nests from May to February until works commence. Any nest observed within this period should be treated as an exclusion zone and buffered from impacts if possible. Nests that cannot viably be protected from destruction will need to be approved to be taken under permit (for those species protected by the *Wildlife (General) Regulations 2010* (section 5.3).
- Within a Soil and Water Management Plan (applied within a Construction Environment Management Plan and completed before works commence), include prescriptions to manage and mitigate sedimentation levels within the aquatic habitats of the River Derwent during (and as a result of) works, particularly in relation to the shallow macrophyte beds adjacent to the causeway. This plan should also mitigate potential impacts from acid sulphate soil.
- Maintain the current structure and position of the causeway regardless of the eventual bridge design. It is understood there is currently no intention to remove the causeway.
- Complete and implement an Artificial Light Management Plan (to take into account light pollution and bird strike mitigation for design considerations with respect to operational lighting of the new crossing and any temporary lighting required during works) – it is understood the proponent has engaged a consultant to complete such a plan.

4.8 Roadkill

On the existing bridge and causeway, our investigations found that roadkill mortalities were concentrated on the exposed causeway, which may have been in part an artefact of the adjacent grassy verges, but could also indicate birds are buffered from collisions in the area of the existing bridge enclosed by steel beams. This is consistent with other investigations which have found that poles can reduce road collisions among marine birds in open coastal areas⁵⁸. Based on this, it is suggested that the design for the new crossing includes some barriers (visible structures) to at least vehicle height as this will represent less of a collision risk than a flatter design such as a causeway. The barriers/visible obstructions should be continuous along the edges of the new crossing or there is a risk that an apparent flight path would be created across the traffic, leading to a high-risk collision area should birds be funnelled into such as spot. In addition, due to the potential association between road collisions and grassy verges providing fodder, the new crossing should not include grassy verges (grassy verges on the terrestrial edges of the adjoining roadways are acceptable).

Given the lack of specificity of previous roadkill records, it is warranted to undertake location specific roadkill counts (such as done in this investigation) following construction, which can monitor roadkill rates and identify any hotspots that may require mitigation. The roadkill survey

⁵⁸ Bard et al. (2002)

area could include any adjoining areas of highway that get modified within the project, so as to identify any mitigation measures for terrestrial species should they be warranted.

As a general rule, levels of roadkill increase with increased road traffic speed. Given the new crossing can be expected to have a higher speed limit than the current 60 km/hr across the existing bridge and causeway, it could be expected to result in increased roadkill if the design remained the same. However, given the potential design changes mentioned in relation to increased structural obstructions and no additional grassy verges, it is uncertain if the chosen design changes will offset the impacts of increased speed. This is something that could be established with monitoring. If speed proves to be a factor in roadkill levels, it may be possible as a mitigation measure to install LED (or equivalent) speed signs with changeable limits to be reduced in high-risk conditions or times of year – for example it may be beneficial to lower speed limits in low visibility conditions (such as fog) due to the previously discussed potential relationship with collisions and visibility.

4.8.1 Summary of roadkill recommendations

- The final design should favour the presence of continuous structural obstructions along each side and should not include any grassy verges on the new crossing (grassy verges on the terrestrial edges of the adjoining roadways are acceptable).
- Implement location specific roadkill monitoring post-construction, to establish if specific mitigation measures have been beneficial.
- Note aspects of roadkill collisions in relation to the recommended Artificial Light Management Plan.

5 LEGISLATIVE IMPLICATIONS AND ASSESSMENT

5.1 Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA)

The project is not considered to be a risk of resulting in significant impacts to Matters of National Environmental Significance (MNES) under the definitions for assessment requirements under this Act. Based on this it does not warrant referral to the federal Minister for consideration as a controlled action. This is covered in more detail in a separate NBES report⁵⁹.

5.1.1 Threatened ecological communities

The only EPBCA listed community within the project land is the vulnerable subtropical and temperate coastal saltmarsh community. Vulnerable communities are not MNES for the purposes of Part 3 of the EPBCA (requirements for environmental approvals) and thus do not require consideration for significant impacts.

5.1.2 Threatened flora

The project land has not been found (nor considered likely) to support EPBCA listed flora and as such there is no potential for significant impacts to threatened flora that are MNES under this Act.

⁵⁹ North Barker Ecosystem Services (June 2021)

5.1.3 Threatened fauna

The proposal has the potential to interact with threatened fauna listed as MNES under this Act, including the eastern barred bandicoot, the Australasian bittern, the Tasmanian devil, eastern and spotted-tailed quolls (and the Australian grayling). Our assessments and consideration of each species have however concluded that the potential for interaction with these species and their habitats is relatively low and/or relatively minor in regard to the potential impacts. Based on this the proposal has (with respect to important populations or otherwise):

- No likelihood of breeding disturbance and therefore no adverse impacts on habitat critical to the survival of the species, no potential to disrupt the breeding cycle of a population, no potential to lead to a long-term decrease in the size of a population and no impacts to habitat to the extent that the species is likely to decline.
- No possible fragmentation effects.
- No likelihood of introduction of disease or harmful invasive species.
- No potential for interference with the recovery of the species.
- No meaningful reduction in the area of occupancy of the species, given that permanent habitat losses are only likely to constitute a very minor and occasional potential foraging resource.

Thus, the proposal has no potential for significant impacts to threatened fauna if it is undertaken in accordance with the recommendations and descriptions within our report.

5.2 Tasmanian Threatened Species Protection Act 1995 (TSPA)

Under the TSPA, a person cannot knowingly, without a permit, 'take' a listed species. With the definition of 'take' encompassing actions that kill, injure, catch, damage, destroy and/or collect threatened species or vegetation elements that support threatened species, e.g. nests and dens.

This definition will apply where the project cannot directly avoid occurrences of *Austrostipa bigeniculata, Ruppia megacarpa* and *Vittadinia gracilis,* as well as nearby *Schoenoplectus tabernaemontani* and *V. muelleri* if the expected extent of works is altered.

5.3 Tasmanian Nature Conservation Act 2002 (NCA)

It can be expected that nests of birds we recorded breeding in the project land may be impacted by the proposal in a way that constitutes knowingly destroying a product of wildlife, including the following species protected under the *Wildlife (General) Regulations 2010* (with expected losses of nests and eggs⁶⁰ based on the observations undertaken for this assessment and the potential extent of permanent works area as presented in our mapping):

- black swan (6 nests estimated maximum 48 eggs)
- Tasmanian native hen (2 nests estimated maximum 20 eggs)
- purple swamp hen (1 nest estimated maximum 5 eggs)
- little grassbird (1 nest estimated maximum 5 eggs)
- welcome swallow (2 nests estimated maximum 14 eggs)

It is noted that nests for these species are typically ephemeral constructions that will not necessarily be re-built in the same location in consecutive seasons. Thus, to adequately inform the number of nests (and eggs) at risk of impacts at the time of construction will require a pre-

⁶⁰ Based on average expected clutch size from Higgins et al (2006)

works survey (as per the recommendation in section 4.7.1.3). It can reasonably be expected though that the level of impacts year to year will be broadly consistent with our observations.

At this point, no dens or burrows are expected to be decommissioned/destroyed for terrestrial fauna.

5.4 Tasmanian Weed Management Act 1999

The various species of declared weeds in the project land each have relevant statutory weed management plans that define the respective municipalities as Zone A or Zone B municipalities according to the scale of known infestations.

According to the provisions of the *Weed Management Act 1999*, Zone B municipalities are those which host moderate or large infestations of the declared weed that are not deemed eradicable because the feasibility of effective management is low at this time. Therefore, the objective is containment of infestations. This includes preventing spread of the declared weed from the municipality or into properties currently free of the weed or which have developed or are implementing a locally integrated weed management plan for that species. As well there is a requirement to prevent spread of the weeds to properties containing sites with significant flora, fauna and vegetation communities.

Zone A localities are areas in which eradication is deemed feasible and is the responsibility of the land manager (or the lease holder).

The various listings and locations of declared weeds within the project land will need to be covered within the recommended Weed and Hygiene Management Plan with respect to control and containment obligations.

5.5 Land Use Planning and Approvals Act 1993 (LUPAA)

LUPAA states that 'in determining an application for a permit, a planning authority must (amongst other things) seek out the objectives set out in Schedule 1⁶¹.

Schedule 1 includes 'The objectives of the Resource Management and Planning System of Tasmania' which are (amongst other things):

'To promote sustainable development of natural and physical resources and the maintenance of ecological processes and genetic diversity'.

Sustainable development includes 'avoiding, remedying or mitigating any adverse effects of activities on the environment'⁶².

The intent of LUPAA will be met through the assessment under Section 600 of the Act, which covers major projects and negates the requirement for separate planning permits from the contingent local councils. The proposal will instead be subject to an assessment process co-ordinated by the Tasmanian Planning Commission.

6 CONCLUSION AND RECOMMENDATIONS

Our results and analyses have established that if our recommendations for mitigation are followed the proposal can proceed without resulting in a significant impact to MNES and that it is not likely to have a significant detrimental impact on values listed as threatened under other Acts or considered as conservation significant for other reasons. Largely this is due to the

⁶¹ Section 51(2)(b) – Part 4 Enforcement of Planning Control – Division 2 Development Control (LUPPA 1993)

⁶² page 56 – *LUPPA 1993*

already modified nature of the general landscape and the capacity to avoid, mitigate and offset anticipated impacts to a satisfactory degree.

The following recommendations are made regarding general management of the proposal area and to ensure minimal impacts to conservation significant values.

6.1 Native Vegetation

- Concentrate direct and irreversible clearance within areas of non-native vegetation (cleared land) and non-threatened vegetation as much as possible, with particular reference to minimising the final construction footprint (temporary and permanent) within AHS vegetation.
- Apply micro-siting approach (with the aid of an ecologist) to areas of the final footprint within native vegetation the micro-siting should aim to make minor adjustments to the footprint on the ground by selecting localised areas with relatively less important values (e.g. lower condition areas), as well as maintaining variation within a community across the project land and local areas containing important values.
- In cases of redesign, maximise the proportion of the footprint within non-native (modified) vegetation and avoid threatened and/or native vegetation (as well as habitat for threatened fauna, or locations of threatened flora).
- Clearly demarcate the permitted impact area (project land or outer boundary of disturbance) either in situ and/or clearly on construction plans and specify on all contractor agreements that works, vehicles and materials must be confined within the designated impact area.
- Incorporate rigorous construction controls around sediment displacement and deposition within a Construction Environmental Management Plan, particularly with respect to the AHS community.
- Areas of threatened communities beyond the impact footprint should be designated as exclusion zones and marked on the ground and/or in construction plans to the degree necessary to ensure no inadvertent impacts occur.
- Incorporate a revegetation plan into the post-construction requirements, covering areas where clearance of native vegetation is not required to be a permanent loss (e.g. borrow pits [if required], temporary access routes and temporary construction disturbance footprints). The plan should outline suitable species for revegetation (sourced from the local environment), as well as revegetation specifics, such as seed application rates, use of established plants, specific planting details, *etc.*

6.2 Threatened Flora

- It is recommended to exclude as many of the known locations of threatened flora as possible from the impact footprint during the final design phases.
- The general areas around threatened flora locations that are not approved to be impacted should be protected from indirect or inadvertent impacts by designating construction exclusion zones around any known occurrences within 10 m of proposed works – exclusion zones must be specified within the detailed design plans and the exclusions should cover but not be limited to mechanical disturbance, dumping of fill, alteration of drainage patterns and soil compaction. Physical barriers or cordons should be applied as necessary to reinforce the exclusion requirements.

6.3 Weeds

- Prepare and implement a stringent project specific Weed Management Plan (which must be linked to contractor requirements within a Construction Environmental Management Plan or similar), which amongst other things must adhere to the principles of best practice guidelines and relevant legislation, and contain requirements and prescriptions for:
 - Weed removal and treatment prior to, during, and after civil works.
 - Requirements for wash-down and inspections of all site plant, including earthmoving machinery⁶³.
 - Specifications around the relocation, importation and reuse of soil and earth during works.
 - Detailed post-works surveys and control, particularly in relation to potential germination of *Amelichloa caudata*, *Galenia pubescens* and *Amsinckia calycina*, as well as consideration of *Amaranthus albus* and *Asphodelus fistulosus*.

6.4 Threatened Fauna (excluding waterbirds)

No specific mitigation measures are warranted for the relevant species, noting the Australian Grayling is outside the scope of this report.

6.5 Waterbirds

- Undertake monthly surveys for bird nests from May to February until works commence. Any nest observed within this period should be treated as an exclusion zone and buffered from impacts if possible. Nests that cannot viably be protected from destruction will need to be approved to be taken under permit (for those species protected by the *Wildlife (General) Regulations 2010* (section 5.3).
- Within a Soil and Water Management Plan (applied within a Construction Environment Management Plan and completed before works commence), include prescriptions to manage and mitigate sedimentation levels within the aquatic habitats of the River Derwent during (and as a result of) works, particularly in relation to the shallow macrophyte beds adjacent to the causeway. This plan should also mitigate potential impacts from acid sulfate soil.
- Maintain the current structure and position of the causeway regardless of the eventual bridge design. It is understood there is currently no intention to remove the causeway.
- Complete and implement an Artificial Light Management Plan (to take into account light pollution and bird strike mitigation for design considerations with respect to operational lighting of the new crossing and any temporary lighting required during works) – it is understood the proponent has engaged a consultant to complete such a plan.

6.6 Roadkill

- The final design should favour the presence of continuous structural obstructions along each side and should not include any grassy verges on the new crossing (grassy verges on the terrestrial edges of the adjoining roadways are acceptable).

⁶³ DPIPWE (2015b); Allen and Gartenstein (2010)

- Implement location specific roadkill monitoring post-construction, to establish if specific mitigation measures have been beneficial.
- Note aspects of roadkill collisions in relation to the recommended Artificial Light Management Plan.

6.7 Consideration of Offsets

- Formalise an offset mechanism and plan for offsetting the loss of AHS vegetation, subject to the final design and the offset requirements from the regulator, with the recommendation being a monetary contribution to conservation projects in the River Derwent, to be managed under the authority of the Derwent Estuary Program. Recommended projects with associated offset value for the AHS (and associated values) include:
 - Construction of a wetland interpretation centre
 - Extension surveys for further patches of AHS vegetation and the key macrophytes that make up the community at this location – including exploration of the potential for *Stuckenia pectinata* in the area
 - Wetland and riparian weed control works
 - Waterbird monitoring and habitat management (primarily weed control)
 - Undertake/commission/sponsor regular rubbish clean-ups along the margins of aquatic habitats around the new crossing for the purposes of maintaining/improving waterbird habitat
- Consider offset recommendations for specific lifeforms (e.g. *Austrostipa bigeniculata* and *Ruppia megacarpa*) if final impacts are greater than expected based on preliminary design considerations.

REFERENCES

- Allen and Gartenstein (2010). *Keeping it clean A Tasmanian field hygiene manual to prevent the spread of freshwater pests and pathogens*. Published by NRM South.
- Backhouse, G., Jackson, J. and O'Connor, J. (2008). National Recovery Plan for the Australian Grayling *Prototroctes maraena*. Department of Sustainability and Environment, Melbourne.
- Bard, A. M., Smith, H., Egensteiner, E.D., Mulholland, R., Harber, T.V., Heath, G.W., Miller, W.J.B. and Weske, J.S. (2002). A Simple Structural Method to Reduce Road-Kills of Royal Terns at Bridge Sites. *Wildlife Society Bulletin.* 30. 603-605.
- Birdlife Australia (2020) available at: https://birdata.birdlife.org.au/
- Brereton and Mooney (1994) Conservation of the nesting habitat of the grey goshawk *Accipiter novaehollandiae* in Tasmanian State Forests
- Bryant, S. L. 2002. Conservation assessment of beach nesting and migratory shorebirds in Tasmania. Nature Conservation Branch Department of Primary Industries Water and Environment: NHT No. NWP 11990.
- Commonwealth of Australia (2020a). Protected Matters Search Tool, www.environment.gov.au. Report – PMST_Z700NQ.

Commonwealth of Australia (2020b):

http://www.environment.gov.au/cgi-bin/wetlands/report.pl

- Commonwealth of Australia (1999). *Environment Protection and Biodiversity Conservation Act* 1999. No. 91, 1999.
- Cooper, R., Clemens, R., Oliveira, N., and Chase, A. (2012). Long-term declines in migratory shorebird abundance in northeast Tasmania. *Stilt* 61, 19–29.
- Department of the Environment (2020). Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.
- Department of the Environment and Energy (2020). National Light Pollution Guidelines for Wildlife including Marine Turtles, Seabirds and Migratory Shorebirds.
- Department of the Environment and Energy (2018). National Strategy for Ecologically Sustainable Development.

https://www.environment.gov.au/about-us/esd/publications/national-esd-strategy

- Department of Environment, Land, Water and Planning (2016). Conservation Advice for the Swift Parrot. Australian Government, Canberra.
- Department of the Environment, Water, Heritage and the Arts (2010). Lowland Native Grasslands of Tasmania — a nationally threatened ecological community. Environment Protection and Biodiversity Conservation Act 1999 Policy Statement 3.18. Australian Government, Canberra.
- Derwent Estuary Program (2020). State of the Derwent Estuary 2020 draft.
- de Salas M.F. and Baker M.J. (2019). *A Census of the Vascular Plants of Tasmania*. Tasmanian Herbarium, Tasmanian Museum and Art Gallery.
- DPIPWE (2020). Natural Values Report # _1_04-Aug-2020, DPIPWE, Natural Values Atlas, Threatened Species Section, Department of Primary Industries, Parks, Water and Environment, Hobart.

- DPIPWE (2015a). *Guidelines for Natural Values Surveys Terrestrial Development Proposals.* Department of Primary Industries, Parks, Water and Environment (Natural and Cultural Heritage Division).
- DPIPWE (2015b). *Weed and Disease Planning and Hygiene Guidelines Preventing the spread of weeds and diseases in Tasmania.* (Eds.) Karen Stewart and Michael Askey-Doran. Department of Primary Industries, Parks, Water and Environment, Hobart, Tasmania.
- DPIPWE (2014). Department of Primary Industries, Parks, Water and Environment. TASVEG 3.0 area by VEGCODE. Tasmanian Vegetation Monitoring and Mapping Program, Resource Management and Conservation Division.
- DPIPWE (2013). Department of Primary Industries, Parks, Water and Environment. TASVEG 3.0, Released November 2013. Tasmanian Vegetation Monitoring and Mapping Program, Resource Management and Conservation Division.
- Department of Sustainability, Environment, Water, Population and Communities/ DSEWPaC (2011). Survey guidelines for Australia's threatened mammals: guidelines for detecting mammals listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. Australian Government, Canberra.
- Dutson, G., Garnett, S. and Gole, C. (2009). Australia's Important Bird Areas Key sites for bird conservation. Bird Australia (RAOU) Conservation Statement NO. 15, October 2009.
- Goff, F.G, Dawson, G.A. and Rochow, J.J. (1982). Site examination for threatened and endangered plant species. *Environmental Management 6 (4) pp 307-316*.
- Google Earth Pro (2020). Various images referenced in text, by DigitalGlobe, TerraMetrics and CNES/ Airbus. Accessed August 2020.
- Harris, S. and Kitchener, A. (2005). *From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation.* Department of Primary Industries, Water and Environment, Printing Authority of Tasmania, Hobart.
- Higgins, et al (eds) 1990 2006. Handbook of Australian, New Zealand and Antarctic Birds. Oxford University Press, Melbourne.
- Holdsworth M, Baker GB, Garnett ST (2021) in press. Tasmanian Azure Kingfisher *Ceyx azureus diemenensis*. In Action Plan for Australian Birds 2020. (Eds ST Garnett and GB Baker) pp. XXX–XXX. CSIRO Publishing, Melbourne).
- Horton, K.G., Nilsson, C., Van Doren, B.M., La Sorte, F.A., Dokter, A.M. and Farnsworth, A. (2019) Bright lights in the big cities: Migratory birds' exposure to artificial light. *Frontiers in Ecology and the Environment*. 17(4), 209-214.
- IBRA 7 (2012). Interim Biogeographic Regionalisation for Australia, Version 7. Map produced by Environment Resources Information Network (ERIN), Australian Government Department of the Environment and Energy, Canberra, Commonwealth of Australia.
- Kirkpatrick, J.B. and Nunez, M. (1980). Vegetation-radiation relationships in mountainous terrain: eucalypt-dominated vegetation in the Risdon Hills, Tasmania. *Journal of Biogeography* v. 7, pp. 197-208.
- Kirkpatrick, A Davison, GD Daniels (2012). Resident attitudes towards trees influence the planting and removal of different types of trees in eastern Australian cities. Landscape and urban planning 107 (2), 147-158.

- Kitchener, A. and Harris, S. (2013). *From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation*. Edition 2. Department of Primary Industries, Parks, Water and Environment, Tasmania.
- Kociolet, A., Grilo, C. and Jacobson, S. (2015) Flight doesn't solve everything: Mitigation of road impacts on birds. *Handbook of Road Ecology.* 33, 281-289.
- Kuchler, A.B. and Zonneveld, S. (2012). *Vegetation Mapping*. Kluwer Academic Publishers, United States, pp. 648.
- Mount, R. E. (2011): Spatial imagery for management of Submerged Aquatic Vegetation (SAV) in the River Derwent estuary. A technical report for the Derwent Estuary Program. Blue Wren Group, School of Geography and Environmental Studies, University of Tasmania, Hobart, Tasmania.
- Natural and Cultural Heritage Division (2015). *Survey Guidelines and Management Advice for Development Proposals that may impact on the Tasmanian Devil (Sarcophilus harrisii).* Department of Primary Industries, Parks, Water and Environment.
- Newman, M. and Cooper, R. (2019). Status of Waterfowl in Tasmania, 2005-06 to 2015-16, in *State of Tasmania's Birds, 2015-16*, Newman, M., Ramshaw, N., Drake, S., Woehler, E., Walter, A. and Webber, W. Reproduced from Tasmanian Bird Report 39, May 2019.
- North Barker Ecosystem Services (2021). Bridgewater Bridge Replacement, Matters of National Environmental Significance, Significant Impact Assessment and Referral Decision Context. For Burbury Consulting obo Department of State Growth.
- Poot, H., Ens, B., Vries, H., Donners, M., Wernand, M. and Marquenie, J. (2008). Green light for nocturnally migrating birds.
- Rodríguez A, Burgan G, Dann P, Jessop R, Negro JJ, et al. (2014). Fatal Attraction of Short-Tailed Shearwaters to Artificial Lights. PLOS ONE 9(10): e110114. https://doi.org/10.1371/journal.pone.0110114
- Reid and Park (2003). Continuing decline of Eastern Curlew, *Numenius madagascariensis*, in Tasmania. *Emu* 103 (3), pp. 279-283.
- Tasmanian State Government (1993). *Land Use Planning and Approvals Act 1993*. No.70 of 1993. Government Printer, Hobart, Tasmania
- Tasmanian State Government (1995). *Threatened Species Protection Act 1995.* No.83 of 1995. Government Printer, Hobart, Tasmania
- Tasmanian State Government (1999). *Weed Management Act 1999.* No.105 of 1999. Government Printer, Hobart, Tasmania.
- Tasmanian State Government (2002). *Nature Conservation Act 2002.* No.63 of 2002. Government Printer, Hobart, Tasmania.
- Tasmanian State Government (2006). *Nature Conservation Amendment (Threatened Native Vegetation Communities) Act 2006*. Government Printer, Hobart, Tasmania.
- Tasmanian Vegetation Monitoring and Mapping Program/ TVMMP (2013). TASVEG 3.0 Metadata Statement. DPIPWE, Conservation Values Information Section, Hobart, Tasmania.
- The Nature Conservancy (1994). *Field Methods for Vegetation Mapping USGS/NPS Vegetation Mapping Program.* Report prepared for the United States Department of Interior, United States Geology Survey and the United States National Parks Service.

- Threatened Species Section (2020). Species Management Profiles from Tasmania's Threatened Species Link. http://www.threatenedspecieslink.tas.gov.au. Department of Primary Industries, Parks, Water and Environment, Tasmania.
- Threatened Species Section (2019). DRAFT (pending approval and release) Listing Statement for *Castiarina insculpta* (Miena Jewel Beetle). Department of Primary Industries, Parks, Water and Environment, Tasmania.
- Threatened Species Section (2006). Recovery Plan: Tasmanian Galaxiidae 2006-2010. Department of Primary Industries, Water, Hobart.
- Threatened Species Unit (2012). Threatened Species Notesheet for *Schoenoplectus tabernaemontani*.
- Triggs, B. (1996). Tracks, Scats and Other Traces A field guide to Australian Mammals. Oxford Press, pp. 352.
- Wapstra, M. (2018). Flowering Times of Tasmanian Orchids: A Practical Guide for Field Botanists, 4th edition. Self-published by the author (July 2018 version).
- Webb, M. (2008). Swift Parrot Breeding Season Survey Report 2007/2008. Unpublished report to the Department of Primary Industries and Water, Hobart.

7/04/2020 Richard White

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8/04/2020 Richard White

8/04/2020 Richard White

4/11/2020 Grant Daniels

4/11/2020 Grant Daniels

4/11/2020 Grant Daniels

3/12/2020 Jared Parry

9/12/2020 Jared Parry

APPENDIX A – VASCULAR PLANT SPECIES LIST

Status	codes:		
ORIC	SIN	NATIONAL SCHEDULE	STATE SCHEDULE
i - in	troduced	EPBC Act 1999	ISP Act 1995
d - d	leclared weed WM Act	CR - critically endangered	e - endangered
en -	endemic to Tasmania	EN - endangered	v - vulnerable
t - w	ithin Australia, occurs only in Tas.	VU - vulnerable	r - rare
Sites:			
1	FUM - WP2 - E, N		7/04/2020 Jared Parry
2	GCL - Hwy Cutting - WP 298 - E, N		7/04/2020 Jared Parry
3	FAG - WP 323 - E, N		7/04/2020 Jared Parry
4	FUM - Northern side of E Derwent Hw	y - WP 328 - E, N	7/04/2020 Jared Parry
5	FUR - Gunn St area - WP 332 - E, N		7/04/2020 Jared Parry
6	FUM - South of E Derwent Hwy - WP 3	359 - E, N	7/04/2020 Jared Parry

- FUM South of E Derwent Hwy WP 359 E, N 6
- 7 GCL - South of E Derwent Hwy - E, N
- FUM E519272, N5269244 8
- 7/04/2020 Jared Parry 7/03/2020 Richard White 9 FUM but remnant areas with native grasses remain - E519332, 7/04/2020 Richard White N5269379 7/04/2020 Richard White 10 GCL remnant with patches of introduced species throughout -E519349, N5269167 7/04/2020 Richard White
- FUM additional species E519409, N5268982 11
- 12 FUM - dam with weedy edges - E519423, N5268906
- FUM additional species E518494, N5268055 13
- GCL remnant with patches of introduced species throughout -14 E518903, N5268479
- ARS E518618, N5267923 15
- NBA E518445, N5266889 16
- 17 DVG - E518602, N5266679
- FUM additional species south side of the Derwent E518678, 18 N5266573
- 19 ASF - drainage area (weedy but with some natives) - E518790, N5266656
- 20 GCL - E, N
- FUM east and westside road E518870, N5268487 21 FUM with ARS elements - E521848, N5267594 22
- 23 ASF - WP 181 - E, N
- 24 DVG Additional Species - E518602, N5266679

Site	Name	Common name	Status
	DICOTYLEDONAE		
	ACERACEAE		
5	Acer pseudoplatanus	sycamore maple	i
	AIZOACEAE		
7	Carpobrotus aequilaterus	angled pigface	i#
12 16 17	Carpobrotus edulis	yellow pigface	i
	APIACEAE		
15	Apium prostratum	sea celery	
5 22	Eryngium vesiculosum	prickfoot	
1 2 4 5 6 9 12 23	Foeniculum vulgare	fennel	d
15	Lilaeopsis polyantha	jointed swampstalks	
	ARALIACEAE		
5	Hedera helix	ivy	i
	ASTERACEAE		
14 16 17 20 21	Arctotheca calendula	capeweed	i
18 22	Carduus pycnocephalus	slender thistle	d

23	Chrysanthemoides monilifera subsp. monilifera	boneseed	d
11 19 1 3 9 22	Cirsium arvense var. arvense Cirsium vulgare	Californian thistle spear thistle	d i
23 4 6 14 18	Convza honariansis	flavleaf fleabane	i
14 21	Cotula australis	southern buttons	1
15	Cotula coronopifolia	water buttons	i
5 10	Dimorphotheca fruticosa	trailing daisy	i
18	Dittrichia graveolens	stinkweed	i
4 5 6 10 14 16	Gazania linearis	tufted gazania	i
21	Gazania rigens	Gazania	i
2 6 9 19 23	Helminthotheca echioides	bristly oxtongue	i
35914	Hypochaeris radicata	rough catsear	i
21	Lactuca serriola f. serriola	prickly lettuce	i
23457 8	Leontodon saxatilis	hairy hawkbit	I
20	Scorzonera laciniata var. laciniata	scorzonera	i
12459	Senecio quadridentatus	cotton fireweed	
10 14 16			
21 22 23	Silvbum marianum	variagated thistle	i
21	Sonchus asper	bluegreen prickly sowthistle	i
24567	Sonchus oleraceus	common sowthistle	i
8 20 22			•
20 21	Taraxacum officinale	common dandelion	i
20	Tragopogon porrifolius subsp. porrifolius	salsify	i
11 21	Vittadinia gracilis	woolly new-holland-daisy	r
10	Vittadinia muelleri	narrowleaf new-holland-daisy	r
	BORAGINACEAE		
	• • • • • •		
22	Amsinckia calycina	hairy fiddleneck	d
22 20	Amsınckıa calycına Cynoglossum suaveolens	nairy fiddleneck sweet houndstongue	d
22 20 18 22	Amsinckia calycina Cynoglossum suaveolens Echium candicans	nairy fiddleneck sweet houndstongue pride of madeira	d i
22 20 18 22	Amsinckia calycina Cynoglossum suaveolens Echium candicans BRASSICACEAE	nairy fiddleneck sweet houndstongue pride of madeira	d i
22 20 18 22 21	Amsinckia calycina Cynoglossum suaveolens Echium candicans BRASSICACEAE Capsella bursa-pastoris	shepherds purse	d i i
22 20 18 22 21 8 9 14 16 20 22 23	Amsinckia calycina Cynoglossum suaveolens Echium candicans BRASSICACEAE Capsella bursa-pastoris Hirschfeldia incana	shepherds purse hoary mustard	d i i i
22 20 18 22 21 8 9 14 16 20 22 23 4 5 6 7 10	Amsinckia calycina Cynoglossum suaveolens Echium candicans BRASSICACEAE Capsella bursa-pastoris Hirschfeldia incana Lepidium africanum	sweet houndstongue pride of madeira shepherds purse hoary mustard common peppercress	d i i i
22 20 18 22 21 8 9 14 16 20 22 23 4 5 6 7 10 14 16 21	Amsinckia calycina Cynoglossum suaveolens Echium candicans BRASSICACEAE Capsella bursa-pastoris Hirschfeldia incana Lepidium africanum	sweet houndstongue pride of madeira shepherds purse hoary mustard common peppercress	d i i i
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22 20 18 22 21 8 9 14 16 20 22 23 4 5 6 7 10 14 16 21 22 22 2 16 20	Amsinckia calycina Cynoglossum suaveolens Echium candicans BRASSICACEAE Capsella bursa-pastoris Hirschfeldia incana Lepidium africanum Lepidium didymum Lepidium draba	hairy fiddleneck sweet houndstongue pride of madeira shepherds purse hoary mustard common peppercress lesser swinecress hoary cress	d i i i i d
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22 20 18 22 21 8 9 14 16 20 22 23 4 5 6 7 10 14 16 21 22 22 2 16 20 15	Amsinckia calycina Cynoglossum suaveolens Echium candicans BRASSICACEAE Capsella bursa-pastoris Hirschfeldia incana Lepidium africanum Lepidium didymum Lepidium draba CAMPANULACEAE Lobelia anceps CARYOPHYLLACEAE	hairy fiddleneck sweet houndstongue pride of madeira shepherds purse hoary mustard common peppercress lesser swinecress hoary cress angled lobelia	d i i i d
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22 20 18 22 21 8 9 14 16 20 22 23 4 5 6 7 10 14 16 21 22 22 2 16 20 15 21 21 21 21 21 22 20	Amsinckia calycina Cynoglossum suaveolens Echium candicans BRASSICACEAE Capsella bursa-pastoris Hirschfeldia incana Lepidium africanum Lepidium didymum Lepidium draba CAMPANULACEAE Lobelia anceps CARYOPHYLLACEAE Polycarpon tetraphyllum Silene gallica var. gallica Silene gallica var. quinquevulnera Spergularia tasmanica Stellaria media CASUARINACEAE	hairy fiddleneck sweet houndstongue pride of madeira shepherds purse hoary mustard common peppercress lesser swinecress hoary cress angled lobelia fourleaf allseed french catchfly french catchfly coastal seaspurrey garden chickweed	d i i i d i i i i i i
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22 20 18 22 21 8 9 14 16 20 22 23 4 5 6 7 10 14 16 21 22 2 16 20 15 21 21 21 21 21 22 20 2 5 13 16	Amsinckia calycina Cynoglossum suaveolens Echium candicans BRASSICACEAE Capsella bursa-pastoris Hirschfeldia incana Lepidium africanum Lepidium draba CAMPANULACEAE Lobelia anceps CARYOPHYLLACEAE Polycarpon tetraphyllum Silene gallica var. gallica Silene gallica var. guinquevulnera Spergularia tasmanica Stellaria media CASUARINACEAE Allocasuarina verticillata	hairy fiddleneck sweet houndstongue pride of madeira shepherds purse hoary mustard common peppercress lesser swinecress hoary cress angled lobelia fourleaf allseed french catchfly french catchfly coastal seaspurrey garden chickweed drooping sheoak	d i i i d i i i i i
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18 2 4 5 6 9 10 16 17 21	Dysphania pumilio Einadia nutans subsp. nutans	clammy goosefoot climbing saltbush	i
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16	Rhagodia candolleana subsp.	coastal saltbush	
	CONVOLVULACEAE		
9 11	Convolvulus arvensis Dichondra repens	field bindweed kidneyweed	i
	CRASSULACEAE		
21	Aeonium arboreum	tree aeonium	i
16	Cotyledon orbiculata	pig's ear	i
21	Crassula multicava subsp. multicava	fairy crassula	i
20 22	Crassula sieberiana	stone-crop	
16 21	Sedum praealtum	shrubby stonecrop	I
	ERICACEAE		
16	Astroloma humifusum	native cranberry	
	EUPHORBIACEAE		
5	Euphorbia helioscopia	sun spurge	i
18	Euphorbia lathyris	caper spurge	i
	FABACEAE		
12 14 21	Acacia baileyana	cootamundra wattle	i
12456	Acacia dealbata subsp. dealbata	silver wattle	
11	Acacia floribunda	gossamer wattle	i
21	Acacia genistifolia	spreading wattle	· ·
6 10 16 17	Acacia mearnsii	black wattle	
5	Acacia pravissima	oven's wattle	i
10	Genista monspessulana	canary broom	d
20	Hardenbergia violacea	purple coralpea	planted
20	Medicago arabica Medicago polymorpho	spotted medick	1
∠I 68010	Medicado polymorpha Medicado sativa		i
20	medicago saliva	laceme	
20	Melilotus indicus	sweet melilot	i
16	Pultenaea pedunculata	matted bushpea	
20	Spartium junceum	spanish broom	 :
21	Trifolium arvense	harestoot clover	:
21	Trifolium dubium	suckling clover	i
20	Trifolium glomeratum	cluster clover	i
21	Trifolium lappaceum	bristly clover	i
20	Trifolium pratense	red clover	i
23567	Trifolium sp.	clover	i
16			d
18	Vicia hirsuta	gorse bairy vetch	u i
234521	Vicia sativa subsp. sativa	common vetch	i
	·····		
11	Vicia sp.	vetch, tare	1
18 19	Vicia tetrasperma	Smooth vetch	I
	FUMARIACEAE		
13	⊢umaria sp.	tumitory	I
	GERANIACEAE		
39	Erodium botrys	long heronsbill	i
2 3 4 5 6 7 8 14 16 21	Erodium moschatum	musky heronsbill	İ

6	Geranium dissectum	cutleaf cranesbill	i
22	Geranium homeanum	cranesbill	i
18	Geranium solanderi	southern cranesbill	
10	Geranium sp.	native geranium	
	GOODENIACEAE		
15	Selliera radicans	shiny swampmat	
	HEMEROCALLIDACEAE		
16	Dianella revoluta	spreading flaxlily	
	HYPOXIDACEAE		
10	Pauridia dabella var. dabella	tinv vellowstar	
	LAMIACEAE		
2	Marrubium vulgare	white horehound	d
567	Prunella vulgaris	selfheal	i
10 11 14	Salvia verbenaca var. verbenaca	wild sage	i
21			
	LINACEAE		
15	Linum marginale	native flax	
21 23	Malva arborea	tree mallow	i
45678	Malva svivestris	tall mallow	i
			•
450		hottlehruch	
4 0 0 5	Callistemon sp. Fucalvotus amvadalina	black peppermint	en
5 13	Eucalyptus globulus subsp. globulus	tasmanian blue gum	on
6	Eucalyptus leucoxylon subsp.	red flowering yellow gum	i
13 16 17	Eucalyptus pulchella	white peppermint	en
456	Eucalyptus sp.	gum	
5 14 1 <i>1</i>	Eucalyptus viminalis subsp. viminalis Melaleuca armillaris	white gum	
21	Melaleuca ericifolia	coast paperbark	
12 14	Enilohium hirtigerum	hairy willowherh	
1214	Epilobium sp.	willowherb	
3	Ovalis perennans	arassland woodsorrel	
3 10 14 16	Oxalis sp.	woodsorrel	
17			
	PITTOSPORACEAE		
9 21	Bursaria spinosa subsp. spinosa	prickly box	
° = .			
24567 111621	Plantago coronopus	buckshorn plantain	I
22			
13456	Plantago lanceolata	ribwort plantain	i
9 10 14			
10 22	Plantado maior	great plantain	i
10		groat plantain	•
	POLYGONACEAE		
5 6 21 20	Polygonum aviculare	creeping wireweed	I
2567	Rumex condomeratus	clustered dock	i
15 18	Rumex crispus	curled dock	i
8 14 19	Rumex pulcher subsp. pulcher	fiddle dock	i
23			

PRIMULACEAE

21 15	Lysimachia arvensis Samolus repens var. repens RESEDACEAE	scarlet pimpernel creeping brookweed	i
13 21	Reseda luteola	weld	i
	ROSACEAE		
20	Acaena echinata	spiny sheeps burr	
2	Acaena novae-zelandiae	common buzzy	;
5 10 21 16 21	Coloneaster nanchelli Cotoneaster dauconbyllus var. serotinus	grey coloneaster	i
6	Malus pumila	apple	i
21	Prunus sp.		i
10	Pyracantha sp.	firethorn	i
1 2 3 9 10 16 21 23	Rosa rubiginosa	sweet briar	i
10 21 20			
124910	Rubus fruticosus	blackberry	d
12 23	Sanguisarba minor	calad humat	÷
2 3 4 5 6 8 9 10 14	Sangusorba minor	Salau Dumet	I
20			
	RUBIACEAE		
18	Asperula conferta	common woodruff	
5	Asperula sp.	woodruff	;
18 23	Coprosma repens Galium aparine	cleavers	i
21	Galium murale	small bedstraw	i
23	Galium sp.	bedstraw	
	SALICACEAE		
13 23	Salix Xfragilis var. fragilis	crack willow	d
14	SANTALACEAE Exocarpos cupressiformis	common native-cherry	
	SADINDACEAE		
3 5 10 16	Dodonaea viscosa subsp. spatulata	broadleaf hopbush	
17 21			
	SCROPHULARIACEAE		
18	Verbascum thapsus	great mullein	i
	SOLANACEAE		
12345	Lycium ferocissimum	african boxthorn	d
6 9 10 14 16 17 22			
23			
4821	Solanum nigrum	blackberry nightshade	i
	VALERIANACEAE		
13	Centranthus ruber	red valerian	i
	VIOLACEAE		
3	Viola hederacea	ivyleaf violet	
	GYMNOSPERMAE		
	CUPRESSACEAE		
5	Cupressus sempervirens	mediterranean cypress	i
	PINACEAE		
29	Pinus radiata	radiata pine	i
	MONOCOTYLEDONAE		
	AGAPANTHACEAE		
5	Agapanthus praecox subsp. orientalis	agapanthus	i

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	AGAVACEAE		
5 21	Agave americana	century plant	i
12 12 18 15 12 19 23 15	Eleocharis acuta Ficinia nodosa Isolepis cernua Schoenoplectus pungens Schoenoplectus tabernaemontani	common spikesedge knobby clubsedge nodding clubsedge sharp clubsedge river clubsedge	r
	JUNCACEAE		
15 12 19 23 3	Juncus kraussii subsp. australiensis Juncus pallidus Juncus sarophorus	sea rush pale rush broom rush	
	JUNCAGINACEAE		
15	Cycnogeton procerum POACEAE	greater waterribbons	
23 11 15 4 5 6 22 21 5 6 1 2 7 9 10	Agrostis capillaris Agrostis sp. Agrostis stolonifera Aira caryophyllea Aira praecox Austrostipa bigeniculata	brown top bent grass blown grass creeping bent silvery hairgrass early hairgrass doublejointed speargrass	i i i r
16 17 21 9 14 20 2 3 4 5 7 9 11 14 17 20	Austrostipa mollis Austrostipa nodosa Austrostipa scabra	soft speargrass knotty speargrass rough spear grass	
24	Austrostipa stuposa	corkscrew speargrass	
20	Avena barbata	bearded oat	i
1 2 3 5 9 10 16 21	Avena sativa	cereal oat	i
10 16	Briza maxima	greater quaking-grass	i
5 9 10 14 17 20	Bromus diandrus	great brome	i
20	Bromus hordeaceus	soft brome	i
14	Bromus sp.	brome	i
21	Catapodium rigidum	ferngrass	i
13	Cynosurus echinatus	rough dogstail	i
2 4 5 6 7 8 9 10 14 16 17 19 23	Dactylis glomerata	cocksfoot	i
18	Digitaria sanguinalis	summergrass	i
5 8 15 21	Ehrharta erecta	panic veldtgrass	i
21	Eleusine tristachya	crowsfoot grass	i
46	Eragrostis pilosa	soft lovegrass	
21 15 19 22	Festuca archeri Festuca arundinacea	archers fescue tall fescue	i
23 9 10 19 23	Holcus lanatus	yorkshire fog	i
∠J 3.18	Hordeum sp	harley harley grass	i
45	l olium multiflorum	italian rvegrass	i
	l olium perenne	nerennial ryegrass	i
14 21	Panicum capillara		
09 240	r anicum capillate Paspalum dilatatum	nashalum	: ;
∠ 4 5 11 01	Phalaris aquatica	toowoomba canarvarass	i
15 19 23	Phraamites australis	southern reed	
14 16	Piptatherum miliaceum	rice millet	i
21	Poa bulbosa	bulbous meadowgrass	i

5 20 20 4 16 17 10 21 9 14 16 17	Poa labillardierei Poa poiformis Poa pratensis Poa sp. Rytidosperma caespitosum Rytidosperma setaceum	silver tussockgrass coastal tussockgrass kentucky bluegrass poa common wallabygrass bristly wallabygrass	i
2 3 4 5 7 18 24 21 21	Rytidosperma sp. Setaria verticillata Themeda triandra Vulpia bromoides Vulpia muralis	wallabygrass whorled pigeongrass kangaroo grass squirreltail fescue wall fescue	i i
15 22	RESTIONACEAE Apodasmia brownii	coarse twinerush	
19	TYPHACEAE Typha latifolia	great reedmace	i

APPENDIX B – BIRD DATA

The total sum of abundance and species richness within each bird survey Zone.

Zone	Abundance	Species richness
1	2642	300
2	4618	342
3	3693	143
4	1706	83
5	3803	287
6	2085	195
7	1426	273
8	429	117
9	151	31
10	145	37
11	591	47
12	133	47

Observed behaviour of species across the site. * no nest or chicks observed but courting and calling was observed.

	Behaviour			
Species	Foraging	Nesting	Roosting/perching	Loafing
Australian pelican Pelecanus conspicillatus	No	No	Yes	Yes
Australian reed-warbler Acrocephalus australis	Yes	No	No	No
Australasian grebe Tachybaptus novaehollandiae	Yes	No	No	No
Australasian shoveler Anas rhynchotis	Yes	No	No	Yes
Black swan <i>Cygnus atratus</i>	Yes	Yes	Yes	Yes
Black-faced cormorant Phalacrocorax fuscescens	Yes	No	Yes	No
Brown falcon Falco berigora	Yes	No	Yes	No
Brown quail <i>Coturnix ypsilophora</i>	Yes	No	No	Yes
Caspian tern <i>Hydroprogne caspia</i>	Yes	No	No	No
Chestnut teal Anas castanea	Yes	No	Yes	Yes
Crested tern Thalasseus bergii	Yes	No	No	No
Domestic goose Anser anser	Yes	No	No	Yes
Eastern great egret	Yes	No	No	Yes

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	Behaviour			
Species	Foraging	Nesting	Roosting/perching	Loafing
Ardea alba modesta				
Eurasian coot <i>Fulica atra</i>	Yes	No	Yes	Yes
Grey teal Anas gracilis	Yes	No	No	No
Great crested grebe Podiceps cristatus	Yes	Yes*	No	Yes
Great cormorant Phalacrocorax carbo	Yes	No	Yes	No
Hoary-headed grebe Poliocephalus poliocephalus	Yes	No	No	No
Kelp gull <i>Larus dominicanus</i>	Yes	No	Yes	Yes
Little black cormorant Phalacrocorax sulcirostris	Yes	No	Yes	No
Little grassbird <i>Megalurus gramineus</i>	Yes	Yes*	Yes	No
Little pied cormorant <i>Microcarbo melanoleucos</i>	Yes	No	Yes	No
Mallard duck Anas platyrhynchos	Yes	Yes	No	No
Masked lapwing Vanellus miles	Yes	No	Yes	Yes
Musk duck <i>Biziura lobata</i>	Yes	No	No	Yes
Pacific black duck hybrid Anas superciliosa	Yes	Yes	Yes	Yes

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	Behaviour			
Species	Foraging	Nesting	Roosting/perching	Loafing
Purple swamphen Porphyrio porphyrio	Yes	Yes*	No	Yes
Silver gull <i>Chroicocephalus</i> novaehollandiae	Yes	No	Yes	Yes
Superb fairy wren <i>Malurus cyaneus</i>	Yes	No	No	No
Swamp harrier Circus approximans	Yes	No	No	No
Tasmanian native hen Tribonyx mortierii	Yes	Yes	No	Yes
Tree martin Petrochelidon nigricans	Yes	No	No	No
Welcome swallow Hirundo neoxena	Yes	Yes	Yes	No
White-bellied sea eagle <i>Haliaeetus leucogaster</i>	Yes	No	No	No
White-faced heron Egretta novaehollandiae	Yes	No	No	No