Lot 4257 on Plan 202951

Parker Road, Kentdale

Targeted aquatic fauna survey report

Bio Diverse Solutions

Final

22nd December 2020

DOCUMENT CONTROL

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1. Introduction, scope and background information

Paris Grove Pty Ltd ("the client") commissioned Bio Diverse Solutions as Environmental Consultants to undertake a targeted aquatic fauna survey within Lot 4257 on Plan 202951 Parker Road, Kentdale. The scope of works included:

- Assessment of the suitability of habitat for conservation significant aquatic species, within the proposed clearing area and downstream of this area, to the point where the tributary meets the Kent River;
- Assessment of barriers noted by the applicant and the likelihood that these will prevent the movement of conservation significant fish into the application area;
- A faunal survey of the area proposed to be cleared at a time when the creek line is most likely to be flowing and when the fish are most active and detectable; this is usually July to September. However, the wet winter and spring preceding the survey (December) resulted in continued water flow through the majority of the creek, albeit at slower and reduced rates than in spring meaning it was suitable to conduct the survey during this period. The survey will target conservation significant aquatic species;
- GPS and map any populations of threatened species (if applicable);
- Preparation of a brief report on survey outcomes; and
- Provision of the client with the IBSA Data package (as required by DWER).

Targeted aquatic fauna assessment was undertaken by Wildlife Ecologist Dr. Karlene Bain and Technical Assistant Charlize van der Mescht (Bio Diverse Solutions) on the 14th of December 2020.

1.1. Site location and Development Proposal

The "area to be cleared" is defined as the 0.45ha area within Lot 4257 on Plan 202951 Parker Road, Kentdale WA. The survey area is located approximately 27 km northwest of the town of Denmark and approximately 30 km northeast of the town of Walpole (refer to Figure 1) and lies within a rural and agricultural landscape. Mount Roe National Park is located approximately 600m west of the site. The client is proposing to clear 0.45ha of native vegetation within Lot 4257 for the purpose of dam construction.

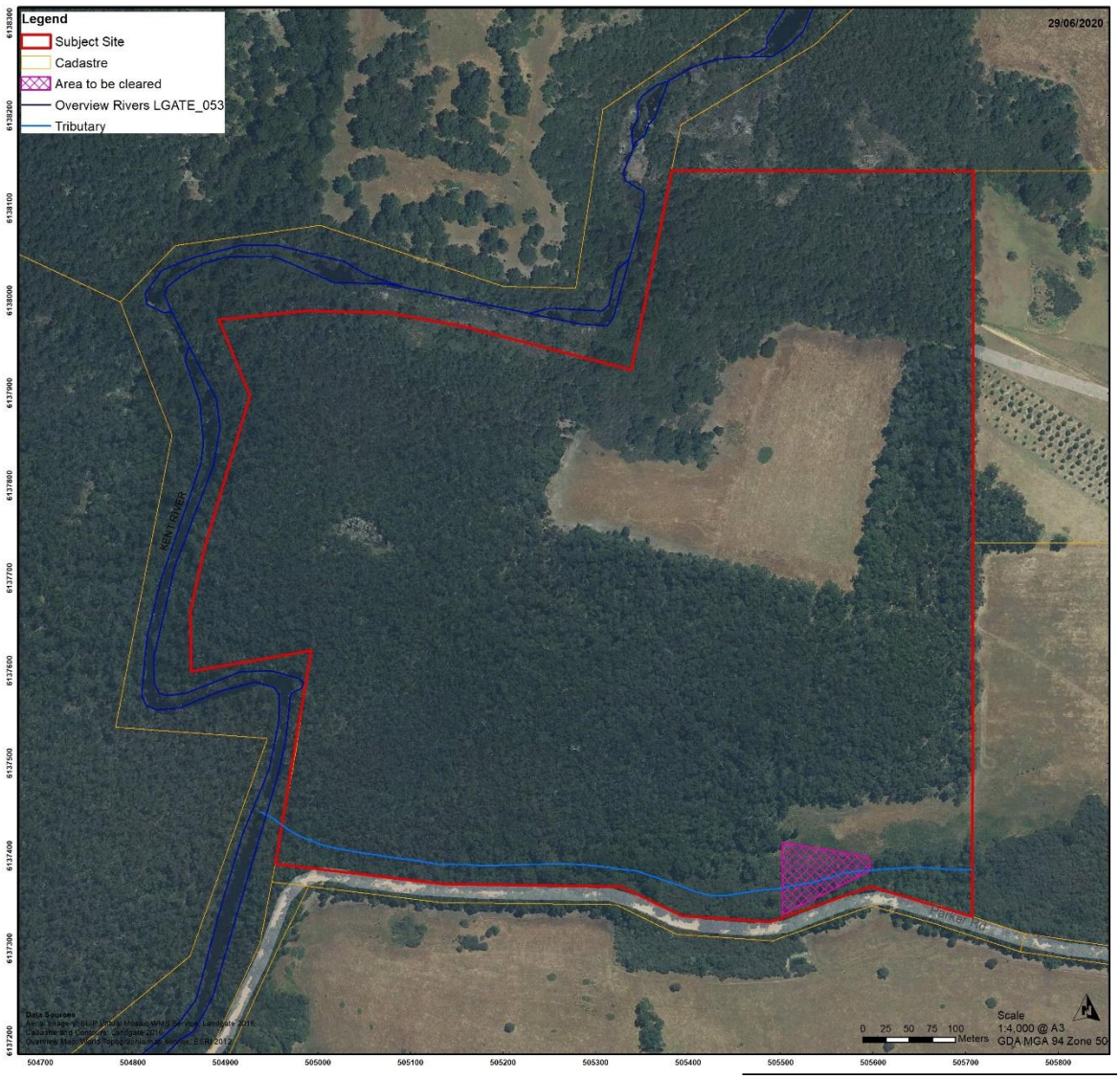


Figure 1: Survey area Locality

2. Desktop Assessment

2.1. Geology and soils

Database searches using the NRInfo Portal (Department of Primary Industries and Regional Development (DPIRD), 2018) shows the survey area lies within the Walpole Hills System (254Wh). The system is described as "*Granitic hills and low hills, in the south of the Warren-Denmark Southland. Loamy gravel, loamy earth, sandy gravel and loamy duplex. Jarrah-marri-karri forest and woodland.*" (DPIRD, 2018). The Warren-Denmark Southland Zone (254) is described as having "*Rises in a series of broad benches from the Southern Ocean north to the Blackwood Valley. Deeply weathered granite and gneiss overlain by Tertiary and Quaternary sediments in the south. Swampy in places."* (DPIRD, 2018).

The preliminary assessment report (DWER, 2020a) provided by the client states the application area intersects one soil map unit:

- Minor Valley S1 Subsystem (254WhS1), described as "*Valleys in granitic terrain, narrow swampy floor; <20 m relief. Gravelly yellow duplex soils on smooth flanks; Jarrah-Marri-Karri forest. Peaty soils on narrow floor; Wattle low forest.*" (Schoknecht et al., 2004).

2.2. Climate

The closest Bureau of Meteorology (BoM) site that is open and provides recent climate statistics is Rocky Gully (Station 009964). Please note that North Walpole (Station 009998) is closer but does not provide long-term climate statistics. The average annual temperature in Rocky Gully ranges from 9.6 – 20.9°C. The average summer temperature ranges between 11.0 - 27.5°C, whilst average winter temperatures range between 6.5 - 15.7°C. The annual mean rainfall for Rocky Gully is 710.2mm (BoM, 2020).

2.3. Habitat Connectivity

"Advice from DBCA has indicated that the Kent River and its tributaries are important habitat for the threatened fish species. There are records in the section of the Kent River near the connection with the tributary of the application area. Even if the tributary is not flowing adequately for most of the year, it still may be suitable habitat for the fish for part of the year. If winter rains significantly increase the creek water level, then fish may migrate up the creek, due to the connectivity to the Kent River" (DWER, 2020a).

2.4. Water

The survey area lies within an unassigned Public Drinking Water Source Area (WALGA, 2018a). The survey area is connected to the Kent River which flows to the south of the survey area. The Kent River originates in Tenterden and flows all the way to the south coast, where it enters the Owingup Swamp (DWER, 2020b).

2.5. Environmentally Sensitive Areas

The survey area does not lie within an Environmentally Sensitive Area (WALGA, 2018b).

2.6. Remnant Vegetation

The survey area lies within the Warren (Warren WAR01 subregion) IBRA region. Hearn et al. (2002) describes the Warren IBRA region as "*Dissected undulating country of the Leeuwin Complex, Southern Perth Basin (Blackwood Plateau), South-West intrusions of the Yilgarn Craton and western parts of the Albany Orogen with loamy soils supporting Karri forest, laterites supporting Jarrah-Marri forest, leached sandy soils in depressions and plains supporting low Jarrah woodlands and paperbark/sedge swamps, and Holocene marine dunes with Agonis flexuosa and Banksia woodlands and heaths."*

The vegetation has been mapped on a broad scale by J.S. Beard (Shepherd *et al.* 2002) in the 1970's, where a system was devised for state-wide mapping and vegetation classification based on geographic, geological, soil, climate structure, life form and vegetation characteristics (Sandiford and Barrett, 2010). Vegetation units were regarded as associations and were grouped into Vegetation Systems representing a particular pattern of association distribution within a given area. A GIS search of J.S. Beards (Beard *et al.* 2013) vegetation classification places the survey area within one System and Vegetation Association (Source Pre-European dataset, DPIRD-006):

- **System Association Name**: Denmark
- **Vegetation Association Number:** 3
- **Floristic Description:** Mainly jarrah and marri *Eucalyptus marginata, Corymbia calophylla.*
- **Remnant Vegetation by Beard Association Rarity in LGA:** 79.32% remaining (GoWA, 2019).
- **Remnant Vegetation by Beard Association Rarity in IBRA Region:** 78.05% remaining (GoWA, 2019).

2.7. Conservation Significant Species

The DWER Preliminary Assessment Report and Request for Information Letter (CPS8739/1) and Item 3 of Schedule 1 identifies that the following conservation significant fish species may utilise the application area:

- Little pygmy perch (*Nannoperca pygmaea*) - Endangered
- Balston's pygmy perch (*Nannatherina balstoni*) - Vulnerable
- Pouched lamprey (*Geotria australis*) – Priority 3
- Western dwarf galaxias (*Galaxiella munda*) - Vulnerable
- Western trout minnow (*Galaxias truttaceus* (Western Australian population)) – Endangered

Although not provided in the letter from DWER, the survey area is within the current species distribution and contains potential habitat for the following species:

- Black-striped minnow (*Galaxiella nigrostriata*) – Endangered

3. Field Survey Methodology

The DWER provided a letter that states assessment / survey is required for the application area (Schedule 1, Item 3) and the survey is required to determine the local population size and distribution of threatened species. These species are as follows:

- Little pygmy perch (*Nannoperca pygmaea*) - Endangered
- Balston's pygmy perch (*Nannatherina balstoni*) - Vulnerable
- Pouched lamprey (*Geotria australis*) – P3
- Western dwarf galaxias (*Galaxiella munda*) - Vulnerable / Threatened
- Western trout minnow (*Galaxias truttaceus* (Western Australian population)) – Endangered

Although not provided in the letter from DWER, the survey area is within the current species distribution and contains potential habitat for the following species:

- Black-striped minnow (*Galaxiella nigrostriata*) - Endangered

Collections occurred in a systematic sampling design that targeted the diversity of potential habitat during daylight hours when identification of individual species (and therefore subsequent release) was easier. Given the ephemeral nature of this system, a sample period when water is most likely to be flowing was selected to maximise detection probability for the above-listed fish. Usually, this period is between July and September, however, the wet winter and spring preceding the survey resulted in continued water flow through the majority of the creek, albeit at slower and reduced rates than in spring meaning it was still suitable to conduct the survey during this period. In addition, the core breeding season was avoided to minimise disturbance to the population.

Given the small width of the tributary and the preference of most target species for shallow water habitat, dip-netting was used as the most effective and least invasive method of capture. Dip-netting occurred in thick aquatic vegetation and flowing water habitats for Galaxiids and Perch species and in soft surface sediments for ammocoetes. Nets are made of 3 mm woven mesh and sample to a depth of 1.5 m. When dip-netting, care was taken to minimise disturbance to habitat.

In deeper sections and faster flowing sections of the tributary, small collapsible traps were used to target the bottom dwelling species and faster moving species and were left *in situ* for up to 30 minutes. The collapsible traps are approximately 250 x 250 x 450 mm, with 3 mm mesh.

A total of 17 sweep sites, 1 releve and 5 trap sites were surveyed (Figure 2).

For temporary holding, fish were kept in a bucket part full of water, measured and identified at monitoring sites and released onsite.

In addition, the creek line habitat was visually assessed for suitability and any barriers to upstream movement were mapped and described.

Field survey work was carried out by Dr Karlene Bain (Wildlife Ecologist) and Charlize van der Mescht (Technical Assistant) from Bio Diverse Solutions on the 14th December 2020 in accordance with the *Survey guidelines for Australia's threatened fish* developed by the Department of Agriculture, Water and the Environment (DAWE) formerly the Department of Sustainability, Water, Population, and Communities (DSEWPaC, 2011). All survey sites were GPS located, photographed and assessed for the suitability of habitat, and the presence of the above-mentioned species.

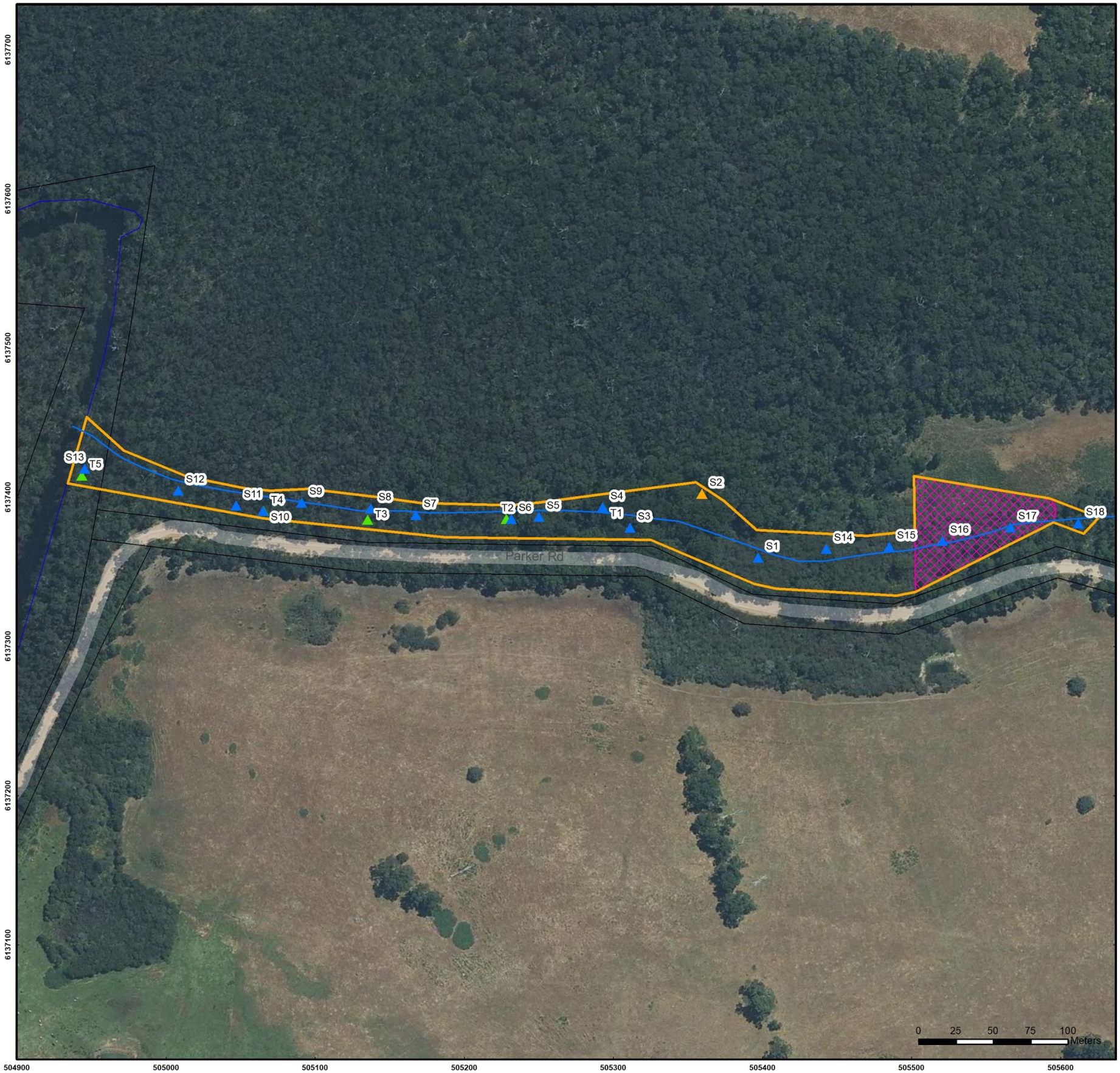
The results presented are based upon field data collected over a limited period of time and are indicative of the environmental condition of the site at the time.

3.1. Survey Limitations and Constraints

An assessment of potential limitations is outlined over the page in Table 1.

Table 1: Survey Limitations and constraints

Limitation	Comment
Scope	The scope was a targeted survey to identify the presence and distribution of five threatened or priority species as listed above.
Disturbances that may affect results	Active acid sulfate soils were detected in one part of the tributary, as evidenced by the presence of exposed peat soils in the creek wall, and oxidation by-products such as pyrite, iron oxide and iron oxide bacterial sludge. This is unlikely to significantly affect water quality when the creek is in full flow, and during periods of recharge which would dilute oxidation by-products such as sulfuric acid and mobilised heavy metals, however there is a possibility that these by-products could affect water quality during periods of low flow when rainfall is limited.
Intensity and timing of survey	The survey adequately targeted the full variation in habitat within the survey area and the downstream creek-line habitat. A single point in time survey will always be limiting, due to seasonal and annual variation in fish movement, however the physical barriers are likely to prevent movement of fish upstream into the area to be cleared irrespective of seasonality. The survey was conducted outside of the ideal season (July-September). However, due to the wet winter and spring preceding the survey resulted in continued water flow through the majority of the creek, albeit at slower and reduced rates than in spring. For this reason, it was not considered a limiting factor.
Sources of information (recent or historic) and availability of contextual information	Site specific data is limited as it is privately owned land, this is not considered a limiting factor for this survey.
Remoteness or access issues	There were no access issues to the site that would affect the survey outcomes.
Experience of personnel	Dr Karlene Bain has over 25 years of fauna survey experience.



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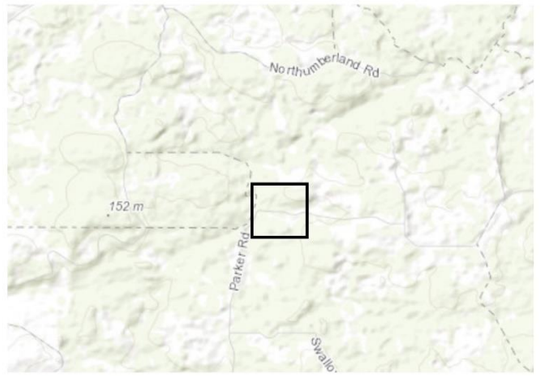

Overview Map Scale 1:100,000

Legend

- Survey Area
- Area to be cleared
- Cadastre
- Tributary

Sample Sites

- Net sweep
- Releve
- Trapping

Hydrography Linear (Heirarchy) (DWER-031)

- Coastal Waterline
- Estuarine
- Mainstream
- Major River
- Minor River
- Significant Stream
- Major Trib
- MinorTrib
- Minor Trib
- Insignificant Trib
- Inundation Area
- Paleo-Drainage Line
- Infrastructure

Scale
1:2,500 @ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: SLIP Virtual Mosaic WMS Service, Landgate 2016
Cadastre and Contours: Landgate 2016
Overview Map: World Topographic map service, ESRI 2012

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Figure 2: Survey Sites map

STATUS	*FILE*	*DATE*
FINAL	**MSC0289**	**22/12/2020**

4. Field Survey Results

4.1. Habitat Description

The survey area is within gently sloping riparian vegetation. The soil consists of dark brown humus podzols on the creek edges. Within the creek, the banks are clay, with deeper peat layers evident in some areas that suggest this is a consistent feature 1-2 m below the surface.

There are three main vegetation types recorded within the survey area and downstream areas. In the upper reaches of the creek, the vegetation consists of tall closed *Taxandria juniperina/Taxandria linearifolia* with a broadly distributed and dense sedge understorey dominated by *Lepidosperma tetraquetrum.* In the areas of creek closer to the Kent River, the riparian habitat is more forested, with a *Corymbia calophylla/Eucalyptus diversicolor* overstorey and a more narrowly defined area of sedge, associated with the creek edge. In the upper reaches of the creek, the creek line is completely covered by dense sedges. This vegetation cover opens in the lower reaches of the creek, however in all cases there is vegetation overhanging the water, areas with undercut clay banks and areas where woody debris and leaf material have accumulated, creating micro-niches that are potentially suitable for threatened fish. See Appendix A for full site-specific descriptions.

The tributary ranges in width from 300mm to 3.2m, and at the time of the survey, the depth ranged between 87mm and 1.6m. The substrate within the creek bed consists of soft brown sand and rocks, with variable contours contributing to flow and pooling of water in different locations along the creek. In all cases, water was tannin stained. Salinity, acidity and heavy metal parameters were not measured at the time of this survey, however at one site exposed peat, the presence of pyrite, iron oxide and iron oxide bacterial sludge were observed (Figure 3). These are indicative of peat oxidation processes which are likely to have an influence on water quality, particularly during periods of low rainfall. The exposed peat and pyrite layers seem to have occurred as a result of decreased ground water levels and natural waterflow patterns eroding the creek bank. The soils at this site smelt like sulfur and the water was clear of tanins.

Three significant barriers to fish movement were identified (Site 4, 10 and 13). Two of these would be expected to be complete barriers to movement irrespective of water flow (Sites 4 and 13) and the third (Site 10) is likely to be only a minor barrier and may be negated when water levels are high. The water flow is dependent on the rainfall and while this survey was undertaken in December, the wet winter and spring preceding the survey resulted in continued water flow through the majority of the creek, albeit at slower and reduced rates than in spring. Images were provided by the landowner that help to demonstrate the nature of the creek line in full flow. See section 4.3 for further details relating to the barriers.


a)


b)


c)

Figure 3: Peat oxidation occurring within the creek line.
a) iron oxide and bacterial sludge, b) pyrite and c) recently exposed peat layer in the creek wall.

4.2. Aquatic species

A total of 4 aquatic species were recorded within and down-stream of the survey area, including *Cherax preisii,* Epheremoptera larvae*, Crinia glauerti,* and *Littoria adelaidensis*. None of these species are conservation significant. Refer to Figure 4 for photographs of the species and Figure 6 for their locations.

No conservation significant species were identified within the survey area.

a)

b)

c)

Figure 4: Examples of aquatic species captured during sampling

a) *Cherax preisii*; b) *Ephemeroptera* larvae c) *Littoria adelaidensis*

4.3. Barriers to movement

Three significant barriers to fish movement were identified at Site 4, 10 and 13 (refer to Figure 5 for photographs and Figure 6 for locations). Two of these would be expected to be complete barriers to movement irrespective of water flow (Sites 4 and 13) and the third (Site 10) is likely to be only a minor barrier and may be negated when water levels are high (Figure 5). When the water levels are low, the barrier at site 10 is likely to be impassable due to the undercut nature of the creek bank at the base of the barrier (Figure 5b).

At their highest point, the barriers at site 4 and 13 are 3.4m and 2.3m from the creek bottom respectively (1.7m, and 1.4m from the water level at the time of the survey). At the time of the survey, water was lightly flowing down the barriers. At full flow, the flow of water down these barriers would be expected to occur with high velocity and volume and this can be seen in images provided by the landowner during Spring 2020 (Figures 5a & 5c). In both cases, the barriers are at a 90-degree angle from the creek bed and in the case of the barrier at Site 4, iron oxide bacteria are contributing to a slimy slippery coating on the wall of the barrier, which would further impede movement by fish up the barrier. The barriers at sites 4 and 13 are likely to be impassable for small species of fish throughout the year. There is no evidence in the vegetation or creek bed to suggest that water levels ever reach a point where these barriers would be reduced, and in instances where water levels do rise in winter/ spring, the volume and velocity of the downstream flow of water would prevent movement of species upstream.

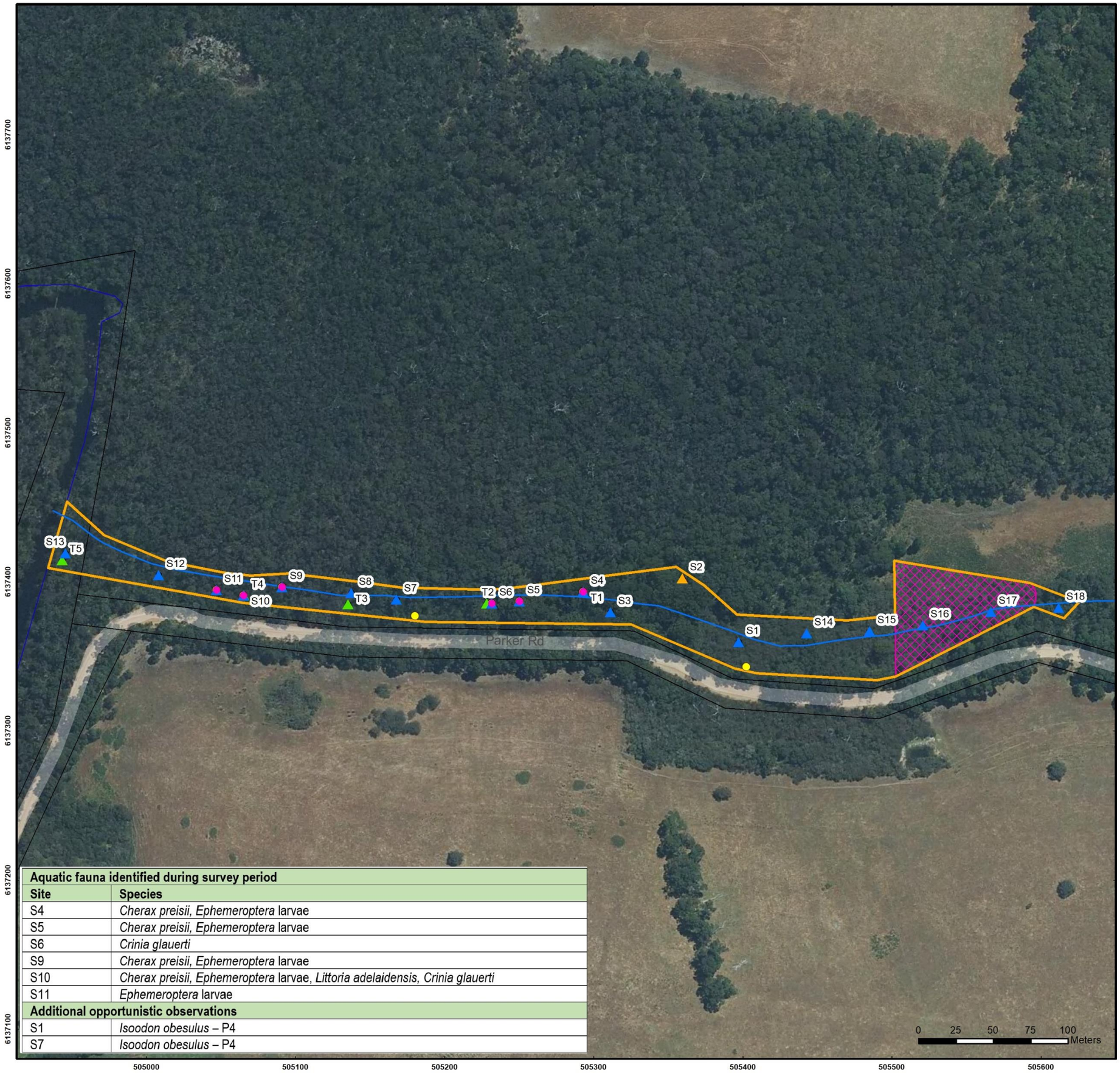

a)


b)


c)

Figure 5: Barriers to fish movement within the survey area and downstream

a) Significant barrier at Site 4. This barrier is coated in slippery iron oxide bacteria; b) Minor barrier at Site 10; the base of this barrier is undercut; c) Significant barrier at Site 13.



Aquatic fauna identified during survey period	
Site	**Species**
S4	*Cherax preisii*, *Ephemeroptera* larvae
S5	*Cherax preisii*, *Ephemeroptera* larvae
S6	*Crinia glauerti*
S9	*Cherax preisii*, *Ephemeroptera* larvae
S10	*Cherax preisii*, *Ephemeroptera* larvae, *Littoria adelaidensis*, *Crinia glauerti*
S11	*Ephemeroptera* larvae
Additional opportunistic observations	
S1	*Isoodon obesulus* – P4
S7	*Isoodon obesulus* – P4

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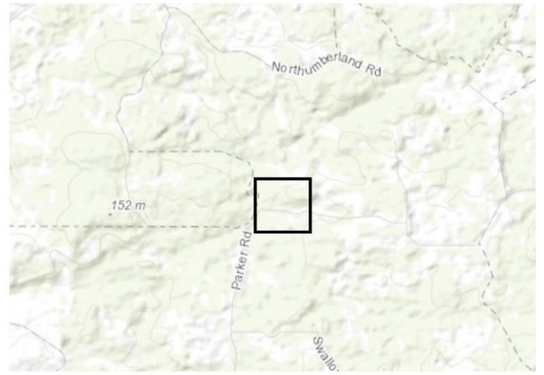

Overview Map Scale 1:100,000

Legend

- Survey Area
- Area to be cleared
- Cadastre
- Tributary

Fauna

- Aquatic
- Isoodon obesulus

Sample Sites

- Net sweep
- Releve
- Trapping

Hydrography Linear (Heirarchy) (DWER-031)

- Coastal Waterline
- Estuarine
- Mainstream
- Major River
- Minor River
- Significant Stream
- Major Trib
- MinorTrib
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- Inundation Area
- Paleo-Drainage Line
- Infrastructure

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Data Sources
Aerial Imagery: SLIP Virtual Mosaic WMS Service, Landgate 2016
Cadastre and Contours: Landgate 2016
Overview Map: World Topographic map service, ESRI 2012

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Figure 6: Survey Results map

STATUS	*FILE*	*DATE*
FINAL	**MSC0289**	**22/12/2020**

5. Summary

The scope for this survey was to provide the client with information on the presence of potentially suitable habitat, the presence of threatened and priority aquatic species and an assessment of the role of existing barriers in preventing upstream dispersal of these species.

A total of 4 aquatic species were recorded within and down-stream of the area to be cleared (Section 4.3, Appendix A). None of these were threatened or priority listed aquatic species.

Three significant barriers to fish movement were identified downstream of the area to be cleared. Two of these barriers would be expected to be complete barriers to movement irrespective of water flow and the third is likely to be a minor barrier and may be negated when water levels are high.

While there is potential habitat for threatened and priority listed fish species within the survey area, the physical barriers to movement that are present downstream of the area to be cleared are expected to exclude these species from the area to be cleared.

6. References

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7. Appendices

Appendix A – Full Species List and Conservation Significant Values Likelihood of Occurrence Analysis

Appendix B - Conservation Status Definitions

Appendix A

Full Species List and Site Data

Conservation Significant Values Likelihood of Occurrence Analysis

Table A1: Aquatic fauna species recorded within survey area

Family	Taxon Name	Vernacular
Parastacidae	*Cherax preisii*	Koonac
Leptophlebiidae	*Ephemeroptera larvae*	Mayfly
Myobatrachidae	*Crinia glauerti*	Glauert's froglet
Pelodryadidae	*Littoria adelaidensis*	Slender tree frog

Table A2: Additional opportunistic observations of non-aquatic species within the survey area

Family	Taxon Name	Vernacular
Peramelidae	*Isoodon obesulus*	Quenda

Table A3: Risk assessment and survey outcomes for potential conservation significant species within the survey area. Species are presented alphabetised under their relevant family.
Note: N = No, Y = Yes, P = Potential, L = Low, M = Medium, H = High

Family	Species	Common Name	Status WA / EPBC	Habitat description	Habitat Present	Likelihood of Detection of Species if present	Species Present
Galaxiidae	Galaxiella munda	Western dwarf galaxias	VU	Relatively undisturbed, permanent stream habitats (rather than the ephemeral wetland habitats where black-striped minnow are typically found). Prefers small, gently flowing creeks and streams. Found in low pH environments (as low as pH 3), but low salt tolerance (susceptible to salinisation)	No	High	N
Galaxiidae	Galaxias truttaceus (Western Australian population)	Western trout minnow	EN / CR	near-coastal freshwater rivers and their tributaries and associated downstream lakes. The species is tolerant of tannin-stained acidic waters.	Yes	High	N
Galaxiidae	Galaxiella nigrostriata	Black-striped minnow	EN	Ephemeral, tannin-stained wetland habitats	Yes	High	N
Geotriidae	Geotria australis	Pouched lamprey	P3 / -	In this survey, the species is most likely to be encountered as an ammocoete burrowing into soft muddy sediments	Yes	High	N
Percichthyidae	Nannoperca pygmaea	Little pygmy perch	EN / -	Near coastal streams. Usually shallow tannin stained, acidic streams with complex instream habitat, often comprising stands of the paperbark Melaleuca rhaphiophylla.	Yes	High	N
Percichthyidae	Nannatherina balstoni	Balston's pygmy perch	VU / VU	Shallow freshwater pools, streams and lakes in sandy areas, often acid and tannin stained. Commonly found in association with tall sedge thickets and riparian vegetation.	Yes	High	N

Site	S1	**Date Surveyed**	14th December 2020
Location	~100m west of the area to be cleared.		
GPS	**Latitude:** -34.906182	**Longitude:** 117.059082	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Quenda runnels and fresh quenda diggings. Lightly flowing shallow water, some pooling. Dense sedges. Stable vegetated banks shallow. Water 87mm deep. 300mm wide creek, steady flow. Sweep small net only.		

Life Form	**Dominant Species**	**Other Species**	**Cover (%)**
Overstorey	*Taxandria linearifolia*		30-70%
Midstorey	*Lepidosperma tetraquetrum, Taxandria linearifolia*		30-70%
Understorey	*Pteridium esculatum, Lepidosperma tetraquetrum, Taxandria linearifolia, Lepidosperma effusum*	*Rubus sp.*	30-70%




Site	S2	**Date Surveyed**	14th December 2020
Location	~140m west of the area to be cleared.		
GPS	**Latitude:** -34.905795	**Longitude:** 117.058667	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	No hollow bearing trees or evidence of quenda/rakali or phascogale.		

Life Form	**Dominant Species**	**Other Species**	**Cover (%)**
Overstorey	*Corymbia calophylla, Eucalyptus diversicolor*		30-70%
Midstorey	*Leucopogon verticillata, Pteridium esculatum, Hovea elliptica, Anigozanthos flavidus*		30-70%
Understorey	*Lepidosperma squamatum, Opercularia hispidula*		30-70%

Site	S3	**Date Surveyed**	14th December 2020
Location	~190m west of the area to be cleared.		
GPS	**Latitude:** -34.906	**Longitude:** 117.05814	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Sedges dense and forming solid mats over the creek. Creek completely covered by sedges. Shallow. Water stationary. Tannin stained. Banks stable and vegetated. 850mm wide, water 185mm deep. Sweep small net only due to density of vegetation and debris in water		

Life Form	Dominant Species	Other Species	Cover (%)
Overstorey	*Taxandria linearifolia* (possibly *juniperina,* too tall to see foliage – tall tree ~40m), *Allocasuarina decussata*		30-70%
Midstorey	*Taxandria linearifolia*		30-70%
Understorey	*Lepidosperma tetraquetrum, Lepidosperma effusum*		30-70%

Site	S4	**Date Surveyed**	14th December 2020
Location	~210m west of the area to be cleared.		
GPS	**Latitude:** -34.905878	**Longitude:** 117.05794	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Deeply incised section of creek. All above this point is shallow pools and light flows. Below is deep and flowing. Bank 1.7m deep at its deepest point and 4.3m wide. Water 1.6m deep at deepest point near the wall. Multiple sweeps with large nets. Trap left onsite beneath waterfall in direction of flow (1.6m deep). Water tannin stained. Bank contains clay with oxidised pyrite (green). Exposed black, spongy peat layer 1.3m below surface. Exposed due to water erosion. Soils in the vicinity smell like Sulfur. Iron oxides and bacterial slime oozing out of the soil in one location at the base of the pyrite wall, on the water line. May be worth conducting acidity and heavy metal tests in summer when the water is still and less diluted by recharge. Creek bed steps down 1.7m with a 90-degree drop, solid flow over the drop and slippery, oozing iron oxide on the surface of the substrate. **This is a significant barrier to fish movement.** Captured in nets downstream of the barrier: *Cherax preisii* and *Ephemeroptera* larvae		

Life Form	Dominant Species	Other Species	Cover (%)
Overstorey	*Eucalyptus diversicolor, Allocasuarina decussata, Taxandria linearifolia/juniperina*		30-70%
Midstorey	*Lepidosperma tetraquetrum, Lepidosperma effusum*		30-70%

Site	S5	**Date Surveyed**	14th December 2020
Location	~250m west of the area to be cleared.		
GPS	**Latitude:** -34.905936	**Longitude:** 117.057472	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Sweep with large net. Captured *Cherax preisii* and *Ephemeroptera* larvae.		

Life Form	**Dominant Species**	**Other Species**	**Cover (%)**
Overstorey	*Allocasuarina decussata, Corymbia calophylla*		30-70%
Mid/understorey	*Lepidosperma tetraquetrum*		30-70%

Site	S6	**Date Surveyed**	14th December 2020
Location	~270m west of the area to be cleared.		
GPS	**Latitude:** -34.905948	**Longitude:** 117.057268	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Open water with dense sedge over banks. 150mm deep, flowing slightly, water tannin stained. Leaf litter and woody debris on creek floor. *Crinia glauerti.* Trap and Large Sweep net used.		

Life Form	**Dominant Species**	**Other Species**	**Cover (%)**
Overstorey	*Allocasuarina decussata,* *Corymbia calophylla*		30-70%
Mid/understorey	*Lepidosperma tetraquetrum*		30-70%

Site	S7	**Date Surveyed**	14th December 2020
Location	~330m west of the area to be cleared.		
GPS	**Latitude:** -34.905924	**Longitude:** 117.056568	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Flowing, 125mm deep 690mm wide. Steps down 650mm solid flow. Sedges completely cover creek shaded and cool. Large net sweep x 5. Quenda diggings.		

Life Form	**Dominant Species**	**Other Species**	**Cover (%)**
Overstorey	*Allocasuarina decussata, Corymbia calophylla*		30-70%
Mid/understorey	*Lepidosperma tetraquetrum*		30-70%

Site	S8	**Date Surveyed**	14th December 2020
Location	~360m west of the area to be cleared.		
GPS	**Latitude:** -34.905885	**Longitude:** 117.056238	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Flowing, water 196mm deep, creek 2.2m wide. Creek bed steps down 720mm with a solid flow over the drop. Minor barrier to fish movement. Sedges completely cover creek, shaded and cool. Trap and large sweep.		

Life Form	Dominant Species	Other Species	Cover (%)
Overstorey	*Allocasuarina decussata, Corymbia calophylla*		30-70%
Midstorey	*Astartea fascicularis, Taxandria linearifolia*		30-70%
Mid/understorey	*Lepidosperma tetraquetrum, Lepidosperma effusum, Opercularia hispida*		30-70%

Site	S9	**Date Surveyed**	14th December 2020
Location	~410m west of the area to be cleared.		
GPS	**Latitude:** -34.90585	**Longitude:** 117.055729	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Flowing down a gradual slope into the pool. 105mm deep 2.7m wide. Captured *Cherax preisii* and *Ephemeroptera larvae*. Sweep with large net x 6.		

Life Form	**Dominant Species**	**Other Species**	**Cover (%)**
Overstorey	*Allocasuarina decussata, Corymbia calophylla*		30-70%
Midstorey	*Taxandria linearifolia*		30-70%
Mid/understorey	*Lepidosperma tetraquetrum, Lepidosperma effusum, Opercularia hispida, Leucopogon verticillata, Pteridium esculatum*		30-70%

Site	S10	**Date Surveyed**	14th December 2020
Location	~430m west of the area to be cleared.		
GPS	**Latitude:** -34.905901	**Longitude:** 117.055447	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Sedges only on the edge of the creek here. 780mm deep 3.2m wide. Drops down 940mm, 90 degrees. Strong flow. Substantial overhang at the base of the drop off, just above the water level. **This is a significant barrier to fish movement**. Trap and sweep with large net. *Crinia glauerti, Littoria adelaidensis.* *Cherax preisii* and *Ephemeroptera* larvae.		

Life Form	Dominant Species	Other Species	Cover (%)
Overstorey	*Allocasuarina decussata, Corymbia calophylla, Agonis flexuosa.*		30-70%
Midstorey	*Agonis flexuosa, Podocarpus drouynianus. Pteridium esculatum*		30-70%
Mid/understorey	*Lepidosperma tetraquetrum, Opercularia hispida, Leucopogon verticillata, Pteridium esculatum*		30-70%

Site	S11	**Date Surveyed**	14th December 2020
Location	~450 west of the area to be cleared.		
GPS	**Latitude:** -34.905868	**Longitude:** 117.055249	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Sedges only on the edge of the creek here. U-bend, 2 small waterfalls down gradual slopes over rock. Creek base substrate more gravelly. Sweep with large net. Depth 204mm. Width 2.2m. *Ephemeroptera* larvae.		

Life Form	**Dominant Species**	**Other Species**	**Cover (%)**
Overstorey	*Allocasuarina decussata, Corymbia calophylla, Agonis flexuosa.*		30-70%
Midstorey	*Agonis flexuosa*		30-70%
Mid/understorey	*Lepidosperma tetraquetrum, Opercularia hispida, Leucopogon verticillata, Pteridium esculatum*		30-70%

Site	S12	**Date Surveyed**	14th December 2020
Location	~490m west of the area to be cleared.		
GPS	**Latitude:** -34.905778	**Longitude:** 117.054822	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Sedges only on the edge of the creek here. Rocky base. Sweep with large net and small net. Width 900mm. Depth 50mm – 310mm. Flowing into pools.		

Life Form	**Dominant Species**	**Other Species**	**Cover (%)**
Overstorey	*Allocasuarina decussata, Corymbia calophylla, Agonis flexuosa.*		30-70%
Midstorey	*Agonis flexuosa*		30-70%
Mid/understorey	*Lepidosperma tetraquetrum, Opercularia hispida, Leucopogon verticillata, Lepidosperma effusum*		30-70%

Site	S13	**Date Surveyed**	14th December 2020
Location	~550m west of the area to be cleared.		
GPS	**Latitude:** -34.905647	**Longitude:** 117.054137	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Sweep with large net and trap Width 2.3m Depth 86mm Drops 1.4m 90 degrees. Strong flow. **This is a significant barrier to fish movement.**		

Life Form	Dominant Species	Other Species	Cover (%)
Overstorey	*Allocasuarina decussata, Corymbia calophylla, Agonis flexuosa, Trymalium odoratissimum*		30-70%
Midstorey	*Agonis flexuosa, Trymalium odoratissimum*		30-70%
Mid/understorey	*Lepidosperma tetraquetrum, Leucopogon verticillata, Lepidosperma effusum*		30-70%

Site	S14	**Date Surveyed**	14th December 2020
Location	~60m west of the area to be cleared.		
GPS	**Latitude:** -34.9061271299682	**Longitude:** 117.059581458066	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Pooling only. Banks brown humus podzols. Dense sedges. 35cm wide creek. Stable vegetated banks shallow. 54mm deep. Sweep with small net only.		

Life Form	**Dominant Species**	**Other Species**	**Cover (%)**
Overstorey	*Taxandria linearifolia*		30-70%
Midstorey	*Lepidosperma tetraquetrum, Taxandria linearifolia*		30-70%
Understorey	*Pteridium esculatum, Lepidosperma tetraquetrum, Taxandria linearifolia, Lepidosperma effusum*	*Rubus sp.*	30-70%

Site	S15	**Date Surveyed**	14th December 2020
Location	~20m west of the area to be cleared.		
GPS	**Latitude:** -34.9061152695884	**Longitude:** 117.060044012881	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Pooling only. Banks brown humus podzols. Dense sedges. 42cm wide creek. Stable vegetated banks shallow. 49mm deep. Sweep with small net only.		

Life Form	**Dominant Species**	**Other Species**	**Cover (%)**
Overstorey	*Taxandria linearifolia*		30-70%
Midstorey	*Lepidosperma tetraquetrum, Taxandria linearifolia*		30-70%
Understorey	*Pteridium esculatum, Lepidosperma tetraquetrum, Taxandria linearifolia, Lepidosperma effusum*	*Rubus sp.*	30-70%

Site	S16	**Date Surveyed**	14th December 2020
Location	Internal to the area to be cleared, ~20m from the western boundary and 25m from the southern boundary.		
GPS	**Latitude:** -34.9060796884488	**Longitude:** 117.060435405416	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Pooling only. Banks brown humus podzols. Dense sedges. 2.7m wide creek. Stable vegetated banks shallow. 65mm deep. Sweep with small net only.		

Life Form	Dominant Species	Other Species	Cover (%)
Overstorey	*Allocasuarina decussata, Corymbia calophylla*		30-70%
Midstorey	*Agonis flexuosa, Taxandria linearifolia*		30-70%
Mid/understorey	*Lepidosperma tetraquetrum, Lepidosperma effusum*		30-70%

Site	S17	**Date Surveyed**	14th December 2020
Location	Internal to the area to be cleared, ~30m from the eastern boundary and 10m from the southern boundary.		
GPS	**Latitude:** -34.9059966657897	**Longitude:** 117.060933541371	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Pooling only. Banks brown humus podzols. Dense sedges. 1.3m wide creek. Stable vegetated banks shallow. 58mm deep. Sweep with small net only.		

Life Form	**Dominant Species**	**Other Species**	**Cover (%)**
Overstorey	*Melaleuca preissiana, Taxandria linearifolia*		30-70%
Midstorey	*Taxandria linearifolia*		30-70%
Mid/understorey	*Lepidosperma tetraquetrum, Lepidosperma effusum*		30-70%

Site	S18	**Date Surveyed**	14th December 2020
Location	~15m east of the area to be cleared.		
GPS	**Latitude:** -34.90597294503	**Longitude:** 117.061431677325	
Landform and Slope	Riparian bank, gentle slope		
Soils	Dark brown humus podzols		
Hydrology	Seasonal wet		
Condition	Excellent		
Comments	Pooling only. Banks brown humus podzols. Dense sedges. 68cm wide creek completely covered with sedges. Stable vegetated banks shallow. 63mm deep. Sweep with small net only.		

Life Form	**Dominant Species**	**Other Species**	**Cover (%)**
Overstorey	*Melaleuca preissiana, Taxandria linearifolia*		30-70%
Midstorey	*Taxandria linearifolia*		30-70%
Mid/understorey	*Lepidosperma tetraquetrum, Lepidosperma effusum*		30-70%

Appendix B

Conservation Status Definitions

Table A3: Conservation code definitions for flora and fauna as listed as threatened or specially protected.

Threatened, Extinct and Specially Protected fauna or flora are species which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

Threat Category	Definition
Threatened - Critically endangered species (CR)	Facing an extremely high risk of extinction in the wild in the immediate future
Threatened - Endangered species (EN)	Facing a very high risk of extinction in the wild in the near future
Threatened - Vulnerable species (VU)	Facing a high risk of extinction in the wild in the medium-term future
Threatened - Extinct (EX)	There is no reasonable doubt that the last member of the species has died
Threatened – Extinct in the wild (EW)	Species is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form
Specially protected species - Migratory species (MI)	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.
Specially protected species – Conservation Dependent (CD)	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
Specially protected species – Other specially protected species (OS)	Fauna otherwise in need of special protection to ensure their conservation

Table A4: Conservation code definitions for flora and fauna as listed as Priority.

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3.

Threat Category	Definition
Priority 1: Poorly-known species	Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation.
Priority 2: Poorly-known species	Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation.
Priority 3: Poorly-known species	Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat.
Priority 4: Rare, Near Threatened and other species in need of monitoring	(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.