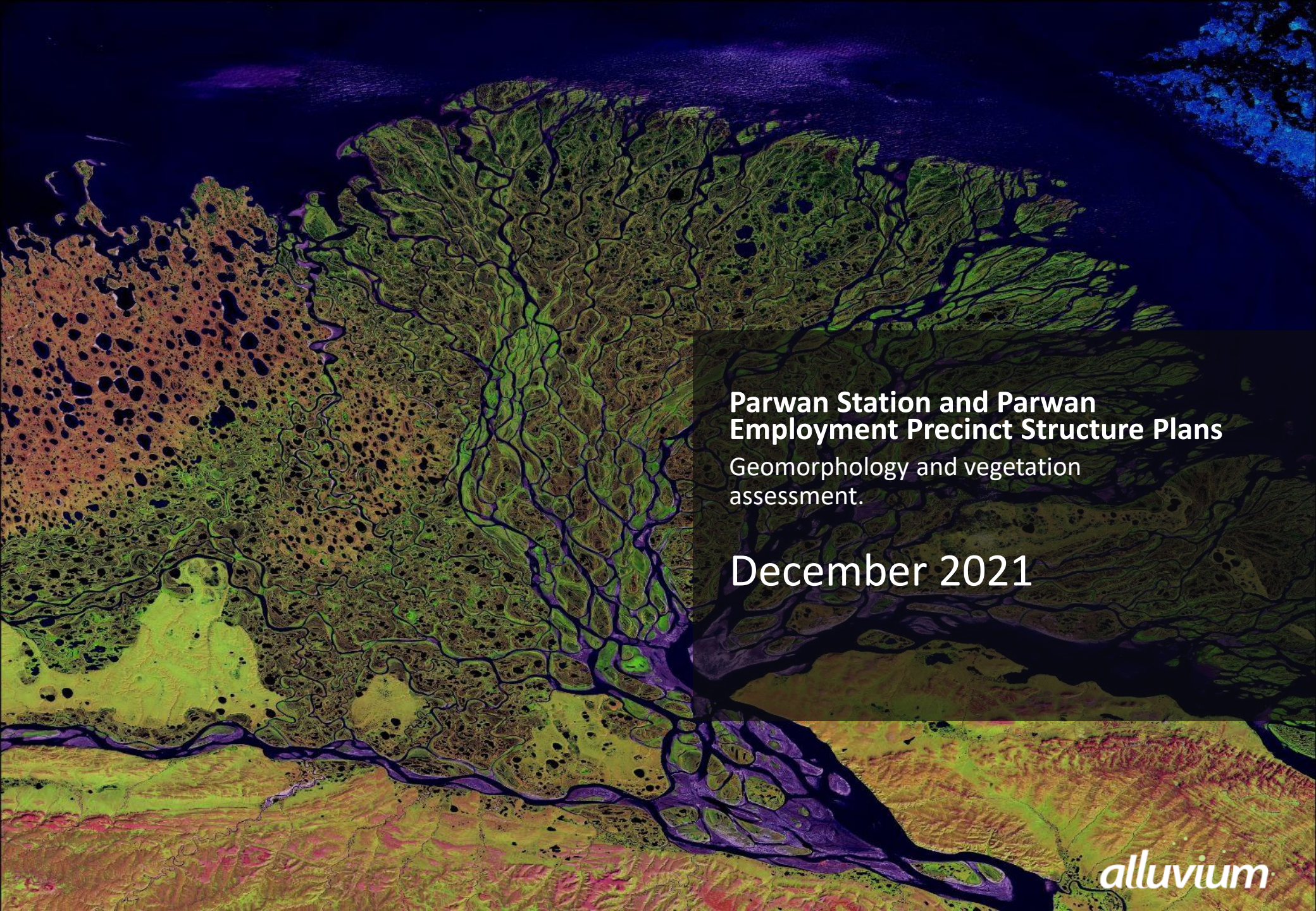

# Parwan Station and Parwan Employment Precinct Structure Plans

Geomorphology and vegetation assessment.

December 2021

alluvium

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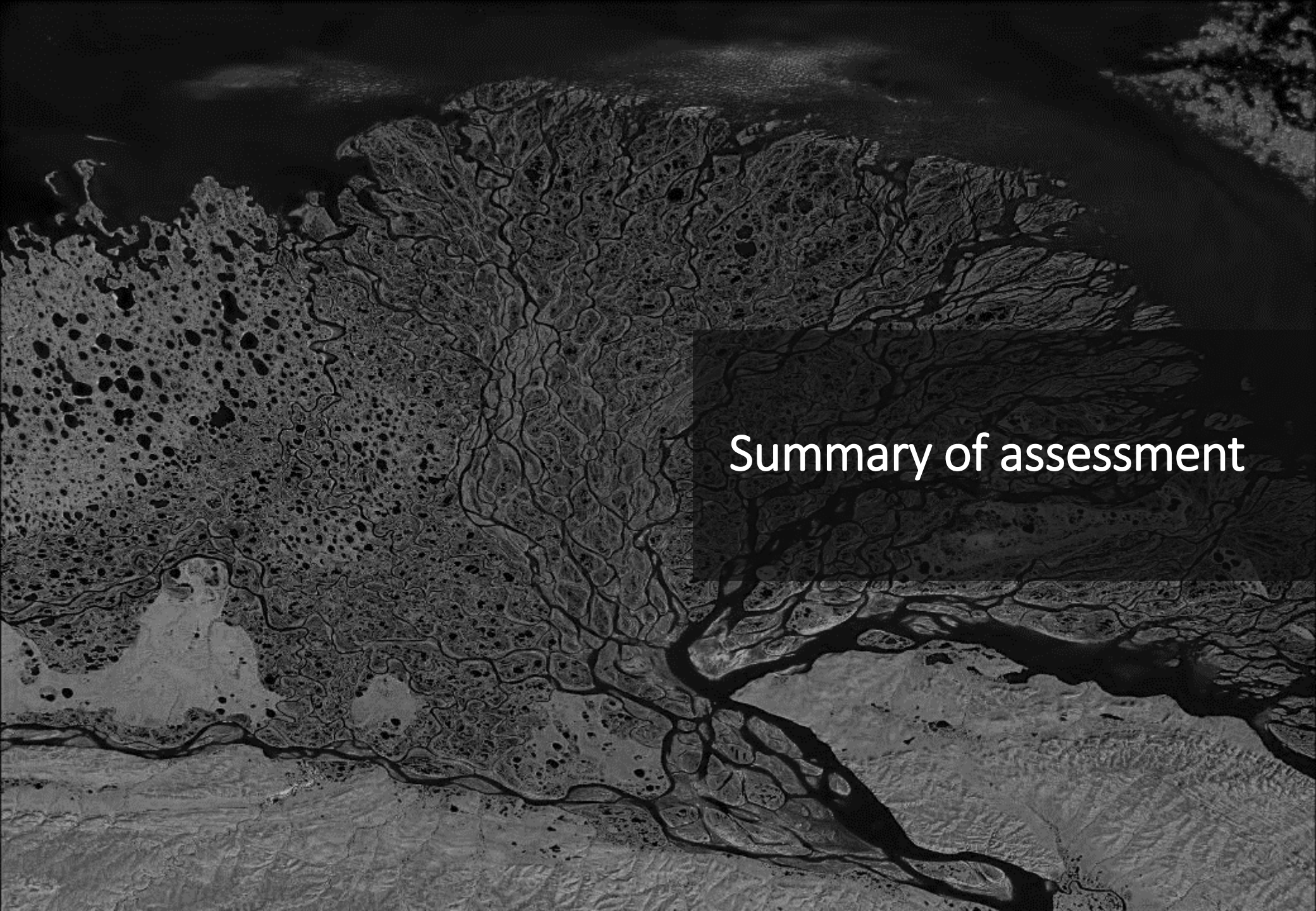

Summary of assessment

# Summary


Alluvium Consulting Australia was engaged by Melbourne Water to conduct an ecological and geomorphology study of the approximately 3500 hectares of land in the Parwan Station Precinct Structure Plan (PSP) and Parwan Agribusiness Precinct.

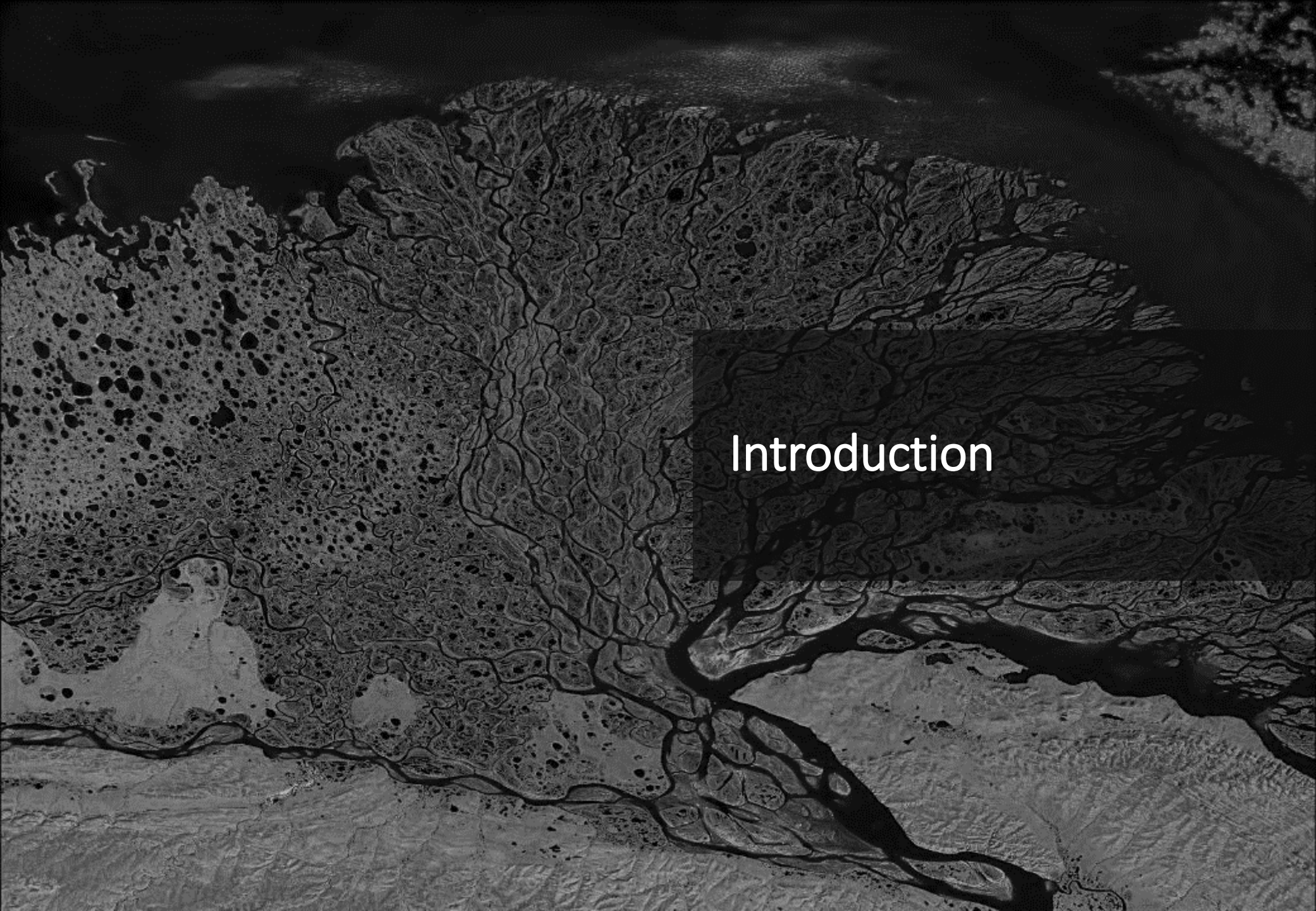
The following scope of services were sought by Melbourne Water:

- Outline and summarise assessment methodology for both desktop and field assessments
- Documentation of field investigations with photos of important sites and examples of waterway conditions encountered
- A description of the type, condition and conservation status of the native species, vegetation communities and fauna habitat identified within the study area.
- A discussion of the significant flora and fauna values along identified waterways, drainage lines and wetlands
- Mapping of the extent of the flora, EVCs, potential fauna habitat and geomorphology values within the study area.
- A discussion of the implications of the findings on national, state and local legislation and policy.
- Descriptions of the geomorphological character of the waterways.
- Determination of existing waterways resilience to change.
- Degree and type of intervention required to achieve Melbourne Water's Healthy Waterway Strategy objectives and 2030 Geomorphic Template – may involve protection, re-construction or construction of new waterway.
- Highlighting biodiversity or geomorphological values which are sensitive to hydrological change and risks posed to them.
- Reference to the 2030 Geomorphic templates in developing management recommendations (for all waterways in the study area that templates are available for).
- Identification of gaps in available information that require targeted surveys or further investigations recommended.

This assessment provides a high-level discussion of the possible impacts of proposed development within the Parwan PSP area. It is envisaged that results of the investigation may influence the preparation of the PSP (preliminary urban & infrastructure layouts) and will provide the necessary early guidance on the development of Melbourne Water's Development Services Schemes (DSS).

Riparian and wetland vegetation values within the study area are highly due to the history of disturbance and current land use activities which have a high impact on the diversity and composition of the vegetation that remains. Throughout much of the study area, exotic plant species are dominant and have established extensive cover that is outcompeting native vegetation.

Substantial effort and resourcing will be required to re-instate hydrology, manage exotic species and re-establish habitat connectivity through much of the study area if the current values are to be retained and improved.


Introduction

# Introduction

Melbourne Water is in the process of developing a Development Services Scheme (DSS) for the Parwan area.

The DSS is a plan for the drainage, waterways and water quality treatment works required to provide effective environmentally robust and sound management of stormwater. The objective of management is to protect the health of waterways from changes in stormwater runoff that result from urban and other forms of development.

As a part of the DSS development, Melbourne Water engaged Alluvium Consulting Australia (Alluvium) to assess the riparian vegetation and geomorphic values that would be impacted by development.

This baseline assessment provides Melbourne Water with a high level inventory of geomorphic and ecological values and processes that can inform the site's Precinct Structure Plan (PSP), and aid the protection of important values and processes and to plan for future connectivity.

This report covers two PSP boundaries. These are the Parwan Station PSP to the north of the study areas and the Parwan Agribusiness PSP (previously Parwan Employment) to the south. Collectively referred to as the Parwan PSP throughout this report.

The Parwan PSP is located approximately 50 km north-west of Melbourne with an area of over 3000 ha (Figure 1). Like other nearby PSP areas, development within these landscapes poses challenges to waterway health due to the potential impacts of stormwater.

The study area contains waterways formed on highly erodible soils, hydrologically sensitive ephemeral waterways and water dependent riparian and wetland ecosystems on both waterways and plains with small local catchments.

A combined vegetation and geomorphology assessment has been conducted by Alluvium. The methods, results and recommendations for the Parwan PSP are described in detail in this report.

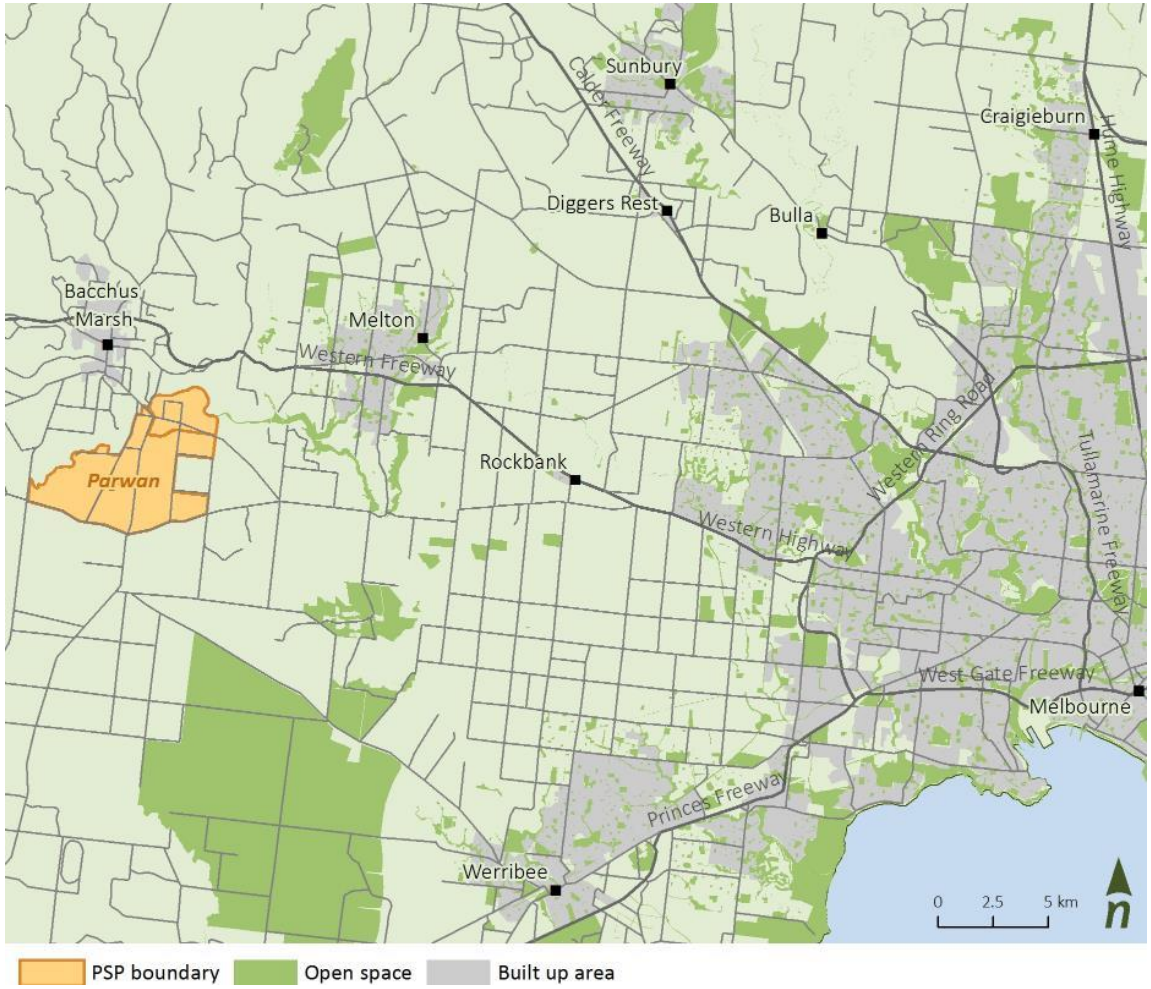
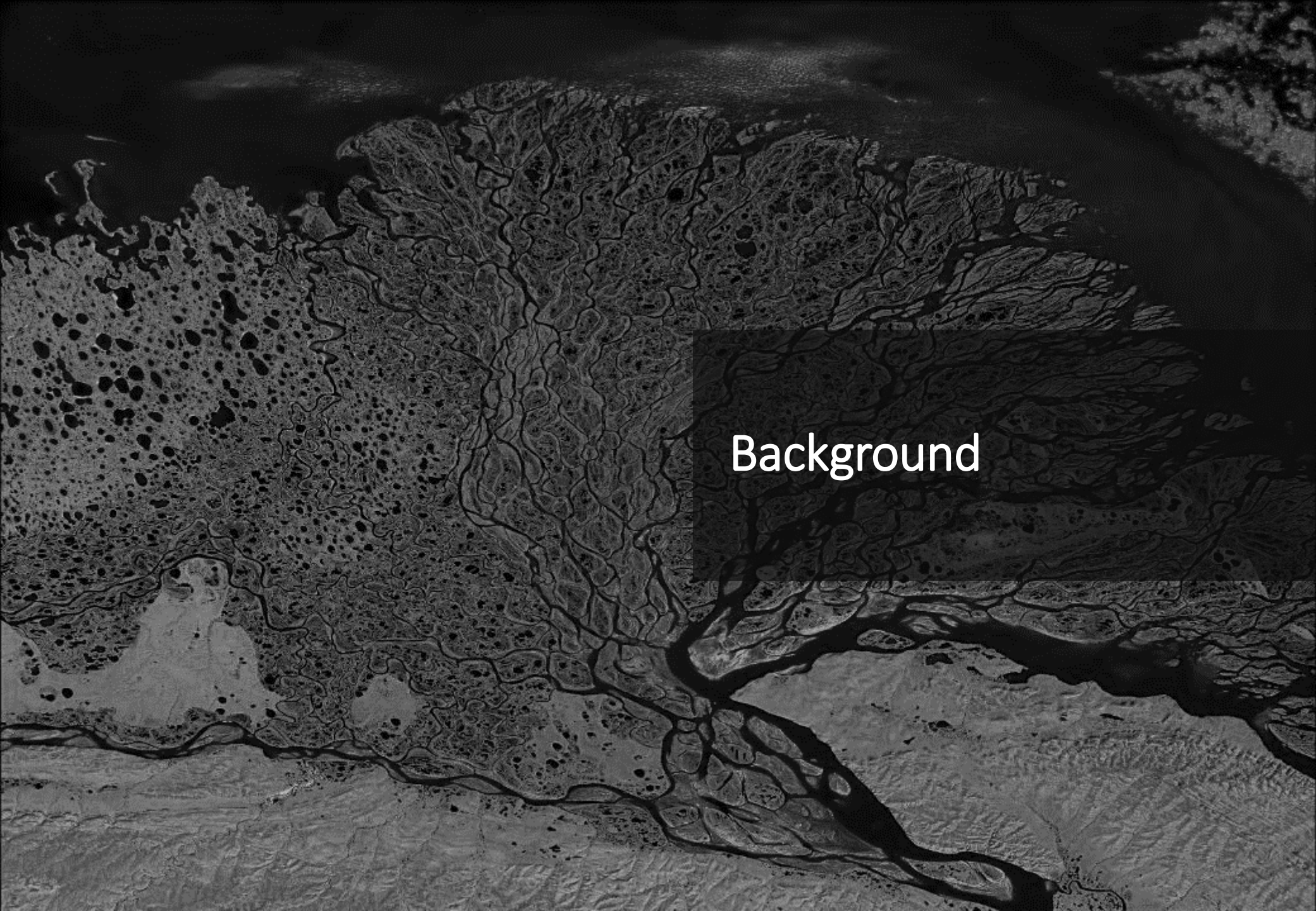



**Figure 1** *Map showing location of study area, note that this captures both the Parwan Station and Parwan Employment PSPs*


Background

# Geology

**The Parwan PSP area lies largely on** the Basalt plateau bordered by Parwan Creek. The PSP area is dominated by three geologic units.

### Darley Gravels

The Darley Gravels are Neogene sedimentary alluvium comprised of gravel, sand and silts sourced from bedrock of the surrounding area. The gravels form a wedge atop the plateau that gradually decrease in thickness towards the east of the study area.

### Newer Volcanic Group

The Miocene-Pleistocene basalt flows of the Newer Volcanic Group rest atop the plateau and found on the higher elevations of the escarpment. This unit forms an undulating plain with a vertical scarp and is prone to rock falls as a result of erosion of underlying material (Earth Tech 2006). This group is very resistant to erosion.

### Werribee Formation

The Werribee formation comprises Eocene sedimentary alluvium with sandy and silty sediments that is pyritic in some parts. The material of the Werribee Formation is generally found on the lower slopes of the escarpment and is poorly cemented and highly erodible (Earth Tech 2006).

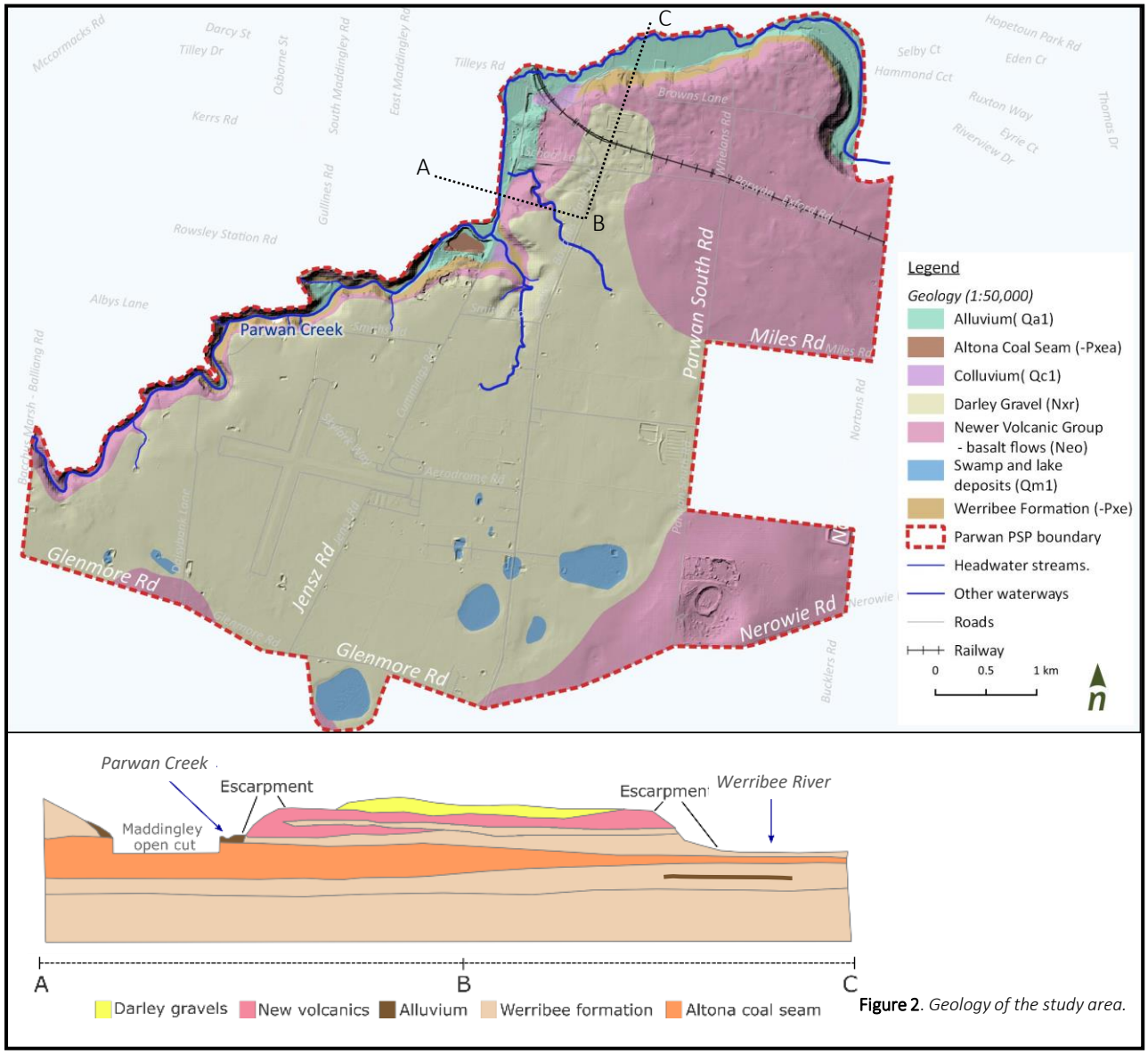



**Figure 2**. *Geology of the study area.*

# Soils

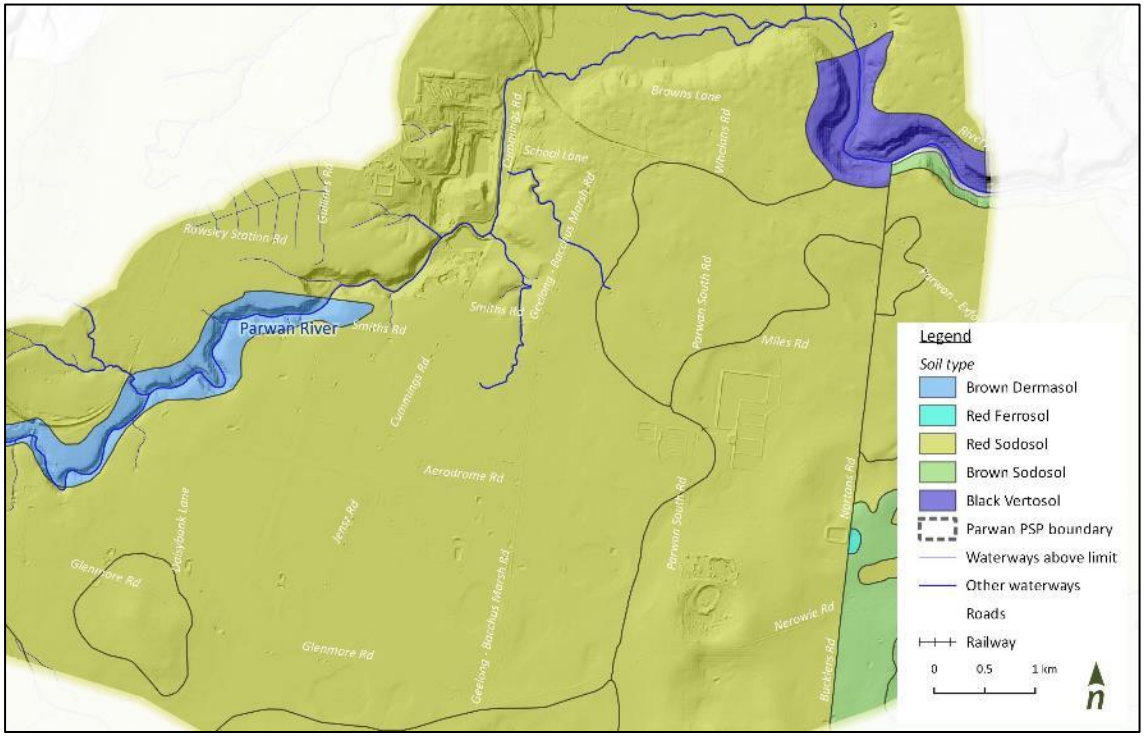



**Figure 3**. *Soil type across the study area*

**Figure 4**. *The bleached horizon of soils associated with the Werribee Formation is fine textured and fragile. Soil structure crumbles easily in the hand.*

**Across the PSP area, soils have been classified** according to the Australian Soil Classification as predominately a Red Sodosol. Sodosols are soils that have a strong texture contrast between the A and B horizons with the upper 0.2 m of the B2 horizon being sodic. Piping or tunnel erosion is very often associated with dispersive sodic soils (Ford et al. 1993). In the field, sodic soils are likely to possess a bleached A2 horizon with an abrupt change to a B2 horizon which has columnar or prismatic structures (CSIRO 2016).

Earth Tech (2006) also described the soils of the PSP area according the parent geology as follows.

### Soils of the Newer Volcanics

Soils of the Newer Volcanics are a fine textured, dark reddish-brown with little differentiation in soil horizons. The texture of these soils, and their position on the plains makes them resistant to erosion while their structure and fertility allow for good vegetation cover (Earth Tech 2006).

### Soils of the Werribee Formation

Soils of the Werribee Formation have a well developed horizon differentiation and are a light coloured, sandy texture. These soils are highly dispersive due to their high sodium content. Erosion risk is further exacerbated by low fertility of the soils and the compaction of ground surfaces which limits vegetation development. These soils are among the most erodible in Victoria (Earth Tech 2006).

# Geomorphological management units

The project study area sits within three distinct geomorphological management units.

**2.1.2 Hills, valley slopes and plains of the Western Uplands, Dissected Uplands**

This geomorphological unit occupies a lower topography than the escarpments and mountains of the Dissected Uplands. It is characterised by undulating hills and broad valleys. Chromosols that tend towards Sodosols in lower topographic positions are common.

**2.1.5 Plateaux and rises of residual Cainozoic landscapes of the Western Uplands, Dissected Uplands**

This geomorphological unit is comprised of Paleozoic rocks capped in places by sands and gravels from Palaeogene and Neogene sediment deposition. Yellow and brown texture contrast soils (both sodic and non-sodic) are associated with this geomorphological unit

**6.1.3 Plains with poorly developed drainage of the Western Plains, Volcanic Plains**

This geomorphological unit is formed by the lava flows of the Newer Volcanics and is characterised by poor drainage and shallow regolith development. Sodosols and Dermosols are often associated with this geomorphological unit.

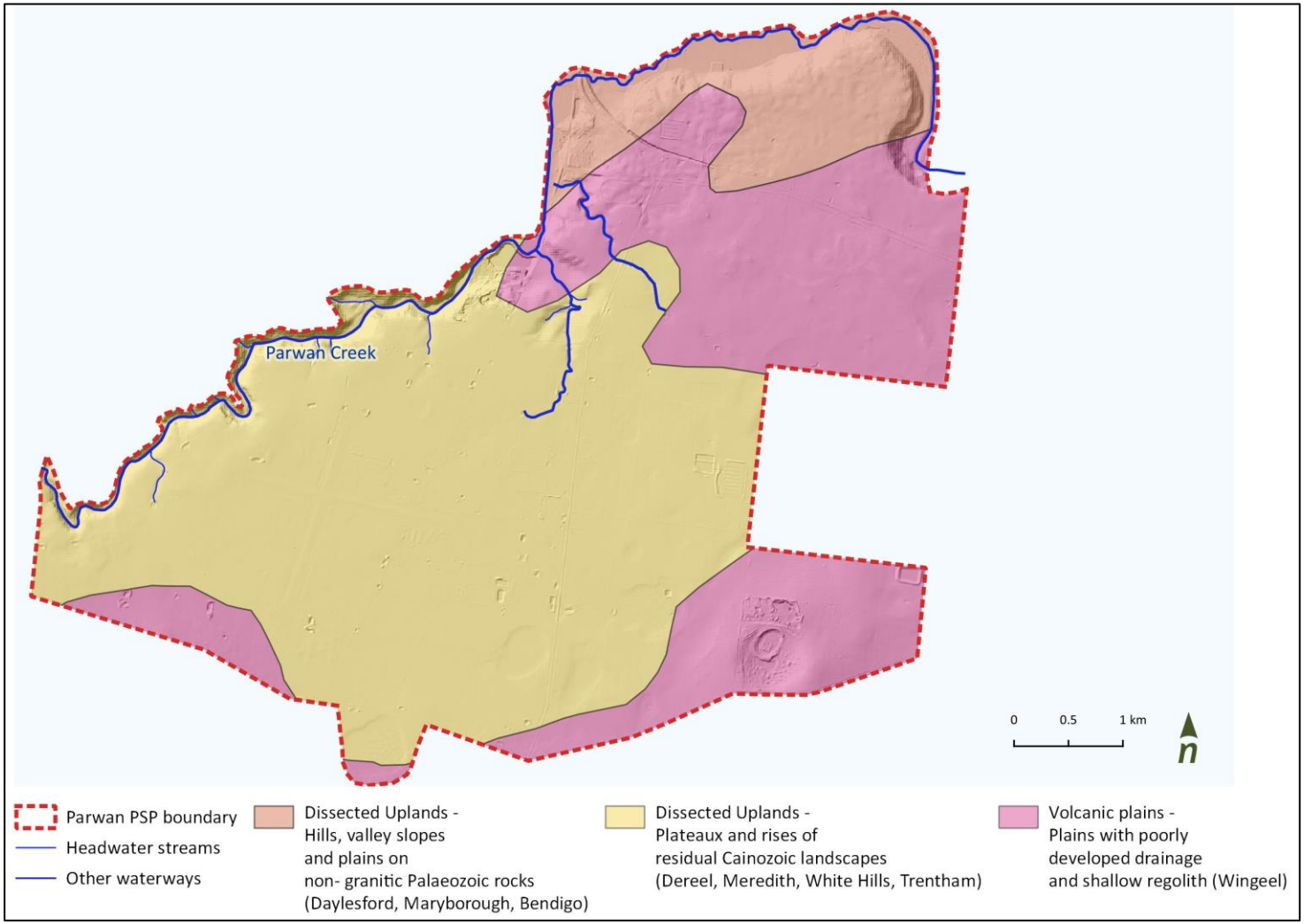



**Figure 5**. *Geomorphological management units of the study area.*

# Waterway reaches and RiverStyles

The RiverStyles framework is a consistent, documented and tested methodology used for categorising stream type. The framework provides a set of procedures that allow for the integration of catchment-scale geomorphic understanding of river forms, processes and linkages.

Many of the main waterways within this study area were previously categorised according to RiverStyle by EarthTech (2006). Field observations and the desktop assessment are largely in agreement with earlier categorisations.

Where RiverStyle was not previously mapped, we have categorised streams based on our observations in the field and a desktop assessment.

We have separated Parwan Creek into 4 geomorphic reaches for the purpose of our assessment (Figure 6). **Reach 1** is confined by the valley margins, with occasions floodplain pockets and a coarse channel bed, **Reach 2** is highly modified section including a straightened diversion channel adjacent the Maddingley open cut mine, **Reach 3** is a meandering, unconfined section that crosses the floodplains north of the escarpment and **Reach 4** is a relatively straight, low energy backwater zone of the Melton Reservoir (Figure 6).

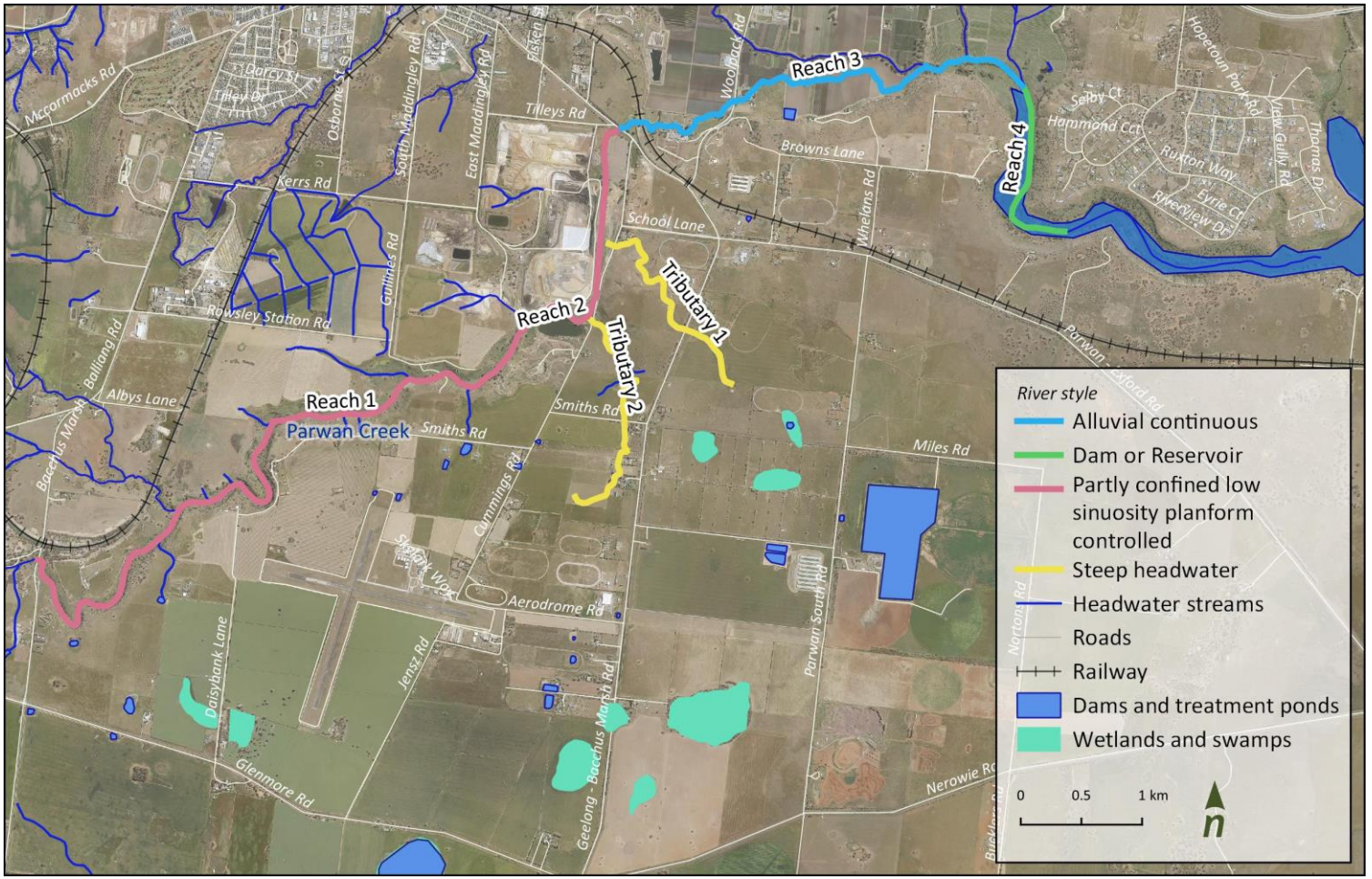



**Figure 6**. *RiverStyles of the study area.*

# EVC benchmarks overview. Wetlands, waterways and reaches demarcation.

Eight Ecological Vegetation Classes are identified in the study area.

Riparian and terrestrial vegetation communities are mapped for waterways. This is because a number of waterways are highly ephemeral and comprises of terrestrial species rather than typically riparian species. This assessment however does not make recommendations for entirely terrestrial components of the landscape. It acknowledges that some largely terrestrial communities can occur where waterways are designated.

Communities associated with waterways include;
Creekline Grassy Woodland (EVC68)
Escarpment Shrubland (EVC 895)
Plains Grassland (EVC 132) Plains Grassy Woodland (EVC 55) Red Gum Swamp (EVC 292) and Plains Woodland/Plains Grassland Mosaic (EVC 693).

Plains Grassy Wetland (EVC 125) and Lignum Swamp (EVC 104) are confirmed to wetlands.

The entire study area is within the Victorian Volcanic Plains (VVP) Bioregion. The Central Victorian Uplands (CVU) bioregion forms the western boundary of the project area.

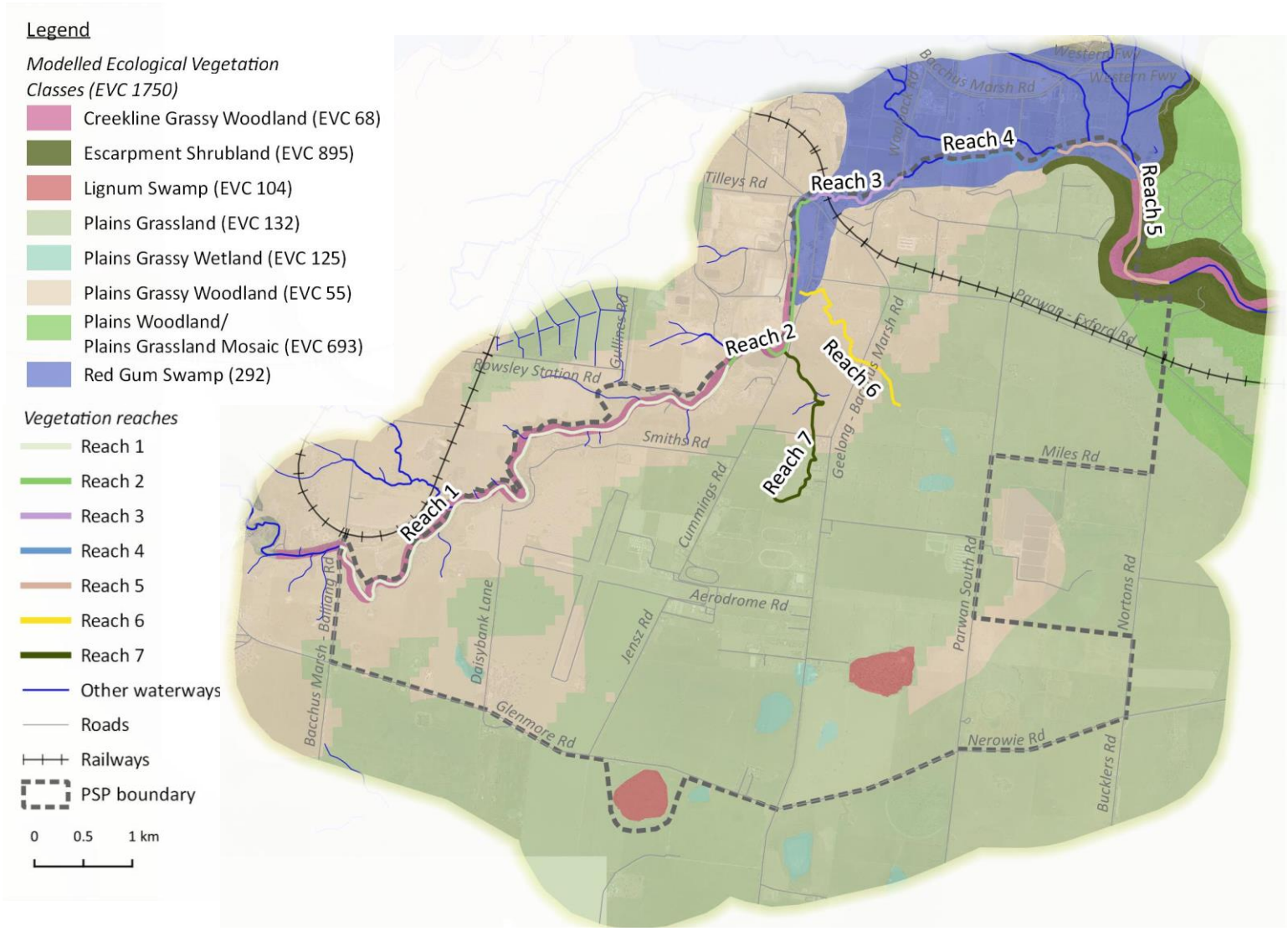



**Figure 7.** *EVC benchmark mapping along waterways and wetlands*

# Vegetation quality observed on waterways

Alluvium assessed the quality of vegetation on waterways in the study area using Melbourne Waters Vegetation Visions template definitions. This method broadly assess vegetation structure, connectivity, diversity, regeneration and the impact of major threats such as weeds and pest animal.

Waterways in the study area have a long history of degradation and impact by a range of land uses. Historically the Parwan was a host site for a range of exotic plant species introduced to colonise areas of highly eroded soils in the upper catchment. Anecdotally species such as *Galenia pubescens var. pubescens* Galenia have been trialled as soil stabilisers in the upper catchment of the waterway.

It is unclear however the extent to which its spread was initiated by land managers or whether it has expanded largely due poor land management practice. The impact of rabbits, stock and miming have resulted in a highly altered landscape susceptible to the establishment of a range of exotic plants tolerant to these perturbations.

There was limited evidence of effective control of invasive plants in the study area. Properties practising intensive agriculture in the lower reaches had performed some control to protect productive areas. However we did not detect areas where it was obvious that sustained effort to protect and improve native vegetation on waterways was being undertaken

Reduced native vegetation diversity has resulted in reduced riparian vegetation condition. As a result waterway condition score is low or very low across the study area.

When originally developed the HWS Vegetation Visions did not considered future development. Development would potentially influence hydrology and in turn any remnants that may occur. A combined approach that improves the resourcing of vegetation management and addresses hydrology would be required to sustain and improve values which are in general quite degraded at present.

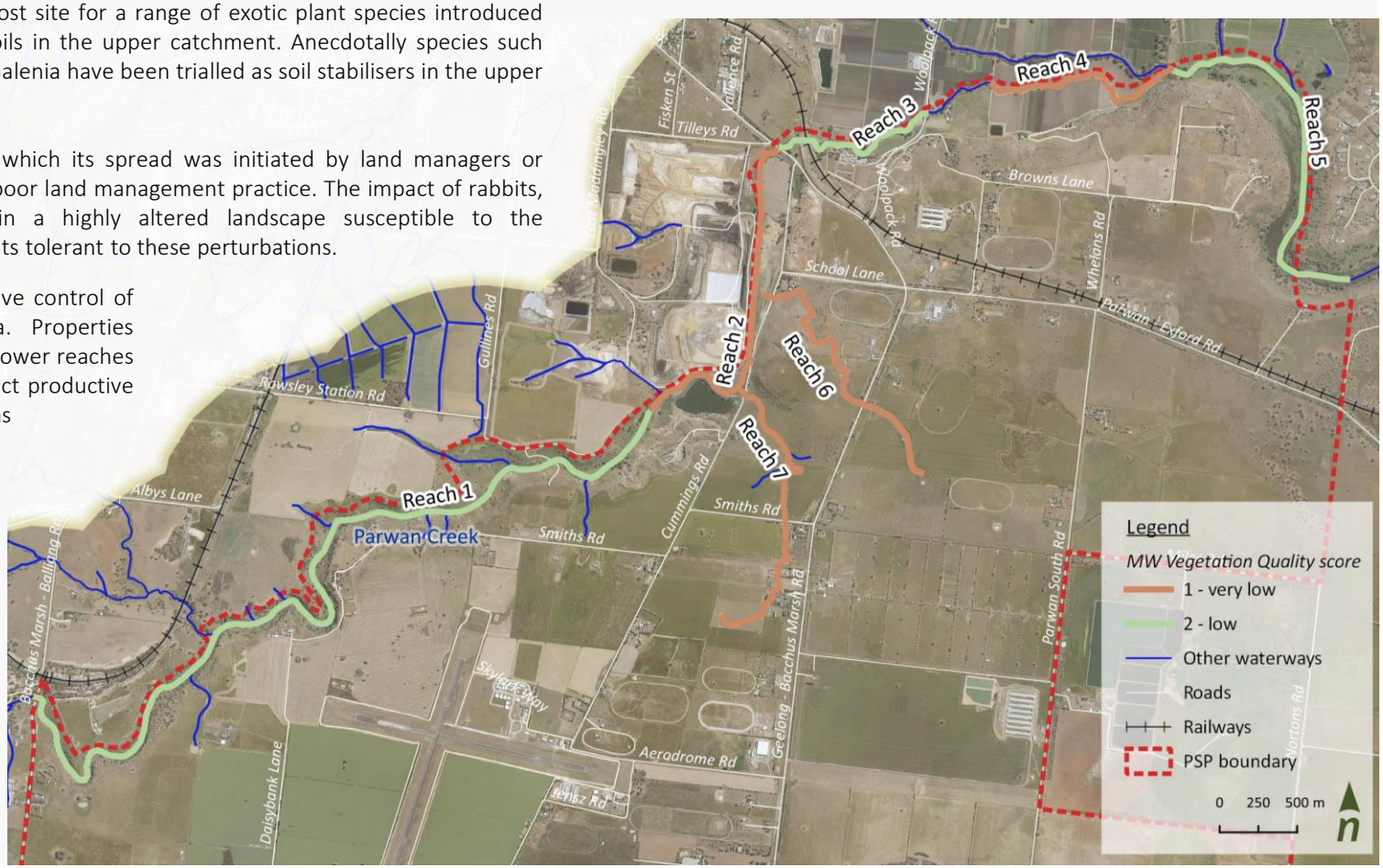



**Figure 8**. *Vegetation quality observed on waterways*

# Wetlands- observed

This project assessed five wetland areas within the study area, two of which are identified in the HWS. These five locations are

- Jensz Swamp
- Binghams Swamp
- Wheat field wetlands (comprising 3 units of which 1 was assessed)
- Genetic Australia wetlands (comprising 3 units of which 2 were assessed) and
- Daisybank Lane Swamp of which only the western portion was assessed from roadside

Of these sites Jensz Swamp was the most substantially intact with Binghams Swamp and Genetics Australia wetlands being somewhat degraded but with much of their potential and function remaining. No native vegetation was identified at the Wheat field wetlands although the site which was accessible had largely intact bathymetry.
A further five wetland sites were identified in aerial image review however these could not be assessed as permission to access these sites was not given.

Further description of wetland types, significance and the modifications that have occurred to these values are provided in the 'assessment of wetlands' component of this report.

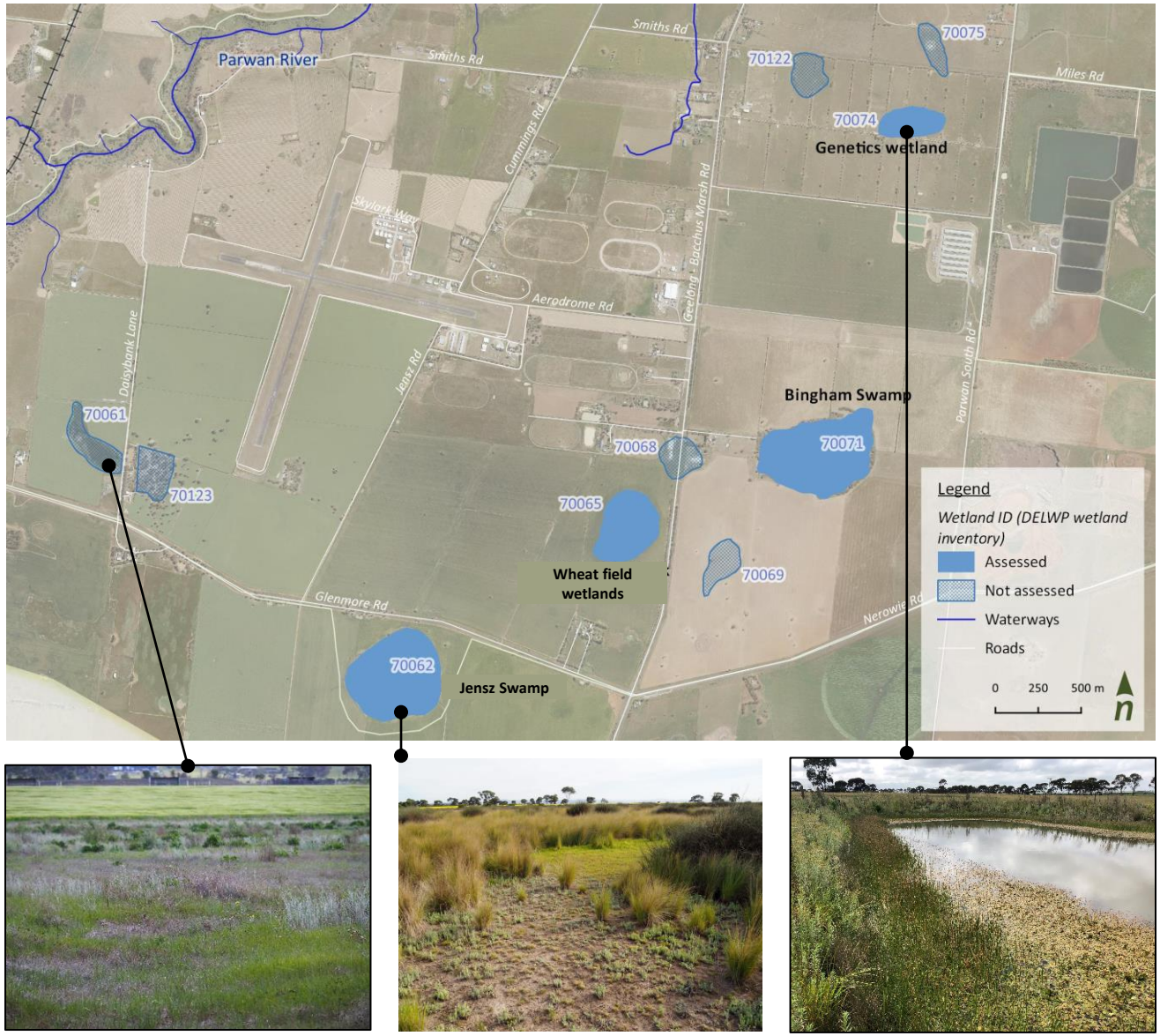
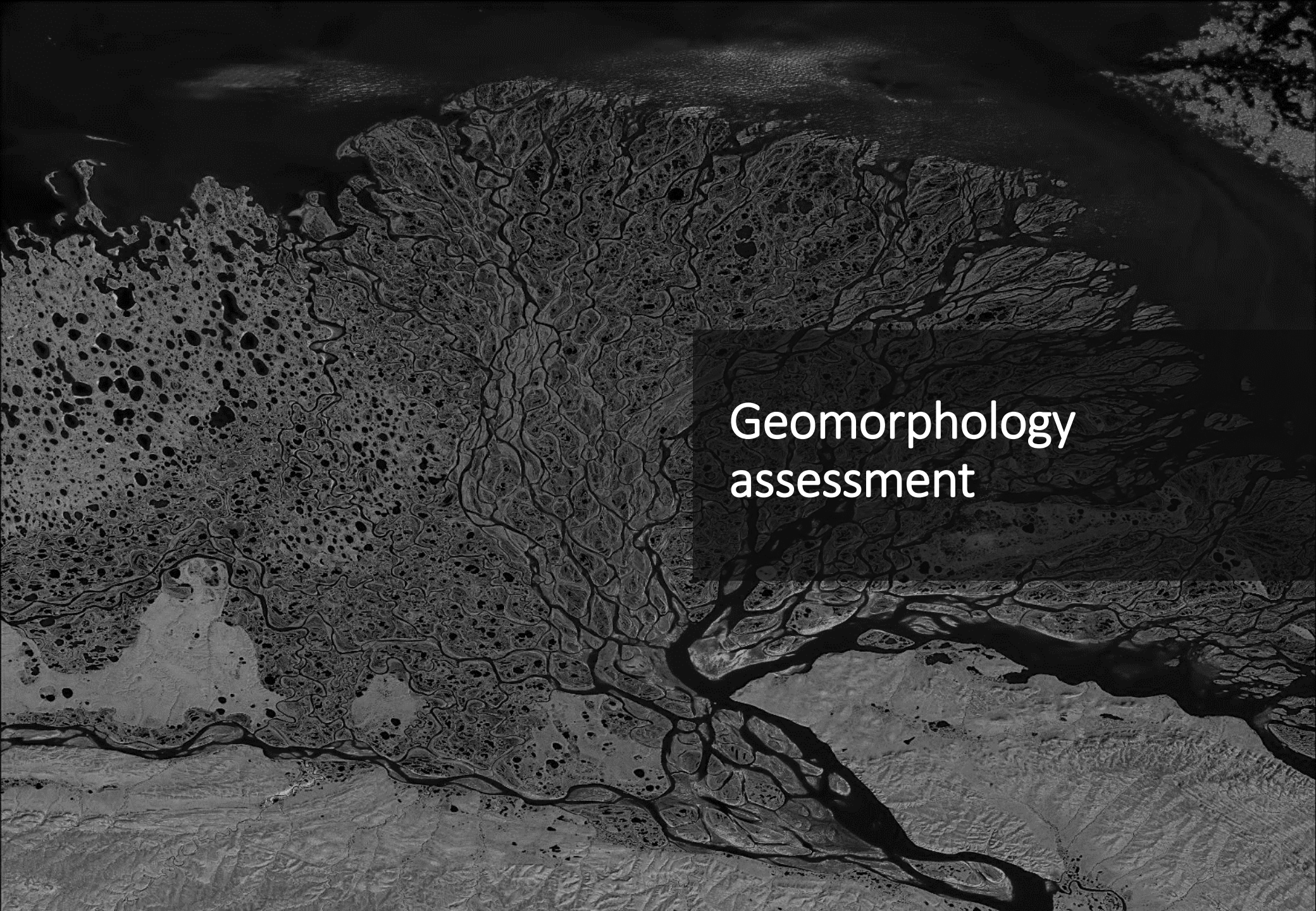



**Figure 9**. *Wetland locations and indicative images.*



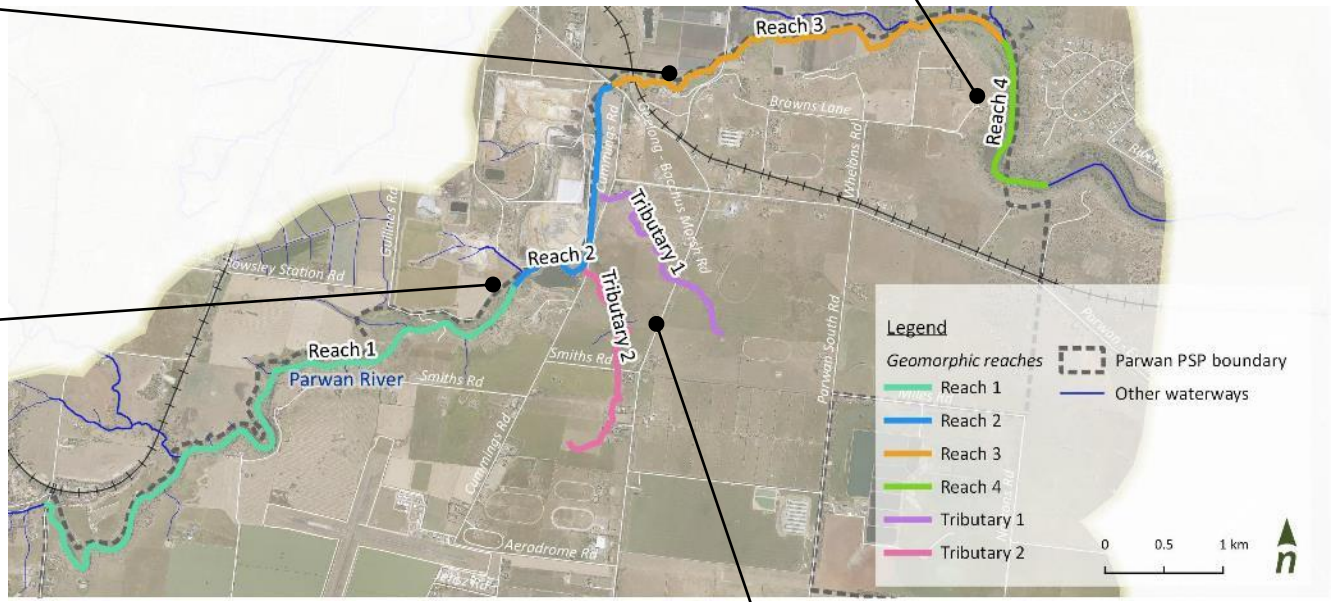
# Geomorphology assessment

# Geomorphic reaches – Parwan Creek

**Reach 3 of the study site is** classified as an Alluvial continuous stream in the RiverStyles framework. This reach is in relatively good condition with only minor evidence of erosion processes. A summary of this reach is provided on the following pages.

**Reach 4 of the study site is** impacted by backwater effects of the Melton reservoir and therefore, is classified as such in the RiverStyles framework. The lower part of this reach is confined and gently sinuous. A summary of this reach is provided on the following pages.

**Reaches 1 and 2 of the study site** are partly confined low sinuosity planform controlled streams. Evidence of erosion processes associated with dispersive subsoils are present throughout these reaches. A summary of each reach is provided on the following pages.

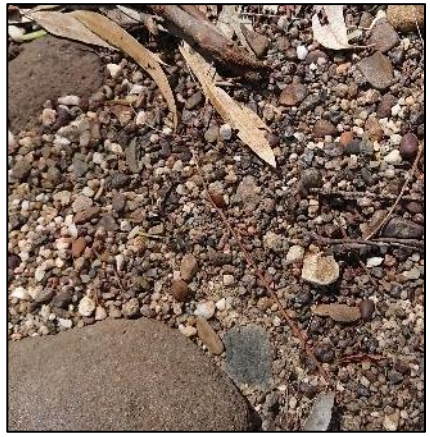



**The two tributaries of the Parwan Creek** have been classified as Steep headwaters in the RiverStyles framework. There s little evidence for historic erosion these reaches, which are dominated by basalt bedrock. A summary of this reach is provided on the following pages.

# Parwan Creek – Reach #1

**This reach of Parwan Creek is a partly confined, planform-controlled stream at the upstream extent of the study area .** Throughout this reach there is evidence of erosion processes associated with dispersive subsoils. These processes are limited in extent throughout the reach, most frequently where soils of the Werribee Formation are exposed or there is limited protection from basalt of the Newer Volcanics. This reach of Parwan Creek is largely confined within steep valley margins.

| Parameter | Partly confined, low sinuosity, planform-controlled |
|---|---|
| Channel | Single, continuous channel. |
| Bank/valley sides | Channel confined by steep valley margins. Valley margins are composed of basalt cliffs, with sand/silt and frequent basalt boulders on the lower slopes. Exposed sodic subsoils are present at locations along the reach. |
| Bed | Typical longitudinal slope is 0.008. Bed material comprises sands and gravels with larger cobbles and basalt boulders present throughout the reach. |
| Planform | Low sinuosity channel confined by the valley margins. |
| Geology | Werribee Formation – sedimentary (sand, silt, clay, gravel). |
| | Newer Volcanics – basalt |
| | Darley Gravel – sedimentary (gravel, silt, sand) |
| | Alluvium - (gravel, sand, silt). |
| Land use | Agriculture |
| Soil type | Red Sodosol – sodic B2 horizon with a strong texture contrast between A horizon and B horizon. |
| | Brown Dermasol – structured B2 horizon, lacking strong texture contrast between the A and B horizons. |
| Sediment load | Ephemeral stream. No streamflow at the time of field inspection. |
| Riparian vegetation | Scatted eucalypt overstory with some native midstory and groundcover. Midstory and groundcover dominated by exotics, especially prickly pear. |
| In stream vegetation | Well vegetated with reeds and rushes |
| Habitat value | Moderate habitat values associated with instream vegetation and basalt boulders and cobbles. |



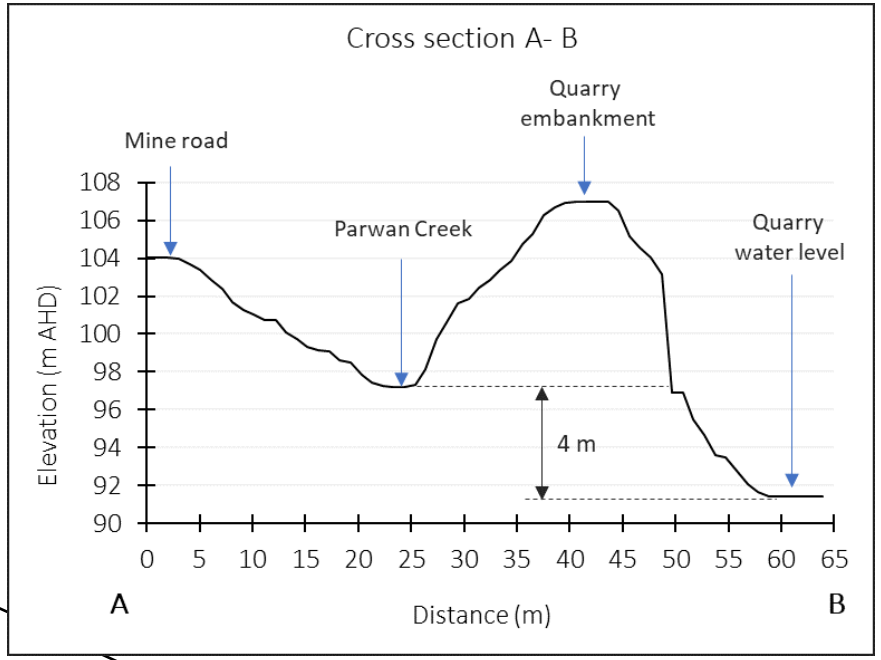
# Parwan Creek – Reach #2

**This reach of Parwan Creek is a confined, planform-controlled stream,** however much of the reach is heavily modified. A major section of this reach comprises a straight constructed waterway diversion to accommodate the adjoining Maddingley open cut. The bed of this reach is actively incising, the adjacent banks of the diversion banks are steep and are also subject to active erosion. Without intervention the diversion will continue to erode. In the absence of interventions to control runoff or alter the channel, Increased runoff following development is likely to exacerbate erosion of the diversion. The bed of Parwan Creek though this reach is covered by fresh sand deposits, delivered to the channel by a small drain on the left bank at the upstream end of the reach.

| Parameter | Partly confined, low sinuosity, planform-controlled |
|---|---|
| Channel | Single, continuous channel. |
| Bank/valley sides | Channel confined by steep valley margins. Valley margins are composed on sand/silt with frequent basalt boulders. |
| Bed | Typical longitudinal slope is 0.003. Bed material comprises sands and gravels with larger cobbles and basalt boulders present throughout the reach. |
| Planform | Very low sinuosity channel confined by the valley margins with a straightened section in the lower part of the reach. |
| Geology | Werribee Formation – sedimentary (sand, silt, clay, gravel). |
| | Newer Volcanics – basalt |
| | Darley Gravel – sedimentary (gravel, silt, sand) |
| | Altona Coal Seam - Lignite |
| | Alluvium - (gravel, sand, silt). |
| Land use | Predominate current land use is associated with coal mining. This reach borders the Maddingley open cut. |
| Soil type | Red Sodosol – sodic B2 horizon with a strong texture contrast between A horizon and B horizon. |
| Sediment load | Ephemeral stream. No streamflow at the time of field inspection. |
| Riparian vegetation | Scatted eucalypt overstory with some native midstory and groundcover. Riparian vegetation is dominated by exotics. Vegetation adjoining the open cut is limited. |
| In stream vegetation | Well vegetated with reeds and rushes |
| Habitat value | Moderate habitat values associated with instream vegetation and basalt boulders and cobbles. |

# Parwan Creek – Reach #2 (cont.)

The upstream section of reach 2 is confined by the Maddingley open cut mine on the left bank and a large quarry embankment on the right bank. The channel bed is perched approximately 4 m above the water level of the adjacent quarry pit. Both banks of the channel are actively eroding at the toe. No waterways discharge into the quarry pit and the source of the water in the pit is likely to be groundwater, sourced from either Parwan Creek, or the surrounding landscape (although this is not certain). If occurring, loss of streamflow through the bed of Parwan Creek and into the quarry pit may be contributing to decreased flow in Parwan Creek. The quarry embankment shows signs of mass failure on the quarry side, and rills and loose sediment are widespread on the Parwan Creek side.


# Parwan Creek – Reach #3

**This reach of Parwan Creek is an alluvial continuous stream.** Unlike upstream reaches of Parwan Creek, reach 3 is not confined by the valley margins or artificial embankments, although it is incised approximately 3 m into the floodplain. There are signs of minor erosion associated with dispersive soils at the edge of the floodplain, but there are no signs of incision within the main channel. There is abundant instream vegetation in the channel but riparian vegetation is sparse, lacking overstory species in some sections and of better quality with a reasonable cover of eucalypts in other sections.

| Parameter | Alluvial continuous |
|---|---|
| Channel | Single, continuous channel. |
| Bank/valley sides | Channel unconfined by valley margins but incised into the floodplain. Bank material is sandy to silt. |
| Bed | Typical longitudinal slope is 0.004. Bed material comprises sands to clay with occasional gravels and cobbles. |
| Planform | Low, sinuosity, unconfined channel. |
| Geology | Werribee Formation – sedimentary (sand, silt, clay, gravel). |
| | Newer Volcanics – basalt |
| | Alluvium - (gravel, sand, silt). |
| Land use | Agriculture, predominately market gardens |
| Soil type | Red Sodosol – sodic B2 horizon with a strong texture contrast between A horizon and B horizon. |
| Sediment load | High suspended sediment load, common in dispersive landscapes, noted by very turbid water. |
| Riparian vegetation | Some sections have limited riparian vegetation which is largely exotic. Other sections of the reach have riparian vegetation with scattered eucalypt overstory and exotic understory. |
| In stream vegetation | Some sections well vegetated with reed and rushes |
| Habitat value | Limited instream habitat |

# Parwan Creek – Reach #4

**This reach of Parwan Creek is impacted by the backwater effects from Melton Reservoir,** as such it has been classified as a dam or reservoir in the RiverStyles framework. Without the effect of the reservoir the reach could best be described as partly confined with floodplain pockets. This reach of the waterway is confined within steep valley sides, although narrow floodplain pockets have developed along either side of the waterway. A large floodplain channel is present between the right bank of the channel and the escarpment edge

| Parameter | Dam or reservoir |
|---|---|
| Channel | Single, continuous channel. |
| Bank/valley sides | Channel is largely confined by the valley margins, although there is some floodplain development within these valley sides. Waterway bank are generally less than 1 m and gently sloping. Bank material comprises sandy silt. |
| Bed | Typical longitudinal slope of 0.001 m/m. Bed substrate is sandy silt to clay. |
| Planform | Low sinuosity channel partly confined by the valley margins. |
| Geology | Werribee Formation – sedimentary (sand, silt, clay, gravel). |
| | Newer Volcanics – basalt |
| | Darley Gravel – sedimentary (gravel, silt, sand) |
| | Alluvium - (gravel, sand, silt). |
| Land use | Agriculture |
| Soil type | Red Sodosol – sodic B2 horizon with a strong texture contrast between A horizon and B horizon. |
| | Black Vertosol – black cracking soils with shrink-swell properties and strong cracking when dry. |
| Sediment load | High suspended sediment load, common in dispersive landscapes, noted by very turbid water. |
| Riparian vegetation | Riparian vegetation has a good cover of eucalypts. Limited midstory. Groundcover consists of largely exotics. |
| In stream vegetation | Limited instream vegetation. |
| Habitat value | Limited habitat value. |

# Tributary #1

**This tributary of Parwan Creek is a steep headwater stream.** The channel is confined within steep valley sides in some sections and less confined in other sections of the reach. It is well vegetated with grasses and shrubs and there is limited evidence of erosion processes. The waterway sits largely on basalt geology which is evident with exposed basalt boulders and bedrock making it somewhat resistant to changes in hydrology in the upper section. The downstream section of the waterway traverses soils of the Werribee formation before entering Parwan Creek. No erosion was observed within the Werribee formation segment but this section of tributary 1 is vulnerable to erosion due to changes in hydrology post-development. The most downstream section of tributary 1 traverses quaternary sands and gravels, which are somewhat susceptible to erosion.

| Parameter | Steep headwater |
|---|---|
| Channel | Single, continuous channel. |
| Bank/valley sides | Channel confined by steep valley margins in the upper section of the reach graduating to less steep and confined in the lower section of the reach. Exposed bedrock and large boulders are common throughout the reach. Bank material composed of bedrock with a thin mantle of sands. |
| Bed | Typical longitudinal slope of 0.05m/m. Well vegetated, with grasses. Bed substrate is silt/sand with frequent boulders and exposed bedrock. |
| Planform | Low sinuosity channel confined by the valley margins. |
| Geology | Newer Volcanics – basalt<br>Darley Gravel – sedimentary (gravel, silt, sand)<br>Alluvium - (gravel, sand, silt). |
| Land use | Agriculture, |
| Soil type | Brown Sodosol – sodic B2 horizon with a strong texture contrast between A horizon and B horizon. |
| Sediment load | Ephemeral stream. No streamflow at the time of field inspection. |
| Riparian vegetation | Poorly vegetated riparian zone. Well grassed, mostly exotic with a lack of mid and overstory species. |
| In stream vegetation | Vegetated with grasses, largely exotic. |
| Habitat value | Limited habitat value. |

# Tributary #2

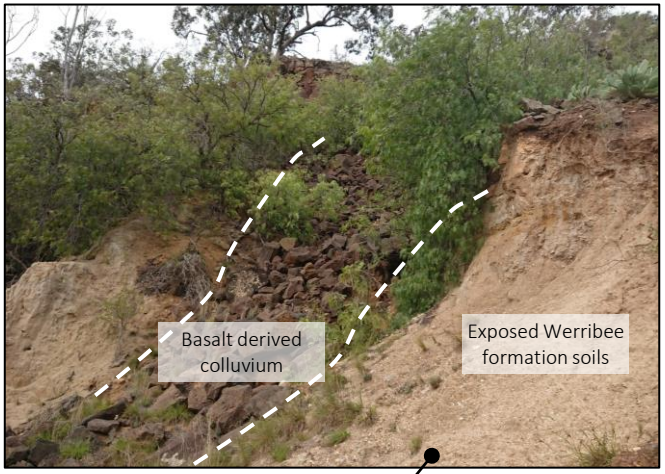
**This tributary of Parwan Creek is a steep headwater stream.** The channel is poorly defined in the upstream section, atop the plateau where it is disconnected by a series of small constructed farm dams. The channel becomes slightly better defined between Smiths Road and the edge of escarpment, after which it becomes steep over the edge of the escarpment and falls onto a relatively flat alluvial fan without a defined channel.

| Parameter | Steep headwater |
|---|---|
| Channel | Single, continuous channel. |
| Bank/valley sides | Partially confined but largely connected to the surrounding floodplain with gently sloping banks. Bank material consists of silts. |
| Bed | Typical longitudinal slope of 0.05m/m. Well vegetated, with grasses. Bed substrate is silt. |
| Planform | Low sinuosity channel, partially confined. |
| Geology | Werribee Formation – sedimentary (sand, silt, clay, gravel). |
| | Newer Volcanics – basalt |
| | Darley Gravel – sedimentary (gravel, silt, sand) |
| | Alluvium - (gravel, sand, silt). |
| Land use | Agriculture |
| Soil type | Brown Sodosol – sodic B2 horizon with a strong texture contrast between A horizon and B horizon. |
| Sediment load | Ephemeral stream. No streamflow at the time of field inspection. |
| Riparian vegetation | Poorly vegetated riparian zone. Well grassed, mostly exotic with a lack of midstory and only acattered overstory species. |
| In stream vegetation | Vegetated with grasses, largely exotic. |
| Habitat value | Limited habitat value. |

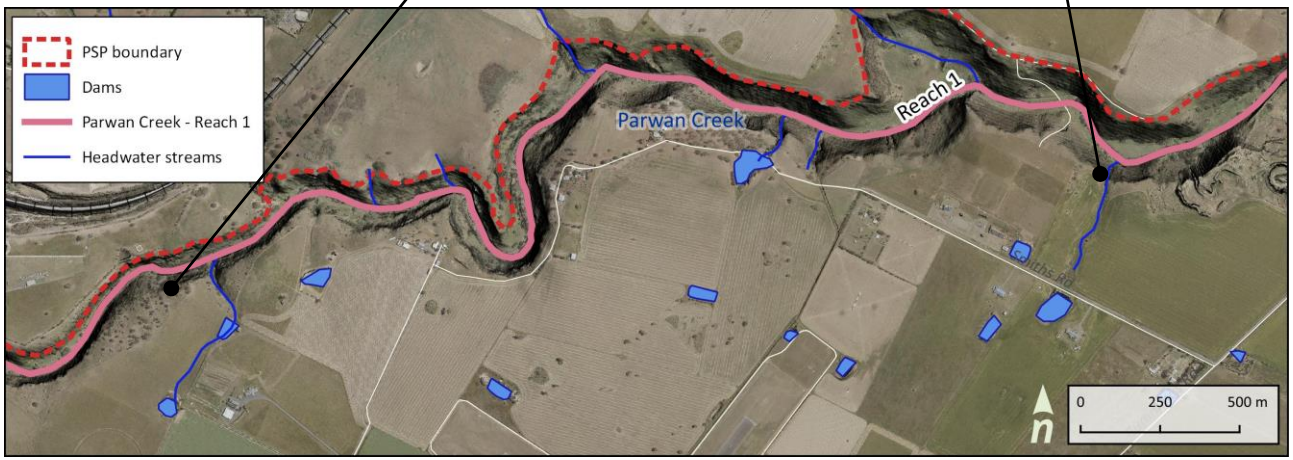
# Smaller waterways on plateau escarpment

**The small tributaries that cross the Parwan Valley escarpment to the west of the PSP area are steep headwater streams.** The channels are often poorly defined atop the plateau and several have had small farm dams constructed in their bed. These headwater stream become better defined as they approach the escarpment edge, where they have incised down and into the underlying basalt bedrock. The headwater streams form small alluvial fans at the toe of the escarpment, which overly floodplain sediment in the Parwan Valley. The bed of several of these headwater streams is mantled with colluvium derived from the basalt bedrock at the apex are covered with finer sediment, and mixture of short grasses and some large tree have established.

| Parameter | Steep headwater |
|---|---|
| Channel | Single, continuous channel. |
| Bank/valley sides | Partially confined but largely connected to the surrounding floodplain with gently sloping banks. Bank material consists of silts. |
| Bed | Typical longitudinal slope of 0.05m/m on plateau, increases to 0.43m/m on escarpment face. Bed substrate is silt on plateau, cobbles/colluvium on escarpment. |
| Planform | Low sinuosity channel, partially confined. |
| Geology | Werribee Formation – sedimentary (sand, silt, clay, gravel). |
| | Newer Volcanics – basalt |
| | Darley Gravel – sedimentary (gravel, silt, sand) |
| | Alluvium - (gravel, sand, silt). |
| Land use | Agriculture |
| Soil type | Brown Sodosol – sodic B2 horizon with a strong texture contrast between A horizon and B horizon. |
| Sediment load | Ephemeral stream. No streamflow at the time of field inspection. |
| Riparian vegetation | Absent |
| In stream vegetation | Vegetated with pasture grasses on upper slope, bare soil on lower slopes. |
| Habitat value | Limited habitat value. |



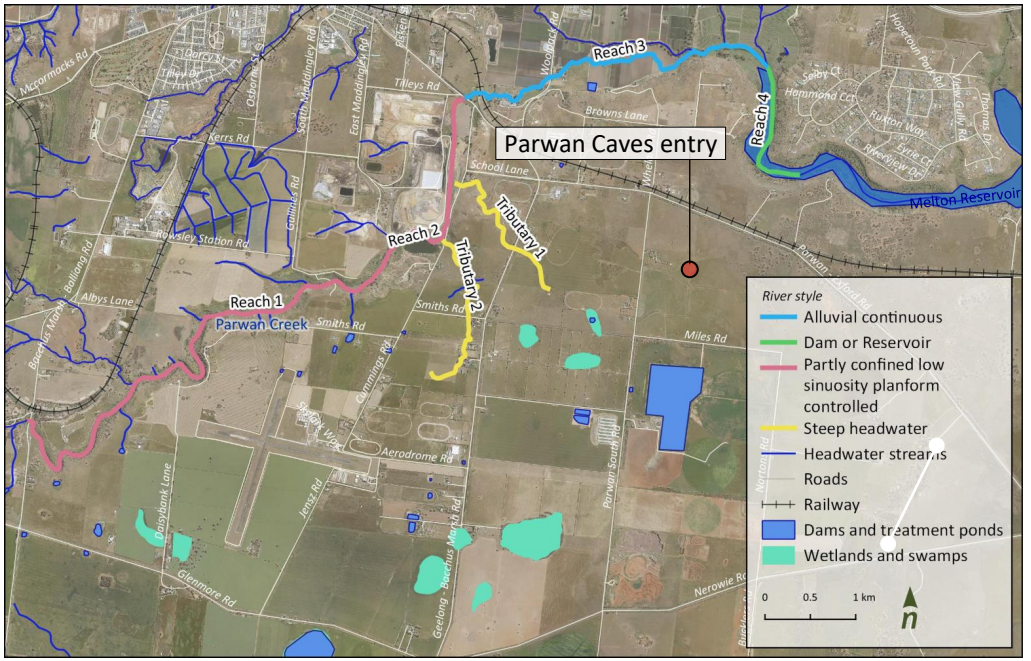




# Parwan Caves

**The Parwan caves** are the only recognised site of geomorphic significance within the study area. There are few lava caves in Victoria and the Parwan cave is the only one known on the Werribee Plains. The caves formed when the basalts of the Newer Volcanics in the study area were laid down. The caves are a lava tube with a partially collapsed roof that forms the cave entrance. The Parwan Caves formed when the outer surface of the lava flow cooled and solidified to a hard crust surrounding a still liquid interior. The interior likely drained through a breach in the solid crust, leaving an elongated hollow interior or lava tunnel.

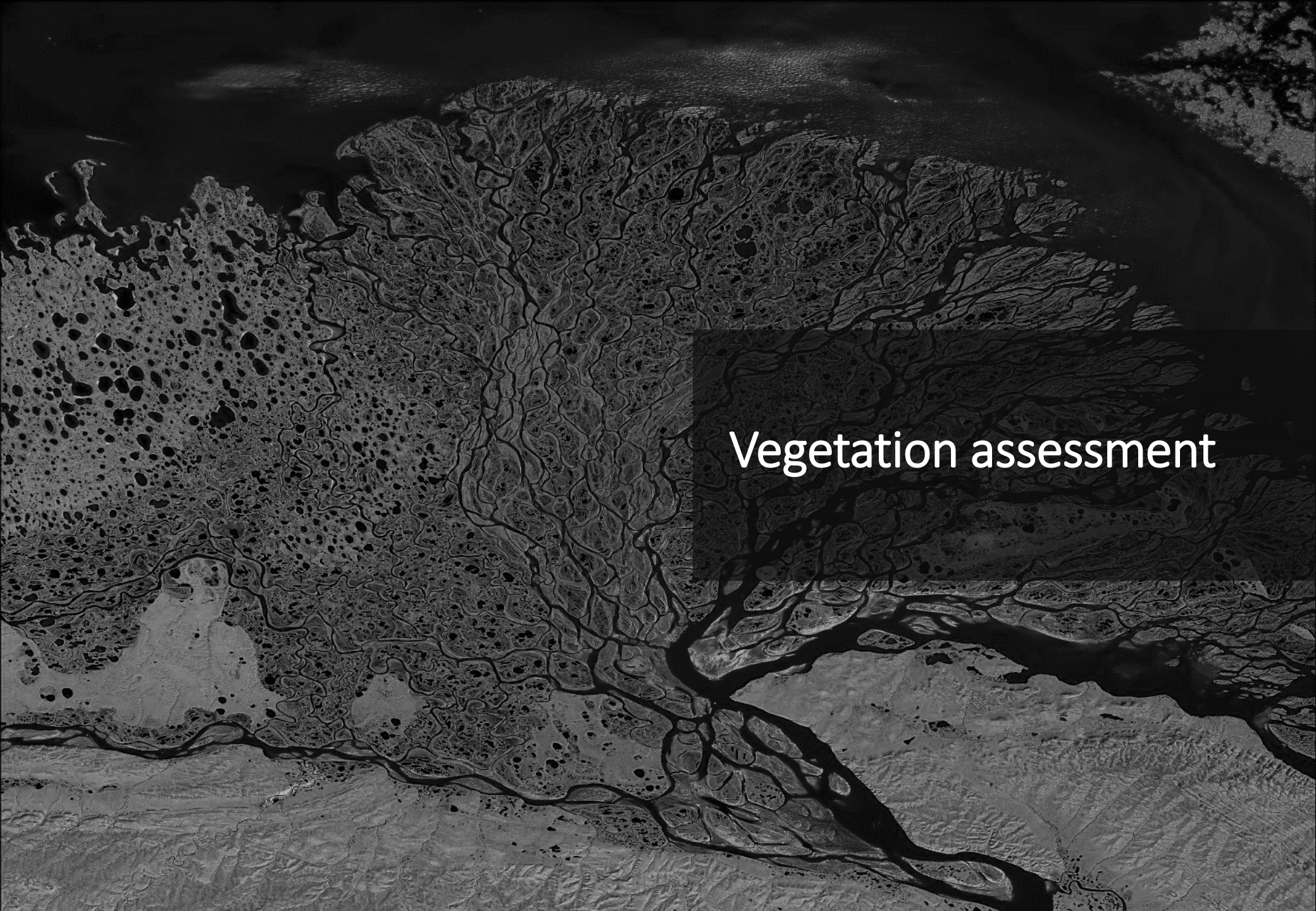
The only surface expression of the caves is a small entrance (~ 1.5 m wide) that is partially obscured be vegetation. The caves lie at a depth of approximately 3m below ground level and are approximately 150 m long and extend in a NE-SW direction. A small ephemeral stream runs along the cave bed for 20 – 40 m either side of the entrance, however no water bodies of ephemeral waterways are mapped within the vicinity of the caves, so the source of water is unknown.. The cave also hosts mounds of phosphate concentrations derived from bat droppings. In these, a previously undescribed magnesium aluminium phosphate mineral (Parwanite) has been recognised. Several large basalt blocks have collapsed from the roof and are scattered on the cave floor, preventing access to the entire system. Whether the caves form part of a larger network or are a single gentility is unknown.




## Possible caves in the Newer Volcanic Group

Although the Parwan Caves are the only known instance of lave tubes in the study area, other caves may have formed within the Newer Volcanics on the plateau. The caves are structural, not erosional, features and therefore are not especially sensitive to changes in surface hydrology following development. The presence of caves beneath the plateau does poses some risk to public safety due to the small opening, and some risk to overlying structures, especially those which are large or require deep and widespread excavation during construction. The lack of surface expression of the lave tube caves means that identifying new caves, or any extensions to the existing Parwan Caves would require geophysical data collection and interpretation. Possible methods include the use of ground penetrating radar, or gravity surveys using airborne instruments. The presence of caves within the study area has the potential to impact on development of the area

Public open space may be a suitable means of preserving the caves, but the area above the caves would need to be carefully managed to ensure public safety is maintained at the narrow opening.


Vegetation assessment

# Vegetation assessment; Methodology

**Desktop assessment.** A desktop review was conducted prior to field work. The Victorian Biodiversity Atlas (VBA) and NaturePrint were referred to as primary data sources. The review was conducted to highlight significant species, communities and overall flora diversity. This provided an historical insight to build a picture of how the flora has changed over time. A review of Melbourne Waters Healthy Waterways Strategy (HWS) and current assessment of vegetation condition was also conducted.

Given the sites geology and the significance of remnant vegetation on the Victorian Volcanic Plain bioregion there was an expectation that significant species and or communities would be identified. In addition, rainfall in the first six months of 2021 was significantly higher than average with 350mm of rain recorded from January 1 to June 30 compared to the long term average of 216mm for the first half of the year (2000-2020). This higher than average rainfall increased the likelihood of some wetland sites being partially inundated.

**Limitations.** This assessment applies to riparian and wetland areas only (see map in the next page). A comprehensive inventory of flora was not undertaken as this assessment was intended to provide an overview of values which can be used as a basis to conduct further detailed assessments. In particular grassland and grassy woodland values of the study area should be subject to further assessment.

Previous studies (largely to the south east of the assessment area) have identified areas of grassland as well as individual scattered tress of conservation significance which have been identified and recorded.

A number of areas were not accessed as permission was not given by landowners or they could not be contacted These sites were reviewed via desktop but require further review particular in the case of remnant wetland sites and those with potential to contain Seasonal Herbaceous Wetlands.

**Mapping and data templates** This study drew upon MWs *Inventory of values and threats* methodology. This methodology was developed to build a consistent approach to vegetation assessment on waterways. The standard application of this method assigns plots of anywhere between 100-500m length along a waterway for assessment. However in this survey the size of assessment areas was extended. The following features were identified as points to demarcate survey reaches

- Changes in parent soil material,
- Differences in vegetation condition
- Confluences with tributaries
- Assets such as bridges culverts or boundary fences as to reflect the character of a waterway.

Exotic species of management concern (i.e. those species which are a high threat to waterway function and riparian biodiversity) were recorded. Also noted was the presence of species which were of low management priority i.e. those that had little biodiversity or waterway function impact. Population attributes including location, extent of infestation and threat to native vegetation were recorded based upon Melbourne Water's template for assessing values and threats.

**Melbourne Water Vegetation Visions templates** Alluvium assessed vegetation quality using Melbourne Waters 5 Vegetation Visions categories as listed below.

| | |
|---|---|
| 1 | Very low |
| 2 | Low |
| 3 | Medium |
| 4 | High |
| 5 | Very high |

No vegetation of high or very high condition was observed. Most vegetation was low or very low quality.

**Wetlands.** In addition to mapping riparian vegetation quality we also reviewed the presence of natural wetlands as these features are a priority listed in the Healthy Waterways Strategy and may be hydrologically impacted by future drainage response . A detailed Index of Wetland Condition (IWC) was not conducted due to time constraints, however our assessment can be used as a guide to determine which wetland sites are likely to be of higher quality if a full IWC was conducted.

# Vegetation assessment; Methodology

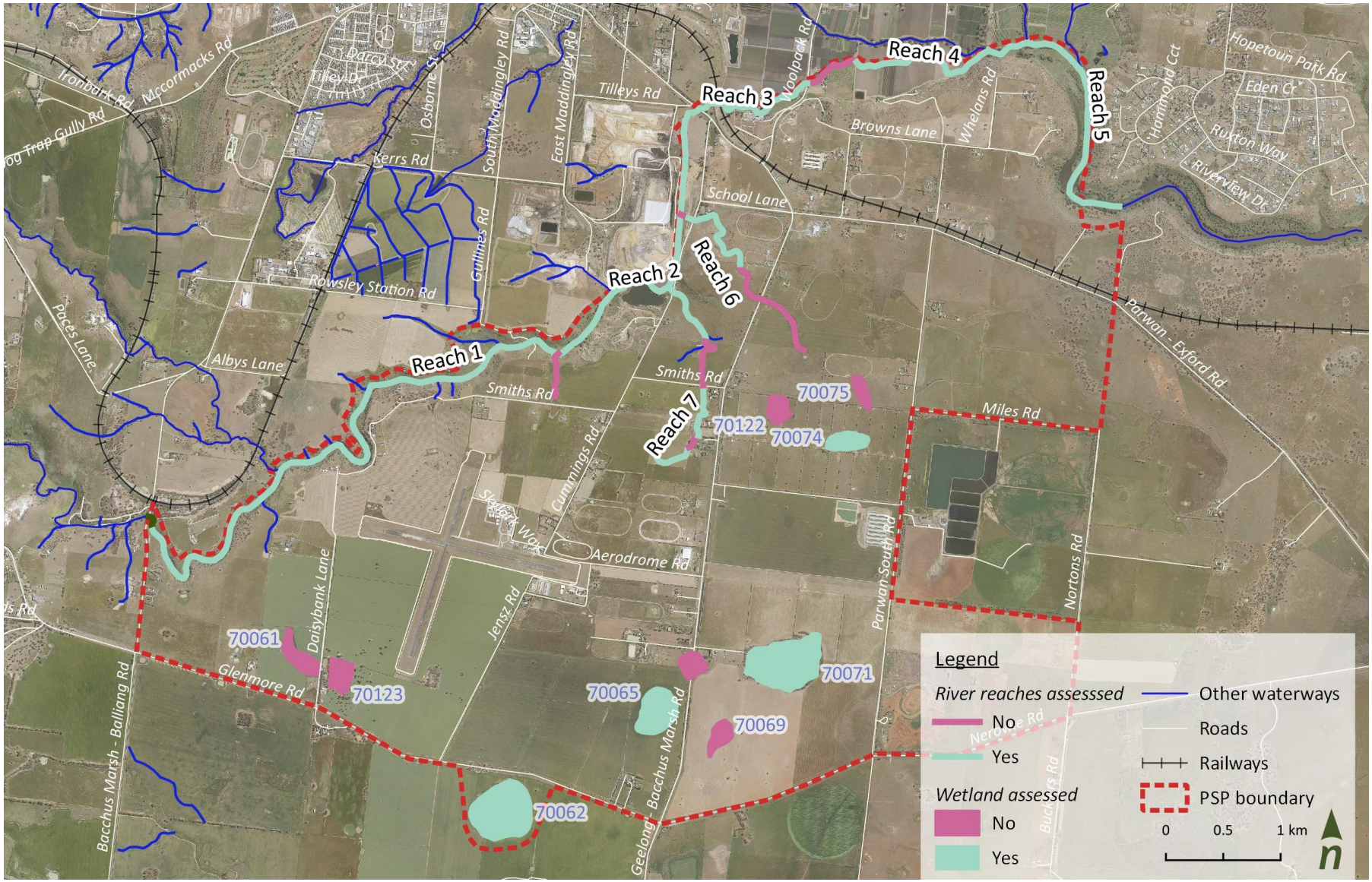
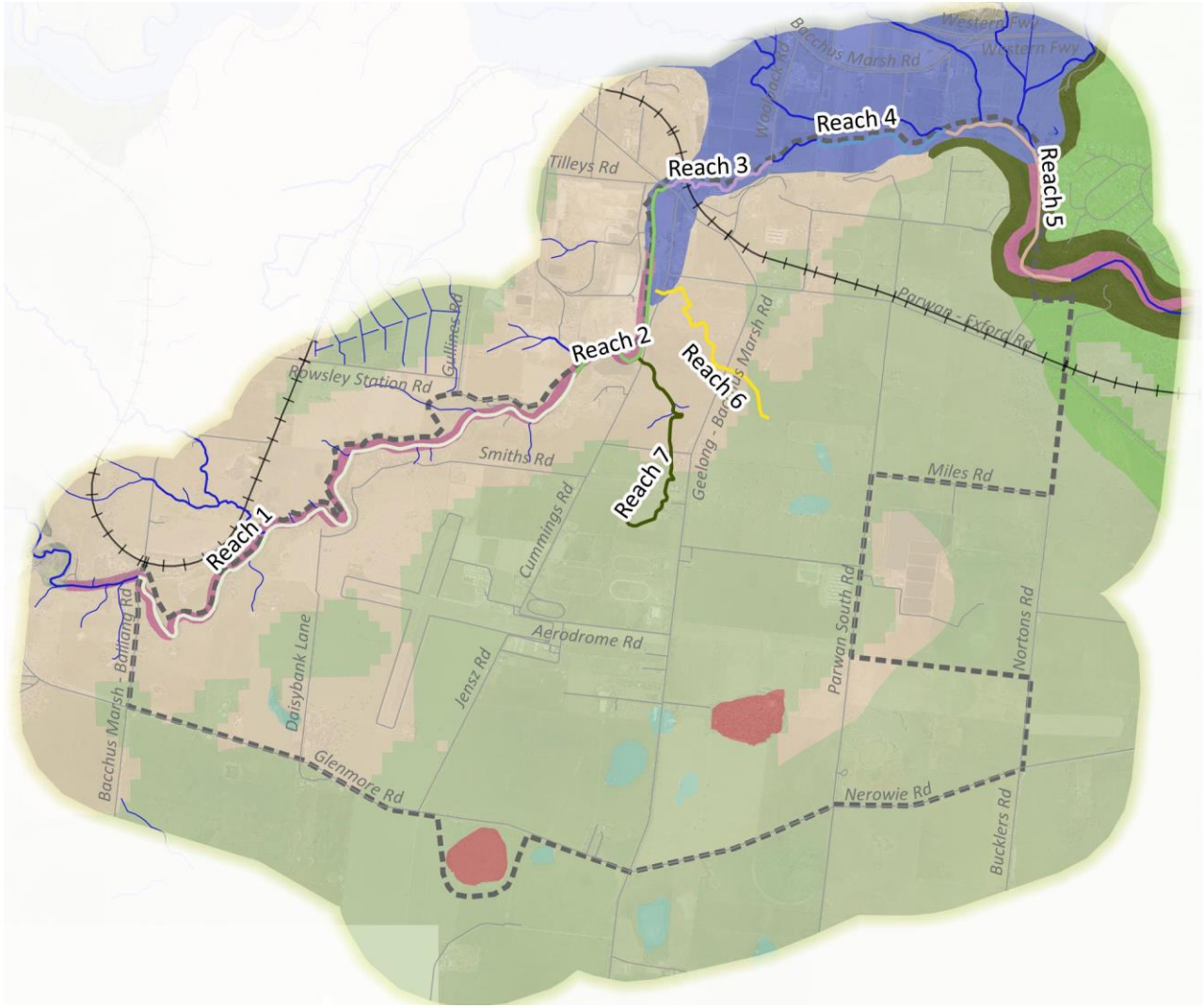



**Figure 10**. *Locations assessed and those unable to be accessed.*

# Ecological Vegetation Classes; Benchmark mapped from Nature Kit




Note that the conservation status of all 8 vegetation communities identified in the study area is listed as Endangered. This is unsurprising considering the extent of clearance of vegetation across the Victorian Volcanic Plains bioregion. In effect all remnant vegetation is of significance within the study area. However as will be described in the following section of this report nearly all areas where remnant vegetation was detected has a high to very high diversity and abundance of exotic vegetation.

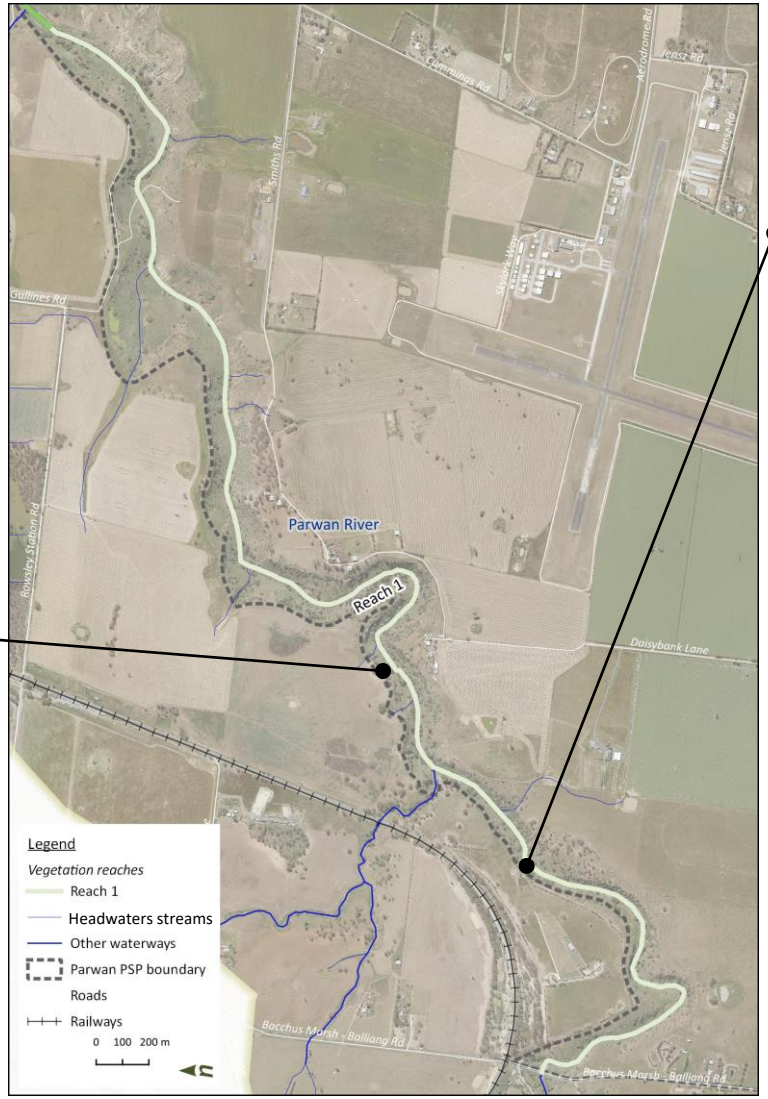
**Figure 11**. *EVC benchmarks.*

# EVCs observed; Reach 1 Creekline Grassy Woodland and Escarpment Shrubland

Reach 1 comprises of EVC 68 Creekline Grassy Woodland. We recorded 88 species, 41 native species and 47 exotic species on Reach 1. It is of high conservation value, listed as Endangered, however it is in poor condition. The coverage of exotic species is clearly greater than that of indigenous species on this reach even though there is not a substantial difference in species richness.

*Rhagodia parabolica* Fragrant Saltbush and *Allocasuarina luehmannii* Buloke are listed as Vulnerable and Endangered respectively under the Victorian Advisory List. 17 of the weed species observed are classified under the CALP Act.

This reach has a discontinuous native overstorey as would be expected in a woodland community comprising mostly of *Eucalyptus camaldulensis* River Red-gum. It occurs at up to 25% cover in some patches along the waterway and floodplain. Some of which are very large with numerous hollows and of very high habitat value. Some possible scar trees observed which deserve further cultural assessment. *Eucalyptus melliodora* Yellow Box and *Eucalyptus macrocarpa* Grey Box occurs on slopes and escarpments to 5% cover.




*Acacia melanoxylon* Blackwood, *Bursaria spinosa subsp. spinosa var. spinosa* Sweet Bursaria, *Casuarina glauca* Swamp Oak (which is planted) and *Allocasuarina luehmannii* Buloke are also present in isolated patches up to a maximum cover of 5%.

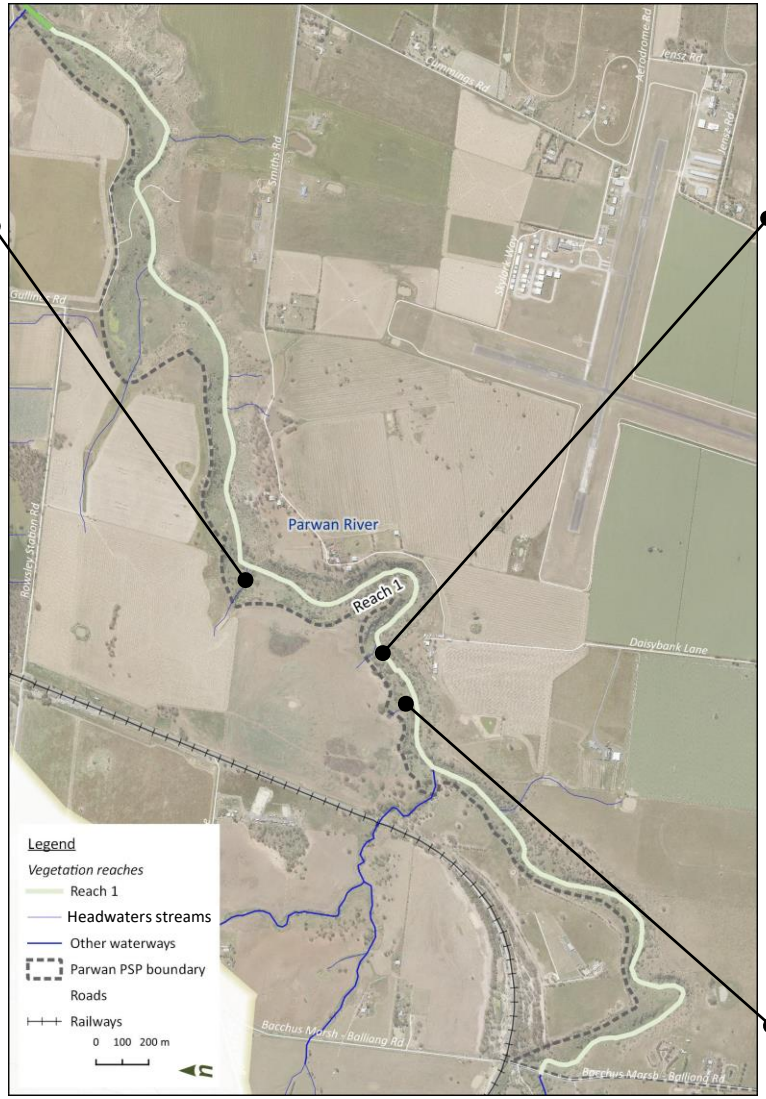
Exotic overstorey species are present at low overall abundance, however isolated patches of *Ulmus procera* English Elm and stands of *Schinus molle* Peppercorn (up to 25% cover and in an isolated patch up to 50% cover)

Mid-storey vegetation is predominantly exotic. Native mid-storey up to 5% cover with species such as *Solanum aviculare* Kangaroo Apple and *Duma florulenta* Lignum occurs in small limited patches. The population *of S. aviculare* is transient and not expected to remain long-term, However *D. florulenta* is an established patch that is likely taking advantage of seasonal seepage and has so far been able to resist exotic species incursion.

# EVCs observed; Reach 1 Creekline Grassy Woodland and Escarpment Shrubland

Mid-storey exotic species are common with up to 25% of weed cover over extensive areas. Patches of 50-75% exotic mid-storey were observed. Dominant species present include: *Lycium ferocissimum* Boxthorn, *Agave spp* Agave., *Asparagus asparagoides* Bridal Creeper with stands of *Tamarix ramosissima* and *Crataegus monogyna* Hawthorn. Small patches of large old *Opuntia stricta* Common Prickly-pear were observed this species was also observed as a groundcover dominant.

Ground-storey vegetation is dominated by exotic species on both banks, with up to 75% weed cover in many areas. Dominant species are *Nassella trichotoma* Serrated Tussock consistent across the left bank and continuing presence (and also in large patches) of *Opuntia spp.*, *Opuntia stricta* and *Aloe maculate* predominantly on the north-facing right bank. *Galenia pubescens var. pubescens* Galenia was observed throughout the reach at up to 25-50% coverage especially on exposed steep banks.

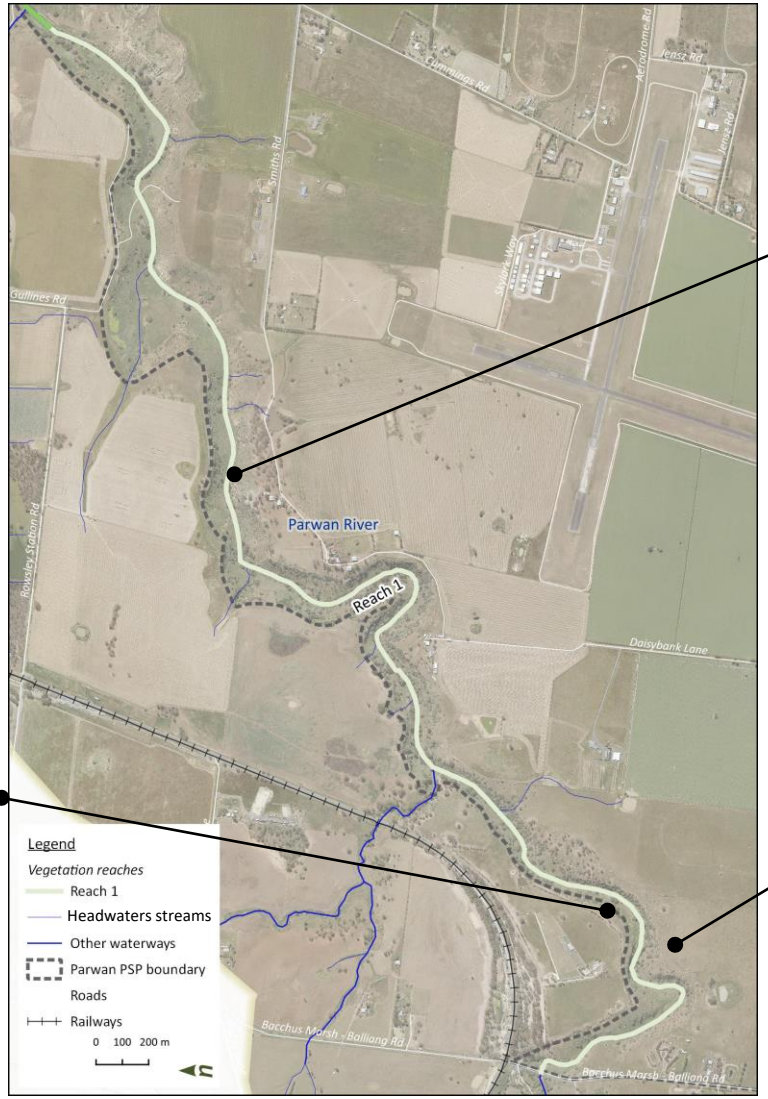



Native ground-storey was limited in diversity and abundance. *Clematis microphylla s.l.* Small Leaf Clematis*, Einadia nutans* Nodding Saltbush *and Rhagodia parabolica* Fragrant Saltbush were observed at up to 5% coverage. Limited coverage of native grass species including *Austrostipa sp* Spear Grass, *Themeda triandra* Kangaroo Grass *and Rytidosperma spp.* Wallaby Grass were recorded at <5% coverage. Rabbits were grazing fiercely on these grass species.

# EVCs observed; Reach 1 Creekline Grassy Woodland and Escarpment Shrubland

The channel and wetted edges of the Parwan has a relatively dense coverage of vegetation largely due to the extent of silty debris covering cobbles on the bed of the waterway. It is unlikely that the bed of the channel would have had such extensive vegetation coverage prior to disturbance in the upper part of the Parwan catchment where hillside erosion has liberate vast quantities of material that have partiallyy settled and consolidated in the bed of the waterway.

Vegetation occurred at up to 50% cover comprising of native and exotic species. *Phragmites australis Phragmites*, is the dominant native species in the bed of the waterway. Exotic species including *Phalaris aquatica* Phalaris and *Juncus acutus subsp. acutus* Spiny Rush were dominant.



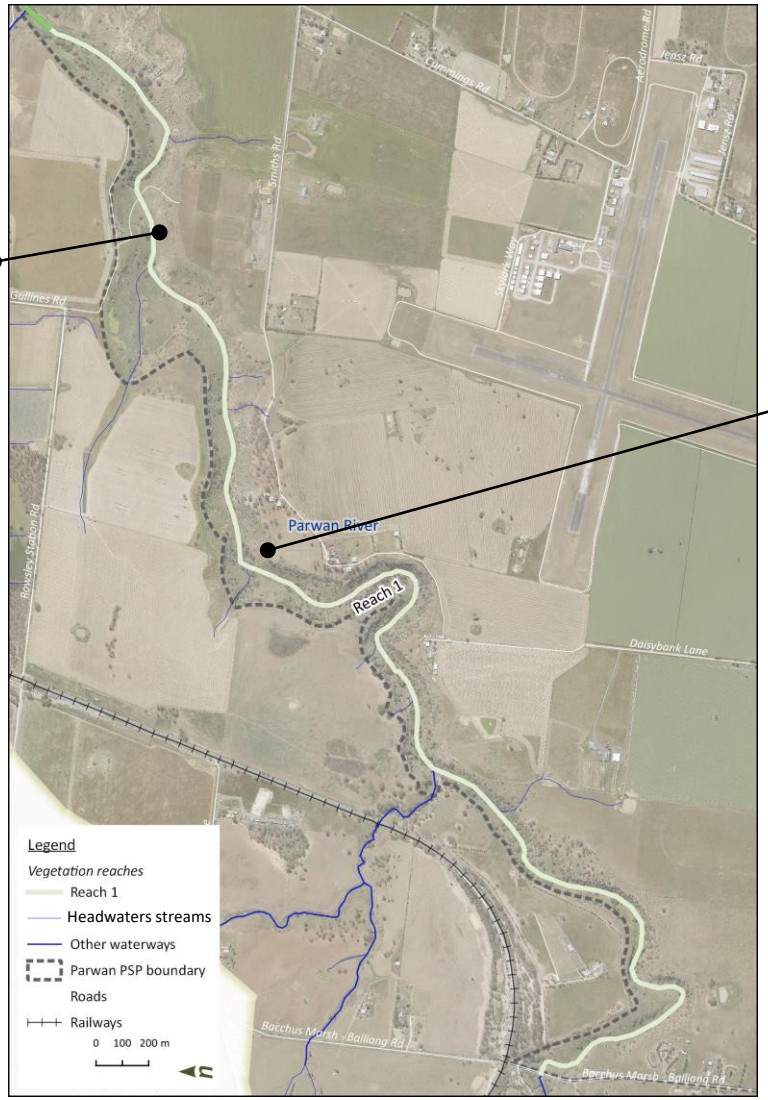

Other frequently encountered species included *Plantago lanceolata*, Ribwort and *Thinopyrum ponticum* Tall Wheat Grass. The later being a salt tolerant species. *Nassella trichotoma* Serrated Tussock formed extensive swathes on floodplain flats'.

# EVCs observed; Reach 1 Creekline Grassy Woodland and Escarpment Shrubland

A clear pattern of the dominance of *Nassella trichotoma* Serrated Tussock with *Lycium ferocissimum* Boxthorn and *Crataegus monogyna* Hawthorn on sheltered slopes was observed. *Galenia pubescens var. pubescens* Galenia and Opuntia sp. dominated on exposed slopes (see above).

Reach 1 is in low/poor condition overall with an abundance of exotic species outcompeting native species. It appears that rabbits are a major factor in reducing the coverage of palatable native species which simultaneously allowing less palatable exotic species to establish and thrive. Exotic species such as *Opuntia sp.* are also providing ample coverage for rabbits to shelter.

The ongoing dominance and potential expansion of exotic species is anticipated unless rabbits are managed at a landscape scale. The impact of climate change is likely to further facilitate the dominance of unpalatable succulent species.

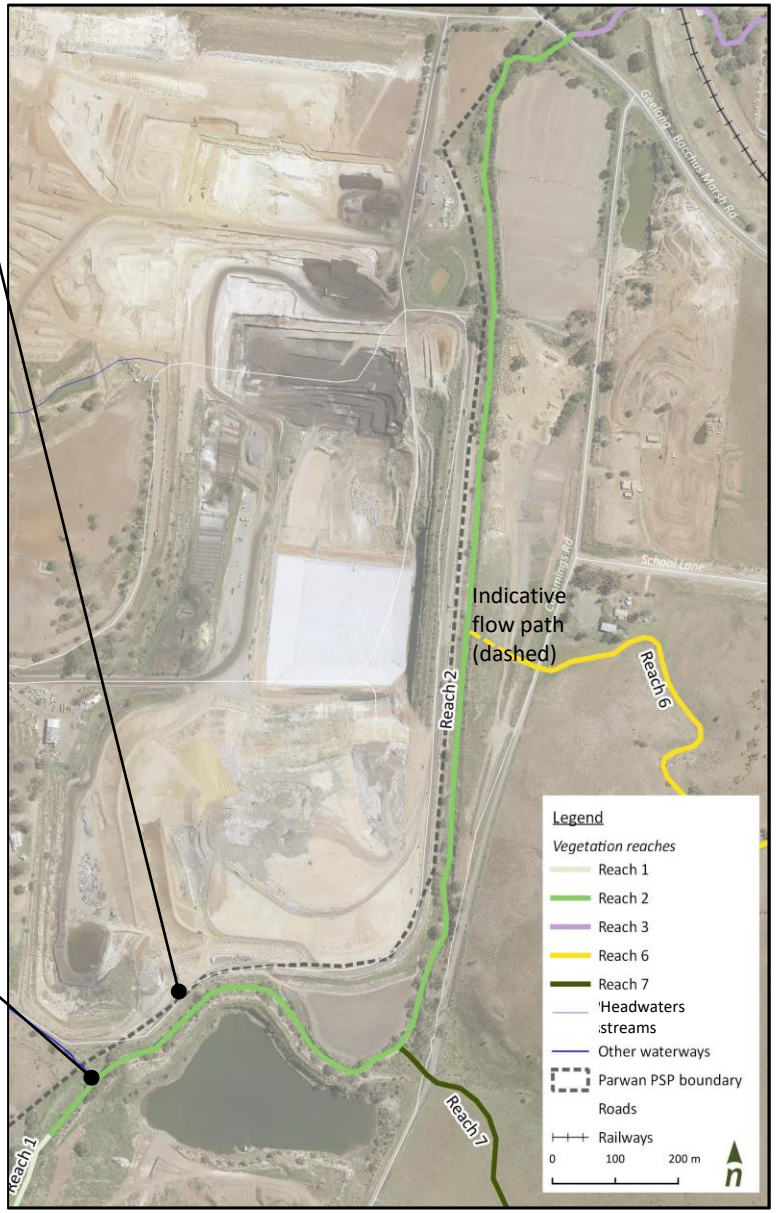



Fringes of scattered native species including trees such as *Allocasuarina luehmannii* Buloke, *Eucalyptus melliodora* Yellow Box and *Eucalyptus macrocarpa* were observed on escarpments with *Eucalyptus camaldulensis* River Red-gum along the waterway and floodplain. Novel 'communities' with dominant succulent species (e.g. *Agave spp.*) are a feature of the reach. Substantial prolonged effort and high resource inputs would be required to improve the condition of vegetation.

# EVCs observed; Reach 2 Creekline Grassy Woodland and Escarpment Shrubland

The vegetation of reach 2 is in very poor condition overall with a high abundance of exotic species. 37 species were recorded comprising 22 exotic species and 15 native species.

This reach begins at a point in the landscape notable for the extensive deposition of fill over the former escarpment shrubland. The Parwan is then formed into a narrow perched channel with degraded Creekline Grassy Woodland engulfed by quarried land to the north and south.




The Parwan then turns north before becoming a gun-barrel straight waterway devoid of its former sinuosity and niche diversity. Few remnants have survived to tell the story of the ancestral distribution of vegetation through this reach. The dominance of exotic species over native species is compounded by extensive fill deposition, siltation, and the re-construction of the channel through quarried land resulting in an almost entirely altered landscape. Furthermore, the impact of rabbit browsing has resulted in loss of native vegetation. Creekline Grassy Woodland (EVC68) Escarpment Shrubland (EVC 895) and Red Gum Swamp (EVC 292) are mapped for this reach. Of these communities only Creekline Grassy Woodland is identifiable. Escarpment shrubland has been largely replaced by exotic vegetation and has been smothered by extensive areas of fill.

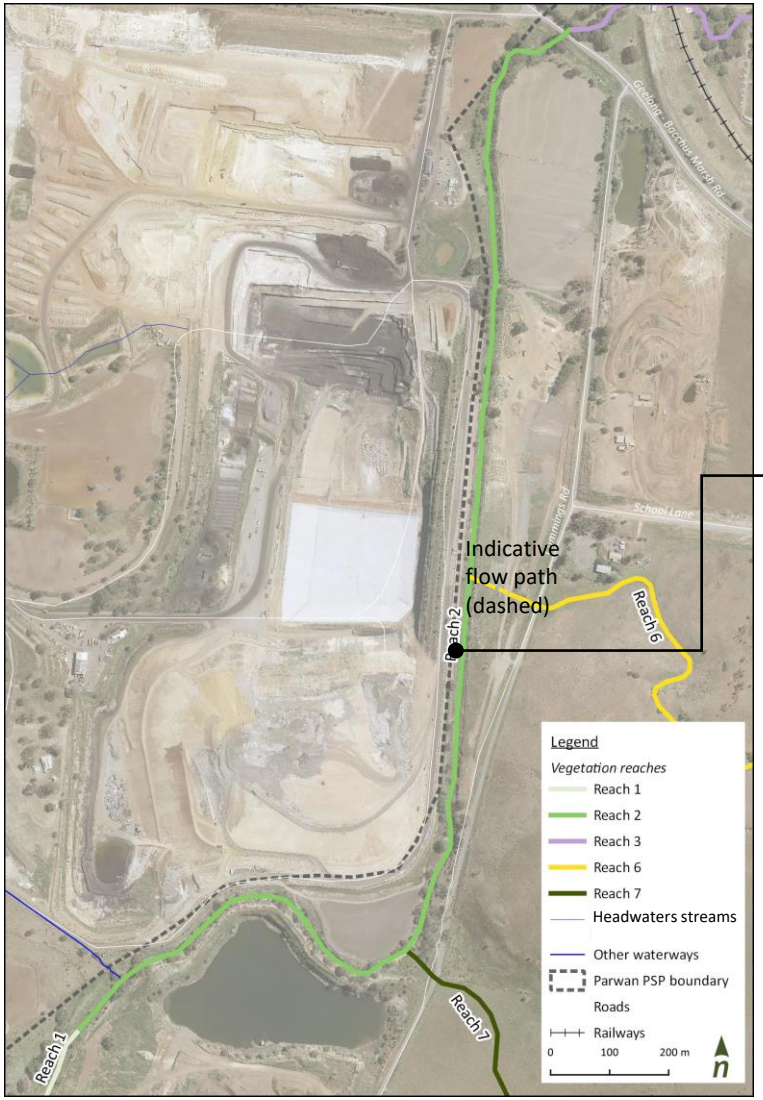
Red Gum Swamp (EVC 292) has been displaced due to the extensive lowering of the waterway resulting in drainage that prevents the formation of swampy vegetation. A range of terrestrial species occupies the fringing drier portions of the waterway. A degraded example of Red Gum Swamp (EVC 292) is partially recognisable further downstream where the Werribee River floodplain begins to influence hydrology and hence making it more suitable for swampy vegetation to persist.

The adjacent road and landfill severely constrain opportunities to re-instate a more natural waterway. Substantial resources would be required to re-shape the waterway supported by ongoing vegetation management for the next 10-20 years.

# EVCs observed; Reach 2 Creekline Grassy Woodland and Escarpment Shrubland

As with Reach 1 we observed high coverage of exotic species with fewer native species however native overstorey is well represented occurring at 25-50% coverage. *Eucalyptus camaldulensis* River Red-gum is the dominant species. This overstorey species is well established with a range of age classes within the reach and evidence of recent recruitment. It is the only native species that appears to be relatively abundant and unlikely to be lost form the system at any stage.

Other native overstorey species included *Acacia implexa* Lightwood, *Eucalyptus melliodora* Yellow Box and *Eucalyptus viminalis,* Manna Gun occur at <5% coverage. *Acacia implexa* Lightwood and *Eucalyptus melliodora* Yellow Box are long lived and likely to remain, however the conditions may be unfavourable for *Eucalyptus viminalis,* Manna Gun occur as the climate continues to dry



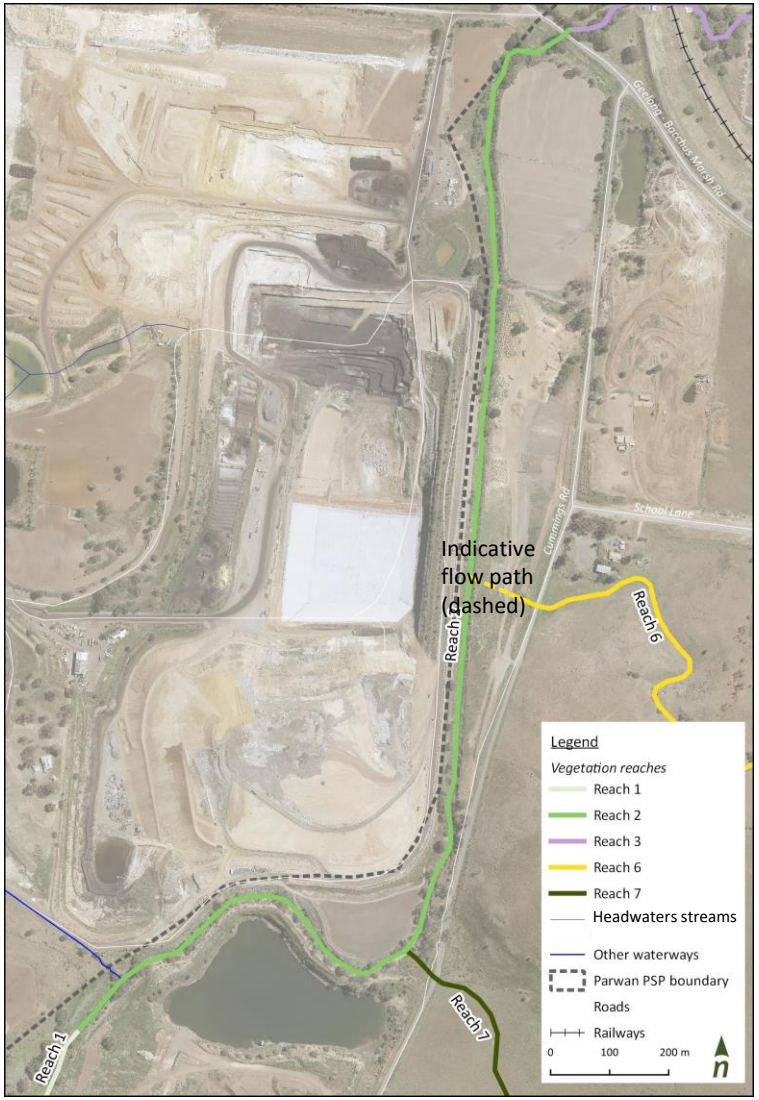

*Schinus molle,* Peppercorn is the dominant exotic overstorey species occurring at up to 25% coverage. This species was observed as mature trees, juvenile specimens that were multi stemmed mid-storey plants as well as recent recruits that were not yet mature. It occurs throughout the reach along the margins of the Parwan and is successfully established in escarpment environments.

# EVCs observed; Reach 2 Creekline Grassy Woodland and Escarpment Shrubland

Mid-storey species diversity is dominated by exotic species with *Lycium ferocissimum* African Box-thorn *Opuntia stricta* Common Prickly-pear *Opuntia puberula* Blind Prickly-pear occurring at up to 25% coverage.

*Lycium ferocissimum* African Box-thorn occurred throughout the reach typically on steep slopes with *Opuntia sp.* Being much more common in the upstream portion of the reach between the quarry lake and current fill site. *Opuntia sp.* Were far less abundant in the straight section of reach 2.

Juvenile *Schinus molle,* Peppercorn were also abundant throughout the reach contributing to mid-storey biomass especially through out the straightened section of the Parwan although this species was less abundant than *Lycium ferocissimum* African Box-thorn



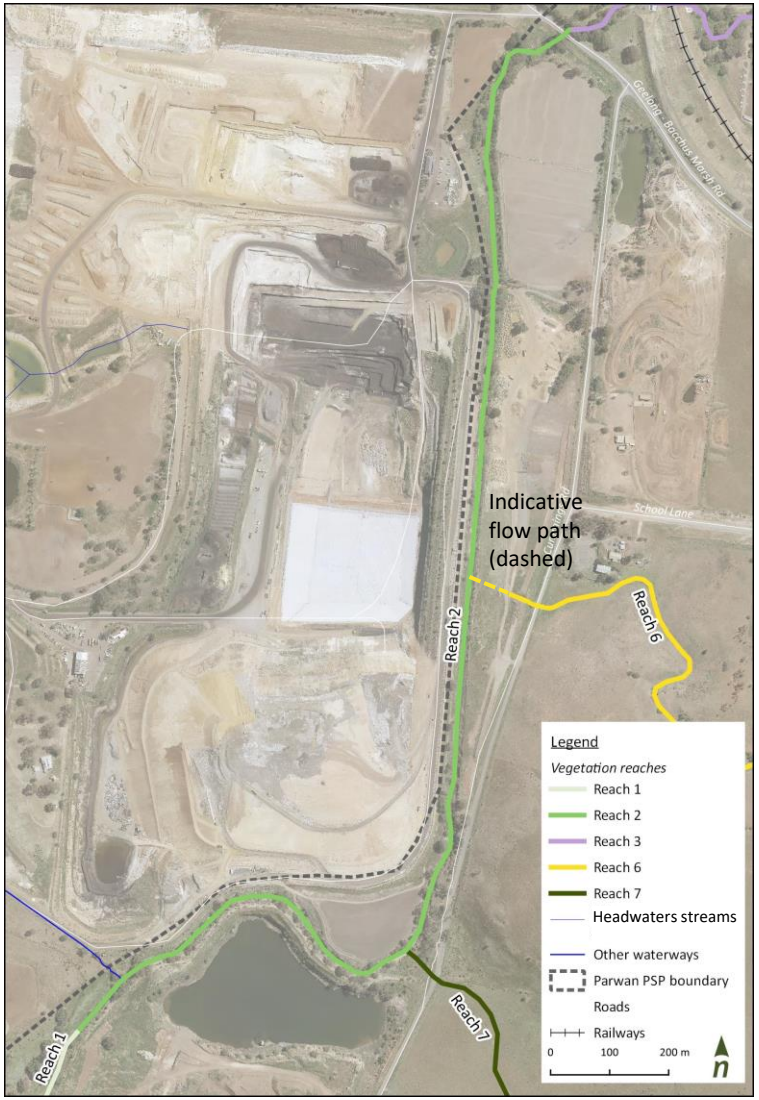

Mid-storey native species were limited to a minor occurrence of *Maireana enchylaenoides* Wingless Bluebush and a small patch of *Rhagodia parabolica* Fragrant Saltbush in tiny portion of relatively diverse vegetation. The surprising lack of diversity of native species may be explained by the disturbance history of the site and the apparent lack of revegetation. The diversion of the waterway during the construction of the quarry, re-location of the Parwan in an area that was not likely to be a waterway and the lack of exotic species control may explain the near absence of native mid-storey. More detailed assessment may reveal the presence of additional mid-storey species.

There is a clear opportunity for improvement with the addition of typical EVC appropriate mid-storey species of the region such as *Acacia mearnsii* Black Wattle *Bursaria spinosa* Sweet Bursaria, *Enchylaena tomentosa var. tomentosa* Ruby Saltbush and *Melicytus dentata s.l.* Tree Violet.

# EVCs observed; Reach 2 Creekline Grassy Woodland and Escarpment Shrubland

Vegetation cover within the channel of reach 2 is highly variable. The upper portion of the reach where there are some patches of cobble still evident retains the greatest range of niches. Native species such as *Bolboschoenus caldwelii* Marsh Club-rush were recorded at up to 25% cover in small patches. Surprisingly *Phragmites australis* Common Reed was recorded at less than 5% coverage, although it would be expected that this species may increase and fluctuate seasonally.

As would be expected exotic species, namely *Juncus acutus subsp. acutus* Spiny Rush and *Phalaris aquatica* Toowoomba Canary-grass were dominant. These species were recorded at up to 25% coverage. As with reach 1 it is unlikely that the bed of the channel would have had such extensive vegetation coverage prior to disturbance in the upper part of the Parwan catchment.




*Galenia pubescens var. pubescens* Galenia and *Nassella trichotoma* Serrated Tussock occupy extensive areas on the adjoining floodplain with coverage of up to 50% across large areas in the upper part of reach 2. *Phalaris aquatica* Toowoomba Canary-grass increases in abundance to occupy up to 25% cover in the lower portions of reach 2.

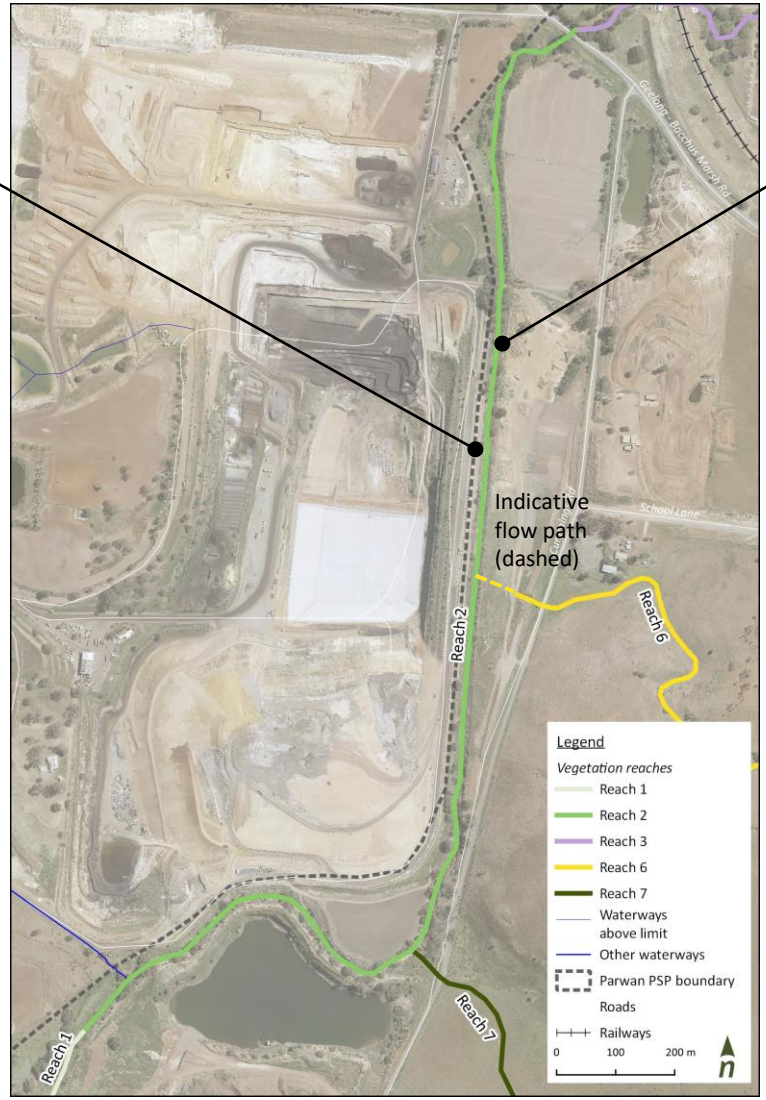
Native ground cover species are greatly reduced throughout the reach with less than 1% cover of the following species observed. *Austrostipa sp* Spear Grass, *Carpobrotus spp.* Pigface *Clematis microphylla* Small-leaved Clematis, *Duma florulenta* Lignum and *Rytidosperma spp.* Wallaby Grass

A small patch of remnant vegetation with additional herbaceous groundcover species was detected with further detailed provided in the closing description of reach 2.

# EVCs observed; Reach 2 Creekline Grassy Woodland and Escarpment Shrubland

Vegetation cover within the channel along the southern portion of reach 2 is very sparse in some areas. Extensive areas of fine sediment mudflat were observed with cover of exotic species ranging from 0% to up to 25%. Exotic species namely *Juncus acutus subsp. acutus* Spiny Rush and *Phalaris aquatica* Toowoomba Canary-grass were dominant on the margins of these locations and may have the capacity to establish on these flats if substrate and hydrological factors are suitable.

Colonisation by *Eucalyptus camaldulensis* River Red-gum and *Schinus molle,* Peppercorn was observed at the margins of the bed of the waterway at low frequency. These may become the dominant cover for this portion of reach 2 as time progresses although there is only 3-5m of bank on the west side wit a high fence between the waterway and a large haul road limiting the space for future vegetation establishment.




A range of additional exotic ground-cover species were observed in the southern portion of reach 2. As with upstream locations *Phalaris aquatica* Toowoomba Canary-grass is dominant with thistle species including *Cirsium vulgare* Spear Thistle and *Cynara cardunculus subsp. flavescens* Artichoke Thistle observed at up to 5% cover. Also occurring at low frequency throughout this portion are *Agave spp.* Agave, *Asparagus asparagoides* Bridal Creeper *Arctotheca calendula* Cape Weed, *Foeniculum vulgare* Fennel and *Oxalis pes-caprae* Soursob. Many of these species will fluctuate seasonally and it would be expected that their cover would increase in late spring and early summer with reductions in autumn and winter.

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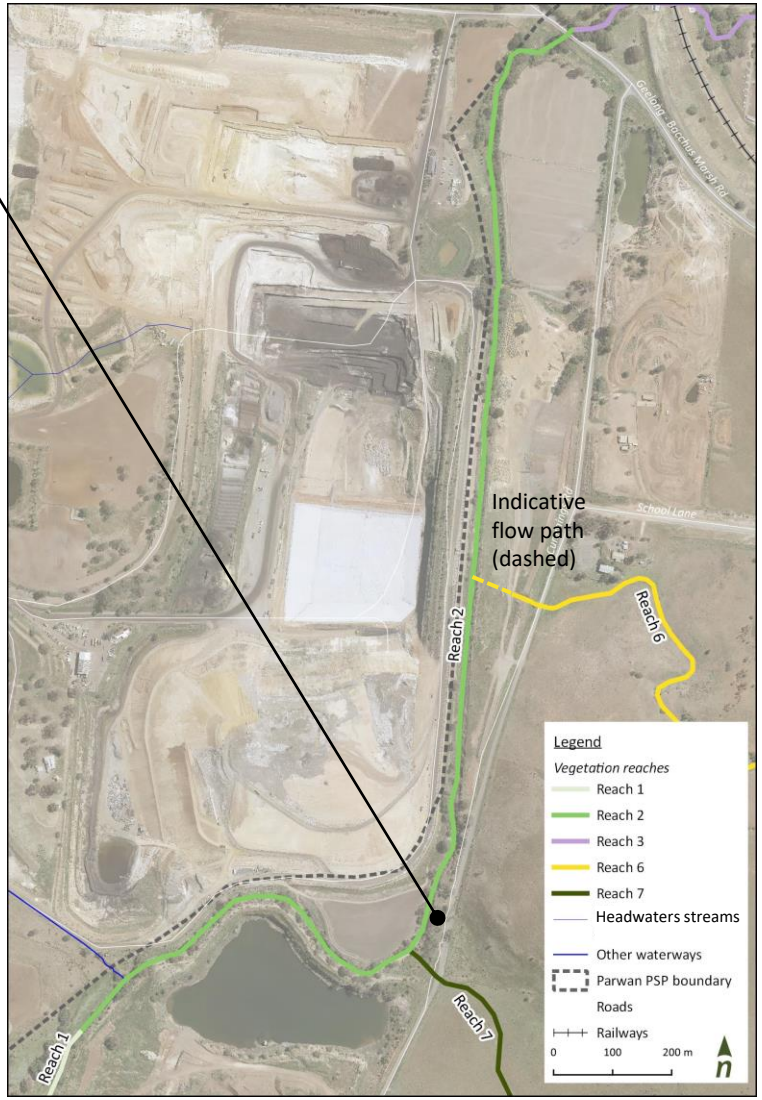
# EVCs observed; Reach 2 Creekline Grassy Woodland and Escarpment Shrubland

Amongst the highly altered vegetation and channel form of reach 2 a tiny pocket of remnant vegetation provides a glimpse of the formerly extensive vegetation community of the region. This small patch of less than 1000m2 contains an overstorey of remnant *Eucalyptus camaldulensis* River Red-gum over *Rhagodia parabolica* Fragrant Saltbush in tiny portion of relatively diverse vegetation.

The ground-storey contains a number of small herbaceous species not observed in areas where extensive fill and soil movement has taken place. There appears to be a surprising lack of browsing pressure by rabbits. Lichens, moss and leaf litter are present as would be expected in areas of more intact vegetation.

*Nassella trichotoma* Serrated Tussock presents an immediate threat to this small patch of remnant vegetation occurring at up to 75% cover over the majority of the patch.

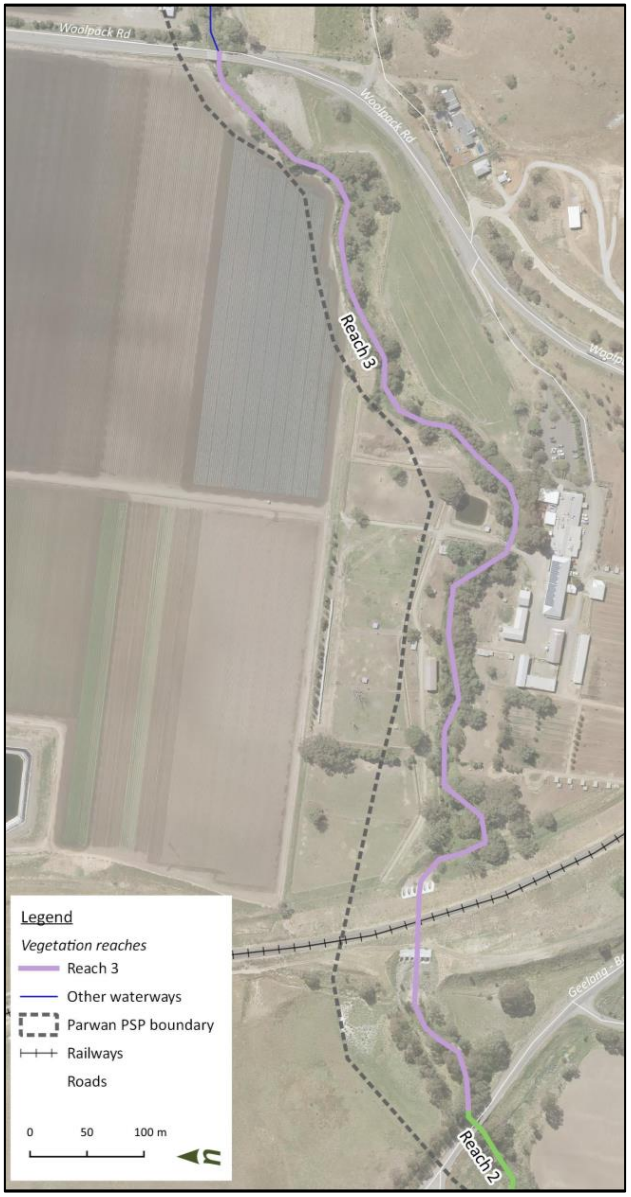



*Glycine clandestine* Twining Glycine *Dichondra repens* Kidneyweed and *Dianella sp.* Were observed. Insufficient material was available to confirm the identification of this Dianella sp., however *Dianella longifolia var. grandis, which is critically endangered,* should not be ruled out. Further assessment and collection is warranted.

# Vegetation observed; Reach 3 degraded EVC 292, Red Gum Swamp

The vegetation of Reach 3 is generally in poor condition overall and is dominated by exotic species. This reach extends from south of the channelised section of the Parwan (adjacent to the quarry/landfill) downstream to Woolshed rd. The majority of the reach falls under the management of a single owner, Genetics Australia which is a stud bull facility. The majority of the waterway is fenced with a riparian strip of 5-20m. Intensive agriculture practices including crop and food production on the property at the north eastern portion of Reach 3 results in a reduced riparian buffer. This portion is not fenced.

Reach 3 no longer supports hydrology that enables the diverse range of ground-flora species characteristics of Red Gum Swamp to survive, other intensive agriculture impacts have also removed these species however framework of *Eucalyptus camaldulensis* River Red-gum remains to indicate the original swamp.




As with all waterways in the study area this reach is dominated by exotic vegetation. A total of 58 species were identified comprising 44 exotic species, and 14 native species of which 9 are indigenous and 5 are non-local planted species occurring at low abundance.

Indigenous overstorey is well represented occurring at 25-50% coverage. *Eucalyptus camaldulensis* River Red-gum is the dominant species. This overstorey species is well established with a range of age classes within the reach and evidence of recent recruitment. It is the only local indigenous species that can be described as abundant. This species is likely to remain secure within Reach 3 along with *Phragmites australis* Common Reed which is tolerant of the currently degraded conditions of the waterway.

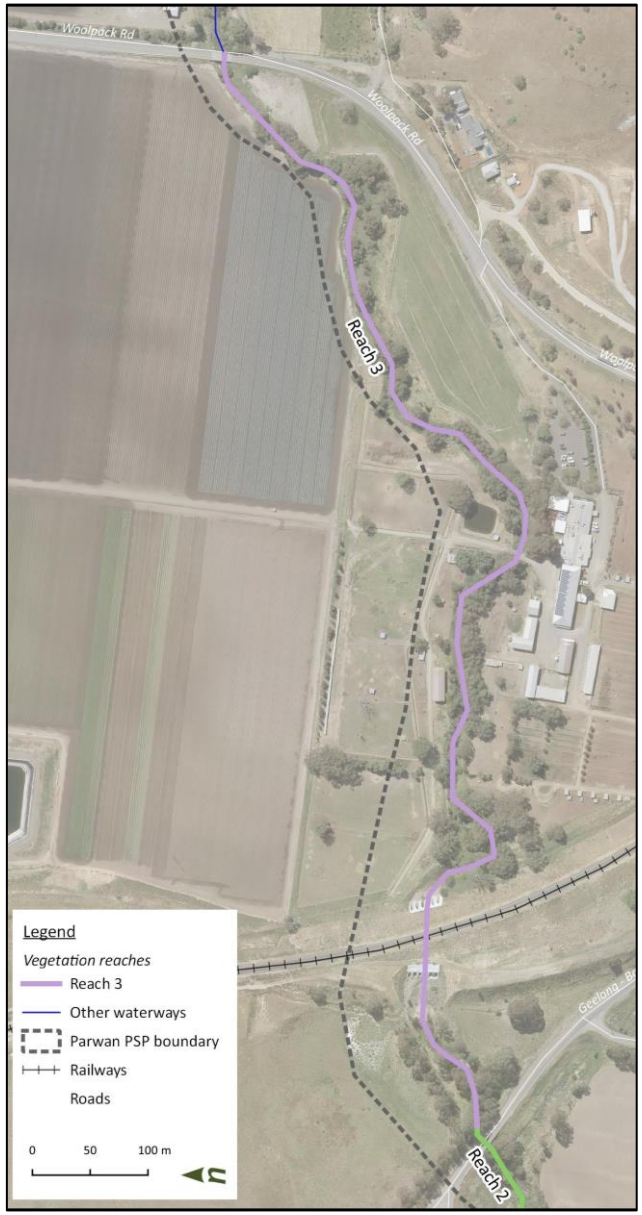
Non-indigenous native overstorey species include *Corymbia maculata* Spotted Gum, *Eucalyptus globulus Blue Gum and Eucalyptus botryoides* Southern Mahogany at <1% coverage planted adjacent to buildings within the grounds of Genetics Australia.

# Vegetation observed; Reach 3 degraded EVC 292, Red Gum Swamp

A range of exotic overstorey and midstory species occur along the Parwan in this reach some of which may have planted while most have established of their own accord. Notable examples include *Poplar sp. w*hich was probably planted and is now expanding. Other typical exotic mid-storey species where observed *Crataegus monogyna* Hawthorn *Lycium ferocissimum* African Box-thorn *Solanum nigrum s.l*. Black Nightshade Blackberry *Rubus fruticosus spp. agg and Schinus molle* Peppercorn Tree at up to 5% cover in the reach. Isolated individuals of *Ulex europaeus* Gorse were observed. The property owner has actively managed weedy exotic species hance them being at low abundance.

The only indigenous mid-storey/shrub species observed in this reach was a single example of *Duma florulenta* Lignum in the upper portion of the reach.

The ground-storey was overwhelming dominated by exotic species which appear to have had a stronghold for some time and have excluded indigenous ground-storey vegetation.




*Cenchrus clandestinus* Kikuyu was dominant at 25-50% cover overall cover. In many areas patches of this species were >1000m2. Other common exotic ground-storey species included *Echium plantagineum* Paterson's Curse, *Ehrharta erecta* Panic Veldt-grass, *Galenia pubescens var. pubescens* Galenia and *Phalaris aquatica* Toowoomba Canary-grass all occurring at 5-25% and often co mingled with *Cenchrus clandestinus* Kikuyu. *Phragmites australis* Common Reed was the only native species able to hold its own in these conditions, it occurred at 5-25% cover. *Juncus flavidus* Gold Rush *Lomandra longifolia subsp. longifolia* Spiny-headed Mat-rush (possibly planted, only 1 observed amongst Kikuyu) *Oxalis spp*. Wood Sorrel all occurred at <1% cover.

A potential contributing factor to the overwhelming presence of exotic ground-flora may be the deposition of sediments and nutrient rich material derived from upstream quarrying and agriculture. Exotic species have taken advantage of these resources and expanded to exclude all but the hardiest of indigenous flora.

# Vegetation observed; Reach 4 highly degraded EVC 292, Red Gum Swamp

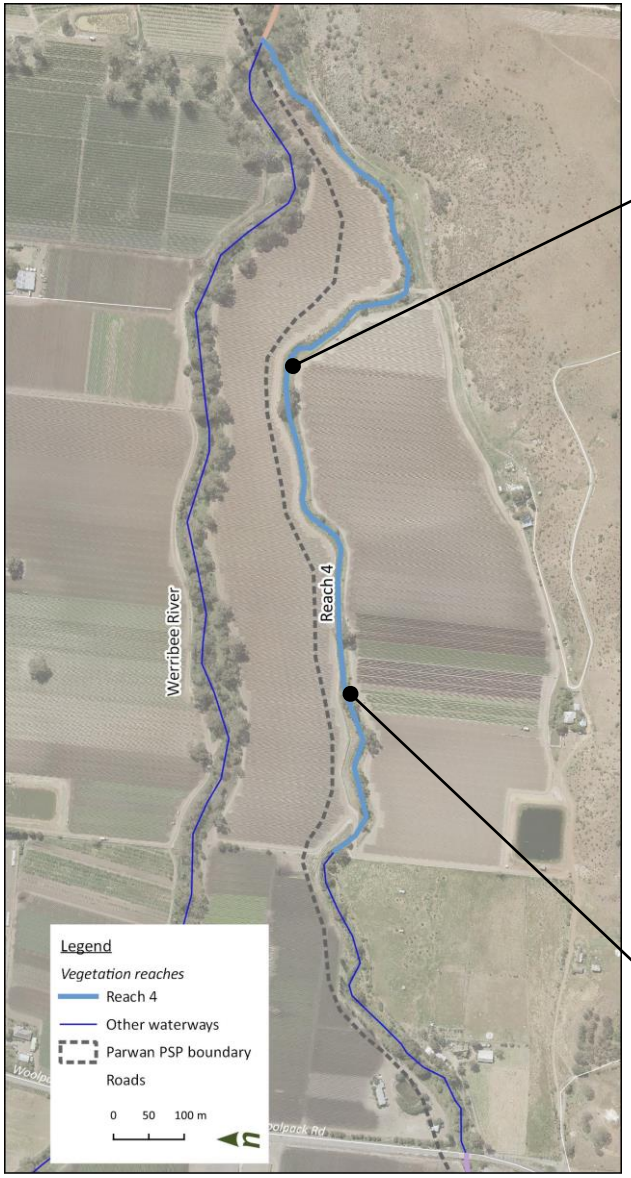
44 species were identified in total comprising 33 exotic species and 11 indigenous species .

This reach is highly modified and is in very poor condition. A simple framework of *Eucalyptus camaldulensis* River Red-gum up to 25% cover remains. Isolated small patches of other species at <5% cover remain, with the exception of *Phragmites australis* Common Reed which occurs at 25-50% cover across reach 4. Other species observed include

| | |
|---|---|
| *Acacia melanoxylon* | Blackwood |
| *Bolboschoenus caldwelii* | Marsh Club-rush |
| *Ficinia nodosa* | Ficinia |
| *Juncus spp.* | Rush |
| *Typha domingensis* | Narrow-leaf Cumbungi |
| *Acacia implexa* | Lightwood |
| *Melicytus dentatus s.l.* | Tree Violet |
| *Rytidosperma spp.* | Wallaby Grass |

Reach 4 flows through intensively managed agricultural land resulting in a narrow band of vegetation generally less than 5m wide. The waterway is largely ephemeral and occasionally received backwatering from the Werribee River during high flows and potentially via filling of Melton Reservoir .

The current hydrology and vegetation cover is significantly different from the former distribution of this vegetation community. Prior to agricultural development and drainage this Red Gum Swamp occupied a large portion of the valley where the Parwan, Werribee and Pyrites converge before the constriction caused by the gorge entrance towards the downstream end of this reach. See Figure 11 for former distribution of this vegetation community.



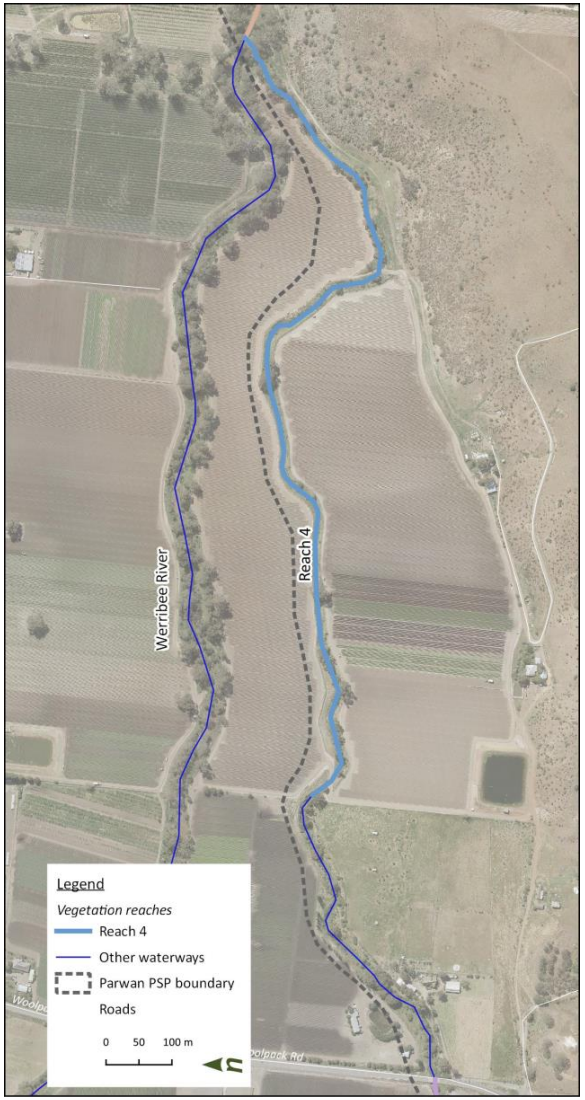

*Eucalyptus camaldulensis* River Red-gum generally with an understorey of exotic vegetation is characteristic of this reach. Extensive patches of exotic grasses and exotic shrubby vegetation are noted for Reach 4.

One of the few native species that appears to have likely expanded its range as a result of the changed nature of this waterway is *Phragmites australis* Common Reed which occurs at 25-50%

# Ecological Vegetation Classes; Reach 4 Highly modified Red Gum Swamp

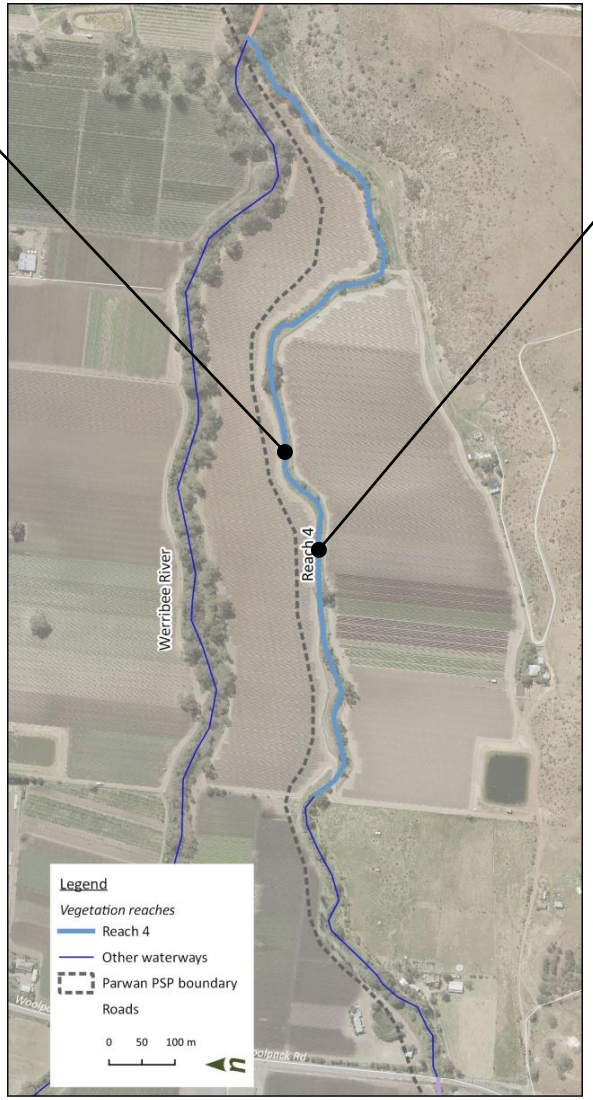
Exotic overstorey and mid-storey species occurred at up to 5% cover. Species observed included;
*Fraxinus angustifolia subsp angustifolia* Desert ash
*Lycium ferocissimum* African Box-thorn
*Opuntia puberula* Blind Prickly-pear
*Opuntia spp.* Prickly Pear
*Schinus molle* Peppercorn
*Rosa rubiginosa* Briar Rose
*Ulmus procera* English Elm

*Ulmus procera* English Elm was not observed in other parts of the study with low abundance observed in Reach 4.




*Fraxinus angustifolia subsp angustifolia* Desert ash and *Lycium ferocissimum* African Box-thorn with *Eucalyptus camaldulensis* River Red-gum and *Phragmites australis* Common Reed.

# Ecological Vegetation Classes; Reach 4 Highly modified Red Gum Swamp




One of the few native species to benefit form the changed nature of this waterway is *Phragmites australis* Common Reed which occurs at 25-50%. Exotic species commonly occurred with *Phragmites australis* Common Reed including;

*Lycium ferocissimum* African Box-thorn
*Opuntia spp.* Prickly Pear
*Schinus molle* Peppercorn
*Rosa rubiginosa* Briar Rose were common

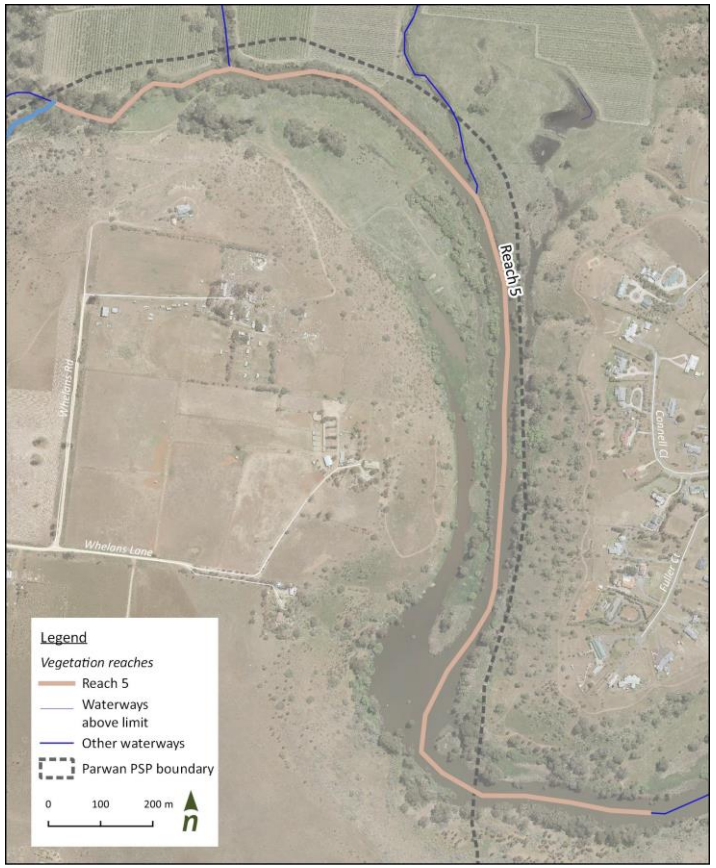
# Ecological Vegetation Classes; Reach 5 Modified Red Gum Swamp

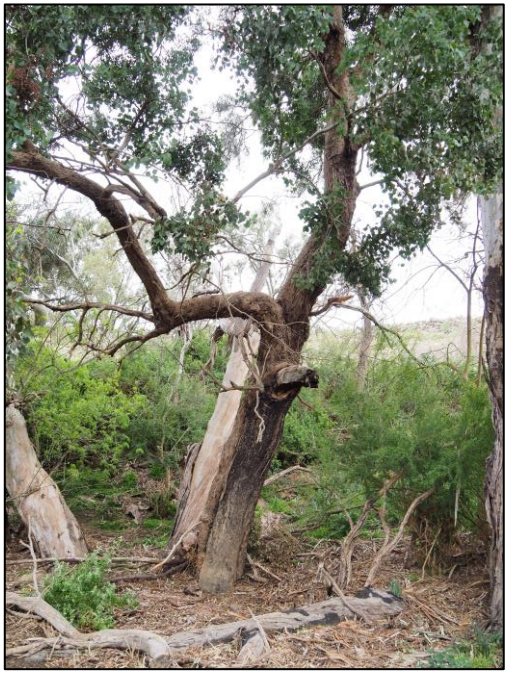
Reach 5 is situated on the Werribee River, it has similar vegetation composition characteristics to Reach 4 however is influenced by the high fill levels in the Melton reservoir and generally higher flow of the Werribee. Reach 5 is not ephemeral.

48 species observed 35 of which are exotic with 13 native species observed

This reach is modified and is in poor condition. A framework of *Eucalyptus camaldulensis* River Red-gum up to 25% cover remains. Isolated small patches of other species at <5% cover remain, with the exception of *Phragmites australis* Common Reed which occurs at 25-50% cover across reach 5. Other species observed include

| | |
|---|---|
| *Acacia melanoxylon* | Blackwood |
| *Acacia implexa* | Lightwood |
| *Carex bichenoviana* | Plains Sedge |
| *Einadia nutans* | Nodding Saltbush |
| *Eucalyptus baueriana subsp. thalassina* | Werribee Blue-box |
| *Euchiton involucratus s.s.* | Star Cudweed |
| *Juncus amabilis* | Hollow Rush |
| *Juncus pallidus* | Tall Rush |
| *Rytidosperma spp.* | Wallaby Grass |
| *Solanum aviculare* | Kangaroo Apple |
| *Typha domingensis* | Narrow-leaf Cumbungi |



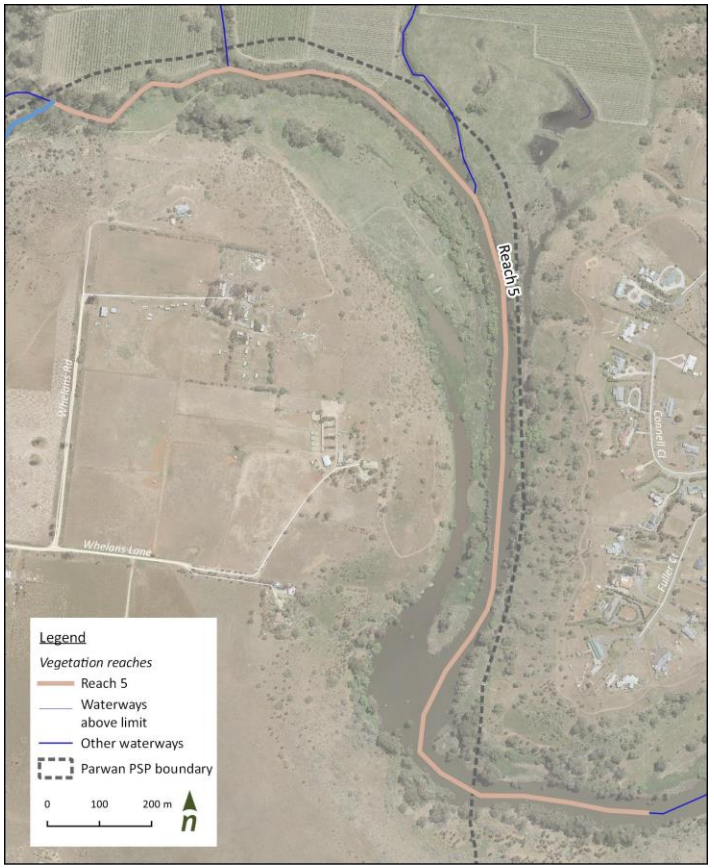



*Eucalyptus baueriana subsp. thalassina* Werribee Blue-box is a significant species and is detailed further in this report. This section of the study area also provides habitat for a number of significant fauna species, notable Growling Grass Frog, heard in abundance through Reach 5 during our site visit.

# Ecological Vegetation Classes; Reach 5 Modified Red Gum Swamp

Vegetation alongside the Werribee River has substantially less agriculture impact than is evident on the Parwan. The riparian strip is wider, more continuous and marginally more diverse. Cover abundance is greater than the Parwan with native species reaching 25-50% cover in some locations.

Extensive floodplain sections influenced by both the Werribee river and Melton Reservoirs mean that this area has not been managed intensively for agriculture. This relative isolation means less direct agricultural impact but it results in a higher load of exotic species with a range of invasive trees, shrubs and groundcover species identified.

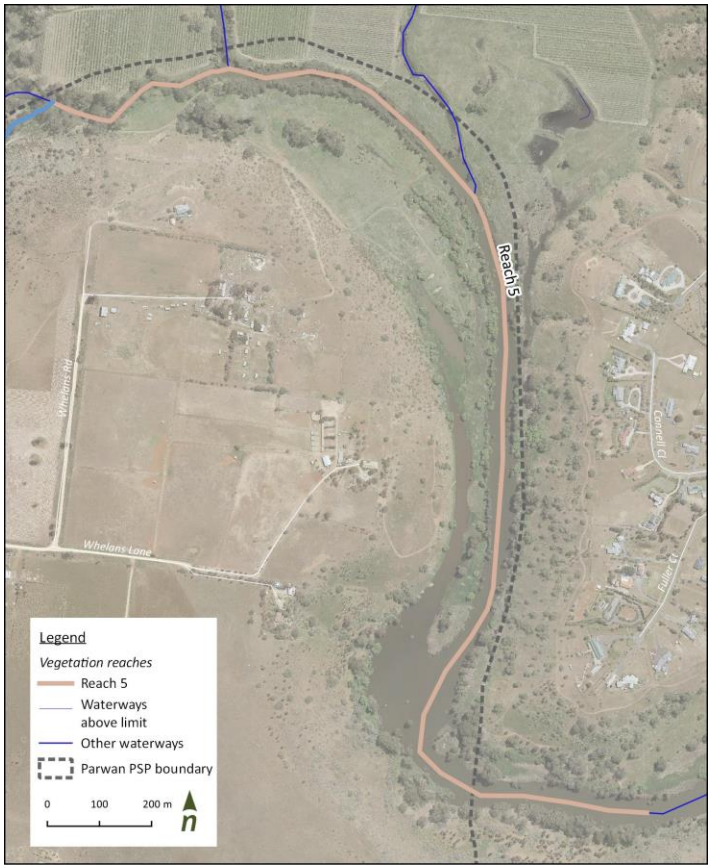



Extensive floodplain sections influenced by both the Werribee river and Melton Reservoirs provided areas of dense habitat for the sheltering of species and a diverse range of habitats for significant species such as Growling Grass Frog. This species requires open areas for basking and may utilise dense areas for shelter at some times of the year. The diversity of habitat in reach 5 is an important feature to consider in future management, its proximity to Melton Reservoir offers protection but management could also improve to reduce weed coverage.

# Ecological Vegetation Classes; Reach 5 Modified Red Gum Swamp

EA wide range of exotic ground-flora species occurred at 25-50% cover combined. Species of potential management concern include.

| | |
|---|---|
| *Cenchrus clandestinus* | Kikuyu |
| *Conium maculatum* | Hemlock |
| *Cynara cardunculus subsp. flavescens* | Artichoke Thistle |
| *Cynodon dactylon* | Couch |
| *Echium plantagineum* | Paterson's Curse |
| *Ehrharta erecta* | Panic Veldt-grass |
| *Ehrharta longiflora* | Annual Veldt-grass |
| *Foeniculum vulgare* | Fennel |
| *Galenia pubescens var. pubescens* | Galenia |
| *Juncus acutus subsp. acutus* | Spiny Rush |
| *Marrubium vulgare* | Horehound |
| *Nassella neesiana* | Chilean Needle-grass |
| *Nassella trichotoma* | Serrated Tussock |
| *Oxalis pes-caprae* | Soursob |
| *Phalaris aquatica* | Toowoomba Canary-grass |
| *Silybum marianum* | Variegated Thistle |
| *Xanthium sp.* | Burr |



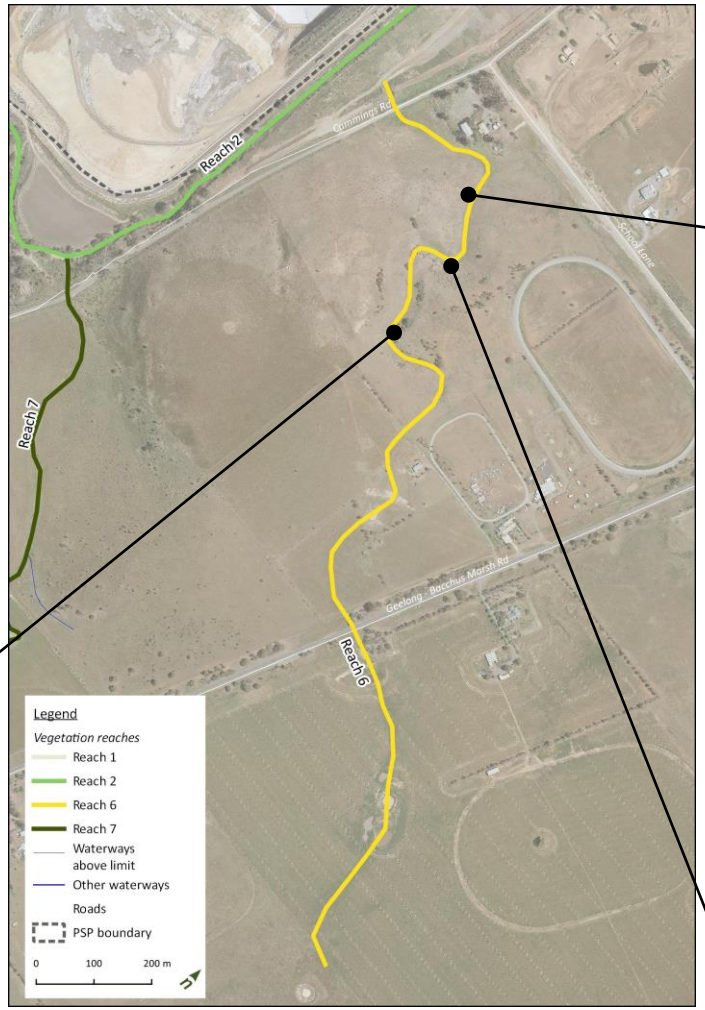

Exotic overstorey and mid-storey species occurred at up to 5% cover. Species observed included;

| | |
|---|---|
| *Fraxinus angustifolia subsp. angustifolia* | Desert ash |
| *Salix fragilis* | Willow |
| *Schinus molle* | Pepper Tree |
| *Lycium ferocissimum* | African Box-thorn |
| *Opuntia puberula* | Blind Prickly-pear |
| *Opuntia spp.* | Prickly Pear |
| *Rubus fruticosus* | Blackberry |
| *Ulex europaeus* | Gorse |

# Ecological Vegetation Classes; Reach 6 Highly modified Escarpment Shrubland (EVC 895)

Native vegetation cover is very restricted in Reach 6 owing to the comprehensive and unrelenting grazing pressure delivered by rabbits. Reach 6 is in very poor condition. Plains Grassy Woodland (EVC 55) is mapped for the lower portion of Reach 6. Plains Grassland (EVC 132) is mapped for the upper portion. We could find no evidence of either in this landscape dominated almost entirely by exotic species tolerant of heavy browsing. 23 species were recorded for the reach, 13 are exotic and 10 are indigenous, 3 of these species appear to be planted.

However a few remnants of Escarpment Shrubland (EVC 895) were observed where steep rocky basalt outcrops were exposed. Small clusters of native vegetation that established decades prior have miraculously survived this this unyielding onslaught. A small patch of *Acacia implexa* Lightwood and *Bursaria spinosa* Sweet Bursaria hint at the escarpment shrubland that dominated these rocky ephemeral sites before the arrival of rabbits and the grazing pressure by domestic stock.



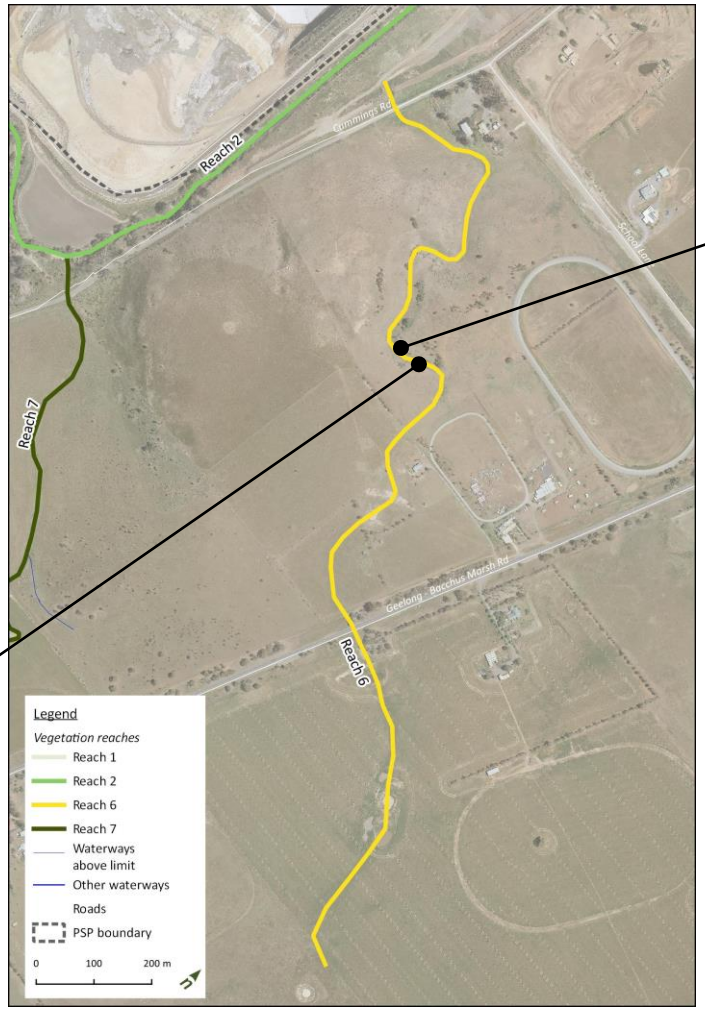

The lower portions of Reach 6 are characterised by broadleaf exotic species that tolerate browsing, grasses and palatable species are absent. *Echium plantagineum* Paterson's Curse occur at 25-50% *Galenia pubescens var. pubescens* Galenia, stoically plugs the gaps. Where both are unable to tolerate the conditions bare ground and *Mesembryanthemum crystallinum* Common Ice-plant glistens in the sun. This succulent species occurs at 5-25% cover in rocky locations where the soil is too sparse for other plants.

# Ecological Vegetation Classes; Reach 6 Highly modified Escarpment Shrubland (EVC 895)

The denuded nature of indigenous vegetation in Reach 6 means that framing a description and comparing it to the EVC benchmark doesn't effectively convey the degraded character of the vegetation. In any case the mapped EVC does not accurately reflect species observed.

The following overstorey species were identified, *Acacia implexa* Lightwood, *Acacia pycnantha* Golden Wattle, *Allocasuarina verticillata* Drooping Sheoak and *Eucalyptus macrocarpa* Grey Box all of which were present at small quantities with the exception of *Eucalyptus macrocarpa* Grey Box which was at 1-5% cover. *Acacia pycnantha* Golden Wattle, *Allocasuarina verticillata* Drooping Sheoak appeared to be planted at the edge of the escarpment in rows of uniform aged plants.

Mid-storey species comprised of *Bursaria spinosa subsp. spinosa var. spinosa* Sweet Bursaria and *Melicytus dentatus* s.l. Tree Violet at < 1% cover.



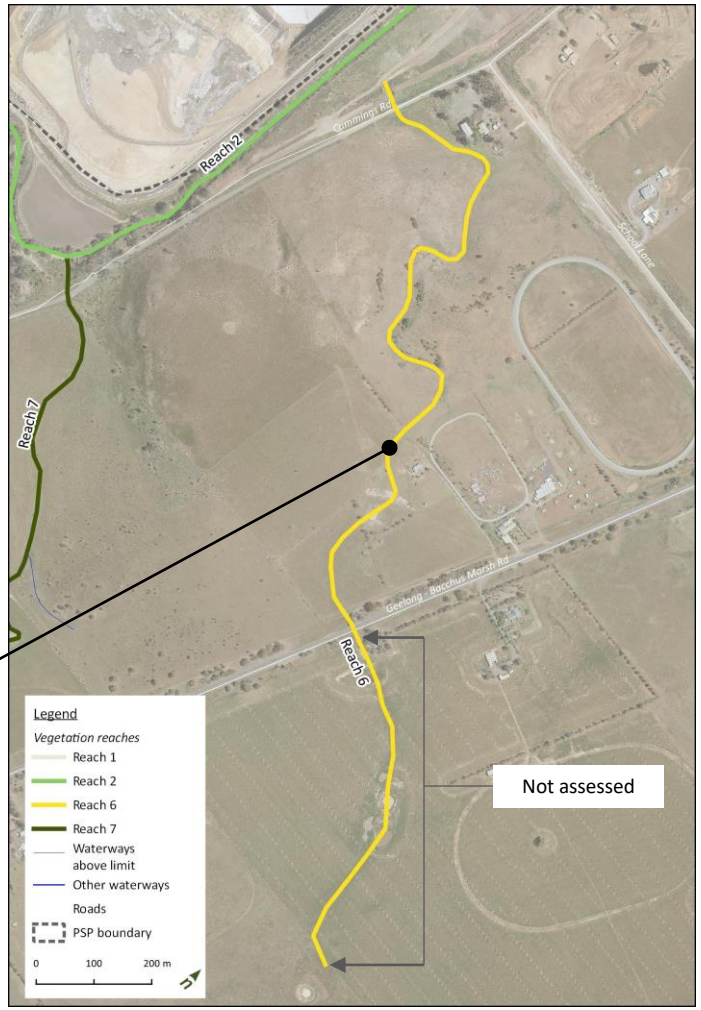

Ground-storey comprised of *Enchylaena tomentosa var. tomentosa* Ruby Saltbush and *Nicotiana suaveolens* Austral Tobacco at <1% cover. A single specimen of *Austrostipa scabra subsp. falcata* Rough Spear-grass was located within an entanglement a dead *Lycium ferocissimum* Boxthorn branches.

Very high grazing pressure by rabbits is an important selective pressure influencing the types of plants able to survive in this reach. Chemical defence is a strategy deployed by the indigenous species *Nicotiana suaveolens* Austral Tobacco. This species manages to survive in rocky ground dominated by exotics. It is at low abundance being <1% coverage but is a likely remain a stable population if other compounding disturbances are limited. This species is listed as Rare in Victoria. This species was also recorded in Reach 1 where similar ecological processes are at play driving the distribution and occurrence of indigenous flora.

# Ecological Vegetation Classes; Reach 6 Highly modified Escarpment Shrubland (EVC 895)

The overwhelming feature of this reach is the lack of diversity and extensive cover of browsing tolerant broadleaf plants which approach 75% coverage collectively. The lower portion of reach 6, downstream of the escarpment drop off is dominated by *Echium plantagineum* Paterson's Curse, *Galenia pubescens var. pubescens* Galenia and *Mesembryanthemum crystallinum* Common Ice-plant.

Above this point exotic grass species become more evident with *Nassella trichotoma* Serrated Tussock at 5-25% cover between *Galenia pubescens var. pubescens* Galenia.




Our assessment was unable to review the waterway and associated vegetation upstream (East of the Geelong-Bacchus Marsh Rd) as permission was not given by the landowner.

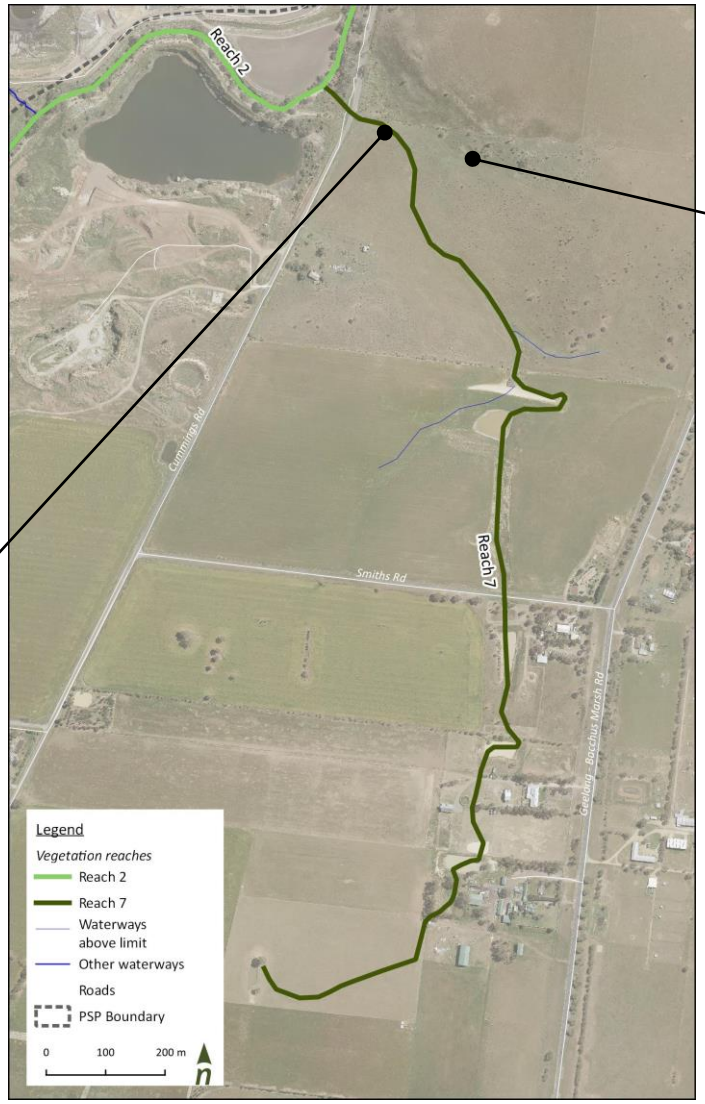
It appears that the majority of this part of reach 6 is cropped and has 2 dams. It is unlikely that there will be significant vegetation values on this portion of reach 6.

Overall Reach 6 is probably the most degraded portion of waterway in the study area and offers limited habitat for indigenous flora and fauna with the exception of *Nicotiana suaveolens* Austral Tobacco

# Ecological Vegetation Classes; Reach 7 Highly modified Plains Grassy Woodland (EVC 55)

A total of 37 species were recorded comprising of 26 exotic species and 11 native species. Plains Grassy Woodland (EVC 55) is mapped for the lower portion of Reach 7. Plains Grassland (EVC 132) is mapped for the upper portion. This reach has been impacted by agriculture and sub-division with a approximately 1/3 currently cropped, 1/3 occupied by dwellings and low density rural subdivision and the remaining 1/3 being effectively unused with neither grazing, cropping or any other agricultural use evident. Little remains of the indigenous vegetation that once occupied this area with native vegetation being less than 5% across the reach.

Overstorey vegetation along this ephemeral waterway was confined to planted Eucalypts in close proximity to dwellings in the upper portion of Reach 7. Planted *Eucalyptus camaldulensis* River Red-gum occupied <1% of the waterway. A stand of *Allocasuarina luehmannii* Buloke was recorded on nearby slopes but is not effectively part of the mapped waterway.




Overstorey exotic vegetation was limited to planted *Salix fragilis* Crack Willow along dams in the upper portion of the waterway. Their cover was <1%.

Mid-storey indigenous vegetation was limited to small patches of *Acacia pycnantha* Golden Wattle in the upper portion of the reach and on slopes with *Allocasuarina luehmannii* Buloke. *Cassinia sifton* Sifton Bush was identified in the lower/northern portion of Reach 7 and appeared to be increasing in abundance with a range of ages visible. The apparent increase may possibly be as a result of reduced grazing pressure.

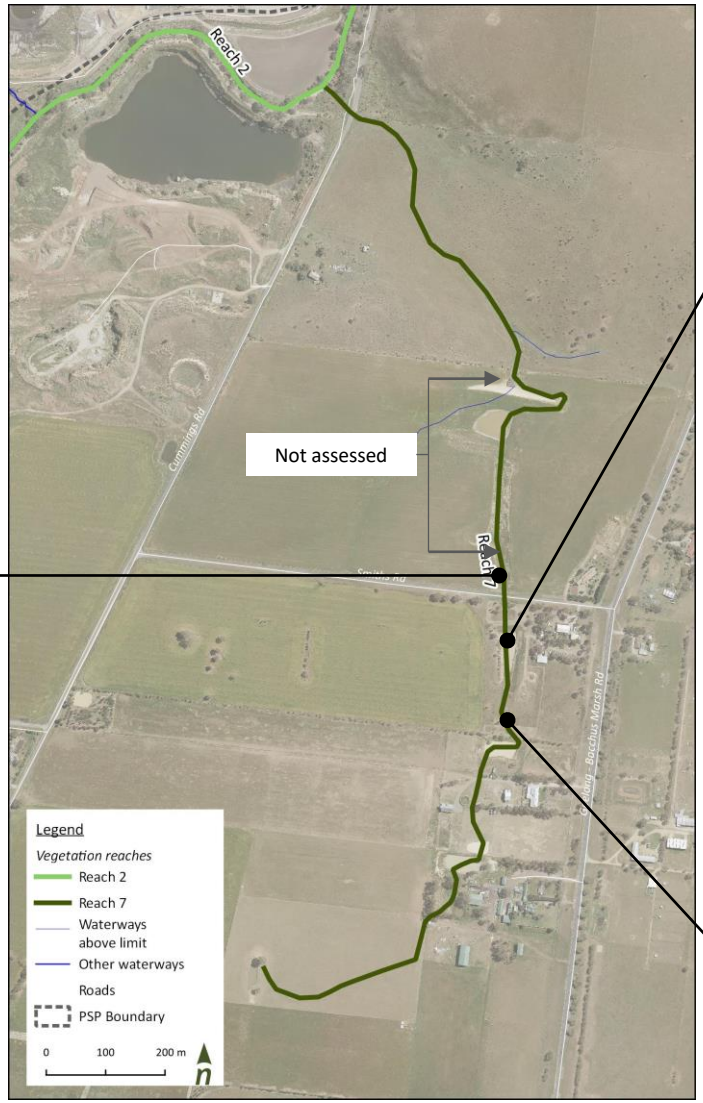
Exotic mid-storey species typical of the study area were observed including *Rosa rubiginosa* Briar Rose and *Lycium ferocissimum* African Box-thorn. In addition *Physalis hederifolia* Sticky Ground-cherry was observed. All occurred at 1-5% cover for the reach.

# Ecological Vegetation Classes; Reach 7 Highly modified Plains Grassy Woodland (EVC 55)

Intensive agriculture and rural subdivision were evident in the mid section of reach 7. A portion south of Smiths Rd could not be accessed however it appeared from our roadside assessment that herbicide had been applied to vegetation for the entire length of this portion of the waterway. The ground was cropped to the east and west.

The upper portion of reach 7 had a range of exotic ground-storey species to 75% cover collectively. *Avena fatua* Wild Oat and *Galenia pubescens var. pubescens* Galenia dominated at up to 50% combined.

Dead material, bare ground and range of other species including *Arctotheca calendula* Cape Weed, *Brassica spp.* Turnip, *Cenchrus clandestinus* Kikuyu *Cynara cardunculus subsp. flavescens* Artichoke Thistle *Dactylis glomerata* Cocksfoot *Echium plantagineum* Paterson's Curse *Foeniculum vulgare* Fennel *Juncus acutus subsp. acutus* Spiny Rush,




*Malva sp.* Mallow *Marrubium vulgare* Horehound *Nassella trichotoma* Serrated Tussock occupied the remaining 25%. *Nassella neesiana* Chilean Needle-grass was observed at low cover an is expected to increase.

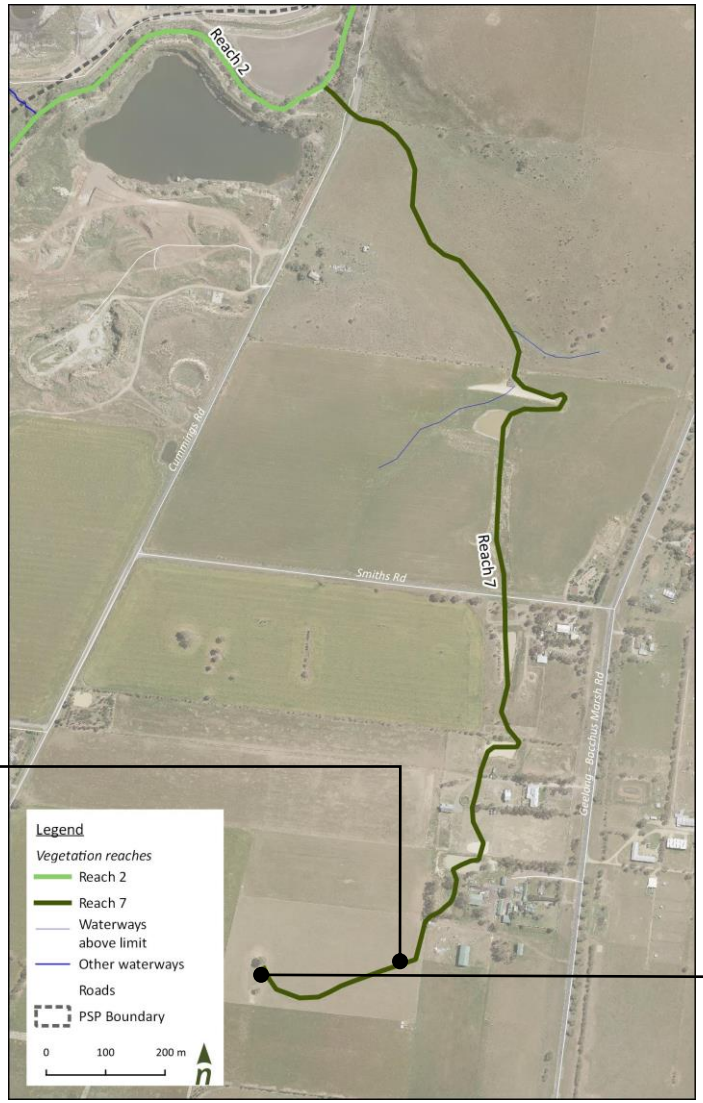
Rural subdivision were evident in the mid section of reach 7 with several dams and minimal indigenous vegetation cover evident. Note juvenile *Eucalyptus camaldulensis* River Red-gum recruiting.

# Ecological Vegetation Classes; Reach 7 Highly modified Plains Grassy Woodland (EVC 55)

Cropping was a feature of the upper portion of reach 7 resulting in low exotic species diversity with large portions occupied by barley varieties and *Lolium spp.* Rye grass cultivar. Occasional patches of *Cynara cardunculus subsp. flavescens* Artichoke Thistle were observed bur are managed by the property owner.

The waterway was a barely discernible shallow depression in the landscape at this point and would rarely flow as a clear defined channel.

No indigenous ground-storey or mid-storey species were observed in this intensively cropped area. A small patch of *Eucalyptus macrocarpa* Grey Box was observed adjacent to a dam at the upstream end of the waterway.



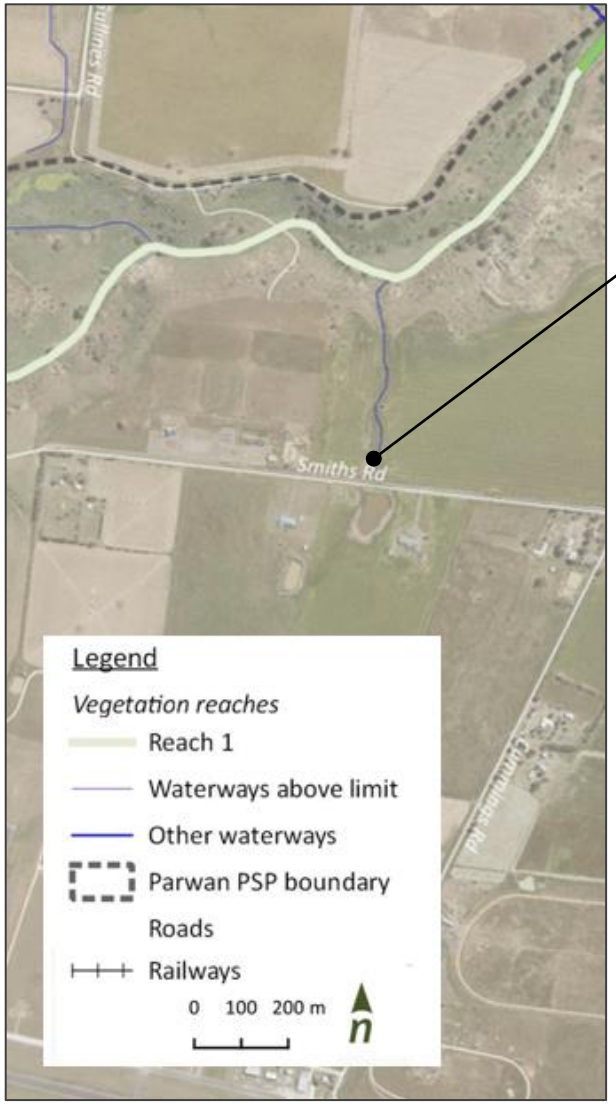

This open paddock is currently grazed by sheep. It is possible that hardy indigenous flora including Juncus sp. may emerge at times, especially in damp areas but in effect naïve vegetation has been removed from this portion of the landscape.

# Minor headwater tributaries

Minor drainage lines in the study area which are upstream of the 60 hectare asset limit were assessed where possible. An example of one of these assets was assessed from roadside at Smiths Rd. This minor tributary flows from south to north and may have intermittent flow in winter or after heavy rainfall events. The site was assessed from roadside as permission to access the land and assess the asset in detail was not provided.

Vegetation at the point at which this location could be assessed was entirely exotic. A single Eucalypt was observed, however this example was over 100m from the observation point therefore a definitive identification could not be made. It is more than likely that this specimen is *Eucalyptus macrocarpa* Grey Box.

*Lycium ferocissimum* African Box-thorn, *Opuntia stricta* Common Prickly-pear and *Rosa rubiginosa* Briar Rose occupied 1-5% of the area observed. No indigenous mid-storey species were observed.




Dominant ground-flora vegetation was *Nassella trichotoma* Serrated Tussock 25-50% with *Phalaris aquatica* Toowoomba Canary-grass and *Dactylis glomerata* Cocksfoot at 5-25%. All other species were at <5% cover comprising

| | |
|---|---|
| *Avena fatua* | Wild Oat |
| *Echium plantagineum* | Paterson's Curse |
| *Galenia pubescens var. pubescens* | Galenia |
| *Helminthotheca echioides* | Ox-tongue |
| *Lolium spp.* | Rye Grass |
| *Plantago lanceolata* | Ribwort |
| *Romulea rosea* | Onion Grass |

# Assessment of wetlands

## Assessment approach

This evaluation of ecological assets considered riparian as well as wetland values. A desktop assessment of wetlands within the study area identified a number of sites of primary concern that had already been recognised and mapped via DELWPs wetlands assessment approach. In addition to these sites of known wetland value a number of locations in the landscape with potential for wetlands value expression were assessed. Aerial imagery taken between 2010 and 2020 was reviewed to identify potential wetland sites.

Known wetland communities within the study area include

- Lignum Swamp (EVC 104)
- Plains Grassy Wetland (EVC 125) and
- Red Gum Swamp (EVC 292)

Our assessment confirmed the presence of these wetland assets and reported on the condition of these sites recording indigenous and exotic species as well as other notes about condition and threats to thee sites. Hydrology for all wetland sites in the study area has been altered to some extent. Those which have a more intact hydrology and those which are generally more treed have survived. Wetland sites that are ephemeral and grassy have been most substantially altered or are lost from the study area. Have. These are also the sites most likely to conform with the definition of Seasonal Herbaceous Wetlands.

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## Description of Seasonal herbaceous wetlands

Seasonal herbaceous wetlands (SHW) are freshwater systems usually inundated by winter and spring rainfall events. These wetlands then dry out completely and may be dry for many consecutive years in drought and low rainfall periods. Seasonal herbaceous wetlands have an open structure dominated by herbs (grasses, sedges and forbs) that are adapted to seasonally wet or waterlogged conditions. A high diversity of conspicuous flowering species are characteristic of SHW as are a range of other herbaceous plants.

Biota

- Trees and shrubs are sparse to absent. When present, they mostly occur as fringing or scattered individuals and their cover accounts for no more than 10% across the wetland
- Vegetative cover is dominated by a ground layer of native wetland graminoids (grasses and sedges) and/or native wetland forbs
- Graminoids that are present often include one or more of the following taxa: *Amphibromus spp., Carex tereticaulis, Deyeuxia spp., Glyceria spp., Lachnagrostis spp., Poa labillardieri,* and *Rytidosperma duttonianum* (other graminoid taxa may also occur, though are not necessarily common)
- At least one native wetland forb species must be present (preferably more) after the ecological community is inundated
- The suite of forbs that may occur within the ecological community's range is variable and potentially large
- Freshwater algae often are present when the wetland is wet or has been recently wet
- Characteristic fauna that may be associated with the ecological community include invertebrate groups that are temporary water specialists
- The types of fauna present can be highly variable and is dependent on the inundation history, current conditions and other factors

Condition

- To meet EPBC Act condition criteria 50% or more of the total cover of plants in the ground layer of the wetland during a 'typical' wet phase must be dominated by native species characteristic of the ecological community.

**Status** Critically Endangered under the Australian Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

## Assessment approach

Our desktop review of the Parwan PSP area identified several locations potentially suitable for SHW. Our on ground assessment focused on these areas to attempt to detect character species which signal the presence of this vegetation type. However our review of potential sites was inconclusive. SHW could not be confirmed during this assessment due to there being insufficient water in the landscape during the time of assessment to trigger the unambiguous expression of SHW. We were able to located some indicator species in low abundance at 2 sites. These locations warrant further investigation in appropriate seasons. The indicator species observed include *Haloragis aspera* Rough Raspwort and *Marsilea drummondii Common* Nardoo.

# Assessment of wetlands

## Groundwater dependant ecosystems

This evaluation focused primarily on vegetation and geomorphology values and threats visible at the time of assessment. This assessment was supported by existing literature and records for significant features and species. The wetland features identified appeared to function primarily as a result of local catchment hydrology with filling or partial filling being observed as a result of current season rainfall and overland flow.

High level assessment of groundwater dependent ecosystems has been conducted by DELWP with several of the wetland features of interest identified in this assessment also being categorised according to their potential dependence on groundwater. With sites being nominated as either having high or moderate GDE in the study area.

Review of the categorisation of groundwater dependence is based on knowledge of vegetation and its capacity to respond seasonally as opposed to being dependant on prolonged wetting to sustain vegetation condition.

**Table 1**. *Groundwater Dependant Ecosystem categorisation by DELWP and proposed based on vegetation.*

| DELWP Groundwater dependence | Proposed GDE based on vegetation | Name | Number |
|---|---|---|---|
| Moderate | Moderate | Jensz | 70062 |
| Moderate | Low/Moderate | Wheat field wetlands | 70068 |
| Moderate | Low | Wheat field wetlnds | 70068 |
| Unclassified | NA | Wheat field wetlnds | 70065 |
| Moderate | Low/Moderate | Genetics Australia wetlands | 70075 |
| Moderate | Low/Moderate | Genetics Australia wetlands | 70122 |
| High | Low/Moderate | Genetics Australia wetlands | 70074 |
| High | Moderate | Binghams Swamp | 70071 |
| Unclassified | NA | Daisybank Lane Swamp | 70123 |

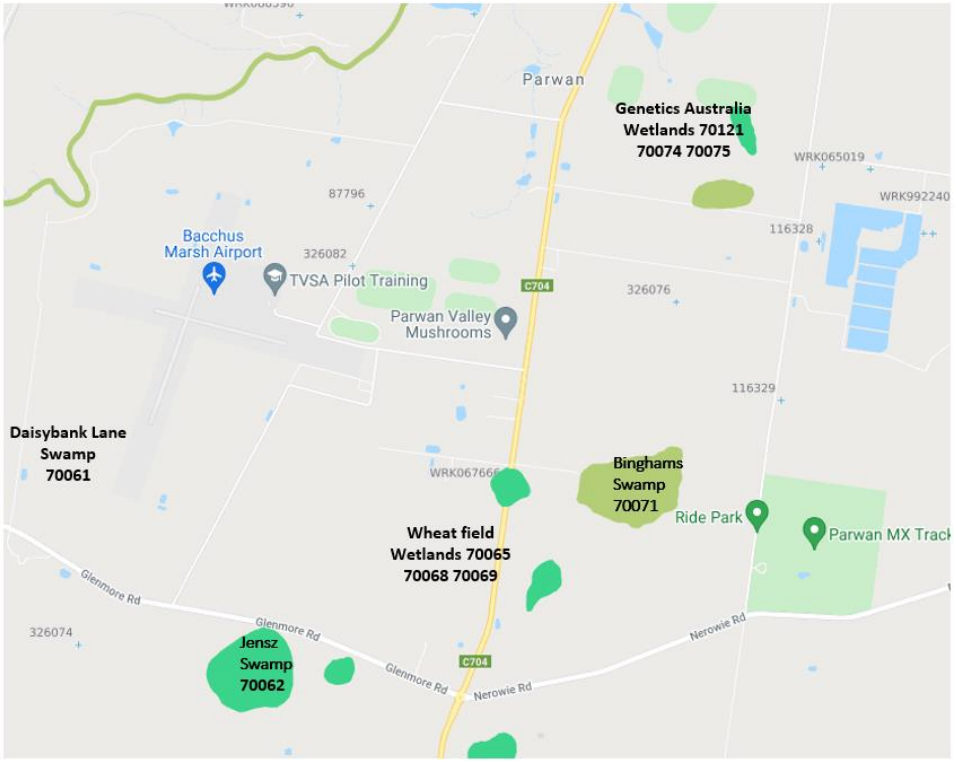
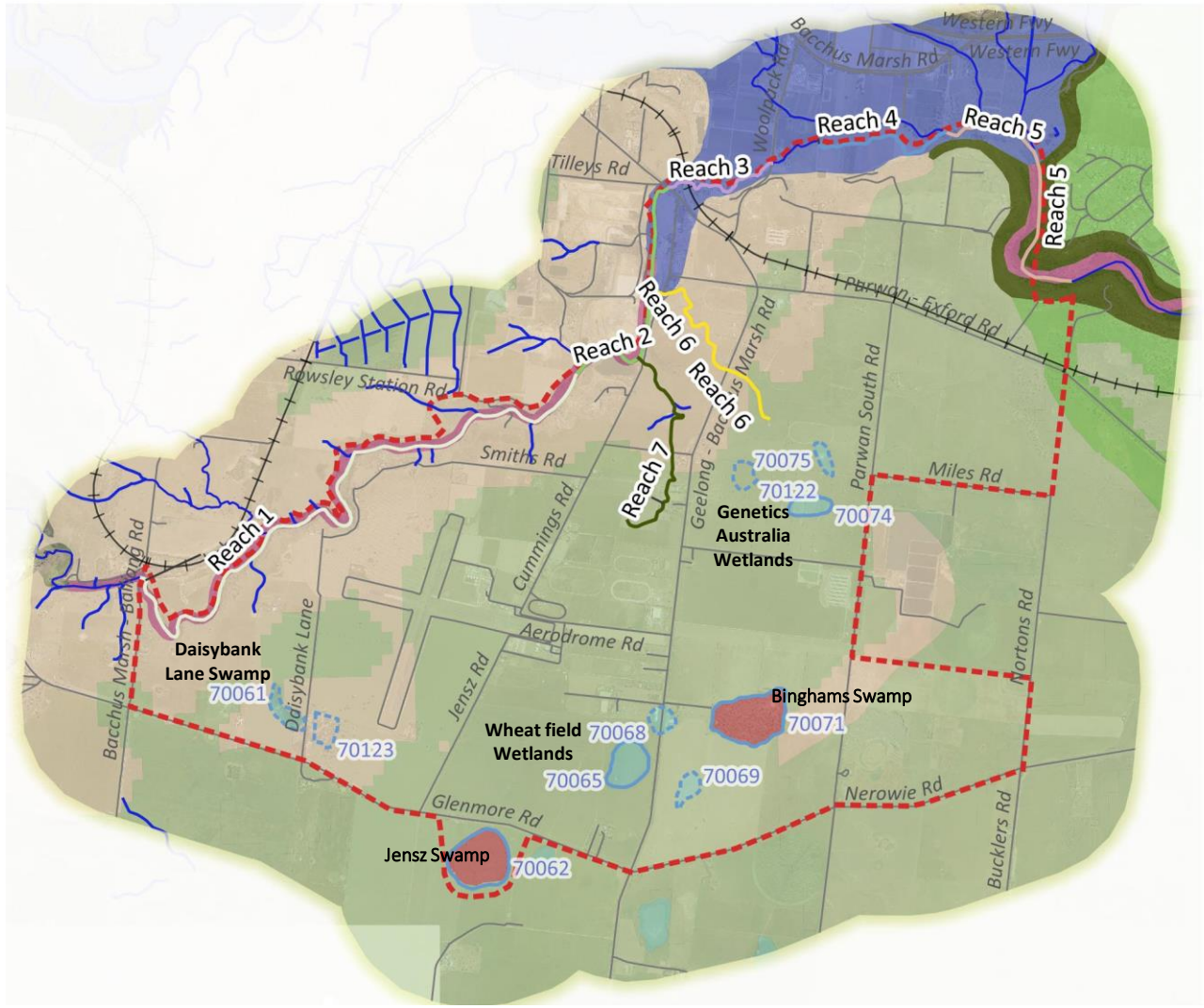



**Figure 12**. *Groundwater Dependant Ecosystem mapping by DELWP.*

Jensz and Binghams Swamp exhibit vegetation types (particular large long lived species such as Lignum and Reiver Red Gum) that are more likely to have the capacity to utilise groundwater.

Ephemeral wetland species such as those typical of SHW are less likely to have dependence on groundwater as these systems are more seasonally dependant. For these reasons we have proposed some changes to the categorisation applied by DELWP

# Ecological Vegetation Classes: Benchmark mapped from Nature Kit




Legend

*Modelled Ecological Vegetation Classes (EVC 1750)*

- Lignum Swamp (EVC 104)
- Plains Grassy Wetland (EVC 125)
- Red Gum Swamp (EVC 292)

*Assessment of wetlands*

- Yes
- No
- Other waterways
- Roads
- Railways
- PSP boundary

0 0.5 1 km

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Note that the conservation status of these wetland vegetation communities identified in the study area is listed as Endangered at a State level. One of these communities, EVC 125 Plains Grassy Wetland can also exhibit characteristics consistent with the federally listed Seasonal Herbaceous Wetland entity.

**Known wetland locations investigated**

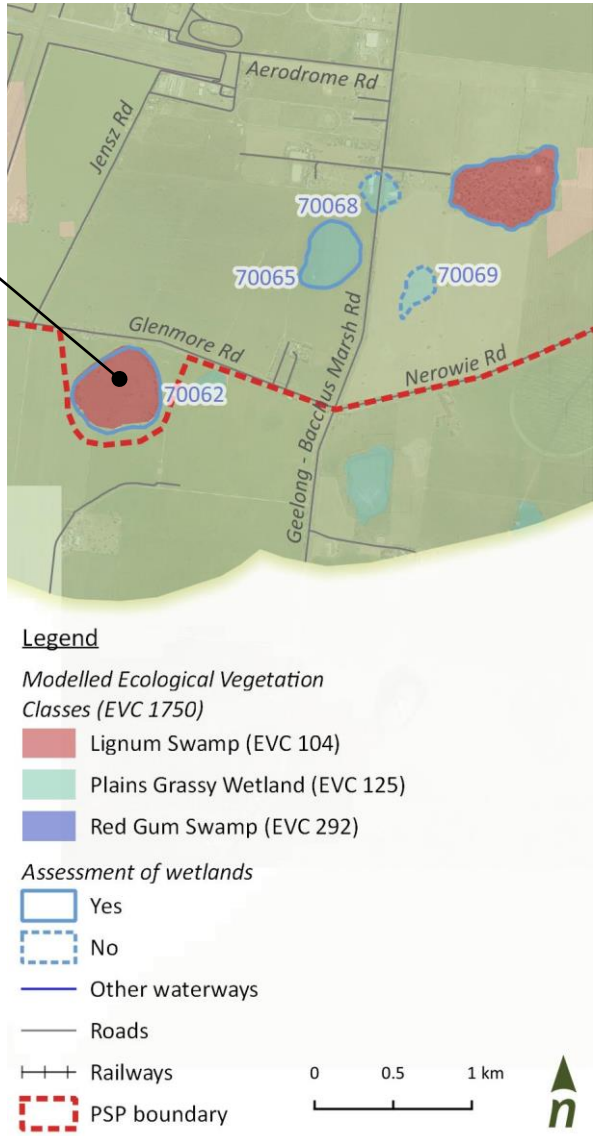
Jensz Swamp (70062)
Binghams Swamp (70071)
Wheat field wetlands (70065)

**Wetland locations identified by aerial photo review with SHW potential**

Genetics Australia wetlands
Daisybank Lane Swamp

**Figure 13**. Wetland *Ecological Vegetation Classes; Benchmark mapped from Nature Kit*

# Jensz Swamp (70062): High quality Lignum Swamp (EVC 104)




Jensz Swamp (wetland inventory ID 70062) is recognised as a site of ecological importance with a number of significant fauna identified. This site comprises of a largely intact Lignum Swamp with 48 species of flora identified comprising 30 indigenous and 18 exotic species. This location is mapped as Lignum Swamp (EVC 104) of approximately 22.8 hectares.

There is a light covering of *Eucalyptus camaldulensis* River Red-gum and *Eucalyptus macrocarpa* Grey Box comprising 1-5% cover. No exotic overstorey species were observed. *Duma florulenta* Lignum is the main shrubby component occurring at 5% cover. Other woody species and small shrubs occurring at <1% included *Acacia acinacea s.s.* Gold-dust Wattle, *Atriplex semibaccata* Berry Saltbush, *Einadia nutans* Nodding Saltbush *Eutaxia microphylla var. microphylla* Common Eutaxia and *Exocarpos strictus* Pale-fruit Ballart. A diverse range of ground flora including grasses, sedges and herbaceous plants was recorded at low abundance. Notable species include *Austrostipa sp* Spear Grass *Lachnagrostis filiformis s.l.* Common Blown-grass *Poa labillardierei var.* (Volcanic Plains) Basalt Tussock-grass *Eleocharis acuta* Common Spike-rush *Eleocharis pusilla* Small Spike-rush. Notable herbaceous species (at 1-5% cover) include *Acaena echinata* Sheep's Burr *Asperula conferta* Common Woodruff *Comesperma volubile* Love Creeper *Crassula sieberiana s.l.* Sieber Crassula *Dichondra repens* Kidney-weed *Epilobium billardiereanum* Variable Willow-herb *Geranium retorsum* Grassland Crane's-bill *Geranium spp.* Crane's Bill *Haloragis aspera* Rough Raspwort *Marsilea drummondii* Nardoo *Senecio glomeratus* Annual Fireweed *Senecio hispidulus s.l.* Rough Fireweed *Stackhousia monogyna* Creamy Candles

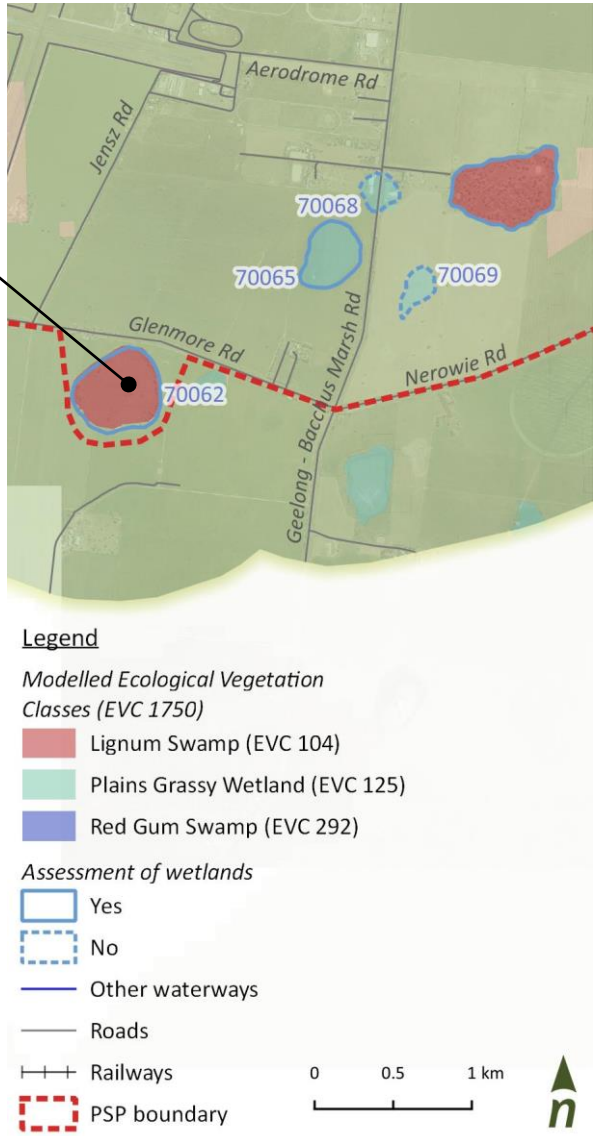
The site was not assessed for its SHW values as the site does not conform with this typology.

# Jensz Swamp (70062): High quality Lignum Swamp (EVC 104)

Jensz Swamp has the most intact vegetation of the study area with a largely intact and diverse range of flora. Exotic species are at low abundance and diversity. Native species constitute the bulk of the biomass and other drivers of change such as intensive grazing by rabbits is minimal at this site.

Jensz Swamp is clearly a site of high ecological value for its flora and has a number of significant fauna records associated with it which are detailed in the fauna section of his report.

Careful consideration of future hydrology and increasing the buffer around the edge of this wetland with a plan to link it to other sites is advised.



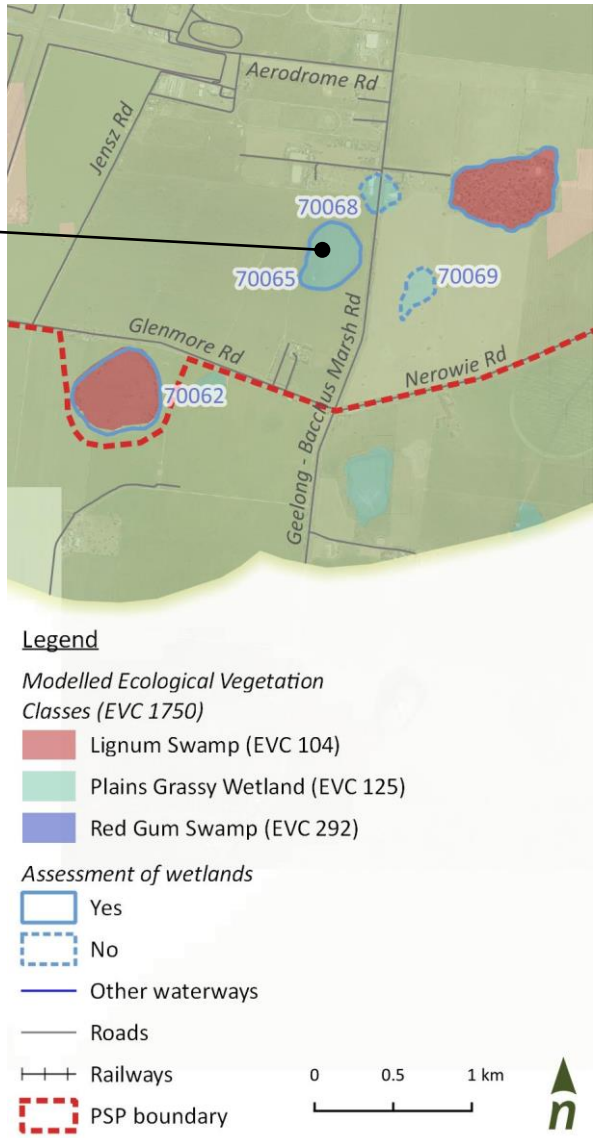

**Other values and threats.**

Jensz Swamp had the most intact vegetation of all sites assessed in this study. It was not grazed, the surrounded cropped areas may have acted as a buffer to the encroachment of exotic species and means that damage by stock is less likely. Changes in hydrology are the biggest threat, the site had undergone some changes to hydrology due to drainage channels associated with the nearby Glenmore Rd, but much of the local catchment remains. It is partially fragmented from adjoining vegetation due to intensive cropping.

In addition to the high ecological values identified at Jensz swamp it is likely that this site also has a range of cultural artefacts and cultural landscape significance. Our assessment did not set out to locate culture significant elements but it seemed immediately apparent that this site has high value. A possible grinding stone had been placed in a prominent position at this productive site.

# Wheat field wetland (70065): formerly EVC 125 Plains Grassy Wetland

Aerial imagery from 2010-2020 was reviewed. This identified variation in the tone of vegetation hinting at the possibility of differing expression of vegetation between seasons (2014 image below). However it was clear on inspection that no native vegetation remained. Variation may be due to the wheat crop remaining green in the bed of the former wetland while the surrounding wheat crop in the landscape dries off.

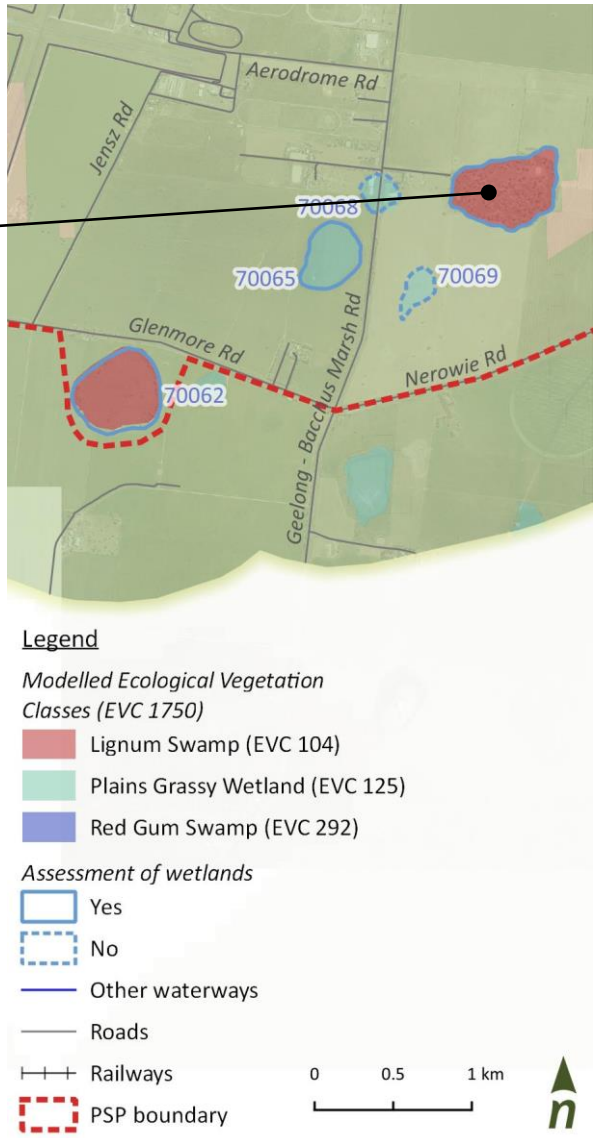



Note the monoculture of wheat and evidence of intensive management. Lines between rows of wheat were inspected in order to attempt to locate indigenous species. Plains Grassy Wetland (EVC 125) no longer occurs on this site. The likely of Seasonal Herbaceous Wetland persisting at this location is very low.

# Binghams Swamp (70071): modified Lignum Swamp (EVC 104)

Binghams Swamp is recognised as a site of ecological importance with a number of significant fauna identified. This site comprises of a partially intact Lignum Swamp with 33 species of flora identified comprising 11 indigenous and 22 exotic species. This location is mapped as Lignum Swamp (EVC 104) of approximately 26.4 hectares.

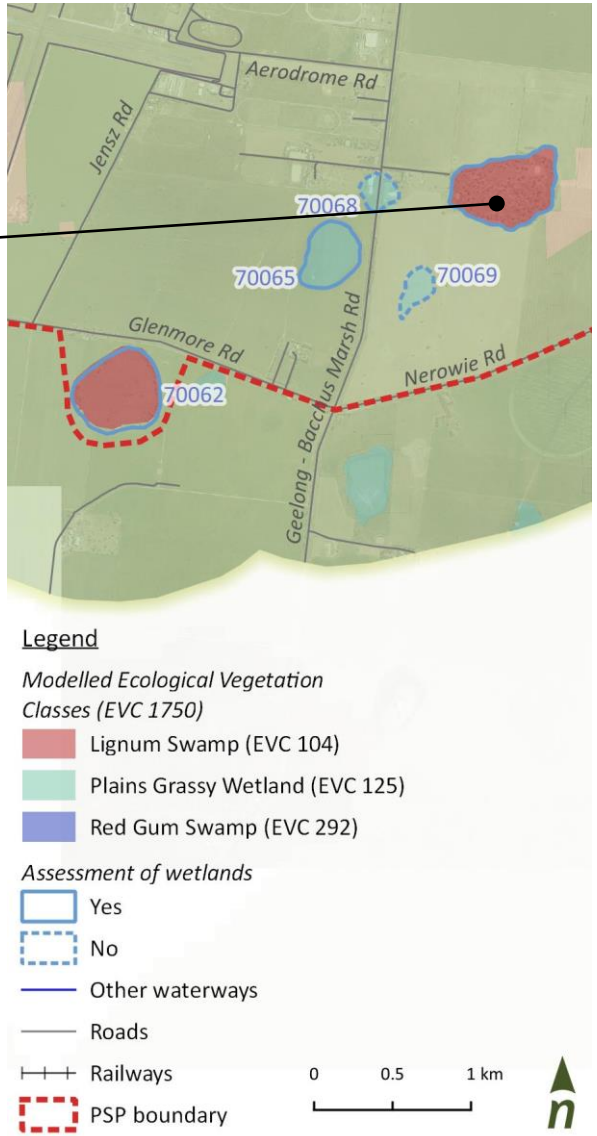
There is a moderate covering of *Eucalyptus camaldulensis* River Red-gum and *Eucalyptus macrocarpa* Grey Box comprising 25-50% cover. No exotic overstorey species were observed. *Duma florulenta* Lignum is the main shrubby component occurring at 25-50% cover. *Juncus spp.* Rush occurred at 5-25% abundance with all other groundflora species at <5% including *Einadia nutans* Nodding Saltbush, *Rytidosperma spp.* Wallaby Gras,s *Carex bichenoviana* Plains Sedge, *Carex inversa* Knob Sedge, *Eleocharis acuta* Common Spike-rush, *Euchiton involucratus s.s.,* Star Cudweed and *Senecio pinnatifolius* Variable Groundsel




The relatively high cover of Juncus spp. and low cover and diversity of other native species suggests some disturbance probably due to grazing followed by inundation. Juncus spp. are able to respond rapidly to these types of events and become dominant biomass of lignum wetlands.

Exotic species diversity and coverage was moderate at this site. Although the diversity of species resulted in high biomass of exotics even though coverage of individual species was not high. *Arctotheca calendula* Cape Weed *Avena fatua* Wild Oat and *Nassella trichotoma* Serrated Tussock occurred at >5% coverage with a diverse range of other species filling in vacant niches. Species of high impact included *Carduus tenuiflorus* Slender thistle *Cirsium vulgare* Spear Thistle, *Cynara cardunculus subsp. flavescens* Artichoke Thistle *Ehrharta erecta* Panic Veldt-grass *Ehrharta longiflora* Annual Veldt-grass *Galenia pubescens var. pubescens* Galenia *Lycium ferocissimum* African Box-thorn *Marrubium vulgare* Horehound and *Oxalis pes-caprae* Soursob. Cumulatively they occupies 25-50%.

# Binghams Swamp (70071): modified Lignum Swamp (EVC 104)




**Other values and threats.**

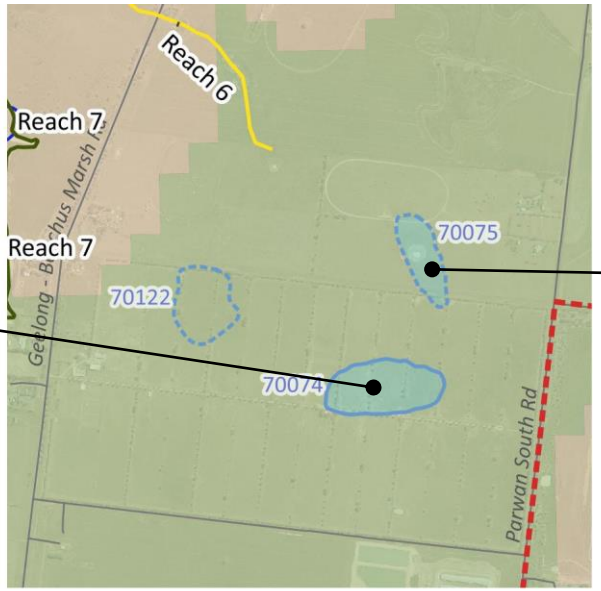
Binghams Swamp partially intact vegetation. It was not grazed at the time of assessment however the property has a large number of goats and it is likely that they are able to access the site on occasions. No significant flora species were observed.

Changes in hydrology are threat with a range of small channels excavated adjacent to parts of the site and structures built within and around the site. The local catchment remains partially intact with some diversion of water both to and away from the swamp as a result of nearby roading. It is partially fragmented from adjoining vegetation due to intensive land use.

A number of immediate impacts were evident including the invasion of *Nassella trichotoma* Serrated Tussock and *Cynara cardunculus subsp. flavescens* Artichoke Thistle.

The combined impacts of rabbit browsing, with *Lycium ferocissimum* Boxthorn and *Cynara cardunculus subsp. flavescens* Artichoke Thistle (e.g. around existing dam excavation) providing harbor was evident. This site still however has a range of significant fauna values recorded and is a high priority to protect, maintain and establish and appropriate buffer. Any surrounding development must carefully consider the impact of changes to hydrology for Bingham's Swamp.

# Genetics Australia wetlands: modified EVC 125 Plains Grassy Wetland



Legend

*Modelled Ecological Vegetation Classes (EVC 1750)*

- Lignum Swamp (EVC 104)
- Plains Grassy Wetland (EVC 125)
- Red Gum Swamp (EVC 292)

*Assessment of wetlands*

- Yes
- No
- Other waterways
- Roads
- Railways
- PSP boundary

0 250 500 m

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Aerial imagery from 2010-2020 was reviewed to identify areas of potential wetlands across the study area that did not have associated site specific data about flora and fauna. Our review identified variation in the tone of vegetation especially evident in 2011 (see above) after high rainfall.

Vegetation for these two wetland locations is mapped as Plains Grassy Wetland (EVC125). Our assessment sough to confirm the presence of this community and to determine of this vegetation may qualify as SHW.

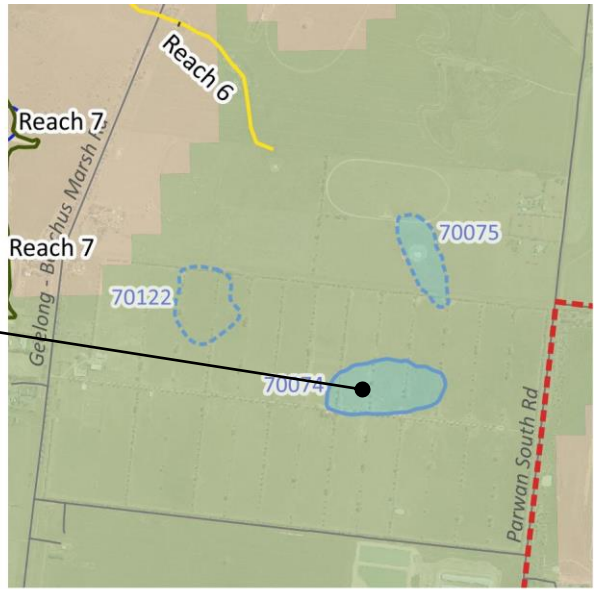
As would be expected of grassland community no native remnant overstorey or mid-storey vegetation was observed. Some planted *Eucalyptus spp.* and *Allocasuarina sp.* were observed. The property on which these wetlands occur is owned by Genetics Australia. This site is a location where a large number stud bulls are kept.

At the time of assessment these locations were grazed by stock with not all portions of the apparent wetland footprint being accessible.

Vegetation on the east side of the north wetland was reviewed. The entire south wetland was able to be reviewed however only a small rim of wetland vegetation in the excavated dam was visible, all other area were dominated by exotic/pasture species.

Across both wetlands a total of 36 species were observed comprising of 19 exotic species and 17 indigenous species. The site was free of problematic species such as *Nassella trichotoma* Serrated Tussock although a small patch of <20m2 of *Nassella neesiana* Chilean Needle-grass was identified at the property entrance to the east but not near wetlands.

# Genetics Australia wetlands: modified EVC 125 Plains Grassy Wetland




The barely discernible shallow depressions in the landscape identified via aerial review were reviewed. Pasture in these locations has been intensively managed for a number of years to provide forage for stock owned by Genetic Australia.

On close inspection these depressions contained several ephemeral wetland species indicative of Pains Grassy Wetland and potentially Seasonal Herbaceous Wetlands. At the time of inspection diversity and abundance of these species was low and we could not determine with certainty as to whether these sites would qualify as SHW under the current guidelines.

Legend

*Modelled Ecological Vegetation Classes (EVC 1750)*

- Lignum Swamp (EVC 104)
- Plains Grassy Wetland (EVC 125)
- Red Gum Swamp (EVC 292)

*Assessment of wetlands*

- Yes
- No
- Other waterways
- Roads
- Railways
- PSP boundary

0 250 500 m

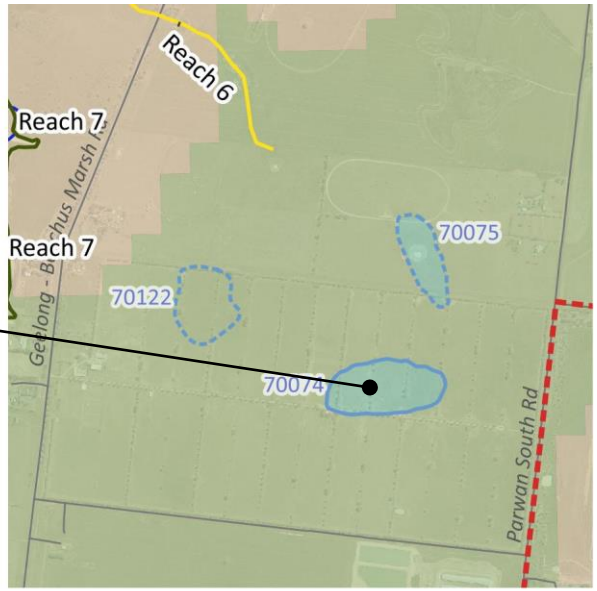
n

Species observed include *Haloragis aspera* Rough Raspwort and *Marsilea drummondii Common* Nardoo, both of which are considered indicator species of SHW but on their own are insufficient to make a determination of SHW. Diminutive examples of *Eleocharis acuta* Common Spike-rush were observed. These plants were being grazed and there was insufficient water int eh landscape for them to reach there full potential height, nevertheless they were flowering.

We suggest that it is possible that these areas may qualify as SHW however the signal was not strong enough at the time of inspection for us to say with certainty that SHW were present. There was insufficient water in the landscape for clear expression of SHW. Further assessment in a year when standing water is visible for several weeks would be required to trigger growth of sufficient diversity and density of wetland species and make a clear determination of SHW.

# Genetics Australia wetlands: modified EVC 125 Plains Grassy Wetland

*Haloragis aspera* Rough Raspwort and *Marsilea drummondii Common* Nardoo, and. diminutive examples of *Eleocharis acuta* Common Spike-rush were observed (see below).




Legend

*Modelled Ecological Vegetation Classes (EVC 1750)*

- Lignum Swamp (EVC 104)
- Plains Grassy Wetland (EVC 125)
- Red Gum Swamp (EVC 292)

*Assessment of wetlands*

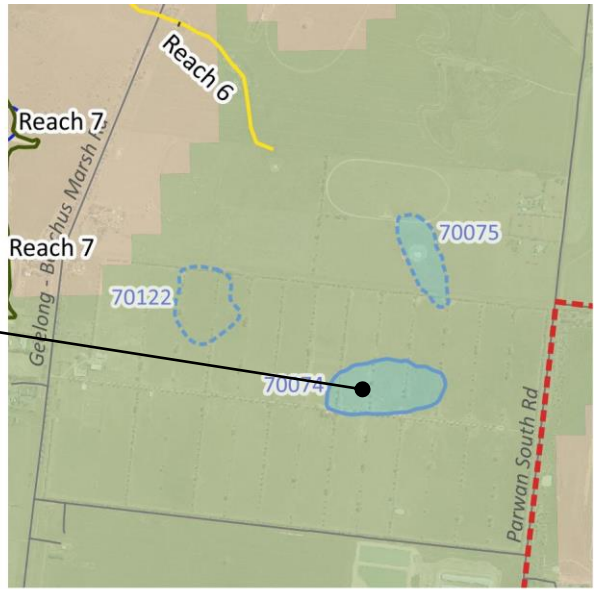
- Yes
- No
- Other waterways
- Roads
- Railways
- PSP boundary

0 250 500 m

n

*Alternanthera denticulata s.s.* Lesser Joyweed above and *Marsilea drummondii Common* Nardoo, below. Both of which are considered indicator species of SHW but on their own are insufficient to make a determination of SHW.

# Genetics Australia wetlands: modified EVC 125 Plains Grassy Wetland




*Potamogeton tricarinatus s.l.* Floating Pondweed above and *Marsilea drummondii Common* Nardoo, below with *Eleocharis acuta* Common Spike-rush. These species are typical of EVC 125 Plains Grassy Wetland.

The southern wetland at Genetics Australia had far less evidence of the former 125 Plains Grassy Wetland than the northern wetland. Vegetation indicative of this community was confined to an excavated dam with species such as *Eleocharis acuta* Common Spike-Rush indicative of the shallow marsh conditions that occur in this location. Note the image above shows a conspicuous green patch indicating the wetland margins. In very wet years vegetation here may comprise of a combination of; grassy and herbaceous species fringing areas of prolonged inundation, shallow marsh species suited to periods of extended inundation and species such *Potamogeton tricarinatus s.l.* Floating Pondweed indicative of the submerged marsh conditions occurring in areas of deeper water. Re-instating the former hydrology is likely to substantially increase the distribution and abundance of wetland vegetation.

Legend

*Modelled Ecological Vegetation Classes (EVC 1750)*

- Lignum Swamp (EVC 104)
- Plains Grassy Wetland (EVC 125)
- Red Gum Swamp (EVC 292)

*Assessment of wetlands*

- Yes
- No
- Other waterways
- Roads
- Railways
- PSP boundary

0 250 500 m

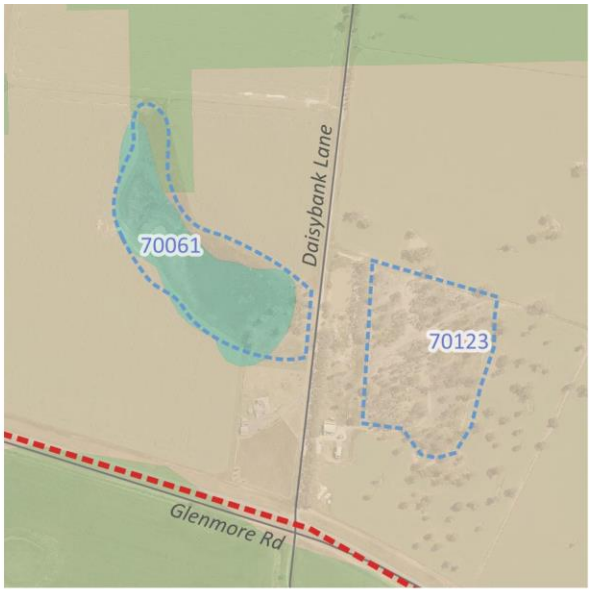
n

# Other wetlands: Daisybank Lane Swamp, possible EVC 125 Plains Grassy Wetland

An area of approximately 5.8 hectares on the west side of Daisybank Lane Swamp in the south western portion of the study area was identified via desktop assessment as a location of potential Seasonal Herbaceous Wetland.

This site was assessed from roadside only as permission was not granted from the landowner to conduct a detailed analysis. The identification of species within the main body of the potential SHW area could not be clearly determined. The site does however conform with the landscape attribute characteristics of a SHW.

Clear evidence of recent and prolonged cropping was evident when assessed and can be observed in aerial images over the past decade. At the time of assessment it appeared that the wetland location was dominated by exotic species however this does not preclude the expression of SHW in a wet year. Inundation would likely trigger the recovery of many wetland species however without formal assessment in an appropriate season it is not possible to determine if the floristic diversity would conform with the definition of a SHW. An improvement would be apparent and more than likely it would comprise of reliable robust species, but due to the lack of access it is not possible to provided greater certainty as the extent or composition of recovery.




Legend

*Modelled Ecological Vegetation Classes (EVC 1750)*

- Lignum Swamp (EVC 104)
- Plains Grassy Wetland (EVC 125)
- Red Gum Swamp (EVC 292)

*Assessment of wetlands*

- Yes
- No
- Other waterways
- Roads
- Railways
- PSP boundary

0 250 500 m

n

The lower middle image is from 2010 which appears to be the wettest year/phase with available aerial imagery. This indicates two distinctive low portions which have potential for SHW expression.

A comprehensive assessment of this site is required in an appropriately wet year. We could neither confirm nor rule out the presence of SHW species at the time of assessment.

Terrestrial Eucalyptus species comprising of *Eucalyptus macrocarpa* Grey Box could be identified as well as native grass species in the terrestrial roadside zone as indicated by the image below. The eastern side Daisybank Lane Swamp grades into a *Eucalyptus macrocarpa* Grey Box woodland.

# Other wetlands: Eastern edge of study area, north of Parwan-Exford Rd


This ephemeral wetland shares some characteristics with Binghams swamp although the area is substantially smaller and there is no publicly available history of fauna observations and records as is available for Binghams. The site comprises of a number of mature and self seeding *Eucalyptus camaldulensis* River Red-gum many of which are likely to bear hollows and provide important habitat for fauna.

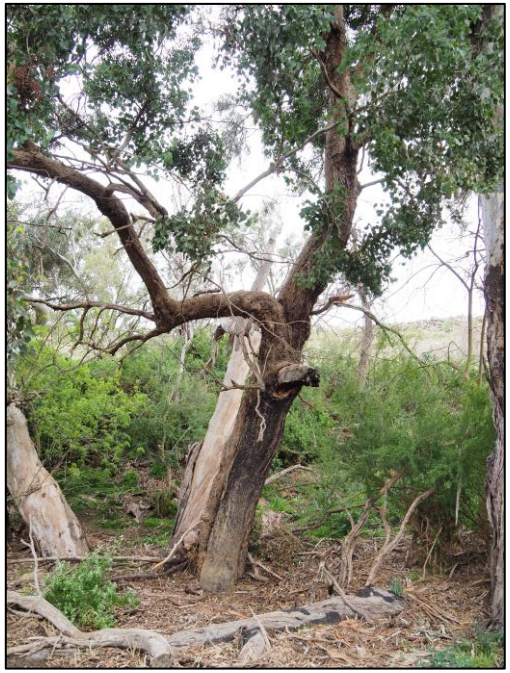
The relatively small scale of this site has resulted in it being missed from existing wetland layers. Vegetation may conform to Lignum Swamp or Red Gum Swamp but further investigation is required. This feature is a strong candidate for protection and as a site to be retained and improved for future open space. Basic changes such as removal of the track that currently dissects this wetland feature and the management of vegetation would continue to improve its habitat trajectory.

An ephemeral wetland adjacent to the Parwan Exford Rd north of the existing railway line was opportunistically reviewed from a public roadside locations. A comprehensive assessment was not carried out however this location of approximately 1.3 hectares is being managed sympathetically by the landowner who was the contact enabling us to access the Parwan Caves.

This ephemeral wetland is not captured on any current data base however is a candidate location for potential future rehabilitation as land use settings may change in the local area. Excess stormwater in a developed landscape would contribute to the decline of this system if water quality, duration of inundation and level are not carefully considered. While not a formal part of the assessment this location should be flagged for future protection with an appropriate watering regime established.

# Significant flora and their conservation status

**Species** *Allocasuarina luehmannii* Buloke
**Status** Vulnerable
**Distribution** Throughout central and north western Victoria, usually growing in woodland with *Eucalyptus microcarpa*, on non-calcareous soils
**Community** EVC 895 Escarpment Shrubland on Reach 1 and 7
**Threats** Non-permitted clearance/smothering by fill, trampling/grazing, competition with woody weeds and exotic ground-flora reducing recruitment



**Species** *Eucalyptus baueriana subsp. thalassina Werribee Blue Box*

**Status** Endangered

**Distribution** Restricted to the Werribee River catchment, mainly around the Bacchus Marsh area but extending south to Werribee. Grows close to watercourses in alluvial soils.

**Community** Red Gum Swamp (EVC 292) in Reach 5

**Threats** Non-permitted clearance/smothering by fill, trampling/grazing, competition with woody weeds and exotic ground-flora reducing recruitment

# Significant flora and their conservation status

(Image; VICFLORA online)

**Species** *Dianella longifolia var. grandis* Dianella
**Status** Critically Endangered

Note that the identification of this species needs to be confirmed for Reach 2. No flowering material was available at the time of assessment however other characterises such as leaf form, structure and habitat are consistent with this species.

**Overview** (from Vicflora online) Plants to 1.3 m tall, tufts solitary or forming loose patches to c. 40 cm wide. Leaves glaucous, rather thick-textured and firm, 12–25 mm wide at midpoint when flattened. Flowers Nov.–Dec.

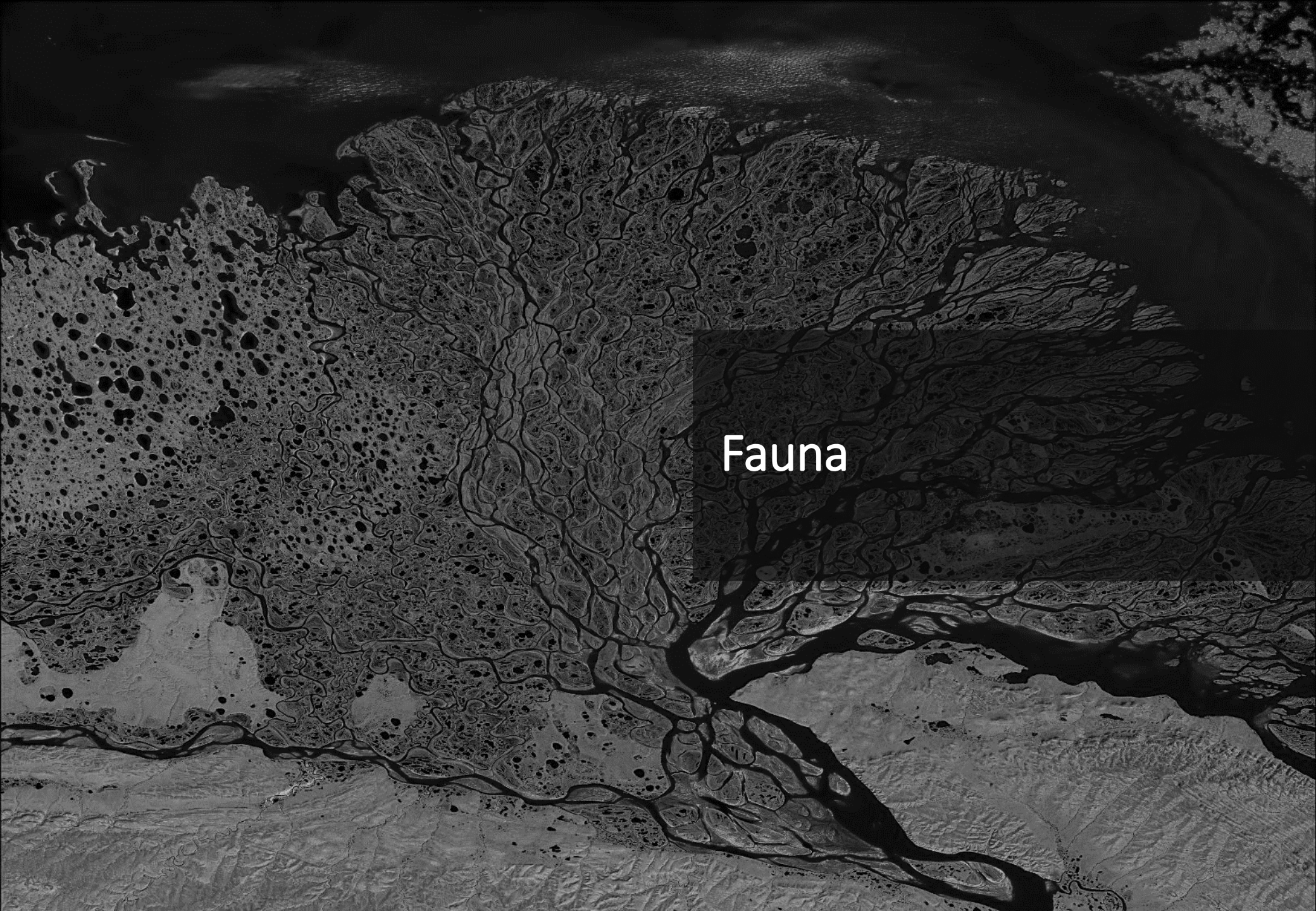
**Distribution** Occurs in lowland plains grassland and grassy woodlands (e.g. Volcanic Plain and Riverina) as well as around rocky outcrops at higher altitudes.
**Community** Creekline Grassy Woodland in Reach 2
**Threats** Non-permitted clearance/smothering by fill, competition with woody weeds and exotic ground-flora impacting mature plants and reducing recruitment

# Significant flora and their conservation status

**Species** *Nicotiana suaveolens* Austral Tobacco
**Status** Rare
**Distribution** Scattered on exposed rocky escarpments and slopes
**Community** EVC 895 Escarpment Shrubland Reach 6 and Reach 1
**Threats** Herbivores, weed competition (particularly exotic ground-flora) and interrupted recruitment due to browsing or inappropriate fire regime

Austral Tobacco (Image; VICFLORA online)

**Species** *Rhagodia parabolica* Fragrant Saltbush
**Status** Rare
**Distribution** The Victorian range of this species is limited however it is common throughout the study area. It occurs in sites that are degraded as well as sites of higher ecological value. It capacity to persist in a range of conditions may be due to its high tolerance to drought and possibly its ability to withstand or resist browsing pressure. It must be stressed that while this species occurs in low quality vegetation this occurrence does not impinge on its conservation significance. Quality takes into account the range of factors contributing to an assessment of vegetation on a waterway but does not diminish significance.
**Community** Creekline Grassy Woodland in Reach 1 and 2
**Threats** Non-permitted clearance/smothering by fill, trampling/grazing, competition with woody weeds and exotic ground-flora reducing recruitment


Fauna

# Significant fauna species and their conservation status

## Assessment

A desk top assessment of significant fauna records was conducted for the study area. Records from the Victorian Biodiversity Atlas (VBA), (drawing on a range of sources including BirdLife Australia) were reviewed and collated. VBA records were assessed to identify species associated with riparian and wetland habitat. Figure 14 identifies the area that was assessed for fauna records. This polygon captures the entire study area and goes beyond this area in order to identify relevant records of species that might utilise similar habitat to that which was observed in the study area.

A search of additional local information was undertaken via Nature Share and iNatualist. This data source identified nearby populations of significant species and provided further detail of their recent presence locally. Nature Share records for the study area were cross checked with VBA records.

Victorian and national status was noted for all significant species. This assessment identified 32 species of significance recorded within the study area. 26 species are birds, 4 mammals, 1 reptile and, 1 frog species was noted for the study area.

To further understand the association between significant species and habitat assets we broadly categorised fauna into the habitat types they are most likely to be associated with.

The broad habitat categorises identified include.

- Large Open Waterbody (e.g. Melton Reservoir at the periphery of the study area.

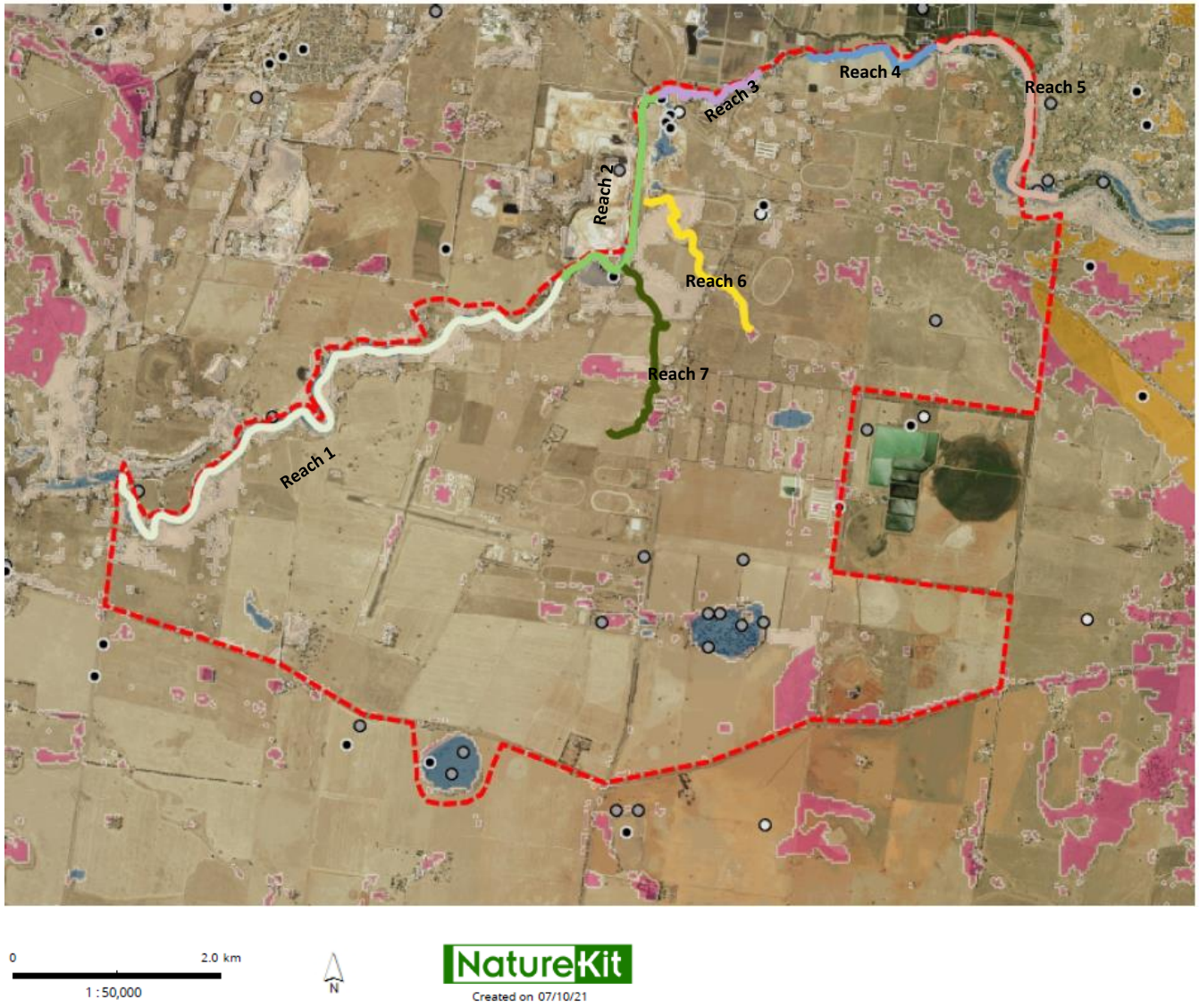



**Figure 14**. *Fauna species records from Nature Print*

# Significant fauna species and their conservation status

- Riparian vegetation (e.g. including Red Gum Swamp and Creekline Grassy Woodland)
- Wetlands (mostly ephemeral wetlands such as Jensz and Binghams Swamp)
- Woodland (associated with riparian areas such as the upper reaches of the Parwan) and
- Transient, generally non resident wide ranging species that may be seasonally responsive.

Note that many species of fauna may occur in several different habitat types, for example Growling Grass Frogs which were observed in Reach 5 in open floodplains adjacent to riparian areas of the Werribee Creek have also been recorded in the upper reaches of the Parwan in Reach 1. They can disperse along waterways and utilise farm dams with appropriate habitat structure in some years. Species such as Australasian Bittern may utilise a range of habitat types with sufficiently dense vegetation including wetlands, riparian areas and large open waterbodies where dense reedy vegetation offers cover for this elusive and cryptic species.

We note that the formation of the Parwanite mineral in the Parwan caves originates from bat droppings. No bat population was observed at the cave entrance during site visits and no information on the ongoing use of the caves as habitat is available.

Other species of management consideration

In addition to those species identified as being of conservation significance Melbourne Water should also consider the potential role that waterways and wetlands can provide in offering habitat for currently common species. Waterways in particular provide important habitat corridors across the landscape for macropods and monotremes. The Eastern Grey Kangaroo *Macropus giganteus* is generally a common species which has been observed in high abundance particular at the urban peri-urban interface after development, where habitat pressures can result in increased numbers of animals using habitat that has been squeezed by urban/industrial development.

Waterways can offer an important habitat refuge and opportunity to move beyond developed areas for this species. Buffer areas enabling their safe transit through the landscape ought be considered at the planning phase.

Furthermore there is an increasing g number of species once thought to be common and widespread now qualifying as species of significance. We are not saying that Eastern Grey Kangaroos are likely to be listed, rather that planning for their habitat needs now may also provide benefits for other species where current population trends may see the listing of formerly common and widespread species. The Platypus *Ornithorhynchus anatinus* being a case in point.

In late 2020 the Victorian Scientific Advisory Committee made their final recommendation to list platypus as threatened in Victoria with the formal listing of this species occurring in early 2021.

Our assessment of the publicly available data identified only a single record of Platypus on the Werribee river in 1988. Anecdotally this species has been observed in the study area more recently but no formal VBA record is lodged.

This species is listed as requiring urgent action for its protection and management and is relevant to the study area. Setting aside sufficient habitat for the maintenance of the resources needed by this species is required. Setting aside sufficient space in the landscape to cater for both terrestrial species such as the Eastern Grey Kangaroo and riparian species such as the Platypus needs to be considered in fulfilling obligations especially for threatened species such as the Platypus.

# Significant fauna species and their conservation status

**Table 2** Significant fauna associated with large open waterbodies in the study area, generally artificial structures but occasionally natural wetlands in years of above average rainfall.

| Scientific name | Common name | Most recent observation | FFG Description | Victorian Advisory List Description | EPBC description | Suitable habitat in study area |
|---|---|---|---|---|---|---|
| *Ardea alba* | Great Egret | 2000 | Listed | Vulnerable | | Likely to use habitat at Melton Reservoir (Reach 5) and possibly opportunistic use of ephemeral habitat in wetland locations. Sites like Jensz Binghams and GA wetlands may be suitable in some years after sufficient rainfall. Less likely to occur in othr riparian reaches. |
| *Aythya australis* | Hardhead | 2005 | | Vulnerable | | Likely to use habitat at Melton Reservoir (Reach 5) and possibly opportunistic use of ephemeral habitat in wetland locations. Sites like Jensz and Binghams Swamp may be suitable in some years after sufficient rainfall. Unlikely to occur in other riparian reaches. |
| *Biziura lobata* | Musk Duck | 1988 | | Vulnerable | | Likely to use habitat at Melton Reservoir (Reach 5) and possibly opportunistic use of ephemeral habitat in wetland locations. Sites like Jensz and Binghams Swamp may be suitable in some years after sufficient rainfall. Unlikely to occur in other riparian reaches. Also recorded near Wheat field wetland in 1988 after a comparatively wet 87/88 summer potentially resulting in ephemeral wetlands being relatively full resulting in use by this species |
| *Oxyura australis* | Blue-billed Duck | 2019 | Listed | Endangered | | Likely to use habitat at Melton Reservoir (Reach 5) and possibly opportunistic use of ephemeral habitat in wetland locations. Sites like Jensz and Binghams Swamp may be suitable in some years after sufficient rainfall. Unlikely to occur in other riparian reaches. Recorded recent;ly at water treatment facility just to the east of the study area indicating viable local population |
| *Phalacrocorax varius* | Pied Cormorant | 2000 | | Near threatened | | Likely to use habitat at Melton Reservoir (Reach 5) and possibly opportunistic use of ephemeral habitat in wetland locations. Sites like Jensz and Binghams Swamp may be suitable in some years after sufficient rainfall with observations confirmed for this species at Jensz . Unlikely to occur in other riparian reaches. |
| *Spatula rhynchotis* | Australasian Shoveler | 2019 | | Vulnerable | | Prefer wetlands with areas of open water fringed by abundant aquatic vegetation e.g. Melton Reservoir (Reach 5) possibly opportunistic use of ephemeral habitat in wetland locations. Sites like Jensz and Binghams Swamp may be suitable in some years after sufficient rainfall. Unlikely to occur in other riparian reaches. Recorded at Binghams swamp |
| *Platalea regia* | Royal Spoonbill | 1991 | | Near threatened | | Likely to use riparian/wetland habitat either permanent or ephemeral water possibly opportunistic use of ephemeral habitat in wetland locations. Sites like Jensz and Binghams Swamp may be suitable in some years after sufficient rainfall. Recorded at Binghams Swamp |
| *Stictonetta naevosa* | Freckled Duck | 1996 | Listed | Endangered | | Prefers permanent fresh water swamps with heavy growth e.g. cumbungi or lignum. Sites like Jensz and Binghams Swamp may be suitable in some years after sufficient rainfall. Recorded at Binghams Swamp |

# Significant fauna species and their conservation status

**Table 3** Significant fauna associated with riparian habitat.

| Scientific name | Common name | Most recent observation | FFG Description | Victorian Advisory List Description | EPBC description | Comment |
|---|---|---|---|---|---|---|
| *Ceyx azureus* | Azure Kingfisher | 1988 | | Near threatened | | Likely to use riparian habitat particularly permanent water. Most observations made at Melton Reservoir (Reach 5) but likely that this species could use habitat on the Parwan in reaches 1, 3 and 4. It is less likely to utilise wetlands unless extended wet periods allow food resources to establish. |
| *Chelodina longicollis* | Eastern Snake-necked Turtle | 1988 | | Data deficient | | May use riparian habitat particularly adjacent to permanent water. Observations made at Melton Reservoir (Reach 5) may utilise wetlands during extended wet periods however vulnerable to predation when moving between habitat in fragmented landscapes such as the study area. |
| *Egretta garzetta* | Little Egret | 1990 | Listed | Endangered | | Likely to use riparian/wetland habitat either permanent or ephemeral water. Observed at Binghams Swamp. May also utilise fringing semiaquatic habitat at Melton Reservoir |
| *Nycticorax caledonicus* | Nankeen Night-Heron | 1988 | | Near threatened | | Observed at Binghams Swamp, may also use riparian habitat particularly adjacent to permanent water reach 5 and potentially reach 1, 3 and 4. |
| *Ornithorhynchus anatinus* | Platypus | 1988 | Listed | Vulnerable | | Riparian dependant observed in the Werribee River at Melton Reservoir. Unlikely to use the Parwan due to its ephemeral nature except during occasional backwatering occurs in Reach 4 |

# Significant fauna species and their conservation status

**Table 4** Significant fauna generally associated with wetland habitat.

| Scientific name | Common name | Most recent observation | FFG Description | Victorian Advisory List Description | EPBC description | Comment |
|---|---|---|---|---|---|---|
| ***Botaurus poiciloptilus*** | **Australasian Bittern** | 1970 | Listed | Endangered | Endangered | May use habitat in study area although record is over 50 years old. This species was observed at Jensz swamp, suitable habitat may also exist at Binghams Swamp and possibly Melton Reservoir. It is unlikely to be recorded in riparian areas especially considering the habitat alterations since this species was observed. |
| *Gallinago hardwickii* | Latham's Snipe | 1990 | | Near threatened | | Likely to use wetland habitat (permanent or ephemeral) where appropriate tussock cover available. Observed at Jensz and Binhams. Suitable habitat may be available at GA wetlands if grassy growth was allowed to develop which currently does not occur due to stock grazing. Unlikely to be associated with riparian habitat in the study area. |
| ***Litoria raniformis*** | **Growling Grass Frog** | 2020 | Listed | Endangered | Vulnerable | Recorded during our assessment, numerous individuals heard calling in Reach 5. Also recorded at a range of wetland and riparian sites in the study area over the past few decades, Previous observations on the Parwan in Reaches 1-5 as well as Jensz and Binghams Swamp. May utilise other ephemeral habitat in wet seasons. It should be assumed that this specie ahs the capacity to occur throughout waterways and wetlands in the study area and it should be accommodated for in future design. |
| *Porzana pusilla* | Baillon's Crake | 1987 | Listed | Vulnerable | | May use wetland habitat (permanent or ephemeral) where appropriate cover and intermittent water body habitat available. Observed at Jensz and habitat is suitable at Binghams, less likely to be at Melton Reservoir and unlikely to use habitat in riparian areas. Generally restricted to wetlands including swamps, billabongs, lakes and reservoirs and temporarily inundated areas. Often prefer wetlands with floating aquatic vegetation |
| ***Rostratula australis*** | **Australian Painted-snipe** | 1989 | Listed | Critically endangered | Endangered | May occasionally use wetland habitat in the study area (permanent or ephemeral) including shallow, terrestrial wetlands, with mudflats and a mosaic of low, patchy vegetation e.g. lignum and cane-grass. Observed at Binghams, may use habitat at Jensz and possibly Melton Reservoir. Unlikely in riparian habitat. |

# Significant fauna species and their conservation status

**Table 5** Significant fauna generally associated with woodland habitat.

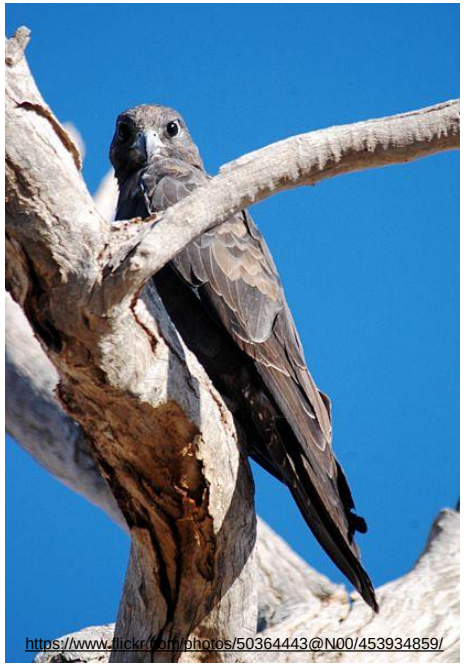
| Scientific name | Common name | Last observed | FFG Description | Victorian Advisory List Description | EPBC description | Comment |
|---|---|---|---|---|---|---|
| *Ardeotis australis* | Australian Bustard | 1911 | Listed | Critically endangered | | A single record very unlikely to occur probably locally extinct. A species of open grasslands and woodlands, not riparian or wetland dependant |
| *Dromaius novaehollandiae* | Emu | 2017 | | Near threatened | | An interesting local record made by the Geelong Field Naturalists, so a credible source, but unknown if this is an escaped farm animal or wild population. A species of open grasslands and woodlands, not riparian or wetland dependant |
| *Phascogale tapoatafa* | Brush-tailed Phascogale | 1982 | Listed | Vulnerable | | A species of box and stringybark Eucalypts Unlikely to use riparian and wetland Eucalypts |
| *Pyrrholaemus sagittatus* | Speckled Warbler | 1977 | Listed | Vulnerable | | May infrequently use riparian habitat, typically lives in dry sclerophyll forests and woodlands, not riparian or wetland dependant |
| *Stagonopleura guttata* | Diamond Firetail | 1988 | Listed | Near threatened | | May use habitat in Reach 1 found in open grassy woodland, or grassland with scattered trees. Observed previously north of Binghams Swamp and in woodlands adjacent to Melton Reservoir. Not riparian or wetland dependant |
| *Climacteris picumnus* | Brown Treecreeper | 1977 | | Near threatened | | May use woodland habitat in the study area but not considered riparian or wetland dependant |
| *Sminthopsis crassicaudata* | Fat-tailed Dunnart | 1988 | | Near threatened | | May use escarpment shrubland and rocky habitat in riparian areas, possibly in Reach 1 or where rocky habitat affords sufficient shelter from predators. Last recorded in open plains presumably in rocky areas north of GA wetlands. Not riparian or wetland dependant |
| *Circus assimilis* | Spotted Harrier | 2019 | | Near threatened | | May use open woodland habitat in Reach 1 or adjacent to large open wetlands with scattered trees adjacent |

# Significant fauna species and their conservation status

**Table 6** Significant fauna that are generally transient.

| Scientific name | Common name | Most recent observation | FFG Description | Victorian Advisory List Description | EPBC description | Comment |
|---|---|---|---|---|---|---|
| *Chlidonias hybrida* | Whiskered Tern | 1987 | | Near threatened | | Transient, using ephemeral flats and wetlands observed at Jensz swamp. This species feeds on small crustaceans, insects and insect larvae, fish and amphibians. May also use habitat at Binghams Swamp and Melton Reservoir. May also forage in open plains. Unlikely in riparian habitat |
| *Falco subniger* | Black Falcon | 2019 | Listed | Vulnerable | | Transient aerial predator, not riparian or wetland dependant but prey on species that are Recorded annually since 2013 (with the exception of 2016). Likely to utilise habiata throughout the study area. |
| *Hieraaetus morphnoides* | Little Eagle | 1990 | Listed | Vulnerable | | Transient predator, not riparian or wetland dependant. Preys upon species that may use a wide range of habitat including riparian and wetland areas. Recorded at Bingham Swamp and Melton Reservoir |
| ***Hirundapus caudacutus*** | **White-throated Needletail** | 1979 | Listed | Vulnerable | Vulnerable | Transient aerial insectivore, not riparian or wetland dependant, the observation of this species was made within a 9km grid that overlaps part of the southern edge of the study area |
| ***Lathamus discolor*** | **Swift Parrot** | 1977 | Listed | Endangered | Critically Endangered | Transient nectivore may occasionally use riparian overstorey when nectar resources available but not riparian or wetland dependant as such, the observation of this species was made within a 9km grid that overlaps part of the southern edge of the study area |
| ***Pteropus poliocephalus*** | **Grey-headed Flying-fox** | 1943 | Listed | Vulnerable | Vulnerable | Transient last recorded 70+ years ago although may be drawn by local fruit production |

JJ Harrison (https://www.jjharrison.com.au/)



https://www.flickr.com/photos/50364443@N00/453934859/

# Significant fauna species and use of key habitat areas within the study site

This assessment reviewed ecological values across the Parwan PSP zone with an emphasis on vegetation. This study identified the generally poor condition of vegetation at the time of assessment.

However much of the habitat associated with riparian and wetland values is highly seasonal. Therefore its potential utilisation by significant fauna should also be viewed in this context. That is, that while fauna records may be intermittent there is still high potential for sites to provide habitat for significant fauna in the right season. Wetlands in particularly may exhibit great fluctuations in the condition of habitat between any given time period and equally may support significant species even in what may be assessed as poor habitat.

A number of key locations stand out as important habitat

- Riparian vegetation Reach 1
- Reaches 3-5 Riparian and floodplain vegetation fringe particularly for GGF and platypus on the Werribee River
- Creekline Grassy Woodland for diverse age structure and potential habitat for significant bird species
- Wetlands (mostly ephemeral wetlands such as Jensz and Binghams Swamp)
- Potential SHW at the Genetics Australia property and properties that were not accessed

Riparian and wetland locations of low habitat potential are also identified below

- Reach 2 is generally in very poor condition however there are records of Growling Grass Frog in the large permanent water body to the south of Reach 2. Any future impact on Reach 2 needs to consider this adjacent value, it was however not assessed as part of our study.
- Reach 6 and 7 are highly degraded with minimal vegetation value and habitat structure for significant fauna.
- Wetlands with a long cropping history now starved from their original hydrology have decreased potential.

## Limitations

A specific assessment or on ground search for significant fauna was not conducted as part of this evaluation. We did not conduct a comprehensive assessment of fauna and their habitat needs. This is an indicative review to highlight fauna and fauna habitat issues across the study area. An on ground assessment of fauna with specialist zoologists is advised combined with planning consideration to maintain habitat connectivity across the landscape

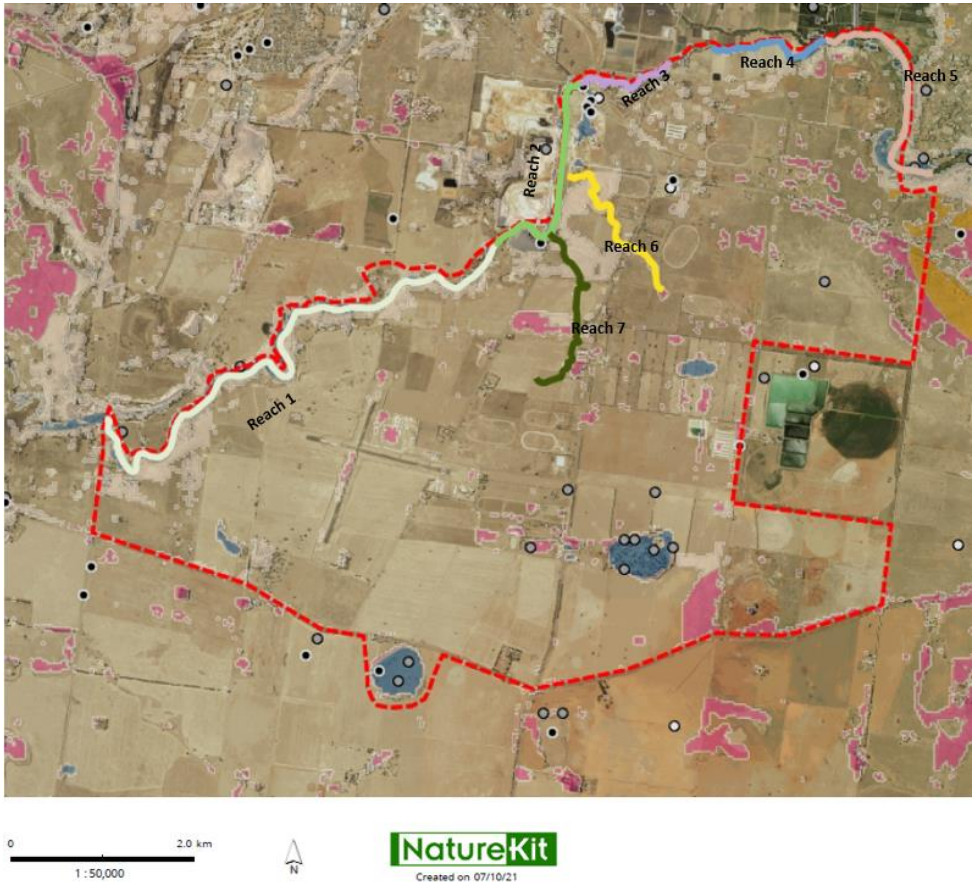
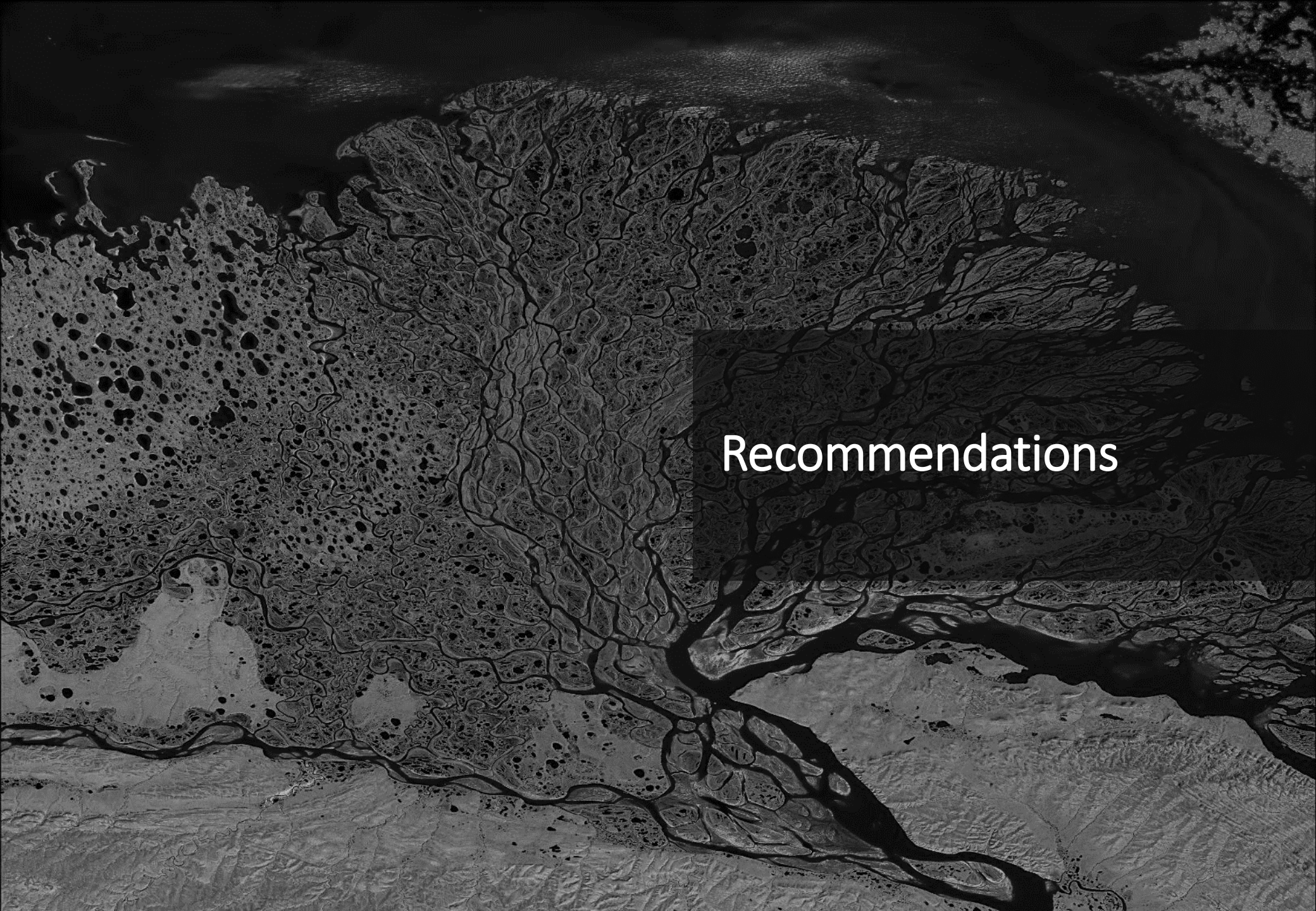



**Figure 15**. *Fauna species records from Nature Print*



# Recommendations

# Key findings

This assessment of the geomorphic and environmental values of the Parwan PSP area has identified a number of significant values as well as landscape and water management challenges.

The geomorphology of the plateau top is largely stable, but the headwater stream that flow towards Parwan Creek are steep and sensitive to erosion under existing and developed conditions. The ecological values of the study area are variable and in some cases, especially in riparian areas, highly degraded. Substantial resources will be required to rehabilitate riparian habitat. Wetland values are more intact and are more amenable to habitat rehabilitation.

The central findings from the assessments are summarised on this page, with commentary and recommendations on the following pages.

1. The headwater streams draining the Parwan Plateau are very steep, and several (but not all) of these waterways cross both dispersive soils and disturbed (unconsolidated) quarry fill. Several of these headwater streams are actively eroding under current conditions.
2. Sodosols of the Werribee Formation are exposed along the escarpment adjacent the right bank of the Parwan River and are sensitive to small changes in runoff.
3. Reach two of Parwan Creek, which has been artificially straightened and confined via a constructed diversion channel, is actively eroding under current conditions. This reach has the potential to be impacted by development unless such development limits the changes in hydrology and/or the diversion is stabilisedid most sensitive to hydrological change due to artificial straightening and lateral confinement by mining operations.
4. Further investigations are required to assess the management options available to stabilise this highly degraded reach of Parwan Creek.
5. Reaches one, three and four of the Parwan Creek are less sensitive to hydrological change due to highly resistant boulders and bedrock exposed in the channel bed (reach one) or well-vegetated channel bed (reach three) or low energy conditions in the backwater of Melton Reservoir (reach four).
6. Geomorphic sensitivity to change is a key driver of biological sensitivity to change.
7. The Parwan Caves, a site of geomorphic significance and host of a rare mineral deposit occur on the plateau surface.
8. Eight vegetation communities (EVCs) identified all are endangered.
9. Five flora species of conservation significance were observed.
10. Extensive buffers and setbacks to protect vegetation combined with active management to reduce the impact of weeds is highly desirable to minimise future impacts
11. Additional vegetation assessments are required particularly where SHW may be evident. These need to be conducted in wet years.
12. Assessment of the groundwater interactions and re-instatement of hydrology is required to further inform the potential ecological rehabilitation of wetlands on the study area
13. Additional fauna surveys may be required as there is a high diversity of significant fauna recorded for the area. Particular attention to EPBC listed species is required.

# Recommendations: geomorphology

The scope of this study was to assess and describe vegetation, geomorphologic processes and identify locations of geomorphic sensitivity to changes in hydrology within the Parwan station and Parwan Employment Precinct areas. The objective was to generate a baseline of information that can inform the response of these values to changes arising from proposed development of the study area including changes arising from modification to the hydrologic regime. From this assessment the following recommendations relating to geomorphology and stormwater management are made:

1. More detailed investigations are required in order to identify the scope of works required to ensure Reach 2 of Parwan Creek is returned to a stable configuration. This channel has been diverted and confined by mining operations and changes in flow regime following development are likely to exacerbate exiting bank collapse and bed incision. More detailed assessments should occur prior to development to ensure a clear pathway for the management and restoration of this eroding reach clearly identified. Those more detailed assessments should include:

    a. Identification of any existing rehabilitation requirements included in any relevant license for the adjacent mine and quarry operations. This may include bringing forward rehabilitation works planned to occur at mine closure, to ensure those works account for the altered hydrology caused by development.

    b. An assessment of channel stability that includes hydrologic and hydraulic modelling for the diversion under exiting and developed conditions.

    c. Development of a management plan for the diversion, the adjacent quarry site and the eroding escarpment between the channel and the quarry.

2. Development of the PSP only proceed with appropriate controls on water management across the study area. These control will require a greater level of investigation and design than that typically applied to urban development in the Melbourne Water region in the following two areas:

    a. Headwater streams that flow over the escarpment on the right bank of Parwan Creek. These small waterways cross dispersive Werribee Formation soils and are therefore are highly susceptible to accelerated erosion. Future water management response will require a higher standard of treatment than BAU prior. Further investigation is required to determine appropriate stormwater management approach for these headwater streams. Further analysis should include:

        - Quantification of the additional volume of runoff likely to be generated by development and the impact of increased runoff on the likelihood of erosion. This assessment should include hydrologic modelling at the annual and event scale, and hydraulic modelling (or similar) in order to develop an erosion potential index for the headwater streams and the two tributaries draining the plateau.

        - An assessment of the most appropriate setback distance from the escarpment edge and from headwater streams for DSS assets and other public and private infrastructure. That assessment should include assessment of the potential for increased groundwater infiltration triggering instability on the escarpment face.

        - Options for revegetation of the disturbed escarpment face adjacent the quarry site and for the establishment of riparian corridors along all headwater streams delivering water from the plateau to Parwan Creek.

3. We recommend the Parwan Caves are protected and that further assessments of the caves are undertaken to:

    a. Map the extent of the caves and then use this more detailed mapping to identify an appropriate setback for constructed waterways, DSS assets or other public or private infrastructure

    b. Understand the source of water entering the caves and the impact development will have on the delivery (and quality) of water delivered to the caves.

4. We recommend that more detailed mapping to identify reference points for waterway, escarpment, and cave setbacks be undertaken. Possible reference points have been included in the recommendations that follow.

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# Recommendations: flora and fauna

In addition to the geomorphology and stormwater management recommendations, we make the following recommendations relating to flora and fauna in the Parwan Station and Parwan Employment Precent PSP area:

1. Further on-ground assessment for fauna values is advised with an emphasis on the assessment of populations and habitat suitability for Growling Grass Frogs throughout the study area. Further fauna assessments should also consider other significant species especially those where appropriate habitat still remains and where observations have been made in more recent time.

2. An assessment of the likely habitat for platypus and a survey of potential populations is proposed especially given the recent declaration of this species as threatened.

3. Wetland features of high current significance and value, especially Jensz Swamp and Binghams Swamp should be afforded the highest protection. Additional assessment of locations that could not be assessed e.g. Daisybank Lane Swamp are advised.

4. A comprehensive plan for the appropriate re-instatement of wetting and drying regimes for wetlands is required. Jensz, Binghams and ephemeral wetlands on the Genetics Australia property, especially those with potential for SHW values are of high priority.

5. Further detailed planning for the re-instatement of vegetation values in Reaches 1 and 5 are of highest priority as these currently have form and structure from which to commence habitat improvement. Reaches 3 and 4 have basic structure to commence rehabilitation but will require substantial efforts to rehabilitate. Values are largely compromised in reaches 2, 6 and 7 with a re-set of ecological values proposed which will require extensive planning to implement and sufficient resourcing over many decades.

6. Planning for the rehabilitation of waterways and wetlands must also take into consideration adjoining terrestrial habitat especially where riparian vegetation will act as a habitat corridor throughout the landscape. High value grassland and grassy woodlands occur on the north eastern boundary of the assessment area. Protection of vegetation on the Werribee River adjoining to the Parwan will facilitate the linking of habitat on an east/west axis.

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# Recommendations: possible reference points for future environmental buffers

This section summarises the possible reference points for setbacks used to protect waterways and sensitive hillslopes in the study area. The buffers are used to both protect existing waterway form and to manage the impacts of development on the hydrological regime of the waterways in the study area. We have identified a possible buffer for each of the four reaches of Parwan Creek, the two tributaries of Parwan Creek and for the headwater streams on the plateau escarpment.

Plateau escarpment: We recommend that a setback be defined to protect the plateau escarpment within the PSP area. The break in slope that defines the top of the plateau escarpment could be used as a reference point for an escarpment setback. The purpose of this setback is to protect the escarpment from erosion and inappropriate development. The setback width will need to be set to ensure that DSS assets do not alter groundwater flow paths and trigger tunnel erosion in the sodic soils on the escarpment face. Further investigations, which could be undertaken once the type and extent of DSS assets has been identified, are needed to determine an appropriate setback width along the eastern and northern escarpments.

Reach 1: We recommend the top of the escarpment that defines the eastern margin of the Parwan Valley through Reach 1 (which can be identified via the break in slope) be used as a reference point for future setbacks to protect Reach 1. Inclusion of the floodplain on the valley floor and the face of the escarpment within a Reach 1 buffer zone will assist to ensure inappropriate development does not impede flood flow within the valley or destabilise the escarpment face.

Headwater streams at escarpment edge: The section of the headwater streams on top of the plateau often lack a clear break in slope that could serve as a top of bank reference points for setbacks. Where this is the case, setbacks should be set using the 100 yr flood extents under developed conditions.

Reach 2: The current top of bank of the quarry embankment and the diversion channel in Reach 2 can serve as a possible reference point for waterway setbacks in reach 2. However, we note that this channel is highly modified and more substantive changes in channel dimensions may require modification of the location to the top of bank. An appropriate top of bank reference point should be identified for Reach 2 once the future channel planform associated with an appropriate waterway rehabilitation program is finalised.

Reach 3: The existing top of bank, which can be clearly identified using LiDAR data, is the most appropriate reference point for waterways setbacks between the upstream end of reach 3 and the junction with the Lerderderg River. Between the junction of the Lerderderg River and the start of Reach 4, the toe of the escarpment should be used as a reference point for setbacks, to avoid inappropriate development impacting on the floodplain channels adjacent the right bank of the Werribee River.

Reach 4: Waterway setbacks in Reach 4 should be designed to avoid inappropriate development impacting on the floodplain channels adjacent the right bank of the Werribee River, which may also be retained as habitat features. The toe of the escarpment is one possible reference point for the maximum extent of a waterway setback in reach 4. Alternative reference point include the top of bank of the Werribee River. The most appropriate setback reference point can be determined once the ultimate land use for the floodplain adjacent the Werribee River is finalised. Setbacks in reach 4 may still allow for open public space within the buffer zone.

Tributaries 1 and 2: The lower gradient section of tributaries 1 and 2 on top of the plateau often lack a clear break in slope that could serve as a top of bank reference points for setbacks. Where this is the case, setbacks should be set using the 100 yr flood extents under developed conditions. Setbacks will need to be wide enough to accommodate planned DSS assets and should also be wide enough to allow a buffer of native riparian vegetation to establish. Where a clear break in slope marks the valley of that cross the escarpment edge, the break in slope that marks the top of the valleys is an appropriate reference points for waterway setbacks.

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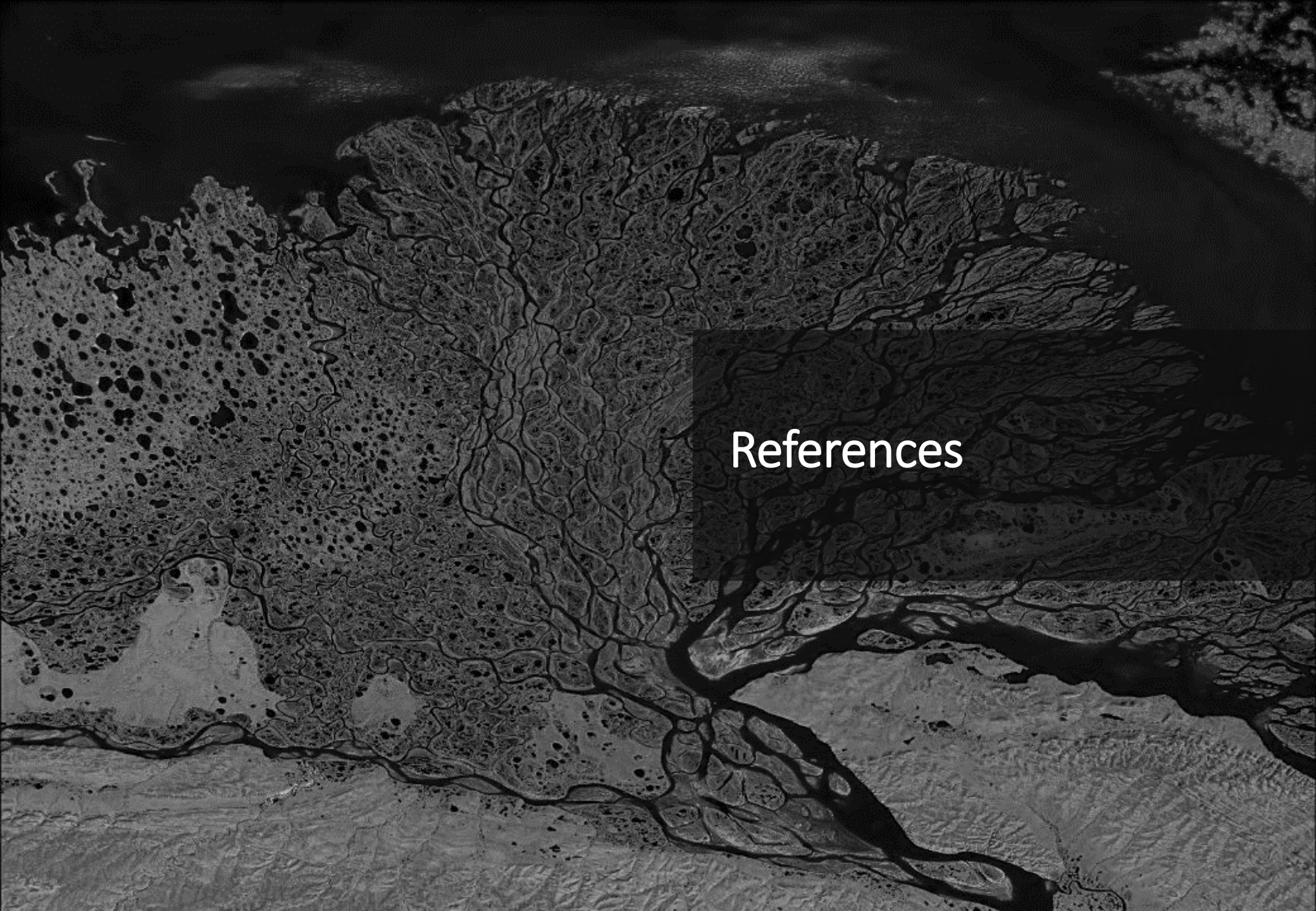

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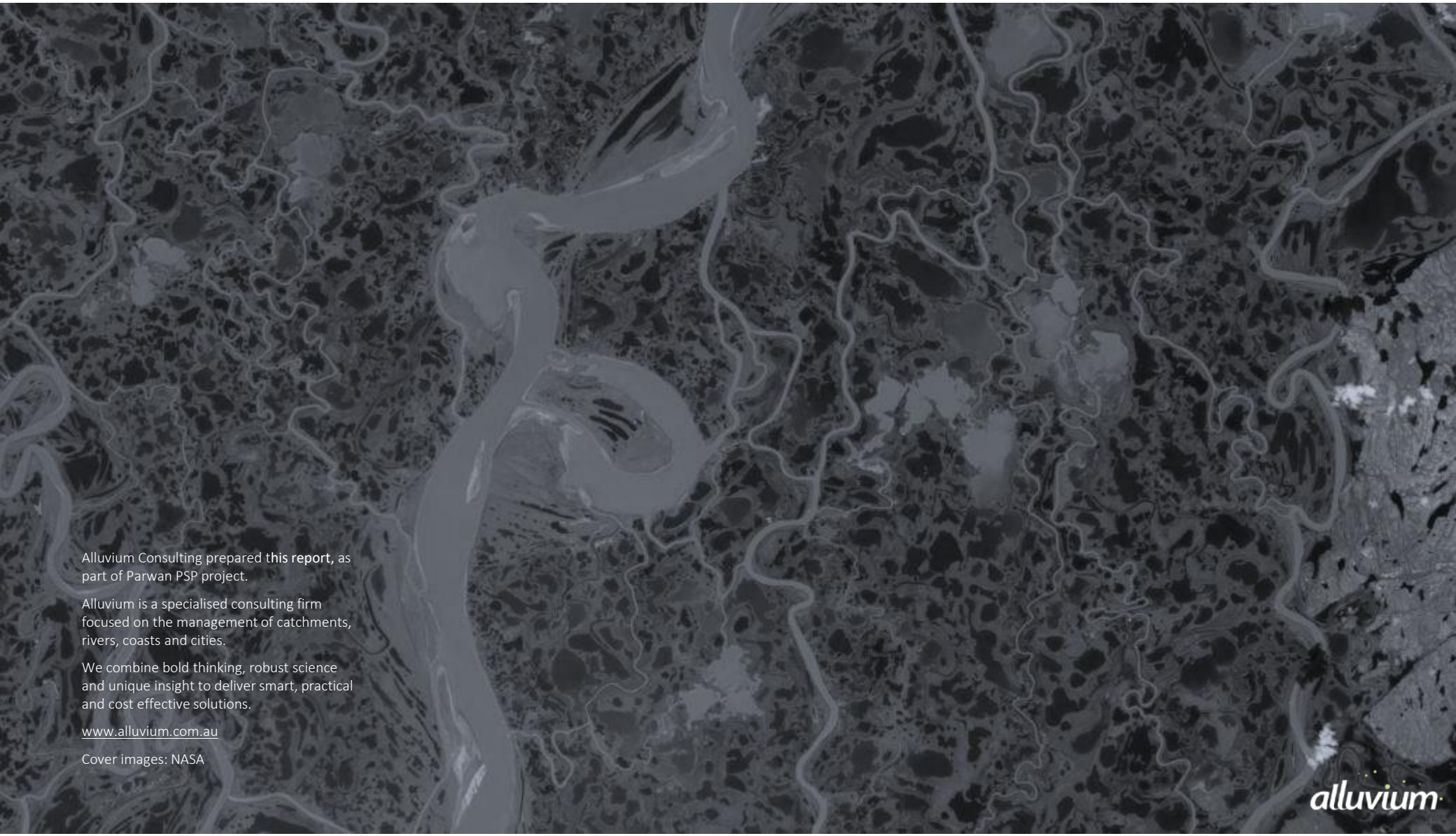

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