



Silverton Wind Farm: Vegetation Monitoring Report - 2018

DRAFT REPORT

Prepared for GE Renewable Energy

29 June 2020

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- Julian Turner (mapping)

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1. Introduction

1.1 Project background

Biosis Pty Ltd was commissioned by GE Renewable Energy (GE) to undertake the 2018 monitoring of the vegetation of Silverton Wind Farm (STWF) in accordance with the operational Biodiversity Adaptive Management Plan (BAMP) (Biosis 2018a). Silverton Wind Farm is located approximately 5 kilometres north of Silverton and 25 kilometres north-west of Broken Hill in the Unincorporated Area of the Far West District of New South Wales (NSW) (Figure 1). The turbines are located on the ridgelines in and around the Mundi-Mundi and Barrier Ranges.

The Silverton Wind Farm project is being undertaken by the Powering Australian Renewables Fund (PARF), a partnership between AGL, QIC and Future Fund. PARF engaged GE-CATCON (a consortium led by GE and Civil and Allied Technical Construction Pty Ltd (hereafter referred to as CATCON) under an Engineer, Procure and Construct (EPC) Contract to deliver the Silverton Wind Farm works. GE is now responsible for management of the STWF site during the operational phase. TransGrid (Network Service Provider – NSW) has been engaged under the Project Agreement to deliver the connection works.

Condition 18(c) of the Project Approval required that prior to the commencement of construction, a Biodiversity Management Plan was to be prepared for the project for the site. The Biodiversity Adaptive Management Plan (BAMP) (Biosis 2018a) was developed to satisfy that condition and the Statement of Commitments (2009) for the operational phase of the wind farm (See BAMP Appendix 2 for details). In particular, the BAMP specifies the implementation, monitoring and reporting activities for the recovery of the critically endangered Porcupine Grass Sparse Woodland (PGSW) as recommended in the recovery plan (Biosis 2018b).

This report has been prepared to document baseline condition of PGSW at STWF as a component of the monitoring and adaptive management approach outlined in the BAMP. In particular, monitoring of PGSW in conjunction with factors that influence vegetation condition, such as climatic conditions, feral goat and introduced flora populations, is to be undertaken as an initial three year investigation following this baseline survey. The purpose of this monitoring is to inform refinement of on-going management to improve the condition of PGSW within the wind farm area. A comprehensive review of monitoring and management will be undertaken after three years to ensure there is a net gain in the conservation value of this community, being after surveys in spring 2021.

1.2 Purpose

This document provides the baseline survey results of the 2018 PGSW community within STWF. Future survey results will be compared to this baseline data to ascertain the nature of the community response to operation of STWF and other environmental factors.

The objectives of this investigation are to:

- Conduct baseline vegetation monitoring of the PGSW community in accordance with the requirements of the BAMP.
- Describe the vascular flora of the PGSW community.
- Liaise with landholders to gather goat population data.
- Validate and update mapping of goat management infrastructure.

- Collation and mapping of existing data on weed populations.
- Analyse and report on the condition based on spring 2018 survey results.

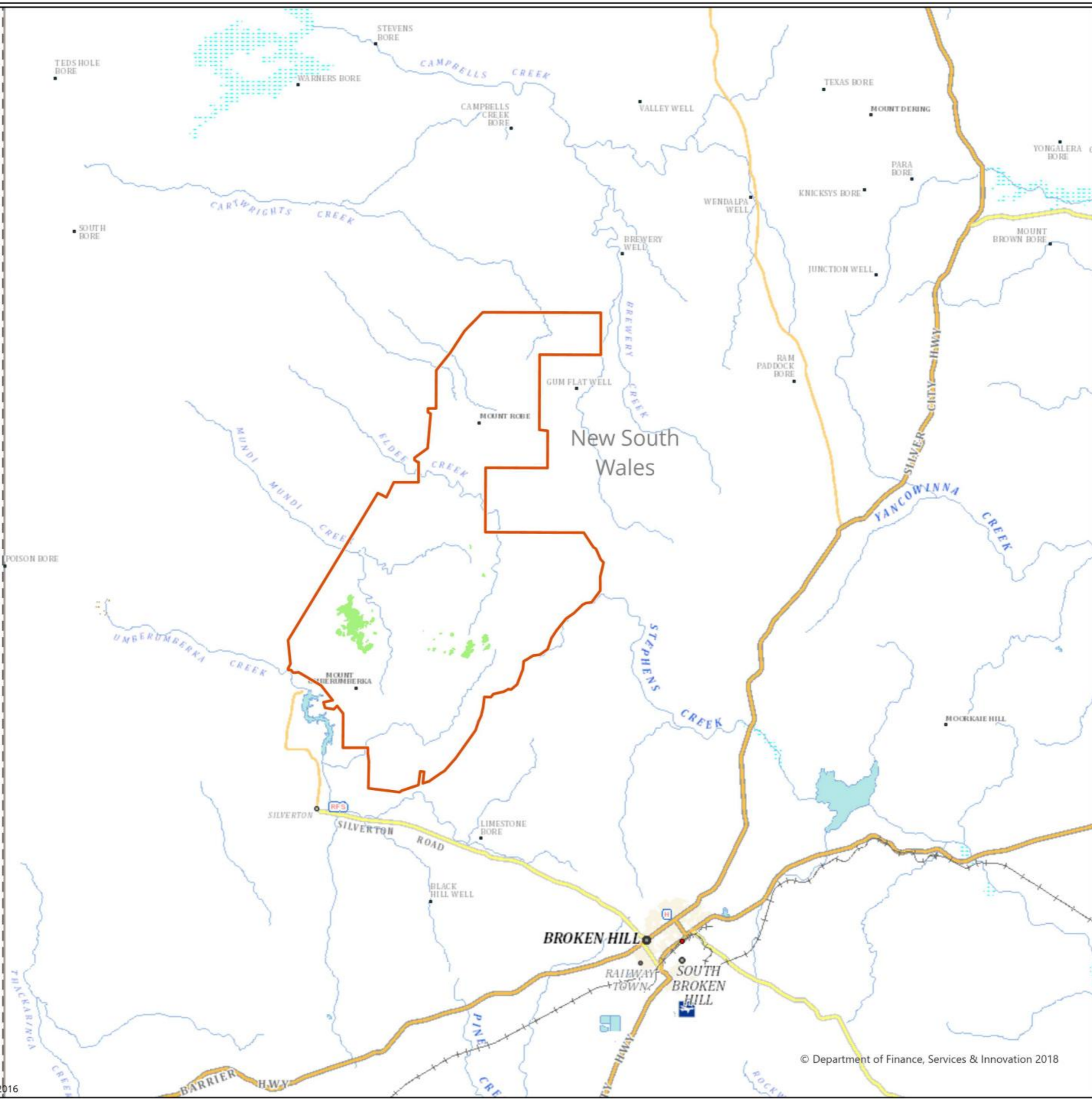
These measures of diversity, structure and function will assist in site management decision-making and provide evidence to demonstrate the attainment of a net improvement in vegetation health and condition.

1.3 Relationship to other plans

This Vegetation Monitoring report is to be read in conjunction with the BAMP (Biosis 2018a), which describes the specific monitoring and management measures to be undertaken during the operational phase of the wind farm to protect and enhance the biodiversity values of the study area. In particular, it provides a cohesive document that details the methods, actions, monitoring and reporting identified for the Barrier Range Dragon Management Plan (Biosis 2018c), Goat Management Plan (Biosis 2018d), Porcupine Grass Sparse Woodland Recovery Plan (Biosis 2018b) and Vegetation Management Plan (Biosis 2018e), into one cohesive implementation document. This allows for an integrated approach to on-ground monitoring and management of biodiversity at the Silverton Wind Farm site.

1.4 Current land management

The Silverton Wind Farm has been constructed on NSW Crown Land offered as leasehold under the authority of the *Western Lands Act 1901*. The land supporting PGSW is currently used by two independent lessees for grazing purposes, including grazing by Feral Goats, under two separate General Purpose Leases. A wind farm lease (Special Purpose Lease) was assigned to PARF as part of financial close on the Silverton Wind Farm project.



Legend

- Study area
- Porcupine Grass Sparse Woodland

South Australia

New South Wales

Figure 1 Location of Silvertown Wind Farm, NSW



Scale: 1:250,000@ A3
 Coordinate System: GDA 1994 MGA Zone 54



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2. Methods

In accordance with the BAMP and associated plans, vegetation monitoring begins with the collection of baseline data in 2018. This will be followed by a program of management, regular monitoring and subsequent adaptive response to monitoring results.

2.1 Pre-survey climate

Monthly climate data for the duration of the monitoring program has been downloaded from the Bureau of Meteorology website <http://www.bom.gov.au>. Data from the weather station at Broken Hill Airport (Station ID 047048) is analysed, as it is the nearest to the study area.

Climate data analysed includes:

- Monthly rainfall total
- Monthly minimum and maximum temperature
- Average rainfall by month
- Average minimum and maximum temperature.

2.1.1 Dynamic nature of arid lands

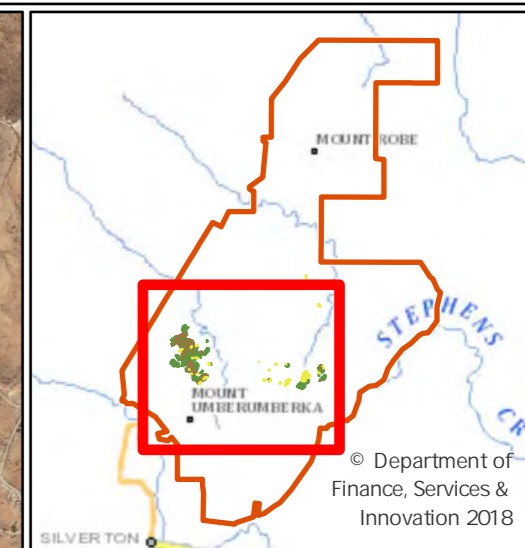
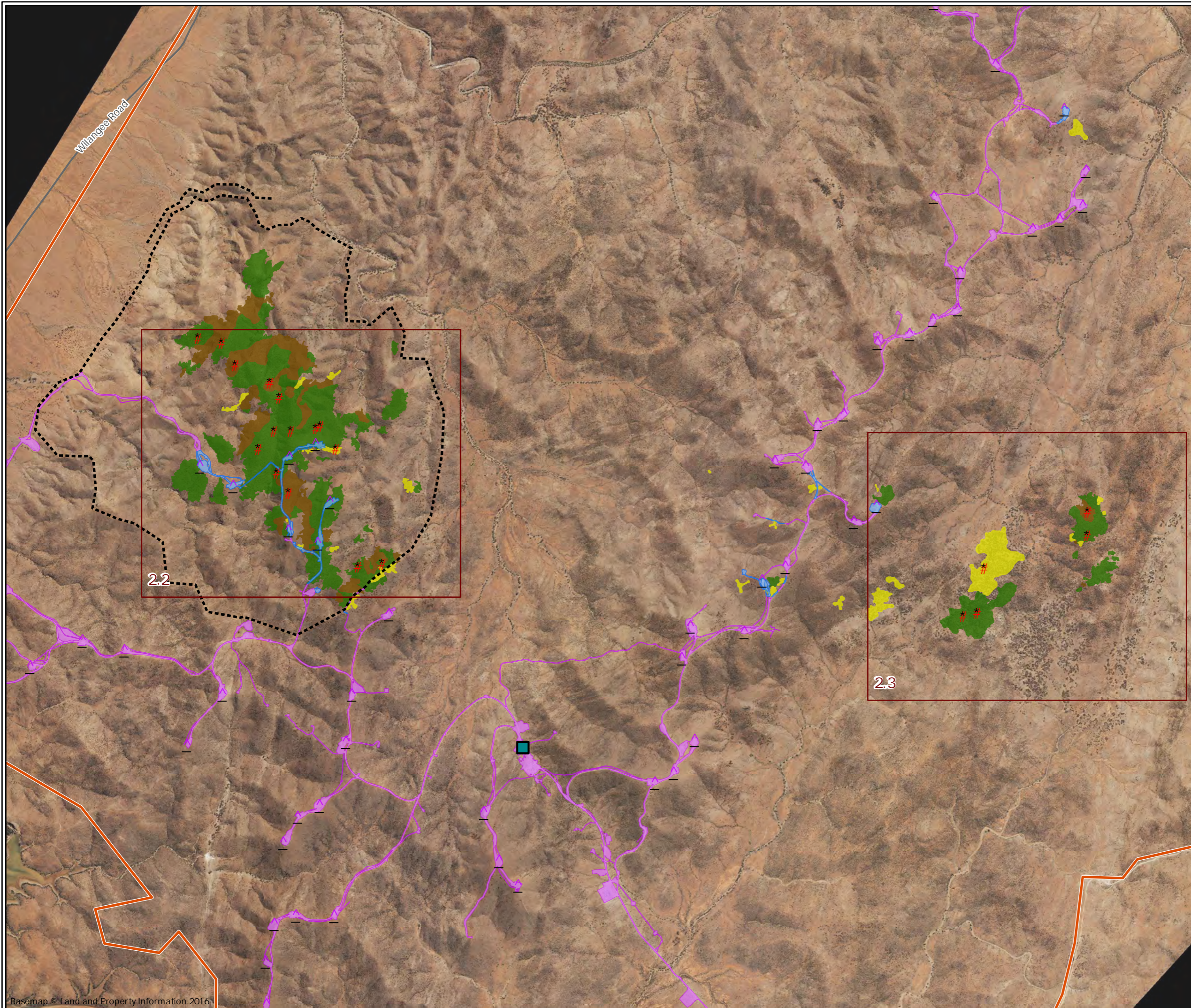
The Silverton Wind Farm is located in the arid zone, where the climate is noted not only for low average rainfall, but high variability in rainfall between years. Extended drought periods are interspersed by rainfall events of varying magnitude, stimulating the growth of flora from dormant seedbanks. Large infrequent rainfall events also provide cues for the recruitment of long-lived perennial plants through flushes of biomass, fruits and seeds (Keith & Tozer 2012). This increased plant growth also triggers population increases in associated fauna species, as resources become abundant.

This inherent variability makes it difficult to detect true change resulting from management actions, particularly in the short term. Having climate data at hand will assist in monitoring the interrelatedness of seasonal weather events and management activities.

2.2 Monitoring site establishment

A goat-proof fence was erected to protect the majority of the PGSW in May 2014. There are only small patches of the community outside the fence. Therefore, monitoring a management response in the vegetation will primarily be achieved through measuring an improvement in 'condition state' from this baseline set of observations.

Twenty monitoring sites (quadrats and associated subplots) have been stratified proportionally within the three known variants of the community according to area (see Section 6.3 of the BAMP). Fifteen sites were located inside the goat fence, with five sites located outside of the goat fence (Figure 2). This will allow for assessment of the impacts of management of goats on vegetation, as well as the success of management actions. Plots were established and permanently marked during this baseline survey.



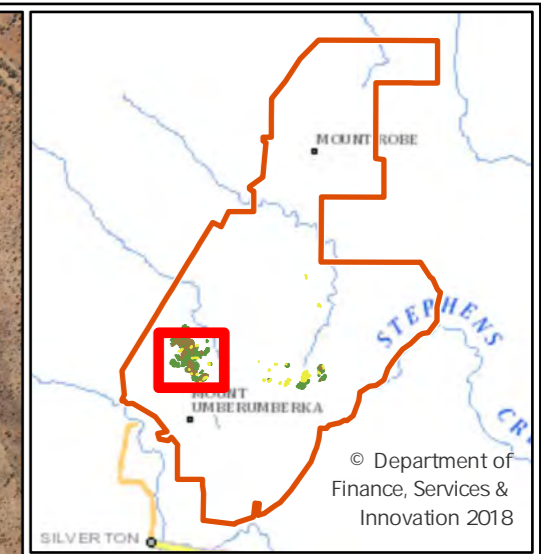
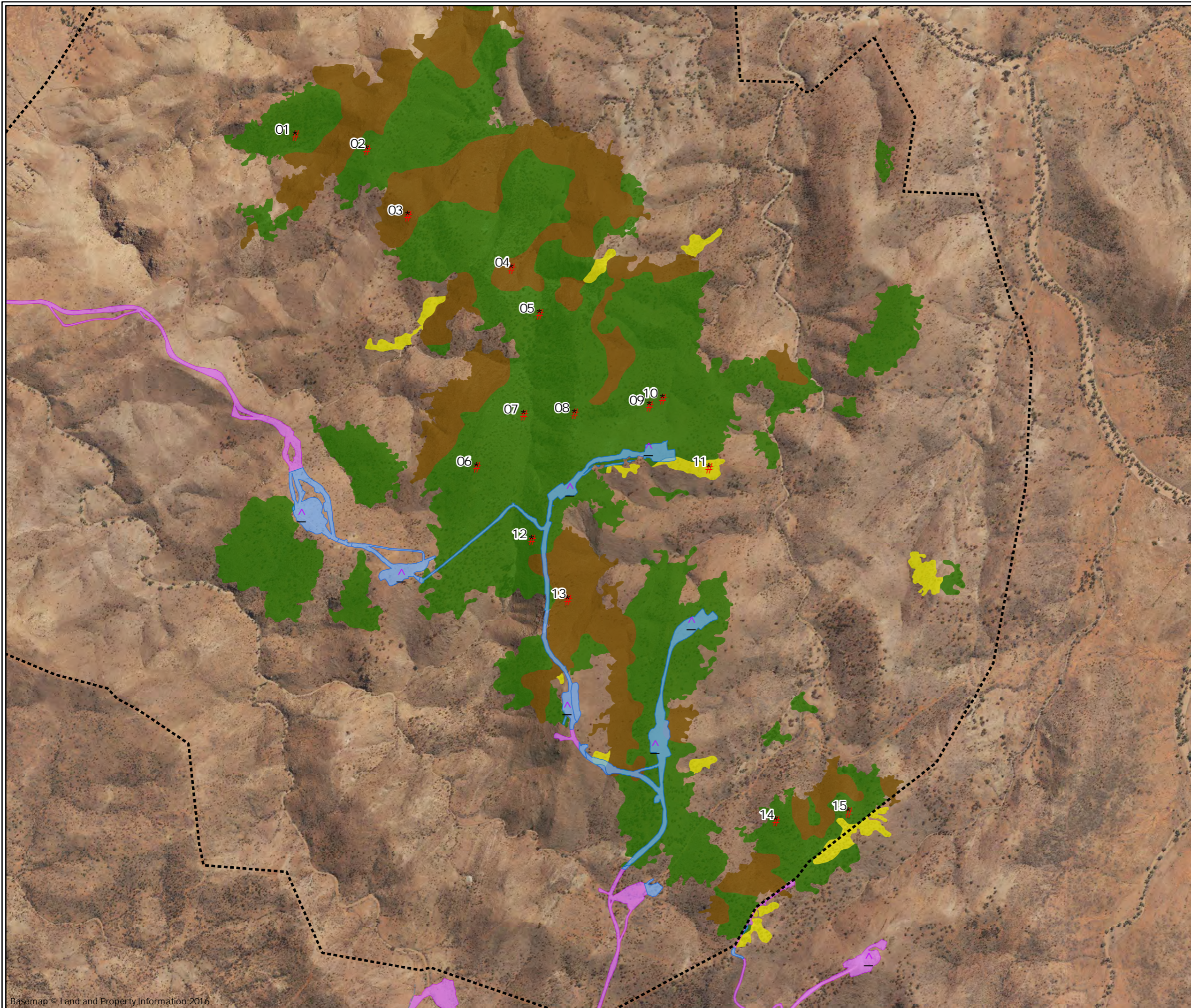
- Legend**
- Study area
 - Infrastructure
 - Infrastructure with PGSW downslope
 - Goat fencing
 - ^ Turbine
 - * Vegetation monitoring site
 - O&M building
- PGSW structural variants
- Porcupine grass with eucalypts
 - Porcupine grass only
 - Eucalypts only

Figure 2.1 Location of permanent vegetation monitoring sites - Overview

0 500 1,000
 Metres
 Scale 1:37,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 54

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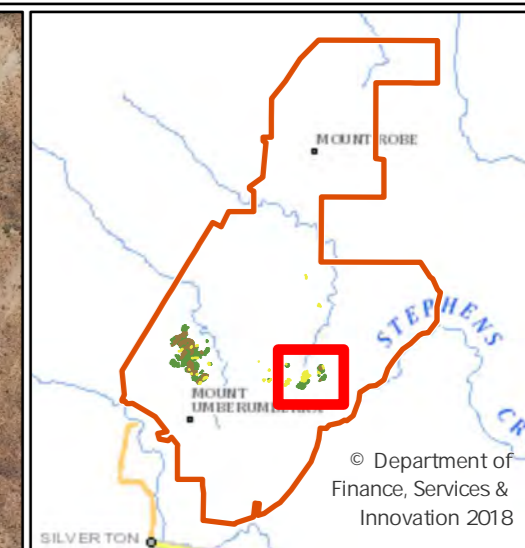
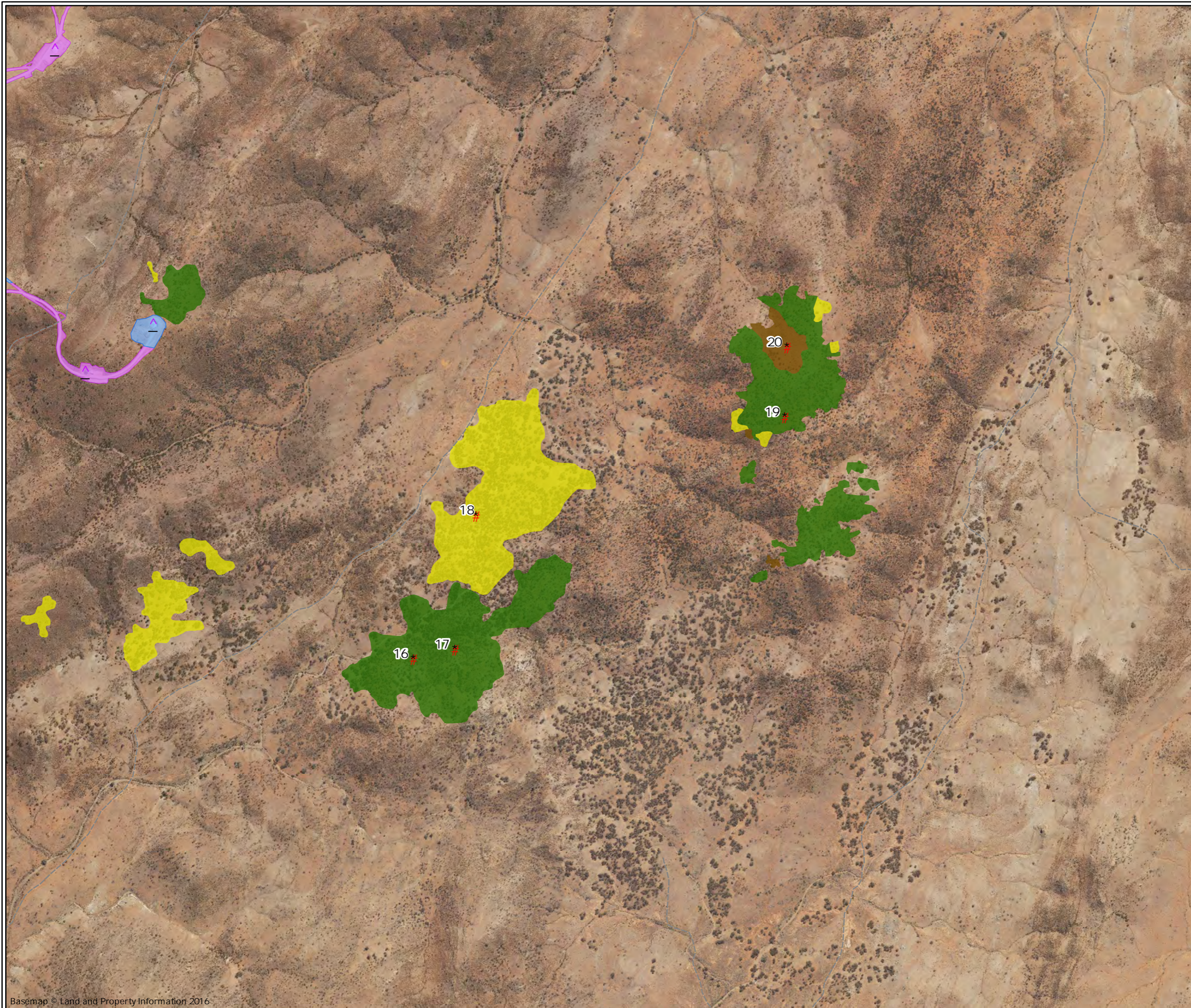
- Legend**
- Study area
 - Infrastructure
 - Infrastructure with PGSW downslope
 - Goat fencing
 - Turbine
 - Vegetation monitoring site
- PGSW structural variants**
- Porcupine grass with eucalypts
 - Porcupine grass only
 - Eucalypts only

Figure 2.2 Location of permanent vegetation monitoring sites - Goat fence / west

0 500
Metres
Scale 1:12,500 @ A3
Coordinate System: GDA 1994 MGA Zone 54

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- Legend**
- Study area
 - Infrastructure
 - Infrastructure with PGSW downslope
 - △ Turbine
 - # Vegetation monitoring site
- PGSW structural variants
- Porcupine grass with eucalypts
 - Porcupine grass only
 - Eucalypts only

Figure 2.3 Location of permanent vegetation monitoring sites - outside goat fence / east

0 500
 Metres
 Scale 1:12,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 54

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In accordance with the NSW vegetation survey standards (Sivertsen 2009), each monitoring site comprises a 20 x 20 metre quadrat, with woody stems recorded in an associated 0.1 hectare plot. To measure fine scale responses, additional 5 x 5 metre subplots have also been established using the same SW corner as the 20 x 20 metre quadrat. The quadrat location was recorded in the SW corner, and the quadrat was aligned with two sides from the SW corner following magnetic north and east. This plot layout is shown in (Figure 3).

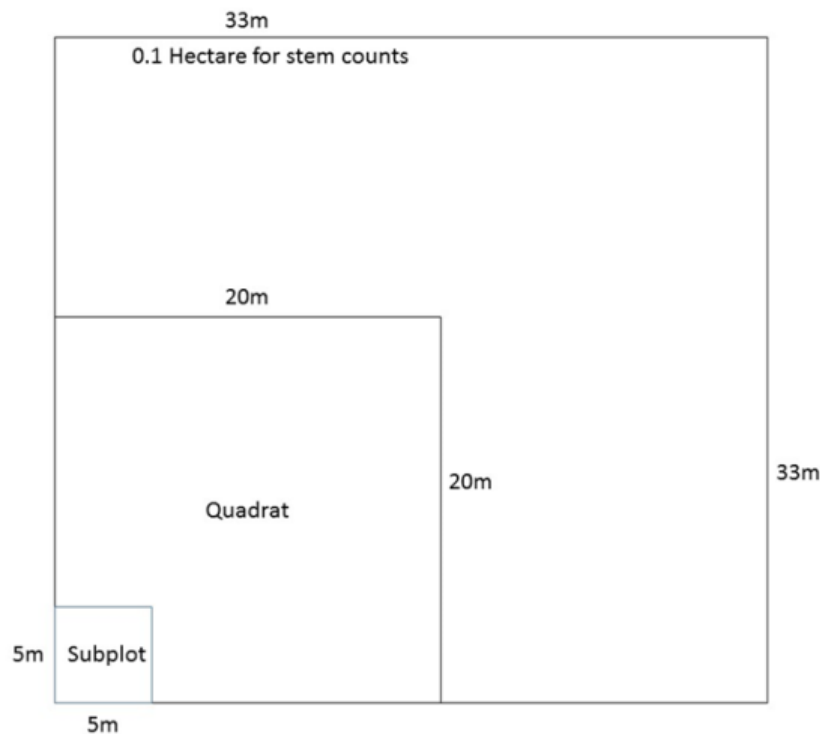


Figure 3 Monitoring plot layout

Survey of the monitoring sites was conducted by four qualified botanists (Steve Mueck, Samantha Barron, Sarah Hilliar and Tim Dredge) on the 23-25 October 2018. An additional survey was conducted by two botanists (Ewan Kelly and Samantha Barron) on 24 and 25 June 2019 to confirm the structural assessment of the vegetation and recapture photopoints at a number of sites.

The monitoring sites were established as follows:

- Prior to commencing survey, site locations, aerial photography and layers identifying existing infrastructure and ecological data were loaded into hand held tablet computers running ArcGIS Collector to allow navigation across the wind farm.
- Sites were accessed on foot and by vehicle.
- At each site a hole was drilled into a rock in the SW corner of each site using a hammer drill, into which a ring bolt was attached using epoxy glue. The rock was sprayed with pink spray paint to increase visibility, and a numbered tag was attached to the ring bolt using a cable tie (See Appendix 1).
- The coordinates of the site were ascertained with the hand held tablet to an accuracy of +/- 5 metres in Geocentric Datum of Australia 1994 (GDA94) using standard map projection Map Grid of Australia 1994 (MGA94).

- ArcGIS collector was used for opportunistic data collection. Quadrat data was collected digitally using Survey123.

2.3 Photopoint monitoring

Photopoints have been established at each site using the following method:

- The survey site was established (Section 2.2) prior to taking photos.
- Site photos were captured using the Open Camera Application on the hand held tablet. Cameras were set to a suitable resolution, and geotagging function turned on so all photos have associated coordinates.
- Camera date and time was checked for accuracy and 'time stamp' function was turned on.
- On arriving at the survey site, Open Camera was started and given time to calibrate to the survey location to ensure accuracy of geotagged co-ordinates.
- A minimum of 12 site photos were captured as follows:
 - Photo of the site tag.
 - From the SW corner (including the corner in image), a portrait and a landscape photo was captured at bearings 0, 45 and 90 degrees.
 - From both the NE corner (including the corner in image), a portrait and a landscape photo was captured at bearings 270, 225 and 180 degrees.
- Field photos have the following requirements:
 - Ensure tapes are placed around the quadrat before taking photos.
 - All strata are to be in view.
 - Step back to ensure corner of the plot is included.
 - Capture ground and sky unless located in a valley and no sky visible.

Any additional photos were also captured as appropriate to capture site condition/species.

2.4 Feral goats

2.4.1 Goat management infrastructure

Exclusion fencing was erected around the majority of the PGSW by leaseholder Blore in May 2014 as part of the Mundi Mundi Conservation Project (Blore 2008), funded by the Total Grazing Pressure Program, Western Local Land Services (LLS). The goat proof fence was erected to temporarily exclude and manage goats for the purposes of protecting PGSW and endangered Barrier Range Dragon. Under the funding agreement, PGSW fencing maintenance is the responsibility of the leaseholder, but no timeframes are specified.

The position of the existing fence and associated goat management infrastructure has been mapped through aerial photo interpretation and liaison with the leaseholder.

2.4.2 Landholder estimates of goat populations

At the time of the vegetation survey, data on the annual goat population over the preceding year have been requested from leaseholders within the project area. For this baseline survey, leaseholders have also been requested to provide insight into how the current populations compare with numbers over the past 10 years.

2.4.3 Scat counts

Abundance and grazing activity by herbivores, including goats, are regularly estimated by scat counts. These have been shown to correlate with actual densities of animals (Russell, Letnic, & Fleming 2011).

Macropod, goat and rabbit scats were counted in all 5 x 5 metre subplots as an approximate measure of herbivore activity. In these baseline surveys, these have been categorised into two classes to provide an indication of past and current grazing pressure – old/dry (grey) and recent/fresh (black). Counts are absolute, for statistical assessment on a continuous scale.

The scats of large macropods likely to occur on the site (e.g. Red Kangaroo *Macropus rufus*, Eastern Grey Kangaroo *M. giganteus*, Western Grey Kangaroo *M. fuliginosus* and Euro *M. robustus*) cannot not be reliably differentiated and so the results for these species have been pooled (Russell, Letnic, & Fleming 2011).

2.5 Condition of PGSW

Porcupine Grass Sparse Woodland is a distinctive and naturally restricted community first identified by NGH Environmental (2008a) following baseline surveys for the Silverton Wind Farm Project. Given the highly restricted distribution of the community, it was subsequently listed as a critically endangered community ((NSW Scientific Committee 2010)) under the NSW *Threatened Species Conservation Act 1995* (replaced by the *Biodiversity Conservation Act 2016* (BC Act)). This community has been formally assigned to the Plant Community Type (PCT) PCT359: Porcupine Grass - Red Mallee - Gum Coolibah hummock grassland / low sparse woodland on metamorphic ranges on the Barrier Range, Broken Hill Complex Bioregion (OEH 2017a).

As detailed in Section 2.1.3 of the PGSW Recovery Plan (Biosis 2018b), variations in species and structural diversity of PGSW is common in its limited geographic range. The PCTs with which PGSW intergrades do not include the characteristic Red Mallee, Gum Coolabah or Porcupine Grass (OEH 2017a). Therefore, PGSW occurs as:

- Porcupine Grass hummock grassland with key eucalypt species present.
- Porcupine Grass hummock grassland without key eucalypt species present.
- Eucalypt species present without/with minimal Porcupine Grass.

Although the community determination (NSW Scientific Committee 2010) identifies Porcupine Grass as a typical community dominant, areas with a canopy layer dominated by Red Mallee and/or Gum Coolabah located on rocky hills containing (or able to be identified as previously having contained) Porcupine Grass, are considered to be part of the listed threatened community, even if these areas currently do not contain Porcupine Grass (Biosis 2018b).

The following section details the monitoring methods to measure the condition of PGSW over time as required by the BAMP.

2.5.1 Vegetation condition

Vegetation condition (floristics and structure) was measured in the 20 metre x 20 metre permanent quadrats, using a simplified form of the NSW vegetation survey standards (Sivertsen 2009). Abundance of all flora species was recorded in the nested 5 x 5 metre subplot (Section 2.5.3).

Within the 20 x 20 metre quadrats (30 x 30 metre for woody stem sizes), the following variables were recorded:

- Structure of vegetation (vegetation strata type, height, dominant species and percent cover of strata), including percent cover of litter, cryptograms, rock and bare ground.

- Projective Foliage Cover (PFC) of all plant species assessed as a relative percentage cover.
- Lineal metres of coarse woody debris (CWD) >10 centimetres diameter.
- Woody stem sizes (within the 30 x 30 metre quadrat).
- Tree health (observations of canopy intactness, insect damage, mistletoe load, epicormic/lignotuber growth etc.).
- Whether regeneration was observed for each woody species.
- Disturbance notes.

A reference specimen has been collected for all plant species where sufficient material was available.

Due to an error in the data collection forms, bare ground and litter were not recorded in the field. Therefore an estimate of bare ground and litter has been extrapolated by subtracting ground layer vegetation cover from 100 per cent (total available cover), and then estimating the proportion of litter to bare ground from site photographs.

2.5.2 Condition of woody species

Woody species occur in low abundance within the community. Therefore the assessment of all woody individuals within the 20 x 20 metre quadrats has been undertaken through an adaptation of the method used by AREA Environmental Consultants and Communication to assess the browsing impacts of goats in Mutawintji NP (AREA 2017). This method is provided in Appendix 2.

For all woody species (or selected key woody species) within each quadrat the following has been documented:

- Height, width at widest point, height of browse line (the boundary between upper normal plant growth and lower stripped and eaten-back growth that indicates the height reached in feeding by the larger browsers) for plants > 2 metres tall.
- Condition above browse line:
 - Good = No dead wood.
 - Dead Wood Fair = Trees with >50% dead wood.
 - Dead Wood Poor = Trees with <50% dead wood.
- Condition below browse line including all plants less than 2 metres in height:
 - Unbrowsed.
 - Low-Moderate browsing.
 - High-Intense browsing.
- Totally browsed (no living growth below browse line).

A condition state of each woody plant to show the current browse state:

- **Uninterrupted** - Fresh new growth with no or very little sign of browsing. Plant growing periodically in relation to natural growth stimuli (rainfall and temperature).
- **Arrested** - Plant in hedged or topiarised form due to intense browsing. New growth continuously eaten and not extending beyond previous browse levels preventing the plant from growing to its natural potential.

- **Retrogressed** - Death of all or some stems previously browsed with new growth occurring from the lower stems. Stem death arises from stresses induced by browse.
- **Released** - New growth from browsed stem not browsed due to temporary or permanent relaxation of browse pressure or plant grown beyond browse line.

2.5.3 Finer scale responses

Nesting of additional smaller subplots will measure fine scale responses of annual / ephemeral plant abundance, which will improve the ability to identify individual species responses to management actions and climatic conditions.

Twenty 5 x 5 metre subplots have been established using the same SW corner as the 20 x 20 metre quadrats (Figure 3). Within these subplots, absolute abundances of all flora species were recorded.

2.6 Introduced flora species

2.6.1 Baseline mapping

Locations of all known populations of introduced flora at the wind farm, particularly NSW DPI priority weeds (Appendix 3), were sought from NGH and CATCON to be collated in a GIS shapefile and mapped in this report to facilitate ongoing management.

During construction, CATCON was responsible for site management and monitoring of the following priority weed locations:

- Existing weed populations.
- Temporary disturbance areas including biomass and spoil derived during road, batter and drain maintenance.
- Restoration areas.
- All other asset/infrastructure maintenance areas.

2.6.2 Ongoing monitoring

In addition to existing weed mapping data for the study area, any additional records arising from the ongoing monitoring during the operational phase of the wind farm will be mapped. Following handover of management from CATCON, GE are responsible for monitoring and subsequent management of introduced weed species as summarised is focussed on three key areas:

- Existing weed populations.
- Areas of construction disturbance.
- Opportunistic observations of new populations documented during the monitoring program.

Inspections will occur more frequently as required, particularly at one and three months following significant rain events (> 25 millimetres) to ensure no new weed incursions have established, or if required following maintenance inspections.

Locations of populations of introduced species observed during ongoing site management by GE operational staff, the future site manager or during ecological monitoring programs are to be provided to the Project Ecologist who will map them in the annual vegetation monitoring report and shapefiles will be provided for inclusion in an annual weed management program.

2.7 Qualifications

Ecological surveys provide a sampling of flora and fauna at a given time and season. There are a number of reasons why not all species will be detected at a site during survey, such as low abundance, patchy distribution, species dormancy, seasonal conditions, and migration and breeding behaviours. In many cases these factors do not present a significant limitation to assessing the overall biodiversity values of a site.

The current monitoring was conducted in spring and winter during an extended drought, which is not an optimal time for survey. As a result of the extended dry conditions, species diversity and abundance is expected to be low relative to any survey conducted following greater rainfall.

2.8 Mapping

Mapping was conducted using hand-held GPS-enabled tablets and aerial photo interpretation. The accuracy of this mapping is therefore subject to the accuracy of the tablets (generally ± 7 metres) and dependent on the limitations of aerial photo rectification and registration.

Mapping has been produced using a Geographic Information System (GIS). Electronic GIS files which contain our flora spatial data are available to incorporate into GE mapping projects informing ongoing management of the site.

2.9 Data analysis

Prior to analysis, field data was collated and reformatted in Microsoft Excel 2016 then tabulated for analysis. Analyses were undertaken in Excel and R version 3.5.3 within RStudio version 1.2.1335 focussing on:

- Climatic conditions prior to survey.
- Species composition within the PGSW community.
- Species richness at each site.
- Cover and abundance of native and introduced flora.
- Ground layer condition (vegetation, litter and bare ground, litter)
- Condition of woody species (particularly the condition above and below the browse line if present)
- Targeted analyses to consider the:
 - Position relative to the goat fence (in or out).
 - Structural variant of PGSW community,

As this is the establishment and baseline phase of the monitoring program it is not possible to undertake any temporal analysis of results. Such analyses will be conducted as data are gathered during subsequent rounds of annual monitoring.

3. Results

3.1 Pre-survey climate

In the year prior to survey in October 2018, an extended drought had resulted in ongoing low monthly rainfall totals relative to the long-term average Figure 4, particularly from January onwards. This was also reflected in the lower number of rain days through that period Figure 5. Total rainfall in the pre-survey 12 month period was 73.0 millimetres, which is well below the long term mean of 247.7 millimetres and close to the lowest rainfall record in a calendar year of 70.2 millimetres in 1982.

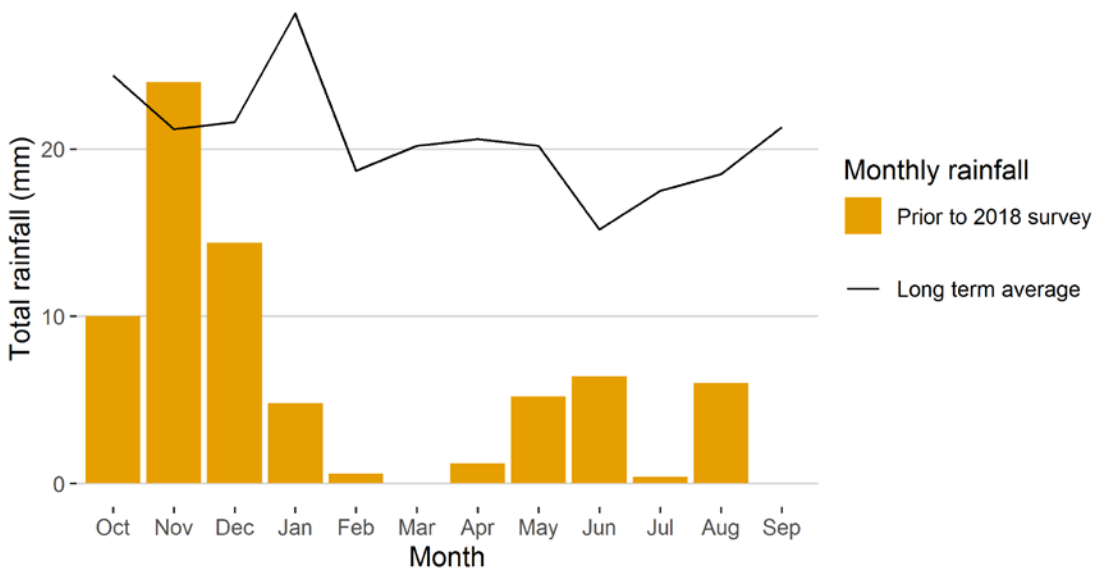


Figure 4 Monthly rainfall totals in the year prior to survey

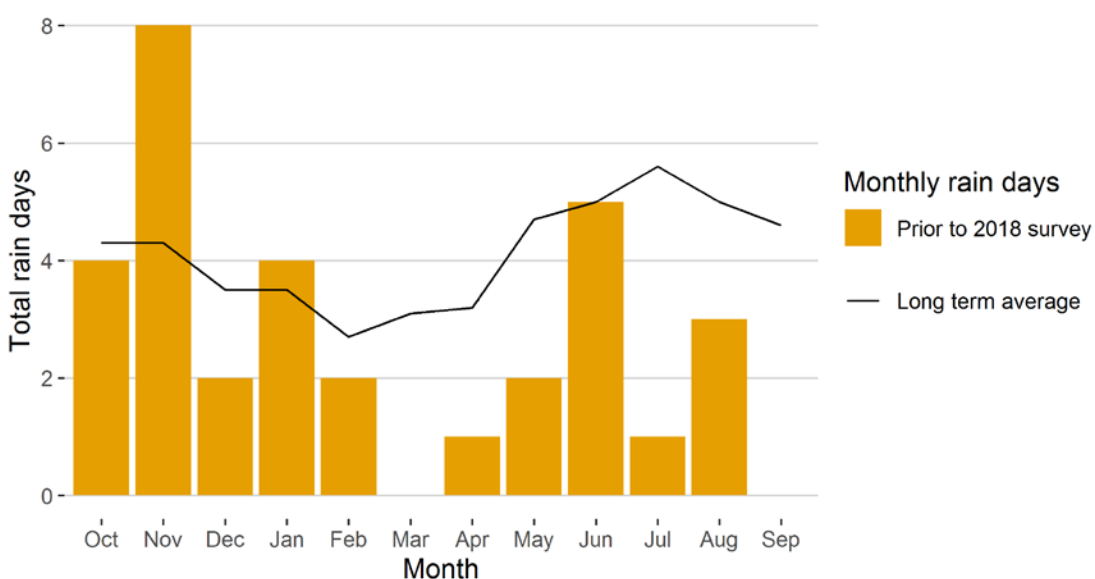


Figure 5 Monthly rain days in the year prior to survey

Average temperatures for each month in the year prior to the baseline survey data did not vary greatly from the long-term average Figure 6, although January and February were hotter than average. Record peak temperatures were not recorded in any month Figure 7.

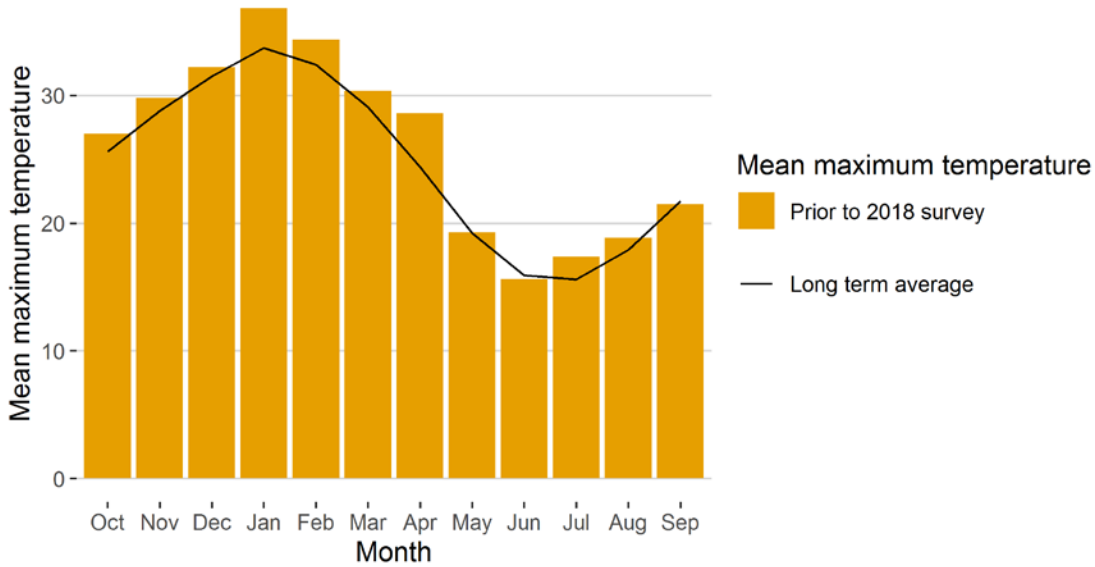


Figure 6 Mean monthly temperature maximums (degrees Celsius) in the year prior to survey

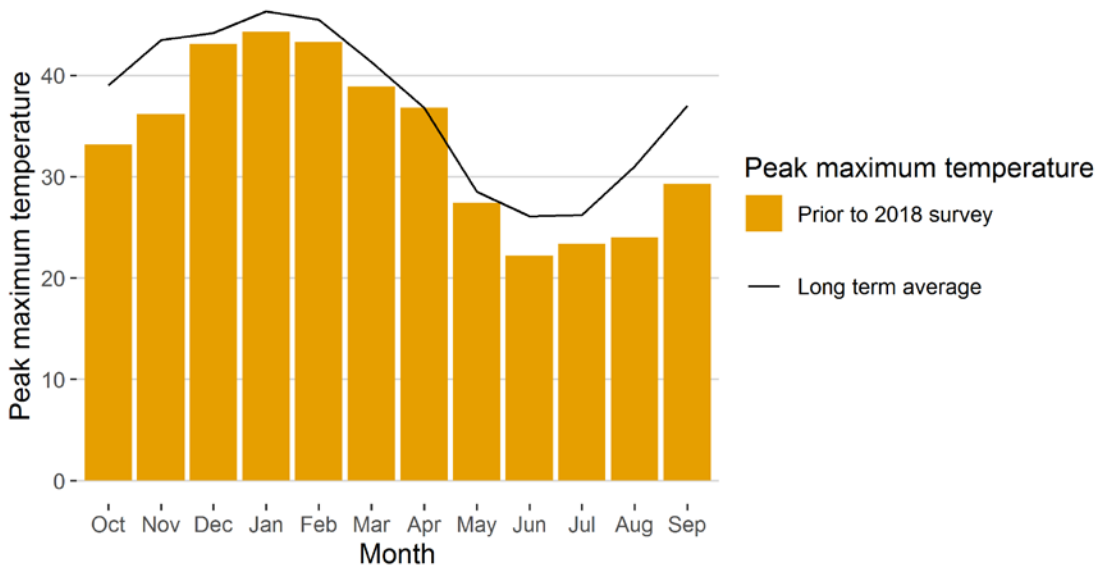


Figure 7 Peak monthly temperature minimums (degrees Celsius) in the year prior to survey

Biosis ecologists were also on-site between 11 and 13 December 2017 to map and validate the full extent of PGSW (Biosis 2018b). While the far west was already in drought in 2017 (annual rainfall in 2017 was 108.6 millimetres), the impact of the extended very dry conditions on PGSW by October 2018 is evident in a photographic comparison of the two survey periods (photographs not from the same location).



Photo 1 Condition of PGSW, 13 December 2017



Photo 2 Condition of PGSW, 23 October 2018

3.2 Sites assessed

Twenty monitoring plots were established during baseline survey in October 2018. All sites were established in close proximity to the planned locations and final locations are detailed in Table 1 (GDA94 Zone 54) and mapped in Figure 2.

Table 1 Location of monitoring plots

Site Number	Community variant	Goat fence	Zone	Easting	Northing
PGSW01	Porcupine Grass with eucalypts	In	54	521924.2	6485480.2
PGSW02	Porcupine Grass with eucalypts	In	54	522175.9	6485428.3
PGSW03	Porcupine Grass only	In	54	522320.7	6485195.8
PGSW04	Porcupine Grass only	In	54	522685.1	6485009.8
PGSW05	Porcupine Grass with eucalypts	In	54	522784.2	6484850.5
PGSW06	Porcupine Grass with eucalypts	In	54	522562.6	6484310.6
PGSW07	Porcupine Grass with eucalypts	In	54	522728.6	6484495.0
PGSW08	Porcupine Grass with eucalypts	In	54	522907.6	6484499.1
PGSW09	Porcupine Grass with eucalypts	In	54	523171.1	6484526.2
PGSW10	Porcupine Grass with eucalypts	In	54	523218.3	6484551.7
PGSW11	Eucalypts only	In	54	523381.2	6484307.8
PGSW12	Porcupine Grass with eucalypts	In	54	522757.4	6484054.3
PGSW13	Porcupine Grass only	In	54	522884.2	6483842.9
PGSW14	Porcupine Grass with eucalypts	In	54	523617.0	6483063.6
PGSW15	Porcupine Grass with eucalypts	In	54	523872.6	6483094.8
PGSW16	Porcupine Grass with eucalypts	Out	54	530012.5	6482542.8
PGSW17	Porcupine Grass with eucalypts	Out	54	530159.0	6482577.0
PGSW18	Eucalypts only	Out	54	530233.0	6483046.8
PGSW19	Porcupine Grass with eucalypts	Out	54	531321.0	6483395.5
PGSW20	Porcupine Grass only	Out	54	531328.7	6483641.8

3.3 Photopoint monitoring

Baseline photopoints were captured in conjunction with the monitoring of the vegetation and are provided in Appendix 1. These photos document the extended dry conditions at the time of baseline survey and illustrate the impact of these conditions on the health of woody species and the Porcupine Grass, which is discussed further in Section 3.5.2.

These photos also document the steep rocky landscape in which the community occurs, and the structural variation of the community (Section 2.5)

3.4 Feral goats

3.4.1 Goat management infrastructure

The position of the existing fence and associated goat management infrastructure has been mapped through liaison with leaseholder Blore and aerial photo interpretation (Figure 8). This indicates the location of key water points and associated trapping yards used to remove goats from landscape.

Since the construction of a goat fence around PGSW in May 2014 to exclude and manage goats for the purposes of protecting PGSW and the endangered Barrier Range Dragon. When goats are grazed in the PGSW, they are harvested approximately every two months, with an average of approximately 500 goats in within the fenced area.

Since 2014, goats have been excluded from within the goat fence during the following periods:

- June 2014 to April 2015
- September 2015 to February 2016
- August 2017 to present, excluding during construction of within the goat fence when the gate remained open to provide site access. Mustering of goats continued during construction in the area.

3.4.2 Landholder estimates of feral goat population

Conversations with the two leaseholders that manage land supporting PGSW indicated that 2018 goat numbers are low when compared with average and good rainfall years (Table 2).

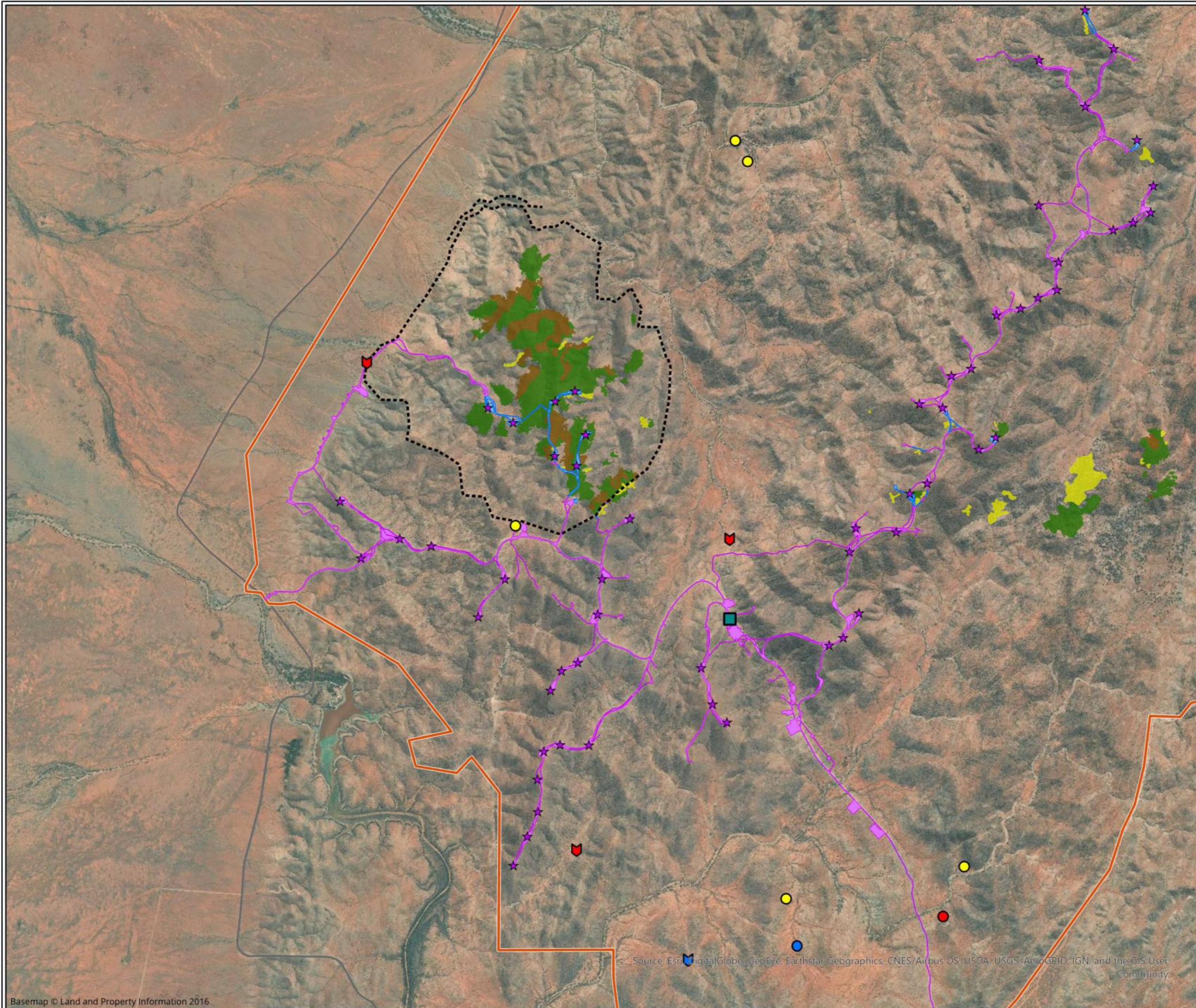
Both leaseholders installed additional management infrastructure in the post Millennium Drought period 2012-2014 of high rainfall, which has increased their capture rates. Additionally, increases in the price per head for goats in mid to late 2018 has made aerial mustering with helicopters economically viable, with leaseholders indicating that this method was worthwhile for a mob of about 200 goats. In late 2018, most leaseholders in the district were apparently using this method.

This combination of drought, additional infrastructure and aerial mustering has removed a greater proportion of goats from the landscape, with leaseholders reporting low numbers of individuals across their properties. Leaseholder Lawrence has provided reporting numbers from his log book, which indicate current numbers are similar to those in 2008/9 during the Millennium Drought. However, given the additional management options and increased capture rates, it is likely that current goat populations in the region are lower than they have been for over 15 years.

Table 2 Estimates of goat numbers provided by leaseholders

Timing	Blore (inside goat fence)	Lawrence (outside goat fence)	Anecdotal price per head
2008/9 (During drought at time of the EIS (NGH Environmental 2008a))	Around 7000 goats a year	2159 – 1973*	
2012-14 (High rainfall period post Millennium Drought)	Around 6000 in the year (Goat fence installed in April 2014)	Around 8000 a year (Additional management infrastructure in place)	\$30
2018	Around 50-100 from within goat fence	3239	

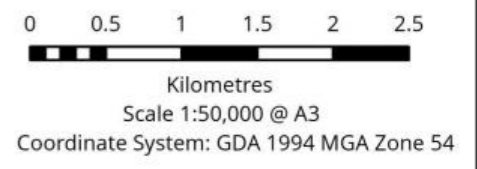
*Combination of low numbers due to drought, and lack of management infrastructure



Legend

- Study area
- Infrastructure
- Infrastructure with PGSW downslope
- Turbine
- O&M building
- PGSW structural variants**
- Porcupine grass with eucalypts
- Porcupine grass only
- Eucalypts only
- Goat management infrastructure**
- Yard
- Fencing
- Trapped**
- Dam
- Trough
- Untrapped**
- Dam
- Trough

Figure 8 Infrastructure for goat management



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In regards to other herbivores in the region, the leaseholders indicated that rabbits used to be present in high numbers, but they seem to currently be managed by rabbit haemorrhagic disease (RHD). They indicated that the rabbits typically breed in winter and spring, with virulence increasing as temperatures increase into summer.

The leaseholders also indicated that the currently high numbers of kangaroos were a concern with regard to total grazing pressure. They reported that kangaroo shooters were working in the region, but felt they 'hardly make a dent' in the population. However, they also noted that individuals were being impacted by the drought, with dead kangaroos a regular sight.

3.4.3 Scat counts

Counts of herbivore scats in the 5 x 5 metre subplots are summarised in Figure 9. Goat scats were most abundant outside the goat fence, with the majority of scats old (dry and grey).

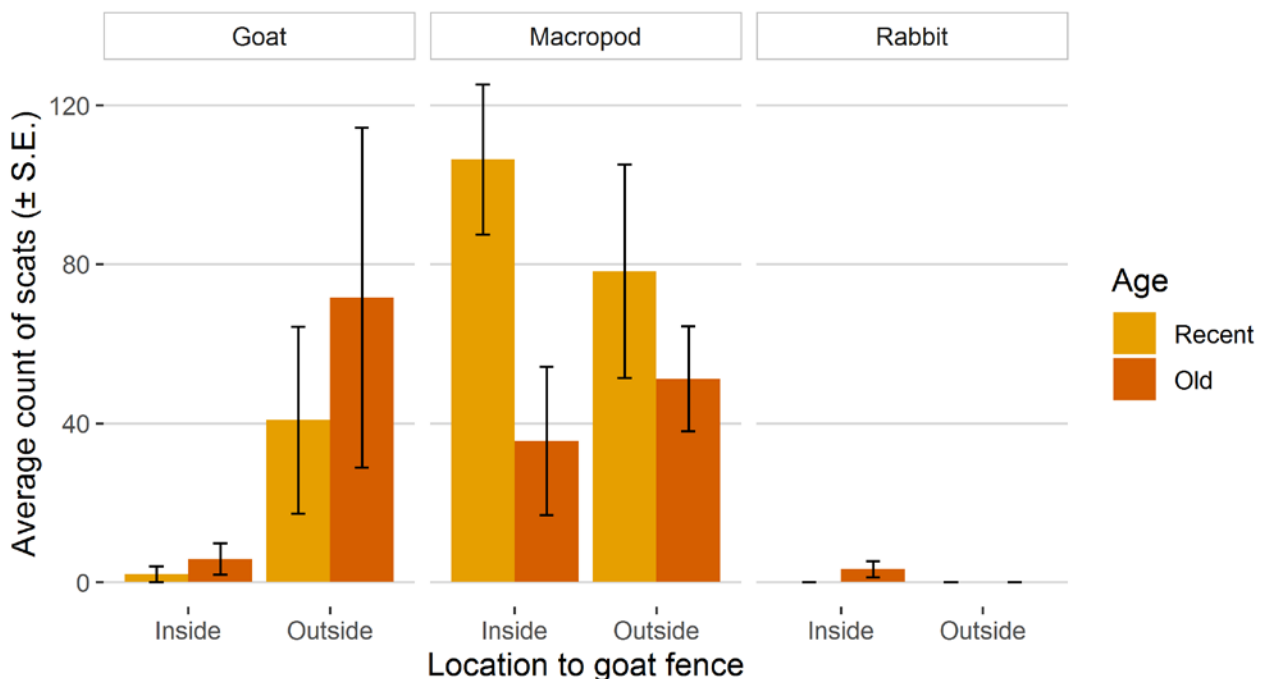


Figure 9 Herbivore scats recorded in 5 x 5 metre subplots

3.5 Condition of PGSW

3.5.1 Species composition of the community

Due to the conditions at the time of survey, species diversity and abundance was low within PGSW. In combination with the unbalanced survey design (due to area of extent of the structural variants inside and outside the goat fence), all data analysis needs to be reviewed cautiously as a small increase in species richness can have a disproportionately large impact on analysis results. It is anticipated that longer-term monitoring over the next three years will provide greater robustness of analysis results. Additionally, while the 5 x 5 metre subplots have been monitored to capture baseline species diversity and abundance, flora presence was insufficient to inform detailed analysis in this baseline assessment.

Across all surveys to date, 96 native and six introduced flora species have been recorded. The current survey documented 53 native species and two introduced species within the monitoring sites (Appendix 4).

A mean of 8.85 native species was recorded in the 20 x 20 metre quadrats, with a range of 3 to 14 native species (Table 3). Given the caveats of the low species presence during the survey and unbalanced survey design, the baseline analysis indicates that species richness is lower in sites within the goat fence (Figure 10). Baseline analysis of the structural variants indicates that the two monitoring plots within the *eucalypts only* variant are the most floristically diverse, with the *Porcupine Grass with eucalypts* variant supporting a few additional species per monitoring plot than the *Porcupine Grass only* vegetation (Figure 11).

The occurrence of flora species recorded in relation to the structural variant of the community and location relative to the goat fence is provided in Table 4.

Table 3 Summary statistics of species richness in 20x20 metre quadrats (n=20)

Statistic	Value
Minimum	3.00
1 st quartile	7.00
Median	8.00
Mean	8.85
3 rd quartile	11.25
Maximum	14.00

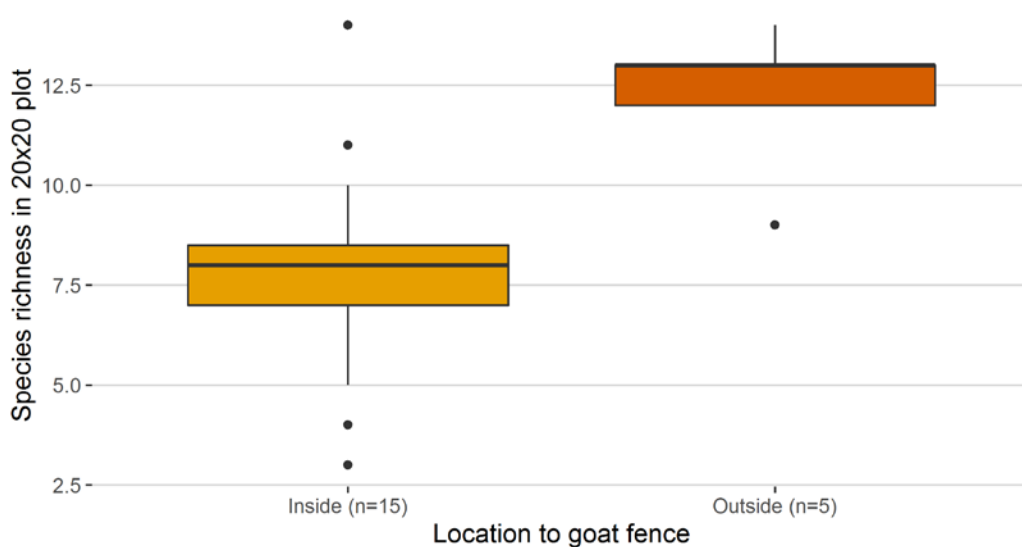


Figure 10 Species richness in 20 x 20 metre quadrats by position relative to the goat fence

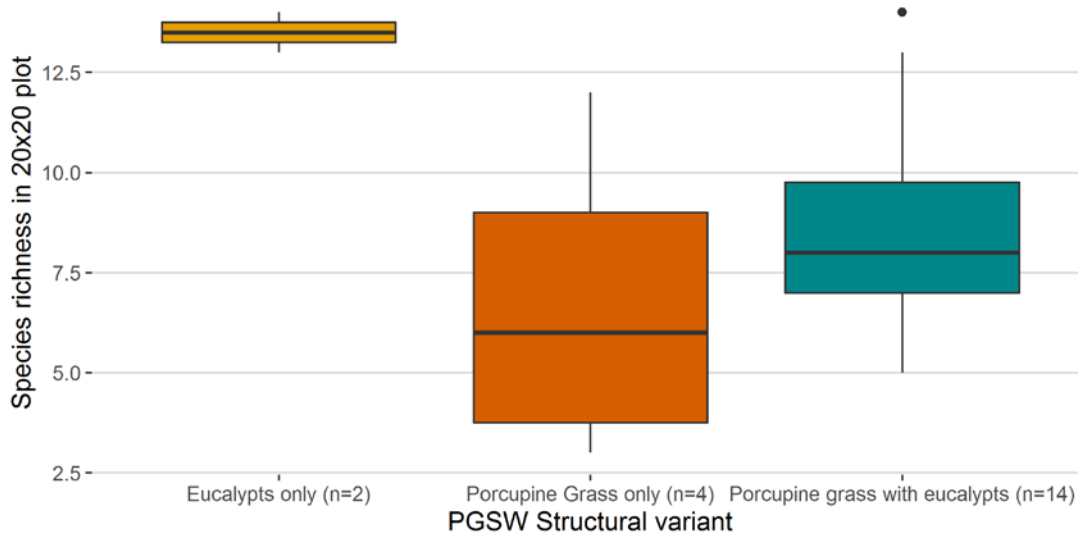


Figure 11 Species richness in 20 x 20 metre quadrats by PGSW structural variant

Table 4 Species recorded in 20 x 20 quadrats within structural variants of PGSW

Species	Common Name	Porcupine Grass with eucalypts	Porcupine Grass only	Eucalypts only
<i>Abutilon leucopetalum</i>	Desert Chinese Lantern	Out*		
<i>Acacia aneura</i>	Mulga Wattle	In*		Out
<i>Acacia tetragonophylla</i>	Curara, Dead Finish	Out	In	Out
<i>Acacia victoriae</i>	Prickly Wattle	In		
<i>Alectryon oleifolius</i>	Boonaree, Western Rosewood	In		In
<i>Atriplex spp.</i>	A Saltbush	In		
<i>Austrostipa scabra</i>	Speargrass	In		
<i>Austrostipa spp.</i>	A Speargrass	In		
<i>Cheilanthes austrotenuifolia</i>	Rock Fern	In		
<i>Cheilanthes lasiophylla</i>	Woolly Cloak-fern	Out	In	
<i>Chenopodium desertorum</i>	Desert Goosefoot	In	In	In
<i>Convolvulus erubescens</i>	Blushing Bindweed		Out	
<i>Cymbopogon ambiguus</i>	Lemon Grass, Scent Grass	Out	Out	In and out
<i>Daucus glochidiatus</i>	Native Carrot	In		
<i>Dissocarpus paradoxus</i>	Cannonball Burr	In and out	Out	Out
<i>Dodonaea lobulata</i>	Lobed Leaf Hop Bush	Out	Out	
<i>*Emex australis</i>	Spiny Emex		In	
<i>Einadia nutans</i>				
<i>Enchylaena tomentosa</i>	Ruby Saltbush	In and out		In and out
<i>Enneapogon cylindricus</i>	Jointed Nineawn	In and out	Out	In

Species	Common Name	Porcupine Grass with eucalypts	Porcupine Grass only	Eucalypts only
<i>Eucalyptus intertexta</i>	Gum Coolibah	In		
<i>Eucalyptus socialis</i>	Red Mallee	In and out	In	In and out
<i>Euchiton sphaericus</i>	Star Cudweed		In	
<i>Euphorbia drummondii</i>	Caustic Weed	Out	Out	Out
<i>Glycine clandestina</i>	Twining glycine	In		
<i>Maireana sclerolaenoides</i>	Woolly-fruit Bluebush	In		In
<i>Maireana</i> spp.	Cotton Bush, Bluebush, Fissure-weed	In and out	In	
<i>Maireana trichoptera</i>	Hairy-wing Bluebush	In and out	Out	Out
<i>Olearia muelleri</i>	Mueller's Daisy Bush			Out
<i>Ptilotus obovatus</i> var. <i>obovatus</i>	Silver Tails	In and out	In	Out
<i>Ptilotus</i> spp.		Out		In
<i>Pycnosorus pleiocephalus</i>	Soft Billy Button	Out	Out	
<i>Rhagodia spinescens</i>	Spiny Saltbush	In	In	
<i>Rhyncharhena linearis</i>	Purple Pentatlope			Out
<i>Sclerolaena diacantha</i>	Grey Copperburr	In		In and out
<i>Sclerolaena obliquicuspis</i>	Limestone Copperburr	In and out		In
<i>Sclerolaena patenticuspis</i>	Spear-fruit Copperburr	In		
<i>Sclerolaena</i> spp.	Copperburr, Poverty-bush	In	In	
<i>Senna artemisioides</i>	Silver Cassia	In and out		
<i>Sida petrophila</i>	Rock Sida	In and out	Out	In
<i>Sida</i> spp.	A Sida	Out	Out	In
<i>Solanum quadriloculatum</i>	Tomato Bush	In and out	Out	In
<i>Solanum</i> spp.	A Nightshade	In	In	
* <i>Trifolium glomeratum</i>	Clustered Clover		In	
<i>Triodia scariosa</i> subsp. <i>scariosa</i>	Porcupine Grass	In and out	In and out	In and out

*In/out indicates position relative to the goat fence.

3.5.2 Threatened flora

As detailed in Section 2.2.4 of the Vegetation Management Plan (VMP) (Biosis 2018e), three threatened plant species (species listed under either the NSW *Biodiversity Conservation Act 2017* (BC Act) or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)) were identified as having the potential to be affected by the Silverton Wind Farm works (NGH Environmental 2008a, NGH Environmental 2008b). These include: Showy Indigo *Indigofera longibractea*, Yellow-keeled Swainsona *Swainsona flavicarinata* and Creeping Darling Pea *Swainsona viridis*. Additionally, there are unconfirmed records of Purple Wood Wattle *Acacia carneorum* on the flats of the Mundi Mundi sandplain surrounding Silverton Wind Farm (Blore 2008). It has not been found on the hills, where PGSW occurs. This species is listed as vulnerable under both the BC Act and the EPBC Act.

None of the above listed species have been recorded within PGSW during the current survey, nor have any other threatened flora species.

3.5.3 Condition of woody species

Woody species occur in low numbers in the PGSW community. The baseline monitoring has found that sites inside the goat fence are more likely to support woody shrubs, particularly Dead Finish *Acacia tetragonophylla* and Western Rosewood *Alectryon oleifolius*, however this may also be a reflection of the larger sample size within the goat fence (Figure 12). The overall condition of Red Mallee *Eucalyptus socialis* is generally lower outside the goat fence, particularly below the browse line (Figure 13) but also above the browse line (Figure 14). Dead Finish generally remains unbrowsed, with Western Rosewood and Mulga Wattle *Acacia aneura* generally subjected to intense browsing, including within the goat fence. Lobed Leaf Hop Bush *Dodonaea lobulata* has only been only recorded outside the goat fence, one individual has been browsed.

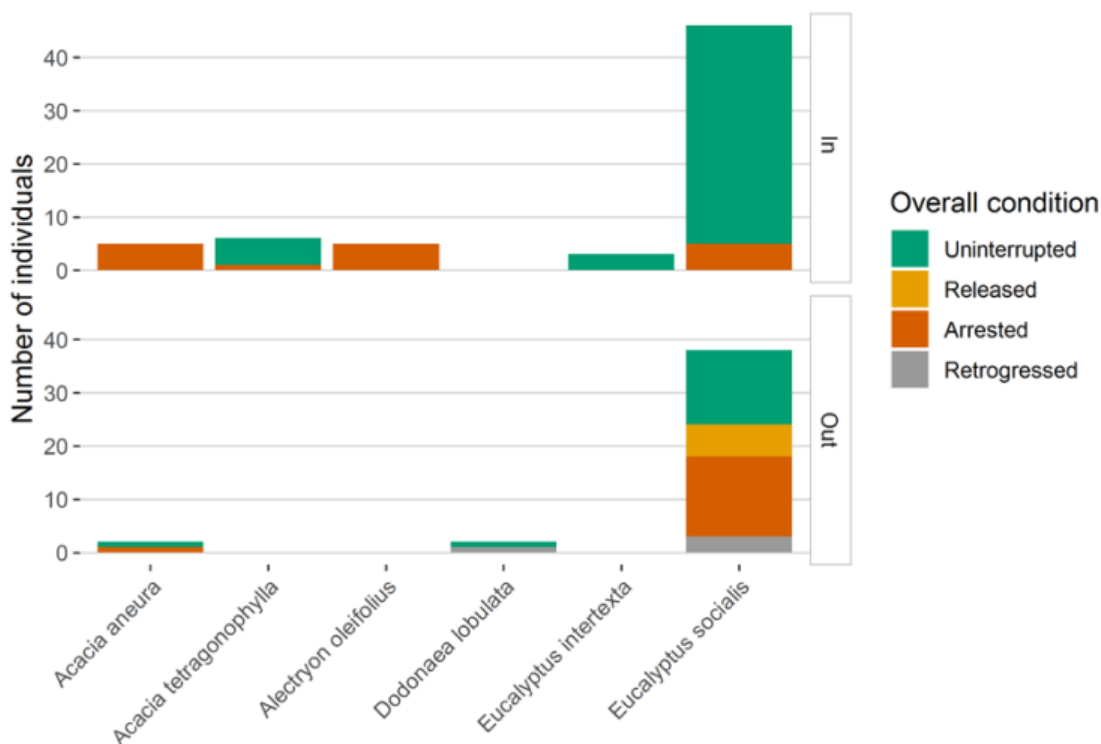


Figure 12 Overall condition of woody species

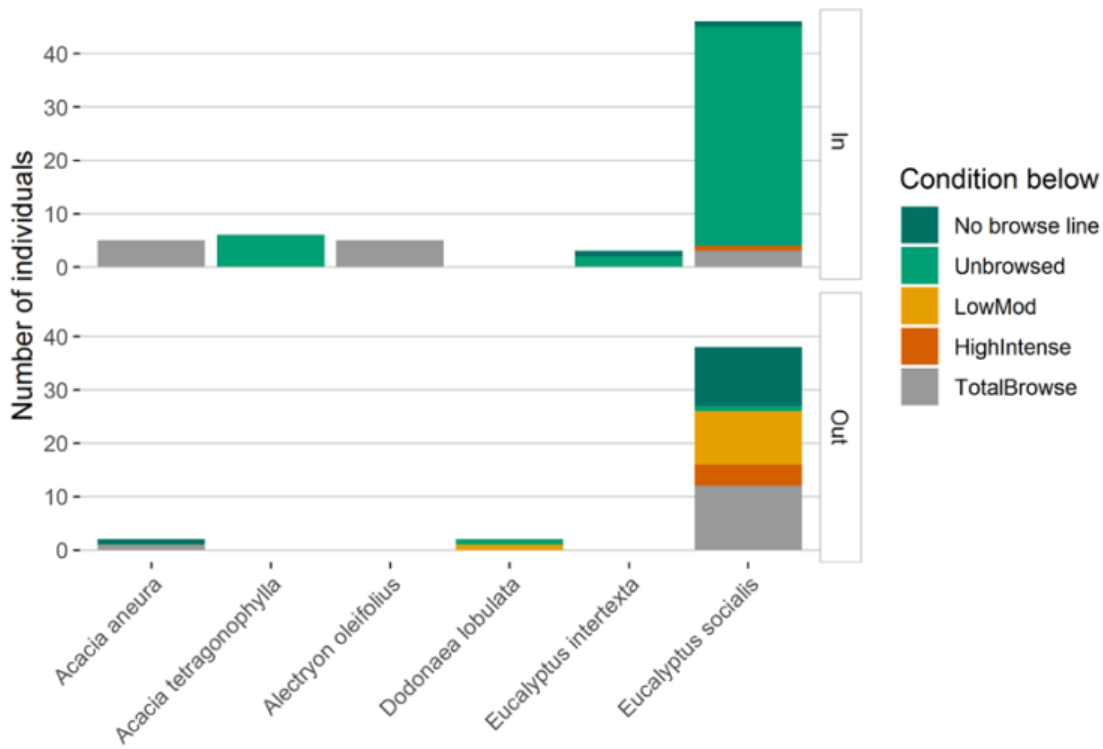


Figure 13 Condition of woody species below the browse line

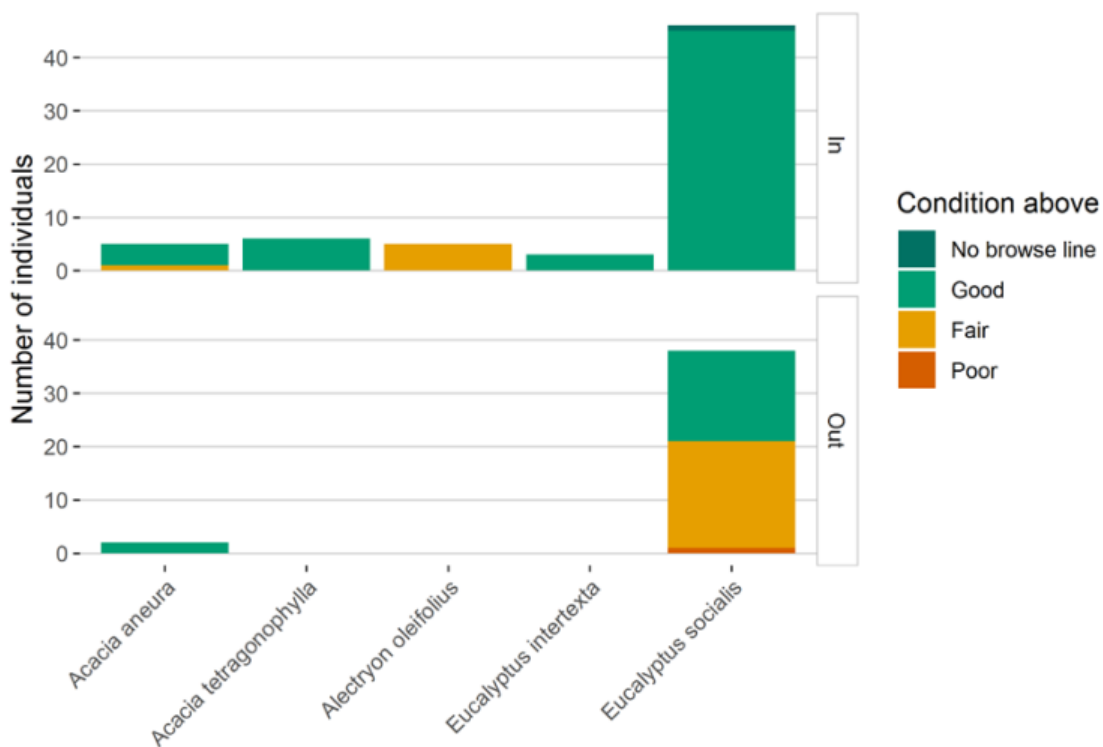


Figure 14 Condition of woody species above browse line

3.5.4 Litter cover

Litter cover was generally higher in the 20 x 20 metre monitoring plots outside the goat fence compared with those inside the goat fence.

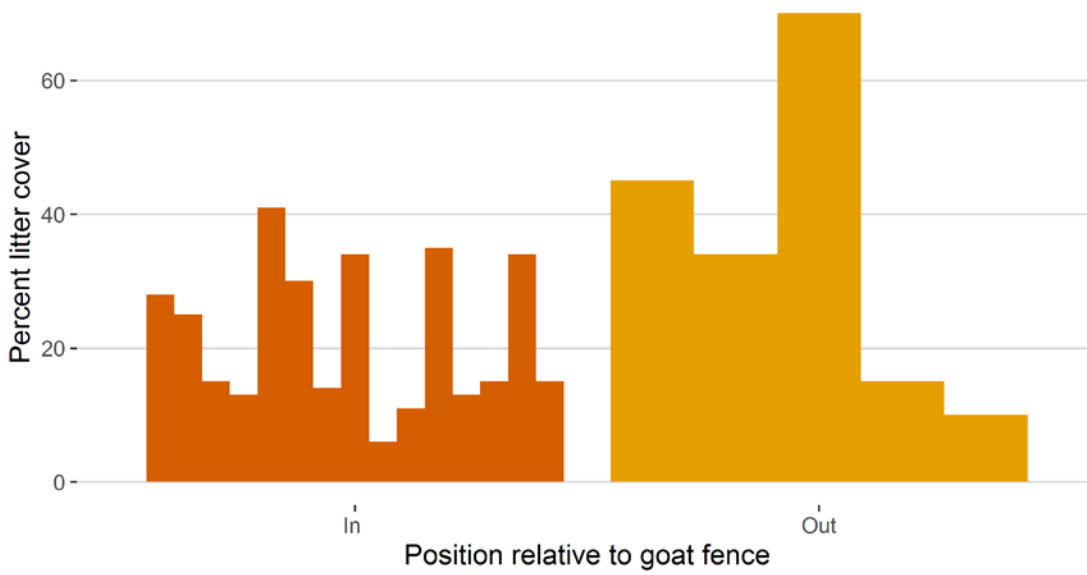


Figure 15 Litter cover within the 20 x 20 metre monitoring plots

3.6 Introduced flora species

The remote location and harsh conditions of the Silverton Wind Farm have generally resulted in a low incidence of weeds to date. These species are likely to be present in greater numbers following high autumn-winter rainfall. These introduced species have potential to disperse throughout the study area, particularly within areas of soil disturbance resulting from construction.

3.6.1 Baseline mapping

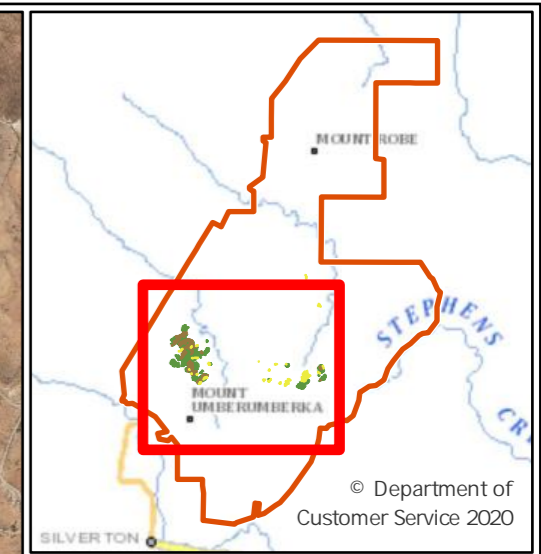
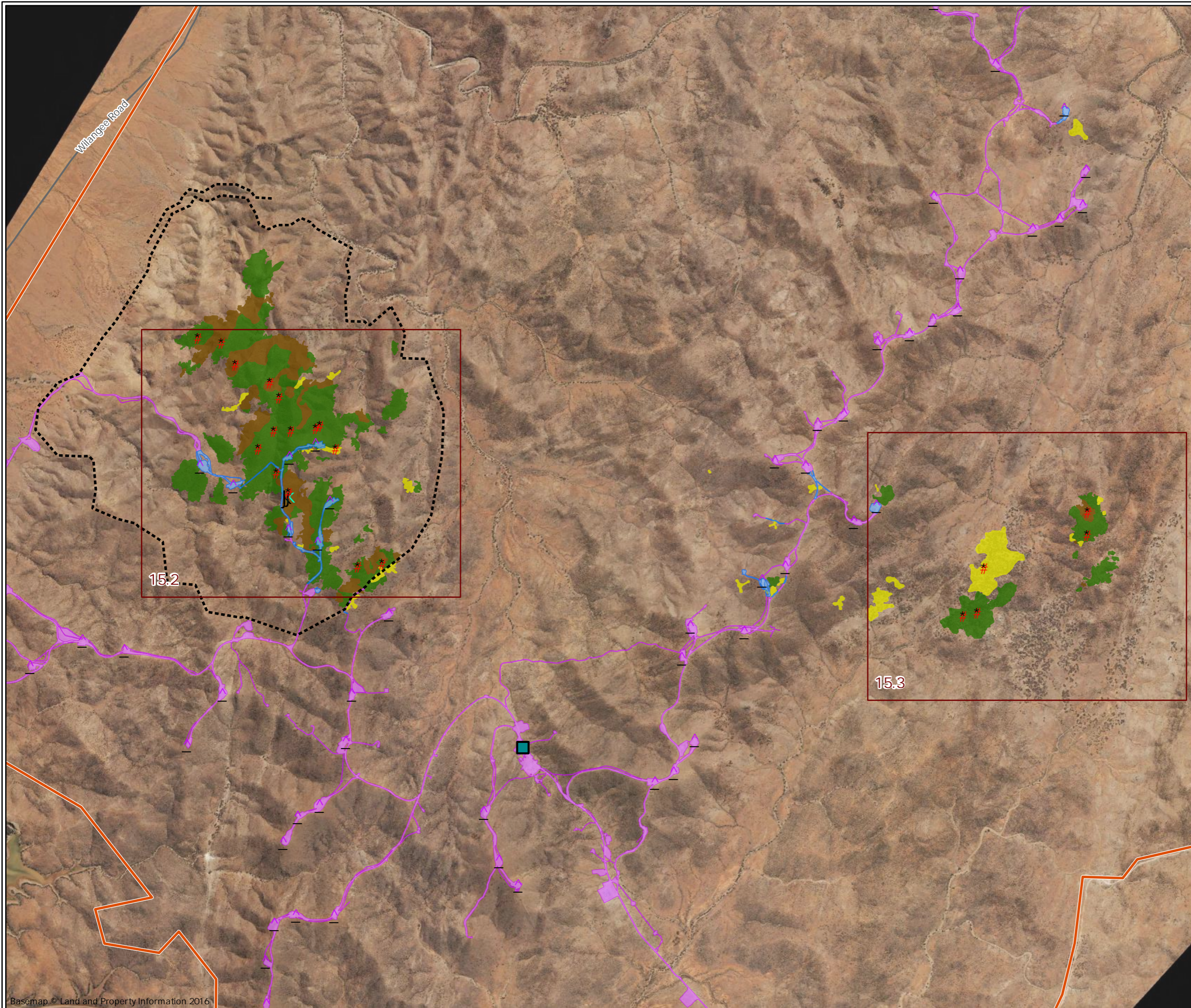
Introduced plant species previously documented within the study area (Biosis 2018e) are detailed in Appendix 3.

The spatial data for records of introduced flora was requested from NGH, namely the accurate location of the African Boxthorn *Lycium ferocissimum* and the location of floristic plot surveys as detailed in the biodiversity addendum for the proposed development of Stage 1 of the wind farm (NGH Environmental 2008b). Unfortunately, NGH advised that given the age of the report/project, the files were not readily locatable and the staff who undertook the field work are no longer with the company. Therefore, no further baseline weed mapping can be prepared.

3.6.2 Ongoing monitoring

Environmental close out information from CATCON from the construction of the wind farm is currently being finalised. Therefore, baseline monitoring of pre and post construction conditions has not been completed. Following finalisation of handover of management from CATCON, an audit of the condition of construction disturbance will be completed to inform on-going management of these areas, in particular the management of weed incursions.

Only two introduced species, Three -cornered Jacks *Emex australis* and Clustered Clover *Trifolium glomeratum* have been recorded at PGSW13 during the baseline monitoring of PGSW (Figure 16). This site is located within the goat fence approximately 60 metres downslope of a turbine access road.



Legend

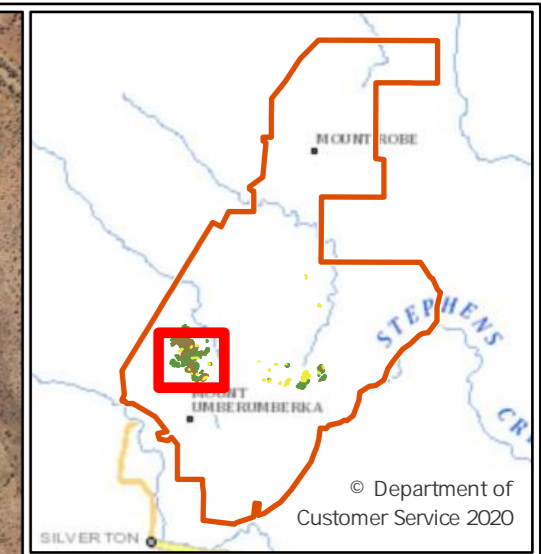
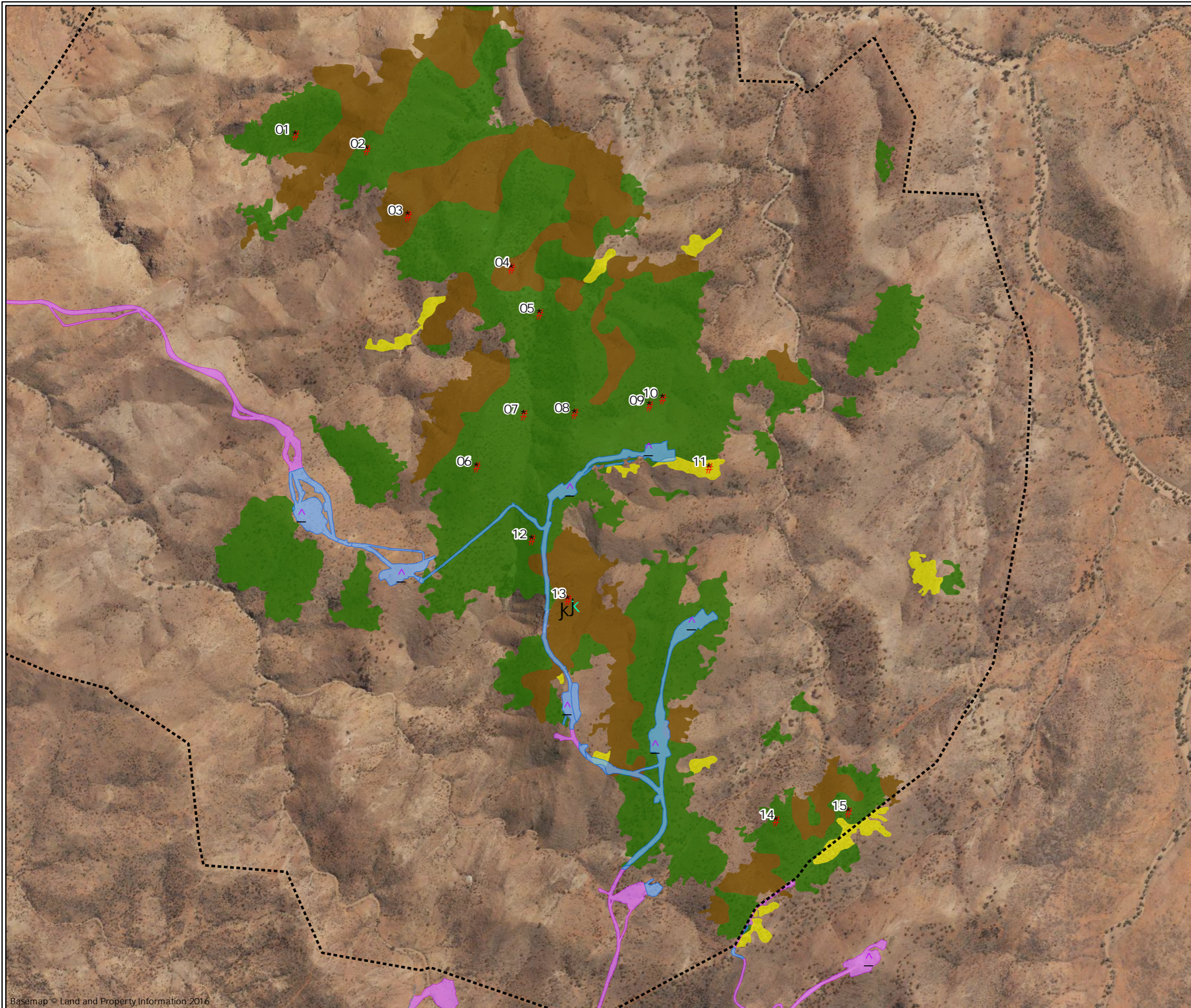
- Study area
 - Infrastructure
 - Infrastructure with PGSW downslope
 - Goat fencing
 - Turbine
 - Vegetation monitoring site
 - O&M building
- Exotic flora
- Emex australis*
 - Trifolium glomeratum*
- PGSW structural variants
- Porcupine grass with eucalypts
 - Porcupine grass only
 - Eucalypts only

Figure 16.1 Exotic flora species - PGSW13 only - Overview

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 Metres
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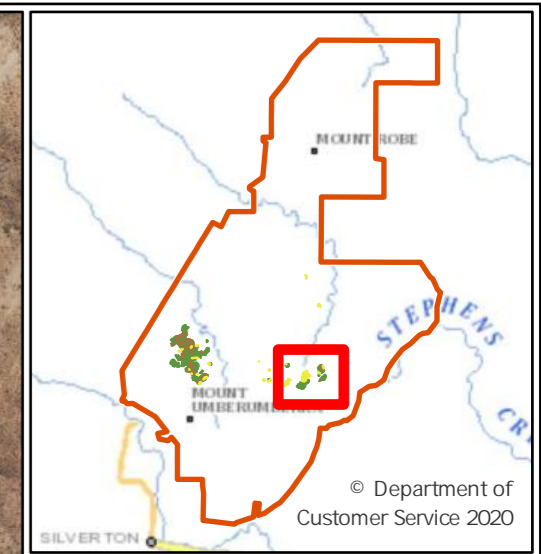
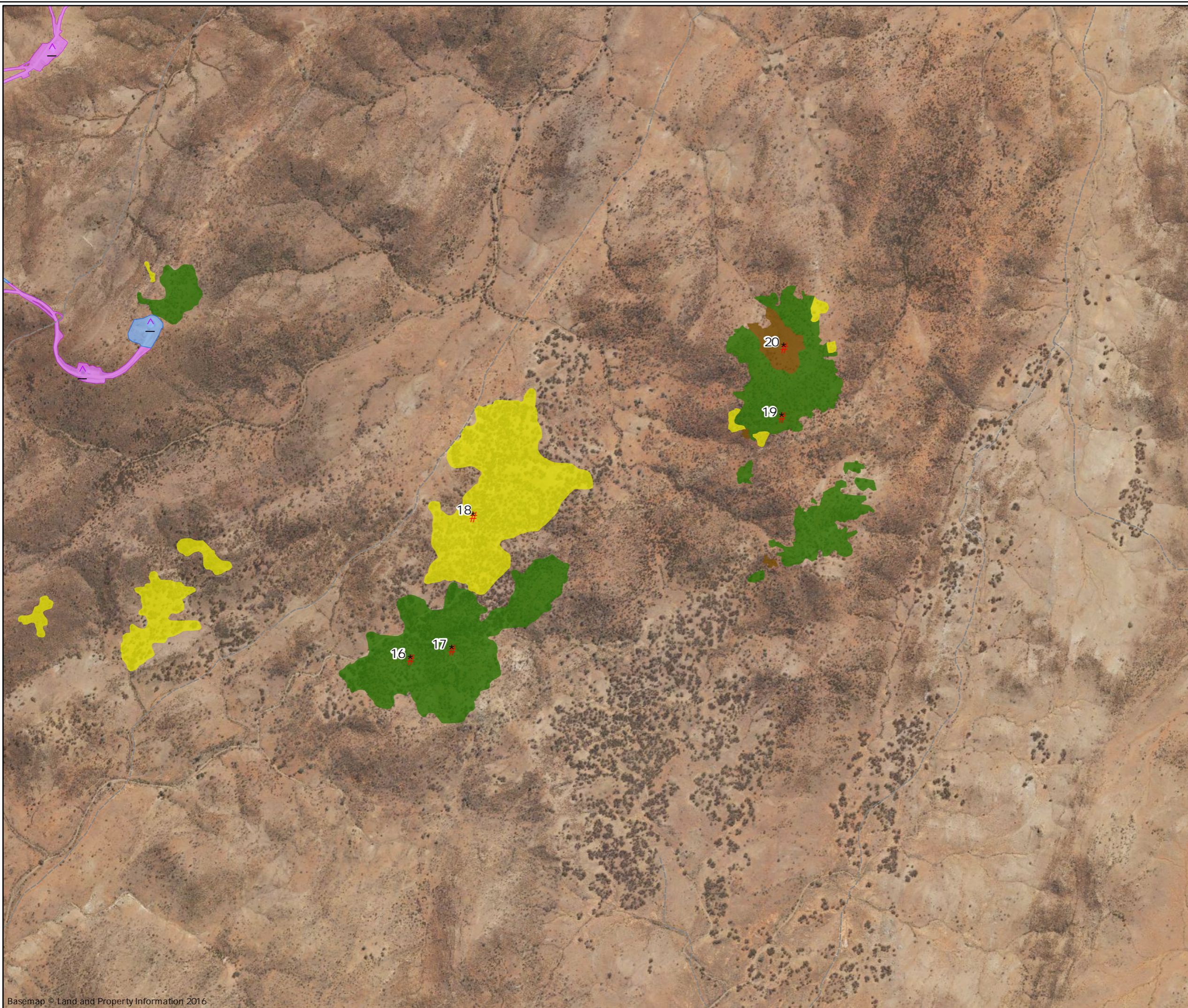
- Legend**
- Study area
 - Infrastructure
 - Infrastructure with PGSW downslope
 - Goat fencing
 - Turbine
 - Vegetation monitoring site
- Exotic flora**
- Emex australis*
 - Trifolium glomeratum*
- PGSW structural variants**
- Porcupine grass with eucalypts
 - Porcupine grass only
 - Eucalypts only

Figure 16.2 Exotic flora species - PGSW13 only - Goat fence / west

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Metres
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- Legend**
- Study area
 - Infrastructure
 - Infrastructure with PGSW downslope
 - ▲ Turbine
 - # Vegetation monitoring site
- PGSW structural variants
- Porcupine grass with eucalypts
 - Porcupine grass only
 - Eucalypts only

Figure 16.3 Exotic flora species - PGSW13 only - outside goat fence / east

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 Metres
 Scale 1:12,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 54

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4. Discussion and conclusions

Baseline monitoring of the PGSW community in 2018 has occurred during a period of extended severe drought (Section 3.1). Therefore, the floristic composition and condition of the vegetation within the community is low, as evidenced by the low site species richness (Section 3.5.1) and visible decline in the condition of Porcupine Grass tussocks (Photo 1 and Photo 2).

The drought conditions are also impacting on feral goats, with reduced numbers in the landscape due to a combination of low levels of palatable vegetation and increased goat management by leaseholders in the area (Section 3.4). Numbers of goat scats recorded at sites within the goat fence were significantly lower than sites outside the goat fence (Figure 9), suggesting that the population density within the goat fence is lower than that the surrounding landscape. As observed in Russell et. al (2011), the goat-proof fence has not affected macropod numbers.

As outlined in the Goat Management Plan (Biosis 2018d), harvesting feral goats by leaseholders has led to a reduction in goat numbers generally. The focus on goat management, however, has now moved to maintaining goats at a level where they remain economically viable for harvest. This change in management focus presents its own set of challenges, as the approach often conflicts with conservation management, where eradication or suppression at very low numbers is the goal (Russell, Letnic, & Fleming 2011). The maintenance of commercial numbers of feral goats within the landscape may ultimately be at odds with the conservation management of PGSW.

The baseline analysis indicates that species richness Figure 10 and litter cover Figure 15 are both higher at sites outside the goat fence, suggesting the impacts of feral goats are lower outside the goat fence. However, this is contrary to the assessment of goat populations in Section 3.4. Field staff indicated that the areas of PGSW outside the goat fence were in less rugged terrain, potentially with greater soil depth and topographic protection than those within the goat fence. These factors may also be influencing variability in site condition, in conjunction with climate and grazing pressures, and this will be investigated further in future survey and analysis. Although consideration of comparative analysis of sites in and outside the fence may provide insights to improving management, monitoring a management response in the vegetation will primarily be achieved through measuring an improvement in 'condition state' from this baseline set of observations at each site as identified in Section 3.2.

Of the woody individuals subject to browsing pressure, the majority of them remain in an Arrested or Retrogressed condition state (Section 3.5.2). Reduced browsing pressure should result in regrowth of the heavily browsed shrubs. In the short-term, a change in condition classes from Arrested form to Released form for most woody individuals within the goat fence would be a measure of reduction in browsing pressure (AREA 2017). However grazing pressure on the woody species within the goat fence is expected to have been increased during the current drought periods, both by feral goats that had access to the area during construction as well as by macropods. Therefore it is unlikely that the condition of these individuals will improve until rainfall increases. With successful goat control, Arrested and Retrogressed forms should not occur (AREA 2017).

As with feral goats, the incidence of introduced flora species is currently low (Section 3.6.2). This is likely to be due to a combination of the remote location of the wind farm and ongoing dry conditions. Only two introduced species have been recorded within the PGSW community, both at PGSW13. Introduced flora are likely to occur in greater numbers following high autumn-winter rainfall, particularly within areas of soil disturbance resulting from construction.

As discussed in Section 2.1.1, arid lands are dynamic and extended drought periods are interspersed by rainfall and flood events of varying magnitude, stimulating the growth of flora from dormant seedbanks. It is anticipated that the maintenance of improved goat management will result in increased plant species diversity, abundance and cover within the goat fence as species have increased opportunities for recruitment, survival and growth (Keith & Tozer 2012).

It is likely that further monitoring of PGSW within the three years post baseline monitoring (2019-2021) will align with a favourable growing season allowing the observation of additional species. This will provide an important opportunity to gain further insight into the composition of the Critically Endangered PGSW as well as the influence of the current management regimes. These insights will inform future conservation management of the community.

References

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Appendices

Appendix 1 Photopoint monitoring

Photo content	Photos	
Site 1 Inside goat fence PCT359 - Porcupine Grass hummock grassland with key eucalypt species present		
Site tag		
Looking north-east		
Looking south-west		

Photo content

Photos

Site 2 Inside goat fence

PCT359 - Porcupine Grass hummock grassland with key eucalypt species present

Site tag



Looking north-east



Looking south-west



Photo content

Photos

Site 3 Inside goat fence

PCT359 - Porcupine Grass hummock grassland without key eucalypt species present

Site tag



Looking north-east



Looking south-west



Photo content

Photos

Site 4 Inside goat fence

PCT359 - Porcupine Grass hummock grassland without key eucalypt species

Site tag



Looking north-east



Looking south-west



Photo content

Photos

Site 5 Inside goat fence

PCT359 - Porcupine Grass hummock grassland with key eucalypt species

Site tag



Looking north-east



Looking south-west



Photo content

Photos

Site 6 Inside goat fence

PCT359 - Porcupine Grass hummock grassland with key eucalypt species (Eucalypts in poor health)

Site tag



Looking north-east



Photo content

Photos

Site 7 Inside goat fence

PCT359 - Porcupine Grass hummock grassland with key eucalypt species.

Site tag



Looking north-east



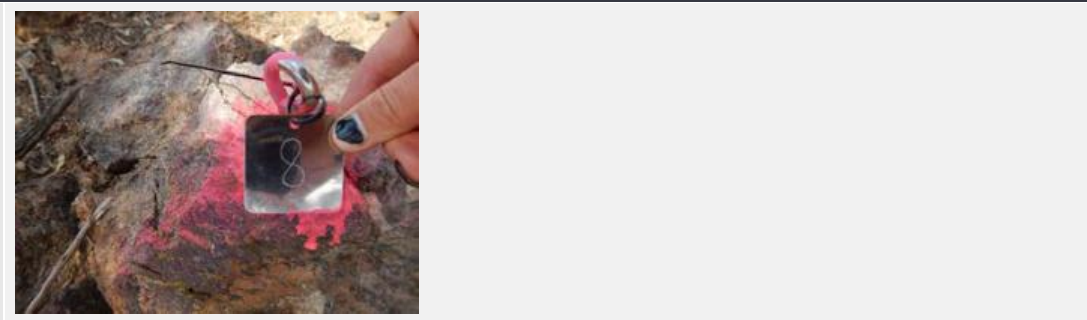
Looking south-west



Photo content | **Photos**

Site 8 Inside goat fence
PCT359 - Porcupine Grass hummock grassland with key eucalypt species.

Site tag



Looking north-east



Looking south-west



Photo content

Photos

Site 9 Inside goat fence

PCT359 - Porcupine Grass hummock grassland with key eucalypt species

Site tag



Looking north-east



Looking south-west



Photo content

Photos

Site 10 Inside goat fence

PCT359 - Porcupine Grass hummock grassland with key eucalypt species

Site tag



Looking north-east



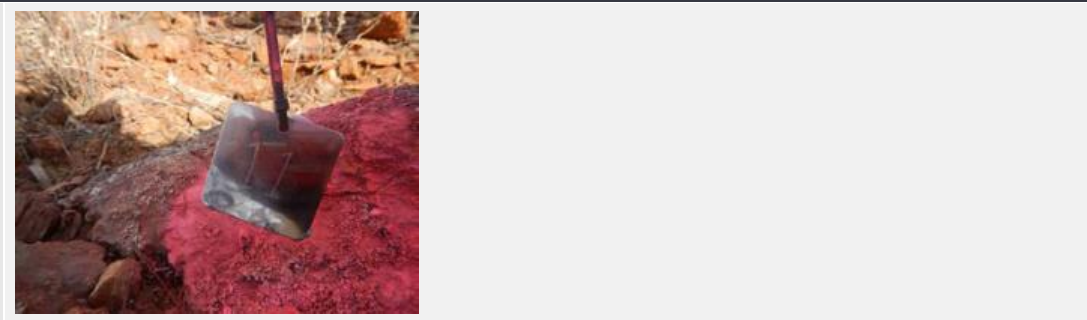
Looking south-west



Photo content	Photos
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Site 11 Inside goat fence
PCT359 - Eucalypt species present without/with minimal Porcupine Grass

Site tag



Looking north-east



Looking south-west



Photo content

Photos

Site 12 Inside goat fence

PCT359 – Porcupine Grass hummock grassland with key eucalypt species present

Site tag



Looking north-east



Looking south-west



Photo content

Photos

Site 13 Inside goat fence

PCT359 - Porcupine Grass hummock grassland without key eucalypt species present

Site tag



Looking north-east



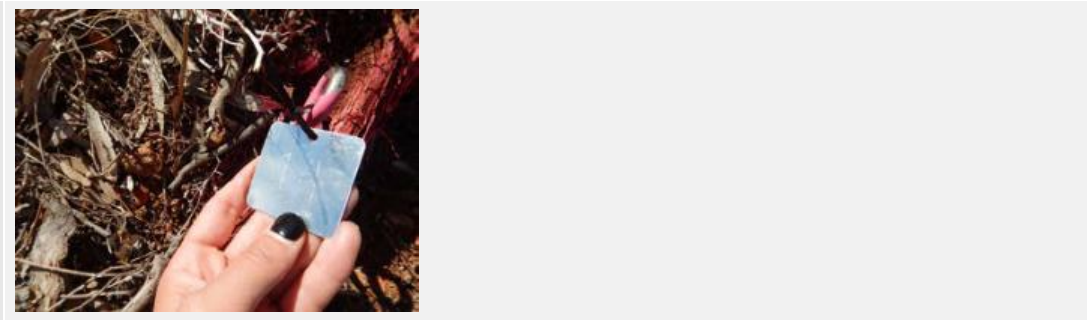
Looking south-west



Photo content | **Photos**

Site 14 Inside goat fence
PCT359 - Porcupine Grass hummock grassland with key eucalypt species present

Site tag



Looking north-east



Looking south-west



Photo content

Photos

Site 15 Inside goat fence

PCT359 - Porcupine Grass hummock grassland with key eucalypt species present

Site tag



Looking north-east



Looking south-west



Photo content

Photos

Site 16 Outside goat fence

PCT359 - Porcupine Grass hummock grassland with key eucalypt species present

Site tag



Looking north-east



Looking south-west



Photo content

Photos

Site 17 Outside goat fence

PCT359 - Porcupine Grass hummock grassland with key eucalypt species present

Site tag



Looking north-east



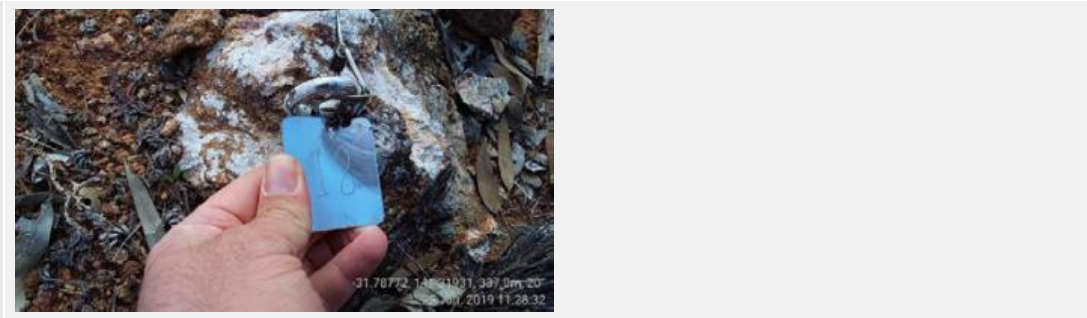
Looking south-west



Photo content | **Photos**

Site 18 Outside goat fence
PCT359 - Eucalypt species present without/with minimal Porcupine Grass

Site tag



Looking north-east



Looking south-west



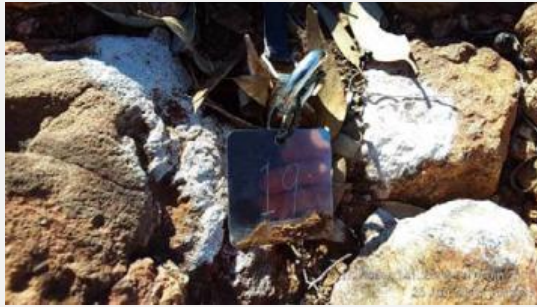
Photo content

Photos

Site 19 Outside goat fence

PCT359 - Porcupine Grass hummock grassland with key eucalypt species present

Site tag






Looking north-east



Looking south-west



Photo content	Photos	
Site 20 Outside goat fence PCT359 - Porcupine Grass hummock grassland without key eucalypt species present		
Site tag		
Looking north-east		
Looking south-west		

Appendix 2 Browsing condition – from AREA 2017

2.1.2 Belt transects (Appendix 1)

The length and width of belt transects were determined to ensure an accurate representation of the overall plant density and diversity was captured within each habitat.

Belt transects were either 50 or 100 metres in length except for the vegetation enclosure which was 20 metres in length and either 2, 4 or 10 metres wide (**Table 2-1**).

Within each belt transect all trees and shrubs were identified (samples taken) and details recorded included:

- Height, width at widest point, height of browse line for plants > 2m.
- Condition above browse line:
 - Good = No dead wood.
 - Dead Wood Fair = Trees with < 50% dead wood.
 - Dead Wood Poor = Trees with > 50% dead wood).
- Condition below browse line including all plants less than 2m in height:
 - Unbrowsed.
 - Low-Moderate browsing.
 - High-Intense browsing.
 - Totally browsed (no living growth below browse line).
- Presence or absence of regeneration.
- A condition state to show the current state of plants.



2.1.3 Condition state (Appendix 1)

Condition states were based on McDonald, J. (2009) and assessed as follows:

- **Uninterrupted** - Fresh new growth with no or very little sign of browsing. Plant growing periodically in relation to natural growth stimuli (rainfall and temperature) (see **Table 2-2** Fig 1 and Fig 2)
- **Arrested** - Plant in hedged or topiarised form due to intense browsing. (see **Table 2-2** Fig 3 and Fig 4) New growth continuously eaten and not extending beyond previous browse levels preventing the plant from growing to its natural potential.
- **Retrogressed** - Death of all or some stems previously browsed with new growth occurring from the lower stems. (see **Table 2-2** Fig 5 and Fig 6). Stem death arises from stresses induced by browse.
- **Released** - New growth from browsed stem not browsed due to temporary or permanent relaxation of browse pressure. or Plant grown beyond browse line. (**Table 2-2** Fig 7 and 8)

Examples of how these relate to plants seen in the field are provided on **Table 2-2**.

Table 2-2: Condition states based on McDonald, J. (2009)

<p>Uninterrupted</p> <p>Note: All stems and foliage intact from the base upwards</p>		
	<p>Fig 1. <i>Acacia aneura</i> (Mulga) uninterrupted at 3m</p>	<p>Fig 2. <i>Dodonea viscosa</i> sub <i>spatulata</i> uninterrupted at 3 m</p>

Arrested

Note: Plants have been intensely browsed and the growth form is hedged with plants unable to grow to full potential



Fig 3. *Dodonea viscose sub spatulata* severely arrested



Fig 4. *Marieana pyramidata* arrested

Retrogressed

Note: Plants re-sprouting from the lower part of the plant and many previously browsed stems are dead



Fig 5. *Acacia aneura* (Mulga) retrogressed



Fig 6. *Marieana pyramidata* retrogressed

Released

Note: Plants are established trees or have managed to grow beyond a distinct browse line.



Fig 7. *Acacia aneura* (Mulga) released



Fig 8. *Flindersia maculosa* (Leopard wood) released

Appendix 3 Introduced flora species recorded

Notes to table:

Source of Records

A – Biosis (This report)
 B - NGH Environmental (NGH Environmental 2008b)
 C – NGH Environmental (NGH Environmental 2008a)
 D – PGSW TS determination (NSW Scientific Committee 2010)
 E – VIS flora survey database (OEH 2017b)
 F – PGSW PCT description (NSW Scientific Committee 2010)
 (Appendix 5)

Weed status:

* WoNS
 # NSW State priority weed (WLLS 2017)
 ^ NSW regional priority weed (WLLS 2017)
 ~ NSW other regional weed/species of concern (WLLS 2017)

Table A 1 Introduced flora species recorded at Silverton Wind Farm

Scientific name	Common name	Source					
		A	B	C	D	E	F
<i>Acetosa vesicaria</i>	Bladder Dock				x		
<i>Alyssum linifolium</i>			x				
<i>Arctotheca calendula</i>	Capeweed		x				
<i>Brassica tournefortii</i> ~			x				
<i>Bromus diandrus</i> ~	Great Brome		x				
<i>Carrichtera annua</i> ~	Ward's Weed		x				
<i>Carthamus lanatus</i>	Saffron Thistle		x	x			
<i>Cenchrus setaceum</i>	Fountain Grass			x			
<i>Centaurea melitensis</i>	Maltese Cockspur		x				
<i>Chenopodium murale</i>	Nettle-leaf Goosefoot		x				
<i>Chloris virgata</i>	Feathertop Rhodes Grass			x			
<i>Echium plantagineum</i>	Patterson's Curse		x	x			
<i>Emex australis</i>	Three -cornered Jacks	x					
<i>Erodium cicutarium</i>	Common Storksbill		x				
<i>Erodium malacoides</i>			x				
<i>Hedypnois rhagadioloides</i>	Cretan Weed			x			
<i>Herniaria cinerea</i>	Hairy Rupturewort		x				
<i>Hordeum leporinum</i> ~	Barley Grass		x				
<i>Hypochaeris glabra</i>	Smooth Catsear		x				
<i>Lamarckia aurea</i>	Goldentop		x				
<i>Limonium lobatum</i> ~	Winged Sea Lavender		x				
<i>Lycium ferocissimum</i> ~*^	African Boxthorn		x	x			
<i>Lysimachia arvensis</i>	Scarlet Pimpernel		x				
<i>Malva parviflora</i>	Small-flowered Mallow		x				
<i>Medicago minima</i>	Woolly Burr Medic		x				

Scientific name	Common name	Source					
		A	B	C	D	E	F
<i>Mesembryanthemum nodiflorum</i>	Small Ice Plant		x				
<i>Rostraria pumila</i>	Roughtail		x				
<i>Salvia verbenaca</i>	Vervain		x				
<i>Schismus barbatus</i>	Arabian Grass		x				
<i>Silene nocturna</i>			x				
<i>Sisymbrium erysimoides</i>	Smooth Mustard		x	x			
<i>Sonchus oleraceus~</i>	Common Sowthistle		x				
<i>Tagetes minuta</i>	Stinking Rodger			x			
<i>Taraxacum officinale</i>	Dandelion			x			
<i>Trifolium glomeratum</i>	Clustered Clover	x					
<i>Urtica urens</i>	Small Nettle		x				
<i>Verbascum virgatum</i>	Twiggy Mullein			x			
<i>Vulpia myuros</i>	Rat's Tail Fescue		x				

Appendix 4 Flora recorded within PGSW

Notes to table:

Status – EPBC Act:	Source of Records
CE – Critically Endangered	A – PGSW Recovery Plan (Biosis 2018b)
EN – Endangered	B – EIS Biodiversity addendum (NGH Environmental 2008b)
VU – Vulnerable	C – PGSW TS determination (NSW Scientific Committee 2010)
Status – BC Act:	D – VIS flora survey database (OEH 2017b)
E1 – endangered species (Part 1, Schedule 1)	E – PCT description (OEH 2017a, Appendix 4)
E2 – endangered population (Part 2, Schedule 1)	F – 2018 Baseline condition monitoring (This report)
E4 – presumed extinct (Part 4, Schedule 1)	
E4A – critically endangered	
V – vulnerable (Part 1, Schedule 2)	

Table A 2 Flora species recorded within PGSW

Scientific name	Common name	EPBC Act	BC Act	Source						
				A	B	C	D	E	F	
Native species										
<i>Abutilon fraseri</i>	Dwarf Lantern-flower				x					
<i>Abutilon leucopetalum</i>	Desert Chinese Lantern			x	x					x
<i>Acacia aneura</i>	Mulga Wattle			x	x	x		x		x
<i>Acacia salicina</i>	Willow Wattle					x		x		
<i>Acacia tetragonophylla</i>	Curara, Dead Finish			x	x	x	x	x		x
<i>Acacia victoriae</i>	Prickly Wattle			x		x	x	x		x
<i>Alectryon oleifolius</i>	Boonaree, Western Rosewood			x						x
<i>Amyema maidenii</i>	Nyinkin			x						
<i>Amyema preissii</i>	Wireleaf Mistletoe			x						
<i>Aristida nitidula</i>	Flat-awned Threeawn			x						
<i>Asteraceae</i> spp.	Daisy									x
<i>Atriplex angulata</i>	Angular Saltbush					x	x	x		
<i>Atriplex pumilio</i>	Mat Saltbush			x						
<i>Atriplex stipitata</i>	Mallee Saltbush			x	x			x		x
<i>Atriplex</i> spp.	A Saltbush									x
<i>Atriplex vesicaria</i>	Bladder Saltbush					x		x		
<i>Austrostipa scabra</i>	Rough Spear-grass				x					x
<i>Austrostipa</i> spp.	Speargrass				x					x
<i>Boerhavia dominii</i>	Tarvine			x						
<i>Brachyscome ciliaris</i>	Variable Daisy				x					
<i>Brachyscome lineariloba</i>	Hard-head Daisy				x					

Scientific name	Common name	EPBC Act	BC Act	Source					
				A	B	C	D	E	F
<i>Bulbine semibarbata</i>	Leek Lily				X				
<i>Calotis hispidula</i>	Bogan Flea			X	X				
<i>Cheilanthes austrotenuifolia</i>	Rock fern			X					X
<i>Cheilanthes lasiophylla</i>	Woolly Cloak-fern			X					X
<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>	Mulga Fern					X		X	
<i>Chenopodium desertorum</i>	Frosted Goosefoot			X		X	X	X	X
<i>Convolvulus erubescens</i>	Blushing Bindweed								X
<i>Cymbopogon ambiguus</i>	Lemon Grass, Scent Grass			X		X	X	X	X
<i>Daucus glochidiatus</i>	Native Carrot				X	X		X	X
<i>Dissocarpus paradoxus</i>	Cannonball Burr			X					X
<i>Dodonaea lobulata</i>	Lobed Leaf Hop Bush				X				X
<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>	Narrow-leaf Hop-bush					X		X	
<i>Einadia nutans</i>	Climbing Saltbush			X					X
<i>Enchylaena tomentosa</i>	Ruby Saltbush			X	X	X	X	X	X
<i>Enneapogon cylindricus</i>	Jointed Nineawn					X		X	X
<i>Eremophila oppositifolia</i> subsp. <i>oppositifolia</i>	Weeooka				X				
<i>Eriochloa crebra</i>	Cup Grass			X					
<i>Erodium crinitum</i>	Blue Heron's-bill				X				
<i>Eucalyptus intertexta</i>	Gum Coolibah			X	X	X	X	X	X
<i>Eucalyptus socialis</i>	Red Mallee			X	X	X	X	X	X
<i>Euchiton sphaericus</i>	Star Cudweed								X
<i>Euphorbia drummondii</i>	Caustic Weed			X					X
<i>Glycine clandestina</i>	Twining Glycine			X					X
<i>Goodenia pusilliflora</i>	Small-flower Goodenia				X				
<i>Hibiscus sturtii</i> var. <i>sturtii</i>	Hill Hibiscus			X					
<i>Lepidium papillosum</i>	Warty Peppercross				X				
<i>Maireana pyramidata</i>	Black Bluebush				X	X		X	X
<i>Maireana sclerolaenoides</i>	Woolly-fruit Bluebush				X				X
<i>Maireana sedifolia</i>	Pearl Bluebush			X	X				
<i>Maireana</i> spp.	Cotton Bush								X
<i>Maireana trichoptera</i>	Hairy-wing Bluebush				X				X
<i>Maireana triptera</i>	Three-wing Bluebush				X				
<i>Marsdenia australis</i>	Doubah, Native Pear			X					
<i>Myriocephalus rhizocephalus</i>	Woolly-heads				X				
<i>Olearia muelleri</i>	Mueller's Daisy Bush								X
<i>Omphalolappula concava</i>	Burr Stickseed				X				

Scientific name	Common name	EPBC Act	BC Act	Source					
				A	B	C	D	E	F
<i>Oxalis perennans</i>	Grassland Wood-sorrel			x					
<i>Pittosporum angustifolium</i>	Weeping Pittosporum				x				
<i>Poaceae</i> spp.	Grass								x
<i>Podolepis capillaris</i>	Invisible plant			x	x				
<i>Ptilotus obovatus</i>	Smoke Bush, Cotton bush			x	x	x	x	x	x
<i>Ptilotus obovatus</i> var. <i>obovatus</i>	Silver Tails								x
<i>Ptilotus</i> spp.									x
<i>Pycnosorus pleiocephalus</i>	Soft Billy Button								x
<i>Rhagodia spinescens</i>	Spiny Saltbush			x	x				x
<i>Rhagodia ulicina</i>	Spiny Goosefoot			x					
<i>Rhodanthe microglossa</i>	Clustered Sunray				x				
<i>Rhodanthe pygmaea</i>	Pygmy Sunray				x				
<i>Rhyncharhena linearis</i>	Purple Pentatropae								x
<i>Salsola tragus</i>	Buckbush								x
<i>Sclerolaena diacantha</i>	Grey Copperburr				x				x
<i>Sclerolaena lanicuspis</i>	Woolly Copperburr				x				
<i>Sclerolaena obliquicuspis</i>	Limestone Copperburr					x	x	x	x
<i>Sclerolaena patenticuspis</i>	Spear-fruit Copperburr			x					x
<i>Sclerolaena</i> spp.	Copperburr, Poverty-bush								x
<i>Senna artemisioides</i> subsp. <i>x artemisioides</i>	Silver Cassia				x	x		x	x
<i>Senna artemisioides</i>	Silver Cassia								x
<i>Setaria paspalidioides</i>	Bristle Grass			x					
<i>Sida ammophila</i>	Sand Sida								x
<i>Sida petrophila</i>	Rock Sida			x	x	x	x	x	x
<i>Sida</i> spp.	A Sida								x
<i>Sisymbrium erysimoides</i>	Smooth Mustard				x				
<i>Solanum ellipticum</i>	Potato Bush				x				x
<i>Solanum quadriloculatum</i>	Tomato Bush				x				x
<i>Solanum</i> spp.	A Nightshade								x
<i>Solanum sturtianum</i>	Thargomindah Nightshade			x		x	x	x	
<i>Stenopetalum lineare</i>	Narrow Thread-petal				x				
<i>Tetragonia moorei</i>	Annual Spinach				x				
<i>Triodia scariosa</i> subsp. <i>scariosa</i>	Porcupine Grass			x	x	x	x	x	x
<i>Vittadinia cuneata</i>	Fuzzweed			x					
<i>Wahlenbergia communis</i>	Tufted Bluebell			x					
<i>Zygophyllum apiculatum</i>	Pointed Twin-leaf				x				

Scientific name	Common name	EPBC Act	BC Act	Source					
				A	B	C	D	E	F
<i>Zygophyllum iodocarpum</i>	Violet Twin-leaf				x				
<i>Zygophyllum ovatum</i>	Dwarf Twin-leaf				x				
Introduced species									
<i>Acetosa vesicaria</i>	Bladder Dock					x			
<i>Carrichtera annua</i>	Ward's Weed				x				
<i>Emex australis</i>	Three -cornered Jacks								x
<i>Limonium lobatum</i>	Winged Sea-lavender				x				
<i>Sonchus oleraceus</i>	Common Sow-thistle				x				
<i>Trifolium glomeratum</i>	Clustered Clover								x

Appendix 5 PCT 359 - Porcupine Grass - Red Mallee - Gum Coolabah hummock grassland low sparse woodland

VIS Classification - Community Profile Report

Plant Community Type ID (PCT ID):

359

PCT Classification Confidence Level: High

PCT Common Name: Porcupine Grass - Red Mallee - Gum Coolabah hummock grassland / low sparse woodland on metamorphic ranges on the Barrier Range, Broken Hill Complex Bioregion

PCT Scientific Name: *Eucalyptus socialis*, *Eucalyptus intertexta* / *Acacia tetragonophylla*, *Maireana pyramidata*, *Acacia aneura* s. lat., *Acacia aneura*, *Dodonaea viscosa* subsp. *angustissima* / *Triodia scariosa* subsp. *scariosa*, *Sida petrophila*, *Chenopodium desertorum*, *Cymbopogon ambiguus*

Photo 1:

Original Entry: jbenison 21/02/2008

21/02/2008

Vegetation Description: This community contains an unusual occurrence of Red Mallee and Gum Coolabah growing in a Porcupine Grass dominated landscape on rocky ranges in the arid zone. Hummock grassland to low sparse woodland with the ground cover dominated by the hummock grass Porcupine Grass (*Triodia scariosa* subsp. *scariosa*). Scattered trees include Red Mallee (*Eucalyptus socialis*) with Gum Coolabah (*Eucalyptus intertexta*). Shrubs are very sparse and include *Acacia aneura* sens lat., *Acacia victoriae* subsp. *arida*., *Acacia tetragonophylla*, *Maireana pyramidata*, *Enchylaena tomentosa*, *Senna* form taxon 'artemisioides' and *Atriplex vesicaria*. The ground cover is dominated by *Triodia scariosa* subsp. *scariosa*. Other ground cover species include *Ptilotus obovatus* var. *obovatus*, *Chenopodium desertorum*, *Sida petrophila*, *Cymbopogon ambiguus*, *Solanum sturtianum*, *Cheilanthes sieberi* subsp. *sieberi*, *Daucus glochidiatus*, *Atriplex angulata*, *Enneapogon cylindricus* and *Sclerolaena obliquicuspis*. Occurs in the arid climate zone on soils composed of eolian red sandy loam or lithosols deposited over rocky outcrops composed of Proterozoic gneiss, phyllite, schist, sandstone and slate (Willyama complex), with a relief to 200 m forming rocky hills in the Umberumberka Range section of the Barrier Range sub-region in the Broken Hill Complex Bioregion, north of Silverton. Grades into widespread hill Mulga communities such as (ID123) and contains elements of ID169 Curly Mallee open woodland that occurs further north on the Barrier Range near Corona but the ground cover in ID169 is not dominated by *Triodia*. Past disturbance may include cutting of trees for use in fencing and towns such as Silverton. A short term and averted threat was a proposed wind farm (plans now modified to lessen impact on plant community). The main long term threat is grazing by goats or stock. Reduced rainfall and hotter temperatures due to climate change could also impact on the regeneration of shrub and tree species. The combination of its very limited extent and current threats leads to an assessment of this community as being threatened requiring protection and management, particularly reduction of grazing pressure.

Emergent species: None

Upper Stratum Species: *Eucalyptus socialis*; *Eucalyptus intertexta*;

Mid Stratum Species: *Acacia tetragonophylla*; *Maireana pyramidata*; *Acacia aneura* s. lat.; *Dodonaea viscosa* subsp. *angustissima*; *Acacia salicina*; *Senna* form taxon 'artemisioides'; *Acacia victoriae* subsp. *arida*; *Enchylaena tomentosa*;

Ground Stratum Species: *Triodia scariosa* subsp. *scariosa*; *Sida petrophila*; *Cymbopogon ambiguus*; *Ptilotus obovatus* var. *obovatus*; *Chenopodium desertorum*; *Solanum sturtianum*; *Cheilanthes sieberi* subsp. *sieberi*; *Daucus glochidiatus*; *Atriplex vesicaria*; *Atriplex angulata*; *Enneapogon cylindricus*; *Sclerolaena obliquicuspis*;

Threatened Plants: Not Assessed

Threatened Fauna: Melastoma affine (Blue Tongue); Delma australis (Marble-faced Delma);

Diagnostic Species: Not Assessed

Height Class (Walker & Hopkins 1990): 2 - Range:0.26-0.50m (Low)

Vegetation Formation: Arid Shrublands (Acacia sub-formation);

Vegetation Class: Stony Desert Mulga Shrublands;

NSW Landscape Name: Barrier Ranges;

Classification source: Surveyed and mapped by NGH Environmental Pty Ltd (2008). Part of broad map unit 27 in Pickard & Norri

Authority: Surveyed and mapped by NGH Environmental Pty Ltd (2008). Part of broad map unit 27 in Pickard & Norris (1994).

Occurs in the Umberumberka Land System (Walker 1991). Some possible links to Floristic Group 9 in Playfair & Robinson (1997) in the North Olary Plains of South Australia. Community very distinct, although there was no plot data existed as of 2008.

Pre-European Mapped Or Modelled: Not mapped or modelled

Current Extent Mapped Or Modelled: Not mapped

Adequacy of plot sampling: None

Number of plots to define PCT: 0

IBRA Bioregion: Broken Hill Complex (>70%);

IBRA Sub-Region: Barrier Range (Not known); Barrier Range Outwash (Not known);

LGA: Unincorporated (>70%);

Lithology: Phyllite , Gneiss , Pegmatite , Slate

Landform Pattern: Hills

Landform Element: Hillcrest , Hillslope

Pre-European Extent: 500 ha ±30%. Estimated from extant vegetation maps: full range

Pre-European Extent Accuracy: 30

Pre-European Comments: A highly restricted community occurring on the southern Barrier Range - comprising a very small part of the 34,000 ha Umberumberka Land System (Walker 1991). Based on mapping in NGH Environmental Pty Ltd (2008) and reports on some further unmapped areas on the Barrier Range (S. Sass pers. comm.).

Current Extent: Not Assessed

Current Extent Accuracy: 30

Current Extent Comments: Mostly not cleared due to its occurrence on rocky hills in the arid zone but some trees may have been cut in the past for smelters at Silverton. Grazing by goats may reduce regeneration of woody species. Part of the current extent is mapped by NGH Environmental Pty Ltd (2008) with about 200 ha of other areas unmapped as of 2009.

PCT Percent cleared: 20.00

% accuracy (of PCT % cleared estimate): +/-30

Variation and Natural Disturbance: It is unusual for Red Mallee to grow on rocky ranges and this may also be the western-most occurrence of Gum Coolabah in NSW. Some areas on the ranges are devoid of trees and are true hummock grasslands - other areas contain scattered trees.

Fire Regime: Fire is infrequent. The hummock grass could burn occasionally depending on fuel loads.

Associated TEC Degree of Fit:

Associated TEC Comments:

Citations: (Pickard J. & Norris E., 1994 ; Playfair R. & Robinson A., 1997 ; Walker P., 1991 ; NGH Env., 2008)

Full Reference Details: (27; 295; 386; 400;). Pickard, J. & Norris, E.H. (1994) The natural vegetation of north-western New South Wales: notes to accompany the 1:1 000 000 vegetation map sheet. Cunninghamia 3(3): 423-464; Playfair, R.M. & Robinson, A.C. (1997) (eds.) A biological survey of the North Olary Plains, South Australia 1995-1997. (Natural Resources Group, Department of Environment and Natural Resources: South Australia); Walker, P.J. (1991) Land systems of western New South Wales. Technical Report No. 25 (Soil Conservation Service of New South Wales: Sydney); NGH Environmental (2008) Biodiversity Assessment: Stage 1 Proposed Silverton Wind Farm. Prepared for Silverton Wind Farm Developments Pty Ltd;

Profile source:

PCT Definition Status: Approved