

1 September 2021

Gabrielle Allan
Principal Planning Officer
Department of Planning, Industry and Environment
6 Stewart Avenue
Newcastle West NSW 2302

Dear Gabrielle

SSD 5594 LW424 – 427 Extraction Plan Flora Trigger Investigation Report

In accordance with the Longwall 424-427 Extraction Plan, Springvale Coal Pty Ltd (Springvale) notified the Department of an exceedance of floristic performances indicators at Paddys Creek and East Gang Gang Shrub Swamps. A preliminary exceedance was also reported at Marrangaroo Swamp.

On 19 July 2021 the Department provided a response to the notification. The following address the requests made by the Department:

Request 1: *A copy of the RPS report titled 'LW 424-427 Seasonal Monitoring Report' (RPS 31 May 2021)*

Response: A copy of the RPS report titled 'LW 424-427 Seasonal Monitoring Report' (RPS 31 May 2021) has been enclosed in Appendix 1.

Request 2: *A copy of the trigger investigation report*

Response: Centennial engaged EcoResolve to prepare the investigation report for the floristic trigger notification. A copy of this report is enclosed in Appendix 2.

Request 3: *A summary of the key findings of the investigation report*

Response: Springvale considers the following key findings from the investigation report:

Reference Sites:

Although the reference sites did not trigger for the Soil Adjusted Vegetation Index (SAVI), the shrub swamp ground control points assessed for percentage live vegetation cover below the baseline range was 64 of 82 (78%) of impact swamps compared to 46 of 77 (60%) of control swamp ground control points. The hanging swamp ground control points assessed for percentage live vegetation cover below the baseline range was 2 of 6 (33%) of impact swamps compared to 0 of 1 (0%) of control hanging swamp ground control points.

This suggests that a high proportion of both reference and impact swamps are experiencing higher than expected percentages of non-live vegetation, and that this

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might be more exaggerated in impact sites due to the confounding factors such as prolonged dry and hot conditions and bushfire recovery rates.

Bushfire Impact:

In the Newnes Plateau area, the recent 2019-2020 bushfires caused immense damage to the Newnes Plateau THPSS swamps. Almost all the swamp area was affected (93%) and 96% of swamps were either partially or completely burnt. Of these, 97% experienced a high to very high burn severity. Follow up field observations of the Newnes Plateau swamps showed that swamp grasses were burnt to ground level.

Recovery of swamp vegetation is occurring, particularly in wetter swamps with long term water supply. In swamps that have been undermined and dried to some degree prior to the fire, it appears that vegetation recovery is hampered and vegetation structure has changed.

Mining Impact:

At the time of the flora monitoring event Longwall 427 was being mined by Springvale. The Marrangaroo lineament had not been intersected, and groundwater level decline had not been observed. Gang Gang East had been directly undermined and Paddy's Creek had previously been within 600m Trigger Investigation Areas (TIA) which is relevant to the assessment of flora triggers.

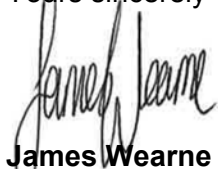
Request 4: A summary of the proposed actions arising from the investigation and the timing of these actions.

Response: Monitoring in accordance with the methodologies outlined in the LW 424-427 Swamp Monitoring Program is recommended to continue to monitor the trajectory of bushfire recovery at both impact and reference sites. This flora monitoring occurs on a seasonal basis with the next monitoring round scheduled to be completed in Spring 2021.

The Department of Agriculture, Water and Environment has been provided a copy of the Investigation Report produced by EcoResolve in accordance with EPBC 2013/6881.

If you require any further information in regard to the above please contact James Wearne on 49358944 or email james.wearne@centennialcoal.com.au.

Yours sincerely



James Wearne
Group Manager Approvals & Environment

Attached

- Appendix 1: LW 424-427 Seasonal Monitoring Report
- Appendix 2: Investigation Report

Enclosed

- DPIE Flora Trigger Notification Response dated 19 July 2021

Appendix 1: Seasonal Monitoring Report

LW424-427 SEASONAL SWAMP MONITORING REPORT

Summer 2020/21 Flora Monitoring Report



148912

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31 May 2021

REPORT

Document status

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Approval for issue

Mark Aitkens



31/05/2021

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Contents

1	INTRODUCTION	1
1.1	Background	1
1.2	Location	1
1.3	Study Area	1
1.4	Purpose	1
1.5	Flora Trigger Values	1
1.6	Limitations	6
1.6.1	General	6
1.6.2	Fire	6
2	METHODOLOGY	7
2.1	Monitoring Design	7
2.1.1	Before After Control Impact	7
2.1.2	'Before' or Baseline data	7
2.2	Methods	7
2.2.1	Seasonal	7
2.2.2	Additional Interim Post Fire Measures	8
2.3	Weather	8
2.3.1	Rainfall	8
2.3.2	Temperature	9
3	RESULTS	15
3.1	Seasonal Remote Sensing	15
3.1.1	Plant Health (Photosynthetic Activity)	15
3.1.2	Ground Control Points	16
3.2	Seasonal, post-fire Analysis	49
4	DISCUSSION	50
4.2	Trigger Exceedances	50
5	RECOMMENDATIONS	51
6	REFERENCES	52

Tables

Table 1-1	Performance measures, Performance Indicator, Preliminary Trigger (Drying) and Triggers for THPSS for SMP LW 424 – 427	2
Table 1-2	Limitations and Mitigation Measures	6
Table 3-1	Mean Area (SAVI $\leq$ 0.12) $\pm$ SE (ha) and 5% and 10% Preliminary Trigger Level	15
Table 3-2	Mean Summary data for all seasons per GCP: Live Green (%) and Exotic (%) including Standard Error (SE)	16
Table 4-1	SMP 424 – 427 Investigation Triggers Exceedances	50

Figures

Figure 1	Monitoring Area for SMP LW424-427	4
Figure 2	Monitoring Area Impact and Control Swamps	5
Figure 3	Minimum Spatial Data Coverage for Baseline Period	11
Figure 4	Central GCP and transect sampling location	12
Figure 5	Western GCP and transect sampling location	13
Figure 6	Eastern GCP and transect sampling location	14
Figure 7	Barrier Swamp SAVI Classification (All Ranges) Summer 2021	25

Figure 8	Barrier Swamp Live Versus Non-Live (SAVI <0.12) Vegetation Cover Summer 2021	26
Figure 9	Best Swamp SAVI Classification (All Ranges) Summer 2021	27
Figure 10	Best Swamp Live Versus Non-Live (SAVI <0.12) Vegetation Cover Summer 2021	28
Figure 11	Firetail Swamp SAVI Classification (All Ranges) Summer 2021	29
Figure 12	Firetail Swamp Live Versus Non-Live (SAVI <0.12) Vegetation Covers Summer 2021	30
Figure 13	Tristar Swamp SAVI Classification (All Ranges) Summer 2021	31
Figure 14	Tristar Swamp Live Versus Non-Live (SAVI <0.12) Vegetation Cover Summer 2021	32
Figure 15	Twin Gully Swamp SAVI Classification (All Ranges) Summer 2021	33
Figure 16	Twin Gully Swamp Live Versus Non-Live (SAVI <0.12) Vegetation Cover Summer 2021	34
Figure 17	Twin Gully Hanging Swamp SAVI Classification (All Ranges) Summer 2021	35
Figure 18	Twin Gully Hanging Swamp Live Versus Non-Live (SAVI <0.12) Vegetation Summer 2021	36
Figure 19	Marrangaroo Swamp SAVI Classification (All Ranges) Summer 2021	37
Figure 20	Marrangaroo Swamp Live Versus Non-Live SAVI (<0.12) Vegetation Cover Summer 2021	38
Figure 21	Paddys Creek Swamp SAVI Classification (All Ranges) Summer 2021	39
Figure 22	Paddys Creek Swamp Live Versus Non-Live (SAVI <0.12) Vegetation Cover Summer 2021	40
Figure 23	Pine Swamp SAVI Classification (All Ranges) Summer 2021	41
Figure 24	Pine Swamp Live Versus Non-Live (SAVI <0.12) Vegetation Cover Summer 2021	42
Figure 25	Pine Hanging Swamp SAVI Classification (All Ranges) Summer 2021	43
Figure 26	Pine Hanging Swamp Live Versus Non-Live (SAVI <0.12) Vegetation Cover Summer 2021	44
Figure 27	East Gang Gang Swamp SAVI Classification (All Ranges) Summer 2021	45
Figure 28	East Gang Gang Swamp Live Versus Non-Live (SAVI <0.12) Vegetation Cover Summer 2021	46
Figure 29	Nine Mile Swamp SAVI Classification (All Ranges) Summer 2021	47
Figure 30	Nine Mile Swamp Live Versus Non-Live (SAVI <0.12) Vegetation Cover Summer 2021	48

Graphs

Graph 1	Mean monthly rainfall for Newnes Forest Centre 36062 (1938-1999) (BOM 2021a) and ALS Newnes Plateau (June 2003 – January 2021)	9
Graph 2	Monthly precipitation for February 2020 to January 2021 compared to mean monthly rainfall for the Newnes Forest Centre 63062 (1938-1999) (BOM 2021a)	9
Graph 3	Mean monthly maximum temperatures at Mount Boyce (February 2020 – January 2021) compared with long-term mean (1991-2021; BOM, 2021b)	10
Graph 4	Mean monthly minimum temperatures at Mount Boyce (February 2020 – January 2021) compared with the long-term mean (1991-2020; BOM, 2021b)	10
Graph 5	Mean live vegetation cover (%) per GCP over time for LW420-422 TIA	49
Graph 6	Average ratio of live vegetation cover (%) per GCP compared to the corresponding LW420-422 baseline counterpart	49

Appendices

Appendix A Seasonal Histograms

1 INTRODUCTION

Centennial Springvale (Centennial) engaged RPS Australia East Pty Ltd (RPS) to undertake the seasonal monitoring of Temperate Highlands Peat Swamps on Sandstone (THPSS) in accordance with the approved Swamp Monitoring Program (SMP) for longwall 424 to 427 (Centennial Coal 2018). The SMP is a requirement of the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) consent issued for the Springvale Extension Project (EPBC 2013/6881). This report documents the results of the summer monitoring works performed in 2020/21.

1.1 Background

Springvale mining operations undermine areas of the Newnes Plateau, and in so doing operate beneath Newnes Plateau Shrub Swamp, (NPSS) and Newnes Plateau Hanging Swamp, (NPHS). NPSS is listed as an Endangered Ecological Community (EEC) under the NSW *Biodiversity Conservation Act 2016* (BC Act). NPSS and NPHS both form part of Temperate Highland Peat Swamp on Sandstone (THPSS), which is listed as an EEC under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Hereafter, this report refers to these swamp communities collectively as THPSS.

1.2 Location

Springvale is located within the western coalfield, approximately 15 kilometres (km) to the northwest of Lithgow and 120 km west-north-west of Sydney, NSW. Springvale Mine is bordered to the north by Angus Place Colliery and to the south-east by Clarence Colliery in the Lithgow Local Government Area (LGA). The monitoring area for SMP LW424-427 is shown in **Figure 1**.

1.3 Study Area

The Study Area is defined as LW424-427 (first and second workings) and Trigger Investigation Area (TIA) (600 m around the underground development) (see **Figure 2**). THPSS located within the area of impact are identified as 'impact swamps'. Swamps eligible for classification as 'control swamps' are those located outside the area of impact that have not been previously or intended to be undermined. Swamps identified as 'impact' and 'control' are identified in **Figure 2**.

1.4 Purpose

The purpose of this report is to:

- Document the monitoring results obtained for the summer 2021 season for LW424-427;
- Compare the baseline (before) conditions and associated preliminary trigger levels reported in RPS (2018) against summer 2021 seasonal data; and
- Identify and report any trigger exceedances.

1.5 Flora Trigger Values

The SMP contains specific performance indicators and an approved Trigger Action Response Plan (TARP) to guide in the interpretation of monitoring results against approved impact thresholds. The TARP also provides a process for investigating impacts and likely causation (e.g. mining or otherwise).

The preliminary trigger values for Brownstein et al (2014) documented in the SMP for LW424-427 for impact swamps are reproduced below in **Table 1-1**. Results reported for this monitoring event are compared against these triggers.

Table 1-1 Performance measures, Performance Indicator, Preliminary Trigger (Drying) and Triggers for THPSS for SMP LW 424 – 427

Performance measure	Performance Indicator	Preliminary trigger	Trigger
Negligible change to the shallow groundwater regime when compared with control swamps	Groundwater levels remain within 95 th percentile of pre-mining groundwater depth for more than 7 consecutive days.	Evidence of a reduction in water table depth or stability, due to underground mining, from piezometers located in impact sites.	Groundwater depth in any piezometer exceeds the 95th percentile pre-mining groundwater depth for more than 7 consecutive days.
		A statistically significant ¹ reduction in the abundance of native wetland species in an impacted swamp relative to the previous survey ⁷ .	A statistically significant ¹ reduction in the abundance of native wetland species in an impacted swamp when compared to control swamps.
		Increased establishment of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height) ²	30% increase in frequency of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height) ²
Negligible erosion of the surface of the swamp	Evidence of natural recruitment comprising characteristic swamp plant species within patches of nonvegetative cover. Characteristic swamp species are defined as terrestrial damp habitat (Tda) or amphibious (A) species ³	Signs of ponding, surface deformation and/ or scouring with corresponding loss of vegetation cover.	20% increase in the extent of non-vegetated area (excluding areas covered by standing water)
		10% increase ² in the extent of non-vegetated area (excluding areas covered by standing water) relative to the previous survey ⁷ .	A single patch of non-vegetative cover greater than 400 m ² doubles in size compared to baseline data ²
Negligible change in the size of the swamp	Swamp boundaries remain within the variation observed throughout the baseline monitoring period. The live green vegetated area within a swamp boundary remains within the variation observed throughout the baseline monitoring period for the corresponding season.	Physical contraction in swamp boundary of 5% or more in any reportable monitoring and/ or Plant health ⁴ of characteristic swamp species reduces in an impact swamp by >5% relative to the same season in the previous year (i.e. 5% or more increase in SANDVI ⁵ scores below 0.15)	Significant ¹ contraction in swamp boundary when compared to baseline conditions and variance observed in control swamps and/ or Significant ¹ loss in photosynthetic activity at a swamp scale compared with baseline conditions
Negligible change in the ecosystem functionality of the swamp	The population size and/ or spatial occurrence of key swamp obligate species ⁶ remains stable at the swamp scale	A statistically significant ¹ reduction in population size and/ or spatial occurrence of a key swamp obligate species in an impacted swamp relative to the previous survey ⁷ .	A statistically significant ¹ reduction in population size and/ or spatial occurrence of a key swamp obligate species in an impacted swamp relative to control swamps.
	The population size and/ or spatial occurrence of key swamp obligate species ⁶ remains stable at the swamp scale	Increased establishment of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height) ²	30% increase in frequency of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height) ²
		A 10% increase in terrestrial dry habitat (Tdr) vegetation as a proportion of total vegetation cover ² in an impacted swamp relative to the previous survey ⁷	Statistically significant ¹ increase in terrestrial dry habitat (Tdr) vegetation as a proportion of total vegetation cover in an impacted swamp relative to control swamps.
Negligible change to the composition or distribution of species within the swamp	The proportion of amphibious (A) vegetation remains within the variability measured during the baseline period	A 10% decrease in amphibious (A) species over as a proportion of total vegetation cover ² in an impact swamp relative to the previous survey ⁷	Statistically significant ¹ decrease in amphibious (A) species cover as a proportion of total vegetation

Performance measure	Performance Indicator	Preliminary trigger	Trigger
			cover in an impacted swamp relative to control swamps.
	The proportion of terrestrial damp habitat (Tda) vegetation remains within the variability measured during the baseline period	A 10% change in terrestrial damp habitat (Tda) species cover as a proportion of total vegetation cover ² in an impact swamp relative to the previous survey ⁷	Statistically significant ¹ change (increase or decrease) in Tda vegetation as a proportion of total vegetation in an impacted swamp relative to control swamps.
	The proportion of terrestrial dry habitat (Tdr) vegetation remains within the variability measured during the baseline period	A 10% increase in terrestrial dry habitat (Tdr) vegetation as a proportion of total vegetation cover ² in an impacted swamp relative to the previous survey ⁷	Statistically significant ¹ increase in terrestrial dry habitat (Tdr) vegetation as a proportion of total vegetation in an impacted swamp relative to control swamps.
	No increase in exotic vegetation cover	10% increase ² in the extent of exotic vegetation cover relative to the previous survey ⁷	statistically significant ¹ increase exotic vegetation as a proportion of total vegetation cover for an impact swamp compared to control swamp
	No increased establishment of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height)	10% increase in the establishment of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height) ² relative to the previous survey ⁷	30% increase in frequency of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height) ²
Negligible change to the structural integrity of the bedrock base or any controlling rockbar/s of the swamp	Measured subsidence does not exceed predictions. No visual cracking or peat slumping that was not present prior to mining.	Measured subsidence exceeds predictions. Visual cracking or peat slumping notable (not present prior to mining)	Measured subsidence in excess of predictions ($>125\%$ of predicted levels) Visual cracking $>50\text{mm}$ in width and 10m in length (not present prior to mining) Peat slumping $>0.5\text{m}$ depth and $>20\text{m}^2$ relative to adjacent swamp surface (not present prior to mining)

¹ Statistically significant is taken to mean a p value <0.05

² Taken from Brownstein et al (2014) and are referred to as 'preliminary'. Subject to change

³ See Brownstein et al (2014) for list of amphibious (A), terrestrial dry habitat (Tdr) and terrestrial damp habitat (Tda)

⁴ Photosynthetic activity as measured by remote sensing using the Soil Adjusted Normalised Difference Vegetation Index (SANDVI)

⁵ SANDVI = Soil Adjusted Normalised Difference Vegetation Index

⁶ Key swamp obligate species include Blue Mountains Water Skink, Giant Dragonfly, Boronia deanei, amphibious vegetation (see Brownstein et al 2014)

⁷ For the purpose of this report, "previous survey" is taken to mean baseline or before dataset (i.e. data collected in winter 2017 to autumn 2019)

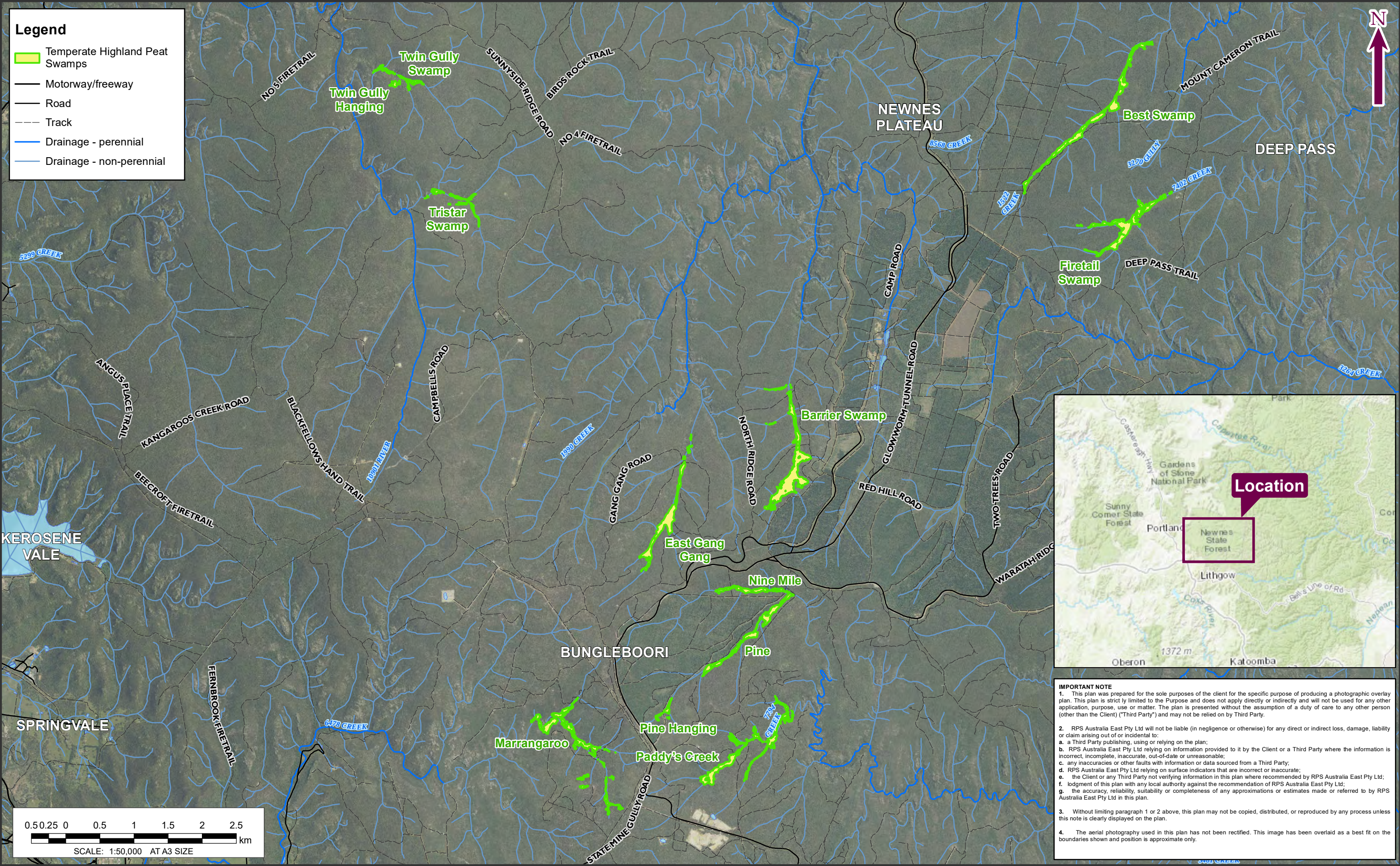


FIGURE 1 : MONITORING AREA FOR SMP LW424-427

LOCATION :
NEWNES PLATEAU

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

DATE : 31/08/2021

PURPOSE: ECOLOGY

VERSION (PLAN BY): A1 (Robert.Suansri)

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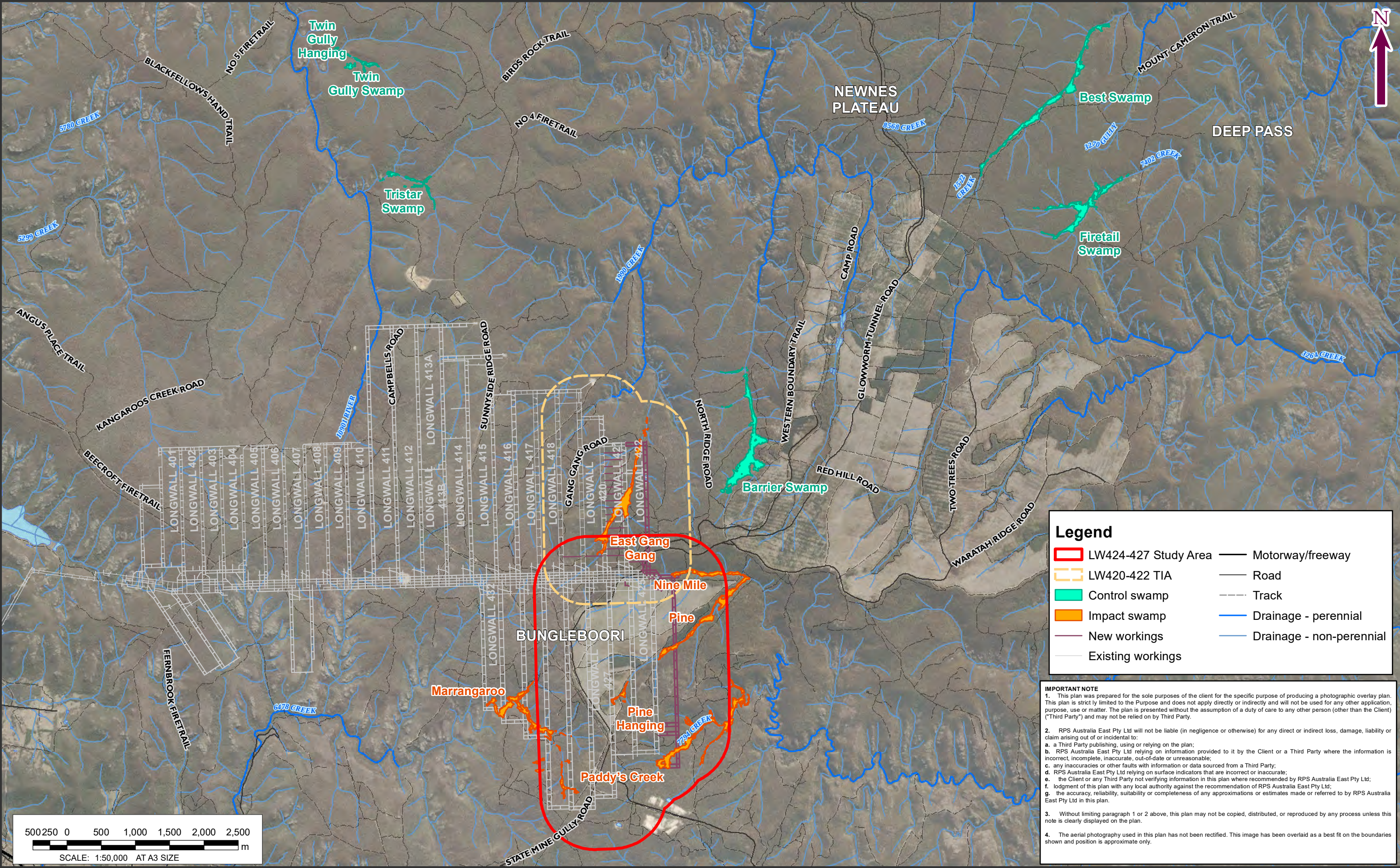


FIGURE 2 : MONITORING AREA IMPACT AND CONTROL SWAMPS

LOCATION :
NEWNES PLATEAU

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

DATE : 31/08/2021

PURPOSE: ECOLOGY

VERSION (PLAN BY): A1 (Robert.Suansri)

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CLIENT: CENTENNIAL COAL
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1.6 Limitations

1.6.1 General

Limitations inherent in the monitoring program and associated measures to minimise the effect of these limitations are listed below in **Table 1-2**.

Table 1-2 Limitations and Mitigation Measures

Limitation	Measures to Minimise
Observer bias in flora identification and condition/abundance estimation	Two observers utilised for flora identification and condition/abundance estimation
Variation in optimal SAVI flight time on account of weather conditions	Imagery supplier is provided clear operational guidance on imagery acquisition to minimise variance between seasons and years
Variation in field survey time frames on account of weather conditions	The timing of data collection is guided by data collection dates in the baseline and prior monitoring periods. The avoidance of data collection during extreme cold and wet/windy weather for safety reasons is likely to limit any weather related impacts on data collection.

1.6.2 Fire

Reported as the largest forest fire in Australian history, the Gospers Mountain Fire is estimated to have burned through more than 512,000 ha before joining with several other fires to burn close to 900,000 ha. The blaze burnt across the Lithgow, Hawkesbury and Central Coast regions from October 2019 to February 2020. This 'mega-fire' affected all swamps across the study area, including both impact and control swamps. Fire intensity across the extent of its influence was generally high (e.g. consistent canopy scorch), however, some variation in fire intensity was likely due to topography and weather factors. It is beyond the scope of this report to measure and the understand fire intensity at the swamp scale, and as such this factor is a limitation in the interpretation of monitoring results.

2 METHODOLOGY

The 'Flora monitoring methods for Newnes Plateau Shrub Swamps and Hanging Swamps' (Brownstein et al 2014) forms the methodological basis for the SMP, which outlines specifications for the seasonal and annual surveys. Methods outlined in Brownstein et al (2014) were adapted and applied to generate the two-year baseline dataset (i.e. winter 2017 to autumn 2019) as documented in Seasonal and Annual Flora Monitoring: Baseline Report for LW424 - 427 (RPS 2019a).

Data from the summer 2020/21 monitoring event were obtained from a repeated application of seasonal flora monitoring methods documented in RPS (2018) (i.e. remote sensing). The extent of the remotely sensed imagery used in this monitoring program is shown in **Figure 3** with field monitoring locations shown in **Figure 4**, **Figure 5**, and **Figure 6**. Matters specifically relating to this monitoring event are outlined in the following sections. The results have been reported with reference to trigger values derived from the SMP (reproduced in **Table 1-1**) and reported in the baseline report (RPS 2019a).

2.1 Monitoring Design

2.1.1 Before After Control Impact

A monitoring program based on the principles of a 'Before After Control Impact' (BACI) design has been used to quantify and evaluate the impacts of longwall mining impacts on THPSS. A BACI monitoring design uses data collected prior to and after the impact event (i.e. 'before' and 'after' data) for each of the 'treatments' (i.e. 'control' and 'impact' sites).

2.1.2 'Before' or Baseline data

Impact and control swamps, as listed in **Table 1-1**, were simultaneously sampled in late August 2017 to denote the start of the monitoring programs baseline data collection period (i.e. 'before' dataset). Sampling continued for a two-year period (i.e. winter 2017 to autumn 2019) to establish the baseline data for seasonal and annual monitoring (i.e. two samples for each 'season' and two annual samples for each of the years in which baseline was collected).

A number of these impact swamps are also included within the TIA for LW419 (RPS 2018) and LW420-422 (RPS 2019b), where undermining began in August 2016 and February 2017 respectively. As a 'before' mining dataset was not able to be collected within the baseline timeline for LW 424-427 (winter 2017 to autumn 2019), the baseline dataset collected for LW419/420-422 will be used for these swamps. **Figure 2** provides the TIA for longwalls 419 to 424-427, with East Gang Gang included in the TIA for LW419 and Nine Mile included within the TIA for LW420-422.

Several control swamps also have baseline datasets for LW419 and LW420-422, however, as these swamps will not be impacted by longwall mining, their 'before' dataset is renewed for LW424-427 Baseline Report (RPS 2019a), beginning in winter 2017.

2.2 Methods

Flora and remote sensing monitoring methods are described in the SMP corresponding to LWs 424 – 427 (Centennial 2018). An overview of the methods used in this monitoring program are outlined in the following sections. Additional post fire measures have been collected following the Gaspers Mountain fire, the method of which is also described in this section.

2.2.1 Seasonal

2.2.1.1 Remote Sensing

Remotely sensed imagery for the spring season comprising red-green-blue and near-infrared (RGBI) bandwidths, with the near-infrared (NIR) bandwidth centred around 720 nm, was obtained by Aerometrex Pty Limited using fixed wing aircraft on 05 March 2021. Data collection and analysis methods used are consistent with those described in RPS (2019a).

2.2.1.2 Ground Control Points

Ground control points (GCPs) provide a field-based validation of information generated from the analysis of remotely sensed imagery (e.g. presence of live plant material) and collect additional information on flora species (e.g. percent weed cover). A minimum of three GCPs were permanently established in each swamp, with each comprising a plot measuring 1 m² in area to directly measure the variables listed below:

- Percentage live vegetation (i.e. photosynthetically active plant material);
- Percentage non-vegetated area (i.e. bare ground, water, litter and standing dead biomass);
- Percentage cover of each exotic plant species; and
- Dominant and co-dominant species in the overstorey, mid-storey and groundcover strata.

Summer 2021 GCP surveys were performed from 9 February to 17 February 2021. Data collection and analysis methods used are consistent with those described in RPS (2019a).

2.2.2 Additional Interim Post Fire Measures

Confounding factors inherent in the monitoring program include drought, climate change and human impacts (forestry practices, recreational 4WDs and motorbikes) as outlined in **Section 1.5**. Measures to overcome limitations introduced by these factors are integrated into the program. However, the Gaspers Mountain fire was a large and unexpected impact on the monitoring program. The following additional measures have been collected in the post fire environment to aid in the data analysis:

- Live vegetation (%) present <3m radius of GCPs;
- Floristic composition, floristic growth habits, and rates of live green regeneration <3m GCPs; and
- Approximate quantity of peat present in soil (%) <3m GCPs.

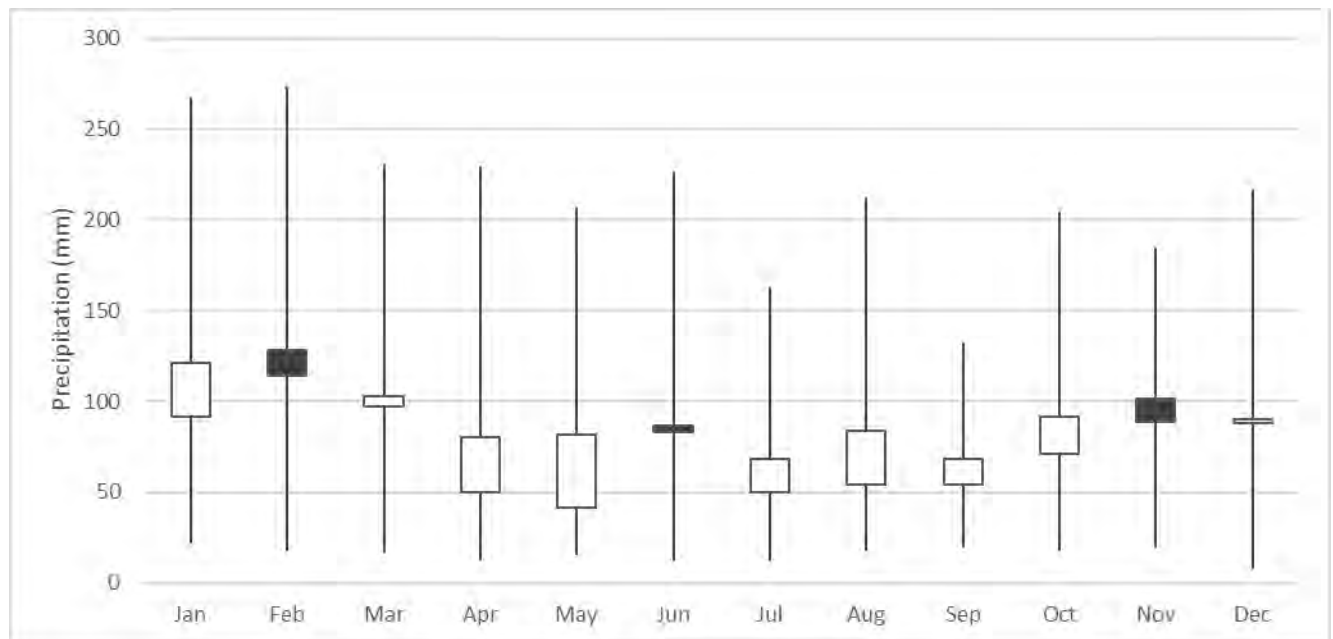
2.3 Weather

Weather conditions associated with the monitoring period were compared with historical datasets to aid interpretation of monitoring results. A summary of mean weather data from the decommissioned Newnes Forest Centre weather station (station number 063062) (1938-1999) and Mt Boyce weather station (station number 063292) is provided in the following sections (BOM 2021a). Supplementary monthly rainfall data collected nearby the closed Newnes Forest Centre (station number 063062) from 2003 to the present was also reviewed and analysed (ALS 2020). The following sections provide a summary of this data.

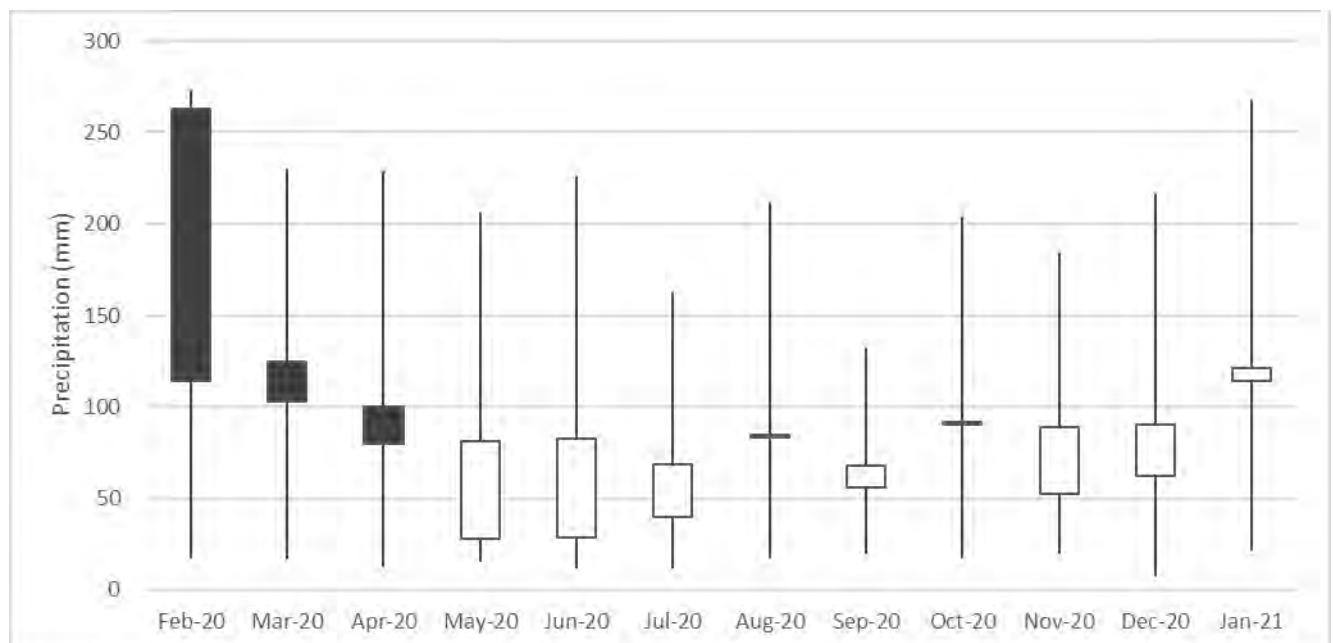
2.3.1 Rainfall

Mean monthly rainfall totals for February, June and November (ALS 2002-2021) exceed the corresponding historical monthly means reported at the Newnes Forest Centre 63062 (1938-1999) (BOM 2021a) as shown by closed candles in **Graph 1**. Mean monthly rainfall (ALS 2002-2021) for the remaining calendar months were substantially lower than the long-term mean (1938-1999) (BOM 2021a). Bars show to 5th and 95th percentiles for BOM weather station 63062 (BOM 2021a). Open candles show ALS mean monthly totals below historical means. Bars show the 5th and 95th centiles for BOM weather station 63062 (BOM 2021a).

Similarly, low rainfall was observed for eight of the twelve months prior to the February 2021 sampling period (**Graph 2**). February, March, April and August all experienced rainfall that exceeded historical means for the area. Remaining months comprised of rainfall which remained below the historical mean for the area.



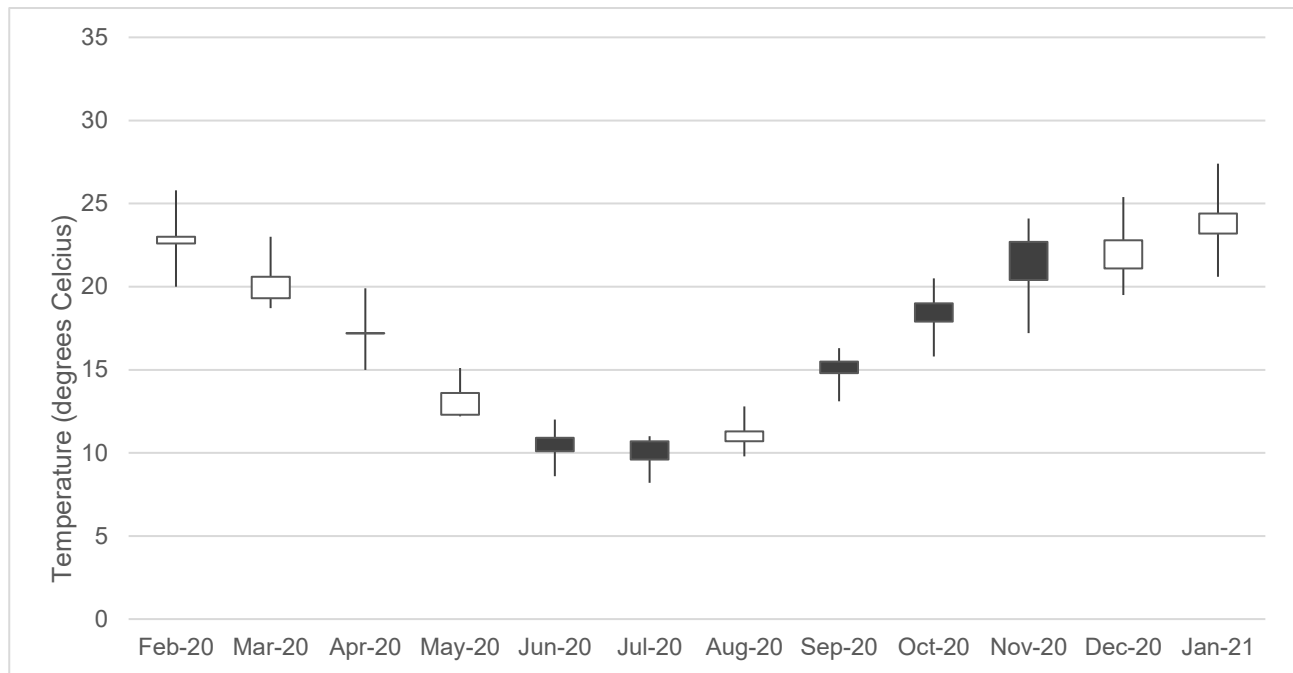
Graph 1 Mean monthly rainfall for Newnes Forest Centre 36062 (1938-1999) (BOM 2021a) and ALS Newnes Plateau (June 2003 – January 2021).



Graph 2 Monthly precipitation for February 2020 to January 2021 compared to mean monthly rainfall for the Newnes Forest Centre 63062 (1938-1999) (BOM 2021a)

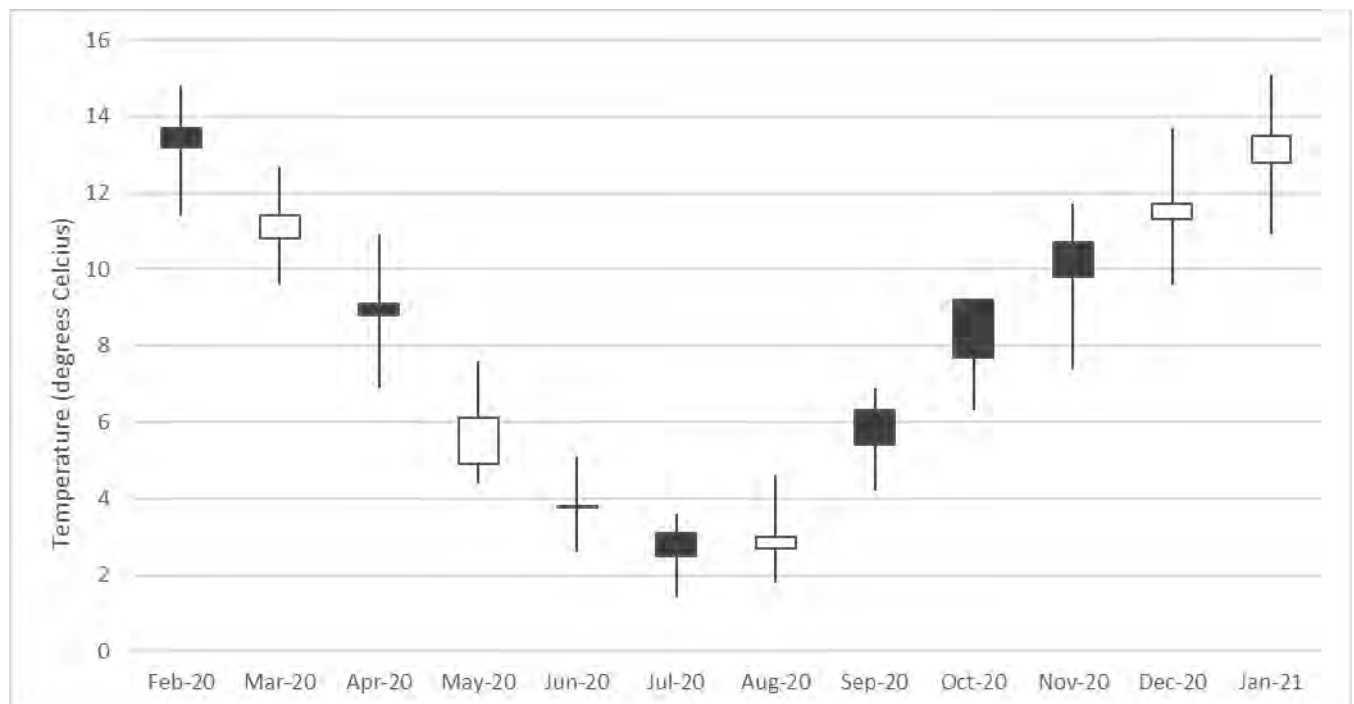
2.3.2 Temperature

The mean maximum monthly temperatures at Mount Boyce (station number 063292) (BOM 2021b) during the three months (November 2020 to January 2021) prior to the summer 2020/21 sampling (i.e. February 2021) were generally comparable with the historical average (1989-2017), with all three months prior to the summer 2020/21 survey effort recording mean maximum monthly temperatures between the 5th and 95th percentiles. Six of the twelve months prior to the survey recorded mean maximum monthly temperatures greater than, or equal to, the historic average (**Graph 3**). Bars show data between the 5th and 95th percentiles. Closed candles show recent mean maximum/minimum monthly temperature exceeding the long-term mean.



Graph 3 Mean monthly maximum temperatures at Mount Boyce (February 2020 – January 2021) compared with long-term mean (1991-2021; BOM, 2021b)

Mean minimum monthly temperature varied throughout the same corresponding three-month period (November 2020 to January 2021) prior to the summer 2020/21 sampling. Two months (December and January) had a mean minimum average temperature which was lower than the historical average but all three months were still located within the 5th and 95th percentile (**Graph 5**). Seven of the twelve months prior to the survey recorded mean minimum monthly temperatures greater than or equal to, the historic average.



Graph 4 Mean monthly minimum temperatures at Mount Boyce (February 2020 – January 2021) compared with the long-term mean (1991-2020; BOM, 2021b)

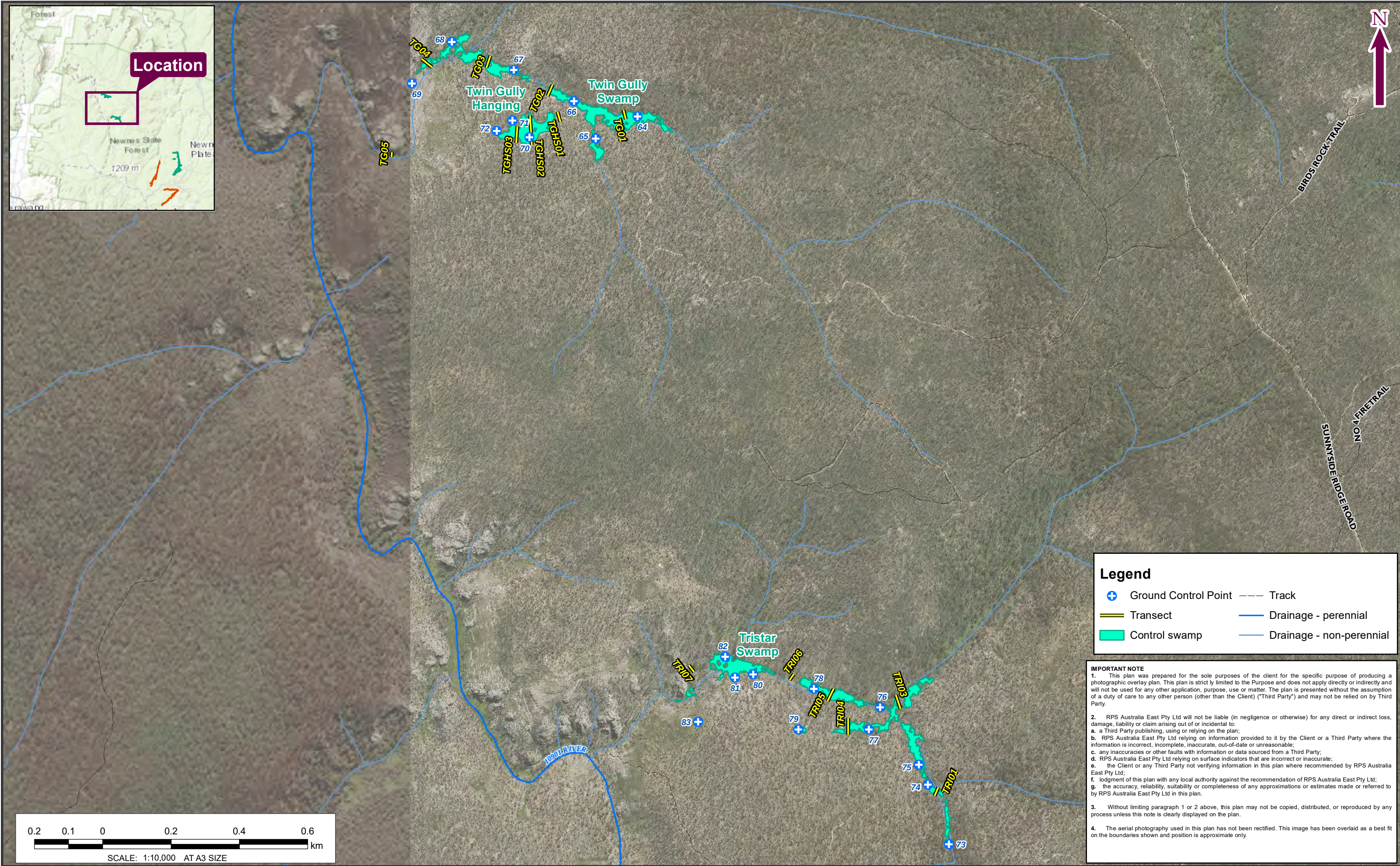


FIGURE 5: WESTERN GCP AND TRANSECT SAMPLING LOCATION

LOCATION :
NEWNES PLATEAU

DATUM:GDA 1994

DATE : 31/08/2021

VERSION (PLAN BY): A1 (Robert.Suansri)

PROJECTION: GDA 1994 MGA Zone 56

PURPOSE: ECOLOGY

PATH: \\ntfile1\Jobs2\Centennial\All Jobs\148912 SV Brownstein 2021 Monitoring LW419-427\10 - Drafting\Arcgis Map Documents\Eco\LW424_427\PR148912_LW424_427_Fig_4-6_Transsects_B_20210831.mxd

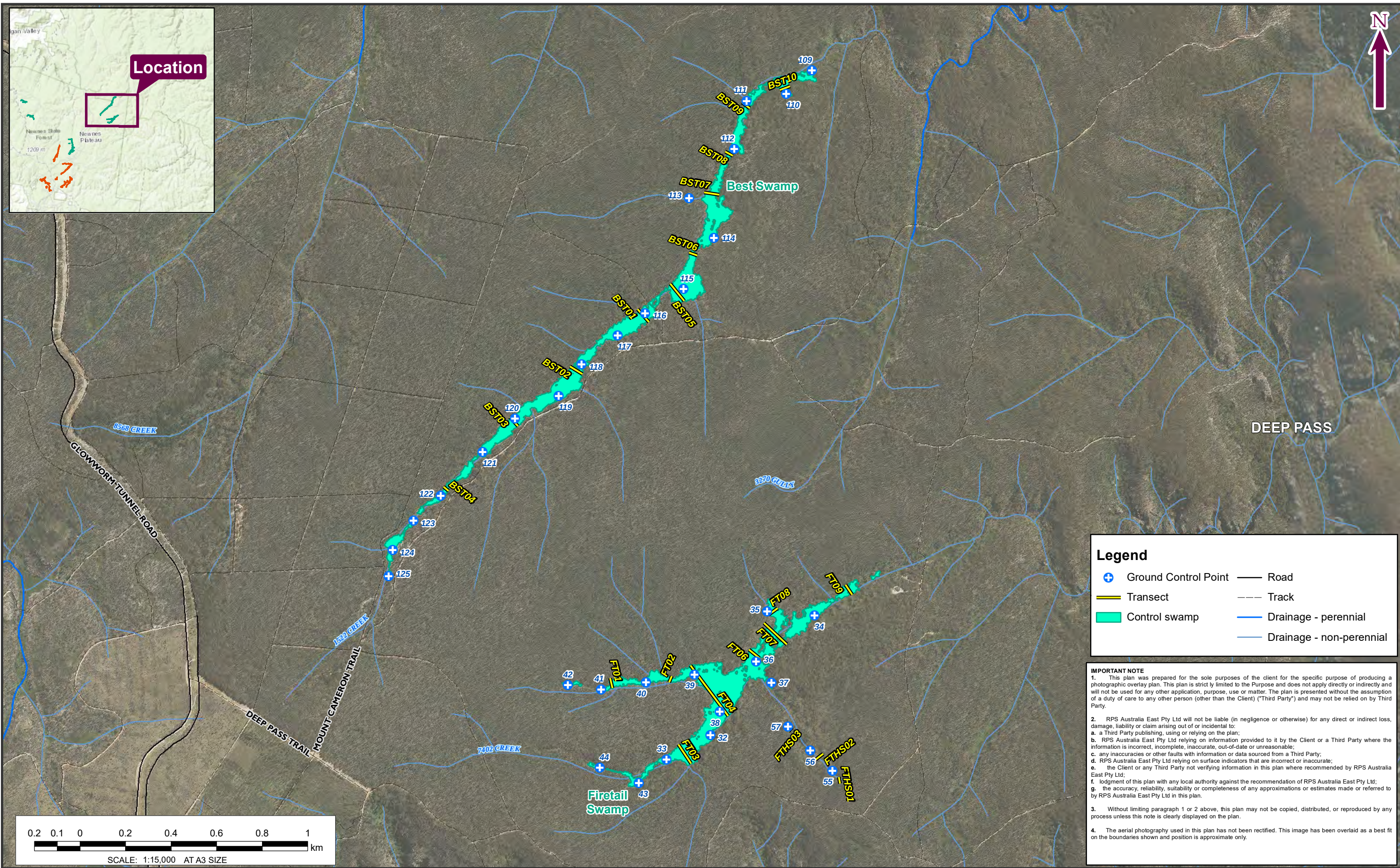


FIGURE 6: EASTERN GCP AND TRANSECT SAMPLING LOCATION

LOCATION :
NEWNES PLATEAU

DATUM:GDA 1994

PROJECTION: GDA 1994 MGA Zone 56

DATE : 31/08/2021

PURPOSE: ECOLOGY

VERSION (PLAN BY): A1 (Robert.Suansri)

PATH: \\ntfile1\Jobs2\Centennial\All Jobs\148912 SV Brownstein 2021 Monitoring LW419-427\10 - Drafting\Arcgis Map Documents\EcoLW424_427\PR148912_LW424_427_Fig_4-6_Transsects_B_20210831.mxd

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
Unit 2A, 45 Fitzroy Street, Carrington, NSW, Australia, 2294 PO Box 120, Carrington, NSW, 2294
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3 RESULTS

3.1 Seasonal Remote Sensing

3.1.1 Plant Health (Photosynthetic Activity)

Plant health monitoring results for each swamp are summarised in **Table 3-1** together with the baseline for LW 419 and LW420-422 against the preliminary trigger levels reported in RPS (2019a).

Table 3-1 Mean Area (SAVI $\leq$ 0.12) $\pm$ SE (ha) and 5% and 10% Preliminary Trigger Level

Swamp	Mean Area (SAVI $\leq$ 0.12) $\pm$ SE (ha)	5% Preliminary Trigger Level (ha)	10% Preliminary Trigger Level (ha)	20% Trigger Level (ha)	Summer 2021
424-427 Baseline Data					
Control Swamps (Shrub)					
Barrier	2.07 $\pm$ 0.976	3.198	3.350	3.655	0.155
Best	0.868 $\pm$ 0.447	1.381	1.447	1.578	0.185
Firetail	0.586 $\pm$ 0.274	0.899	0.942	1.028	0.181
Tristar	0.130 $\pm$ 0.077	0.217	0.228	0.248	0.084
Twin Gully	0.091 $\pm$ 0.065	0.164	0.172	0.187	0.074
Control Swamps (Hanging)					
Twin Gully Hanging	0.078 $\pm$ 0.034	0.118	0.123	0.134	0.063
Impact Swamps (Shrub)					
Marrangaroo	0.606 $\pm$ 0.291	0.942	0.987	1.076	1.010
Paddys Creek	0.286 $\pm$ 0.136	0.442	0.463	0.506	0.891
Pine	0.446 $\pm$ 0.272	0.755	0.791	0.862	0.511
Impact Swamps (Hanging)					
Pine Hanging	0.0012 $\pm$ 0.0007	0.002	0.002	0.0023	0.003
LW420-422 Baseline (Existing Data Set)					
Control Swamps (shrub)					
Barrier	1.928 $\pm$ 0.956	3.028	3.172	3.461	0.158
Best	0.848 $\pm$ 0.400	1.310	1.373	1.498	0.178
Firetail	0.585 $\pm$ 0.276	0.904	0.948	1.033	0.195
Tristar	0.151 $\pm$ 0.088	0.251	0.263	0.287	0.116
Twin Gully	0.108 $\pm$ 0.073	0.190	0.199	0.217	0.083
Control Swamps (hanging)					
Twin Gully Hanging	0.117 $\pm$ 0.040	0.165	0.172	0.188	0.090
Impact Swamp (shrub)					
Nine Mile	0.167 $\pm$ 0.076	0.256	0.268	0.292	0.123
LW419 Baseline (Existing Data Set)					
Control Swamps (shrub)					
Barrier	2.192 $\pm$ 0.583	2.914	3.053	3.330	0.257
Firetail	1.245 $\pm$ 0.297	1.619	1.696	1.850	0.293
Tristar	0.345 $\pm$ 0.079	0.445	0.466	0.509	0.402
Twin Gully	0.117 $\pm$ 0.036	0.161	0.168	0.184	0.124
Control Swamp (hanging)					
Twin Gully Hanging	0.218 $\pm$ 0.039	0.270	0.283	0.308	0.125
Impact Swamps (Shrub)					

Swamp	Mean Area (SAVI ≤ 0.12) ± SE (ha)	5% Preliminary Trigger Level (ha)	10% Preliminary Trigger Level (ha)	20% Trigger Level (ha)	Summer 2021
East Gang Gang	0.506 ± 0.105	0.642	0.672	0.733	4.492

Results that exceed the corresponding baseline (i.e. SAVI is ≤ to 0.12) by >20% are coloured orange, which indicates:

- A trigger level exceedance for impact swamps; or
- Variation outside prior measured variation for control swamps.

Results that exceed the corresponding baseline (i.e. SAVI is ≤ to 0.12) by >10% are coloured grey, which indicates:

- A preliminary trigger level exceedance for impact swamps; or
- Variation outside prior measured variation for control swamps.

Statistical significance is included in **Table 3-1** as a requisite indication of a trigger event, as described in **Table 1-1**.

Seasonal histograms illustrating the spectral distribution of photosynthetic activity for summer 2021 against the spring (2017 and 2018) baseline results (shaded) are provided in **Appendix A**.

Maps showing the spatial representation of SAVI categories and non-live vegetation land cover for each impact swamp are shown in **Figures 7 to 30**. Under the LW424-427 baseline, two swamps experienced triggers >20% threshold (Paddys Creek and Pine Hanging). East Gang Gang also recorded a trigger exceedance >20% threshold when compared to the LW419 baseline. Zero control swamps (Tristar, Twin Gully and Firetail) were outside the variation observed in the baseline period.

3.1.2 Ground Control Points

Results obtained from GCP reconnaissance performed in the summer 2021 monitoring event are summarised in **Table 3-2**. Cells coloured grey indicate Live Green (%) values below baseline range and Exotic (%) values above baseline range.

Table 3-2 Mean Summary data for all seasons per GCP: Live Green (%) and Exotic (%) including Standard Error (SE)

Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) ± SE	Exotic (%) ± SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
LW424-427 Baseline						
Control Swamps (shrub)						
Barrier	1	94.25 ± 2.10	0.00 ± 0.00	92.15	90	0
Barrier	2	74.13 ± 11.87	0.00 ± 0.00	62.26	70	0
Barrier	3	77.13 ± 9.35	0.00 ± 0.00	67.78	30	0
Barrier	4	95.75 ± 3.85	0.00 ± 0.00	91.90	60	0
Barrier	5	94.38 ± 3.42	0.00 ± 0.00	90.96	70	0
Barrier	6	71.88 ± 17.21	0.00 ± 0.00	54.67	50	0
Barrier	7	79.75 ± 8.12	0.00 ± 0.00	71.63	90	0
Barrier	8	65.63 ± 8.54	0.00 ± 0.00	57.09	75	0
Barrier	9	89.75 ± 7.85	0.00 ± 0.00	81.90	95	0
Barrier	10	88.88 ± 5.01	0.00 ± 0.00	83.87	80	0
Barrier	11	85.00 ± 8.82	0.00 ± 0.00	76.18	60	0
Barrier	12	65.63 ± 7.18	0.00 ± 0.00	58.45	30	0
Barrier	13	94 ± 5.93	0.00 ± 0.00	88.07	30	0

REPORT

Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Barrier	14	77.5 $\pm$ 9.06	0.00 $\pm$ 0.00	68.44	60	0
Barrier	15	87.25 $\pm$ 5.37	0.00 $\pm$ 0.00	81.88	85	0
Barrier	16	82.63 $\pm$ 12.01	0.00 $\pm$ 0.00	70.62	50	0
Barrier	17	83.25 $\pm$ 11.99	0.00 $\pm$ 0.00	71.26	65	0
Barrier	18	65.63 $\pm$ 19.41	0.00 $\pm$ 0.00	46.22	90	0
Barrier	19	93 $\pm$ 5.24	0.00 $\pm$ 0.00	87.76	80	0
Barrier	20	84.88 $\pm$ 8.54	0.00 $\pm$ 0.00	76.34	40	0
Barrier	21	80 $\pm$ 9.97	0.00 $\pm$ 0.00	70.03	60	0
Barrier	22	74.75 $\pm$ 15.01	0.00 $\pm$ 0.00	59.74	85	0
Barrier	23	89 $\pm$ 5.49	0.00 $\pm$ 0.00	83.51	60	0
Barrier	24	79.63 $\pm$ 12.64	0.00 $\pm$ 0.00	66.99	30	0
Barrier	25	87.5 $\pm$ 8.02	0.00 $\pm$ 0.00	79.48	80	0
Barrier	26	85 $\pm$ 9.45	0.00 $\pm$ 0.00	75.55	70	0
Barrier	27	73.25 $\pm$ 9.23	0.00 $\pm$ 0.00	64.02	40	0
Barrier	28	99.25 $\pm$ 1.24	0.00 $\pm$ 0.00	98.01	60	0
Barrier	29	91 $\pm$ 2.75	0.00 $\pm$ 0.00	88.25	95	0
Barrier	30	85.38 $\pm$ 6.08	0.00 $\pm$ 0.00	79.30	95	0
Barrier	31	96.75 $\pm$ 2.35	0.00 $\pm$ 0.00	94.40	99	0
Firetail	32	92.88 $\pm$ 6.87	0.00 $\pm$ 0.00	86.01	85	0
Firetail	33	86.25 $\pm$ 12.36	0.00 $\pm$ 0.00	73.89	50	0
Firetail	34	96.13 $\pm$ 2.31	0.00 $\pm$ 0.00	93.82	65	0
Firetail	35	76.88 $\pm$ 9.99	0.00 $\pm$ 0.00	66.89	20	0
Firetail	36	81.25 $\pm$ 11.61	0.00 $\pm$ 0.00	69.64	50	0
Firetail	37	55.63 $\pm$ 16.84	0.00 $\pm$ 0.00	38.79	60	0
Firetail	38	93.63 $\pm$ 4.72	0.00 $\pm$ 0.00	88.91	80	0
Firetail	39	79.38 $\pm$ 10.08	0.00 $\pm$ 0.00	69.30	60	0
Firetail	40	95.38 $\pm$ 2.78	0.00 $\pm$ 0.00	92.60	60	0
Firetail	41	70 $\pm$ 9.26	0.00 $\pm$ 0.00	60.74	5	0
Firetail	42	62.5 $\pm$ 8.66	0.00 $\pm$ 0.00	53.84	65	0
Firetail	43	91.88 $\pm$ 4.98	0.00 $\pm$ 0.00	86.90	45	0
Firetail	44	41.25 $\pm$ 6.75	0.00 $\pm$ 0.00	34.50	30	0
Twin Gully	64	89.38 $\pm$ 3.5	0.00 $\pm$ 0.00	85.88	85	0
Twin Gully	65	97.00 $\pm$ 1.56	0.00 $\pm$ 0.00	95.44	65	0
Twin Gully	66	81.25 $\pm$ 10.31	0.00 $\pm$ 0.00	70.94	50	0
Twin Gully	67	95.00 $\pm$ 3.14	0.00 $\pm$ 0.00	91.86	95	0
Twin Gully	68	84.00 $\pm$ 8.87	0.00 $\pm$ 0.00	75.13	80	0
Twin Gully	69	71.88 $\pm$ 8.22	0.00 $\pm$ 0.00	63.66	55	0
Tristar	73	71.88 $\pm$ 7.06	0.00 $\pm$ 0.00	64.82	80	0
Tristar	74	76.88 $\pm$ 7.30	0.00 $\pm$ 0.00	69.58	75	0
Tristar	75	91.38 $\pm$ 5.90	0.00 $\pm$ 0.00	85.48	100	0
Tristar	76	92.25 $\pm$ 4.42	0.00 $\pm$ 0.00	87.83	75	0
Tristar	77	76.88 $\pm$ 6.25	0.00 $\pm$ 0.00	70.63	75	0
Tristar	78	78.63 $\pm$ 16.14	0.00 $\pm$ 0.00	62.49	35	0
Tristar	79	85.38 $\pm$ 7.26	0.00 $\pm$ 0.00	78.12	60	0

REPORT

Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Tristar	80	64.38 $\pm$ 16.41	0.00 $\pm$ 0.00	47.97	85	0
Tristar	81	69.38 $\pm$ 21.00	0.00 $\pm$ 0.00	48.38	30	0
Tristar	82	84.63 $\pm$ 8.73	0.00 $\pm$ 0.00	75.90	95	0
Best	109	81.5. $\pm$ 10.51	0.00 $\pm$ 0.00	70.99	80	0
Best	110	68.75 $\pm$ 17.19	0.00 $\pm$ 0.00	51.56	95	0
Best	111	85.25 $\pm$ 8.63	0.00 $\pm$ 0.00	76.62	95	0
Best	112	69.25 $\pm$ 13.55	0.00 $\pm$ 0.00	55.70	60	0
Best	113	76.88 $\pm$ 10.17	0.00 $\pm$ 0.00	66.71	80	0
Best	114	87.13 $\pm$ 9.74	0.00 $\pm$ 0.00	77.39	80	0
Best	115	88.00 $\pm$ 10.61	0.00 $\pm$ 0.00	77.39	70	0
Best	116	85.63 $\pm$ 6.38	0.00 $\pm$ 0.00	79.25	80	0
Best	117	91.88 $\pm$ 4.51	0.00 $\pm$ 0.00	87.37	75	0
Best	118	84.38 $\pm$ 5.81	0.00 $\pm$ 0.00	78.57	80	0
Best	119	71.25 $\pm$ 14.11	0.00 $\pm$ 0.00	57.14	30	0
Best	120	97.00 $\pm$ 2.30	0.00 $\pm$ 0.00	94.70	95	0
Best	121	95.00 $\pm$ 2.67	0.00 $\pm$ 0.00	92.33	70	0
Best	122	95.50 $\pm$ 3.78	0.00 $\pm$ 0.00	91.72	60	0
Best	123	96.88 $\pm$ 3.59	0.00 $\pm$ 0.00	93.29	85	0
Best	124	73.50 $\pm$ 16.55	0.00 $\pm$ 0.00	56.95	15	0
Best	125	56.25 $\pm$ 8.81	0.00 $\pm$ 0.00	47.44	40	0
Control Swamps (Hanging)						
Firetail Hanging	55	80.5 $\pm$ 13.45	0.00 $\pm$ 0.00	67.05	90	0
Firetail Hanging	56	38.75 $\pm$ 17.8	0.00 $\pm$ 0.00	20.95	40	0
Firetail Hanging	57	59.38 $\pm$ 12.31	0.00 $\pm$ 0.00	47.07	50	0
Twin Gully Hanging	70	88.75 $\pm$ 6.68	0.00 $\pm$ 0.00	82.07	90	0
Twin Gully Hanging	71	77.50 $\pm$ 9.64	0.00 $\pm$ 0.00	67.86	65	0
Twin Gully Hanging	72	80.38 $\pm$ 5.66	0.00 $\pm$ 0.00	74.72	70	0
Impact Swamps (Shrub)						
Pine	132	95.88 $\pm$ 1.16	0.00 $\pm$ 0.00	94.72	90	0
Pine	133	90.00 $\pm$ 6.48	0.00 $\pm$ 0.00	83.52	95	0
Pine	134	72.75 $\pm$ 10.22	0.00 $\pm$ 0.00	62.53	75	0
Pine	135	90.88 $\pm$ 9.02	0.00 $\pm$ 0.00	81.86	70	0
Pine	136	92.25 $\pm$ 6.93	0.00 $\pm$ 0.00	85.32	70	0
Pine	137	76.00 $\pm$ 12.97	0.00 $\pm$ 0.00	63.03	60	0
Pine	138	87.50 $\pm$ 9.02	0.00 $\pm$ 0.00	78.48	25	0
Pine	139	91.63 $\pm$ 5.72	0.00 $\pm$ 0.00	85.91	20	1
Pine	140	92.88 $\pm$ 4.40	0.00 $\pm$ 0.00	88.48	20	0
Pine	213	77.88 $\pm$ 11.69	0.00 $\pm$ 0.00	66.19	95	0
Pine	214	96.75 $\pm$ 1.88	0.00 $\pm$ 0.00	94.87	99	0
Pine	215	96.00 $\pm$ 3.00	0.00 $\pm$ 0.00	93	99	0
Pine	216	95.00 $\pm$ 5.90	0.00 $\pm$ 0.00	89.1	70	0
Paddy's Creek	156	97.38 $\pm$ 2.51	0.00 $\pm$ 0.00	94.87	5	0
Paddy's Creek	157	94.88 $\pm$ 3.57	0.00 $\pm$ 0.00	91.31	70	0
Paddy's Creek	158	98.63 $\pm$ 1.13	0.00 $\pm$ 0.00	97.5	55	0

REPORT

Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Paddy's Creek	159	92.88 $\pm$ 8.26	0.00 $\pm$ 0.00	84.62	35	0
Paddy's Creek	160	88.5 $\pm$ 9.43	0.00 $\pm$ 0.00	79.07	60	0
Paddy's Creek	161	79.38 $\pm$ 8.74	0.00 $\pm$ 0.00	70.64	45	0
Paddy's Creek	162	99.63 $\pm$ 0.37	0.00 $\pm$ 0.00	99.26	90	0
Paddy's Creek	163	97.63 $\pm$ 1.6	0.00 $\pm$ 0.00	96.03	95	0
Paddy's Creek	164	98.25 $\pm$ 2.41	0.00 $\pm$ 0.00	95.84	95	0
Paddy's Creek	165	99.25 $\pm$ 0.63	0.00 $\pm$ 0.00	98.62	20	0
Paddy's Creek	166	98.25 $\pm$ 1.18	0.00 $\pm$ 0.00	97.07	3	0
Paddy's Creek	167	96.88 $\pm$ 2.25	0.00 $\pm$ 0.00	94.63	40	0
Paddy's Creek	168	98.25 $\pm$ 1.59	0.00 $\pm$ 0.00	96.66	25	0
Paddy's Creek	169	98.25 $\pm$ 1.18	0.00 $\pm$ 0.00	97.07	95	0
Paddy's Creek	171	96.5 $\pm$ 3.59	0.00 $\pm$ 0.00	92.91	90	0
Paddy's Creek	172	90.88 $\pm$ 5.74	0.00 $\pm$ 0.00	85.14	95	0
Paddy's Creek	173	96.63 $\pm$ 2.3	0.00 $\pm$ 0.00	94.33	0	0
Paddy's Creek	174	95.63 $\pm$ 3.98	0.00 $\pm$ 0.00	91.65	10	1
Paddy's Creek	175	45 $\pm$ 15	0.00 $\pm$ 0.00	30	50	0
Paddy's Creek	176	94.75 $\pm$ 8.58	0.00 $\pm$ 0.00	86.17	15	0
Paddy's Creek	177	98.25 $\pm$ 1.24	0.00 $\pm$ 0.00	97.01	30	0
Paddy's Creek	178	99.63 $\pm$ 0.53	0.00 $\pm$ 0.00	99.1	10	0
Paddy's Creek	179	97.63 $\pm$ 2.48	0.00 $\pm$ 0.00	95.15	20	0
Paddy's Creek	180	98.38 $\pm$ 2.45	0.00 $\pm$ 0.00	95.93	25	0
Paddy's Creek	181	84 $\pm$ 9.58	0.00 $\pm$ 0.00	74.42	75	0
Paddy's Creek	182	76.13 $\pm$ 7.93	0.00 $\pm$ 0.00	68.2	10	0
Paddy's Creek	183	80.63 $\pm$ 23.24	0.00 $\pm$ 0.00	57.39	30	0
Paddy's Creek	184	92.13 $\pm$ 6.83	0.00 $\pm$ 0.00	85.3	90	0
Paddy's Creek	185	93.5 $\pm$ 3.36	0.00 $\pm$ 0.00	90.14	15	0
Marrangaroo	186	77.63 $\pm$ 14.11	0.00 $\pm$ 0.00	63.52	80	0
Marrangaroo	187	96.25 $\pm$ 3.5	0.00 $\pm$ 0.00	92.75	70	0
Marrangaroo	188	96.5 $\pm$ 4.87	0.00 $\pm$ 0.00	91.63	65	0
Marrangaroo	189	93.13 $\pm$ 10.17	0.00 $\pm$ 0.00	82.96	85	0
Marrangaroo	190	80.14 $\pm$ 13.76	0.00 $\pm$ 0.00	66.38	60	0
Marrangaroo	191	92.5 $\pm$ 6.78	0.00 $\pm$ 0.00	85.72	95	0
Marrangaroo	192	95 $\pm$ 4.83	0.00 $\pm$ 0.00	90.17	70	0
Marrangaroo	193	55 $\pm$ 14.02	0.00 $\pm$ 0.00	40.98	5	0
Marrangaroo	194	95.75 $\pm$ 3.5	0.00 $\pm$ 0.00	92.25	80	0
Marrangaroo	195	98.38 $\pm$ 1.56	0.00 $\pm$ 0.00	96.82	5	0
Marrangaroo	196	70.63 $\pm$ 9.34	0.00 $\pm$ 0.00	61.29	70	0
Marrangaroo	197	89.38 $\pm$ 5.07	0.00 $\pm$ 0.00	84.31	10	0
Marrangaroo	198	92.13 $\pm$ 6.03	0.00 $\pm$ 0.00	86.1	65	0
Marrangaroo	199	85.5 $\pm$ 4.83	0.00 $\pm$ 0.00	80.67	35	0
Marrangaroo	200	90.13 $\pm$ 5.93	0.00 $\pm$ 0.00	84.2	95	0
Marrangaroo	201	78 $\pm$ 20.36	0.00 $\pm$ 0.00	57.64	50	0
Marrangaroo	202	96.13 $\pm$ 3.06	0.00 $\pm$ 0.00	93.07	90	0
Marrangaroo	203	90.38 $\pm$ 5.59	0.00 $\pm$ 0.00	84.79	50	0

REPORT

Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) ± SE	Exotic (%) ± SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Marrangaroo	204	94.5 ± 5.1	0.00 ± 0.00	89.40	80	0
Marrangaroo	205	98.38 ± 1.64	0.00 ± 0.00	96.74	90	0
Marrangaroo	206	95.25 ± 4.88	0.00 ± 0.00	90.37	80	0
Marrangaroo	207	98.5 ± 2.48	0.00 ± 0.00	96.02	95	0
Marrangaroo	208	97.13 ± 3.13	0.00 ± 0.00	94	90	0
Marrangaroo	209	96.38 ± 3.54	0.00 ± 0.00	92.84	85	0
Marrangaroo	210	94.75 ± 4.07	0.00 ± 0.00	90.68	90	0
Marrangaroo	211	93.63 ± 5.03	0.00 ± 0.00	88.60	90	0
Impact Swamps (Hanging)						
Pine Hanging	212	93.75 ± 6.11	0.00 ± 0.00	87.64	90	0
LW420-422 Baseline (Existing Data)						
Control Swamps (Shrub)						
Barrier	1	94.88 ± 1.20	0.00 ± 0.00	93.68	90	0
Barrier	2	81.00 ± 5.15	0.00 ± 0.00	75.85	70	0
Barrier	3	84.00 ± 3.43	0.00 ± 0.00	80.57	30	0
Barrier	4	97.50 ± 1.72	0.00 ± 0.00	95.78	60	0
Barrier	5	96.13 ± 1.14	0.00 ± 0.00	94.99	70	0
Barrier	6	73.75 ± 8.32	0.00 ± 0.00	65.43	50	0
Barrier	7	86.00 ± 3.86	0.00 ± 0.00	82.14	90	0
Barrier	8	73.13 ± 4.72	0.00 ± 0.00	68.41	75	0
Barrier	9	91.00 ± 3.80	0.00 ± 0.00	87.2	95	0
Barrier	10	91.38 ± 2.67	0.00 ± 0.00	88.71	80	0
Barrier	11	86.88 ± 3.65	0.00 ± 0.00	83.23	60	0
Barrier	12	72.50 ± 5.05	0.00 ± 0.00	67.45	30	0
Barrier	13	95.25 ± 2.82	0.00 ± 0.00	92.43	30	0
Barrier	14	83.75 ± 4.26	0.00 ± 0.00	79.49	60	0
Barrier	15	91.00 ± 2.70	0.00 ± 0.00	88.3	85	0
Barrier	16	84.50 ± 5.84	0.00 ± 0.00	78.66	50	0
Barrier	17	88.25 ± 3.47	0.00 ± 0.00	84.78	65	0
Barrier	18	79.38 ± 3.83	0.00 ± 0.00	75.55	90	0
Barrier	19	94.25 ± 1.84	0.00 ± 0.00	92.41	80	0
Barrier	20	86.75 ± 4.41	0.13 ± 0.12	82.34	40	0
Barrier	21	84.38 ± 4.58	0.00 ± 0.00	79.8	60	0
Barrier	22	77.25 ± 6.82	0.00 ± 0.00	70.43	85	0
Barrier	23	89.00 ± 2.88	0.00 ± 0.00	86.12	60	0
Barrier	24	88.38 ± 1.68	0.00 ± 0.00	86.7	30	0
Barrier	25	90.00 ± 3.89	0.00 ± 0.00	86.11	80	0
Barrier	26	88.75 ± 4.07	0.00 ± 0.00	84.68	70	0
Barrier	27	80.75 ± 4.97	0.00 ± 0.00	75.78	40	0
Barrier	28	99.25 ± 0.59	0.00 ± 0.00	98.66	60	0
Barrier	29	91.63 ± 1.37	0.00 ± 0.00	90.26	95	0
Barrier	30	85.38 ± 2.87	0.00 ± 0.00	82.51	95	0
Barrier	31	96.00 ± 1.42	0.00 ± 0.00	94.58	99	0
Firetail	32	96.00 ± 1.01	0.00 ± 0.00	94.99	85	0

REPORT

Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Firetail	33	91.25 $\pm$ 3.19	0.00 $\pm$ 0.00	88.06	50	0
Firetail	34	97.38 $\pm$ 0.80	0.00 $\pm$ 0.00	96.58	65	0
Firetail	35	77.50 $\pm$ 4.19	0.00 $\pm$ 0.00	73.31	20	0
Firetail	36	88.13 $\pm$ 3.67	0.00 $\pm$ 0.00	84.46	50	0
Firetail	37	55.63 $\pm$ 7.55	0.00 $\pm$ 0.00	48.08	60	0
Firetail	38	93.88 $\pm$ 2.12	0.00 $\pm$ 0.00	91.76	80	0
Firetail	39	86.88 $\pm$ 3.45	0.00 $\pm$ 0.00	83.43	60	0
Firetail	40	95.88 $\pm$ 1.05	0.00 $\pm$ 0.00	94.83	60	0
Firetail	41	67.50 $\pm$ 5.28	0.00 $\pm$ 0.00	62.22	5	0
Firetail	42	62.50 $\pm$ 4.81	0.00 $\pm$ 0.00	57.69	65	0
Firetail	43	94.38 $\pm$ 1.66	0.00 $\pm$ 0.00	92.72	45	0
Firetail	44	38.75 $\pm$ 3.65	0.00 $\pm$ 0.00	35.1	30	0
Twin Gully	64	90.00 $\pm$ 2.36	0.00 $\pm$ 0.00	87.64	85	0
Twin Gully	65	97.25 $\pm$ 0.81	0.00 $\pm$ 0.00	96.44	65	0
Twin Gully	66	83.13 $\pm$ 5.35	0.00 $\pm$ 0.00	77.78	50	0
Twin Gully	67	94.63 $\pm$ 1.43	0.00 $\pm$ 0.00	93.2	95	0
Twin Gully	68	84.63 $\pm$ 4.78	0.00 $\pm$ 0.00	79.85	80	0
Twin Gully	69	67.50 $\pm$ 2.19	0.00 $\pm$ 0.00	65.31	55	0
Tristar	73	70.63 $\pm$ 3.15	0.00 $\pm$ 0.00	67.48	80	0
Tristar	74	78.13 $\pm$ 3.67	0.00 $\pm$ 0.00	74.46	75	0
Tristar	75	93.38 $\pm$ 1.99	0.00 $\pm$ 0.00	91.39	100	0
Tristar	76	93.50 $\pm$ 1.63	0.00 $\pm$ 0.00	91.87	75	0
Tristar	77	82.5 $\pm$ 3.22	0.00 $\pm$ 0.00	79.28	75	0
Tristar	78	77.38 $\pm$ 7.69	0.00 $\pm$ 0.00	69.69	35	0
Tristar	79	91.63 $\pm$ 2.49	0.00 $\pm$ 0.00	89.14	60	0
Tristar	80	76.88 $\pm$ 2.95	0.00 $\pm$ 0.00	73.93	85	0
Tristar	81	69.38 $\pm$ 9.92	0.00 $\pm$ 0.00	59.46	30	0
Tristar	82	87.13 $\pm$ 4.43	0.00 $\pm$ 0.00	82.7	95	0
Best	109	82.13 $\pm$ 4.90	0.00 $\pm$ 0.00	77.23	80	0
Best	110	82.50 $\pm$ 6.31	0.00 $\pm$ 0.00	76.19	95	0
Best	111	90.25 $\pm$ 2.89	0.00 $\pm$ 0.00	87.36	95	0
Best	112	79.25 $\pm$ 6.61	0.00 $\pm$ 0.00	72.64	60	0
Best	113	75.00 $\pm$ 5.65	0.00 $\pm$ 0.00	69.35	80	0
Best	114	92.75 $\pm$ 3.36	0.00 $\pm$ 0.00	89.39	80	0
Best	115	95.13 $\pm$ 2.34	0.00 $\pm$ 0.00	92.79	70	0
Best	116	88.13 $\pm$ 2.81	0.00 $\pm$ 0.00	85.32	80	0
Best	117	93.75 $\pm$ 2.10	0.00 $\pm$ 0.00	91.65	75	0
Best	118	86.88 $\pm$ 3.56	0.00 $\pm$ 0.00	83.32	80	0
Best	119	81.25 $\pm$ 3.97	0.00 $\pm$ 0.00	77.28	30	0
Best	120	97.63 $\pm$ 1.10	0.00 $\pm$ 0.00	96.53	95	0
Best	121	93.75 $\pm$ 3.31	0.00 $\pm$ 0.00	90.44	70	0
Best	122	94.88 $\pm$ 2.28	0.00 $\pm$ 0.00	92.6	60	0
Best	123	98.75 $\pm$ 0.59	0.00 $\pm$ 0.00	98.16	85	0
Best	124	85.63 $\pm$ 4.68	0.00 $\pm$ 0.00	80.95	15	0

REPORT

Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Best	125	67.25 $\pm$ 6.77	0.00 $\pm$ 0.00	60.48	40	0
Control Swamps (Hanging)						
Firetail Hanging	55	86.13 $\pm$ 3.60	0.00 $\pm$ 0.00	82.53	90	0
Firetail Hanging	56	33.75 $\pm$ 9.22	0.25 $\pm$ 0.24	24.53	40	0
Firetail Hanging	57	61.25 $\pm$ 5.26	0.00 $\pm$ 0.00	55.99	50	0
Twin Gully Hanging	70	90.00 $\pm$ 3.43	0.00 $\pm$ 0.00	86.57	90	0
Twin Gully Hanging	71	83.75 $\pm$ 3.87	0.00 $\pm$ 0.00	79.88	65	0
Twin Gully Hanging	72	82.50 $\pm$ 2.68	0.00 $\pm$ 0.00	79.82	70	0
Impact Swamps (Shrub)						
Nine Mile	126	85.5 $\pm$ 3.67	0.00 $\pm$ 0.00	81.83	50	0
Nine Mile	127	92.00 $\pm$ 2.51	0.00 $\pm$ 0.00	89.49	85	0
Nine Mile	128	76.63 $\pm$ 3.49	0.00 $\pm$ 0.00	73.14	75	0
Nine Mile	129	87.25 $\pm$ 4.30	0.00 $\pm$ 0.00	82.95	90	0
Nine Mile	130	82.88 $\pm$ 6.11	0.00 $\pm$ 0.00	76.77	40	0
Nine Mile	131	82.00 $\pm$ 4.16	0.00 $\pm$ 0.00	77.84	99	0
LW419 Baseline (Existing Data)						
Control Swamps (Shrub)						
Barrier	1	88.25 $\pm$ 3.92	0.00 $\pm$ 0.00	84.33	90	0
Barrier	2	79.69 $\pm$ 4.56	0.00 $\pm$ 0.00	75.13	70	0
Barrier	3	86.63 $\pm$ 2.78	0.00 $\pm$ 0.00	83.85	30	0
Barrier	4	97.38 $\pm$ 1.16	0.13 $\pm$ 0.12	96.22	60	0
Barrier	5	96.44 $\pm$ 0.66	0.00 $\pm$ 0.00	95.78	70	0
Barrier	6	82.81 $\pm$ 3.20	0.00 $\pm$ 0.00	79.61	50	0
Barrier	7	87.81 $\pm$ 3.07	0.63 $\pm$ 0.40	84.74	90	0
Barrier	8	75.00 $\pm$ 3.87	0.00 $\pm$ 0.00	71.13	75	0
Barrier	9	93.44 $\pm$ 1.18	0.00 $\pm$ 0.00	92.26	95	0
Barrier	10	93.00 $\pm$ 1.71	0.00 $\pm$ 0.00	91.29	80	0
Barrier	11	84.31 $\pm$ 2.00	1.88 $\pm$ 1.77	82.31	60	0
Barrier	12	83.78 $\pm$ 4.93	0.00 $\pm$ 0.00	78.85	30	0
Barrier	13	95.88 $\pm$ 1.00	0.00 $\pm$ 0.00	94.88	30	0
Barrier	14	80.56 $\pm$ 10.96	0.00 $\pm$ 0.00	69.6	60	0
Barrier	15	90.06 $\pm$ 2.06	0.13 $\pm$ 0.12	88	85	0
Barrier	16	88.63 $\pm$ 2.52	0.00 $\pm$ 0.00	86.11	50	0
Barrier	17	91.75 $\pm$ 1.14	0.00 $\pm$ 0.00	90.61	65	0
Barrier	18	71.56 $\pm$ 4.62	6.25 $\pm$ 5.91	66.94	90	0
Barrier	19	92.19 $\pm$ 3.49	5.00 $\pm$ 4.72	88.7	80	0
Barrier	20	90.00 $\pm$ 2.79	0.13 $\pm$ 0.12	87.21	40	0
Barrier	21	86.25 $\pm$ 3.31	0.38 $\pm$ 0.25	82.94	60	0
Barrier	22	90.13 $\pm$ 2.15	0.00 $\pm$ 0.00	87.98	85	0
Barrier	23	85.00 $\pm$ 2.86	0.00 $\pm$ 0.00	82.14	60	0
Barrier	24	86.25 $\pm$ 2.64	0.00 $\pm$ 0.00	83.61	30	0
Barrier	25	86.50 $\pm$ 4.90	0.00 $\pm$ 0.00	81.6	80	0
Barrier	26	86.00 $\pm$ 2.10	0.00 $\pm$ 0.00	83.9	70	0

REPORT

Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Barrier	27	85.63 $\pm$ 3.86	0.13 $\pm$ 0.12	81.77	40	0
Barrier	28	98.00 $\pm$ 1.22	0.25 $\pm$ 0.24	96.78	60	0
Barrier	29	79.31 $\pm$ 10.80	0.00 $\pm$ 0.00	68.51	95	0
Barrier	30	74.63 $\pm$ 10.53	0.00 $\pm$ 0.00	64.1	95	0
Barrier	31	94.88 $\pm$ 1.42	0.63 $\pm$ 0.59	93.46	99	0
Firetail	32	96.50 $\pm$ 0.64	0.00 $\pm$ 0.00	95.86	85	0
Firetail	33	93.13 $\pm$ 1.90	0.00 $\pm$ 0.00	91.23	50	0
Firetail	34	94.56 $\pm$ 2.24	0.00 $\pm$ 0.00	92.32	65	0
Firetail	35	73.44 $\pm$ 4.26	0.38 $\pm$ 0.35	69.18	20	0
Firetail	36	90.63 $\pm$ 1.88	0.00 $\pm$ 0.00	88.75	50	0
Firetail	37	55.63 $\pm$ 7.22	0.63 $\pm$ 0.59	48.41	60	0
Firetail	38	89.06 $\pm$ 3.63	1.88 $\pm$ 1.24	85.43	80	0
Firetail	39	94.81 $\pm$ 1.14	1.25 $\pm$ 1.18	93.67	60	0
Firetail	40	97.56 $\pm$ 0.73	0.00 $\pm$ 0.00	96.83	60	0
Firetail	41	61.56 $\pm$ 6.42	0.00 $\pm$ 0.00	55.14	5	0
Firetail	42	65.25 $\pm$ 4.06	4.50 $\pm$ 3.00	61.19	65	0
Firetail	43	89.13 $\pm$ 2.53	0.00 $\pm$ 0.00	86.6	45	0
Firetail	44	35.38 $\pm$ 2.22	0.63 $\pm$ 0.59	33.16	30	0
Twin Gully	64	79.69 $\pm$ 11.08	0.00 $\pm$ 0.00	68.61	85	0
Twin Gully	65	86.31 $\pm$ 4.41	1.50 $\pm$ 1.17	81.9	65	0
Twin Gully	66	88.75 $\pm$ 3.09	0.00 $\pm$ 0.00	85.66	50	0
Twin Gully	67	90.81 $\pm$ 2.16	0.00 $\pm$ 0.00	88.65	95	0
Twin Gully	68	74.50 $\pm$ 10.75	0.38 $\pm$ 0.25	63.75	80	0
Twin Gully	69	65.69 $\pm$ 2.62	0.00 $\pm$ 0.00	63.07	55	0
Tristar	73	62.19 $\pm$ 8.9	0.00 $\pm$ 0.00	53.29	80	0
Tristar	74	82.19 $\pm$ 3.67	0.63 $\pm$ 0.59	78.52	75	0
Tristar	75	87.94 $\pm$ 4.48	0.50 $\pm$ 0.47	83.46	100	0
Tristar	76	92.94 $\pm$ 1.78	0.13 $\pm$ 0.12	91.16	75	0
Tristar	77	84.38 $\pm$ 4.16	0.63 $\pm$ 0.59	80.22	75	0
Tristar	78	87.44 $\pm$ 3.69	0.00 $\pm$ 0.00	83.75	35	0
Tristar	79	91.50 $\pm$ 2.78	0.00 $\pm$ 0.00	88.72	60	0
Tristar	80	76.25 $\pm$ 10.63	0.00 $\pm$ 0.00	65.62	85	0
Tristar	81	81.88 $\pm$ 2.95	0.25 $\pm$ 0.15	78.93	30	0
Tristar	82	88.75 $\pm$ 2.64	0.00 $\pm$ 0.00	86.11	95	0
Control Swamps (Hanging)						
Firetail HS	55	70.94 $\pm$ 5.96	1.25 $\pm$ 1.18	64.98	90	0
Firetail HS	56	43.44 $\pm$ 10.33	1.56 $\pm$ 1.48	33.11	40	0
Firetail HS	57	70.31 $\pm$ 5.37	4.38 $\pm$ 4.13	64.94	50	0
Twin Gully HS	70	86.81 $\pm$ 3.95	0.00 $\pm$ 0.00	82.86	90	0
Twin Gully HS	71	81.88 $\pm$ 4.09	2.50 $\pm$ 2.36	77.79	65	0
Twin Gully HS	72	75.69 $\pm$ 3.80	7.50 $\pm$ 7.09	71.89	70	0
Impact Swamps (Shrub)						
East Gang Gang	90	76.75 $\pm$ 10.79	0.00 $\pm$ 0.00	65.96	5	0

Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
East Gang Gang	91	79.94 $\pm$ 11.00	0.00 $\pm$ 0.00	68.94	2	0
East Gang Gang	92	59.69 $\pm$ 9.62	5.63 $\pm$ 5.32	50.07	40	0
East Gang Gang	93	96.63 $\pm$ 1.16	0.00 $\pm$ 0.00	95.47	2	0
East Gang Gang	94	90.94 $\pm$ 2.77	0.00 $\pm$ 0.00	88.17	1	0
East Gang Gang	95	90.88 $\pm$ 2.50	0.88 $\pm$ 0.60	88.38	1	0
East Gang Gang	96	55.00 $\pm$ 2.68	4.13 $\pm$ 2.89	52.32	40	0
East Gang Gang	97	84.13 $\pm$ 10.54	0.25 $\pm$ 0.15	73.59	5	0

A summary for shrub swamps is provided as follows:

- Percent live vegetation cover below the baseline range was recorded for 64 of 82 (78%) of impact swamp GCPs.
- Percent live vegetation cover below the baseline range was recorded for 46 of 77 (60%) of control swamp GCPs.

A summary for hanging swamps is provided as follows:

- Percent live vegetation cover below the baseline range was recorded for 2 of 6 (33%) of impact hanging swamp GCPs.
- Percent live vegetation cover below the baseline range was recorded for 0 of 1 (0%) of control hanging swamp GCPs

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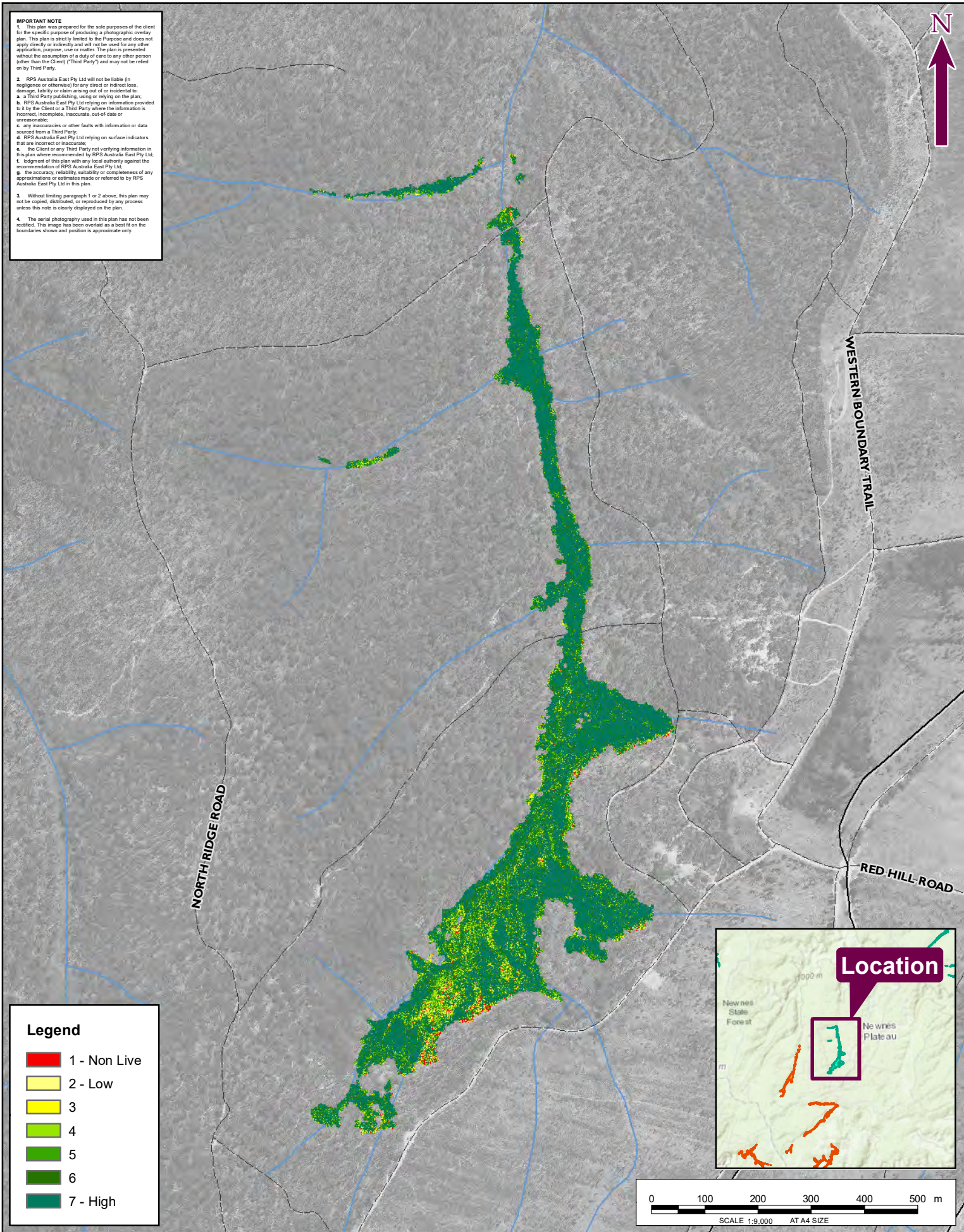


FIGURE 7
BARRIER SWAMP SAVI CLASSIFICATION (ALL RANGES) SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert Suansri

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
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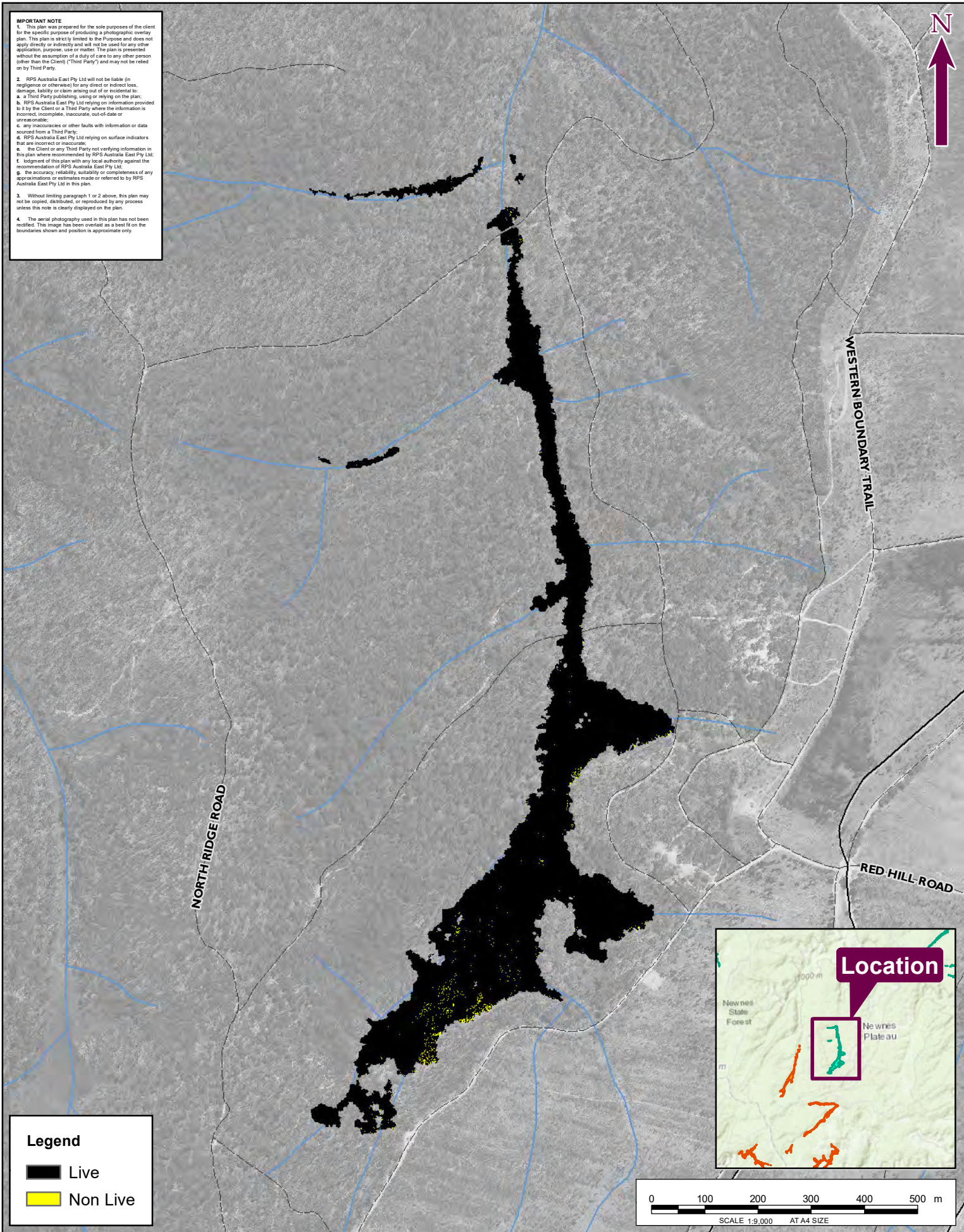


FIGURE 8
BARRIER SWAMP LIVE VERSUS NON-LIVE (SAVI <0.12) VEGETATION COVER SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert.Suansri

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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Legend

- 1 - Non Live
- 2 - Low
- 3
- 4
- 5
- 6
- 7 - High

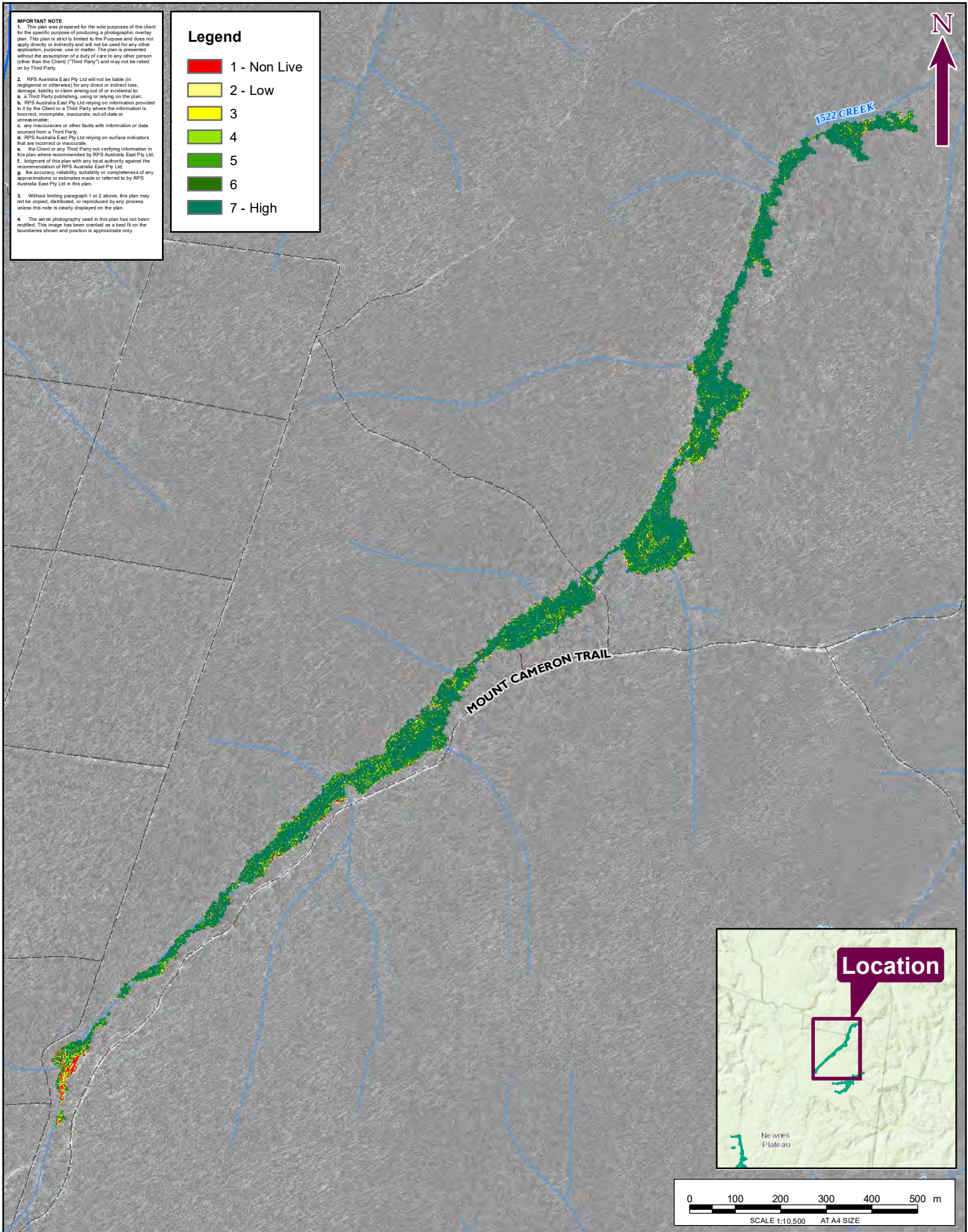


FIGURE 9
BEST SWAMP SAVI CLASSIFICATION (ALL RANGES) SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert Suansri

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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d. RPS Australia East Pty Ltd relying on surface indicators that are incorrect or inaccurate;

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Legend

 Live

 Non Live

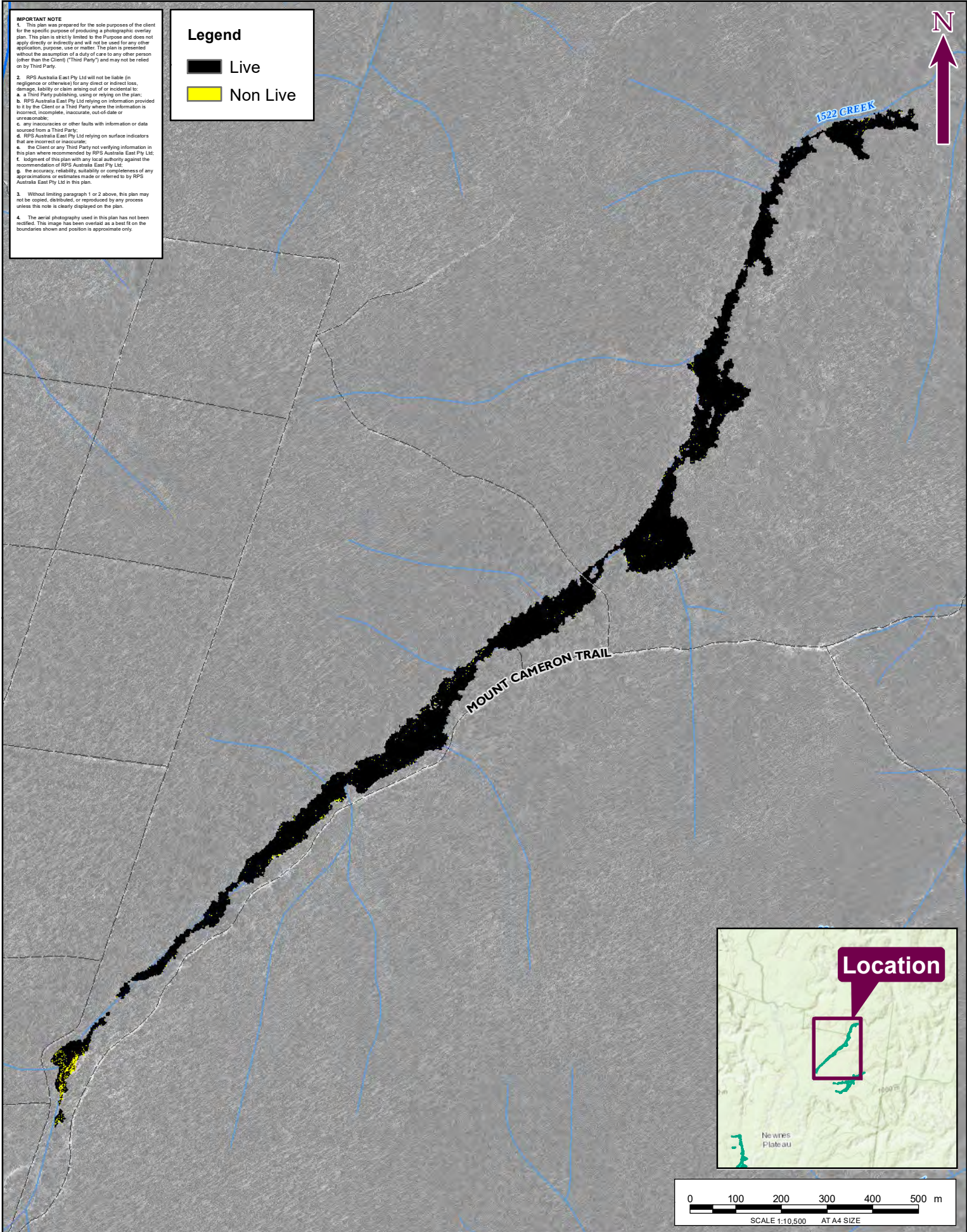


FIGURE 10
BEST SWAMP LIVE VERSUS NON-LIVE (SAVI <0.12) VEGETATION COVER
SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert Suansri

CLIENT: CENTENNIAL COAL

JOB REF: PR148912

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
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Legend

- 1 - Non Live
- 2 - Low
- 3
- 4
- 5
- 6
- 7 - High

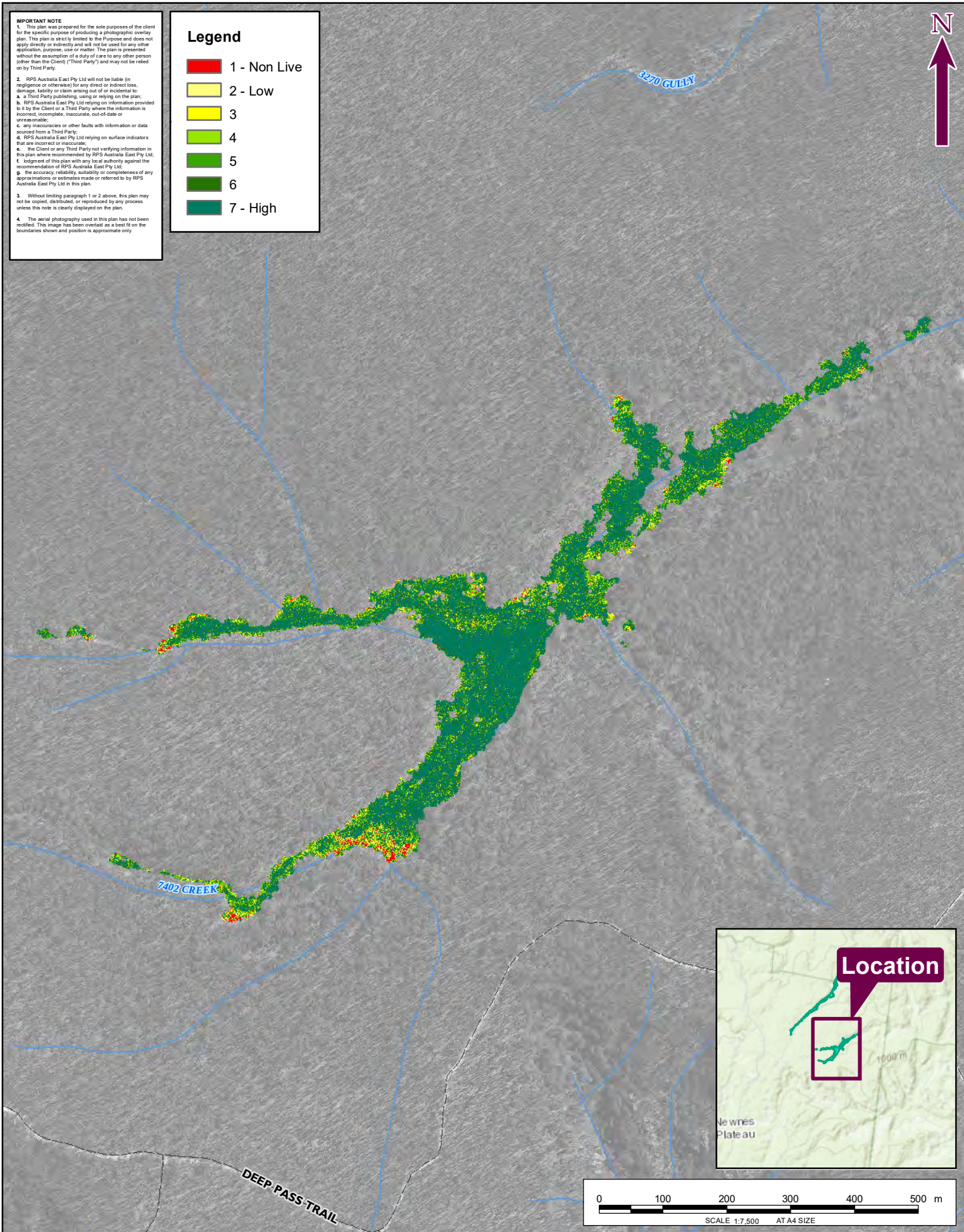


FIGURE 11
FIRETAIL SWAMP SAVI CLASSIFICATION (ALL RANGES) SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert Suansri

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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Legend

 Live

 Non Live

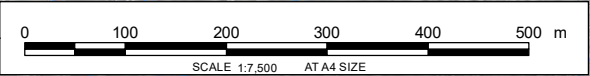
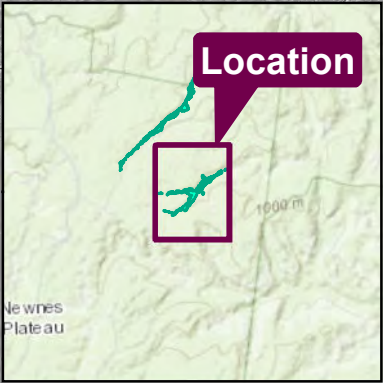
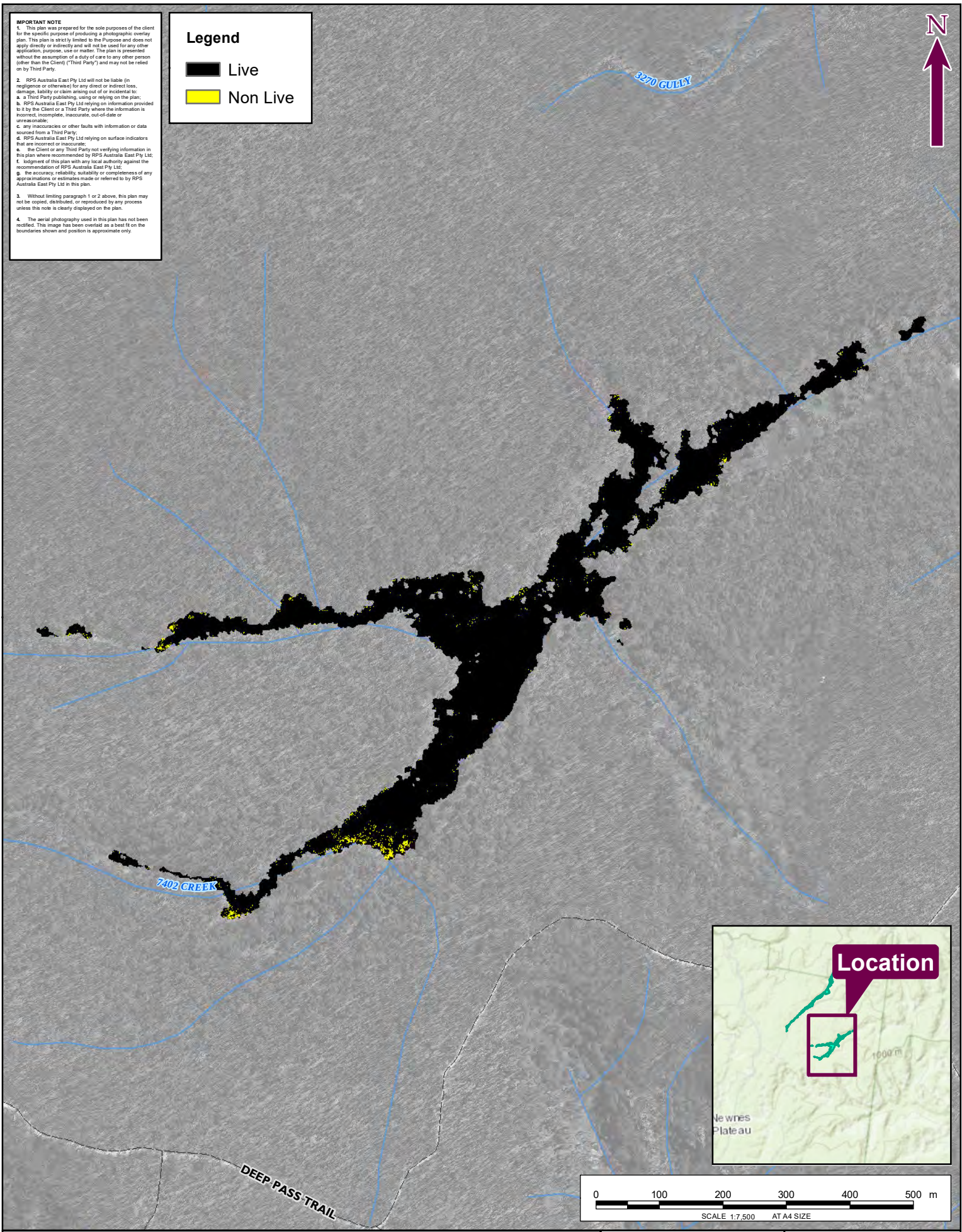


FIGURE 12
FIRETAIL SWAMP LIVE VERSUS NON-LIVE (SAVI <0.12) VEGETATION COVERS SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert.Suansri

CLIENT: CENTENNIAL COAL

JOB REF: PR148912

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Legend

- 1 - Non Live
- 2 - Low
- 3
- 4
- 5
- 6
- 7 - High

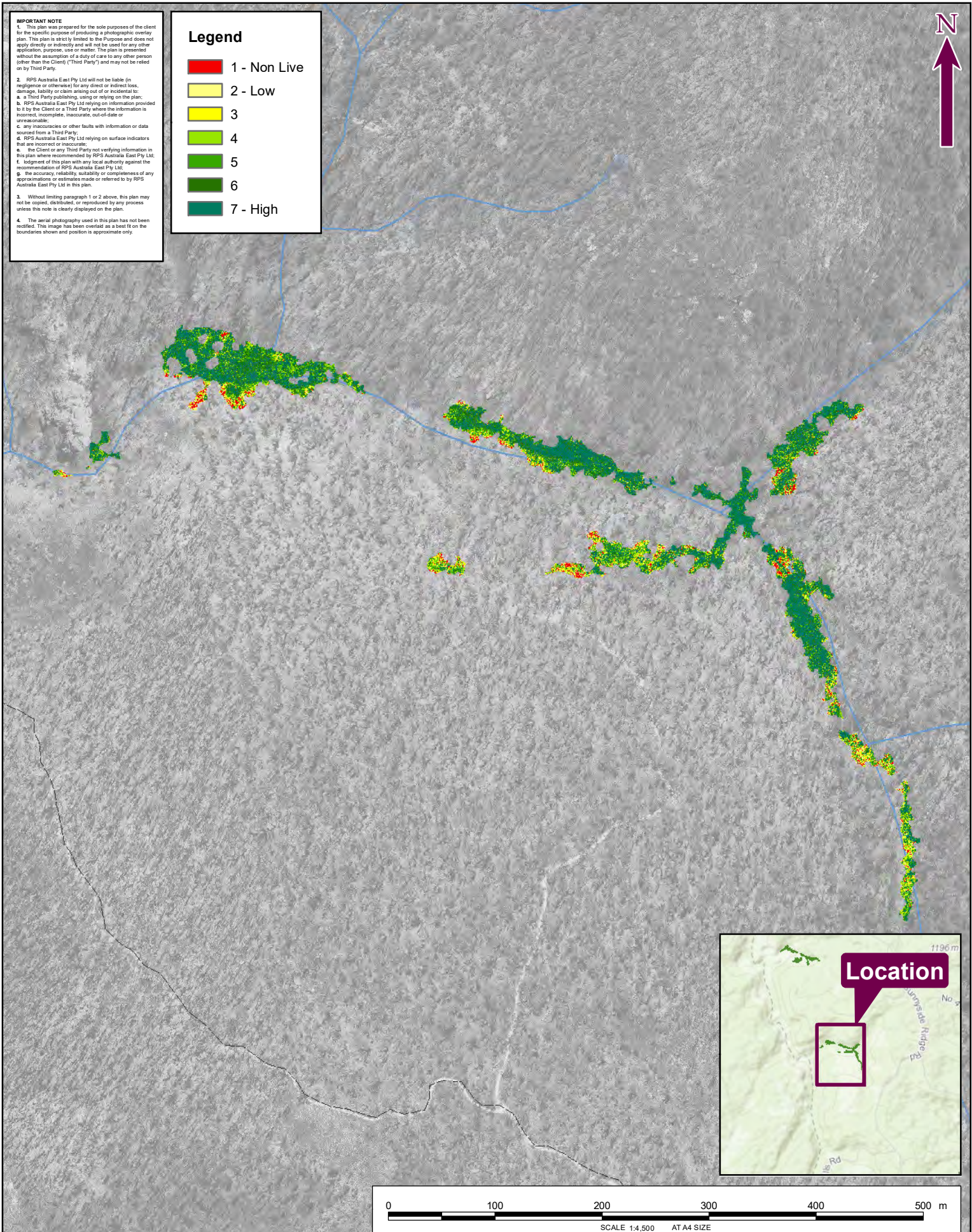


FIGURE 13
TRISTAR SWAMP SAVI CLASSIFICATION (ALL RANGES) SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/05/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: John.Hembra

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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Legend

 Live

 Non Live

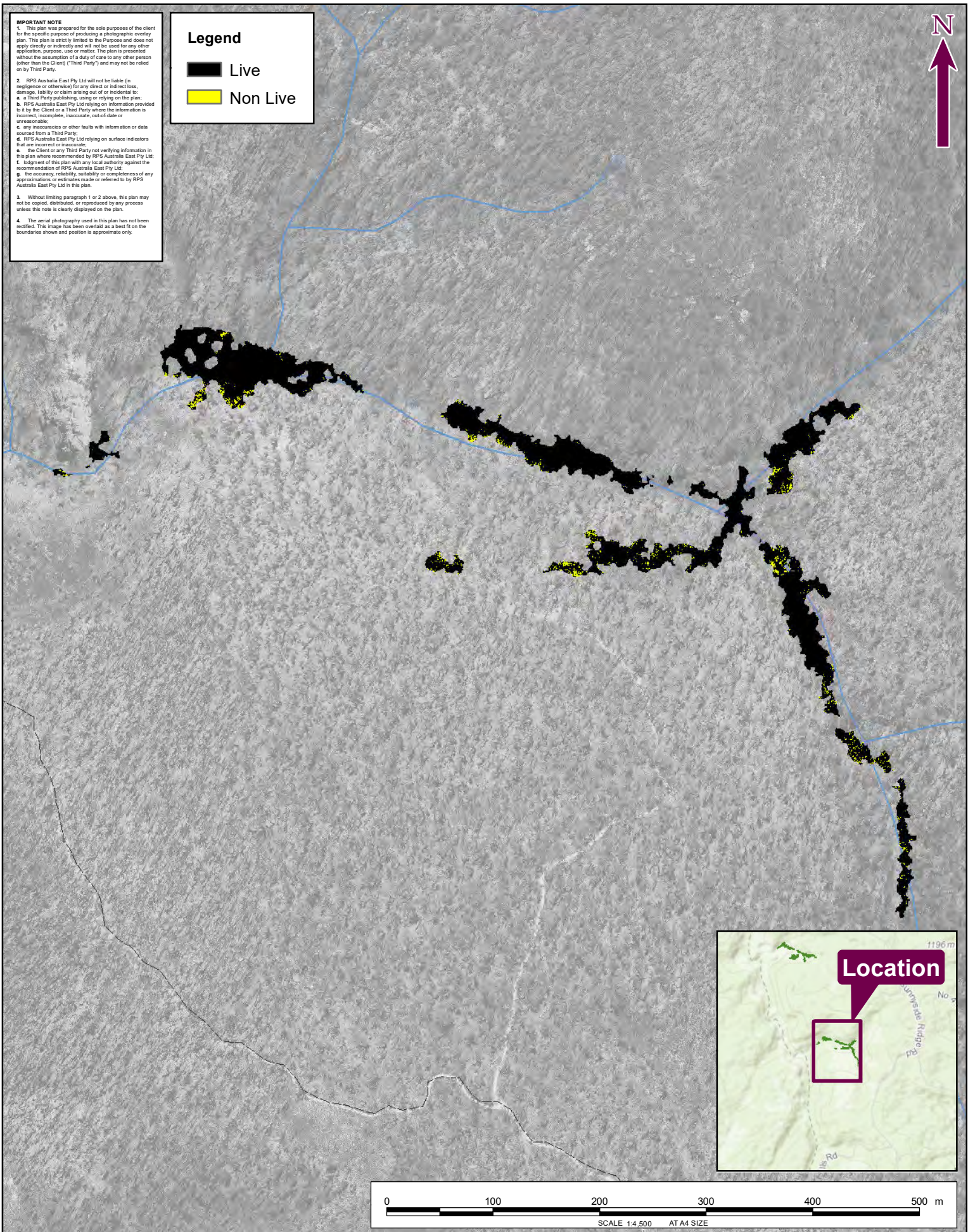


FIGURE 14
TRISTAR SWAMP LIVE VERSUS NON-LIVE (SAVI <0.12) VEGETATION COVER SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/05/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: John.Hembra

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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Legend

- 1 - Non Live
- 2 - Low
- 3
- 4
- 5
- 6
- 7 - High

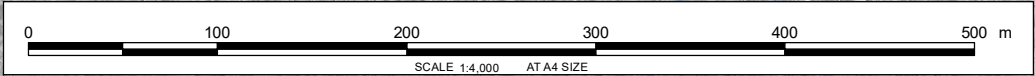
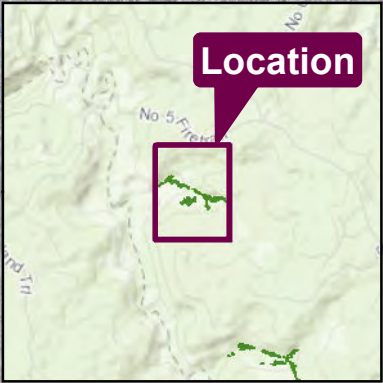
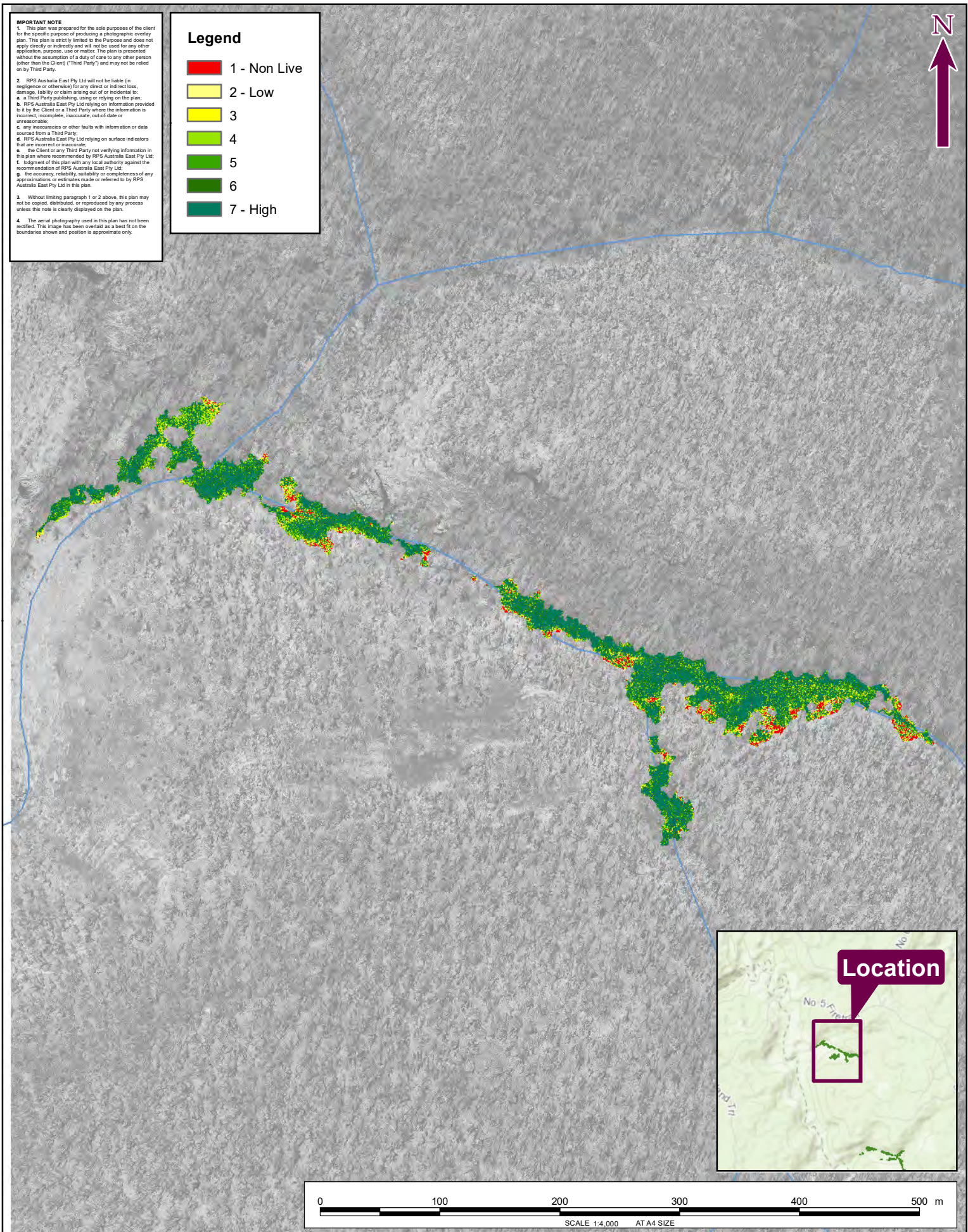


FIGURE 15
TWIN GULLY SWAMP SAVI CLASSIFICATION (ALL RANGES) SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/05/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: John.Hembra

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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Legend

 Live

 Non Live

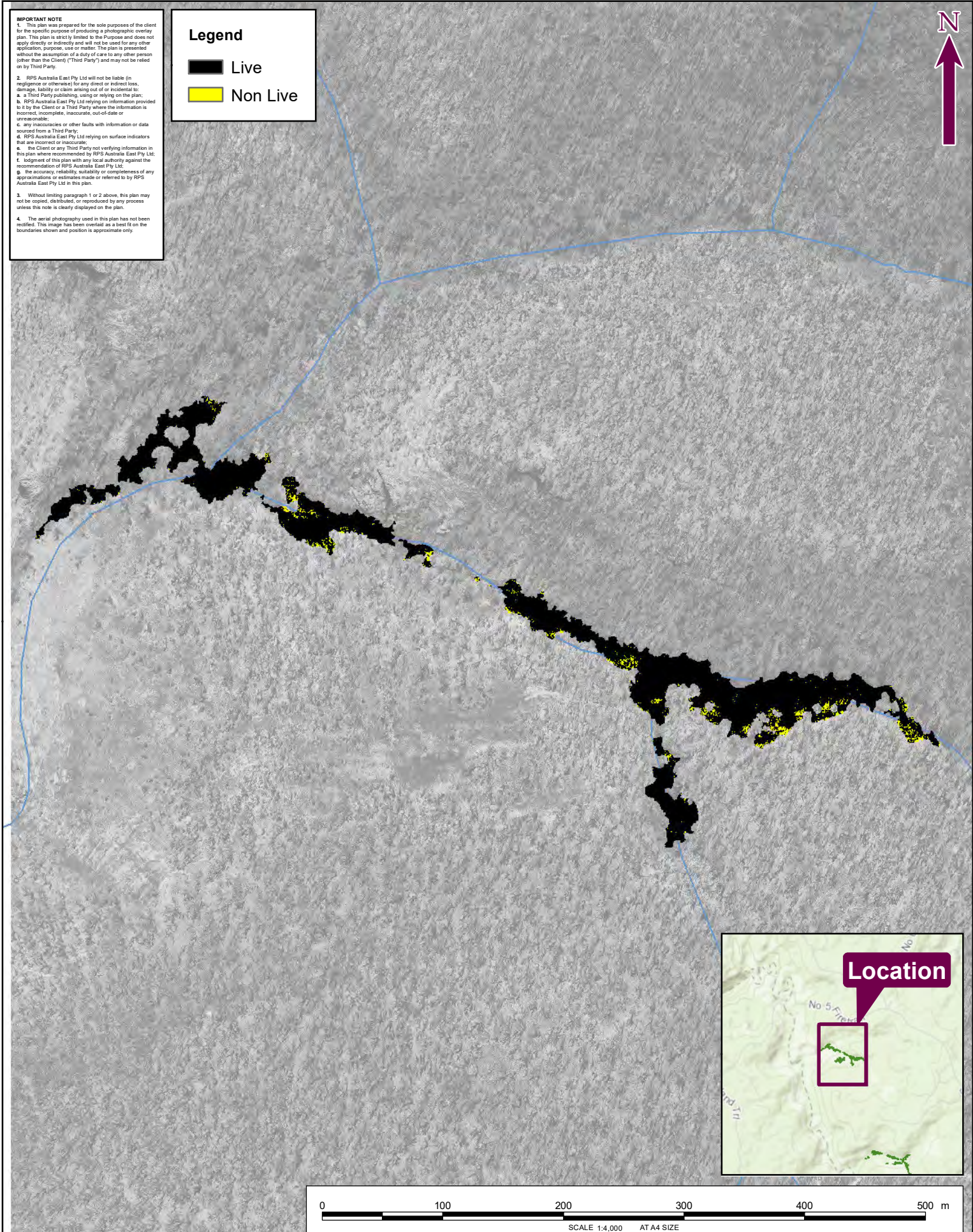


FIGURE 16
TWIN GULLY SWAMP LIVE VERSUS NON-LIVE (SAVI <0.12) VEGETATION COVER SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/05/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: John.Hembra

CLIENT: CENTENNIAL COAL

JOB REF: PR148912

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Legend

- 1 - Non Live
- 2 - Low
- 3
- 4
- 5
- 6
- 7 - High

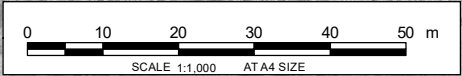
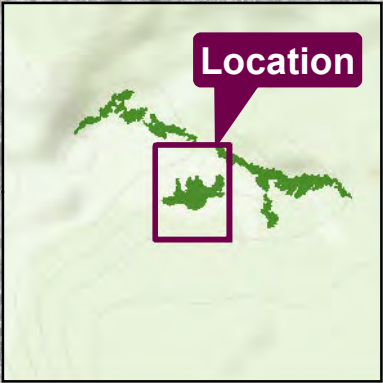
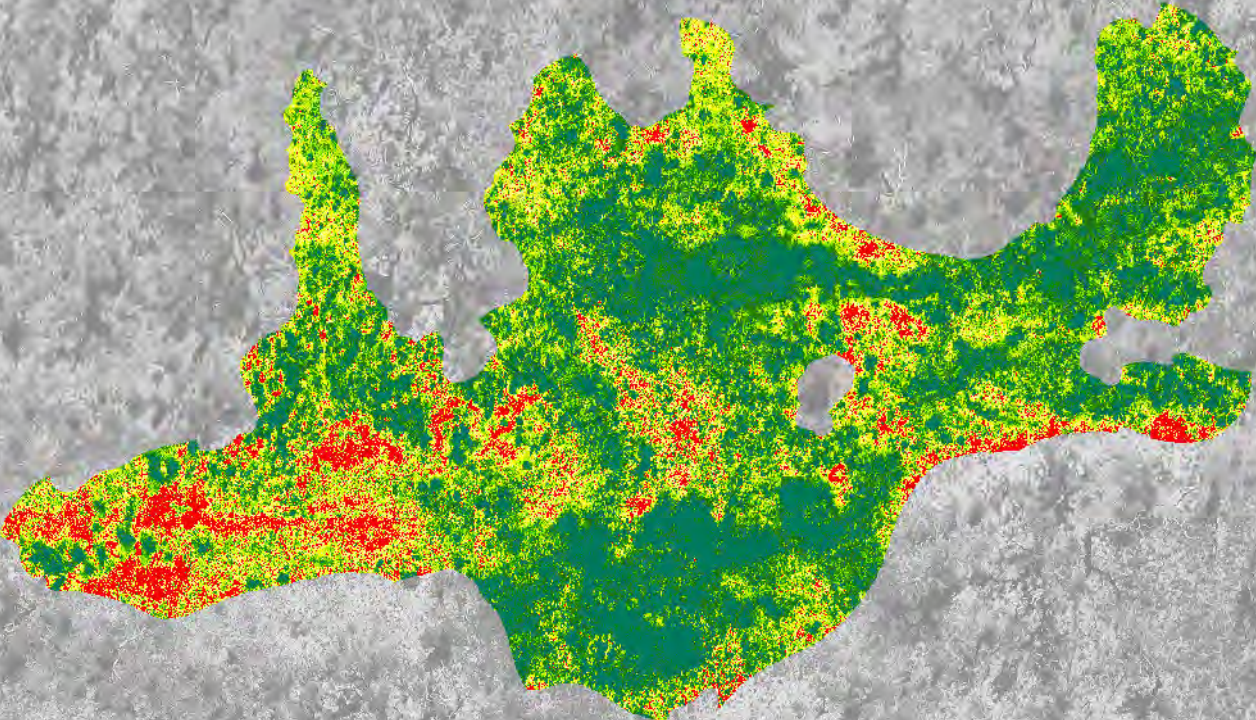


FIGURE 17
TWIN GULLY HANGING SWAMP SAVI CLASSIFICATION (ALL RANGES)
SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/05/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: John.Hembra

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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Legend

 Live

 Non Live

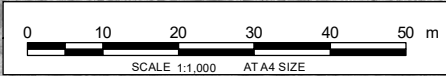
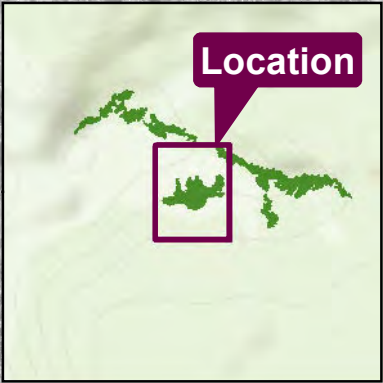
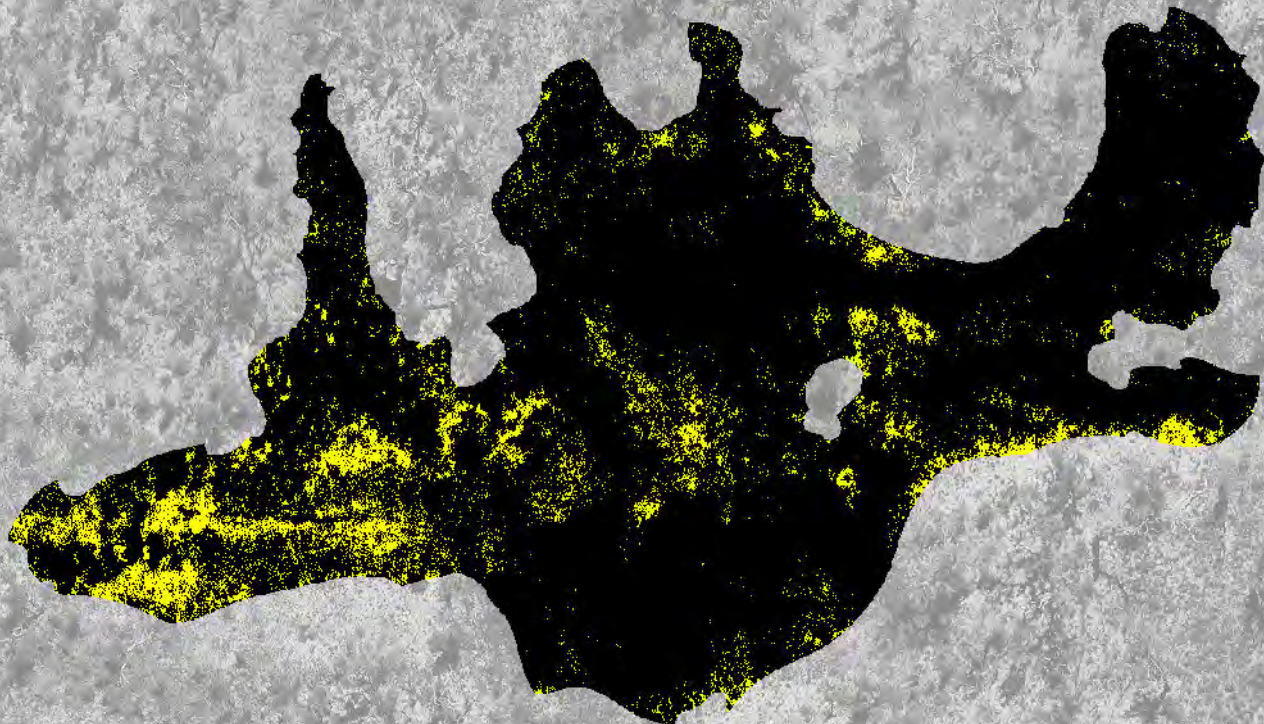


FIGURE 18
TWIN GULLY HANGING SWAMP LIVE VERSUS NON-LIVE (SAVI <0.12)
VEGETATION SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/05/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: John.Hembra

CLIENT: CENTENNIAL COAL

JOB REF: PR148912

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- 1 - Non Live
- 2 - Low
- 3
- 4
- 5
- 6
- 7 - High

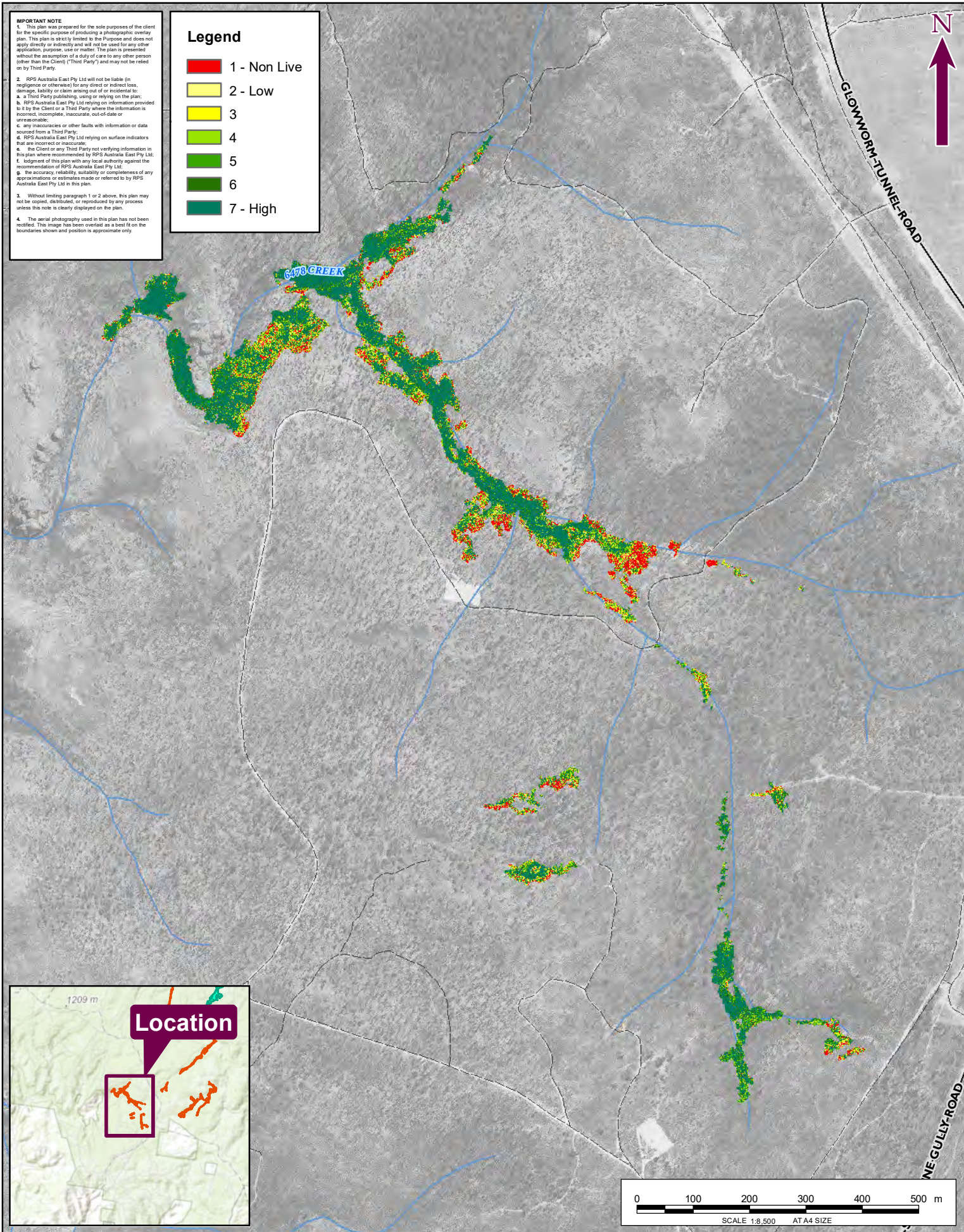


FIGURE 19
MARRANGAROO SWAMP SAVI CLASSIFICATION (ALL RANGES) SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert.Suansri

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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Legend

 Live

 Non Live

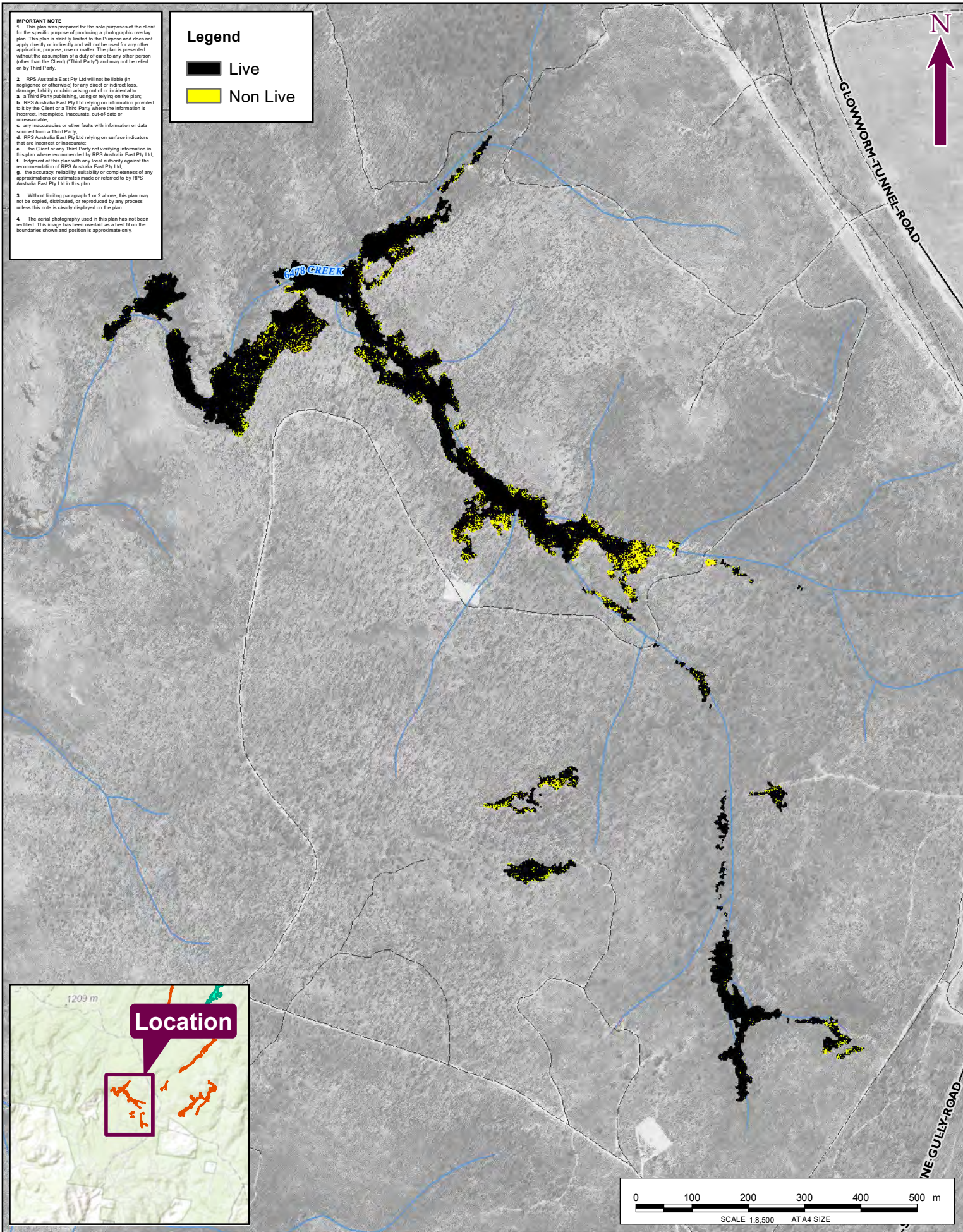


FIGURE 20
MARRANGAROO SWAMP LIVE VERSUS NON-LIVE SAVI (<0.12)
VEGETATION COVER SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert.Suansri

CLIENT: CENTENNIAL COAL
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Legend

- 1 - Non Live
- 2 - Low
- 3
- 4
- 5
- 6
- 7 - High

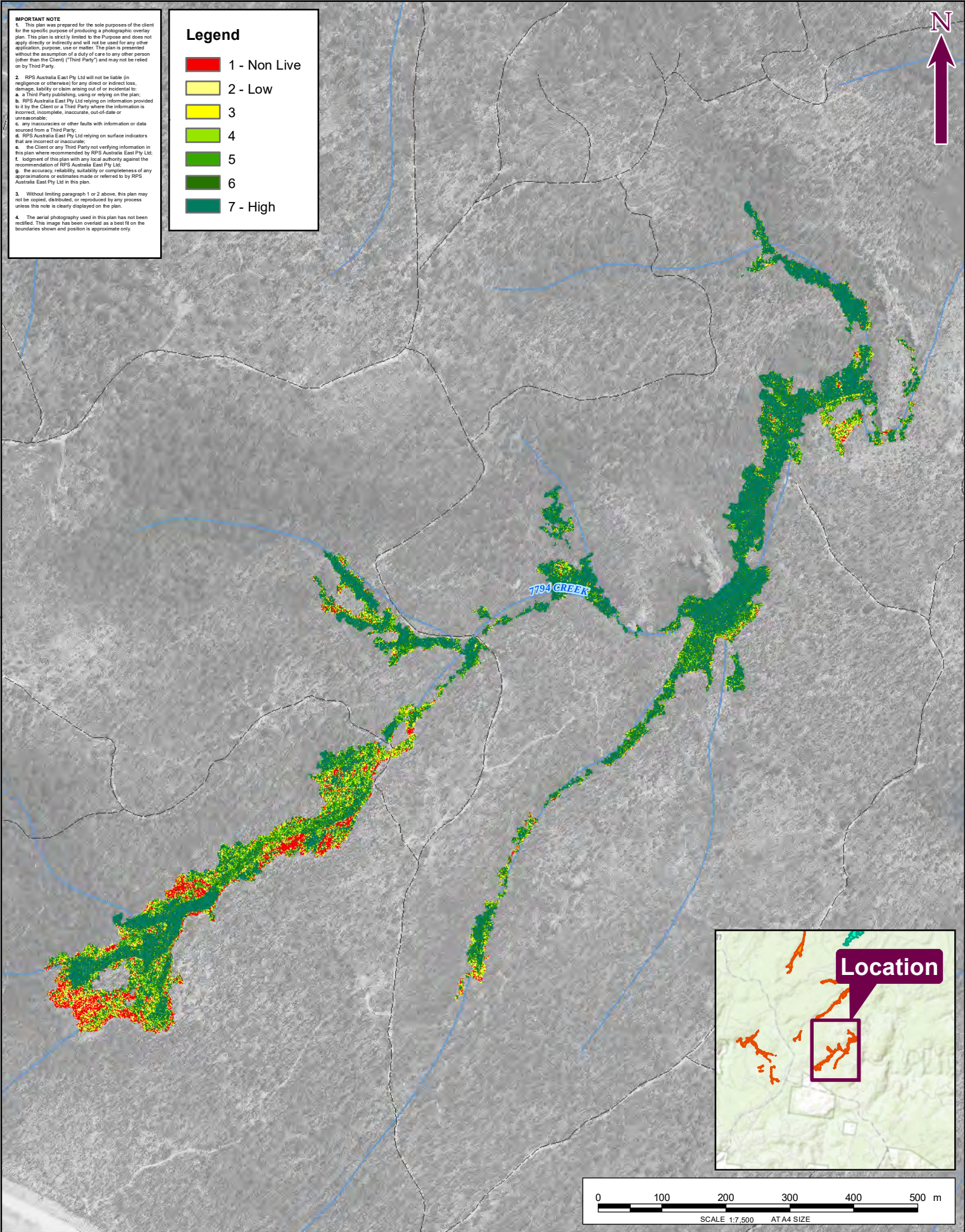


FIGURE 21
PADDYS CREEK SWAMP SAVI CLASSIFICATION (ALL RANGES) SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert.Suansri

CLIENT: CENTENNIAL COAL
 JOB REF: PR148912

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Legend

 Live

 Non Live

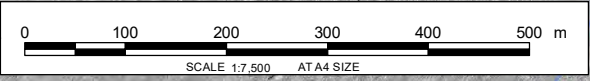
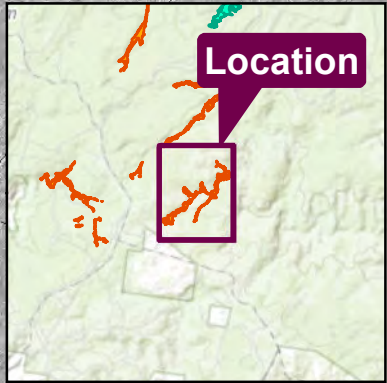
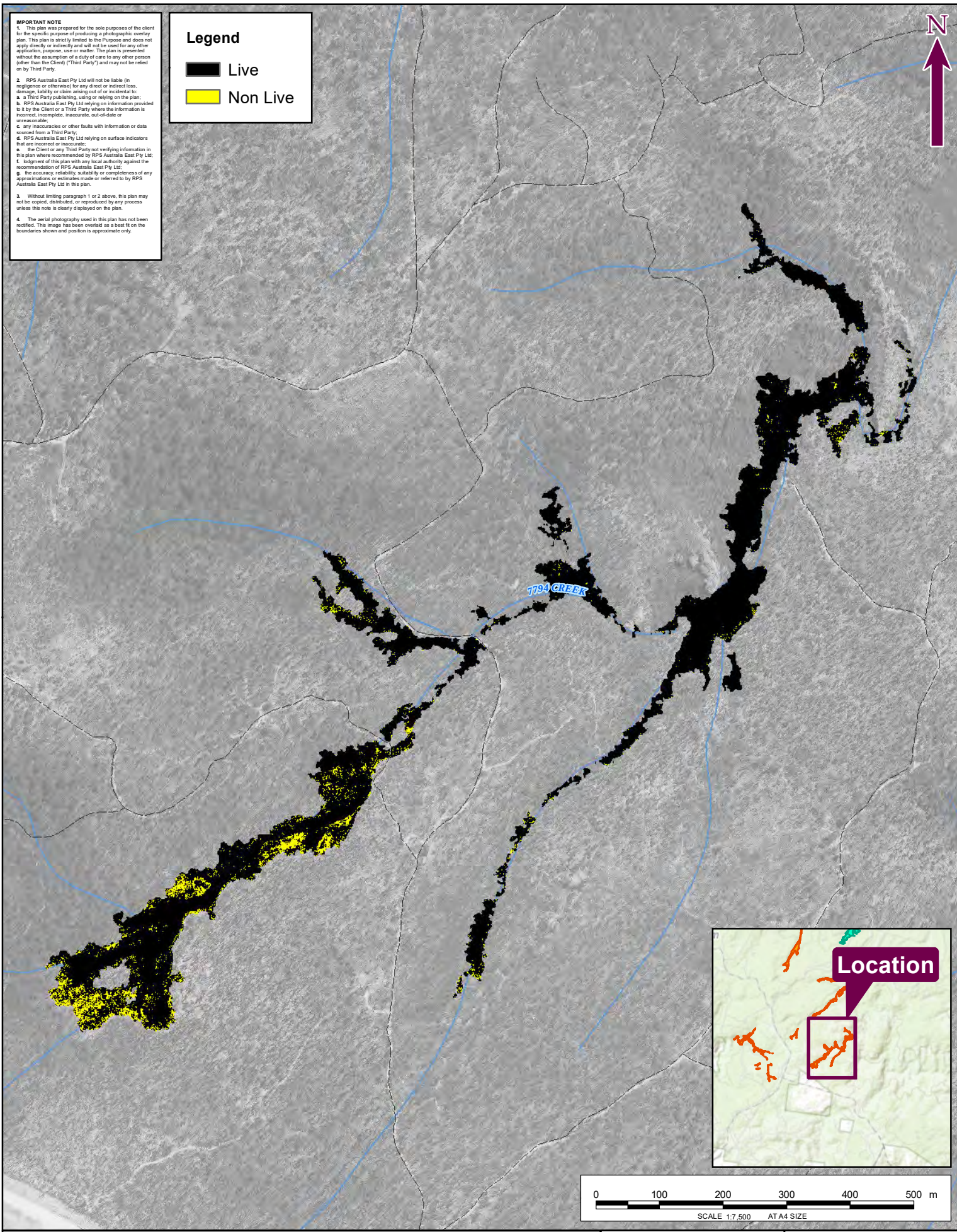


FIGURE 22
PADDYS CREEK SWAMP LIVE VERSUS NON-LIVE (SAVI <0.12)
VEGETATION COVER SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert.Suansri

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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Legend

- 1 - Non Live
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- 6
- 7 - High

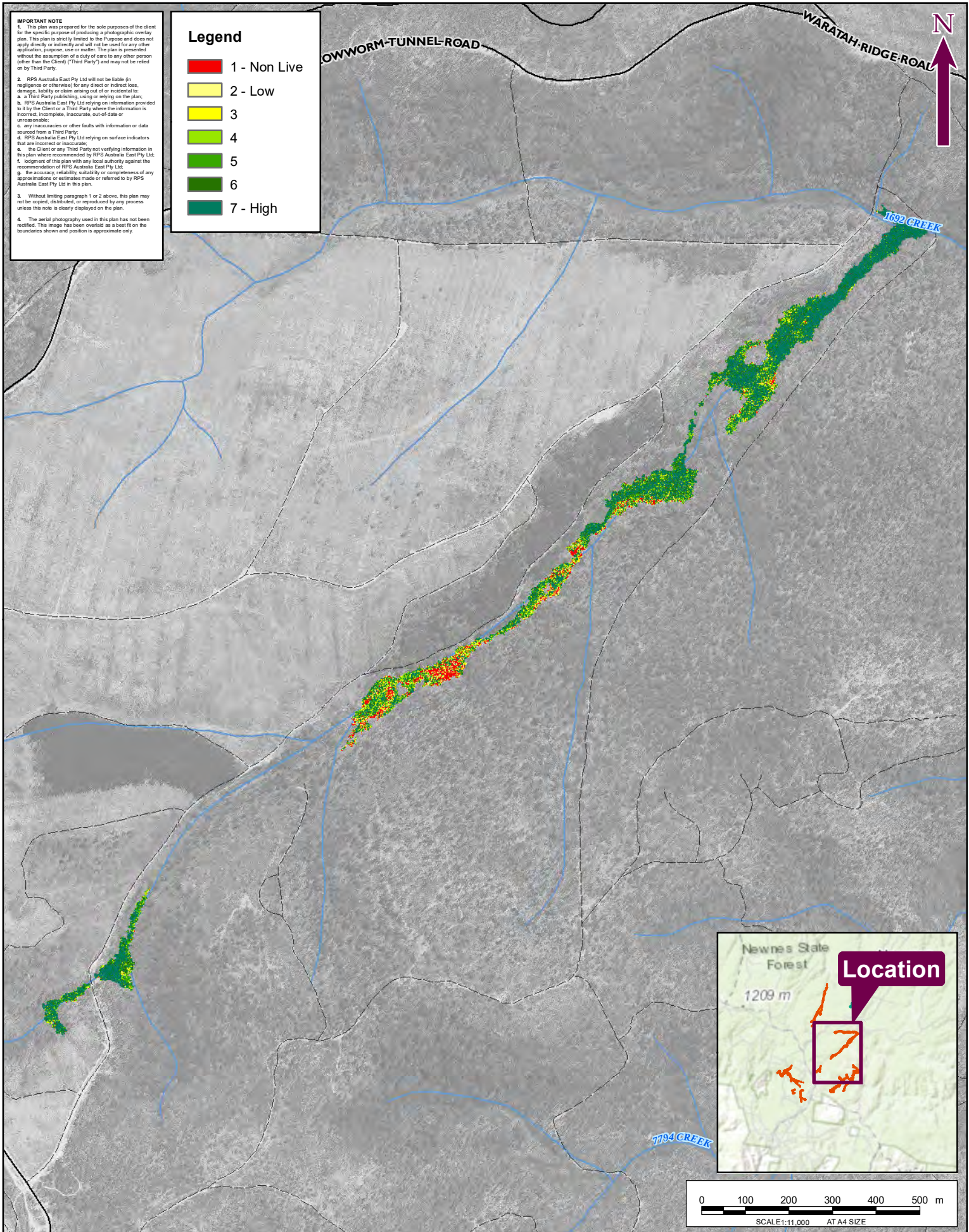


FIGURE 23
PINE SWAMP SAVI CLASSIFICATION (ALL RANGES) SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: B
PURPOSE: ECOLOGY	TECHNICIAN: Robert.Suansri

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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Legend

Live

Non Live

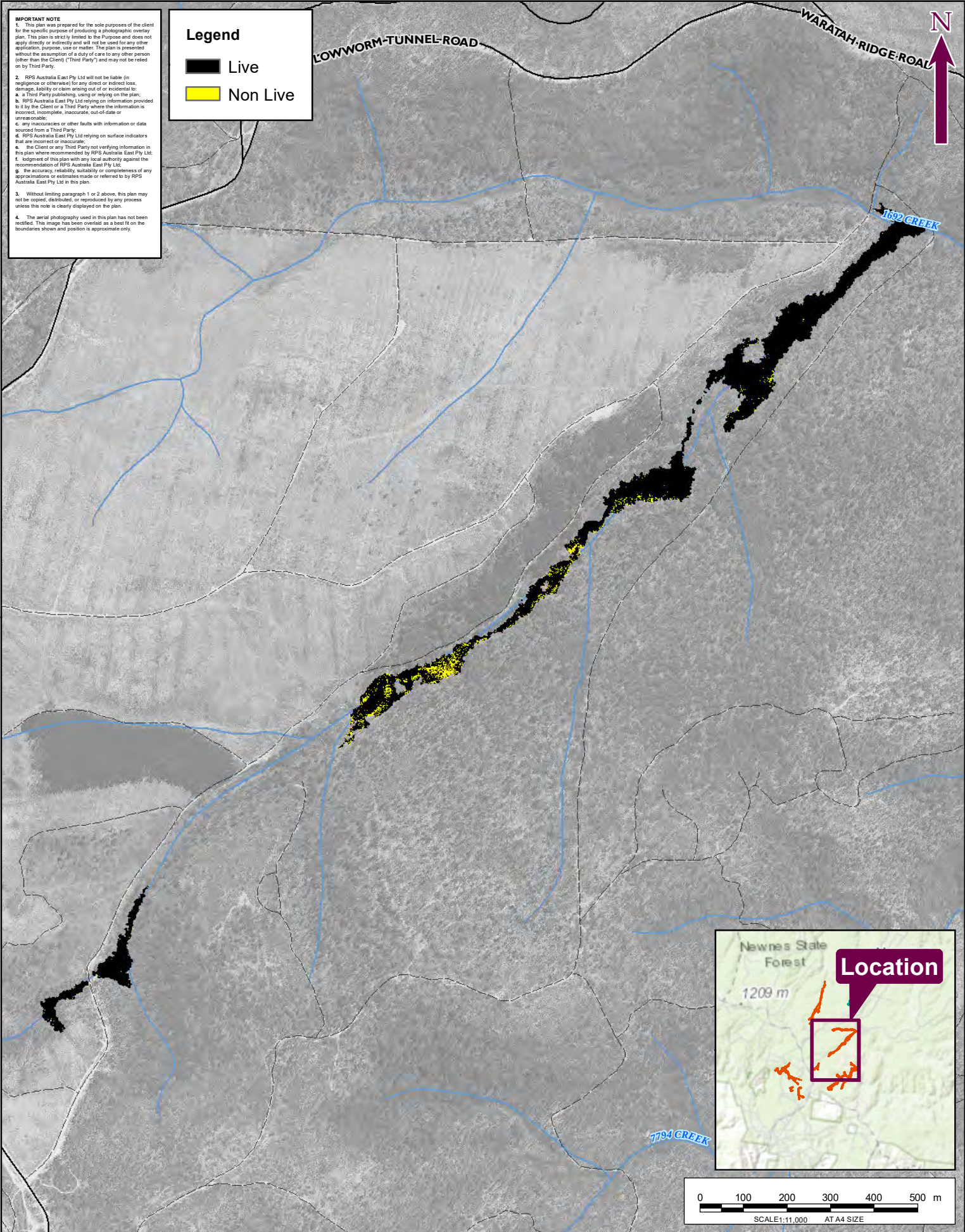


FIGURE 24
PINE SWAMP LIVE VERSUS NON-LIVE (SAVI <0.12) VEGETATION COVER
SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: B
PURPOSE: ECOLOGY	TECHNICIAN: Robert.Suansri

CLIENT: CENTENNIAL COAL

JOB REF: PR148912

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Legend

- 1 - Non Live
- 2 - Low
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- 5
- 6
- 7 - High

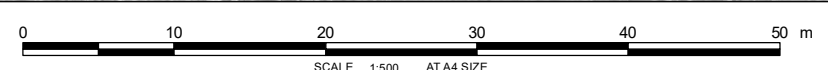
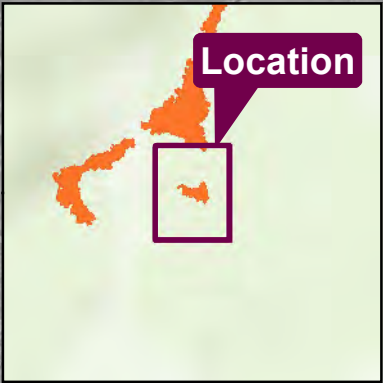
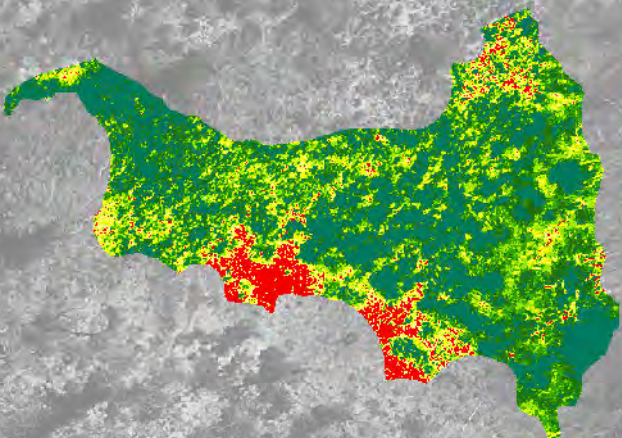


FIGURE 25
PINE HANGING SWAMP SAVI CLASSIFICATION (ALL RANGES) SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/05/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: John.Hembra

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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Legend

 Live

 Non Live

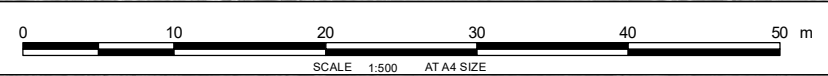
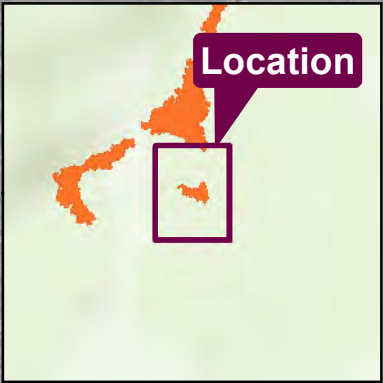
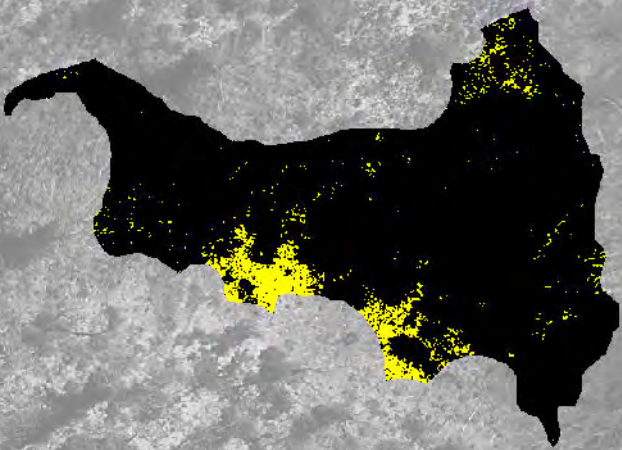


FIGURE 26
PINE HANGING SWAMP LIVE VERSUS NON-LIVE (SAVI <0.12)
VEGETATION COVER SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/05/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: John.Hembra

CLIENT: CENTENNIAL COAL

JOB REF: PR148912

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Legend

- 1 - Non Live
- 2 - Low
- 3
- 4
- 5
- 6
- 7 - High

GANG GANG ROAD

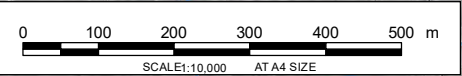
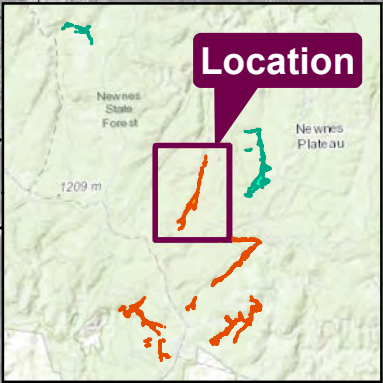


FIGURE 27
EAST GANG GANG SWAMP SAVI CLASSIFICATION (ALL RANGES)
SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert.Suansri

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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Legend

 Live

 Non Live



GANG GANG ROAD

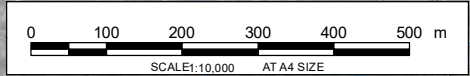
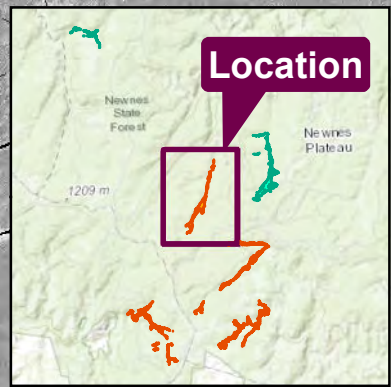


FIGURE 24
PINE SWAMP LIVE VERSUS NON-LIVE (SAVI <0.12) VEGETATION COVER
SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert.Suansri

CLIENT: CENTENNIAL COAL

JOB REF: PR148912

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- 1 - Non Live
- 2 - Low
- 3
- 4
- 5
- 6
- 7 - High

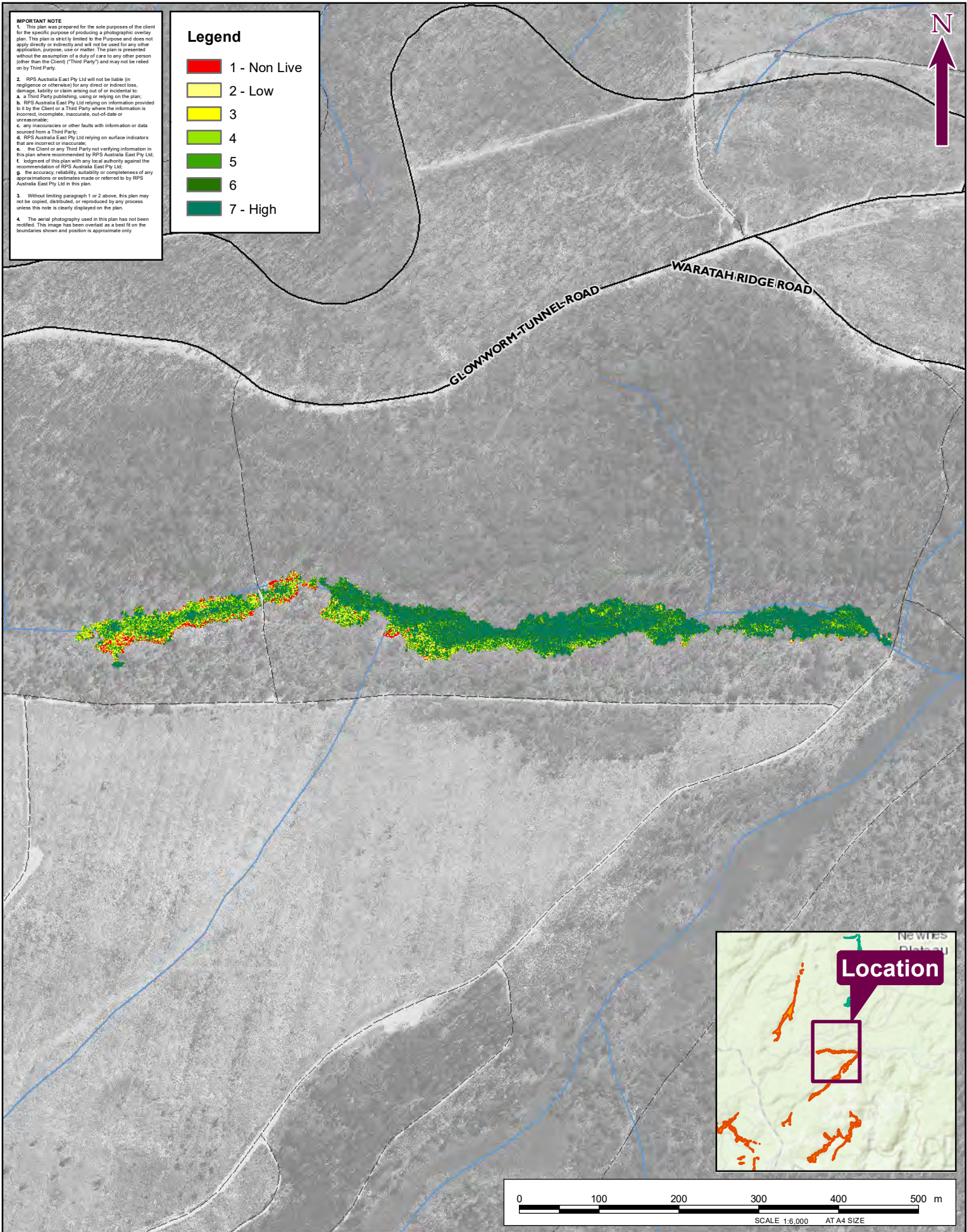


FIGURE 29
NINE MILE SWAMP SAVI CLASSIFICATION (ALL RANGES) SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert Suansri

CLIENT: CENTENNIAL COAL
JOB REF: PR148912

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Legend

 Live

 Non Live

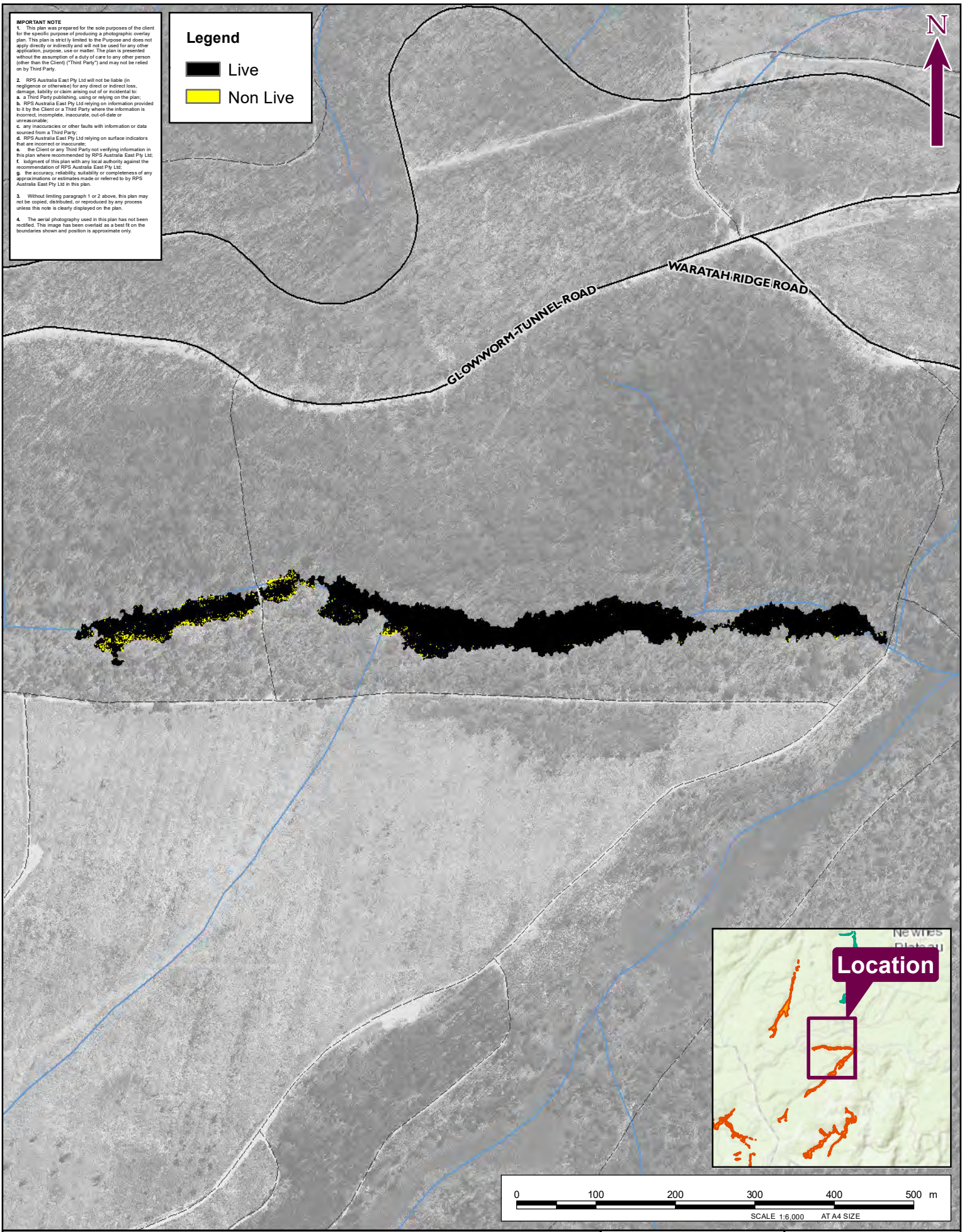


FIGURE 30
NINE MILE LIVE VERSUS NON-LIVE (SAVI <0.12) VEGETATION COVER
SUMMER 2021

LOCATION: NEWNES PLATEAU, NSW	DATUM: GDA94 PROJECTION: MGA Zone 56
DATE: 31/08/2021	VERSION: A1
PURPOSE: ECOLOGY	TECHNICIAN: Robert.Suansri

CLIENT: CENTENNIAL COAL

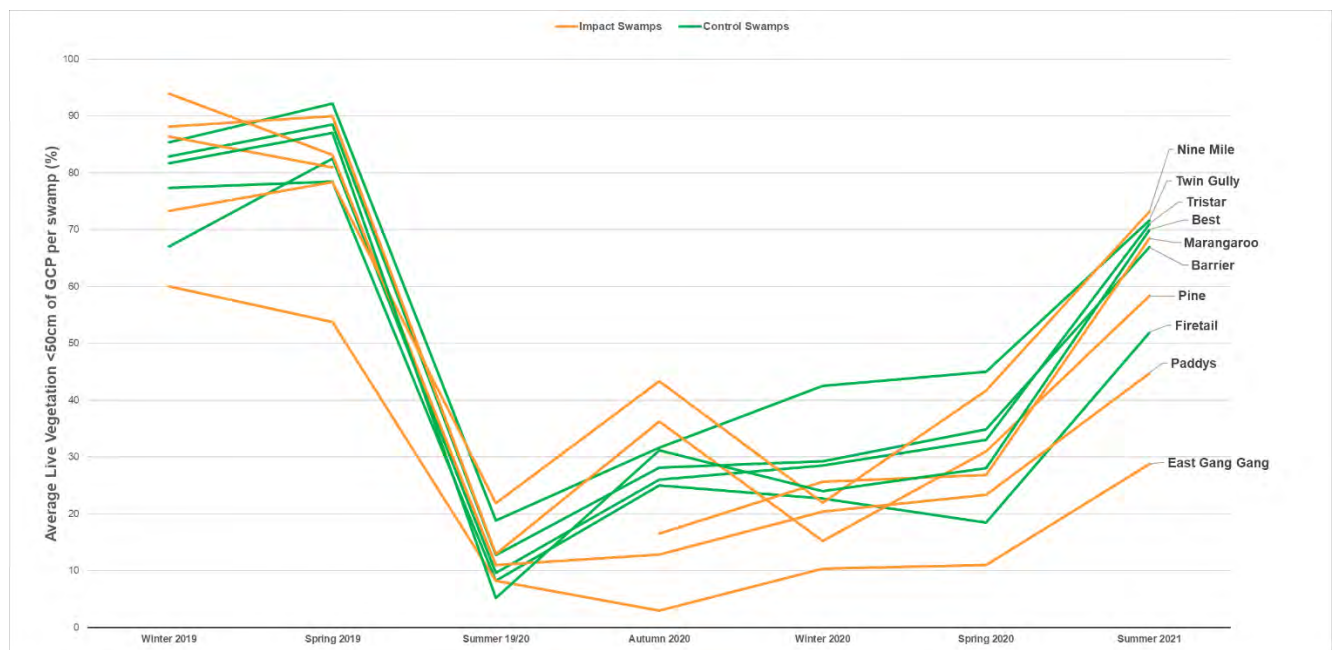
JOB REF: PR148912

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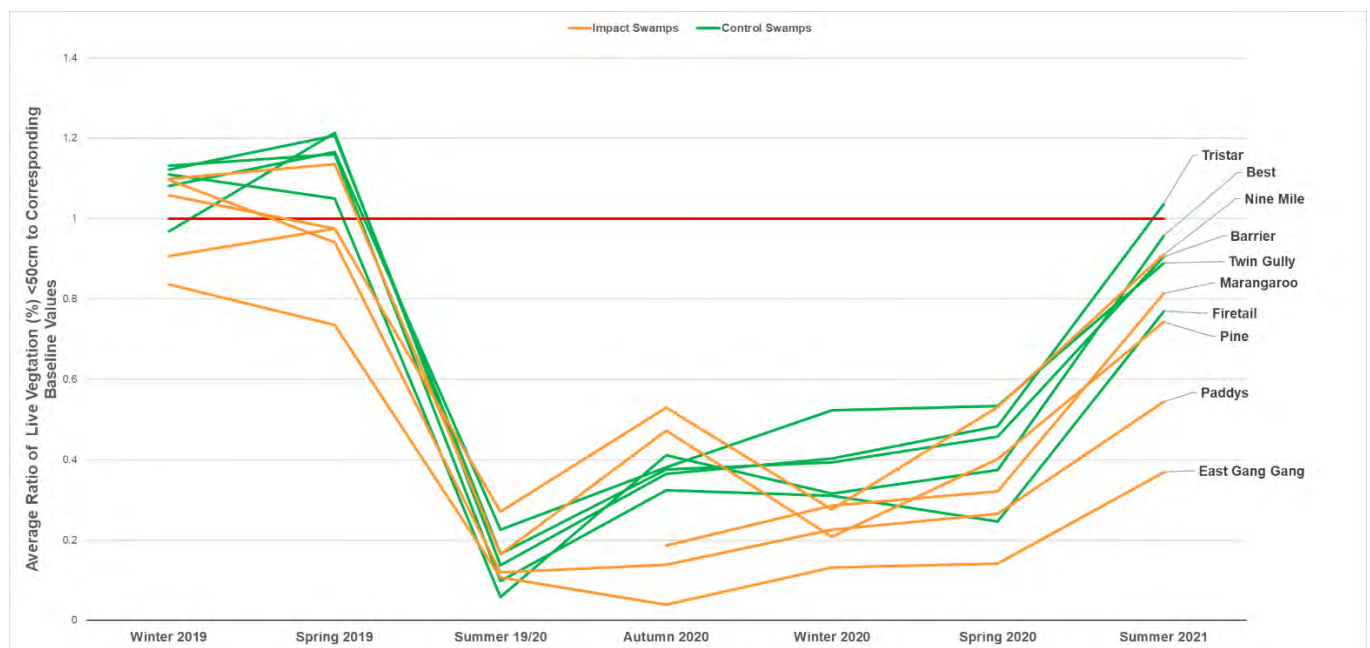
3.2 Seasonal, post-fire Analysis

Graph 5 presents the mean GCP live vegetation cover within 50cm (%) per swamp over time. Data is grouped by impact swamps (orange) and control swamps (green).



Graph 5 Mean live vegetation cover (%) per GCP over time for LW420-422 TIA

Graph 6 presents the average ratio of GCP live vegetation cover within 50 cm (%) to the corresponding baseline value for the respective GCP. Impact swamps are plotted in orange, control swamps are plotted in green. Baseline data remains a constant of 1 and is represented by the red horizontal axis.



Graph 6 Average ratio of live vegetation cover (%) per GCP compared to the corresponding LW420-422 baseline counterpart.

4 DISCUSSION

Summary of results for the summer 2021 monitoring period are provided in the following sections.

4.1 Seasonal Remote Sensing

4.1.1 Shrub Swamps

Paddys Creek and East Gang Gang exhibited a trigger exceedance for increased non-live vegetation cover at the swamp scale [i.e. total area for SAVI <0.12 exceeded the baseline trigger level specified in RPS (2019)]. Marrangaroo exceeded the preliminary trigger level for this metric. None of the control swamps were beyond the expected variation for this metric.

While the Gospers Mountain Fire is the primary reason for the substantive increase in non-live vegetation cover across all swamps, monitoring data suggests a potential for a divergence in the response of impact swamps to the effects of fire compared to regeneration response observed in control swamps. RPS has recommended the implementation of the Trigger Action Response Plan (TARP) (Centennial, 2016) to investigate the divergence in treatment groups. It is possible that an interaction effect has occurred, rendering impact swamps with impaired capacity to regenerate after the fire event.

4.1.2 Hanging Swamps

Pine Hanging swamp generated a trigger exceedance for increased non-live vegetation cover at the swamp scale [i.e. total area for SAVI <0.12 exceeded the baseline preliminary trigger level specified in RPS (2019)].

As for shrub swamps, it appears that there may be an interaction effect on swamp vegetation regeneration as indicated in **Section 4.1.1**.

4.2 Trigger Exceedances

The reported monitoring results identify trigger level exceedances for impact swamps as outlined in **Table 4-1**.

Table 4-1 SMP 424 – 427 Investigation Triggers Exceedances

Swamp	Pine	Marrangaroo	Paddy's Creek	Pine Hanging	Nine Mile	East Gang Gang
Plant health (SAVI<0.12)			✓	✓		✓

5 RECOMMENDATIONS

As per the reported triggers in **Section 4.2** and in accordance with Chart 1 of SMP LW 424 – 427 (Centennial Coal 2018), it is recommended that an investigation be performed to determine if the trigger exceedances observed in impact swamps are mining or non-mining related [see Chart 2 of SMP LW 424 – 427 (Centennial Coal 2018)]. Non-mining related factors to be considered in the investigation include:

- Forestry activity;
- Erosion;
- Swamp damage;
- Bush fire;
- Vandalism; or
- Weather.

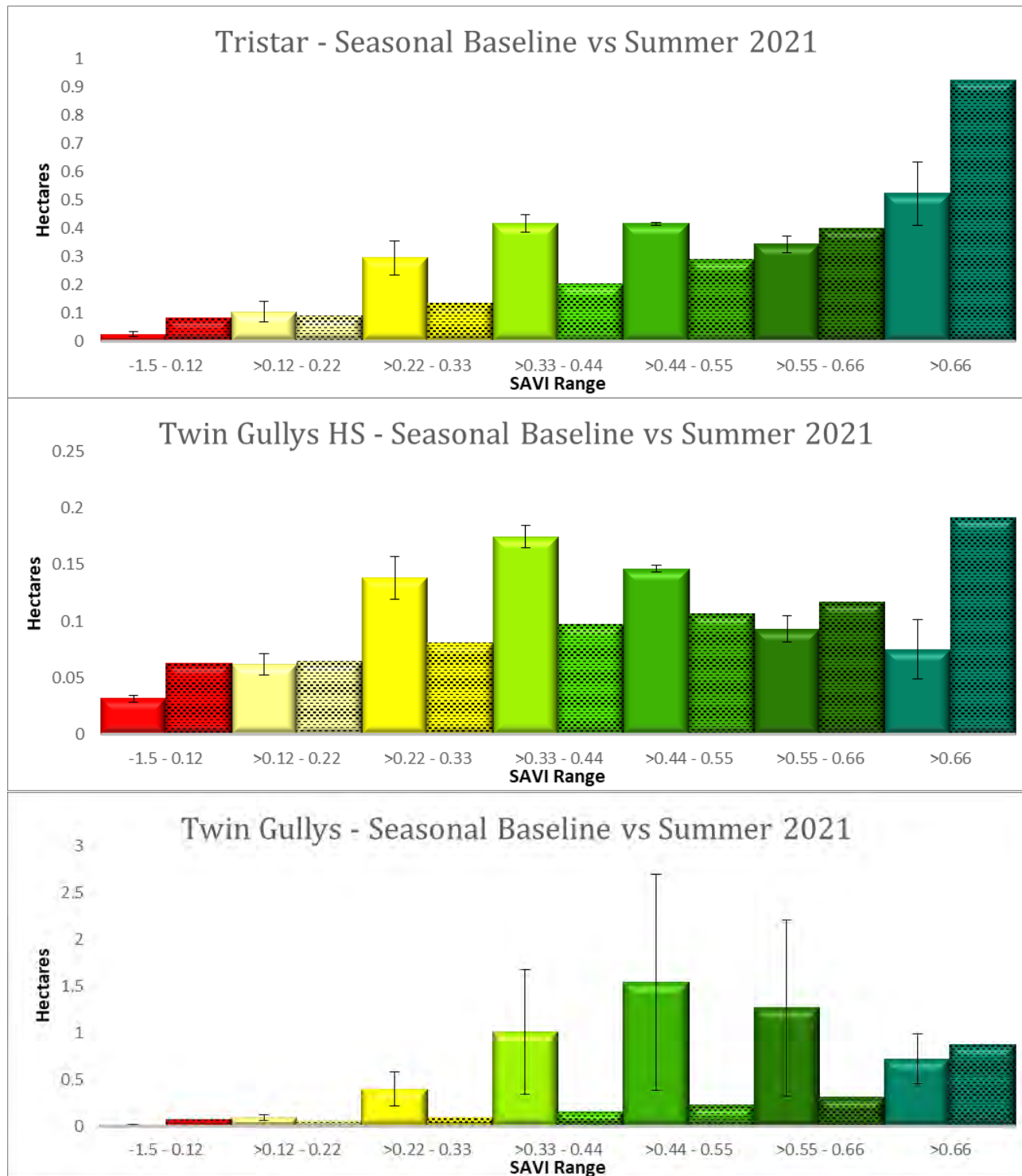
Further recommendations would be provided in the investigation report should mining activity be identified as the reason for trigger exceedance.

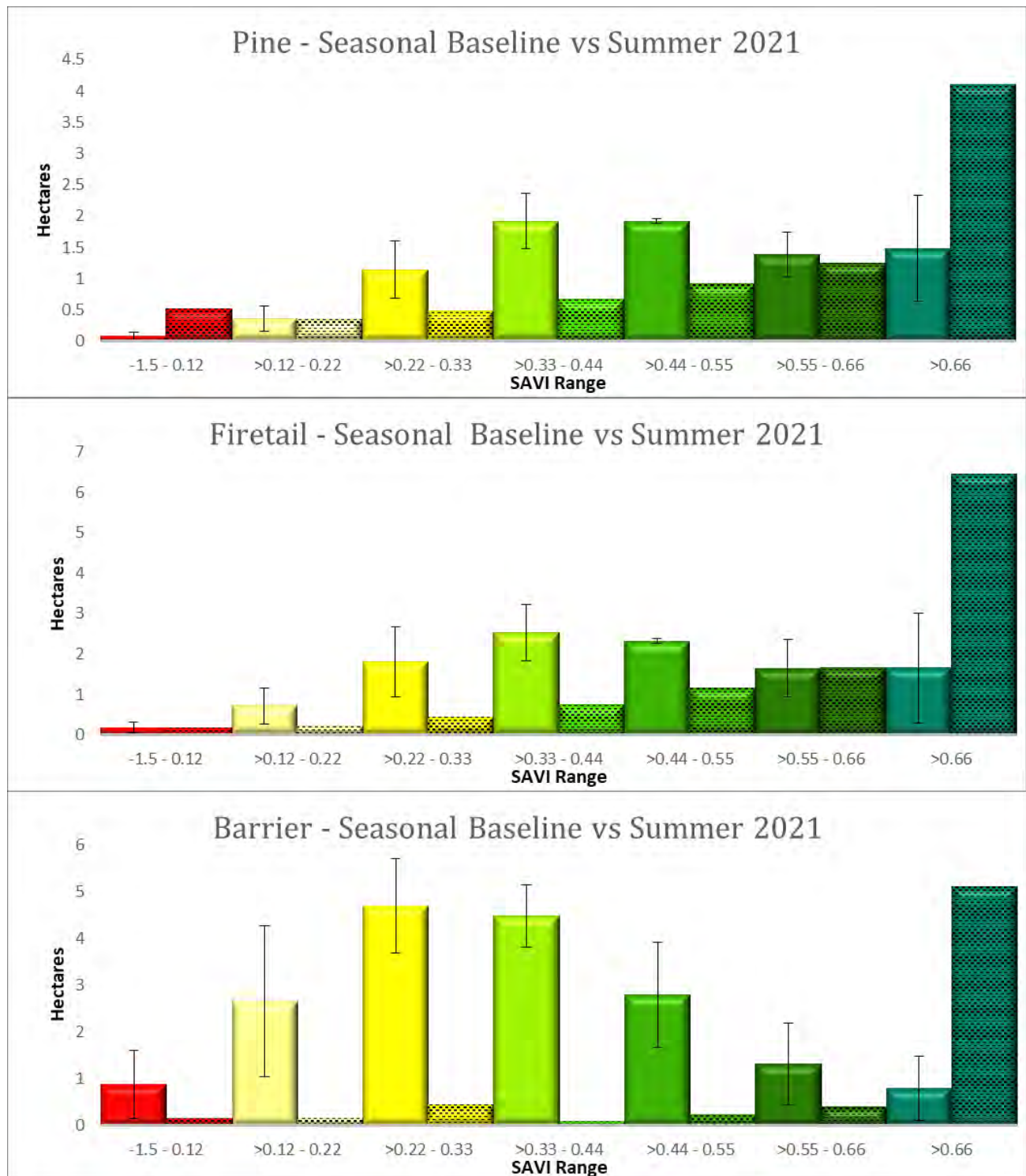
6 REFERENCES

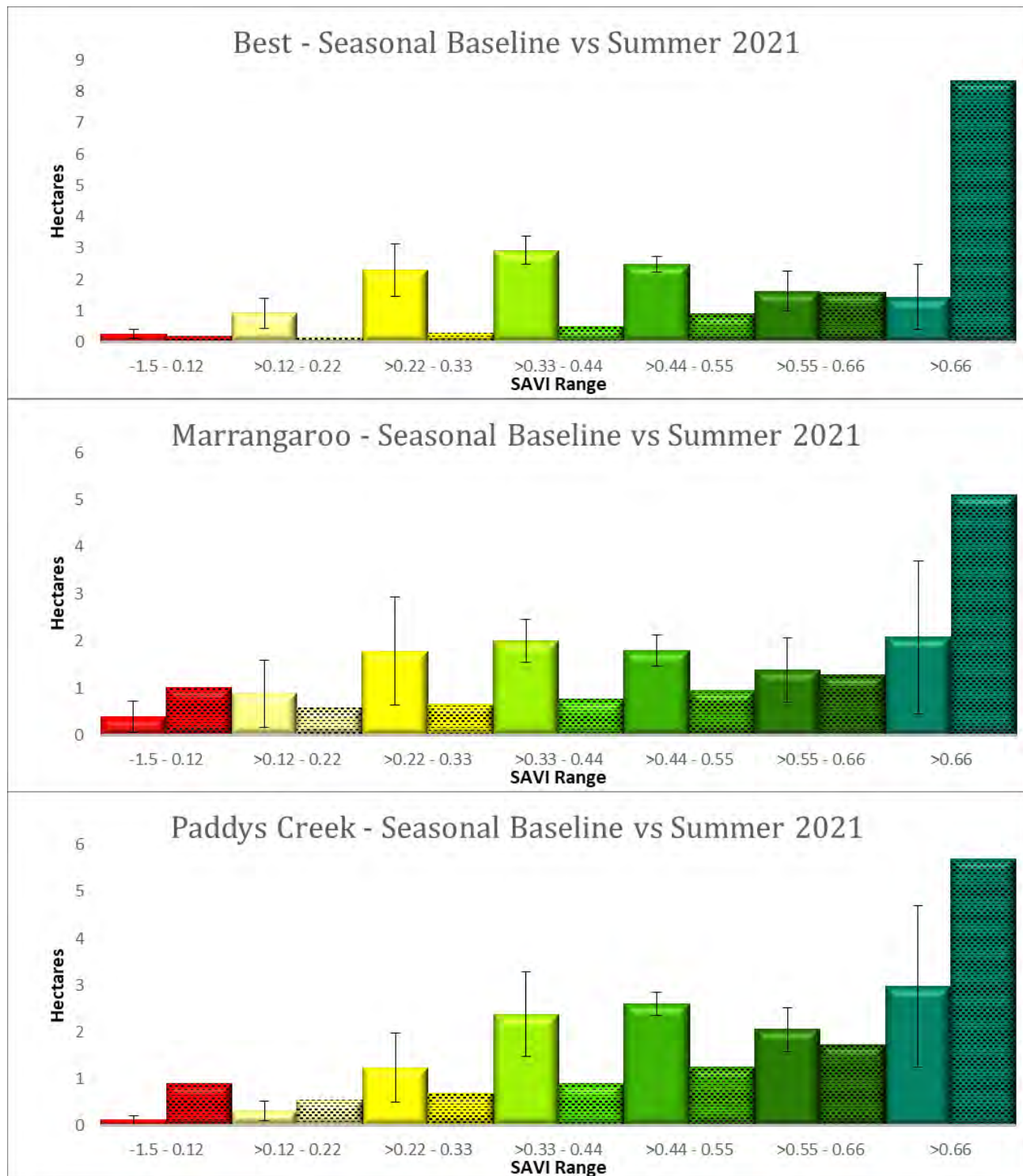
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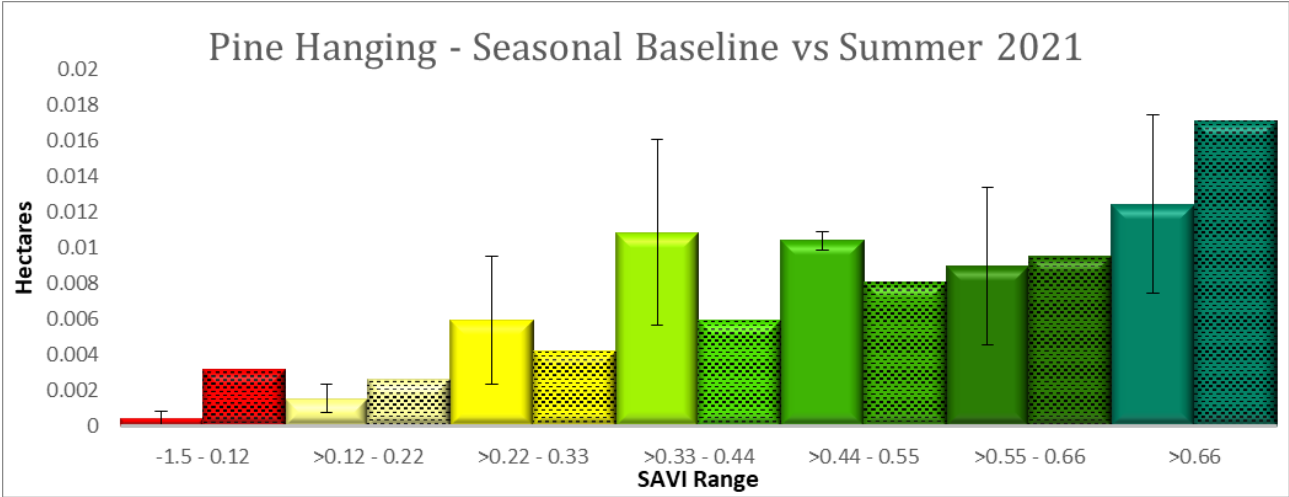
Appendix A

Seasonal Histograms









Appendix 2: Investigation Report

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Trigger Investigation Report

Springvale LW 424 – 427: Summer 2020/2021



Prepared for: Natalie Gardiner – Environment and Community Coordinator @ Centennial

Prepared by: Arne Bishop – Ecology Director @ EcoResolve Pty Ltd

Date: 31 August 2021

Project no: ER019



Contents

TRIGGER INVESTIGATION REPORT	I
Springvale LW 424 – 427: Summer 2020/2021	i
Disclaimer	v
Document Control	v
1 INTRODUCTION	1
1.1 Background	1
1.2 Legislative Context	1
1.3 Purpose	2
1.4 Preliminary Trigger and Trigger Values	2
2 METHODOLOGY	4
2.1 Seasonal Remote Sensing	4
2.2 Ground Control Points	4
2.3 Groundwater level monitoring	4
2.4 Trigger Action Response Plan	5
2.4.1 Data Accuracy	5
2.4.2 Reference Swamp Comparison	5
2.4.3 Potential anthropogenic/natural impacts	5
2.4.4 Abnormal weather conditions	6
2.4.5 Mining within 600m	6
2.4.6 Evidence of possible mining impacts	6
2.4.7 Carry out additional field surveys and/or consider more frequent or additional monitoring	6
2.4.8 Monitor for if conditions worsen	6
3 RESULTS	6
3.1 Data Accuracy	6
3.2 Reference Swamp Comparison	7
3.2.1 Seasonal Swamp Monitoring	7
3.2.2 Ground Control Points	16
3.3 Reference Swamp Comparison	22
3.4 Potential anthropogenic/natural impacts	23
3.4.1 Bushfire	23
3.4.2 Abnormal weather conditions	25
3.5 Mining within 600m	28
3.6 Evidence of possible mining impacts	28
3.7 Carry out additional field surveys and/or consider more frequent or additional monitoring	28
3.8 Monitor for if conditions worsen	29
3.9 Groundwater Monitoring	29
4 DISCUSSION	31



5	CONCLUSION AND RECOMMENDATIONS.....	31
6	REFERENCES.....	32
7	APPENDIX 1: TRIGGER ACTION RESPONSE PLAN (TARP) CHARTS 1-3.....	33
8	APPENDIX 2: PERFORMANCE AND TRIGGER VALUES	37
9	APPENDIX 3: GROUNDWATER MONITORING TRIGGERS.....	38



Figures, Tables and Graphs

Figure 1. Monitoring, Study, TIA Area's and Impact and Control Swamps	3
Table 1 Mean Area ($SAVI \leq 0.12$) $\pm$ SE (ha) and 5% and 10% Preliminary Trigger Level (Extracted from RPS, 2021)	8
Figure 2 SAVI classification and live versus non-live ($SAVI < 0.12$) Triggered Swamps	10
Figures 3 and 4 – SAVI classification and live versus non-live ($SAVI < 0.12$) Marrangaroo Preliminary Trigger (Extracted from RPS, 2021)	11
Figures 5 and 6 – SAVI classification and live versus non-live ($SAVI < 0.12$) Paddys Creek Triggered (Extracted from RPS, 2021)	12
Figures 7 and 8 – SAVI classification and live versus non-live ($SAVI < 0.12$) Pine Hanging Triggered (Extracted from RPS, 2021)	13
Figures 9 and 10 – SAVI classification and live versus non-live ($SAVI < 0.12$) East Gang Gang Triggered (Extracted from RPS, 2021)	14
Graph 1 – Seasonal Histograms – SAVI classification and live versus non-live ($SAVI < 0.12$) Triggered (Extracted from RPS, 2021)	15
Table 2 Mean Summary data for all seasons per GCP: Live Green (%) and Exotic (%) including Standard Error (SE)	16
Graph 2 Mean GCP live vegetation cover within 50cm (%) per swamp over time.	24
Graph 3 average ratio of GCP live vegetation cover within 50 cm (%) to the corresponding baseline value for the respective GCP	24
Graph 4 Mean monthly rainfall for Newnes Forest Centre 36062 (1938–1999) (BOM2021a) and ALS Newnes Plateau (June 2003 – January 2021)	25
Graph 5 Monthly precipitation for February 2020 to January 2021 compared to mean monthly rainfall for the Newnes Forest Centre 63062 (1938–1999) (BOM 2021a)	26
Graph 6 Mean monthly maximum temperatures at Mount Boyce (February 2020 – January 2021) compared with long term mean (1991–2021; BOM 2021b)	27
Graph 7 Mean monthly minimum temperatures at Mount Boyce (February 2020 – January 2021) compared with the long term mean (1991–2020; BOM 2021b)	28
Figure 11. SAVI and Groundwater Trigger Overlay	30
Table 3 Performance Measures, Performance Indicator, Preliminary Trigger (drying) and Triggers for THPSS for SMP LW 424–427	37
Table 4 LW424–427 Groundwater Monitoring Summary	38



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Document Control

Version - date	Purpose	Author	Reviewer	Approved by
V1 – 15/08/2021	Draft for Client review	Hugh James and Nina Bishop	Arne Bishop	Arne Bishop
V2 – 31/08/2021	Final for issue to DPIE	Hugh James and Nina Bishop	Natalie Gardiner	Arne Bishop



1 Introduction

Springvale Mine is located within the western coalfield, approximately 15 kilometres (km) to the northwest of Lithgow and 120 km west-north-west of Sydney, NSW. Springvale Mine (Springvale) is an underground coal mine, producing high quality thermal coal which is then supplied to Mt Piper power station and further to both domestic and international markets.

During seasonal swamp monitoring for Summer 2020 to 2021 the measure for non-live vegetation within two potential undermining impact swamps exceeded the performance measure trigger levels within the Longwalls (LW) 424 – 427 Swamp Monitoring Program (SMP). As a result, in accordance with the mine approval conditions (SSD-5594 and EPBC 2013/6881), EcoResolve Pty Ltd (EcoResolve) prepared a "Notification" to the relevant authorities and a 'Trigger Investigation Report' (this report) to interrogate the causation of the trigger level exceedances.

1.1 Background

Springvale mining operations undermine areas of the Newnes Plateau beneath Shrub Swamps and Hanging Swamps that are both commensurate with Temperate Highland Peat Swamp on Sandstone (THPSS) which is an Endangered Ecological Community (EEC) listed under the Commonwealth Environment Protection Biodiversity Conservation Act 1999 (EPBC Act). Shrub Swamps are also listed as an EEC under NSW Biodiversity Conservation Act 2016 (BC Act). These Swamp communities are hereafter collectively referred to as THPSS.

1.2 Legislative Context

Underground coal mining commenced at Springvale Mine (Springvale) in 1995 following the granting of Development Consent (DA 11/92) on 27 July 1992 by the then Minister for Planning. On 21 September 2015, Development Consent SSD-5594 was approved by the then Planning Assessment Commission (under delegation from the Minister of Planning). The approval allows for continued underground mining operations at Springvale at existing production rates until 31 December 2028. EPBC 2013/6881 granted on 15 October 2015 allows for the expansion of underground mining under Development Consent SSD 5594. Springvale utilise the longwall mining method to extract coal from the Lithgow Seam.

On 31st May 2021, RPS reported that; Paddy's Creek and East Gang Gang Shrub Swamps, and Pine Hanging Swamp had exhibited an increased non-live vegetation cover at the swamp scale (Soil Adjusted Vegetation Index; SAVI<0.12), a notifiable exceedance of the trigger value for non-live vegetation cover. As a result, in accordance with the LW 424-427 Extraction Plan, prepared as per Schedule 3, Condition 10(h) of SSD_5594, Springvale Coal Pty Ltd (Springvale) commissioned this Trigger Investigation Report.



This report enacts upon the 'Trigger Action Response Plan' (TARP) required as per chart 3 of the LW 424–427 SMP in response to the trigger level exceedances identified within the 'LW424–427 Seasonal Swamp Monitoring Report' for Summer 2020–2021 (RPS, 2021).

1.3 Purpose

The purpose of this report is to complete the investigation in accordance with the trigger action response plan in the 424–427 Swamp Monitoring Program. This includes

- Considering if there is a correlation between the flora trigger timing and a potential groundwater change.
- Considering the climate data and the influence it has this had on the species composition.
- Investigating potential correlations with the anthropogenic causes (e.g. swamps burning in 2013 and 2019/2020 and if there is a cumulative impact from repeated bushfire on recovery rates).
- Considering whether the impacts are mining related.

1.4 Preliminary Trigger and Trigger Values

Preliminary trigger and trigger values have been set to provide a framework for monitoring and managing THPSS that may be impacted by the secondary extraction of coal from the Springvale mine. Measurable monitoring response triggers have been established to manage consequences from mining related impacts on THPSS. The aim of the preliminary triggers is to provide an initial indication prior to a performance indicator being exceeded (trigger value) to allow time for intervention or adaptive management prior to the trigger value being exceeded. Where a trigger value is exceeded, this indicates that more substantial action is required to investigate the causation of the impact and where necessary mitigate the impact and/or identify if an offset is required in accordance with the LW424–427 SMP TARP.

The calculated preliminary trigger and trigger values for the LW424–427 SMP are documented in the baseline report (RPS 2019). Results reported for the Summer 2020/2021 monitoring event are compared against these triggers. The monitoring area for the LW424–427 SMP is depicted in **Figure 1** and includes the location of both 'impact' and 'control' swamps.

Figure 1. Monitoring, Study, TIA Area's and Impact and Control Swamps

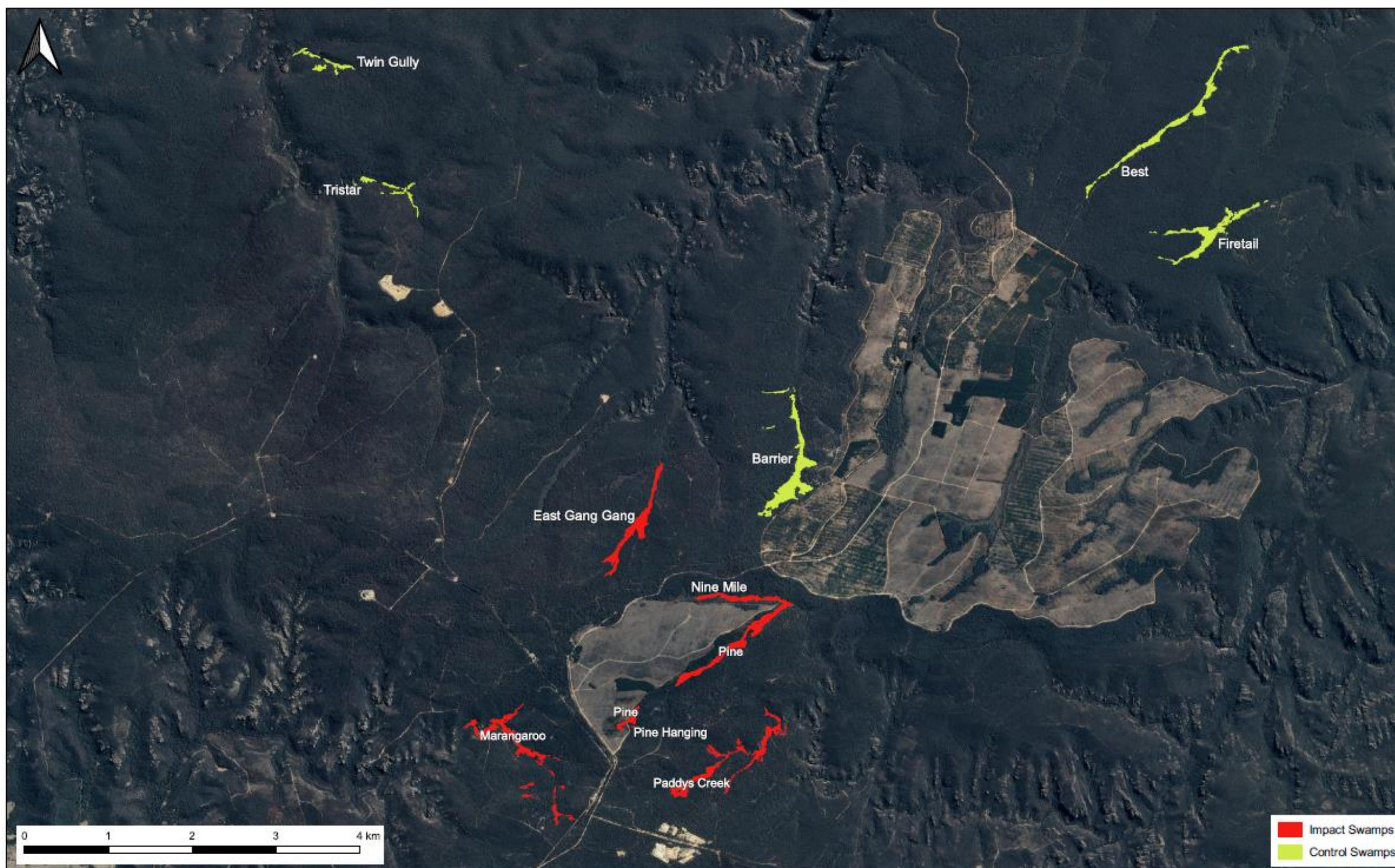


Figure 1: Springvale Impact and Control Swamps

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2 Methodology

The 'Flora monitoring methods for Newnes Plateau Shrub Swamps and Hanging Swamps' (Brownstein et al 2014) provides the methodology for the LW 424-427 SMP, which outlines specifications for the seasonal and annual surveys. Methods outlined in Brownstein et al (2014) were adapted and applied to generate the two-year baseline dataset from Winter 2017 to Autumn 2019, as documented in Seasonal and Annual Flora Monitoring: Baseline Report for LW424 – 427 (RPS 2019).

The extent of the remotely sensed imagery used in the LW 424-427 monitoring program is depicted in **Figure 2**. The results have been reported in the following sections in accordance with the trigger values stipulated in the LW 424-427 SMP and the observed variance of measured swamp attributes reported in the baseline report (RPS 2019).

2.1 Seasonal Remote Sensing

Remote sensed imagery for the Spring season comprising Red-Green-Blue (RGB) and Near-Infrared (NI) bandwidths, with the near-infrared (NIR) bandwidth centred around 720 nm, was obtained by Aerometrex Pty Ltd using fixed wing aircraft on the 5th March 2021. Data collection and analysis methods used are consistent with those described in RPS (2019).

2.2 Ground Control Points

Ground control points (GCPs) provide a field-based validation of information generated from the analysis of remotely sensed imagery (e.g. presence of live plant material) and collect additional information on flora species (e.g. percent weed cover). A minimum of three GCPs were permanently established in each swamp, with each comprising a plot measuring 1 m² in area to directly measure the variables listed below:

- Percentage live vegetation (i.e. photosynthetically active plant material);
- Percentage non-vegetated area (i.e. bare ground, water, litter and standing dead biomass);
- Percentage cover of each exotic plant species; and
- Dominant and co-dominant species in the overstorey, mid-storey and groundcover strata.

Summer 2021 GCP surveys were performed from 9 February to 17 February 2021. Data collection and analysis methods used were consistent with those described in RPS (2019).

2.3 Groundwater level monitoring

A summary of groundwater aquifer piezometers monitoring associated with LW424-427 are detailed in **Appendix 3, Table 5**.



2.4 Trigger Action Response Plan

A TARP forms part of the approved LW 424–427 SMP and sets out management measures for Centennial to undertake in the case of a Trigger exceedance. These management measures are outlined in Chart 2 (Appendix 1) and include the following investigations that are to be carried out within two months:

- Check for data inaccuracies (including; misreading, human error, instrument damage, instrument malfunction, data handling error, calculation error, and plotting error.)
- Similar triggers at reference sites (e.g. compare data from reference sites)
- Identify potential anthropogenic/natural impacts (including; forestry activity, erosion, swamp damage, bushfire, and vandalism.)
- Abnormal weather conditions
- Mining within 600m
- Evidence of possible mining impacts

Chart 3 (Appendix 1) has similar implications to Chart 2 with additional outcomes including some further recommendations as follows;

- Carry out additional field surveys
- Consider more frequent or additional monitoring
- Monitor if conditions worsen

2.4.1 Data Accuracy

Potential sources of error within the data set are identified by the TARP to include misreading, human error, instrument malfunction, data handling errors, calculation errors and plotting error. This report addresses these potential sources of error by independent review of raw transect and GCP field data against what was reported by RPS 2021.

2.4.2 Reference Swamp Comparison

The reference swamps Barrier, Central Carne, Best, Firetail, Twin Gully, Twin Gully Hanging, and Tristar were spatially analysed with reference to the baseline report RPS (2018). These results were then compared against the trigger levels applied to impact swamps.

2.4.3 Potential anthropogenic/natural impacts

Reported as the largest forest fire in Australian history, the Gospers Mountain Fire is estimated to have burned through more than 512,000 ha before joining with several other fires to burn close to 900,000 ha. The blaze burnt across the Lithgow, Hawkesbury and Central Coast regions from October 2019 to February 2020. This 'mega-fire' affected all swamps across the study area, including both impact and control swamps. Fire intensity across the extent of its influence was generally high (e.g. consistent canopy scorch), however, some variation in fire intensity was likely due to topography and weather factors.



2.4.4 Abnormal weather conditions

Potential impacts with regards to weather events such as above or below average rainfall period, storm events, lightning and drought conditions have been assessed through investigating BOM weather records over that period.

2.4.5 Mining within 600m

Mining within the Trigger Investigation Area (TIA; i.e. 600m) is a possible indicator of whether mining is related to the impact or not. At the time of the reporting trigger mining was being conducted in Longwall 427 and the Marrangaroo Swamp lineament had not been intersected. Groundwater triggers have previously been reported at Gang Gang Swamp, Paddys Creeks Swamp and Pine Swamp. At the time of the flora monitoring event (and the preparation of this report) no groundwater level declines had been observed at Marrangaroo Swamp/

2.4.6 Evidence of possible mining impacts

If the above investigations indicate that the observed impact is mining related further recommendations will be made. For example, in accordance with Chart 3 (Appendix 1), recommendations may include further monitoring be conducted and/or reassessed to confirm if conditions worsen or stabilise.

2.4.7 Carry out additional field surveys and/or consider more frequent or additional monitoring.

Further field surveys or increased monitoring may be warranted in circumstances where anomalous conditions are inconclusive, or data gaps are identified.

2.4.8 Monitor for if conditions worsen

If the impact is mining related and anomalous condition worsen they are to be reported to the appropriate Government department and a 'Severe Impact Investigation' is to be conducted in accordance with Chart 3 of the TARP.

3 Results

3.1 Data Accuracy

To ensure human error such as incorrect calculation or other data handling errors had not contributed to the trigger exceedance, the reported results of RPS 2021 were compared with raw data to ensure there were no anomalies. The data sampled was found to be consistent. In addition, this data was compared with SAVI indicating human error in recording, calculating, or transcribing the data was unlikely a contributing factor to the measured trigger exceedance.



3.2 Reference Swamp Comparison

3.2.1 Seasonal Swamp Monitoring

Plant health monitoring results for each swamp are summarised in **Table 1** together with the baseline for LW 419 and LW420–422 against the preliminary trigger levels reported in RPS (2019).



Table 1 Mean Area (SAVI $\leq$ 0.12) $\pm$ SE (ha) and 5% and 10% Preliminary Trigger Level (Extracted from RPS, 2021)

Swamp	Mean Area (SAVI $\leq$ 0.12) $\pm$ SE (ha)	5% Preliminary Trigger Level (ha)	10% Preliminary Trigger Level (ha)	20% Trigger Level (ha)	Summer 2021
424-427 Baseline Data					
Control Swamps (Shrub)					
Barrier	2.07 $\pm$ 0.976	3.198	3.350	3.655	0.155
Best	0.868 $\pm$ 0.447	1.381	1.447	1.578	0.185
Firetail	0.586 $\pm$ 0.274	0.899	0.942	1.028	0.181
Tristar	0.130 $\pm$ 0.077	0.217	0.228	0.248	0.084
Twin Gully	0.091 $\pm$ 0.065	0.164	0.172	0.187	0.074
Control Swamps (Hanging)					
Twin Gully Hanging	0.078 $\pm$ 0.034	0.118	0.123	0.134	0.063
Impact Swamps (Shrub)					
Marrangaroo	0.606 $\pm$ 0.291	0.942	0.987	1.076	1.010
Paddys Creek	0.286 $\pm$ 0.136	0.442	0.463	0.506	0.891
Pine	0.446 $\pm$ 0.272	0.755	0.791	0.862	0.511
Impact Swamps (Hanging)					
Pine Hanging	0.0012 $\pm$ 0.0007	0.002	0.002	0.0023	0.003
LW420-422 Baseline (Existing Data Set)					
Control Swamps (shrub)					
Barrier	1.928 $\pm$ 0.956	3.028	3.172	3.461	0.158
Best	0.848 $\pm$ 0.400	1.310	1.373	1.498	0.178
Firetail	0.585 $\pm$ 0.276	0.904	0.948	1.033	0.195
Tristar	0.151 $\pm$ 0.088	0.251	0.263	0.287	0.116
Twin Gully	0.108 $\pm$ 0.073	0.190	0.199	0.217	0.083
Control Swamps (hanging)					
Twin Gully Hanging	0.117 $\pm$ 0.040	0.165	0.172	0.188	0.090
Impact Swamp (shrub)					
Nine Mile	0.167 $\pm$ 0.076	0.256	0.268	0.292	0.123
LW419 Baseline (Existing Data Set)					
Control Swamps (shrub)					
Barrier	2.192 $\pm$ 0.583	2.914	3.053	3.330	0.257
Firetail	1.245 $\pm$ 0.297	1.619	1.696	1.850	0.293
Tristar	0.345 $\pm$ 0.079	0.445	0.466	0.509	0.402
Twin Gully	0.117 $\pm$ 0.036	0.161	0.168	0.184	0.124
Control Swamp (hanging)					
Twin Gully Hanging	0.218 $\pm$ 0.039	0.270	0.283	0.308	0.125
Impact Swamps (Shrub)					
East Gang Gang	0.506 $\pm$ 0.105	0.642	0.672	0.733	4.492



Results that exceed the corresponding baseline (i.e. SAVI is $\leq$ to 0.12) by >20% are coloured orange, which indicates:

- A trigger level exceedance for impact swamps; or
- Variation outside prior measured variation for control swamps.

Results that exceed the corresponding baseline (i.e. SAVI is $\leq$ to 0.12) by >10% are coloured grey, which indicates:

- A preliminary trigger level exceedance for impact swamps; or
- Variation outside prior measured variation for control swamps.

Statistical significance is included as a requisite indication of a trigger event.

Under the LW424–427 baseline, two swamps experienced triggers >20% threshold (Paddys Creek and Pine Hanging). East Gang Gang also recorded a trigger exceedance >20% threshold when compared to the LW419 baseline. Note that East Gang Gang is also included in the TIA for LW419 and LW420–422. The swamps that experienced triggers are identified below on **Figure 2** and the SAVI classification and live versus non-live (SAVI < 0.12) for the swamps which had preliminary triggers and triggers are depicted in **Figures 3–10**. Zero control swamps (Tristar, Twin Gully, Barrier, Best, Carne Central and Firetail) were outside the standard error variation observed in the baseline period (RPS 2019).

Figure 2 SAVI classification and live versus non-live (SAVI <0.12) Triggered Swamps

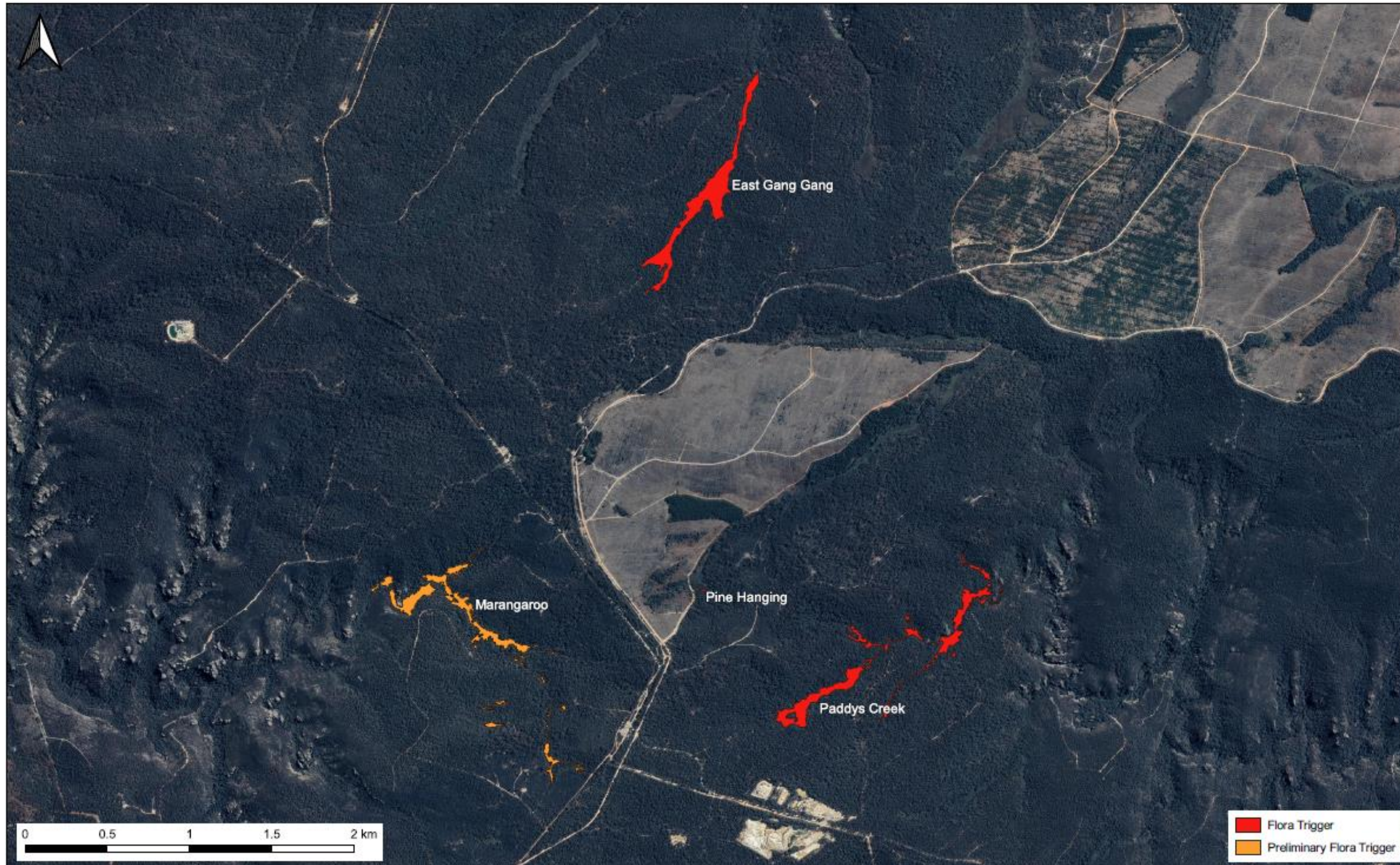


Figure 2: SAVI Trigger Swamps

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Author: Kazz Tokek
Date: 15.08.2021
Dept: Ecology

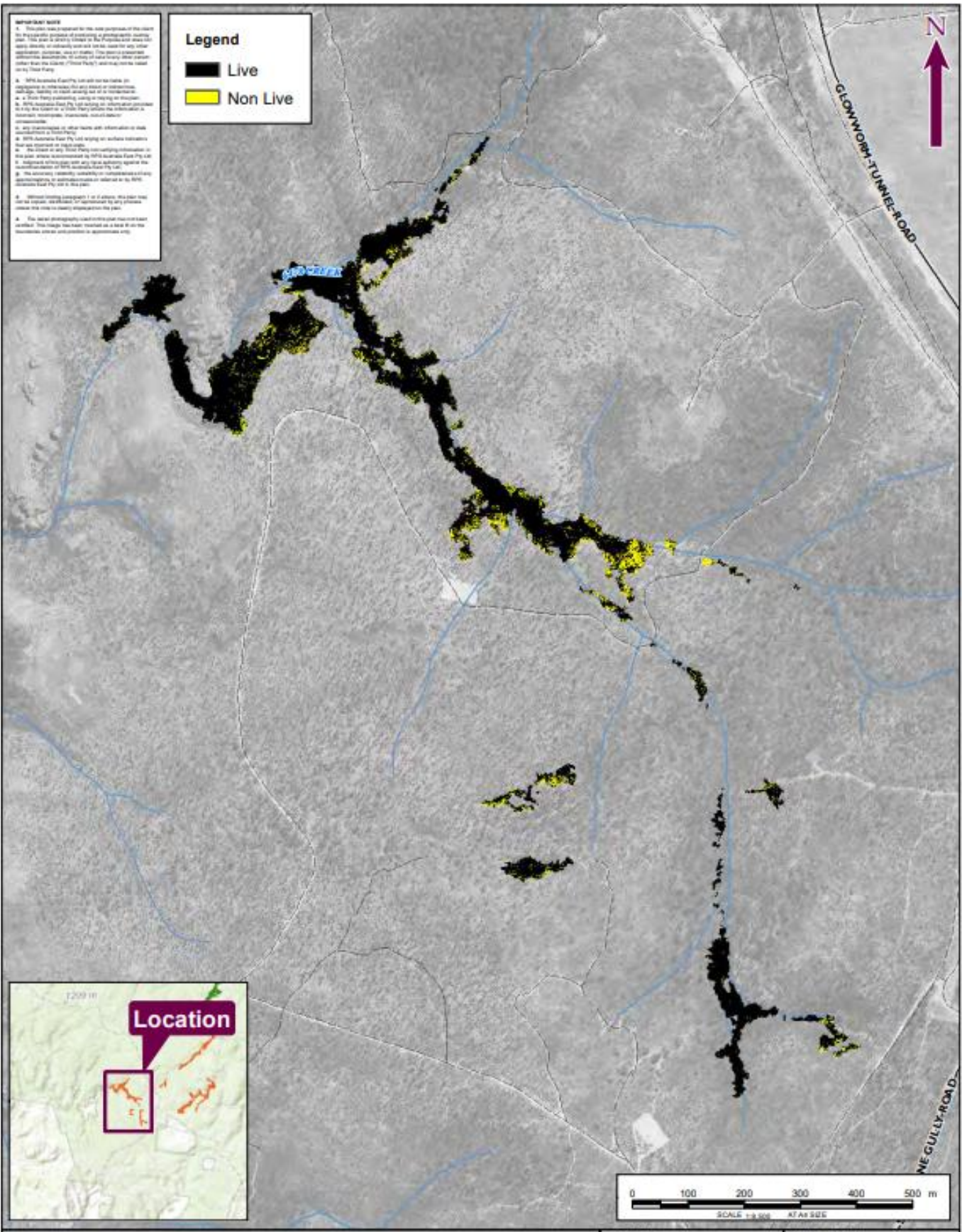
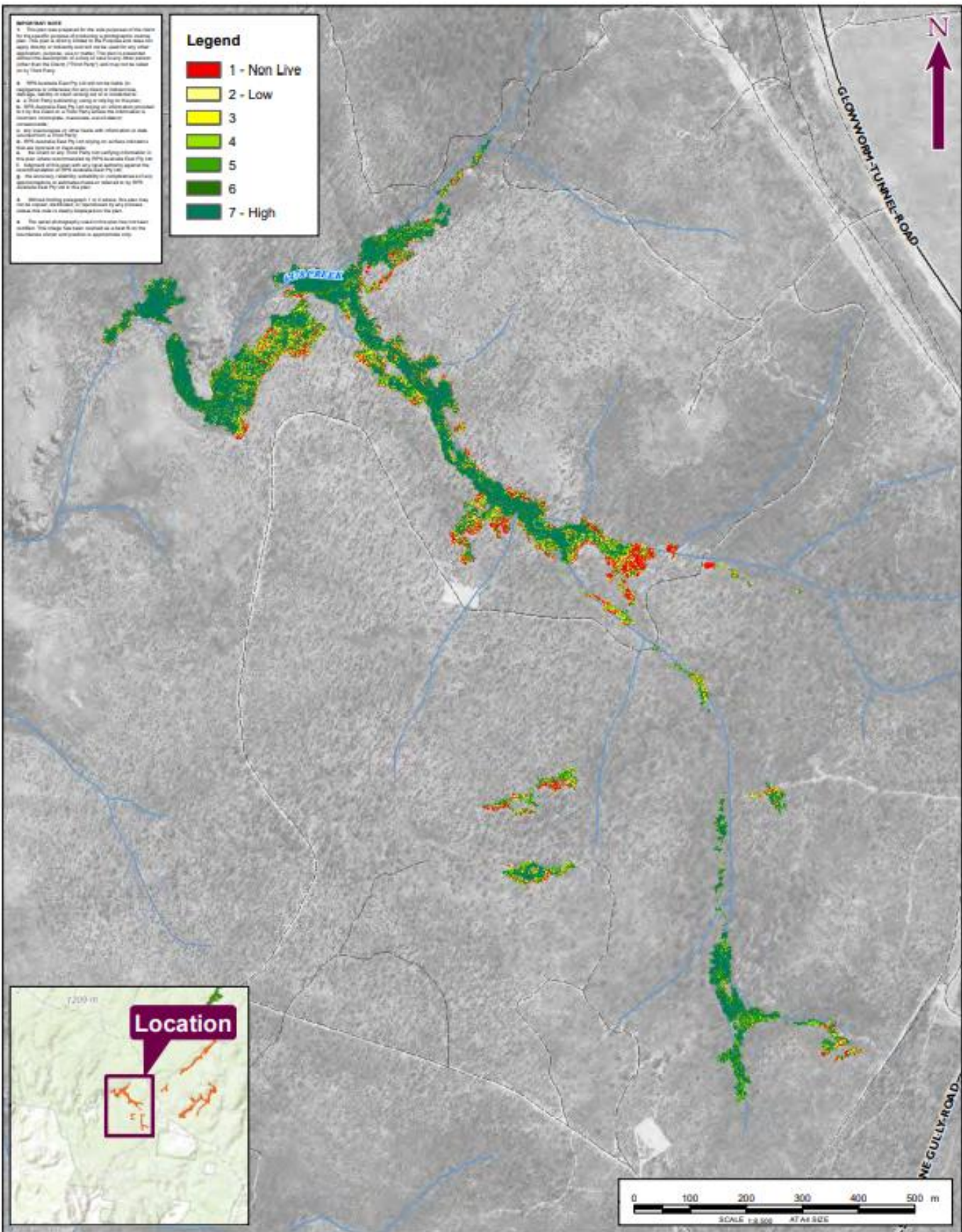
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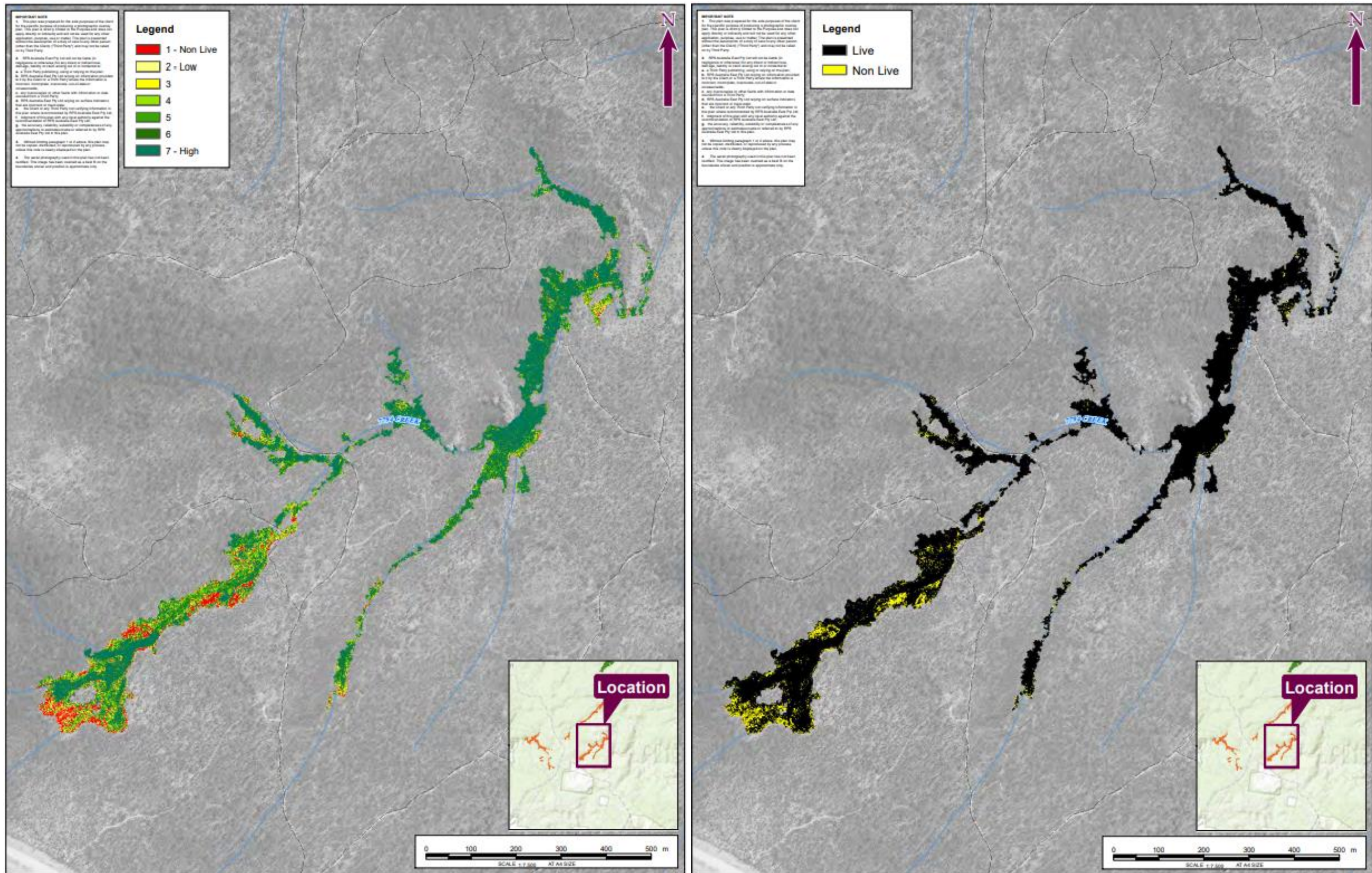
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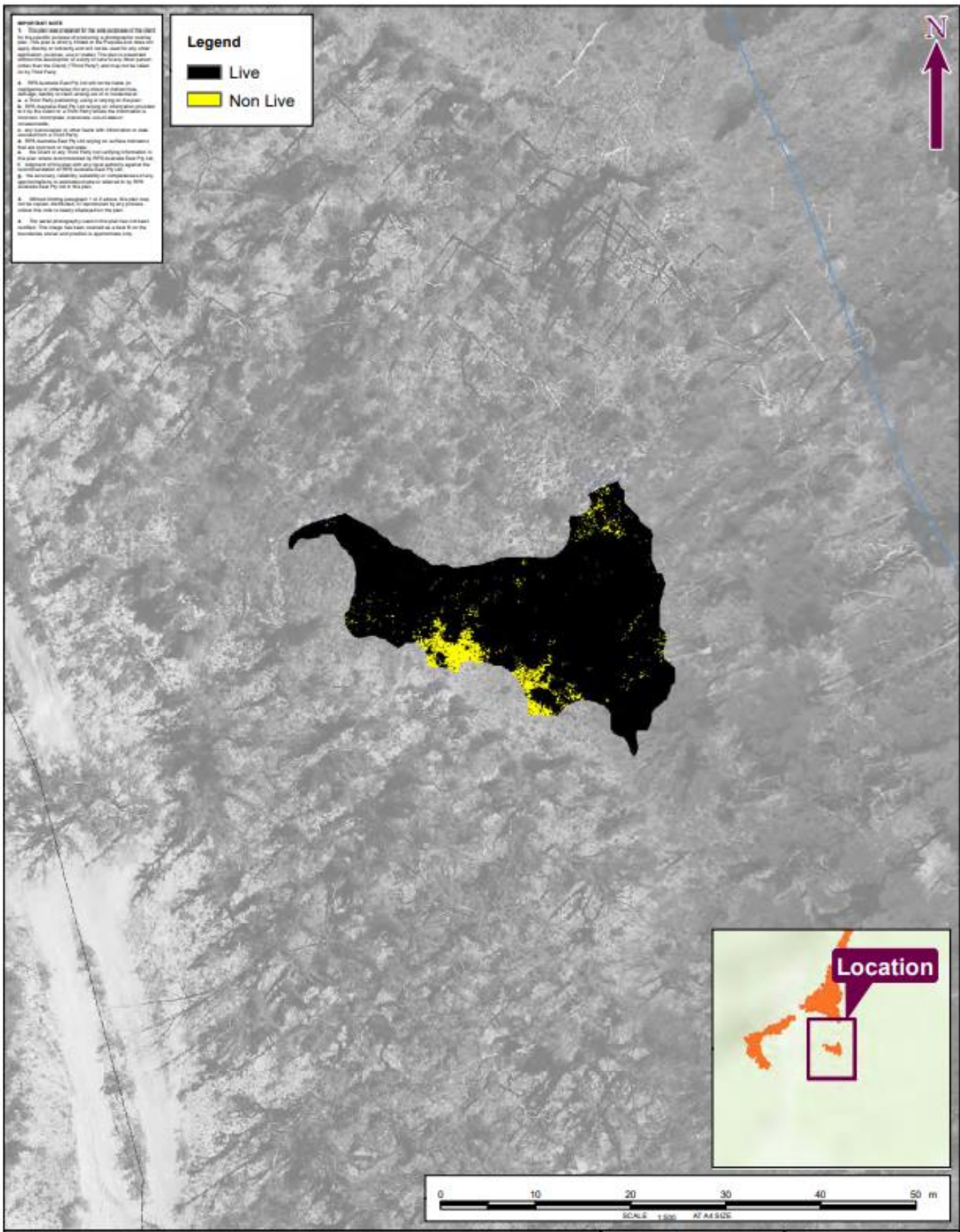
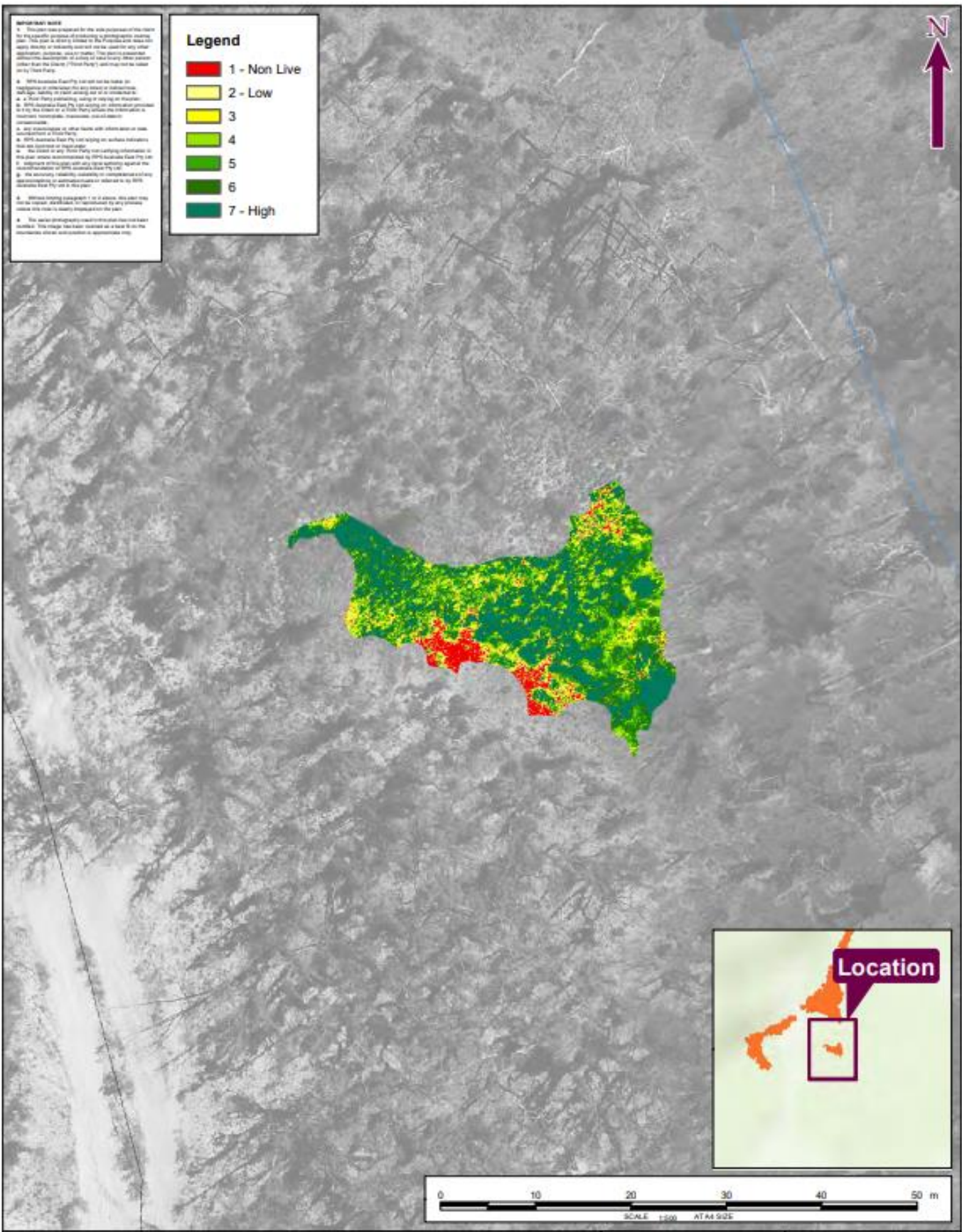
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Figures 3 and 4 – SAVI classification and live versus non-live (SAVI < 0.12) Marrangaroo Preliminary Trigger (Extracted from RPS, 2021)



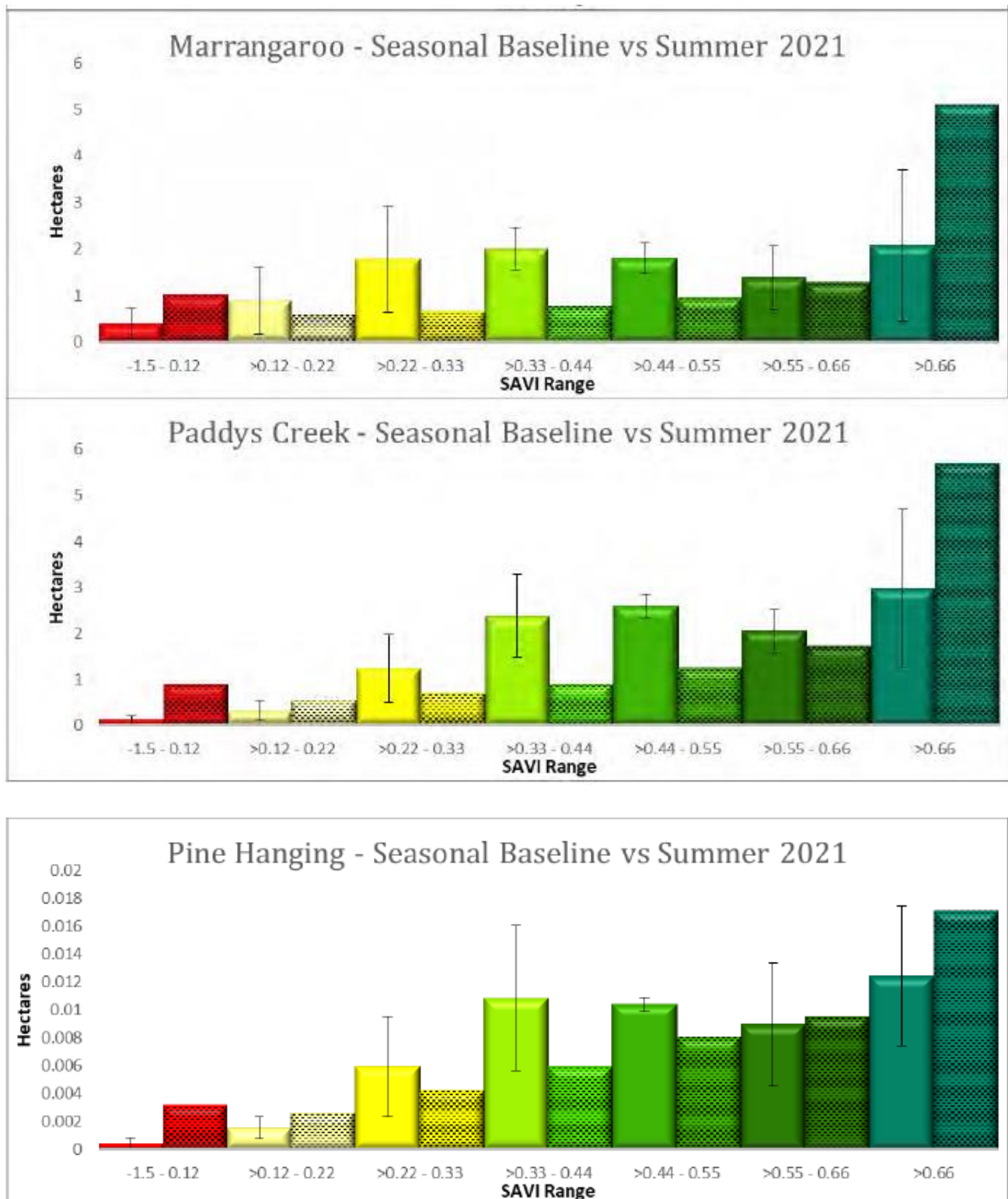
Figures 5 and 6 - SAVI classification and live versus non-live (SAVI < 0.12) Paddy's Creek Triggered (Extracted from RPS, 2021)

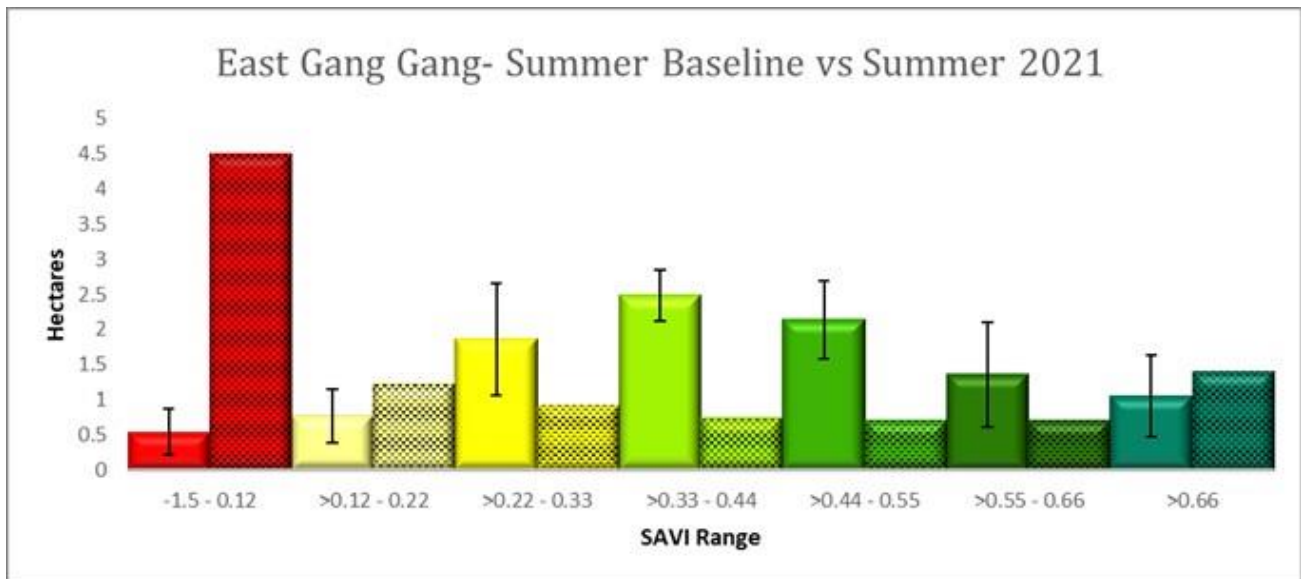


Figures 7 and 8 – SAVI classification and live versus non-live (SAVI < 0.12) Pine Hanging Triggered (Extracted from RPS, 2021)

Page 14

Graph 1 – Seasonal Histograms – SAVI classification and live versus non-live (SAVI <0.12) Triggered (Extracted from RPS, 2021)





3.2.2 Ground Control Points

Results obtained from GCP reconnaissance performed in the Summer 2021 monitoring event are summarised in **Table 2**. Cells coloured grey indicate Live Green (%) values below baseline range and Exotic (%) values above baseline range. Of note, the summer observations should only be compared to those of the baseline summer observations due to seasonal variation.

Table 2 Mean Summary data for all seasons per GCP: Live Green (%) and Exotic (%) including Standard Error (SE)

Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
LW424-427 Baseline						
Control Swamps (shrub)						
Barrier	1	94.25 $\pm$ 2.10	0.00 $\pm$ 0.00	92.15	90	0
Barrier	2	74.13 $\pm$ 11.87	0.00 $\pm$ 0.00	62.26	70	0
Barrier	3	77.13 $\pm$ 9.35	0.00 $\pm$ 0.00	67.78	30	0
Barrier	4	95.75 $\pm$ 3.85	0.00 $\pm$ 0.00	91.90	60	0
Barrier	5	94.38 $\pm$ 3.42	0.00 $\pm$ 0.00	90.96	70	0
Barrier	6	71.88 $\pm$ 17.21	0.00 $\pm$ 0.00	54.67	50	0
Barrier	7	79.75 $\pm$ 8.12	0.00 $\pm$ 0.00	71.63	90	0
Barrier	8	65.63 $\pm$ 8.54	0.00 $\pm$ 0.00	57.09	75	0
Barrier	9	89.75 $\pm$ 7.85	0.00 $\pm$ 0.00	81.90	95	0
Barrier	10	88.88 $\pm$ 5.01	0.00 $\pm$ 0.00	83.87	80	0
Barrier	11	85.00 $\pm$ 8.82	0.00 $\pm$ 0.00	76.18	60	0
Barrier	12	65.63 $\pm$ 7.18	0.00 $\pm$ 0.00	58.45	30	0
Barrier	13	94 $\pm$ 5.93	0.00 $\pm$ 0.00	88.07	30	0



Swamp	GCP #	Baseline		Summer 2021 (0.5m radius)		
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Tristar	80	64.38 $\pm$ 16.41	0.00 $\pm$ 0.00	47.97	85	0
Tristar	81	69.38 $\pm$ 21.00	0.00 $\pm$ 0.00	48.38	30	0
Tristar	82	84.63 $\pm$ 8.73	0.00 $\pm$ 0.00	75.90	95	0
Best	109	81.5 $\pm$ 10.51	0.00 $\pm$ 0.00	70.99	80	0
Best	110	68.75 $\pm$ 17.19	0.00 $\pm$ 0.00	51.56	95	0
Best	111	85.25 $\pm$ 8.63	0.00 $\pm$ 0.00	76.62	95	0
Best	112	69.25 $\pm$ 13.55	0.00 $\pm$ 0.00	55.70	60	0
Best	113	76.88 $\pm$ 10.17	0.00 $\pm$ 0.00	66.71	80	0
Best	114	87.13 $\pm$ 9.74	0.00 $\pm$ 0.00	77.39	80	0
Best	115	88.00 $\pm$ 10.61	0.00 $\pm$ 0.00	77.39	70	0
Best	116	85.63 $\pm$ 6.38	0.00 $\pm$ 0.00	79.25	80	0
Best	117	91.88 $\pm$ 4.51	0.00 $\pm$ 0.00	87.37	75	0
Best	118	84.38 $\pm$ 5.81	0.00 $\pm$ 0.00	78.57	80	0
Best	119	71.25 $\pm$ 14.11	0.00 $\pm$ 0.00	57.14	30	0
Best	120	97.00 $\pm$ 2.30	0.00 $\pm$ 0.00	94.70	95	0
Best	121	95.00 $\pm$ 2.67	0.00 $\pm$ 0.00	92.33	70	0
Best	122	95.50 $\pm$ 3.78	0.00 $\pm$ 0.00	91.72	60	0
Best	123	96.88 $\pm$ 3.59	0.00 $\pm$ 0.00	93.29	85	0
Best	124	73.50 $\pm$ 16.55	0.00 $\pm$ 0.00	56.95	15	0
Best	125	56.25 $\pm$ 8.81	0.00 $\pm$ 0.00	47.44	40	0
Control Swamps (Hanging)						
Firetail Hanging	55	80.5 $\pm$ 13.45	0.00 $\pm$ 0.00	67.05	90	0
Firetail Hanging	56	38.75 $\pm$ 17.8	0.00 $\pm$ 0.00	20.95	40	0
Firetail Hanging	57	59.38 $\pm$ 12.31	0.00 $\pm$ 0.00	47.07	50	0
Twin Gully Hanging	70	88.75 $\pm$ 6.68	0.00 $\pm$ 0.00	82.07	90	0
Twin Gully Hanging	71	77.50 $\pm$ 9.64	0.00 $\pm$ 0.00	67.86	65	0
Twin Gully Hanging	72	80.38 $\pm$ 5.66	0.00 $\pm$ 0.00	74.72	70	0
Impact Swamps (Shrub)						
Pine	132	95.88 $\pm$ 1.16	0.00 $\pm$ 0.00	94.72	90	0
Pine	133	90.00 $\pm$ 6.48	0.00 $\pm$ 0.00	83.52	95	0
Pine	134	72.75 $\pm$ 10.22	0.00 $\pm$ 0.00	62.53	75	0
Pine	135	90.88 $\pm$ 9.02	0.00 $\pm$ 0.00	81.86	70	0
Pine	136	92.25 $\pm$ 6.93	0.00 $\pm$ 0.00	85.32	70	0
Pine	137	76.00 $\pm$ 12.97	0.00 $\pm$ 0.00	63.03	60	0
Pine	138	87.50 $\pm$ 9.02	0.00 $\pm$ 0.00	78.48	25	0
Pine	139	91.63 $\pm$ 5.72	0.00 $\pm$ 0.00	85.91	20	1
Pine	140	92.88 $\pm$ 4.40	0.00 $\pm$ 0.00	88.48	20	0
Pine	213	77.88 $\pm$ 11.69	0.00 $\pm$ 0.00	66.19	95	0
Pine	214	96.75 $\pm$ 1.88	0.00 $\pm$ 0.00	94.87	99	0
Pine	215	96.00 $\pm$ 3.00	0.00 $\pm$ 0.00	93	99	0
Pine	216	95.00 $\pm$ 5.90	0.00 $\pm$ 0.00	89.1	70	0
Paddy's Creek	156	97.38 $\pm$ 2.51	0.00 $\pm$ 0.00	94.87	5	0
Paddy's Creek	157	94.88 $\pm$ 3.57	0.00 $\pm$ 0.00	91.31	70	0
Paddy's Creek	158	98.63 $\pm$ 1.13	0.00 $\pm$ 0.00	97.5	55	0



Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Paddy's Creek	159	92.88 $\pm$ 8.26	0.00 $\pm$ 0.00	84.62	35	0
Paddy's Creek	160	88.5 $\pm$ 9.43	0.00 $\pm$ 0.00	79.07	60	0
Paddy's Creek	161	79.38 $\pm$ 8.74	0.00 $\pm$ 0.00	70.64	45	0
Paddy's Creek	162	99.63 $\pm$ 0.37	0.00 $\pm$ 0.00	99.26	90	0
Paddy's Creek	163	97.63 $\pm$ 1.6	0.00 $\pm$ 0.00	96.03	95	0
Paddy's Creek	164	98.25 $\pm$ 2.41	0.00 $\pm$ 0.00	95.84	95	0
Paddy's Creek	165	99.25 $\pm$ 0.63	0.00 $\pm$ 0.00	98.62	20	0
Paddy's Creek	166	98.25 $\pm$ 1.18	0.00 $\pm$ 0.00	97.07	3	0
Paddy's Creek	167	96.88 $\pm$ 2.25	0.00 $\pm$ 0.00	94.63	40	0
Paddy's Creek	168	98.25 $\pm$ 1.59	0.00 $\pm$ 0.00	96.66	25	0
Paddy's Creek	169	98.25 $\pm$ 1.18	0.00 $\pm$ 0.00	97.07	95	0
Paddy's Creek	171	96.5 $\pm$ 3.59	0.00 $\pm$ 0.00	92.91	90	0
Paddy's Creek	172	90.88 $\pm$ 5.74	0.00 $\pm$ 0.00	85.14	95	0
Paddy's Creek	173	96.63 $\pm$ 2.3	0.00 $\pm$ 0.00	94.33	0	0
Paddy's Creek	174	95.63 $\pm$ 3.98	0.00 $\pm$ 0.00	91.65	10	1
Paddy's Creek	175	45 $\pm$ 15	0.00 $\pm$ 0.00	30	50	0
Paddy's Creek	176	94.75 $\pm$ 8.58	0.00 $\pm$ 0.00	86.17	15	0
Paddy's Creek	177	98.25 $\pm$ 1.24	0.00 $\pm$ 0.00	97.01	30	0
Paddy's Creek	178	99.63 $\pm$ 0.53	0.00 $\pm$ 0.00	99.1	10	0
Paddy's Creek	179	97.63 $\pm$ 2.48	0.00 $\pm$ 0.00	95.15	20	0
Paddy's Creek	180	98.38 $\pm$ 2.45	0.00 $\pm$ 0.00	95.93	25	0
Paddy's Creek	181	84 $\pm$ 9.58	0.00 $\pm$ 0.00	74.42	75	0
Paddy's Creek	182	76.13 $\pm$ 7.93	0.00 $\pm$ 0.00	68.2	10	0
Paddy's Creek	183	80.63 $\pm$ 23.24	0.00 $\pm$ 0.00	57.39	30	0
Paddy's Creek	184	92.13 $\pm$ 6.83	0.00 $\pm$ 0.00	85.3	90	0
Paddy's Creek	185	93.5 $\pm$ 3.36	0.00 $\pm$ 0.00	90.14	15	0
Marrangaroo	186	77.63 $\pm$ 14.11	0.00 $\pm$ 0.00	63.52	80	0
Marrangaroo	187	96.25 $\pm$ 3.5	0.00 $\pm$ 0.00	92.75	70	0
Marrangaroo	188	96.5 $\pm$ 4.87	0.00 $\pm$ 0.00	91.63	65	0
Marrangaroo	189	93.13 $\pm$ 10.17	0.00 $\pm$ 0.00	82.96	85	0
Marrangaroo	190	80.14 $\pm$ 13.76	0.00 $\pm$ 0.00	66.38	60	0
Marrangaroo	191	92.5 $\pm$ 6.78	0.00 $\pm$ 0.00	85.72	95	0
Marrangaroo	192	95 $\pm$ 4.83	0.00 $\pm$ 0.00	90.17	70	0
Marrangaroo	193	55 $\pm$ 14.02	0.00 $\pm$ 0.00	40.98	5	0
Marrangaroo	194	95.75 $\pm$ 3.5	0.00 $\pm$ 0.00	92.25	80	0
Marrangaroo	195	98.38 $\pm$ 1.56	0.00 $\pm$ 0.00	96.82	5	0
Marrangaroo	196	70.63 $\pm$ 9.34	0.00 $\pm$ 0.00	61.29	70	0
Marrangaroo	197	89.38 $\pm$ 5.07	0.00 $\pm$ 0.00	84.31	10	0
Marrangaroo	198	92.13 $\pm$ 6.03	0.00 $\pm$ 0.00	86.1	65	0
Marrangaroo	199	85.5 $\pm$ 4.83	0.00 $\pm$ 0.00	80.67	35	0
Marrangaroo	200	90.13 $\pm$ 5.93	0.00 $\pm$ 0.00	84.2	95	0
Marrangaroo	201	78 $\pm$ 20.36	0.00 $\pm$ 0.00	57.64	50	0
Marrangaroo	202	96.13 $\pm$ 3.06	0.00 $\pm$ 0.00	93.07	90	0
Marrangaroo	203	90.38 $\pm$ 5.59	0.00 $\pm$ 0.00	84.79	50	0



Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Marrangaroo	204	94.5 $\pm$ 5.1	0.00 $\pm$ 0.00	89.40	80	0
Marrangaroo	205	98.38 $\pm$ 1.64	0.00 $\pm$ 0.00	96.74	90	0
Marrangaroo	206	95.25 $\pm$ 4.88	0.00 $\pm$ 0.00	90.37	80	0
Marrangaroo	207	98.5 $\pm$ 2.48	0.00 $\pm$ 0.00	96.02	95	0
Marrangaroo	208	97.13 $\pm$ 3.13	0.00 $\pm$ 0.00	94	90	0
Marrangaroo	209	96.38 $\pm$ 3.54	0.00 $\pm$ 0.00	92.84	85	0
Marrangaroo	210	94.75 $\pm$ 4.07	0.00 $\pm$ 0.00	90.68	90	0
Marrangaroo	211	93.63 $\pm$ 5.03	0.00 $\pm$ 0.00	88.60	90	0
Impact Swamps (Hanging)						
Pine Hanging	212	93.75 $\pm$ 6.11	0.00 $\pm$ 0.00	87.64	90	0
LW420-422 Baseline (Existing Data)						
Control Swamps (Shrub)						
Barrier	1	94.88 $\pm$ 1.20	0.00 $\pm$ 0.00	93.68	90	0
Barrier	2	81.00 $\pm$ 5.15	0.00 $\pm$ 0.00	75.85	70	0
Barrier	3	84.00 $\pm$ 3.43	0.00 $\pm$ 0.00	80.57	30	0
Barrier	4	97.50 $\pm$ 1.72	0.00 $\pm$ 0.00	95.78	60	0
Barrier	5	96.13 $\pm$ 1.14	0.00 $\pm$ 0.00	94.99	70	0
Barrier	6	73.75 $\pm$ 8.32	0.00 $\pm$ 0.00	65.43	50	0
Barrier	7	86.00 $\pm$ 3.86	0.00 $\pm$ 0.00	82.14	90	0
Barrier	8	73.13 $\pm$ 4.72	0.00 $\pm$ 0.00	68.41	75	0
Barrier	9	91.00 $\pm$ 3.80	0.00 $\pm$ 0.00	87.2	95	0
Barrier	10	91.38 $\pm$ 2.67	0.00 $\pm$ 0.00	88.71	80	0
Barrier	11	86.88 $\pm$ 3.65	0.00 $\pm$ 0.00	83.23	60	0
Barrier	12	72.50 $\pm$ 5.05	0.00 $\pm$ 0.00	67.45	30	0
Barrier	13	95.25 $\pm$ 2.82	0.00 $\pm$ 0.00	92.43	30	0
Barrier	14	83.75 $\pm$ 4.26	0.00 $\pm$ 0.00	79.49	60	0
Barrier	15	91.00 $\pm$ 2.70	0.00 $\pm$ 0.00	88.3	85	0
Barrier	16	84.50 $\pm$ 5.84	0.00 $\pm$ 0.00	78.66	50	0
Barrier	17	88.25 $\pm$ 3.47	0.00 $\pm$ 0.00	84.78	65	0
Barrier	18	79.38 $\pm$ 3.83	0.00 $\pm$ 0.00	75.55	90	0
Barrier	19	94.25 $\pm$ 1.84	0.00 $\pm$ 0.00	92.41	80	0
Barrier	20	86.75 $\pm$ 4.41	0.13 $\pm$ 0.12	82.34	40	0
Barrier	21	84.38 $\pm$ 4.58	0.00 $\pm$ 0.00	79.8	60	0
Barrier	22	77.25 $\pm$ 6.82	0.00 $\pm$ 0.00	70.43	85	0
Barrier	23	89.00 $\pm$ 2.88	0.00 $\pm$ 0.00	86.12	60	0
Barrier	24	88.38 $\pm$ 1.68	0.00 $\pm$ 0.00	86.7	30	0
Barrier	25	90.00 $\pm$ 3.89	0.00 $\pm$ 0.00	86.11	80	0
Barrier	26	88.75 $\pm$ 4.07	0.00 $\pm$ 0.00	84.68	70	0
Barrier	27	80.75 $\pm$ 4.97	0.00 $\pm$ 0.00	75.78	40	0
Barrier	28	99.25 $\pm$ 0.59	0.00 $\pm$ 0.00	98.66	60	0
Barrier	29	91.63 $\pm$ 1.37	0.00 $\pm$ 0.00	90.26	95	0
Barrier	30	85.38 $\pm$ 2.87	0.00 $\pm$ 0.00	82.51	95	0
Barrier	31	96.00 $\pm$ 1.42	0.00 $\pm$ 0.00	94.58	99	0
Firetail	32	96.00 $\pm$ 1.01	0.00 $\pm$ 0.00	94.99	85	0



Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Best	125	67.25 $\pm$ 6.77	0.00 $\pm$ 0.00	60.48	40	0
Control Swamps (Hanging)						
Firetail Hanging	55	86.13 $\pm$ 3.60	0.00 $\pm$ 0.00	82.53	90	0
Firetail Hanging	56	33.75 $\pm$ 9.22	0.25 $\pm$ 0.24	24.53	40	0
Firetail Hanging	57	61.25 $\pm$ 5.26	0.00 $\pm$ 0.00	55.99	50	0
Twin Gully Hanging	70	90.00 $\pm$ 3.43	0.00 $\pm$ 0.00	86.57	90	0
Twin Gully Hanging	71	83.75 $\pm$ 3.87	0.00 $\pm$ 0.00	79.88	65	0
Twin Gully Hanging	72	82.50 $\pm$ 2.68	0.00 $\pm$ 0.00	79.82	70	0
Impact Swamps (Shrub)						
Nine Mile	126	85.5 $\pm$ 3.67	0.00 $\pm$ 0.00	81.83	50	0
Nine Mile	127	92.00 $\pm$ 2.51	0.00 $\pm$ 0.00	89.49	85	0
Nine Mile	128	76.63 $\pm$ 3.49	0.00 $\pm$ 0.00	73.14	75	0
Nine Mile	129	87.25 $\pm$ 4.30	0.00 $\pm$ 0.00	82.95	90	0
Nine Mile	130	82.88 $\pm$ 6.11	0.00 $\pm$ 0.00	76.77	40	0
Nine Mile	131	82.00 $\pm$ 4.16	0.00 $\pm$ 0.00	77.84	99	0
LW419 Baseline (Existing Data)						
Control Swamps (Shrub)						
Barrier	1	88.25 $\pm$ 3.92	0.00 $\pm$ 0.00	84.33	90	0
Barrier	2	79.69 $\pm$ 4.56	0.00 $\pm$ 0.00	75.13	70	0
Barrier	3	86.63 $\pm$ 2.78	0.00 $\pm$ 0.00	83.85	30	0
Barrier	4	97.38 $\pm$ 1.16	0.13 $\pm$ 0.12	96.22	60	0
Barrier	5	96.44 $\pm$ 0.66	0.00 $\pm$ 0.00	95.78	70	0
Barrier	6	82.81 $\pm$ 3.20	0.00 $\pm$ 0.00	79.61	50	0
Barrier	7	87.81 $\pm$ 3.07	0.63 $\pm$ 0.40	84.74	90	0
Barrier	8	75.00 $\pm$ 3.87	0.00 $\pm$ 0.00	71.13	75	0
Barrier	9	93.44 $\pm$ 1.18	0.00 $\pm$ 0.00	92.26	95	0
Barrier	10	93.00 $\pm$ 1.71	0.00 $\pm$ 0.00	91.29	80	0
Barrier	11	84.31 $\pm$ 2.00	1.88 $\pm$ 1.77	82.31	60	0
Barrier	12	83.78 $\pm$ 4.93	0.00 $\pm$ 0.00	78.85	30	0
Barrier	13	95.88 $\pm$ 1.00	0.00 $\pm$ 0.00	94.88	30	0
Barrier	14	80.56 $\pm$ 10.96	0.00 $\pm$ 0.00	69.6	60	0
Barrier	15	90.06 $\pm$ 2.06	0.13 $\pm$ 0.12	88	85	0
Barrier	16	88.63 $\pm$ 2.52	0.00 $\pm$ 0.00	86.11	50	0
Barrier	17	91.75 $\pm$ 1.14	0.00 $\pm$ 0.00	90.61	65	0
Barrier	18	71.56 $\pm$ 4.62	6.25 $\pm$ 5.91	66.94	90	0
Barrier	19	92.19 $\pm$ 3.49	5.00 $\pm$ 4.72	88.7	80	0
Barrier	20	90.00 $\pm$ 2.79	0.13 $\pm$ 0.12	87.21	40	0
Barrier	21	86.25 $\pm$ 3.31	0.38 $\pm$ 0.25	82.94	60	0
Barrier	22	90.13 $\pm$ 2.15	0.00 $\pm$ 0.00	87.98	85	0
Barrier	23	85.00 $\pm$ 2.86	0.00 $\pm$ 0.00	82.14	60	0
Barrier	24	86.25 $\pm$ 2.64	0.00 $\pm$ 0.00	83.61	30	0
Barrier	25	86.50 $\pm$ 4.90	0.00 $\pm$ 0.00	81.6	80	0
Barrier	26	86.00 $\pm$ 2.10	0.00 $\pm$ 0.00	83.9	70	0

Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Firetail	33	91.25 $\pm$ 3.19	0.00 $\pm$ 0.00	88.06	50	0
Firetail	34	97.38 $\pm$ 0.80	0.00 $\pm$ 0.00	96.58	65	0
Firetail	35	77.50 $\pm$ 4.19	0.00 $\pm$ 0.00	73.31	20	0
Firetail	36	88.13 $\pm$ 3.67	0.00 $\pm$ 0.00	84.46	50	0
Firetail	37	55.63 $\pm$ 7.55	0.00 $\pm$ 0.00	48.08	60	0
Firetail	38	93.88 $\pm$ 2.12	0.00 $\pm$ 0.00	91.76	80	0
Firetail	39	86.88 $\pm$ 3.45	0.00 $\pm$ 0.00	83.43	60	0
Firetail	40	95.88 $\pm$ 1.05	0.00 $\pm$ 0.00	94.83	60	0



Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
Barrier	27	85.63 $\pm$ 3.86	0.13 $\pm$ 0.12	81.77	40	0
Barrier	28	98.00 $\pm$ 1.22	0.25 $\pm$ 0.24	96.78	60	0
Barrier	29	79.31 $\pm$ 10.80	0.00 $\pm$ 0.00	68.51	95	0
Barrier	30	74.63 $\pm$ 10.53	0.00 $\pm$ 0.00	64.1	95	0
Barrier	31	94.88 $\pm$ 1.42	0.63 $\pm$ 0.59	93.46	99	0
Firetail	32	96.50 $\pm$ 0.64	0.00 $\pm$ 0.00	95.86	85	0
Firetail	33	93.13 $\pm$ 1.90	0.00 $\pm$ 0.00	91.23	50	0
Firetail	34	94.56 $\pm$ 2.24	0.00 $\pm$ 0.00	92.32	65	0
Firetail	35	73.44 $\pm$ 4.26	0.38 $\pm$ 0.35	69.18	20	0
Firetail	36	90.63 $\pm$ 1.88	0.00 $\pm$ 0.00	88.75	50	0
Firetail	37	55.63 $\pm$ 7.22	0.63 $\pm$ 0.59	48.41	60	0
Firetail	38	89.06 $\pm$ 3.63	1.88 $\pm$ 1.24	85.43	80	0
Firetail	39	94.81 $\pm$ 1.14	1.25 $\pm$ 1.18	93.67	60	0
Firetail	40	97.56 $\pm$ 0.73	0.00 $\pm$ 0.00	96.83	60	0
Firetail	41	61.56 $\pm$ 6.42	0.00 $\pm$ 0.00	55.14	5	0
Firetail	42	65.25 $\pm$ 4.06	4.50 $\pm$ 3.00	61.19	65	0
Firetail	43	89.13 $\pm$ 2.53	0.00 $\pm$ 0.00	86.6	45	0
Firetail	44	35.38 $\pm$ 2.22	0.63 $\pm$ 0.59	33.16	30	0
Twin Gully	64	79.69 $\pm$ 11.08	0.00 $\pm$ 0.00	68.61	85	0
Twin Gully	65	86.31 $\pm$ 4.41	1.50 $\pm$ 1.17	81.9	65	0
Twin Gully	66	88.75 $\pm$ 3.09	0.00 $\pm$ 0.00	85.66	50	0
Twin Gully	67	90.81 $\pm$ 2.16	0.00 $\pm$ 0.00	88.65	95	0
Twin Gully	68	74.50 $\pm$ 10.75	0.38 $\pm$ 0.25	63.75	80	0
Twin Gully	69	65.69 $\pm$ 2.62	0.00 $\pm$ 0.00	63.07	55	0
Tristar	73	62.19 $\pm$ 8.9	0.00 $\pm$ 0.00	53.29	80	0
Tristar	74	82.19 $\pm$ 3.67	0.63 $\pm$ 0.59	78.52	75	0
Tristar	75	87.94 $\pm$ 4.48	0.50 $\pm$ 0.47	83.46	100	0
Tristar	76	92.94 $\pm$ 1.78	0.13 $\pm$ 0.12	91.16	75	0
Tristar	77	84.38 $\pm$ 4.16	0.63 $\pm$ 0.59	80.22	75	0
Tristar	78	87.44 $\pm$ 3.69	0.00 $\pm$ 0.00	83.75	35	0
Tristar	79	91.50 $\pm$ 2.78	0.00 $\pm$ 0.00	88.72	60	0
Tristar	80	76.25 $\pm$ 10.63	0.00 $\pm$ 0.00	65.62	85	0
Tristar	81	81.88 $\pm$ 2.95	0.25 $\pm$ 0.15	78.93	30	0
Tristar	82	88.75 $\pm$ 2.64	0.00 $\pm$ 0.00	86.11	95	0
Control Swamps (Hanging)						
Firetail HS	55	70.94 $\pm$ 5.96	1.25 $\pm$ 1.18	64.98	90	0
Firetail HS	56	43.44 $\pm$ 10.33	1.56 $\pm$ 1.48	33.11	40	0
Firetail HS	57	70.31 $\pm$ 5.37	4.38 $\pm$ 4.13	64.94	50	0
Twin Gully HS	70	86.81 $\pm$ 3.95	0.00 $\pm$ 0.00	82.86	90	0
Twin Gully HS	71	81.88 $\pm$ 4.09	2.50 $\pm$ 2.36	77.79	65	0
Twin Gully HS	72	75.69 $\pm$ 3.80	7.50 $\pm$ 7.09	71.89	70	0
Impact Swamps (Shrub)						
East Gang Gang	90	76.75 $\pm$ 10.79	0.00 $\pm$ 0.00	65.96	5	0



Swamp	GCP #	Baseline			Summer 2021 (0.5m radius)	
		Live Green (%) $\pm$ SE	Exotic (%) $\pm$ SE	Lower Threshold (%)	Live Green (%)	Exotic (%)
East Gang Gang	91	79.94 $\pm$ 11.00	0.00 $\pm$ 0.00	68.94	2	0
East Gang Gang	92	59.69 $\pm$ 9.62	5.63 $\pm$ 5.32	50.07	40	0
East Gang Gang	93	96.63 $\pm$ 1.16	0.00 $\pm$ 0.00	95.47	2	0
East Gang Gang	94	90.94 $\pm$ 2.77	0.00 $\pm$ 0.00	88.17	1	0
East Gang Gang	95	90.88 $\pm$ 2.50	0.88 $\pm$ 0.60	88.38	1	0
East Gang Gang	96	55.00 $\pm$ 2.68	4.13 $\pm$ 2.89	52.32	40	0
East Gang Gang	97	84.13 $\pm$ 10.54	0.25 $\pm$ 0.15	73.59	5	0

A summary for shrub swamps is provided as follows:

- Percent live vegetation cover below the baseline range was recorded for 64 of 82 (78%) of impact swamp GCPs.
- Percent live vegetation cover below the baseline range was recorded for 46 of 77 (60%) of control swamp GCPs.

A summary for hanging swamps is provided as follows:

- Percent live vegetation cover below the baseline range was recorded for 2 of 6 (33%) of impact hanging swamp GCPs.
- Percent live vegetation cover below the baseline range was recorded for 0 of 1 (0%) of control hanging swamp GCPs.

3.3 Reference Swamp Comparison

The reference (control) site comparison as part of the BACI designed swamp monitoring program identified that no reference swamps triggered against the SAVI metric ($SAVI < 0.12$).

Although the reference sites did not trigger for the SAVI, the shrub swamp ground control points assessed for percentage live vegetation cover below the baseline range was 64 of 82 (78%) of impact swamps compared to 46 of 77 (60%) of control swamp ground control points. The hanging swamp ground control points assessed for percentage live vegetation cover below the baseline range was 2 of 6 (33%) of impact swamps compared to 0 of 1 (0%) of control hanging swamp ground control points. This suggests that a high proportion of both reference and impact swamps are experiencing higher than expected percentages of non-live vegetation, and that this might be more exaggerated (exceeding trigger levels) in impact sites due to the confounding factors such as prolonged dry and hot conditions and bushfire recovery rates.



3.4 Potential anthropogenic/natural impacts

The examination of aerial imagery identified that there has been no significant forestry activity, erosion events or swamp damage due to vandalism located within the catchments or swamp boundaries of triggered swamps.

3.4.1 Bushfire

The bushfires of the summer of 2019–2020 burnt through approximately 853,977 ha of the Greater Blue Mountains World Heritage Area, (Department of Agriculture Water and the Environment, 2020) and adjacent areas, including those above Centennial's Springvale Coal mining operation. The Newnes Plateau was severely affected (K. A. Fryirs et al., 2021).

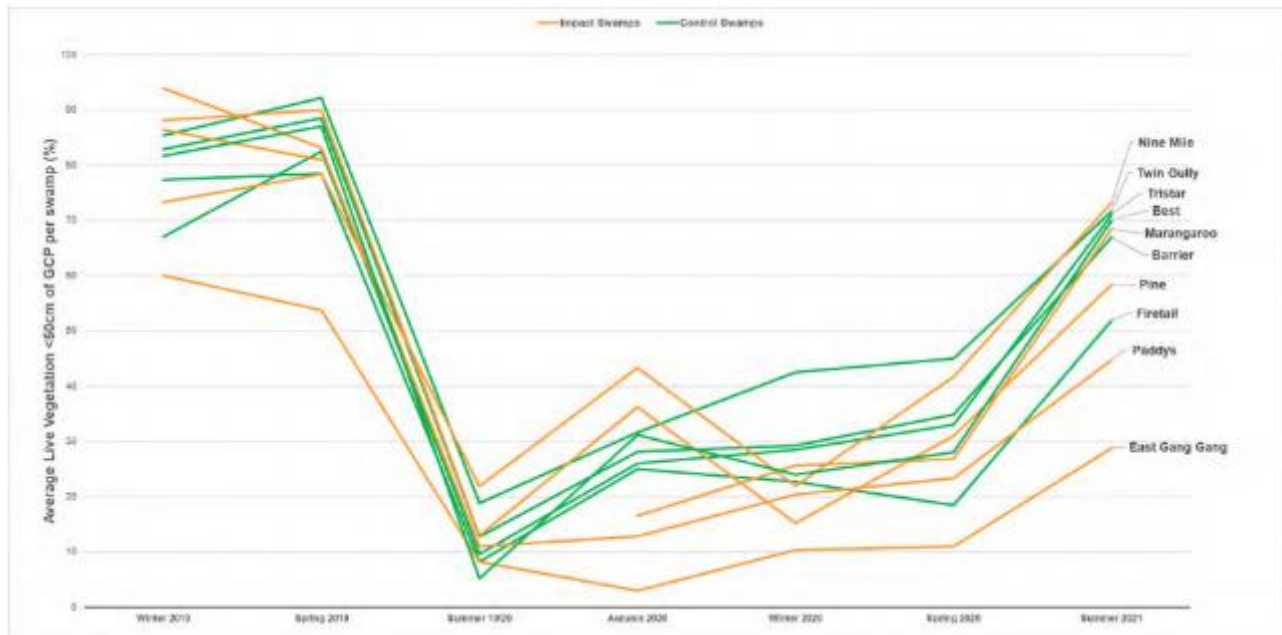
In the Newnes Plateau area, the effect of the fires was severe. Almost all the swamp area was affected (93%) and 96% of swamps were either partially or completely burnt. Of these, 97% experienced a high to very high burn severity. Follow up field observations of the Newnes Plateau swamps showed that swamp grasses were burnt to ground level. In most of the affected swamps, the surface organic matter was lost, while in the most severe cases, the upper peat layer (the alternating organic sands (AOS) (K. Fryirs, Freidman, B., Williams, R., Jacobsen, G., 2014) were also burnt. Post fire, heavy rainfall has led to surface erosion and rill and gully formation. There has been, in some places, significant ash transport. While further surveys have not yet been undertaken, K. A. Fryirs et al. (2021) propose that swamps with greater soil moisture were burnt less severely.

The recent 2019–2020 bushfires caused immense damage to the Newnes Plateau THPSS swamps. Recovery of swamp vegetation is occurring, particularly in wetter swamps with long term water supply. In swamps that have been undermined and dried to some degree prior to the fire, it appears that vegetation recovery is hampered and vegetation structure has changed.

The primary concern for swamp recovery is that the peat layer has been entirely burnt within some of the most heavily impacted swamps and they may take decades or centuries to recover (K. A. Fryirs et al., 2021). Investigation of the effect of the fires on the surface organic fines and alternating organic sands in both control and impact swamps, including water retention abilities, would be useful for interpreting impact and recovery data.

Monitoring post fire will need to focus on the recovery rates between control and impact sites and their trajectory back towards benchmark condition. Monitoring will be required to ascertain if they are on a slower recovery trajectory or if they are transitioning away from persisting as swamp communities.

Graph 2 presents the mean GCP live vegetation cover within 50cm (%) per swamp over time. Data is grouped by impact swamps (orange) and control/ reference swamps (green).



Graph 2 Mean GCP live vegetation cover within 50cm (%) per swamp over time.

Graph 3 presents the average ratio of GCP live vegetation cover within 50 cm (%) to the corresponding baseline value for the respective GCP. Impact swamps are plotted in orange, control swamps are plotted in green. Baseline data remains a constant of 1 and is represented by the red horizontal axis.



Graph 3 average ratio of GCP live vegetation cover within 50 cm (%) to the corresponding baseline value for the respective GCP

Although the recovery rates for swamps post fire are lower for East Gang Gang and Paddys Swamps which triggered for the SAVI metric ($SAVI < 0.12$), it is evident in the graphs above that all

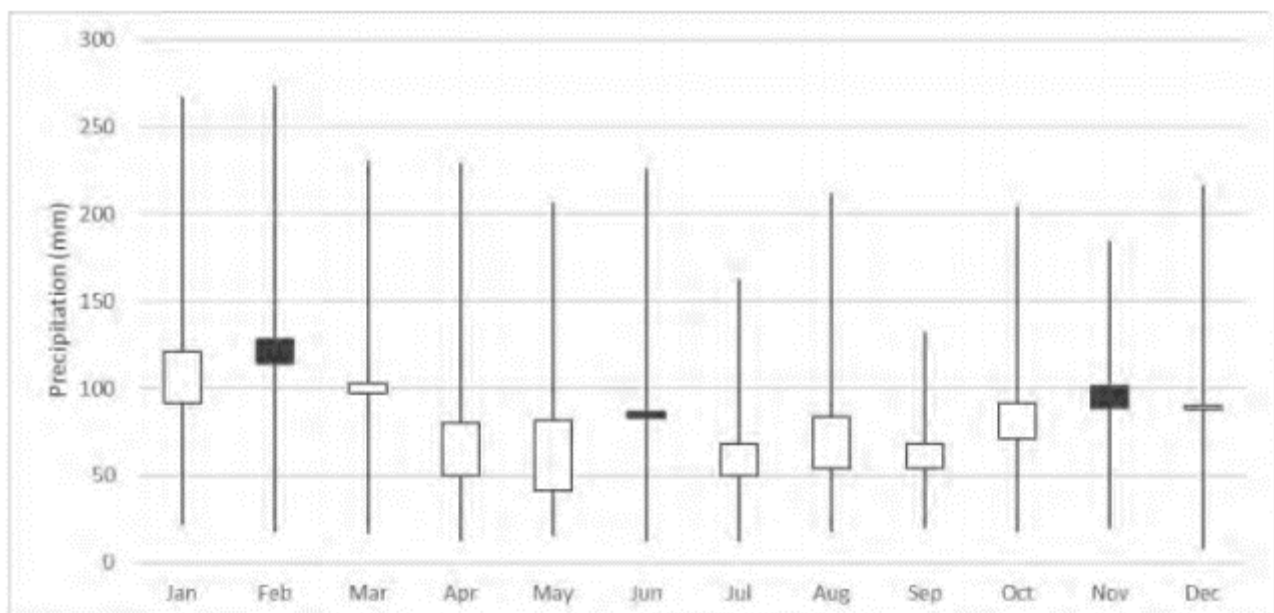
swamps are on a recovery trajectory post fire and it is unclear at this stage whether all swamps will make a full recovery back to within the pre-fire baseline natural variance.

3.4.2 Abnormal weather conditions

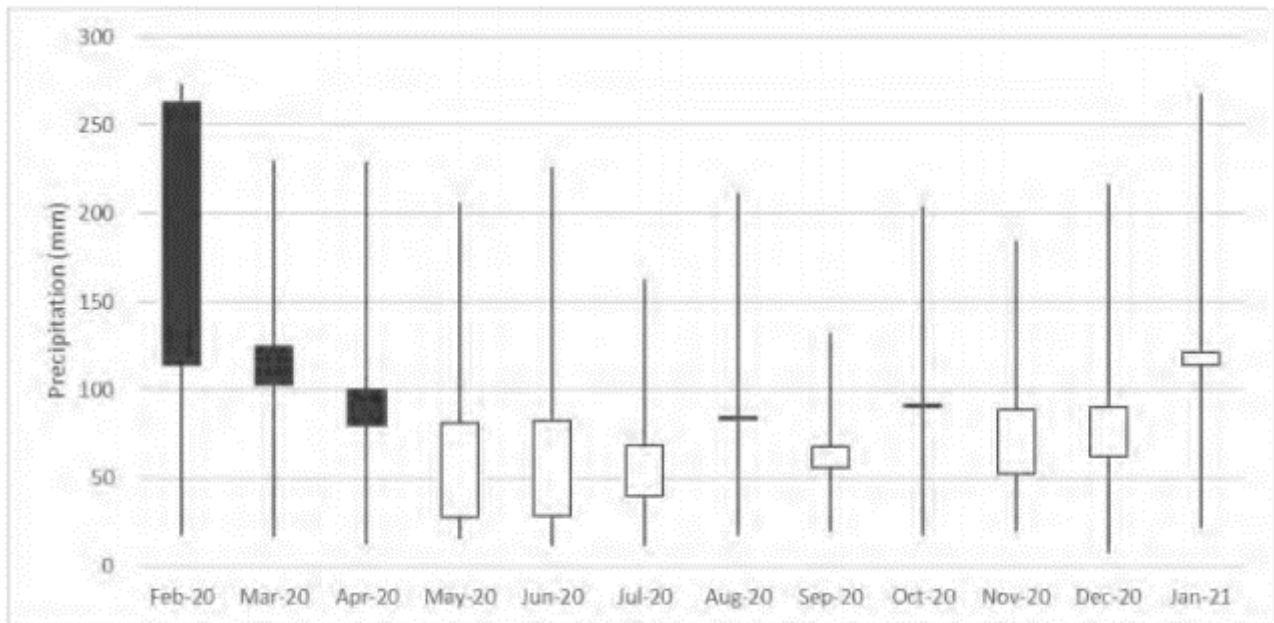
Weather conditions associated with the monitoring period were compared with historical datasets to aid interpretation of monitoring results. A summary of mean weather data is provided in the following sections.

3.4.2.1 Rainfall

Mean monthly rainfall totals for February, June and November (ALS 2002–2021) exceed the corresponding historical monthly means reported at the Newnes Forest Centre 36062 (1938–1999) (BOM 2021a) as shown by closed candles in Graph 4. Mean monthly rainfall (ALS 2002–2021) for the remaining calendar months were substantially lower than the long-term mean (1938–1999) (BOM 2021a).



Graph 4 Mean monthly rainfall for Newnes Forest Centre 36062 (1938–1999) (BOM2021a) and ALS Newnes Plateau (June 2003 – January 2021)

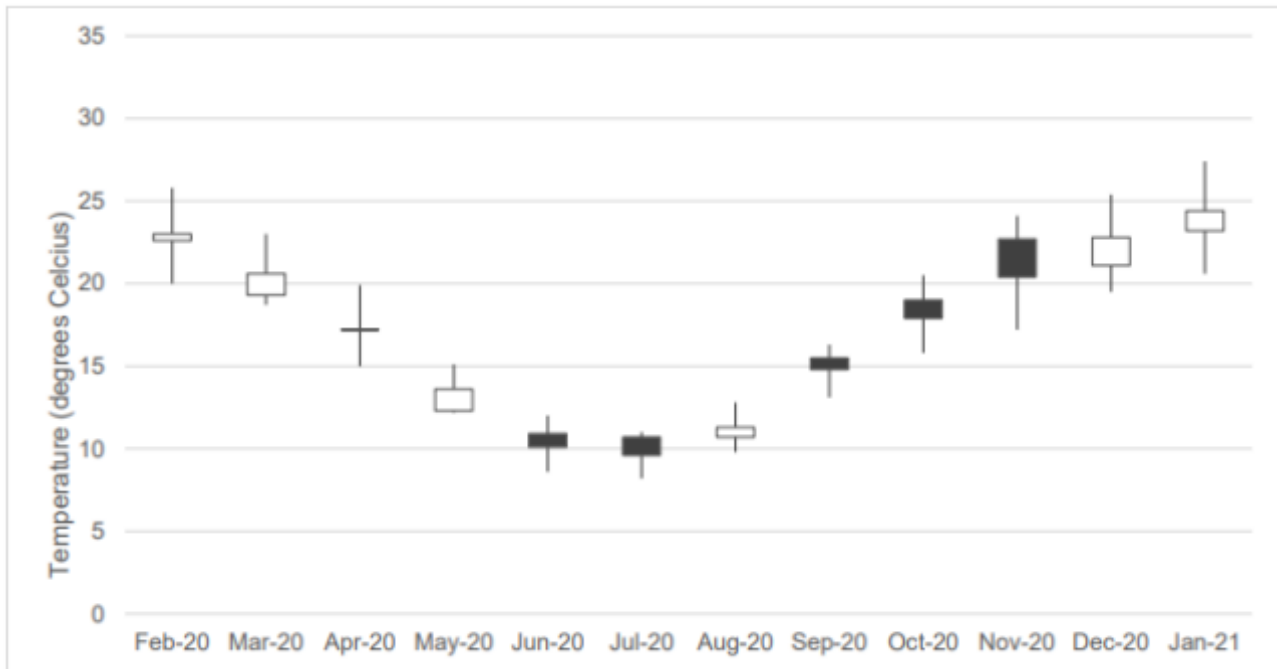


Graph 5 Monthly precipitation for February 2020 to January 2021 compared to mean monthly rainfall for the Newnes Forest Centre 63062 (1938-1999) (BOM 2021a)

Low rainfall was observed for eight of the twelve months prior to the February 2021 sampling period (**Graph 5**). February, March, April and August all experienced rainfall that exceeded historical means for the area. Remaining months comprised of rainfall which remained below the historical mean for the area.

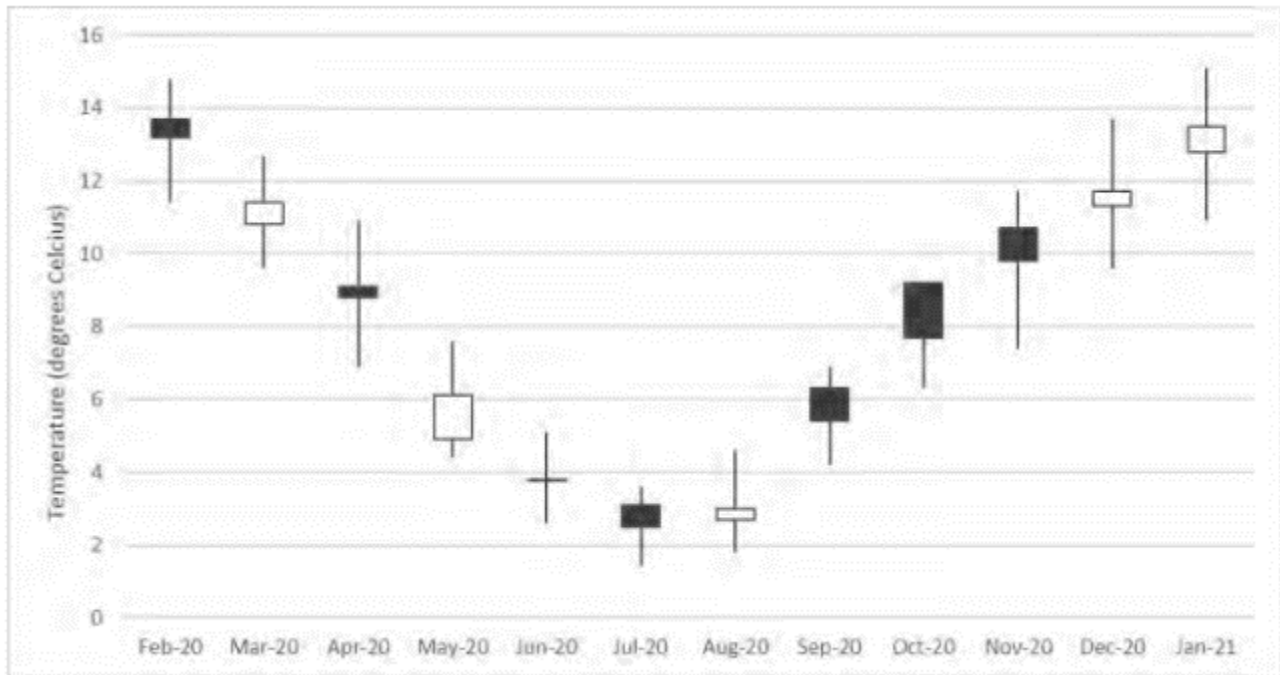
3.4.2.2 Temperature

The mean maximum monthly temperatures at Mount Boyce (station number 063292) (BOM 2021b) during the three months (November 2020 to January 2021) prior to the summer 2020/21 sampling (i.e. February 2021) were generally comparable with the historical average (1989-2017), with all three months prior to the summer 2020/21 survey effort recording mean maximum monthly temperatures between the 5th and 95th percentiles. Six of the twelve months prior to the survey recorded mean maximum monthly temperatures greater than, or equal to, the historic average (**Graph 6**).



Graph 6 Mean monthly maximum temperatures at Mount Boyce (February 2020 – January 2021) compared with long term mean (1991–2021; BOM 2021b)

Mean minimum monthly temperature varied throughout the same corresponding three-month period (November 2020 to January 2021) prior to the summer 2020/21 sampling. Two months (December and January) had a mean minimum average temperature which was lower than the historical average, but all three months were still located within the 5th and 95th percentile (**Graph 7**).



Graph 7 Mean monthly minimum temperatures at Mount Boyce (February 2020 – January 2021) compared with the long term mean (1991–2020; BOM 2021b)

3.5 Mining within 600m

Paddy's Creek and East Gang Gang Shrub Swamps triggered for non-live vegetation cover at swamp scale (SAVI<0.12). Similarly, Pine Hanging Swamp also triggered for the same metric. Paddy's Creek and East Gang Gang Shrub Swamps and Pine Hanging Swamp impact trigger events were within 600m of the active mining zone during or prior to the Summer 2020/2021 monitoring period. However, Marangaroo exceeded the preliminary trigger level for this metric, and it is not located within 600m of any active mining, nor has it experienced a groundwater trigger (refer to **Figure 11**). Therefore, this preliminary trigger is considered not to be mining related at this stage.

3.6 Evidence of possible mining impacts

Given the confounding factor of the recent bushfires and the variance in intensity it is difficult to ascertain if the impacts are primarily mining related and if they are likely to recover at a reduced rate due to their resilience being hampered from mining practices.

3.7 Carry out additional field surveys and/or consider more frequent or additional monitoring.

Further field surveys or increased monitoring are not considered warranted at this stage because although the anomalous conditions are inconclusive, there are no data gaps which have been identified that require further investigation. The ongoing monitoring program is considered sufficient for monitoring the post bushfire recovery rates in the swamps.



3.8 Monitor for if conditions worsen

In accordance with Chart 3, recommendations include that further monitoring is conducted and reassessed to confirm if conditions worsen or stabilise within the next 6 months.

If within a 6-month period, the conditions worsen they are to be reported to the appropriate Government department and a 'Severe Impact Investigation' is to be conducted.

3.9 Groundwater Monitoring

Previous groundwater triggers have been reported for East Gang Gang, Paddy's Creek, Pine and Nine Mile Swamp (refer to **Figure 11**), however, Marrangaroo has not experienced groundwater level changes as a result of lineament interaction..

Figure 11. SAVI and Groundwater Trigger Overlay

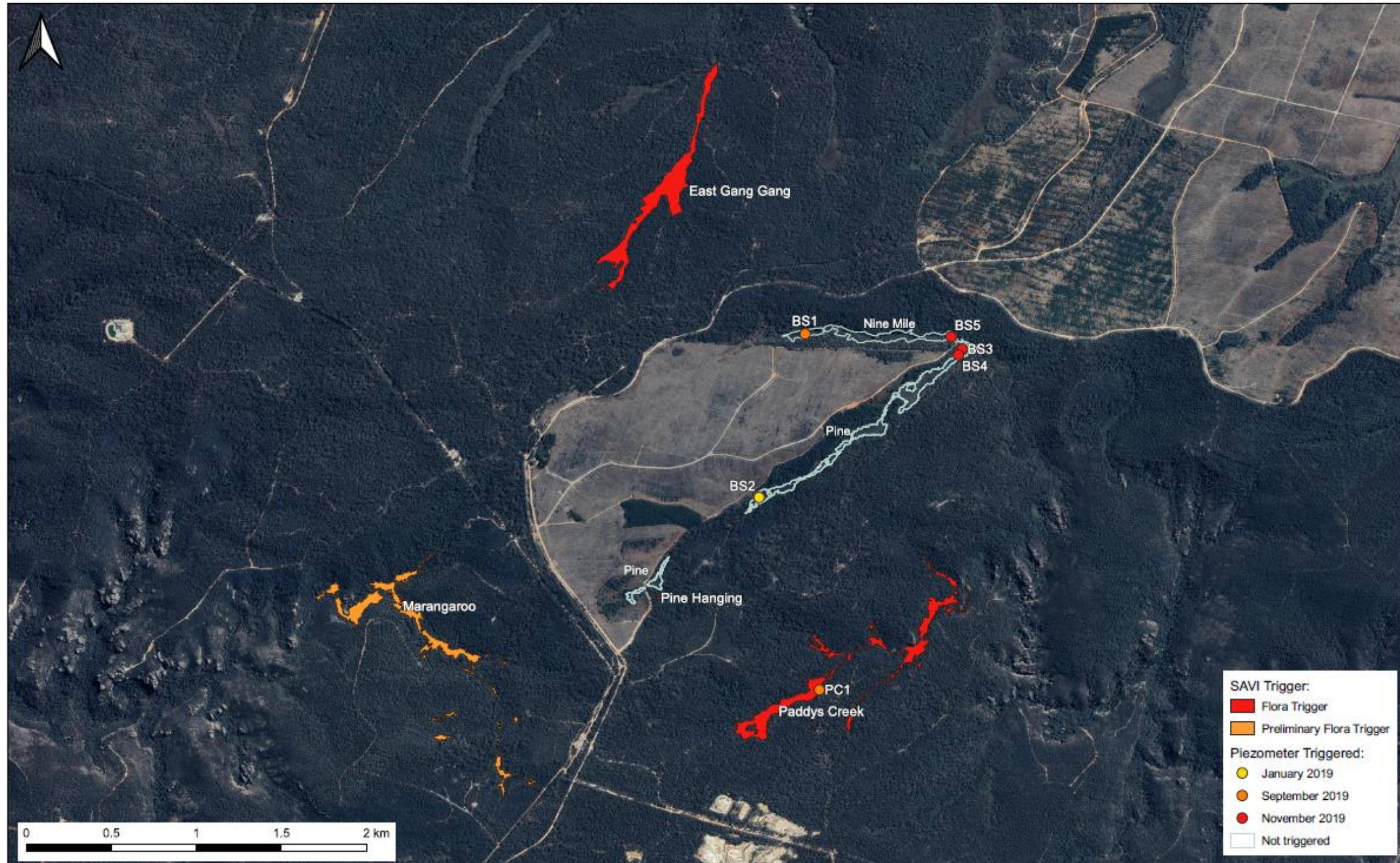


Figure 11: SAVI and Groundwater Piezometer Triggers for Impact Swamps

Job No.: ER019
Client: Centennial Coal Pty Ltd

Author: Kazz Tokak
Date: 15.08.2021
Dept: Ecology
Coordinate Reference System: GDA 94 MGA Zone 56

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4 Discussion

The Swamp Monitoring Program (SMP) for Longwalls (LW) 424 – 427, requires Centennial to monitor THPSS to ensure that potential impacts from mining are avoided, minimised or, where necessary, mitigated or offset. The SMP sets agreed trigger values for each monitoring program (Subsidence, Flora, Fauna, Groundwater and Surface water) to ensure necessary action is taken in response to changes in the monitored values, beyond the trigger values. Where a trigger event occurs an investigation will be conducted to assess the origin of the impact (whether it is mining related) and take appropriate steps to continue to monitor and report on the issue or implement adaptive management in consultation with relevant agencies to mitigate, remediate or offset the impact.

It is apparent from the evidence provided, that impacts have occurred at Paddy's Creek and East Gang Gang Shrub Swamps and Pine Hanging Swamp with all three swamps triggered for non-live vegetation cover at swamp scale ($SAVI < 0.12$). Confounding factors associated with the 'lineament theory', drought conditions and the Gospers Mountain Fire limit the ability to measure these impacts or state whether conditions have stabilised relative to reference sites.

In Summer 2019/2020 the Gospers Mountain bushfires caused immense damage to all the impact and reference swamps and all swamps triggered except one reference (Barrier). Recovery of swamp vegetation is occurring, particularly in wetter reference swamps with more consistent water supply. In impact swamps which have been undermined and dried to some degree prior to the fire, it appears that vegetation recovery is hampered, and vegetation structure has changed. Ongoing monitoring is required to measure the recovery trajectory and intervention through remediation investigations would be of benefit.

5 Conclusion and Recommendations

The steps that must be followed when preparing a Trigger investigation such as this report are outlined Chart 1, 2 and 3 within the Appendices. These set out the framework and necessary timeframes to implement a TARP. Authorities were notified within 5 days of the trigger exceedance. Data review has been completed and documented herewith and is consistent with the TARP process.

The Trigger exceedance of non-live vegetation cover has been demonstrated not to be attributable to human error or data inaccuracies. A comparison of measures across both control and impact swamps has indicated that although comparable, the non-live vegetation cover increase is notably in the impact swamps. The confounding factors of drought conditions lowering the groundwater and surface water levels combined with repeated fire (most recently catastrophic) make it difficult to attribute the decline in THPSS to undermining impacts alone. Rather it is likely that the undermining may have reduced the THPSS resilience or increased its susceptibility to these environmental factors. Continued monitoring is required to ascertain if the



conditions are anomalous prior to implementation of further actions. The current monitoring program is considered sufficient for this purpose.

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7 Appendix 1: Trigger Action Response Plan (TARP) Charts 1-3.

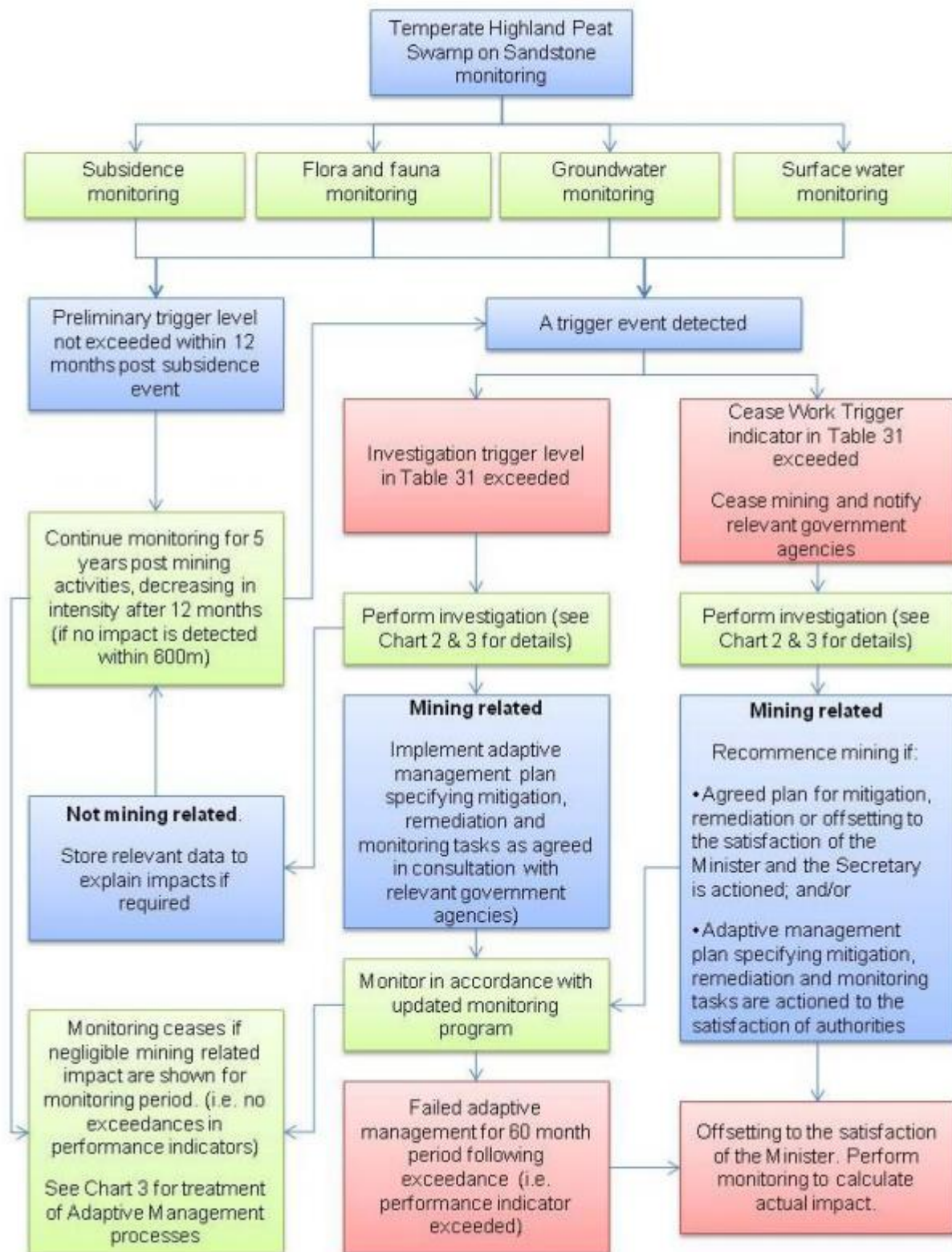
Chart 1: Trigger Action Response Plan – Overview



Chart 2: Trigger Action Response Plan – Management Measures

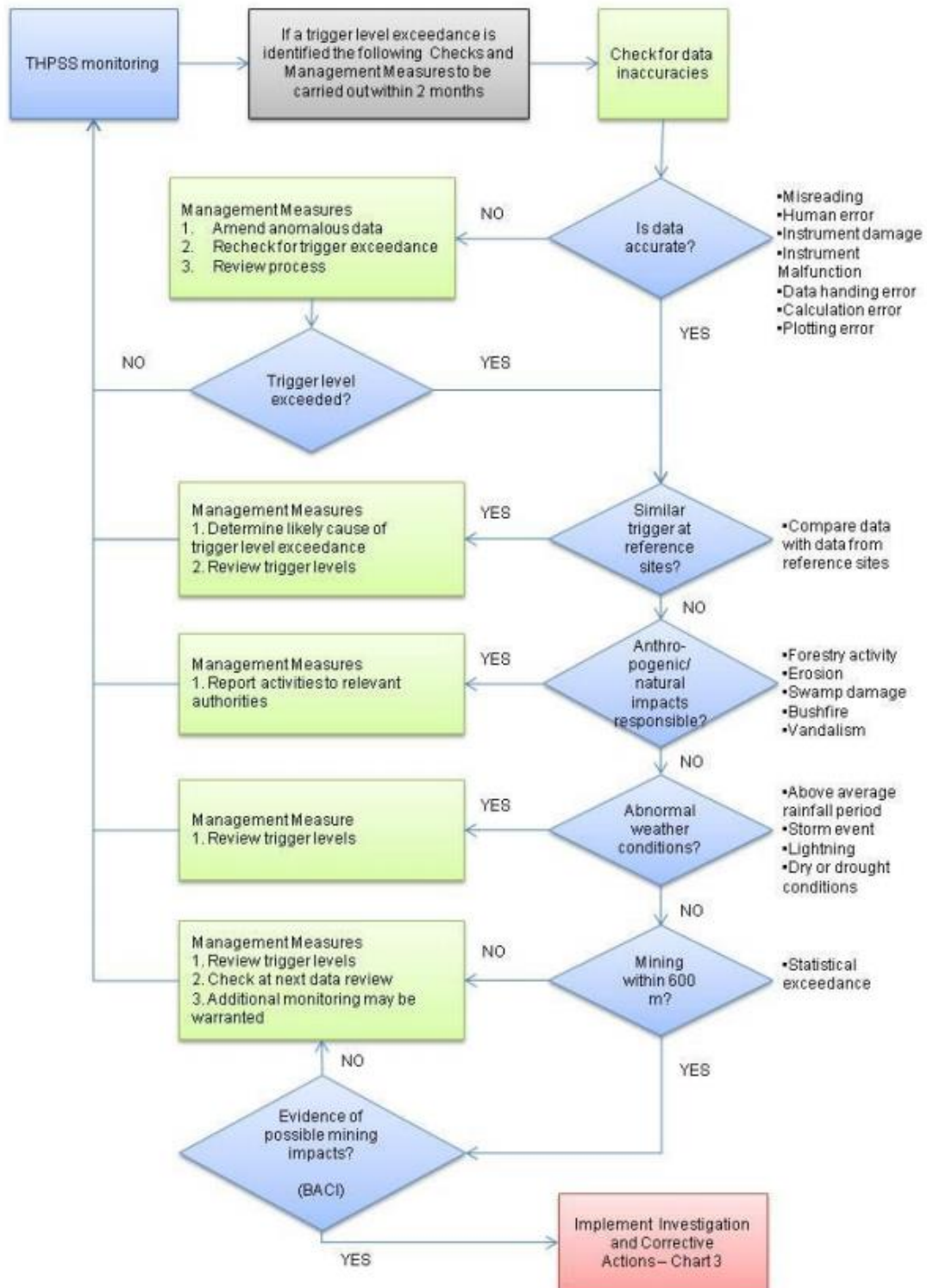
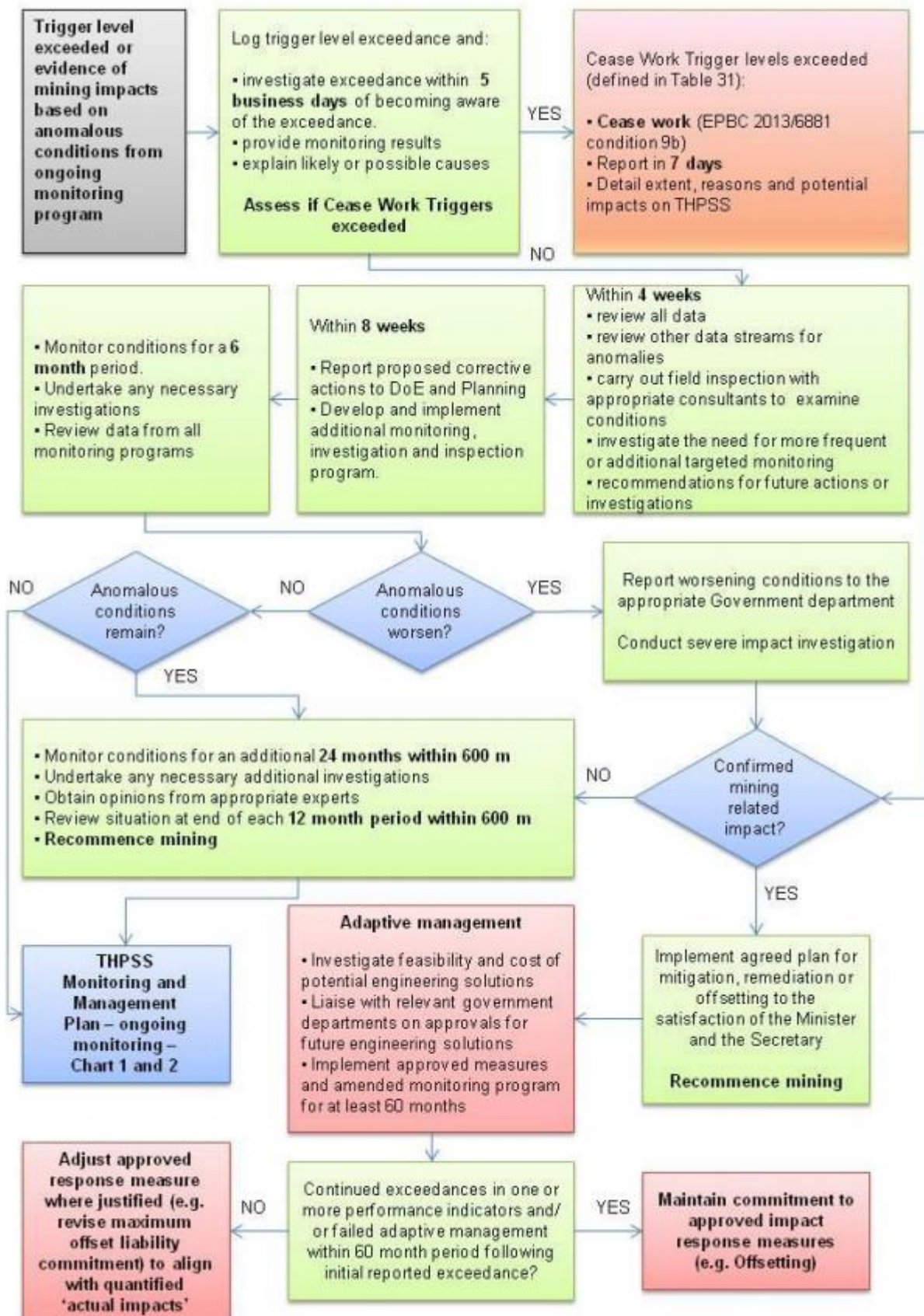


Chart 3: Trigger Action Response Plan – Corrective Actions



8 Appendix 2: Performance and Trigger Values

Table 3 Performance Measures, Performance Indicator, Preliminary Trigger (drying) and Triggers for THPSS for SMP LW 424–427

Performance measure	Performance Indicator	Preliminary trigger	Trigger
Negligible change to the shallow groundwater regime when compared with control swamps	Groundwater levels remain within 95 th percentile of pre-mining groundwater depth for more than 7 consecutive days.	Evidence of a reduction in water table depth or stability, due to underground mining, from piezometers located in impact sites.	Groundwater depth in any piezometer exceeds the 95 th percentile pre-mining groundwater depth for more than 7 consecutive days.
		A statistically significant ¹ reduction in the abundance of native wetland species in an impacted swamp relative to the previous survey ⁷ .	A statistically significant ¹ reduction in the abundance of native wetland species in an impacted swamp when compared to control swamps.
Negligible erosion of the surface of the swamp	Evidence of natural recruitment comprising characteristic swamp plant species within patches of nonvegetative cover. Characteristic swamp species are defined as terrestrial damp habitat (Tda) or amphibious (A) species ³	Increased establishment of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height) ²	30% increase in frequency of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height) ²
		Signs of ponding, surface deformation and/or scouring with corresponding loss of vegetation cover.	20% increase in the extent of non-vegetated area (excluding areas covered by standing water)
Negligible change in the size of the swamp	Swamp boundaries remain within the variation observed throughout the baseline monitoring period. The live green vegetated area within a swamp boundary remains within the variation observed throughout the baseline monitoring period for the corresponding season.	10% increase ² in the extent of non-vegetated area (excluding areas covered by standing water) relative to the previous survey ⁷ .	A single patch of non-vegetative cover greater than 400 m ² doubles in size compared to baseline data ²
		Physical contraction in swamp boundary of 5% or more in any reportable monitoring and/or Plant health ⁴ of characteristic swamp species reduces in an impact swamp by >5% relative to the same season in the previous year (i.e. 5% or more increase in SANDVI ⁵ scores below 0.15)	Significant ¹ contraction in swamp boundary when compared to baseline conditions and variance observed in control swamps and/or Significant ¹ loss in photosynthetic activity at a swamp scale compared with baseline conditions
Negligible change in the ecosystem functionality of the swamp	The population size and/or spatial occurrence of key swamp obligate species ⁶ remains stable at the swamp scale	A statistically significant ¹ reduction in population size and/or spatial occurrence of a key swamp obligate species in an impacted swamp relative to the previous survey ⁷ .	A statistically significant ¹ reduction in population size and/or spatial occurrence of a key swamp obligate species in an impacted swamp relative to control swamps.
		Increased establishment of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height) ²	30% increase in frequency of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height) ²
Negligible change to the composition or distribution of species within the swamp	The population size and/or spatial occurrence of key swamp obligate species ⁶ remains stable at the swamp scale	A 10% increase in terrestrial dry habitat (Tdr) vegetation as a proportion of total vegetation cover ² in an impacted swamp relative to the previous survey ⁷	Statistically significant ¹ increase in terrestrial dry habitat (Tdr) vegetation as a proportion of total vegetation cover in an impacted swamp relative to control swamps.
		A 10% decrease in amphibious (A) species cover as a proportion of total vegetation cover ² in an impact swamp relative to the previous survey ⁷	Statistically significant ¹ decrease in amphibious (A) species cover as a proportion of total vegetation
Performance measure	Performance Indicator	Preliminary trigger	Trigger
			cover in an impacted swamp relative to control swamps.
		The proportion of terrestrial damp habitat (Tda) vegetation remains within the variability measured during the baseline period	Statistically significant ¹ change (increase or decrease) in Tda vegetation as a proportion of total vegetation in an impacted swamp relative to control swamps.
		The proportion of terrestrial dry habitat (Tdr) vegetation remains within the variability measured during the baseline period	Statistically significant ¹ increase in terrestrial dry habitat (Tdr) vegetation as a proportion of total vegetation in an impacted swamp relative to control swamps.
		No increase in exotic vegetation cover	statistically significant ¹ increase exotic vegetation as a proportion of total vegetation cover for an impact swamp compared to control swamp
		No increased establishment of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height)	30% increase in frequency of eucalypt and/or pine seedlings ($\leq 1\text{m}$ in height) ²
		Measured subsidence does not exceed predictions. No visual cracking or peat slumping that was not present prior to mining.	Measured subsidence in excess of predictions (>125% of predicted levels) Visual cracking >50mm in width and 10m in length (not present prior to mining) Peat slumping >0.5m depth and >20m ² relative to adjacent swamp surface (not present prior to mining)

¹ Statistically significant is taken to mean a p value <0.05

² Taken from Brownstein et al (2014) and are referred to as 'preliminary'. Subject to change

³ See Brownstein et al (2014) for list of amphibious (A), terrestrial dry habitat (Tdr) and terrestrial damp habitat (Tda)

⁴ Photosynthetic activity as measured by remote sensing using the Soil Adjusted Normalised Difference Vegetation Index (SANDVI)

⁵ SANDVI = Soil Adjusted Normalised Difference Vegetation Index

⁶ Key swamp obligate species include Blue Mountains Water Skink, Giant Dragonfly, Boronia deanei, amphibious vegetation (see Brownstein et al 2014)

⁷ For the purpose of this report, "previous survey" is taken to mean baseline or before dataset (i.e. data collected in winter 2017 to autumn 2019)



9 Appendix 3: Groundwater Monitoring triggers

Table 4 LW424–427 Groundwater Monitoring Summary

Bore ID	Swamp	Monitoring	Impact / Reference Site	600m Longwall Proximity	Monitoring Frequency
Swamp Water Level and Soil Moisture Monitoring					
GG1	Gang Gang East	Swamp Water Level	Impact	427 / Lineament	Weekly / Monthly
GG2 SM	Gang Gang East	Soil Moisture Monitoring	Impact	427 / Lineament	Monthly
GG2	Gang Gang East	Swamp Water Level	Impact	427 / Lineament	Weekly / Monthly
GG2 SM	Gang Gang East	Soil Moisture Monitoring	Impact	427 / Lineament	Monthly
GG3	Gang Gang East	Swamp Water Level	Impact	427 / Lineament	Weekly / Monthly
GG3 SM	Gang Gang East	Soil Moisture Monitoring	Impact	427 / Lineament	Monthly
BS1	Pine	Swamp Water Level	Impact	422	Weekly / Monthly
BS1 SM proposed	Pine	Soil Moisture Monitoring	Impact	422	Monthly
BS2	Pine	Swamp Water Level	Impact	424	Weekly / Monthly
BS2 SM Proposed	Pine	Soil Moisture Monitoring	Impact	424	Monthly
BS3	Pine/ Nine Mile	Swamp Water Level	Impact	424 / Lineament	Weekly / Monthly
BS3 SM proposed	Pine/ Nine Mile	Soil Moisture Monitoring	Impact	424 / Lineament	Monthly
BS4 (PSS) Proposed	Pine	Swamp Water Level	Impact	424	Weekly / Monthly
BS4 (PSS) SM Proposed	Pine	Soil Moisture Monitoring	Impact	424	Monthly



Bore ID	Swamp	Monitoring	Impact / Reference Site	600m Longwall Proximity	Monitoring Frequency
BS5 (NMSS) Proposed	Nine Mile	Swamp Water Level	Impact	422	Weekly / Monthly
BS5 (NMSS) SM Proposed	Nine Mile	Soil Moisture Monitoring	Impact	422	Monthly
PC1	Paddy's Creek	Swamp Water Level	Impact	424 - 426	Weekly / Monthly
PC1 SM Proposed	Paddy's Creek	Soil Moisture Monitoring	Impact	424 - 426	Monthly
PC2	Paddy's Creek	Swamp Water Level	Impact	424 - 426	Weekly / Monthly
PC2 SM Proposed	Paddy's Creek	Soil Moisture Monitoring	Impact	424 - 426	Monthly
MS1	Marrangaroo	Swamp Water Level	Impact	427 / Lineament	Weekly / Monthly
MS1 SM proposed	Marrangaroo	Soil Moisture Monitoring	Impact	427 / Lineament	Monthly
MS2	Marrangaroo	Swamp Water Level	Impact	427 / Lineament	Weekly / Monthly
MS2 SM proposed	Marrangaroo	Soil Moisture Monitoring	Impact	427 / Lineament	Monthly
CC1	Carne Central	Swamp Water Level	Reference	N/A	Monthly
CC1 SM proposed	Carne Central	Soil Moisture Monitoring	Reference	N/A	Monthly
CC2	Carne Central	Swamp Water Level	Reference	N/A	Monthly
CC2 SM proposed	Carne Central	Soil Moisture Monitoring	Reference	N/A	Monthly
BA1	Barrier	Swamp Water Level	Reference	N/A	Monthly
BA1 SM Proposed	Barrier	Soil Moisture Monitoring	Reference	N/A	Monthly
BA2	Barrier	Swamp Water Level	Reference	N/A	Monthly
BA3 SM Proposed	Barrier	Soil Moisture Monitoring	Reference	N/A	Monthly
BA3	Barrier	Swamp Water Level	Reference	N/A	Monthly
BA3 SM Proposed	Barrier	Soil Moisture Monitoring	Reference	N/A	Monthly
TG1	Twin Gully Swamp	Swamp Groundwater Level	Reference	N/A	Monthly



Bore ID	Swamp	Monitoring	Impact / Reference Site	600m Longwall Proximity	Monitoring Frequency
TG1 SM proposed	Twin Gully Swamp	Soil Moisture Monitoring	Reference	N/A	Monthly
TG2	Twin Gully Swamp	Swamp Groundwater Level	Reference	N/A	Monthly
TG2 SM proposed	Twin Gully Swamp	Soil Moisture Monitoring	Reference	N/A	Monthly
TS1	Tristar Swamp	Swamp Water Level	Reference	N/A	Monthly
TS2	Tristar Swamp	Swamp Water Level	Reference	N/A	Monthly
TS2 SM proposed	Tristar Swamp	Soil Moisture Monitoring	Reference	N/A	Monthly
TS3	Tristar Swamp	Swamp Water Level	Reference	N/A	Monthly
TS3 SM proposed	Tristar Swamp	Soil Moisture Monitoring	Reference	N/A	Monthly
FS1	Firetail Swamp	Swamp Water Level	Reference	N/A	Monthly
FS1 SM proposed	Firetail Swamp	Soil Moisture Monitoring	Reference	N/A	Monthly
FS2	Firetail Swamp	Swamp Water Level	Reference	N/A	Monthly
FS2 SM proposed	Firetail Swamp	Soil Moisture Monitoring	Reference	N/A	Monthly
BE1	Best Swamp	Swamp Water Level	Reference	N/A	Monthly
BE1 SM proposed	Best Swamp	Soil Moisture Monitoring	Reference	N/A	Monthly
BE2	Best Swamp	Swamp Water Level	Reference	N/A	Monthly
BE2 SM Proposed	Best Swamp	Soil Moisture Monitoring	Reference	N/A	Monthly
Shallow Groundwater Monitoring Adjacent to Swamps					
SPR1603	Gang Gang East	Shallow Perched Groundwater Monitoring	Impact	427 / Lineament	Monthly
SPR1604	Carne Central	Shallow Perched Groundwater Monitoring	Reference	N/A	Monthly
SPR1605	Nine Mile / Pine	Shallow Perched Groundwater Monitoring	Impact	424 / Lineament	Monthly
SPR1606	Paddy's Creek	Shallow Perched Groundwater Monitoring	Impact	424 - 426	Monthly
SPR1607	Marrangaroo	Shallow Perched Groundwater Monitoring	Impact	427	Monthly
SPR1608	Barrier	Shallow Perched Groundwater Monitoring	Reference	N/A	Monthly