

# **ANNUAL *PERSOONIA HIRSUTA* CONDITION MONITORING REPORT**

Illawarra Metallurgical Coal, 2019 Survey



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## OVERVIEW

Illawarra Coal conducted its seventh round of annual condition monitoring of the *Persoonia hirsuta* population at West Cliff. The monitoring was undertaken in accordance with the approved *P. hirsuta* Offset Management Plan, which complies with EPBC Approval Condition 2. The monitoring was completed by two Niche ecologists over 2 days in November 2019 during the peak flowering period for the species.

## REVIEW OF PREVIOUS SURVEYS

### FloraSearch 2009

A study by FloraSearch (2009) was conducted to quantify the distribution of *P. hirsuta* prior to construction of the Stage 3 Coal Wash Emplacement and indicated a local high density of the species on the broad ridgetop to the north-east of Brennans Creek and low density occurrences on the ridgetops to the north and south of the core population. Beyond these the concentrations were widely scattered isolated individual plants.

At least 88 plants of *P. hirsuta*, or approximately 66% of the total population, were identified by FloraSearch (2009) within the core population. Of the core patch, approximately 20 plants have been lost to the Stage 3 emplacement development and at least seven are within the footprint of Stage 4 emplacement.

### Niche 2012 (Baseline Study)

Niche Environment and Heritage undertook a field survey of the core *P. hirsuta* population in November 2012 to establish a baseline population estimate and distribution of *P. hirsuta* for the Offset Management Plan. Two representatives from Illawarra Coal were also present and assisted with the surveys.

A total of 44 individuals were recorded within the core population area. A single individual was recorded approximately 14 metres to the north of the core population area and it is assumed that it will be impacted by the Stage 4 emplacement. Height and age class were also recorded.

A further nine individuals were recorded within the West Cliff lease area in areas where the species had been previously recorded, seven along Brennans Creek Road to the north and three along the south-west boundary with the Appin Road easement.

The core population was in good condition. The core area had a good level of inherent resilience (capacity to regenerate), a high level of native plant species richness, a low level of exotic plant cover and all structural layers are intact (canopy, mid-storey, shrubs and ground-cover).

The previous southern extension of the core population had been impacted by the construction of an approved haul road, which resulted in an indirect impact through edge effects. However, whilst the increased light levels and altered drainage had locally altered the native vegetation in a narrow, localised strip along this edge, the condition of this vegetation was still good with a low level of exotic cover. Some exotic perennial grasses, such as *Eragrostis curvula* (African lovegrass) and *Chloris gayana* (Rhodes grass) occurred occasionally along the road and track edges within the mine site and exclusion of these exotics from the core *P. hirsuta* population was considered a high priority.

It was estimated that the core *Persoonia* area had not experienced a fire event for up to 24 years. This was evident in the senescing (dead or dying) *Banksia ericifolia*, the low cover of annual herbs, grasses and obligate seeding short-lived shrubs. The fire history map for the study area (Wollondilly Bush Fire Risk Management Plan 2007) supported this, with the last reported fire event mapped around 1989.

### **Spring 2013**

The 2013 survey was undertaken by Illawarra Coal. The total Offset population (Core population) in 2013 was 38 plants. Discounting 5 new plants that were identified during this survey, the Offset area had experienced an overall population decline of 11 plants since baseline (2012). It was concluded that the majority of the *P. hirsuta* plants in the Offset were reaching the end of their natural lifecycle; there appeared to be no recruitment occurring at the time which was likely a natural occurrence as no evidence suggested otherwise.

### **Spring 2014**

The 2014 survey was undertaken by Illawarra Coal. The total Offset population in 2014 was 36 plants. Discounting 8 new plants that had been identified in the Offset since baseline (2012), the Offset area had experienced an overall population decline of 16 plants. Again, there were no visible impacts from dust or apparent disease and it was concluded that the mortality was due to the plants reaching the end of their natural lifecycle.

Three immature plants were identified (estimated age between 1 and 2.5 years). All were situated on cleared easement. Recruitment within the population was limited to previously disturbed areas.

One mature plant was discovered within the Stage Two Emplacement rehabilitation.

### **Spring 2015**

The total count of live plants in the Offset in spring 2015 was 29. Discounting 9 new plants that had been identified in the Offset since baseline (2012), the Offset area had experienced an overall population decline of 24 plants. Although the vegetation remained in good condition, the *P. hirsuta* population in the Offset continued to decline because of the plants reaching senescence and the absence of a germination cue. Any recent recruitment of *P. hirsuta* (3 immature plants in 2014) had been limited to previously disturbed areas (in this case a powerline easement). Other known (healthier) populations at Couridjah and Yanderra, NSW, had a more recent fire history than West Cliff (D. Gregory pers.obs.).

### **Spring 2016**

The total count of live plants within the Offset in 2016 was 11:

- Discounting 9 new plants that had been identified in the Offset since baseline (2012), the Offset area had experienced an overall population decline of 42 plants:
  - 16 of these were burned as part of the approved conservation burn trial in April 2016; and
  - 26 are likely due to age related causes;
- No new plants were identified in the Offset during 2016.

There appeared to be no recruitment occurring during 2016.

### **Spring 2017**

The total count of live plants within the Offset in 2017 was 10:

- 1 new plant was identified in the Offset during 2017.
- All 10 plants were identified post-baseline. Discounting the 10 plants that had been identified in the Offset since baseline (2012), the offset has declined by 44 plants.
  - 28 plants have died likely due to age related causes (since the baseline in 2012);
  - 16 plants were burned as part of the approved conservation burn trial in April 2016;

A seedling was identified within the powerline corridor on Dam Road, indicating recruitment is occurring but limited to previously disturbed areas.

### **Spring 2018**

The total count of live plants within the Offset in 2018 was 10:

- 28 plants have died likely due to age related causes (since the baseline in 2012);
- 16 plants were burned as part of the approved conservation burn trial in April 2016; and
- No new plants were identified in the Offset during 2018.

### **SPRING 2019**

#### **Aim**

To inspect all *P. hirsuta* plants to determine:

1. Survivorship and recruitment:
  - a. Condition;
  - b. Reproductive activity and age to maturity; and
  - c. Any imminent threat or risk to the plants health (e.g. apparent disease, excessive dust deposition).

#### **Methods**

All *P. hirsuta* plants were inspected to record the following attributes:

- Height and width;
- Age class;
- Condition; and
- Comments on any imminent threat or risk to the plants health (e.g. apparent disease, excessive dust deposition).

Height was measured using a tape measure, measuring from the ground surface to the point on the plant, without physically moving any part of the plant. Condition was defined using a combination of factors, including the percent cover of leaves, colour of leaves and the presence or absence of fruit or flowers, rating condition from 0 to 6, or from very poor condition to excellent condition (Appendix A).

Any new individuals were recorded with a Garmin GPS. The plants were also flagged with fluorescent, biodegradable flagging tape.

## Results

### Offset Population

The total count of live plants within the Offset in 2019 was 136 (10 from previous years and 126 planted in 2019):

- one plant has died likely due to age related causes (since the baseline in 2012).
- 128 plants were translocated from the Mount Annan Botanic Gardens and placed adjacent to the offset area.
- One new plant (SH004) was identified in the Offset during 2019, within the demarcated fencing near CF001.

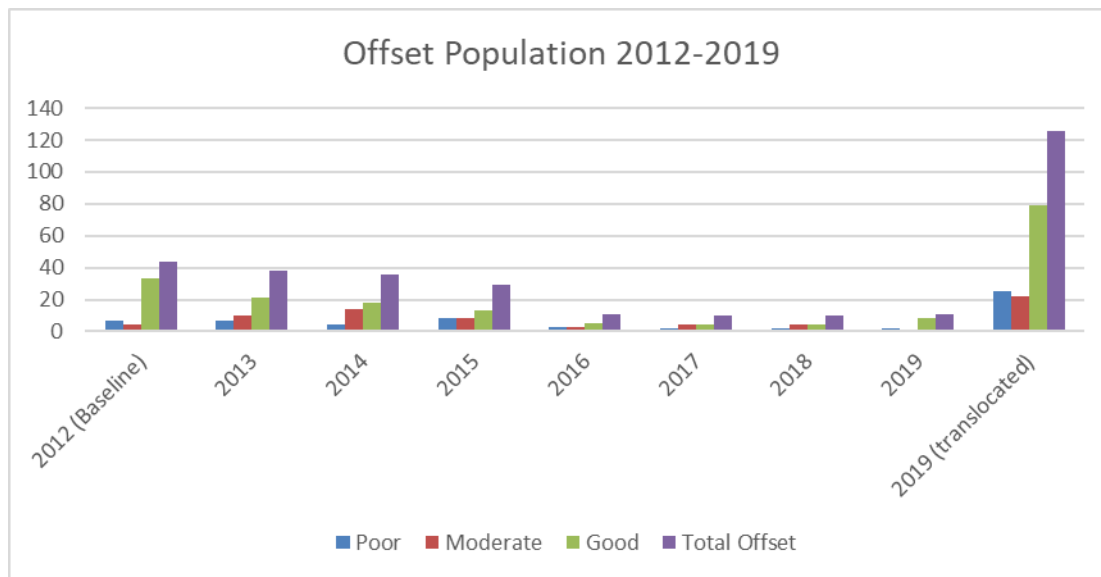


Figure 1: Comparison of *Persoonia hirsuta* condition and population within the Offset across years.

### West Cliff Other Areas

An additional 28 live individuals are being monitored within the surrounding West Cliff lease (see Figure 3), five new individuals were identified within the non-core non-impacted area along the Dam Road, adjacent to previously live skeletons of *P. hirsuta*.

### Translocation Area

A new area of *Persoonia hirsuta* was planted by the Australian Botanical Gardens in 2019. These additional 128 individuals are being monitored within the surrounding West Cliff lease (see Figure 2 and Figure 3), two of these individuals have since died. Please note the tags on the individual plants did not have an individual identification number and results may vary from the botanical gardens labelling system.

### Total Site Count

The total count for live *P. hirsuta* plants at West Cliff in spring 2019 was 175, including plants that have been identified post-baseline (2012) and the additional 128 plants translocated (Figure 2). Excluding these, there has been a decrease of three plants in 2019, two of the translocated individuals and one in the non-impact area.

The results are tabulated in Appendix B.

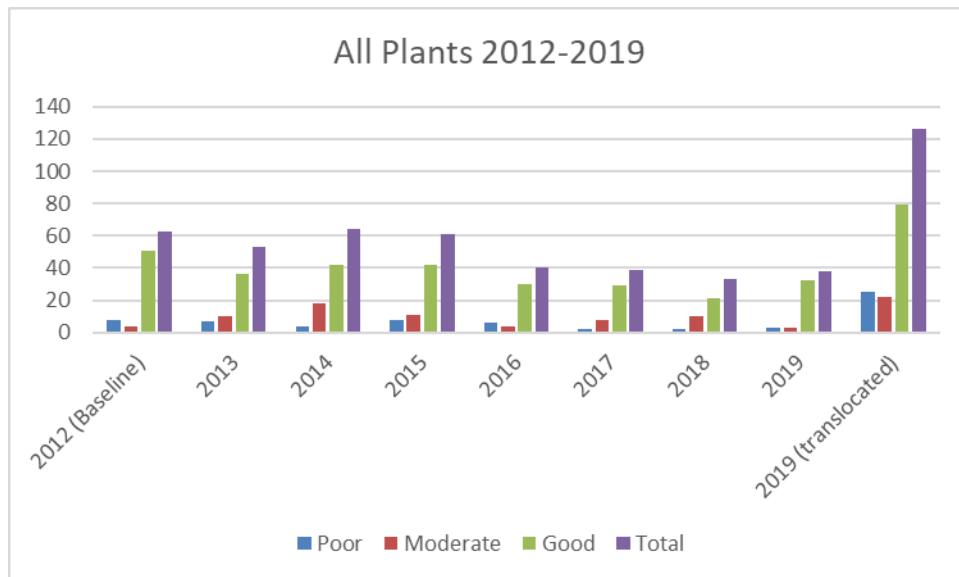


Figure 2: Comparison of condition and population of all plants across years

### Discussion

The overall health of the core population of *P. hirsuta* is good as the plants are producing flowers and fruits in most cases. Flowering and fruiting is more prevalent in plants that are located within dense bush rather than those beneath powerlines or on the roadside.

The vegetation in the Offset and surrounding West Cliff site remains in good condition. The conservation burn area is regenerating well. Illawarra Coal is monitoring the site for emergent seedlings. No recruitment of *P. hirsuta* within the burn trial area has been observed to date.

The two *Personia hirsuta* individuals growing in the coal wash emplacement rehabilitation is considered a significant observation and will contribute to the understanding of the species' capacity for regeneration within the rehabilitation areas.

As per previous years, recruitment is limited to previously disturbed areas (beneath powerlines) or close to a skeleton of a previously known record.

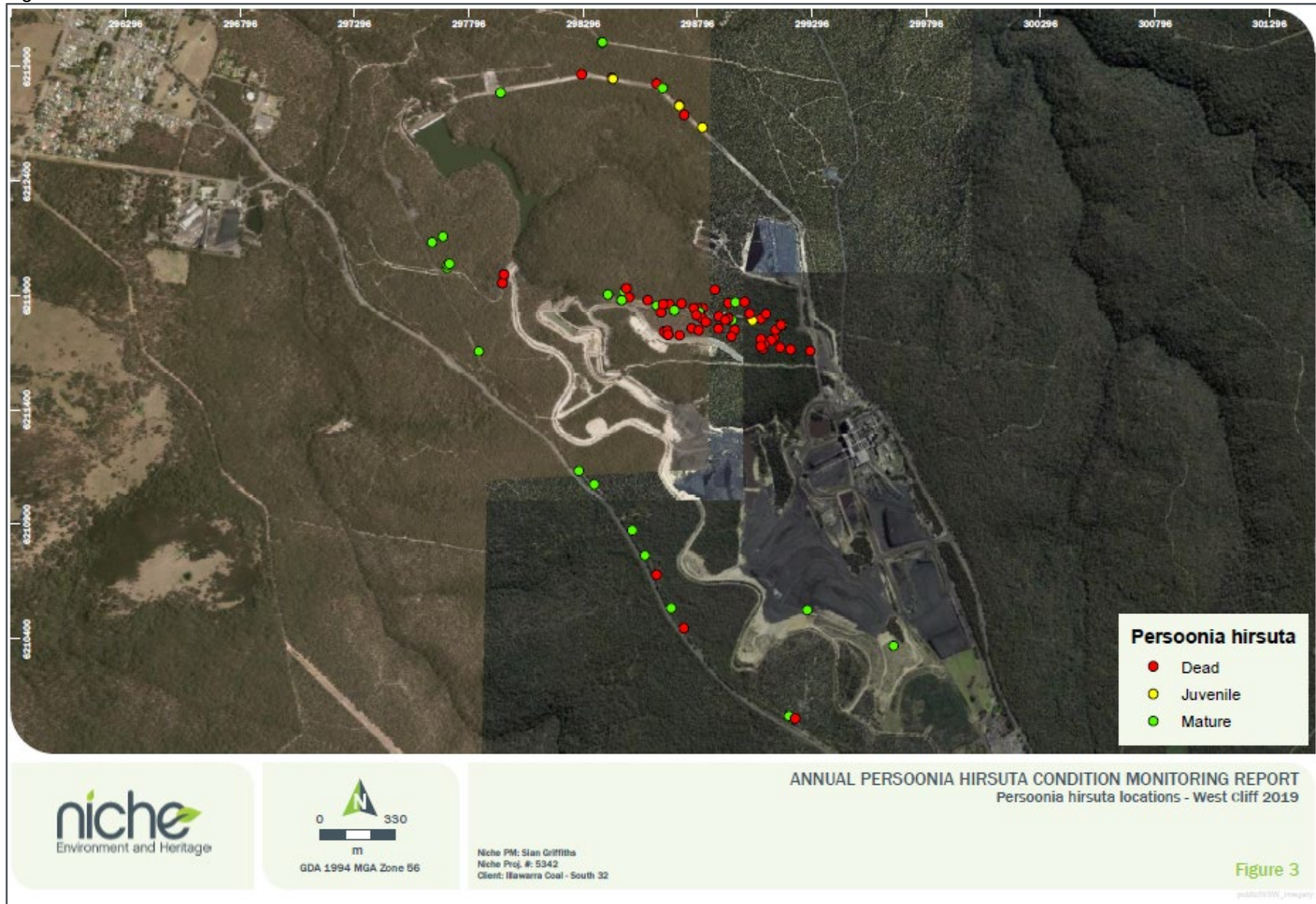
### Ongoing Research and Conservation Management

In accordance with EPBC 2010/5350 Condition 3, Illawarra Coal is undertaking targeted research on *Personia hirsuta* including:

- Habitat and demography;
- Population genetics;
- Seed biology, germination and recruitment and propagation, and
- Pollination.

Refer to Appendix C – *Personia* Research Status and Strategy for more detail.

Figure 3: *P. hirsuta* records.



## REFERENCES

Alison Haynes Honours Thesis (2015). Conservation genetics of the rare and endangered plant, *Persoonia hirsuta* (Proteaceae). University of Wollongong, NSW.

BHPBIC *Persoonia hirsuta* Offset Management Plan

FloraSearch (2009). Illawarra Coal - Bulli Seam Operations Project - Terrestrial Flora Assessment. Illawarra Coal and BHP Billiton, eds. Bulli Seam Operations - Appendix E - Terrestrial Flora Assessment. EPBC Referral 2010/5350. Orange, NSW: FloraSearch.

Stephanie Wilmott Honours Thesis (2013). The Demography and Habitat Characteristics of *Persoonia hirsuta*. University of Wollongong, NSW.



**APPENDIX A: RATING SYSTEM USED TO DETERMINE THE CONDITION OF *P. HIRSUTA* INDIVIDUALS**

<b>Rating</b>	<b>Condition</b>	<b>Determinants</b>
0	Very Poor	0-15% cover of leaves 100% of leaves dull or browning No fruits or flowers
1	Poor	15-30% cover of leaves >75% of leaves dull or browning No fruits or flowers
2	Fairly Poor	30-45% cover of leaves >50% of leaves dull or browning No fruit or flowers
3	Moderate	45-60% cover of leaves 50% of leaves dull or browning Some fruits or flowers
4	Good	60-75% cover of leaves <50% leaves dull or browning Presence of fruits or flowers
5	Very good	75-90% cover of leaves <25% of leaves dull or browning Presences of fruits or flowers
6	Excellent	90-100% cover of leaves 0% leaves dull or browning Presence of fruits or flowers

## APPENDIX B: RECORDS FROM 2019

Area	2019 Label	Label	Height (mm)	Width (mm)	Age Class	Condition	E	N
Emplacement Rehab	-	DG023	250	700	Mature	Moderate	299655	6210366
Emplacement Rehab	-	DG033	400	700	Mature	Very Good	299277	6210523
Non-core non-impacted	-	ns027			Dead	Dead	298819	6212634
Non-core non-impacted	-	ns028			Dead	Dead	298718	6212726
Non-core non-impacted	-	ns029			Dead	Dead	298619	6212825
Non-core non-impacted	-	ns030			Dead	Dead	298290	6212866
Non-core non-impacted	-	ns031	600	800	Mature	Moderate	297935	6212786
Non-core non-impacted	-	ns033	400	900	Mature	Very Good	298682	6210531
Non-core non-impacted	-	ns034	500	1500	Mature	Excellent	299213	6210048
Non-core non-impacted	-	ns035			Dead	Dead	298619	6210678
Non-core non-impacted	-	cm021	400	1500	Senescent	Dead	298740	6212688
Non-core non-impacted	-	DG003	1000	1300	Mature	Very Good	297701	6212019
Non-core non-impacted	-	DG004	600	1400	Mature	Very Good	297704	6212032
Non-core non-impacted	-	DG005	700	700	Mature	Very Good	298346	6211073
Non-core non-impacted	-	DG006	500	1100	Mature	Very Good	298511	6210872
Non-core non-impacted	-	DG007	700	1800	Mature	Excellent	298568	6210760
Non-core non-impacted	-	PM001	400	800	Mature	Excellent	299196	6210059
Non-core non-impacted	-	DG013	450	950	Mature	Excellent	297712	6212037
Non-core non-impacted	-	DG014			Dead	Dead	297943	6211952
Non-core non-impacted	-	DG015	600	1600	Mature	Excellent	297684	6212156
Non-core non-impacted	-	DG017			Dead	Dead	297944	6211953
Non-core non-impacted	-	DG008	750	1000	Mature	Very Good	298644	6212804
Non-core non-impacted	-	DG018	1100	1300	Mature	Very Good	298381	6213005
Non-core non-impacted	-	DG019	600	700	Mature	Very Good	298379	6213004
Non-core non-impacted	-	DG020	800	1300	Mature	Very Good	298377	6213006
Non-core non-impacted	-	DG021	600	1400	Mature	Very Good	298382	6213005
Non-core non-impacted	-	DG022	800	700	Mature	Very Poor	297842	6211654
Non-core non-impacted	-	DG024			Dead	Dead	298422	6212851
Non-core non-impacted	-	JC001			Dead	Dead	297951	6211989
Non-core non-impacted	-	JC002	850	1700	Mature	Excellent	297637	6212132
Non-core non-impacted	-	DG027			Dead	Dead	299223	6210048
Non-core non-impacted	-	SG001	300	200	Mature	Excellent	298278	6211131
Non-core non-impacted	-	DG028			Dead		298718	6212731
Non-core non-impacted	-	DG029			Dead	Dead	298721	6212729
Non-core non-impacted	-	ER001/DG012	520	1000	Mature	Excellent	298717	6212727
Non-core non-impacted	-	DG031			Dead	Dead	298719	6212730
Non-core non-impacted	-	DG032					298738	6210444
Offset	-	DG025	700	600	Mature	Good	298475	6211914
Offset	-	ns001			Dead	Dead	299291	6211655
Offset	-	ns002			Dead	Dead	299134	6211714
Offset	-	ns003			Dead	Dead	299073	6211686
Offset	-	ns004			Dead	Dead	299095	6211692
Offset	-	ns005			Dead	Dead	299083	6211666
Offset	-	ns006	700	800	Mature	Fairly Poor	298950	6211791
Offset	-	ns007			Dead	Dead	298960	6211747

Area	2019 Label	Label	Height (mm)	Width (mm)	Age Class	Condition	E	N
Offset	-	ns008			Dead	Dead	298946	6211718
Offset	-	ns009			Dead	Dead	298888	6211752
Offset	-	ns010			Dead	Dead	298772	6211754
Offset	-	ns011			Dead	Dead	298663	6211731
Offset	-	ns012			Dead	Dead	298651	6211741
Offset	-	ns013			Dead	Dead	298664	6211744
Offset	-	ns014	400	800	Mature	Moderate	298619	6211853
Offset	-	ns015			Dead	Dead	298579	6211877
Offset	-	ns017			Dead	Dead	299074	6211798
Offset	-	ns018			Dead	Dead	298820	6211843
Offset	-	ns019			Senescent	Dead	298798	6211844
Offset	-	ns020			Dead	Dead	298673	6211861
Offset	-	ns021	700	1000	Mature	Good	298806	6211827
Offset	-	ns022	800	1100	Mature	Good	298807	6211825
Offset	-	ns024			Dead	Dead	298815	6211801
Offset	-	ns025	700	1300	Mature	Very Good	298695	6211834
Offset	-	ns026			Dead	Dead	298931	6211797
Offset	-	cm001			Dead	Dead	299119	6211704
Offset	-	cm002	300	100	Juvenile	Poor	299037	6211788
Offset	-	cm003			Dead	Dead	298933	6211799
Offset	-	cm004			Dead	Dead	298889	6211807
Offset	-	cm005			Dead	Dead	298833	6211781
Offset	-	cm006			Dead	Dead	298669	6211727
Offset	-	cm007			Dead	Dead	298638	6211825
Offset	-	cm008			Mature	Dead	298405	6211903
Offset	-	cm009			Dead	Dead	298485	6211930
Offset	-	cm010			Dead	Dead	298933	6211865
Offset	-	cm011	550	800	mature	Good	298963	6211868
Offset	-	cm012			Dead	Dead	299003	6211871
Offset	-	cm013			Dead	Dead	299025	6211820
Offset	-	cm014			Dead	Dead	299098	6211818
Offset	-	cm015			Dead	Dead	298781	6211844
Offset	-	cm016			Dead	Dead	298728	6211863
Offset	-	cm017			Dead	Dead	299138	6211748
Offset	-	cm018			Dead	Dead	298719	6211724
Offset	-	cm019			Dead	Dead	298792	6211812
Offset	-	cm020			Dead	Dead	298918	6211790
Offset	-	DG001			Dead	Dead	299089	6211685
Offset	-	DG002			Dead	Dead	298802	6211746
Offset	-	AH001			Dead	Dead	299074	6211709
Offset	-	AW001			Dead	Dead	299204	6211662
Offset	-	AW002			Dead	Dead	299159	6211671
Offset	-	DG009			Dead	Dead	298646	6211861
Offset	-	DG010			Senescent	Dead	298498	6211889
Offset	-	DG011	750	600	Mature	Excellent	298406	6211903
Offset	-	CB004			Dead	Dead	299074	6211676
Offset	-	CF001	600	1300	Mature	Excellent	298466	6211878
Stage 4	-	ns016			Dead	Dead	298873	6211924
Non-core non-impacted	-	SH001	250	80	Juvenile	Excellent	298819	6212634
Non-core non-impacted	-	SH002	100	100	Juvenile	Excellent	298717	6212727

Area	2019 Label	Label	Height (mm)	Width (mm)	Age Class	Condition	E	N
Non-core non-impacted	-	SH003	100	10	Juvenile	Excellent	298427	6212845
Non-core non-impacted	-	YN001	150	100	Juvenile	Excellent	298427	6212845
Non-core non-impacted	-	YN002	50	10	Juvenile	Excellent	298427	6212845
Offset	-	SH004	200	500	Mature	Excellent	298466	6211878
Translocated	PB001	A2018-0172/7-3	80	90	Juvenile	Good	299162	6211770
Translocated	PB002	P2017-1049/1-55	320	100	Juvenile	Very Good	299162	6211770
Translocated	PB003	P2017-2068/2-31	280	100	Juvenile	Very Good	299162	6211770
Translocated	PB004	A2018-0172/7-106	20	100	Juvenile	Good	299162	6211770
Translocated	PB005	P2017-2068/2-34	50	60	Juvenile	Very Good	299162	6211770
Translocated	PB006	P2017-1049/1-48	190	120	Juvenile	Fairly Poor	299162	6211770
Translocated	PB007	P2017-1049/1-11	380	150	Juvenile	Very Good	299162	6211770
Translocated	PB008	A2018-0172/7-12	100	30	Juvenile	Good	299162	6211770
Translocated	PB009	P2017-2068/2-63	120	120	Juvenile	Good	299162	6211770
Translocated	PB010	A2018-0172/7-35	120	40	Juvenile	Good	299162	6211770
Translocated	PB011	P2017-2068/2-28	100	35	Juvenile	Fairly Poor	299162	6211770
Translocated	PB012	A2018-0172/7-36	110	50	Juvenile	Very Good	299162	6211770
Translocated	PB013	A2018-0172/7-33	60	80	Juvenile	Fairly Poor	299162	6211770
Translocated	PB014	A2018-0172/7-27	150	130	Juvenile	Very good	299162	6211770
Translocated	PB015	P2017-2068/2-75	200	120	Juvenile	Good	299162	6211770
Translocated	PB016	A2018-0172/7-2	220	130	Juvenile	Very Good	299162	6211770
Translocated	PB017	A2018-0172/7-10	115	115	Juvenile	Very Good	299162	6211770
Translocated	PB018	A2018-0172/7-1	100	60	Juvenile	Very Good	299162	6211770
Translocated	PB019	P2017-2068/2-102	230	100	Juvenile	Very Good	299162	6211770
Translocated	PB020	P2017-1049/1-23	200	80	Juvenile	Fairly Poor	299162	6211770
Translocated	PB021	A2018-0172/7-50	110	110	Juvenile	Good	299162	6211770
Translocated	PB022	P2017-1049/1-20	230	150	Juvenile	Very Good	299162	6211770
Translocated	PB023	A2018-0172/7-64	100	100	Juvenile	Very Good	299162	6211770
Translocated	PB024	NOTAG-62	110	70	Juvenile	Very Good	299162	6211770
Translocated	PB025	P2017-1049/1-1	370	200	Juvenile	Very Good	299162	6211770
Translocated	PB026	A2018-0172/7-61	100	120	Juvenile	Very Good	299162	6211770
Translocated	PB027	P2017-1049/1-14	260	110	Juvenile	Very Good	299162	6211770
Translocated	PB028	A2018-0172/7-45	40	10	Juvenile	Very Poor	299162	6211770
Translocated	PB029	A2018-0172/7-32	15	30	Juvenile	Fairly Poor	299162	6211770
Translocated	PB030	P2017-1049/1-87	300	185	Juvenile	Moderate	299162	6211770
Translocated	PB031	P2017-1049/1-63	300	120	Juvenile	Good	299162	6211770
Translocated	PB032	A2018-0172/7-74	70	25	Juvenile	Fairly Poor	299162	6211770
Translocated	PB033	P2017-1049/1-4	120	50	Juvenile	Moderate	299162	6211770
Translocated	PB034	A2018-0172/7-76	110	120	Juvenile	Good	299162	6211770
Translocated	PB035	A2018-0172/7-30	110	120	Juvenile	Very Good	299162	6211770
Translocated	PB036	A2018-0172/7-29	70	30	Juvenile	Moderate	299162	6211770
Translocated	PB037	P2017-2068/2-35	130	100	Juvenile	Good	299162	6211770
Translocated	PB038	P2017-1049/1-44	350	180	Juvenile	Very Good	299162	6211770
Translocated	PB039	P2017-2068/2-2	340	130	Juvenile	Very Good	299162	6211770
Translocated	PB040	A2018-0172/7-26	100	20	Juvenile	Fairly Poor	299162	6211770
Translocated	PB041	P2017-2068/2-58	230	270	Juvenile	Good	299162	6211770
Translocated	PB042	A2018-0172/7-30	70	50	Juvenile	Good	299162	6211770
Translocated	PB043	A2018-0172/7-40	20	20	Juvenile	Fairly Poor	299162	6211770
Translocated	PB044	P2017-2068/2-44	260	70	Juvenile	Moderate	299162	6211770
Translocated	PB045	P2017-1049/1-105	270	150	Juvenile	Good	299162	6211770
Translocated	PB046	P2017-1049/1-18	160	110	Juvenile	Good	299162	6211770

Area	2019 Label	Label	Height (mm)	Width (mm)	Age Class	Condition	E	N
Translocated	PB047	A2018-0172/7-52	100	70	Juvenile	Good	299162	6211770
Translocated	PB048	P2017-2068/2-5	500	230	Juvenile	Very Good	299162	6211770
Translocated	PB049	A2018-0172/7-65	160	170	Juvenile	Very Good	299162	6211770
Translocated	PB050	A2018-0172/7-7	160	50	Juvenile	Moderate	299162	6211770
Translocated	PB051	P2017-2068/2-24	140	150	Juvenile	Moderate	299162	6211770
Translocated	PB052	P2017-1049/1-41	430	260	Juvenile	Very Good	299162	6211770
Translocated	PB053	P2017-1049/1-16	250	130	Juvenile	Very Good	299162	6211770
Translocated	PB054	A2018-0172/7-50	50	120	Juvenile	Very Good	299162	6211770
Translocated	PB055	A2018-0172/7-56	150	50	Juvenile	Very Good	299162	6211770
Translocated	PB056	P2017-1049/1-57	250	30	Juvenile	Moderate	299162	6211770
Translocated	PB057	A2018-0172/7-3	110	50	Juvenile	Moderate	299162	6211770
Translocated	PB058	A2018-0172/7-60	100	70	Juvenile	Good	299162	6211770
Translocated	PB059	P2017-2068/2-39	270	150	Juvenile	Good	299162	6211770
Translocated	PB060	A2018-0172/7-40	120	80	Juvenile	Very Good	299162	6211770
Translocated	PB061	P2017-2068/2-22	250	150	Juvenile	Very Good	299162	6211770
Translocated	PB062	A2018-0172/7-42	120	120	Juvenile	Fairly Poor	299162	6211770
Translocated	PB063	P2017-2068/2-6	220	200	Juvenile	Very Good	299162	6211770
Translocated	PB064	A2018-0172/7-61	110	90	Juvenile	Fairly Poor	299162	6211770
Translocated	PB065	A2018-0172/7-9	100	50	Juvenile	Good	299162	6211770
Translocated	PB066	P2017-2068/2-11	200	140	Juvenile	Very Good	299162	6211770
Translocated	PB067	P2017-1049/1-115	170	10	Juvenile	Very Poor	299162	6211770
Translocated	PB068	A2018-0172/7-121	110	20	Juvenile	Moderate	299162	6211770
Translocated	PB069	P2017-2068/2-48	230	140	Juvenile	Good	299162	6211770
Translocated	PB070	A2018-0172/7-32	150	60	Juvenile	Good	299162	6211770
Translocated	PB071	A2018-0172/7-51	210	90	Juvenile	Good	299162	6211770
Translocated	PB072	P2017-1049/1-59	200	120	Juvenile	Moderate	299162	6211770
Translocated	PB073	P2017-1049/1-24	210	150	Juvenile	Good	299162	6211770
Translocated	PB074	P2017-1049/1-38	200	50	Juvenile	Moderate	299162	6211770
Translocated	PB075	P2017-1049/1-4	380	160	Juvenile	Very Good	299162	6211770
Translocated	PB076	P2017-2068/2-21	250	170	Juvenile	Moderate	299162	6211770
Translocated	PB077	A2018-0172/7-108	150	5	Juvenile	Very Poor	299162	6211770
Translocated	PB078	P2017-1049/1-23			Dead	Dead	299162	6211770
Translocated	PB079	A2018-0172/7-71	70	70	Juvenile	Fairly Poor	299162	6211770
Translocated	PB080	A2018-0172/7-20	70	60	Juvenile	Fairly Poor	299162	6211770
Translocated	PB081	P2017-1049/1-14	220	150	Juvenile	Good	299162	6211770
Translocated	PB082	A2018-0172/7-85	110	50	Juvenile	Fairly Poor	299162	6211770
Translocated	PB083	P2017-2068/2-25	100	40	Juvenile	Moderate	299162	6211770
Translocated	PB084	A2018-0172/7-118	110	50	Juvenile	Moderate	299162	6211770
Translocated	PB085	A2018-0172/7-38	100	100	Juvenile	Very Poor	299162	6211770
Translocated	PB086	P2017-1049/1-43	350	200	Juvenile	Very Good	299162	6211770
Translocated	PB087	P2017-2068/2-102	150	150	Juvenile	Moderate	299162	6211770
Translocated	PB088	A2018-0172/7-34	150	70	Juvenile	Good	299162	6211770
Translocated	PB089	NO TAG -52	100	50	Juvenile	Very Poor	299162	6211770
Translocated	PB090	P2017-2068/2-55	220	100	Juvenile	Moderate	299162	6211770
Translocated	PB091	A2018-0172/7-29	200	130	Juvenile	Good	299162	6211770
Translocated	PB092	A2018-0172/7-49	100	80	Juvenile	Good	299162	6211770
Translocated	PB093	A2018-0172/7-17	200	35	Juvenile	Good	299162	6211770
Translocated	PB094	P2017-2068/2-26	110	100	Juvenile	Very Poor	299162	6211770
Translocated	PB095	P2017-2068/2-111	110	130	Juvenile	Good	299162	6211770
Translocated	PB096	A2018-0172/7-103	30	10	Juvenile	Very Poor	299162	6211770

Area	2019 Label	Label	Height (mm)	Width (mm)	Age Class	Condition	E	N
Translocated	PB097	P2017-2068/2-15	100	20	Juvenile	Poor	299162	6211770
Translocated	PB098	P2017-2068/2-114	150	100	Juvenile	Good	299162	6211770
Translocated	PB099	A2018-0172/7-112	40	30	Juvenile	Moderate	299162	6211770
Translocated	PB100	A2018-0172/7-18	120	50	Juvenile	Moderate	299162	6211770
Translocated	PB101	P2017-2068/2-41	130	70	Juvenile	Good	299162	6211770
Translocated	PB102	P2017-1049/1-31	180	100	Juvenile	Good	299162	6211770
Translocated	PB103	P2017-2068/2-13	60	40	Juvenile	Moderate	299162	6211770
Translocated	PB104	P2017-1049/1-33	220	150	Juvenile	Fairly Poor	299162	6211770
Translocated	PB105	A2018-0172/7-7	100	120	Juvenile	Very Good	299162	6211770
Translocated	PB106	A2018-0172/7-54	70	30	Juvenile	Moderate	299162	6211770
Translocated	PB107	P2017-2068/2-36	50	20	Juvenile	Good	299162	6211770
Translocated	PB108	P2017-2068/2-27	110	40	Juvenile	Good	299162	6211770
Translocated	PB109	P2017-2068/2-119	210	110	Juvenile	Good	299162	6211770
Translocated	PB110	P2017-2068/2-117	220	100	Juvenile	Good	299162	6211770
Translocated	PB111	A2018-0172/7-64	120	100	Juvenile	Good	299162	6211770
Translocated	PB112	P2017-1049/1-16	110	40	Juvenile	Moderate	299162	6211770
Translocated	PB113	A2018-0172/7-82	100	100	Juvenile	Good	299162	6211770
Translocated	PB114	A2018-0172/7-13	150	60	Juvenile	Good	299162	6211770
Translocated	PB115	A2018-0172/7-21	100	50	Juvenile	Good	299162	6211770
Translocated	PB116	A2018-0172/7-8	100	50	Juvenile	Good	299162	6211770
Translocated	PB117	A2018-0172/7-37	200	110	Juvenile	Good	299162	6211770
Translocated	PB118	A2018-0172/7-46	150	100	Juvenile	Good	299162	6211770
Translocated	PB119	A2018-0172/7-53	100	20	Juvenile	Very Poor	299162	6211770
Translocated	PB120	A2018-0172/7-42	150	30	Juvenile	Fairly Poor	299162	6211770
Translocated	PB121	P2017-1049/1-47	210	150	Juvenile	Very Good	299162	6211770
Translocated	PB122	P2017-1049/1-9	350	200	Juvenile	Very Good	299162	6211770
Translocated	PB123	P2017-1049/1-6	250	200	Juvenile	Very Good	299162	6211770
Translocated	PB124	A2018-0172/7-5	80	50	Juvenile	Moderate	299162	6211770
Translocated	PB125	P2017-2068/2-19	150	100	Juvenile	Good	299162	6211770
Translocated	PB126	A2018-0172/7-107	100	10	Juvenile	Poor	299162	6211770
Translocated	PB127	P2017-1049/1-12	200	200	Juvenile	Good	299162	6211770
Translocated	PB128	NOTAGE-78			Dead	Dead	299162	6211770

## APPENDIX C: PERSOONIA HIRSUTA RESEARCH STRATEGY AND STATUS

### EPBC Approval (2010/5350) Condition 3 – South32 Illawarra Coal Persoonia Research Status Update and Strategy

Prepared by: David Gregory – IC Land and Biodiversity Specialist

Review Date: 19<sup>nd</sup> Dec 2019

Condition Requirement	Status
3. The person taking action must engage a suitably qualified expert to undertake and make public ally available targeted research to inform conservation knowledge of Persoonia hirsuta. The research must:	<p>The ‘targeted research’ is being undertaken by both the University of Wollongong and Royal Botanic Gardens and Domain Trust. The following research has been completed by University of Wollongong to date:</p> <ol style="list-style-type: none"><li>1. Honours project #1 titled The Demography and Habitat Characteristics of the Endangered Persoonia hirsuta (submitted 2013)</li><li>2. Honours project #2 titled Conservation genetics of the rare and endangered plant, Persoonia hirsuta (proteaceae) (submitted 2015)</li><li>3. Honours Project #3 (Continuation of #2) titled Can the seed bank act as a reservoir of genetic diversity? A Conservation genetic study of Persoonia hirsute</li></ol> <p>UOW will publish the outcomes from this work. We expect the final paper/s to be available in 2020.</p> <p>The research conducted by the Royal Botanic Gardens and Domain Trust (PlantBank) is being done in 3 phases (with the addition of some side projects):</p> <ol style="list-style-type: none"><li>1. Catelotti, K.A. &amp; Offord, C.A. (2017). <i>Managing and conserving native plant species in the mining environment - seed germination biology and alternative ex situ storage of Persoonia germplasm for restoration</i>. (ACARP 24013) (2017). Project complete.</li><li>2. Emery, N. &amp; Offord, C. (2019). <i>The inclusion of high interest native plants in mine site restoration programs: propagation, translocation and field re-introduction</i>. (ACARP 24013). Project complete; and</li><li>3. ACARP 2413 – Same title and extension of above. The current ACARP project C24013 at the Australian PlantBank has made significant progress addressing these issues by unravelling the mechanisms that control seed dormancy and germination of several rare Persoonia species. Notably, this work has most recently resulted in significant breakthrough with the first successful production of P. hirsuta nursery stock grown from seed. Furthermore, preliminary protocols for vegetative propagation of these species ex situ have also been developed, resulting in the production of nursery stock available for the first experimental reintroduction of P. hindii. The proposed project extension seeks to improve the conservation capacity for this genus in the mining industry by conducting subsequent experimental plantings of P. hindii on a mining lease. Furthermore, with the renewed capacity to produce P. hirsuta plant stock, a project extension will enable the first field reintroductions of this species to be included in the project. Therefore, a three-year work program is proposed comprising extension of experimental translocations in time and number of species with enough time to conduct appropriate monitoring schedules, concurrent with experimental research into the underlying ecological and biological constraints regarding propagating these recalcitrant and high interest native species for rehabilitation purposes. This innovative program will ensure these high interest species can be included and managed in</li></ol>

Condition Requirement

Status

revegetation for effective mine site rehabilitation and closure or as rescue populations to enhance the biodiversity value of offset sites.

Mt Annan PlantBank Side projects

1. PhD (Collaboration with Royal Botanic Gardens and Western Sydney University) titled *Addressing Drivers of Dieback in an Endangered Shrub Species, Persoonia hirsuta (Hairy Geebung)*.  
The aim of this project is to assess environmental factors that may be linked to dieback, particularly those related to beneficial and detrimental microbes and to plant nutrition. These factors will be assessed in field and glasshouse experiments and using state-of-the-art laboratory techniques. This project will commence mid-2018 and run for the next 3 years. Currently completing a landscape study to address the following questions:
  - Does *P. hirsuta* associate with a unique set of microbes and fungi?
  - Are there distinct localized biotic and abiotic soil properties where *P. hirsuta* occurs?
  - Can we explain the distribution and abundance of *P. hirsuta* by a set of predictive variables?
  - Are there differences in soil characteristics and community composition for healthy *P. hirsuta* individuals compared to those experiencing dieback?
2. Genetics  
To facilitate an improved conservation program for *Persoonia hirsuta* with an SOS Threatened Species conservation focus, the following questions are proposed for this study:
  1. Do *P. hirsuta* subsp. *hirsuta* and *P. hirsuta* subsp. *evoluta* merit a taxonomic level of distinction, and if so, should they be considered as a subspecies or species? Is this classification informative about the genetic diversity of this species?
  - 2) How related is the population at Yengo National Park with the *P. hirsuta* populations?
  - 3) What is the genetic diversity within each *P. hirsuta* population?
  - 4) Is there evidence of gene flow between the subspecies of *P. hirsuta* and/or species sympatric with *P. hirsuta*?
  - 5) How much diversity do the ex-situ collection and the existing offset site capture relative to the diversity present in the source populations and across all populations?
  - 6) Do seedlings of *P. hirsuta* bear similar genetic signatures of parents or that of sympatric species (i.e. is there evidence of hybridisation?)?
  - 7) Which individuals should be selected for future translocation events to maximize genetic diversity?

- a. Document current understanding of *Persoonia hirsuta* ecology and genetics;

UOW honours project #1 - Thesis titled *The demography and Habitat Characteristics of the Endangered Persoonia hirsuta* by Stephanie Wilmott. Project was completed in October 2013. The study investigated the following:

- Current distribution and abundance
- Soil stored seed bank – to determine if seed is dispersed or retained directly under the plant; and
- Habitat requirements – Indicator species, soil particle size/composition and elevation

Current understanding of genetics was summarised in the Conservation Genetics Projects (UOW project #2 & #3) which is summarised in Condition (5) below. UOW will publish the outcomes of these works in a paper in 2020. See also the work highlighted above by PlantBank (Side Project #2).

- b. Outline previously documented management and conservation actions;

This will be outlined in the final report when published.



Condition Requirement	Status
c. Investigate: i. Pollination biology	Royal Botanic Gardens have commenced pollinator observations on <i>P. hirsuta</i> . This work will form part of the ACARP research mentioned above.
ii. Requirements of its pollinators	As above.
iii. Soil seed bank dynamics and the role of various disturbances (including fire) in germination and recruitment;	<p>Soil seed bank was investigated as part of project #1 as mentioned above. This study found that all of the sites where <i>P. hirsuta</i> populations were present were found to have high levels of disturbance. The type of disturbance and the level of disturbance <i>P. hirsuta</i> can tolerate, and perhaps benefit from, was not tested experimentally. The RBG ACARP project will attempt to develop a robust and informative experimental framework for examining germination cues for <i>Persoonia</i> species seed, including temperature, chemical, physical and temporal treatments. Soil stored seed was also a topic of investigation in the UOW project #3.</p> <p>The University of Wollongong was engaged by Illawarra Coal to investigate post-fire seedling emergence patterns at a site consisting of approximately 8000 m<sup>2</sup> of dry sclerophyll forest at Yanderra, on the edge of the Southern Highlands, NSW. The site was burned in a wildfire in late October 2013. This study was the first to record the spatial and temporal pattern of post-fire seedling emergence in <i>P. hirsuta</i> and found that of 16 burned skeletons, the seed banks immediately below 10 of them produced a flush of seedlings mostly seven months after the fire (Alison Haynes Thesis 2015). The results were published in the UOW project #2 (Conservation Genetics).</p> <p>Illawarra Coal conducted an ecological burn within the West Cliff <i>Persoonia</i> Offset in April 2016. The aim of the burn was to promote germination of <i>P. hirsuta</i> and increase the density of the species within the area. IC prepared a Burn Plan and designed a post-fire monitoring program and is currently monitoring for seedlings. None have been found to date.</p>
iv. Phenology and seasonal growth of <i>Persoonia hirsuta</i>	<p>Illawarra Coal is conducting annual population and condition surveys at West Cliff. These surveys examine the growth, health and survival of the plants growing within the Offset area at West Cliff. An annual report is provided to DOE each year in accordance with EPBC 2010/5350 Condition (h).</p> <p>In addition, The ACARP research mentioned above culminated in the first translocation trial on a mining lease for <i>P. hirsuta</i>. Post-translocation monitoring includes examination of growth and mortality.</p>
v. Population genetic structure, levels of genetic diversity, minimum viable population size and management actions	<p>UOW honours project #2 - titled <i>Conservation Genetics of the Rare and Endangered Persoonia hirsuta (Proteaceae)</i>. Project was completed July 2015 and investigated the following:</p> <ul style="list-style-type: none"> <li>• Developing and optimising a set of species-specific microsatellite primers suitable for fine scale population genetic analysis in this study, and in later studies of paternity analyses.</li> <li>• Using microsatellite data from adult plants to estimate patterns of allelic and genotypic diversity, fine and coarse scale genetic differentiation and mating systems; and</li> <li>• Investigating the species' demographic response to fire by taking advantage of a wildfire in October 2013 that burned one of the adult stands, providing the opportunity to document spatial and temporal patterns of seedling emergence and growth.</li> </ul> <p>Further research in this area continued under Honours project # 3 – Completed Nov 16.</p> <p>There were five major aims of this project:</p>

Condition Requirement	Status
	<ul style="list-style-type: none"> <li>• Extract and amplify DNA of a reliable and workable quality from <i>Persoonia hirsuta</i> seed material using PCR.</li> <li>• Select and optimise markers based on quality, repeatability and variability.</li> <li>• Use material from each of two populations to genotype seed from canopy and soil stored seed bank to: <ul style="list-style-type: none"> <li>○ Verify that seed genotypes were reflective of the embryo, whilst not containing maternal DNA</li> <li>○ Compile a representative sample of the seed bank</li> </ul> </li> <li>• Infer patterns of mating using paternity analyses, estimation of pollen dispersal distances and variation in male reproductive success across time. Calculate single and multilocus outcrossing rates.</li> <li>• Compare levels and partitioning of genetic diversity within the adult and seed bank populations.</li> </ul> <p>In addition, see PlantBank Side Project #2 mentioned above.</p>
<p>vi. Impact of dieback disease and control techniques on <i>Persoonia hirsuta</i> and its habitat; and</p>	<p>PhD (Collaboration with Royal Botanic Gardens and Western Sydney University) titled <i>Addressing Drivers of Dieback in an Endangered Tree Species, Persoonia hirsuta (Hairy Geebung)</i>.</p> <p>The aim of this project is to assess environmental factors that may be linked to dieback, particularly those related to beneficial and detrimental microbes and to plant nutrition. These factors will be assessed in field and glasshouse experiments and using state-of-the-art laboratory techniques. This project will commence mid-2018 and run for the next 3 years.</p> <p>Currently completing a landscape study to address the following questions:</p> <ol style="list-style-type: none"> <li>1. Does <i>P. hirsuta</i> associate with a unique set of microbes and fungi?</li> <li>2. Are there distinct localized biotic and abiotic soil properties where <i>P. hirsuta</i> occurs?</li> <li>3. Can we explain the distribution and abundance of <i>P. hirsuta</i> by a set of predictive variables?</li> <li>4. Are there differences in soil characteristics and community composition for healthy <i>P. hirsuta</i> individuals compared to those experiencing dieback?</li> </ol>
<p>vii. Impact of fire on <i>Persoonia hirsuta</i> and its habitat</p>	<p>As mentioned above, <i>UOW Conservation Genetics...</i> (Project #2) thesis Investigated the species' demographic response to fire by taking advantage of a wildfire in October 2013 that burned one of the adult stands, providing the opportunity to document spatial and temporal patterns of seedling emergence and growth. IC has conducted an ecological burn within the Offset in 2016 and is monitoring to measure the plants' response to fire at West Cliff.</p>

Key Milestones	Target Completion Date	Status
1. Demography and Habitat Project Completed	Nov 2013	Completed Nov 2013
2. Conservation Genetics Project Completed	June 2015	Honours Thesis completed June 15, UOW currently publishing this work.
3. Mating Systems Project Complete	Oct 2016	Completed Oct 2016
4. Annual population monitoring Completed	Dec 13, 14, 15, 16, 17, 18 & 19	Dec 13, 14, 15, 16, 17, 18 & 19 completed
5. Mt Annan Propagation Trials using cuttings completed	Trial 1 WC cuttings collected by – June 2014 Trial 2 (Couridjah) cuttings collected by – Dec 2014	Trial 1 completed with no success Trial 2 ongoing, no long-term success

	<p>Trial 3 WC cuttings collected by – March 2015          Trial 4 – WC cuttings collected by end of 2016          Trial 5 – WC and Yanderra April 2018</p>	<p>Trial 3 underway, 16 cuttings successful to begin with, but mortality high – No plants have since survived.          Trial 4 Mortality high, few plants remaining in nursery and progress very slow.          Trial 5 – Cuttings have been potted but no root establishment yet.</p>
6. Conduct Ecological burn – West Cliff Offset	Autumn 2016	Burn completed in Apr 2016. Commenced post-fire monitoring program. No <i>P. hirsuta</i> seedlings recorded to-date.
7. Royal Botanic Gardens ACARP Project Report Completed	May 2017 (Part 1). Oct 2019 (Part 2), May 2022 (Part 3)	Part 1 and Part 2 complete. Part 3 planned to commence mid-2019.
8. PhD Project (RBG & UWS)	March 2021	Not yet commenced
9. Submit Final Project Report	June 2021	Original deadline was May 2017 – Request submitted to extend by another two years - Granted. Additional request submitted to extend till 2021 to allow for PhD project and additional work being undertaken by RBG.

END OF REPORT