



ecoplanning
ecology | planning | offsets

Subsidence Impacts on Threatened Flora Species on Waratah Rivulet and the Eastern Tributary



Metropolitan Colliery, Helensburgh, NSW

Assessment of Impacts on Threatened Flora, February 2022

Prepared for: Metropolitan Coal

18 February 2022 Version: Final 1.0

PROJECT NUMBER	2020-240	
PROJECT NAME	Subsidence Impacts on Threatened Flora Species on Waratah Rivulet and the Eastern Tributary	
PROJECT ADDRESS	Metropolitan Colliery, Helensburgh, NSW	
PREPARED FOR	Metropolitan Coal	
AUTHOR/S	Elizabeth Norris	
REVIEW	Technical	QA
	Elizabeth Norris	Ed Cooper
VERSION	Version	Date to client
	Final 1.0	16 March 2022
ACKNOWLEDGEMENTS	This report has been prepared by Ecoplaning with support from Resource Strategies, Metropolitan Coal, Eco Logical Australia, and Bio-Analysis.	
COVER PHOTO	Site ET2-2, Eastern Tributary (21 January 2021), Elizabeth Norris.	

This report should be cited as: 'Ecoplaning (2022). Subsidence Impacts on Threatened Flora Species on Waratah Rivulet and the Eastern Tributary– Metropolitan Colliery, Helensburgh, NSW. Prepared for Metropolitan Coal.'

Disclaimer: This report has been prepared by Ecoplaning Pty Ltd for Metropolitan Coal and may only be used for the purpose agreed between these parties, as described in this report. The opinions, conclusions and recommendations set out in this report are limited to those set out in the scope of works and agreed between these parties. Ecoplaning P/L accepts no responsibility or obligation for any third party that may use this information or for conclusions drawn from this report not provided in the scope of works or following changes occurring subsequent to the date that the report was prepared.

ECOPANNING PTY LTD | 74 HUTTON AVENUE BULLI NSW 2516 | M: 0421 603 549



ecoplaning

ecology | planning | offsets

i

Contents

1	Introduction.....	1
2	Potential Threatened Flora.....	3
2.1	Key Assessment Considerations	4
3	Background	6
3.1	Climatic Conditions	6
3.2	Aquatic Ecology Monitoring on the Eastern Tributary.....	8
3.3	Site Inspections.....	8
3.3.1	Eastern Tributary – Stream Monitoring Site ET2.....	8
3.3.2	Eastern Tributary – Stream Monitoring Site ET4.....	9
3.3.3	Waratah Rivulet – Stream Monitoring Site WT3.....	10
3.3.4	Woronora River (WR) and O'Hares Creek (OC)	10
4	Assessment.....	12
4.1	Waratah Rivulet and the Eastern Tributary.....	12
5	Conclusions	15
6	References	16

Figures

Figure 1: Aquatic Monitoring Sites	2
--	---

Tables

Table 1: Monthly rainfall (mm) for survey period (September 2008 to March 2020).....	6
--	---



1 Introduction

In accordance with the Longwalls 305-307 Biodiversity Management Plan (BMP), the exceedance of any biodiversity subsidence impact performance indicator triggers an assessment against the biodiversity subsidence impact performance measure: '*Negligible impact on threatened species, populations, or ecological communities*', where *Negligible* is defined in the Project Approval as '*small and unimportant such as to be not worth considering*'.

Bio Analysis Pty Ltd monitors aquatic biota (macroinvertebrates and macrophytes) biannually in autumn and spring in streams within the Project area and surrounds. Aquatic ecology monitoring results are assessed by Bio Analysis Pty Ltd against the following aquatic biota performance indicator:

The aquatic macroinvertebrate and macrophyte assemblages in streams and pools are not expected to experience long-term impacts as a result of mine subsidence.

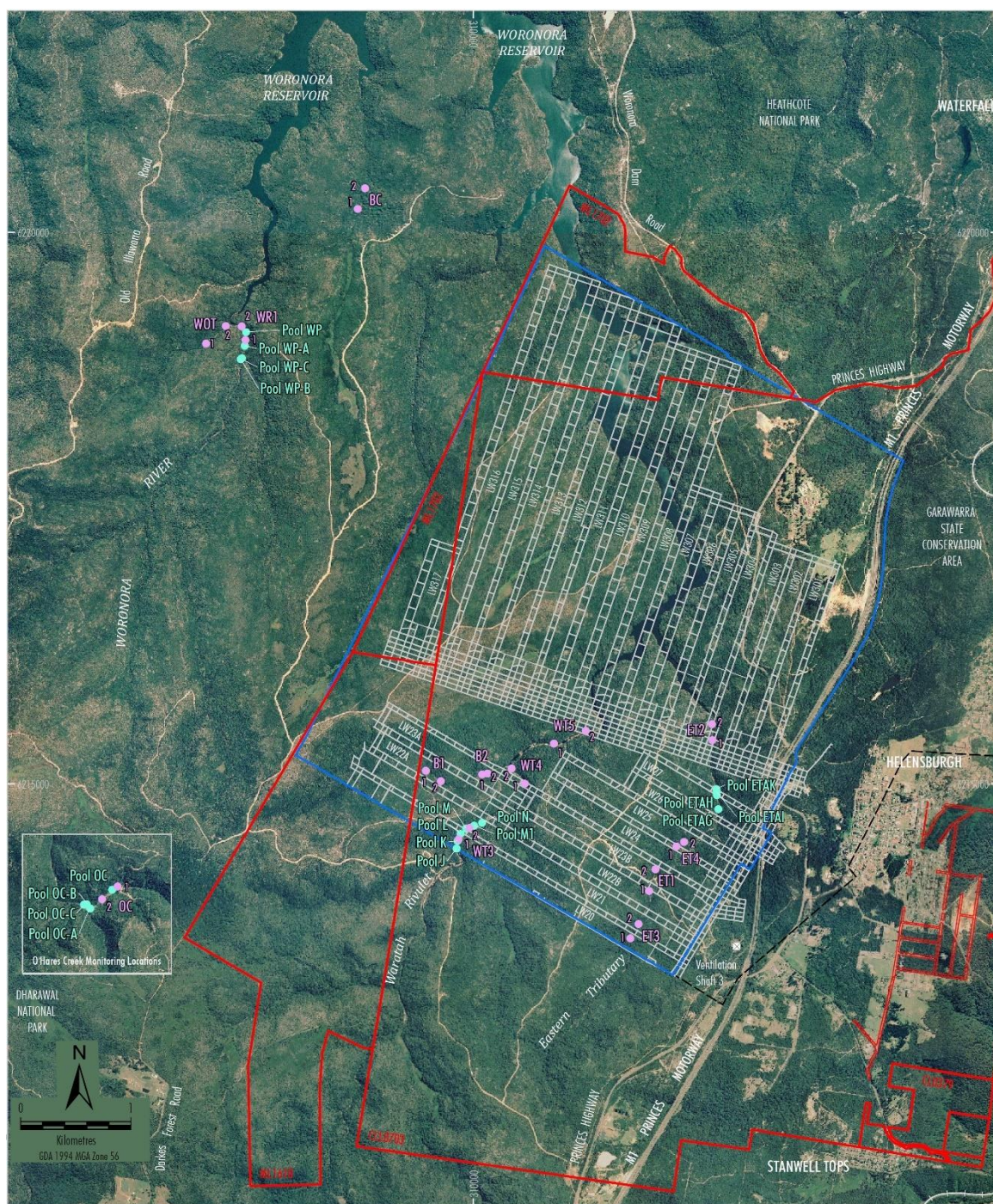
In accordance with the Longwalls 305-307 BMP, the threatened flora assessments of aquatic ecology monitoring locations have been triggered by the exceedance of the aquatic ecology performance indicator at two locations on the Eastern Tributary and one location on Waratah Rivulet. Specifically, the aquatic ecology performance indicator has been exceeded at the following locations (**Figure 1**) as reported in spring 2020 (Bio-Analysis Draft Report 2020):

- Stream monitoring site ET2 on the Eastern Tributary due to altered numbers of Atyidae between autumn 2016 and autumn 2019, and from autumn 2020 to spring 2020.
- Stream monitoring site ET4 on the Eastern Tributary due to mining-related changes to the structure of assemblages of aquatic macroinvertebrates since spring 2019.
- Stream monitoring site WT3 on Waratah Rivulet due to altered numbers of Atyidae between in autumn 2018 and subsequent surveys.

In accordance with the Metropolitan Coal Longwalls 305-307 BMP, Ms Elizabeth Norris (Ecoplanning Pty Ltd) was commissioned by Metropolitan Coal to undertake an assessment of the subsidence impacts on threatened flora that may be associated with aquatic ecology monitoring Sites ET2 and ET4 on the Eastern Tributary and WT3 on Waratah Rivulet. Site inspections were undertaken on February 2 and 3, 2022.

This report is the third threatened flora species assessment report prepared by Ecoplanning Pty Ltd for the aquatic ecology monitoring location ET2 and the first for ET4 and WT3 listed above.

Delays to the originally scheduled site assessments in December 2021 were encountered due to the extended periods of heavy rainfall during December 2020 and January 2022, resulting in continued catchment closures. This report is thus based upon the delayed site assessments conducted on 2 and 3 February 2022.



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area
- Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)

Monitoring

- Pool Aquatic Ecology Sampling Site
- Stream Aquatic Ecology Sampling Site

Source: Land and Property Information (2015); Date of Aerial Photography 1998;
Department of Industry (2015); Metropolitan Coal (2019)

Peabody
METROPOLITAN COAL
Aquatic Ecology Monitoring Locations

Figure 1

Figure 1: Aquatic Monitoring Sites

2 Potential Threatened Flora

Four threatened flora species listed under the *NSW Biodiversity Conservation Act 2016* (BC Act) (previously the *NSW Threatened Species Conservation Act, 1995*) were recorded in the baseline flora survey for the Project Area (Bangalay Botanical Surveys 2008), viz:

- *Acacia bynoeana* (Bynoe's Wattle)
- *Astrotricha crassifolia* (Thick-leaf Star-hair)
- *Melaleuca deanei* (Deane's Paperbark)
- *Pultenaea aristata* (Prickly Bush-pea)

Two threatened species (unconfirmed collections reported in the baseline flora survey of Bangalay Botanical Services 2008) also have the potential to occur in the Project Area:

- *Epacris purpurascens* var. *purpurascens*
- *Leucopogon exolasius* (Woronora Beard-heath)

Two additional threatened flora species, *Acacia baueri* subsp. *aspera* and *Cryptostylis hunteriana* (Leafless Tongue Orchid), have been recorded within the Project Area or surrounds since the baseline surveys by Eco Logical Australia.

Of these, three threatened flora species, *Astrotricha crassifolia*, *Pultenaea aristata* and *Leucopogon exolasius*, are known or have the potential to occur adjacent to or in riparian vegetation.

As described in the Longwalls 305-307 BMP, no threatened aquatic flora listed under the *Fisheries Management Act, 1994*, BC Act or *Environment Protection and Biodiversity Conservation Act, 1999* have been recorded within the Project Area or in the Woronora Reservoir. Therefore, this assessment has been prepared with regard to the terrestrial threatened flora described below which are known or have the potential to occur adjacent to or in riparian vegetation.

Astrotricha crassifolia occurs in dry sclerophyll woodland on sandstone (Department of Planning, Infrastructure and Environment [DPIE] 2020a). It occurs on ridgetops on the Patonga Plateau north of Sydney, and in the Royal National Park and on the Woronora Plateau south of Sydney (Warman & Beckers 2011, Benson & McDougall 1993). In the Project Area it most often occurs in dry sclerophyll woodland on mid to lower slopes including adjacent to riparian scrub (Norris pers. obs.). One individual was recorded at riparian vegetation monitoring site MRIP07 (along the Eastern Tributary, downstream of Longwall 27) in all survey seasons inclusive of spring 2008 to autumn 2012 riparian vegetation surveys, however, has not been recorded at this site since spring 2012 due to flood impacts undermining the root zone of this individual (pers. obs.).

Several individuals of *Astrotricha crassifolia* have been recorded downstream of riparian vegetation monitoring site MRIP08 (along the Eastern Tributary, downstream of Longwall 27) in the vicinity of aquatic monitoring site ET2 (Ecoplanning 2020). Individuals were recorded adjacent to and in the riparian zone.

A population of *Astrotricha crassifolia* (some 55 individuals) was recorded in the vicinity of and downstream of riparian vegetation monitoring site MRIP12 on the Eastern Tributary (Eco Logical Australia, 2017b). Most individuals were recorded on lower slopes, above the riparian zone, however some (14 individuals) were also recorded in the riparian zone.

Astrotricha crassifolia has not been recorded within riparian vegetation monitoring sites on the Waratah Rivulet.

Pultenaea aristata is endemic to the Woronora Plateau and is often associated with upland swamp vegetation communities and in wet heath and shrubby sclerophyll woodland (Benson & McDougall 1996; DPIE 2020b). It is also known to occur in association with areas of impeded drainage and creek lines with sandstone woodland and gully forest communities. (DPIE 2020b). It's a widespread and common species within the Project Area and surrounds (Bangalay Botanical Surveys, 2008). This species has not been recorded within the riparian vegetation monitoring sites along the Eastern Tributary or within areas affected by dieback which are regularly traversed as part of the flora monitoring program (Ecological Australia various dates). A small population of *Pultenaea aristata* occurs above the riparian zone adjacent to the Eastern Tributary in the vicinity of Fire Trail 9J crossing.

Leucopogon exolasius generally occurs in woodland on sandstone (DPIE 2020c), in sparsely vegetated sand deposits, or on rocky sandstone hillsides near creeks (Benson & McDougall 1995). This species has not been recorded within monitoring sites on the Waratah Rivulet or Eastern Tributary, or within the areas affected by dieback which are regularly traversed as part of the flora monitoring program (Eco Logical Australia various dates).

No threatened flora populations or critical habitat have been listed for the Eastern Tributary, or any other streams on the Woronora Plateau.

2.1 Key Assessment Considerations

Consistent with the Longwalls 305-307 BMP, factors to be taken into consideration in the assessment of threatened species are as follows:

Key Assessment Considerations

1. *What is the nature of the environmental consequence (e.g., the potential for adverse impacts on upland swamps, riparian vegetation, slopes and ridgetops or aquatic habitats)?*
2. *What are the potential factors that may have contributed to the environmental consequence (e.g., the degree of subsidence effects, ineffective management measures or prevailing climatic conditions)?*
3. *Which threatened species have the potential to be impacted?*
4. *What are the potential impacts on the lifecycle of the potential threatened species (e.g., foraging, breeding/reproduction, nesting, shelter, and movement/dispersal)?*
5. *What are the potential impacts on the habitat of the potential threatened species (e.g., area affected)?*

6. *Has the habitat connectivity of the threatened species been affected (e.g., loss of stream pool habitat connectivity)?*
7. *What actions, if any, are most appropriate to mitigate the impacts and/or to minimise future impacts?*



3 Background

3.1 Climatic Conditions

Table 1 provides the monthly rainfall data from the Helensburgh 2 Metropolitan Coal Weather Station located approximately 3 km east of the Project Area, for the period September 2008 to June 2021 (courtesy Eco Logical Australia 2022).

Following the previous inspections of aquatic monitoring sites in January 2021 (Ecoplanning 2021), monthly rainfall from June 2020 through to June 2021 was varied with selected months receiving well over average rainfall (July, August and October 2020 and March 2021), well below average rainfall (September, November 2020 and January, February, April and June 2021) with the remaining months receiving near average rainfall (**Table 1**).

Table 1: Monthly rainfall (mm) for survey period (September 2008 to March 2020)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008									89.0	53.5	64.5	82.0
2009	35.5	210.0	102.0	155.5	152.5	80.5	55.5	5.0	26.0	120.5	63.5	63.5
2010	37.0	182.5	118.5	30.5	89.5	169.0	47.5	43.0	173.5	75.0	103.5	90.5
2011	42.0	4.0	164.5	59.5	51.0	167.0	169.5	91.0	75.0	80.0	162.5	76.0
2012	180.5	242.0	235.5	117.5	15.0	129.5	45.5	5.5	22.5	63.5	54.5	28.0
2013	171.0	220.5	67.0	104.5	106.5	283.5	7.0	11.0	80.5	12.0	217.5	54.5
2014	31.5	50.5	218.5	59.0	11.5	28.0	8.0	93.0	25.5	79.5	39.5	182.5
2015	113.5	96.0	32.5	445.0	101.5	62.5	53.0	81.5	38.5	30.5	119.0	60.5
2016	275.0	31.0	46.5	55.5	36.0	394.5	92.5	84.0	52.5	15.5	36.0	67.5
2017	63.0	172.0	404.5	70.0	13.5	174.5	12.5	18.5	0.5	37.0	39.0	52.5
2018	38.0	83.0	139.0	19.0	11.5	95.5	1.0	16.0	41.0	175.5	117.0	93.5
2019	58.0	44.0	180.5	24.0	6.5	88.5	36.5	48.0	130.0	29.5	40.0	2.5
2020	88.5	550.5	132.5	75.5	75.0	48.0	218.0	129.5	32.0	162.0	55.0	104.5
2021	88.0	101.0	391.0	18.5	128.0	55.0						
Mean ¹	131.1	158.4	156.3	125.3	128.4	145.1	96.0	88.9	76.8	92.0	104.6	103.0

¹ Mean data sourced from Bureau of Meteorology Station Number 068024 (Darkes Forest – Kintyre) (www.bom.gov.au) March 2021). Each monthly long-term mean is calculated using all data obtained since the commencement of monitoring at Station 068024. Highlighted data refers to current reporting period, with February 2020 and September 2019 well above average.

The extended period of dry weather throughout 2017 to 2019 was followed by moderately wet conditions in autumn 2020 and moderate rainfall in spring 2020 prior to which well above average rainfall fell in August 2020. The beginning of 2021 was dry with March recording well above average rainfall followed by below average rainfall for April, May and June. The overall better rainfall conditions experienced since 2020 was evident in vegetation across the catchment where species previously recorded in a stressed condition indicated by leaf

yellowing and observed plant dieback were found to be in good condition with new growth commonly recorded (Eco Logical Australia 2021a and 2021b).

3.2 Aquatic Ecology Monitoring on the Eastern Tributary

Aquatic ecology monitoring is conducted biannually at a range stream monitoring sites in accordance with the approved monitoring program specified in the Longwalls 305- 307 BMP. Selected aquatic control sites for comparison against sites ET2, ET4 and WT3 are Woronora River (WR1 and WR2) and O'Hares Creek (OC1 and OC2) both located beyond the Project Area (**Figure 1**).

3.3 Site Inspections

Inspection of the riparian vegetation corridors occurring along the Eastern Tributary, Waratah Rivulet, Woronora River and O'Hares Creek adjacent to the aquatic ecology monitoring sites indicated that streamside shrubs and ground layer species continually incur flood impacts with flood-swept and prone vegetation commonly observed. A review of rainfall data (**Table 1**) indicated that above average rainfall was experienced in the months of July and October 2020 and March 2021 further contributing to the flood impacts observed to streamside vegetation and sediments during the current site inspection. Below average rainfall was experienced at all other times from July 2020.

3.3.1 Eastern Tributary – Stream Monitoring Site ET2

ET2-1

The pool at site ET2-1 upstream of the rock bar was near full, with water flow occurring over the rock bar, and into an extended pool below the rock bar. This is in contrast to the previous January 2021 survey where water flow over the rock bar disappeared underground for over 100m downstream. At the time of the current inspection the water at ET2-1 was clear, however the in-stream rocky surfaces were covered with iron floc.

Minor erosion of streamside sediments was evident where roots of shrub and ground layer species were exposed. Evidence of flood-swept vegetation was seen on the streamside sedge *Schoenus melanostachys*.

Generally, streamside shrubs and ground layer species were observed in healthy condition, although several individuals, recorded previously (*Banksia ericifolia* subsp. *ericifolia* and *Allocasuarina littoralis*), were prone and senescent. Individuals of *Lomatia myricoides* and *Prostanthera linearis* were observed in healthy condition with *Lomatia myricoides* in flower.

The RoTAP¹ species *Hibbertia nitida* was also found in healthy condition with several seedlings regenerating along the sandy banks.

No threatened flora species were observed or are known to occur in the vicinity of Site ET2-1.

No areas of unusual vegetation dieback were observed.

ET2-2

The pool level at ET2-2 was lower than usual evidenced by rock staining, and the water colour was slightly yellow-brown and cloudy with depth. Iron floc was present on in-stream rocks with

¹ RoTAP – Species listed in *Rare of Threatened Australian Plants (RoTAP)* (Briggs and Leigh 1988)

minor staining on streamside sedges. Erosion of streamside sandy sediments has occurred on the western bank with flood debris, litter and several prone shrubs observed.

Most vegetation was found in healthy condition including the shrubs, *Persoonia pinifolia*, *Banksia ericifolia* var. *ericifolia*, *Acacia obtusifolia* and *Allocasuarina littoralis*. Groundlayer species including *Bauera rubioides*, *Gleichenia microphylla* and *Schoenus melanostachys* were also in healthy condition. The shrubs *Tristania neriifolia* and *Lomatia myricoides* displayed evidence of minor dieback, with *Lomatia myricoides* in flower at the time. *Baumea juncea* was flood-swept but generally in healthy condition with new growth present,

Astrotricha crassifolia is known to occur in the vicinity of Site ET2-2. During the previous January 2021 inspection (Ecoplanning 2021), several individuals previously found growing adjacent to site ET2-2 were unable to be relocated, likely a result of high-water flow impacts removing the sandy unconsolidated sediment in which they were growing. During the current survey, one individual, presumed missing previously, was relocated within the riparian zone and was found to be in healthy condition and having recently flowered. All other individuals which occur adjacent to the riparian zone were relocated and also found to be in healthy condition.

The RoTAP species *Hibbertia nitida* also occurs sporadically in the vicinity of site ET2-2 and individuals were found to be in a healthy condition. A second RoTAP species, *Lomandra fluviatilis*, also occurs sporadically in the vicinity of site ET2-2. Most individuals of this ground layer species were found with minor leaf dieback, a typical feature of this groundlayer plant within the riparian zone.

No areas of unusual vegetation dieback were observed.

3.3.2 Eastern Tributary – Stream Monitoring Site ET4

ET4-1

The condition of streamside vegetation along the Eastern Tributary from the crossing at 9J Fire Trail to site ET4-1 showed evidence of high-water flow impacts with prone shrubs and flood debris common and many areas of sediment scouring present and exposing roots of shrubs and groundlayer species. Bank loss is also evident in parts where the existing walking track is becoming diminished. The water colour was brown with sediment and instream rocky areas were covered with iron floc, a condition that continued downstream to site ET4-1.

Despite the flood impacts most shrub species in the vicinity of ET4-1 including *Lomatia myricoides*, *Banksia ericifolia* var. *ericifolia*, *Leptospermum morrisonii*, *Allocasuarina littoralis*, *Baeckea linifolia* and *Tristania neriifolia* were in healthy condition. Groundlayer species including *Schoenus melanostachys*, *Lomandra fluviatilis* *Bauera rubioides* were also observed in healthy condition. Several old dead shrubs were found prone adjacent to the stream and one individual of *Banksia ericifolia* var. *ericifolia* was found to be senescing.

A number of individuals of *Lomatia myricoides* were found to be in flower, and the RoTAP shrub *Hibbertia nitida* was also found in good health.

No areas of unusual vegetation dieback were observed.

ET4-2

Approximately 50m downstream of ET4-1, water flow disappeared underground at a point where instream bedrock had cracked. Water flow then reappeared at site ET4-2. Shrub and groundlayer species in the vicinity of the cracked and bare instream bedrock was found to generally good condition.

Site ET4-2 is characterised by an extensive rock platform with water flow occurring along the northern edge only. A number of shallow rainwater pools were present across the platform. Similar to ET4-1, the water colour is yellow brown and cloudy with depth and iron floc is present on all instream rocky areas.

The adjacent vegetation includes the shrub species including *Banksia ericifolia* var. *ericifolia*, *Persoonia pinifolia*, *Leptospermum morrisonii*, *Lomatia myricoides*, *Allocasuarina littoralis*. Few groundlayer species are present due to the extensive rock platform but includes *Bauera rubioides* and *Lomandra fluviatilis*, the latter amongst rocky areas. Minor dieback is present and likely related to previous flood impacts to some shrubs but generally, most were observed in good health.

An area on the southern side of ET4-2 directly upslope of the rock platform contained an unusual patch of shrub dieback dominated by *Allocasuarina littoralis*.

3.3.3 Waratah Rivulet – Stream Monitoring Site WT3

WT3-1

At WT3-1 the water colour was found to be clear although cloudy with depth and brown algae appears to be widespread across instream rocky areas.

Streamside vegetation was found to be generally in good health including the shrubs *Banksia ericifolia* var. *ericifolia*, *Leptospermum polygalifolium* and *Acacia obtusifolia*. Several individuals of *Banksia ericifolia* var. *ericifolia* exhibited some older senescing branches suspected as a result of previous high-water flows. An area of sediment deposition has accumulated over time on the eastern side of the Rivulet downstream from Flat Rock Crossing and now supports a range of groundlayer species

No areas of unusual vegetation dieback were observed.

3.3.4 Woronora River (WR) and O'Hares Creek (OC)

Woronora River sites WR1 and WR2 and O'Hares Creek sites OC1 and OC2 are located outside of the Project Area to the north-west (Woronora Special Area) and south of the Project Area (Dharawal National Park) respectively.

At the time of inspection water flow was consistent at all sites with clear water present. Previous flood impacts were observed through the presence of prone shrubs, flood-swept streamside shrub and ground layer species and woody flood debris at both WR and OC sites. Erosion of sandy streamside sediments was observed at all sites but were scattered and to a lesser degree than that observed at longwall sites. A small amount of green algae was evident at site OC-1 likely indicating a nutrient load from upstream.

At O'Hares Creek, dense ground-layer is present along extensive areas of the stream edge, dominated by *Sporadanthus gracilis*, *Sticherus flabellatus*, *Gleichenia microphylla* and *Schoenus melanostachys* with *Gleichenia microphylla* displaying dieback in several patches. Several individuals of *Banksia ericifolia* subsp. *ericifolia* growing adjacent to the stream edge displayed some minor leaf yellowing. Most other shrubs were found to be in healthy condition including *Allocasuarina littoralis*, *Tristania neriifolia*, *Grevillea longifolia*, *Leptospermum polygalifolium* and *Acacia obtusifolia*.

A similar vegetation condition was found at the Woronora River sites with the common shrubs *Leptospermum polygalifolium*, *Persoonia pinifolia*, *Epacris obtusifolia*, *Allocasuarina littoralis*, *Hakea salicifolia* and the groundlayer species *Chorizandra cymbaria*, *Centrolepis strigosa*, *Juncus planifolius* observed generally in good health. Flood swept individuals of *Banksia ericifolia* var. *ericifolia*, *Acacia obtusifolia* and *Schoenus melanostachys* displaying minor dieback and some dead branches. Several senescent individuals were prone over the stream.

At both control sites, no areas of unusual dieback were observed.

No threatened flora species were observed or are known to occur in the vicinity of sites WR1 and WR2 (DPIE 2021).

Leucopogon exolasius has previously been recorded in the vicinity of the Trail 10C crossing on O'Hares Creek at site OC1 (DPIE 2021) but was not relocated during the current site inspection.

The RoTAP species *Hibbertia nitida* also occurs sporadically in the vicinity of sites WR and OC with individuals found to be in a healthy condition. The RoTAP species *Lomandra fluviatilis* is also present within these sites and found to range from healthy condition to individuals having minor leaf dieback.

4 Assessment

This section briefly addresses each of the key assessment considerations identified in the Longwalls 305-307 BMP as they relate to the condition of the vegetation and any impacts to potential threatened flora observed on February 2 and 3 2022 along the Eastern Tributary (ET2) and Waratah Rivulet (WT3).

4.1 Waratah Rivulet and the Eastern Tributary

1. *What is the nature of the environmental consequence?*

The observed changes at stream monitoring site ET2 on the Eastern Tributary were that significantly fewer Atyidae were collected between autumn 2020 and spring 2020 altering the macrophyte assemblage at this site. No evidence of any significant impact to aquatic macrophytes was recorded (Bio-Analysis Spring 2020 Draft Report).

The observed changes at stream monitoring site ET4 on the Eastern Tributary, mining related changes to the structure of aquatic macroinvertebrates continue to be detected since the spring 2019 survey. (Bio-Analysis Spring 2020 Draft Report).

The observed changes at stream monitoring site WT3 on Waratah Rivulet were that statistical analysis detected a significant change in mean diversity of macroinvertebrates in spring 2016, autumn 2018 and in subsequent surveys including spring 2020 (Bio-Analysis Spring 2020 Draft Report).

At the time of the February 2022 site inspection, impacts to terrestrial shrubs and ground cover species within the riparian zone along the Eastern Tributary and Waratah Rivulet appear to be as a result of previous high energy water flows over the previous 12 to 18 months during July and October 2020 and in particular March 2021 due to well above average rainfall events. Impacts that may have resulted from changes in aquatic habitat and or hydrology prior to these, and earlier events, are uncertain.

2. *What are the potential factors that may have contributed to the environmental consequence?*

See '1' above.

3. *Which threatened species have the potential to be impacted?*

As described in **Section 2**, no threatened aquatic flora listed under the *Fisheries Management Act, 1994*, BC Act or *Environment Protection and Biodiversity Conservation Act, 1999* have been recorded within the Project underground mining area or in the Woronora Reservoir.

Three threatened terrestrial flora species have the potential to occur adjacent to or in the riparian areas in the vicinity of the aquatic ecology monitoring locations, namely *Astrotricha crassifolia*, *Pultenaea aristata* and *Leucopogon exolasius* (**Section 2**).

A population of *Pultenaea aristata* is known to occur in the vicinity of ET1-1 along the Eastern Tributary, upslope of the riparian zone. This species has not been recorded in the vicinity of the other aquatic monitoring sites along the Eastern Tributary discussed in this report.

A population of *Astrotricha crassifolia* is known to occur adjacent to and in the riparian zone of ET2-2 along the Eastern Tributary.

No threatened species were identified within the riparian zone or adjacent areas of ET4 and WT3.

4. What are the potential impacts on the lifecycle of the potential threatened species?

Potential impacts on the lifecycle of individuals of the threatened species include dieback and death of any individuals located within the riparian zone as a result of water ponding and inundation, high energy stream flow from flood impacts or as a result of reductions in pool water levels.

As *Pultenaea aristata* and *Leucopogon exolasius* are not known to occur in the areas affected (ET2, ET4 and WT3), no impacts on the lifecycle of these species are expected to occur, or to place the local viable populations at risk of extinction. Suitable habitat for *Pultenaea aristata* and *Leucopogon exolasius* is not present within the area impacted (**Section 2**).

Downstream of ET2-2 is a small population of *Astrotricha crassifolia* (Ecoplanning 2020). For the most part, this population is located above the flood zone of the Eastern Tributary, however, two individuals were located within 2 m of the stream edge. During the previous January 2021 inspection one of these individuals was unable to be relocated, presumably due to high energy stream flow from flood impacts experienced during March and October 2020. During the current inspection, the remaining individual located within the riparian zone was relocated and found to be in healthy condition and having recently flowered.

A further nine *Astrotricha crassifolia* have previously been recorded upslope of the riparian zone and all were found to be in good condition during the current survey.

5. What are the potential impacts on the habitat of the potential threatened species?

Potential impacts on the habitat of the threatened species include bank inundation, vegetation dieback, bank scouring/sediment loss, and sediment deposition causing impacts to potential habitat.

Potential habitat for *Astrotricha crassifolia* and *Pultenaea aristata* on the Eastern Tributary (refer **Section 2**) can interface with riparian vegetation but from the current site inspection, the main impacts to habitat have resulted from high energy water flows and physical damage from the movement of woody debris and sediment loss and bank scouring.

6. Has the habitat connectivity of the threatened species been affected?

The habitat connectivity has not been affected, nor has become fragmented for *Astrotricha crassifolia* and *Pultenaea aristata* along the Eastern Tributary as a result of mine subsidence impacts. Suitable habitat is found adjacent and upslope of the riparian areas for both these species and is present elsewhere within the Project Area and will not be subject to fragmentation.

Leucopogon exolasius has not been recorded within the Eastern Tributary or Waratah Rivulet monitoring sites. This species is only known from individuals recorded downstream of all

riparian monitoring sites along the Eastern Tributary where more suitable habitat is present (Bangalay Botanical Services 2008).

Populations of *Pultenaea aristata* located on slopes adjacent to ET1-1 have not been impacted by the changes in stream water levels. Habitat connectivity for the *Pultenaea aristata* has not been affected and is unlikely to be affected in the future by subsidence impacts to the Eastern Tributary. Extensive flora surveys for the Metropolitan Coal Project (Bangalay Botanical Surveys, 2008) and long-term observations of this species through the riparian vegetation monitoring program (Eco Logical Australia, various dates) has shown that *Pultenaea aristata* is widespread and common in the Project Area and surrounds, and that *Astrotricha crassifolia* is found in discrete populations at various localities in the Project Area on mid to lower slopes, adjacent to and in riparian areas.

7. What actions, if any, are most appropriate to mitigate the impacts and/or to minimise future impacts?

No detrimental impacts on the *Astrotricha crassifolia*, *Pultenaea aristata* and *Leucopogon exolasius* have occurred and are considered unlikely to occur in the future along the Eastern Tributary as a result of the subsidence impacts recorded to date.

5 Conclusions

Based on the assessments detailed in **Section 4**, the biodiversity impact performance measure '*Negligible impact on threatened species*', has not been exceeded as a result of subsidence impacts on aquatic ecology along Eastern Tributary.

6 References

- Bangalay Botanical Surveys (2008). *Metropolitan Coal Project Baseline Flora Survey – Proposed Longwall Mining Area*. Final Report to Helensburgh Coal Pty. Ltd.
- Benson, D. and McDougall, L. (1993). Ecology of Sydney plant species: Part 1. *Cunninghamia* 3(2): 257-422.
- Benson, D. and McDougall, L. (1995). Ecology of Sydney plant species: Part 3. *Cunninghamia* 4(2): 217-424.
- Benson, D. and McDougall, L. (1996). Ecology of Sydney plant species: Part 4. *Cunninghamia* 4(4): 553-756.
- Bio-Analysis Pty Ltd (Draft Spring 2020 Report). *Aquatic Ecology Monitoring Metropolitan Coal Longwalls 20-27 Autumn 2020 Survey*.
- Briggs, J.D. and Leigh, J.H. (1988). Rare or Threatened Australian Plants. Australian National Parks & Wildlife Service Special Publication No 14.
- Bureau of Meteorology (2021). Climate Online Data <http://www.bom.gov.au/climate/data>
- Eco Logical Australia (2021a). Metropolitan Coal Vegetation Monitoring Longwalls 20-22 - Autumn 2021. Report prepared for Metropolitan Coal.
- Eco Logical Australia (2021b). Metropolitan Coal Vegetation Monitoring Longwalls 23-27 - Autumn 2021. Report prepared for Metropolitan Coal.
- Ecoplaning (2020). *Subsidence impacts on Riparian Vegetation on the Eastern Tributary*. Report prepared for Metropolitan Coal.
- Metropolitan Coal (2019). *Longwalls 305-307 Biodiversity Management Plan*. Peabody Energy.
- NPWS (2003). *Native Vegetation of the Woronora, O'Hares and Metropolitan Catchments*. Sydney. NSW National Parks and Wildlife Service.
- NSW Department of Planning, Infrastructure and Environment (2020a). Thick -leaf Star-hair Profile. Accessed at: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10074>
- NSW Department of Planning, Infrastructure and Environment (2020b). *Pultenaea aristata* Profile . Accessed at: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10710>
- NSW Department of Planning, Infrastructure and Environment (2020c). *Leucopogon exolasius* Profile . Accessed at: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10473>
- NSW Department of Planning, Infrastructure and Environment (2021). BioNet Atlas. Accessed at: <https://www.environment.nsw.gov.au/atlasapp/Default.aspx?a=1>

Warman, D. and Beckers, D. (2011). Status of the Vulnerable shrub *Astrotricha crassifolia* (Araliaceae) in Brisbane Water National Park, NSW: an update. *Cunninghamia* 12(2): 137-142