BUSHFIRE PLANNING AUSTRALIA

BUSHFIRE ASSESSMENT REPORT

Proposed Multi-level Residential Development

11 – 17 Mosbri Crescent, The Hill

Lot 1 DP 204077

Prepared for: Crescent Newcastle Pty Ltd

Bushfire Planning Australia

Stuart Greville
Accredited Bushfire Practitioner
BPAD-26202
✆ 0400 917 792
✉ stuart@bfpa.com.au

Ref: 1855
Version: AMENDED – April 2021

Disclaimer and Limitation

This report is prepared solely for Crescent Newcastle Pty Ltd (the 'Client') for the specific purposes of only for which it is supplied (the 'Purpose'). This report is not for the benefit of any other person; either directly or indirectly and is strictly limited to the purpose and the facts and matters stated in it and will not be used for any other application.

This report is based on the site conditions surveyed at the time the document was prepared. The assessment of the bushfire threat made in this report is made in good faith based on the information available to Bushfire Planning Australia at the time.

The recommendations contained in this report are considered to be minimum standards and they do not guarantee that a building or assets will not be damaged in a bushfire. In the making of these comments and recommendations it should be understood that the focus of this document is to minimise the threat and impact of a bushfire.

Finally, the implementation of the adopted measures and recommendations within this report will contribute to the amelioration of the potential impact of any bushfire upon the development, but they do not and cannot guarantee that the area will not be affected by bushfire at some time.

Document Status: 1855 – Multi-level Residential Development

Version	Status	Purpose	Author	Review Date
1	Draft	Draft for Review	Stuart Greville	16th November 2018
2	Draft	Draft for Client Review	Stuart Greville	16th November 2018
3	Final	Final for Submission	Stuart Greville	17th December 2018
4	AMENDED	Delete Figure 8	Stuart Greville	25th February 2019
5	REVISED	Final for re-submission	Stuart Greville	3rd May 2021

Certification

As the author of this Bushfire Assessment Report (BAR), I certify this BAR satisfies section 4.14 of the *Environmental Planning and Assessment Act 1979* and Appendix 4 of Planning for Bushfire Protection 2006.

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

Stuart Greville

Accredited Bushfire Practitioner

BPAD-26202

Date: 3 May 2021

In signing the above, I declare the report is true and accurate to the best of my knowledge at the time of issue

Executive Summary

Bushfire Planning Australia (BPA) has been engaged by Crescent Newcastle Pty Ltd (the 'Client') to undertake a Bushfire Assessment Report (BAR) for the proposed construction of 172 new residential dwellings; comprising eleven (11) two storey townhouses and 161 units contained in four (4) multi-level buildings.

The NSW Rural Fire Service (RFS) previously issued a Bush Fire Safety Authority (BFSA) on 25 June 2019 (RFS Ref: D19/303) for the proposed assessment, subject to a series of conditions. Subsequent to the issue of the BFSA, an amended development application has been lodged with the City of Newcastle (CoN) seeking minor modifications to the proposed development. These modifications do not affect the proposed built form or require amendments to the recommended bushfire mitigation measures. The modifications are limited to significanty mitigating potential mine subsidence.

The modified submission is being lodged with Council as part of the original Development Application (DA2019/00061), accordingly the BAR remains valid with regard to addressing the provisions contained in Planning for Bushfire Protection 2006 (PBP 2006) as the original DA was submitted prior to the adoption of Planning for Bushfire Protection 2019 (PBP 2019) in March 2020.

The original BAR was carried out in accordance with methodology outlined in PBP 2006 and AS3959-2009 and provides the information required by cl.44 of the Rural Fires Regulation 2013.

The bushfire hazard assessment contained in the original BAR was reviewed to ensure the findings remained valid. A site inspection was carried out by Stuart Greville on 8 April 2021 and observations made confirmed the vegetation formations remaining consistent with the previous bushfire hazard assessment. It was evident during the site inspection the bushfire management recommendations contained in the Vegetation Management Plan (VMP) prepared by Coast Ecology (7 February 2018) have not been implemented.

The revised assessment re-affirmed the site was exposed to a low-risk bushfire hazard mainly located to the east of the subject site. The bushfire hazard is located within a CoN owned and managed park (Arcadia Park) which is currently under restoration. The reporting commissioned by CoN determined the area of unmanaged vegetation to be less than 1 hectare. Furthermore, CoN commission VMP recommended to implement APZs around the perimeter of the park.

Following the issue of the BFSA, further investigation was undertaken with the intent of excluding the vegetation as a hazard based on the area of unmanaged vegetation being less than 1 hectare. An assessment undertaken by Petersen Bushfire supporting the low-threat hazard assessment was not supported by the RFS. Accordingly, the vegetation within Arcadia Park has been assessed as a bushfire hazard and the recommendations contained in the original BAR shall remain.

Notwithstanding the position of the RFS, large areas of the subject are not identified as being bushfire prone; included all land occupied by the proposed townhouses addressing Mosbri Crescent. The remainder of the site is only identified as a Vegetation Buffer. As all vegetation within the site will be removed, following development commencing on the site, the site will not contain any bushfire prone vegetation. In this regard, and considering the scale of the built form, revised recommendations have been included recommending the required Bushfire Attack Levels (BALs) of several parts of the development are reduced.

The proposed development is able to achieve an acceptable level of protection from bushfire which can be achieved through a combination of strategies. In this instance the design of the proposed building will be constructed using non-combustible materials; including a combination of masonry, glass and metal. In addition to the materials used in the construction, all internal areas and the external balconies will be protected by a sprinkler system. The sprinkler system will protect each individual unit from the risk of damage from a fire and prevent the spread of a fire to other parts of the building.

Although the BAL rating for the overall development is considered to BAL-LOW due to the low-threat hazard being contained to an area approximately 1 hectare in area, the following recommendations have been generated to enable the proposed development to achieve the aims and objectives of PBP 2006; commensurate to the actual bushfire risk the individual components of the proposed development will be exposed to:

1. The entire site shall be managed as an Inner Protection Area (IPA) as outlined within section 4.1.3 of PBP 2006 and Appendix 5 of PBP 2006 and the RFS document *Standards for asset protection zones*;
2. All townhouse fronting Mosbri Crescent are rated BAL-LOW as there is insufficient risk to warrant specific bushfire construction requirements and the townhouses will be shielded from the low-threat hazard by 3 multi-storey buildings;
3. Eastern elevations of Buildings A, B and C are rated BAL-29;
4. The northern and southern elevations of Buildings A, B and C are rated BAL-19;
5. The western elevation of Buildings A, B and C are rated BAL-12.5;
6. The new buildings are to be linked to a reliable water supply network and that suitable fire hydrants are located throughout the development site that are clearly marked and provided for the purposes of bushfire protection. Fire hydrant spacing, sizing and pressure shall comply with AS2419.1 2005 and section 4.1.3 of PBP 2006; and
7. Consideration should be given to landscaping and fuel loads on site to decrease potential fire hazards on site.

This assessment has been made based on the bushfire hazards observed in and around the site at the time of inspection and production (December 2018, February 2019 and April 2021).

Should the above recommendations be implemented, the existing bushfire risk should be suitably mitigated to offer an acceptable level of protection to life and property for those persons and assets occupying the site but they do not and cannot guarantee that the area will not be affected by bushfire at some time.

Although the BAL rating for the overall development is considered to BAL-LOW due to the low-threat hazard being contained to an area approximately 1 hectare in area, the following recommendations have been generated to enable the proposed development to achieve the aims and objectives of PBP 2006; commensurate to the actual bushfire risk the individual components of the proposed development will be exposed to:

1. The entire site shall be managed as an Inner Protection Area (IPA) as outlined within section 4.1.3 of PBP 2006 and Appendix 5 of PBP 2006 and the RFS document *Standards for asset protection zones*;
2. All townhouse fronting Mosbri Crescent are rated BAL-LOW as there is insufficient risk to warrant specific bushfire construction requirements and the townhouses will be shielded from the low-threat hazard by 3 multi-storey buildings;
3. Eastern elevations of Buildings A, B and C are rated BAL-29;
4. The northern and southern elevations of Buildings A, B and C are rated BAL-19;
5. The western elevation of Buildings A, B and C are rated BAL-12.5;
6. The new buildings are to be linked to a reliable water supply network and that suitable fire hydrants are located throughout the development site that are clearly marked and provided for the purposes of bushfire protection. Fire hydrant spacing, sizing and pressure shall comply with AS2419.1 2005 and section 4.1.3 of PBP 2006; and
7. Consideration should be given to landscaping and fuel loads on site to decrease potential fire hazards on site.

This assessment has been made based on the bushfire hazards observed in and around the site at the time of inspection and production (December 2018, February 2019 and April 2021).

Should the above recommendations be implemented, the existing bushfire risk should be suitably mitigated to offer an acceptable level of protection to life and property for those persons and assets occupying the site but they do not and cannot guarantee that the area will not be affected by bushfire at some time.

Table of Contents

Executive Summary ..... **iii**

1. Introduction **1**

2. Site Description **2**

2.1. Bushfire Prone Land 4

2.2. Proposed Development 6

2.3. Aims and Objectives 8

3. Bushfire Hazard Assessment **9**

3.1. Vegetation Assessment 9

3.1.1. Arcadia Park 9

3.1.2. Vegetation Assessment 22

3.2. Slope Assessment 23

3.3. Significant Environmental Features 26

3.4. Threatened Species, populations or ecological communities 26

3.5. Aboriginal Objects 26

4. Bushfire Protection Measures **27**

4.1. Asset Protection Zones 27

4.1.1. Determining the Appropriate Setbacks 27

4.2. Access 28

4.3. Fire Brigade Intervention 29

4.4. Services – water electricity and gas 29

4.4.1. Water 29

4.4.2. Electricity 29

4.4.3. Gas 29

4.5. Construction Standards – Bushfire Attack Level 30

4.6. Landscaping and Vegetation Management 34

5. Conclusion and Recommendations **36**

6. References **37**

Figures

Figure 1: Site Locality Plan 3
Figure 2: Bushfire Prone Land Map (Newcastle City Council) 5
Figure 3: Indicative 3D Model Perspective View (Marchese Partners) 6
Figure 4: Building C – South elevation 7
Figure 5: Building A – South Elevation 7
Figure 6: Building C – North Elevation 7
Figure 7: Arcadia Park Vegetation Management Plan (Coast Ecology) 11
Figure 8: Vegetation Formations (Keith & NSW RFS 2015) 20
Figure 9: Vegetation Mapping (Greater Hunter Vegetation Mapping v4.0, VIS ID 3855) 21
Figure 10: Slope Survey Plan 24
Figure 11: Bushfire Hazard Assessment – Slope & Vegetation 25
Figure 12: Route to site from nearest NSW Fire & Rescue brigade 29
Figure 13: Section – looking south towards townhouses and Building B 32
Figure 14: BAL Contour Plan 33

Tables

Table 1: Arcadia Park rehabilitation Zones 9
Table 2: Vegetation classifications 22
Table 3: Slope Analysis 23
Table 4: Recommended APZ setbacks 28
Table 5: Potential BAL Assessment (AS3959-2009 – Method 2) 31

Plates

Plate 1: Aerial view of King Edward Park and Arcadia Park in background (date unknown) 2
Plate 2: Looking west from The Obelisk over Arcadia Park over Wolfe Street (2019) 13
Plate 3: Looking into site from Wolfe Street (2019) 13
Plate 4: Zone 4 – active open space at southern end of Arcadia Park (2019) 13
Plate 5: Zone 4 – looking north below Wolfe Street (2019) 14
Plate 6: Newcastle East Primary School is located across Kitchener Parade, north of the site (2019) 14
Plate 7: Vehicle access to Arcadia Park is available at the eastern end of Kitchener Parade 14
Plate 8: April 2021 looking north towards Kitchener Parade 15
Plate 9: Concrete footpaths direct pedestrian traffic into Arcadia Park from The Terrace 15
Plate 10: Dual use vehicle access road and path from Kitchener Parade 16
Plate 11: Several areas of open space used for picnic areas scattered within the park 16
Plate 12: Zone 3b (Rainforest) up to park boundary 16
Plate 13: Picnic tables and access path looking north through Arcadia Park 17

Plate 14: April 2021 looking towards picnic tables 17
Plate 15: Interconnected paths within Arcadia Park separate surface fuel. 18
Plate 16: April 2021 looking towards divergent paths – noting growth in vegetation 18
Plate 17: Active revegetation within 15m of the boundary of Arcadia Park is contrary to the VMP 19
Plate 18: Substantial new planting has increased the density of potentially hazardous vegetation adjoining the park boundary 19

Appendices

Appendix A: Architectural Drawings
Appendix B: Biodiversity Assessment
Appendix C: Vegetation Management Plan
Appendix D: AHIMS Search Results
Appendix E: BAL Assessor Report

1. Introduction

Bushfire Planning Australia (BPA) has been engaged by Stronach Property (the 'Client') to undertake a Bushfire Assessment Report (BAR) for the proposed construction of a 172 dwelling residential development at 11-17 Mosbri Crescent, The Hill (the 'site'). The development comprises eleven (11) two storey townhouses and 161 units contained in four (4) multi-level buildings.

The assessment aims to consider and assess the bushfire hazard and associated potential bushfire threat relevant to the proposed development, and to outline the minimum mitigative measures which would be required in accordance with the provisions of the New South Wales Rural Fire Service (RFS) publication *Planning for Bushfire Protection 2006* (PBP 2006) that has been released and adopted through the *Environmental Planning and Assessment Amendment* (Planning for Bushfire Protection) *Regulation 2007* and the *Rural Fires Regulation 2013*.

The original BAR was submitted to the Council and referred to the RFS in early 2019. Subsequent to the submission of further information, the RFS issued a Bush Fire Safety Authority (BFSA) on 25 June 2019. The BFSA supported the development subject to a series of conditions; including bushfire mitigation measures such as Asset Protection Zones and design and construction requirements.

The current BAR has been updated based on a revised development application that includes mine grouting. The bushfire hazard assessment was reviewed and a supplementary site inspection undertaken to verify the findings of the original slope and vegetation assessment.

2. Site Description

Address	11-17 Mosbri Crescent, The Hill
Title	Lot 1 DP 204077
LGA	Newcastle City Council
Site Area	~1.2 hectares
Land Use Zone	R3 Medium Density Residential
Context	The site is currently occupied by the NBN Television Studios. The Studio is contained within a large single building; approximately 10m high. The building is surrounded by car parks and hard stand. Several trees remain on the site, generally on the eastern site boundary.
Topography	The site sits in a gully at the eastern end of Mosbri Crescent. For the most part the site rises to the east towards Arcadia Park. Beyond the site to the north, east and south the landform steeply rises up to Kitchener Parade, Wolfe Street and The Terrace.
Fire History	The site lies within a local government area with a Fire Danger Index (FDI) rating of 100.

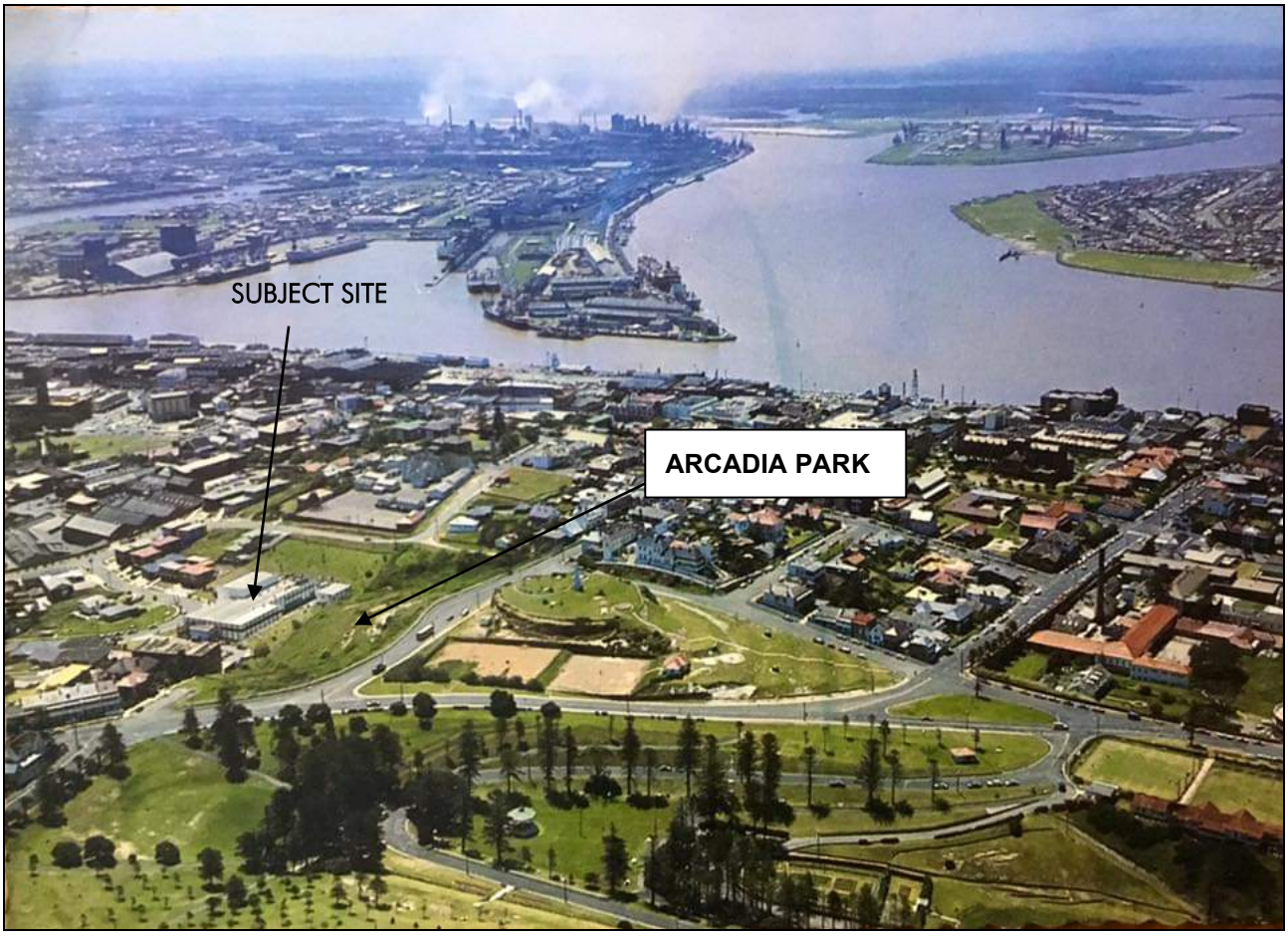


Plate 1: Aerial view of King Edward Park and Arcadia Park in background (pre 1980)

Lot 1 DP204077 'The Hill'

Figure 1

Site Location

Subject Site
100m buffer
140m buffer

SOURCE:
Base Map © Land and Property Information 2015 © Commonwealth of Australia (Geoscience Australia) 2016. Creative Commons Attribution 4.0 International Licence.

N
W E
S

0 100 200 300
Meters

A3 Scale: 1:6,000

File:NBN_Studio_Fig01_SiteLocation_181011 Date: 11/10/2018

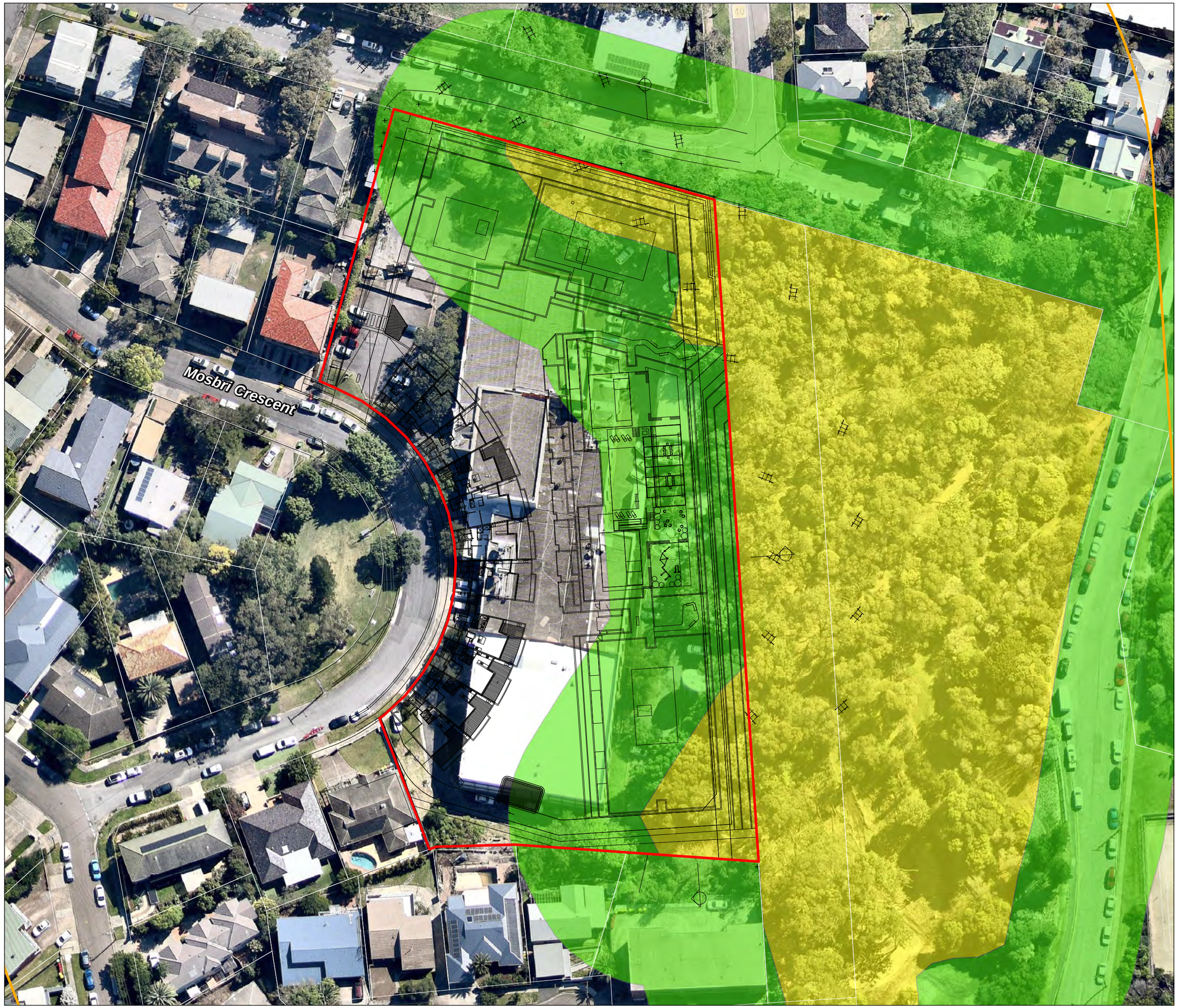
2.1. Bushfire Prone Land

Bushfire activity is prevalent in landscapes that carry fuel and the two predominant bushfire types are grassland and forest fires. Factors such as topographic characteristics and quantity of fuel loads influence the intensity and spread of fire. The scale of a bushfire hazard is tailored to the characteristics of the hazard, the size and characteristics of the affected population, types of land use exposed to bushfire, predicted development growth pressures and other factors affecting bushfire risk. **Figure 2** demonstrates the only identified bushfire threat was identified as the lower risk Category 2 vegetation. Category 2 vegetation is considered a lower risk due to the limited potential fire size. Vegetation Category 2 consists of:

- Rainforests;
- Lower risk vegetation parcels. These vegetation parcels represent a lower bush fire risk to surrounding development and consist of:
  - Remnant vegetation;
  - Land with ongoing land management practices that actively reduces bushfire risk. These areas must be subject to a plan of management or similar that demonstrates that the risk of bush fire is offset by strategies that reduce bush fire risk; AND include:
    - Discrete urban reserve/s;
    - Parcels that are isolated from larger uninterrupted tracts of vegetation and known fire paths;
    - Shapes and topographies which do not permit significant upslope fire runs towards development;
    - Suitable access and adequate infrastructure to support suppression by firefighters;
    - Vegetation that represents a lower likelihood of ignitions because the vegetation is surrounded by development in such a way that an ignition in any part of the vegetation has a higher likelihood of detection.

Whilst Category 2 vegetation includes small, isolated parcels of vegetation, there is no discrete limit on the area of vegetation that can be identified as a bushfire hazard. It is noted the NSW RFS Guide for Bushfire Prone Land Mapping excludes single areas of vegetation less than 1 hectare in area and greater than 100m from any other bushfire prone land from being mapped as bushfire prone.

Figure 2 clearly demonstrates the townhouses addressing Mosbri Crescent are not sited on land mapped as bushfire prone land; albeit they reside on a parcel of land designated as bushfire prone land.



Lot 1 DP204077 'The Hill'

Figure 2

NSW Bush Fire Prone Land

BUSHFIRE PLANNING AUSTRALIA

Subject Site
100m buffer
140m buffer
Watercourse

Bushfire Prone Land

Vegetation Category 2
Buffer

SOURCE:
Cadastral Boundary: NSW Department of Finance, Services and Innovation 2018
NSW Bush Fire Prone Land: NSW Rural Fire Service 2018
Aerial Photo: NearMap 19/09/2018

N
W E
S

0 10 20 30 40
Meters

A3 Scale: 1:800

File:NBN_Studio_Fig02_BPL_210401 Date: 1/04/2021

GEOVIEW
GIS & mapping solutions for infrastructure, town planning & environmental management

2.2. Proposed Development

The development seeks consent for:

- Demolition of all existing structures;
- Earthworks, including mine grouting
- Construction of residential accommodation comprising 172 dwellings, being:
  - Eleven (11) two storey townhouse style dwellings fronting Mosbri Crescent, located above a basement car park;
  - Three (3) residential flat buildings (Building A, B, and C) containing 161 dwellings, ranging from one to three bedrooms, being;
    - Building A including a nine (9) storey east wing and six (6) storey west wing;
    - Building B comprises seven (7) levels and a roof top communal open space, with nine (9) townhouse style dwellings facing the internal courtyard;
    - Building C comprises five (5) levels;
  - Ground floor and first level car parking;
- Interconnected car parking for Building A, B & C located on the ground floor and first level;
- Pedestrian path, providing connection from Mosbri Crescent to Kitchener Parade; and
- Associated landscaping, communal open space, services and site infrastructure.

Of the 172 dwellings; 56 units face Arcadia Park; on the eastern elevation.

The architectural drawings are contained in **Appendix A.**

Figure 3: Indicative 3D Model Perspective View (Marchese Partners)

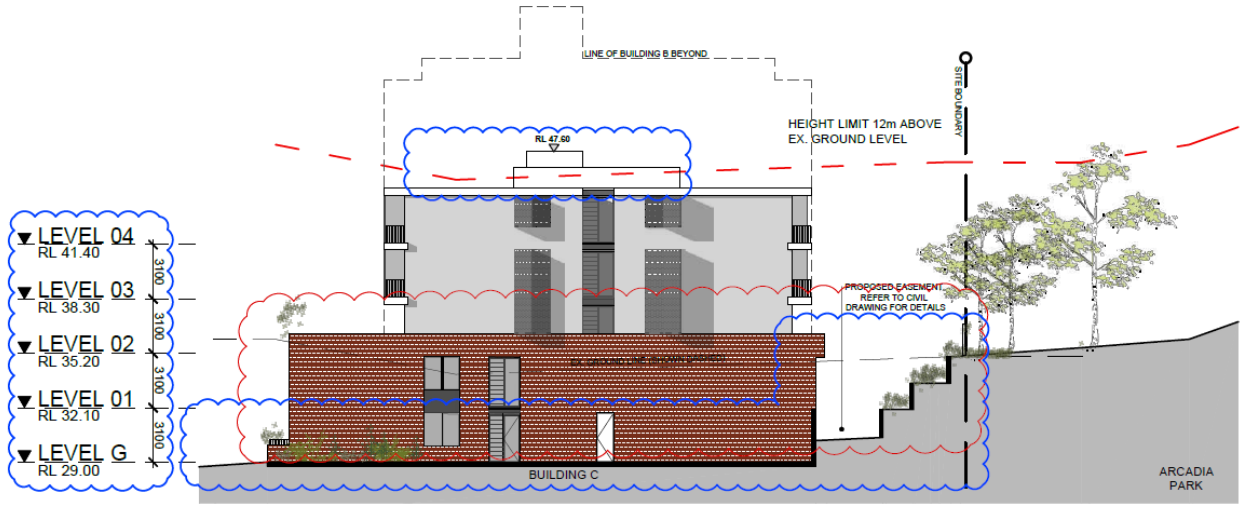


Figure 4: Building C – South elevation

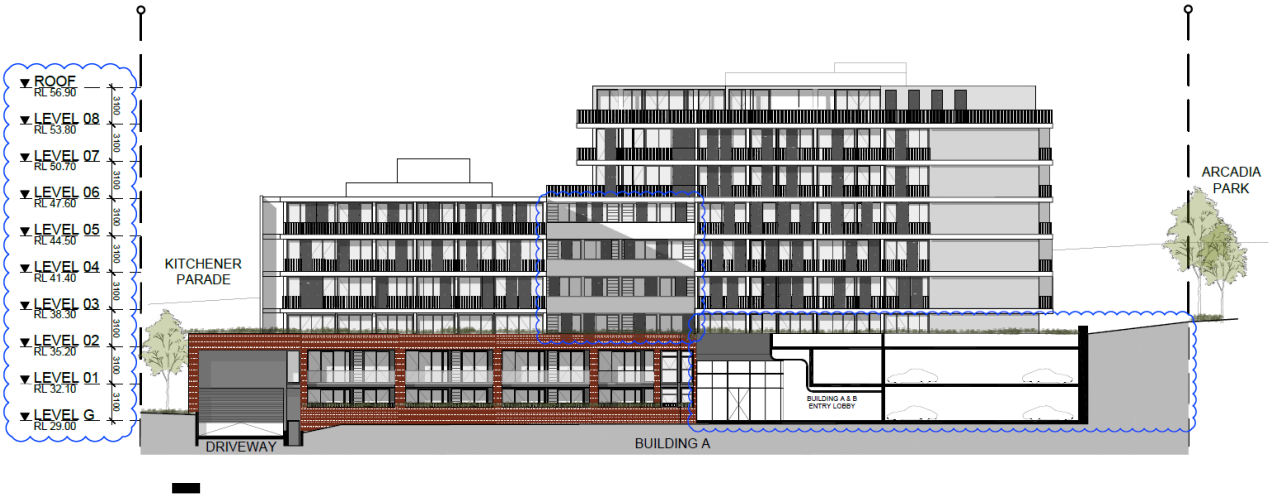


Figure 5: Building A – South Elevation

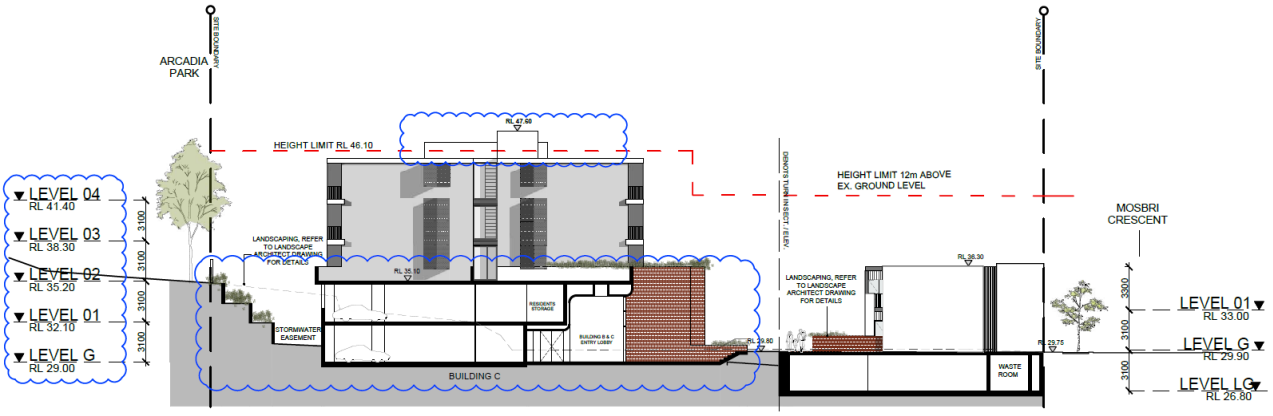


Figure 6: Building C – North Elevation (note townhouses lower than Arcadia Park)

2.3. Aims and Objectives

This assessment has been undertaken in accordance with clause 44 of the Rural Fires Regulation 2013. This BTA also addresses the aims and objectives of PBP 2006, being:

- Afford occupants of any buildings adequate protection from exposure to a bushfire;
- Provide a defendable space to be located around buildings;
- Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition;
- Ensure that safe operational access and egress for emergency service personnel and residents is available;
- Provide for ongoing management and maintenance of bushfire protection measures, including fuel loads in the asset protection zone (APZ); and
- Ensure that utility services are adequate to meet the needs of firefighters (and others assisting in bushfire fighting).

3. Bushfire Hazard Assessment

3.1. Vegetation Assessment

Vegetation classification over the site and surrounding area has been carried out as follows:

- Aerial Photograph Interpretation to map the vegetation classification and extent;
- Review of LiDAR point cloud data (NSW LPI);
- Reference to Keith Vegetation Formations mapping (VIS_ID 3848) (**Figure 8)**;
- Reference to regional vegetation community mapping (Greater Hunter Vegetation Mapping) (**Figure 9)**;
- Arcadia Park Biodiversity Assessment prepared by Coast Ecology – 7th February 2018 (**Appendix B**); and
- Arcadia Park Vegetation Management Plan prepared by Coast Ecology – 7th February 2018 (**Appendix C**);
- Site inspection 30th October 2018 and 8th April 2021 (**Plates 2 – 18**).

In accordance with PBP 2006, an assessment of the vegetation over a distance of 100m in all directions from the site was undertaken. Vegetation that may be considered a bushfire hazard was identified in all directions from the development footprint. The vegetation classification is based on the revised Table 2.3 in AS3959-2009 and Appendix 2 of PBP 2006.

The site is located within a high-density urban area comprising predominantly multi-unit developments and large detached dwellings. The only classified bushfire prone land (Vegetation Category 2) is limited to the existing vegetation with Arcadia Park; located immediately east of the site. Several paths, accessways and trails are found throughout the park providing access to the north, south and east. Several picnic tables and chairs are scattered throughout the park and it is actively used by residents for passive and active recreation. **Plates 1 – 12** indicate the various existing vegetation communities and structures throughout Arcadia Park and surrounding areas.

3.1.1. Arcadia Park

Arcadia Park is owned and managed by Newcastle City Council (NCC). NCC have engaged Coast Ecology to complete various studies as part of a rehabilitation program to assist the restoration of the Park. In addition to a Biodiversity Assessment (BA) (**Appendix C**), Coast Ecology prepared a Vegetation Management Plan (VMP) (**Appendix D**) to support the rehabilitation program. Table 2 (see **Table 1** below) of the VMP identified 4 discrete zones within Arcadia Park which are shown in **Figure 7**. The total area of the zones with bushfire prone vegetation is 9,868m^2; being Zone 1 and 3 combined. In addition to the vegetated areas, the managed components of the park (Zone 2 and 4) had a combined area of 5,384m^2. It is noted that the VMP included several areas of vegetation outside of Arcadia Park that are located in the Kitchener Road road reserve.

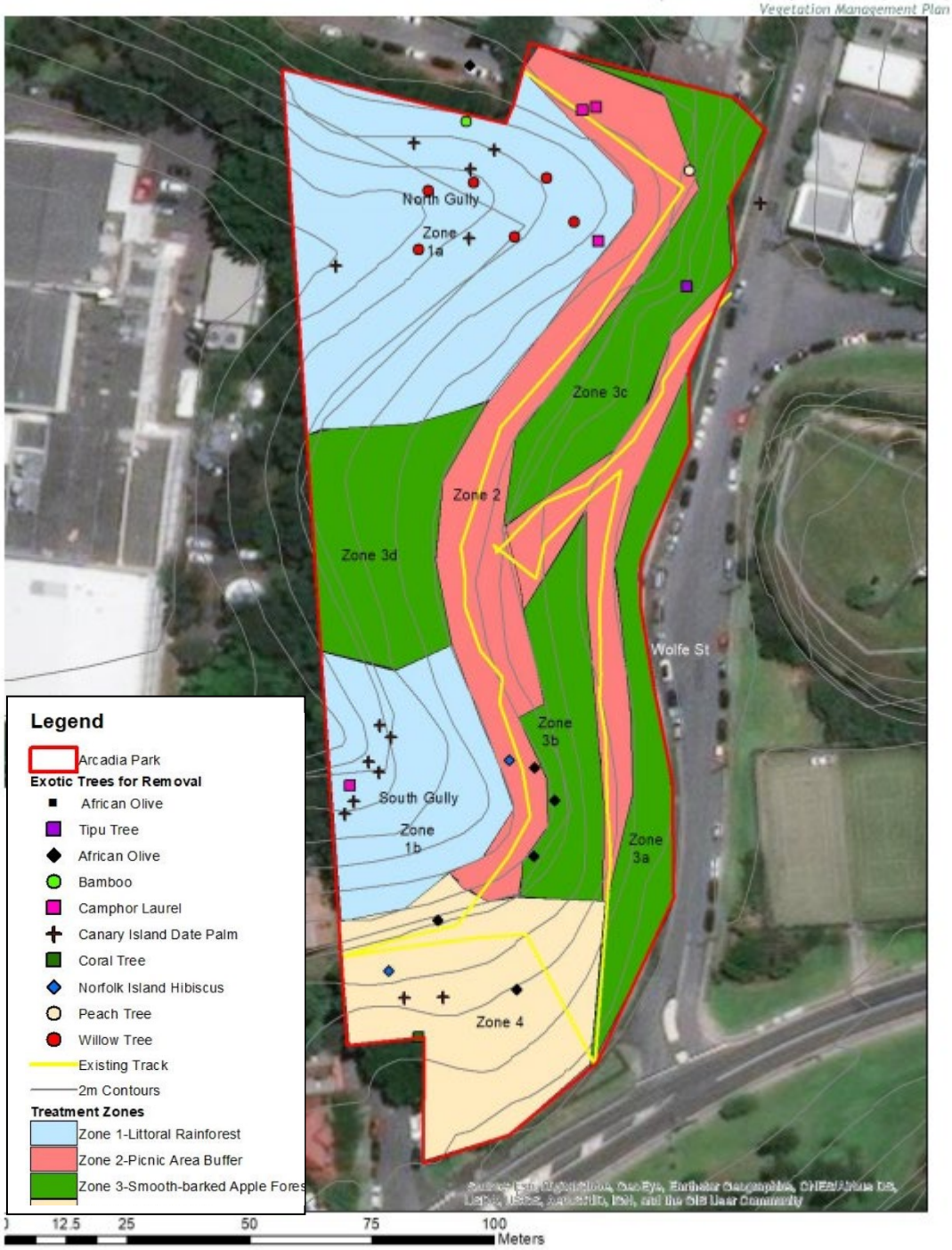
Table 1 Arcadia Park rehabilitation Zones

Treatment Zone	Objective	Description	Area
Zone 1	Littoral Rainforest *(rainforest)**	There are two gullies in Arcadia Park, one in the north west and one in the south west. These areas are considered suitable for the establishment of a Littoral Rainforest Community. Species selected for planting are consistent with the community profile descriptions from LHCCREMS (2003) MU 4 Littoral Rainforest and Bell's (1998) Littoral Rainforest (refer Table 3 for species list).	5,333m^2

Treatment Zone	Objective	Description	Area
Zone 2	Buffer Zone/Picnic Areas (*managed land*)*	Existing pathways and open space areas around picnic benches will be sparsely planted with upper and middle stratum species to maintain an open, parkland feel for passive recreation purposes.	3,300m^2
Zone 3	Smooth- barked Apple Woodland (*forest*)*	Areas outside of the gullies and existing tracks and parklands are suitable for the establishment of a Smooth-barked Apple Woodland. Flora species from this community currently occur in Arcadia Park and this community naturally occurs in the local area. Parts of this zone have however already been planted during recent bush regeneration works, using species mostly from a Littoral Rainforest Community. Removal of recently planted species is not necessary however any additional plantings are to use species listed for this zone in Table 3. Species selected for planting in the Smooth-barked Apple community are consistent with the community profile descriptions from LHCCREMS (2003) MU 30 Coastal Plains Smooth-barked Apple Woodland. However, this zone will be planted at a higher density than a "woodland" to prevent tracks and trails being created through the zone.	4,535m^2
Zone 4 [redacted]	Open Space *(managed land/ low threat vegetation)** [redacted]	The grassland area in the south of Arcadia Park under the Norfolk Island Pines will be retained for passive recreation. Minimal revegetation is required other than replacement of exotic canopy trees with native tree species.	2,084m^2

* *Equivalent Keith vegetation classification*

[redacted]



COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

Figure 2. Arcadia Park: Existing Environment & Proposed Treatment Zones
Newcastle City Council
Arcadia Park Job No. 170807 Date. 04/12/2017

Figure 7: Arcadia Park Vegetation Management Plan (Coast Ecology)

The VMP recommended a series of bushfire management measures including the following:

- Establishing an APZ around the boundary of Arcadia Park;
- Exclusion of planting canopy trees within the APZ;
- Maintenance of a sparse shrub layer (ie. covering no more than 20% of the APZ)
- Maintenance of the APZ by manually removing fine fuels from the APZ; and
    - The bushfire risk management of the site will need to allow for annual re-assessment of the risk as the vegetation establishes/ grows on the site.

The VMP also recommends the plant distribution to avoid trees within the APZ and the shrub density within the APZ is to be <20% coverage.

Further to the recommended APZs, the VMP recommended a 14m wide open area along the centreline of the existing access tracks. The 14m contained the existing track (up to 4m wide) with a 5m buffer either side.

The management measures recommended by the VMP including the APZs and cleared areas adjoining the existing tracks have not been implemented. Evidence of revegetation around the boundary of Arcadia Park was visible during the site inspection and shown in **Plate 11**; contrary to the recommendations of the VMP.

Whilst the vegetation assessment acknowledged the recommendations of the VMP, the bushfire hazard assessment assumed worst case scenario conditions whereby all vegetation was assessed at maturity; as required by PBP 2006.

It was observed during the April 2021 site inspection that none of the recommended bushfire mitigation measures had been implemented. Conversely, additional planting and revegetation has been completed that has further increased the structure and density of the vegetation; thereby resulting in more available biomass that may promote the spread of fire; particularly across the sub-storey/ surface.

As the additional planting has been carried out in areas of Arcadia Park already identified as unmanaged vegetation; the extent of the measurable bushfire hazard has not increased.

Plate 2: Looking west from The Obelisk over Arcadia Park over Wolfe Street (2019)

Plate 3: Looking into site from Wolfe Street (2019)

Plate 4: Zone 4 – active open space at southern end of Arcadia Park (2019)

Plate 5: Zone 4 – looking north below Wolfe Street (2019)

Plate 6: Newcastle East Primary School is located across Kitchener Parade, north of the site (2019)

Plate 7: Vehicle access to Arcadia Park is available at the eastern end of Kitchener Parade

Plate 8: April 2021 looking north towards Kitchener Parade

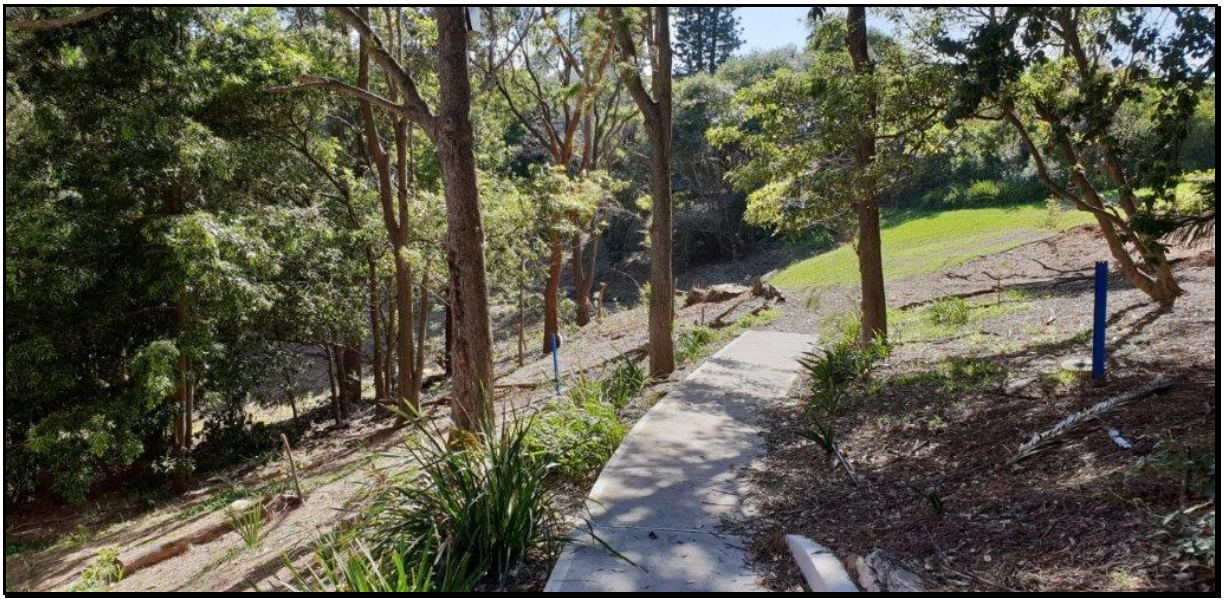


Plate 9: Concrete footpaths direct pedestrian traffic into Arcadia Park from The Terrace

Plate 10: Dual use vehicle access road and path from Kitchener Parade

Plate 11: Several areas of open space used for picnic areas scattered within the park

Plate 12: Zone 3b (Rainforest) up to park boundary

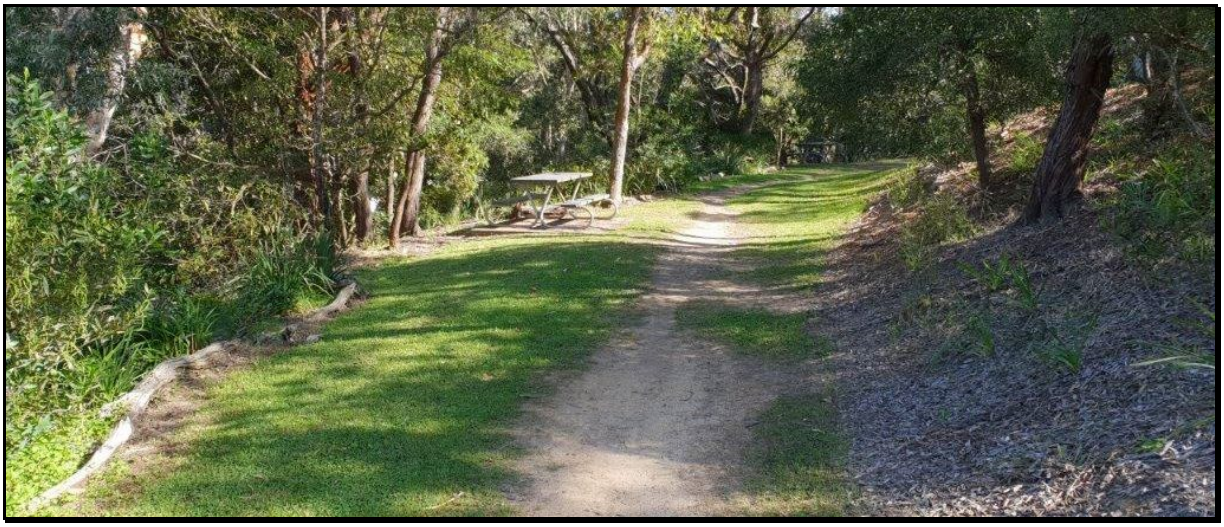


Plate 13: Picnic tables and access path looking north through Arcadia Park

Plate 14: April 2021 looking towards picnic tables

Plate 15: Interconnected paths within Arcadia Park separate surface fuel.

Plate 16: April 2021 looking towards divergent paths – noting growth in vegetation

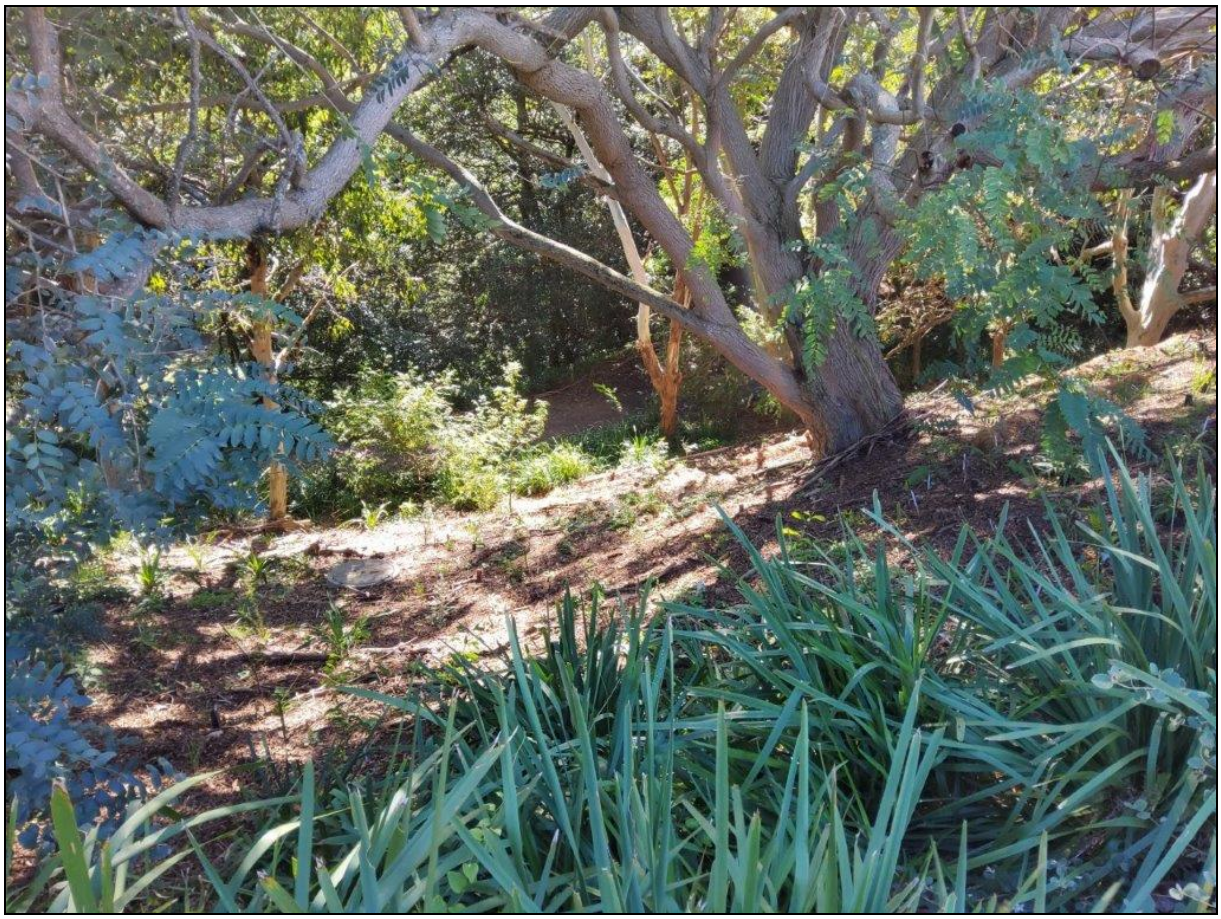


Plate 17: Active revegetation within 15m of the boundary of Arcadia Park is contrary to the VMP

Plate 18: Substantial new planting has increased the density of potentially hazardous vegetation adjoining the park boundary

Lot 1 DP204077 'The Hill'

Figure 8

Vegetation (Keith)

BUSHFIRE PLANNING AUSTRALIA

Subject Site

100m buffer

140m buffer

Watercourse

Vegetation Formation

Cleared

Coastal Floodplain Forests

SOURCE:
Cadastral Boundary: NSW Department of Finance, Services and Innovation 2018
Vegetation Formation: Vegetation Formations and Classes of NSW (version 3.03 - 200m Raster) - David A. Keith and Christopher C. Simpson.
VIS_ID 3848
Aerial Photo: NearMap 11/09/2018

N W E S

0 25 50 75 100 125 150 175 200 225 250 275 300 325 350 375 400 425 450 475 500 525 550 575 600 625
Meters

A3 Scale: 1:12,500

File:NBN_Studio_Fig03_VegKeith_181011 Date: 11/10/2018

Lot 1 DP204077 'The Hill'

Figure 9

Vegetation (Greater Hunter)

BUSHFIRE PLANNING AUSTRALIA

Subject Site

100m buffer

140m buffer

Keith Classification

Cleared/Managed Land

South Coast Sands Dry Sclerophyll Forests

SOURCE:
Cadastral Boundary: NSW Department of Finance, Services and Innovation 2018
Vegetation Formation: Greater Hunter Native Vegetation Mapping v4.0. VIS ID 3855
Aerial Photo: NearMap 19/09/2018

N
W E
S

0 50 100 150 200 250 300
Meters

A3 Scale: 1:6,000

File:NBN_Studio_Fig04_VegHunter_181011 Date: 11/10/2018

3.1.2. Vegetation Assessment

Following review of the available information; including the documents prepared on behalf of NCC by Coast Ecology and the site inspection, the existing vegetation observed within and surrounding the site is summarised in **Table 2**.

Table 2: Vegetation classifications

Direction of Bushfire Attack/ Transect	Vegetation or Other Infrastructure	Classification of Vegetation Formations AS3959-2009/ PBP 2006	Overall Fuel Load PBP 2006
T1 – west	*Urban land, road, multi-unit residential flat buildings, detached dwellings, school (SFPP)*	*Low-threat vegetation/ managed land*	<4.5 t/ ha
T2 – north east	*Urban land, road, multi-unit residential flat buildings, detached dwellings, water reservoir, school (SFPP)*	*Low-threat vegetation/ managed land*	<4.5 t/ ha
T3 - east	*Arcadia Park; urban park under restoration (<1 hectare)*	*Remnant vegetation (Rainforest)*	10 t/ ha
T4 - east	*Arcadia Park; urban park under restoration (<1 hectare)*	*Remnant vegetation (Rainforest)*	10 t/ ha
T5 – south east	*Arcadia Park; urban park under restoration (<1 hectare)*	*Remnant vegetation (Rainforest)*	10 t/ ha
T6 - south	*Urban land, road, multi-unit residential flat buildings, detached dwellings*	*Low-threat vegetation/ managed land*	<4.5 t/ ha
T7 -west	*Urban pocket park with several trees and managed surface (~1,000m^2)*	*Low-threat vegetation/ managed land*	<4.5 t/ ha

3.2. Slope Assessment

The slope assessment was undertaken as follows:

- Review of LiDAR point cloud data – including DEM (NSW LPI);
- Detail survey of existing and design contours; and
- Site inspection 24th October 2018 and 8th April 2021.

An assessment of the slope over a distance of 140m in the hazard direction from the site boundary was undertaken. The effective slope was then calculated under the classified vegetation where there was a fire run greater than 50m. The topography of the site has been evaluated to identify both the average slope and by identifying the maximum slope present. These values help determine the level of gradient which will most significantly influence the fire behaviour of the site.

The effective slope in all directions is shown in **Figure 10** and **Table 3.**

The final bushfire hazard assessment defining vegetation classifications and effective slope is shown in **Figure 11.**

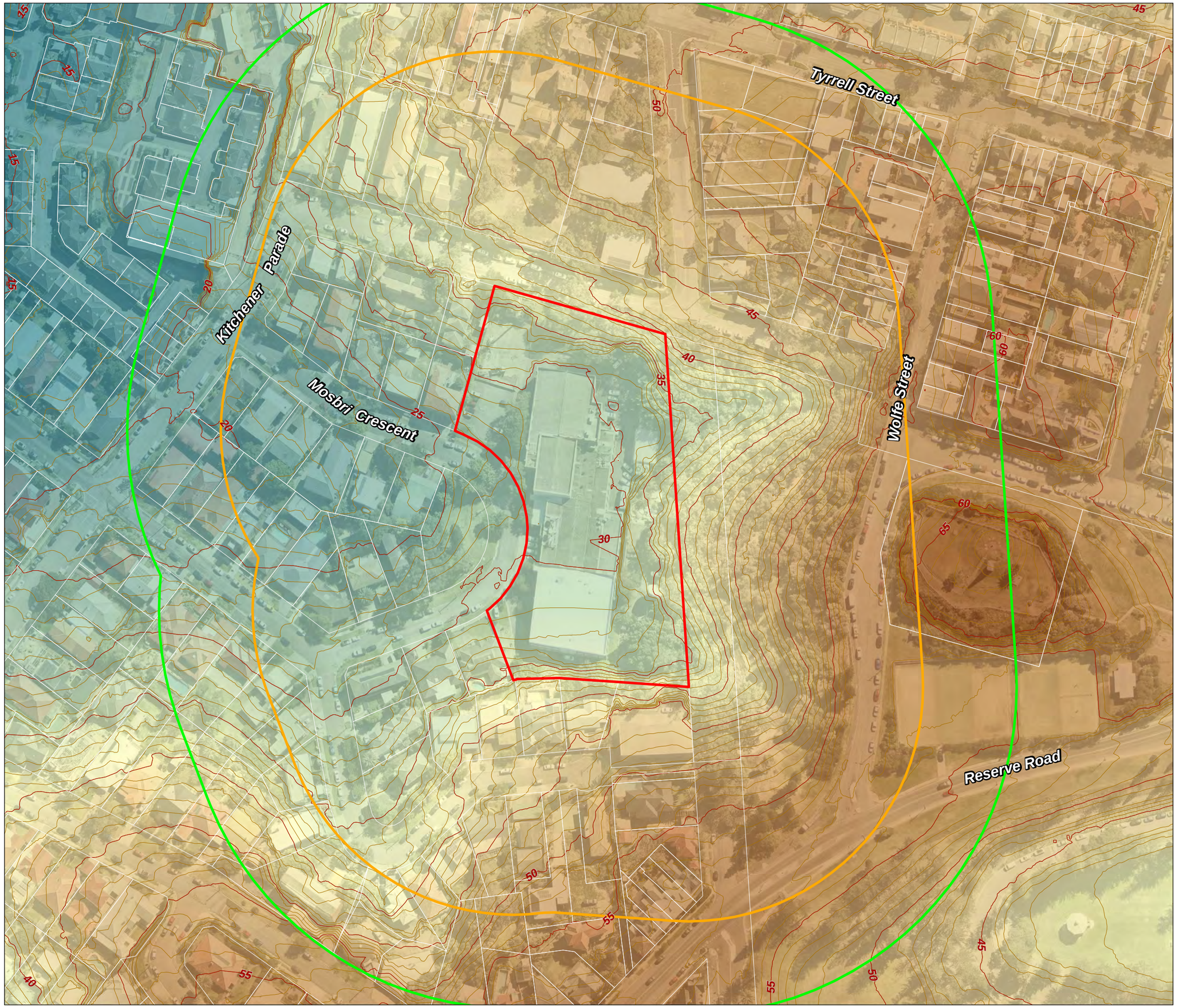
Table 3: Slope Analysis

Direction of Bushfire Attack/ Transect	Classification of Vegetation Formations AS3959-2009/ PBP 2006	Slope	Fire Run
T1 – west	*Low-threat vegetation/ managed land*	5.6°	n/a
T2 – north east	*Low-threat vegetation/ managed land*	-8.1°	n/a
T3 - east	*Remnant vegetation (Rainforest)*	-14.0° (-10°)	90m
T4 - east	*Remnant vegetation (Rainforest)*	-14.1° (-10°)	65m
T5 – south east	*Remnant vegetation (Rainforest)*	-16.3° (-10°)	65m
T6 - south	*Low-threat vegetation/ managed land*	-10.7° (-10°)	n/a
T7 - west	*Low-threat vegetation/ managed land*	5.4°	n/a

Lot 1 DP204077 'The Hill'

Figure 10

Elevation



BUSHFIRE PLANNING AUSTRALIA

- Subject Site
- 100m buffer
- 140m buffer
- Contour (5m)
- Contour (1m)

Elevation

High : 69.4m

Low : 7.9m

SOURCE:
Cadastral Boundary: NSW Department of Finance, Services and Innovation 2018
Surface analysis: Derived from Newcastle201409-LID1-AHD_3846354_56_0002_0002_1m © Department Finance, Services and Innovation 2011
Aerial Photo: NearMap 19/09/2018

N W E S

0 25 50 75
Meters

A3 Scale: 1:1,500

File:NBN_Studio_Fig05_Elevation_181011 Date: 11/10/2018

GEOVIEW
GIS & mapping solutions for infrastructure, town planning & environmental management

Lot 1 DP204077 'The Hill'

Figure 11

Slope and Vegetation Assessment

BUSHFIRE PLANNING AUSTRALIA

- Subject Site
- 100m buffer
- 140m buffer
- RL
- Transect
- Contour (5m)
- Contour (1m)
- SFPP
- Proposed Level 2 building
- Existing walking tracks
- Zone 1: Hunter Macleay DSF (Coastal Foothills Spotted Gum – Ironbark Forest) (5,333m²)
- Zone 2: Managed Land/ Low Threat (Picnic Area Buffer) (2,084m²)
- Zone 3: Sydney Coastal DSF (Coastal Plains Smooth-barked Apple Woodland) (3,300m²)
- Zone 4: Managed Land/ Low Threat (Open space) (4,535m²)

SOURCE:
Cadastral Boundary: NSW Department of Finance, Services and Innovation 2018
Surface analysis: Derived from Newcastle201409-LID1-AHD_3846354_56_0002_0002_1m © Department Finance, Services and Innovation 2011
Vegetation Mapping: Coast Ecology VMP 7th Feb 2018
Aerial Photo: NearMap 19/09/2018

N W E S

0 25 50 75
Meters

A3 Scale: 1:1,500

File:NBN_Studio_Fig06_SlopeVeg_190409 Date: 9/04/2019

GEOVIEW
GIS & mapping solutions for infrastructure, town planning & environmental management

3.3. Significant Environmental Features

There are no known environmental features of significance within the development footprint or the balance of the site. The development footprint is wholly located within that part of the site that is predominantly cleared.

3.4. Threatened Species, populations or ecological communities

The area of the site to be affected by the proposed development has been identified to avoid impact on any threatened species, population or EEC. All bushfire mitigation measures; including APZs have considered the existing and potential biodiversity values to avoid impact where possible.

3.5. Aboriginal Objects

An updated search (3 May 2021) of the AHIMS database (results contained in **Appendix B**) confirmed there are no Aboriginal sites or places recorded in or near the subject site. However, a recent Aboriginal Due Diligence Assessment for the proposed development completed by Umwelt Consultants (27 April 2021) observed an artefact along the northern boundary of the site. Whilst the proposed bushfire mitigation measures will not affect the artefact, it is understood further investigation will be completed to assess the impact of the development on the identified artefact.

4. Bushfire Protection Measures

This BTA has adopted the methodology to determine the appropriate Bushfire Protection Measures (BPMs) detailed in PBP 2006. As part of the BTA, the recommended BPMs demonstrate the aims and objectives of PBP 2006 have been satisified; includinig the matters considered by the RFS necessary to protect persons, property and the environment from the danger that may arise from a bushfire.

4.1. Asset Protection Zones

An APZ is an area surrounding a development that is managed to reduce the bushfire hazard to an acceptable level to mitigate the risk to life and property. The required width of the APZ varies with slope and the type of hazard. An APZ can consist of both an inner protection area (IPA) and an outer protection area (OPA). In this instance the entire APZ and the balance of the development site shall be managed as an IPA.

An APZ can include the following:

- Lawns;
- Discontinuous gardens;
- Swimming pools;
- Roads, driveways and managed verges;
- Unattached non-combustible garages with suitable separation from the dwelling;
- Open space / parkland; and
- Car parking.

The presence of a few shrubs or trees in the APZ is acceptable provided that they:

- Do not touch or overhang any buildings;
- Are well spread out and do not form a continuous canopy;
- Are not species that retain dead material or deposit excessive quantities of ground fuel in a short period or in a danger period; and
- Are located far enough away from any dwelling so that they will not ignite the dwelling by direct flame contact or radiant heat emission.

Woodpiles, wooden sheds, combustible material storage areas, large areas / quantities of garden mulch, stacked flammable building materials etc. are not be recommended in the APZ.

4.1.1. Determining the Appropriate Setbacks

Previously, areas of vegetation less than 1 hectare would be excluded from being classified as bushfire prone; which was supported by AS3959-2009. Accordingly, there would be no requirement for APZs. Although the RFS recognise the lower risk presented by these small parcels of land, the RFS position is that they remain a threat and therefore must be assessed as a hazard. The dispensation offered by the RFS is that these areas should be assessed as a rainforest; and the APZs for *rainforest* may be applied; regardless of the classification of the existing vegetation.

In determining the appropriate setbacks, the bushfire mitigation measures to be implemented by NCC within Arcadia Park have been considered. In addition to the 9m setback from the eastern site boundary and the residential buildings, a minimum 10m APZ (up to 18m) is to be established within Arcadia Park by NCC in accordance with the recommendations of the Coast Ecology VMP; equalling a combined minimum 18m setback between the nearest unmanaged bushfire hazard and the residential building.

Regardless of the APZ to be established within Arcadia Park by NCC, an assessment based on the unique site characteristics identified by the BAR was undertaken to determine the minimum required APZs. Accordingly, the intensity of a bushfire event presented as the radiant heat exposure was calculated at several locations throughout the development site.

The site lies within the Newcastle City Council LGA and therefore is assessed under a FDI rating of 100. The Detailed Method (Method 2) outlined in Australian Standard AS3959-2009 Construction of buildings in bushfire prone areas was used to confirm the Bushfire Attack Level for the development. The BAL assessor report detailing the inputs used is contained in **Appendix E**.

Refer to **Table 4** for the recommended APZs.

Table 4: Recommended APZ setbacks

Direction of Bushfire Attack/ Transect	Classification of Vegetation Formations AS3959-2009/ PBP 2006	Slope	APZ 29kW/m^2
T1 – west	*Low-threat vegetation/ managed land*	5.6°	0m
T2 – north east	*Low-threat vegetation/ managed land*	-8.1°	0m
T3 - east	*Remnant vegetation (Rainforest)*	-14.0° (-10°)	6m
T4 - east	*Remnant vegetation (Rainforest)*	-14.1° (-10°)	6m
T5 – south east	*Remnant vegetation (Rainforest)*	-16.3° (-10°)	6m
T6 - south	*Low-threat vegetation/ managed land*	-10.7° (-10°)	0m
T7 - west	*Low-threat vegetation/ managed land*	5.4°	0m

The APZs detailed in **Table 4** are considered to provide sufficient separation distance between the proposed development and the nearest vegetation; exclusive of the APZs to be established in Arcadia Park.

Notwithstanding the previous commentary regarding the exclusion of the vegetation within Arcadia Park as a hazard, an assessment to determine the maximum potential radiant heat exposure was completed; assuming *rainforest* vegetation in unmanaged conditions on a 10 degree upslope. As the buildings are to be located a minimum 9m from the site boundary, the maximum radiant heat exposure the buildings would be exposed to was determined to be less than 15kW/m^2 (14.57kW/m^2).

Based on the above assessment, the 9m separation between the proposed buildings and Arcadia Park will minimise the bushfire risk to the future buildings during a bushfire to an acceptable level; regardless of the APZs to be established by NCC within Arcadia Park.

4.2. Access

In the unlikely event of a serious bushfire, it will be essential to ensure that adequate ingress / egress and the provision of defendable space is afforded to the development. Although the development contains no new roads, the development is required to provide on-site parking in accordance with the relevant development control plan.

PBP 2006 has no specific access requirements for multi-level residential developments; in addition to the standard requirement detailed in section 4.1.3 of PBP 2006. As the development has a street frontage to Mosbri Crescent, and direct access to all on-site parking is available, the proposed development satisfies the access requirement under PBP 2006.

Refer to **Appendix 1** for proposed development showing access.

4.3. Fire Brigade Intervention

The nearest NSW Fire & Rescue brigade is 1.3km from the site at 44 Union Street, Cooks Hill; with relatively easy access with several alternate routes and a response within 4 minutes upon leaving the station.

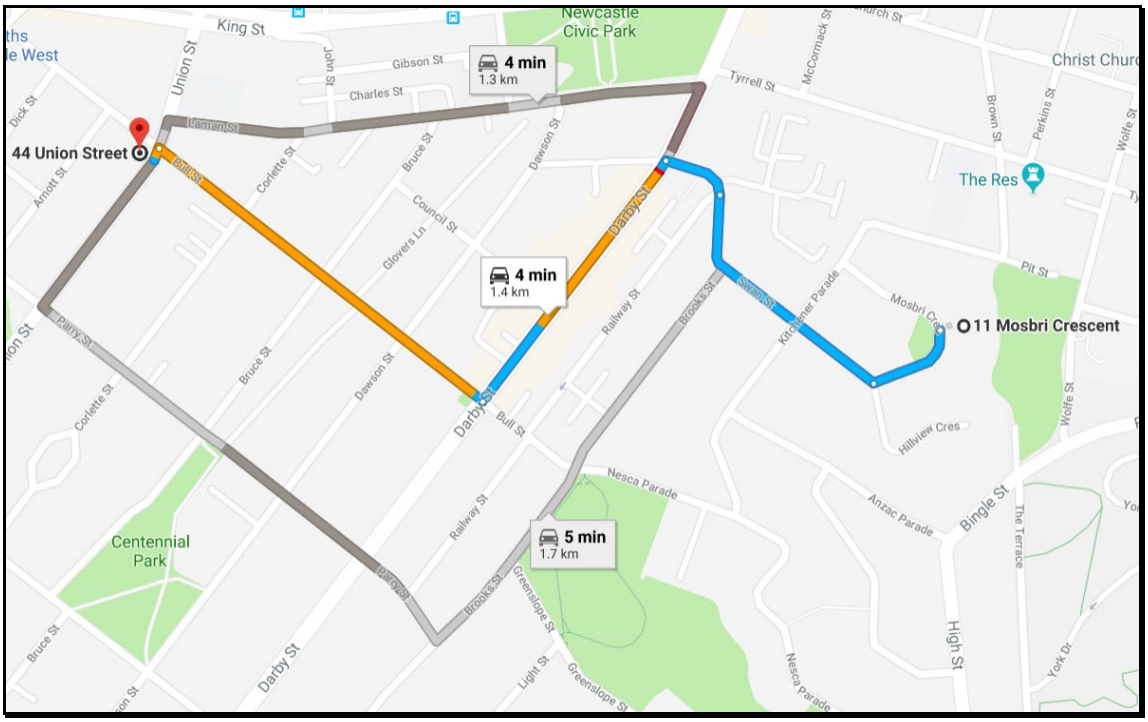


Figure 12: Route to site from nearest NSW Fire & Rescue brigade

4.4. Services – water electricity and gas

4.4.1. Water

Fire hydrant spacing, sizing and pressure should comply with AS 2419.1 – 2005. Hydrants are not to be located within any road carriageway.

The proposed development will be connected to the internal reticulated water supply.

4.4.2. Electricity

All electricity services are located underground.

4.4.3. Gas

Any reticulated or bottled gas should be installed and maintained according to the requirements of the relevant authorities and AS 159-2002. It is expected that the location of gas services will not lead to ignition of surrounding bushland or the fabric of buildings.

4.5. Construction Standards – Bushfire Attack Level

All buildings; including multi-unit buildings, constructed within the site must satisfy the Performance Requirements of the National Construction Code: Building Code of Australia (BCA). The BCA applies to dwellings located within designated bushfire areas, which are defined as:

> *Land which has been designated under a power in legislation as being subject, or likely to be subject to, bushfires.*

The *Deemed-to-Satisfy* (DTS) provisions of the BCA can only be achieved if buildings in bushfire prone areas are constructed in accordance with Australian Standard *AS3959-2009 Construction of buildings in bushfire prone areas*.

Building design and the materials used for construction of future dwellings should be chosen based on the information contained within AS3959-2009, and accordingly the designer/architect should be made aware of this recommendation.

As part of satisifying the BCA, a sprinkler system will be installed in all units, including internal areas and external balconies. As shown in the architectural drawings in **Appendix A**, the façade/s of the entire eastern elevations of Buildings A, B, C are setback from the edge of the building by balconies. In addition, the majority of the glazed elements providing access to the balconies will require sliding doors.

The determinations of the appropriate bushfire attack level (BAL) is based on the maximum potential radiant heat exposure. BALs are based upon parameters such as weather modelling, fire-line intensity, flame length calculations, as well as vegetation and fuel load analysis. The determination of the BAL is derived by assessing the:

- Relevant FDI = 100;
- Flame temperature = 1090K;
- Slope = upslope;
- Vegetation classification = <*1 hectare*; and
- Building location.

Section 2.2.3.2 of AS3959-2009 excludes areas of vegetation less than 1 hectare and not within 100m of other areas of vegetation being classified. In these instances, the BAL shall be classified as BAL-LOW. The identified bushfire hazard nearest to the subject site was calculated by Coast Ecology; and verified by BPA, as having an area of less than 1 hectare. Following the establishment of the recommended APZs and open area clearing alongside the existing tracks, the area of unmanaged vegetation (in accordance with RFS requirements for vegetation management) will be considerably less than 1 hectare.

Similar to AS3959-2009, the RFS Guide for Bush Fire Prone Land Mapping also excludes areas of vegetation less than 1 hectare from being classified as a bushfire hazard. Notwithstanding the Australian Standard and a supporting RFS guideline, PBP 2006 takes precedence in development assessment. Therefore, irrespective of AS3959-2009 and the RFS guidelines; parcels of vegetation less than 1 hectare should be treated as remnant for development assessment purposes. Consequently, APZ and construction standards should be applied accordingly.

Further investigation was undertaken by Petersen Bushfire subsequent to the RFS issuing the BFSA in June 2019 focusing on re-classifying the vegetation within Arcadia Park as a low-hazard in accordance with the provisions for Low Threat Vegetation – Exclusions outlined in Section A1.4 of PBP 2019. Similar to calculations contained in the VMP completed by Coast Ecology, Petersen Bushfire confirmed the extent of the measurable bushfire hazard was 1 hectare or less. A report was submitted to the RFS in 2020 seeking a re-assessment of the BFSA, in particular the BAL ratings. Based on the bushfire hazard being less than 1 hectare in area, the provisions of PBP 2019 exclude the vegetation from being considered for the purposes of PBP 2019. Subsequent correspondence from the

RFS did not support these findings (including the Coast Ecology VMP) and reaffirmed the vegetation within the park cannot be excluded under section A1.10 of PBP 2019.

With regard to recommending a combination of bushfire mitigations measures for the proposed development, this BAR has previously demonstrated the proposed development is able to provide the required APZ and other bushfire mitigation measures such as access and utility supplies. For the purpose of completing this assessment, the BAL for the proposed development has been calculated for completeness.

The Detailed Method (Method 2) outlined in AS3959-2009 was used to calculate the Bushfire Attack Level (BAL) for the development. The NBC Bushfire Attack Assessor V3.0 was used to model the bushfire radiant heat exposure which determined the applicable BAL. Refer to **Table 5** and **Figure 14** for the distance between the classified bushfire hazard and the proposed dwelling lots. The BAL Assessor Report is contained in **Appendix E**.

Table 5: Potential BAL Assessment (AS3959-2009 – Method 2)

Transect/ Direction	Vegetation Classification AS3959-2009	Slope	APZ (29kW/m^2)	Distance from Hazard	Bushfire Attack Level (BAL)
T3, T4, T5 East	*Rainforest*	10° upslope	6m	0m-<5m	BAL-FZ
				5m-<6m	BAL-40
				6m-<8m	BAL-29
				8m-<10m	BAL-19
				10m-<100m	BAL-12.5

As the proposed development is setback 9m from the eastern site boundary, the BAL assessment concluded that a BAL-19 rating would apply; if the identified bushfire hazard was not excluded. However, Section 4 of AS3959-2009 does not provide additional construction requirements where there is insufficient risk to warrant specific construction requirements. This conclusion is predicated on low threat vegetation and non-vegetated areas; being those areas that satisfy the requirements of Clause 2.2.3.2 of AS3959-2009.

Although the small parcel of vegetation within Arcadia Park is unlikely to support a fully developed, the BAR calculated the required BALs; commensurate with the bushfire risk the development was exposed. The results of the modelling confirmed that only the eastern elevations of Buildings A, B and C were rated BAL-29. All other elevations were potentially be exposed to radiant heat levels less than 12.5kW/m^2; being **BAL-12.5**.

Supported by the Bush Fire Prone Land Mapping (**Figure 2**), the area of the site where the proposed townhouses are sited is not mapped as being within the vegetation buffer. Although the site is identified as designated bush fire prone land, only a portion of the site is mapped as being bushfire prone. With consideration to the RFS and CoN mapping, and accounting for the placement of the townhouses directly on Mosbri Crescent it was determined that the townhouses would have no direct exposure to the source of bushfire attack, should a Arcadia Park be able to support a fire of any intensity. The siting of Buildings A, B, C shield the townhouses from any direct bushfire attack. The townhouses are a minimum 50m from the eastern property boundary, and only 2 narrow (<9m wide) gaps between the buildings. Furthermore, the highest level of the townhouses is approximately the same elevation as the lowest level of Arcadia Park (**Figure 13**).

In summary the recommended BALs for each aspect of the development have carefully been considered based on the risk profile each elevation and the component is exposed to.

It was found that the townhouses would not be exposed to sufficient risk to warrant any bushfire construction requirements; including measures to protect the buildings from ember attack. Due to the scale of Buildings A, B and C, being 20m high; low threat bushfire hazard the development is exposed; proximity to the coastline and typical prevailing coastal winds; it is considered highly unlikely that the townhouses would be

subject to extreme ember attack. A fire igniting within hazardous vegetation; including the species contained within the hazard, is unlikely to gather sufficient energy or support a fire of sufficient scale to enable to discharge of embers that would carry far enough, with enough heat to impact on any materials on/ within the townhouses. For this reason it is unnecessary for the townhouses to be constructed to withstand ember attack.

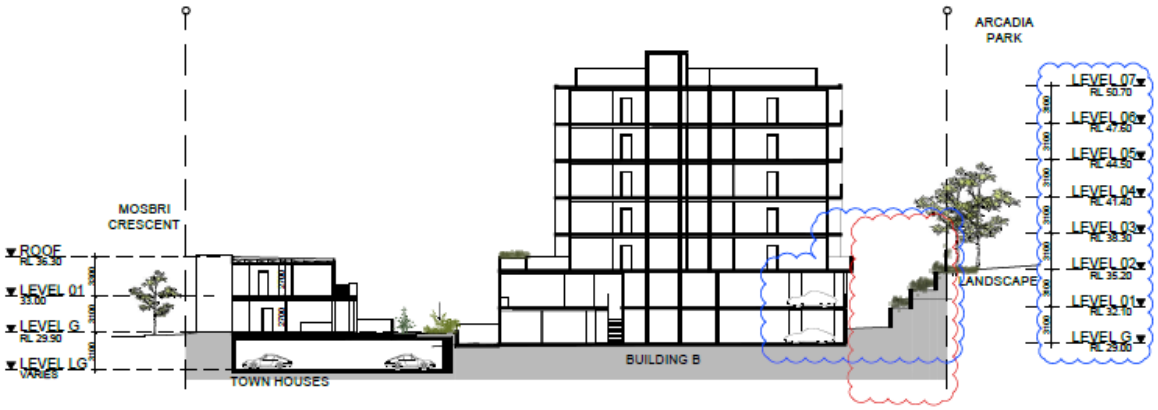


Figure 13: Section – looking south towards townhouses and Building B

Lot 1 DP204077 'The Hill'

Figure 14

BAL Contour Plan

BUSHFIRE PLANNING AUSTRALIA

- Subject Site
- 100m buffer
- 140m buffer
- RL
- Transect
- SFPP
- Proposed Level 2 building
- APZ
- Existing walking tracks
- Zone 1: Hunter Macleay DSF (Coastal Foothills Spotted Gum – Ironbark Forest) (5,333m²)
- Zone 2: Managed Land/ Low Threat (Picnic Area Buffer) (2,084m²)
- Zone 3: Sydney Coastal DSF (Coastal Plains Smooth-barked Apple Woodland) (3,300m²)
- Zone 4: Managed Land/ Low Threat (Open space) (4,535m²)

Required Bushfire Attack Levels (AS3959-2009)

- BAL - FZ
- BAL - 40
- BAL - 29
- BAL - 19
- BAL - 12.5

Indicative Flame Width (SFR)

SOURCE:
Cadastral Boundary: NSW Department of Finance, Services and Innovation 2018
Surface analysis: Derived from Newcastle201409-LID1-AHD_3846354_56_0002_0002_1m © Department Finance, Services and Innovation 2011
Vegetation Mapping: Coast Ecology VMP 7th Feb 2018
Aerial Photo: NearMap 19/09/2018

N W E S

0 25
Meters

A3 Scale: 1:800

File:NBN_Studio_Fig07_BALs_190409 Date: 9/04/2019

GEOVIEW
GIS & mapping solutions for infrastructure, town planning & environmental management

4.6. Landscaping and Vegetation Management

In APZs and IPAs, the design and management of the landscaped areas in the vicinity of buildings have the potential to improve the chances of survival of people and buildings. Reduction of fuel does not require the removal of all vegetation. Trees and plants can provide some bushfire protection from strong winds, intense heat and flying embers (by filtering embers) and changing wind patterns.

Generally landscaping in and around a bushfire hazard should consider the following:

- Priority given to retaining species that have a low flammability;
- Priority given to retaining species which do not drop much litter in the bushfire season and which do not drop litter that persists as ground fuel in the bush fire season;
- Priority given to retaining smooth barked species over stringy bark; and
- Create discontinuous or gaps in the vegetation to slow down or break the progress of fire towards the dwellings.

Landscaping within APZs and IPAs should give due regard to fire retardant plants and ensure that fuel loads do not accumulate as a result of the selected plant varieties.

The principles of landscaping for bushfire protection aim to:

- Prevent flame impingement on dwellings;
- Provide a defendable space for property protection;
- Reduce fire spread;
- Deflect and filter embers;
- Provide shelter from radiant heat; and
- Reduce wind speed.

Plants that are less flammable have the following features;

- High moisture content;
- High levels of salt;
- Low volatile oil content of leaves;
- Smooth barks without ‘ribbons’ hanging from branches or trunks; and
- Dense crown and elevated branches.

Avoiding understorey planting and regular trimming of the lower limbs of trees also assists in reducing fire penetration into the canopy. Rainforests species such as Syzygium and figs are preferred to species with high fine fuel and/or oil content.

Trees with loose, fibrous or stringy bark should be avoided. These trees can easily ignite and encourage ground fire to spread up to, and then through the crown of trees.

Consideration should be given to vegetation fuel loads present on site with particular attention to APZs.

Careful thought must be given to the type and physical location of any proposed site landscaping. Inappropriately selected and positioned vegetation has the potential to ‘replace’ any previously removed fuel load.

Bearing in mind the desired aesthetic and environment sought by site landscaping, some basic principles have been recommended to help minimise the chance of such works contributing to the potential hazard on site.

Whilst it is recognised that fire-retardant plant species are not always the most aesthetically pleasing choice for site landscaping, the need for adequate protection of life and property requires that a suitable balance between visual and safety concerns be considered.

It is reiterated again that it is essential that any landscaped areas and surrounds are subject to ongoing fuel management and reduction to ensure that fine fuels do not build up.

5. Conclusion and Recommendations

Bushfire Planning Australia has been engaged by Crescent Newcastle Pty Ltd to undertake a Bushfire Assessment Report for the proposed construction of 172 new residential dwellings; comprising eleven (11) two storey townhouses and 161 units contained in four (4) multi-level buildings.

An amended development application has been lodged with the City of Newcastle (CoN) seeking minor modifications to the proposed development. As noted above, the modifications to the proposed development made in 2020; including the reduction in building height, do not affect the proposed built form or require amendments to the recommended bushfire mitigation measures. The modifications are limited to mitigating potential mine subsidence.

The modified submission is being lodged with Council as part of the original Development Application (DA2019/00061), accordingly the BAR remains valid with regard to addressing the provisions contained in Planning for Bushfire Protection 2006 (PBP 2006) as the original DA was submitted prior to the adoption of Planning for Bushfire Protection 2019 (PBP 2019) in March 2020.

The bushfire hazard assessment contained in the original BAR was reviewed to ensure the findings remained valid. The revised assessment re-affirmed the site was exposed to a low-risk bushfire hazard mainly located to the east of the subject site. The bushfire hazard is located within a CoN owned and managed park (Arcadia Park) which is currently under restoration. The reporting commissioned by CoN determined the area of unmanaged vegetation to be less than 1 hectare.

The proposed development is able to achieve an acceptable level of protection from bushfire which can be achieved through a combination of strategies. The following recommendations have been generated to enable the proposed development to achieve the aims and objectives of PBP 2006; commensurate to the actual bushfire risk the individual components of the proposed development will be exposed to:

1. The entire site shall be managed as an Inner Protection Area (IPA) as outlined within section 4.1.3 of PBP 2006 and Appendix 5 of PBP 2006 and the RFS document *Standards for asset protection zones*;
2. All townhouses fronting Mosbri Crescent are rated BAL-LOW as there is insufficient risk to warrant specific bushfire construction requirements and the townhouses will be shielded from the low-threat hazard by 3 multi-storey buildings;
3. Eastern elevations of Buildings A, B and C are rated BAL-29;
4. The northern and southern elevations of Buildings A, B and C are rated BAL-19;
5. The western elevation of Buildings A, B and C are rated BAL-12.5;
6. The new buildings are to be linked to a reliable water supply network and that suitable fire hydrants are located throughout the development site that are clearly marked and provided for the purposes of bushfire protection. Fire hydrant spacing, sizing and pressure shall comply with AS2419.1 2005 and section 4.1.3 of PBP 2006; and
7. Consideration should be given to landscaping and fuel loads on site to decrease potential fire hazards on site.

These recommendations are based on a thorough assessment of the bushfire threat under Planning for Bushfire Protection 2006. The compliance tables in **Appendix F** demonstrate the development satisfies the aims and objectives of PBP 2006 and the specific objectives for infill development.

In conclusion, should the recommendations above be duly considered and incorporated, the bushfire hazard present should be reduced to a level considered necessary to provide an adequate level of protection to life and property of the site, however they do not and cannot guarantee that the area will not be affected by a bushfire at any time.

6. References

- Coast Ecology (2018) *Biodiversity Assessment*, *The City of Newcastle Proposed Restoration of Arcadia Park, The Hill* (Coast Ecology Job No: 170807 7 February 2018)
- Coast Ecology (2018) *Review of Environmental Factors, The City of Newcastle Proposed Restoration of Arcadia Park, The Hill* (Coast Ecology Job No: 170807 7 February 2018)
- Coast Ecology (2018) Vegetation Management Plan, *The City of Newcastle Proposed Restoration of Arcadia Park, The Hill* (Coast Ecology Job No: 170807 7 February 2018)
- NSW Rural Fire Service (2005). *Standards for Asset Protection Zones*. NSW Rural Fire Service.
- NSW Rural Fire Service (2006). *Planning for Bushfire Protection – A Guide for Councils*, Planners, Fire Authorities, Developers and Home Owners.
- Ramsay, GC and Dawkins, D (1993). *Building in Bushfire-prone Areas – Information and Advice*. CSIRO and Standards Australia.
- Rural Fires and Environmental Assessment Legislation Amendment Act 2002.
- Standards Australia (2009). AS 3959 – 2009: Construction of Buildings in Bushfire-prone Areas.

Appendix A: Architectural Drawings

Marchese Partners

UPDATED PLANS AVAILABLE ON REQUEST

Appendix B: Biodiversity Assessment

Coast Ecology

NEWCASTLE CITY COUNCIL

Proposed Restoration of Arcadia Park, The Hill

BIODIVERSTIY ASSESSMENT

Job No: 170807

Date: 7 February 2018

Vendor Nbr: 10677

COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

PO Box 3005 Wamberal NSW 2260
T: 0404 858573 E: kristy@coastecology.com.au W: coastecology.com.au
Kristy McQueen operates as a Sole Trader under registered business name Coast Ecology ABN: 24 924 674 371

Proposed Restoration of Arcadia Park, The Hill, Biodiversity Assessment

Issue	Date	Description	Author	Reviewed By
A	04/12/2017	DRAFT	KM	MM
B	07/02/2018	FINAL	KM	NCC

PO Box 3005 Wamberal NSW 2260
T: 0404 858573 E: kristy@coastecology.com.au W: coastecology.com.au
Kristy McQueen operates as a Sole Trader under registered business name Coast Ecology ABN: 24 924 674 371

EXECUTIVE SUMMARY

Newcastle City Council engaged Coast Ecology to prepare a Biodiversity Assessment (BA) to consider potential impacts of the proposed restoration of Arcadia Park on any threatened species or communities.

The BioNet database search reported 2,050 records of 44 threatened species and 25 Endangered Ecological Communities (EEC's) that had previously been recorded in the Study Area. A Protected Matters search reported 71 listed threatened species and 70 listed migratory species from the Study Area. Of these, 12 threatened fauna species and 2 threatened flora species were considered to have potential marginal habitat on the Site. It was concluded that the proposed restoration works are unlikely to significantly impact any threatened and/or migratory species listed under state or federal legislation as the site does not provide important habitat features for these threatened species and the restoration works are minor in that they do not impact the habitat that threatened species may only utilise occasionally (i.e. clearing of only exotic trees and some *Acacia binervia* at the end of their lifespan).

State Legislation

The assessment of significance of impact on threatened flora and fauna with potential habitat on the site concluded that the proposed restoration works are unlikely to adversely affect these species such that a viable local population of the species is likely to be placed at risk of extinction. This is based on the limited breeding and roosting habitat available in Arcadia Park and the minor nature of the works which involves clearing of exotic canopy trees and native Acacia species at the end of their lifespan. As such, a Species Impact Statement or entry into the Biodiversity Offset Scheme is not required for the proposed restoration works.

Federal Legislation

Following an assessment of significance, it was concluded that the proposed restoration works would not have a significant impact on the threatened Grey-headed Flying-fox, Swift Parrot or Koala as Arcadia Park does not support an important population of these species as it provides only limited foraging opportunities and no breeding or roosting habitat. The proposed restoration will not result in an alteration in the availability or quality of habitat to the extent that the species is likely to decline, and no harmful invasive species or disease will become established in the threatened species' habitat or interfere with the recovery of these species. Based on the above assessment it is considered that a referral to SEWPaC is not required.

CONTENTS

1. INTRODUCTION 5
2. THE SITE/STUDY AREA 5
3. PROPOSED WORKS 5
4. DESKTOP STUDIES 6
4.1 DATABASE SEARCHES 6
4.2 VEGETATION MAPPING 7
4.2.1 LHCCREMS (2003) 7
5. FIELD SURVEYS 8
5.1 FLORA 8
5.2 VEGETATION MAPPING 8
5.2.1 SOUTHERN GULLY 9
5.2.2 NORTHERN GULLY 10
5.2.3 PICNIC AREAS 11
5.2.4 WOLFE STREET ROADSIDE 12
5.3 FAUNA/HABITAT ASSESSMENT 13
6. ASSESSMENT OF SIGNIFICANCE: BC ACT 17
7. ASSESSMENT OF SIGNIFICANCE: EPBC ACT 17
8. RECOMMENDATIONS 18
9. REFERENCES 18
10. FIGURES 19
11. APPENDIX A: DESKTOP RESULTS 26
12. APPENDIX B: HABITAT ASSESSMENT 41
13. APPENDIX C: ASSESSMENT OF SIGNIFICANCE: BC ACT 52
14. APPENDIX D: ASSESSMENT OF SIGNIFICANCE: EPBC ACT 64

1. INTRODUCTION

Newcastle City Council (NCC) engaged Coast Ecology to prepare a Vegetation Management Plan (VMP) for the restoration of vegetation at Arcadia Park, The Hill. To facilitate the restoration works, Council requires approval under Part 5 of the Environmental Planning & Assessment Act 1979 (EP&A Act) and is thus required to prepare a Review of Environmental Factors (REF). This Biodiversity Assessment (BA) informs the REF.

2. THE SITE/STUDY AREA

Arcadia Park covers an area of approximately 1.5 ha and is bound by Wolfe Street to the east, Pit Street to the north, commercial development (NBN building) to the east and Reserve Road to the south at The Hill in Newcastle. As the name suggests, The Hill is a suburb of Newcastle that has a higher elevation than adjoining coastal suburbs. It adjoins Newcastle's central business district and is 500 metres from Newcastle Beach (Figures 1& 2).

The Study Area is defined as a 10 x 10 km area centred on Arcadia Park and includes the broader local area which may be impacted upon, either directly or indirectly. Database searches are conducted within this Study Area limit (Figures 3&4).

3. PROPOSED WORKS

Restoration works aim to improve the natural diversity within Arcadia Park by replacing exotic vegetation with native vegetation. More specifically, the two gully's within Arcadia Park will be restored to a Littoral Rainforest community and the remainder of the park will be restored to an open forest resembling a vegetation community endemic to the area.

Key Restoration activities include:

- Primary weed removal across the park, which would require removal of large exotic tree species. Middle stratum is sparse but is largely native and/or recently planted. The lower stratum consists mainly of exotic grasses and herbs which will be either physically removed, treated with appropriate herbicide in accordance with product instructions or treated with solarisation as appropriate.
- Removal of up to 50% of Coast Myall *Acacia binervia* previously planted on the site which have now reached the end of their life and are either dead or in poor health (Photograph 1)
- Mulching of trees *in-situ* and stockpiling of mulch
- Spreading of mulch (once it has matured 2-4 months)
- Re-planting across the park using tube stock of appropriate species
- Ongoing maintenance of planted species, including watering and replacement planting.
- Ongoing secondary weed removal for 4 years.
- Installation and monitoring of 21 nest boxes

Photograph 1. Dead Coast Myall Acacia binervia proposed for removal

4. DESKTOP STUDIES

4.1 DATABASE SEARCHES

A database search was conducted within a 10 x 10 km area centred on Arcadia Park from the following databases:

- BioNet website for the Atlas of NSW Wildlife. BioNet is a portal for accessing government held information about plants and animals in NSW. It is supported by several NSW government held agencies including Office of Environment and Heritage (OEH) (National Parks and Wildlife and Royal Botanic Gardens and Domain Trust), Department of Primary Industries (Forests NSW and Fisheries NSW) and the Australian Museum. BioNet contains records for threatened species and endangered ecological communities listed under the Biodiversity Conservation Act 1995 (BC Act) and the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) which have been recorded within the locality. The search was conducted on 13/11/17 using search coordinates:- North: -32.88 West: 151.72 East: 151.86 South: -32.98]. The search returned a total of 2,050 records of 44 species. Species listed as being part of the bilateral migratory bird agreements with China (CAMBA), Japan (JAMBA) and Republic of Korea (ROKAMBA) are also listed http://www.bionet.nsw.gov.au/
- Australian Government: Department of the Environment Protected Matters Search Tool for Matters of National Environmental Significance (NES) listed under the EPBC Act that may occur in the Study Area. a point search was conducted on 13/11/17 using search coordinates: -32.932195 151.778225 http://www.environment.gov.au/topics/about-us/legislation/environment-protection-and-biodiversity-conservation-act-1999/protected

- New South Wales Government web based data portal: SEED (Sharing and Enabling Environmental Data). The data base provides mapping and site information such as: soil landscapes, acid sulphate soil risk maps, SEPP boundaries. Major partners in the data include Planning & Environment, Office of Environment and Heritage, Spatial Services, Department of Industry Resources & Energy, EPA, Primary Industries, Department of Industry, Department of Primary Industries Water and Water NSW. https://www.seed.nsw.gov.au/

A full list of threatened species (pursuant to the BC Act) and Endangered Ecological Communities (EECs) recorded in the Study Area from database searches are provided in Tables A1 and A2 (Appendix A) respectively. The locations of threatened flora and fauna previously recorded within a 10-km radius of the Study Area are shown in Figures 3 and 4 respectively. Results of the protected matters search tool are provided in Tables A3, A4 and A5 (Appendix A).

4.2 VEGETATION MAPPING

4.2.1 LHCCREMS (2003)

Electronic Vegetation Mapping prepared by Lower Hunter Central Coast Regional Environmental Management Strategy (LHCCREMS, 2003) was viewed using Mapinfo (Figure 5). LHCCREMS (2003) mapped seven vegetation communities within a 1km radius of Arcadia Park (Table A6; Appendix A). Arcadia Park was mapped as having two vegetation communities:

- Coastal Foothills Spotted Gum
- Coastal Plains Smooth-barked Apple Woodland

Coastal Foothills Spotted Gum (MU15)

Coastal Foothills Spotted Gum - Ironbark Forest is a moderately tall open forest dominated by *Corymbia maculata* in combination with one or several ironbark species *E. siderophloia, E. paniculata or E.fibrosa. E. acmenoides, E. umbra* and *Syncarpia glomulifera* are common associate trees. The upper mid-storey is often composed of an open stratum of *Allocasuarina torulosa*. Depending on recent fire history mesic understorey elements can be present or absent Typically the shrub layer is open with species such as *Persoonia linearis, Polysicas sambucifolius, Breynia oblongifolia* and *Daviesia ulicifolia*. In the northern extent around Lake Macquarie *Pultenaea villosa* and *Podolobium ilicifolium* can become more prevalent. In the southern extent around Wyong the shrub layer often contains *Melaleuca nodosa*. The ground cover is dominated by a number of common grasses including *Imperata cylindrica var major, Entolasia stricta, Themeda australis* and *Microlaena stipoides var stipoides*.

The coastal foothills from Ourimbah to Beresfield represent the length of its range. The crests and slopes of ridgelines on the northern rim of Lake Macquarie extend to coastal locations at Glenrock SRA. Outcropping of this assemblage also occur near Toronto and on Pulbah Island. At the drier extremes of its range this assemblage merges with Map Unit 17. Examples of such cross overs occur near the northern limit of the Sugarloaf range and on the western extent of the Myall Range at Quorrobolong. It is also floristically and structurally similar to Map Unit 16 Seaham Spotted Gum – Ironbark Forest.

Coastal Plains Smooth-barked Apple Woodland (MU30)

Coastal Plains Smooth-barked Apple Woodland is a dry shrubby forest occurring along the coastal plain south from the Wyong Region to Medowie near Port Stephens in the north. *Angophora costata* and *Corymbia gummifera* consistently occur as dominant canopy species usually to height of between 20-25 metres. In some areas *Eucalyptus umbra* and *E. capitellata* will be dominant or co-dominant. Other noticeable variations in canopy species include the presence of *E.piperata* and *E.globoidea* in Medowie State Forest and the occasional occurrence of *C. maculata* near Wallsend to the north west of Lake Macquarie.

The dry shrubby mid-story is characterised by the occurrence of *Allocasuarina littoralis*, *Banksia spinulosa,* and *Acacia myrtifolia*. These features often become well developed where the forest canopy is more open. Less commonly found in the mid-story are *Leptospermum polygalifolium, Dodonaea triquetra, Lambertia formosa, and Dillwynia retorta*. The ground layer is dominated by grasses such as *Entolasia stricta and Themeda australis*. Other common species found among the lower stratum are *Lomandra obliqua, Pteridium esculentum, Phyllanthus hirtellus, Imperata cylindrica var major,* and *Lepidosperma laterale*.

It is distributed across a range of sedimentary geologies from the Narabeen Group, Permian Coal Measures and Medowie sediments on low to undulating topography. Soil landscapes of Doyalson, Awaba and Medowie support typical examples of this assemblage. Evidence of frequent and/or recent fire events are apparent across its distribution in the region, as are the impacts of urban expansion.

5. FIELD SURVEYS

Field Surveys were undertaken by an experienced botanist/soil geologist and ecologist on 1 November 2017.

5.1 FLORA

A full list of flora species and their relative abundance across the park is provided in Table A7 (Appendix A). In summary:

- A total of 120 species were recorded in Arcadia Park during flora surveys conducted in November 2017, 75 native species and 45 exotics, 10 of which are noxious. No threatened species were recorded on the site.
- The majority of flora recorded in Arcadia Park has been planted and as such, the native vegetation community that occurred in the park pre-disturbance is not known. The species present do however give an indication as to whether the soil landscape is compatible with a particular community.
- Native canopy species recorded in Arcadia Park include: Swamp Mahogany *Eucalyptus robusta*, Bangalay *Eucalyptus botryoides*, Flooded gum *Eucalyptus grandis* followed by Turpentine *Syncarpia glomulifera*, Broad-leaved White Mahogany *Eucalyptus umbra,* Smooth-barked Apple *Angophora costata,* Red Bloodwood *Corymbia gummifera* and Spotted Gum *Corymbia maculata*. Non-eucalypt canopy species include Coastal Myall *Acacia binervia*, Tuckeroo *Cupaniopsis anacardioides*, River Oak *Casuarina cunninghamiana* and Black She-Oak *Allocasuarina littoralis*.
- Exotic canopy species include Canary Island Date Palm *Phoenix canariensis**, Camphor Laurel *Cinnamomum camphora**, Norfolk Island Hibiscus *Lagunaria patersonii subsp. bracteatus**, Weeping Willow *Salix babylonica**, African Olive *Olea europa subsp. cuspidata**, New Zealand Christmas Bush *Metrosideros stipoides,* Umbrella Tree *S. actinophylla** and Norfolk Island Pines *Araucaria heterophylla*.

5.2 VEGETATION MAPPING

The mixture of canopy species present in Arcadia Park have some consistencies with the species list of Coastal Foothills Spotted Gum-Ironbark Forest mapped on the site by (LHCCREMS 2003; Figure 5) however it does not contain any Ironbark, which is a characteristic species of this community. The vegetation in the park has a number of consistencies with the Coastal Plains Smooth-barked Apple Woodland through the presence of characteristic species such as *A. costata, C. gummifera, E. umbra* and *A. littoralis*.

The dominant canopy species recorded across Arcadia Park include mature Coast Myall *Acacia binervia*, Bracelet Honey Myrtle *Melaleuca armillaris*, Sweet Pittosporum *Pittosporum undulatum*, Swamp Mahogany *E. robusta*, Turpentine *Syncarpia glomulifera*, Coast Banksia *Banksia integrifolia subsp. integrifolia*, River Oak *Casuarina cunninghamiana*,

Camphor Laurel *Cinnamomum camphora**, Norfolk Island Hibiscus *Lagunaria patersonii subsp. bracteatus** and Broad-leaved Paperbark *Melaleuca quinquenervia*,

The vegetation in Arcadia Park is not defined as threatened under state or federal legislation.

5.2.1 SOUTHERN GULLY

The native canopy layer in this gully was dominated by Turpentine *Syncarpia glomulifera,* Swamp Mahogany *E. robusta*, Spotted Gum *C. maculata* and Cheese Tree *Glochidion ferdinandii*. Exotic canopy species include Canary Island Date Palm *Phoenix canariensis**, Camphor Laurel *Cinnamomum camphora** and Norfolk Island Hibiscus *Lagunaria patersonii subsp. bracteatus**. The middle stratum was largely absent with the exception of juvenile Tuckeroo *Cupaniopsis anacardioides*. The lower stratum is dominated by the exotic Wandering Jew *Tradescantia fluminensis** and Guinea Grass *Megathyrus maximus var maximus** (Photograph 2).

Photograph 2. Southern Gully Vegetation

5.2.2 NORTHERN GULLY

The native canopy vegetation in the northern Gully was dominated by Coast Myall *Acacia binervia,* Broad-leaved Paperbark *M. quinquenervia*, Sweet Pittosporum *Pittosporum undulatum*, Bangalay *Eucalyptus botryoides,* Black She-oak *Allocasuarina littoralis* and Port Jackson Fig *Ficus rubiginosa*. Dominant exotic canopy species include Weeping Willow *Salix babylonica**, Canary Island Date Palm *P. canariensis**, Camphor Laurel *C. camphora** and African Olive *Olea europa subsp. cuspidata**. The middle stratum consists of juvenile Tuckeroo *C. anacardioides* and juvenile Umbrella Tree *Schefflera actinophylla**. Lower stratum consisted of exotic herbs and grasses (Photograph 3).

Photograph 3. Northern Gully Vegetation

5.2.3 PICNIC AREAS

Two main tracks dissect Arcadia Park (Figure 2), linking Wolfe St, Reserve Rd and Pit St. While there has been significant planting in the middle section of the park around the existing picnic benches, it has a parkland feel, with planted lower stratum, limited middle stratum cover and woodland density in the canopy (Photograph 4).

Photograph 4. Vegetation in the middle of the park around picnic tables

5.2.4 WOLFE STREET ROADSIDE

The corner of Reserve Rd and Wolfe St consists of a parkland environment characterised by exotic grass understory and mature Norfolk Island Pines *Araucaria heterophylla* (Photograph 5). Planted vegetation along Wolfe St consists of Sweet Pittosporum *P. undulatum,* Coastal Tea-tree *Leptospermum laevigatum,* Bracelet Honey Myrtle *M. armillaris,* Callistemon sp (Crimson Bottlebrush *Callistemon citrinus,* Willow Bottlebrush *Callistemon salignus* and *Callistemon sp.* (cultivar)),* Cheese Tree *Glochidion ferdinandii*, Native Rosella *Hibiscus heterophyllus subsp heterophyllus* and Flooded Gum *Eucalyptus grandis*. Exotic species include African Olive *Olea europa subsp. cuspidata**, New Zealand Christmas Bush *Metrosideros stipoides,* Umbrella Tree *S. actinophylla**, Norfolk Island Hibiscus *L. subsp. bracteatus** and Canary Island Date Palm *P. canariensis**.

Photograph 5. Parkland environment on the corner of Wolfe St and Reserve Rd

Photograph 6. Roadside vegetation planted along Wolfe Street

5.3 FAUNA/HABITAT ASSESSMENT

Arcadia Park is isolated from other tracks of bushland and as such, the habitat value of the park is limited to highly mobile species such as birds and bats and/or species adapted to living in and around urban areas. Common brushtail possum, Common ringtail possum, small terrestrial mammals such as Bush Rat and antechinus are possible however the feral Black rat is also likely to utilise the park.

Microbats and megabats are also potential visitors to the park. The park provides some foraging opportunities for Grey-headed Flying-fox but is not a known roost/breeding site for this species. Arcadia Park also provides foraging opportunities for a range of microbats. Some species of microbats will roost/nest in tree hollows or under bark. These types of roosting habitat are very difficult to detect from the ground, so while it is possible that the site also provides nesting and roosting opportunities for some species of microbats, including threatened species, opportunities are likely to be limited.

The park would provide habitat for reptiles such as common lizards and skinks. There is limited habitat potential for amphibians however the enclosed drain may provide some habitat opportunities for hardy species.

The park also provides foraging and nesting habitat for a range of bird species however it lacks good quality hollows for hollow dependant species such as parrots or owls. Arcadia Park provides potential foraging habitat for powerful owls and while there are no recorded occurrences on the BioNet database, NCC staff have indicated that there has been a previous sighting of this species in Arcadia Park (observer and date observed unknown, refer email from P Freeman dated 17/01/18).

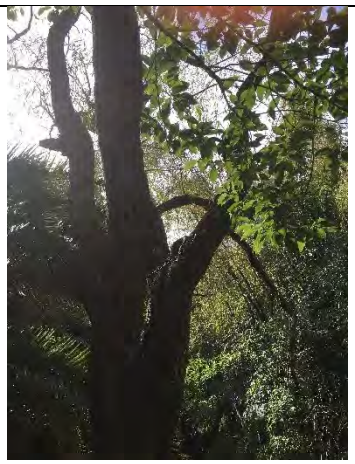
Seven trees were identified as having hollows during the site inspection conducted in November 2017 and February 2018 (Table 1). Six of these trees were Weeping Willows and the hollows were close to the ground (i.e. <2 m) (Table 1, Photograph 7). While these hollows may be utilised by commonly occurring species adapted to urban environments such as possums, they are considered unlikely to be utilised by bird species due to their exposed nature and proximity to the ground which would expose them to easy predation. None of the hollows had signs of recent utilisation such as scats, fur, feathers or scratch marks and two of the hollow entrances were covered with spider web indicating that they have not been used recently. The hollows are considered unsuitable for threatened hollow dependant birds such as Little Lorikeet and Powerful Owl. The sixth tree observed with hollows was an African Olive tree that appeared to have one small hollow entry. The depth of the hollow could not be determined from the ground.

Arcadia Park contains a diversity of native flora species, some of which are unlikely to have been found on the site pre-European settlement. The site contains numerous Swamp Mahogany *E. robusta*, which is typically found in low-lying sclerophyll forests. This species is significant in that it is one of the few winter flowering species in the area and thus provides an important food source during winter for a range of fauna species, including threatened species such as Swift Parrot, Regent Honeyeater and Koalas. Spotted Gum *C. maculata*, another winter flowering species, also occur on the site and combined would provide a food resource for nectivorous fauna species during the winter.

Photograph 7. Tree Hollows in the lower trunk section of Weeping Willow trees

Table 1. Hollow bearing trees identified in Arcadia Park

ident	y_proj	x_proj	Species	Comment
617	6355658	385722.5	Willow Tree	 1x20cm diameter hollow < 1 m from the ground

618	6355671	385724.5	Willow Tree	 1x15cm diameter hollow <1 m from the ground
619	6355672	385733.8	Willow Tree	 Trunk hollow at the base of the tree <1 m from the ground. Four entries, diameter 10 - 20 cm. A spider web covered the entrance, no signs of scats or scratches and no evidence of use.
622	6355661	385742.2	Willow Tree	 2 x hollows however no depth, diameter 5 cm approximately 3 m from the ground.

623	6355664	385754.4	Willow Tree	 Two hollows, approximately 20 cm diameter, <1.5 m from the ground.
624	6355673	385748.8	Willow Tree	 1 hollow approximately 5 cm diameter 1.5 m from the ground
639	6355521	385726.4	African Olive	 One hollow approximately 5 cm diameter, limited depth, <1.5 m from the ground.

6. ASSESSMENT OF SIGNIFICANCE: BC ACT

Results of the NSW BioNet search for threatened flora and fauna listed under state and federal legislation (BC Act and EPBC Act respectively) found 7 threatened flora and 74 threatened/migratory fauna had previously been recorded within a 10x10km area centred on Arcadia Park. A habitat assessment of these threatened species is provided in Appendix B, Table B1.

Following a site assessment, Arcadia Park contains potential habitat for 12 threatened fauna and 2 threatened flora species. Table 2 below summarises the habitat assessment and lists species with habitat potential within Arcadia Park.

The assessment of significance of impact on threatened flora and fauna with potential habitat on the site concluded that the proposed restoration works are unlikely to adversely affect these species such that a viable local population of the species is likely to be placed at risk of extinction (Appendix C). This is based on the limited breeding and roosting habitat available in Arcadia Park and the minor nature of the works which involves clearing of exotic canopy trees and native Acacia species at the end of their lifespan. As such, a Species Impact Statement or entry into the Biodiversity Offset Scheme is not required for the proposed restoration works

7. ASSESSMENT OF SIGNIFICANCE: EPBC ACT

Following an assessment of significance (Appendix D), it was concluded that the proposed restoration works would not have a significant impact on the threatened Grey-headed Flying-fox, Swift Parrot or Koala as Arcadia Park does not support an important population of these species as it provides only limited foraging opportunities and no breeding or roosting habitat. The proposed restoration will not result in an alteration in the availability or quality of habitat to the extent that the species is likely to decline, and no harmful invasive species or disease will become established in the threatened species' habitat or interfere with the recovery of these species. Based on the above assessment it is considered that a referral to SEWPaC is not required.

able 2. Threatened Species / Communities listed under state and federal legislation with habitat potential on The Site

Common Name	Scientific Name	NSW Status	Federal Status
White-bellied Sea Eagle	*Haliaeetus leucogaster*	V,P	
Eastern Osprey	*Pandion cristatus*	V,P	
Little Lorikeet	*Glossopsitta pusilla*	V,P	
Swift Parrot	*Lathamus discolor*	E,P,	CE
Powerful Owl	*Ninox strenua*	V,P	
Varied Sittella	*Daphoenositta chrysoptera*	V,P	
Koala	*Phascolarctos cinereus*	V,P	V
Grey-headed Flying-Fox	*Pteropus poliocephalus*	V,P	V
Little Bentwing-bat	*Miniopterus australis*	V,P	
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	V,P	
Eastern Freetail Bait	*Mormopterus norfolkensis*	V,P	
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V,P	
Heath Wrinklewort	*Rutidosis heterogama*	V,P	V
Black-eyed Susan	*Tetratheca juncea*	V,P	V

V=Vulnerable, P=Protected, CE=Critically Endangered, E=Endangered

8. RECOMMENDATIONS

- Appropriate erosion and sediment control measures are to be installed prior to the commencement of clearing works.
- Species selected for planting are to be from the profile lists: *Littoral Rainforest* (Bell, 1998; LHCCREMS, 2003) or Coastal Plains Smooth-barked Apple Woodland (LHCCRMS, 2003).
- Restoration of Arcadia Park is to be undertaken in accordance with the VMP for a 4-year period.
- Exotic tree species that contain hollows are to be inspected immediately prior to felling by an ecologist to ensure that they are not being utilised by fauna.
- Twenty one nest boxes are to be installed prior to felling of exotic hollow bearing trees.
- Visitor access to Arcadia Park is to be regulated through the use of signage, planting and fencing to insure disturbance is minimised.
- Council staff and clearing contractors are to be equipped with spill kits and be educated in their use in the event of a spill from machinery operating on-site.
- Minimise disturbance from fire. Arcadia Park is currently not included in the Newcastle Bushfire Risk Management Plan (NBRMP). It is recommended that Newcastle City Council obtain advice on bushfire management, with consideration of the implemented VMP.
- Plants in Arcadia Park are to be monitored for evidence of disease or introduced pathogens such as Myrtle Rust. Monitoring is to be undertaken by Council staff during the 4-year monitoring of Arcadia Park. If Myrtle Rust, other pathogens or disease are identified in Arcadia Park, they are to be treated immediately using appropriate methods (refer NSW DPI http://www.dpi.nsw.gov.au/biosecurity/plant/established-plant-pests-and-diseases/). This is expanded on in the VMP.
- Arcadia Park is not to be used as an off-leash dog area. Signage is to include exclusion of dogs and other domestic animals.

9. REFERENCES

Bell SAJ, 1998. Glenrock SRA and Awabakal NR, Vegetation Survey, Volume 2: Community Profiles, A Fire Management Document prepared by Eastcoast Flora Survey. August 1998.

Clements A & Associates, 2016. Assessment of possible occurrence of Littoral Rainforest in bushland parcels in the Newcastle Local Government Area: Arcadia Park, Nesca Park, Lloyd Street Reserve. Prepared by Tony Rodd and Ruth Palsson for Newcastle City Council. 14 June 2016.

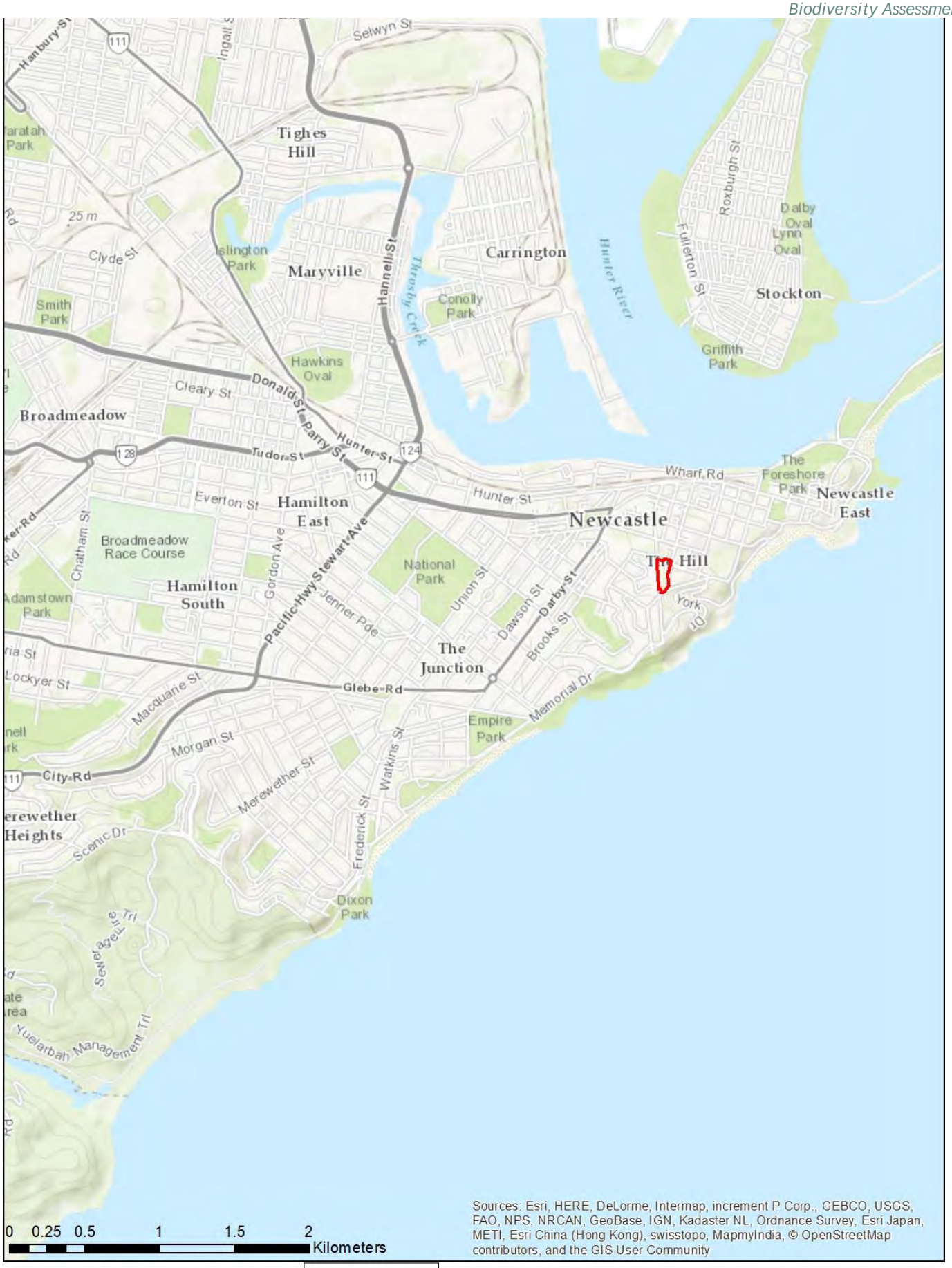
LHCCREMS (2003). Lower Hunter Central Coast Regional Environmental Management Strategy: Vegetation Survey, Classification and Mapping.

NSW Scientific Committee, 2004. Littoral rainforest in the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing- final determination
http://www.environment.nsw.gov.au/determinations/LittoralRainforestEndSpListing.htm

OEH undated. Threatened species profiles and references therein.
http://www.environment.nsw.gov.au/threatenedSpeciesApp/

10. FIGURES

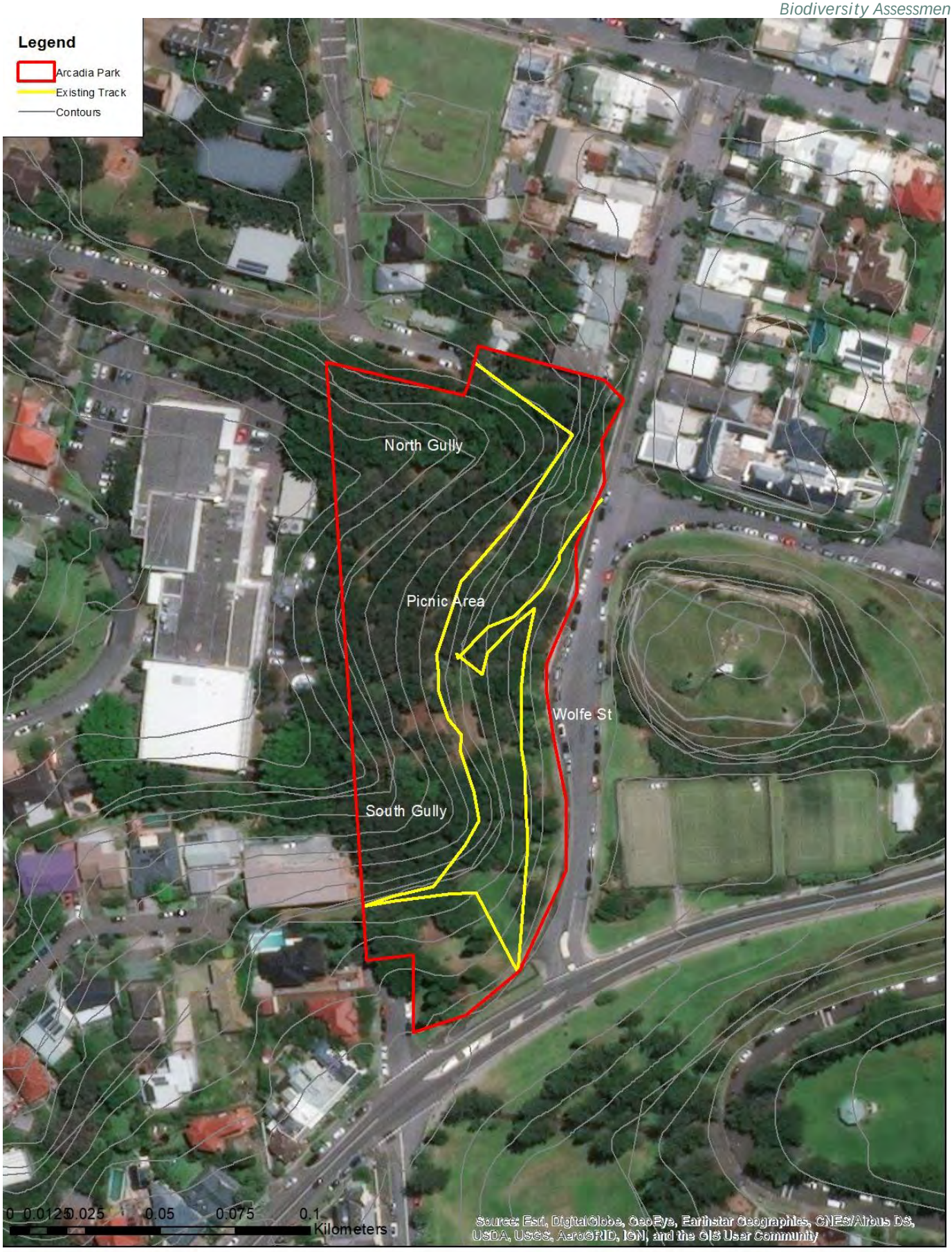
Figure 1. Locality
Figure 2. Arcadia Park Site Map
Figure 3. Threatened flora recorded in Study Area: BioNet
Figure 4. Threatened fauna recorded in Study Area: BioNet
Figure 5. Vegetation mapping (LHCCREMS)
Figure 6. Site Assessment: Coast Ecology



COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

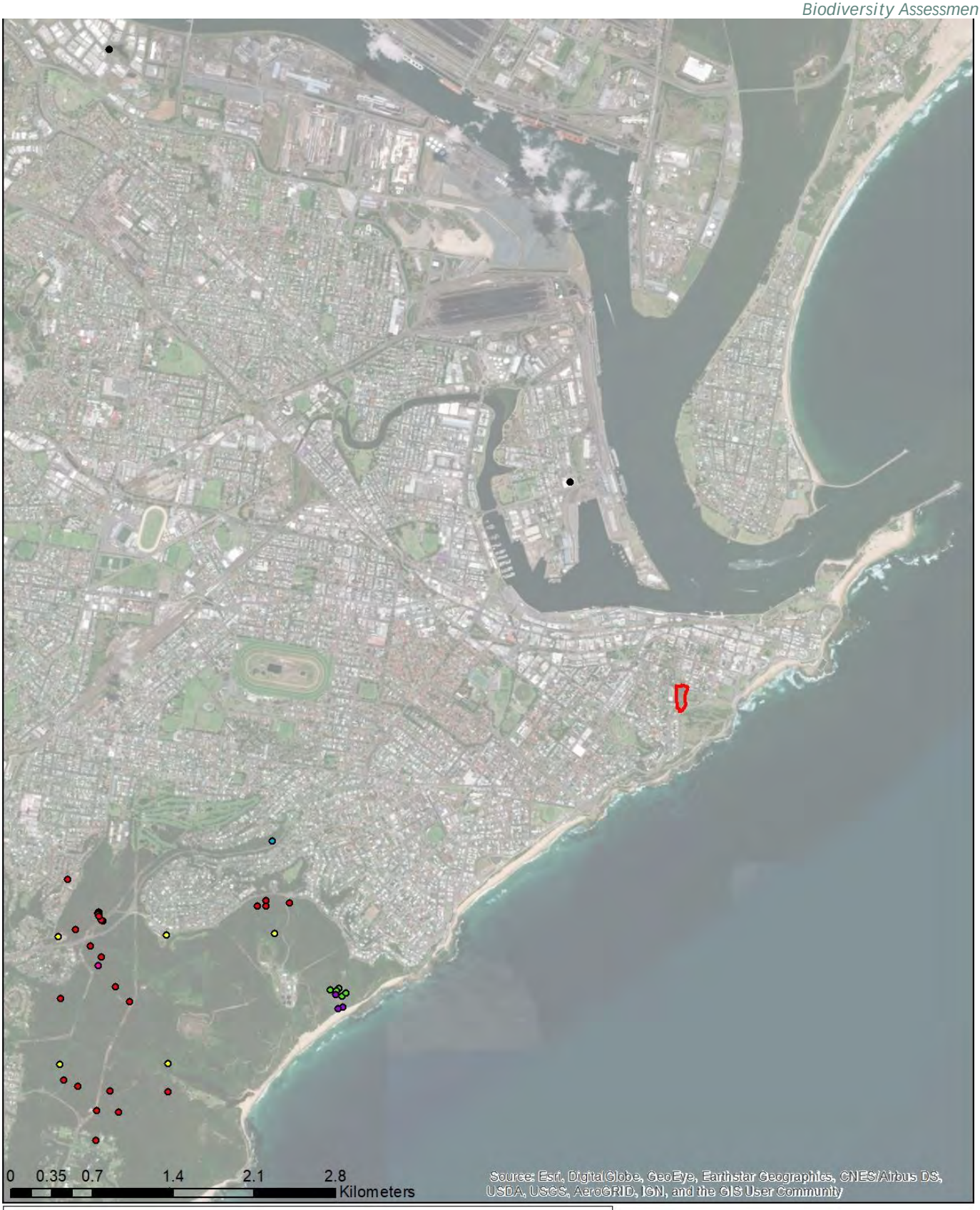
Legend
Arcadia Park

Figure 1. Locality
Newcastle City Council
Arcadia Park Job No. 170807 Date. 21/08/2017



COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

Figure 2. Arcadia Park
Newcastle City Council
Arcadia Park Job No. 170807 Date. 21/08/2017



COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

Figure 3.Threatened Flora Records 10 x 10 km: BioNet
Newcastle City Council
Arcadia Park Job No. 170807 Date. 21/08/2017

Legend

- Arcadia Park
- White-fronted Chat
- White-bellied Sea-Eagle
- Wandering Albatross
- Varied Sittella
- Turquoise Parrot
- Terek Sandpiper
- Swift Parrot
- Superb Fruit-Dove
- Square-tailed Kite
- Southern Giant Petrel
- Sooty Oystercatcher
- Sooty Owl
- Red Knot
- Providence Petrel
- Powerful Owl
- Pied Oystercatcher
- New Zealand Fur-seal
- Masked Booby
- Little Tern
- Little Lorikeet
- Little Bentwing-bat
- Lesser Sand-plover
- Koala
- Humpback Whale
- Hawksbill Turtle
- Grey-headed Flying-fox
- Grey-crowned Babbler (eastern subspecies)
- Green and Golden Bell Frog
- Green Turtle
- Greater Sand-plover
- Greater Broad-nosed Bat
- Great Knot
- Flesh-footed Shearwater
- Eastern Osprey
- Eastern Grass Owl
- Eastern Freetail-bat
- Eastern Curlew
- Eastern Bentwing-bat
- Dugong
- Curlew Sandpiper
- Bush Stone-curlew
- Broad-billed Sandpiper
- Black-tailed Godwit
- Australasian Bittern

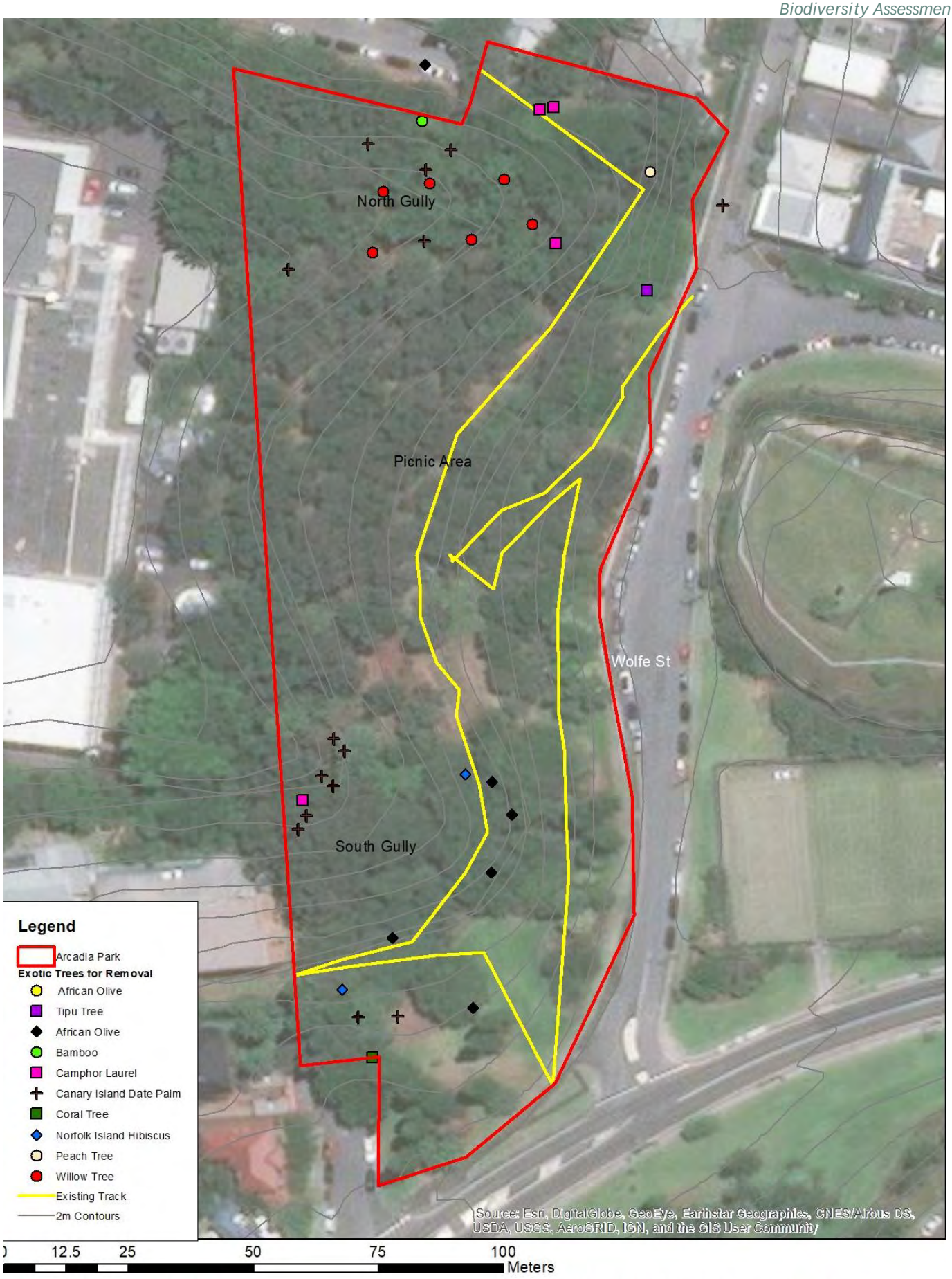
COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

Figure 4.Threatened Fauna Records 10 x 10 km: BioNet
Newcastle City Council
Arcadia Park Job No. 170807 Date. 21/08/2017

Figure 5. Vegetation Mapping (LHCCREMS, 2003)
Arcadia Park, The Hill
NEWCASTLE CITY COUNCIL

Date: 15 November 2017 Job No: 170807

COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS



COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

Figure 6. Arcadia Park: Existing Environment
Newcastle City Council
Arcadia Park Job No. 170807 Date. 04/12/2017

11. APPENDIX A: DESKTOP RESULTS

Table A1. BioNet Search Results for threatened species listed under the BC Act and EPBC Act with 10 km of the Study Area.

Family	Scientific Name	Common Name	NSW Status	Comm. Status	Records
Plants					
Asteraceae	*Rutidosis heterogama*	Heath Wrinklewort	V,P	V	11
Elaeocarpaceae	*Tetratheca juncea*	Black-eyed Susan	V,P	V	36
Fabaceae (Faboideae)	*Pultenaea maritima*	Coast Headland Pea	V,P		4
Orchidaceae	*^^Diuris praecox*	Rough Doubletail	V,P,2	V	143
Polygonaceae	*Muehlenbeckia costata*	Scrambling Lignum	V,P		1
Proteaceae	*Grevillea shiressii*		V,P	V	1
Zannichelliaceae	*Zannichellia palustris*		E1,P		3
Amphibians					
Hylidae	*Litoria aurea*	Green and Golden Bell Frog	E1,P	V	2
Cheloniidae	*Chelonia mydas*	Green Turtle	V,P	V	3
Cheloniidae	*Eretmochelys imbricata*	Hawksbill Turtle	P	V	2
Birds					
Columbidae	*Ptilinopus superbus*	Superb Fruit-Dove	V,P		2
Apodidae	*Apus pacificus*	Fork-tailed Swift	P	C,J,K	3
Diomedeidae	*Diomedea exulans*	Wandering Albatross	E1,P	E,J	2
Procellariidae	*Ardenna carneipes*	Flesh-footed Shearwater	V,P	J,K	4
Procellariidae	*Ardenna grisea*	Sooty Shearwater	P	C,J	1
Procellariidae	*Ardenna pacificus*	Wedge-tailed Shearwater	P	J	14
Procellariidae	*Ardenna tenuirostris*	Short-tailed Shearwater	P	J,K	11
Procellariidae	*Calonectris leucomelas*	Streaked Shearwater	P	C,J,K	1
Procellariidae	*Macronectes giganteus*	Southern Giant Petrel	E1,P	E	3
Procellariidae	*Pterodroma solandri*	Providence Petrel	V,P	J	1
Sulidae	*Sula dactylatra*	Masked Booby	V,P	J,K	1
Ardeidae	*Ardea ibis*	Cattle Egret	P	C,J	5
Ardeidae	*Botaurus poiciloptilus*	Australasian Bittern	E1,P	E	1
Ardeidae	*Egretta sacra*	Eastern Reef Egret	P	C	2
Threskiornithidae	*Plegadis falcinellus*	Glossy Ibis	P	C	1
Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	V,P	C	8
Accipitridae	*Lophoictinia isura*	Square-tailed Kite	V,P,3		1
Accipitridae	*Pandion cristatus*	Eastern Osprey	V,P,3		8
Burhinidae	*Burhinus grallarius*	Bush Stone-curlew	E1,P		3
Haematopodidae	*Haematopus fuliginosus*	Sooty Oystercatcher	V,P		20
Haematopodidae	*Haematopus longirostris*	Pied Oystercatcher	E1,P		20

Charadriidae	*Charadrius leschenaultii*	Greater Sand-plover	V,P	V,C,J,K	3
Charadriidae	*Charadrius mongolus*	Lesser Sand-plover	V,P	E,C,J,K	154
Charadriidae	*Charadrius veredus*	Oriental Plover	P	J,K	1
Charadriidae	*Pluvialis fulva*	Pacific Golden Plover	P	C,J,K	50
Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	P	C,J,K	10
Scolopacidae	*Arenaria interpres*	Ruddy Turnstone	P	C,J,K	53
Scolopacidae	*Calidris acuminata*	Sharp-tailed Sandpiper	P	C,J,K	357
Scolopacidae	*Calidris canutus*	Red Knot	P	E,C,J,K	68
Scolopacidae	*Calidris ferruginea*	Curlew Sandpiper	E1,P	CE,C,J,K	###
Scolopacidae	*Calidris melanotos*	Pectoral Sandpiper	P	J,K	1
Scolopacidae	*Calidris ruficollis*	Red-necked Stint	P	C,J,K	475
Scolopacidae	*Calidris tenuirostris*	Great Knot	V,P	CE,C,J,K	8
Scolopacidae	*Gallinago hardwickii*	Latham's Snipe	P	C,J,K	16
Scolopacidae	*Limicola falcinellus*	Broad-billed Sandpiper	V,P	C,J,K	37
Scolopacidae	*Limnodromus semipalmatus*	Asian Dowitcher	P	C,J,K	6
Scolopacidae	*Limosa lapponica*	Bar-tailed Godwit	P	C,J,K	224
Scolopacidae	*Limosa limosa*	Black-tailed Godwit	V,P	C,J,K	29
Scolopacidae	*Numenius madagascariensis*	Eastern Curlew	P	CE,C,J,K	68
Scolopacidae	*Numenius phaeopus*	Whimbrel	P	C,J,K	15
Scolopacidae	*Philomachus pugnax*	Ruff	P	C,J,K	1
Scolopacidae	*Tringa brevipes*	Grey-tailed Tattler	P	C,J,K	106
Scolopacidae	*Tringa glareola*	Wood Sandpiper	P	C,J,K	1
Scolopacidae	*Tringa nebularia*	Common Greenshank	P	C,J,K	20
Scolopacidae	*Tringa stagnatilis*	Marsh Sandpiper	P	C,J,K	7
Scolopacidae	*Xenus cinereus*	Terek Sandpiper	V,P	C,J,K	247
Stercorcariidae	*Stercorarius parasiticus*	Arctic Jaeger	P	J,K	1
Laridae	*Anous stolidus*	Common Noddy	P	C,J	1
Laridae	*Chlidonias leucopterus*	White-winged Black Tern	P	C,J,K	1
Laridae	*Gelochelidon nilotica*	Gull-billed Tern	P	C	18
Laridae	*Hydroprogne caspia*	Caspian Tern	P	C,J	5
Laridae	*Sterna hirundo*	Common Tern	P	C,J,K	162
Laridae	*Sternula albifrons*	Little Tern	E1,P	C,J,K	282
Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V,P		2
Psittacidae	*Lathamus discolor*	Swift Parrot	E1,P,3	CE	1
Psittacidae	*Neophema pulchella*	Turquoise Parrot	V,P,3		1
Strigidae	*Ninox strenua*	Powerful Owl	V,P,3		5
Tytonidae	*Tyto longimembris*	Eastern Grass Owl	V,P,3		1
Tytonidae	*Tyto tenebricosa*	Sooty Owl	V,P,3		4
Meliphagidae	*Epthianura albifrons*	White-fronted Chat	V,P		12
Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	V,P		1
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V,P		1
Mammals					
Phascolarctidae	*Phascolarctos cinereus*	Koala	V,P	V	1
Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	V,P	V	14

Molossidae	*Mormopterus norfolkensis*	Eastern Freetail-bat	V,P		1
Vespertilionidae	*Miniopterus australis*	Little Bentwing-bat	V,P		1
Vespertilionidae	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V,P		3
Vespertilionidae	*Scoteanax rueppellii*	Greater Broad-nosed Bat	V,P		1
Dugongidae	*Dugong dugon*	Dugong	E1,P		2
Otariidae	*Arctocephalus forsteri*	New Zealand Fur-seal	V,P		1
Balaenopteridae	*Megaptera novaeangliae*	Humpback Whale	V,P	V	1

Table A2. Endangered Ecological Communities under the BC Act and EPBC Act within the Study Area.

Common Name	NSW status	Comm. status	Records
Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	E3	CE	K
Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions	E3	CE	K
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3	V	P
Coastal Upland Swamp in the Sydney Basin Bioregion	E3	E	K
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3		K
Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions	E3		K
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	E3		K
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	V2	CE	K
Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions	E3		K
Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion	E4B	CE	K
Kincumber Scribbly Gum Forest in the Sydney Basin Bioregion	E4B		K
Kurri Sand Swamp Woodland in the Sydney Basin Bioregion	E3		K
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3	CE	P
Lower Hunter Spotted Gum-Ironbark Forest in the Sydney Basin Bioregion	E3		K
Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions	V2		K
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	E3	CE	K
Quorrobolong Scribbly Gum Woodland in the Sydney Basin Bioregion	E3		K
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3		K
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3		K
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3		K
Sydney Freshwater Wetlands in the Sydney Basin Bioregion	E3		K
Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions	E3		K
Umina Coastal Sandplain Woodland in the Sydney Basin Bioregion	E3		K
Warkworth Sands Woodland in the Sydney Basin Bioregion	E3	CE	K
White Box Yellow Box Blakely Red Gum Woodland	E3	CE	K

Table A3. Protected Matters Search Tool Summary for Matters of National Environmental Significance under the EPBC Act within the Study Area.

NES	Summary
World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1: Hunter Estuary Wetlands
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	1: EEZ and Territorial Sea
Listed Threatened Ecological Communities:	3: Central Hunter Valley eucalypt forest and woodland Lowland Rainforest of Subtropical Australia Subtropical and Temperate Coastal Saltmarsh
Listed Threatened Species:	71(See below)
Listed Migratory Species:	70 (See below)

Table A4. Protected Matters Search Tool Results for Threatened Species listed under the EPBC Act within the Study Area.

Scientific Name	Common Name	Status
Birds		
Anthochaera Phrygia	Regent Honeyeater	E
Botaurus poiciloptilus	Australasian Bittern	E
Calidris canutus	Red Knot	E
Calidris ferruginea	Curlew Sandpiper	CE
Calidris tenuirostris	Great Knot	CE
Charadrius leschenaultii	Greater Sand Plover	V
Charadrius mongolus	Lesser Sand Plover	E
Dasyornis brachypterus	Eastern Bristlebird	E
Diomedea epomophora epomophora	Southern Royal Albatross	V
Diomedea epomophora sanfordi	Northern Royal Albatross	E
Diomedea exulans antipodensis	Antipodean Albatross	V
Diomedea exulans exulans	Tristan Albatross	E
Diomedea exulans gibsoni	Gibson's Albatross	V
Diomedea exulans (sensu lato)	Wandering Albatross	V
Fregetta grallaria grallaria	White-bellied Storm-Petrel (Tasman Sea), Whitebellied Storm-Petrel (Australasian)	V
Grantiella picta	Painted Honeyeater	V
Lathamus discolor	Swift Parrot	E
Macronectes giganteus	Southern Giant-Petrel	E
Macronectes halli	Northern Giant-Petrel	V
Numenius madagascariensis	Eastern Curlew	CE
Pachyptila turtur subantarctica	Fairy Prion (southern)	V
Phoebetria fusca	Sooty Albatross	V
Pterodroma leucoptera leucoptera	Gould's Petrel	E
Pterodroma neglecta neglecta	Kermadec Petrel	V
Rostratula australis	Australian Painted Snipe	E
Thalassarche bulleri	Buller's Albatross,	V
Thalassarche cauta cauta	Shy Albatross,	V
Thalassarche cauta salvini	Salvin's Albatross	V
Thalassarche cauta steadi	White-capped Albatross	V
Thalassarche eremita	Chatham albatross	E
Thalassarche melanophris	Black-browed Albatross	V
Thalassarche melanophris impavida	Campbell Albatross	V
Fish		
Epinephelus daemelii	Black Rockcod,	V
Amphibians		
Heleioporus australiacus	Giant Burrowing Frog	V

Litoria aurea	Green and Golden Bell Frog	V
Litoria littlejohni	Littlejohn's Tree Frog,	V
Mammals		
Balaenoptera musculus	Blue Whale	E
Chalinolobus dwyeri	Large-eared Pied Bat,	V
Dasyurus maculatus maculatus	Spotted-tail Quoll,	E
Eubalaena australis	Southern Right Whale	E
Megaptera novaeangliae	Humpback Whale	V
Petauroides volans	Greater Glider	V
Phascolarctos cinereus	Koala	V
Potorous tridactylus tridactylus	Long-nosed Potoroo	V
Pseudomys novaehollandiae	New Holland Mouse	V
Pteropus poliocephalus	Grey-headed Flying-fox	V
Plants		
Corunastylis insignis	Wyong Midge Orchid	CE
Cryptostylis hunteriana	Leafless Tongue-orchid	V
Cynanchum elegans	White-flowered Wax Plant	E
Diuris praecox	Newcastle Doubletail	V
Eucalyptus camfieldii	Camfield's Stringybark	V
Eucalyptus parramattensis subsp. decadens	Earp's Gum	V
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V
Melaleuca biconvexa	Biconvex	V
Phaius australis	Lesser Swamp-orchid	E
Rutidosis heterogama	Heath Wrinklewort	V
Streblus pendulinus	Siah's Backbone	E
Syzygium paniculatum	Magenta Lilly Pilly	V
Tetratheca juncea	Black-eyed Susan	V
Reptiles		
Caretta caretta	Loggerhead Turtle	E
Chelonia mydas	Green Turtle	V
Dermochelys coriacea	Leatherback Turtle	E
Eretmochelys imbricata	Hawksbill Turtle	V
Natator depressus	Flatback Turtle	V
Hoplocephalus bungaroides	Broad-headed Snake	V
Sharks		
Carcharias taurus	Grey Nurse Shark CE	
Carcharodon carcharias	Great White Shark	V
Rhincodon typus	Whale Shark	V

Table A5. Protected Matters Search Tool Results for Migratory Species listed under the EPBC Act with 10 km of the Study Area.

Scientific Name	Common Name	Status
Terrestrial Species		
Cuculus optatus	Oriental Cuckoo	M
Haliaeetus leucogaster	White-bellied Sea-Eagle	M
Hirundapus caudacutus	White-throated Needletail	M
Merops ornatus	Rainbow Bee-eater	M
Monarcha melanopsis	Black-faced Monarch	M
Monarcha trivirgatus	Spectacled Monarch	M
Motacilla flava	Yellow Wagtail	M
Myiagra cyanoleuca	Satin Flycatcher	M
Rhipidura rufifrons	Rufous Fantail	M
Wetlands Species		
Actitis hypoleucos	Common Sandpiper	M
Ardea alba	Great Egret,	M
Ardea ibis	Cattle Egret	M
Arenaria interpres	Ruddy Turnstone	M
Calidris acuminata	Sharp-tailed Sandpiper	M
Calidris canutus	Red Knot	M
Calidris ferruginea	Curlew Sandpiper	M, CE
Calidris melanotos	Pectoral Sandpiper	M
Calidris ruficollis	Red-necked Stint	M
Calidris tenuirostris	Great Knot	M
Charadrius bicinctus	Double-banded Plover	M
Charadrius leschenaultia	Greater Sand Plover	M
Charadrius mongolus	Lesser Sand Plover,	M
Gallinago hardwickii	Latham's Snipe,	M
Gallinago megala	Swinhoe's Snipe	M
Gallinago stenura	Pin-tailed Snipe	M
Heteroscelus brevipes	Grey-tailed Tattler	M
Limicola falcinellus	Broad-billed Sandpiper	
Limosa lapponica	Bar-tailed Godwit	M
Limosa limosa	Black-tailed Godwit	M
Numenius madagascariensis	Eastern Curlew	M, CE
Numenius minutus	Little Curlew,	M
Numenius phaeopus	Whimbrel	M
Pandion haliaetus	Osprey	M
Philomachus pugnax	Ruff	M
Pluvialis fulva	Pacific Golden Plover	M
Pluvialis squatarola	Grey Plover	M
Tringa stagnatilis	Marsh Sandpiper,	M
Xenus cinereus	Terek Sandpiper	M

Table A6. Vegetation Mapped within 2 km of the Study Area (LHCCREMS, 2003)

MU	Name	Description
1a	Coastal Warm Temperate-Sub Tropical Rainforest	subalIiances as identified by Floyd (1990); 37 (*Ceratopetalum /Schizomeria /Acmena /Doryphora)* and 42 (*Acmena / Doryphora/ Dendrocnide / Ficus*) and some influences of 14 (*Doryphora-Daphnandra micrantha- Dendrocnide-Ficus-Toona*). It is most often found in gullies and on lower slopes and underneath Narrabeen sandstone benches of the coastal range. It also occurs on the rich alluvial plains of the Yarramalong, Ourimbah and Mandalong Valleys. This assemblage describes two distinct forest structures Closed Forest (MU1a) and Tall Open Forest MU1. Analysis of floristic data did not distinguish separate assemblages based on the presence or absence of Eucalypts and Syncarpia above a rainforest canopy. Over half of the sites describing this assemblage support tall emergents of *Eucalyptus saligna* and *Syncarpia glomulifera* above a distinctive rainforest canopy usually with a projected foliage cover greater than 70%. Available structural mapping based on aerial photo interpretation was inconclusive in the identification of this community. The identification of Map Unit 1a has been undertaken using a combination of data layers each using different and unknown criteria to map rainforest. At best this can be used to flag where rainforest species are likely to be dominant in the canopy.
15	Coastal Foothills Spotted Gum	Coastal Foothills Spotted Gum - Ironbark Forest is a moderately tall open forest dominated by *Corymbia maculata* in combination with one or several ironbark species *E. siderophloia, E. paniculata or E.fibrosa. E.acmenoides, E. umbra and Syncarpia glomulifera* are common associate trees. Localised abundances of canopy species vary with notable outliers including the codominance of *E.microcorys* on the Mandalong foothills behind Wyong and the dominance of *E.paniculata* and absence of *C.maculata* at Point Woolstoncraft near Lake Macquarie. The upper mid-storey is often composed of an open stratum of *Allocasuarina torulosa*. Depending on recent fire history mesic understorey elements can be present or absent. Typically the shrub layer is open with species such as *Persoonia linearis, Polysicas sambucifolius, Breynia oblongifolia and Daviesia ulicifolia*. In the northern extent around Lake Macquarie *Pultenaea villosa* and *Podolobium ilicifolium* can become more prevalent. In the southern extent around Wyong the shrub layer often contains *Melaleuca nodosa*. The ground cover is dominated by a number of common grasses including *Imperata cylindrica var major, Entolasia stricta, Themeda australis and Microlaena stipoides var stipoides*. The coastal foothills from Ourimbah to Beresfield represent the length of its range. The crests and slopes of ridgelines on the northern rim of Lake Macquarie extend to coastal locations at Glenrock SRA. Outcropping of this assemblage also occur near Toronto and on Pulbah Island. At the drier extremes of its range this assemblage merges with Map Unit 17. Examples of such cross overs occur near the northern limit of the Sugarloaf range and on the western extent of the Myall Range at Quorrobolong. It is also floristically and structurally similar to Map Unit 16 Seaham Spotted Gum – Ironbark Forest. To the north of the region this assemblage aligns to Forest Ecosystem 52 Foothills Grey Gum-Ironbark- Spotted Gum (NPWS, 1999a). Understorey features suggest a close resemblance although canopy species vary with *E. punctata* giving way to *E. propinqua* and *E. umbra* merging to *E. carnea* as northerly distance from the Hunter River increases.
30	Coastal Plains	Coastal Plains Smoothbarked Apple Woodland is a dry shrubby forest occurring along the coastal plain south from the Wyong Region to Medowie

	Smooth-barked Apple Woodland	near Port Stephens in the north. *Angophora costata* and *Corymbia gummifera* consistently occur as dominant canopy species usually to height of between 20-25 metres. In some areas *Eucalyptus umbra* and *E.capitellata* will be dominant or co-dominant. Other noticeable variations in canopy species include the presence of *E.piperata* and *E.globoidea* in Medowie State Forest and the occasional occurrence of *C.maculata* near Wallsend to the north west of Lake Macquarie. The dry shrubby mid-story is characterised by the occurrence of *Allocasuarina littoralis*, *Banksia spinulosa*, and *Acacia myrtifolia*. These features often become well developed where the forest canopy is more open. Less commonly found in the mid-story are *Leptospermum polygalifolium*, *Dodonaea triquetra, Lambertia formosa*, and *Dillwynia retorta*. The ground layer is dominated by grasses such as *Entolasia stricta* and *Themeda australis*. Other common species found among the lower stratum are *Lomandra obliqua*, *Pteridium esculentum*, *Phyllanthus hirtellus*, *Imperata cylindrica var major*, and *Lepidosperma laterale*.
48	Coastal Clay Heath	Coastal Clay Heath occurs on or near coastal headlands where Narrabeen sandstone soils occur in close proximity to wind blown sands, such that the two mix with no uniformity. Coastal Clay Heath contains a combination of Eucalypt and Heath spp. with the former generally sparsely distributed or forming tight patchy clumps. Canopy height remains below 3 metres. Species such as *Eucalyptus capitellata*, *Eucalyptus umbra* , *Angophora costata*, and *Corymbia gummifera* may be present often in mallee form. At Norah Head the endangered species *E. camfieldii is* also present. The majority of the canopy derives from the dominant shrub stratum. Species such as *Allocasuarina distyla*, *Hakea dactyloides*, *Melaleuca nodosa* and *Dodonaea triquetra*, are dominant species in the shrub stratum. Other species frequently found are *Acacia myrtifolia*, *Banksia oblongifolia*, *Callistemon linearis*, and *Banksia spinulosa*. The ground layer is characterised by *Themeda australis*, *Mirbelia rubiifolia*, *Pimelea linifolia*, *Gonocarpus teucrioides*, *Ptilothrix deusta*, *Lambertia formosa*, and *Lomandra obliqua*. The parasitic twiner *Cassytha glabella forma glabella* is sometimes present and often occurs in dense clumps.
50	Coastal Sand Scrub	Coastal Sand Scrub occurs on deep Quaternary sands usually on foredunes. It is a relatively dense, low community subject to desiccating salt winds. Floristically it is quite simple with *Leptospermum laevigatum* occurring with a very high frequency to form the main canopy species alongside *Banksia integrifolia subsp integrifolia*, *Myoporum boninense subsp australe*, and *Acacia sophorae* amongst others. Where more nutrients and shelter are available *Angophora costata* (often Mallee from) can occur as a small tree. Fleshy ground covers such as *Carpobrotus glaucescens* and *Scaevola calenulace* are widespread and often occur with *Monotocca elliptica* and *Lomandra longifolia*. Coastal Sand Scrub occurs along the coast from Port Stephens to Gosford. It has been heavily cleared and modified by urban development and sandmining. In some instances eg. Munmorah SRA, some species of this assemblage have been used in regeneration.
51	Coastal Headland Complex	Coastal Headland Complex occurs on the areas of rocky coastal headlands exposed to strong winds and salt spray. Structurally, this community varies according to the level of exposure to windshear, ranging from Very Low Open Woodland in areas where pockets of shelter are found, to Closed Scrub or Heathland in exposed areas to Grassland in areas of extreme exposure. Where stunted trees do occur they appear in mallee form. No individual species of eucalypt dominates the community as localised variations from *Eucalyptus pilularis, Angophora costata* and *E. umbra* are common. However, *Banksia integrifolia subsp integrifolia or Allocasuarina distyla* are regularly prominent either in the mid stratum or canopy. The shrub stratum can be well developed and often dominated by *Westringia fruticosa and*

		Acacia longifolia. Understorey herbs consist of *Themeda australis, Lomandra longifolia, Imperata cylindrica var major, Pimelea linifolia and Gonocarpus teucrioides*. In the most exposed situations, trees and shrubs may be totally absent, resulting in a grassland community comprised of species such as *Themeda australis, Imperata cylindrica and Lomandra longifolia*. At Wyrrabalong trig there can be found an atypical example of this community where *Corymbia maculata* occurs as an emergent tree due to the Narrabeen sandstone cap found on Cromarty Hill. Similar communities are not described in NPWS (1999a) for the Northern Region of NSW, however such assemblages would be expected to occur.
53	Beach Spinifex	No attempt has been made to map this community given its highly localised and variable location. Beach Spinifex occurs on beach sands, fore-dunes, unstable sand dunes and blowouts of Quaternary Holocene sands along the coastal fringe. This community typically has poorly developed structure and is usually very open and low due to its exposed location and unstable substrate. It is characterised by the presence of *Spinifex sericeus*. Other species present may include *Sporobolus virginicus* and the exotic *Hydrocotyle bonariensis*. In depressions between sand dunes, species such as *Carex pumila* and *Isolepis nodosa* may also be found. Good examples can be found in Munmorah State Recreation Area and Wyrrabalong National Park.

Table A7. Flora Species List November 2017

Scientific Name	Common Name	Family	Form[a]	BC Status[b]	Observed[c]	Occurrence[d]	Previous List[e]
Acacia binervia	Coast Myall	Mimosoideae	s	N	x	C	
Acacia brownii	Heath Wattle	Mimosoideae	s	N	x	R	x
Acacia falcata	Sickle Wattle	Mimosoideae	s	N	x	R	
Acacia fimbriata	Fringed Wattle	Mimosoideae	st	N	x	O	x
Acacia implexa	Hickory Wattle	Mimosoideae	st	N			x
Acacia irrorata	Green Wattle	Mimosoideae	st	N	x	O	x
Acacia longifolia var. *longifolia*	Sydney Golden Wattle	Mimosoideae	s	N	x	O	
Acacia myrtifolia	Red Stem Wattle	Mimosoideae	s	N	x	R	
Acacia sp	Wattle	Mimosoideae	st	N	x	R	
Acacia suaveolens	Sweet Scented Wattle	Mimosoideae	s	N	x	O	x
Acacia terminalis	Sunshine Wattle	Mimosoideae	s	N	x	R	
Acacia ulicifolia	Prickly Moses	Mimosoideae	s	N	x	R	
Acmena smithii	Lillypilly	Myrtaceae	t	N			x
Allocasuarina distyla	Scrub She-oak	Casuarinaceae	s	N	x	O	x
Allocasuarina littoralis	Black She-oak	Casuarinaceae	st	N	x	O	
Alpinia caerulea	Native Ginger	Zingiberaceae	h	N	x	R	x
*Andropogon virginicus**	Whisky Grass	Poaceae	h	E	x	O	
Angophora costata	Smooth-barked Apple	Myrtaceae	t	N	x	R	
*Araucaria heterophylla**	Norfolk Island Pine	Araucariaceae	t	E	x	O	x
*Araujia sericifera**	Moth Vine	Apocynaceae	v	E	x	R	
Archontophoenix cunninghamiana	Bangalow Palm	Arecaceae	t	N	x	O	x
*Asparagus aethiopicus**	Asparagus Fern	Asparagaceae	h	E#	x	R	
*Bambusia balcooa**	Giant Bamboo	Poaceae	h	E	x	R	
Banksia aemula	Wallum Banksia	Proteaceae	s	N	x	R	x
Banksia collina	Hairpin Banksia	Proteaceae	s	N	x	R	
Banksia ericifolia	Heath-leaved Banksia	Proteaceae	s	N			x
Banksia integrifolia subsp. *integrifolia*	Coast Banksia	Proteaceae	s	N	x	M	
Banksia oblongifolia	Fern-leaved Banksia	Proteaceae	s	N			x
Banksia robur	Wallum Banksia	Proteaceae	s	N	x	R	
Banksia spinulosa	Hairpin Banksia	Proteaceae	s	N	x	R	x
*Bidens pilosa**	Cobbler's Pegs	Asteraceae	h	E	x	O	
Bothriochloa macra	Red-leg Grass	Poaceae	h	N	x	O	
Brachychiton acerifolius	Illawarra Flame Tree	Malvaceae	t	N	x	R	
Brachyscome multifida	Cut-leaved Daisy	Asteraceae	h	N	x	O	x
Breynia oblongifolia	Coffee Bush	Phyllanthaceae	s	N	x	O	
*Briza maxima**	Quaking Grass	Poaceae	h	E	x	O	
*Briza minor**	Shivery Grass	Poaceae	h	E	x	R	
*Bromus cartharticus**	Prairie Grass	Poaceae	h	E	x	M	

Callistemon citrinus	Crimson Bottlebrush	Myrtaceae	s	N	x	R	
Callistemon linearis	Narrow-leaved Bottlebrush	Myrtaceae	s	N			x
Callistemon salignus	Willow Bottlebrush	Myrtaceae	s	N	x	R	
Callistemon sp	Taree Pink	Myrtaceae	s	*	x	R	x
Callistemon viminalis x comboyensis	Wilfire	Myrtaceae	s	E	x	M	
Carex sp(appressa)		Cyperaceae	h	N	x	R	x
Casuarina cunninghamiana	River Oak	Casuarinaceae	t	N	x	M	
Centella asiatica	Swamp Pennywort	Apiaceae	h	N	x	M	
*Cestrum parqui**	Chilean Cestrum	Solanaceae	s	E#	x	R	
Chrysanthemoides monilifera subsp. *rotundata**	Boneseed	Asteraceae	s	E#	x	R	
*Cinnamomum camphora**	Camphor Laurel	Lauraceae	t	E#	x	M	
Cissus antarctica	Native Grape	Vitaceae	v	N			x
Commelina cyanea	Scurvy Weed	Commelinacea e	h	N	x	O	
Cordyline sp		Asteliaceae	s	N			x
Correa alba	White Correa	Rutaceae	s	N	x	R	
Corymbia gummifera	Red Bloodwood	Myrtaceae	t	N	x	R	
Corymbia maculata	Spotted Gum	Myrtaceae	t	N	x	R	
Crinum pedunculatum	Crinum Lily	Amaryllidaceae	h	N			x
Cupaniopsis anacardioides	Tuckeroo	Sapindaceae	t	N	x	C	
Dianella caerulea	Blue Flax Lily	Phormiaceae	h	N	x	M	
Dichondra repens	Kidney Weed	Convolvulaceae	h	N	x	C	
Dillwynia retorta	Eggs and Bacon	Faboideae	s	N			x
Diospyros australis	Black Plum	Ebenaceae	t	N			x
Dodonaea triquetra	Hop Bush	Sapindaceae	s	N			x
Doryanthes excelsa	Gymea Lily	Doryanthaceae	h	N			x
Ehretia acuminata	Koda	Boraginaceae	S	N	x	R	
*Ehrharta erecta**	Panic Veldtgrass	Poaceae	h	E	x	M	
Elaeocarpus reticulatus	Blueberry Ash	Elaeocarpaceae	st	N	x	R	x
Eucalyptus amplifolia	Cabbage Gum	Myrtaceae	t	N			x
Eucalyptus botryoides	Bangalay	Myrtaceae	t	N	x	O	
Eucalyptus grandis	Flooded gum	Myrtaceae	t	N	x	O	
Eucalyptus punctata	Grey Gum	Myrtaceae	t	N			x
Eucalyptus robusta	Swamp Mahogany	Myrtaceae	t	N	x	M	
Eucalyptus umbra	Broad-leaved White Mahogany	Myrtaceae	t	N	x	R	
Ficinia nodosa	-	Cyperaceae	h	N	x	M	x
Ficus coronata	Sandpaper Fig	Moraceae	t	N			x
Ficus rubiginosa	Port Jackson Fig	Moraceae	t	N	x	R	
Glochidion ferdinandii	Cheese Tree	Phyllanthaceae	st	N	x	O	
Goodenia ovata	Hop Goodenia	Goodeniaceae	h	N	x	M	
*Grevillea robusta**	Silky Oak	Proteaceae	t	E	x	O	
Hakea bakeriana	-	Proteaceae	s	N			x
Hakea sericea	Needlebush	Proteaceae	s	N	x	R	x
Hakea teretifolia	Needlebush	Proteaceae	s	N			x

Hibbertia scandens	Climbing Guinea-flower	Dilleniaceae	v	N	x	R	x
Hibiscus heterophyllus subsp heterophyllus	Native Rosella	Malvaceae	s	N	x	O	
Homalanthus populifolius	Bleeding Heart	Euphorbiaceae	s	N	x	O	x
Hymenosporum flavum	Native Frangipani	Pittosporaceae	t	N	x	R	x
*Hypochaeris radicata**	Flatweed	Asteraceae	h	E	x	M	
Hypolepis muelleri	Harsh Ground Fern	Dennstaedtiaceae	h	N	x	O	
Imperata cylindrica	Blady Grass	Poaceae	h	N			x
Indigofera australis	Native Indigo	Faboideae	s	N			x
*Ipomoea cairica**	Blue Morning Glory	Convolvulaceae	v	E#	x	R	
*Ipomoea indica**	Coastal Morning Glory	Convolvulaceae	v	E#	x	R	
Jacksonia scoparia	Dogwood	Faboideae	s	N	x	R	
Kennedia rubicunda	Dusky Coral Pea	Faboideae	v	N	x	R	
*Lagunaria patersonii subsp bracteatus**	Norfolk Island Hibiscus	Malvaceae	s	E	x	M	
Lambertia formosa	Mountain Devil	Proteaceae	s	N			x
Leptospermum continentale	Prickly Tea Tree	Myrtaceae	s	N			x
Leptospermum juniperinum	Prickly Tea-tree	Myrtaceae	s	N	x	R	x
Leptospermum laevigatum	Coast Tea-tree	Myrtaceae	s	N	x	C	
Leptospermum polygalifolium	Lemon Scented Tea-tree	Myrtaceae	s	N	x	R	
Leucopogon parviflorus	Coastal Beard-heath	Styphelioideae	s	N			x
Livistona australis	Cabbage Tree Palm	Arecaceae	t	N	x	R	
Lomandra longifolia	Spiky-headed Mat-rush	Lomandraceae	h	N	x	M	
Marsdenia rostrata	Milk Vine	Apocynaceae	v	N	x	R	
*Megathyrus maximus var maximus**	Guinea Grass	Poaceae	h	E	x	M	
Melaleuca armillaris	Bracelet Honey Myrtle	Myrtaceae	s	N	x	C	
Melaleuca nodosa	Prickly-leaved Paperbark	Myrtaceae	s	N			x
Melaleuca quinquenervia	Broad-leaved Paperbark	Myrtaceae	t	N	x	M	
Melaleuca thymifolia	Thyme Honey Myrtle	Myrtaceae	s	N			x
Metrosideros stipoides	New Zealand Christmas Bush	Myrtaceae	s	E	x	O	
Mirbelia rubiifolia	Heathy Mirbelia	Faboideae	s	N			x
*Modiola caroliniana**	Red-flowered Mallow	Malvaceae	h	E	x	O	
*Monstera deliciosa**	Fruit-salad Plant	Araceae	h	E	x	R	
*Nerium oleander**	Oleander	Apocynaceae	s	E	x	R	
*Nothoscordum gracile**	Onion Weed	Alliaceae	h	E	x	O	
Olea europa subsp. *cuspidata**	African Olive	Oleaceae	st	E#	x	C	
Oxalis perrenans	-	Oxalidaceae	h	N	x	O	
Parsonsia straminea	Common Silkpod	Apocynaceae	v	N	x	O	
*Pennisetum clandestinum **	Kikuyu	Poaceae	h	E	x	O	
Persoonia linearis	Narrow-leaved Geebung	Proteaceae	s	N			x
*Phoenix canariensis**	Canary Island Date Palm	Arecaceae	t	E	x	M	
Pittosporum revolutum	Yellow Pittosporum	Pittosporaceae	s	N			x
Pittosporum undulatum	Sweet Pittosporum	Pittosporaceae	t	N	x	C	
*Plantago lanceolata**	Ribwort	Plantaginaceae	h	E	x	C	
*Poa annua**	Winter Grass	Poaceae	h	E	x	M	

Poa poiformis		Poaceae	h				x
Polymeria calycina	Bindweed	Convolvulaceae	v	N			x
Polyscias elegans	Celery Wood	Araliaceae	t	N	x	R	
*Prunus persica**	Peach Tree	Rosaceae	t	E	x	R	
Pultenaea paleacea	Chaffy Bush-pea	Faboideae	s	N			x
Pultenaea villosa	Hairy Bush-pea	Faboideae	s	N			x
*Salix babylonica**	Weeping Willow	Salicaceae	t	E#	x	O	
Sannantha pluriflora	-	Myrtaceae	s	N			x
Scaevola albida		Goodeniaceae	h	N	x	O	x
*Schefflera actinophylla**	Umbrella Tree	Araliaceae	t	E#	x	O	
*Senna pendula var glabrata**		Caesalpinioideae	s	E#	x	R	
*Sisyrinchium rostulatum (sp A)**	Pigroot	Iridaceae	h	E	x	O	
Solanum aviculare	Kangaroo Apple	Solanaceae	h	N	x	O	
*Solanum chenopodioides**	Whitelip Nightshade	Solanaceae	h	E	x	O	
*Solanum mauritianum**	Wild Tobacco	Solanaceae	s	E	x	C	
*Solanum nigrum**	Black Nightshade	Solanaceae	h	E	x	R	
*Soliva sessilis**	Jojo	Asteraceae	h	E	x	O	
*Sonchus oleraceus**	Common Sow-thistle	Asteraceae	h	E	x	O	
*Stenotaphrum secundatum **	Buffalo Grass	Poaceae	h	E	x	M	
Syncarpia glomulifera	Turpentine	Myrtaceae	t	N	x	O	
Themeda triandra	Kangaroo Grass	Poaceae	h	N	x	M	
Tipuana tipu	Tipu Tree	Fabaceae	t	E	x	R	
*Tradescantia fluminensis**	Wandering Jew	Commelinaceae	h	E	x	C	
Trema tomentosa	Native Peach	Ulmaceae	s	N	x	M	
*Tropaeolum majus**	Nasturtium	Tropaeolaceae	h	E	x	O	
Viola hederacea	Ivy-leaved Violet	Violaceae	h	N	x	M	
Westringia fruiticosa	Coast Westringia	Lamiaceae	s	N	x	R	
Wikstroemia indica							x
Wollemia nobilis	Wollemi Pine	Araucariaceae	s	N	x	R	
Xanthorrhoea macronema	-	Xanthorrhoaceae	h	N			x

[a] h=herb, v=vine, s=shrub, t=tree,

[b] N=Native, E=Exotic, #=Noxious weed

[c] X=recorded in current survey

[d] C=Common, M=Moderately common, O=Occasional, R=Rare,

[e] Previous List = refers to the species list that past bush regeneration works were based on. Not all of these species were recorded in Arcadia Park during the current site visit.

12. APPENDIX B: HABITAT ASSESSMENT

Family	Scientific Name	Common Name	NSW status	Comm. status	Habitat Preference	Records	Likelihood of Occurrence
Hylidae	*Litoria aurea*	Green and Golden Bell Frog	E1,P	V	Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha spp*.) or spikerushes (*Eleocharis spp*.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas. The species is active by day and usually breeds in summer when conditions are warm and wet. Males call while floating in water and females produce a raft of eggs that initially float before settling to the bottom, often amongst vegetation. Tadpoles feed on algae and other plant-matter; adults eat mainly insects, but also other frogs. Preyed upon by various wading birds and snakes.	70	Low. Site lacks suitable habitat.
Columbidae	*Ptilinopus superbus*	Superb Fruit-Dove	V,P		Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees. Part of the population is migratory or nomadic. There are records of single birds flying into lighted windows and lighthouses, indicating that birds travel at night. At least some of the population, particularly young birds, moves south through Sydney, especially in autumn. Breeding takes place from September to January. The nest is a structure of fine interlocked forked twigs, giving a stronger structure than its flimsy appearance would suggest, and is usually 5-30 metres up in rainforest and rainforest edge tree and shrub species. The male incubates the single egg by day, the female incubates at night. Identifiable all year.	35	Low. No rainforest community currently occurs in Arcadia Park.
Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	P	C	The White-bellied Sea-eagle is distributed around the Australian coastline, including Tasmania, and well inland along rivers and wetlands of the Murray Darling Basin. In New South Wales it is widespread along the east coast, and along all major inland rivers and waterways.	373	Moderate. Arcadia Park may provide ancillary foraging and/or nesting habitat

				Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. Occurs at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest). Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts'. Nests are large structures built from sticks and lined with leaves or grass. Feed mainly on fish and freshwater turtles, but also waterbirds, reptiles, mammals and carrion. Hunts its prey from a perch or whilst in flight (by circling slowly, or by sailing along 10–20 m above the shore). Prey is usually carried to a feeding platform or (if small) consumed in flight, but some items are eaten on the ground. May be solitary, or live in pairs or small family groups consisting of a pair of adults and dependent young. Typically lays two eggs between June and September with young birds remaining in the nest for 65-70 days.		
Accipitridae	*Lophoictinia isura*	Square-tailed Kite	V,P,3	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland. Is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage. Appears to occupy large hunting ranges of more than 100km2. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.	8	Low. Arcadia Park does not provide suitable habitat for this species due to its isolation from other woodlands.
Accipitridae	*Pandion cristatus*	Eastern Osprey	V,P,3	Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water. Breed from July to	120	Moderate. Arcadia Park

					September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea. Incubation of 2-3 eggs, usually by the female, is about 40 days. Female remains with young almost until they fly, usually after about nine weeks in the nest.		may provide ancillary foraging and/or nesting habitat
Burhinidae	*Burhinus grallarius*	Bush Stone-curlew	E1,P		Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Largely nocturnal, being especially active on moonlit nights. Feed on insects and small vertebrates, such as frogs, lizards and snakes. Nest on the ground in a scrape or small bare patch. Two eggs are laid in spring and early summer.	541	Low. Arcadia Park does not provide suitable habitat for this species.
Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V,P		Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species. Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards Gregarious, travelling and feeding in small flocks (<10), though often with other lorikeets. Flocks numbering hundreds are still occasionally observed and may have been the norm in past centuries. Roosts in treetops, often distant from feeding areas. Nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2-15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees often chosen, including species like Allocasuarina. Nesting season extends from May to September. In years when flowering is prolific, Little Lorikeet pairs can breed twice, producing 3-4 young per attempt. However, the survival rate of fledglings is unknown.	177	Moderate. Arcadia Park may be used for isolated foraging by this species.
Psittacidae	*Lathamus discolor*	Swift Parrot	E1,P,3	E	Migrates to the Australian south-east mainland between March and October.	211	Moderate. Arcadia Park may provide foraging opportunities

				On the mainland they occur in areas where eucalypts are flowering profusely or where there is abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Inland Grey Box *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis*. Return to some foraging sites on a cyclic basis depending on food availability. Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum Eucalyptus globulus. Identifiable from March to September.		for this species.
Psittacidae	*Neophema pulchella*	Turquoise Parrot	V,P,3	Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals. Prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants or browsing on vegetable matter. Forages quietly and may be quite tolerant of disturbance. However, if flushed it will fly to a nearby tree and then return to the ground to browse as soon as the danger has passed. Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust.	30	Low. no farmlands occur around Arcadia Park.
Strigidae	*Ninox strenua*	Powerful Owl	V,P,3	The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine Syncarpia glomulifera, Black She-oak Allocasuarina littoralis, Blackwood Acacia melanoxylon, Rough-barked Apple Angophora floribunda, Cherry Ballart Exocarpus cupressiformis and a number of eucalypt species. The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider. There may be marked regional differences in the prey taken by Powerful Owls. For example in southern NSW, Ringtail Possum make up the bulk of prey in the lowland or coastal habitat. At higher	1234	Moderate. Foraging and/or roosting habitat present however no nesting habitat occurs in Arcadia Park.

				elevations, such as the tableland forests, the Greater Glider may constitute almost all of the prey for a pair of Powerful Owls. Flying foxes are important prey in some areas; birds comprise about 10-50% of the diet depending on the availability of preferred mammals. As most prey species require hollows and a shrub layer, these are important habitat components for the owl. Pairs of Powerful Owls demonstrate high fidelity to a large territory, the size of which varies with habitat quality and thus prey densities. In good habitats a mere 400 can support a pair; where hollow trees and prey have been depleted the owls need up to 4000 ha. Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. While the female and young are in the nest hollow the male Powerful Owl roosts nearby (10-200 m) guarding them, often choosing a dense "grove" of trees that provide concealment from other birds that harass him. Powerful Owls are monogamous and mate for life. Nesting occurs from late autumn to mid-winter, but is slightly earlier in north-eastern NSW (late summer - mid autumn). Clutches consist of two dull white eggs and incubation lasts approximately 38 days. Identifiable all year.		
Tytonidae	*Tyto longimembris*	Eastern Grass Owl	V,P,3	Eastern Grass Owls are found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. They rest by day in a 'form' - a trampled platform in a large tussock or other heavy vegetative growth. If disturbed they burst out of cover, flying low and slowly, before dropping straight down again into cover. Always breeds on the ground. Nests are found in trodden grass, and often accessed by tunnels through vegetation. Breeding season is highly variable and dependent on environmental conditions, but in NSW nesting most typically occurs in autumn or winter.	1	Low. No suitable habitat in Arcadia Park.
Tytonidae	*Tyto tenebricosa*	Sooty Owl	V,P,3	Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Roosts by day in the hollow of a tall forest tree or in heavy vegetation; hunts by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum (*Pseudocheirus peregrinus*) or Sugar Glider (*Petaurus breviceps*). Nests in very large tree-hollows.	365	Low. No rainforest habitat occurs within Arcadia Park.

Meliphagidae	*Epthianura albifrons*	White-fronted Chat	V,P	Gregarious species, usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. They are insectivorous, feeding mainly on flies and beetles caught from or close to the ground. Have been observed breeding from late July through to early March, with 'open-cup' nests built in low vegetation. Nests in the Sydney region have also been seen in low isolated mangroves. Nests are usually built about 23 cm above the ground (but have been found up to 2.5 m above the ground). Two to three eggs are laid in each clutch, and the complete nesting cycle from nest-building to independent young is approximately 50 days Birds can breed at one year of age and are estimated to live for five years.	16	Low. No suitable habitat occurs in Arcadia Park.
Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	V,P	Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Flight is laborious so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross large open areas. Live in family groups that consist of a breeding pair and young from previous breeding seasons. A group may consist of up to fifteen birds. All members of the family group remain close to each other when foraging. A soft 'chuck' call is made by all birds as a way of keeping in contact with other group members. Feed on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses. Build and maintain several conspicuous, dome-shaped stick nests about the size of a football. A nest is used as a dormitory for roosting each night. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts. Nests are maintained year-round, and old nests are often dismantled to build new ones. Breed between July and February. Usually two to three eggs are laid and incubated by the female. During incubation, the adult male and several helpers in the group may feed the female as she sits on the nest. Young birds are fed by all other members of the group. Territories range from one to fifty hectares (usually around ten hectares) and are defended all year. Territorial disputes with neighbouring groups are frequent and may last up to several hours, with much calling, chasing and occasional fighting.	19	Low. No suitable habitat occurs in Arcadia Park.
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V,P	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy. Builds a	141	Moderate. Suitable forging habitat however

					cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years. Generation length is estimated to be 5 years.		isolated patch only.
Phascolarctidae	*Phascolarctos cinereus*	Koala	V,P	V	Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Inactive for most of the day, feeding and moving mostly at night. Spend most of their time in trees, but will descend and traverse open ground to move between trees. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size. Generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery. Females breed at two years of age and produce one young per year. Preferred feed trees in Newcastle include: Primary food tree species: Tallowwood Eucalyptus microcorys, Parramatta red gum E. parramattensis, Forest red gum E. tereticornis, Orange gum E. bancroftii, Swamp mahogany E. robusta, Cabbage gum E. amplifolia Secondary food tree species Narrow-leaved red gum E. seeana, Craven grey box E. largeana, Slaty red gum E. glaucina, Grey gum E. biturbinata, Small-fruited grey gum E. propinqua, Large-fruited grey gum E. canaliculate, Red mahogany E. resinifera, Steel box E. rummeryi, Mountain mahogany E. notabilis, Rudder's box E. rudderi, Grey box E. moluccana, White-topped box E. quadrangulate, Yellow box E. melliodora Stringybarks/supplementary species Stringybark E. tindaliae, Blue-leaved stringybark E. agglomerate, Thin-leaved stringybark E. eugeniodes, Diehard stringybark E. cameronii, White stringybark E. globoidea.	567	Moderate. Arcadia Park has primary (*E. robusta* and *E. amplifolia*) and secondary (Grey Gum *E. punctata*) feed trees on site and may provide foraging habitat for dispersing male koalas.
Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	V,P	V	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Individual camps may have tens of thousands of animals and are used for mating, and for giving birth and rearing young.	5258	Moderate. Foraging habitat for this species is present in Arcadia Park.

				Annual mating commences in January and conception occurs in April or May; a single young is born in October or November. Site fidelity to camps is high; some camps have been used for over a century. Can travel up to 50 km from the camp to forage; commuting distances are more often <20 km. Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines. Also forage in cultivated gardens and fruit crops.		
Molossidae	*Mormopterus norfolkensis*	Eastern Freetail-bat	V,P	Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures. Usually solitary but also recorded roosting communally, probably insectivorous.	188	Moderate. Potential foraging and roosting habitat occurs in Arcadia Park.
Vespertilionidae	*Miniopterus australis*	Little Bentwing-bat	V,P	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters. In NSW the largest maternity colony is in close association with a large maternity colony of Eastern Bentwing-bats (Miniopterus schreibersii) and appears to depend on the large colony to provide the high temperatures needed to rear its young. Maternity colonies form in spring and birthing occurs in early summer. Males and juveniles disperse in summer. Only five nursery sites /maternity colonies are known in Australia. Identifiable Mid spring to mid-autumn	358	Moderate. Potential foraging and roosting habitat occurs in Arcadia Park.
Vespertilionidae	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V,P	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Maternity caves have very specific temperature and humidity regimes. At other times of the year, populations disperse within about 300 km range of maternity caves. Cold caves are used for hibernation in southern Australia. Breeding or roosting colonies can number from 100 to	552	Moderate. Potential foraging habitat occurs in Arcadia Park.

				150,000 individuals. Hunt in forested areas, catching moths and other flying insects above the tree tops. hibernate from June to August		
Vespertilionidae	*Scoteanax rueppellii*	Greater Broad-nosed Bat	V,P	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species. Little is known of its reproductive cycle, however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young. Identifiable mid spring to mid autumn.	196	Moderate. Potential foraging and roosting habitat occurs in Arcadia Park.

GROUPED FAUNA	Habitat	Species	Likelihood of Occurrence
	Oceanic	Wandering Albatross, , Flesh-footed Shearwater, Sooty Shearwater, Southern Giant Petrel, Providence Petrel, Sooty Oystercatcher, Pied Oystercatcher, Sooty Tern, Providence Petrel, Wedge-tailed Shearwater, Short-tailed Shearwater, Streaked Shearwater, Lesser Frigatebird, Masked Booby, Arctic Jaeger, Common Noddy,	Low
	Aerial, many habitats	Fork-tailed Swift, White-throated Needletail	Low
	Estuarine, Wetland	Black-tailed Godwit, Broad-billed Sandpiper, Curlew Sandpiper, Eastern Curlew, Whimbrel, Great Knot, Red Knot, Greater Sand-plover Lesser Sandplover, Pacific Golden Plover, Bar-tailed Godwit, Black-tailed Godwit, Marsh Sandpiper, Terek Sandpiper, Sharp-tailed Sandpiper, Common Sandpiper, Grey-tailed Tattler, Common Greenshank, Little Tern, Red-necked Stint, Asian Dowitcher, White-winged Black Tern, Gull-billed Tern, Caspian Tern, Common Tern, Little Tern,	Low
	Freshwater Wetland	Magpie Goose, Latham's Snipe, Australian Painted Snipe, Black-necked Stork, Bluebilled Duck, Comb-crested Jacana, Ruff, Wood Sandpiper, Cattle Egret, Glossy Ibis, Eastern Grass Owl, Freckled Duck, Giant Dragonfly	Low
	Rocky intertidal zone	Eastern Reef Egret, Ruddy Turnstone,	Low

	Riparian Habitat				Southern Myotis, Black Bittern, Australasian Bittern		Low
PLANTS							
Asteraceae	*Rutidosis heterogama*	Heath Wrinklewort	V,P	V	Grows in heath on sandy soils and moist areas in open forest and has been recorded along disturbed roadsides. All year Populations may die back with no above-ground plants evident after a few seasons.	281	Low. Arcadia Park lacks heath on sandy soils.
Elaeocarpaceae	*Tetratheca juncea*	Black-eyed Susan	V,P	V	It is usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover. However, it has also been recorded in heathland and moist forest. The majority of populations occur on low nutrient soils associated with the Awaba Soil Landscape. While some studies show the species has a preference for cooler southerly aspects, it has been found on slopes with a variety of aspects. It generally prefers well-drained sites below 200m elevation and annual rainfall between 1000 - 1200mm. The preferred substrates are sandy skeletal soil on sandstone, sandy-loam soils, low nutrients; and clayey soil from conglomerates, pH neutral. It usually spreads via underground stems which can be up to 50 cm long. Consequently, individual plants may be difficult to identify. It also reproduces sexually but this requires insect pollination. Large populations of this species are particularly important. Cryptic, only detectable when in flower generally July to December but may be irregular due to prevailing climatic conditions.	1469	Moderate. Suitable habitat occurs in Arcadia Park. The Soil Landscape of Arcadia Park is not Awaba, but is Killingworth which has associations the Newcastle Coal Measures of the Awaba Hills region.
Fabaceae (Faboideae)	*Pultenaea maritima*	Coast Headland Pea	V,P		The species occurs in grasslands, shrublands and heath on exposed coastal headlands and adjoining low coastal heath. Found on clay or sandy loam or clay loam over sandstone at altitude 5-30 m . Associated with Banksia integrifolia and Themeda australis. Flowers from (June) August to March; fruit occurs from January to March.	19	Low. Arcadia Park does not have suitable habitat for this species.
Orchidaceae	^^*Diuris praecox*	Rough Doubletail	V,P,2	V	Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey. Exists as subterranean tubers most of the year. It produces leaves and flowering stems in winter. Undetectable except when in flower between July and August depending on prevailing climatic conditions.	30	Moderate. Arcadia Park is a slope near coast which was once an open forest.
Proteaceae	*Grevillea shiressii*		V,P	V	Grows along creek banks in wet sclerophyll forest with a moist understorey in alluvial sandy or loamy soils. Flowers mainly late winter to Spring (July-December), with seed released at maturity in October. Flowers are bird pollinated and seeds are dispersed by ants.	12	Low. Arcadia Park does not have suitable habitat for this species.

				A fire sensitive obligate seeder that is highly susceptible to local extinction due to frequent fire, however, fire is likely to be relatively infrequent in the habitat of G. shiressii. Seed germination does occur in the absence of fire, however some physical disturbance is likely to promote seed germination.		
Polygonaceae	*Muehlenbeckia costata*	Scrambling Lignum	V,P	Scrambling Lignum is a scrambling climber. The low straggling stems are up to 5 m long and have turned up ends. The oval-shaped leaves are 3 - 14 cm long and 1.5 - 9 cm wide. The flowers are spread evenly along the branches and produce black, warty, shiny nuts 2.5 - 3.5 mm long. These are covered by large fleshy flower parts when ripe. Large numbers of seedlings appear following bush fires, with most plants living for only 2 - 3 years. Rare individuals may live for 10 years. It has a scattered distribution from Queensland to the Blue Mountains in NSW. Records on the New England Tablelands and North West Slopes include Bald Rock north of Tenterfield, Warra and Butterleaf National Parks near Glen Innes and Mt Kaputar. Grows in coarse sandy soils and peat in heath, mallee and open eucalypt woodland on granite or acid volcanic outcrops at higher altitudes.		Low. Arcadia Park does not have granite or acid volcanic outcrops.
Zannichelliaceae	*Zannichellia palustris*		E1,P	In NSW, known from the lower Hunter and in Sydney Olympic Park. Grows in fresh or slightly saline stationary or slowly flowing water. Flowers during warmer months. NSW populations behave as annuals, dying back completely every summer.	23	Low. Arcadia Park does not have suitable habitat for this species.

13. APPENDIX C: ASSESSMENT OF SIGNIFICANCE: BC ACT

A number of legislative changes came into effect on 25th August 2017. The Native Vegetation Act 2003, Threatened Species Conservation Act 1995, Nature Conservation Trust Act 2001 and Parts 7 to 9 of the National Parks and Wildlife Act 1974 were repealed. In their place, the Biodiversity Conservation Act 2016, Local Land Services Act 2013 and State Environmental Planning Policy (vegetation in non-rural Areas) 2017 were established.

The key elements of the Biodiversity Conservation Act (BC Act) are:

- It introduces Biodiversity Offset Scheme (BOS) which expands offsets beyond major projects to include other types of developments
- Provides a consistent Biodiversity Assessment Method (BAM)
- It introduces flexible offset delivery options
- Assessors are required to be an Accredited Person
- It consolidates Private Land Conservation Agreement types
- It introduces Areas of Outstanding Biodiversity Value (AOBV)

Activities that fall under Part 5 of the EP&A Act can choose to opt in to the BOS if an Assessment of Significance (5-part test) is significant. Alternatively, assessment can continue down the Species Impact Statement (SIS) pathway. The current assessment falls under Part 5 of the EP&A Act and as such, an assessment of significance (formerly a 7-part test but modified to a 5-part test) is required under the BC Act.

The BC Act includes a "test for determining whether proposed development or activity likely to significantly affect threatened species or ecological communities, or their habitats". Section 7.3 identifies five factors which "must be taken into account" by a consent or determining authority in administering Part 5 of the EP&A Act, as relevant in the circumstances.

5-part test (a-e)

(1) The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats:

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

(2) The Minister may, by order published in the Gazette with the concurrence of the Minister for Planning, issue guidelines relating to the determination of whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats. Any such guidelines may include consideration of the implementation of strategies under the Biodiversity Conservation Program.

A habitat assessment (Table B1) considered the potential for Arcadia Park to provide habitat (feeding, roosting or breeding/nesting) for any threatened species and threatened ecological communities listed under Schedules 1&2 (respectively) of the BC Act.

No potential habitat for threatened ecological communities were identified in Arcadia Park during habitat assessment. A 5-part test is relevant for 12 threatened fauna and 2 threatened flora species that may potentially utilise/have habitat in Arcadia Park.

Unless otherwise cited, information was obtained from the OEH species profiles and references contained therein.
http://www.environment.nsw.gov.au/threatenedSpeciesApp/

Effects on a Threatened Species

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

White-bellied Sea-eagle

The White-bellied Sea-Eagle is a large eagle that has long broad wings and a short, wedge-shaped tail. It measures 75-85 cm in length, and has a wingspan of 180-220 cm. Adults are predominantly white and grey. The head, breast and belly, and the feathering on the legs, are white. The back and upper surfaces of the wings are grey, and the undersides are greyish-black with a smaller area of white along the leading edge. The tail is grey at the base, and has a white tip. The large, hooked bill is grey with a darker tip, and the eye is dark brown. The legs and feet are cream-white, with long black talons. Both sexes are similar in appearance but females are larger than the males. Juveniles are brown with

lighter markings. White-bellied Sea-eagles may be solitary, or live in pairs or small family groups consisting of a pair of adults and dependent young.

The White-bellied Sea-eagle is distributed around the Australian coastline, including Tasmania, and well inland along rivers and wetlands of the Murray Darling Basin. In New South Wales it is widespread along the east coast, and along all major inland rivers and waterways.

Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. Occurs at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest).

Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts'. Nests are large structures built from sticks and lined with leaves or grass. Feed mainly on fish and freshwater turtles, but also waterbirds, reptiles, mammals and carrion.

Hunts its prey from a perch or whilst in flight (by circling slowly, or by sailing along 10–20 m above the shore). Prey is usually carried to a feeding platform or (if small) consumed in flight, but some items are eaten on the ground. May be solitary, or live in pairs or small family groups consisting of a pair of adults and dependent young. Typically lays two eggs between June and September with young birds remaining in the nest for 65-70 days.

Arcadia Park provides potential foraging habitat for this species and potential roost and nest sites as there is limited other woodland/forest environments in the vicinity. No nests were recorded on site during surveys indicating that Arcadia Park is not currently being utilised as a nesting location for this species. No potential nest/roost trees (i.e. large native emergent trees or Norfolk Island Pines) will be removed as part of the proposed restoration of the park. Thus, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Eastern Osprey

The Eastern Osprey is a large, water-dependent bird of prey, distinctive in flight and when perched. Despite its wing-span of up to 1.7 m, it is noticeably smaller than the White-bellied Sea-eagle. In flight it can be recognised by its distinctly bowed wings that are dark brown above, and barred underneath, and with white underwing coverts. Perched, the upperparts are dark brown and the underparts are white. The female has a dark streaky collar. The head is mainly white with a blackish stripe through the eye.

The Osprey has a global distribution with four subspecies previously recognised throughout its range. However, recent studies have identified that there are two species of Osprey - the Western Osprey (*P. halietus*) with three susbpecies occurring in Europe, Asia and the Americas and the Eastern Osprey (*P. cristatus*) occurring between Sulawesi (in Indonesia), Australia and New Caledonia. Eastern Ospreys are found right around the Australian coast line, except for Victoria and Tasmania. They are common around the northern coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south-eastern Australia. There are a handful of records from inland areas.

The favour coastal areas, especially the mouths of large rivers, lagoons and lakes and feed on fish over clear, open water. Osprey breed from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of

the sea. Incubation of 2-3 eggs, usually by the female, is about 40 days. Female remains with young almost until they fly, usually after about nine weeks in the nest.

Arcadia Park provides potential roost and nest sites as there is limited other woodland/forest environments in the vicinity. No nests were recorded on site during surveys indicating that Arcadia Park is not currently being utilised as a nesting location for this species. No potential nest/roost trees (i.e. large native emergent trees or Norfolk Island Pines) will be removed as part of the proposed restoration of the park. Thus, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Little Lorikeet

The Little Lorikeet is a small (16-19 cm; 40 g) bright green parrot, with a red face surrounding its black bill and extending to the eye. The undertail is olive-yellow with a partly concealed red base, and the underwing coverts are bright green. The mantle is imbued with light brown. The call in flight is diagnostically different from other lorikeets, being a shrill and rolling screech: 'zit-zit' or 'zzet'. Although difficult to observe while foraging high in treetops, a flock's constantly chattering contact calls give it away. Flight is fast, direct and through or above the canopy.

The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs.

Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species. Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards

Gregarious, travelling and feeding in small flocks (<10), though often with other lorikeets. Flocks numbering hundreds are still occasionally observed and may have been the norm in past centuries. Roosts in treetops, often distant from feeding areas. Nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees often chosen, including species like Allocasuarina. Nesting season extends from May to September. In years when flowering is prolific, Little Lorikeet pairs can breed twice, producing 3-4 young per attempt. However, the survival rate of fledglings is unknown.

Arcadia Park provides potential foraging habitat for this species however as it is isolated, it is likely to be only intermittently used. There are limited opportunities for nesting in Arcadia park for this species as the site does not contain any hollows in smooth barked eucalypts or hollows in allocasuarinas. No potential feed trees or future nest trees (i.e. natives) will be removed as part of the proposed restoration of the park. Thus, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Swift Parrot

The Swift Parrot is small parrot about 25 cm long. It is bright green with red around the bill, throat and forehead. The red on its throat is edged with yellow. Its crown is blue-purple. There are bright red patches under the wings. One of most distinctive features from a

distance is its long (12 cm), thin tail, which is dark red. This distinguishes it from the similar lorikeets, with which it often flies and feeds. Can also be recognised by its flute-like chirruping or metallic "kik-kik-kik" call.

Breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW mostly occurs on the coast and south west slopes.

Swift Parrots migrates to the Australian south-east mainland between March and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Inland Grey Box *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis*. They return to some foraging sites on a cyclic basis depending on food availability. Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum Eucalyptus globulus.

Arcadia Park provides potential foraging habitat for this species as the preferred feed trees: *E. robusta, C. maculata and C. gummifera* occur on site. However, there are no records of this species having occurred on the site, the site is outside the breeding range of this species and the proposed works will not remove any potential foraging trees. Thus, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Powerful Owl

The Powerful Owl is the largest owl in Australasia. It is a typical hawk-owl, with large yellow eyes and no facial-disc. Adults reach 60 cm in length, have a wingspan of up to 140 cm and weigh up to 1.45 kilograms. Males are larger than females. The upper parts of the Powerful Owl are dark, greyish-brown with indistinct off-white bars. The underparts are whitish with dark greyish-brown V-shaped markings. Juvenile Powerful Owls have a white crown and underparts that contrasts with its small, dark streaks and dark eye patches. The call of this species may be heard at any time of the year, but it is more vocal during the autumn breeding season. It has a slow, deep and resonant double hoot, with the female's being higher pitched and expressing an upward inflection on the second note.

The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered records on the western slopes and plains suggesting occupancy prior to land clearing. Now at low densities throughout most of its eastern range, rare along the Murray River and former inland populations may never recover.

The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest.

The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine *Syncarpia glomulifera*, Black She-oak *Allocasuarina littoralis*, Blackwood *Acacia melanoxylon*, Rough-barked Apple *Angophora floribunda*, Cherry Ballart *Exocarpus cupressiformis* and a number of eucalypt species.

The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider. There may be marked regional differences in the prey taken by Powerful Owls. For example in southern NSW, Ringtail Possum make up the bulk of prey in the lowland or coastal habitat. At higher elevations, such as the tableland

forests, the Greater Glider may constitute almost all of the prey for a pair of Powerful Owls. Flying foxes are important prey in some areas; birds comprise about 10-50% of the diet depending on the availability of preferred mammals. As most prey species require hollows and a shrub layer, these are important habitat components for the owl.

Pairs of Powerful Owls demonstrate high fidelity to a large territory, the size of which varies with habitat quality and thus prey densities. In good habitats a mere 400 can support a pair; where hollow trees and prey have been depleted the owls need up to 4000 ha.

Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. While the female and young are in the nest hollow the male Powerful Owl roosts nearby (10-200 m) guarding them, often choosing a dense "grove" of trees that provide concealment from other birds that harass him.

Powerful Owls are monogamous and mate for life. Nesting occurs from late autumn to mid-winter but is slightly earlier in north-eastern NSW (late summer - mid autumn). Clutches consist of two dull white eggs and incubation lasts approximately 38 days.

Arcadia Park provides potential foraging habitat for this species and while there are no recorded occurrences on the BioNet database, NCC staff have indicated that there has been a previous sighting of this species in Arcadia Park (observer and date observed unknown, refer email from P Freeman dated 17/01/18). While there are hollows in Weeping Willow trees on the site, the hollows are not suitable for nesting by this species as they are low to the ground and lack the depth required by nesting pairs. Removal of these hollow trees are therefore considered unlikely to affect the nesting habitat available to this species. The trees may however provide habitat for prey species such as ringtail possums. The proposed installation of nest boxes will mitigate the loss of nesting habitat for prey of this species. Thus, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Varied Sittella

The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades.

This species inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland. They feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy. Varied Sittella build a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.Generation length is estimated to be 5 years.

Arcadia Park does provide potential habitat for this species and there is a nearby record of this species from 2015. The proposed works do not require the removal of native eucalyptus trees or other potential foraging habitat for this species. Thus, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Koala

The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. It was briefly historically abundant in the 1890s in the Bega District on the south coast of NSW,

although not elsewhere, but it now occurs in sparse and possibly disjunct populations. Koalas are also known from several sites on the southern tablelands.

They inhabit eucalypt woodlands and forests and feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. They are inactive for most of the day, feeding and moving mostly at night. Koalas spend most of their time in trees, but will descend and traverse open ground to move between trees.

Their home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size. They are generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery. Females breed at two years of age and produce one young per year.

The site does not fall under the SEPP 44 definition of "core koala habitat" as it lacks recent records or breeding females. While the site does have a number of Swamp Mahogany *E. robusta* which are a schedule 2 feed trees (under SEPP 44), they do not consistute >15% of the total number of trees in the upper or lower strata so the site does not constitute "potential koala habitat" under SEPP 44. However, in addition to having E. robusta, Arcadia park also has a number of preferred feed trees, including primary feed trees (Cabbage Gum *E. amplifolia*) and secondary (Grey Gum *E. punctata*) feed trees on site. Thus, Arcadia Park does provide foraging opportunities for dispersing male koalas. The proposed works do not require the removal of any preferred feed trees of this species. It is recommended that pre-clearing surveys be conducted on the site to ensure there are no fauna present in trees to be felled. Thus, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Eastern Bentwing-bat

The Eastern Bentwing-bat has chocolate to reddish-brown fur on its back and slightly lighter coloured fur on its belly. It has a short snout and a high 'domed' head with short round ears. The wing membranes attach to the ankle, not to the base of the toe. The last bone of the third finger is much longer than the other finger-bones giving the "bent wing" appearance. It weighs up to 20 grams, has a head and body length of about 6 cm and a wingspan of 30 - 35 cm.

Eastern Bentwing-bats occur along the east and north-west coasts of Australia.

- Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.
- Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young.
- Maternity caves have very specific temperature and humidity regimes.
- At other times of the year, populations disperse within about 300 km range of maternity caves.
- Cold caves are used for hibernation in southern Australia.
- Breeding or roosting colonies can number from 100 to 150,000 individuals.
- Hunt in forested areas, catching moths and other flying insects above the tree tops
- Hibernate from June to August

Arcadia Park provides foraging habitat for this species only and while the surrounding urban environment may provide some roosting opportunities outside of the breeding season, it is unlikely to support a viable population of this species. The proposed works require the removal of exotic species along with native *A. binervia* (at the end of their life span). The

hollows present in Weeping Willows *Salix babylonica* are not suitable roosting habitat for this species and as such, their removal will not impact the roosting or breeding opportunities for this species. Thus, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Little Bentwing-bat

Little Bentwing-bats are small dark chocolate brown insectivorous bats with a body length of about 45 mm. The tip of the wing is formed by a particularly long joint of the third finger, folded back and bent under the wing while the bat is at rest. The fur is long and thick, especially over the crown and around the neck, and is slightly lighter in colour on the belly. They have distinctly short muzzles, and short, rounded roughly triangular shaped ears. Distinguished from the Common Bentwing-bat by its smaller size.

East coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW.

- Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas.
- Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.
- They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters.
- In NSW the largest maternity colony is in close association with a large maternity colony of Eastern Bentwing-bats (*Miniopterus schreibersii*) and appears to depend on the large colony to provide the high temperatures needed to rear its young.
- Maternity colonies form in spring and birthing occurs in early summer. Males and juveniles disperse in summer.
- Only five nursery sites /maternity colonies are known in Australia.
- Identifiable Mid spring to mid-autumn

Arcadia Park provides foraging habitat for this species however the park and surrounding urban environment has limited hollow bearing trees for roosting to support a viable population of this species. The proposed works require the removal of exotic species along with native *A. binervia* (at the end of their life span) however the bark on these tree species is also considered unsuitable for roosting beneath. The hollows present in Weeping Willows *Salix babylonica* are not suitable roosting habitat for this species and as such, their removal will not impact the roosting or breeding opportunities for this species. Thus, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Eastern Freetail-bat

The Eastern Freetail-bat has dark brown to reddish brown fur on the back and is slightly paler below. Like other freetail-bats it has a long (3 - 4 cm) bare tail protruding from the tail membrane. Freetail-bats are also known as mastiff-bats, having hairless faces with wrinkled lips and triangular ears. They weigh up to 10 grams.

The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW.

- Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range.

- Roost mainly in tree hollows but will also roost under bark or in man-made structures.
- Usually solitary but also recorded roosting communally, probably insectivorous

Arcadia Park provides foraging habitat for this species however the park and surrounding urban environment has limited hollow bearing trees for roosting to support a viable population of this species. The proposed works require the removal of exotic species along with native *A. binervia* (at the end of their life span) however the bark on these tree species is also considered unsuitable for roosting beneath. The hollows present in Weeping Willows *Salix babylonica* are not suitable roosting habitat for this species and as such, their removal will not impact the roosting or breeding opportunities for this species. Thus, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Greater Broad-nosed Bat

The Greater Broad-nosed Bat is a large powerful bat, up to 95 mm long, with a broad head and a short square muzzle. It is dark reddish-brown to mid-brown above and slightly paler below. It is distinguished from other broad-nosed bats by its greater size. While similar to the Eastern False Pipistrelle Falsistrellus tasmaniensis, it differs by having only two (not four) upper incisors.

The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 m.

- Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest.
- Although this species usually roosts in tree hollows, it has also been found in buildings.
- Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m.
- Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species.
- Little is known of its reproductive cycle, however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young.
- Identifiable mid spring to mid autumn

Arcadia Park provides foraging habitat for this species however the park and surrounding urban environment has limited hollow bearing trees to support a viable population of this species. The proposed works require the removal of exotic species along with native *A. binervia* (at the end of their life span) however the bark on these tree species is also considered unsuitable for roosting beneath. The hollows present in Weeping Willows *Salix babylonica* are not suitable roosting habitat for this species and as such, their removal will not impact the roosting or breeding opportunities for this species. Thus, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Grey-headed Flying-fox

The Grey-headed Flying-fox is the largest Australian bat, with a head and body length of 23 - 29 cm. It has dark grey fur on the body, lighter grey fur on the head and a russet collar

encircling the neck. The wing membranes are black and the wingspan can be up to 1 m. It can be distinguished from other flying-foxes by the leg fur, which extends to the ankle.

Grey-headed Flying-foxes are generally found within 200 km of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia. In times of natural resource shortages, they may be found in unusual locations.

- Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.
- Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.
- Individual camps may have tens of thousands of animals and are used for mating, and for giving birth and rearing young.
- Annual mating commences in January and conception occurs in April or May; a single young is born in October or November.
- Site fidelity to camps is high; some camps have been used for over a century.
- Can travel up to 50 km from the camp to forage; commuting distances are more often <20 km.
- Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines.
- Also forage in cultivated gardens and fruit crops.

Arcadia Park provides foraging habitat only for this species as the park does not provide habitat for a roosting camp. The proposed works require the removal of exotic species along with native *A. binervia* (at the end of their life span). While some of the exotic species contain fruit, they are not considered important food souces for this species and the retained vegetation in the park will continue to provide foraging opportunities for visits from this species. Thus, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Tetratheca juncea

This species is confined to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock.

- It is usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover. However, it has also been recorded in heathland and moist forest.
- The majority of populations occur on low nutrient soils associated with the Awaba Soil Landscape.
- While some studies show the species has a preference for cooler southerly aspects, it has been found on slopes with a variety of aspects.
- It generally prefers well-drained sites below 200m elevation and annual rainfall between 1000 - 1200mm. The preferred substrates are sandy skeletal soil on sandstone, sandy-loam soils, low nutrients; and clayey soil from conglomerates, pH neutral.
- It usually spreads via underground stems which can be up to 50 cm long. Consequently, individual plants may be difficult to identify. It also reproduces sexually but this requires insect pollination.

- Large populations of this species are particularly important.

Arcadia Park provides only marginal habitat for this species and as it is highly visible during its flowering period, the absence of previous records on the site indicate that there is no viable population of this species in Arcadia Park. As such, the proposed works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Diuris praecox

Known from locations between Bateau Bay and Smiths Lake where they grow on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey. This species exists as subterranean tubers most of the year. It produces leaves and flowering stems in winter.

There have been no recorded occurrences of this species in Arcadia Park and while this species is cryptic and difficult to identify, it is considered that if it were present, it would have been observed by one of the many bush regenerators that have worked on the site. Thus, it is considered unlikely that a local population of this species occurs in Arcadia park and as such, the proposed restoration works are unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Effects on an Endangered Ecological Community

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

N/A. No endangered ecological communities occur in Arcadia Park.

Effect on Habitat of a Threatened Species

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality

A total of 36 exotic trees will be removed during Stage 1 of the implementation of the Vegetation Management Plan (VMP). However, all viable native canopy trees will be retained in the park and as such will continue to provide connectivity and shelter within the park. Works will not result if further isolation or fragmentation of native bushland.

Arcadia park provides foraging habitat for the White-bellied Sea-eagle, Eastern Osprey, Little Lorikeet, Swift Parrot, Powerful Owl, Koala and Grey-headed Flying-fox however it does not provide potential nesting habitat for these species. The site provides potential foraging and nesting habitat for Varied Sittella however there have been no records of this species on the site. A number of microbats have potential habitat in Arcadia Park however as it is very isolated, it is unlikely that it provides important habitat for microbats as small tree hollows are not available. Thus, the habitat to be modified in Arcadia Park is not important habitat to the long-term survival of these species.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

Arcadia Park has not been declared as an area of outstanding biodiversity value.

Constitutes a Key Threatening Process

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process

The proposal does not contribute to a Key Threatening Process as clearing will be of exotic trees and dying native trees and the implementation of the VMP will result in extensive re-vegetation of the park, resulting in a net increase in native bushland.

Concluding Comments and Recommendations

It is considered that the proposal is not likely to result in a significant effect on any threatened species or ecological communities. It is therefore concluded that a Species Impact Statement (or assessment under Biodiversity Assessment Methodology (BAM) as part of the Biodiversity Offset scheme (BOS)) is not required for the proposed restoration works.

14. APPENDIX D: ASSESSMENT OF SIGNIFICANCE: EPBC ACT

A Protected Matters search was undertaken on 13/11/2017 within a 10x10 km area centred on Arcadia Park to determine the likely occurrence of Matters of National Environmental Significance.

A summary of matters of National Environmental Significance is provided in Table A3 (Appendix A), results of the Protected Matters Search Tool Results for Threatened Species listed under the EPBC Act with 10 km of the Study Area are provided in Table A4 (Appendix A) and results of the Protected Matters Search Tool Results for Migratory Species listed under the EPBC Act with 10 km of the Study Area are provided in Table A5 (Appendix A).

The Study Area does not contain any World Heritage Properties, National Heritage Places, Great Barrier Reef Marine Park or Commonwealth Marine Areas. It does contain one Wetland of International Importance (Hunter Estuary Wetlands), three listed threatened ecological communities (Central Hunter Valley eucalypt forest and woodland; Lowland Rainforest of Subtropical Australia, Subtropical and Temperate Coastal Saltmarsh), 71 listed threatened species and 70listed migratory species.

Following a site inspection and habitat assessment:

- Arcadia Park does not form part of the Hunter Estuary Wetland and the proposal is unlikely to impact this wetland.
- Arcadia Park does not contain the threatened ecological communities: Central Hunter Valley eucalypt forest and woodland, Subtropical and Temperate Coastal Saltmarsh or Lowland Rainforest of Subtropical Australia. The latter community occurs > 2km from the coast.
- Arcadia Park does not contain potential habitat for migratory species or threatened wetland or wading bird species.
- Arcadia Park has potential foraging habitat for one vulnerable species (Grey-headed Flying-fox *Pteropus poliocephalus*) however the proposal does not require removal of important foraging habitat.

Significant Impact Guidelines (DEHWA, 2009) have been prepared in order to decide whether an action is likely to have a significant impact. In determining the nature and magnitude of an action's impact, it is important to consider matters such as:

- all on-site and off-site impacts,
- all direct and indirect impacts,
- the frequency and duration of the action,
- the total impact which can be attributed to that action over the entire geographic area affected, and over time,
- the sensitivity of the receiving environment, and
- the degree of confidence with which the impacts of the action are known and understood.

Vulnerable threatened Species

Vulnerable species within the Study Area:

Pteropus poliocephalus	Grey-headed Flying-fox	V
Phascolarctos cinereus	Koala	V

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

a) lead to a long-term decrease in the size of an important population of a species

Under the meaning of the Act, an "important" population is one that is necessary for a species' long-term survival and recovery, and may include key source populations for breeding and dispersal, populations necessary for maintaining genetic diversity and populations near the limit of the species range.

Arcadia Park provides foraging opportunities only for the Grey-headed Flying-fox and the proposed works will not result in a reduction in the size of the local population of this species. Arcadia Park has not been identified as 'core koala habitat' as there are no records of breeding females or previous records on the site. As such, an important population of these species does not occur in Acadia Park.

b) reduce the area of occupancy of an important population

The proposed works will not reduce the area of occupancy of an important population of Grey-headed Flying-Fox or Koala

c) fragment an existing important population into two or more populations

Arcadia Park does not support an important population of these species.

d) adversely affect habitat critical to the survival of a species

Arcadia Park provides potential foraging habitat only and is not considered critical to the survival of these species.

e) disrupt the breeding cycle of an important population

These species does not breed on Arcadia Park, as such works will not disrupt the breeding cycling of an important population.

f) modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed works will not remove native species but rather increase the diversity and abundance of native habitat, ultimately improving the quality of habitat available to these species for foraging.

g) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The proposed works will result in a reduction in the exotic (including invasive) flora species on Arcadia Park.

h) introduce disease that may cause the species to decline, or

Tubestock infected by Myrtle rust could potentially impact *E. robusta*, a preferred feed tree for Koalas. To mitigate against this, plants in Arcadia Park are to be monitored for evidence of disease or introduced pathogens such as Myrtle Rust. Monitoring is to be undertaken by Council staff during the 4-year monitoring of Arcadia Park. If Myrtle Rust, other pathogens or disease are identified in Arcadia Park, they are to be treated immediately using appropriate methods (refer NSW DPI http://www.dpi.nsw.gov.au/biosecurity/plant/established-plant-pests-and-diseases/).

This is expanded on in the VMP.

i) interfere substantially with the recovery of the species.

The proposed works will not interfere with the recovery of these species.

Critically Endangered Threatened Species

Critically endangered species within the Study Area:

Lathamus discolour Swift Parrot CE

An action is likely to have a significant impact on a critically endangered species if there is a real chance or possibility that it will:

a) lead to a long-term decrease in the size of a population

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations, or
- a population, or collection of local populations, that occurs within a particular bioregion.

Arcadia Park does not have a population of swift parrot and there is no record of occurrence of this species.

b) reduce the area of occupancy of the species

There have been no recorded occurrences of this species (evidence of occupancy) and no feed trees for this species will be removed as part of the proposed works, thus the area of occupancy will not be affected.

c) fragment an existing population into two or more populations

No population occurs on the Subject Site.

d) adversely affect habitat critical to the survival of a species

Arcadia park does not have habitat that is critical to the survival of this species

e) disrupt the breeding cycle of a population

This species breeds in Tasmania, thus the proposed restoration works will not disrupt the breeding cycle of this species.

f) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Swamp Mahogany *E. robusta*, is a known feed tree for this species in the winter. The availability or quality of this feed tree will not be impacted by the proposed works.

g) result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

The proposed works will not result in invasive species that are harmful to the species.

h) introduce disease that may cause the species to decline, or

Tubestock infected by Myrtle rust could potentially impact *E. robusta*, a preferred feed tree for Swift Parrot. To mitigate against this, plants in Arcadia Park are to be monitored for evidence of disease or introduced pathogens such as Myrtle Rust. Monitoring is to be

undertaken by Council staff during the 4-year monitoring of Arcadia Park. If Myrtle Rust, other pathogens or disease are identified in Arcadia Park, they are to be treated immediately using appropriate methods (refer NSW DPI http://www.dpi.nsw.gov.au/biosecurity/plant/established-plant-pests-and-diseases/). This is expanded on in the VMP.

i) interfere with the recovery of the species.

The proposed works will not interfere with the recovery of this species.

Based on the above assessment it is considered that a referral to SEWPaC is not required.

Appendix C: Vegetation Management Plan

Coast Ecology

THE CITY OF NEWCASTLE

Proposed Restoration of Arcadia Park, The Hill

VEGETATION MANAGEMENT PLAN

Job No: 170807

Date: 7 February 2018

Vendor Nbr: 10677

COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

PO Box 3005 Wamberal NSW 2260
T: 0404 858573 E: kristy@coastecology.com.au W: coastecology.com.au
Kristy McQueen operates as a Sole Trader under registered business name Coast Ecology ABN: 24 924 674 371

Proposed Restoration of Arcadia Park, The Hill, Vegetation Management Plan

Issue	Date	Description	Author	Reviewed By
A	04/12/2017	DRAFT	KM	MM
B	07/02/2018	FINAL	KM	NCC

PO Box 3005 Wamberal NSW 2260
T: 0404 858573 E: kristy@coastecology.com.au W: coastecology.com.au
Kristy McQueen operates as a Sole Trader under registered business name Coast Ecology ABN: 24 924 674 371

CONTENTS

1 INTRODUCTION 4
1.1 FRAMEWORK FOR NATURAL ASSET MANAGEMENT 4
2 OBJECTIVES 4
2.1 KEY DELIVERABLES 5
3 DESCRIPTION OF THE SITE 6
3.1 LOCATION 6
3.2 CATCHMENT DESCRIPTION 6
3.3 FLORA CHARACTERISTICS 9
3.4 ASSESSMENT OF EXISTING VEGETATION 9
3.5 FAUNA ASSEMBLAGES AND HABITAT TYPES 11
3.6 WEEDS AND PESTS 14
3.7 CORRIDORS & CONNECTIVITY 15
3.8 HYDROLOGY 15
3.9 TOPOGRAPHY & GEOLOGY 16
4 MANAGEMENT ISSUES 17
4.1 GENERAL 17
4.2 THREATENED SPECIES/POPULATIONS/COMMUNITIES 17
4.3 DISEASE/PATHOGENS 17
4.4 BUSH FIRE 18
4.5 TREE PRESERVATION 19
4.6 CONTRACTOR'S SITE FACILITIES 19
4.7 CONSULTATION 19
5 VMP IMPLEMENTATION 20
5.1 SITE ESTABLISHMENT 20
5.2 TREATMENT OF EXOTICS 20
5.3 REVEGETATION 22
5.4 NATURAL REGENERATION 32
5.5 HABITAT AUGMENTATION 32
5.6 TIMEFRAME/STAGING 33
5.7 ACTION PLAN 34
5.8 MONITORING 34
5.9 REPORTING 35
6 REFERENCES 37
7 APPENDIX A: 38
8 APPENDIX B: ACTION PLAN 48

1 INTRODUCTION

Newcastle City Council (NCC) commissioned Coast Ecology to prepare a Vegetation Management Plan (VMP) for Site Restoration works at Arcadia Park, The Hill. Arcadia Park is approximately 1.5 ha in size and contains a mixture of native and exotic vegetation in the canopy. Recent bush regeneration works (by The Obelisk Hill-Arcadia Park Landcare group and Newcastle Ramblers Bushwalking Club and assisted by Newcastle City Council Park Services) has reduced exotic invasion in the middle stratum to a minimum however exotic grasses and herbs dominate the lower stratum. The parkland environment is popular for passive recreation such as picnics, walking and bird watching.

1.1 FRAMEWORK FOR NATURAL ASSET MANAGEMENT

Under Commonwealth legislation, the proposed works are subject to the provisions of the Environmental Protection and Biodiversity Conservation Act 1999 (EP&BC Act). An assessment of the proposed restoration works in relation to the EP&BC Act for Matters of National Environmental Significance (MNES) concluded that the works would not have a significant impact on MNES (refer REF, Coast Ecology, 2017).

The proposed works do not require development consent under SEPP Infrastructure or Newcastle LEP. Thus, they fall under Part 5 of the Environmental Planning and Assessment Act (EP&A Act) and their impacts on threatened species were assessed using an Assessment of Significance (5-part test). This test concluded that the restoration of Arcadia Park would not result in a significant impact on threatened species or endangered ecological communities. As such, the preparation of a Species Impact Statement (SIS) or consideration in the Biodiversity Offset Scheme (BOS) was not required under the Biodiversity Conservation Act (BC Act).

2 OBJECTIVES

The works are confined to within Arcadia Park (Figure 1). Restoration works will be managed by Newcastle Councils Bushland Services department (hereafter referred to as CBS).

The overall objective of the VMP is to restore the vegetation in Arcadia Park to native vegetation communities that may once have occurred in the area and improve the natural biodiversity of the park. Council have indicated that if appropriate, they would like to see the gully areas restored to a littoral rainforest community

More specifically, the following objectives apply:

1. Sensitive removal of exotic tree species and dead native species, avoiding damage to retained native species including recently planted areas.
2. Reuse of felled material on site (i.e. as mulch)
3. Removal of exotic species from the middle and lower stratum
4. Revegetation of Arcadia Park using appropriate species (Refer Section 5)
5. Creation a Littoral Rainforest community in the two gully's and a Coastal Plains Smooth-barked Apple Forest in the higher elevation areas.
6. Allow for the continued use of the park for passive recreation purposes
7. Maintain appropriate environmental safeguards for the duration of the works
8. Improve the biodiversity value of the park by
    a. increasing the abundance and diversity of native vegetation
    b. providing more habitat availability for native fauna through the provision of appropriate native feed trees and the installation of nest boxes.

9. Conduct monitoring and maintenance over a minimum 4-year period to suppress invading and emerging weeds and assist in the successful restoration of the area into the future.

2.1 KEY DELIVERABLES

The performance criteria of the VMP are to achieve:

- A zero-negative impact to the surrounding native vegetation during clearing and restoration implementation works,
- Stabilise disturbed soil as soon as possible following disturbance to minimise regrowth of exotic species,
- A minimum 95% eradication of all weeds following Phase 1,
- A minimum 80% survival rate of all trees and shrubs planted at the end of the 4-year monitoring period,
- The following % surface area coverage for each zone:
    - Zone 1, Littoral Rainforest: A lower stratum native surface area coverage of approximately 30%, a middle stratum surface area coverage of >70% and an upper surface area coverage (including emergent) of >95% after 10 years (estimated after 4-year monitoring period).
    - Zone 2, Existing Tracks and Picnic Areas: A lower stratum native surface area coverage of >95%, a middle stratum surface area coverage of <5% and an upper surface area coverage of < 30% after 10 years (estimated after 4-year monitoring period).
    - Zone 3, Coastal Plains Smooth-barked Apple Woodland: A lower stratum native surface area coverage of >95%, a middle stratum surface area coverage of >60% and an upper stratum surface area coverage of >60% after 10 years (estimated after 4-year monitoring period).
    - Zone 4, Open Space Area: A lower stratum exotic grass surface area coverage of >95%, a middle stratum surface area coverage of <5% and survival of 30 native trees to replace exotic trees removed from this zone (estimated after 4-year monitoring period).
- Improve the aesthetic quality of Arcadia Park following the completion of Phase 1 works
- Continued control of targeted weeds to maintain the required 95% eradication rate at the end of the 4-year monitoring period,
- An increase in fauna diversity.
    - Local bird watching groups could be encouraged to undertake annual bird counts commencing prior to the commencement of works to provide baseline data.
    - Installed nest boxes should be monitored and maintained annually for 4 years to determine usage by fauna.

3 DESCRIPTION OF THE SITE

3.1 LOCATION

Arcadia Park is bound by Wolfe Street to the east, Pit Street to the north, commercial development (NBN building) to the east and Bingle Street/Reserve Road to the south at The Hill in Newcastle (Figure 1).

As the name suggests, The Hill is a suburb of Newcastle that has a higher elevation than adjoining suburbs. It is located in a central position between Newcastle's central business district and 500 m from Newcastle Beach.

3.2 CATCHMENT DESCRIPTION

The catchment is characterized by residential development within a coastal setting. While there are open space areas around Arcadia Park, they are characterized by exotic grasses. The nearest native bushland is approximately 3.5 km to the south in Glenrock State Conservation Area (SCA).

3.2.1 SIZE

Arcadia Park is approximately 1.5 ha in size.

3.2.2 LANDUSE

Arcadia Park is zoned RE1 Public Recreation under Newcastle Local Environmental Plan (LEP) 2012 (LPI, 2011).

Objectives of this zones are;

RE1 Public Recreation

- To enable land to be used for public open space or recreational purposes.
- To provide a range of recreational settings and activities and compatible land uses.
- To protect and enhance the natural environment for recreational purposes.

Permitted without consent is Environmental Protection Works.

The landuse on Arcadia Park currently consists of:

- cleared grassed areas and picnic benches that are utilized for passive recreation,
- landscaped areas and
- native and exotic bushland.

Arcadia Park currently provides for passive recreation in accordance with the RE1 objectives, including access though the park between Wolfe St, Pit St and Bingle Street. This access will be maintained following completion of works as will the parkland areas and picnic benches.

Newcastle LEP

The Hill is listed as significance Item 580 under Schedule 5 Environmental Heritage.

Section 5.10 Heritage Conservation objectives are:

(a) to conserve the environmental heritage of the City of Newcastle,

(b) to conserve the heritage significance of heritage items and heritage conservation areas, including associated fabric, settings and views,

(c) to conserve archaeological sites,

(d) to conserve Aboriginal objects and Aboriginal places of heritage significance.

While the VMP is not inconsistent with the objectives of the LEP, development consent is required for the proposed works as they are a listed heritage item. If, however, the applicant has notified the consent authority and the consent authority has advised the applicant in writing before any work is carried out that it is satisfied that the proposed development is of a minor nature or is for the maintenance of the heritage item, consent is not required. This has been included in the recommendations of the REF and BA.

The Hill Heritage Conservation Area

Arcadia Park falls under The Hill Heritage Conservation Area (NCC, 2016). One of the elements (of relevance) that is to be preserved include:

- Gardens, street trees and public open space.

The VMP aims to improve the native flora and fauna abundance within the Arcadia Park public open space area.

Heritage Places and Plans of Management 2000

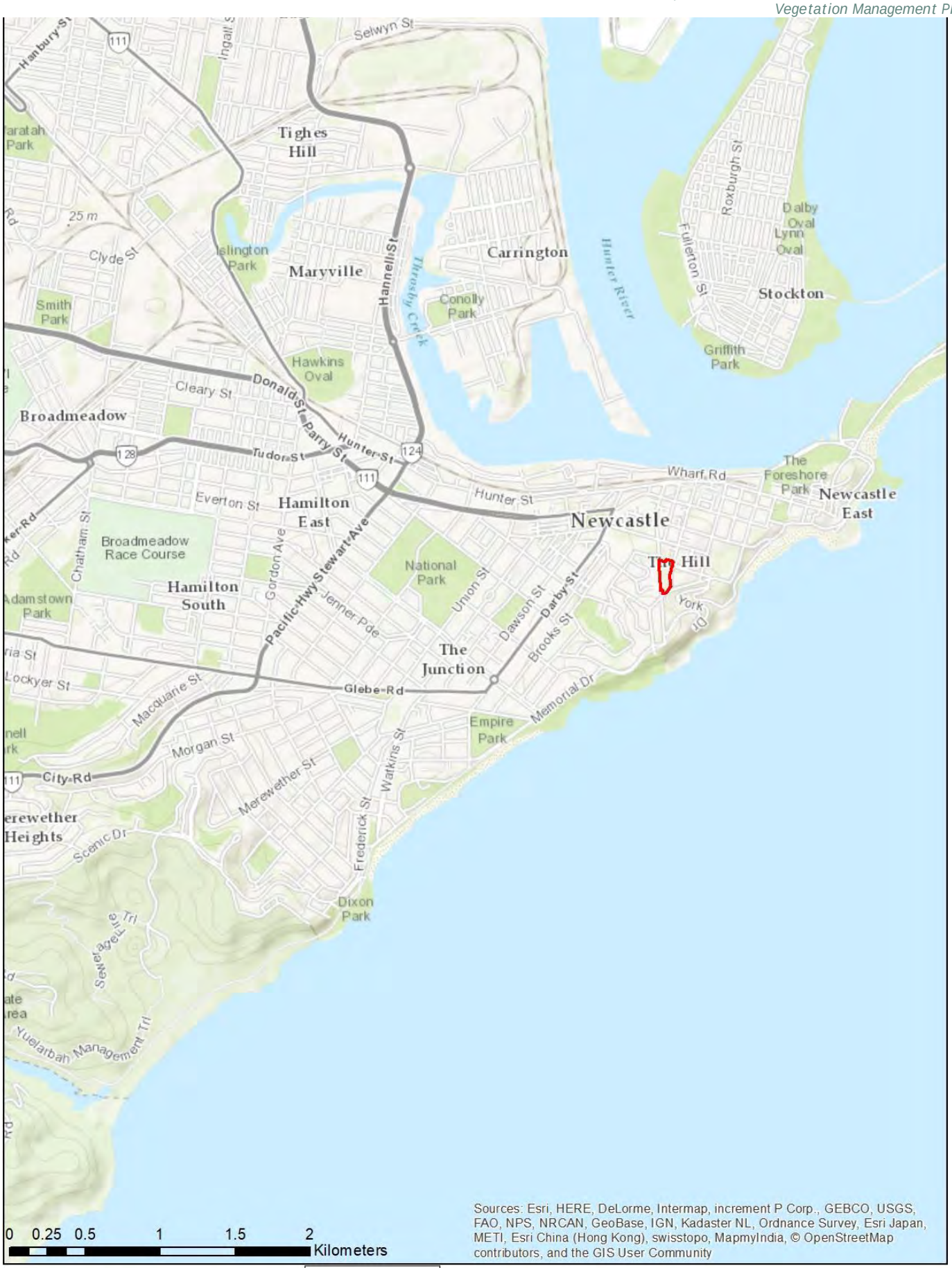
Arcadia Park (land in DP 54152 and closed road, Appendix 1) is included in the supporting information for Plan of Management for King Edward Park in the Heritage Places and Plans of Management.

No specific objectives for Arcadia Park were provided in the document and the landscape concept plan (p86) does not encompass Arcadia Park.

Issues/recommendations raised in the document that may be interpreted as relevant to the VMP for Arcadia Park include:

- Improvements to the park should be integrated…so that the former unity of the landscape of this area can be restored.
- The area requires an integrated landscape plan
- Any park furniture/fencing should be in keeping with Heritage objectives.

The proposed restoration works outlined in the VMP are not inconsistent with the overall objectives of Heritage Places and Plans of Management (2000) document.



COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

Legend
Arcadia Park

Figure 1. Locality
Newcastle City Council
Arcadia Park Job No. 170807 Date. 21/08/2017

3.3 FLORA CHARACTERISTICS

- A total of 120 species were recorded in Arcadia Park during flora surveys conducted in November 2017, 75 native species and 45 exotics, of which 10 are noxious (Table A1, Appendix A). No threatened species were recorded on the site.
- The majority of flora recorded in Arcadia Park has been planted and as such, the native vegetation community that occurred in the park pre-disturbance is not known. The species present do however give an indication as to whether the soil landscape is compatible with a particular community.
- Native canopy species recorded in Arcadia Park include: Swamp Mahogany *Eucalyptus robusta*, Bangalay *Eucalyptus botryoides*, Flooded gum *Eucalyptus grandis* in addition to Turpentine *Syncarpia glomulifera*, Broad-leaved White Mahogany *Eucalyptus umbra,* Smooth-barked Apple *Angophora costata,* Red Bloodwood *Corymbia gummifera* and Spotted Gum *Corymbia maculata*. Non-eucalypt canopy species include Coastal Myall *Acacia binervia*, Tuckeroo *Cupaniopsis anacardioides*, River Oak *Casuarina cunninghamiana* and Black She-Oak *Allocasuarina littoralis*.
- Common exotic canopy species include Canary Island Date Palm *Phoenix canariensis**, Camphor Laurel *Cinnamomum camphora**, Norfolk Island Hibiscus *Lagunaria patersonii subsp. bracteatus**, Weeping Willow *Salix babylonica**, African Olive *Olea europa subsp. cuspidata**, New Zealand Christmas Bush *Metrosideros stipoides,* Umbrella Tree *S. actinophylla** and Norfolk Island Pines *Araucaria heterophylla*.
- The vegetation communities within Arcadia Park have been mapped by the Lower Hunter Central Coast Regional Environmental Management Strategy Vegetation Survey, Classification and Mapping (LHCCREMS, 2003) as MU 15 Coastal Foothills Spotted Gum-Ironbark Forest and MU30 Coastal Plains Smooth-barked Apple Woodland. The mixture of canopy species present in Arcadia Park are not consistent with the Coastal Foothills Spotted Gum-Ironbark however it does have consistencies with the Coastal Plains Smooth-barked Apple Woodland through the presence of characteristic species such as *A. costata, C. gummifera, E. umbra* and *A. littoralis*.

3.4 ASSESSMENT OF EXISTING VEGETATION

3.4.1 SOUTHERN GULLY

The native canopy layer in the southern gully was dominated by Turpentine *Syncarpia glomulifera,* Swamp Mahogany *E. robusta*, Spotted Gum *C. maculata* and Cheese Tree *Glochidion ferdinandii*. Exotic canopy species include Canary Island Date Palm *Phoenix canariensis**, Camphor Laurel *Cinnamomum camphora** and Norfolk Island Hibiscus *Lagunaria patersonii subsp. bracteatus**. The middle stratum was largely absent with the exception of juvenile Tuckeroo *Cupaniopsis anacardioides*. The lower stratum is dominated by the exotic Wandering Jew *Tradescantia fluminensis** and Guinea Grass *Megathyrus maximus var maximus** (Plate 1).

3.4.2 NORTHERN GULLY

The native canopy vegetation in the northern Gully was dominated by Coast Myall *Acacia binervia,* Broad-leaved Paperbark *M. quinquenervia*, Sweet Pittosporum *Pittosporum undulatum*, Bangalay *Eucalyptus botryoides,* Black She-oak *Allocasuarina littoralis,* Flooded gum *Eucalyptus grandis,* and Port Jackson Fig *Ficus rubiginosa*. Dominant exotic canopy species include Weeping Willow *Salix babylonica**, Canary Island Date Palm *P. canariensis**, Camphor Laurel *C. camphora**, Norfolk Island Hibiscus *L. subsp. bracteatus**, Silky Oak *Grevillea robusta** and African Olive *Olea europa subsp. cuspidata**. The middle stratum was sparse and consisted of juvenile Tuckeroo *C. anacardioides* and juvenile Umbrella Tree *Schefflera actinophylla**. Lower stratum consisted of exotic herbs and grasses (Plate 2).

3.4.3 PICNIC AREAS

Two main tracks dissect Arcadia Park (Figure 2), linking Wolfe St, Reserve Rd and Pit St. While there has been significant planting in the middle section of the park around the existing picnic benches, it has a parkland feel, with planted lower stratum, limited middle stratum cover and woodland density in the canopy (Plate 3).

3.4.4 WOLFE STREET ROADSIDE

The corner of Reserve Rd and Wolfe St consists of a parkland environment characterised by exotic grass understory and mature Norfolk Island Pines *Araucaria heterophylla*. Planted vegetation along Wolfe St consists of Sweet Pittosporum *P. undulatum,* Coastal Tea-tree *Leptospermum laevigatum,* Bracelet Honey Myrtle *M. armillaris,* Callistemon sp (Crimson Bottlebrush *Callistemon citrinus,* Willow Bottlebrush *Callistemon salignus* and *Callistemon sp.* (cultivar)),* Cheese Tree *Glochidion ferdinandii*, Native Rosella *Hibiscus heterophyllus subsp heterophyllus* and Flooded Gum *Eucalyptus grandis*. Exotic species include African Olive *Olea europa subsp. cuspidata**, New Zealand Christmas Bush *Metrosideros stipoides,* Umbrella Tree *S. actinophylla**, Norfolk Island Hibiscus *L. subsp. bracteatus** and Canary Island Date Palm *P. canariensis** (Plate 4).

Plate 1. Southern Gully Vegetation

Plate 2. Northern Gully Vegetation

Plate 3. Vegetation in the middle of the park around picnic tables

Plate 4. Roadside vegetation planted along Wolfe Street

3.5 FAUNA ASSEMBLAGES AND HABITAT TYPES

Arcadia Park is isolated from other tracks of bushland and as such, the habitat value of the park is limited to highly mobile species such as birds and bats and/or species adapted to living in and around urban areas. Common brushtail possum, Common ringtail possum, small terrestrial mammals such as Bush Rat and antechinus are possible however the feral Black rat is also likely to utilise the park.

Microbats and megabats are also potential visitors to the park. The park provides some foraging opportunities for Grey-headed Flying-fox but is not a known roost/breeding site for this species. Arcadia Park also provides foraging opportunities for a range of microbats. Some species of microbats will roost/nest in tree hollows or under bark. These types of roosting habitat are very difficult to detect from the ground, so while it is possible that the site also provides nesting and roosting opportunities for some species of microbats, including threatened species, opportunities are likely to be limited.

The park would provide habitat for reptiles such as common lizards and skinks. There is limited habitat potential for amphibians however the enclosed drain may provide some habitat opportunities for hardy species.

The park also provides foraging and nesting habitat for a range of bird species however it lacks good quality hollows for hollow dependant species such as parrots or owls. Arcadia Park provides potential foraging habitat for powerful owls and while there are no recorded occurrences on the BioNet database, NCC staff have indicated that there has been a previous sighting of this species in Arcadia Park (observer and date observed unknown, refer email from P Freeman dated 17/01/18).

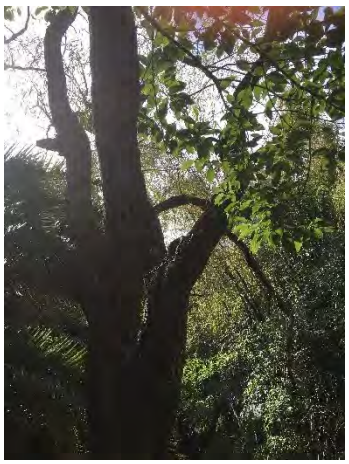
Seven trees were identified as having hollows during the site inspection conducted in November 2017 (Table 1). Six of these trees were Weeping Willows and the hollows were close to the ground (i.e. <2 m) (Table 1, Photograph 6). The diameter of these hollows was approximately 10cm. While these hollows may be utilised by commonly occurring species adapted to urban environments such as possums, they are considered unlikely to be utilised by bird species due to their exposed nature and proximity to the ground which would expose them to easy predation. None of the hollows had signs of recent utilisation such as scats, fur, feathers or scratch marks and two of the hollow entrances were covered with spider web indicating that they have not been used recently. The hollows are considered unsuitable for threatened hollow dependant birds such as Little Lorikeet and Powerful Owl. The seventh tree observed with hollows was an African Olive tree that appeared to have one small hollow entry. The depth of the hollow could not be determined from the ground.

Arcadia Park contains a diversity of native flora species, some of which are unlikely to have been found on the site pre-European settlement. The site contains numerous Swamp Mahogany *E. robusta*, which is typically found in low-lying sclerophyll forests. This species is significant in that it is one of the few winter flowering species in the area and thus provides an important food source during winter for a range of fauna species, including threatened species such as Swift Parrot, Regent Honeyeater and Koalas. Spotted Gum *C. maculata*, another winter flowering species, also occur on the site and combined would provide a food resource for nectivorous fauna species during the winter.

Plate 5. Tree Hollows in the lower trunk section of Weeping Willow trees

Table 1. Hollow bearing trees identified in Arcadia Park

ident	y_proj	x_proj	Species	Comment
617	6355658	385722.5	Willow Tree	 1x20cm diameter hollow < 1 m from the ground

618	6355671	385724.5	Willow Tree	 1x15cm diameter hollow <1 m from the ground
619	6355672	385733.8	Willow Tree	 Trunk hollow at the base of the tree <1 m from the ground. Four entries, diameter 10 – 20 cm. A spider web covered the entrance, no signs of scats or scratches and no evidence of use.
622	6355661	385742.2	Willow Tree	 2 x hollows however no depth, diameter 5 cm approximately 3 m from the ground.

623	6355664	385754.4	Willow Tree	 Two hollows, approximately 20 cm diameter, <1.5 m from the ground.
624	6355673	385748.8	Willow Tree	 1 hollow approximately 5 cm diameter 1.5 m from the ground
639	6355521	385726.4	African Olive	 One hollow approximately 5 cm diameter, limited depth, <1.5 m from the ground.

3.6 WEEDS AND PESTS

A total of 43 exotics species were recorded on Arcadia Park, 10 of which are declared noxious weeds. Table A2 (Appendix A) lists noxious weeds and their recommended treatment.

3.7 CORRIDORS & CONNECTIVITY

Arcadia Park is an isolated patch of bushland and is likely to provide connectivity for highly mobile species only. It is noted however that Ordinance Street verge and the surrounds of Obelisk Hill are in the process of being returned to a Littoral Rainforest which may provide some connectivity to the coastline bushland of King Edward Park.

3.8 HYDROLOGY

Arcadia Park does not contain any natural water courses or water bodies. A constructed drainage line controls the flow of surface water through Arcadia Park.

3.9 TOPOGRAPHY & GEOLOGY

Based on the NSW Geological Maps: Newcastle 1:250,000 series, Arcadia Park is on Quaternary soils characterized by gravel, sand, silt, clay, "Waterloo Rock" Marine and freshwater deposits (NSW Planning & Environment, 1966).

The Soil Landscape is Killingworth which is described as consisting of undulating to rolling hills and low hills on the Newcastle Coal Measures of the Awaba Hills region. Elevation is 50-160m, local relief 30-100 m, slopes are 3-20%. Predominately uncleared tall open forests (Matthei, 1995). The landscape at Arcadia Park is up to 30%, which is considerably steeper than described.

The topography on Arcadia Park ranges from steep slopes (Plate 6), gullies (Plate 7), terraced areas (Plate 8) and hilltops (Plate 9). The elevation at the bottom western side of Arcadia Park is 34 m AHD while at the top of Arcadia Park off Wolfe Street it is 58 m AHD.

Plate 6. Slopes

Plate 7. Gully

Plate 8. Terraced Areas

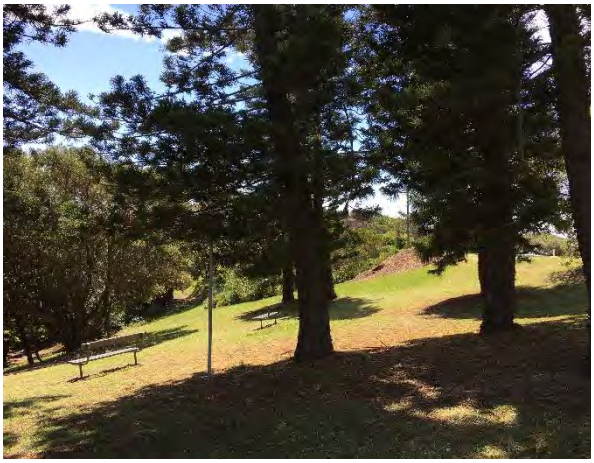


Plate 9. Hilltop/Open Areas

4 MANAGEMENT ISSUES

4.1 GENERAL

Restoration works are to be planned, managed and constructed as to cause the least possible inconvenience to the public and shall ensure that suitable and safe pedestrian and traffic access around the work site is available and that access to private property is maintained. Where safe access cannot be maintained, signage is to be installed to inform the public of alternative routes.

4.2 THREATENED SPECIES/POPULATIONS/COMMUNITIES

No threatened flora or fauna species were recorded in Arcadia Park during surveys and the park does not contain important habitat features (such as suitable hollow bearing trees) for any threatened species that have previously been recorded in the local area. No endangered ecological communities (EEC's) occur in the park.

4.3 DISEASE/PATHOGENS

Plants on the Site are to be monitored for evidence of disease or introduced pathogens such as Myrtle Rust. Monitoring is to be undertaken by Council staff during the 4-year monitoring of Arcadia Park.

Myrtle Rust

Introduction of pathogens such as Myrtle rust are a listed threat to the Littoral Rainforest EEC on the OEH profile. Myrtle rust (*Puccinia psidii*) is a fungal disease which infects plants in the Myrtaceae family. Common Australian Myrtaceae species include eucalyptus, willow myrtle, turpentine, bottlebrush, paperbark, tea tree and lilly pilly. Generally myrtle rust starts as small purple spots on leaves. Bright yellow spores form in pustules within these purple spots. Pustules fade to dull yellow and then grey as the infection ages. In severe infections, spots enlarge and merge, often causing leaf distortion.

Since myrtle rust was first detected in NSW in April 2010 it has spread across the eastern Australian landscape in bushland reserves, home gardens, commercial operations and amenity settings such as parks and street plantings. Myrtle rust can now be found in New South Wales, Victoria, Queensland, Tasmania and on the Tiwi Islands in the Northern Territory.

When myrtle rust was first detected, a response was initiated to eradicate myrtle rust. The response was unsuccessful because myrtle rust spores are very easily dispersed by wind. In December 2010 eradication efforts were abandoned and transitioned to management.

Myrtle Rust was not identified on the Site during surveys. Recommendations to prevent the spread of Myrtle rust to Arcadia Park include:

- Source plants (i.e. nursery stock/seedlings) are to be checked often for signs of myrtle rust
- Records are to be kept of inspections and plant movements
- Plants are not to be moved from the nursery to Arcadia Park if there is any evidence of Myrtle rust detected at the nursery.
- Always start jobs with clean equipment and clean vehicles
- If Myrtle Rust, other pathogens or disease are identified on the Site, they are to be treated immediately using appropriate methods (refer NSW DPI http://www.dpi.nsw.gov.au/biosecurity/plant/established-plant-pests-and-diseases/).

Fusarium Wilt *Fusarium oxysporum (sourced from RBGS, undated)*

Fusarium wilt is a devastating disease of certain species of palms that was first observed in Australia in the early 1980s when palms began to die at Centennial Park in Sydney.

Palms affected by this disease are characterised by an unusual type of frond death - fronds may die more rapidly on one side of the tree, or from the base or from the centre of the tree. Most characteristically the pinnae and spines on one side of an individual frond die first and the lower fronds die rapidly so that eventually only a few surviving fronds form a spike at the top of the tree.

Eventually the whole palm will die. Affected fronds when removed from the plant will often show discolouration of the vascular bundles. This is best seen if the cut surface is wet and cleaned. Small blackened areas should be visible on the cut surface.

The disease is caused by a fungus, *Fusarium oxysporum*. This fungus has many different strains that cause wilt diseases in a range of plants, although each strain is restricted to a very limited host range - the strain that affects palms is restricted to palms.

The fungus was thought to only be a significant problem in certain species of *Phoenix*, viz., *P. canariensis* and *P. dactylifera*. Glasshouse tests have shown that *P. reclinata* can be infected by the fungus, but symptoms have been rarely observed in the field. Recently similar symptoms were observed in *Washingtonia filifera* planted at Centennial Park and *Fusarium oxysporum* was isolated from them. Similar results have been recorded for this species in California, so it seems that this species of palm is also a susceptible host of the fungus.

Once a tree is infected it will eventually die and this may take as little as two months or up to several years. There are no effective fungicides and control is dependent on avoidance of the disease - several steps must be taken:

1. Assume that every susceptible palm is a source of the fungus and always sterilise chain saws and cutting implements between use.
2. Do not move palms from suspect areas (e.g. eastern Sydney) to areas where the disease does not occur. Obtain transplant palms from areas thought to be clean of the disease and have them tested.
3. Use high levels of hygiene in all horticultural practices relating to palms. Clean equipment after each job and do not transport soil.
4. Ensuring adequate water and a good supply of nutrients to palms. Potassium is often important in their nutrition and disease resistance.
5. Do not plant *Phoenix* or *Washingtonia* species of palms in areas where the disease is known to occur.

In relation to treatment of Canary Island Date Palm *Phoenix canariensis** in Arcadia Park, once removed, the plants are to be mulched *in-situ*. No Phoenix or Washingtonia species will be planted as part of the revegetation works so even if present, there would be no hosts for the fungus to attack.

4.4 BUSH FIRE

Arcadia Park is currently not included in the Newcastle Bushfire Risk Management Plan (NBRMP). It is recommended that Newcastle City Council obtain advice on bushfire management, with consideration of the implemented VMP.

Notwithstanding bushfire management advice, this VMP recommends:

- Establishing an APZ around the boundary of Arcadia Park.
- Exclusion of planting canopy trees within the APZ.

- Maintaining a sparse shrub layer (i.e. covering no more than 20% of the APZ)
- Maintenance of the APZ by manually removing fine fuels from the APZ.
- The bushfire risk management of the site will need to allow for annual re-assessment of the risk as the vegetation establishes/grows on the Site.

4.5 TREE PRESERVATION

Other than as directed by this VMP, no native trees are to be removed from Arcadia Park. Where there is risk of damage to the root system of mature native trees on site, special precautions to avoid such damage may be required including the installation of barrier fencing during mechanical removal of exotics.

4.6 **CONTRACTOR**'S SITE FACILITIES

Any facilities are to be located away from retained native trees and be accessible from either Pitt Street or Reserve Road. The storage of materials, including herbicides and chemicals, shall be stored within designated areas and in such a way as to not cause damage to the environment or cause risk or hazard to persons or property.

Storage areas are to be kept neat and tidy and reinstated to pre-existing condition or better at completion of works.

Appropriate construction safety and warning signs are to be erected and maintained during works. Signs showing the name and contact telephone number of the project manager are to be clearly visible from outside Arcadia Park. Site security is to be maintained for the work to ensure at all times that the security of private and public assets are not compromised. Appropriate safeguards, including barricades, temporary fences, warning lights, warning signs and other items that are required for protection of workers, Council staff and the public are to be installed where required. All work areas are to be kept clean and tidy and all general rubbish shall be appropriately disposed of.

4.7 CONSULTATION

The following departments were contacted for advice regarding the suitability of the various exotic tree species recorded on site for reuse in on-site mulching:

- NSW DPI -Biosecurity Officer
- Local Land Services Biosecurity Officer/Land Management Officer
- Newcastle City Council Bushland Services Officer

The consensus was that it is preferable to re-use the exotic trees as mulch on-site rather than transferring to another location, and that where possible, roots are to be removed and no branches or stumps left onsite to avoid re-growth of exotic species.

Council have indicated that they will be installing community consultation signage prior to the commencement of works and undertaking letterbox drops informing residents of the proposed works.

5 VMP IMPLEMENTATION

5.1 SITE ESTABLISHMENT

The boundary of *Treatment Zones* (discussed in Section 5.3.1) are shown approximately in Figure 2 and were drawn along contour lines on a map. These boundaries can be adjusted slightly to reflect what is on the ground if required (i.e. recently planted areas or large trees etc).

The project manager is to walk Arcadia Park with CBS staff to assist with identifying the limits of each *Treatment Zone* and the exotic tree species for removal to ensure no native trees are inadvertently removed. Large exotic trees with a diameter at breast height (DBH) > 30cm have been mapped (Figure 2) however there are many exotic trees with a DBH <30cm that have not been mapped and that require removal. For example, up to 10 African Olive trees require removal along the Pit Street boundary in the northern gully which have not been mapped in Figure 2.

Appropriate erosion and control measures are to be installed prior to the commencement of works. Cleared areas proposed for stockpiling and access to these areas are to be clearly marked and appropriate erosion and sediment control measures placed around these areas.

Signs placed at entry points to the park are to include information regarding the extent and timing of clearing works and information on the aims of the restoration works. Signs should include a request that the public respect restoration works by utilising the main access tracks.

5.2 TREATMENT OF EXOTICS

5.2.1 GENERAL

- Bush regeneration works are to be undertaken by qualified bush regenerators experienced in the identification of exotic versus native species and the appropriate use of chemicals/herbicides. The methods of weed control for each zone will be guided by this VMP however CBS staff may need to adapt the techniques to address management issues as they arise during the restoration period.
- Control measures for the removal of noxious weeds recorded on Arcadia Park are provided in Table A2 (Appendix A).
- Where possible, manual removal of weeds is preferable to chemical removal to reduce risk to the environment.
- Weed control methods shall limit the amount of off target damage caused wherever practical. Low impact bush regeneration approaches shall be used where native vegetation is dominant. An understanding of plant biology and physiology will be essential in applying the correct method to the situation.
- Prevent soil erosion of cleared areas (i.e. Jute matting or mulch followed by revegetation as soon as practical following soil disturbance).
- Weeds shall be removed and disposed of with care to prevent spreading seeds and vegetative pieces.
- Glyphosate based herbicide (such as "Roundup" and Roundup Bi active", or equivalent) shall be generally used (as per label instructions) for spot foliar spray bush regeneration techniques.
- Foliar spraying is not suitable in areas immediately adjacent to native vegetation. High volume spot spraying is not permitted.

- Weeds which cannot be controlled by herbicide or where the use of herbicide is likely to impact native species, are to be removed by hand. The entire weed shall be removed.
- Seed heads from noxious exotic material from lower stratum shall be bagged and removed from site and deposited of at an appropriate waste facility

5.2.2 LOWER STRATUM EXOTICS

Exotic herbs and grasses can be physically removed, treated with appropriate herbicide in accordance with product instructions or treated with solarisation as appropriate.

Solarisation can be used to control lower stratum exotic species. Solarisation uses plastic covering to capture and retain heat in the soil produced from the sun on hot, sunny days. During summer, temperatures in the top 12cm to 15cm of soil covered with plastic can reach 50°C. If the ground is moist and the edges of the plastic sheets are sealed, some of the moisture will be converted to steam and, over a period of four to six weeks, most of the damaging soil fungi, bacteria and nematodes, along with weed seeds and insects pests, will be destroyed. This is a low-cost, non-chemical, environmentally friendly method of sterilising the soil. Beneficial organisms survive or quickly recover from this treatment and the heat has facilitated the breakdown of organic matter in the soil, resulting in a slow release of plant nutrients, particularly nitrogen.

Wandering Jew *Tradescantia fluminensis** covers the ground in a thick mat and as this species doesn't produce seed, treatment requires the physical removal of ALL vegetation pieces.

5.2.3 MIDDLE STRATUM EXOTICS

Smaller trees (up to 10 cm in diameter) can be lopped and the stumps treated with chemical OR manually removed. Middle stratum exotics include Umbrella Tree *S. actinophylla**, Wild Tobacco, African Olive, Norfolk Island Hibiscus *Lagunaria patersonii subsp. bracteatus**, New Zealand Christmas Bush *Metrosideros stipoides* among others.

5.2.4 UPPER STRATUM

Exotic species in the upper stratum include very large specimens of: Canary Island Date Palm *P. canariensis**, Camphor Laurel *C. camphora**, Norfolk Island Hibiscus *L. patersonii subsp. bracteatus**, Weeping Willow *S. babylonica** and African Olive *O. europa subsp. cuspidata**. In addition, up to 50% of planted Coast Myall *Acacia binervia* are at the end of their life span and require removal.

The mechanical removal of trees can be undertaken using one or a combination of the following techniques:

- Professional tree arborists can cut down bigger mature exotic trees however this leaves a stump in the ground. This is a useful technique in minimizing disturbance to surrounding native vegetation but some stumps may need treating to ensure they do not re-sprout.
- Alternatively, excavators can push over the entire tree, removing the stump at the same time. While this method is quick and effective, it can result in disturbance of soil from machinery which may lead to the rapid re-establishment of exotic species. Thus, cleared areas are to be mulched and a ground cover established quickly.
- Exotic trees including roots are to be removed and mulched *in-situ*. The fronds of Canary Island Date Palm *Phoenix canariensis** do not mulch well however can still be used to supress weed regrowth as ground cover if desired. Seeds and spine

section of the fronds however should be disposed of at an appropriate waste disposal facility.

- Where appropriate, the remnant mature natives are to be marked using temporary fencing or flagging, to prevent machinery causing compaction of the root zone.

5.3 REVEGETATION

5.3.1 TREATMENT ZONES

The total area of Arcadia Park is approximately 15,000m^2 (1.5 ha). The following treatment zones (Table 2) referred to in this VMP are shown in Figure 2.

Table 2. Summary of Treatment Zone, Description and Area

Treatment Zone	Objective	Description	Area m^2
Zone 1	Littoral Rainforest	There are two gullies in Arcadia Park, one in the north west and one in the south west. These areas are considered suitable for the establishment of a Littoral Rainforest Community. Species selected for planting are consistent with the community profile descriptions from LHCCREMS (2003) MU 4 Littoral Rainforest and Bell's (1998) Littoral Rainforest (refer Table 3 for species list).	5,333m^2
Zone 2	Buffer Zone/Picnic Areas	Existing pathways and open space areas around picnic benches will be sparsely planted with upper and middle stratum species to maintain an open, parkland feel for passive recreation purposes.	3,300m^2
Zone 3	Smooth-barked Apple Woodland	Areas outside of the gullies and existing tracks and parklands are suitable for the establishment of a Smooth-barked Apple Woodland. Flora species from this community currently occur in Arcadia Park and this community naturally occurs in the local area. Parts of this zone have however already been planted during recent bush regeneration works, using species mostly from a Littoral Rainforest Community. Removal of recently planted species is not necessary however any additional plantings are to use species listed for this zone in Table 3. Species selected for planting in the Smooth-barked Apple community are consistent with the community profile descriptions from LHCCREMS (2003) MU 30 Coastal Plains Smooth-barked Apple Woodland. However, this zone will be planted at a higher density than a "woodland" to prevent tracks and trails being created through the zone.	4,535m^2
Zone 4	Open Space	The grassland area in the south of Arcadia Park under the Norfolk Island Pines will be retained for passive recreation. Minimal revegetation is required other than replacement of exotic canopy trees with native tree species.	2,084m^2

Table 3 summaries species suitable for planting within each Zone.

ZONE 1 - Littoral Rainforest

The Key Deliverables for Zone 1 are to achieve a lower stratum native surface area coverage of >30%, a middle stratum surface area coverage of >70% and an upper surface area coverage (including emergent) of >95% after 10 years (estimated after 4-year monitoring period). This will result in a closed canopy of Littoral Rainforest, with a low to moderate density in the lower stratum and moderate to high density in the middle and upper stratum, with sparse emergent species.

The existing native canopy in Zone 1 has some consistencies with Littoral Rainforest (LHCCREMS, 2003) with the presence of emergent individuals of sclerophyll species such as Bangalay *E. botryoides*, Smooth-barked Apple *A. costata*, Cheese Tree *Glochidion ferdinandi*, Tuckeroo *Cupaniopsis anacardioides*, Cabbage Tree Palm *Livistona australis,* Sweet Pittosporum *Pittosporum undulatum*, Coast Banksia *B. integrifolia* subsp. *integrifolia* and Broad-leaved Paperbark *M. quinquenervia*.

Revegetation of Zone 1 will create approximately 5,333m^2 of Littoral Rainforest. Plantings will include upper, middle and lower stratum species from Table 3 to create a dense Littoral Rainforest community.

ZONE 2 - Buffer Zone/Picnic Areas

The Key Deliverables for Zone 2 are to achieve a lower stratum native surface area coverage of >95%, a middle stratum surface area coverage of <5% and an upper surface area coverage of < 30% after 10 years (estimated after 4-year monitoring period). This will result in a dense lower stratum of grasses and sedges, an open middle stratum and a sparse upper stratum cover around existing tracks and picnic areas. Native grasses and sedges are to be planted alongside the tracks and native trees are to be planted to replace the exotic trees following their removal from this Zone. This will provide the existing tracks (which are up to 4 m wide), with a buffer of 5 m either side, creating an open area of approximately 14 m along the centreline of the existing tracks.

Species used in the revegetation of Zone 2 will be selected from the Coastal Plains Smooth-barked Apple Woodland community profile species list (MU30, LHCCREMS, 2003, Table 3).

ZONE 3 - Smooth-barked Apple Woodland

The Key Deliverables for Zone 3 are to achieve a lower stratum native surface area coverage of >95%, a middle stratum surface area coverage of >60% and an upper surface area coverage of >60% after 10 years (estimated after 4-year monitoring period). This will result in a dense layer of grasses and sedges with moderate cover in the middle and upper stratum.

The portion of this zone along Wolf Street (Zone 3a: approximately 964m^2) is already established following bush regeneration works in 2015. Below the walking track running parallel to Wolfe Street (Zone 3b: approximately 906m^2) has been recently revegetated during bush regeneration works in 2016-2017. No further planting is required in areas where revegetation using native species has been undertaken (Zone 3a&3b). Thus, while Zone 3 covers an area of 4,535m2, only Zones 3c & 3d (approximately 2,665 m^2) require re-vegetation.

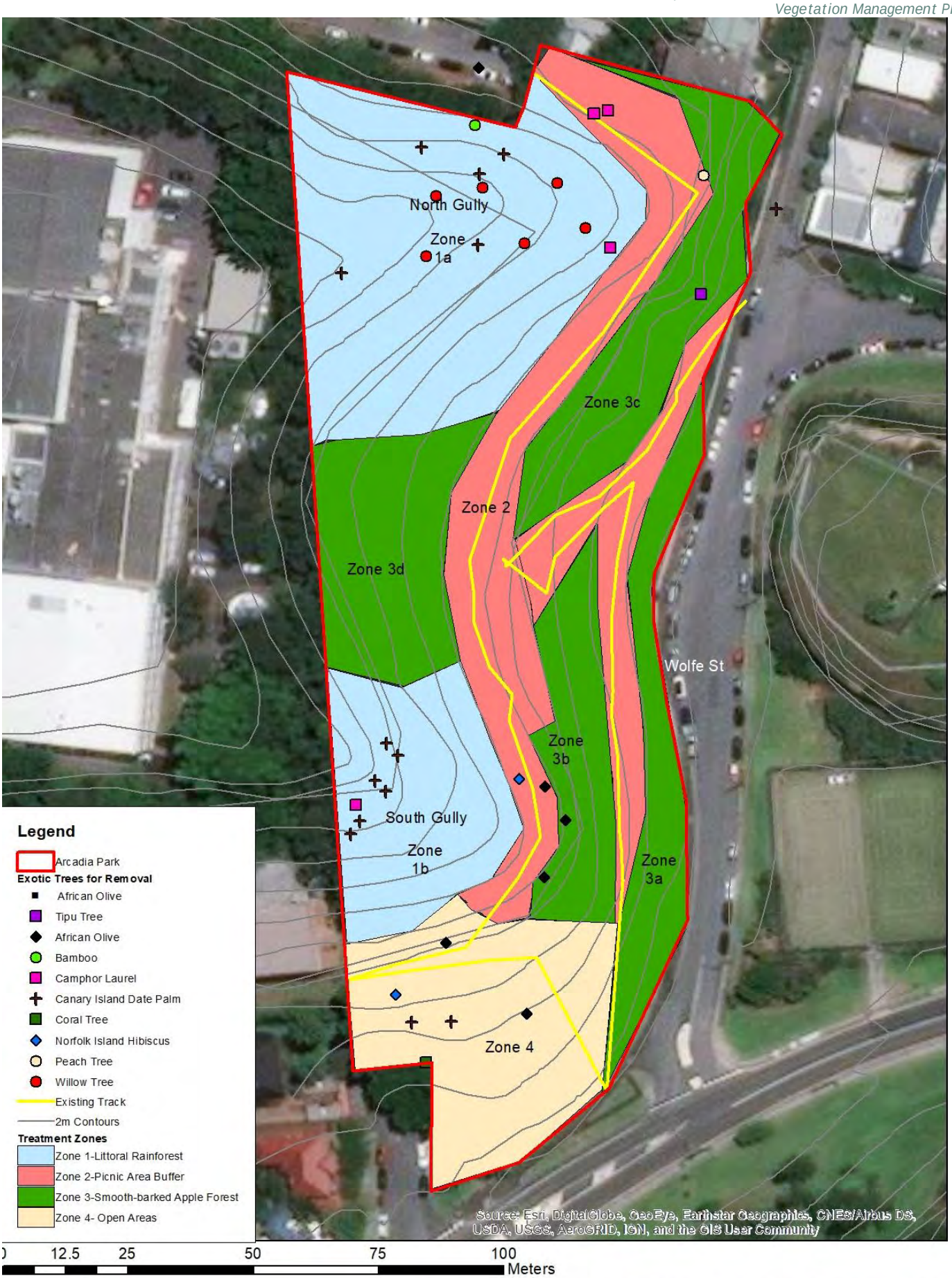
Several species that occur in this zone are consistent with the Coastal Plains Smooth-barked Apple Woodland community profile (MU30, LHCCREMS, 2003), including Smooth-barked Apple *A. costata*, Red Bloodwood *C. gummifera*, Broad-leaved White Mahogany *E. umbra,* Turpentine *S. glomulifera* and Black She-oak *A. littoralis*.

Species used in the revegetation of Zone 3 will be selected from the Coastal Plains Smooth-barked Apple Woodland community profile species list (MU30, LHCCREMS, 2003, Table 3).

Zone 4

The Norfolk Island Pines are not native to the area however as these trees are iconic and historically significant, they will be retained. All other exotic trees, including Norfolk Island Hibiscus, will be removed from this zone and replaced with native trees from the selection in Table 3.

The Key Deliverables for Zone 3 are to achieve a lower stratum exotic grass surface area coverage of >95%, a middle stratum surface area coverage of <5% and survival of 30 native trees to replace exotic trees removed from this zone (determined after 4-year monitoring period). No planting is required in lower and middle stratum and the exotic grasses (mainly Buffalo Grass) can be retained. This will maintain the open space character of this zone.



COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

Figure 2. Arcadia Park: Existing Environment & Proposed Treatment Zones
Newcastle City Council
Arcadia Park Job No. 170807 Date. 04/12/2017

5.3.2 PLANT SPECIES SELECTION

The species to be used for revegetation within each zone are summarised in Table 3. It is acknowledged that not all species listed in Table 3 will be available for planting. However, all efforts are to be made to source a variety of species. In addition, plants are to be selected from each form (i.e. fern, grass, shrubs, trees etc) from Table 3 for planting within each zone. Species that establish rapidly such as Blady Grass *Imperata cylindrica*, are to be planted sparingly to avoid monocultures of these types of species.

Density of plant forms per zone are listed in Table 4.

Table 3. Species for Planting within each Zone

Scientific Name	Common Name	Family	Form	Source
Zone 1				
Lower Stratum				
Adiantum formosum	Giant Maidenhair	Adiantaceae	e	B
Adiantum hispidulum	Rough Maidenhair	Adiantaceae	e	B
Doodia aspera	Rasp Fern	Blechnaceae	e	B
Pellaea falcata var. falcata	Sickle Fern	Sinopteridaceae	e	B
Doodia aspera	Rasp Fern	Blechnaceae	f	LC
Oplismenus imbecillis	Basket Grass	Poaceae	g	LC
Poa affinis		Poaceae	g	B
Viola hederacea	Native Violet	Violaceae	h	LC
Cissus antarctica	Native Grape	Vitaceae	l	LC
Clematis aristata	Old Man's Beard	Ranunculaceae	l	B
Geitonoplesium cymosum	Scrambling Lily	Philesiaceae	l	B
Glycine clandestine	Love Creeper	Fabaceae	l	LC
Smilax australis	Native Sarsaparilla	Smilacaceae	l	B, LC
Smilax glyciphylla	Sweet Sarsaparilla	Smilacaceae	v	LC
Dianella caerulea var. assera	Flax Lily	Lilliaceae	v	B
Gahnia clarkei	Saw Sedge	Cyperaceae	v	LC
Gahnia melanocarpa	Saw Sedge	Cyperaceae	v	B
Lomandra longifolia	Mat Rush	Xanthorrhoeaceae	v	B, LC
Middle Stratum				
Acmena smithii (normal form)	Lillypilly	Myrtaceae	s	B, LC
Breynia oblongifolia	Breynia	Euphorbiaceae	s	B
Callistemon salignus	Willow Bottlebrush	Myrtaceae	s	B
Notelaea longifolia	Large-leaved Olive	Oleaceae	s	LC
Polyscias elegans	Celerywood	Araliaceae	S	LC
Rapanea variabilis	Mutton Wood	Myrsinaceae	s	LC
Synoum glandulosum	Scentless Rosewood	Meliaceae	s	LC
Wilkiea huegeliana	Wilkiea	Monimiaceae	s	B
Upper Stratum				
Banksia integrifolia subsp. *integrifolia*	Coast Banksia	Proteaceae	t	LC
Cassine australis var. australis	Red-fruited Olive Plum	Celastraceae	t	B
Cupaniopsis anacardioides	Tuckeroo	Sapindaceae	t	B, LC
Diospyros australis	Black Plum	Ebenaceae	t	B
Endiandra sieberi	Corkwood	Lauraceae	t	LC
Glochidion ferdinandi var. ferdinandi	Cheese Tree	Euphorbiaceae	t	B, LC
Guioa semiglauca	Guioa	Sapindaceae	t	B
Livistona australis	Cabbage Tree Palm	Arecaceae	t	LC
Melaleuca quinquenervia	Broad-leaved Paperbark	Myrtaceae	t	LC

Pittosporum undulatum	Sweet Pittosporum	Pittosporaceae	t	B, LC
Scolopia braunii	Flintwood	Salicaceae	t	B
Syzygium paniculatum [a c]	Magenta Lillypilly	Myrtaceae	t	B, LC
Emergent Trees				
Angophora costata	Smooth-barked Apple	Myrtaceae	t	LC
Eucalyptus tereticornis	Forest Red Gum	Myrtaceae	t	LC
Eucalyptus botroides	Bangalay	Myrtaceae	t	LC
Eucalyptus robusta#	Swamp Mahogany	Myrtaceae	t	CE
Zone 2				
Lower Stratum				
Entolasia stricta	Wiry Panic	Poaceae	g	LC
Themeda australis	Kangaroo Grass	Poaceae	g	LC
Lomandra obliqua	Fish bones	Xanthorrhoeaceae	v	LC
Pteridium esculentum	Bracken	Dennstaedtiaceae	e	
Imperata cylindrica var major	Blady Grass	Poaceae	g	LC
Phyllanthus hirtellus	Thyme Spurge	Elaeocarpaceae	s	LC
Lepidosperma laterale	Sword Sedge	Cyperaceae	v	LC
Pimelea linifolia	Rice Flower	Thymelaeaceae	s	LC
Panicum simile	Two colour Panic	Poaceae	g	LC
Pratia purpurascens	White Root	Lobeliaceae	h	LC
Pseuderanthemum variabile	Pastel Flower	Acanthaceae	h	LC
Epacris pulchella	NSW Coral Heath	Epacridaceae	s	LC
Gonocarpus tetragynus	Poverty Raspwort	Haloragaceae	h	LC
Aristida vagans	Three-awn Speargrass	Poaceae	g	LC
Mirbelia rubiifolia	Mirbelia	Fabaceae	s	LC
Upper Stratum				
Angophora costata	Smooth-barked Apple	Myrtaceae	t	LC
Corymbia gummifera	Red Bloodwood	Myrtaceae	t	LC
Eucalyptus capitellata	Brown Stringy-bark	Myrtaceae	t	LC
Eucalyptus umbra	Broad-leaved White Mahogany	Myrtaceae	t	LC
Eucalyptus piperita	Sydney Peppermint	Myrtaceae	t	LC
Eucalyptus racemosa	Snappy Gum	Myrtaceae	t	LC
Eucalyptus haemastoma	Scribbly Gum	Myrtaceae	t	LC
Eucalyptus punctata	Grey Gum	Myrtaceae	t	LC
Eucalyptus resinifera subsp resinifera	Red Mahogany	Myrtaceae	t	LC
Corymbia maculata	Spotted Gum	Myrtaceae	t	LC
Syncarpia glomulifera	Turpentine	Myrtaceae	t	LC
Eucalyptus robusta#	Swamp Mahogany	Myrtaceae	t	CE
Zone 3				
Lower Stratum				
Entolasia stricta	Wiry Panic	Poaceae	g	LC
Themeda australis	Kangaroo Grass	Poaceae	g	LC
Lomandra obliqua	Fish bones	Xanthorrhoeaceae	v	LC
Pteridium esculentum	Bracken	Dennstaedtiaceae	e	
Imperata cylindrica var major	Blady Grass	Poaceae	g	LC
Phyllanthus hirtellus	Thyme Spurge	Elaeocarpaceae	s	LC
Lepidosperma laterale	Sword Sedge	Cyperaceae	v	LC
Pimelea linifolia	Rice Flower	Thymelaeaceae	s	LC
Panicum simile	Two colour Panic	Poaceae	g	LC
Pratia purpurascens	White Root	Lobeliaceae	h	LC
Pseuderanthemum variabile	Pastel Flower	Acanthaceae	h	LC

Epacris pulchella	NSW Coral Heath	Epacridaceae	s	LC
Gonocarpus tetragynus	Poverty Raspwort	Haloragaceae	h	LC
Aristida vagans	Three-awn Speargrass	Poaceae	g	LC
Mirbelia rubiifolia	Mirbelia	Fabaceae	s	LC
Middle Stratum				
Allocasuarina littoralis	Black She-oak	Casuarinaceae	t	LC
Banksia spinulosa	Hairpin Banksia	Proteaceae	s	LC
Acacia myrtifolia	Myrtle Wattle	Mimosaceae	s	LC
Leptospermum polygalifolium	Lemon-scented Tea-tree	Myrtaceae	s	LC
Dodonaea triquetra	Common Hop Bush	Sapindaceae	s	LC
Lambertia formosa	Mountain Devils	Proteaceae	s	LC
Dillwynia retorta	Heathy Parrot Pea	Fabaceae	s	LC
Gompholobium latifolium	Broad-leaf Wedge Pea	Fabaceae	s	LC
Xanthorrhoea latifolia subsp latifolia	Grass Tree	Xanthorrhoeaceae	g	LC
Pultenaea paleacea	Bush Pea	Fabaceae	s	LC
Melaleuca nodosa	Ball Honeymyrtle	Myrtaceae	s	LC
Upper Stratum				
Angophora costata	Smooth-barked Apple	Myrtaceae	t	LC
Corymbia gummifera	Red Bloodwood	Myrtaceae	t	LC
Eucalyptus capitellata	Brown Stringy-bark	Myrtaceae	t	LC
Eucalyptus umbra	Broad-leaved White Mahogany	Myrtaceae	t	LC
Eucalyptus piperita	Sydney Peppermint	Myrtaceae	t	LC
Eucalyptus racemosa	Snappy Gum	Myrtaceae	t	LC
Eucalyptus haemastoma	Scribbly Gum	Myrtaceae	t	LC
Eucalyptus punctata	Grey Gum	Myrtaceae	t	LC
Eucalyptus resinifera subsp resinifera	Red Mahogany	Myrtaceae	t	LC
Corymbia maculata	Spotted Gum	Myrtaceae	t	LC
Syncarpia glomulifera	Turpentine	Myrtaceae	t	LC
Eucalyptus robusta#	Swamp Mahogany	Myrtaceae	t	CE
Zone 4				
Upper Stratum				
Angophora costata	Smooth-barked Apple	Myrtaceae	t	LC
Corymbia gummifera	Red Bloodwood	Myrtaceae	t	LC
Eucalyptus haemastoma	Scribbly Gum	Myrtaceae	t	LC
Eucalyptus punctata	Grey Gum	Myrtaceae	t	LC
Eucalyptus resinifera subsp resinifera	Red Mahogany	Myrtaceae	t	LC
Corymbia maculata	Spotted Gum	Myrtaceae	t	LC
Eucalyptus robusta#	Swamp Mahogany	Myrtaceae	t	CE

Form: t=tree, s=shrub, g=grass, v=sedge, e=fern, l=vine, h=herb (MacDonald *et al*, 1998)
Source: CE=recorded on site by Coast Ecology, B= listed in Bell's (1998) Littoral Rainforest profile, LC=listed in LHCCREMS's (2003) Littoral Rainforest profile.
[a] Listed as Endangered under NSW Legislation
[b] Listed as Endangered under Federal Legislation
[c] Listed as Vulnerable under Federal Legislation
Swamp Mahogany is not part of MU4 or MU30 however it is a significant feed tree as it is one of the few eucalyptus species in the area to flower during the winter, providing a winter food source for fauna.

5.3.3 PLANT DISTRIBUTION

- Trees, shrubs and ground cover are to be planted where exotic trees are removed.
- Notwithstanding advice for bushfire management, trees are NOT to be planted within the APZ (width to be determined) and shrub density within the APZ is to be < 20% coverage. This may be altered when a bushfire management plan for the site becomes available.
- Plant species are to be evenly distributed within each zone to achieve an even mix across the landscape (i.e. avoid clumps of the same species).

5.3.4 PLANT SIZE AND CONDITION

- All tubestock plants shall be minimum standard forestry tube size.
- While plants are to be of local provenance, it is NOT a requirement that seed be sourced from Arcadia Park.
- all tubestock is to be from seed, NOT cuttings.
- All plants shall be delivered to Arcadia Park as vigorous, well established plants with good sized healthy root systems (i.e. no evidence of root curl, restriction or damage)
- All plants must be free from disease and pests, and in good form consistent with the species or variety.
- All plants must be "hardened off", not soft or forced, and be suitable for planting in the natural climatic conditions prevailing at Arcadia Park.

5.3.5 PLANTING DENSITY

The density of a planting can have significant influence on its value for biodiversity. Research from the South West Slopes of NSW showed that dense plantings on hilltops do not support many reptile species, whereas sparse plantings do. Bats also avoid dense plantings. Other research has shown that dense plantings support shrub-loving bird species (Munro & Lindenmayer, 2015). Thus, the density of plantings selected may depend on the target species. In this case, there are no specific target species, however restoration works will ideally provide habitat for a range of fauna species. Native remnant vegetation tends to have some dense and some sparse patches, and also small clearings. Ideally, plantings should replicate this variability in density (Munro & Lindenmayer, 2015).

For tubestock planting, trees and shrubs should be planted at a density similar to that found in nearby remnant native vegetation (Munro & Lindenmayer, 2015).

The density proposed provide for a range of habitat types and aim to achieve the Key Deliverables listed in Section 2.1. The density of plants required of each form for each zone is listed in Table 4.

Table 4. Density and number of plant forms to be planted per zone

	Density	No.	Density	No.	Density	No.	Density	No.	Total
Form	Zone 1 5,333 m^2		Zone 2 3,300 m^2		Zone 3 (part only) 4,535-1,870=2,665 m^2		Zone 4 2,084m^2		
Ferns	2 fern/4m^2	2,666	1 fern/25m^2	132	1 fern/25m^2	107	N/A		2,905
Grasses	1 grasses/4m^2	1,333	3 grasses/m^2	9,900	3 grasses/m^2	7,995	N/A		19,228
Herbs	N/A		1 herb/25m^2	132	1 herb/25m^2	107	N/A		239
Vines	1 vine/4m^2	1,333	N/A		N/A		N/A		1,333
Sedges	1 sedge/25m^2	213	1 sedge/9m^2	367	1 sedge/9m^2	296	N/A		876
Shrub	1 shrub/9m^2	593	1 shrub/100m^2	33	1 shrub/4m^2	666	N/A		1,292
Trees	1 tree/9m^2	593	1 tree/144m^2	23	1 tree/16m^2	167	1 tree/70m^2	30	813
Emergent sp.	1 emergent/90 m^2	60	N/A		N/A		N/A		60
Total		6,791		10,587		9,338		30	26,746

5.3.6 GENERAL PLANTING REQUIREMENTS

- All plants must be of local provenance (i.e. locally occurring and grown plants).
- Do not plant in unsuitable weather conditions such as extremes of heat or cold or wind. Early spring or autumn are the preferred planting periods.
- All tube stock is to be watered well in the days leading up to planting to ensure vigour and reduce stress prior to planting.
- Cultivate the subgrade within each approximate 200 mm diameter hole to a depth of 150-200 mm and loosen compacted sections on the side of the hole if they occur. Remove all roots and debris.
- Include Terraform or equivalent soil condition/slow release fertiliser granules (with a high nitrogen content) / water holding products into hole and mix with loose material. Mix backfill soil to avoid clumps of fertilizer likely to burn plant roots.
- Position plants so that the soil level of the plant root ball is level with the finished surface of the soil surrounding the hole or slightly indented to form a bowl to encourage water penetration where site conditions allow.
- Carry out backfilling of excavated soil, ensuring complete filing and consolidation of voids in and around the root system.
- Place mulch as required (refer Section 5.3.7).

5.3.7 MULCH

Exotic species recommended for removal are to be mulched *in-situ* and stockpiled in pre-determined bunded areas with appropriate erosion and sediment control measures in place. Following removal/treatment of middle and lower stratum exotic species, mulch is to be spread to a minimum depth of 100mm across areas of rehabilitation. Planting is NOT to be undertaken until the mulch has aged. If the mulch has been spread out across the site, the aging process will be quicker (approximately 2-4 months). If the mulch is stockpiled, mulch is to be left to age for greater than 4 months prior to planting tubestock.

Nitrogen draw-down occurs when a woody mulch leaches available nitrogen from the soil in order to decompose. The use of woody mulch, particularly mulch that has not aged, has long been considered to have a negative impact on the growth of plants as they must compete for nitrogen. While this may be true for shallow rooted plants such as vegetables, it is unlikely to be an issue for deep rooted plants. As such, the relatively short aging periods suggested above are unlikely to impact the long-term growth of tubestock. To avoid any nitrogen deficiency, apply a couple of handfuls of high-nitrogen fertiliser with each tubestock or before laying the mulch.

If there is insufficient mulch obtained from exotic tree removal, out sourced mulch shall be a blend of woodchip and leaf material of the type commonly marketed as "forest blend".

Mulch shall also comply with the following requirements:

- Mulch is to be installed at a depth of 100 mm during Phase 1 works.
- Mulch shall only be derived from waste timber. Under no circumstances shall wood chip, derived from trees, which have been specifically harvested for that purpose, be accepted by Council.
- It shall be free of soil, weeds, stones, vermin, insects or other foreign material.

- Mulch shall be kept in a weed free condition, and additional mulch reinstated as required during Phase 2 maintenance

5.3.8 TREE GUARDS

Tree guards are not a requirement of Phase 1 works however if plant survival is below 70% and is a result of fauna cropping, the installation of tree guards during Phase 2 maintenance works is required. In this instance, plantings must be bagged and staked with biodegradable cardboard guards.

5.3.9 WATERING

CBS staff shall determine the appropriate amount of watering necessary to successfully achieve the objectives and performance requirements of the VMP.

Nevertheless, the expectation is watering shall comprise the application of approximately five (5) litres of water per tube stock plant (or whatever amount is required to ensure an adequate moisture status for the plant and surrounding soil) at weekly intervals for a period of eight (8) weeks from the time the plants are planted. For the remainder of the contract, each plant shall receive the same level of watering at fourteen-day intervals depending on the soil moisture of the planting site.

Plants shall not be permitted to dry out at any time. The frequency of watering may be varied during periods of adequate rainfall. Weather conditions will dictate if more or less frequently than fortnightly watering is required. This shall be determined by the CBS staff.

Council shall be responsible for devising a suitable method of providing water for the plants.

5.3.10 DISEASE AND INSECT CONTROL

Plants shall be sprayed to control disease and insect infestation, when/if required. The extent of spraying and the fungicides and insecticides to be used must be approved by the Supervisor. Refer also to Section 4.3 of this VMP.

5.4 NATURAL REGENERATION

While natural regeneration is the cheapest option for revegetation and the resulting seedlings are genetically appropriate for local conditions, the site has been so highly modified that natural regeneration is unlikely to form a dense native vegetation community. Thus, revegetation will rely primarily on plantings to achieve the Key Deliverables.

5.5 HABITAT AUGMENTATION

One of the objectives of the VMP is to improve the biodiversity value of the park by:

b. providing more habitat availability for native fauna through the provision of appropriate native feed trees and the installation of nest boxes.

The majority of native flowering plants flower from Spring -Autumn and while a variety of native shrubs and trees have been recommended for planting in Arcadia Park (refer Table 3), only a limited number of species flower during winter. As such, it is important to include winter flowering species to provide a year-round food resource for fauna (including migratory bird species). Swamp Mahogany *E. robusta* and Spotted Gum *Corymbia maculata*, are two winter flowering trees that have been included in the planting list (Table 3) to provide a food source during winter.

Many fauna species are hollow dependant (i.e. they require hollows for nesting to complete their life cycle). Other fauna species are hollow opportunists and will use hollows if they are available, for shelter and/or nesting.

It is recommended that the restoration of Arcadia Park includes the installation of nest boxes. Based on Newcastle Councils Guidelines for Urban Forests:

> *"If the tree for removal contained hollows, then install three or more nest boxes for each tree hollow removed in adjacent trees (or nearby areas) or on posts." (NCC, 2015)*

Seven hollow bearing trees (all exotic species; refer Table 1) require removal, thus a minimum of 21 next boxes are recommended for installation based on council's guidelines. The size and target species of the nest boxes recommended here are based on the size of hollows being removed and the threatened and or non-threatened fauna species that are considered likely to occur in Arcadia Park.

Recommended nest boxes for installation are:

- Brushtail Possum boxes x 3
- Ringtail Possum boxes x 3
- Parrot boxes x 6
- Microbat boxes x 9

Good quality materials are to be used in the construction of nest boxes to ensure a life span of 20 + years. For example, marine grade plywood or recycled hardwood or equivalent, with stainless steel hinges and fixtures. It is recommended that nest boxes be sourced from a reputable supplier with experience in nest box construction. Nest boxes should be installed a minimum 6 meters above the ground to protect the boxes from vandalism and be located on the north-east side of the tree to avoid the hot western afternoon sun and strong southerly winds.

Hollows from the Weeping Willows and African Olive are to be cut from the trunk and placed on the ground as habitat for terrestrial species. Cut sections of Acacia binervia trees identified for removal can also be left whole as required to demarcate perimeters or as additional habitat for terrestrial fauna.

5.6 TIMEFRAME/STAGING

Ideally, all exotic vegetation, including exotic trees, are to be removed from Arcadia Park during Phase 1 works, followed by *in-situ* mulching of exotic trees, spreading of the mulch across disturbed areas and installation of nest boxes. Phase 2 weed removal and planting is to be undertaken within 8 months of completion of Phase 1.

If, however, a staged approach is required due to budget constraints, resource (staff) availability or other factors, then each stage is to follow the Phase 1&2 guidelines below. Careful planning would be required using a Staged approach to ensure later Stages do not cause damage to early Stage restoration works. Areas furthest from access points should be included in early Staging and tree felling techniques would need to be modified to ensure they do not impact recently planted areas.

5.6.1 Phase 1 (6 months)

Phase 1 works are to be undertaken in the following sequence and be completed within a 6-month period from commencement of clearing:

1. Site Establishment
    a. Establish and maintain a safe worksite
    b. Supply, implement and monitor effective environmental controls during the period of monitoring (i.e. erosion and sediment control measures)

2. Remove mature exotic trees from Arcadia Park and *in-situ* mulching and stockpiling of mulch
3. Primary weed removal of middle and lower stratum exotics using mechanical, manual and/or chemical techniques as appropriate across the park
4. Soil Preparation/Stabilization
5. Spreading of mulch across disturbed areas
6. Revegetation (after mulch has matured - refer Section 5.3.7), including planting and watering of tubestock
7. Installation of a minimum of 21 nest boxes as described in Section 5.5.
8. Submission of a Benchmark Condition Report (Section 5.8.1) for independent review at the completion of Phase 1 works.

5.6.2 Phase 2 (4 years)

Phase 2 commences at the completion of Phase 1 works and includes monitoring and maintenance for 4 years.

9. Carry out routine inspections (bi-annual) including regular watering of new plants
10. Carry out further targeted spraying and weeding.
11. Replant and protect same species, maintaining an 80% survival rate of planted natives to achieve full coverage of the site in accordance with the key deliverables
12. Annual monitoring of nest boxes to determine usage.
13. Submit Annual Management Plan in the same month each year for four years (Section 5.8.2)

5.7 ACTION PLAN

The Action Plan summarizing key deliverables and actions required to achieve the key deliverables is provided in Appendix B.

5.8 MONITORING

While restoration works will be undertaken by CBS staff, it is recommended that monitoring of works and review of Annual Management Plans be overseen by a suitably qualified person external to CBS (hereafter referred to as the Supervisor).

The scope and extent of any changes to the VMP that may be required will be determined by the Supervisor after reviewing the Benchmark Condition Report and/or Annual Management Plans.

5.8.1 METHOD FOR SITE MONITORING & INSPECTIONS

PHOTOGRAPHIC STATIONS

Fixed photographic monitoring stations shall be established in 8 monitoring plots prior to starting works within each of the work Zones. The stations are to be clearly marked using a star picket or equivalent.

The photographic stations are to be specifically located in positions to take full advantage of expected changes to capture a clear visual record of works completed. Photographs shall be taken in the same orientation each time, so comparisons can be made with previous photographs.

Photographs are to be clearly referenced, labelled and included in the Benchmark Condition Report and each of the subsequent Annual Management Plans, which are to be submitted to the Supervisor for review.

The following information shall be included with the photographs:

- A photographic monitoring stations map that clearly shows station locations within each of the work Zones. Show unique "station" names for easy reference.
- An indication of the direction each photograph was taken.

For the Benchmark Condition Report, photographs should be taken:

- Before any clearing/spraying and weeding takes place
- Immediately after completion of all planting (i.e. end of Phase 1 works).

For the Annual Management Plans, photographs should be taken at a set time every year for the duration of the works.

INSPECTIONS

The restoration works are to be inspected by the Supervisor following the review of the Benchmark Condition Report and Annual Management Plans which are to be submitted to the Supervisor to ensure the objectives and performance requirements are being met.

5.9 REPORTING

5.9.1 BENCHMARK CONDITION REPORT

A detailed "Benchmark" Condition Report shall be prepared by CBS staff and submitted to the Supervisor for review immediately after completion of Phase 1 works. If works are undertaken in Stages, a benchmark condition report is required for each stage.

The format and inclusions for that report shall be in accordance with Section 5.9.2.

5.9.2 ANNUAL MANAGEMENT PLAN

A detailed Management shall be prepared by the CBS staff and submitted to the Supervisor for review annually during the 4-year Monitoring, Reporting and Maintenance phase (i.e. Phase 2). Each Annual Management Plan shall be submitted in the same month each year.

The purpose of the Annual Management Plans are to progressively document the success (or not) of the Restoration Works, and to assist the Supervisor in evaluating the extent of required follow-up maintenance works (if any) that are to be carried out to achieve the objectives and key deliverables.

Each Annual Management Plan shall include the following as a minimum:

- Description of Weed and Revegetation Condition at each Work Zone (determined from a minimum of six 20x20 m plots placed randomly across the park)
    - Description of each zone
    - % Survival of plants estimated for each Zone
    - % Native Cover within each stratum in each Zone
    - % Exotic cover within each stratum in each Zone
    - Number of native and exotic flora species present
- Determine nest box usage/species using qualified tree climbers/ecologists to inspect hollows annually.
- Work effort that CBS have undertaken within that year
    - Date
    - Staff numbers and staff names
    - Hours and details of the restoration work undertaken

- Where maintenance and/or treatment works are recommended, quantify for each Zone the following:
    - Anticipated staff and hours needed to carry out the recommended maintenance works;
    - What machinery, equipment, materials and chemicals would be needed;
    - What species weeds need to be targeted and exactly where;
    - What species of tree and shrubs need to be replanted - numbers and exact locations;
    - If a species is not performing in the conditions, this should be included in the report and alternative species selected from Table 3;
    - any other maintenance works issues.
- Miscellaneous Project Related Issues
- Details of Active searches for signs of disease/pathogens, including Myrtle rust
- Photographs
- At least 2 recent photographs taken from each fixed photographic monitoring station in each Work Zone (for comparison with previous photographs).

Each Annual Management Plan must be submitted as one (1) complete document in PDF format to the Supervisor in the same month each year. If works are undertaken in Stages, the Annual Management Plans must include monitoring results from all Stages.

6 REFERENCES

Lower Hunter Central Coast Regional Environmental Management Strategy (LHCCREMS, 2003). Vegetation Survey, Classification and Mapping - Map Unit Profiles

MacDonald RC, RF Isbell, JG Speight, J Walker & MS Hopkins, 1998. Australian Soil and Land Survey: Field Handbook, 2nd ed. Department of Primary Industries and Energy and CSIRO Australia.

Munro & Lindenmayer, 2015. Planting for Wildlife: A Practical Guide to Restoring Native Woodlands, CSIRO Publishing.

Newcastle Bushfire Management Committee, 2012. Bush Fire Risk Management Plan.

NCC, 2015. Newcastle City Council: Technical Manual Urban Forest (Updated April 2015), http://www.newcastle.nsw.gov.au/Newcastle/media/Documents/Development%20and%20Building/DCP%202012/Technical%20Manuals%20and%20Additional%20Information/Urban_Forest_Technical_Manual_April_2015.pdf

NSW DPI, undated. Weedwise. New South Wales Department of Primary Industries, http://weeds.dpi.nsw.gov.au/Weeds/Details/60#profile

NSW Planning & Environment (1966). Resources and Energy, Newcastle 1:250,000 Geological Map, Map Sheet S1/56-02. http://www.resourcesandenergy.nsw.gov.au/miners-and-explorers/geoscience-information/products-and-data/maps/geological-maps/1-250-000/newcastle-250k-geological-map

NSW Rural Fire Service, undated. Standards for Asset Protection Zones. https://www.rfs.nsw.gov.au/__data/assets/pdf_file/0010/13321/Standards-for-Asset-Protection-Zones.pdf

RBGS, undated. Royal Botanic Garden Sydney. Fusarium wilt of Palms https://www.rbgsyd.nsw.gov.au/science/plants/pests-diseases/fusarium-wilt-of-palms

7 APPENDIX A:

Table A1. Flora Species Recorded in Arcadia Park: November 2017

Scientific Name	Common Name	Family	Form[a]	TSC Status[b]	Observed[c]	Occurrence[d]	Previous List[e]
Acacia binervia	Coast Myall	Mimosoideae	s	N	x	C	
Acacia brownii	Heath Wattle	Mimosoideae	s	N	x	R	x
Acacia falcata	Sickle Wattle	Mimosoideae	s	N	x	R	
Acacia fimbriata	Fringed Wattle	Mimosoideae	st	N	x	O	x
Acacia implexa	Hickory Wattle	Mimosoideae	st	N			x
Acacia irrorata	Green Wattle	Mimosoideae	st	N	x	O	x
Acacia longifolia var. *sophorae*	Sydney Golden Wattle	Mimosoideae	s	N	x	O	
Acacia myrtifolia	Red Stem Wattle	Mimosoideae	s	N	x	R	
Acacia sp	Wattle	Mimosoideae	st	N	x	R	
Acacia suaveolens	Sweet Scented Wattle	Mimosoideae	s	N	x	O	x
Acacia terminalis	Sunshine Wattle	Mimosoideae	s	N	x	R	
Acacia ulicifolia	Prickly Moses	Mimosoideae	s	N	x	R	
Acetosa sagittata	Turkey Rhubarb	Polygonaceae	h	E			x
Acmena smithii	Lillypilly	Myrtaceae	t	N			x
Allocasuarina distyla	Scrub She-oak	Casuarinaceae	s	N	x	O	x
Allocasuarina littoralis	Black She-oak	Casuarinaceae	st	N	x	O	
Alpinia caerulea	Native Ginger	Zingiberaceae	h	N	x	R	x
*Andropogon virginicus**	Whisky Grass	Poaceae	h	E	x	O	
Angophora costata	Smooth-barked Apple	Myrtaceae	t	N	x	R	
Anredera cordifolia	Madiera Vine	Basellaceae	v	E		C	x
*Araucaria heterophylla**	Norfolk Island Pine	Araucariaceae	t	E	x	O	x
*Araujia sericifera**	Moth Vine	Apocynaceae	v	E	x	R	
Archontophoenix cunninghamiana	Bangalow Palm	Arecaceae	t	N	x	O	x
*Asparagus aethiopicus**	Asparagus Fern	Asparagaceae	h	E#	x	R	
*Bambusia balcooa**	Giant Bamboo	Poaceae	h	E	x	R	
Banksia aemula	Wallum Banksia	Proteaceae	s	N	x	R	x
Banksia collina	Hairpin Banksia	Proteaceae	s	N	x	R	
Banksia ericifolia	Heath-leaved Banksia	Proteaceae	s	N			x
Banksia integrifolia subsp. *integrifolia*	Coast Banksia	Proteaceae	s	N	x	M	
Banksia oblongifolia	Fern-leaved Banksia	Proteaceae	s	N			x
Banksia robur	Wallum Banksia	Proteaceae	s	N	x	R	
Banksia spinulosa	Hairpin Banksia	Proteaceae	s	N	x	R	x
*Bidens pilosa**	Cobbler's Pegs	Asteraceae	h	E	x	O	
Bothriochloa macra	Red-leg Grass	Poaceae	h	N	x	O	
Brachychiton acerifolius	Illawarra Flame Tree	Malvaceae	t	N	x	R	
Brachyscome multifida	Cut-leaved Daisy	Asteraceae	h	N	x	O	x
Breynia oblongifolia	Coffee Bush	Phyllanthaceae	s	N	x	O	

*Briza maxima**	Quaking Grass	Poaceae	h	E	x	O	
*Briza minor**	Shivery Grass	Poaceae	h	E	x	R	
*Bromus cartharticus**	Prairie Grass	Poaceae	h	E	x	M	
Callistemon citrinus	Crimson Bottlebrush	Myrtaceae	s	N	x	R	
Callistemon linearis	Narrow-leaved Bottlebrush	Myrtaceae	s	N			x
Callistemon salignus	Willow Bottlebrush	Myrtaceae	s	N	x	R	
Callistemon sp	Taree Pink	Myrtaceae	s	*	x	R	x
Callistemon viminalis x comboyensis	Wildfire	Myrtaceae	s	E	x	M	
Carex sp(appressa)		Cyperaceae	h	N	x	R	x
Casuarina cunninghamiana	River Oak	Casuarinaceae	t	N	x	M	
Centella asiatica	Swamp Pennywort	Apiaceae	h	N	x	M	
*Cestrum parqui**	Chilean Cestrum	Solanaceae	s	E#	x	R	
Chrysanthemoides monilifera subsp. *rotundata**	Boneseed	Asteraceae	s	E#	x	R	
*Cinnamomum camphora**	Camphor Laurel	Lauraceae	t	E#	x	M	
Cissus antarctica	Native Grape	Vitaceae	v	N			x
Commelina cyanea	Scurvy Weed	Commelinaceae	h	N	x	O	
Cordyline sp		Asteliaceae	s	N			x
Correa alba	White Correa	Rutaceae	s	N	x	R	
Corymbia gummifera	Red Bloodwood	Myrtaceae	t	N	x	R	
Corymbia maculata	Spotted Gum	Myrtaceae	t	N	x	R	
Crinum pedunculatum	Crinum Lily	Amaryllidaceae	h	N			x
Cupaniopsis anacardioides	Tuckeroo	Sapindaceae	t	N	x	C	
Dianella caerulea	Blue Flax Lily	Phormiaceae	h	N	x	M	
Dichondra repens	Kidney Weed	Convolvulaceae	h	N	x	C	
Dillwynia retorta	Eggs and Bacon	Faboideae	s	N			x
Diospyros australis	Black Plum	Ebenaceae	t	N			x
Dodonaea triquetra	Hop Bush	Sapindaceae	s	N			x
Doryanthes excelsa	Gymea Lily	Doryanthaceae	h	N			x
Ehretia acuminata	Koda	Boraginaceae	S	N	x	R	
*Ehrharta erecta**	Panic Veldtgrass	Poaceae	h	E	x	M	
Elaeocarpus reticulatus	Blueberry Ash	Elaeocarpaceae	st	N	x	R	x
Eucalyptus amplifolia	Cabbage Gum	Myrtaceae	t	N			x
Eucalyptus botryoides	Bangalay	Myrtaceae	t	N	x	O	
Eucalyptus grandis	Flooded gum	Myrtaceae	t	N	x	O	
Eucalyptus punctata	Grey Gum	Myrtaceae	t	N			x
Eucalyptus robusta	Swamp Mahogany	Myrtaceae	t	N	x	M	
Eucalyptus umbra	Broad-leaved White Mahogany	Myrtaceae	t	N	x	R	
Ficinia nodosa	-	Cyperaceae	h	N	x	M	x
Ficus coronata	Sandpaper Fig	Moraceae	t	N			x
Ficus rubiginosa	Port Jackson Fig	Moraceae	t	N	x	R	
Glochidion ferdinandii	Cheese Tree	Phyllanthaceae	st	N	x	O	
Goodenia ovata	Hop Goodenia	Goodeniaceae	h	N	x	M	
*Grevillea robusta**	Silky Oak	Proteaceae	t	E	x	O	

Hakea bakeriana	-	Proteaceae	s	N			x
Hakea sericea	Needlebush	Proteaceae	s	N	x	R	x
Hakea teretifolia	Needlebush	Proteaceae	s	N			x
Harpephyllum caffrum	Kaffir Plum						
Hibbertia scandens	Climbing Guinea-flower	Dilleniaceae	v	N	x	R	x
Hibiscus heterophyllus subsp heterophyllus	Native Rosella	Malvaceae	s	N	x	O	
Homalanthus populifolius	Bleeding Heart	Euphorbiaceae	s	N	x	O	x
Hymenosporum flavum	Native Frangipani	Pittosporaceae	t	N	x	R	x
*Hypochaeris radicata**	Flatweed	Asteraceae	h	E	x	M	
Hypolepis muelleri	Harsh Ground Fern	Dennstaedtiaceae	h	N	x	O	
Imperata cylindrica	Blady Grass	Poaceae	h	N			x
Indigofera australis	Native Indigo	Faboideae	s	N			x
*Ipomoea cairica**	Blue Morning Glory	Convolvulaceae	v	E#	x	R	
*Ipomoea indica**	Coastal Morning Glory	Convolvulaceae	v	E#	x	R	
Jacksonia scoparia	Dogwood	Faboideae	s	N	x	R	
Kennedia rubicunda	Dusky Coral Pea	Faboideae	v	N	x	R	
*Lagunaria patersonii subsp bracteatus**	Norfolk Island Hibiscus	Malvaceae	s	E	x	M	
Lambertia formosa	Mountain Devil	Proteaceae	s	N			x
Leptospermum continentale	Prickly Tea Tree	Myrtaceae	s	N			x
Leptospermum juniperinum	Prickly Tea-tree	Myrtaceae	s	N	x	R	x
Leptospermum laevigatum	Coast Tea-tree	Myrtaceae	s	N	x	C	
Leptospermum polygalifolium	Lemon Scented Tea-tree	Myrtaceae	s	N	x	R	
Leucopogon parviflorus	Coastal Beard-heath	Styphelioideae	s	N			x
Livistona australis	Cabbage Tree Palm	Arecaceae	t	N	x	R	
Lomandra longifolia	Spiky-headed Mat-rush	Lomandraceae	h	N	x	M	
Marsdenia rostrata	Milk Vine	Apocynaceae	v	N	x	R	
*Megathyrus maximus var maximus**	Guinea Grass	Poaceae	h	E	x	M	
Melaleuca armillaris	Bracelet Honey Myrtle	Myrtaceae	s	N	x	C	
Melaleuca nodosa	Prickly-leaved Paperbark	Myrtaceae	s	N			x
Melaleuca quinquenervia	Broad-leaved Paperbark	Myrtaceae	t	N	x	M	
Melaleuca thymifolia	Thyme Honey Myrtle	Myrtaceae	s	N			x
Metrosideros stipoides	New Zealand Christmas Bush	Myrtaceae	s	E	x	O	
Mirbelia rubiifolia	Heathy Mirbelia	Faboideae	s	N			x
*Modiola caroliniana**	Red-flowered Mallow	Malvaceae	h	E	x	O	
*Monstera deliciosa**	Fruit-salad Plant	Araceae	h	E	x	R	
*Nerium oleander**	Oleander	Apocynaceae	s	E	x	R	
*Nothoscordum gracile**	Onion Weed	Alliaceae	h	E	x	O	
Olea europa subsp. *cuspidata**	African Olive	Oleaceae	st	E#	x	C	
Oxalis perrenans	-	Oxalidaceae	h	N	x	O	
Parsonsia straminea	Common Silkpod	Apocynaceae	v	N	x	O	
*Pennisetum clandestinum **	Kikuyu	Poaceae	h	E	x	O	
Persoonia linearis	Narrow-leaved Geebung	Proteaceae	s	N			x
*Phoenix canariensis**	Canary Island Date Palm	Arecaceae	t	E	x	M	

Pittosporum revolutum	Yellow Pittosporum	Pittosporaceae	s	N			x
Pittosporum undulatum	Sweet Pittosporum	Pittosporaceae	t	N	x	C	
*Plantago lanceolata**	Ribwort	Plantaginaceae	h	E	x	C	
*Poa annua**	Winter Grass	Poaceae	h	E	x	M	
Poa poiformis		Poaceae	h				x
Polymeria calycina	Bindweed	Convolvulaceae	v	N			x
Polyscias elegans	Celery Wood	Araliaceae	t	N	x	R	
*Prunus persica**	Peach Tree	Rosaceae	t	E	x	R	
Pultenaea paleacea	Chaffy Bush-pea	Faboideae	s	N			x
Pultenaea villosa	Hairy Bush-pea	Faboideae	s	N			x
*Salix babylonica**	Weeping Willow	Salicaceae	t	E#	x	O	
Sannantha pluriflora	-	Myrtaceae	s	N			x
Scaevola albida		Goodeniaceae	h	N	x	O	x
*Schefflera actinophylla**	Umbrella Tree	Araliaceae	t	E#	x	O	
*Senna pendula var glabrata**		Caesalpinioideae	s	E#	x	R	
*Sisyrinchium rostulatum (sp A)**	Pigroot	Iridaceae	h	E	x	O	
Solanum aviculare	Kangaroo Apple	Solanaceae	h	N	x	O	
*Solanum chenopodioides**	Whitelip Nightshade	Solanaceae	h	E	x	O	
*Solanum mauritianum**	Wild Tobacco	Solanaceae	s	E	x	C	
*Solanum nigrum**	Black Nightshade	Solanaceae	h	E	x	R	
*Soliva sessilis**	Jojo	Asteraceae	h	E	x	O	
*Sonchus oleraceus**	Common Sow-thistle	Asteraceae	h	E	x	O	
*Stenotaphrum secundatum **	Buffalo Grass	Poaceae	h	E	x	M	
Syncarpia glomulifera	Turpentine	Myrtaceae	t	N	x	O	
Themeda triandra	Kangaroo Grass	Poaceae	h	N	x	M	
Tipuana tipu	Tipu Tree	Fabaceae	t	E	x	R	
*Tradescantia fluminensis**	Wandering Jew	Commelinaceae	h	E	x	C	
Trema tomentosa	Native Peach	Ulmaceae	s	N	x	M	
*Tropaeolum majus**	Nasturtium	Tropaeolaceae	h	E	x	O	
Viola hederacea	Ivy-leaved Violet	Violaceae	h	N	x	M	
Westringia fruiticosa	Coast Westringia	Lamiaceae	s	N	x	R	
Wikstroemia indica							x
Wollemia nobilis	Wollemi Pine	Araucariaceae	s	N	x	R	
Xanthorrhoea macronema	-	Xanthorrhoaceae	h	N			x

[a] h=herb, v=vine, s=shrub, t=tree,

[b] N=Native, E=Exotic, #=Noxious weed

[c] X=recorded in current survey

[d] C=Common, M=Moderately common, O=Occasional, R=Rare,

[e] Previous List = refers to the species list that past bush regeneration works were based on. Not all of these species were recorded in Arcadia Park during the current site visit.

Table A2. Noxious Weeds, their classification, impacts and treatment

Common Name	Scientific Name	Class	Impact	Treatment
Madiera Vine	*Anredera cordifolia*		Madeira vine is an invasive climber that is native to South America (Bolivia, Paraguay, Uraguay, Southern Brazil and Northern Argentina). In Australia it has been used as an ornamental plant in gardens, but has become an invasive environmental weed, blanketing and smothering both shrubs and trees. The weight of the vine can cause smaller trees to collapse and die.	Successful control of Madeira vine requires all the tubers and bulbils to be removed or killed. Control activities are long-term, and require regular follow-up for many years. Single control activities generally cause disturbance that results in vigorous regrowth and can lead to worse infestation levels unless dedicated follow-up occurs. Physical removal of Madeira vine is difficult because of the extent of underground tubers and aerial bulbils but may be practical at smaller or immature infestation sites or as a follow-up measure to remove persistent tubers. Tubers, bulbils and vegetative material must be disposed of appropriately, as they will regrow if they are left in contact with the soil. Cut vines can remain 'alive' in the tree canopy for up to two years (surviving on energy from the aerial bulbils). Cutting and pulling the vines from the canopy should be avoided as it results in a shower of viable bulbils. If this is necessary (where there is extreme stress on the host plant), tarpaulins should be laid on the ground to collect as many of the aerial bulbils as possible. Herbicides can be effective and the main application techniques are scrape and paint and foliar spraying. Best results are achieved during the warmer months, however, Madeira vine grows year-round and a herbicide application during late winter may allow easier access and better control during the following spring and summer months.
Turkey Rhubarb	*Acetosa sagittata*		Turkey rhubarb is highly invasive, growing vigorously during spring and summer. It has escaped from gardens into nearby bushland where it forms dense tangles that smother ground flora and small shrubs.	No advice provided
Asparagus Fern	*Asparagus aethiopicus**	4	Gound asparagus forms dense blankets of growth above ground and a profusion of roots and tubers below ground which suppresses other ground flora and reduces available soil moisture and nutrients. It is able to tolerate dry periods due to its well developed crowns and numerous tubers. It is a common	The rate and spread of ground asparagus can be minimised by preventing seed formation and controlling plants before flowering begins. Plants can be controlled by crowning - the practice of digging out the entire crown (by severing the tough surrounding roots) that sits just below the surface of the soil, and leaving the roots and watery tubers in situ. This helps to prevent unnecessary disturbance in sensitive areas, particularly coastal dune environments. Any small segment of the crown that is left behind can grow a new crown. Bag and burn the crown and any fruiting stems. Carefully spot

Common Name	Scientific Name	Class	Impact	Treatment
			garden plant which easily re-establishes after being dumped as garden waste and has become a serious environmental weed.	spray, or recrown any regrowth or seedlings. Care must be taken when applying herbicides to avoid damaging desirable species growing nearby. Large infestations may require spot spraying, and a penetrant should be used in coastal areas where ground asparagus forms a waxy coating (NSW DPI, undated).
Chilean Cestrum	*Cestrum parqui**	3	Green cestrum is a vigorous plant that can out-compete other vegetation. Green cestrum is toxic to animals including cattle, sheep, horse, pigs, poultry and humans.	Total eradication of green cestrum requires a combination of control techniques and frequent follow up work. Once a single control event occurs green cestrum can have vigorous regrowth from stumps or roots not removed or from dormant seed in the ground. Monitor control areas for regrowth and if necessary retreat the area using another form of control. New infestations should be destroyed before they flower and produce berries. Physical control: Green cestrum can be controlled by repeated cutting down, digging or pushing out by mechanical equipment. All the yellow roots must be removed and destroyed appropriately to prevent regrowth. The roots can be burnt. Chemical control: Herbicides are often the most effective and economical way of controlling green cestrum. However, only a registered herbicide should be used to control green cestrum infestations. For a list of registered herbicides and application methods see the Noxious and Environmental Weed Control Handbook. Take care not to contaminate watercourses near clumps of green cestrum. Also, ensure that spray drift does not affect desirable plants in areas being treated and that operators follow the recommended safety precautions when handling and using herbicides. Mulch: Mulch can be used to suppress seedling growth after chemical or physical control. Mulch also retains moisture in the soil and provides protection for native plants that can be sown to replace the green cestrum plants (NSW DPI, undated).
Boneseed	*Chrysanthemoides monilifera subsp. rotundata**	4	Bitou bush affects native plants mainly through competition, its high growth rate and, possibly, by releasing chemical inhibitors. Dense stands of bitou bush exclude other indigenous plants leading to decreasing floral biodiversity and, consequently, changes in faunal diversity. Stands of bitou bush also reduce	There are a number of different treatment techniques that can be used to control bitou bush but it is often better to combine a number of techniques for the best results. Mechanical treatment: Mature bitou bush plants can be slashed, whilst seedlings can be hand-pulled to remove the entire root system. Plants are liable to resprout after slashing alone, but applying herbicide to stems immediately after cutting should prevent regrowth. Herbicide information: Herbicides registered for bitou bush can be applied in winter at low rates that effectively kill the weed, yet have minimal impacts on coastal vegetation. Glyphosate and metsulfuron

Common Name	Scientific Name	Class	Impact	Treatment
			the aesthetic appeal of natural environments and reduce recreational access to beaches and along walking trails. In 1999, bitou bush was listed as a Key Threatening Process to Biodiversity in NSW and as a Weed of National Significance.	methyl have been the herbicides most widely and successfully used against bitou bush (NSW DPI, undated).
Camphor Laurel	*Cinnamomum camphora**		Camphor laurel has the ability to adapt to the disturbed environment, it has prolific seed production and rapid growth rate as well as a lack of serious predators or diseases	Professional tree arborists can cut down bigger mature camphor laurel trees, mulch the timber and grind the stump out of the ground. This is a particularly good technique in urban areas, roadsides and backyards where a tree needs to be totally removed. Alternatively, the entire tree can be pushed over with an excavator or bulldozer.
Blue Morning Glory	*Ipomoea cairica**		Coastal morning glory is vigorous perennial climber that is capable of very rapid growth. It was widely cultivated as a garden ornamental and is now common in coastal areas particularly on river banks and tolerates a wide variety of soils types. Coastal morning glory spreads quickly either forming a dense mat along the ground or climbing on any vertical support into the canopy sometimes up to 4.5 m. Infestations can smother native vegetation, reducing biodiversity and displacing native animals due to habitat destruction.	Climbing stems can be cut and left in situ to wither and die. Rooted stems and ground-running stems can be treated with translocatable herbicide such as glyphosate, with some degree of success using the following method: 1. Roll up long ground-running stems, to within 1 m of their first firmly rooted point of contact with the ground. 2. Cut the rolled stems, and either take them off-site for disposal, or leave them to dry out ensuring they do not remain in contact with the soil. 3. Stem-scrape a long section of the remaining rooted stem (at least 20 cm) and apply the herbicide immediately (within 10 seconds of making the scrape).
Coastal Morning Glory	*Ipomoea indica**		Purple morning glory, native to South America, is a vigorous perennial climber that can form either a dense ground cover or climb high into the canopy smothering native vegetation. Purple morning glory reportedly grows in a wide variety of soils	As above

Common Name	Scientific Name	Class	Impact	Treatment
			and situations. However, it prefers moist areas - particularly nutrient rich sites. It is commonly recorded in urban areas, wasteland, along roadsides and on rainforest margins. It was widely cultivated as a garden ornamental and has become naturalised in many coastal areas.	
African Olive	*Olea europa* subsp. *cuspidata**		African olive is an aggressive woody weed that invades native bushland, creating a dense shady canopy that excludes the growth of native understorey plants. African olive is a very long-lived tree and permanently changes the plant diversity and structure of bushland. It is a tropical wild olive that comes from eastern Africa. It is related to the edible European olive however the fruit is not edible and has no commercial value.	No advice provided
Weeping Willow	*Salix babylonica**		Willows are among the worst weeds in Australia due to their invasiveness, potential for spread, and economic and environmental impacts. They have invaded riverbanks and wetlands in temperate Australia, occupying thousands of kilometres of streams and numerous wetland areas. Unlike most other vegetation, willows spread their roots into the bed of a watercourse, slowing the flow of water and reducing aeration. They form thickets which divert	Hand pulling of seedlings less than 0.5 m tall is the most practical and environmentally safe way of removing young plants. Leaving small roots in the ground does not lead to suckering or regrowth. Using large machinery such as excavators or bulldozers to remove larger trees and root systems is not recommended except in dry areas. In wet areas bulldozers push broken branches into the ground and thus generate numerous new plants. Smaller twigs should be bagged and disposed of at tip facilities so that they do not sprout and cause further problems.

Common Name	Scientific Name	Class	Impact	Treatment
			water outside the main watercourse or channel, causing flooding and erosion where the creek banks are vulnerable. Willow leaves create a flush of organic matter when they drop in autumn, reducing water quality and available oxygen. This, together with the amount of water willows use, damages stream health. The replacement of native vegetation by willows reduces habitat for both land and aquatic animals.	
Umbrella Tree	*Schefflera actinophylla**		Umbrella tree invades national parks, remnant bushland, undisturbed forests and reserves, causing harm to local ecosystems' flora and fauna.	No advice provided
Cassia	*Senna pendula var glabrata**		Cassia is popular garden plant that invades native ecosystems, particularly in coastal areas. It is a fast growing plant that can suppress the growth of native species and displace them. It produces large amounts of long-lived seeds	Spread by seed and sometimes by suckers. No control advice provided.

Noxious Weed Class	Legal Requirements: Newcastle City Council
3	Regionally Controlled Weed The plant must be fully and continuously suppressed and destroyed
4	Locally Controlled Weed The plant must not be sold, propagated or knowingly distributed

NB. Where available, control advice was taken from the NSW Department of Primary Industries Weed Wise website:
http://weeds.dpi.nsw.gov.au/?sq_content_src=%2BdXJsPWh0dHAlM0ElMkYlMkZ3ZWVkcy5kcGkubnN3Lmdvdi5hdSUyRndlZWRzUHVibGIjJTJGQ291bmNpbCUyRkRldGFpbHMmYWxsPTE%3D&search=go&id=86

WARNING - ALWAYS READ THE LABEL
Users of agricultural or veterinary chemical products must always read the label and any permit, before using the product, and strictly comply with the directions on the label and the conditions of any permit. Users are not absolved from compliance with the directions on the label or the conditions of the

permit by reason of any statement made or not made in this information. To view permits or product labels go to the Australian Pesticides and Veterinary Medicines Authority website www.apvma.gov.au

8 APPENDIX B: ACTION PLAN

Phase 1: Initial Works	
Key Deliverable	Action
Achieve a zero-negative impact to the environment during clearing and restoration implementation works	• Establish and maintain a safe worksite • Install appropriate signage/fencing/barricades and traffic control • Supply, implement and monitor effective environmental controls during the period of monitoring. • Install appropriate erosion and sediment control measures
Achieve a minimum 95% eradication of all weeds following Phase 1	• Supply all resources to carry out initial clearing of exotic species • Remove exotic tree species and dead native trees • Remove exotic middle stratum species • Treat exotic lower stratum species (refer Section 5.2)
Stabilise disturbed soil as soon as possible following disturbance to minimise regrowth of exotic species	• Mulch removed trees and stockpile mulch until middle and lower stratum exotics have been removed/successfully treated. • Spread mulch to a minimum depth of 100 mm. • Allow mulch a minimum 2 months to mature prior to tube stock planting
Supply all resources and carry out at least 2 repeat weed treatments to ensure weed eradication prior to new planting	• Follow-up treatment of weed species using a combination of manual and chemical treatment within the first two months after initial removal.
Supply all resources to plant native tube stock from species listed in Table 3 at densities listed in Table 4 to achieve the following % surface area coverage for each zone (shown in Figure 2): • Zone 1, Littoral Rainforest: A lower stratum native surface area coverage of >30%, a middle stratum surface area coverage of >70% and an upper surface area coverage (including emergent) of >95% after 10 years (estimated after 4-year monitoring period). • Zone 2, Existing Tracks and Picnic Areas: A lower stratum native surface area coverage of >95%, a middle stratum	• Supply all materials and carry out soil stabilization, preparation/conditioning prior to new planting • Tube stock can be from seed collected from Arcadia Park or supplied by a reputable native nursery with supplies of local species. All stock is to be free from disease and pathogens prior to movement • Loosen compacted sections on the side of planting holes and include Terraform or equivalent soil condition/slow release fertiliser granules/water holding products into hole and mix with loose material. Mix backfill soil to avoid clumps of fertilizer likely to burn plant roots. • Carry out watering of new trees and shrubs. Councils Bushland Services staff

surface area coverage of <5% and an upper surface area coverage of < 30% after 10 years (estimated after 4-year monitoring period). • Zone 3, Coastal Plains Smooth-barked Apple Woodland: A lower stratum native surface area coverage of >95%, a middle stratum surface area coverage of >60% and an upper surface area coverage of >60% after 10 years (estimated after 4-year monitoring period). • Zone 4, Open Space Area: A lower stratum exotic grass surface area coverage of >95%, a middle stratum surface area coverage of <5% and survival of 30 native trees to replace exotic trees removed from this zone (estimated after 4-year monitoring period).	shall determine the appropriate amount of watering necessary to successfully achieve the objectives and performance requirements of the VMP.
Habitat Augmentation	• Installation of a minimum of 21 nest boxes as described in Section 5.5. • Place cut hollows and some branches/limbs on the ground for terrestrial habitat.
Improve the aesthetic quality of the park following the completion of Phase 1 works	• Disestablish and restore each zone, work compound and access roads/points at completion of Phase 1 works • Responsibly dispose of all waste material • Remove temporary signage/ fencing/barricades • Submit a "benchmark" Condition Report quantifying the extent of weed eradication for each Zone, and extent of newly planted trees, shrubs and ground cover for each Zone at the time of completion of Phase 1 works.
Phase 2: Monitoring and Maintenance Period	
Achieve a minimum 80% survival rate of all species planted at the end of the 4-year monitoring period	• Carry out routine inspections; regular watering of new plants; minor hand weeding during Phase 2 for 4 years. • Carry out further targeted spraying and weeding, as required, for each Zone. • Replant and protect same species if mortality rates are unacceptably high for each Zone

	• Continue to monitor the Site for signs of disease/pathogens (i.e. myrtle rust). Submit four Annual Management Plans in the same month each year, quantifying the success of weed eradication and the success rate of newly planted species and advising any remedial actions required. • Annual Management Plans are to be reviewed by a suitably qualified person independent of the works (i.e. outside of Council) • The fourth report is to be titled 'Closure Report'.
Habitat Augmentation	• Annual monitoring of nest boxes to determine usage and undertaken any necessary repairs/box replacements.
Achieve an increase in fauna diversity.	• Local bird watching groups could be encouraged to undertake annual bird counts commencing prior to the commencement of works to provide baseline data. • Installed nest boxes should be monitored and maintained annually for 4 years to determine usage by fauna.

Appendix D: AHIMS Search Results

AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : 1855 The Hill

Client Service ID : 380182

Stuart Greville

[redacted]

Date: 02 November 2018

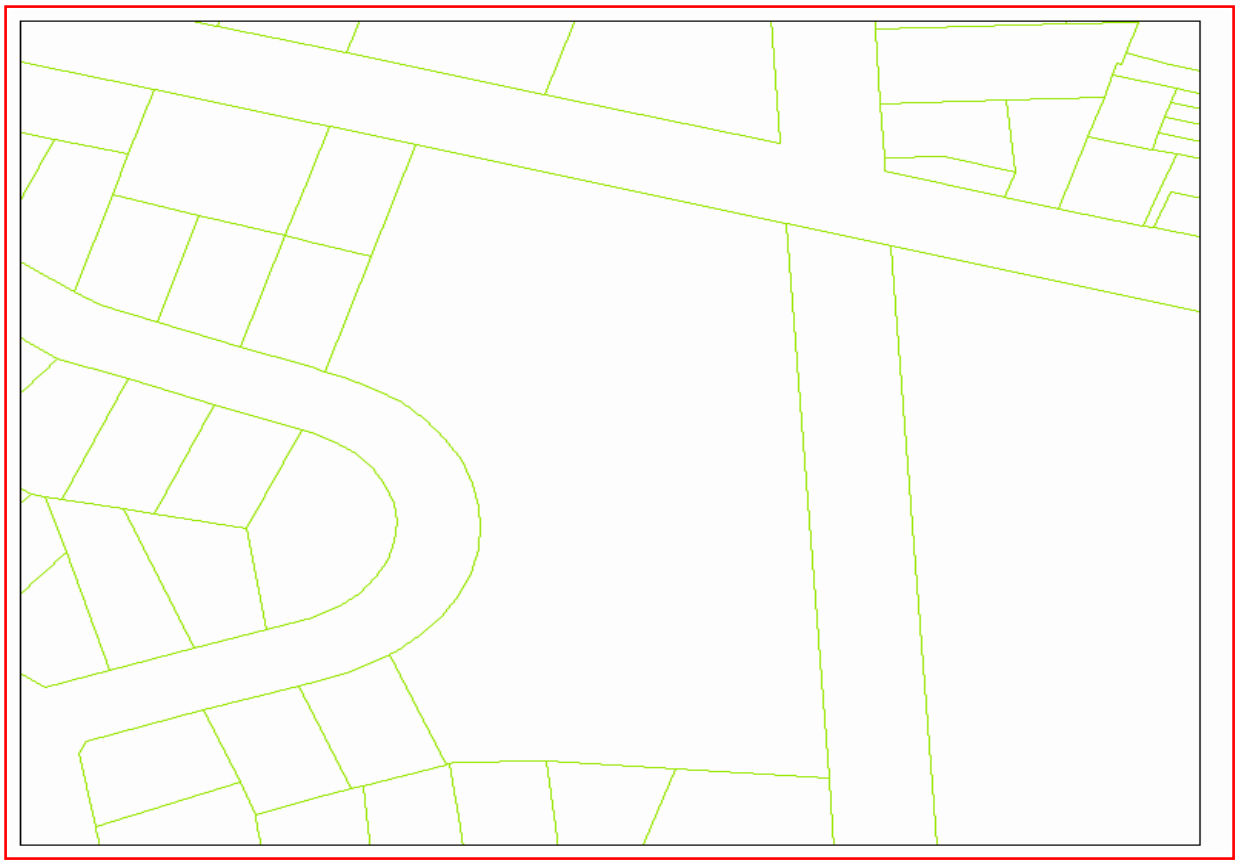
Attention: Stuart Greville

Email: [redacted]

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lat, Long From : -32.932, 151.7763 - Lat, Long To : -32.9311, 151.7777 with a Buffer of 50 meters, conducted by Stuart Greville on 02 November 2018.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the NSW Government Gazette (http://www.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request

Important information about your AHIMS search

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date .Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

3 Marist Place, Parramatta NSW 2150
Locked Bag 5020 Parramatta NSW 2220
Tel: (02) 9585 6380 Fax: (02) 9873 8599

ABN 30 841 387 271
Email: ahims@environment.nsw.gov.au
Web: www.environment.nsw.gov.au

Appendix E: BAL Assessor Report

Bushfire Planning Australia

NBC Bushfire Attack Assessment Report V3.0

AS3959 (2009) Appendix B - Detailed Method 2

Print Date: 21-Mar-19 **Assessment Date:** 25-Sep-18

Site Street Address: 1855 Mosbri Crescent, The Hill

Assessor: Stuart Greville; Bushfire Planning Australia

Local Government Area: Newcastle **Alpine Area:** No

Equations Used

Transmissivity: Fuss and Hammins, 2002
Flame Length: RFS PBP, 2001/Vesta/Catchpole
Rate of Fire Spread: Noble et al., 1980
Radiant Heat: Drysdale, 1985; Sullivan et al., 2003; Tan et al., 2005
Peak Elevation of Receiver: Tan et al., 2005
Peak Flame Angle: Tan et al., 2005

Run Description: T1 - West

Vegetation Information

Vegetation Type:	Non-Hazard	**Vegetation Group:**	Non-Hazard
Vegetation Slope:	5.6 Degrees	**Vegetation Slope Type:**	Upslope
Surface Fuel Load(t/ha):	0	**Overall Fuel Load(t/ha):**	0
Vegetation Height(m):	0	Only Applicable to Shrub/Scrub and Vesta	

Site Information

Site Slope:	5 Degrees	**Site Slope Type:**	Level
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	101

Fire Inputs

Veg./Flame Width(m):	100	**Flame Temp(K)**	1090

Calculation Parameters

Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	100

Program Outputs

Category of Attack:	VERY LOW	**Peak Elevation of Receiver(m):**	0
Level of Construction:	BAL LOW	**Fire Intensity(kW/m):**	0
Radiant Heat(kW/m2):	29	**Flame Angle (degrees):**	5
Flame Length(m):	0	**Maximum View Factor:**	0
Rate Of Spread (km/h):	0	**Inner Protection Area(m):**	101
Transmissivity:	0.722	**Outer Protection Area(m):**	0

Run Description: T2 - North east

Vegetation Information

Vegetation Type:	Non-Hazard	**Vegetation Group:**	Non-Hazard
Vegetation Slope:	8.1 Degrees	**Vegetation Slope Type:**	Upslope
Surface Fuel Load(t/ha):	0	**Overall Fuel Load(t/ha):**	0
Vegetation Height(m):	0	Only Applicable to Shrub/Scrub and Vesta	

Site Information

Site Slope:	5 Degrees	**Site Slope Type:**	Upslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	101

Fire Inputs

Veg./Flame Width(m):	100	**Flame Temp(K)**	1090

Calculation Parameters

Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	100

Program Outputs

Category of Attack:	VERY LOW	**Peak Elevation of Receiver(m):**	8.84
Level of Construction:	BAL LOW	**Fire Intensity(kW/m):**	0
Radiant Heat(kW/m2):	0	**Flame Angle (degrees):**	0
Flame Length(m):	0	**Maximum View Factor:**	0
Rate Of Spread (km/h):	0	**Inner Protection Area(m):**	101
Transmissivity:	0.722	**Outer Protection Area(m):**	0

Run Description: T3 - Hunter Macleay DSF

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	10 Degrees	**Vegetation Slope Type:**	Upslope
Surface Fuel Load(t/ha):	14	**Overall Fuel Load(t/ha):**	24.6
Vegetation Height(m):	0.9	Only Applicable to Shrub/Scrub and Vesta	

Site Information

Site Slope:	0 Degrees	**Site Slope Type:**	Upslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	9

Fire Inputs

Veg./Flame Width(m):	32.94	**Flame Temp(K)**	1090

Calculation Parameters

Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	100

Program Outputs

Category of Attack:	MODERATE	**Peak Elevation of Receiver(m):**	2.15
Level of Construction:	BAL 19	**Fire Intensity(kW/m):**	10710
Radiant Heat(kW/m2):	15.73	**Flame Angle (degrees):**	74
Flame Length(m):	4.48	**Maximum View Factor:**	0.238
Rate Of Spread (km/h):	0.84	**Inner Protection Area(m):**	9
Transmissivity:	0.87	**Outer Protection Area(m):**	0

Run Description: T4 - Sydney Coastal DSF

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	10 Degrees	**Vegetation Slope Type:**	Upslope
Surface Fuel Load(t/ha):	21.3	**Overall Fuel Load(t/ha):**	27.3
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	

Site Information

Site Slope:	0 Degrees	**Site Slope Type:**	Upslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	9

Fire Inputs

Veg./Flame Width(m):	23.79	**Flame Temp(K)**	1090

Calculation Parameters

Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	100

Program Outputs

Category of Attack:	HIGH	**Peak Elevation of Receiver(m):**	3.54
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	18083
Radiant Heat(kW/m2):	28.91	**Flame Angle (degrees):**	58
Flame Length(m):	8.35	**Maximum View Factor:**	0.434
Rate Of Spread (km/h):	1.28	**Inner Protection Area(m):**	9
Transmissivity:	0.876	**Outer Protection Area(m):**	0

Run Description: T5 - Hunter Macleay DSF

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	10 Degrees	**Vegetation Slope Type:**	Upslope
Surface Fuel Load(t/ha):	14	**Overall Fuel Load(t/ha):**	24.6
Vegetation Height(m):	0.9	Only Applicable to Shrub/Scrub and Vesta	

Site Information

Site Slope:	0 Degrees	**Site Slope Type:**	Upslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	9

Fire Inputs

Veg./Flame Width(m):	23.79	**Flame Temp(K)**	1090

Calculation Parameters

Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	100

Program Outputs

Category of Attack:	MODERATE	**Peak Elevation of Receiver(m):**	2.13
Level of Construction:	BAL 19	**Fire Intensity(kW/m):**	10710
Radiant Heat(kW/m2):	14.92	**Flame Angle (degrees):**	72
Flame Length(m):	4.48	**Maximum View Factor:**	0.226
Rate Of Spread (km/h):	0.84	**Inner Protection Area(m):**	9
Transmissivity:	0.87	**Outer Protection Area(m):**	0

Run Description: T6 - South

Vegetation Information

Vegetation Type:	Non-Hazard	**Vegetation Group:**	Non-Hazard
Vegetation Slope:	10 Degrees	**Vegetation Slope Type:**	Upslope
Surface Fuel Load(t/ha):	0	**Overall Fuel Load(t/ha):**	0
Vegetation Height(m):	0	Only Applicable to Shrub/Scrub and Vesta	

Site Information

Site Slope:	5 Degrees	**Site Slope Type:**	Upslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	101

Fire Inputs

Veg./Flame Width(m):	100	**Flame Temp(K)**	1090

Calculation Parameters

Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	100

Program Outputs

Category of Attack:	VERY LOW	**Peak Elevation of Receiver(m):**	8.84
Level of Construction:	BAL LOW	**Fire Intensity(kW/m):**	0
Radiant Heat(kW/m2):	0	**Flame Angle (degrees):**	0
Flame Length(m):	0	**Maximum View Factor:**	0
Rate Of Spread (km/h):	0	**Inner Protection Area(m):**	101
Transmissivity:	0.722	**Outer Protection Area(m):**	0

Run Description: T7 - West

Vegetation Information

Vegetation Type:	Non-Hazard	**Vegetation Group:**	Non-Hazard
Vegetation Slope:	5.4 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	5	**Overall Fuel Load(t/ha):**	8
Vegetation Height(m):	0	Only Applicable to Shrub/Scrub and Vesta	

Site Information

Site Slope:	5 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	20

Fire Inputs

Veg./Flame Width(m):	20	**Flame Temp(K)**	1090

Calculation Parameters

Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	100

Program Outputs

Category of Attack:	LOW	**Peak Elevation of Receiver(m):**	0
Level of Construction:	BAL 12.5	**Fire Intensity(kW/m):**	0
Radiant Heat(kW/m2):	0	**Flame Angle (degrees):**	0
Flame Length(m):	0	**Maximum View Factor:**	0
Rate Of Spread (km/h):	0	**Inner Protection Area(m):**	20
Transmissivity:	0.831	**Outer Protection Area(m):**	0

Run Description:	Zone 1 - Littoral Rainforest		
Vegetation Information			
Vegetation Type:	Rainforest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	10 Degrees	**Vegetation Slope Type:**	Upslope
Surface Fuel Load(t/ha):	10	**Overall Fuel Load(t/ha):**	13.2
Vegetation Height(m):	1.4	Only Applicable to Shrub/Scrub and Vesta	
Site Information			
Site Slope:	0 Degrees	**Site Slope Type:**	Level
Elevation of Receiver(m):	Default	**APZ/Separation(m):**	9
Fire Inputs			
Veg./Flame Width(m):	32.94	**Flame Temp(K)**	1090
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	100
Program Outputs			
Category of Attack:	MODERATE	**Peak Elevation of Receiver(m):**	2.31
Level of Construction:	BAL 19	**Fire Intensity(kW/m):**	4105
Radiant Heat(kW/m2):	17.01	**Flame Angle (degrees):**	73
Flame Length(m):	4.83	**Maximum View Factor:**	0.257
Rate Of Spread (km/h):	0.6	**Inner Protection Area(m):**	9
Transmissivity:	0.87	**Outer Protection Area(m):**	0

Appendix F: Planning for Bushfire Protection 2006/018 Compliance Tables

Appendix F: Planning for Bushfire Protection 2006 – Compliance Table: Residential Subdivision

Table 8 Aims and Objectives of Planning for Bushfire Protection 2006

Objectives	Comment
(i) Afford occupants of any building adequate protection from exposure to a bushfire	It is unlikely that any occupants of the proposed buildings will be directly exposed to a major bushfire due to the limited size of the potential hazard within Arcadia Park. The setback (9m) between the building and Arcadia Park in addition to the minimum 10m (up to 18m) APZ that Newcastle City Council has been recommended to be established within Arcadia Park will provide adequate protection from a bushfire.
(ii) Provide a defendable space to be located around buildings	Where required, an APZ will be provided that will ensure no part of the development will be exposed to radiant heat levels exceeding 29kW/m^2. The APZ provides a defendable space that is capable of providing an environment in which a person can undertake property protection after the passage of bushfire with some level of safety. Furthermore, due to the small area of the only bushfire hazard, it is unlikely that the building will be exposed to a fully developed fire.
(iii) Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition	The APZs have been calculated to provide a suitable buffer between any future buildings and the bushfire hazard; commensurate with the vegetation formation and slope.
(iv) Ensure safe operational access and egress for emergency service personnel and residents	All residents have direct access to a public road that leads away from the development site in the opposite direction to the bushfire hazard.
(v) Provide for ongoing management and maintenance of bushfire protection measures, including fuel loads in the asset protection zone (APZ)	The area of the property affected by an APZ will likely be contained within common property. Accordingly, maintenance of the APZ in accordance with Appendix 4 of the PBP 2006 and Standards for APZs should be incorporated into the strata statement.

(vi) Ensure that utility services are adequate to meet the needs of firefighters	The proposed development is able to be connected to all essential utility services to meet the needs of firefighters; including a reliable (reticulated) water supply.

Table 10 Specifications and Requirements for Bushfire Protection Measures for Infill Development (Chapter 4.3.5 PBP 2006)

Performance Criteria	Acceptable Solutions	Complies	Comment
In relation to Asset Protection Zones: • A defendable space is provided onsite; and • An asset protection zone is provided and maintained for the life of the development.	An APZ is provided in accordance with Appendix 2.	✓	Appropriate APZs have been identified on the plan (**Figure 14**) based on the slope and vegetation assessment undertaken as part of this BAR.
In relation to siting and design: • Buildings are sited and designed to minimise the risk of bushfire attack.	Buildings are designed and site in accordance with the siting and design principles in this section.	✓	All proposed buildings are setback a minimum of 9m from Arcadia Park. Of the 172 proposed dwellings; only 56 face Arcadia Park. The NCC: BCA requires buildings greater than 25m to be provided with a sprinkler system throughout. Furthermore, all openings are to be protected, which may require wall wetting sprinklers

In relation to construction standards • It is demonstrated that the proposed building can withstand bushfire attack in the form of wind, smoke, embers, radiant heat and flame contact	Construction determined in accordance with the Addendum: Appendix 3 and the requirements for attached garages and other structures in this section.	✓	Section 4 of AS3959-2009 does not provide additional construction requirements where there is insufficient risk to warrant specific construction requirements. This conclusion is predicated on low threat vegetation and non-vegetated areas; being those areas that satisfy the requirements of Clause 2.2.3.2 of AS3959-2009. The proposed development is able to achieve an acceptable level of protection from bushfire which can be achieved through a combination of strategies. In this instance the design of the proposed building will be constructed using non-combustible materials; including a combination of masonry, glass and metal. In addition to the materials used in the construction, all internal areas and the external balconies will be protected by a sprinkler system. The sprinkler system will protect each individual unit from the risk of damage from a fire and prevent the spread of a fire to other parts of the building.
In relation to access requirements • Safe operational access is provided (and maintained) for emergency services personnel in suppressing bushfire while residents are seeking to relocate, in advance of a bushfire (satisfying the intent and performance criteria for access roads in sections 4.1.3 and 4.2.7).	Compliance with section 4.1.3 for property access roads. Compliance with section 4.2.7 for access standards for internal roads.	✓	All roads are all-weather, sealed roads allowing safe and direct access for fire fighting vehicles to all lots.
In relation to water and utility services: • Adequate water and electricity services are provided for firefighting operations; and • Gas and electricity services are located so as not to contribute to the risk of fire to a building.	Compliance with section 4.1.3 for services – water, electricity and gas.	✓	All services will be provided in accordance with the relevant standards and codes; including section 4.1.3 of PBP 2006.

In relation to landscaping: • It is designed and managed to minimise flame contact and radiant heat to buildings, and the potential for wind driven embers to cause ignitions.	Compliance with Appendix 5.	✓ Able to comply	