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RALSTON AVE_BELROSE CONCEPT PLAN REPORT

Prepared for Matthews Civil Pty Ltd
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HASSELL

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Front cover image: HASSELL Lakeway In-Drive Redevelopment, Claremont, Western Australia_Photographed Peter Bennetts

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Contents

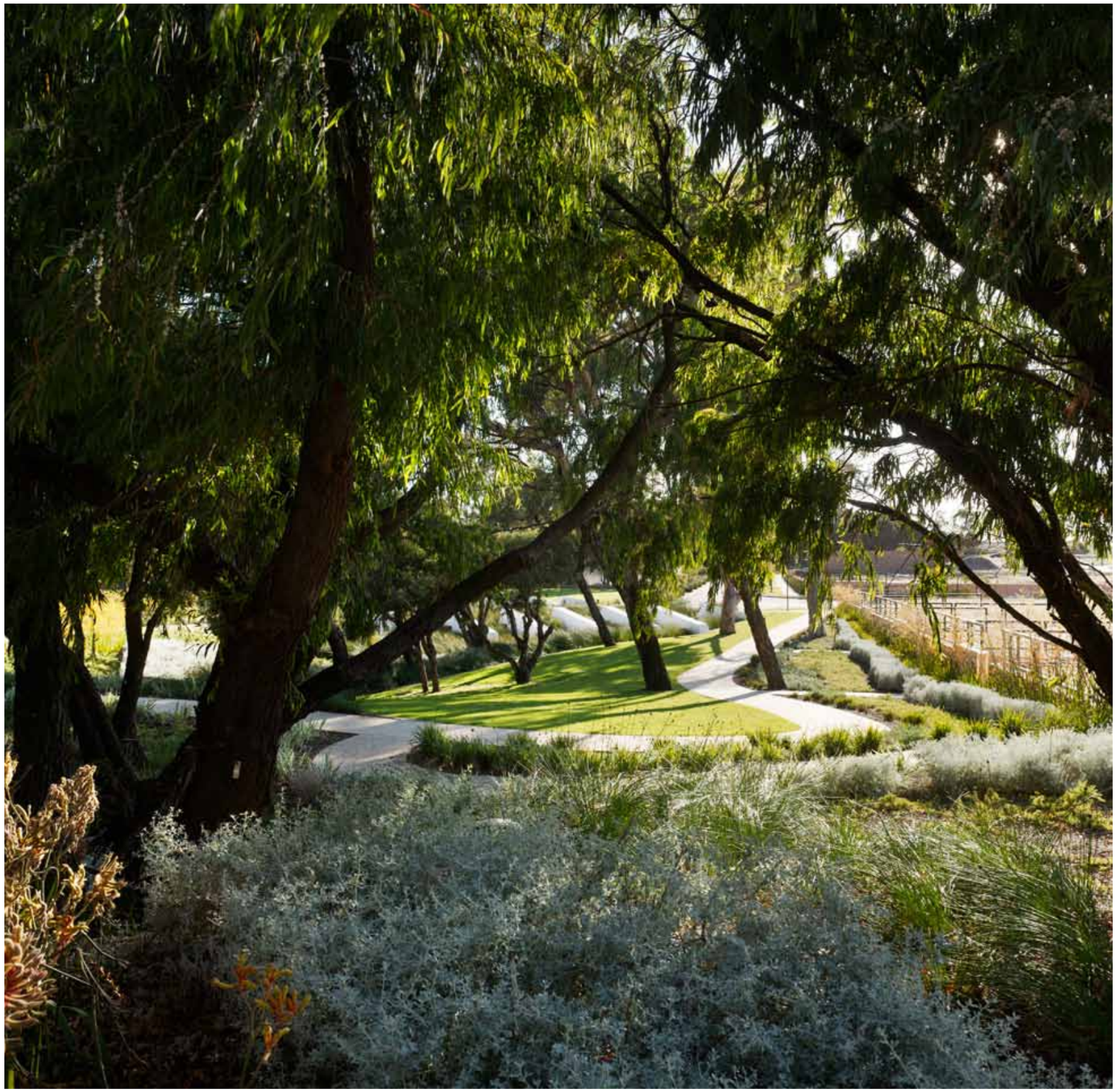
To undertake a benchmark residential project, working in a collaborative partnership to achieve a high quality land development, incorporating excellence in design, open space treatments, landscaping and construction.

The process of review and analysis has involved a series of planning and design options for potential lot layouts and lot size scenarios. Through a process of consultation and environmental analysis, a concept master plan has been developed that includes the following key features:
_Mix of residential densities to suit topography, location and visual context
_Pedestrian / Cycle links
_Public access to bushland
_Sympathetic development appropriate to its visual setting
_Managed bushland edges and adjoining lands

The language of the site and its natural setting, is clearly one of bushland and typical Sydney northern beaches sandstone character. This is a fundamental asset and one that has very eagerly been recognised by the project team as a core design driver for the future project outcome.

The design team and project client have, from this site appreciation, defined the following as the fundamental project design drivers:
_To work with the bushland feel
_To embrace the natural character
_To preserve trees and native vegetation
_To incorporate the setting as the underpinning language of future works
_To reinforce the existing connections to residential housing, walking trails and bush
_To use timber, sandstone, gravels and Australian bushland colours in the materiality of the project
_To celebrate views from the site
_To be sensitive regards views to the site
_To ensure optimum lot orientation
_To provide lot sizes most appropriate to families

This report aims to communicate the processes and outcomes for the design work that has been undertaken for the public open space and streetscapes at the Ralston Avenue Belrose site and aims to reinforce the project vision and underpin the above noted design approach.



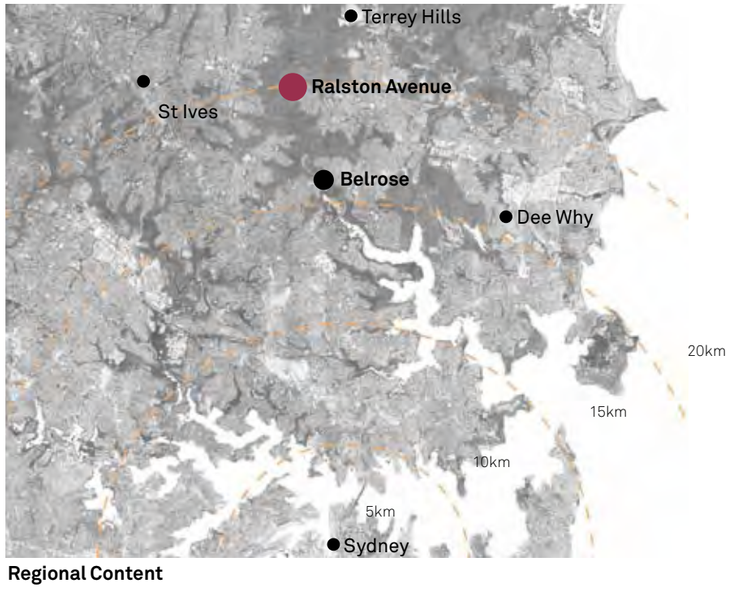
HASSELL Lakeway In-Drive Redevelopment, Claremont, Western Australia_Photographed Peter Bennetts

02____Context

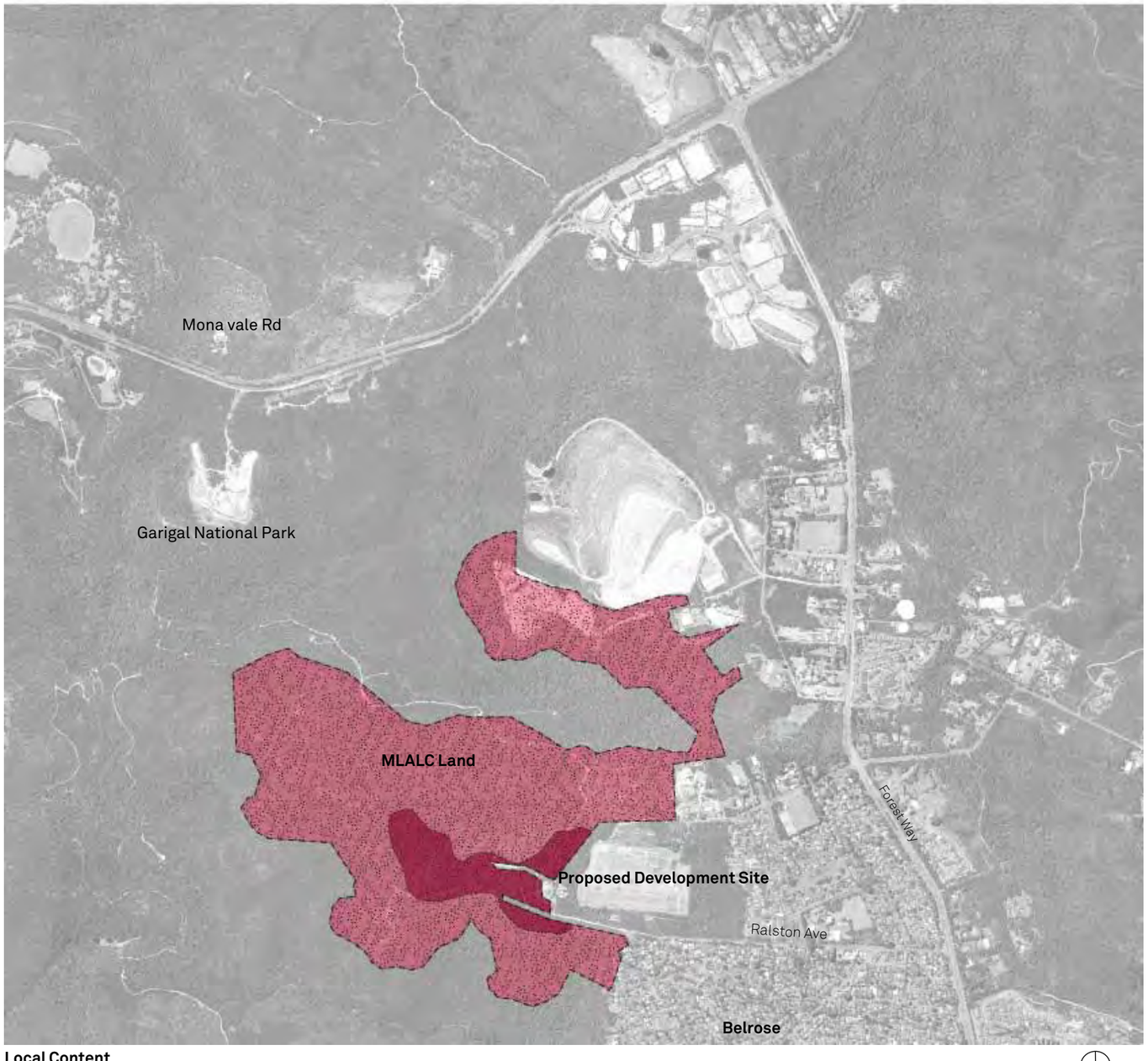
Site
_Lot 1 of DP1139826, Ralston Avenue Belrose

Design Approach
The design team and project client are agreed that the land is to be developed in a manner which:
_Creates a “landmark” flagship development in environmental terms
_Provides a quality development that cares for the environment and the community
_Utilises the land efficiently for its most productive use
_Enhances and connects with the environment
_Is commercially viable and responds to the market
_Is in accordance with accepted standards of development and environmental responsibility
_Achieves ecologically sustainable development
_Provides, where reasonably practicable, job opportunities for members of the Metropolitan Local Aboriginal Land Council (MLALC) in respect of the Project
_Maximises the commercial potential of the land and returns to the land owners
_Builds capacity for MLALC through knowledge sharing

The design development process included the following design considerations;
_Create a strong sense of place in prestigious new land estate
_Have appropriate regard for the natural setting and proximity to the adjoining bushland of Garigal National Park
_Create suburban housing lots in a bush landscape context
_Utilise existing road and other infrastructure to support new housing lots
_Lot design and orientation to capture district views and solar access
_Provide future and surrounding community with access to and through the site connecting to existing bushland walking trails



Regional Content



Local Content

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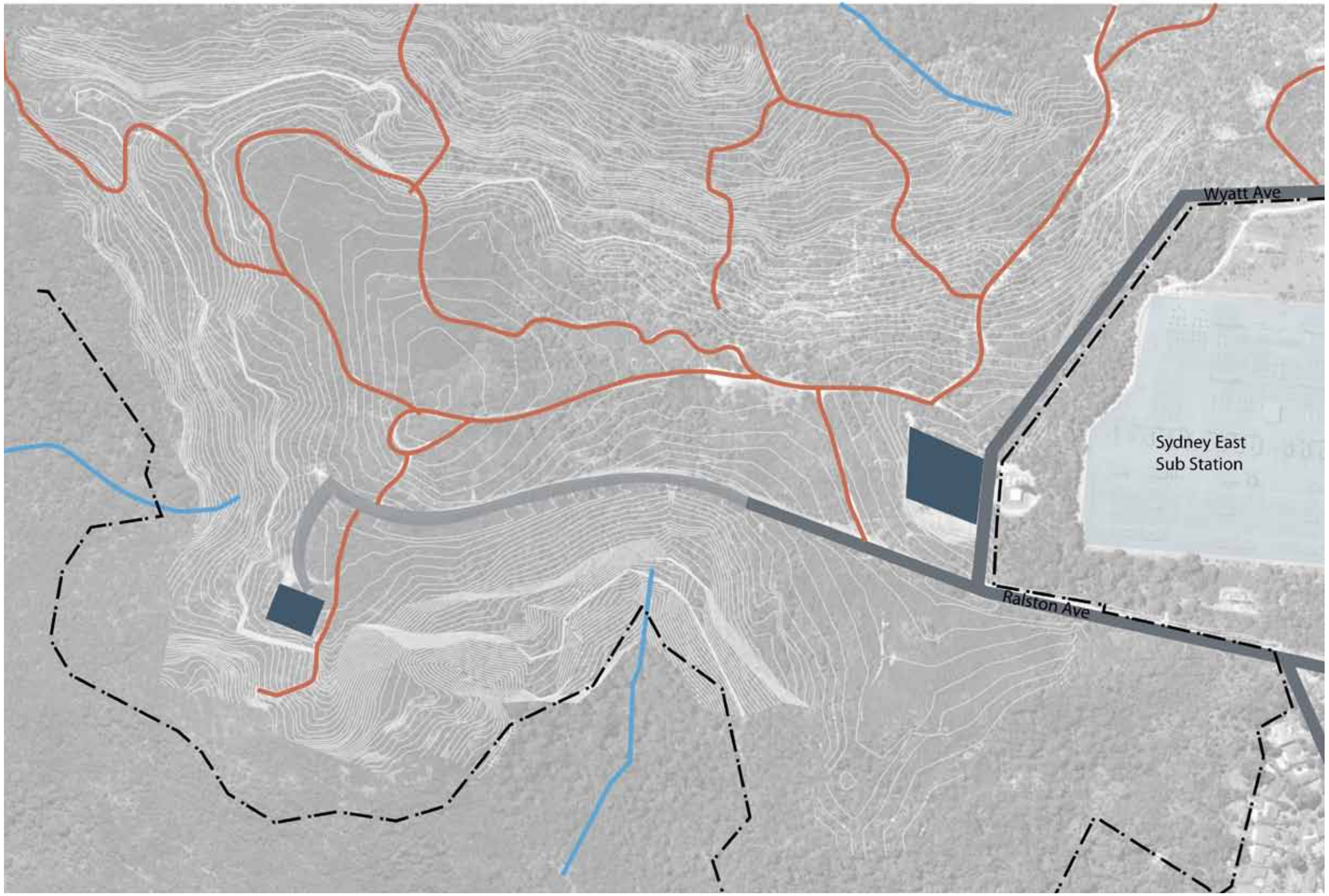


Legend

- _ Existing Southern Road
- _Road Reserve
- _Sydney East Sub Station
- _Private Property
- _Existing Walking trail
- _Watercourse
- _MLALC Boundary

Existing Site Conditions

03____Site Assessment

Ecological Context
To establish a site specific vernacular for the Ralston Avenue Belrose site it has been important to find the authentic relationship between its existing character, quality and that of its future intended use. The vernacular derived at is one that layers the many natural and cultural influences that have formed the site specific character and allows for both its retention and embellishment as key assets to the future site users.

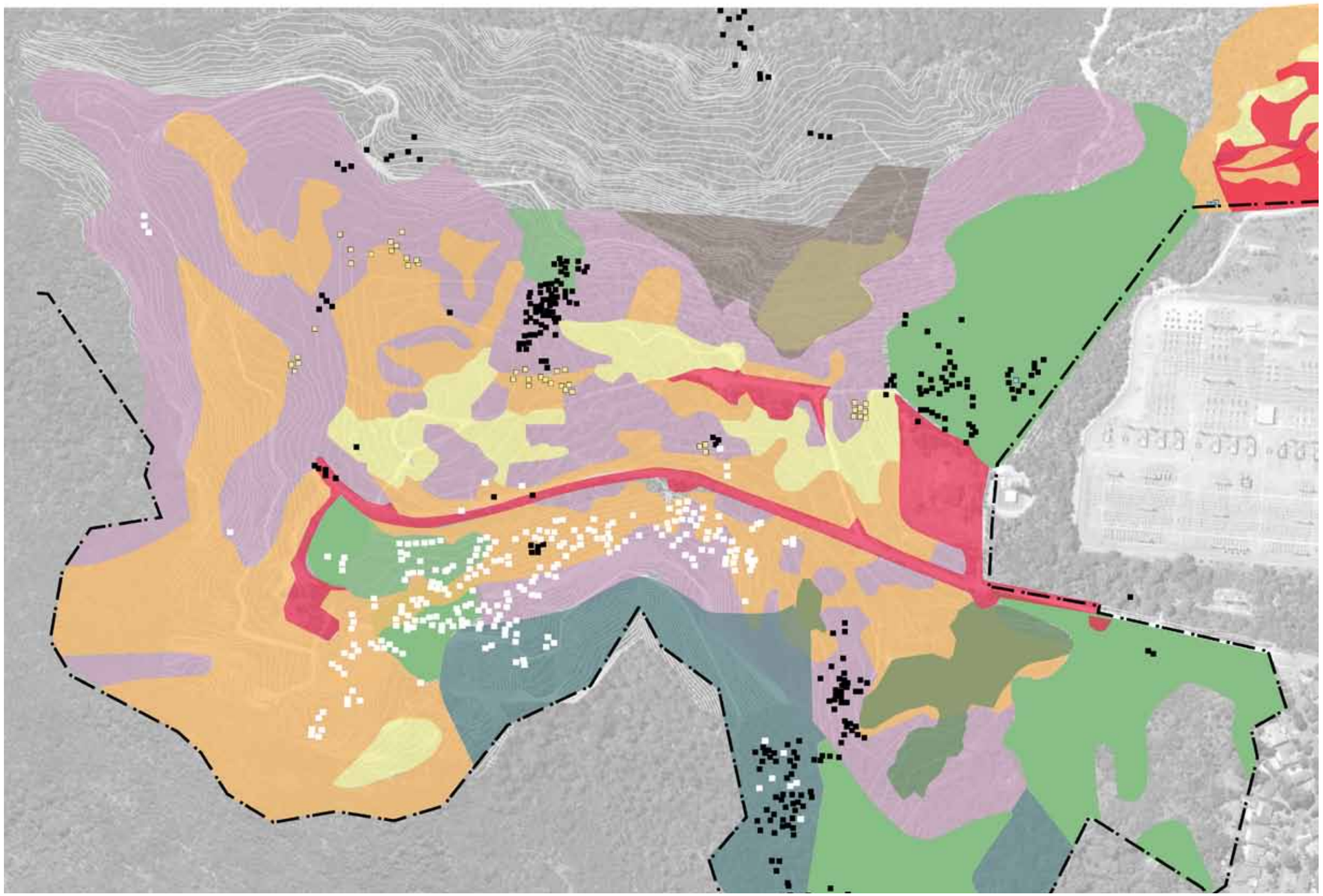
Objectives:
_To provide ecological connectivity, function and biodiversity
_To acknowledge vegetation communities remnant to the site and its greater context
_To establish planting schedules that are representative of an appropriate selection of existing vegetation communities
_To reference remnant ecologies in the formation of landscape characters
_To procure local provenance plant material
_To reference contextual drainage patterns with site Water Sensitive Urban Design (WSUD) initiatives
_To establish monitoring and maintenance initiatives that support establishing ecologies

A detailed site analysis has been undertaken to provide constraints mapping based on both physical characteristics and statutory requirements and are represented on the following analysis diagrams:
_Site Conditions
_Overland Flow
_Remnant Vegetation
_APZs and EEC's
_Land Use
_Access and Circulation
_Open Space
_Slope and Aspect
_Primary Views

It is from this analysis that the concept master plan has been informed and from which it has evolved.

Flora and Fauna Analysis

The flora and fauna analysis reflects the existing flora and fauna on the proposed development land, as provided by specialist consultants Travers, Bushfire and Ecology.



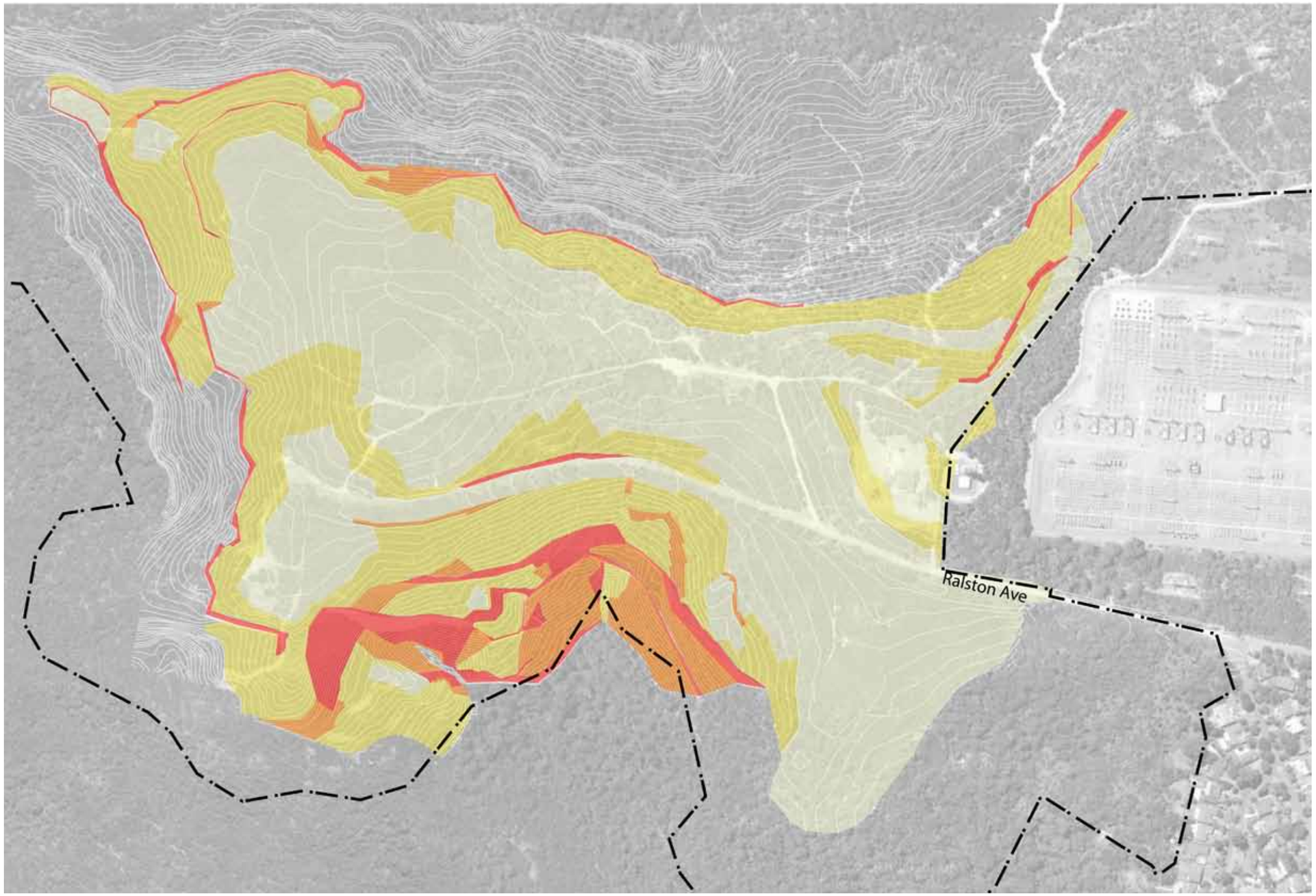
Flora and Fauna Analysis

Data as provided by Travers Environmental, Bush Fire and Ecology (14-11-12)

03____Site Assessment

Slope Analysis

The slope analysis assessment reveals the gradients across the proposed development land, and highlights zones of high and low degree slopes.



Legend

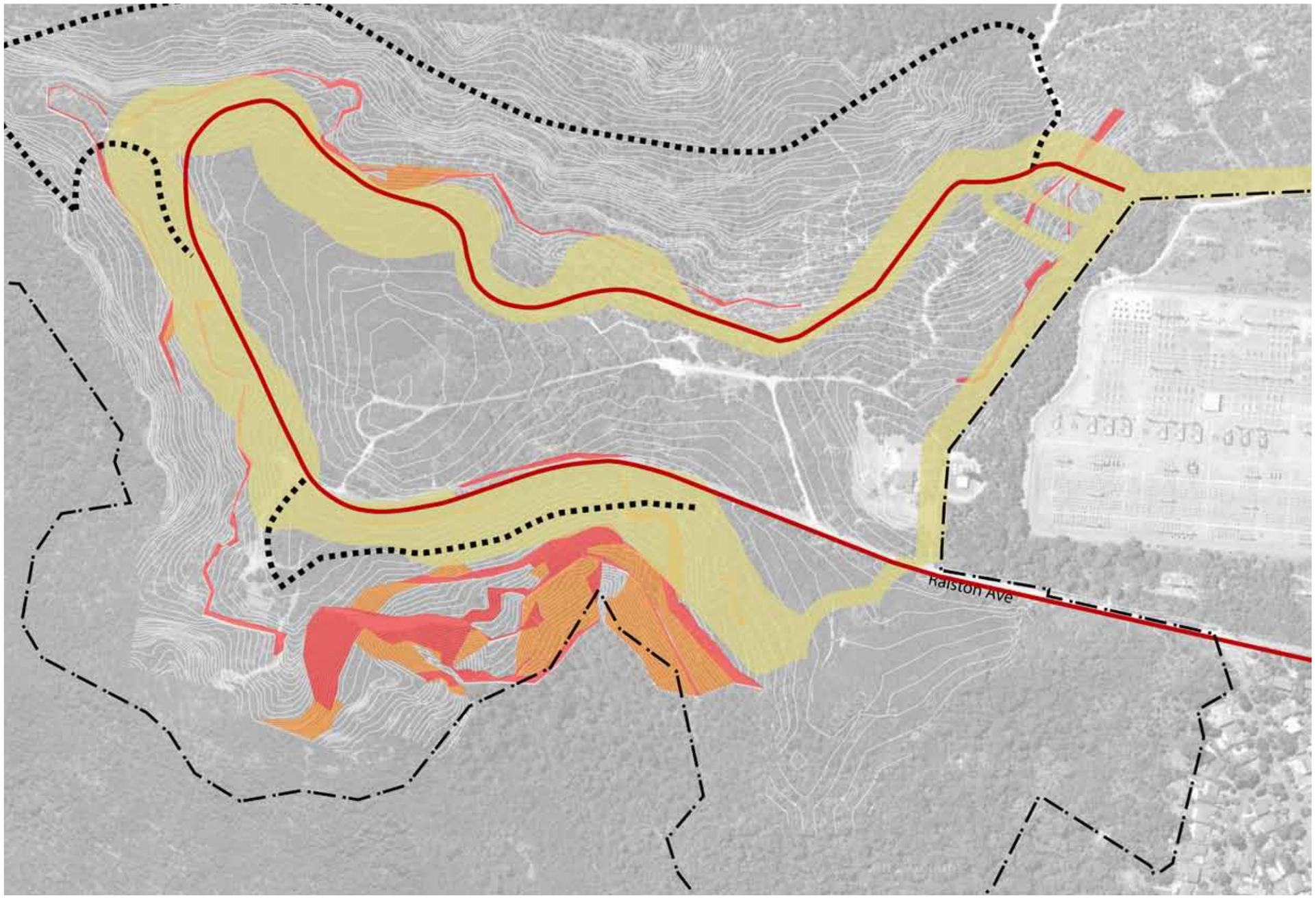
- _0-5 degree slope
- _5-17 degree slope
- _18-24 degree slope
- _25 degree slope and over
- _MLALC Boundary

Slope Analysis

Data as provided by Travers Environmental, Bush Fire and Ecology (14-11-12)

Bush Fire Analysis

The bush fire analysis reflects not only the anticipated fire trails (both on and off road) but importantly the areas of proposed Asset Protection regards possible bush fire threat.



Legend

- _Practical Assets Protection Zone
- _Firetrail (on-road)
- _Firetrail (partial off-road)
- _18-24 degree slope
- _25 degree slope and over
- _MLALC Boundary

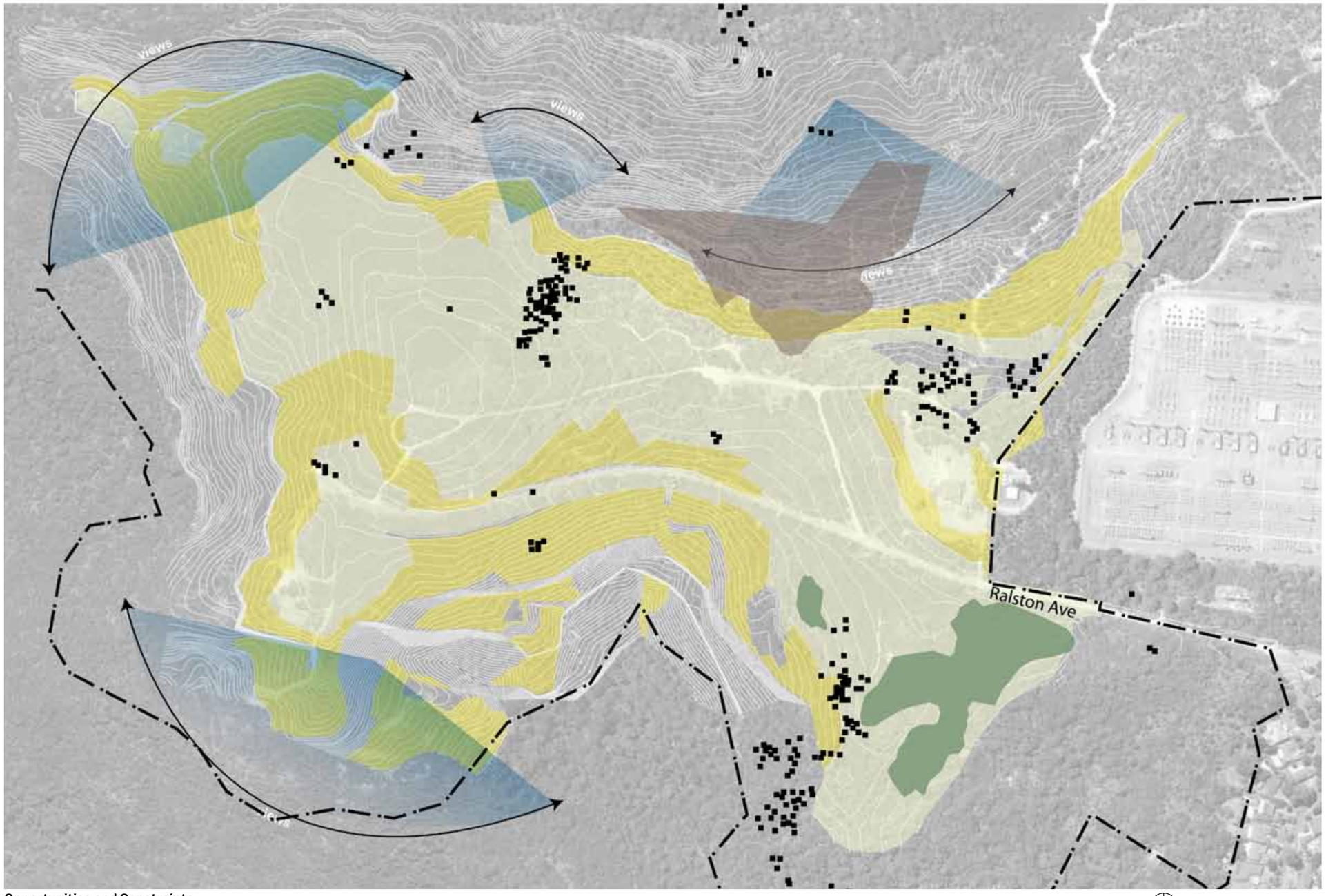
Bush Fire Analysis

Data as provided by Travers Environmental, Bush Fire and Ecology (14-11-12)

03____Site Assessment

Opportunities and Constraints

The opportunities and constraints plan is a composite plan that highlights the key site opportunities and environmental assets that have been integral to defining the projects design direction.



Legend

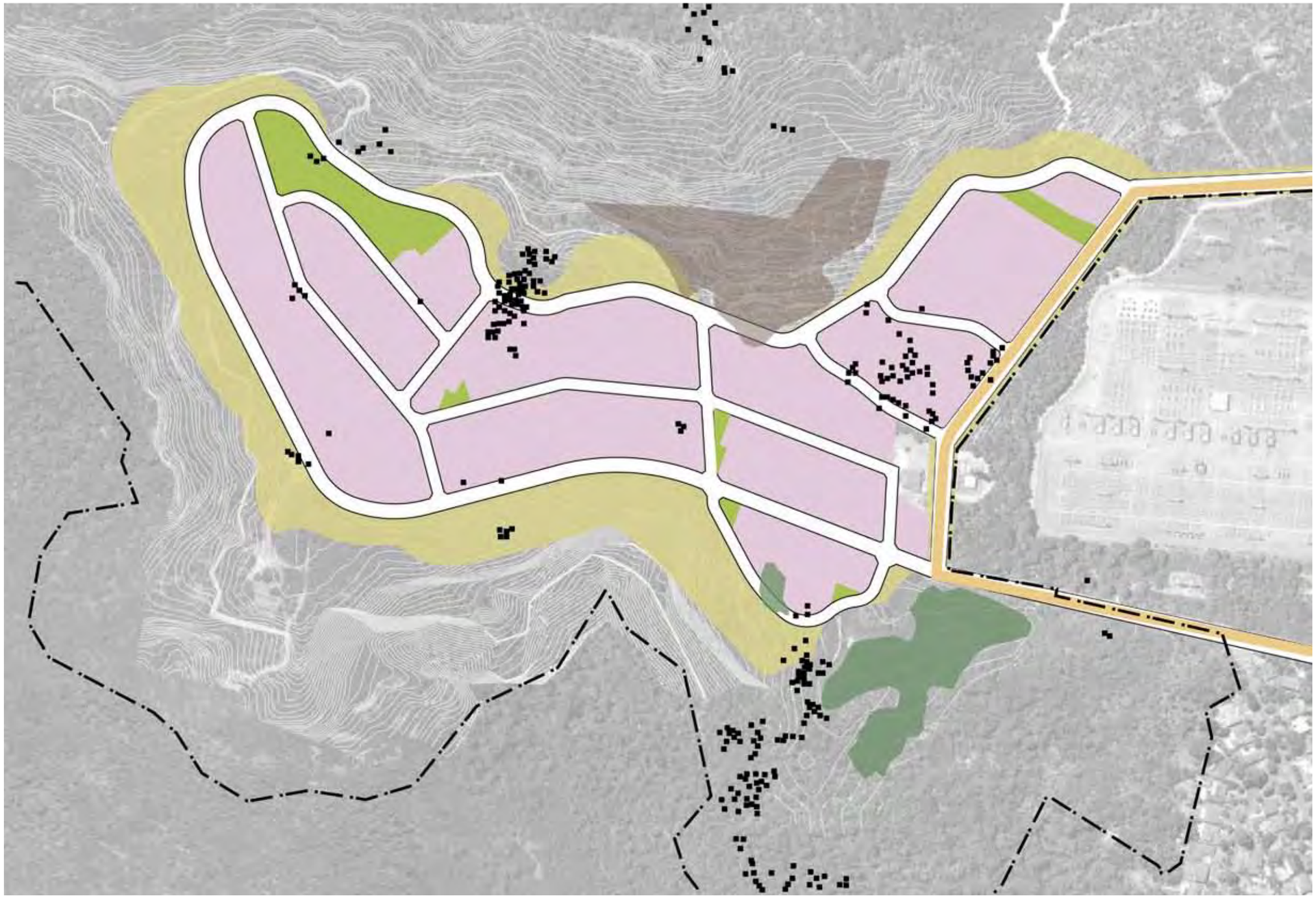
- _Coastal Upland Swamp (EEC)
- _Red Crowned Toadlet Habitat
- _Angophera crassifolia
- _Major Slopes
- _Minor Slopes
- _Views
- _MLALC Boundary

Opportunities and Constraints

Data input provided by Travers Environmental, Bush Fire and Ecology (15-03-12)

Proposed Site Usage

Layering each of the previous site assessment plans upon each other reveals a fundamental composite plan that allows the proposed development land to be laid out in such a way as to preserve and work with the sites natural assets and geographical constraints.



Legend

- _Managed Open Space Pocket Parks and Bushland Parks
- _Main roads
- _Minor roads
- _ Residential Land
- _Coastal Upland Swamp (EEC)
- _Road Crowned Toadlet Habitat
- _Angophera crassifolia
- _Asset Protection Zone
- _MLALC Boundary

Proposed Site Usage

The landscape concept is to establish a site specific vernacular by finding the authentic relationship between the sites existing character and quality and its future intended use, and layering these together to form a unique site specific story.

Objectives
The unifying design philosophy for the site will be that of unique environmental fit. This approach seeks to satisfy the requirements of both the amenity and ecological values of the site and to provide a balanced integration with the built form.

The primary objective of the landscape design for the site is to realise a holistic site responsive design outcome. The landscape outcome must meld the planning opportunities & constraints, the potential visual impacts and any required mitigations to achieve an integrated landscape based solution.

Landscape Interpretation
The presence of natural bushland and the backdrop as viewed towards St Ives and East Killara dominate the site's character. The broad flat expanse across the majority of the site juxtapose with the steep edges to the south, west and north. While very few mature trees currently exist there are isolated specimens and pockets of vegetation that are impressive and provide for a unique experience.

Desired Landscape Experience
The site has strong diversity in landform, district views and vistas and elevation that provide a great opportunity for the integration of residential development while still being able to maintain the existing landscape experience.

Achieving this desired landscape experience will involve;
_Enhancement and management of the endangered ecological community (EEC)
_Providing strong connectivity throughout the site with the public open space system and pedestrian/ cycle network
_Engagement and management of the bushland edge
_Appropriate built form guidelines for housing lots
_Subtle planting of the ridge lines to mitigate any effect of new housing on visually prominent areas

The experienced landscape is a manifestation of a number of constituent parts all of which are interrelated. The quality design and well considered integration of these parts in the context of the existing landscape is the key to project success. To that end the ultimate design needs to be a fused solution that balances the tangibles of architecture, infrastructure, open space and planning with community expectation and input. The collaborative establishment of the principles for the 'tangible' elements within the landscape will in turn allow for the 'intangible 'elements of social capital and environmental stewardship to flourish. As per the project vision, this land development aims to achieve an 'integrated landscape based' solution to the design through;
_Enhancing and making efficient use of open space for recreational and/or ecological function
_Strengthening the visual character of the site by positively contributing to the public domain
_Responding to a variety of cultural requirements in terms of use and aesthetics
_Adopting current design ideas, principles and materials
_Providing easily accessible and safe open space
_Ensuring high levels of natural surveillance of open space
_Ensuring easy accessibility by emergency service and fire vehicles
_Providing a sense of arrival to the key site entry points
_Providing safe functional linkages along streets and in parks between places of activity
_Creating linkages between open spaces along the streets inside the site and into surrounding areas by a clear street tree planting strategy
_Creating a legible and functional road network that provides good connections with the surrounding areas
_Providing appropriately located and adequately sized safe open spaces and facilities that support a range of both active and passive uses
_Salvaging, stockpiling and re-using material from demolished land to minimise landfill
_Enhancing the sustainability of the development by minimising water usage, contributing to biodiversity and enhancing passive energy systems
_Providing for water re-use on existing and future open space
_Establishing ecological connectivity through establishment of terrestrial habitat
_Creating a sense of ownership over the public domain and encourage passive surveillance to create community guardianship
_Ensuring landscaping has regard to the future functions of the area through improvement in the quality and maintainability of the open space assets

01_ Distributor Road
02_ Perimeter Road
03_ Local Road
04_ Native Street trees
05_ Lot Boundaries
06_ Pocket Park
07_ Bushland Park
08_ Walking Trail

0 20 40 80m

Revision	Date	Scale	Client	Project Name	Drawing
Concept Master Plan	31 August 2012	1:2000@A3	Matthews Civil pt ltd	Ralston Ave Belrose,NSW	01

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04____Landscape Concept

Landscape Hardwork Materiality

Objectives

To ensure that all nominated landscape materials are complimentary of the site context and are robust and easily maintained.

Each element with the landscape, be it built form, infrastructure and the space between, needs to be designed in a way that considers the other and the unique environmental and cultural story of the site. These include:

_Water Sensitive Urban Design (WSUD) and the Integrated Water Cycle Management
_Existing vegetation, its protection, management and educational opportunities
_Landscape Regeneration & Revegetation of areas of open space and drainage corridors
_Site Roads, access connection and adaptation to site constraints and opportunities
_Site Access & Movement for pedestrians / cyclists
_Public Open Space Integration, understanding intensity of uses and hierarchy
_Private Open Space & Integration with Public Open Space and the associated edge conditions
_Built Form & Integration into topography & aspect
_Landscape Materiality

Design Considerations

Fundamental principles regards the selection of landscape materials are that they should:

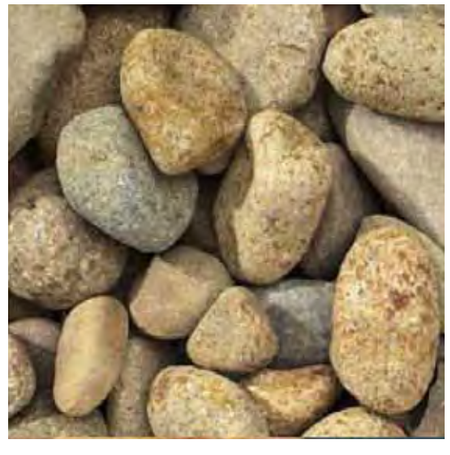
_Respond to the bushland environment
_Always be used in a combination of two – timber/ steel, concrete/ steel, timber/stone or stone/ steel
_Relate to the human scale
_Materials – Hardwood timbers, site timbers, galvanized steel, stainless steel aluminium/ crushed gravels / exposed concrete with local aggregate and local stone
_Be of colours derived from the local site character
_Be climate responsive
_Integration in both colour and material between built form and landscape elements
_Integrate with vegetation and built form
_Have a low impact on environment











Landscape Softwork Materiality

Objectives

_To establish a vegetation structure to the site that promotes reduction in the 'urban heat island effect' and creates comfortable micro-climates
_To create an aesthetically pleasing environment and strengthen visual character of the estate
_To enhance the vegetation communities endemic to the site
_To promote a sense of hierarchy and identity in streets
_To provide ecological connectivity, function and biodiversity
_To promote plantings of cultural relevance to the varied language groups
_To form linkages through the use of 'ribbon' plantings
_To utilise passive irrigation where possible
_To maximise tree planting opportunities and maintain Belrose as a 'green and leafy' suburb

Design Considerations

_Use appropriately sized trees to meet scale requirements of each street
_Street tree plantings to be coordinated with underground services, lighting, traffic plan and driveway crossovers
_Retain existing trees where possible as part of streetscape planting
_Coordinate tree spacing and location with private lot tree planting to avoid large gaps between canopies
_Link open spaces and community meeting points with 'ribbon' planting to form an estate wide orientation and place making identity
_Use deciduous species to provide winter solar access to lots as necessary
_Street trees shall be planted on both sides of all streets except Access place
_Locate 'cultural plantings' in formal groupings or strategic locations as feature trees to provide cultural interest and a sense of place
_Adopt a copsing approach to street tree planting except at entries. Copsing of trees shall be no closer than 1m apart and no further than 15m apart. Group in ones, twos and threes only.
_Only use formally spaced alley planting to designated entry points to Belrose, and along park edges as indicated
_Use nominated species as shown in species list and to areas located in the street tree master plan
_Street trees located in rain gardens to obtain passive irrigation from stormwater runoff
_Apply a combination of planting strategies including natural regeneration, forward planting, revegetation of disturbed areas and advanced tree planting to streets and entries
_Community and local landcare/ bushcare with revegetation and management of open space and endangered ecological communities
_Expansion of potential habitat corridors

Maintenance and Management

_Provide a clear strategy for the establishment and on going management of various landscape zones in order to ensure both an ecologically productive and high quality landscape finish in perpetuity
_Establish landscapes that are readily maintainable, provide high quality aesthetic amenity and recreational / interpretive facilities
_Provide low maintenance landscape areas capable of enduring periods of minimal maintenance and anti-social behaviour
_Design and implement formal WSUD infrastructure components to perform a variety of functions including stormwater treatment and detention and erosion and sediment control
_Restore and enhance bushland and riparian environments using local provenance seed to increase habitat and biodiversity as well as enhance aesthetic and recreational amenity
_Plan and maintain a diversity of recreational opportunities including quality, multi-use public open space facilities that meet community expectations
_Design quality streetscape environments that encourage street activity, promote transitional spaces between the private and public domain and improve visual amenity by retaining and increasing streetscape vegetation
_Ensure the design and management of landscape zones considers local environmental constraints, water use minimisation, management of stormwater processes, social equity and economic viability

Indicative Species

Trees

_*Angophora costata* / Smooth-Barked Apple
_*Corymbia gummifera* / Red Bloodwood
_*Eucalyptus haemastoma* / Scribbly Gum
_*Eucalyptus punctata* / Grey Gum

Shrubs and Groundcovers

_*Acacia myrtifolia* / Red Stem Wattle
_*Banksia ericifolia* var. *ericifolia* / Heath-leaved Banksia
_*Banksia spinulosa* / Hairpin Banksia
_*Dianella caerula* var. *caerula* / Flax Lily
_*Dianella caerula* var. *producta* / Blue Flax Lily
_*Hakea dactyloides* / Broad-leaved Hakea
_*Imperata cylindrica* var. *major* / Blady Grass
_*Juncus usitatus* / Common Rush
_*Leptospermum laterale* / Variable Sword-sedge
_*Lomandra longifolia* / Spiky-headed Mat-Rush
_*Microlaena stipoides* var. *stipoides* / Weeping Rice Grass
_*Persoonia lanceolata* / Lance-leaved Geebung
_*Themeda australis* / Kangaroo Grass
_*Xanthorrhoea media* subsp. *media* / Forest Grass Tree


Angophora costata


Corymbia gummifera


Eucalyptus haemastoma


Banksia spinulosa


Themeda australis


Persoonia lanceolata

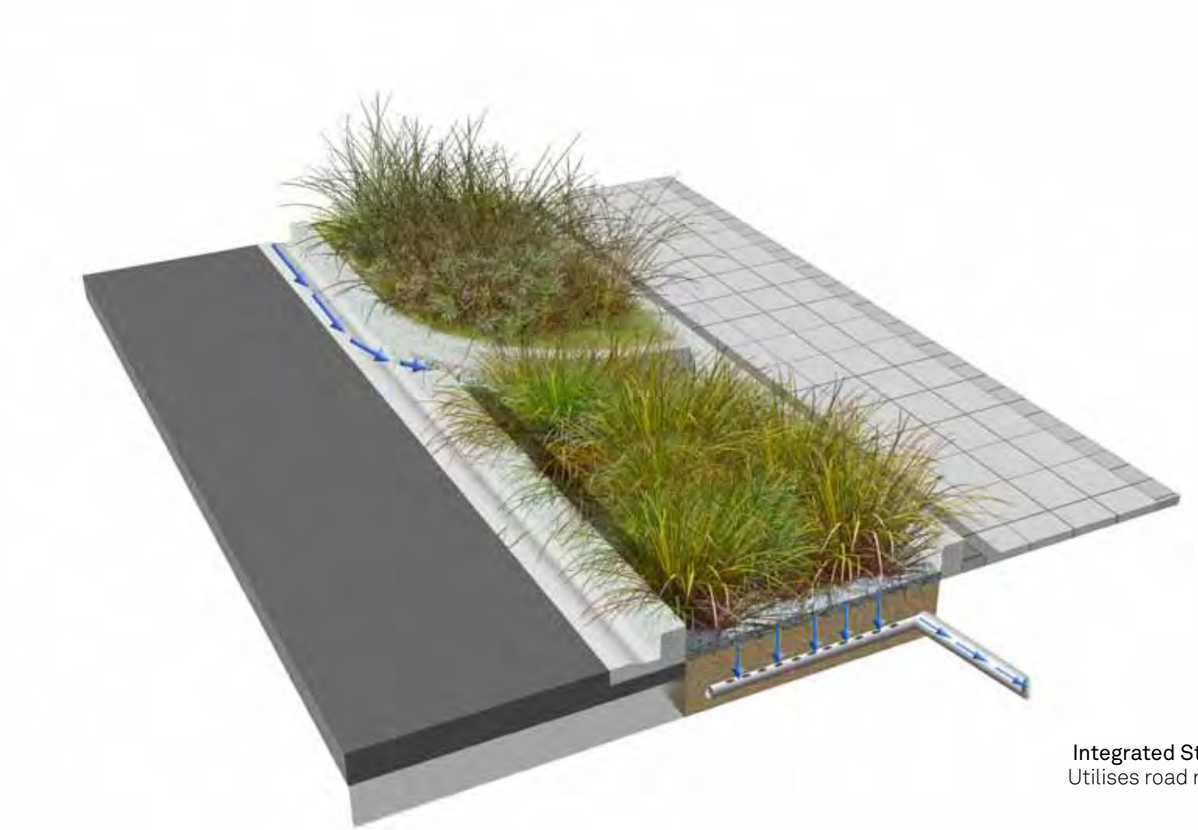

Microlaena stipoides var. *stipoides*


Xanthorrhoea media subsp. *media*

05____Integrated Water Cycle Management

Objectives
The fundamental approach to stormwater management across the site is one of integrated water management. A holistic approach that allows for maximised public access, increased natural vegetation across the site, improved visual amenity and enhanced water quality.

Design Considerations
_Adopting passive irrigation where possible for vegetation, particularly street trees
_Pipe drains through a detention basins prior to discharge to bushland
_Piped outlets to discharge above ground to rain gardens or linear vegetated swale
_On-site detention to limit discharges to the adjoining bushland
_All street kerb lines on parks are to be broken to allow infiltration into planted buffer zones
_Rain gardens and vegetated swales to provide bio-retention
_All stormwater collected from the estate is expressed above ground in a new vegetated swale
_Establishing the ‘treatment train’ – swales & buffer strips, bio–retention swales, sedimentation basins and wetlands to ponds

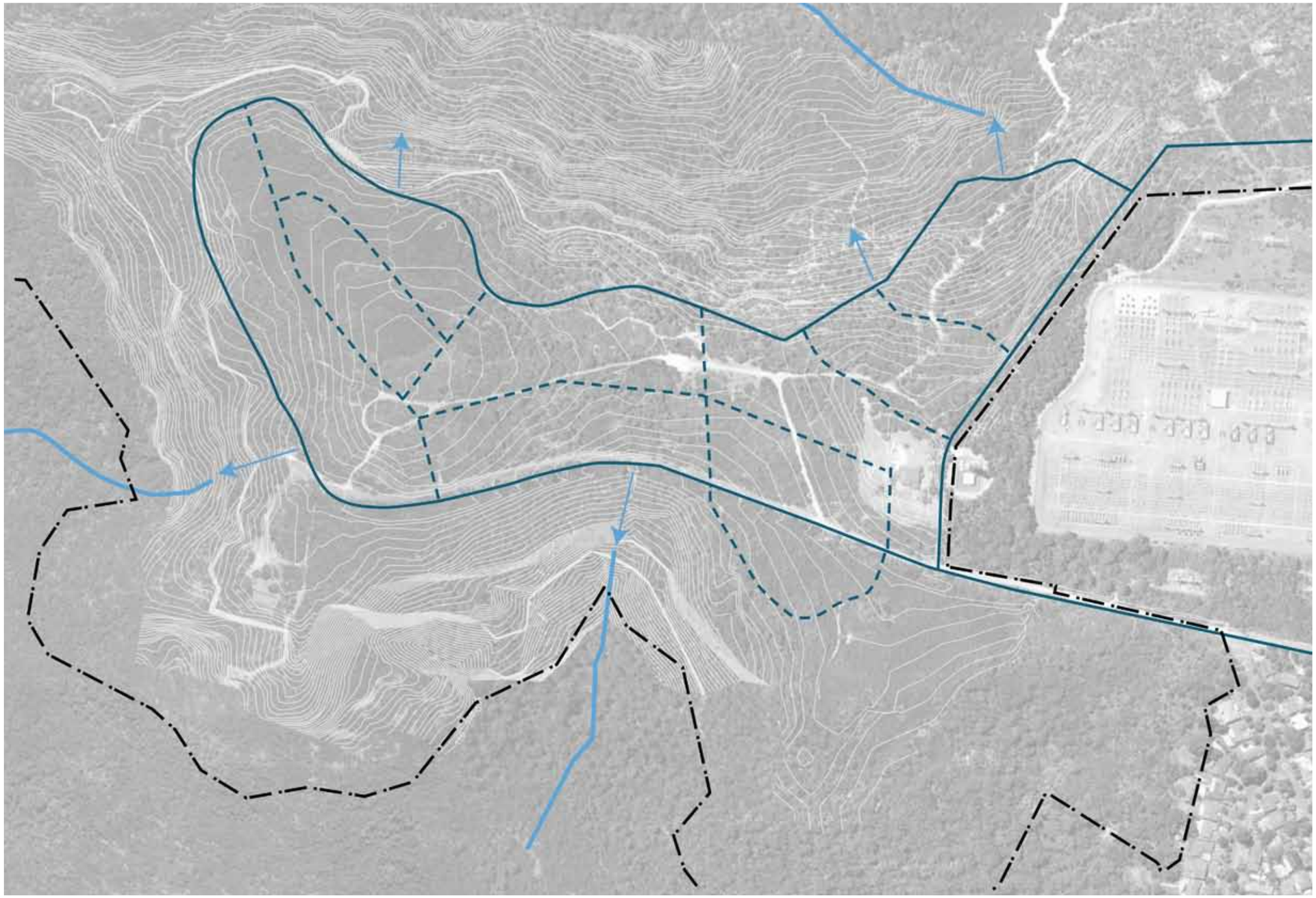


Integrated Storm Water Management
Utilises road runoff to naturally irrigate planted street verges

Examples of success native plantings to street edges, irrigated through road runoff

05____Integrated Water Cycle Management

The integrated water cycle plan denotes the proposed stormwater management approach and notional site discharge points.



Legend

- _Kerb and Gutter
- _Pervious pavement
- _Stormwater Outlet
- _Watercourses
- _MLALC Boundary

06____Open Space

Parks

The character of the proposed site is one of bushland, nature, openness and varying degrees of spatial outlook and intimacy. It is critical therefore that the concept plan provide varying types of open space for the community to engage with these qualities across the site.

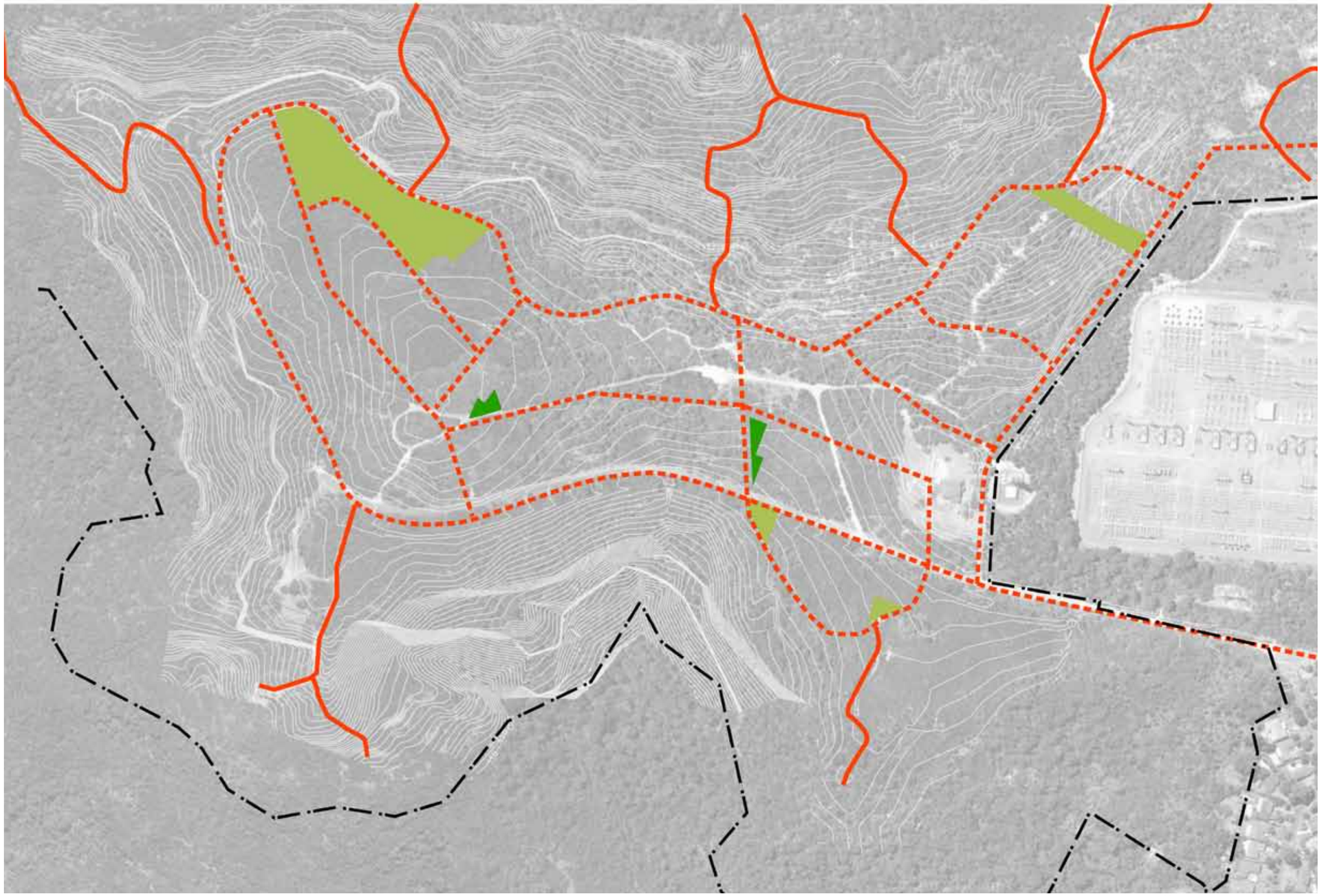
Within the concept plan it is proposed that this is achieved through;
_Bushland parks
_Pocket parks
_Entry precinct
_Pedestrian network
_Walking trails

Objectives
_To create safe public open spaces, with high levels of passive surveillance
_To build upon and review existing qualities of each park setting and provide a balance of varying uses across the estate
_To provide passive green space to enhance the aesthetics of the estate and contribute to memorable and enjoyable experiences
_To provide a variety of recreational and sporting opportunities in close proximity to all residents
_To enhance ecological function of the estate through provision of native fauna habitat
_To provide spaces for community expression and engagement
_To create a distinctive identity for the estate
_To build pedestrical networks into and across park's bicycle and pedestrian paths
_To retain existing trees where possible with the location of parks and design
_To create environmental micro climates for the comfort of residents
_To name parks in consultation with the Community

Design Considerations
_Create visual rewards through location of amenities in highly visible locations to enhance visual character, identity, surveillance and to limit vandalism
_Utilise open space for integrated stormwater management incorporating water sensitive urban design principles
_Visibility across parks should be maintained with limited inclusions of shrub planting or other objects that inhibit site lines
_Pedestrian paths to be located on desired lines as indicated
_Provide shade trees and structures to seating and play areas
_Provide detail grading and retaining systems to allow for levels associated with existing trees to be retained
_All lighting to conform to relevant Australian standards
_Trees are to be planted in mulched garden beds where possible and are to be selected with a clear trunk to 2m
_Seed stock is to be sourced locally and used for generation of all plant material
_Balance and maintaining ecological values with public usage requirements
_Establish the hierarchy of open space types
_Activities within the parks are to provide both passive and active recreation
_Ensure a consistent and balanced use of materials and vegetation types
_Consider and balance with the RFS requirements

06____Open Space

The open space plan aims to define the entry precincts, and varied open space treatments, and including various means of pedestrian access through and adjacent to the site.



Legend

- _Pocket park
- _Bushland Park
- _Walking trail
- _Pedestrian network
- _MLALC Boundary

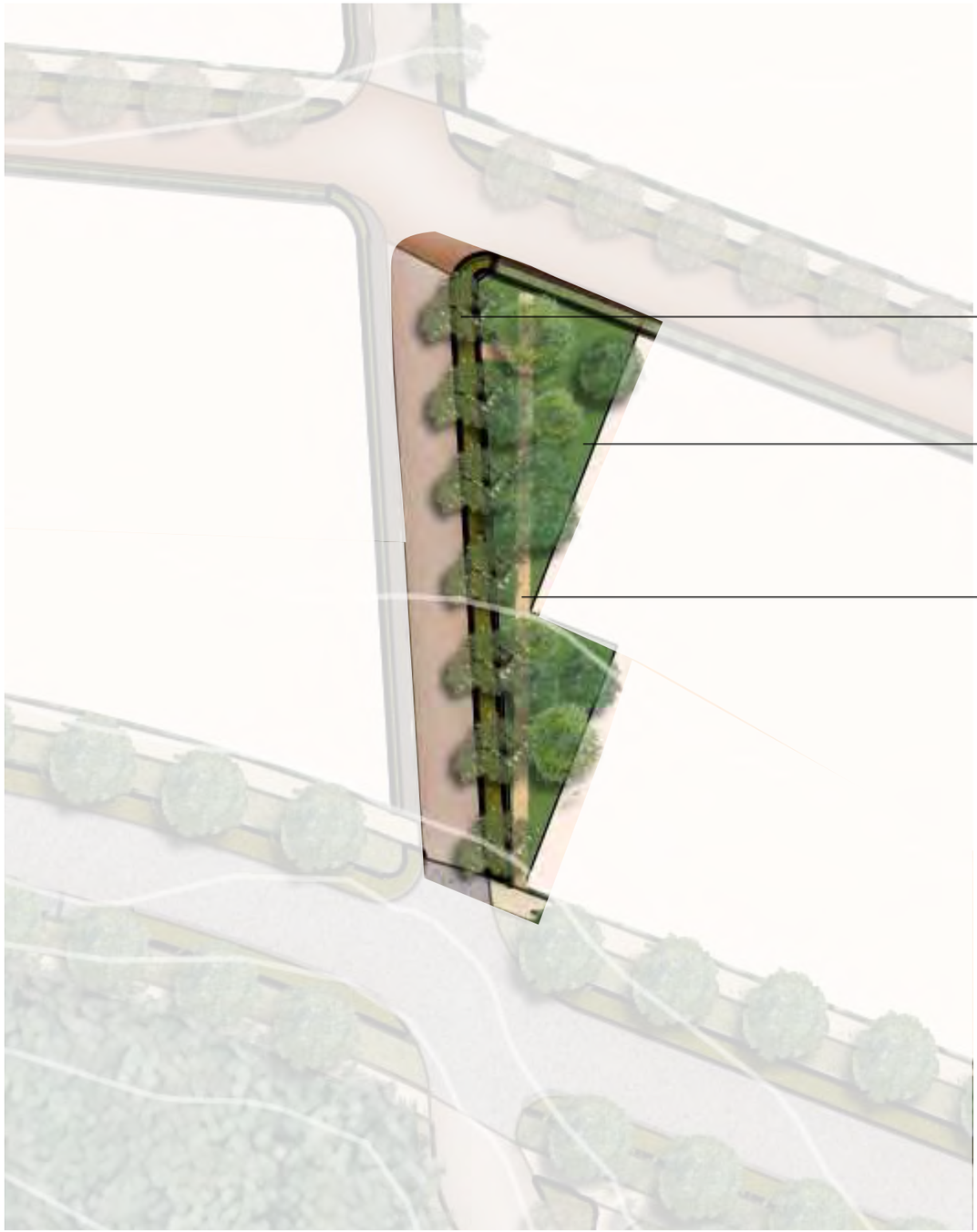
06____Open Space

Pocket Park

Critical to the successful open space program across the site is to ensure public accessibility and engagement, and that the uses are varied and provide for a diverse range of activity.

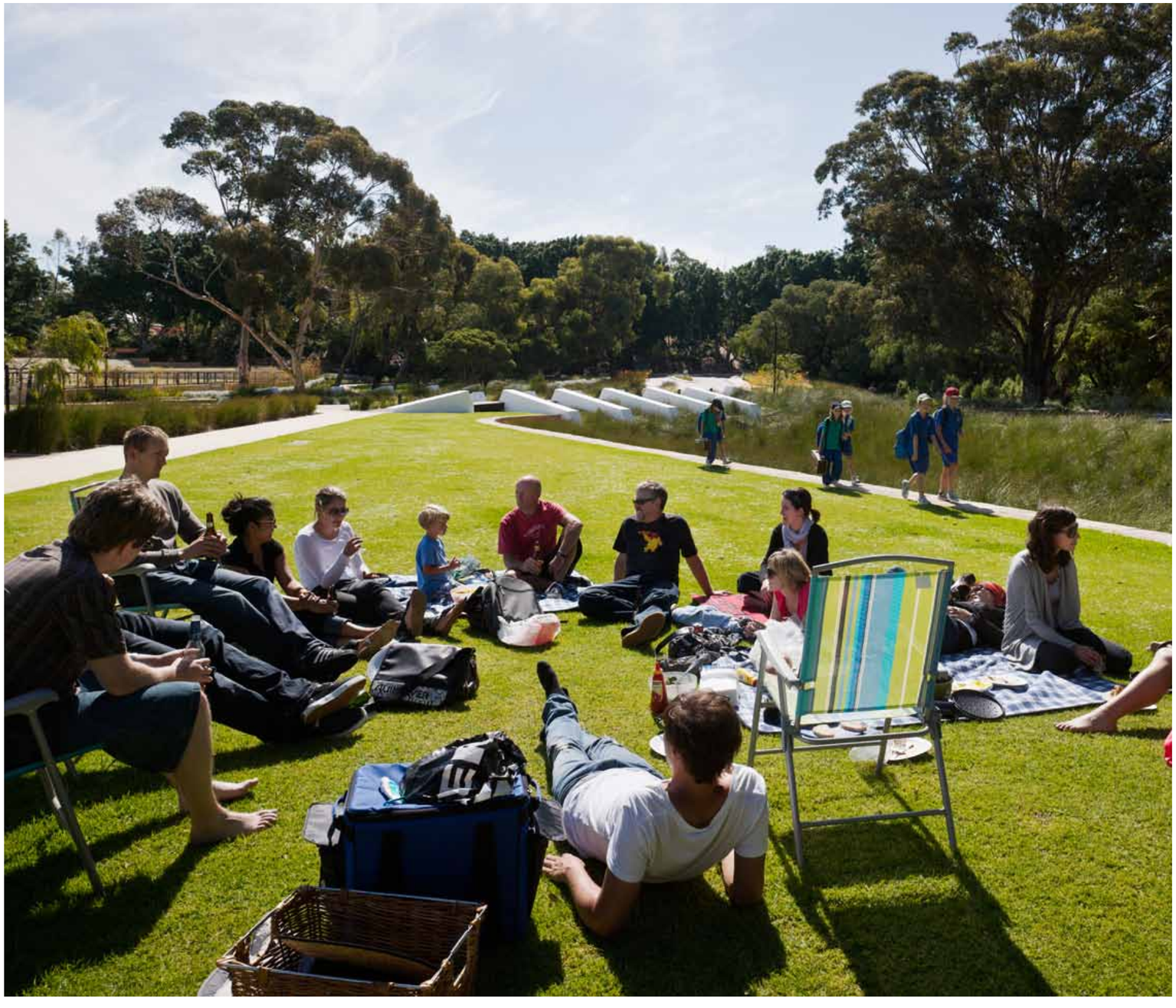
An important part of this approach will be the ‘Pocket Parks’. These are to be local suburban parks, that are regularly maintained and include:
_Paved access paths
_Shade trees
_Visually diverse plantings
_All weather shelters
_Open lawn areas
_Garbage bins
_Signage
_Drinking fountains
_Bench seating
_Lighting
_Dedicated children’s play equipment (0-10ages)
_Passive surveillance

Each pocket park across the site is to be located to maximise solar access and to take advantage of the local bushland character, sandstone outcrops and/or viewing outlooks where possible. Normally these pocket parks will be unified in character across the site through their material selection and design configuration, but differing marginally in order to cater for varied children age groups and their associated learning and development needs.



NTS

Pocket Park



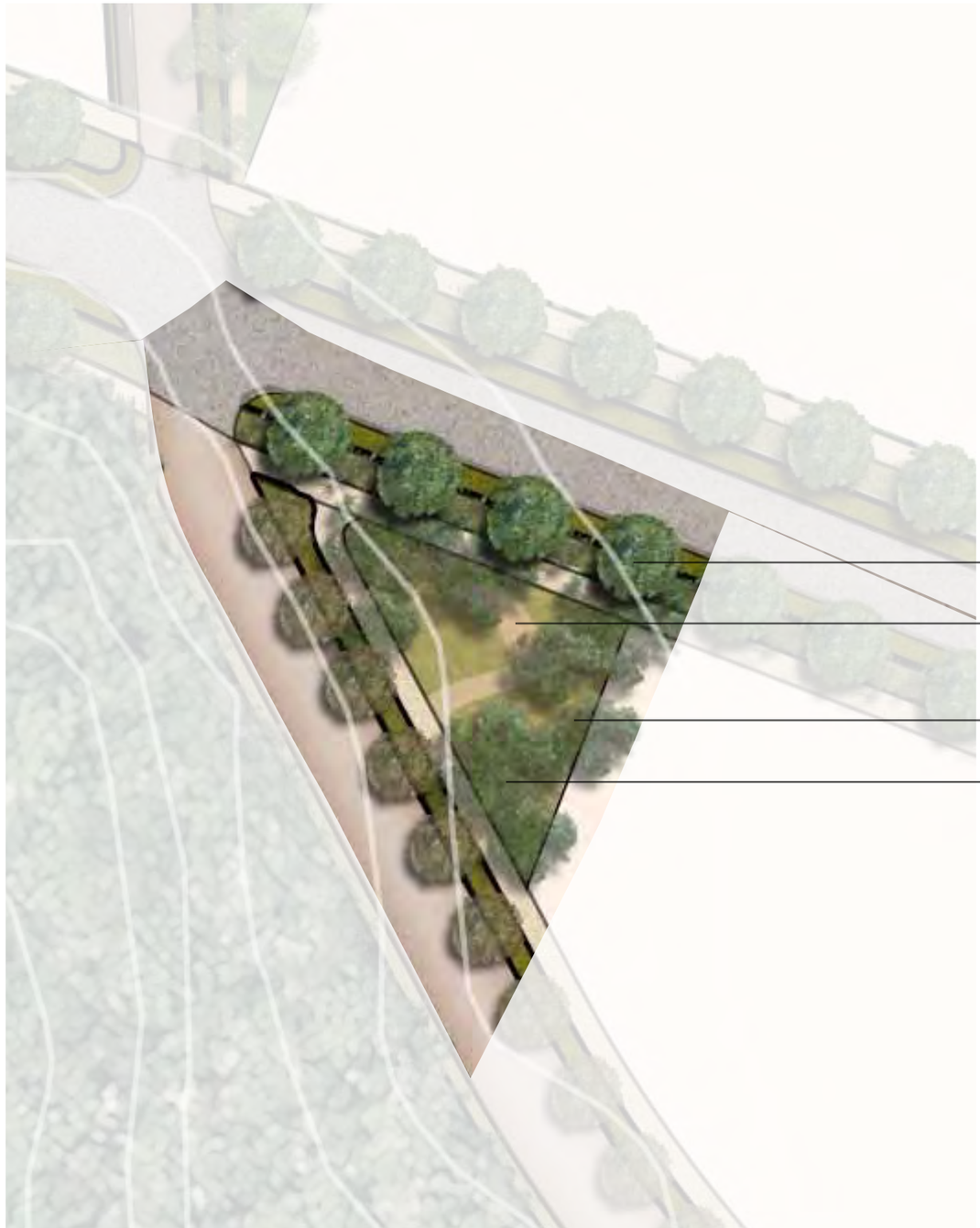
06____Open Space

Bushland Parks

Bushland Parks, proposed across the site, will be an essential open space element to the success of the development, as they provide the link between development and adjoining bushland and are the character ‘driver’ of the proposed site built works.

Each bushland park aims to preserve, enhance and maintain the existing natural asset of the site - the views, the tree canopy, the understory vegetation, the sandstone, the gradients, the overland flows. It is the existing natural assets of the site that define these park spaces and it is therefore proposed that all new works be done as a ‘light touch’ to include:
_Interpretation signage
_Art pieces
_Boardwalks
_Gravel paths
_Supplementary native endemic tree plantings
_Fenced off preservation zones
_Amenity/low level surveillance lighting
_Interpreted furniture and viewing platforms

The bushland parks will allow for alternative open space and recreational use than proposed in the pocket parks and importantly ensure the site integrates with its setting beyond its interface at its edges.



06____Open Space

Walking Trails and Pedestrian Network

Community engagement, both across the site and from the adjoining neighbourhood, is an essential project aspiration and therefore a key design driver in the concept plan development.

Access to existing National Park walking trails are proposed to be retained and signage to these entry points are to be clearly defined in order to ensure the site retains its link with the wider bushland environment.

Similarly the concept plan aim's to build on the existing language of site permeability in ensuring multiple measures of traversing, crossing and or circulating the site, be it to connect with the bushland tracks or simply to walk a street circuit and return home. It is proposed that this be done through a well defined and prioritised pedestrian network of paths, that includes footpaths to main connector roads and pedestrian friendly minor streets and link roads.

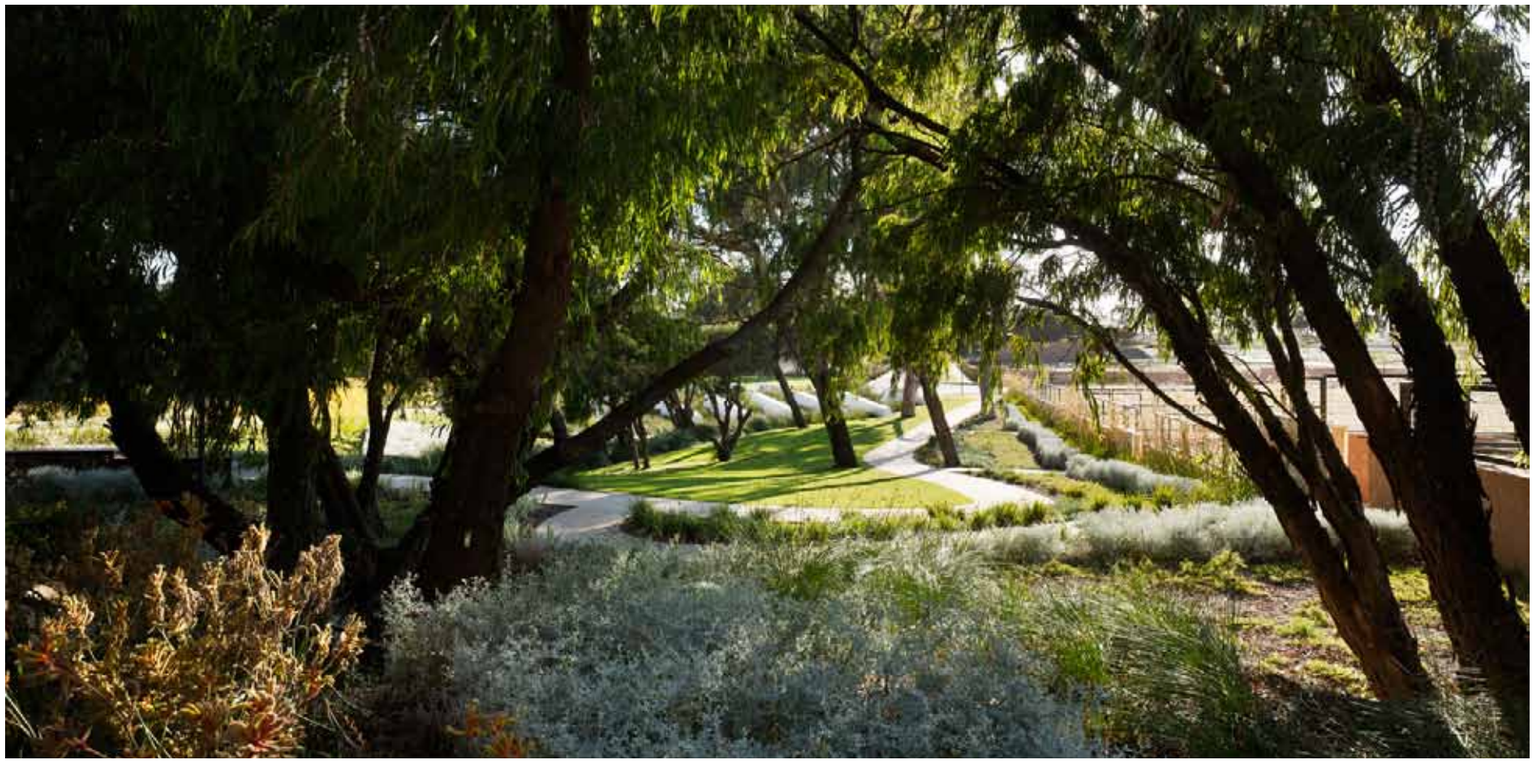
06____Open Space

Entry Precinct

The arrival experience to the proposed development is clearly one of a residential suburb set amongst bushland. Importantly therefore is the need to ensure that the entry precinct both recognise and celebrate this quality characteristic.

Through select mature tree planting, discreet signage and integrated artwork the entry to the development shall be
_Of Belrose
_Appropriate to the northern beaches
_A reinforcement of the unique site setting
_Emblematic of the quality of the development

Lighting, material selection, plantings will in all instances be subtle and be designed in an integrated way that works with, not against, the bushland character, the outlook views, the surrounding neighbourhood and language of the northern beaches.



07____Street Hierarchy

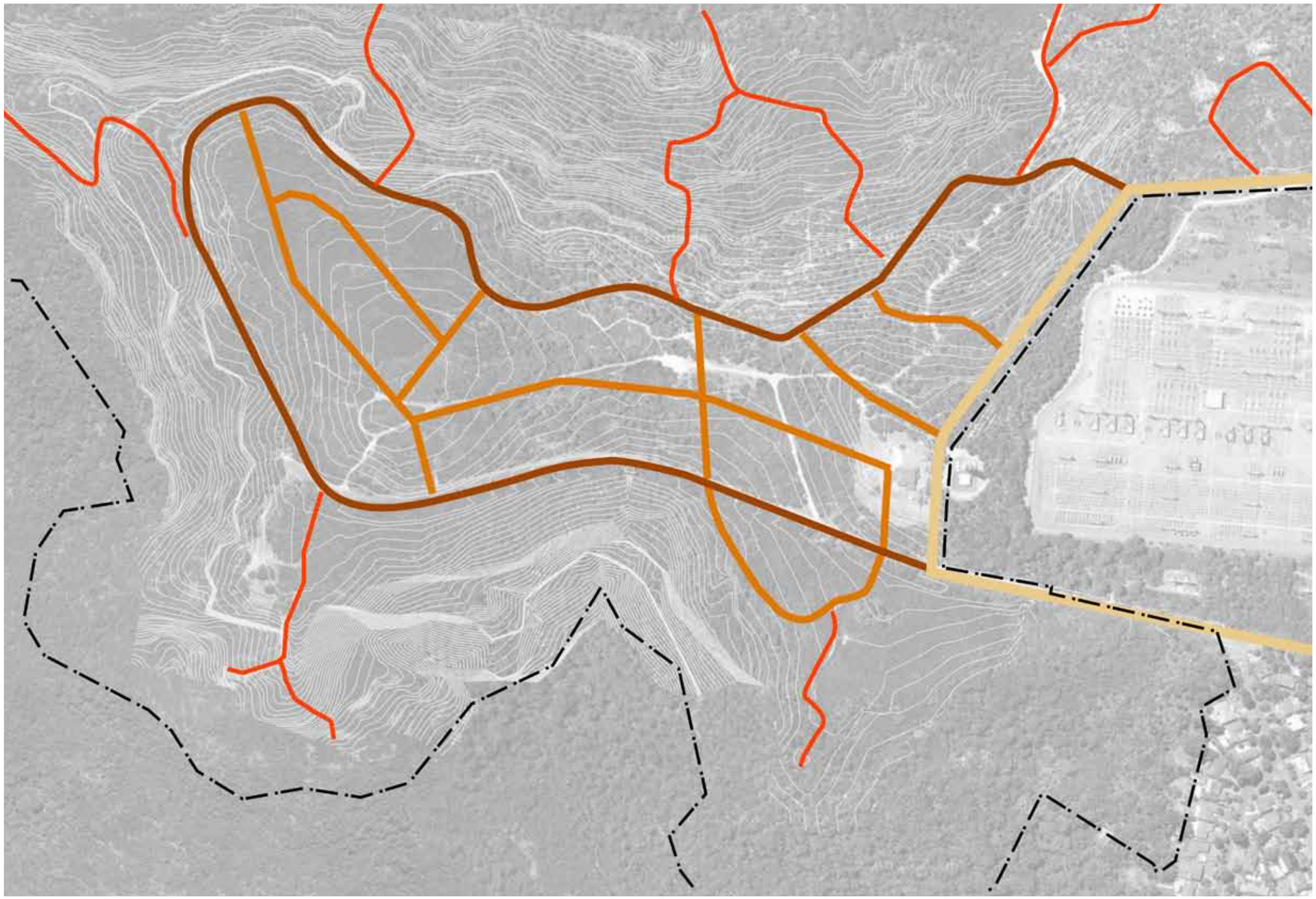
Site Roads

Streets are more than just places for cars and movement. They provide pedestrian and bicycle routes, they assist with the legibility and identity of a place and they provide spaces for daily encounters between residents and neighbours.

Objectives
_Establish an appropriate Street Hierarchy
_Create a safe 'pedestrical' system (pedestrian and bicycle network) to promote active transport and a healthy community
_Provide a network of connected share ways to promote walking and bicycle use and safety
_Encourage 'street life' through provision of meeting points in parks readily accessible through the pedestrical network
_To provide equal access for all in the public domain and access to private lots

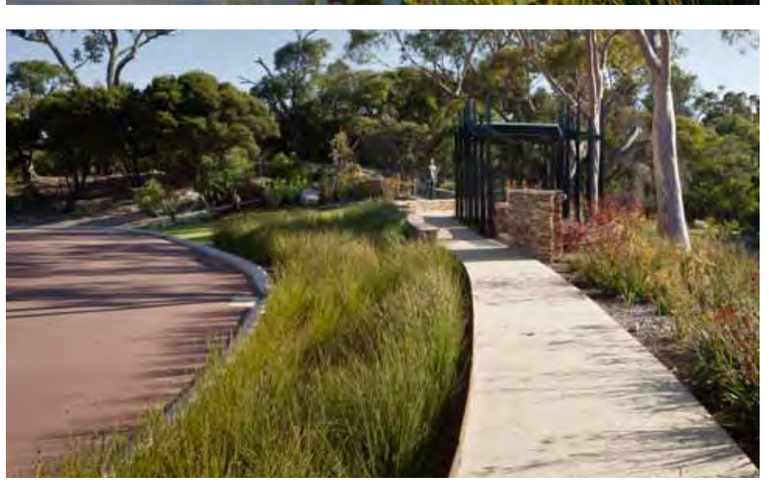
Design Considerations
_Locate pedestrian paths where possible and practical to enhance connectivity to parks and other destinations and to minimise road crossings
_Footpaths are to comply with Australian Standards-- and are to be continuous with smooth transitions in level
_Pram ramps are to grade down to road level
_Standard path to be 1.2m wide brushed concrete
_Pathways to be generally located 600mm off boundary

The proposed concept plan has a Street Hierarchy that includes:
_Distributor Roads that have 13m wide carriageways with provision for on street parking on both sides and tree bay and rain gardens to define the parking areas. These roads will also include a pedestrian pathway to one side and planted drainage to the other. The verge widths will vary between 1m adjacent parks, up to 3.5m with cycling encouraged on the roadway.
_Perimeter Roads will have 7m wide carriage way with space for parking cars on one side only. These streets will not have footpaths the connector roads will be established to feel like community spaces and as such cyclist and pedestrians will be encouraged to use the roadways.
_Local Roads will have 6m wide carriage ways with no space for parking cars. These streets will have no footpaths and act somewhat like back streets and or small suburban lanes where cricket can happen freely.
_Pedestrians and cyclists will be encouraged to use the roadway throughout the development. The site is not a through road destination, but rather a community. The roads will be designed as a slow speed share way environment and will therefore not require vigorously formalised pedestrian paths throughout.

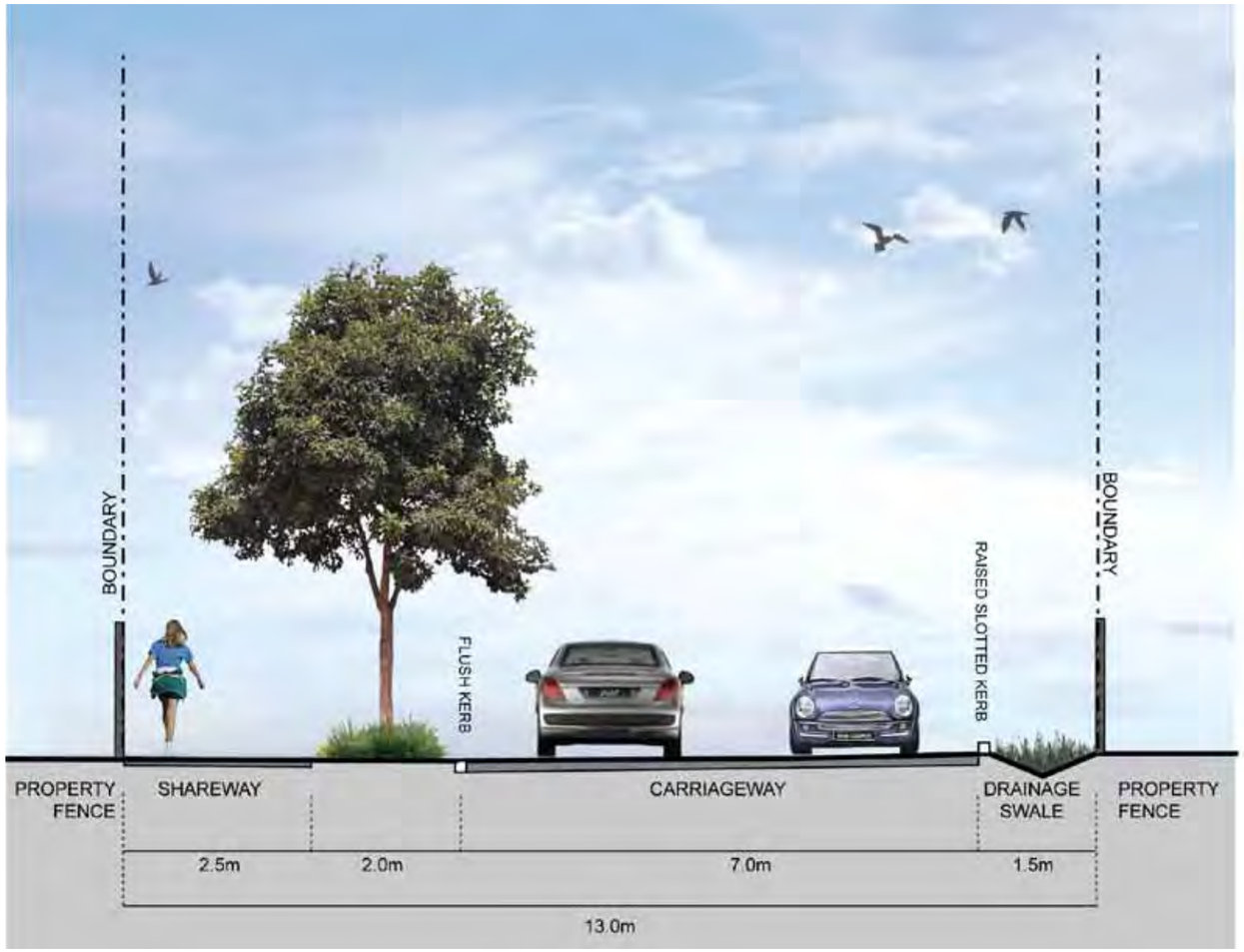


Legend

- _Distributor Road
- _Perimeter Road
- _Local Street
- _Walking tracks (off-site)
- _MLALC Boundary

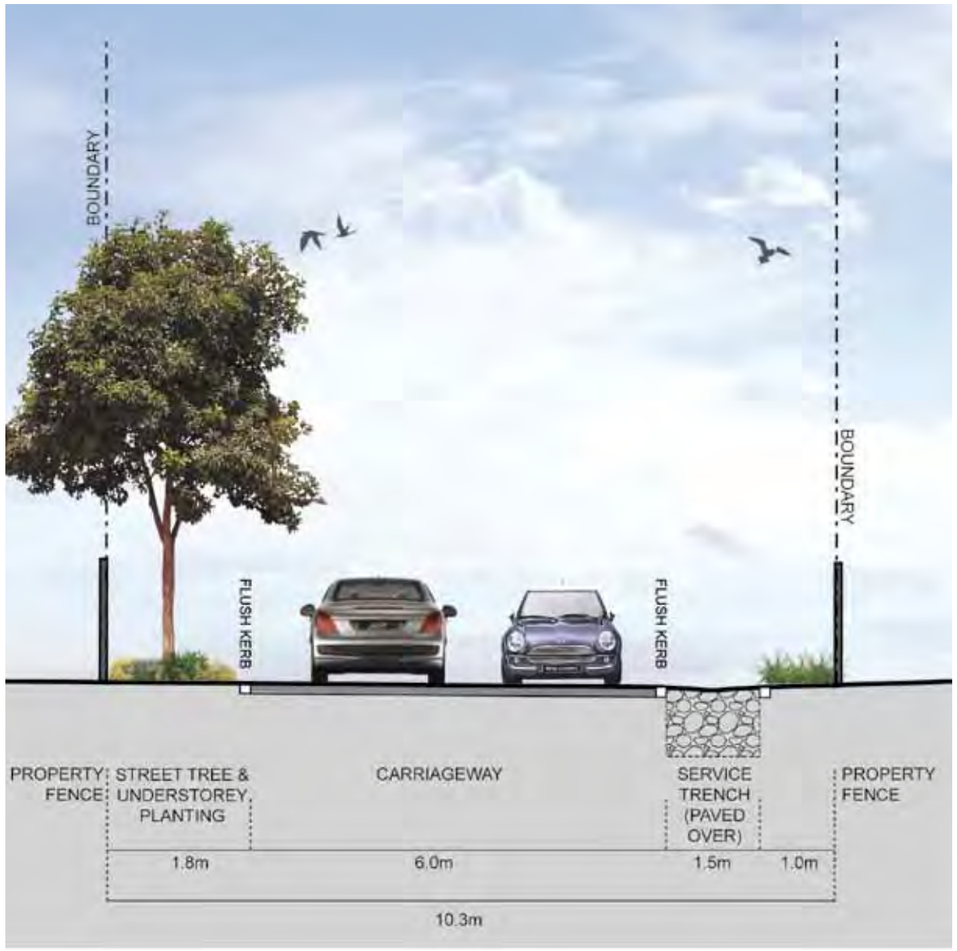


Distributor Road



Perimeter Road

07____Street Hierarchy



Local Road

08____Built Form

Architectural form and material selection is as important to the success of this development, as the appropriate master planning concept and preservation of the bushland character.

The language of the finished development will be driven as much by the natural and retained setting as it will by the new homes and the families and community that inhabit them.

According it is a clear intent of the development concept plan to present a vision for the built form in terms of colours, materiality and form.

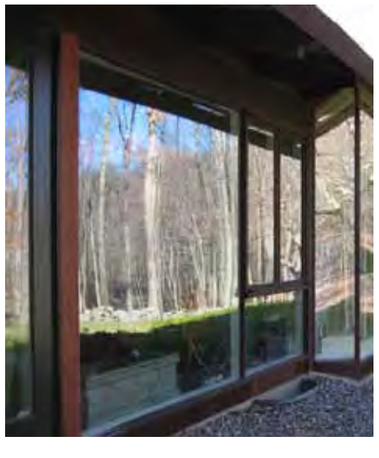
Colours

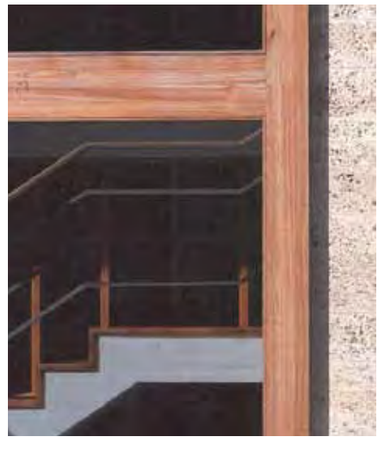
Sydney sandstone and the surrounding bushland clearly form the drivers for the intended colour palette for the development. Renders, guttering, painted woodwork and or framing, fascias and general architectural trim should work with this base framework and in doing so compliment the setting.

Colours of Sydney bushland
Blues and Greys - of the changing moods of the sky
Creams and Golds - of the sandstone heaths and underlying soils
Browns and Greens - of the bushland vegetation
Black - for elements to recede into the landscape

Materials

Similarly, building materials in face brickwork renders, roof tiles should be clean and simple such that the architectural form of the housing is what is recognised and not the diversity or variety of construction finishes.

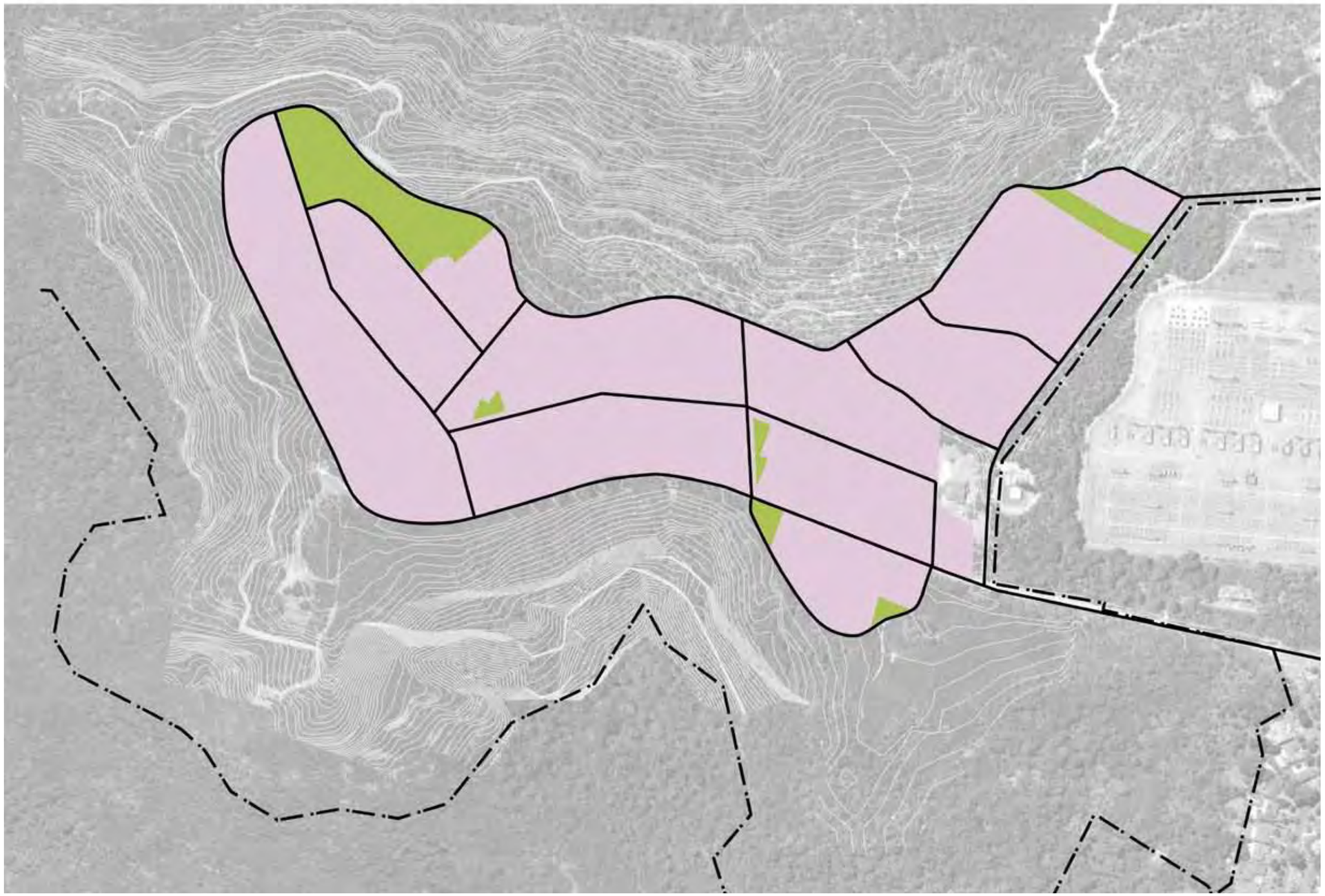




08____Built Form

Form

Precedent images and graphics have been carefully selected to reinforce a desire for homes that work with and compliment the unique character of the site and increase the visual amenity of the development as one that has occurred in unison with the bush.



Legend

_R2 - Residential Zone 2

_RE1 - Recreational Zone 1

_MLALC Boundary

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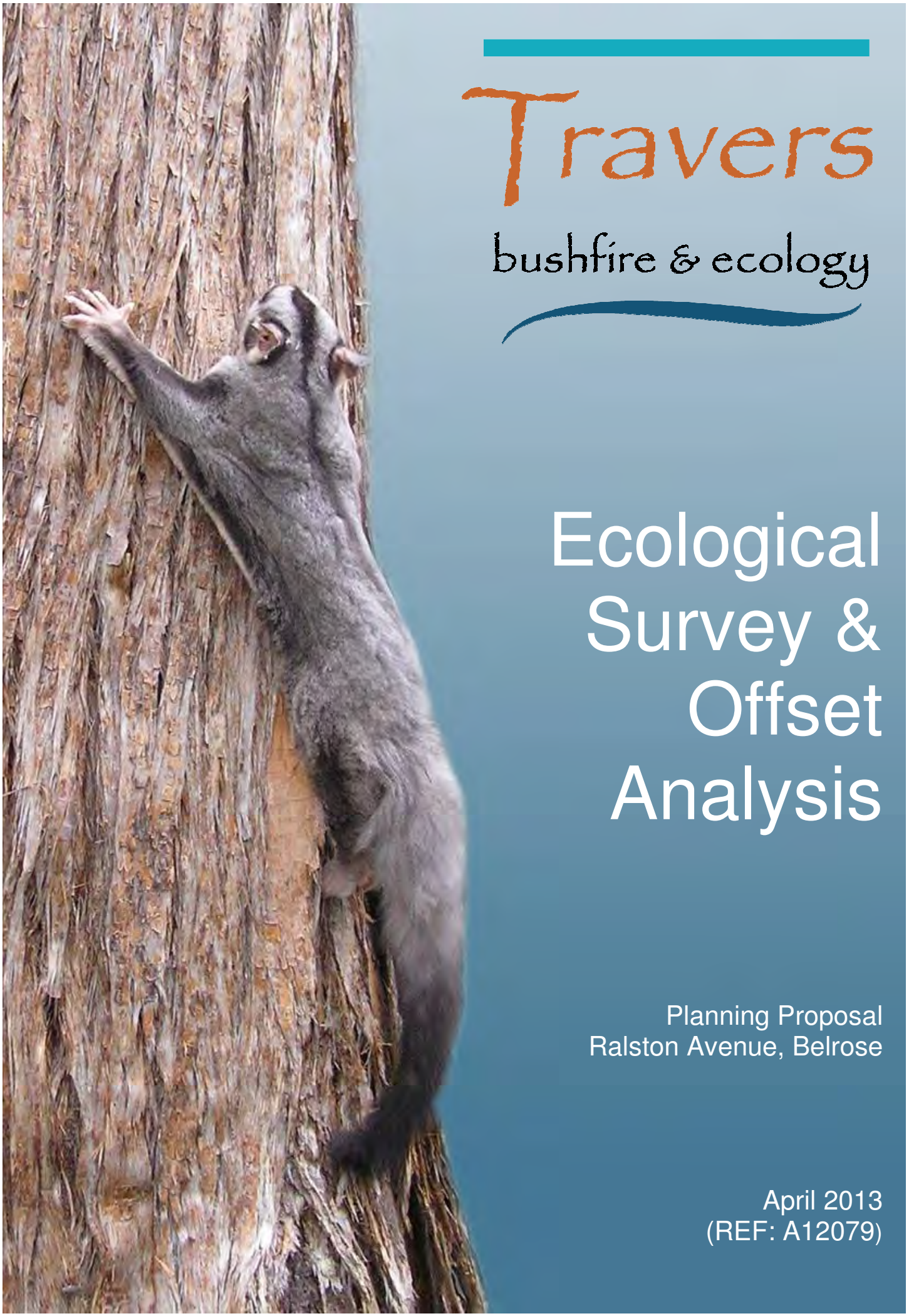

Travers

bushfire & ecology

Ecological Survey & Offset Analysis

Planning Proposal
Ralston Avenue, Belrose

April 2013
(REF: A12079)

Travers

bushfire & ecology

Ecological Survey & Offset Analysis

Ralston Avenue, Belrose

Report Authors:	John Travers, Michael Sheather-Reid, Lindsay Holmes & Corey Mead
Plans prepared:	Nick Barclay Trent Matheson
Checked by:	Michael Sheather-Reid on behalf of John Travers
Date:	10 April 2013
File:	A12079

Disclaimer:

This report has been prepared to provide advice to the client on matters pertaining to the particular and specific development proposal as advised by the client and / or their authorised representatives. This report can be used by the client only for its intended purpose and for that purpose only. Should any other use of the advice be made by any person including the client then this firm advises that the advice should not be relied upon. The report and its attachments should be read as a whole and no individual part of the report or its attachments should be interpreted without reference to the entire report.

Survey effort has been reduced to provide an indication of the insitu vegetation and fauna habitat present. The 7 part test is based on this survey data and further survey may result in the observation of threatened species not considered in this assessment. Consequently further target threatened species survey may be required by the determining authority. The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy. Consequently the location of all mapped features is to be confirmed by a registered surveyor.

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Executive Summary

Travers bushfire & ecology has been engaged to undertake ecological constraints survey and offset analysis of a proposed residential and environmental management rezoning for lands located off Ralston Avenue Belrose.

Extensive ecological survey has been undertaken to identify the presence of any listed threatened flora and fauna species, endangered ecological communities (EECs) and threatened fauna habitat which may be affected by the proposed residential development area located at the end of Ralston Avenue, Belrose.

The lands, owned by Metropolitan Local Aboriginal Land Council (MLALC), form part of a large parcel of land of some 135.3ha not including the proposed road corridor extensions covering 3.1615 ha, that has both development and conservation potential subject to the outcomes of ecological assessment. The proposed development area excluding the asset protection zones represents 17.15ha, or less than 13% of the total land parcel owned by MLALC. The total impact area as a result of the planning proposal including asset protection zones and proposed road extensions is 25 ha.

The site is identified within Warringah Local Environmental Plan (LEP) 2011 as 'deferred land' and as such LEP 2000 applies until a review of deferred lands is complete and a planning proposal process is undertaken to bring this land into Warringah's standard LEP 2011.

It is proposed that the developable area of the site will be rezoned to accommodate a variety of residential dwellings that will meet the existing and likely future housing demand within the local area. The concept plan report and indicative development concept plan provides for approximately 169 lots with the average lot size across the site is expected to be 600m2. The balance of the developable area of the site will comprise public open space, stormwater management and asset protection zones (APZ) for bushfire protection.

The planning proposal for residential development is located on a ridgeline plateau at the end of Ralston Avenue, Belrose and is surrounded by conservation lands, which have ecological value and currently provide an important link with the surrounding Garigal National Park. The watercourses and landscape that lead into the adjoining national park estate are known to contain rare and threatened species. It also forms part of the natural connective landscape that supports Garigal National Park and provides connectivity to other surrounding catchments.

Extensive ecological surveys began in late 2011 and were completed in November 2012 with floristic survey being undertaken over a much wider area than is likely to be developed. Fauna survey has mostly been conducted within the proposed development area and immediate surrounds. Due to the landscape features of the likely development area there has been a detailed focus on a number of threatened species and EECs.

Albeit that the landscape has conservation value, it also has development value and the intent of this ecological assessment is to identify the critical features of conservation value in terms of the rare and threatened species, EECs and habitat that are important for maintaining viable threatened species populations and ecological processes of the surrounding natural landscape.

As the recorded threatened species have different lifecycle requirements, the identification of critical habitat areas may require further investigation or expert advice. As a result of the ecological survey and assessment, the potential impact of the proposed development area on the following matters is considered to be the most critical:

- The impact of stormwater and associated residential activities and services either directly or indirectly on the surrounding natural landscape and associated watercourses, rare and threatened species habitat and EECs.
- The protection of rare or threatened species habitat to maintain viable populations including foraging habitat and areas critical for breeding and recruitment.
- Continued provision of connected landscape for wildlife to continue to access important habitat areas.
- Effective management of edge impacts along the urban bushland interface to minimise the risk of weed invasions, waste disposal and general damage.
- Effective treatment and maintenance of stormwater treatment measures and outlets.
- Effective management of asset protection zones and dual conservation of rare or threatened species habitat.
- Access to allow targeted maintenance and implementation of hazard reduction and ecological burns.
- Ownership and management responsibility of the proposed offset lands.
- Performance targets to be achieved to permit a balanced development and conservation outcome.

A planning proposal has been prepared that aims to utilise developable portions of the site. This ecological assessment report provides an overview of the expected impacts based on the proposed layout of the planning proposal and ecological survey data derived to date.

It is proposed that the developable area of the site will be rezoned to accommodate a variety of residential dwellings that will in part meet the existing and likely future housing demand within the local area.

Bushfire management, road access and emergency egress

The Bushfire Protection Assessment Report (*Travers bushfire & ecology 2012)* has found that the site is capable of supporting the required bushfire protection measures and can comply with PBP 2006. The extent of managed land for asset protection purposes defines the outer extent of the land proposed for a residential zone.

The key bushfire management principle for the proposed planning scheme is to ensure that future development is capable of complying with *Planning for Bush Fire Protection NSW RFS (2006)*.

The Bushfire Protection Assessment found that bushfire can potentially affect the site from the surrounding forest and heath vegetation communities resulting in possible ember, radiant heat and, potentially, flame attack. The previous fire history of the surrounding landscape is such that considerable planning focus has been undertaken for traffic capability, asset protection, emergency management, fire trail construction, hazardous fuels management, building construction standards, water management and peripheral land management. The bushfire risk posed to the rezoning proposal, however, can be mitigated by a suite of bushfire protection measures which are implemented and managed in perpetuity.

Bushfire protection measures include the imposition of asset protection zones in accordance with PBP 2006. The bushfire risk inherent within the site requires not only adequate asset protection but also adequate perimeter access for defence, emergency egress and evacuation, several evacuation routes in the event one or more options are closed, adequate water and fire fighting capabilities.

Proposed Offsetting

Travers bushfire & ecology has been requested to undertake an offset analysis of the lands surrounding the proposed development area, being owned by MLALC, as a means of offsetting the loss of flora and fauna habitat as a result of the proposed planning proposal.

This approach is permissible subject to compliance with the NSW Office of Environment and Heritage's 'Principles for the use of biodiversity offsets in NSW' and the submission of a *maintain or improve test* such as under biodiversity certification or a biobanking assessment.

The offset analysis in this report identifies the losses of each vegetation community due to the planning proposal, potential restoration gains and the estimated loss of rare and threatened flora populations *(Tetratheca glandulosa, Grevillea caleyi, Eucalyptus leumanniana and Angophora crassifolia)* based on the ecological survey results. This is a primary step in understanding the quantum of the biodiversity offsets being provided.

Prior to the consideration of biodiversity offsets it is a general biodiversity management principle to avoid or mitigate against the potential biodiversity impacts. Consequently the proposal has provided protection for the majority of the insitu EEC, the Coastal Upland Swamp. The impact of the proposed planning scheme on rare and threatened species habitat is also considered.

The offset lands are significant in area and strategically located adjoining Garigal National Park which would feasibly form part of a biodiversity offset package involving mostly a protection offset and minor restoration offset areas.

Table 1 - Summary of Vegetation Community Offset Ratios

Veg Code	Vegetation Community	Protection Offset Ratios	Potential Restoration Offsets (ha)	Combined Restoration & Protection Offset Ratios
A	Short Heath (to 2.5m tall)	0.48:1	Nil	0.48:1
B	Tall Heath (2.5 - 5m tall)	2.90:1	Nil	2.90:1
B2	Damp Tall Heath	5.78:1	Nil	5.78:1
C	Low Open Forest (to 10m tall)	4.32	2.83	4.64:1
D	Open Forest (10+m tall)	7.18:1	Nil	7.18:1
E	Cleared, Managed, Landscaped or Weed Plume	N/A	Nil	N/A
F	Coastal Upland Swamp	11.00:1	Nil	11.00:1
G	Sandstone Gully Forest	61.13:1	Nil	61.13:1
H	Riparian Woodland/Forest	Nil Loss	0.47	Gain (0.82 ha)
	Average Offset Ratio	**4.5**	**3.30**	**4.63:1**

It is expected that the conservation value of the offset lands, for recorded and potential fauna populations in particular, will need to be calculated through the use of the biobanking assessment tool or a biodiversity certification *maintain or improve test*. However the offset analysis based on the known vegetation and estimated populations provides an indication that the offset area is likely to provide an adequate offset outcome from a vegetation perspective.

The most impacted vegetation communities are Short Heath and Tall Heath as these are most prevalent within the proposed development area. Based on the generated offset ratios, it is likely that the Short Heath vegetation communities will become a focus for provision of offsets as this is the primary community that is most affected and the offset ratio is below generally accepted ratio. The landscape value of the impacted areas for threatened species will also have a bearing on the adequacy of the proposed offsets. Based on the vegetation offset ratios, the offset lands appear to provide a favourable offset ratio for all the recorded rare and threatened flora and fauna species. This outcome is subject to completing a *maintain or improve test* for threatened flora and fauna species and expert investigation of key threatened fauna species.

Recorded threatened flora, fauna and EECs

Ecological survey and assessment has been undertaken to identify the presence of threatened species, EECs and populations as listed on the schedules of the *Threatened Species Conservation Act 1995*, the *Environment Protection and Biodiversity Conservation Act 1999* and the *Fisheries Management Act 1994*.

In respect of matters required to be considered under the *Environmental Planning and Assessment Act 1979* and relating to the species / provisions of the *Threatened Species Conservation Act 1995;*

- Eight (8) threatened fauna species have been recorded within and immediately surrounding the proposed development area. Giant Burrowing Frog (*Helioporus australiacus*), Red-crowned Toadlet (*Psedophryne australis*), Rosenberg's Goanna (*Varanus rosenbergii*), Powerful Owl (*Ninox strenua*), Little Lorikeet (*Glossopsitta pusilla*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Little Bentwing-bat (*Miniopterus australis*) and Eastern Bentwing-bat (*Miniopterus orianae oceansis*).

- Two (2) threatened flora species including *Tetratheca glandulosa* and *Grevillea caleyi.*

- One (1) EEC - Coastal Upland Swamp of the Sydney Basin Bioregion was recorded.

In respect of matters required to be considered under the *Environment Protection and Biodiversity Conservation Act 1999;*

- Two (2) threatened fauna species Giant Burrowing Frog (*Helioporus australiacus*) and Grey-headed Flying-fox (*Pteropus poliocephalus*),

- No protected migratory bird species,

- Two (2) threatened flora species including *Tetratheca glandulosa* (listed as vulnerable) and *Grevillea caleyi* (listed as endangered),

- No EECs listed under this Act were recorded within the total land parcel.

In respect of matters relative to the *Fisheries Management Act 1994*, no suitable habitat for threatened marine or aquatic species was observed within the subject site and there are no matters requiring further consideration under this Act.

Floristic constraints

Vegetation community survey has been undertaken throughout the land parcel owned by Metropolitan Local Aboriginal Land Council, the affected unformed road corridors and the proposed offset lands.

Target threatened flora searches have been undertaken within the proposed residential areas and the immediate surrounding landscape. Target flora survey has not been undertaken in the entire offset lands, except for the purposes of identifying the presence or absence of threatened flora species. Therefore individual records as mapped are not considered to be the full extent of the threatened or rare plant populations within the offset lands.

The vegetation communities within and surrounding the land parcel subject to the proposed development area (inclusive of affect road corridors) includes:

Table 2 - Vegetation communities present within the planning study area

Veg Code	Vegetation Community	Vegetation within Offset lands (ha)	Total Vegetation within development and APZ (ha)	Total Vegetation in Study Area (ha)
A	Short Heath (to 2.5m tall)	1.19	2.44	3.63
B	Tall Heath (2.5 - 5m tall)	20.08	6.92	27.00
B2	Damp Tall Heath	2.66	0.46	3.12
C	Low Open Forest (to 10m tall)	38.78	8.96	47.74
D	Open Forest (10+m tall)	28.61	3.98	32.59
E	Cleared, Managed, Landscaped or Weed Plume	3.39	2.23	5.62
F	Coastal Upland Swamp (EEC)	1.65	0.15	1.80
G	Sandstone Gully Forest	17.73	0.29	18.02
H	Riparian Woodland/Forest	0.345	0	0.345
	Total	**114.43**	**25.43**	**139.86**

The proposed development area and associated road corridors provide known habitat for the following threatened flora species and an EEC:

- *Tetratheca glandulosa* (101 plants mostly within proposed residential zone)
- *Grevillea caleyi* (6 plants within proposed residential zone)
- EEC - Coastal Upland Swamp (1.8 ha in total land parcel)

In addition, the total land parcel also contains two populations of rare ROTAP listed threatened species:

- *Eucalyptus luehmanniana* (estimated 3,062 plants within study area including offset lands)
- *Angophora crassifolia* (estimated 978 plants within study area including offset lands).

Based on the floristic survey results, the EEC, *Coastal Upland Swamp of the Sydney Basin Bioregion* provides the most significant vegetation constraint to development of the land. Coastal Upland Swamp occurs on the southern aspect of Ralston Avenue and in the north of the proposed Wyatt Avenue.

The EEC - Coastal Upland Swamp occurs in several patches covering a total of 1.8ha. 1.65ha or 92% of Coastal Upland Swamp will be retained as part of the proposed planning scheme. The Coastal Upland Swamp is also a 'protected' groundwater dependent ecosystem under the NSW Groundwater Dependent Ecosystem Policy.

A buffer is typically imposed around such sensitive groundwater dependent ecosystems which are subject to the hydrological / hydrogeological study and a stormwater management plan. Ralston Avenue, which currently extends through to the south western boundary provides a physical barrier for the existing Upland Swamp. The planning proposal provides a natural vegetation buffer of 30m to the north west of the largest patch of Coastal Upland Swamp. An asset protection zone provides additional separation.

Following ecological surveys in May 2008 and December 2011, target survey for potential threatened flora species has been undertaken in October (spring) 2012. *Pimelea curviflora var. curviflora* has not been detected within the proposed residential zone to date. *Tetratheca glandulosa* and *Grevillea caleyi* were also resurveyed in October 2012 to ascertain their full coverage across the development site.

Based upon the floristic survey, the current potential botanical constraints are;

- *Tetratheca glandulosa* and *Grevillea caleyi,* threatened plant species under both the *TSC Act* (1995) and *EPBC Act* (1999).
- EEC - Coastal Upland Swamp, previously known as Sandstone Hanging Swamp which will require buffers for future protection.
- *Angophora crassifolia,* a rare (ROTAP) species found within the taller vegetation stratas and occasionally in Tall Heath / Damp Tall Heath.
- *Eucalyptus luehmanniana,* a rare (ROTAP) species has been observed, usually within tall heath or low open woodland in close proximity to Ralston Avenue, mostly on the southern side of the road on southwest to southeast facing slopes.

We advise that, based on the vegetation community mapping, the Low Open Forest and Open Forest communities appear to provide the best potential threatened flora habitat. However the recorded number and densities of threatened species are low.

The offset lands provide extensive areas of habitat for these species as demonstrated by target survey for *Eucalyptus luehmanniana* and *Angophora crassifolia.* The offset lands are also expected to provide habitat for *Tetratheca glandulosa* and *Pimelea curviflora var. curviflora* and *Grevillea caleyi.*

Given the estimated large numbers of *Eucalyptus luehmanniana* and *Angophora crassifolia* in the offset lands, approximately 80% of the estimated *Eucalyptus luehmanniana* population (3,062 records) and 80% of the estimated *Angophora crassifolia* population (978 records) will be retained by the planning proposal.

Due to the lack of target survey for *Tetratheca glandulosa* within the offset lands the total loss of the population cannot currently be estimated. Significant areas of habitat are present within the offset lands, therefore, it is expected that the loss of these plants within the proposed development is not likely to be significant in terms of the percentage population loss.

A very small population of *Grevillea caleyi* (6 plants) are potentially directly affected by road works and the development area. There is further suitable habitat within adjoining lands to the east of the proposed development area surrounding the electricity substation and Open Forest communities within the proposed offset lands. Based on the proposed plans, on site protective measures can potentially be implemented to protect the majority of the existing small population within and adjoining the road corridor. It is also likely that this species can be propagated and restored to an appropriate protected location.

Fauna constraints

Eight (8) threatened fauna species have been recorded within, or in close proximity to, the development area during surveys to date. The recorded species include:

- Powerful Owl (*Ninox strenua*),
- Grey-headed Flying-fox (*Pteropus poliocephalus*),
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis),*
- Little Bentwing-bat (*Miniopterus australis),*
- Little Lorikeet (*Glossopsitta pusilla*),
- Rosenberg's Goanna (*Varanus rosenbergi*),
- Red-crowned Toadlet (*Pseudophryne australis*), and
- Giant Burrowing Frog (*Helieoporus australiacus*)

Although not recorded within the proposed development area, it is considered that the proposed development area also has potential for the following additional threatened fauna species to occur and offer constraints to development:

- Southern Brown Bandicoot (*Isoodon obesulus)*
- Eastern Pygmy Possum (*Cercartetus nanus*)
- Spotted-tailed Quoll (*Dasyurus maculatus*), and
- New Holland Mouse (*Pseudomys novaehollandiae*).

The Southern Brown Bandicoot and New Hollland Mouse are known to re-colonise areas of burnt heath during regrowth stages and the Spotted-tailed Quoll has large home ranges.

Of the recorded fauna species, three (3) have potential to offer a constraint to development within the proposed residential area due to a dependence on the habitat in part within, and extending beyond, the proposed development area. These are:

- Rosenberg's Goanna (*Varanus rosenbergi*),
- Red-crowned Toadlet (*Pseudophryne australis*), and
- Giant Burrowing Frog (*Helieoporus australiacus*).

Fauna surveys to date have revealed that the site is utilised by Rosenberg's Goanna for foraging purposes. No terrestrial termite mounds suitable for nesting have been observed to date within the proposed development area.

Mr Gerry Swan – a recognised Rosenberg Goanna specialist, was engaged to undertake a preliminary site study which has resulted in the location of one termite mound with a juvenile exit point and several more burrows (Cygnate Surveys and Consultancy November 2012). This termite mound and recorded burrows have however been located outside of the proposed development area. Further burrows have been identified in suitable habitat areas to the north and north-west of the proposed development area. Mr Gerry Swan has concluded that the proposed development site is not critical to the survival of the population, that there is adequate habitat surrounding the proposed residential development site to maintain a viable population, and the proposed residential development is not likely to result in a significant movement of connectivity restriction to the local population. Mr Swan also states that the proposed development is not likely to have a significant impact on the Rosenberg Goanna population. Interface management between the development area and mapped critical habitat areas as identified by Mr Swan needs to be investigated in further detail.

Dry spring weather conditions leading into the October spring survey limited the accuracy of determining breeding aggregations important for Red-crowned Toadlet. Four locations have been identified for potential breeding habitat, however, more are expected in surrounding

watercourses. The expected locations are within upper level drainages just off the plateau escarpment. This species is generally well represented by records in the surrounding connective landscape.

The specimen of Giant Burrowing Frog recorded on site is likely to have been a juvenile in dispersal. Juvenile frogs may disperse far from breeding areas, however, adults of this species are also known to occupy territories several hundred metres from breeding areas. There is potential breeding habitat within the drainage line in the north eastern corner of the proposed residential area as well as within a small portion of the Coastal Upland Swamp located to the south east, however, tadpoles were not recorded in these locations. Drainages that flow off the escarpment become more suitable for this species along lower reaches where tadpole pools are more permanent.

Giant Burrowing Frog is known to generally occupy riparian areas for breeding that flow from naturally vegetated upper catchment landscapes. The critical areas for breeding along drainage lines have not been determined to date and the utilisation of remaining habitat is difficult due to the cryptic nature of this species. Records of this species to date are otherwise limited in the connective surrounds.

Further investigation is required for Giant Burrowing Frog to determine whether the planning scheme will cause an adverse or significant impact based on the habitat utilisation and surrounding known habitat of this species. Significant areas of potential breeding habitat within the proposed offset lands are available for Rosenberg's Goanna, Giant Burrowing Frog and the Red-crowned Toadlet. All of the recorded frog species can be indirectly impacted by stormwater drainage and hence the management of stormwater will be important in maintaining viable threatened species populations.

Ecological impacts of the proposed planning scheme

The planning proposal results in a potential loss of one hundred and one (101) *Tetratheca glandulosa* plants, and a potential loss of six (6) *Grevillea caleyi* plants within the areas proposed for residential rezoning, including road corridors. Significant areas of potential *Tetratheca glandulosa* habitat exist within the offset lands and more extensive populations are likely to be present. However, limited *Grevillea caleyi* habitat is present within the proposed development area and either protection or restoration mitigation measures are recommended for the small population present within the disturbed northern reaches of the total land parcel.

An estimated 80% of both populations of *Eucalyptus luehmanniana* and *Angophora crassifolia* will be conserved. There is an estimated three thousand and sixty-two (3,062) *Eucalyptus luehmanniana* and nine hundred and seventy eight (978) *Angophora crassifolia* being protected within the proposed offset lands.

The planning proposal directly impacts on 0.15ha of the EEC – Coastal Upland Swamp but conserves a larger contiguous area of 1.27ha to the south of Ralston Avenue plus a further 0.53ha to the north of the Wyatt Avenue within the proposed offset lands. The retention of the 0.15ha patch is not feasible within the current planning scheme and represents an 8 % loss of this community within the study area.

The heath habitat is being utilised as foraging habitat for Rosenberg's Goanna (*Varanus rosenbergi*). Peripheral areas of the planning proposal also provide suitable habitat for Red-crowned Toadlet (*Pseudophryne australis*) and dispersal and potential breeding habitat for Giant Burrowing Frog (*Helieoporus australiacus*).

The other recorded threatened species are not considered to be site dependent and will not be adversely affected by the proposed planning scheme.

Based on the advice of Mr Gerry Swan, the Rosenberg Goanna population is expected not to be significantly impacted and a viable population can be maintained in the presence of the proposed development. The nearest most likely breeding areas for Rosenberg's Goanna are in the north and north east portion of the study area as confirmed by Mr Gerry Swan, inclusive of lands north of the substation site. Other areas also exist to the southern, south western, eastern, and north eastern aspects of the proposed residential areas.

The recorded Giant Burrowing Frog (a desiccated carcass confirmed by DNA analysis) is likely to be a juvenile and therefore may have been in dispersal at the time of capture. There is potential breeding habitat for this species within the perennial streams that drain off the plateau. Some potential breeding area is also present within the EEC Coastal Upland Swamp located in the south eastern portion of the site. More suitable breeding habitat is most likely to be found in the lower extent of watercourses and the other drainage lines that flow from the site, including Bare Creek, Fireclay Gully, French's Creek and Middle Harbour Creek. Survey is required to determine whether the Giant Burrowing Frog will be significantly impacted and whether sufficient habitat is available to maintain a viable local population. An expert has been engaged to prepare and expert report for the giant burrowing frog.

Conclusion

As a result of the ecological assessment process, the impacts of the proposed development on the following matters are considered to be the most critical:

- The impact of stormwater quantity and quality on the surrounding natural landscape and associated watercourses.
- The conservation of threatened species habitat.
- Ecological connectivity.
- Effective edge management along the urban bushland interface to minimise the risk of weed invasions, waste disposal and general damage.
- Effective management of asset protection zones and dual conservation for insitu ecological resources.
- Ownership and management responsibility of the proposed offset lands.
- Performance targets to be achieved to permit a balanced development and conservation outcome.

The planning proposal is located in a sensitive catchment position adjoining lands that form connective habitat with Garigal National Park. The habitat present within the study area contains significant areas of breeding and foraging habitat for threatened fauna and flora species.

Survey to date has indicated that, in particular for threatened flora species, there is likely to be adequate rare and threatened species populations conserved within the proposed offset lands and adjoining landscapes to not result in a significant impact. The impacts on the recorded EEC – Coastal Upland Swamp are also low with the proposed residential development area conserving 92% of all surveyed areas.

With regard to threatened fauna species, the study lands also contain suitable habitat for the recorded and potential threatened species. However future development potential of the site is dependent on the reliance of the recorded threatened species on the habitat present within and surrounding the plateau, whether breeding locations are directly impacted,

potential loss of connective habitat and any indirect impacts that may be caused by stormwater inputs.

This is particularly important for the recorded and potentially site dependent fauna species such as Rosenberg's Goanna (*Varanus rosenbergi*), Red-crowned Toadlet (*Pseudophryne australis*) and Giant Burrowing Frog (*Helieoporus australiacus*). The ecological impact on these site dependent species is being addressed through the preparation of expert reports.

It is important to note that rezoning applications are managed through the Gateway Process as determined by the NSW Department of Planning and Warringah Shire Council. Consequently, the process involves the following ecological assessment steps:

- Preparation and submission of flora and fauna reporting to Council and the NSW Office of Environment and Heritage (OEH).
- Undertake additional flora and fauna survey as required by NSW Office of Environment and Heritage (OEH) (negotiated through a joint Council and OEH working group).
- Undertake assessment of impacts and prepare a biodiversity offset package as required by Council and OEH.
- Determination of suitability of land for the proposed residential development.

It is the intention of the proponents to apply for biodiversity certification as a means of approving the project. As a biodiversity offset is proposed, an examination of proposed offsets and provision of relevant information and assessment will be needed in the form of a biodiversity offset package for the proposed planning scheme which will be expected to satisfy a *maintain or improve test*.

There is no doubt that the proposed offset areas provide a major contribution to the adjoining national park estate and appear to provide typically acceptable offsets based on the loss and gain of vegetation communities. Adequacy of the offsets will need to be determined through the application the Biodiversity Certification Assessment Methodology or the Biobanking Assessment Methodology. Additional offsets including restoration of habitat may be required to adequately offset the loss of threatened flora and fauna habitat.

An expert report has been prepared by Mr Gerry Swan on Rosenberg's Goanna and Dr Michael Mahoney has been engaged to provide an expert report on the Giant Burrowing Frog and to conduct target survey for Red-crowned toadlet to ensure that these matters are professionally investigated.

List of abbreviations

APZ	asset protection zone
BPA	bushfire protection assessment
CLUMP	conservation land use management plan
DCP	Development Control Plan
DEC	NSW Department of Environment and Conservation (superseded by DECC from 4/07)
DECC	NSW Department of Environment and Climate Change (superseded by DECCW from 10/09)
DECCW	NSW Department of Environment, Climate Change and Water (superseded by OEH from 4/11)
EEC	endangered ecological community
EPA	Environmental Protection Agency
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESMP	ecological site management plan
FF	flora and fauna assessment
FM Act	*Fisheries Management Act 1994*
FMP	fuel management plan
HTA	habitat tree assessment
IPA	inner protection area
LEP	Local Environment Plan
LGA	local government area
NES	national environmental significance
NPWS	NSW National Parks and Wildlife Service
NSW DPI	NSW Department of Industry and Investment
OEH	Office of Environment and Heritage (Part of the NSW Department of Premier and Cabinet)
OPA	outer protection area
PBP	*Planning for Bush Fire Protection 2006: A Guide for Councils, Planners, Fire Authorities and Developers*
POM	plan of management
RF Act	*Rural Fires Act*
RFS	NSW Rural Fire Service
ROTAP	rare or threatened Australian plants
SEPP 44	*State Environmental Protection Policy No 44 – Koala Habitat Protection*
SEWPAC	Federal Department of Sustainability, Environment, Water, Population and Communities
SIS	species impact statement

SULE	safe useful life expectancy
TPO	tree preservation order
TPZ	tree preservation zone
TRRP	tree retention and removal plan
TSC Act	*Threatened Species Conservation Act 1995*
VMP	vegetation management plan

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Introduction 1

Travers bushfire & ecology has been engaged to undertake ecological and bushfire assessments of a proposed development and offset area of land located off Ralston Avenue Belrose within Lot 1 DP 1139826.

The lands, owned by Metropolitan Local Aboriginal Land Council (MLALC), form part of a large parcel of land of some 135.3ha not including the proposed road corridor extensions, that has both development and conservation potential subject to the outcomes of ecological assessment. The proposed development area excluding the asset protection zones, represents 17.15ha, or less than 13% of the total land parcel owned by MLALC. The total impact area as a result of the planning proposal including asset protection zones and proposed road extensions is 25 ha.

The site is identified within Warringah Local Environmental Plan (LEP) 2011 as 'deferred land' and as such LEP 2000 applies until a review of deferred lands is complete and a planning proposal process is undertaken to bring this land into Warringah's standard LEP 2011.

It is proposed that the developable area of the site will be rezoned to accommodate a variety of residential dwellings that will meet the existing and likely future housing demand within the local area. The concept plan report and indicative development concept plan provides for approximately 169 lots with the average lot size across the site is expected to be 600m2.

The balance of the developable area of the site will comprise public open space, stormwater management and asset protection zones (APZ) for bushfire protection. Each of these elements is intended to enable the recreational use of these spaces and to utilise the natural landscape as a defining element of the visual character, reduce bushfire risk and mitigate potential impacts on water quality.

Travers bushfire & ecology has undertaken a preliminary offset analysis of the remaining lands owned by the proponents as a means of offsetting the quantified loss of flora and fauna habitat as a result of the proposed development. As it is an important principle to avoid or mitigate the potential ecological impacts, fauna specialists have been engaged to provide advice on specific fauna issues.

The study area, including the entirety of the offset lands, is identified in Figures 2 and 3. The proposed development area includes the proposed residential area including the required APZs to mitigate the site's bushfire risks.

1.0 Planning proposal

The planning proposal is to rezone approximately a 22 ha portion of Lot 1 DP 1139826 for future residential development including the required asset protection zones of 6.12 ha (Figure 1). The remaining portions of Lot 1 DP 1139826 (approximately 114.43 ha) will be placed into an environmental protection zone as a biodiversity offset. Outside of Lot 1 the proposed development area impacts an additional 2.16 ha within Lot 2634 DP 1139826 and unformed road corridors including Wyatt Avenue.

Lot 1 DP 1139826 includes lands immediately surrounding the Belrose Waste Management Facility and extensive sandstone escarpment slopes immediately adjoining Garigal National Park (Figure 2). The proposed offset area is an ecologically significant landscape which is known to contain threatened flora, fauna, ROTAP species and the EEC – Coastal Upland Swamp.

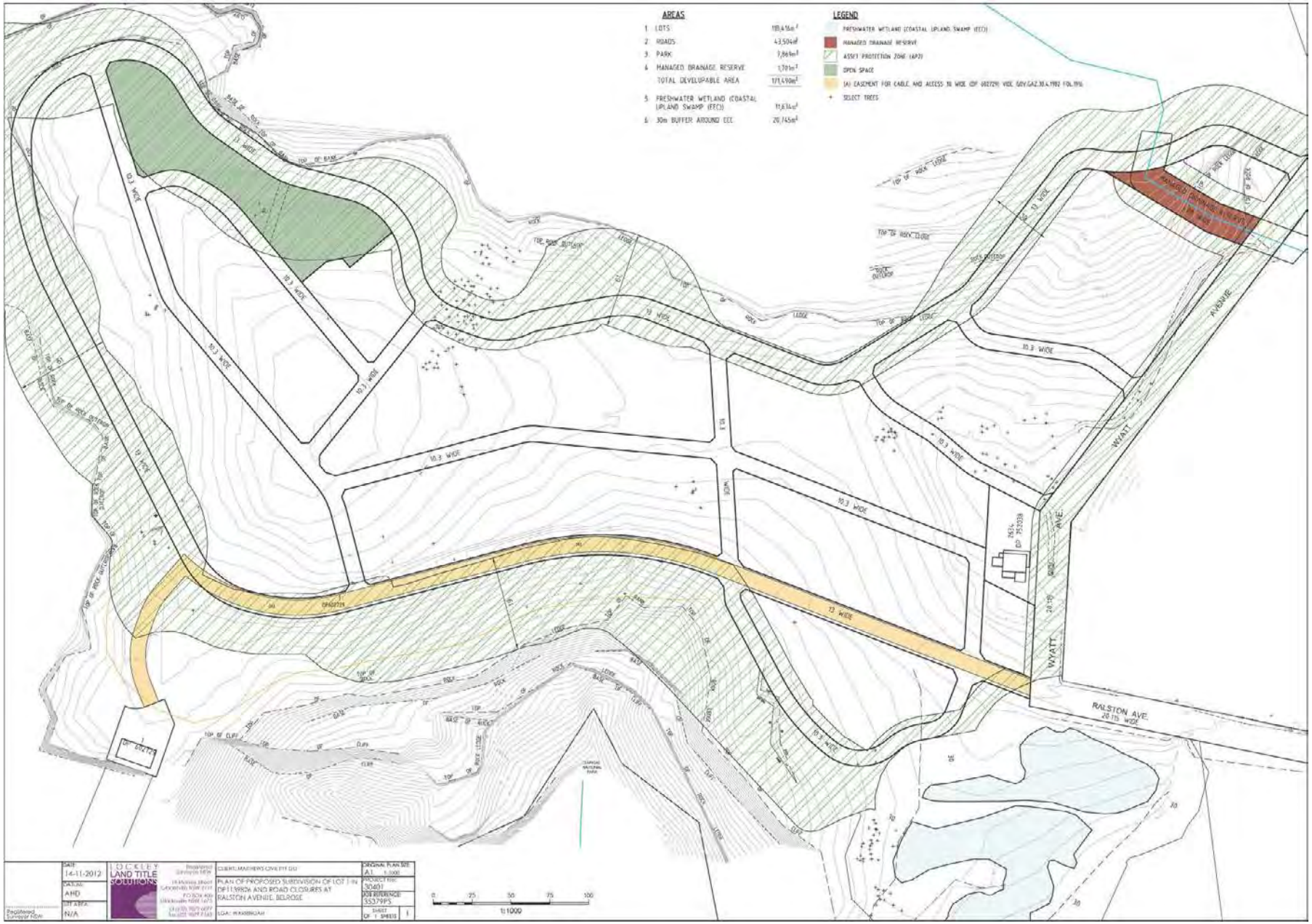

Figure 1 – Plan of proposed development Lot 1 in DP1139826

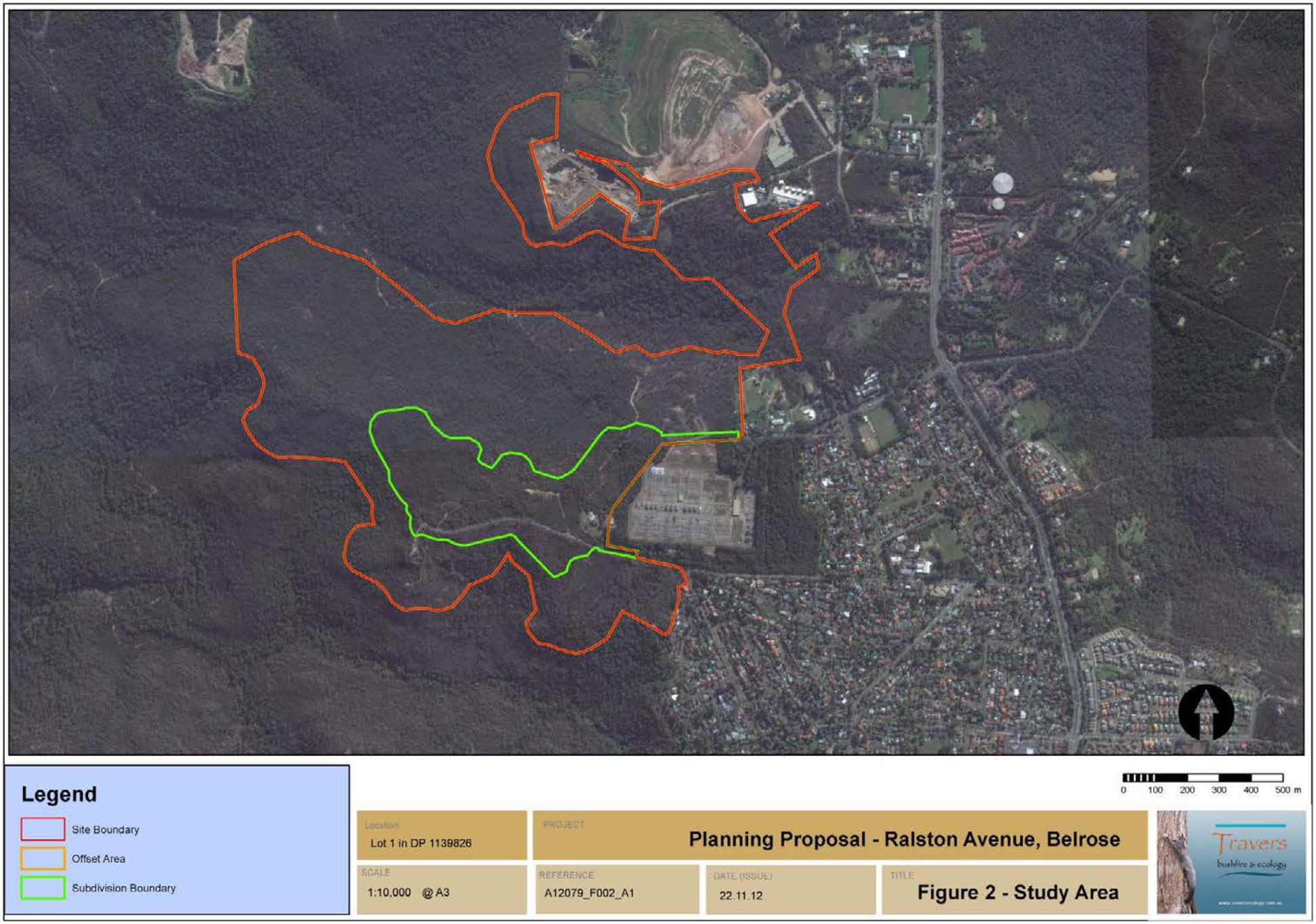

Figure 2 – Study area inclusive of development lands within Lot 1 of DP1139826

Survey Effort & Results

2

Flora and fauna survey effort is shown on Figure 3 Vegetation Communities and Flora Survey Effort, Figure 4 Fauna Survey Effort and results.

2.1 Flora survey methodology and dates

Table 1 - Flora survey method and effort

Flora Survey	Method	Dates
Vegetation Communities	Aerial photographic interpretation and ground-truthing	7 May 2008, 6 December 2011 28 March 2012 30 March 2012 16-17 August 2012 3-4 September 2012 12-16 September 2012 23-24 October 2012
Stratified Sampling	20x20m quadrats in all existing vegetation communities excluding landscaped areas and 2 flora transects	5-7 May 2008 6-8 December 2011 28 March 2012 30 March 2012 16-17 August 2012 3-4 September 2012 12-16 September 2012 23-24 October 2012
Target Searches	Target searches in known habitats	6-7 May 2008 6-8 December 2011 28 March 2012 30 March 2012 16-17 August 2012 3-4 September 2012 12-16 September 2012 17, 19, 23-24 October 2012

Aerial images from *Spatial Information Exchange*, *Nearmap* and *Google EarthPro* were utilised in the field to aid in the identification of the various vegetation communities. This was then ground-truthed from foot traverses and driving along designated tracks. Each quadrat and transect was marked using *Trimble* GPS that generally has an accuracy of within 1-2m.

Many quadrats have been undertaken within the proposed development area and study area with various sets of quadrats used to confirm the presence or absence of EEC vegetation types (Duffys Forest and Coastal Upland Swamps).

Target threatened flora searches have been undertaken thoroughly and extensively throughout the proposed development area in winter, spring, summer and autumn. Some target searches were undertaken within the offset lands, however, many of the observations were more incidental and may not reflect the true or full extent (population) of the various species due to the size of the area being covered, seasonal survey and limitations of accessibility. The approximate distribution of known threatened flora occurrences is mapped on Figure 3.

Target searches were undertaken in accessible areas for those listed threatened species known to occur or with habitat potential within the local area.

Field survey in 2011 was conducted over a three (3) day period which included refinements to the vegetation mapping in 2008, target searches for threatened species, a further eleven (11) quadrats undertaken in 2011 and general random plots within tall heath or Open Forest to test further for the presence of Duffys Forest EEC utilising Smith and Smith's Duffys Forest Index.

In March 2012, flora survey was undertaken to the north east of the proposed development area off Wyatt Avenue.

In August and September 2012, studies were undertaken within the offset areas to assist in defining vegetation communities and threatened species potential, with incidental and some target survey of threatened species when time permitted.

In October 2012, target threatened species survey was undertaken for (primarily) *Tetratheca glandulosa*, *Haloragodendron lucasii*, *Lasiopetalum joyceae*, *Microtis angusii*, *Persoonia hirsuta*, *Pimelea curviflora var curviflora*, *Grevillea caleyi, Angophora crassifolia* and *Eucalyptus luehmanniana.*

2.2 Fauna survey methodology and dates

Site survey effort accounting for techniques deployed, duration, and weather conditions are outlined in Table 2 and are depicted on Figure 4.

Current standard fauna survey techniques employed by *Travers bushfire & ecology* in line with relevant survey guidelines, as well as current survey knowledge, are provided in Attachment 2. Fauna survey techniques that have been tailored to the site are provided below.

2.2.1 Diurnal birds

All diurnal bird surveys have been opportunistic observations during other survey methods. This is considered to be adequate based on the high number of diurnal hours spent in the field to date.

2.2.2 Nocturnal birds

Given the suitability of habitat present Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*) and Barking Owl (*Ninox connivens*) were targeted by call-playback techniques.

Observations for large hollows suitable for owls and signs of owl activity, in particular whitewash below perches / roost sites, were undertaken during survey.

2.2.3 Arboreal mammals

Koala (*Phascolactos cinereus*), Yellow-bellied Glider (*Petaurus australis*) were targeted by call-playback only from locations identified on Figure 4.

2011 surveys

Arboreal Type A Elliott traps were used along trap-lines indicated on Figure 4, consisting of five (5) traps each separated by 20-50m. Eastern Pygmy Possum was principally targeted and accordingly arboreal traps were placed more commonly in larger flowering *Banksia* trees.

2012 surveys

Arboreal hair tubes were placed along transect lines indicated on Figure 4, consisting of five (5) tubes each separated by 20-50m. Again, Eastern Pygmy Possum was principally targeted and accordingly arboreal traps were placed more commonly in larger flowering *Banksia* trees. The honey-water lure sprayed onto the branches and down to the base of the tree was a high honey concentrate.

2.2.4 Terrestrial mammals

2011 surveys

Bandicoot sized cage traps were used to target Southern Brown Bandicoot. These were placed along trap-lines of five (5) traps baited with the standard bait mix and laced with white truffle oil.

Elliott type B traps were placed along the same trap-lines as arboreal traps. These were baited with the standard bait mix and also laced with white truffle oil as an additional effort towards targeting Southern Brown Bandicoot. This method captured three (3) of the larger long-nosed bandicoot.

Large cage traps were used to target Spotted-tailed Quoll. Four (4) traps were placed at the outer limits of the site above sandstone edges. These traps were baited with sardines and nearby trees were smeared with jellymeat cat food as a lure.

Two surveillance cameras were placed within heath vegetation at opposing ends of the proposed development area. The viewing area was baited with standard bait mix, truffle oil and sardines to target the trap shy Southern Brown Bandicoot and the Spotted-tailed Quoll.

2012 surveys

Bandicoot sized cage traps and larger quoll sized cage were used to target Southern Brown Bandicoot. These were placed along trap-lines of four to six (4-6) traps (Figure 4), baited with the standard bait mix and laced with white truffle oil. Five (5) individually placed large cage traps were also placed and baited, targeting bandicoot (see Figure 4). A total of fifteen (15) quoll sized traps and twenty (20) bandicoot sized traps were placed targeting bandicoot over ten (10) consecutive nights, however five (5) of the large traps were also baited to target Spotted-tailed Quoll and Rosenberg's Goanna in the last four days / nights.

Five (5) large cage traps targeting quoll were used at the outer limits of the site above sandstone edges. These traps were baited with sardines, two-week old dead chickens and nearby trees were smeared with jellymeat cat food as a lure.

Three (3) surveillance cameras were placed within the proposed development area. These cameras were moved after the first five (5) nights to a second location for the next four (4) nights totalling six (6) surveillance camera locations. At four (4) locations the camera was placed facing cage traps to assist in determining trap shy animals on site. Three (3) of these traps were baited targeting both bandicoot and quoll. It should be noted here that Northern Brown Bandicoot (*Isoodon macrourus*) and Long-nosed Bandicoot (*Parameles nasuta*) have been captured by *Travers bushfire & ecology* on meat baits alone.

The other two (2) camera locations were placed facing bait placed on the ground. One (1) of these was the standard bait mix with truffle oil the other also had sardines. See Figure 4 for trap and camera locations.

2.2.5 Bats

2011 surveys

Two (2) harp traps were placed along flyways of internal vehicle trails where an overhanging tree branch could funnel captures into the trap.

Active Anabat monitoring and passive recording stations were undertaken.

2012 surveys

Bats were targeted by passive anabat recording, spotlighting and habitat searches.

2.2.6 Amphibians

2011 surveys

Searches for Red-crowned Toadlet were undertaken along the drainage line where a previous recording was made in 2008 as well as selected other potential locations opportunistically found.

2012 surveys

Diurnal habitat searches were undertaken around the escarpment edge to determine suitable locations for Red-crowned Toadlet and / or Giant Burrowing Frog breeding potential. The survey period followed a dry spring period and most ephemeral drainages were completely dry, including both locations where Red-crowned Toadlet were recorded previously. Where pools were found, tadpole searches were undertaken at this time as well as during nocturnal surveys. Clapping and yelling was carried out to evoke a call response from the Red-crowned Toadlet where suitable habitat was present.

During nocturnal searches along drainage lines, spotlighting was undertaken to search for Giant Burrowing Frog. This species is best spotlighted on wet nights down to 13ºC, however, both survey nights were under dry conditions. The first nocturnal surveys were undertaken the night after the only rainy day and night of the survey period. This wet night was however also very windy and generally inappropriate for frog survey.

Funnel traps placed for reptiles as described below also target frogs.

2.2.7 Reptiles

2011 surveys

Two (2) surveillance cameras were placed within heath vegetation at opposing ends of the proposed development area. The viewing area was baited with sardines to target Rosenberg's Goanna. Two (2) afternoons (13 & 15/12/11) during the survey week were considered most suitable for Rosenberg's Goanna activity. The species was only opportunistically surveyed at this time.

2012 surveys

Four (4) funnel trap transects were placed within the proposed development area targeting reptiles and frogs. Six (6) funnel traps were placed on either side of the approximately 10-15m long fence line at each transect. Funnel trap transects were located within or near to representations of different vegetation communities.

Five (5) large cage traps targeting Rosenberg's Goanna and Spotted-tailed Quoll were placed at the outer limits of the site above sandstone edges. These traps were baited with sardines, two-week old dead chickens and nearby trees were smeared with jellymeat cat food as a lure.

Three (3) surveillance cameras were faced to baited cages targeting goanna, bandicoot and quoll. One (1) additional camera location was baited with sardines. See Figure 2 for trap and camera locations. Locations indicated with a "Q" on Figure 2 were baited with meat targeting goanna and quoll.

Table 2 – Fauna survey effort

Fauna Group	Date	Weather Conditions	Survey Method	Survey Effort / Time (24hr)
Diurnal Birds	1/05/08	7/8 cloud, light NE wind, no rain, temp 18°C	Diurnal Opportunistic	3hrs 55min 1005 - 1400
		8/8 cloud, no wind, no rain, temp 19.5°C	Diurnal Opportunistic	1hr 20min 1440 - 1600
	2/05/08	0/8 cloud, no wind, no rain, temp 24°C	Diurnal Opportunistic	4hrs 30min 1300 - 1730
	12/12/11	8/8 cloud, moderate gusty SE wind, early showers, temp 18-20°C	Diurnal Opportunistic	4hrs 30min 1345 - 1815
		8/8 cloud, light SE wind, no rain, temp 18°C	Diurnal Opportunistic	1hr 35min 1845 - 2020
	13/12/11	8-4/8 cloud, light gusty SE wind, no rain, temp 20-24°C	Diurnal Opportunistic	9hrs 45min 1035 - 2020
	14/12/11	8/8 cloud, light-mod SE wind, no rain, temp 18-20°C	Diurnal Opportunistic	4hrs 50min 1040 - 1530
	15/12/11	7-5/8 cloud, no wind, no rain, temp 18-22°C	Diurnal Opportunistic	4hrs 45min 0955 - 1440
		2/8 cloud, no wind, no rain, temp 24°C	Diurnal Opportunistic	35mins 1600 - 1635
	16/12/11	6-8/8 cloud, no wind, no rain, temp 17-21°C	Diurnal Opportunistic	6hrs 55min 0950 - 1645
	15/10/12	0/8 cloud, no wind, no rain, temp 27-20°C	Diurnal Opportunistic	6hrs 30min 1300 - 1930
	16/10/12	5/8 cloud, light NE wind, no rain, temp 23-34°C	Diurnal Opportunistic	7hrs 30min 0900 - 1630
	17/10/12	3/8 cloud, light NE wind, no rain, temp 22-28°C	Diurnal Opportunistic	8hrs 20min 0750 - 1610
	18/10/12	8-4/8 cloud, no wind, no rain, temp 18-26°C	Diurnal Opportunistic	6hrs 20min 0740 - 1400
	19/10/12	8-2/8 cloud, no wind, no rain, temp 17-28°C	Diurnal Opportunistic	3hrs 40min 0800 - 1140
		2/8 cloud, no wind, no rain, temp 28°C	Diurnal Opportunistic	2hrs 50min 1220 - 1510
	20/10/12	0/8 cloud, no wind, no rain, temp 18-30°C	Diurnal Opportunistic	4hrs 25min 0735 - 1200
	21/10/12	7/8 cloud, no wind, no rain, temp 17-24°C	Diurnal Opportunistic	2hrs 20min 0740 - 1000
	22/10/12	8/8 cloud, mod SE wind, showers, temp 13-18°C	Diurnal Opportunistic	8hrs 10min 1040 - 1850
	23/10/12	2/8 cloud, no wind, no rain, temp 16-22°C	Diurnal Opportunistic	4hrs 10min 1050 - 1500
		1/8 cloud, no wind, no rain, temp 19-15°C	Diurnal Opportunistic	3hrs 15min 1600 - 1915
	24/10/12	0/8 cloud, light SW wind, no rain, temp 18-28°C	Diurnal Opportunistic	4hrs 50min 0930 - 1420
	25/10/12	0/8 cloud, light NE wind, no rain, temp 17-29°C	Diurnal Opportunistic	4hrs 40min 0750 - 1230
Nocturnal Birds	2/05/08	0/8 cloud, light SW wind, no rain, temp 15°C	Owl call playback and spotlighting	2hrs 15min 1815 - 2030
	12/12/11	8/8 cloud, no wind, no rain, temp 17°C	Spotlighting	1hr 5min 2035 - 2140
			Call playback (Powerful, Barking and Masked Owls)	commenced @ 2050
	13/12/11	7/8 cloud, light SE wind, no rain, temp 18°C	Spotlighting	1hr 30min 2045 - 2215
			Call playback (Powerful, Barking and Masked Owls)	commenced @ 2050

Nocturnal Birds (Cont.)	23/10/12 25/10/12	3/8 cloud, no wind, no rain, temp 15-13°C 0/8 cloud, no wind, no rain, ¾ moon, temp 22-18°C	Spotlighting Call playback (Powerful, Barking and Masked Owls) Spotlighting Call playback (Powerful, Barking and Masked Owls)	3hrs 15min 1925 - 2240 commenced @ 1940 2hrs 50min 1930 - 2220 commenced @ 1940
Arboreal Mammals	2/05/08 12/12/11 13/12/11 14/12/11 15/12/11 22/10/12 23/10/12 24/10/12 25/10/12	0/8 cloud, light SW wind, no rain, temp 15°C 8/8 cloud, no wind, no rain, temp 17°C 8/8 cloud, none-light wind, no rain, temp ~15°C 7/8 cloud, light SE wind, no rain, temp 18°C 8/8 cloud, light SE wind, no rain, temp ~16°C 8/8 cloud, no wind, no rain, temp ~16°C 8/8 cloud, no wind, no rain, temp ~16°C 8/8 cloud, mod SE wind, previous showers, temp >9°C no wind, no rain, temp >9°C 3/8 cloud, no wind, no rain, temp 15-13°C light SW wind, no rain, temp >12°C light NE wind, no rain, temp >15°C 0/8 cloud, no wind, no rain, ¾ moon, temp 22-18°C	Spotlighting + Call playback (Koala) Spotlighting Call playback (Koala and Yellow-bellied Glider) Elliot trapping Spotlighting Call playback (Koala and Yellow-bellied Glider) Elliot trapping Elliot trapping Elliot trapping Elliot trapping Hair tubes (alternating large & small) Hair tubes (alternating large & small) Spotlighting Call playback (Koala and Yellow-bellied Glider) Hair tubes (alternating large and small) Hair tubes (alternating large and small) Spotlighting Call playback (Koala and Yellow-bellied Glider)	2hrs 15min 1815 - 2030 1hr 5min 2035 - 2140 Commenced @ 2110 15 trap nights 1hr 30min 2045 - 2215 Commenced @ 2110 30 trap nights 30 trap nights 30 trap nights 45 trap nights 45 trap nights 3hrs 15min 1925 - 2240 commenced @ 1955 45 trap nights 45 trap nights 2hrs 50min 1930 - 2220 commenced @ 1955
Terrestrial Mammals	2/05/08 12/12/11 13/12/11 14/12/11 15/12/11	0/8 cloud, light SW wind, no rain, temp 15°C 8/8 cloud, no wind, no rain, temp 17°C 8/8 cloud, none-light wind, no rain, temp ~15°C 7/8 cloud, light SE wind, no rain, temp 18°C 8/8 cloud, light SE wind, no rain, temp ~16°C 8/8 cloud, no wind, no rain, temp ~16°C 8/8 cloud, no wind, no rain, temp ~16°C	Spotlighting Spotlighting Elliot trapping Cage trapping (small bandicoot size) Spotlighting Elliot trapping Cage trapping (small - bandicoot size) Cage trapping (large - quoll size) Elliot trapping Cage trapping (small - bandicoot size) Cage trapping (large - quoll size) Elliot trapping Cage trapping (small - bandicoot size) Cage trapping (large - quoll size)	2hrs 15min 1815 - 2030 1hr 5min 2035 - 2140 15 trap nights 10 trap nights 1hr 30min 2045 - 2215 30 trap nights 20 trap nights 4 trap nights 30 trap nights 20 trap nights 4 trap nights 30 trap nights 20 trap nights 4 trap nights

Terrestrial Mammals (Cont.)	15/10/12	no wind, no rain, temp >15°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
	16/10/12	light NE wind, no rain, temp >19°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
	17/10/12	no wind, no rain, temp >14°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
	18/10/12	no wind, no rain, temp >13°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
	19/10/12	no wind, no rain, temp >15°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
	20/10/12	no wind, no rain, temp >12°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
	21/10/12	no wind, no rain, temp >12°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
	22/10/12	8/8 cloud, mod SE wind, previous showers, temp >9°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
			Hair tubes (alternating large and small)	45 trap nights
	23/10/12	3/8 cloud, no wind, no rain, temp 15-13°C	Spotlighting	3hrs 15min 1925 - 2240
		no wind, no rain, temp >9°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
			Hair tubes (alternating large and small)	45 trap nights
	24/10/12	light SW wind, no rain, temp >12°C	Cage trapping (small - bandicoot size)	20 trap nights
			Cage trapping (large - quoll size)	15 trap nights
			Surveillance camera	3 camera nights
			Hair tubes (alternating large and small)	45 trap nights
	25/10/12	0/8 cloud, no wind, no rain, ¾ moon, temp 22-18°C	Spotlighting	2hrs 50min 1930 - 2220
		light NE wind, no rain, temp >15°C	Hair tubes (alternating large and small)	45 trap nights
Bats	2/05/08	0/8 cloud, light SW wind, no rain, temp 15°C	Anabat II x3 / spotlighting	2hrs 55min 1735 - 2030
	12/12/11	8/8 cloud, no wind, no rain, temp 17°C	Spotlighting / Anabat active monitoring	1hr 5min 2035 - 2140
		8/8 cloud, none-light wind, no rain, temp ~15°C	Harp (Constantine) trapping	1 trap night
	13/12/11	7/8 cloud, light SE wind, no rain, temp 18°C	Spotlighting	1hr 30min 2045 - 2215
		8/8 cloud, light SE wind, no rain, temp ~16°C	Anabat passive monitoring	O'night from 2035

Bats (Cont.)			Harp (Constantine) trapping	2 trap nights
	14/12/11	8/8 cloud, no wind, no rain, temp ~16°C	Harp (Constantine) trapping	2 trap nights
	15/12/11	8/8 cloud, no wind, no rain, temp ~16°C	Harp (Constantine) trapping	2 trap nights
	16-18/12/11	Various (mostly fine)	Anabat passive monitoring	O'night for 3 nights
	23/10/12	3/8 cloud, no wind, no rain, temp 15-13°C	Spotlighting	3hrs 15min 1925 - 2240
		no wind, no rain, temp >9°C	Anabat passive monitoring	O'night from 1925
	25/10/12	0/8 cloud, no wind, no rain, ¾ moon, temp 22-18°C	Spotlighting	2hrs 50min 1930 - 2220
		light NE wind, no rain, temp >15°C	Anabat passive monitoring	2hrs 25min 1925 - 2150
Reptiles	1/05/08	7/8 cloud, light NE wind, no rain, temp 18°C	Habitat search, opportunistic	3hrs 55min 1005 - 1400
		8/8 cloud, no wind, no rain, temp 19.5°C	Habitat search, opportunistic	1hr 20min 1440 - 1600
	2/05/08	0/8 cloud, no wind, no rain, temp 24°C	Habitat search, opportunistic	4hrs 30min 1300 - 1730
	12/12/11	8/8 cloud, moderate gusty SE wind, early showers, temp 18-20°C	Diurnal opportunistic	4hrs 30min 1345 - 1815
		8/8 cloud, light SE wind, no rain, temp 18°C	Diurnal opportunistic	1hr 35min 1845 - 2020
	13/12/11	8-4/8 cloud, light gusty SE wind, no rain, temp 20-24°C	Opportunistic habitat searches	9hrs 45min 1035 - 2020
	14/12/11	8/8 cloud, light-mod SE wind, no rain, temp 18-20°C	Diurnal opportunistic	4hrs 50min 1040 - 1530
	15/12/11	7-5/8 cloud, no wind, no rain, temp 18-22°C	Opportunistic habitat searches	4hrs 45min 0955 - 1440
		2/8 cloud, no wind, no rain, temp 24°C	Opportunistic habitat searches	35mins 1600 - 1635
	16/12/11	6-8/8 cloud, no wind, no rain, temp 17-21°C	Diurnal opportunistic	6hrs 55min 0950 - 1645
	15/10/12	0/8 cloud, no wind, no rain, temp 27-20°C	Opportunistic / habitat searches	6hrs 30min 1300 - 1930
	16/10/12	5/8 cloud, light NE wind, no rain, temp 23-34°C	Opportunistic / habitat searches	7hrs 30min 0900 - 1630
			Funnel trapping	24 trap days
	17/10/12	3/8 cloud, light NE wind, no rain, temp 22-28°C	Opportunistic / habitat searches	8hrs 20min 0750 - 1610
			Funnel trapping	24 trap days
	18/10/12	8-4/8 cloud, no wind, no rain, temp 18-26°C	Opportunistic / habitat searches	6hrs 20min 0740 - 1400
			Funnel trapping	24 trap days
	19/10/12	8-2/8 cloud, no wind, no rain, temp 17-28°C	Opportunistic / habitat searches	3hrs 40min 0800 - 1140
			Funnel trapping	24 trap days
		2/8 cloud, no wind, no rain, temp 28°C	Opportunistic / habitat searches	2hrs 50min 1220 - 1510
			Funnel trapping	24 trap days
	20/10/12	0/8 cloud, no wind, no rain, temp 18-30°C	Opportunistic / habitat searches	4hrs 25min 0735 - 1200
			Funnel trapping	24 trap days
	21/10/12	7/8 cloud, no wind, no rain, temp 17-24°C	Opportunistic / habitat searches	2hrs 20min 0740 - 1000
			Funnel trapping	24 trap days
	22/10/12	8/8 cloud, mod SE wind, showers, temp 13-18°C	Opportunistic / habitat searches	8hrs 10min 1040 - 1850
		1/8 cloud, no wind, no rain, temp 19-15°C	Opportunistic / habitat searches	3hrs 15min 1600 - 1915
			Funnel trapping	24 trap days
	24/10/12	0/8 cloud, light SW wind, no rain, temp 18-28°C	Opportunistic / habitat searches	4hrs 50min 0930 - 1420
			Funnel trapping	24 trap days
	25/10/12	0/8 cloud, light NE wind, no rain, temp 17-29°C	Opportunistic / GPS cotton line to find burrows	4hrs 40min 0750 - 1230
			Funnel trapping	24 trap days

Amphibians	23/10/12	2/8 cloud, no wind, no rain, temp 16-22°C	Opportunistic / habitat searches	4hrs 10min 1050 - 1500
			Funnel trapping	24 trap days
	13/12/11	8-4/8 cloud, light gusty SE wind, no rain, temp 20-24°C	Opportunistic habitat searches	9hrs 45min 1035 - 2020
		7/8 cloud, light SE wind, no rain, temp 18°C	Spotlighting + Call Identification	1hr 30min 2045 - 2215
	15/12/11	7-5/8 cloud, no wind, no rain, temp 18-22°C	Opportunistic habitat searches	4hrs 45min 0955 - 1440
		2/8 cloud, no wind, no rain, temp 24°C	Opportunistic habitat searches	35mins 1600 - 1635
	15/10/12	no wind, no rain, temp >15°C	Funnel trapping	24 trap nights
	16/10/12	light NE wind, no rain, temp >19°C	Funnel trapping	24 trap nights
	17/10/12	no wind, no rain, temp >14°C	Funnel trapping	24 trap nights
	18/10/12	no wind, no rain, temp >13°C	Funnel trapping	24 trap nights
	19/10/12	no wind, no rain, temp >15°C	Funnel trapping	24 trap nights
	20/10/12	no wind, no rain, temp >12°C	Funnel trapping	24 trap nights
	21/10/12	no wind, no rain, temp >12°C	Funnel trapping	24 trap nights
	22/10/12	8/8 cloud, mod SE wind, previous showers, temp >9°C	Funnel trapping	24 trap nights
	23/10/12	1/8 cloud, no wind, no rain, temp 19-15°C	Diurnal habitat searches	3hrs 15min 1600 - 1915
		no wind, no rain, temp 15-13°C	Spotlighting /call identification / tadpole searches	3hrs 15min 1925 - 2240
		no wind, no rain, temp >9°C	Funnel trapping	24 trap nights
	25/10/12	0/8 cloud, no wind, no rain, ¾ moon, temp 22-18°C	Spotlighting / call Identification / tadpole searches	2hrs 50min 1930 - 2220

Flora and Fauna Survey results

3

3.1 Site Features

Table 3 provides a summary of the planning, cadastral, topographical features and noted disturbance of and within the proposed development area.

Table 3 – Site features

Location	Part of Lot 1 DP 1139826
Size	Approximately 15-16ha
Local government area	Warringah
Grid reference	333600E 6266800N
Elevation	Approximately 150-170m AHD
Topography	Situated upon a plateau area with minor slopes, increasing near the northern and southern development boundary.
Geology and soils	Geology; sandstone Soils; Lambert Soil Landscape, Somersby Soil Landscape and Hawkesbury Soil Landscape
Catchment & drainage	French's Creek (to the south) and Fireclay Creek (to the north) into Middle Harbour Creek.
Vegetation	Coastal Sandstone Heath and Sydney Sandstone Ridgetop Woodland (predominately)
Existing land use	Crown Land and residential
Clearing	Clearing for the existing residence and Asset Protection Zones, and any road, track and existing electrical structures.

3.2 Flora

3.2.1 Flora species

Native and exotic plant species observed within the vegetation communities of the study area are listed within Table 4. A total of two hundred and ninety nine (299) flora species were observed within the study area during the survey. This number comprised 226 native species and 73 exotic species. It should be noted that the majority of exotic species were only recorded adjacent to the Ralston Avenue entrance into the development area, around the existing residence or adjacent to prominent tracks. The remainder of the development area contained very few weeds. During the investigations, two (2) threatened flora species were sighted, *Tetratheca glandulosa* and *Grevillea caleyi*.

Table 4 – Plant species observations for the study area

Family	Scientific Name	Common Name	Form
Mimosaceae	*Acacia brownii*	-	s
Mimosaceae	*Acacia decurrens*	Black Wattle	t
Mimosaceae	*Acacia floribunda*	Sally Wattle	s
Mimosaceae	*Acacia longifolia* var. *longifolia*	Sydney Golden Wattle	s
Mimosaceae	*Acacia lunata*	Box-leaved Wattle	s
Mimosaceae	*Acacia myrtifolia*	Red Stem Wattle	s
Mimosaceae	*Acacia parramattensis*	Sydney Green Wattle	t
Mimosaceae	*Acacia saligna**	Orange Wattle	s
Mimosaceae	*Acacia suaveolens*	Sweet Scented Wattle	s
Mimosaceae	*Acacia terminalis*	Sunshine Wattle	s
Mimosaceae	*Acacia ulicifolia*	Prickly Moses	s
Polygonaceae	*Acetosa saggitata**	Turkey Rhubarb	g
Asteraceae	*Actinotus helianthi*	Flannel Flower	g
Asteraceae	*Actinotus minor*	Lesser Flannel Flower	g
Asteraceae	*Ageratina adenophora**	Crofton Weed	g
Casuarinaceae	*Allocasuarina distyla*	Scrub She-oak	s
Casuarinaceae	*Allocasuarina littoralis*	Black She-oak	t
Myrsinaceae	*Anagallis arvensis var. caerulea**	Blue Pimpernel	g
Poaceae	*Andropogon virginicus**	Whisky Grass	g
Myrtaceae	*Angophora costata*	Smooth-barked Apple	t
Myrtaceae	*Angophora crassifolia*	-	t
Myrtaceae	*Angophora hispida*	Dwarf Apple	s
Poaceae	*Anisopogon avenaceus*	Oat Speargrass	g
Apocnyaceae	*Araujia sericifera**	Mothvine	v
Poaceae	*Aristida vagans*	Three-awn Speargrass	g
Asparagaceae	*Asparagus aethiopicus**	Asparagus Fern	g
Asteraceae	*Aster subulatus**	Wild Aster	g
Araliaceae	*Astrotricha floccosa*	-	s
Poaceae	*Austrodanthonia sp.*	Wallaby Grass	g
Poaceae	*Avena fatua**	Wild Oats	g
Poaceae	*Axonopus affinis**	Narrow-leaved Carpet Grass	g
Myrtaceae	*Baeckea diosmifolia*	-	s
Myrtaceae	*Baeckea imbricata*	-	s
Restionaceae	*Baloskion gracile*	-	g
Proteaceae	*Banksia ericifolia* var. *ericifolia*	Heath-leaved Banksia	s
Proteaceae	*Banksia marginata*	Silver Banksia	s
Proteaceae	*Banksia oblongifolia*	-	s
Proteaceae	*Banksia serrata*	Old Man Banksia	t
Proteaceae	*Banksia spinulosa*	Hairpin Banksia	s
Cunoniaceae	*Bauera rubioides*	River Rose	s
Asteraceae	*Bidens pilosa**	Cobbler's Pegs	g
Pittosporaceae	*Billardiera scandens* var. *scandens*	Apple Dumplings	v
Blandfordiaceae	*Blandfordia nobilis*	Christmas Bells	g
Blechnaceae	*Blechnum cartilagineum*	Gristle Fern	g

Family	Scientific Name	Common Name	Form
Rutaceae	*Boronia ledifolia*	Sydney Boronia	s
Rutaceae	*Boronia pinnata*	Pinnate Boronia	s
Rutaceae	*Boronia serrulata*	Native Rose	s
Fabaceae	*Bossiaea heterophylla*	Variable Bossiaea	s
Fabaceae	*Bossiaea obcordata*	Spiny Bossiaea	s
Fabaceae	*Bossiaea scolopendria*	-	s
Poaceae	*Briza maxima**	Quaking Grass	g
Poaceae	*Briza minor**	Shivery Grass	g
Poaceae	*Bromus cartharticus**	Prairie Grass	g
Cunoniaceae	*Callicoma serratifolia*	Black Wattle	t
Myrtaceae	*Callistemon linearis*	Narrow-leaved Bottlebrush	s
Dicksoniaceae	*Calochlaena dubia*	Rainbow Fern	g
Lauraceae	*Cassytha pubescens*	Common Devil's Twine	v
Cyperaceae	*Caustis flexuosa*	Curly Sedge	g
Cyperaceae	*Caustis pentandra*	-	g
Gentianaceae	*Centaurium erythraea**	Pink Stars	g
Apiaceae	*Centella asiatica*	Swamp Pennywort	g
Carophyllaceae	*Cerastium glomeratum**	Mouse-ear Chickweed	g
Poaceae	*Chloris gayana**	Rhodes Grass	g
Asteraceae	*Chrysanthemoides monilifera* subsp. *monilifera**	Bitou Bush	s
Asteraceae	*Cirsium vulgare**	Spear Thistle	g
Ranunculaceae	*Clematis aristata*	Old Man's Beard	v
Polygalaceae	*Comesperma ericinum*	Matchheads	s
Proteaceae	*Conospermum longifolium* subsp. *longifolium*	Smokebush	s
Asteraceae	*Conyza bonariensis**	Flax-leaf Fleabane	g
Asteraceae	*Conyza sumatrensis**	Fleabane	g
Asteraceae	*Coreopsis lanceolata**	-	g
Poaceae	*Cortaderia selloana**	Pampas Grass	g
Myrtaceae	*Corymbia gummifera*	Red Bloodwood	t
Malaceae	*Cotoneaster pannosus**	Cotoneaster (cultivar)	s
Asteraceae	*Crassocephalum crepidioides**	Thickheads	g
Orchidaceae	*Cryptostylis erecta*	Bonnet Orchid	g
Orchidaceae	*Cryptostylis subulata*	Targe Tongue Orchid	g
Cyatheaceae	*Cyathea cooperi*	Straw Treefern	t
Apiaceae	*Cyclospermum leptophyllum**	Slender Celery	g
Poaceae	*Cynodon dactylon*	Common Couch	g
Cyperaceae	*Cyperus eragrostis**	Umbrella Sedge	g
Goodeniaceae	*Dampiera stricta*	Blue Dampiera	g
Myrtaceae	*Darwinia fascicularis* subsp. *fascicularis*	-	s
Asteraceae	*Delairea odorata**	Cape Ivy	v
Phormiaceae	*Dianella caerulea* var. *caerulea*	Flax Lily	g
Phormiaceae	*Dianella caerulea* var. *producta*	Blue Flax Lily	g
Phormiaceae	*Dianella prunina*	-	g

Family	Scientific Name	Common Name	Form
Poaceae	*Digitaria sanguinalis**	Crab Grass	g
Fabaceae	*Dillwynia floribunda* var. *floribunda*	Parrot Pea	s
Fabaceae	*Dillwynia glaberrima*	Parrot Pea	s
Fabaceae	*Dillwynia retorta* var. *retorta*	Eggs and Bacon	s
Orchidaceae	*Dipodium punctatum*	Hyacinth Orchid	g
Asteraceae	*Dittrichia graveolens**	Stinkwort	g
Sapindaceae	*Dodonaea triquetra*	Hop Bush	s
Droseraceae	*Drosera peltata*	Sundew	g
Droseraceae	*Drosera spathulata*	Common Sundew	g
Poaceae	*Ehrharta erecta**	Panic Veldtgrass	g
Eleocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash	t
Poaceae	*Eleusine indica**	Crowsfoot Grass	g
Restionaceae	*Empodisma minus*	-	g
Poaceae	*Entolasia marginata*	Bordered Panic	g
Poaceae	*Entolasia stricta*	Wiry Panic	g
Epacridaceae	*Epacris longiflora*	Native Fuschia	s
Epacridaceae	*Epacris microphylla*	Coral Heath	s
Epacridaceae	*Epacris obtusifolia*	-	s
Epacridaceae	*Epacris pulchella*	NSW Coral Heath	s
Poaceae	*Eragrostis brownii*	Brown's Lovegrass	g
Poaceae	*Eragrostis curvula**	African Lovegrass	g
Asteraceae	*Erigeron karvinskianus**	Mexican Daisy	g
Fabaceae	*Erythrina sykesii**	Coral Tree	t
Myrtaceae	*Eucalyptus haemastoma*	Scribbly Gum	t
Myrtaceae	*Eucalyptus luehmanniana*	Yellowtop Ash	t
Myrtaceae	*Eucalyptus oblonga*	-	t
Myrtaceae	*Eucalyptus piperita* subsp. *piperita*	Sydney Peppermint	t
Myrtaceae	*Eucalyptus punctata*	Grey Gum	t
Myrtaceae	*Eucalyptus sieberi*	Silvertop Ash	t
Asteraceae	*Euchiton sphaericus*	Cudweed	g
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry	v
Cyperaceae	*Ficinia nodosa*	Knobby Club-rush	g
Cyperaceae	*Gahnia clarkei*	Tall Saw-sedge	g
Cyperaceae	*Gahnia melanocarpa*	Black-fruit Saw-sedge	g
Cyperaceae	*Gahnia sieberiana*	Red-fruited Saw-sedge	g
Asteraceae	*Gamochaeta spicata**	Cudweed	g
Gleicheniaceae	*Gleichenia dicarpa*	Pouched Coral Fern	g
Euphorbiaceae	*Glochidion ferdinandii*	Cheese Tree	t
Fabaceae	*Glycine microphylla*	-	v
Fabaceae	*Gompholobium grandiflorum*	Golden Glory Pea	s
Fabaceae	*Gompholobium latifolium*	Broad-leaf Wedge-pea	s
Haloragaceae	*Gonocarpus teucroides*	Raspwort	g
Goodeniaceae	*Goodenia bellidifolia*	Daisy-leaved Goodenia	g
Goodeniaceae	*Goodenia dimorpha* var. *dimorpha*	-	g
Goodeniaceae	*Goodenia hederacea*	Ivy-leaved Goodenia	g
Proteaceae	*Grevillea buxifolia* subsp. *buxifolia*	Grey Spider Flower	s

Family	Scientific Name	Common Name	Form
Proteaceae	*Grevillea caleyi* [TS]	-	s
Proteaceae	*Grevillea linearifolia*	Linear-leaf Grevillea	s
Proteaceae	*Grevillea sericea*	Pink Spider Flower	s
Proteaceae	*Grevillea* sp. (cultivar)*	-	s
Proteaceae	*Grevillea speciosa*	Red Spider Flower	s
Haemodoraceae	*Haemodorum corymbosum*	Bloodroot	g
Haemodoraceae	*Haemodorum planifolium*	Bloodroot	g
Proteaceae	*Hakea dactyloides*	Broad-leaved Hakea	s
Proteaceae	*Hakea salicifolia*	Willow Hakea	s
Proteaceae	*Hakea sericea*	Needlebush	s
Proteaceae	*Hakea teretifolia*	Dagger Hakea	s
Zingiberaceae	*Hedychium gardnerianum**	Ginger Lily	g
Lamiaceae	*Hemigenia purpurea*	Narrow-leaved Hemigenia	s
Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower	g
Dilleniaceae	*Hibbertia bracteata*	-	s
Dilleniaceae	*Hibbertia cistiflora*	-	s
Dilleniaceae	*Hibbertia empetrifolia subsp. uncinata*	-	g
Dilleniaceae	*Hibbertia linearis*	-	g
Euphorbiaceae	*Homalanthus populifolius*	Bleeding Heart	s
Fabaceae	*Hovea linearis*	-	g
Apiaceae	*Hydrocotyle bonariensis**	Kurnell Curse / Pennywort	g
Clusiaceae	*Hypericum gramineum*	Small St Johns Wort	g
Asteraceae	*Hypochaeris glabra**	Smooth Catsear	g
Asteraceae	*Hypochaeris radicata**	Flatweed	g
Restionaceae	*Hypolaena fastigata*	Tassel Rope-rush	g
Poaceae	*Imperata cylindrica* var. *major*	Blady Grass	g
Convolvulaceae	*Ipomoea indica**	Coastal Morning Glory	v
Proteaceae	*Isopogon anemonifolius*	Flat-leaved Drumsticks	s
Proteaceae	*Isopogon anethifolius*	Round-leaved Drumsticks	s
Fabaceae	*Jacksonia scoparia*	Dogwood	s
Juncaceae	*Juncus articulatus*	Jointed Rush	g
Juncaceae	*Juncus planifolius*	Broad Rush	g
Juncaceae	*Juncus usitatus*	Common Rush	g
Fabaceae	*Kennedia rubicunda*	Dusky Coral Pea	v
Myrtaceae	*Kunzea ambigua*	Tick Bush	s
Myrtaceae	*Kunzea capitata*	Pink Buttons	s
Proteaceae	*Lambertia formosa*	Mountain Devil	s
Verbenaceae	*Lantana camara**	Lantana	s
Sterculiaceae	*Lasiopetalum ferrugineum* var. *ferrugineum*	Rusty Velvet-bush	s
Sterculiaceae	*Lasiopetalum parviflorum*	-	s
Rutaceae	*Leionema diosmeum*	-	s
Cyperaceae	*Lepidosperma filiforme*	-	g
Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge	g
Cyperaceae	*Lepidosperma limicola*	-	g

Family	Scientific Name	Common Name	Form
Restionaceae	*Leptocarpus tenax*	Slender Twine-rush	g
Myrtaceae	*Leptospermum grandifolium*	Woolly Tea-tree	s
Myrtaceae	*Leptospermum laevigatum*	Coast Tea-tree	s
Myrtaceae	*Leptospermum polygalifolium*	Lemon Scented Tea-tree	s
Myrtaceae	*Leptospermum squarrosum*	-	s
Myrtaceae	*Leptospermum trinervium*	Flaky-barked Tea-tree	s
Restionaceae	*Lepyrodia scariosa*	Scale Rush	g
Epacridaceae	*Leucopogon esquamatus*	-	s
Epacridaceae	*Leucopogon lanceolatus*	Lance-leaf Beard-heath	s
Epacridaceae	*Leucopogon microphyllus*	Small-leaved Whitebeard	s
Oleaceae	*Ligustrum sinense**	Small-leaved Privet	s
Liliaceae	*Lilium formosanum**	Formosan Lily	g
Lindsaeaceae	*Lindsaea linearis*	Screw Fern	g
Lindsaeaceae	*Lindsaea microphylla*	Lacy Wedge-fern	g
Lomandraceae	*Lomandra cylindrica*	-	g
Lomandraceae	*Lomandra filiformis* subsp. *filiformis*	Wattle Mat-rush	g
Lomandraceae	*Lomandra glauca* subsp. *glauca*	-	g
Lomandraceae	*Lomandra gracilis*	-	g
Lomandraceae	*Lomandra longifolia*	Spiky-headed Mat-rush	g
Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush	g
Lomandraceae	*Lomandra obliqua*	Twisted Mat-rush	g
Proteaceae	*Lomatia myricoides*	River Lomatia	s
Proteaceae	*Lomatia silaifolia*	Crinkle Bush	s
Caprifoliaceae	*Lonicera japonica**	Japanese Honeysuckle	v
Myrtaceae	*Melaleuca armillaris*	Bracelet Honey Myrtle	s
Myrtaceae	*Melaleuca hypericifolia*	-	s
Meliaceae	*Melia azedarach* var. *australasica*	White Cedar	t
Euphorbiaceae	*Micrantheum ericoides*	-	s
Poaceae	*Microlaena stipoides* var. *stipoides*	Weeping Rice Grass	g
Myrtaceae	*Micromyrtus ciliata*	-	s
Fabaceae	*Mirbelia rubiifolia*	-	s
Loganiaceae	*Mitrasacme polymorpha*	Mitrewort	g
Davalliaceae	*Nephrolepis cordifolia**	Fish-bone Fern	g
Apocynaceae	*Nerium oleander**	Oleander Bush	s
Rubiaceae	*Opercularia aspera*	Common Stinkweed	g
Poaceae	*Oplismenus aemulus*	Basket Grass	g
Poaceae	*Oplismenus imbecillis*	-	g
Oxalidaceae	*Oxalis exilis*	-	g
Asteraceae	*Ozothamnus diosmifolius*	Ball Everlasting	s
Poaceae	*Panicum simile*	Two Colour Panic	g
Poaceae	*Paspalum dilatatum**	Paspalum	g
Iridaceae	*Patersonia glabrata*	Leafy Purple-flag	g
Iridaceae	*Patersonia sericea*	Wild Iris	g
Poaceae	*Pennisetum clandestinum**	Kikuyu	g
Polygonaceae	*Persicaria decipiens*	Slender Knotweed	g
Proteaceae	*Persoonia isophylla*	-	s

Family	Scientific Name	Common Name	Form
Proteaceae	*Persoonia lanceolata*	Lance-leaved Geebung	s
Proteaceae	*Persoonia levis*	Broad-leaved Geebung	s
Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung	s
Proteaceae	*Persoonia oblongata*	-	s
Proteaceae	*Petrophile pulchella*	Conesticks	s
Rutaceae	*Phebalium squamulosum* subsp. *squamulosum*	-	s
Euphorbiaceae	*Phyllanthus hirtellus*	Thyme Spurge	s
Faboideae	*Phyllota phylicoides*	Heath Phyllota	s
Phytolaccaceae	*Phytolacca octandra**	Inkweed	s
Thymelaeaceae	*Pimelea linifolia* subsp. *linifolia*	Slender Rice Flower	s
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	s
Plantaginaceae	*Plantago lanceolata**	Ribwort	g
Apiaceae	*Platysace ericoides*	Heathy Platysace	s
Apiaceae	*Platysace lanceolata*	Lance-leaf Platysace	s
Apiaceae	*Platysace linearifolia*	Narrow-leafed Platysace	s
Rhamnaceae	*Pomaderris ferruginea*	-	s
Rubiaceae	*Pomax umbellata*	Pomax	g
Euphorbiaceae	*Poranthera ericifolia*	-	s
Dennstaedtiaceae	*Pteridium esculentum*	Bracken	g
Cyperaceae	*Ptilothrix deusta*	-	g
Fabaceae	*Pultenaea scabra*	-	s
Fabaceae	*Pultenaea stipularis*	-	s
Fabaceae	*Pultenaea tuberculata*	-	s
Rubiaceae	*Richardia brasiliensis**	White Eye	g
Euphorbiaceae	*Ricinus communis**	Castor Oil Plant	s
Rosaceae	*Rubus fruticosus* subsp. agg.*	Blackberry	s
Polygonaceae	*Rumex crispus**	Curled Dock	g
Goodeniaceae	*Scaevola ramosissima*	Purple Fan Flower	g
Cyperaceae	*Schoenus apogon*	Fluke Bog-rush	g
Cyperaceae	*Schoenus brevifolius*	Bog-rush	g
Schizaeaceae	*Schizaea bifida*	Forked Comb-fern	g
Asteraceae	*Senecio madagascariensis**	Fireweed	g
Cesalpinioideae	*Senna pendula* var. *glabrata**	-	s
Poaceae	*Setaria parviflora**	-	g
Malvaceae	*Sida rhombifolia**	Paddy's Lucerne	g
Smilacaceae	*Smilax glyciphylla*	Sarsaparilla	v
Solanaceae	*Solanum mauritianum**	Wild Tobacco	s
Solanaceae	*Solanum nigrum**	Black Nightshade	g
Solanaceae	*Solanum sisymbriifolium*	-	s
Asteraceae	*Sonchus oleraceus**	Common Sow-thistle	g
Anthericaceae	*Sowerbaea juncea*	Vanilla Lily	g
Poaceae	*Sporobolus africanus**	Parramatta Grass	g
Epacridaceae	*Sprengelia incarnata*	Swamp Heath	s
Stackhousiae	*Stackhousia nuda*	-	g
Stackhousiae	*Stackhousia viminea*	-	g

Family	Scientific Name	Common Name	Form
Poaceae	*Stenotaphrum secundatum**	Buffalo Grass	g
Menispermiaceae	*Stephania japonica* var. *discolor*	Snake Vine	v
Gleicheniaceae	*Sticherus flabellatus*	Umbrella Fern	g
Stylidiaceae	*Stylidium graminifolium*	Trigger Plant	g
Stylidiaceae	*Stylidium lineare*	Trigger Plant	g
Epacridaceae	*Styphelia laeta* subsp. *latifolia*	Five Corners	s
Epacridaceae	*Styphelia tubiflora*	-	s
Asteraceae	*Tagetes minuta**	Stinking Roger	g
Asteraceae	*Taraxacum officinale**	Dandelion	g
Elaeocarpaceae	*Tetratheca ericifolia*	Black-eyed Susan	g
Elaeocarpaceae	*Tetratheca glandulosa*[TS]	Black-eyed Susan	g
Elaeocarpaceae	*Tetratheca thymifolia*	Black-eyed Susan	g
Poaceae	*Themeda australis*	Kangaroo Grass	g
Anthericaceae	*Thysanotus tuberosus*	Fringed Lily	g
Commelinaceae	*Tradescantia fluminsis**	Wandering Jew	g
Fabaceae	*Trifolium repens**	White Clover	g
Verbenaceae	*Verbena bonariensis**	Purpletop	g
Verbenaceae	*Verbena quadrangularis**	-	g
Fabaceae	*Vicia sativa* subsp. *sativa**	Common Vetch	v
Fabaceae	*Viminaria juncea*	Native Broom	s
Fabaceae	*Wisteria sinensis**	Wisteria	v
Epacridaceae	*Woollsia pungens*	-	s
Xanthorrhoaceae	*Xanthorrhoea arborea*	Broad-leaf Grass Tree	s
Xanthorrhoaceae	*Xanthorrhoea media* subsp. *media*	Forest Grass Tree	g
Xanthorrhoaceae	*Xanthorrhoea resinosa*	-	g
Apiaceae	*Xanthosia pilosa*	Woolly Xanthosia	g
Apiaceae	*Xanthosia tridentata*	Rock Xanthosia	g
Proteaceae	*Xylomelum pyriforme*	Woody Pear	t
Xyridaceae	*Xyris gracilis*	Slender Yellow-eye	g
Araeceae	*Zantedeschia aethiopica**	White Arum Lily	g
Rutaceae	*Zieria smithii*	Sandfly Zieria	s

t = tree
s = shrub
g = groundcover
v = vine
w = water/wetland plant
[TS] indicates threatened species

3.2.2 Vegetation communities

A total of seven (7) vegetation structures were identified that conform to five (5) separate and distinct communities. The vegetation communities observed are:

- Coastal Sandstone Heath and comprising – Short Heath, Tall Heath and Damp Tall Heath variations. Damp Tall Heath fits the description afforded by Smith and Smith (2005) for Sandstone Coastal Heath (vegetation unit 19, subunit iv).

- Sydney Sandstone Ridgetop Woodland and comprising - Low Open Forest and Open Forest variations.

- Disturbed areas – Cleared, Managed, Landscaped or Weed Plume.

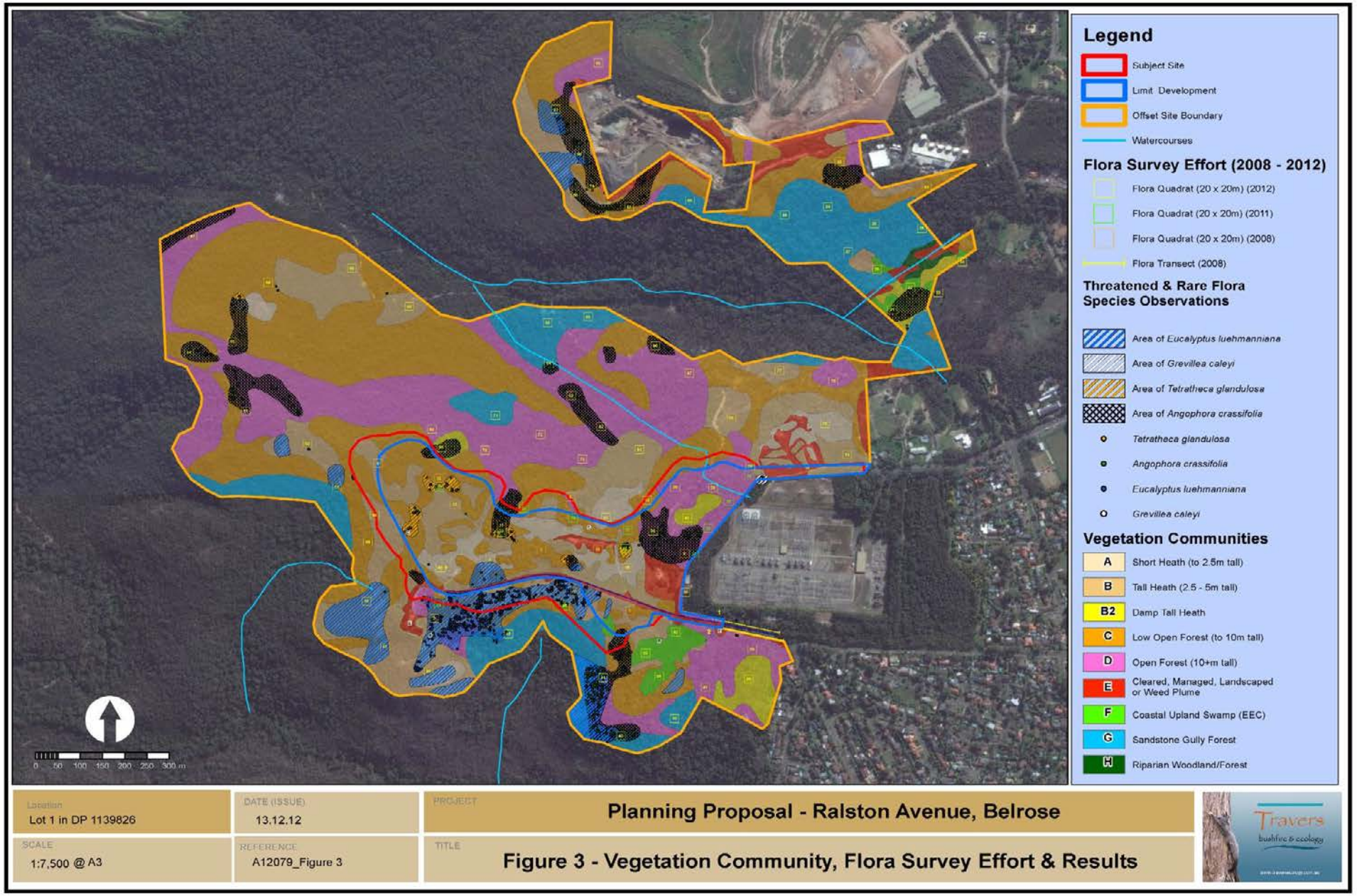

Figure 3 – Vegetation communities and flora survey results within Lot 1 in DP1139826

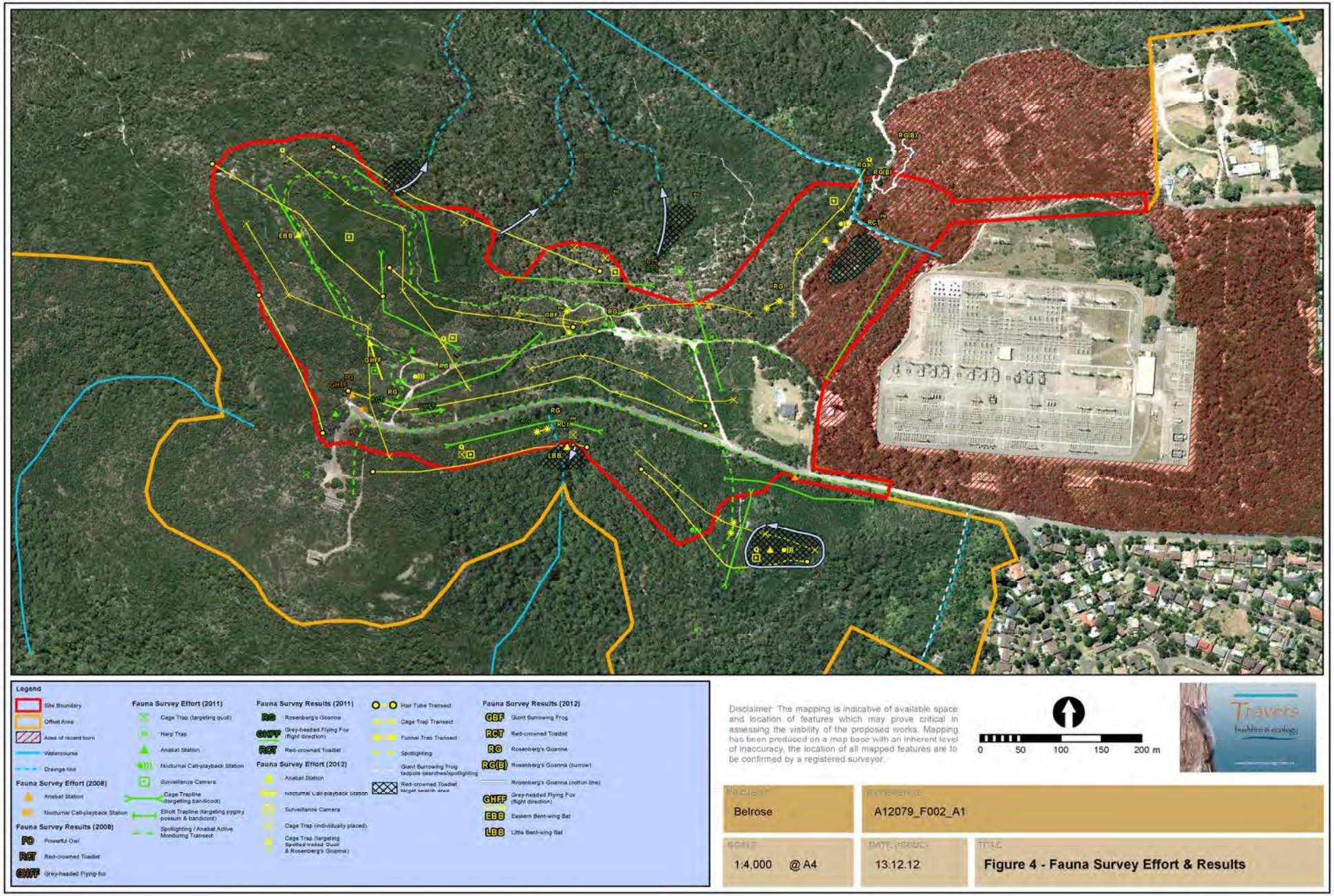

Figure 4 – Fauna survey and results within proposed development area of Lot 1 in DP1139826

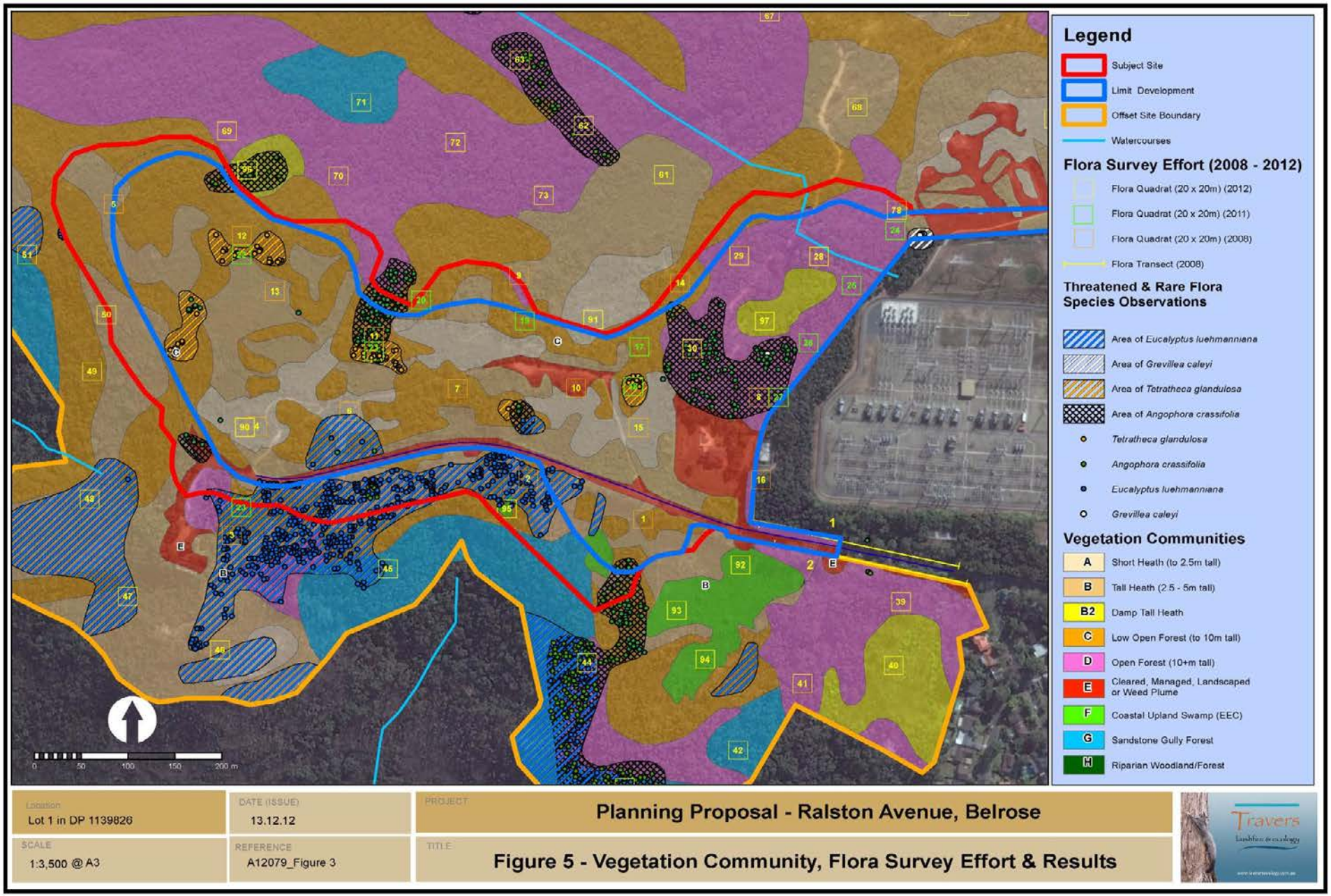

Figure 5 – Vegetation communities and flora survey results within development area (zoom in)

- Coastal Upland Swamp (Protected EEC vegetation of the same name).
- Sandstone Gully Forest.

Vegetation Community A – Short Heath

Photo 1 – Low Heath vegetation approximately 200m west of the existing dwelling

Occurrence – In relation to the proposed development area, this community occurs near to the centre of the site to the north of Ralston Avenue. The Low Heath vegetation is most similar to Sydney Coastal Heath as mapped by Smith and Smith 2000.

Structure – Low heath vegetation consisting of many *Fabaceae* plants generally to a height of up to 2.5m tall, with very occasional emergents. There is a dominance of shrub species and herbaceous groundcovers that are generally very dense. The species diversity within this community is generally lower than the Forest communities.

Disturbances – This vegetation community is impacted by walking / driving tracks.

Common Species

Angophora hispida (Dwarf Apple), *Grevillea speciosa* (Red Spider Flower), *Banksia ericifolia* var. *ericifolia* (Heath-leaved Banksia), *Hemigenia purpurea* (Narrow-leaved Hemigenia), *Actinotus minor* (Lesser Flannel Flower), *Hakea teretifolia* (Dagger Hakea), *Phyllota phylicoides* (Heath Phyllota), *Xanthorrhoea media* subsp. *media* (Forest Grass Tree), *Persoonia lanceolata* (Lance-leaved Geebung), *Tetratheca ericifolia* (Black-eyed Susan), *Dillwynia floribunda* var. *floribunda* (Parrot Pea) and *Epacris pulchella* (NSW Coral Heath).

Significance – Not endangered or threatened within Warringah LGA.

Vegetation Community B & B2 – Tall Heath and Damp Tall Heath

Occurrence – In relation to the proposed development area, this community occurs frequently to the south of Ralston Avenue, along the northern edge of Ralston Avenue, and within the north west portion of the flora study area. The Tall Heath and Damp Tall Heath vegetation is most similar to Sydney Coastal Heath as mapped by *Smith and Smith* 2000.

The Damp Tall Heath appears to have been artificially created by concentrated stormwater drainage from development areas upslope on adjoining lands or is associated with an existing surface drainage line.

Structure – Tall heath vegetation consisting of a dominance of *Allocasuarina distyla* with several other heath species. Some emergent trees exist. The dominance by the *Allocasuarina distylla* limits the diversity of plant species within those surveyed quadrats. The average height of vegetation within this community is 2.5-5m.

Damp Tall Heath vegetation is typically a moderately dense scrub comprising of *Banksia ericifolia* with a combination of Hakea, Allocasuarina and Leptospermum species. South of Ralston Avenue, the vegetation community has been caused through disturbance and the structure varies more so with the presence of some tree ferns and weeds.

Disturbances – This vegetation community is impacted by walking / driving tracks.

Common Species

Allocasuarina distyla (Scrub She-oak), *Leptospermum squarrosum, Darwinia fascicularis, Banksia ericifolia* var. *ericifolia* (Heath-leaved Banksia), *Hakea teretifolia* (Dagger Hakea), *Banksia spinulosa* var. *spinulosa* (Hairpin Banksia), *Actinotus minor* (Lesser Flannel Flower), *Lepyrodia scariosa* (Scale Rush) and *Leptocarpus tenax* (Slender Twine-rush)

Photo 2 – Tall Heath vegetation in quadrat 5 (2008) looking east.

Significance – Likely to provide some good quality habitat for the threatened or ROTAP species *Tetratheca glandulosa, Eucalyptus luehmanniana*, *Angophora crassifolia* and *Lomandra brevis.*

Vegetation Community C – Low Open Forest

Occurrence – In relation to the proposed development area, this community occurs around the fringes on higher degrees of sloping land, in addition to small patches within the central portion of the site and more extensively to the north western corner. The Low Open Forest vegetation is most similar to Sydney Sandstone Ridgetop Woodland as mapped by *Smith and Smith* 2000. In 2005, *Smith and Smith* described a wider extent of communities with a description for Yellow-top Ash Mallee (Vegetation Community 21). This community is a scrubland with *E. luehmanniana* and *C. gummifera* as dominants with heath and sedge understorey species. This community is not considered threatened within the Warringah LGA but *E. luehmanniana* is a rare species.

Whilst the Low Open Forest is diverse with a mix of upper strata species, the area containing *E. luehmanniana* was prevalent within approximately 100m north and south of Ralston Avenue. It was generally never found more than 100m north of Ralston Avenue within the proposed development area, although some smaller patches were located on south westerly slopes to the west of the proposed development area. The extent of the *E. luehmanniana* to the south of Ralston Avenue was extensive and it crept downslope to the edges of the sandstone gully forest, although was less prevalent within the taller surrounding vegetation.

Structure – Low Open Forest vegetation consists of a high proportion of heath species in the lower layers of vegetation with a low proportion of grass species. This community contains trees typically to a height of between 5-10m with a projected foliage cover (PFC) of 20-35%.

Disturbances – This vegetation community is impacted by walking / driving tracks.

Common Species

Trees: *Corymbia gummifera* (Red Bloodwood), *Eucalyptus piperita* (Sydney Peppermint), *Eucalyptus haemastoma* (Scribbly Gum), *Eucalyptus luehmanniana* (Yellow top Ash), *Angophora hispida* (Dwarf Apple) and *Angophora crassifolia.*

Shrubs: *Allocasuarina distyla* (Scrub She-oak), *Banksia ericifolia* var*. ericifolia* (Heath-leaved Banksia), *Hakea teretifolia* (Dagger Hakea), *Banksia spinulosa* var. *spinulosa* (Hairpin Banksia), *Leptospermum polygalifolium* (Lemon Scented Tea-tree), *Gompholobium grandiflorum* (Golden Glory Pea), *Grevillea speciosa* (Red Spider Flower), *Grevillea buxifolia* (White Spider Flower), *Hakea sericea* (Needlebush), *Phyllota phylicoides* (Heath Phyllota) and *Platysace linearifolia* (Narrow-leafed Platysace).

Groundcovers: *Actinotus minor* (Lesser Flannel Flower), *Caustis flexuosa* (Curly Sedge), *Xanthorrhoea media* subsp. *media* (Forest Grass Tree), *Patersonia sericea* (Wild Iris), *Xanthosia tridentata* (Rock Xanthosia), *Lomandra glauca* subsp. *glauca*, *Pimelea linifolia* subsp. *linifolia* (Slender Rice Flower) and *Lomandra gracilis.*

Significance – Two rare (ROTAP) species were quite common within this community, *Eucalyptus luehmanniana* and *Angophora crassifolia.* The threatened species *Tetratheca glandulosa* has also been observed.

Photo 3 – Low Open Forest within the central portion of the proposed development area

Vegetation Community D – Open Forest

Occurrence – The community occurs immediately west and south of the Sydney East Substation and at terminal end of Ralston Avenue. It was extensive further north within the study area. The Open Forest vegetation could be a combination of either Sydney Sandstone Ridgetop Woodland or Duffys Forest (an EEC) as mapped by *Smith and Smith* 2000. Assessment of the vegetation within all 2008 and 2011 quadrats found the vegetation not to be representative of Duffys Forest (in accordance with *P & J Smith's* Duffys Forest Index).

Structure – Open Forest structure but taller than the Low Open Forest, generally above 10m tall. This vegetation community contains a mixture of healthy understorey species with a moderate dominance of sclerophyllous species. Taller Eucalypt species dominate such as *Eucalyptus punctata* and *Eucalyptus sieberi.* This vegetation community comprises a partially grassy understorey unlike the low heath and tall heath vegetation communities.

Disturbances - This vegetation community is impacted by walking / driving tracks, a communication tower and an electricity substation.

Common Species

Trees: *Eucalyptus punctata* (Grey Gum), *Corymbia gummifera* (Red Bloodwood), *Angophora costata* (Smooth-barked Apple), *Eucalyptus sieberi* (Silver-top Ash) and *Allocasuarina littoralis* (Black She-oak).

Shrubs: *Acacia terminalis* (Sunshine Wattle), *Melaleuca hypericifolia, Banksia ericifolia* var. *ericifolia* (Heath-leaved Banksia), *Platysace linearifolia* (Narrow-leafed Platysace), *Callistemon linearis* (Narrow-leaved Bottlebrush) and *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle).

Groundcovers: *Entolasia marginata* (Bordered Panic), *Entolasia stricta* (Wiry Panic), *Tetratheca ericifolia* (Black-eyed Susan), *Pimelea linifolia* subsp. *linifolia* (Slender Rice Flower), *Lomandra longifolia* (Spiky-headed Mat-rush), *Lindsaea microphylla* (Lacy Wedge-fern) and *Lomandra gracilis.*

Significance – This vegetation community provides some habitat for the recorded threatened or ROTAP species *Tetratheca glandulosa, Eucalyptus luehmanniana* and *Angophora crassifolia.*

Where vegetation within the canopy is dominated by *Eucalyptus sieberi* and *Corymbia gummifera,* this provides very good potential habitat for the threatened species *Grevillea caleyi,* particularly to the north and north east of the existing residence.

Photo 4 – Open Forest vegetation along the northern edge of Ralston Avenue

Vegetation Community E – Cleared, Managed, Landscaped or Weed Plume

Occurrence – In relation to the *flora study area* this community only occurs within the centre of the site adjacent to the intersection of some major tracks, the managed grounds and residential lot, other built structures and the weed plume along the edge of Ralston Avenue near the existing gate.

Structure – Contains shrub and heath vegetation with no trees and a grassy and annual understorey.

Disturbances – This vegetation community is impacted by walking/driving tracks, and a high proportion of annuals, exotic grasses and Pampas Grass.

Photo 5 – Disturbed area with weed plume near the centre of the site

Common Species

Cortaderia selloana (Pampas Grass), *Acacia saligna* (Orange Wattle), *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle), *Andropogon virginicus* (Whisky Grass), *Eragrostis curvula* (African Lovegrass), *Centella asiatica* (Swamp Pennywort), *Hakea teretifolia* (Dagger Hakea), *Cynodon dactylon* (Common Couch), *Seneca madagascariensis* (Fireweed), *Paspalum dilatatum* (Paspalum) and *Bidens pilosa* (Cobbler's Pegs).

Vegetation Community F – Coastal Upland Swamp

Occurrence – This vegetation community occurs in patches to the south of Ralston Avenue, varying in size up to 1.27ha.

Structure – Sedge, heath or scrub usually under 2.5m tall with few emergents and few Eucalyptus / Angophora specimens.

Disturbances – Recent fire within the remnants, south of Ralston Avenue.

Common Species

Baeckea imbricata, *Banksia ericifolia* (Heath-leaved Banksia), *Bauera rubioides* (River Rose), *Dillwynia floribunda* var. *floribunda* (Parrot Pea), *Hakea teretifolia* (Dagger Hakea), *Leptospermum squarrosum*, *Viminaria juncea* (Native Broom), *Empodisma minus*, *Lepidosperma* spp., *Schoenus brevifolius* (Bog-rush), *Leptocarpus tenax* (Slender Twine-rush), *Lepyrodia scariosa* (Scale Rush), *Goodenia dimormpha* and *Xyris gracilis* (Slender Yellow-eye).

Significance – This community is regionally significant and falls under the EEC Coastal Upland Swamps of the Sydney Basin Bioregion. This community may provide good habitat for the threatened frog species, Red-crowned Toadlet and Giant Burrowing Frog.

Photo 6 – Coastal upland swamp vegetation with fringing low open forest or tall heath in in the background.

Vegetation Community G – Sandstone Gully Forest

Occurrence – This vegetation community occurs in steeper portions of land to the south of Ralston Avenue generally outside of the proposed development area and thus not surveyed in much detail. It tends to occur on sheltered southerly facing slopes.

Structure – An Open Forest structure of Eucalypts, Angophoras and Corymbias with a moderately healthy understorey and some herbs, forbs and ferns in the ground layer. Trees are usually between 10-20m in height.

Disturbances – There has been recent fire within the remnant south of Ralston Avenue.

Common (Canopy) Species

Eucalyptus piperita (Sydney Peppermint), *Angophora costata* (Smooth-barked Apple) and *Corymbia gummifera* (Red Bloodwood).

3.2.3 Potential and observed threatened flora species

Searches of the Atlas of NSW Wildlife database (OEH 2012) and the EPBC habitat database were undertaken to identify records of threatened flora and fauna species located within or with potential to occur within a 10km radius of the site. Field habitat assessments were conducted to determine if the study area provided suitable habitat for these species. This data is provided in Attachment 1.

It is considered that the proposed development area provides suitable habitat for the following flora species:

- *Acacia bynoeana*
- *Callistemon linearifolius*
- *Epacris purpurascens* var*. purpurascens*
- *Eucalyptus camfieldii*
- *Grevillea caleyi* *
- *Haloragodendron lucasii*
- *Lasiopetalum joyceae*
- *Melaleuca deanei*
- *Microtis angusii*
- *Persoonia hirsuta*
- *Pimelea curviflora* var*. curviflora*
- *Tetratheca glandulosa* *

Species indicated with a '*' were recorded within the study area during surveys.

During field surveys in December 2011, *Tetratheca glandulosa* was observed in a few select locations, usually within the Low Open Forest vegetation community on the northern side of Ralston Avenue. The largest clump containing approximately twenty (20) specimens was observed approximately 125m to the North West of the existing residence. *Tetratheca glandulosa* has a peak flowering time of July to November with some flowers persisting until late December. The specimens observed were flowering but the flowers were senescing making them difficult to locate. The low Open Forest and Open Forest vegetation communities and some tall heath provide good through to excellent habitat for the species.

Target threatened flora surveys were completed in August through to October 2012. The October 2012 survey was undertaken in the peak flowering period of *Tetratheca glandulosa*. Additional clumps of *Tetratheca glandulosa* were discovered and larger populations were also recorded at existing known locations. The Low Open Forest and part of the Open Forest areas provide suitable habitat for *Tetratheca glandulosa* however only a small number of limited clumps were found. There were large populations of *Tetratheca ericifolia* and *Tetratheca thymifolia* particularly on the southern side of Ralston Avenue and near the northern boundary of the proposed development area extending further north into the broader study area.

The north eastern portion of the proposed development area provides ideal habitat for *Grevillea caleyi. S*everal specimens have been located previously recorded either within or adjacent to the study area of Lot 1 in DP1139826 (Atlas of NSW Wildlife, OEH 2012), however most records are more than 50 years old. One record in the late 1990s was located between the existing residence and the substation. This narrow bushland area is outside of the study area and was not surveyed, but given that the vegetation is taller and contains *Eucalyptus sieberi* and *Corymbia gummifera,* the habitat looks to be very suitable. Additionally, the EPBC listed species report generated states that the Belrose Grevillea caleyi site is listed under the register of the national estate (RNE). This is an indicative place only and no map has been provided. Thus it would be expected that *Grevillea caleyi* is likely to occur in close proximity to the study area.

The Atlas of NSW Wildlife records have many *Grevillea caleyi* sightings along Forest Way and Mona Vale Road between Belrose and Ingleside which tends to follow a ridge line or near the plateau area where taller vegetation occurs, not heath communities. The most

suitable vegetation is the taller Open Forest which occurs to the north and north east of the existing residence in close proximity to the existing trails near or along the Wyatt Avenue road reserve. Incidental sightings of three (3) individuals were recorded along the Wyatt Avenue road reserve (see Figure 1 for locations). One (1) specimen was located to the west of the substation approximately 150m to the north, north east of the existing residence. No other specimens have been observed. The north eastern portion of the proposed development area contains suitable habitat such as within other Open Forest vegetation if *Eucalyptus sieberi* is present with which this species is often found in association. Although *Grevillea caleyi* may have potential habitat, the recorded occurrence is low within the proposed development area. *Eucalyptus sieberi* was found to occur more frequently within the vegetation communities north of the proposed development area. We note that the existing *Grevillea caleyi* record within the north western portion of the offset lands is from the year 1892 and has an assumed accuracy of 10km. The second *Grevillea caleyi* record adjacent to Ralston Avenue within the proposed development area is from the year 1930 and has an assumed accuracy of 4km. Neither of these records can be used reliably for assessment purposes.

Epacris purpurascens var. *purpurascens* may also be present on site in close proximity to existing drainage lines nearer the perimeter of the study area and on sandstone benches that have a high clay content which again occur near the northern and southern study area boundary. There are no close records of this species (Atlas of NSW Wildlife OEH 2012) to the proposed development area and the amount of suitable habitat in terms of square metres is very low. As such, the potential for occurrence within the proposed development area is considered to be low or very low.

The other listed flora species have not been observed in 2008 or 2011 during the May and December surveys respectively. Whilst these survey times may be outside of the flowering period for those species, they are considered to have a low or moderate potential to occur, with most more likely to occur within the Low Open Forest or Open Forest vegetation communities.

Intensive target threatened flora survey undertaken in spring 2012 within the proposed development area expanded the current known populations of existing recorded threatened flora species but no new threatened flora species were observed.

Angophora crassifolia, listed as a rare Australian plant (ROTAP species) has been observed broadly across the proposed development area and continues into the broader study area. This is a rare species due to its geographical range, occurring primarily in the northern suburbs of Sydney in near coastal locations, predominately within the Warringah LGA. This small tree was usually found in clumps within the Low Open Forest or Open Forest vegetation communities. All specimens observed within and immediately adjoining the proposed development have been identified by GPS. All observed specimens are shown on Figure 1.

Eucalyptus luehmanniana is also a rare plant (ROTAP) species which was found in the tall heath and Low Open Forest on south east to south west facing slopes on or near sandstone benches near the top of the ridge. The population within the southern portion of the proposed development area continues to the south until the edge of the gully forest vegetation. All individual specimens within and immediately adjoining the proposed development were identified by GPS. All observed specimens are shown on Figure 1.

3.2.4 Endangered populations

No endangered flora populations occur within a 10km radius of the proposed development area.

3.2.5 Endangered ecological communities

Existing vegetation mapping of the local area was obtained from *Warringah Council* that identified much of the land near the centre of the proposed development area as 'Coastal Sandstone Heath'. The vegetation nearer the perimeter of the proposed development area was mapped as 'Sydney Sandstone Ridgetop Woodland'. The vegetation mapping performed by *Smith and Smith 2000* did not identify any Duffys Forest EEC vegetation within the proposed development area, however, adjoining lands to the east and a small patch to the south of the adjoining Sydney East Substation were identified as containing Duffys Forest vegetation.

Duffys Forest

All 2008 and 2011 quadrats have been compared against the Scientific Committee's determination to assess whether or not Duffys Forest EEC is present or absent within the study area. Whilst a number of quadrats appeared to have a number of Duffys Forest species present, when using the Duffys Forest Index as derived by *P & J Smith Ecological Consultants* (2000), the index was high for Sydney Sandstone Ridgetop Woodland as opposed to Duffys Forest. As such, the vegetation within the study area is not considered to be representative of EEC - Duffys Forest. The Council mapped EEC – Duffys Forest is not present within the site. It was observed just outside of the proposed development area on the south eastern side of the substation.

Coastal Upland Swamp

The Coastal Upland Swamp is representative of the EEC - Coastal Upland Swamp of the Sydney Basin Bioregion. The Damp Tall Heath vegetation community has some floristic similarities compared to the listed indicative species described in the final determinations of the EEC. The presence of taller vegetation not typical of the described EEC, association with a drainage line, and the presence of less than 50% of species within the quadrat listed on the final determinations, indicates that the Damp Tall Heath is not consistent with the EEC - Coastal Upland Swamp in the Sydney Basin Bioregion.

3.2.6 Significant ecological communities

The EEC - Coastal Upland Swamp occurs at locations within the proposed development area that are on the southern side of Ralston Avenue and to the north of Wyatt Avenue. Both areas are mostly within the proposed offset areas. In early due diligence studies, this community was identified as Sandstone Hanging Swamp over a smaller area. The EEC determination for Coastal Upland Swamp effectively expands the areas of this sensitive community, based on a broader floristic assemblage.

Coastal Upland Swamps are recognised groundwater dependent ecosystems which are generally to be protected under the NSW Groundwater Dependent Ecosystem Policy. The impact of surface and subsurface drainage within its catchment is also considered, typically resulting in an ecological buffer to be established. A buffer of 30m has been provided in addition to separation created by APZs.

The vegetation that contains *Eucalyptus luehmanniana* as a dominant species was considered by *Smith and Smith* (2005) to be a rare vegetation community in Australia. The current development concept protects 80% of this vegetation within the proposed offset area.

3.2.7 Rare and threatened flora occurrence and potential impacts

The following is a summary of our current knowledge of the threatened flora populations within and surrounding the site and the estimated impacts as a result of the proposed development area.

Grevillea Caleyi – Only one small area containing three (3) specimens has been recorded on the fence line between the Wyatt Avenue corridor and the substation which may or may not be impacted by a future road extension. A historical record is also located within the proposed offset lands within Open Forest vegetation but, due to the age and inaccuracy of the record (year 1892 – 10km accuracy), it is not a reliable position of the record and may no longer be present. The same applies for the second record within the proposed development area which was recorded in 1930 with 4km accuracy. The development proposal is not directly removing this population however the proposed Wyatt Avenue extension may have a direct impact upon these specimens. It is unknown if the five (5) specimens form part of a larger population that continues into the substation lands although there is a good possibility that this might be the case based on existing Atlas of NSW Wildlife records and the vegetation types present (Figure 1). One (1) further individual was observed within the main development area approximately 150m from the existing residential dwelling and will be directly impacted.

Potential habitat areas for this species have been observed within the proposed development and offset areas. We note however that intensive target searches for *Grevillea caleyi* have not been undertaken within the offset areas, but have been recorded if found within quadrats, on the meander between quadrats and along existing walking track edges. There were no further observations of *Grevillea caleyi* within the proposed development area or offset lands. The taller vegetation communities including the Open Forest and parts of the Sandstone Gully Forest where *Eucalyptus sieberi* and *Corymbia gummifera* are dominant canopy species in association with laterite soils may be suitable. The threatened species profile also notes that *Grevillea caleyi* is known to occur at an altitude of between 170 to 240m ASL. Given that the development area and offset lands are approximately 180m ASL, we expect that the ridge line areas with Open Forest provide the most likely habitat.

The Wyatt Avenue extension should aim to avoid impacting the stand of three (3) individuals by ensuring the road and proposed cut and fill do not impact on the recorded location.

Tetratheca glandulosa – Several clumps of this species have been recorded throughout the proposed development area during the ideal survey period of spring 2012. Some specimens were previously recorded in December 2011 at the very end of the flowering period, with many at that time holding on to senescing flowers or flowers that had recently fallen from the plant and were still visible on the ground.

The majority of observed clumps of *Tetratheca glandulosa* were located in the Low Open Forest vegetation community. It was thought that the dense nature of the short heath would be unlikely to host the species except on the edges as it intergrades with other taller vegetation types. The potential habitat within the Tall Heath is considered to be low overall (although variable) because of the dense nature of the Banksia / Leptospermum / Hakea / Allocasuarina association, so if it does occur, the density of *Tetratheca glandulosa* is not expected to be high. The Sandstone Gully Forest is likely to provide only marginal potential habitat or low potential habitat as the gully vegetation is not on the ridge line which the species favours.

The potential habitat of the species is moderate to high in the Low Open Forest and Open Forest communities. Throughout the proposed development area, large numbers of other *Tetratheca* species were sighted, notably *Tetratheca ericifolia* and *Tetratheca thymifolia,* however there were not large numbers of *Tetratheca glandulosa* recorded despite the good habitat potential.

Intensive target searches for *Tetratheca glandulosa* have not been undertaken within the offset areas. Target searches have been undertaken within the quadrats, on the meander between quadrats and along existing walking track edges, however, only one (1) additional patch has been identified outside of the proposed development area. High numbers of *Tetratheca ericifolia* and *Tetratheca thymifolia* were also observed in the offset areas and it is believed that if target survey was undertaken in the offset areas, many clumps of *Tetratheca glandulosa* would be observed.

Eucalyptus luehmanniana – The species is rare but not listed on the schedules of the *TSC Act* or *EPBC Act* as a threatened species. This species was observed readily on the sandstone terraces and upper slopes on the southern side of Ralston Avenue on the south west to south east slopes, usually above the Sandstone Gully Forest. Large numbers of this species have been recorded within the proposed development area and within the proposed offset lands. The extent and size of the existing population was considered too large and too time consuming to map as individual records outside of the proposed development area. Therefore the exact population is unknown and the mapped distribution may not reflect the full extent of the species. However, observed habitat areas were mapped and the population size has been estimated on the basis of recorded densities. Approximately 80% of the estimated population will be retained within the proposed offset lands.

The proposed development will likely remove all specimens of *Eucalyptus luehmanniana* on the northern side of Ralston Avenue. Specimens located on the southern side of Ralston Avenue fall within a proposed APZ. Whilst there is no assurity of their retention, there are opportunities to retain further trees and still comply with the standards for APZs.

Angophora crassifolia – This species was located sporadically in clumps throughout the proposed development area, typically more so on the outskirts in the taller vegetation communities such as Low Open Forest and Open Forest and occasionally in the Tall Heath. Some large clumps were also located within the offset area and it is likely that the population is more extensive than mapped. Approximately 80% of the estimated population will be retained within the proposed offset lands.

3.3 Fauna

3.3.1 Recorded fauna species

To date, a total of ninety-seven (97) fauna species were observed within the proposed development area during the survey. This number comprised 54 species of bird, 18 species of mammal, 18 species of reptile and 7 species of amphibian.

Table 5 – Fauna observations for the study area

Common Name	Scientific Name	Method Observed		
Birds		**May 2008**	**Dec 2011**	**Oct 2012**
Australian Magpie	*Gymnorhina tibicen*		O	O
Australian Owlet-nightjar	*Aegotheles cristatus*			C
Australian Raven	*Corvus coronoides*	O C	O C	O C
Bar-shouldered Dove	*Geopelia humeralis*		O	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	O	O C	O C
Brown-headed Honeyeater	*Melithreptus validirostris*	O C		
Brown Thornbill	*Acanthiza pusilla*		O C	O C
Brown Quail	*Coturnix ypsilophora*	O	O	O T
Brush Bronzewing	*Phaps elegans*	O	C	
Channel-billed Cuckoo	*Scythrops novaehollandiae*		C	C
Common Koel	*Eudynamys scolopacea*		C	C
Common Myna *	*Acridotheres tristis*	O		O
Crested Pigeon	*Ocyphaps lophotes*	O		
Crimson Rosella	*Platycerous elegans*			O C
Eastern Spinebill	*Acanthorhynchus tenuirostris*	O C	O C	O C
Eastern Whipbird	*Psophodes olivaceus*	O C	O C	O C
Eastern Yellow Robin	*Eopsaltria australis*	O	O C	O C
Fairy Martin	*Hirundo ariel*		O	
Fan-tailed Cuckoo	*Cacomantis flabelliformis*		C	C
Golden Whistler	*Pachycephala pectoralis*	O		C
Grey Butcherbird	*Cracticus torquatus*	O C	C	C
Grey Fantail	*Rhipidura fuliginosa*	O C	C	O C
Grey Shrike-thrush	*Colluricincla harmonica*	O	O C	O C
Laughing Kookaburra	*Dacelo novaeguineae*		O C	O C
Little Lorikeet [TS]	*Glossopsitta pusilla*	C		
Little Wattlebird	*Anthochaera chrysoptera*	O C	O C	O C
Masked Lapwing	*Vanellus miles*		C	C
New Holland Honeyeater	*Phylidonyris novaehollandiae*	O C	O C	O C
Pied Currawong	*Strepera graculina*	C	O C	O C
Powerful Owl [TS]	*Ninox strenua*	Sp C P		
Rainbow Lorikeet	*Trichoglossus haematodus*	C	C	O C
Red-browed Finch	*Neochmia temporalis*	O C	O C	O C
Red Wattlebird	*Anthochaera carunculata*	O C		C
Red-whiskered Bulbul *	*Pycnonotus jocosus*		C	C
Rufous Whistler	*Pachycephala rufiventris*		C	O C
Scarlet Honeyeater	*Myzomela sanguinolenta*	C		
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*		C	
Silvereye	*Zosterops lateralis*	O C	O C	O C
Southern Boobook	*Ninox novaeseelandiae*			C
Spotted Pardalote	*Pardalotus punctatus*	O C	C	O C
Spotted Quail-thrush	*Cinclosoma punctatum*			C [PR]
Striated Pardalote	*Pardalotus striatus*	O C		C
Striated Thornbill	*Acanthiza lineata*		O C	O C
Sulphur Crested Cockatoo	*Cacatua galerita*	C	O C	O C
Superb Fairy-wren	*Malurus cyaneus*		O C	C
Tawny Frogmouth	*Podargus strigoides*	O		
Variegated Fairy-wren	*Malurus lamberti*		O C	O C

Common Name	Scientific Name	Method Observed		
Welcome Swallow	*Hirundo neoxena*	O	O	O
White-browed Scrubwren	*Sericornis frontalis*	O C	O C	O C
White-cheeked Honeyeater	*Phylidonyris nigra*			C [PR]
White-eared Honeyeater	*Lichenostomus leucotis*	O C	O C	O C
White-throated Nightjar	*Eurostopodus mystacalis*			O C
Yellow-faced Honeyeater	*Lichenostomus chrysops*	O C	O	C
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	C		O C
Mammals				
Brown Antechinus	*Antechinus stuartii*		T R	
Bush Rat	*Rattus fuscipes*		T R	T R
Common Brushtail Possum	*Trichosurus vulpecula*		S T R	T R
Common Ringtail Possum	*Pseudocheirus peregrinus*		S	
Dog *	*Canis familiaris*	O	O C	O R
Eastern Bentwing-bat [TS]	*Miniopterus orianae oceansis*			A
Forest Bat	*Vespadelus sp*	A		
Gould's Wattled Bat	*Chalinolobus gouldii*		A	A
Grey-headed Flying-fox [TS]	*Pteropus poliocephalus*	S C	O	O
Horse *	*Equus caballus*	O	O	O
Little Bentwing-bat [TS]	*Miniopterus australis*			A
Little Forest Bat	*Vespadelus vulturnus*			A [PR]
Long-nosed Bandicoot	*Parameles nasuta*		T R	T R
Rabbit *	*Oryctolagus cuniculus*			O
Short-beaked Echidna	*Tachyglossus aculeatus*		O	I
Sugar Glider	*Petaurus breviceps*		T	I C
Swamp Wallaby	*Wallabia bicolor*		O R	O T R
White-striped Freetail-bat	*Austronomus australis*			A
Reptiles				
Blackish Blind Snake	*Ramphotyphops nigrecens*		H	
Burton's Legless Lizard	*Lialis burtonis*			T
Copper Tailed Skink	*Ctenotus taeniolatus*	O	H	T
Delicate Skink	*Lampropholis delicata*		O	O T
Diamond Python	*Morelia spilota*	O	O	O
Eastern Bearded Dragon	*Pogona barbata*	O		O R
Eastern Blue Tongue Lizard	*Tiliqua scincoides*		T	T
Eastern Brown Snake	*Pseudonaja textilis*			O
Eastern Tiger Snake	*Notechis scutatus*	O		
Eastern Water Dragon	*Physignathus lesueurii*			O
Eastern Water Skink	*Eulamprus quoyii*			O
Grass Skink	*Lampropholis guichenoti*			T
Rosenberg's Goanna [TS]	*Varanus rosenbergii*		T	O T
Lace Monitor	*Varanus varius*		O	O T
Mainland She-oak Skink	*Cyclodomorphus michaeli*			H
Red-throated Skink	*Pseudemoia platynota*	H		
Weasel Skink	*Saproscincus mustelina*		O [PR]	T
Yellow-faced Whip Snake	*Demansia psammophis*	H		T
Amphibians				
Broad-palmed Frog	*Litoria latopalmata*		C [PR]	
Common Eastern Froglet	*Crinia signifera*	C	O C	C T
Giant Burrowing Frog [TS]	*Heleioporus australiacus*			T/DNA
Leaf Green Tree Frog	*Litoria phyllochroa*			C
Peron's Tree Frog	*Litoria peronii*			C

Common Name	Scientific Name	Method Observed		
Red-crowned Toadlet [TS]	*Pseudophryne australis*	O C	C	H
Striped Marsh Frog	*Limnodynastes peronii*		C	H

Note: * indicates introduced species
[TS] indicates threatened species

All species listed are identified to a high level of certainty unless otherwise noted as:
[PR] indicates species identified to a 'probable' level of certainty
[PO] indicates species identified to a 'possible' level of certainty

A	-	Anabat II/SD-1	C	-	Call Identification
O	-	Observation	P	-	Call-playback Response
T	-	Trap (Elliott, cage, etc)	H	-	Habitat Search
S	-	Spotlight	I	-	Scat, Track or Sign Identification
R	-	Surveillance Camera	DNA	-	DNA Analysis

3.3.2 Fauna habitats

The extent of the offset area surrounding the proposed development area is the only locally undeveloped area of the Lambert soil type within the connective natural landscape to the south of Mona Vale Road and west of Forest Way. The proposed development area covers the plateau area within this soil landscape. Habitat features of the Lambert soil type include:

- Presence of greater than 50% rock outcrops
- Open and closed heathland and scrubland
- Broad ridges, wide benches with low broken scarps
- Small hanging valleys and poor drainage areas

Alternatively, the highly developed Somersby soil type is characterised by low open woodland and scrubland typically with less rock outcropping. The remaining surrounding mostly uncleared Hawkesbury sandstone to the north, west and south, whilst providing similar rocky features, provides slopes in excess of 25% and is characterised by open woodland and Tall Open Forest.

The fauna habitats present throughout the proposed development area include:

- Vegetated areas of Short Heath, Tall Heath, Wet Heath, Hanging Swamp and Low Open Forest with a healthy to scrub understorey
- Nectar producing *Eucalyptus* trees providing foraging resources for all seasons excluding winter
- Other nectar producing resources, principally *Angophora*, *Melaleuca, Banksia* and *Acacia* species
- Sandstone rock outcrops, crevices, overhangs and small caves at various aspects
- Sparse to dense shrub layers, ground covers and leaf litter.
- Small to medium sized hollows in low density only within the Low Open Forest Community
- Fallen branches
- Loose sandy soil suitable for digging, burrowing and foraging
- Moist soil within hanging swamps
- Depressions providing temporary soaks after heavy rainfall
- Ephemeral drainage lines off a heath-land plateau into sandstone rocky slopes
- Artificial debris and refuse

These fauna habitats combine to present a site that has good fauna habitat, particularly for reptiles.

3.3.3 Hollow-bearing trees

A complete assessment of hollows for hollow dependent threatened fauna species within any proposed development area would typically be required for assessment purposes. This comprehensive survey has not been undertaken to date. However the available size, range and quality of hollows were noted during site visits with no large (30cm+), and limited medium (10-30cm), hollows present. Powerful Owls utilise large tree hollows for nesting and Rosenberg's Goanna may occasionally utilise terrestrial / fallen hollows for shelter.

Generally, eucalypt tree species present within the proposed development area are of a low, stunted or 'mallee' type growth nature. This means that they have multiple growth stems from a base root. Any presence of hollows in these trees would provide only a limited number of small hollows of suitable quality for fauna usage. Some small hollows providing quality refuge were noted within vegetation communities C and D.

3.3.4 Koala habitat

Two (2) Koala food tree species (*Eucalyptus punctata* and *Eucalyptus haemastoma*) listed on Schedule 2 of State Environmental Planning Policy No. 44 - Koala Habitat Protection, were observed within the proposed development area. These trees comprised of greater than 15% of the total number of trees within the Low Open Forest (Sydney Sandstone Ridge-top Woodland) and Open Forest (Sydney Sandstone Ridge-top Woodland) vegetation communities and therefore are classified under SEPP 44 as Potential Koala Habitat.

Despite the presence of potential Koala habitat, Koala habitation of the Open Forest habitat of the proposed development area is considered unlikely based on existing records. A search of the *Atlas of NSW Wildlife* (OEH 2012) database found fifty-nine (59) records of Koala habitation within a 10km radius from the proposed development area since 1940. The majority of these records are located within Ku-ring-gai National Park and Berowra Valley and Berowra Valley Regional Park, further north.

Only four (4) Koala records exist in the nearby locality. Three (3) of these records are located on the other side of Forest Way from 1940, 1994 and 1997. The only likely route of passage from these areas to the site is across the northern portion of Forest Way, north of Bundaleer Street. Roadside signage indicating possible Koala passage along this road portion is present however there are no Koala records within 3km of this road section. The only remaining Koala record is located within the connective bushland areas to the site approximately 5km around to the south of Davison in 1940.

The proposed development area is therefore not considered to be 'Core Koala Habitat' as defined under SEPP 44. Call-playback techniques did not evoke a male response during surveys to date. No scat searches, however, have been conducted within the Open Forest vegetation communities to date which may not be seen as adequate to completely argue against presence.

3.3.5 Potential and observed threatened fauna species

Searches of the *Atlas of NSW Wildlife* database (OEH 2012) and the *EPBC* habitat database were undertaken to identify records of threatened flora and fauna species located within, or with potential to occur within, a 10km radius of the site. Field habitat assessments have determined if the proposed development area provides suitable habitat for these species. This data is provided in Attachment 1.

Fauna survey has confirmed the proposed development area and surrounds as having high quality habitat for threatened fauna species. Eight (8) recorded threatened fauna species have been recorded to date with potential for others to occur as indicated below. Such potential is also based on the presence of nearby recent records in similar habitat.

Table 6 – Potential and observed threatened fauna species

COMMON NAME	TSC Act	EPBC Act	Potential to occur
Giant Burrowing Frog	V	V	recorded
Red-crowned Toadlet	V	-	recorded
Rosenberg's Goanna	V	-	recorded
Little Lorikeet	V	-	recorded
Powerful Owl	V	-	recorded
Grey-headed Flying-fox	V	V	recorded
Little Bentwing-bat	V	-	recorded
Eastern Bentwing-bat	V	-	recorded
Swift Parrot	E	E	✓
Barking Owl	V	-	✓
Spotted-tailed Quoll	V	E	✓
Southern Brown Bandicoot	E	E	✓
Eastern Pygmy Possum	V	-	✓
New Holland Mouse	-	V	✓
Little Eagle	V	-	low
Glossy Black-Cockatoo	V	-	low
Varied Sittella	V	-	low
Scarlet Robin	V	-	low
East-coast Freetail Bat	V	-	low
Greater Broad-nosed Bat	V	-	low
Gang-gang Cockatoo	V	-	unlikely
Masked Owl	V	-	unlikely
Koala	V	-	unlikely
Yellow-bellied Sheathtail-bat	V	-	unlikely

There is no suitable habitat present within, or close to, the proposed development area for threatened aquatic species listed under the *Fisheries Management Act* 1994. As such the provisions of this Act do not require any further consideration.

3.3.6 Threatened fauna occurrence and impacts

The following is a summary of our current knowledge of the threatened fauna within and surrounding the site and the potential impacts as a result of the proposed development area.

Giant Burrowing Frog *(Heleioporus australiacus)*

There is potential breeding habitat for the Giant Burrowing Frog within the perennial streams that drain off the plateau which includes the stream that runs north west from the substation and, to a lesser extent, the stream that runs south from the substation (see Figure 2). The larger southernmost Coastal Upland Swamp also contains potential breeding habitat. It is however considered likely that breeding potential increases in the lower extents of these streams that flow from the site including Bare Creek Fireclay Gully, French's Creek and Middle Harbour Creek.

Giant Burrowing Frog was previously recorded in 1996 to the north near Fireclay Gully on outer edge of the offset area (possibly adjacent to the Heath Trail). This species was also recorded to the south-west in 2010 along French's Creek, near the intersection of Middle Harbour Creek (again possibly adjacent to the French's Creek Trail).

This species is typically known to breed in drainages that flow from natural sandstone habitats. Whilst this may suggest that adults would utilise mostly the north eastern and south eastern extents of the proposed development area, the species has been found to burrow, forage and generally occupy territories hundreds of metres from riparian areas (Webb, 1983; Lemckert et al., 1998). As with other frog species, the young also have wide dispersal ranges as a natural behaviour to colonise new suitable habitats in the locality. This species may have large dispersal capability.

The individual recorded during survey was found desiccated in a funnel trap and identified in the hand to a probable level of certainty. The specimen was later confirmed by DNA analysis to be Giant Burrowing Frog. The captured Giant Burrowing Frog is likely to be juvenile based on its size and therefore may have been in dispersal at the time of capture. The capture point was in the middle of the proposed development area (see Figure 2) and approximately 350m from the nearest considered breeding habitat.

The habitat present throughout the proposed development area may be important for the following reasons:

- it is part of a catchment area that feeds into recorded locations and nearby potential breeding areas;
- soil attributes are in part a sandy substrate which may be suitable for burrowing and foraging but depth is limited by shallow ironstone layers and sandstone bedrock;
- low heath and hanging swamp vegetation is in close proximity to the proposed development area; and
- may form part of an overland dispersal route for young.

This species is potentially restricted by Mona Vale Road to the north and urban development in the remaining surrounds. The extent of the local population is not known but existing records potentially suggests suitable habitat occurs within the broader catchment area within the offset lands and the surrounding Garigal National Park.

Red-crowned Toadlet *(Pseudophryne australis)*

Red-crowned Toadlets use small ephemeral drainage lines, which feed water from the top of ridges to perennial creeks below. This species is confined to the Hawkesbury sandstone formation and is not usually found in the vicinity of permanent water (Ehmann, 1997). Breeding habitat is small puddles or depressions where rock or leaf litter holds back water temporarily (Ehmann, 1997; State Forests Threatened Species Protocol, 1997). Breeding congregations can occur deep in grass and debris beside such non-perennial creeks gutters etc. They have also been noted to be very partial to damp shelves and cracks in sandstone where they have been observed emerging at dusk (NPWS 1997). At other times, individuals disperse and are found under rocks, logs etc. on sandstone ridges (Cogger, HG. 2000).

The Red-crowned Toadlet was initially recorded to the central north of the proposed development area in both 2008 and 2011. In 2011 it was also recorded north of the western endpoint of Ralston Avenue. Both of these recorded locations were found to be dry during the recent 2012 survey. As the recent surveys were undertaken following a dry spring period, other potential breeding locations were also dry, particularly the ephemeral drainages along the northern aspects of the escarpment. This restricted identification of further breeding locations.

The species was recorded to a 'probable' level of certainty by tadpole identification at two further locations within the proposed development area, in the north east and central south during recent surveys (see Figure 2), both were within pools along drainages.

The Red-crowned Toadlet has also been recorded at various locations in the surrounding connective habitats into Garigal National Park. There is not much currently known of frog home ranges and movements. Given that it is never found far from breeding areas and it displays slow movement, this species is assumed to have a reduced capacity to disperse. The potential impacts on this species from the proposed development include:

- Removal of one (1) recorded and one (1) potential breeding area;
- Indirect impacts of altered water quality and / or quantity onto the three (3) remaining recorded breeding areas and three (3) other potential breeding areas, which will affect some known frog locations within 100m of the proposed development landscape.

Further investigation into the occurrence of this species within and adjoining the site is likely to be required to be able to determine the significance of impact.

Rosenberg's Goanna (*Varanus rosenbergi*)

On the east coast of NSW, the Rosenberg's Goanna (also known as Heath Monitor) is a Hawkesbury / Narrabeen sandstone outcrop specialist (State Forests of NSW, 1995). The Rosenberg's Goanna is largely restricted to heath (NPWS 1997); inhabiting humid woodlands, dry hardwood forests and heathland where it shelters in self-dug burrows, hollow logs, rock crevices and sandstone outcrops (Cogger 1992), usually with a sandy substrate (State Forests of NSW, 1997).

Eggs are generally laid within a terrestrial termite mound but they are unlikely to use termite mounds exclusively for nesting purposes. Ross Wellington, in a reply to supplementary ecological statement prepared by the respondent (NSW Land & Environment Court Proceedings No 10322 of 2009) stated that they are known to nest under rock ledges and in earth excavations beneath rocks, and also in tree hollows.

The Rosenberg's Goanna is a mobile species and is a lot more versatile than currently reported (Gerry Swan pers. com. 2012). For example, the species has been observed in the Rhylstone area utilising grassland areas for foraging purposes (entering burrows and preying on a young rabbit) and has been observed entering backyards with little native vegetation.

The Rosenberg's Goanna was previously recorded only from cage trapping of a juvenile in 2011. Recent surveys in more suitable, warmer weather conditions observed the species at a number of locations throughout the proposed development area as well as trapping of an individual in a cage trap. The trapped monitor had a cotton spool taped to the tail with biodegradable sticky tape (a method suggested by reptile expert Gerry Swan). The cotton line was later followed with GPS to two burrow locations, one located just within and the other located just outside of the north eastern portion of the proposed development area extent (see Figure 2).

This 2012 trapped individual was collected following the observation of a separate individual in the western site portions. The trapped juvenile of the previous year was not likely up to the size of the recently observed and captured individuals. Therefore, it is considered that there are a minimum of three (3) Rosenberg's Goannas utilising the site's habitats.

This species is also called Heath Monitor due to its reported preference for heath communities. However the recorded locations of Rosenberg's Goanna on site may be an artifact that the sightings were made along tracks through the heath. Rosenberg's Goanna is often observed using the edge of tracks for basking and presumably to get around more easily.

The rocky escarpment edge surrounding the proposed development area extent will likely also prove important for the species by providing a number of burrowing opportunities particularly where termite mounds are found (see Figure 2).

Observations and previous targeted surveys by *Travers bushfire & ecology* have found that hanging swamp and wet heath areas are often associated with recorded locations and may function to diversify foraging options. Tall Heath and Low Open Forest vegetation communities also function for habitat where these connect the important habitat areas. Rosenberg's Goanna has also been observed using a wide range of vegetation types in the Shoalhaven area using Shale Sandstone Transition Forest, Turpentine Forest, Sandstone Forest, Heath Woodland and Mallee Heath (Gerry Swan pers.com. 2012). Therefore, this species may be more of a generalist than currently believed and may utilise most habitat areas within its home range for foraging.

No terrestrial termite mounds have been recorded present within the development area to date. Due to the density of tall heath through the site, such mounds may be present but are very difficult to locate. Termite mounds may also be present further abroad and foraging opportunities are still present in the locality.

Mr Gerry Swan – a recognised Rosenberg Goanna specialist, was engaged to undertake a preliminary site study which has resulted in the location of one termite mound with a juvenile exit point and several more burrows (Cygnate Surveys and Consultancy November 2012). This termite mound and recorded burrows have however been located outside of the proposed development area. Further burrows have been identified in suitable habitat areas to the north and north-west of the proposed development area. Mr Gerry Swan has concluded that the proposed development site is not critical to the survival of the population, that there is adequate habitat surrounding the proposed residential development site to maintain a viable population, and the proposed residential development is not likely to result in a significant movement of connectivity restriction to the local population. Mr Swan also states that the proposed development is not likely to have a significant impact on the Rosenberg Goanna population. Interface management between the development area and mapped critical habitat areas as identified by Mr Swan needs to be investigated in further detail.

This species may be restricted by Mona Vale Road to the north and urban development in the remaining surrounds. However as this species is capable of and has been previously observed crossing roads (despite the risk of collisions), the home ranges are likely to be large and capable of extending beyond existing unfenced road corridors (Gerry Swan pers.com. 2012). Home ranges for this species (at least on Kangaroo Island) for thirteen (13) studied animals ranged from 1.71ha to 43.7ha with a mean of 19.44ha. The proposed residential area is quite small compared to the total available habitat in the locality (Gerry Swan pers.com. 2012).

Little Lorikeet *(Glossopsitta pusilla)*

Little Lorikeets mostly occur in dry, open eucalypt forests and foraging in small flocks on nectar and pollen in the tree canopy, particularly on profusely flowering eucalypts. Long term investigations indicate that breeding birds are resident from April to December, and even during their non-resident period, they may return to the nest area for short periods if there is some tree flowering in the vicinity (Courtney & Debus 2006).

The proposed development area provides sub-optimal foraging habitat for the Little Lorikeet. This species was recorded during initial surveys in 2008, however the location of the recording was not documented as the species was not listed as threatened at this time. No Little Lorikeets were recorded during 2011 or during recent 2012 surveys over two (2) weeks during the breeding period, suggesting that breeding is not taking place within the proposed development area or nearby. Development within the proposed development area would remove seasonally available foraging resources (excluding winter) however would not be considered likely to significantly impact on this species.

Powerful Owl *(Ninox strenua)*

The Powerful Owl inhabits mature rainforest, wet and dry eucalypt forest and woodland. Optimal habitat includes a tall shrub layer and abundant hollows supporting high densities of arboreal mammals. Roosting is generally within dense foliage of mid canopy trees in sheltered gullies. Large trees with hollows at least 45cm in diameter and 100cm deep are required for nesting. Estimates of the home range of this species vary greatly, but territories are thought to range from 800 to 1500ha (Kavanagh 1997).

The proposed development area provides no suitable breeding hollows for the Powerful Owl. No suitable hollows were observed in the nearby surrounds. The proposed development area also provides unlikely roosting habitat. Powerful Owl may utilise the site for foraging, given the presence of arboreal prey species, however these are present in low density given the low density of available hollow resources.

The Powerful Owl was recorded responding to call playback during 2008 surveys. Call-playback may call Owls away from core foraging and roosting areas. No sign of Owl activity but evidence of whitewash below roosting locations was found evident in the low Open Forest areas during extensive recent habitat searches. This species is not likely to offer a constraint to development within the proposed development area.

Grey-headed Flying-fox *(Pteropus poliocephalus)*

Grey-Headed Flying-foxes are canopy feeding frugivores and nectarivores, inhabiting a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas. This species roosts in camps, which may contain tens of thousands of individuals. Camps are commonly formed in gullies, typically not far from water and usually in vegetation with a dense canopy (Tidemann 1998). Generally foraging is within 20km of camps but individuals are known to commute up to 50km to a productive food source.

The proposed development area provides no suitable roosting or breeding habitat for the Grey-headed Flying-fox. A nearby large camp is located at Gordon over 3.5km from the proposed development area and individuals observed during surveys were likely foraging out from this camp site. The proposed development area provides seasonal foraging opportunity for the Grey-headed Flying-fox (excluding winter) within the low Open Forest areas. Loss of foraging resources within the subject site would not likely cause a significant impact on this species, therefore this species will not likely offer a constraint to development.

Little Bentwing-bat *(Miniopterus australis)* and Eastern Bentwing-bat *(Miniopterus orianae oceanensis)*

These species are considered here together due to similar habitat requirements.

The Little Bentwing-bat forages below the canopy and the Eastern Bentwing-bat forages above and below the canopy within Open Forests and woodlands, feeding on small insects. The species roosts in a range of habitats including stormwater channels, under bridges, occasionally in buildings, old mines and, in particular, caves (Dwyer 1995). Caves are an important resource for both species, particularly for breeding where maternity caves must have suitable temperature, humidity and physical dimensions to permit breeding (Dwyer 1995).
Both of these species were recorded during recent 2012 surveys by only one or two call sequence (passes) on the Anabat recorder. Neither species were recorded during previous Anabat surveys. This suggests only low use of the proposed development area, which is understandable due to the predominant heath structure within the site.

Whilst suitable caves for roosting and breeding may be present in the surrounding locality, and perhaps the nearby central south of the proposed development area, there are no such opportunities within the proposed development area itself. Therefore development within the proposed development area will impact only on suitable foraging habitat for both species. Such removal of foraging habitat will not likely offer a constraint to development within the subject site area.

3.3.7 Threatened fauna species with potential to occur

Swift Parrot (*Lathamus discolor*)

The Swift Parrot is a migratory species that breeds in Tasmania and its offshore islands in summer. In late March, almost the entire population migrates to mainland Australia spreading from Victoria through to central and coastal NSW and south east Queensland (Schodde and Tidemann, 1986). Winter flowering trees are an important resource for this species.

The several recorded eucalypt trees present within the proposed development area are not recognised winter flowering species. Therefore, this species is not considered likely to offer a constraint to development within the proposed development area. The likely presence of this species is simply based on a very close record to the north of the proposed development area in 2009. The tree species utilised for foraging is not documented within this record but may occur on site based on the location of the record.

Barking Owl *(Ninox connivens)*

The Barking Owl utilises dry sclerophyll forests and woodlands containing many large trees suitable for roosting or breeding and will utilise adjacent cleared areas for foraging. The Barking Owl utilises large hollows for nesting (Schodde & Tidemann 1986).

The Barking Owl has been recorded nearby to the south west in 1999, as well as a recording of the (likely) same pair in 2003 further south in the same connective forest area. Given the expected lifespan and home range of this species there is potential utilisation of the site.

The proposed development area provides sub-optimal habitat for this species which may be utilised for foraging but will unlikely be utilised for roosting and contains no suitable hollows for breeding. There were no signs of Owl activity within the proposed development area

during recent extensive field investigations. Therefore, this species is not likely to offer a constraint to development.

Spotted-tailed Quoll (*Dasyurus maculatus*)

The southern subspecies of Spotted-tailed Quoll *D. m. maculates* inhabits a range of treed habitats including rainforests, wet and dry sclerophyll forests, woodland and coastal heathland, scrub and dunes, swamp forest, mangroves, on beaches and sometimes in grassland or pastoral areas adjacent to forested areas (Belcher et al. 2008, Long & Nelson 2010).

Quolls favour areas with dense overstorey and understorey and use hollow-bearing trees, hollow-tree buttresses, fallen logs, small caves, rock crevices, boulder fields, rocky-cliff faces and underground burrows as den sites for shelter / breeding (Long & Nelson 2010). Multiple dens are used and movement between these is every 1-4 days. It appears to prefer moist forest types and inland riparian habitat for movement. Despite its occurrence in inland riparian areas, it also ranges over dry ridges (NPWS 1999).

Female home ranges are generally non-overlapping and 88-1,515ha in size. Male home ranges are much larger, from 359-5,512 ha in size, and overlap and encompass multiple female home ranges. The species is capable of covering large distances in a short period of time, with animals recorded moving at least 8km in a day and 19km in a week (Long & Nelson 2010). Habitat that is critical to the survival of the Spotted-tailed Quoll includes large patches of forest with adequate denning resources and relatively high densities of medium sized mammalian prey.

The proposed development area provides obvious suitable habitat for the Spotted-tailed Quoll and utilisation of the site on occasion is expected, based on records, the large home range of the species and preference for a range of habitats. Three (3) records along the urban interface of Belrose and Davidson from 1993 were taken on successive days and were likely the same individual. The species is likely to be utilising the nearby connective habitats given a record to the nearby west in 2009. The unique habitat attributes of the site make it a potential foraging resources and the rocky escarpment, particularly the cave system to the immediate south, may be utilised for denning.

The Spotted-tailed Quoll has not been recorded during targeted trapping effort to date. However, given the species difficulty in capture, and large home ranges, the site may still prove part of this species range. However this species is not likely to be significantly affected by the proposed development.

Southern Brown Bandicoot (*Isoodon obesulus*)

The Southern Brown Bandicoot has been detected in a range of habitats including Open Forest, woodland, heaths, agricultural land and urban areas, preferring areas with thick ground cover which provide protection from predators (Braithwaite, 1988). Environment Australia (2000) recorded this species from a range of habitat types, though it was more typically found in heathland environments on sandy friable soils. When located in forests and woodlands there is generally a healthy or shrubby understorey characterised by *Acacia*, *Banksia*, *Daviesia, Epacris, Hakea*, *Leptospermum*, *Melaleuca* and *Platylobium* species.

Distribution is patchy along the NSW coast and foothills with current information suggesting only two population strongholds, one in the far south eastern corner and the other within the Northern Sydney Metropolitan Area. Research undertaken by Macquarie University indicates that the sub-populations within Ku-ring-gai and Garigal National Parks may have been genetically different (DEC 2006). Additionally, this species is found to display a preference

for newly regenerating natural heathland habitat following fire or clearing (Menkhorst & Seebeck 1990; Braithwaite and Gullan 1978; Stoddart and Braithwaite 1979; Opie 1980).

The proposed development area provides high quality habitat for the Southern Brown Bandicoot. The species was expected to occur, based on nearby records, in similar habitat to the north, west and south of the proposed development area. OEH has suggested a high degree of trapping effort as the best means of determining presence of this species. Cage trapping over eight to ten (8-10) consecutive nights repeated for two (2) sessions, at least one (1) month apart is recommended.

Recent cage trapping effort was undertaken extensively throughout the proposed development area for ten (10) consecutive nights for one (1) session. Prior to this, cage trapping effort in 2011 was undertaken less extensively for four (4) consecutive nights. Supplementary survey effort using hair tubes and use of infra-red cameras to acceptable standards have been undertaken as part of recent surveys. To date, Southern Brown Bandicoot has not been recorded present within the site.

Eastern Pygmy Possum *(Cercartetus nanus)*

The Eastern Pygmy-possum is found from rainforest through sclerophyll forest to heath. Banksia and myrtaceous shrubs and trees are favoured (Turner and Ward, 2008). An important determinant of habitat quality may be the proportion of the year in which pollen is available and the species is usually associated with floristically diverse shrub community, especially those including Banksia species.

The proposed development area provides suitable habitat for the Eastern Pygmy Possum based on the floristic diversity within the heath and Open Forest communities and particularly the presence of several Banksia species. Most local records are located on the other side of Forest Way which potentially represents a separate population, however one record exists within 700m to the west in 2003 suggesting that a population is present in the surrounding connective landscape.

This species has not been recorded during survey undertaken to date.

New Holland Mouse (*Pseudomys novaehollandiae)*

Across the species' range, the New Holland Mouse is known to inhabit open heathland, open woodland with a heathland understorey and vegetated sand dunes (Fox & Fox 1978; Fox & Mckay 1981; Hocking 1980; Keith & Calaby 1968; Lazenby et al. 2008; Norton 1987; Posamentier & Recher 1974; Pye 1991; Wilson 1991). Sites where the New Holland Mouse is found are often high in floristic diversity, especially leguminous perennials (Haering & Fox 1997; Kemper & Wilson 2008). The species has been found to peak in abundance during the early to mid-stages of vegetation succession three to five years after fire (Braithwaite & Gullan 1978; Fox & Fox 1978; Fox & Mckay 1981; Posamentier & Recher 1974).

The proposed development area provides suitable habitat for the New Holland Mouse based on the sandy substrate, presence of heath and high floristic diversity. Not many records are known of this species in Northern Sydney, however, one (1) record exists to the nearby south west in 2001.

This species has not been recorded during survey undertaken to date.

3.3.8 Endangered populations

There is no listed endangered fauna population within the Warringah LGA.

There is an endangered Gang-gang Cockatoo population listed in the Hornsby and Ku-ring-gai LGAs and a Koala population is located in the Pittwater LGA. The geographical extent of these populations does not include the study area or suburbs immediately adjacent, therefore, this matter requires no further consideration.

3.3.9 Connectivity

To the north, west and south there is extensive bushland that adjoins Garigal National Park and Middle Harbour Creek catchment (Figure 4). This extensive area of bushland covers no less than 500ha and is fragmented further north only by Mona Vale Road before heading into Ku-ring-gai National Park towards Berowra and north of Terrey Hills. There is additional connectivity to the north east towards Narrabeen Lakes and the Warriewood-Ingleside escarpment however this is fragmented by Forest Way.

Both Mona Vale Road and Forest Way are very busy roads that would provide a potential barrier for movement for terrestrial fauna species. However, it is noted that these roads are not fenced in all locations and wildlife is likely to attempt to cross, at risk of being hit by traffic, at night, or at sunrise when traffic is low.

The majority of the directly connective landscape to the site provides open forest, open woodland and heath habitat associated with steeper gully Hawkesbury soils and exposed slopes.

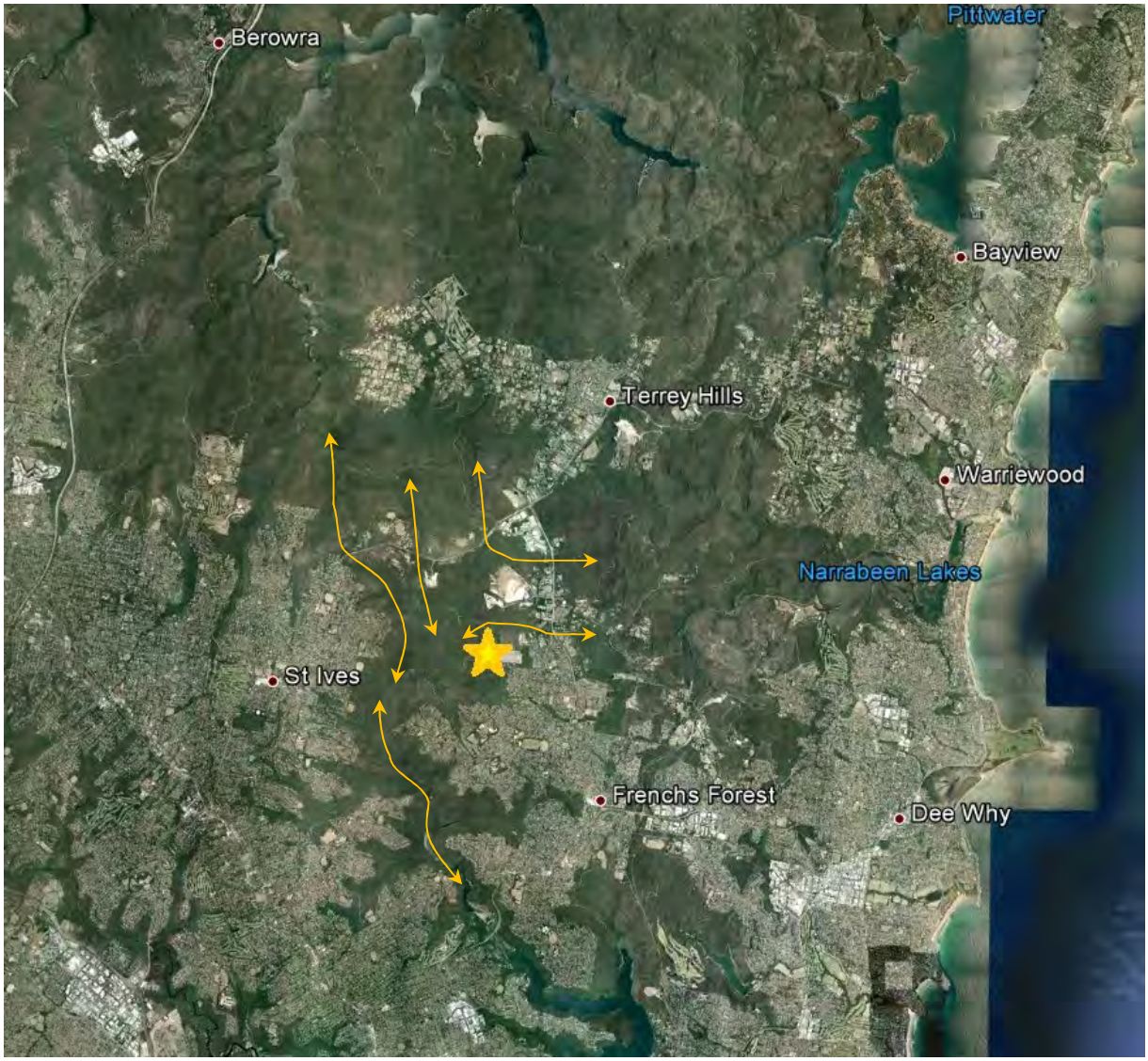

Figure 6 – Vegetation connectivity

3.4 Threatening processes

The following 'key threatening processes' listed under the *TSC Act* (1995) are likely to influence the proposed mitigation measures that apply to the development area. They include:

- Bush rock removal
- Clearing of native vegetation
- Infection of frogs by amphibian chytrid causing the disease chytridiomycosis
- Invasion of native plant communities by exotic perennial grasses
- Infection of native plants by *Phytophthora cinnamomi*
- Introduction and establishment *of Exotic Rust Fungi* of the order *Pucciniales* pathogenic on plants of the family *Myrtaceae*
- Loss or degradation (or both) of sites used for hill-topping by butterflies
- Predation by the feral cat *Felis catus*
- Removal of dead wood and dead trees.

The proposed development area is located along a ridge plateau which extends out from urbanised areas of Belrose. Approximately half of the proposed development area contains

heath and coastal upland swamp communities which have a limited extent beyond the proposed development area due to the topographical nature of this plateau. As such, it should be considered that these communities which provide good quality and somewhat isolated habitat for selected fauna species (including the Southern Brown Bandicoot and Heath Monitor) will be removed as a result of the proposed development.

Biodiversity Offsets 4

4.1 Background

Biometric vegetation survey within the proposed offset area has been undertaken to confirm the vegetation communities present (Figure 3). The biometric survey of vegetation communities has been used to provide a preliminary analysis as to whether the offset lands are likely to meet typically acceptable offset targets.

It is important to note that for approval purposes of a potential site for biodiversity offsets, NSW OEH typically require the sites to be assessed using a *maintain or improve test* such as under the biocertification assessment methodology or the Biobanking assessment method as used for Biobanking applications. Either method is acceptable but the methods can result in different outcomes as to the potential offset requirements. *Travers bushfire & ecology* considers that the method to be used is subject to whether a site is to be offered as a conservation zone such as under an environmental planning instrument or alternatively as a Biobanking site. Where significant and comprehensive fauna survey has been undertaken, the survey data will provide further information that may influence and / or support the proposed offsets.

A basic component of any offset analysis is the calculation of losses and gains (typically in hectares) of each vegetation community which identifies the offset ratios for each vegetation community. This process by itself does not adequately assess the conservation value of the landscape due to the need to take into account the typical lifecycle and habitat requirements of known and potential threatened species in the locality. Factors such as the size of the impacted remnants, the amount of habitat loss and the degree of connectivity to surrounding habitat areas also affect the conservation and offset value of lands. The *maintain or improve test* and the Biobanking method, predicts the conservation values based on a comprehensive data set of species records and habitat requirements which are too complex to consider simply as a loss and gain of vegetation communities.

However, the loss and gain of each vegetation community enables the determination of the available offset ratios of each community which may be used to support an application for development and the provision of an offset in accordance with the NSW OEH *Principles for the use of Biodiversity Offsets in NSW* (NSW OEH 2010). The determination of adequacy of the offsets will need to be determined through the use of the *maintain or improve test* and or the Biobanking assessment method for *NSW TSC Act* listed matters and the 'Offset Calculator' as provided by SEWPAC for *EPBC Act* listed matters.

Notwithstanding the principles of use biodiversity offsets in NSW (OEH 2012) the key objectives of a biodiversity offset strategy for a proposed development include:

- to achieve a *maintain or improve* outcome of total native vegetation cover including protection and restoration offsets,
- to secure sites with suitable habitats to compensate for the loss of onsite habitats and which contains suitable habitat for the threatened flora and fauna species previously observed within the development area, and

- to enable long-term management of conserved bushland areas in accordance with an approved vegetation management plan or equivalent.

A *maintain or improve* is determined on the basis of acceptable methodologies that estimate the expected loss and gain in flora and fauna habitat and is a calculation process that provides offset ratios. Any offset ratio of 3:1 or greater is generally considered to meet minimum offset ratios, however, typical ratios of 5:1 or greater are more acceptable subject to the presence or absence of threatened species and EECs.

To ensure an open, objective and transparent offset analysis, it is policy to use of the Biobanking Assessment Method or the Biocertification Assessment – Maintain or Improve test to determine whether adequate offsets have been provided.

4.2 Offset security

A key principle of the offsetting guidelines published by DECCW is to provide security in perpetuity for the offset outcomes. As such, the offset areas can be protected in a number of ways including:

- Rezoned as E2 (environmental protection) usually in combination with a Voluntary Conservation Agreement,
- Protection and management as public reserve under the Local Government Act
- Protected under a conservation covenant or equivalent
- Transferred into national park estate
- Established as a Biobanking site

The method of protection is to be resolved in consultation with the NSW Office of Environment & Heritage. Please note that an environmental zoning without another form of legislative protection such as a voluntary conservation agreement is not considered to be adequate security.

The type of security provided must also consider the ability to effectively manage the proposed offset lands for biodiversity conservation purposes and whether the offset lands remain under private or public ownership. It is current policy that if the offset lands are to remain in private ownership then either the site is offered as a Biobanking site or a Voluntary Conservation Agreement is established.

Section 6.2 identifies the principles that must be met in order to provide a viable offset site.

4.3 Principles for use of biodiversity offsets in NSW

The following principles have been defined by the NSW Office of Environment and Heritage for the use of biodiversity offsets in NSW. The proposed offset sites are considered in the context of these principles.

1. Impacts must be avoided first by using prevention and mitigation measures

The proposal must demonstrate avoidance of impact using prevention and mitigation measures. Subject to the assessment process, the development concept should be able to demonstrate avoidance of significant impacts.

2. All regulatory requirements must be met

All other existing legislative requirements must be met. This principle will be addressed as part of the gateway determination of the planning proposal and subsequent development applications.

3. Offsets must never reward ongoing poor performance

The proponents must demonstrate satisfactory performance in managing, protecting and maintaining the conservation values of the landscape subject to the approved development application. Current and ongoing land management practices demonstrate that the land is currently being managed in an appropriate manner but will require resources in the future to maintain the lands for biodiversity conservation purposes.

4. Offsets will complement other government programs

In this case the offset lands have significant strategic conservation value, being located adjoining Garigal National Park.

5. Offsets must be underpinned by sound ecological principles

The ecological survey, biodiversity offset analysis and subsequent assessment process is intended to flesh out the ecological implications of the proposed development and the offset arrangements. Consultation with NSW OEH, Warringah Council and SEWPAC are critical to this process to ensure that the offsets are ecologically sound.

6. Offsets should aim to result in a net improvement in biodiversity over time

The provision of the offset site is a major part of the process of seeking a net improvement in biodiversity but its protection and future management must be based on best practice conservation management practices. Future monitoring of the offset site must demonstrate a net improvement in biodiversity values as a result of land management practices including target weed control, revegetation or regeneration works and / or changes in land practices such as ecological or hazard reduction burns.

7. Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs

The offset site must clearly demonstrate that it adequately offsets the impact of the development throughout the entire development process.

8. Offsets should be agreed to prior to the impact occurring

The offsets are required to be approved by the Director General prior to commencement of any actions related to current development applications.

9. Offsets must be quantifiable – the impacts and benefits must be reliably estimated

The offset analysis needs to determine the following parameters:

- The area of Impact,
- The types of ecological communities affected,
- The condition of habitat,

- The conservation status and / or scarcity / rarity of ecological communities,
- The Level of security afforded to the site.

These are key issues to resolve as part of the assessment process and consultation with NSW OEH.

10. Offsets must be targeted

The offsets must demonstrate that they target the biodiversity values impacted by the proposed development. Where it does not offset specific ecological impacts, either alternative offsets may need to be provided such as through restoration on other lands.

11. Offsets must be located appropriately

The offset sites must be large enough to be of conservation value and must also be located to support other conservation areas or ecological corridors. Access must also be available for management purposes.

12. Offsets must be supplementary

The proposed offset areas are not to be under any other conservation agreement and must not be offered as biodiversity offset under any other scheme.

13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conserving agreements or a contract

The proposed offset must be enforceable through the development consent. Considerations to the transfer of ownership of the land to a public authority, provision of long term funding for the management of the offset site and / or entering into a Voluntary Conservation Agreement are important matters to be resolved.

4.4 Vegetation offsets

The following sections provide a summary of the offset outcomes that can potentially be achieved by the planning proposal.

4.4.1 Offset calculations

The offset calculations provided below are a qualitative assessment of the offset areas being provided and whether they meet typically acceptable offset ranges. These results should not be used to identify whether the offsets are adequate to achieve a *maintain or improve* outcome. This is more appropriately assessed using the Biocertification or Biobanking assessment methods.

Floristic quadrat sampling (using the biometric field assessment method) has been undertaken within the existing vegetation communities to provide a baseline data set upon which offset analysis is undertaken. Floristic quadrats undertaken on site are directly comparable to the CMA benchmark figures and have enabled the vegetation mapping to be more accurately defined within the study area.

The following Tables 7 - 9 provide qualitative results based on the vegetation survey to date.

Table 7 - Vegetation offset outcomes

Veg code	Vegetation community	Vegetation within offset lands (ha) *(Note 5)*	Vegetation within APZ (ha)	Vegetation within developmen area (ha)	Total vegetation loss (ha)	Total vegetation in study area (ha)	Protection offset ratios	Potential restoration offsets (ha)	Combined restoration & protection offset ratios
A	Short Heath (to 2.5m tall)	1.19	0	2.44	2.44	3.63	0.48:1	Nil	0.48:1
B	Tall Heath (2.5 - 5m tall)	20.08	2.29	4.63	6.92	27.00	2.90:1	Nil	2.90:1
B2	Damp Tall Heath	2.66	0	0.47	0.46	3.12	5.78:1	Nil	5.78:1
C	Low Open Forest (to 10m tall)	38.78	2.8	6.16	8.96	47.74	4.32	2.83	4.64:1
D	Open Forest (10+m tall)	28.61	0.53	3.45	3.98	32.59	7.18:1	Nil	7.18:1
E	Cleared, Managed, Landscaped or Weed Plume	3.39	0.15	2.08	2.23	5.62	N/A	Nil	N/A
F	Coastal Upland Swamp	1.65	0.07	0.08	0.15	1.80	11.00:1	Nil	11.00:1
G	Sandstone Gully Forest	17.73	0.29	0	0.29	18.02	61.13:1	Nil	61.13:1
H	Riparian Woodland/Forest	0.345	0	0	0	0.345	Nil Loss	0.47	Gain (0.82 ha)
	Total	**114.43**	**6.12**	**19.31**	**25.43**	**139.86**	**4.5**	**3.30**	**4.63:1**

Table 8 - Estimated loss and gain of rare or threatened flora populations in study area

Species code	Threatened flora	Estimated population in offset lands	Recorded population in APZ	Recorded population in development area	Estimated total population loss	Estimated total population in study area	Estimated % loss of population	Significance of loss
El	Eucalyptus leuhmanniana	3062	713	21	734	3796	19	Not Significant
Dc	Grevillea caleyi	0	0	6	6	6	**100**	**Mitigation Measures potentially required. Subject to target survey in offset lands**
Tg	Tetratheca glandulosa	4	0	101	101	105	**95**	**Subject to target survey in offset lands**
Ac	Angophora crassifolia	978	38	192	230	1208	19	Not Significant
	Total	4044	751	320	1071	5,115		

Table 9 - Potential rare or threatened flora habitat offset outcomes

Species code	Threatened flora	Potential habitat within offset lands (ha) *(Note 5)*	Potential habitat within APZ (ha)	Habitat within development area (ha)	Total habitat loss (ha)	Total habitat in study area (ha)	Protection offset ratios	Potential restoration offsets (ha)	Combined restoration & protection offset ratios
El	*Eucalyptus luehmanniana* (Note 1)	6.61	1.36	0.54	1.90	8.51	3.48:1	0.00	3.48:1
Gc	*Grevillea caleyi* (Note 2)	38.78	2.8	6.16	8.96	47.74	4.32	2.83	4.64:1
Tg	*Tetratheca glandulosa* (Note 3 & 5)	67.39	3.33	9.61	12.94	80.33	5.21:1	2.83	5.43:1
Ac	*Angophora crassifolia* (Note 4)	70.55	3.33	10.08	13.41	83.96	5.26:1	0.47	5.30.1

Note 1 – Potential habitat for *Eucalyptus luehmanniana* consists of selected lands on the south and south west aspects
Note 2 – Potential habitat for *Grevillea caleyi* consists of Low Open Forest areas within study area
Note 3 – Potential habitat for *Tetratheca glandulosa* consists of all Low Open Forest and Open Forest vegetation
Note 4 – Potential habitat for *Angophora crassifolia* consists of all Damp Tall Heath, Low Open Forest and Open Forest vegetation
Note 5 – Habitat areas based on known occurrences, target survey for *Tetratheca glandulosa* has not been comprehensively completed for the offset areas (out of season survey has been undertaken), all population and habitat estimates may change subject to completion of target flora survey within the offset lands.

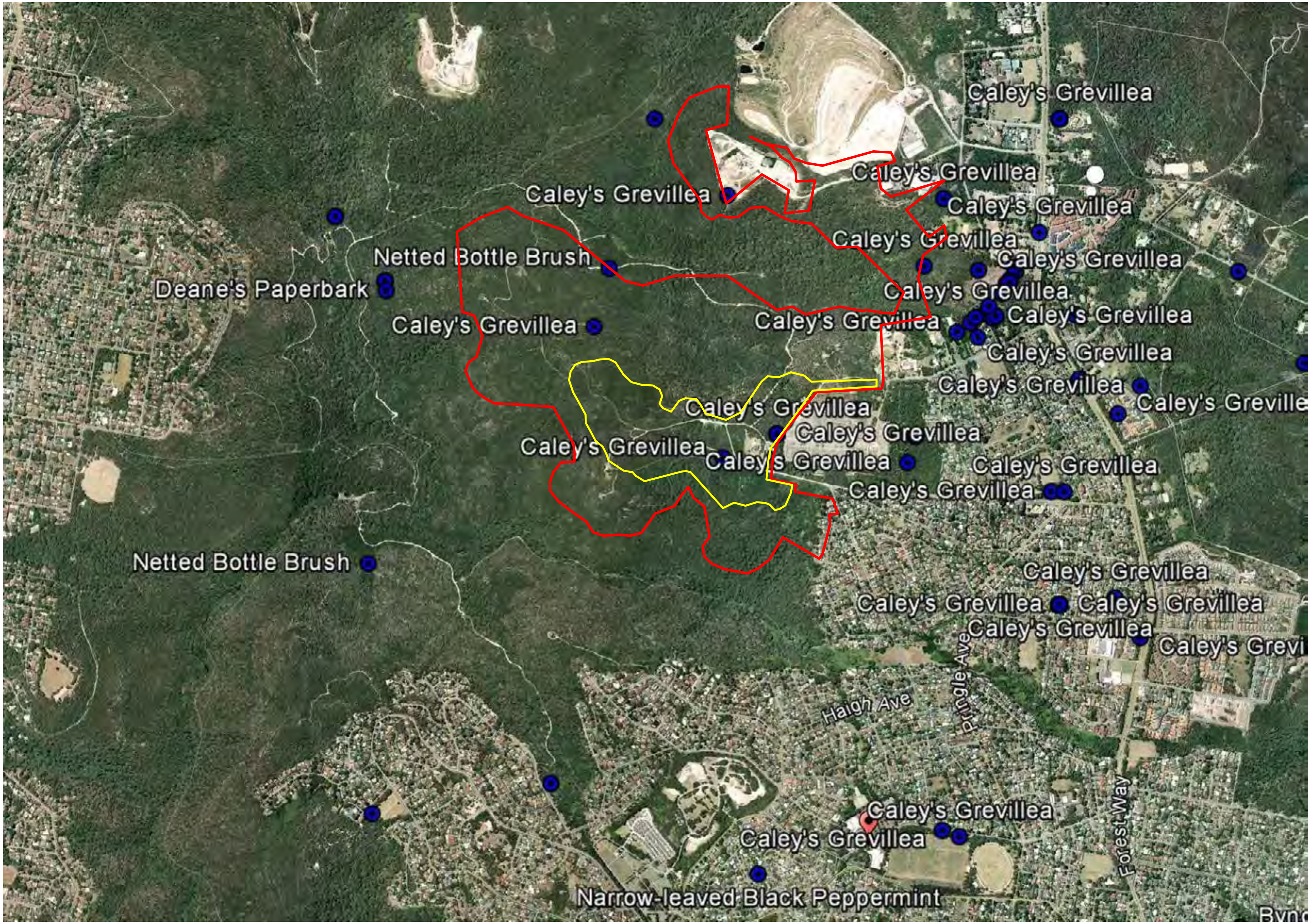

Figure 7 – Threatened flora records within and adjoining the offset area

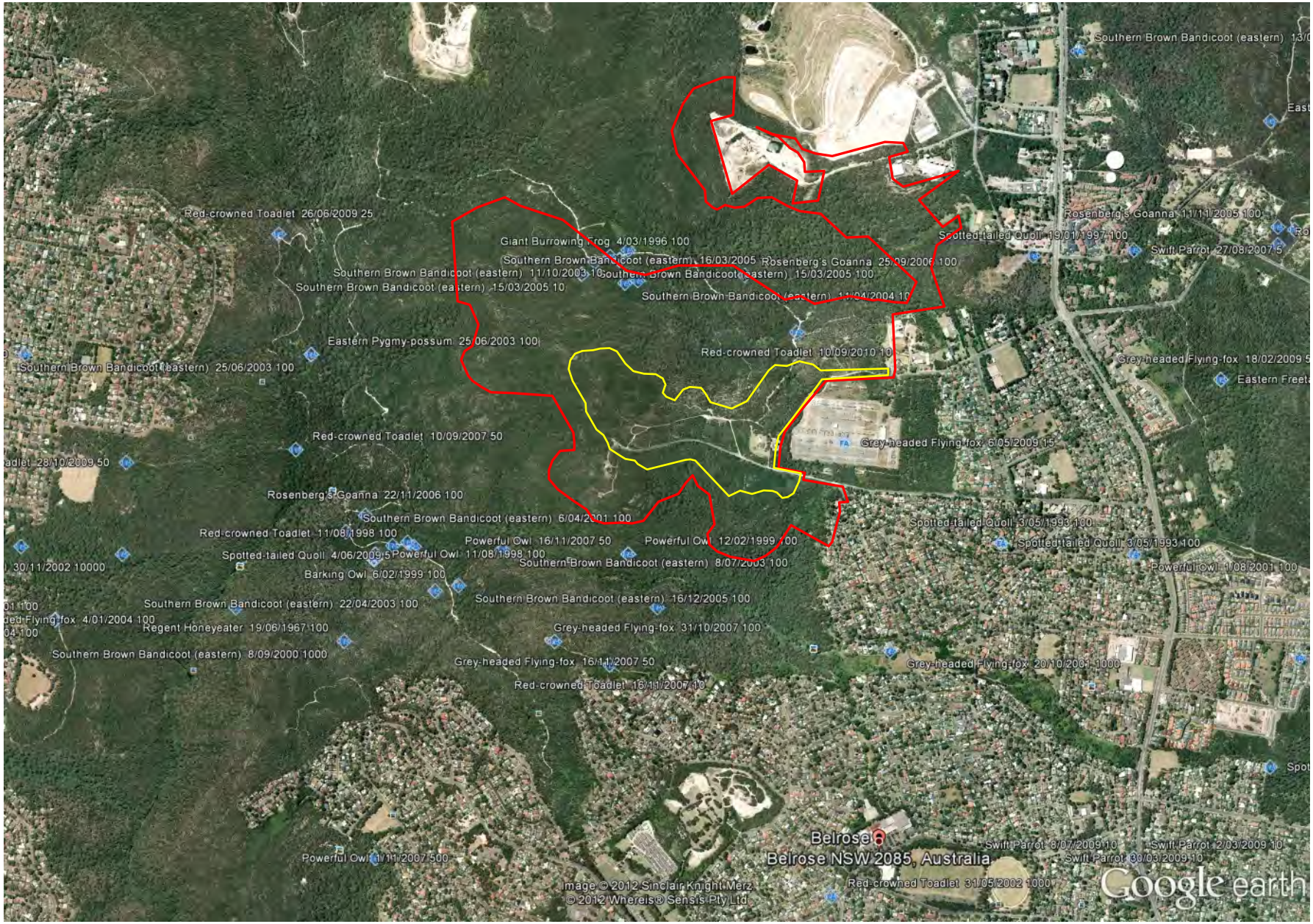

Figure 8 – Threatened fauna records within and adjoining the offset area

4.4.2 Concluding offset comments

The offset ratios provided by the proposed conservation area are within typically acceptable ranges for all vegetation communities, with the exception of Short Heath (offset ratio of 0.48:1) and to a lesser extent Damp Tall Heath (offset ratio of 2.90:1). In some cases offset ratios of less than 3:1 is acceptable provided it is supported by a biobanking assessment or biocertification, maintain or improve test. The proposed conservation area provides a favourable offset for the recorded endangered ecological community Coastal Upland Swamp. The offset ratios for Short Heath and Tall Heath are low or marginal and may potentially require an offset external to the site.

The available offsets of suitable habitat for the recorded rare and threatened flora including *Angophora crassifolia, Eucalyptus luehmanniana, Grevillea caleyi* and *Tetratheca glandulosa* are also within typically acceptable offset ranges (Table 9).

Despite the loss of the current recorded population of *Grevillea caleyi*, Tables 7 - 9 above indicate favourable offset outcomes for *Grevillea caleyi* based on the recorded habitat areas and potential habitat areas within the offset area. The recorded area may also form part of an existing population within the adjoining substation lands to the east of the site.

Based on the combined soil landscape and vegetation distributions, the habitat for *Grevillea caleyi* is not limited to the site. Based on the distribution of Open Forest vegetation (Figure 7), existing records and the presence of *Eucalyptus sieberi*, there are further areas of potential habitat within the offset lands and to the east of the site in the substation lands.

Mitigation measures such as protection of the existing plants insitu by modification of the proposed Wyatt Avenue extension, or provision of an on site or off site restoration offset, are possible approaches to addressing the loss of this species. However subject to the completion of target *Grevillea caleyi* survey, the total habitat areas and total population losses will be more accurately determined.

Although not assessed in the above tables, the offset lands also provide potential offsets for Red-crowned Toadlet, Southern Brown Bandicoot, Eastern Pygmy Possum, New Holland Mouse, Spotted-tail Quoll, Little Lorikeet, Little Bentwing-bat, Giant Burrowing Frog, Eastern Bentwing-bat, Grey-headed Flying-fox, Powerful Owl and Rosenberg's Goanna.

For those recorded site dependent threatened species, it is important to identify possible foraging and breeding areas within the local landscape as a means of identifying whether the proposal directly impacts on critical habitat areas for the recorded threatened fauna species. The potential offset value of the proposed conservation area needs to be assessed for threatened fauna species and investigation is needed to identify whether sufficient land to maintain viable populations (Figure 8). The offset area provides significant habitat for Red-crowned Toadlet which is also likely to give a favourable offset outcome. The habitat for Giant Burrowing Frog within the study area has not been defined as yet and is subject to further investigation.

There is no doubt that the proposed offset lands provide a significant contribution to securely conserved areas and provide benefit to Garigal National Park as existing extended habitat. It is current NSW OEH advice that the method of calculation of offsets and their adequacy should not be based on the loss and gain of vegetation communities only, as habitat preferences for threatened flora and fauna species do not correlate to floristic assemblage alone but is also dependent on the habitat attributes. In addition, it is important that the offset calculation process should be transparent and comparable to other sites. Accordingly, a specific offset analysis using the Biobanking assessment method or the biodiversity certification assessment method is recommended to determine the *adequacy* of the proposed lands for biodiversity offsetting purposes.

Ecological Impacts & Constraints

5

5.1 Recorded threatened species and endangered ecological community

In respect of matters required to be considered under the *Environmental Planning and Assessment Act 1979* and relating to the species / provisions of the *Threatened Species Conservation Act 1995;*

- Eight (8) threatened fauna species occur, being Giant Burrowing Frog (*Helioporus australiacus*), Red-crowned Toadlet (*Psedophryne australis*), Rosenberg's Goanna (*Varanus rosenbergii*), Powerful Owl (*Ninox strenua*), Little Lorikeet (*Glossopsitta pusilla*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Little Bentwing-bat (*Miniopterus australis*) and Eastern Bentwing-bat (*Miniopterus orianae oceansis*).

- Two (2) threatened flora species including *Tetratheca glandulosa* and *Grevillea caleyi.*

- One (1) EEC - Coastal Upland Swamp of the Sydney Basin Bioregion were recorded.

In respect of matters required to be considered under the *Environment Protection and Biodiversity Conservation Act 1999;*

- Two (2) threatened fauna species occur, being Giant Burrowing Frog (*Helioporus australiacus*) and Grey-headed Flying-fox (*Pteropus poliocephalus*),

- No protected migratory bird species,

- Two (2) threatened flora species occur, being *Tetratheca glandulosa* (listed as vulnerable) and *Grevillea caleyi* (listed as endangered),

- No EECs listed under this Act were recorded within the proposed development area.

In respect of matters relative to the *Fisheries Management Act 1994*, no suitable habitat for threatened marine or aquatic species was observed within the proposed development area and there are no matters requiring further consideration under this Act.

5.2 Ecological Impacts of the proposed planning scheme

The planning proposal results in a potential loss of one hundred and one (101) *Tetratheca glandulosa* plants, and a potential loss of six (6) *Grevillea caleyi* plants within the areas proposed for residential rezoning, including road corridors. Significant areas of potential *Tetratheca glandulosa* habitat exist within the offset lands and more extensive populations are likely to be present. However, limited *Grevillea caleyi* habitat is present within the proposed development area and either protection or restoration mitigation measures are recommended for the small population present within the disturbed northern reaches of the total land parcel.

An estimated 80% of both populations of *Eucalyptus luehmanniana* and *Angophora crassifolia* will be conserved. There is an estimated three thousand and sixty-two (3,062) *Eucalyptus luehmanniana* and nine hundred and seventy eight (978) *Angophora crassifolia* being protected within the proposed offset lands.

The planning proposal directly impacts on 0.15ha of the EEC – Coastal Upland Swamp but conserves a larger contiguous area of 1.27ha to the south of Ralston Avenue plus a further 0.53ha in the northern portion of the land parcel proposed as offset lands. The retention of the 0.15ha patch is not feasible within the current planning scheme and represents an 8 % loss of this community.

The habitat of the proposed development area is being utilised as foraging habitat for Rosenberg's Goanna (*Varanus rosenbergi*). Peripheral areas of the planning proposal also provide suitable habitat for Red-crowned Toadlet (*Pseudophryne australis*), and suitable habitat for Giant Burrowing Frog (*Helieoporus australiacus*).

The other recorded threatened species are not considered to be site dependent and will not be adversely affected by the proposed planning scheme.

Rosenberg's Goanna and the Giant Burrowing Frog are significant threatened fauna species records which potentially require further investigation.

Based on the advice of Mr Gerry Swan, the Rosenberg Goanna population is expected not to be significantly impacted and a viable population can be maintained in the presence of the proposed development. The nearest most likely breeding areas for Rosenberg's Goanna are in the north and north east portion of the study area as confirmed by Mr Gerry Swan, inclusive of lands north of the substation site. Other areas also exist to the southern, south western, eastern, and north eastern aspects of the proposed residential areas.

The recorded Giant Burrowing Frog (a desiccated carcass confirmed by DNA analysis) is likely to be a juvenile and therefore may have been in dispersal at the time of capture as there is potential breeding habitat for this species within the perennial streams that drain off the plateau. Some potential for breeding is also present within the EEC Coastal Upland Swamp located in the south eastern portion of the site. More suitable breeding habitat is most likely to be found in the lower extent of watercourses and the other drainage lines that flow from the site, including Bare Creek Fireclay Gully, French's Creek and Middle Harbour Creek. Further investigation is required to determine whether the Giant Burrowing Frog will be significantly impacted and whether sufficient habitat is available to maintain a viable local population.

Significant areas of potential breeding habitat are available within the proposed offset lands for Rosenberg's Goanna, Giant Burrowing Frog and the Red-crowned Toadlet. All of the recorded frog species are indirectly impacted by stormwater drainage and hence the planned management of stormwater will be important in maintaining viable threatened species populations.

Investigation and / or survey on these species will provide further insight into the impact of the planning scheme on these species. Identification of breeding habitat and protection of breeding areas are important mitigative measures for maintaining viable local populations of threatened fauna.

5.3 Ecological constraints

The ecological constraints are a combination of the insitu EEC – Coastal Upland Swamp, and threatened species constraints. The flora and fauna survey results to date indicate that the threatened flora populations, whilst present on site, are not likely to form a significant constraint to development and are subject to target survey for *Tetratheca glandulosa* and *Grevillea caleyi* within the adjoining offset lands and surrounding landscape.

The site and surrounding landscape provide important habitat for rare threatened flora species including *Eucalyptus luehmanniana and Angophora crassifolia.*

Threatened fauna populations potentially represent a more significant constraint to development, subject to the use of the proposed development area for breeding purposes and whether viable populations can be supported by the surrounding landscape.

This constraints assessment has identified that further investigation is warranted into the site dependent threatened fauna species Rosenberg's Goanna (*Varanus rosenbergi*), Red-crowned Toadlet (*Pseudophryne australis*), and Giant Burrowing Frog (*Helieoporus australiacus*). A preliminary expert report on the Rosenberg's Goanna has been prepared by Mr Gerry Swan (Cygnate Surveys and Consultancy November 2012).

5.3.1 Flora constraints

Vegetation community survey has been undertaken throughout the total land parcel owned by MLALC (including the offset lands), target threatened flora searches have been undertaken within the proposed residential areas and the immediate surrounding landscape.

Target flora survey has not been undertaken in the entire offset lands, except for the purposes of identifying the presence or absence of threatened flora species. Therefore individual records as mapped are not considered to be the full extent of the threatened or rare plant populations within the offset lands.

The MLALC land parcel and associated road corridors provide known habitat for the following threatened flora species and an EEC:

- *Tetratheca glandulosa* (101 plants mostly within proposed residential zone)
- *Grevillea caleyi* (6 plants within proposed residential zone)
- EEC - Coastal Upland Swamp (1.8ha)

The land parcel (study area) also contains two (2) populations of the following rare ROTAP listed threatened species:

- *Eucalyptus luehmanniana* (estimated 3,062 plants within study area including offset lands)
- *Angophora crassifolia* (estimated 978 plants within study area including offset lands)

Based on the floristic survey results, the EEC, Coastal Upland Swamp of the Sydney Basin Bioregion provides the most significant vegetation constraint to development of the land. Coastal Upland Swamp occurs on the southern aspect of Ralston Avenue and in the northern portion of the land parcel.

The EEC - Coastal Upland Swamp occurs in several patches covering a total of 1.8ha. 1.65ha or 92% of Coastal Upland Swamp will be retained as part of the proposed planning scheme. The Coastal Upland Swamp is also a *protected* groundwater dependent ecosystem under the NSW Groundwater Dependent Ecosystem Policy.

A buffer is typically imposed around such sensitive groundwater dependent ecosystems which are subject to the hydrological / hydrogeological study and a stormwater management plan. Ralston Avenue, which currently extends through to the south western boundary, provides a physical barrier for the existing Upland Swamp. The planning proposal provides a natural vegetation buffer of 30m to the north west of the largest patch of Coastal Upland Swamp. An APZ provides additional separation.

Following surveys in May 2008 and December 2011, target survey for potential threatened flora species has been undertaken in October (spring) 2012, in particular for *Pimelea curviflora var. curviflora* which has not been detected within the proposed residential zone to

date. *Tetratheca glandulosa* and *Grevillea caleyi* were also resurveyed in October 2012 to ascertain their full coverage across the development area.
Based upon the floristic survey, the current potential botanical constraints are;

- *Tetratheca glandulosa* and *Grevillea caleyi,* threatened plant species under both the *TSC Act* (1995) and *EPBC Act* (1999)
- EEC - Coastal Upland Swamp, previously known as Sandstone Hanging Swamp which will require buffers for future protection
- *Angophora crassifolia,* a rare (ROTAP) species found within the taller vegetation stratas and occasionally in Tall Heath / Damp Tall Heath
- *Eucalyptus luehmanniana,* a rare (ROTAP) species has been observed, usually within Tall Heath or Low Open Forest in close proximity to Ralston Avenue, mostly on the southern side of the road on south west to south east facing slopes

Based on the vegetation community mapping, the Low Open Forest and Open Forest communities appear to provide the best potential threatened flora habitat. However, the recorded number and densities of threatened species are low.

The offset lands provide extensive areas of habitat for these species, as demonstrated by target survey for *Eucalyptus luehmanniana* and *Angophora crassifolia.* The offset lands are also expected to provide habitat for *Tetratheca glandulosa* and *Pimelea curviflora var. curviflora* and *Grevillea caleyi.*

Given the estimated large numbers of *Eucalyptus luehmanniana* and *Angophora crassifolia* in the offset lands, approximately 80% of the estimated *Eucalyptus luehmanniana* population (3,062 records) and 80% *Angophora crassifolia* of the population (978 records) will be retained.

Due to the lack of target survey for *Tetratheca glandulosa* within the offset lands, the total loss of the population cannot currently be estimated. Significant areas of habitat are present within the offset lands, therefore, it is expected that the loss of these plants within the proposed development area is not likely to lead to *significant* impact.

A very small population of *Grevillea caleyi* (six (6) plants) are potentially directly affected by road works and the development area. There is further suitable habitat within adjoining lands to the east of the proposed residential area surrounding the electricity substation and Open Forest communities within the proposed offset lands. Based on the proposed plans, on site protective measures can potentially be implemented to protect the majority of the existing small population within and adjoining the road corridor. It is also likely that this species can be propagated and restored to an appropriate protected location.

5.3.2 Fauna constraints

Eight (8) threatened fauna species have been recorded within, or in close proximity to, the development area during surveys to date. The recorded species include:

- Powerful Owl (*Ninox strenua*),
- Grey-headed Flying-fox (*Pteropus poliocephalus*),
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis),*
- Little Bentwing-bat (*Miniopterus australis),*
- Little Lorikeet (*Glossopsitta pusilla*),
- Rosenberg's Goanna (*Varanus rosenbergi*),
- Red-crowned Toadlet (*Pseudophryne australis*), and
- Giant Burrowing Frog (*Helieoporus australiacus*).

It is considered that the development area also has potential for the following additional threatened fauna species to occur:

- Southern Brown Bandicoot (*Isoodon obesulus*) – not recorded within the proposed development area,
- Eastern Pygmy Possum (*Cercartetus nanus*) – not recorded within the proposed development area,
- Spotted-tailed Quoll (*Dasyurus maculatus*) – not recorded within the proposed development area, and
- New Holland Mouse (*Pseudomys novaehollandiae*) – not recorded within the proposed development area.

The Southern Brown Bandicoot and New Holland Mouse are known to re-colonise areas of burnt heath during regrowth stages and the Spotted-tailed Quoll has exceptionally large home ranges. However, none of these species have been recorded within the proposed development area.

Of the recorded fauna species, three (3) have potential to offer a constraint to development within the proposed residential area due to a dependence on the habitat within and surrounding the proposed area. These are:

- Rosenberg's Goanna (*Varanus rosenbergi*),
- Red-crowned Toadlet (*Pseudophryne australis*), and
- Giant Burrowing Frog (*Helieoporus australiacus*).

Fauna surveys to date have revealed that the proposed residential area is utilised by Rosenberg's Goanna for foraging purposes, however, locations of burrows within the proposed area have not been fully located. No terrestrial termite mounds suitable for nesting have been observed to date within the proposed development area, but recent burns may provide better access for further investigation. We expect to find potential termite mounds in wooded areas. Further investigation is required for this species to determine whether the planning scheme is considered a significant impact based on the habitat utilisation and surrounding known habitat of this species.

Mr Gerry Swan – a recognised Rosenberg Goanna specialist located a termite mound with a juvenile exit point and several more burrows. The Termite nest and observed burrows are located outside of the proposed development area. Mr Gerry Swan has concluded that the proposed development site is not critical to the survival of the population, that there is adequate habitat surrounding the proposed residential development site to maintain a viable population, and the proposed residential development is not likely to result in a significant movement of connectivity restriction to the local population. Mr Swan also states that the proposed development is not likely to have a significant impact on the Rosenberg Goanna population. Mr Swan has identified a critical habitat area for this species which may require further investigation to refine the extent to which development can encroach to the northern aspect of the site.

Dry spring weather conditions leading into the October spring survey limited accuracy of determining breeding aggregations important for Red-crowned Toadlet. Four (4) locations have been identified for potential breeding habitat, however, more are expected in surrounding watercourses. The expected locations are within upper level drainages just off the plateau escarpment. This species is generally well represented by records in the surrounding connective landscape and is potentially affected by the proposed development

The specimen of Giant Burrowing Frog recorded onsite is likely to have been a juvenile in dispersal. Juvenile frogs may disperse far from breeding areas however, adults of this species are also known to occupy territories several hundred metres from breeding areas. There is potential breeding habitat within the drainage line in the north eastern corner of the proposed residential area as well as within a small portion of the Coastal Upland Swamp located to the south east, however, tadpoles were not recorded in these locations. Drainages that flow off the escarpment become more suitable for this species along lower reaches where tadpole pools are more permanent.

Giant Burrowing Frog is known to generally occupy riparian areas for breeding that flow from naturally vegetated upper catchment landscapes. The critical areas for breeding along drainage lines have not been determined to date and the utilisation of remaining habitat is difficult due to the cryptic nature of this species. Records of this species to date are otherwise limited in the connective surrounds.

Further investigation or expert advice is required for Giant Burrowing Frog to determine whether the planning scheme is considered a significant impact, based on the habitat utilisation and surrounding known habitat of this species.

Conclusions & Recommendations 6

6.1 Conclusions

The proposed development area is located in a sensitive catchment position, adjoining lands that form connective habitat with Garigal National Park. The habitat present within the study area contains significant areas of breeding and foraging habitat for threatened fauna and flora species.

Survey to date has indicated that in particular for threatened flora species, there are likely to be adequate populations conserved within the proposed offset lands and adjoining landscapes to not result in a significant impact. The impacts on the recorded EEC – Coastal Upland Swamp are also low.

With regard to threatened fauna species, the study lands also contain suitable habitat for the recorded and potential threatened species. However, future development potential of the site is dependent of the reliance of the recorded threatened species on the habitat present within and surrounding the plateau, whether breeding locations are directly impacted, potential loss of connective habitat and any indirect impacts that may be caused by stormwater inputs.

This is particularly important for the recorded, and potentially site dependent, fauna species such as Rosenberg's Goanna (*Varanus rosenbergi*), Red-crowned Toadlet (*Pseudophryne australis*), and Giant Burrowing Frog (*Helieoporus australiacus*). The ecological impact on site dependent species will be further investigated and, if appropriate, additional survey conducted to locate potential breeding areas that are critical habitat for these species.

As a biodiversity offset is proposed, an examination of proposed offsets and provision of relevant information and assessment will be needed in the form of a biodiversity offset package.

There is no doubt that the proposed offset areas provide a major contribution to the adjoining national park estate and appear to provide typically acceptable offsets based on the loss and gain of vegetation communities. Adequacy of the offsets will need to be determined through the application the biodiversity certification assessment methodology or the Biobanking assessment methodology. Additional offsets, including restoration of habitat, may be required to adequately offset the loss of threatened flora and fauna habitat.

6.2 Mitigation measures

The following measures are recommended to avoid and mitigate the loss of threatened flora and fauna habitat and to minimise the adverse impacts on the surrounding terrestrial and aquatic ecosystems:

- Accurately identify the potential breeding locations of recorded threatened fauna species and provide adequate protection.

- Identify critical habitat areas for breeding and identify the management of interfaces within residential developments areas.

- The implications of development and works within open space areas on the surrounding environment needs to consider potential impacts on the surrounding national park estate, the quality and condition of watercourses and threatened species habitat. Open space areas typically provide a buffer against potential negative impacts associated with the development. In this case, open space areas surrounding the proposed residential lands provide a managed buffer including APZs, a partially vegetated landscape for wildlife and a managed interface with the surrounding conserved lands. It is expected that pathways, fire trails and stormwater drainage and treatment measures would feasibly be located within the open space areas. These are not intended to be fully cleared zones but are to maintain a visual and ecological buffer with selective retention of healthy trees in accordance with APZs management requirements.

- Stormwater management is recommended to achieve a performance standard that will protect the surrounding conservation areas in the long term. Consequently, the target quality should be equivalent to the receiving water quality (similar pre and post development). Ensure all stormwater inputs are treated to a receiving waters standard commensurate with 'MUSIC' modeling for water quality and quantity model in pre and post development conditions. In addition, the presence of groundwater dependent ecosystems means that groundwater discharges need to be maintained (similar pre and post development) through the careful management of surface runoff, permeable surfaces and to maintain the current quantity and peak discharges from site.

- Ensure protection of an acceptable population within the offset lands and minimise losses of threatened or rare flora within managed zones.

- Provide adequate buffers to all sensitive watercourse and upland swamp areas.

- Provide a comprehensive landscape management plan that integrates ecological, bushfire, stormwater and open space requirements.

- Strategically place road and fence barriers to minimise access to sensitive habitat areas.

- Provide on site and off site restoration areas that can offset the loss of threatened species habitat and provide an overall net benefit to local threatened species populations or existing conservation areas.

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Attachment 1

Threatened flora & fauna species habitat assessment

Table A1.1 – Threatened flora habitat assessment								
Scientific Name DATABASE SOURCE	**TSC Act**	**EPBC Act**	**GROWTH FORM AND HABITAT REQUIREMENTS**	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**			
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Acacia bynoeana OEH EPBC	E1	V	Erect or spreading shrub to 0.3m high growing in heath and dry sclerophyll Open Forest on sandy soils. Often associated with disturbed areas such as roadsides. Distribution limits N-Newcastle S-Berrima.	x	✓ mostly near existing tracks	✓	x	Low
Acacia gordonii OEH	E1	E	Erect or spreading shrub 0.5-1.5m high growing in heath and dry sclerophyll forest on sandstone outcrops. Distribution limits N-Bilpin S-Faulconbridge.	x	x	-	-	x
Acacia terminalis ssp terminalis OEH EPBC	E1	E	Erect shrub to 2m tall, flowers from March to July. Occurs in eucalypt woodland or forest, usually in sandy soil on creek banks, hill slopes or in shallow soil in rock crevices and sandstone platforms on cliffs. Typically restricted to the Port Jackson and eastern suburbs of Sydney.	x	x	-	-	x
Asterolasia elegans EPBC	E1	E	Erect shrub 1-3m high growing in moist sclerophyll forests on Hawkesbury sandstone slopes hillsides. Distribution limits Maroota region.	x	x	-	-	x
Caladenia tessellata OEH EPBC	E1	V	Terrestrial orchid. Clay-loam or sandy soils. Distribution limits N-Swansea S-south of Eden.	x	x	-	-	x

Table A1.1 – Threatened flora habitat assessment								
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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Callistemon linearifolius OEH	V	-	Shrub to 4m high. Dry sclerophyll forest on coast and adjacent ranges. Distribution limits N-Nelson Bay S-Georges River.	x	✓ very limited to drainage line areas	✓	✓	Low
Chamaesyce psammogeton OEH	E1	-	Prostrate herb. Coastal dunes. Distribution limits N-Tweed Heads S-Jervis Bay	x	x	-	-	x
Cryptostylis hunteriana OEH EPBC	V	V	Saprophytic orchid. Grows in swamp heath on sandy soils. Distribution limits N-Gibraltar Range S-south of Eden.	x	x	-	-	x
Darwinia biflora OEH EPBC	V	V	Erect or spreading shrub to 0.8m high. Grows in heath or understorey of woodland on or near shale-capped ridges underlain by Hawkesbury sandstone. Distribution limits N-Gosford S-Cheltenham.	x	x	-	-	x
Darwinia peduncularis OEH	V	-	Divaricate shrub to 1.5m high. Grows in dry sclerophyll forest on sandstone hillsides and ridges. Distribution limits N-Glen Davis S-Hornsby.	x	x	-	-	x
Deyeuxia appressa OEH EPBC	E1	E	Erect grass to 0.9m high. Grows on wet ground. Distribution limits N-Hornsby S-Bankstown.	x	x	-	-	x

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Diuris bracteata OEH	E1	Extinct	An orchid that grows in dry sclerophyll woodland. Was thought to be extinct until approximately 10yrs ago. Found in the Sydney Basin Bioregion. Flowers in September.	x	x	-	-	x
Epacris purpurascens var. purpurascens OEH	V	-	Erect shrub to 1.5m high growing in sclerophyll forest and scrub and near creeks and swamps on Sandstone. Distribution limits N-Gosford S-Blue Mountains.	x	✓ limited to the edge of drainage lines	✓	✓	Low - Moderate
Eucalyptus camfieldii OEH EPBC	V	V	Stringybark to 10m high. Grows on coastal shrub heath and woodlands on sandy soils derived from alluviums and Hawkesbury sandstone. Distribution limits N-Norah Head S-Royal NP.	x	✓ most of the central plateau area	✓	✓	Moderate
Eucalyptus nicholii OEH	V	-	This species is widely planted as an urban street tree and in gardens but is quite rare in the wild. It is confined to the New England Tablelands of NSW, where it occurs from Nundle to north of Tenterfield, largely on private property.	x	x	-	-	x
Eucalyptus scoparia OEH	E1	V	Smooth-barked tree only known from vicinity of Bald Rock.	x	x	-	-	x

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Genoplesium baueri OEH	E1	-	A terrestrial orchid that grows in sparse sclerophyll forest and moss gardens over sandstone. Distribution limits N – Hunter Valley S – Nowra	x	x	-	-	x
Genoplesium plumosum OEH	E4A	-	Terrestrial Orchid that grows in mallee scrubland and Callitris Woodland. Distribution south from Griffith	x	x	-	-	x
Grammitis stenophylla OEH	E1	-	A small lithophytic fern with fronds generally <5cm. Occurs in rainforest and wet sclerophyll forest in the coastal divisions of NSW.	x	x	-	-	x
Grevillea caleyi OEH EPBC	E1	E	Shrub mostly 1-3m high. Grows in laterite. Distribution limits Terrey Hills-Belrose area.	x	✓ ideal habitat to the north and north-east of the existing residence	✓	✓	Recorded
Grevillea shiressii OEH	V	V	Shrub 2-5m high. Flowers mainly spring. Grows along creek banks in wet sclerophyll forest. Sandy soil on Hawkesbury sandstone. Restricted to the Gosford area. CC.	x	x	-	-	x

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Haloragodendron lucasii OEH EPBC	E1	E	Straggling shrub to 1.5m high. Grows in open forest on sheltered slopes near creeks. Distribution limits Ku-ring-gai Plateau and Mt Wilson.	x	✓ marginal habitat near drainage lines around the fringes of the proposed development area	✓	x	Very low
Hibbertia puberula OEH	E1	-	Shrublets with branches up to 30cm long. Not been seen for 40 years however early records are from Hawkesbury River area in Sydney and the Blue Mountains.	x	x	-	-	x
Hibbertia superans OEH	E1	-	Small spreading shrub to 0.3m high. Grows on sandstone, usually in or near SSTF. Distribution limits N-Glenorie S-Kellyville disjunct Mt Boss.	x	x	-	-	x
Kunzea rupestris EPBC	V	V	Shrub to 1.5m high. Grows in cracks and fissures on Hawkesbury sandstone rock platforms. Distribution limits N-Maroota S-Glenorie.	x	x	-	-	x
Lasiopetalum joyceae OEH EPBC	V	V	Erect shrub to 2m high. Grows in heath and open forest on Hawkesbury sandstone. Distribution limits Hornsby Plateau.	x	✓ Limited by geographic range. Nearest record 5km away	x	✓	Low

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Leptospermum deanei OEH EPBC	V	V	Shrub to 5m high. Grows on forested slopes. Distribution limits Near watershed of Lane Cove River.	x	x	-	-	x
Melaleuca biconvexa OEH EPBC	V	V	Tall shrub. Grows in wetlands adjoining perennial streams and on the banks of those streams, generally within the geological series known as the Terrigal Formation. Distribution limits N-Port Macquarie S-Jervis Bay.	x	x	-	-	x
Melaleuca deanei OEH EPBC	V	V	Shrub to 3m high. Grows in heath on sandstone. Distribution limits N-Gosford S-Nowra.	x	✓ limited to the low open woodland and open woodland vegetation communities	✓	✓	Low-moderate
Microtis angusii OEH EPBC	E1	E	Terrestrial orchid at Ingleside. Grows in heavily disturbed lateritic soils (Somersby Soil Landscape) and past Duffys Forest EEC vegetation. The current vegetation from its known location is also highly disturbed.	x	✓ marginal	x	✓	Very low
Persoonia hirsuta OEH EPBC	E1	E	Erect to decumbent shrub. Grows in dry sclerophyll forest and woodland on Hawkesbury sandstone with infrequent fire histories. Distribution limits N-Glen Davis S-Hill Top.	x	✓ limited to the open woodland vegetation community	x	✓	Low

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Persoonia laxa OEH	E4	Ext.	Decumbent or prostrate shrub. Not been seen since 1908. Once recorded in Newport and Manly.	x	x	-	-	x
Persoonia mollis ssp. maxima OEH EPBC	E1	E	Erect to prostrate shrub. Grows in moist to wet sclerophyll forests on Hawkesbury sandstone. Distribution limits N-Cowan S-Hornsby.	x	x	-	-	x
Pimelea curviflora var. curviflora OEH EPBC	V	V	Woody herb or sub-shrub to 0.2-1.2m high. Grows on Hawkesbury sandstone near shale outcrops. Distribution Sydney.	x	✓ limited to the low open woodland and open woodland vegetation communities and some tall heath	✓	✓	Moderate
Pimelea spicata EPBC	E1	E	Decumbent or erect shrub to 0.5m high. Occurs principally in woodland on soils derived from Wianamatta Shales. Distribution limits N-Lansdowne S-Shellharbour.	x	x	-	-	x
Prostanthera junonis OEH	E1	E	Small shrub. Grows in sclerophyll forest and heath in shallow soil on sandstone. Distribution limits Somersby region.	x	x	-	-	x

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Prostanthera marifolia OEH	E4a	Critic. E	Erect shrub to 0.3m high. Woodland dominated by Eucalyptus sieberi and Corymbia gummifera. In deeply weathered clay soil with ironstone nodules. Has been recorded previously in the Sydney Harbour region.	x	x	-	-	x
Sarcochilus hartmannii OEH	V	V	An orchid which grows on volcanic rocks, often in shallow soil in sclerophyll forest or exposed sites usually at an elevation above 500m. Distribution – north from the Richmond River in the far north of NSW.	x	x	-	-	x
Senecio spathulatus OEH	E	-	A low growing daisy that prefers primary dunes. Known to occur at Cape Howe and between Kurnell north to Myall Lakes National Park. Also occurs in coastal locations in eastern Victoria.	x	x	-	-	x
Syzygium paniculatum OEH	V	V	Small tree. Subtropical and littoral rainforest on sandy soil. Distribution limits N-Forster S-Jervis Bay.	x	x	-	-	x

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Tetratheca glandulosa OEH EPBC	V	V	Spreading shrub to 0.2m high. Sandy or rocky heath or scrub. Distribution limits N-Mangrove Mountain S-Port Jackson.	✓	✓ most vegetation communities have some potential habitat but away from the damper areas	✓	✓	Recorded
OEH	- Denotes species listed within 10km of the subject site on the *Atlas of NSW Wildlife* database							
EPBC	- Denotes species listed within 10km of the subject site in the *EPBC Act* habitat search							
V	- Denotes vulnerable listed species under the relevant Act							
E or E1	- Denotes endangered listed species under the relevant Act							
NOTE:	1. This field is not considered if no suitable habitat is present within the subject site 2. 'Records' refer to those provided by the *Atlas of NSW Wildlife* database. Updated 1:100,000 database mapsheet requests to OEH are undertaken every 3 months as recommended. 3. 'Nearby' or 'recent' records are species specific accounting for home range, dispersal ability and life cycle.							

Table A1.2 – Threatened fauna habitat assessment								
COMMON NAME ***Scientific Name*** DATABASE SOURCE	**TSC Act**	**EPBC Act**	**PREFERRED HABITAT** ***Distribution Limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**			
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Giant Burrowing Frog *Heleioporus australiacus* OEH EPBC	V	V	Inhabits open forests and riparian forests along non-perennial streams, digging burrows into sandy creek banks. *Distribution Limit: N-Near Singleton S-South of Eden.*	✓	-	-	-	-
Stuttering Frog *Mixophyes balbus* EPBC	E	V	Terrestrial inhabitant of rainforest and wet sclerophyll forests. *Distribution Limit: N-near Tenterfield S-South of Bombala*.	×	×	-	-	×
Giant Barred Frog *Mixophyes iteratus* EPBC	E	E	Terrestrial inhabitant of rainforest and open forests. *Distribution Limit: N-Border Ranges National Park. S-Narooma.*	×	×	-	-	×
Red-crowned Toadlet *Pseudophryne australis* OEH	V	-	Prefers sandstone areas, breeds in grass and debris beside non-perennial creeks or gutters. Individuals can also be found under logs and rocks in non-breeding periods. *Distribution Limit: N-Pokolbin. S-near Wollongong.*	✓	-	-	-	-

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Green and Golden Bell Frog *Litoria aurea* OEH EPBC	E	V	Prefers the edges of permanent water, streams, swamps, creeks, lagoons, farm dams and ornamental ponds. Often found under debris. *Distribution Limit: N-Byron Bay S-South of Eden.*	×	×	-	-	×
Littlejohn's Tree Frog *Litoria littlejohnii* EPBC	V	V	Found in wet and dry sclerophyll forest associated with sandstone outcrops at altitudes 280-1,000m on eastern slopes of Great Dividing Range. Prefers flowing rocky streams. *Distribution Limit: N-Hunter River S-Eden.*	×	✓	×	×	×
Rosenberg's Goanna *Varanus rosenbergi* OEH	V	-	Hawkesbury sandstone outcrop specialist. Inhabits woodlands, dry open forests and heathland sheltering in burrows, hollow logs, rock crevices and outcrops. *Distribution Limit: N-Nr Broke. S-Nowra Located in scattered patches near Sydney, Nowra and Goulburn.*	✓	-	-	-	-
Broad-headed Snake *Hoplocephalus bungaroides* EPBC	E	V	Sandstone outcrops, exfoliated rock slabs and tree hollows in coastal and near coastal areas. *Distribution Limit: N-Mudgee Park. S-Nowra.*	×	✓	×	×	×

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Cotton Pygmy-goose *Nettapus coromandelianus* OEH	E	-	An aquatic species found in tropical to subtropical coastal lagoons, swamps and large bodies of calm fresh water with abundant vegetation. *Distribution Limit: N-Tweed Heads. S-Pambula.*	×	×	-	-	×
Superb Fruit-dove *Ptilinopus superbus* OEH	V	-	Rainforests, adjacent mangroves, eucalypt forests, scrubland with native fruits. *Distribution Limit: N-Border Ranges National Park. S-Bateman's Bay.*	×	×	-	-	×
Black-necked Stork *Ephippiorhynchus asiaticus* OEH	E	-	Occurs in tropical to warm temperate terrestrial wetlands, estuarine and littoral habitats such as mangroves, tidal mudflats, floodplains, open woodlands, irrigated lands, bore drains, sub-artesian pools, farm dams and sewerage ponds. *Distribution Limit: N-Tweed Heads. S-Nowra.*	×	×	-	-	×
Australasian Bittern *Botaurus poiciloptilus* OEH EPBC	V	E	Found in or over water of shallow freshwater or brackish wetlands with tall reedbeds, sedges, rushes, cumbungi, lignum and also in ricefields, drains in tussocky paddocks, occasionally saltmarsh, brackish wetlands. *Distribution Limit: N-North of Lismore. S- Eden.*	×	×	-	-	×

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Black Bittern *Ixobrychus flavicollis* OEH	V	-	Found in shadowy, leafy waterside trees such as callistemons, casuarinas, paperbarks, eucalypts, mangroves and willows along tidal creeks, freshwater and brackish streams & ponds, sheltered mudflats and oyster slats. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	×	-	-	×
Little Eagle *Hieraaetus morphnoides* OEH	V	-	Utilises plains, foothills, open forests, woodlands and scrublands; river red gums on watercourses and lakes. *Distribution Limit - N-Tweed Heads. S-South of Eden.*	×	✓	×	×	low
Osprey *Pandion haliaetus* OEH	V	-	Utilises waterbodies including coastal waters, inlets, lakes, estuaries and offshore islands with a dead tree for perching and feeding. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	×	-	-	×
Bush Stone-curlew *Burhinus grallarius* OEH	E	-	Utilises open forests and savannah woodlands, sometimes dune scrub, savannah and mangrove fringes. *Distribution Limit: N-Border Ranges National Park. S-Near Nowra.*	×	×	-	-	×

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Australian Painted Snipe *Rostratula australis* EPBC	V	V	Most numerous within the Murray-Darling basin and inland Australia within marshes and freshwater wetlands with swampy vegetation. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	×	-	-	×
Gang-gang Cockatoo *Callocephalon fimbriatum* OEH	V	-	Prefers wetter forests and woodlands from sea level to > 2,000m on Great Dividing Range, timbered foothills and valleys, timbered watercourses, coastal scrubs, farmlands and suburban gardens. *Distribution Limit: mid north coast of NSW to western Victoria.*	×	Sub-optimal	×	×	unlikely
Glossy Black-Cockatoo *Calyptorhynchus lathami* OEH	V	-	Open forests with *Allocasuarina* species and hollows for nesting. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	✓ Foraging only	×	✓	low
Little Lorikeet *Glossopsitta pusilla* OEH	V	-	Inhabits forests, woodlands; large trees in open country; timbered watercourses, shelterbeds, and street trees. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	✓	-	-	-	-

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Swift Parrot *Lathamus discolour* OEH EPBC	E	E	Inhabits eucalypt forests and woodlands with winter flowering eucalypts. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	×	marginal	✓	✓	✓
Turquoise Parrot *Neophema pulchella* OEH	V	-	Inhabits coastal scrubland, open forest and timbered grassland, especially ecotones between dry hardwood forests and grasslands. *Distribution Limit: N-Near Tenterfield. S-South of Eden.*	×	✓	×	×	Not likely
Superb Parrot *Polytelis swainsonii* OEH	V	V	Inhabits open woodland and riverine forests of inland NSW. *Distribution Limit: N-Near Walgett. S-South of Deniliquin.*	×	×	-	-	×
Barking Owl *Ninox connivens* OEH	V	-	Inhabits principally woodlands but also open forests and partially cleared land and utilises hollows for nesting. *Distribution Limits: N-Border Ranges National Park. S-Eden.*	×	✓	✓	2003	✓
Powerful Owl *Ninox strenua* OEH	V	-	Forests containing mature trees for shelter or breeding and densely vegetated gullies for roosting. *Distribution Limits: N-Border Ranges National Park. S-Eden.*	✓	-	-	-	-

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Masked Owl *Tyto novaehollandiae* OEH	V	-	Open forest and woodlands with cleared areas for hunting and hollow trees or dense vegetation for roosting. *Distribution Limit: N-Border Ranges National Park. S-Eden.*	×	✓	×	-	unlikely
Sooty Owl *Tyto tenebricosa* OEH	V	-	Tall, dense, wet forests containing trees with very large hollows. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	×	×	-	-	×
Eastern Bristlebird *Dasyornis brachypterus* EPBC	E	E	Coastal woodlands, dense scrubs and heathlands, especially where low heathland borders taller woodland or dense tall tea-tree. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	✓	×	×	×
Black-chinned Honeyeater *Melithreptus gularis gularis* OEH	V	-	Found in woodlands containing box-ironbark associations and River Red Gums, also drier coastal woodlands of the Cumberland Plain and Hunter Richmond and Clarence. *Distribution Limit: N-Cape York pen. Qld. S-Victor H. Mt Lofty Ra & Flinders Ra. SA.*	×	marginal	×	×	×

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					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Regent Honeyeater *Xanthomyza Phrygia* OEH EPBC	E4A	E	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. *Distribution Limit: N-Urbanville. S-Eden.*	×	×	✓	×	Not likely
Grey-crowned Babbler *Pomatostoomus temporalis temporalis* OEH	V	-	Found in dry open forests, woodland scrubland, farmland with isolated trees. Distribution Limit mostly west of Great Dividing Range except Hunter Valley. *Distribution Limit: N-Qld widespread. S-Mornington Pen. E-se SA.*	×	×	-	-	×
Varied Sittella *Daphoenositta chrysoptera* OEH	V	-	Open eucalypt woodlands/forests (except heavier rainforests); mallee, inland acacia, coastal tea-tree scrubs; golf courses, shelterbelts, orchards, parks, scrubby gardens. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	×	✓	×	×	low
Scarlet Robin *Petroica boodang* OEH	V	-	Found in foothill forests, woodlands, watercourses; in autumn-winter, more open habitats: river red gum woodlands, golf courses, parks, orchards, gardens. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	✓	×	×	low

Table A1.2 – Threatened fauna habitat assessment								
COMMON NAME ***Scientific Name*** DATABASE SOURCE	**TSC Act**	**EPBC Act**	**PREFERRED HABITAT** ***Distribution Limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**			
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Spotted-tailed Quoll *Dasyurus maculatus* OEH EPBC	V	E	Dry and moist open forests containing rock caves, hollow logs or trees. *Distribution Limit: N-Mt Warning National Park. S-South of Eden.*	×	✓	✓	✓	✓
Southern Brown Bandicoot *Isoodon obesulus* OEH EPBC	E	E	Utilises a range of habitats containing thick ground cover - open forest, woodland, heath, cleared land, urbanised areas and regenerating bushland. *Distribution Limit: N-Kempsey. S-South of Eden.*	×	✓	✓	✓	✓
Koala *Phascolarctos cinereus* OEH	V	-	Inhabits both wet and dry eucalypt forest on high nutrient soils containing preferred feed trees. *Distribution Limit: N-Tweed Heads. S-South of Eden.*	×	✓	✓	×	unlikely
Eastern Pygmy Possum *Cercatetus nanus* OEH	V	-	Found in a variety of habitats from rainforest through open forest to heath. Feeds on insects but also gathers pollen from banksias, eucalypts and bottlebrushes. Nests in banksias and myrtaceous shrubs. *Distribution Limit: N-Tweed Heads. S-Eden.*	×	✓	×	✓	✓

Table A1.2 – Threatened fauna habitat assessment								
COMMON NAME ***Scientific Name*** DATABASE SOURCE	**TSC Act**	**EPBC Act**	**PREFERRED HABITAT** ***Distribution Limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**			
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Yellow-bellied Glider *Petaurus australis* OEH	V	-	Tall mature eucalypt forests with high nectar producing species and hollow bearing trees. *Distribution Limit- N-Border Ranges National Park. S-South of Eden.*	×	✓	×	×	×
Long-nosed Potoroo *Potorous tridactylus* EPBC	V	V	Coastal heath and dry and wet sclerophyll forests with a dense understorey. *Distribution Limit: N-Mt Warning National Park. S-South of Eden.*	×	✓	×	×	×
Brush-tailed Rock-wallaby *Petrogale penicillata* EPBC	E	V	Found in rocky gorges with a vegetation of rainforest or open forests to isolated rocky outcrops in semi-arid woodland country. *Distribution Limit: N-North of Tenterfield. S-Bombala.*	×	✓	×	×	×
Grey-headed Flying-fox *Pteropus poliocephalus* OEH EPBC	V	V	Found in a variety of habitats including rainforest, mangroves, paperbark swamp, wet and dry open forest and cultivated areas. Forms camps commonly found in gullies and in vegetation with a dense canopy. *Distribution Limit: N-Tweed Heads. S-Eden.*	✓	-	-	-	-

Table A1.2 – Threatened fauna habitat assessment								
COMMON NAME ***Scientific Name*** DATABASE SOURCE	**TSC Act**	**EPBC Act**	**PREFERRED HABITAT** ***Distribution Limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**			
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris* OEH	V	-	Rainforests, sclerophyll forests and woodlands. *Distribution Limit: N-North of Walgett. S-Sydney.*	×	✓	×	×	unlikely
East-coast Freetail Bat *Micronomus norfolkensis* OEH	V	-	Inhabits open forests and woodlands foraging above the canopy and along the edge of forests. Roosts in tree hollows, under bark and buildings. *Distribution Limit: N-Woodenbong. S-Pambula.*	×	✓	✓	✓	low
Large-eared Pied Bat *Chalinolobus dwyeri* OEH EPBC	V	V	Warm-temperate to subtropical dry sclerophyll forest and woodland. Roosts in caves, tunnels and tree hollows in colonies of up to 30 animals. *Distribution Limit: N-Border Ranges National Park. S-Wollongong.*	×	✓	×	×	×
Little Bentwing-bat *Miniopterus australis* OEH	V	-	Roosts in caves, old buildings and structures in the higher rainfall forests along the south coast of Australia. *Distribution Limit: N-Border Ranges National Park. S-Sydney.*	✓	-	-	-	-

Table A1.2 – Threatened fauna habitat assessment								
COMMON NAME ***Scientific Name*** DATABASE SOURCE	**TSC Act**	**EPBC Act**	**PREFERRED HABITAT** ***Distribution Limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**			
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Eastern Bentwing-bat *Miniopterus orianae oceansis* OEH	V	-	Prefers areas where there are caves, old mines, old buildings, stormwater drains and well timbered areas. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	✓	-	-	-	-
Eastern Falsistrelle *Falsistrellus tasmaniensis* OEH	V	-	Recorded roosting in caves, old buildings and tree hollows. *Distribution Limit: N-Border Ranges National Park. S-Pambula.*	×	Sub-optimal	×	×	unlikely
Large-footed Myotis *Myotis macropus* OEH	V	-	Roosts in caves, mines, tunnels, buildings, tree hollows and under bridges. Forages over open water. *Distribution limits: N-Border Ranges National Park. S-South of Eden.*	×	×	-	-	×
Greater Broad-nosed Bat *Scoteanax rueppellii* OEH	V	-	Inhabits areas containing moist river and creek systems, especially tree lined creeks. *Distribution Limit: N-Border Ranges National Park. S-Pambula.*	×	✓	×	✓	low

Table A1.2 – Threatened fauna habitat assessment								
COMMON NAME ***Scientific Name*** DATABASE SOURCE	**TSC Act**	**EPBC Act**	**PREFERRED HABITAT** ***Distribution Limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**			
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
New Holland Mouse *Pseudomys novaehollandiae* EPBC	-	V	Occurs in heathlands, woodlands, open forest and paperbark swamps and on sandy, loamy or rocky soils. Coastal populations have a marked preference for sandy substrates, a heathy understorey of leguminous shrubs less than 1m high and sparse ground litter. Recolonise of regenerating burnt areas. *Distribution Limit: N-Border Ranges National Park. S-South of Eden.*	×	✓	✓	×	✓
Macquarie Perch *Macquaria australasica* EPBC	V	E	Occurs in south east Australia at moderate to high altitudes in rivers and reservoirs. Historical records show the species was widespread and abundant in the upper reaches of the Lachlan, Murrumbidgee and Murray Rivers and their tributaries. Allen (1989) states that introduced populations are present in Nepean River and water supply dams in the Sydney area. Occurs in lakes and flowing streams, usually in deep holes.	×	×	-	-	×

Table A1.2 – Threatened fauna habitat assessment								
COMMON NAME ***Scientific Name*** DATABASE SOURCE	**TSC Act**	**EPBC Act**	**PREFERRED HABITAT** ***Distribution Limit***	**RECORDED ON SITE (✓)**	**IF NOT RECORDED ON-SITE**			
					Suitable Habitat Present (✓)	**Nearby and/or high number of record(s) (✓)** *Notes 1,2 & 3*	**Record(s) from recent years (✓)** *Notes 1,2 & 3*	**Potential to occur**
Australian Greyling *Prototroctes maraena* EPBC	Part 2, Section 19 – Protected Fish	V	Clear, moderate to fast flowing water in the upper reaches of rivers (sometimes to altitudes above 1,000m). Typically found in gravel bottom pools. Often forming aggregations below barriers to upstream movement (e.g. weirs, waterfalls).	x	x	-	-	x
OEH	- Denotes species listed within 10km of the subject site on the *Atlas of NSW Wildlife* database							
EPBC	- Denotes species listed within 10km of the subject site in the *EPBC Act* habitat search							
V	- Denotes vulnerable listed species under the relevant Act							
E	- Denotes endangered listed species under the relevant Act							
NOTE:	1. This field is not considered if no suitable habitat is present within the subject site 2. 'Records' refer to those provided by the *Atlas of NSW Wildlife* database. Updated 1:100,000 database mapsheet requests to OEH are undertaken every 3 months as recommended. 3. 'Nearby' or 'recent' records are species specific accounting for home range, dispersal ability and life cycle.							

Table A1.3 – Migratory fauna species habitat assessment				
COMMON NAME ***Scientific Name***	**PREFERRED HABITAT** ***Migratory Breeding***	**Suitable Habitat Present (✓)**	**Recorded on Site (✓)**	**COMMENTS**
White-bellied Sea Eagle (*Haliaeetus leucogaster*)	Coasts, islands, estuaries, inlets, large rivers, inland lakes, reservoirs. *Sedentary; dispersive.*	×	-	-
White-throated Needletail (*Hirundapus caudacutus*)	Air space over forests, woodlands, farmlands, plains, lakes, coasts, towns; companies forage often along favoured hilltops and timbered ranges. *Breeds Siberia, Himalayas, and east to Japan. Summer migrant to eastern Australia.*	✓	×	-
Rainbow Bee-eater (*Merops ornatus*)	Open woodlands with sandy, loamy soil; sandridges, sandspits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves, rainforest, woodlands, golf courses. *Breeding resident in northern Australia. Summer breeding migrant to south-east and south west Australia.*	Sub-optimal	×	-
Black-faced Monarch (*Monarcha melanopsis*)	Rainforests, eucalypt woodlands; coastal scrubs; damp gullies in rainforest, eucalypt forest; more open woodland when migrating. *Summer breeding migrant to coastal south east Australia, otherwise uncommon*.	Sub-optimal	×	-
Satin Flycatcher (*Myiagra cyanoleuca*)	Heavily vegetated gullies in forests, taller woodlands, usually above shrub-layer; during migration, coastal forests, woodlands, mangroves, trees in open country, gardens. *Breeds mostly south east Australia and Tasmania over warmer months, winters in north east Qld.*	Sub-optimal	×	-

Table A1.3 – Migratory fauna species habitat assessment				
COMMON NAME ***Scientific Name***	**PREFERRED HABITAT** ***Migratory Breeding***	**Suitable Habitat Present (✓)**	**Recorded on Site (✓)**	**COMMENTS**
Rufous Fantail (*Rhipidura rufifrons*)	Undergrowth of rainforests / wetter eucalypt forests / gullies; monsoon forests, paperbarks, sub-inland and coastal scrubs; mangroves, watercourses; parks, gardens. On migration, farms, streets buildings. *Breeding migrant to south east Australia over warmer months. Altitudinal migrant in north east NSW in mountain forests during warmer months.*	✓	×	-
Great Egret (*Ardea alba*)	Shallows of rivers, estuaries; tidal mudflats, freshwater wetlands; sewerage ponds, irrigation areas, larger dams, etc. *Dispersive; cosmopolitan.*	×	-	-
Cattle Egret (*Ardea ibis*)	Stock paddocks, pastures, croplands, garbage tips, wetlands, tidal mudflats, drains. *Breeds in summer in warmer parts of range including NSW.*	×	-	-
Latham's Snipe (*Gallinago hardwickii*)	Soft wet ground or shallow water with tussocks and other green or dead growth; wet parts of paddocks; seepage below dams; irrigated areas; scrub or open woodland from sea-level to alpine bogs over 2,000m; samphire on saltmarshes; mangrove fringes. *Breeds Japan. Regular summer migrant to Australia. Some overwinter.*	×	-	-
Fork-tailed Swift (*Apus pacificus*)	Aerial: over open country, from semi-arid deserts to coasts, islands; sometimes over forests, cities. *Breeds Siberia, Himalayas, and east to Japan south east Asia. Summer migrant to east Australia. Mass movements associated with late summer low pressure systems into east Australia. Otherwise uncommon.*	✓	×	-

Attachment 2

Fauna survey methodologies

The fauna survey methods outlined within this Appendix are techniques employed by *Travers bushfire & ecology,* based on industry standards as well as additional methods found to be effective for select fauna groups. The fauna survey techniques deployed for each specific site are outlined within the survey effort table in the main body of this report. The techniques selected will depend upon the site characteristics and extent of available habitat as well as restrictions such as available survey time and weather conditions.

If any additional or target survey techniques for fauna species are undertaken, beyond the methods outlined within this Appendix, the details of these will be described within the main body of this report.

1 Standard survey techniques

1.1 Diurnal birds

Diurnal birds are typically identified visually and / or by calls during diurnal surveys. Habitat searches to identify nests, feathers, eggs, or signs of foraging may be utilised more specifically for identifying threatened diurnal bird species.

Visual observations are made more accurate with the use of binoculars and where necessary or practical, with the use of a spotting scope. Binoculars are carried by the fauna surveyor at all times during nocturnal and diurnal fauna surveys. A birding field guide is always available in the field when required for verifications.

Calls are identified in the field by the fauna surveyor. If an unknown call is heard it is cross-matched to comprehensive bird call reference libraries taken into the field. A call library of birds occupying the NSW coastal areas is also stored into a mobile phone for a quick reference. This phone is carried into the field at all times and may be used for call-playback methods and recording calls for later analysis.

Diurnal bird census points may be undertaken at large sites where the total area may not be effectively covered during the survey period, or as a measure to ensure focused bird only survey.

1.2 Nocturnal birds

Searches for evidence of Owl roosts, key perches and potential Owl roosting / breeding hollows are made during diurnal site searches. Whitewash, feathers or regurgitated pellets give key information. Pellets are sent for analysis of contents to assist in identification where necessary.

The presence of nocturnal birds during the nocturnal period is first determined by quiet listening after dusk for calls by individuals emerging from diurnal roosts. Following this and provided no calls are heard, call-playback techniques are employed for threatened species that have suitable habitat present.

Threatened nocturnal birds known to provide response to call-playback techniques include Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Sooty Owl (*Tyto tenebricosa*), Grass Owl (*Tyto capensis*), Black Bittern (*Ixobrychus flavicollis*), Australian Bittern (*Botaurus poiciloptilus*) and Bush Stone-curlew (*Burhinus grallarius*).

Each call is typically played for five minute periods with five minute intervals of quiet listening for a response. This is followed with spotlighting and periods of quiet listening throughout the nocturnal survey.

Separation distances between broadcasting stations during a single night of survey are advised for different species within survey guidelines. These include 1km between Owl calls and 3km between Bush Stone-curlew calls. Subsequent to this, separate broadcasting stations will be deployed on the same night where sites of significant size are surveyed. Separations for bitterns are not advised and these may be broadcast at a number of stations along suitable habitat areas.

Stag-watching will be undertaken where suitable large hollows for Owl nesting / roosting show signs of activity or are located within development areas. Stag-watching of nesting trees should be undertaken during the recognised nesting period for Owls with potential to occur.

1.3 Arboreal mammals

Arboreal mammals may be surveyed using Elliott type A, B and / or C traps, small and / or large hair tubes, spotlighting, call-playback techniques, scat searches or searches for other signs of activity.

Baiting and layout for Elliott trapping and hair tubing are typically incorporated into terrestrial trapping and hair tubing effort, unless where target survey is undertaken. Standard baiting and layout is therefore described in Section A1.3.2 below within terrestrial survey methods. Where gliders are targeted, the standard bait mix may be additionally laced with a nectarivor powder mix used for feeding captive birds. Where Brush-tailed Phascogales are targeted, the standard bait mix may be additionally laced with an insectivore powder mix. Where Eastern Pygmy Possum is targeted, the bait mix will be more heavily laced with honey.

Elliott traps for arboreal captures are placed onto tree mounted platforms that are attached to the trunk 2-3m above the ground, at an incline to facilitate drainage during inclement weather. Plastic sleeves are placed around or over traps when there is a possibility of wet weather in the forecast. Arboreal hair tubes are attached to the trunk of trees using rubber bands with the tube entry facing down, preventing water entry.

For all arboreal traps and hair tubes a mixture of honey and water is sprayed onto the trunk up to 8m above the trap and around the trap as a lure. Where Eastern Pygmy Possum is targeted, a high concentrate honey water mix is also sprayed from the base of trunk up and along connective branches.

Arboreal traps and hair tubes are placed in trees selected to bias target species. These are often flowering or sap flow trees for gliders, rough-barked trees for the Brush-tailed Phascogale and Banksias for the Eastern Pygmy possum.

Where habitat is suitable, the presences of Koala (*Phascolactos cinereus*), Yellow-bellied Glider (*Petaurus australis*) and Squirrel Glider (*Petaurus norfolcensis*) may be targeted by call-playback techniques. Calls are played for five minute periods during nocturnal surveys. This is followed by quiet listening and spotlighting.

1.3.1 Koala survey

Koala survey is undertaken where the site is considered to provide potential habitat under the definitions of SEPP 44 - Koala Habitat Protection, or in the presence of feed trees listed in Appendix 1 of the Recovery Plan for the Koala. Habitat may also be defined according to locally prepared Koala Plans of Management.

SEPP 44 is applied to land within Local Government Areas (LGAs) listed under Schedule 1 of the Policy. Part 2 is applied to land which has an area of greater than 1ha or has, together with any adjoining land in the same ownership, an area of more than 1ha.

To determine Potential Koala Habitat (PKH) under the definitions of SEPP 44 an estimate of the percentage density of each tree species within vegetation communities is determined by averaging the percentage of stems counted. PKH is defined as land where at least 15% of the total number of trees in the upper or lower strata constitutes any of the tree species listed in Schedule 2 of the Policy.

Where Koala habitat is considered to be present, the site will be surveyed on foot, with known Koala food trees being inspected for signs of use. Trees are inspected for characteristic scratch and claw marks on the trunk and scats around the base of each tree. Koalas may also be targeted during nocturnal survey involving call-playback techniques and spotlighting.

For large sites, Koala search quadrats may be employed within portions of communities where feed trees are present at suitable densities. All Koala feed trees within quadrats are searched for signs of activity, including characteristic claw marks on the trunk and faecal pellets around the base. Pellet searches are undertaken according to the tree base search methods described in *Phillips & Callaghan* (2008). Search quadrats are less labour intensive than the SAT techniques described below but may only be an initial survey effort to determine presence / absence.

Where any Koala activity is recorded the complete Spot Assessment Technique (SAT) described by *Phillips & Callaghan* (2008) may be undertaken as a measure of Koala *activity*. This technique may also be employed in the first instance as an indicator of presence / absence, particularly where a site has potential Koala activity based on previous records.

For any survey technique, the location and density of Koala droppings, if found, are documented.

1.4 Terrestrial mammals

Various traps may be used to survey for the presence of terrestrial mammals. These include Elliott trapping, medium and large cage trapping, small and large hair tubing and pitfall traps. Other survey methods for terrestrial mammals include the use of camera surveillance, spotlighting and activity searches.

Arboreal and terrestrial Elliott traps and hair tubes are placed in grids, or more commonly along trap-lines of 5-10 traps separated by distances of 20-50m, depending on site size and variation of habitat. Trap or hair tube sizes selected at each trap station may alternate or may have an emphasis on certain sizes according to target species.

Selection of terrestrial Elliott trap, cage trap, hair tube or pitfall trap locations has an emphasis on nearby foliage, runways, shelters and signs of activity.

Standard bait mix for all Elliott traps, medium cage traps and hair tubes is a mixture of rolled oats, honey and peanut butter. Standard bait mix may be supplemented with sardines in large hair tubes or cage traps to simultaneously target Spotted-tailed Quoll. Cage traps may also be baited solely with meat or roadkill to target Spotted-tailed Quoll. Where Potoroos or Bandicoots are targeted, truffle oil may be used to lace the standard bait mix or used on its own.

Where difficult to access, sensitive or extended trapping periods are undertaken surveillance cameras can be used in terrestrial mammal surveys. The surveillance camera is mounted on a tree and directed towards a closed baited cage trap. Surveillance cameras may also be used to detect use or monitor activity at burrows, hollows, nests, etc.

During diurnal site searches, assessment is made of 'found' scats, markings, diggings, runways and scratches located. Any scats or pellets not readily identifiable (particularly predator scats) may be collected and sent to Barbara Triggs for identification of contents, hair or bone fragments.

1.5 Bats

Micro-chiropteran bats are surveyed by echolocation using Anabat detectors or trapped using harp (Constantine) traps, mist nets or trip lines. Microchiropteran bats are also surveyed by searches of subterranean habitats such as caves, tunnels or shafts where present, or by searching structures such as under bridges and abandoned buildings or wall / ceiling cavities, where entry is possible.

Anabat Mk 2 and SD-1 detectors are used in fixed passive monitoring positions and / or during active nocturnal monitoring. Active monitoring is used in conjunction with spotlighting or during stag-watching for greater accuracy of recorded call identification.

Bat call recordings are interpreted through Anabat V and Anabat CF Storage and Interface Module ZCAIM devices and analysed using Anabat 6 and Analook 3.3q computer software packages.

Harp traps and mist nets are placed along suitable 'flyways' such as along open narrow road / river corridors to maximise the likelihood of captures. Traps may be purpose set to capture bats emerging from roosts by being placed at the entry of tunnels / caves or draped over the edge of bridges. Trip lines are placed over water to trip low flying drinking bats into the water. These bats are collected as they swim to the water's edge.

Harp traps are checked during early nocturnal survey, as well as each morning. Mist nets and trip lines require constant monitoring. Captured bats are identified using field identification guides. Bats are released at the point of capture after dusk or placed under trunk bark / splits of nearby trees.

Mega-chiropteran bat species, such as Grey-headed Flying-fox, are surveyed by targeting flowering / fruiting trees during spotlighting activities and by listening to distinctive vocalisations. Suitable roosting habitat is searched for presence of small or large established camps during diurnal survey periods.

1.6 Amphibians

Amphibians are surveyed by vocal call identification, call-playback, spotlighting along the edge of water-bodies, pitfall trapping, funnel trapping, by driving along sealed roads near waterways, habitat searches and collection of tadpoles.

Calls are identified in the field by the fauna surveyor. For similar calling species or if an unknown male call is heard, it is cross-matched to frog call reference libraries taken into the field. A call library of frogs occupying the NSW coastal areas is also stored into a mobile phone for a quick reference. This phone is carried into the field at all times and may be used for call-playback methods and recording calls for later analysis.

All threatened frog species may be targeted by use of call-playback techniques where suitable habitat exists, with some species more reliable than others in providing a response. Red-crowned Toadlet may also be targeted by clapping and loud retort along suitable habitat drainages in order to evoke a call response.

Any amphibians found are visually identified and, when required to be examined, are handled with latex gloves and kept moist until release. Any tadpoles requiring capture are collected with a scoop net and placed within a snap-lock clear plastic bag for analysis of colour and morphological features.

Amphibian survey yields best results during or following wet periods with seasonal breeding and subsequent male calling varying according each species. Targeted survey is thus undertaken in appropriate seasons.

1.7 Reptiles

Reptiles are surveyed opportunistically during diurnal site visit(s), but also by habitat searches, pitfall trapping, funnel trapping, by driving along roads on humid nights and by camera surveillance at burrows.

Habitat searches for reptiles are undertaken in likely localities such as under logs, rocky slabs on rock surfaces, under sheet debris, under bark exfoliations and leaf litter at the base of trees and along the edge of wetlands. Aspect and land surface thermal properties are considered to determine best search locations particularly along rocky escarpments.

During warmer months spotlighting may assist survey effort particularly during humid conditions.

1.8 Invertebrates

Target survey is undertaken for the Cumberland Plain Land Snail (*Meridolum corneovirens*) when in proximity to previous *Atlas of NSW Wildlife* database records and particularly where its typical host vegetation community is present. The most appropriate areas of observed habitat are searched. Dense areas of leaf litter with likely moisture retaining properties are scraped using a three pronged rake. Logs, stumps, artificial refuse and rocks are also turned over. In large survey areas, search quadrats are undertaken evenly across highest quality habitat areas to estimate population size.

The top (spiral side), side (showing aperture) and underside (showing umbilicus) of snail specimens found are photographed and sent to Michael Shea of the Australian Museum Malacology Unit for confirmation of identification.

2 Habitat Trees

Hollow-bearing tree surveys use a *Trimble* handheld GPS unit to log both field reference location as well as tree data. Data such as hollow types, hollow size, tree species, diameter at breast height, canopy spread and overall height are documented. A metal tag with the tree number is placed on the trunk for field relocation purposes. Other habitat features such as nests and significant sized mistletoe for foraging are also noted.

3 Survey Effort Table Descriptors:

Target - Where effort is specifically concentrated towards an individual species. Selected target species will be identified within the survey effort table and where necessary described within the report.

Opportunistic - Where birds are identified by observation, call or indirect methods as the opportunity arises.

Habitat search - Where suitable areas of habitat for selected fauna groups such as frogs, reptiles and invertebrates are specifically searched.

Diurnal Bird Census Point(s) - Are bird surveys undertaken within a specified area surrounding a point (or in a quadrat) for a specified amount of time. Size and time will be specified in the survey effort table. These are more typically undertaken across larger sites where the total area cannot be effectively covered during the survey period. Subsequently, census points are selected to adequately represent each of the habitat areas present and particularly areas designated for proposed development. Often census points are commenced at locations where bird activity is noticeably high.

Spotting-scope Outlook - A *Nikon* spotting scope with 16~47 zoom at x60 magnification on a mounted tripod is used for distant inspections of diurnal birds. This is undertaken at wetlands for viewing waterfowl and waders but also other difficult to access areas. It may also be used for inspecting activity at nests, hollows and combined with spotlight for a panoramic search in open areas.

Call-playback - This involves broadcasting recorded calls through a 15 watt Toa 'Faunatech' amplifier to evoke a response from species known to reply. Species selected for call-playback will be indicated in the survey effort table.

Spotlighting - Is carried out using a hand held 55 watt spotlight powered by a 12 volt rechargeable battery. This technique involves walking amongst the woodland areas, forest fringes, along roads, trails and fence lines so that a maximum number of trees can be observed. Spotlighting around water-bodies and particularly along the shallow fringes is used for finding frogs. Spotlighting is used in combination with binoculars or spotting scope for closer night inspections.

Stag-watching - Involves watching hollows in the dusk period approximately 15 minutes prior to dark until 30 minutes following dark. Placement of the observer on the ground allows for a silhouette of any emerging fauna to be seen against the lighter sky background such that a spotlight is not required, which would likely to disrupt emergence behaviour. Where any movement is observed, a spotlight may then be used for identification purposes.

Search Quadrats - Are undertaken within a specified area surrounding a point (or in a quadrat) for a specified amount of time. These are more typically undertaken across larger sites where the total area cannot be effectively covered during the survey period. Subsequently quadrats are selected to adequately represent each of the suitable habitat areas present and particularly areas designated for proposed development. The use of this technique simply as an initial time-effective suitable indicator of presence / absence of Koalas has been discussed with Koala expert, Stephen Phillips.

Koala Spot Assessment Technique (SAT) - Method outlined by *Phillips & Callaghan* (2008) and accepted by the Australian Koala Foundation to determine Koala activity levels. Activity levels are calculated from the proportion of trees showing signs of Koala use as indicated by the presence of scats as well as site location within the state.

Elliott trapping - using Elliott type A (33x10x10cm) and Type B (45x15x15cm), B and/or Type C traps for trapping small sized mammals. Trapping nights' effort will be indicated in the survey effort table. Trapping layout, trap sizes, baiting and trapping period will be outlined within the site specific methodology section.

Medium Cage trapping - using medium sized cage traps (17x17x45cm foldout cages with tread-plate mechanism or 22x25x58cm rigid cage with tread-plate mechanism) for trapping up to cat/bandicoot sized mammals. Trapping layout, target species, baiting and trapping period will be outlined within the site specific methodology section.

Large Cage trapping - using large sized cage traps (25x25x50cm foldout cages with pull lever (meat) mechanism, 28x28x60cm foldout cages with tread-plate mechanism or 30x30x70cm rigid cage with tread-plate mechanism) for trapping up to quoll sized mammals. Trapping layout, target species, baiting and trapping period will be outlined within the site specific methodology section.

Hair tubing - using small (40mm diameter x 120mm long) and/or large (90mm diameter x 200mm long) PVC pipe sections for collecting mammal hair samples. At one end of each tube is an enclosed chamber where the bait is placed and capped. Small drill holes in the inside face of the chamber allow the smell of the bait to permeate out through the tube without allowing access to the bait. At the other open entry end, double-sided tape is attached around the inner rim so hair samples of animals entering the tube are collected. Hair samples collected are sent to Barbara Triggs for identification. Trapping layout, tube sizes, baiting and trapping period will be outlined within the site specific methodology section.

Pitfall trapping - is used to survey for small terrestrial mammals, frogs, reptiles and invertebrates. Pitfall trapping involves the use of 15cm diameter and 60cm long PVC stormwater pipe sections placed vertically into pre dug holes. The pipe is placed and set firm with surrounding soil so that the top rim is level with the ground surface. Drift fences made of damp-proof-course 270mm wide are held tight and upright by wooden and steel pegs and run along the length of each trap-line. Drift fences are run over the middle of each pit in the trap line ensuring at least 5m of fencing is run along each side of each pit. Ground fauna passing beyond the pitfall transect are diverted towards the pits along the fence line.

Funnel trapping - is used to survey mainly for frogs and reptiles. Funnel traps are 18cm x 18cm x 75cm long and constructed of shade cloth with an internal spring and wire frame in a similar design to yabby traps. At each end an inward facing funnel directs fauna through a 4cm hole and into the trap. Herpetofauna search the walls and corners for an exit and discover it difficult to re-find the internal exit hole. As with pitfall traps, funnel traps are used with drift fences that divert fauna towards the trap entry. At least 5m of fencing is run between each funnel trap which may be placed on either side of the fence. Trapping layout, target species, fence lengths and trapping period will be outlined within the site specific methodology section.

Passive Anabat monitoring - involves leaving the bat recorder in a fixed mounted position to record call-sequences of passing bats. Recording locations are determined in order to represent different available foraging structures for various micro-chiropteran bat species. Dams, cleared flyways, high insect activity areas, forest edges and ecotones are particularly targeted.

Active Anabat monitoring - is a method of active microbat recording during stag-watching or during complete nocturnal survey. Active monitoring involves an SD-1 recorder allied with a PDA for viewing call-sequences in real-time. When calls are heard the transducer microphone is actively directed towards the calling animal with the aid of a spotlight, so

longer and clearer call sequences may be recorded. When calls of a potential threatened species are observed on the PDA screen a view by spotlight of the bat size and wing morphology is attempted for greater identification accuracy.

Active vehicle Anabat monitoring - is a method of active microbat recording deployed when large distances need to be covered in a nocturnal survey period. A Hi-mic extension cable allows the transducer microphone to be placed on a bracket on the roof of a travelling vehicle so calls may be viewed whilst driving. The vehicle travels at no more than 40km/h to prevent wind interference. When calls of a potential threatened species are observed on the dash mounted PDA screen active spotlighting is undertaken.

Harp trapping - is used to capture microchiropteran bats. Harp traps have an aluminium frame with a two-bank 4.2m^2 area and calico capture bag set along the base area.

Mist netting - is used to capture microchiropteran bats. The mist net capture area is 2.4m high and 9m wide and supported by two 3.5m poles which are braced with ropes and pegs. Design is a 0.08mm ultrafine nylon monofilament thread arranged in a 14x14mm mesh, with four horizontal capture pockets. These features are specific for the use to capture micro-chiropteran bat species and are provided from the only known supplier in Poland.

Trip lining - is used to capture microchiropteran bats. Fishing line is strung tight on pegs in a zig-zag pattern across open water-bodies just above the water surface to trip drinking bats into the water.

Camera surveillance - is used to monitor activity at burrows, hollows, etc. or to survey for species presence at baited stations. A Reconyx Hyperfire digital weatherproof camera is used with a passive infrared motion detector and a night-time infrared illuminator. The camera is mounted on a tree or tripod and takes three consecutive photo frames on the detection of movement up to 30m away or the detection of a heat/cold source different to the ambient temperature.

Weather conditions - Survey effort for each fauna group accounting for methods undertaken, duration, and weather conditions are provided in the survey effort table. Weather details are documented for all survey techniques and include:

- Air temperature
- Cloud cover
- Rain (e.g. none, light drizzle, heavy drizzle, heavy rain);
- Recent rain events (where relevant);
- Wind strength e.g. calm, light (leaves rustle), moderate (moves branches), strong (moves tree crowns).
- Wind direction
- Moon (where relevant) (e.g. none, 1/4 moon, 1/2 moon, 3/4 moon, full moon);

GONDWANA CONSULTING

BRINGING PEOPLE AND THE ENVIRONMENT TOGETHER

Proposed Residential Development Belrose NSW

OPEN SPACE AND RECREATION STUDY

for
Matthews Civil Pty Ltd
28 November 2012

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"Proposed Residential Development – Belrose, NSW
Open Space and Recreation Study"

FINAL

ISSUED: 28 November, 2012

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Open Space and Recreation Study
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Executive Summary

A Joint Venture has been entered into between Matthews Civil Pty Ltd and the Metropolitan Local Aboriginal Land Council (MLALC) for land currently owned by the MLALC in Belrose, within the Warringah Local Government Area (LGA), and part of Sydney's Northern Beaches. The Joint Venture is seeking to rezone the site for the development of approximately 169 residential lots. This Open Space and Recreation Study has been prepared to identify the open space and recreation needs of the proposed development site.

The site is known as the Ralston Avenue Subject Site, located west of existing residential housing in Ralston Avenue and the Sydney East Substation at Belrose. The site is presently characterised by remnant bushland vegetation; an existing road is located along the plateau and the remainder of the site is characterised by gentle to steep sloping sandstone escarpments. The site currently provides access to a formal walking trail through Garigal National Park, known as the Heath Trail, and provides opportunity for informal recreation for the local community.

A Study Area has been developed for the purpose of analysing the current provision, needs and future provision of open space and recreation. The Study Area is defined as all lands within a 2km radius of the proposed development site. This includes the majority of Belrose and Davidson, with a small portion of Frenchs Forest and St Ives (located outside of the LGA).

The demographic profile of Belrose has been compared to the demographic profile of the Warringah LGA and Greater Sydney, to establish current and future demands for open space and recreation. In summary, the residents of Belrose are on average older than the residents of Warringah and Greater Sydney, this is likely to reflect the large presence of aged care facilities within the suburb. Although the resident population is generally older, the predominant age group in 2011 was 0-14 years, this age group is forecast to remain the predominant age group in 2036, however there is expected to be a significant increase in residents within the 15-29 age group and the 75+ years age group. Belrose is a well established family orientated suburb. Provision of open space and recreation within the proposed development site should reflect this demographic profile and the needs of children and youth, as well as an ageing population.

A comprehensive review of background documents has been undertaken during the preparation of this Open Space and Recreation Study. A number of Council plans and strategies have been reviewed, along with relevant State planning documents. This review, and the recommendations of the State and Local plans and strategies, has been used to inform the recommendations of this Study. Although there may be variances in recommendations of the plans and strategies, the intent of the recommendations is to ensure the provision of the most appropriate open space and recreation within the area, and the encouragement of participation in recreation for all members of the community.

An analysis of open space and recreation within the Study Area indicates that there are a wide variety of opportunities available for the enjoyment of open space and. Forest Way, located in the eastern portion of the Study Area, acts as a constraint to movement. The provision of Local parks has been compared to NSW State Guidelines and the majority of the Study Area is well provided for with Local Parks. There are no existing Local parks within 400m of the proposed development site.

A similar analysis has been carried out for Local sportgrounds and District sportsgrounds within the Study Area. It was found that, although the Study Area is well provided for with Local sportsgrounds, the proposed development site is located just beyond the 1km buffer.

The proposed development site however falls within the 2km buffer area for Lionel Watts Reserve, identified as a District park.

In consideration of the trends in participation and the needs and issues identified through Council's community consultation, it can be summarised that Warringah's community is highly active with participation in recreation high for all age groups. There is high demand for unstructured recreation opportunities to cater for a variety of age groups. There is a need to improve access to open space and recreation opportunities, particularly for youth, older people and people with disabilities. Linkages between existing facilities are important, and the need to improve the current network of linkages has been identified. Within the Study Area, a strategy to upgrade and, in some instances, remove existing playgrounds has been identified to ensure provision within the area meets the current and future needs of the community.

Council has identified a hierarchy for the provision of open space and recreation within Warringah LGA, and the Study Area. Asset provision is determined in accordance with this hierarchy. It is important to ensure that provision of open space and recreation facilities within the proposed development site is consistent with the Council identified hierarchy and that the appropriate assets are provided. The provision of open space and recreation facilities within the proposed development site should encourage participation by a wide range of members of the community. This could be achieved through the provision of multi-use facilities and opportunities that cater for a variety of ages, including linkages to Council's existing network of open space and recreation within the surrounding area.

In conclusion, and consistent with Council's existing average provision of open space, recommendations of existing State and Local plans and strategies, and the demographic profile of the Belrose suburb, the following recommendations have been made for the provision of open space and recreation within the proposed development site:

- Provide Local Parks, including a neighbourhood playground, in the form of:
  a) One large, approximately 0.7ha, Local Park with facilities to cater for children, youth and the older residents, such as neighbourhood playground, half court basketball court (or similar) and other park facilities; and
  b) Several smaller "pocket" parks located elsewhere in the site, and suitably distant from the above park.
- Provide a multi-use path through the Asset Protection Zone (APZ) around the perimeter of the proposed development site – linking to the Heath Trail as well as linking to, and forming part of, bike and regional trails already proposed by Council. A number of seats could also be incorporate at intervals throughout the APZ and adjacent to the multi use path.
- Include interpretive signage within the Local park/s and adjacent to the multi-use path (potentially adjacent to seating).
- Ensure detailed design of the open space and recreation facilities is in accordance with Council plans, strategies and guidelines.
- Consider a Voluntary Planning Agreement for the undeveloped portion of the MLALC site, beyond the boundary of the APZ, for the protection of the natural environment and to assist in the amelioration of any "edge effects" of the site.

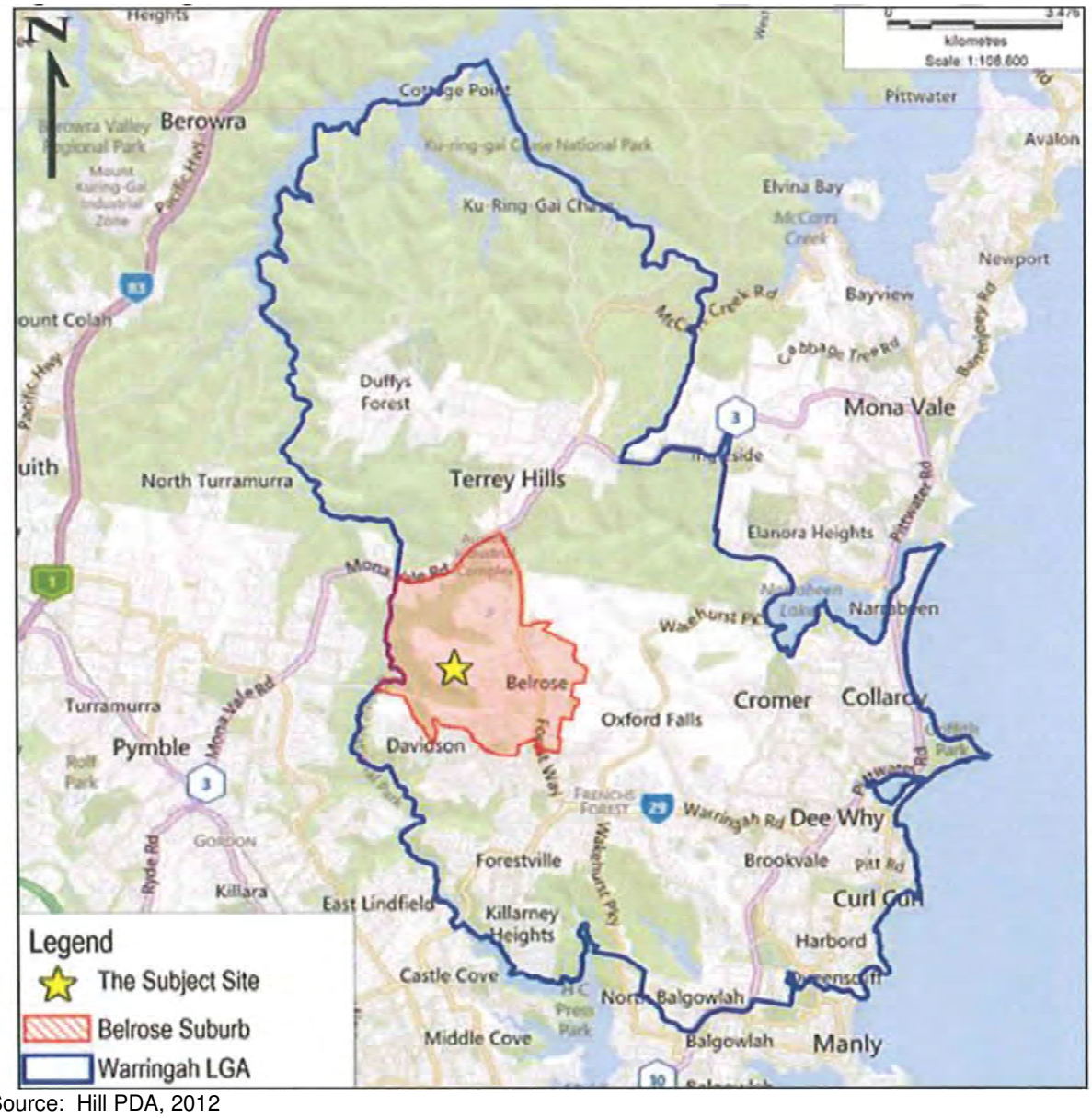
1 Introduction

1.1 Background

A Joint Venture has been entered into between Matthews Civil Pty Ltd and the Metropolitan Local Aboriginal Land Council (MLALC). The Joint Venture is seeking to rezone a site within Belrose, NSW, for a proposed residential development. The site is known as the Ralston Avenue Site, it is situated on MLALC land extending west of existing residential housing in Ralston Avenue and the Sydney East Substation, Belrose.

Gondwana Consulting Pty Ltd has been commissioned to prepare an Open Space and Recreation Study. The aim of the study is to establish the current supply of open space and recreation within the Study Area, as well as identify the needs of the residents of the proposed development area and the wider community. Figure 1 shows the location of the proposed development site (Ralston Ave Subject Site) within a regional context.

Figure 1: Location of proposed development site within a regional context



Source: Hill PDA, 2012

1.2 The proposal

At the time of this Study, the Joint Venture is considering approximately 169 housing lots to be developed at the Ralston Avenue site, with an average lot size of approximately 600m2.

The Draft Concept Plan for the proposed development, shown in Figure 2, identifies a large area of managed open space to provide recreational opportunities for residents. The proposed development site is to be surrounded by an Asset Protection Zone (APZ) as a means of protecting the residential homes and infrastructure from bushfire threat from the remainder of the site and the adjoining Garigal National Park. The APZ provides opportunity for informal recreation. In addition to the managed open space, an area of Coastal Upland Swamp at the south eastern corner of the development site is identified for protection.

1.3 Study Area

The proposed development site is located within the Warringah LGA, part of Sydney's Northern Beaches, in the suburb of Belrose. As requested in the Brief, a Study Area has been defined as all land within a 2 kilometre radius of the proposed development site. The supply and demand of open space and recreation within this Study Area, as well as constraints and opportunities, is analysed in the remainder of this report. Recommendations for the provision of open space and recreation facilities within the proposed development site are provided in Section 7.

The Study Area is identified in Figure 5, later in this report. It incorporates most of the suburb of Belrose and most of the suburb of Davidson, which lies to the south of Belrose. In addition, a small portion of Frenchs Forest is included in the Study Area, in the vicinity of Lionel Watts Sportsground; and a small portion of St Ives, containing Garigal National Park, is located inside of the western boundary of the Study Area.

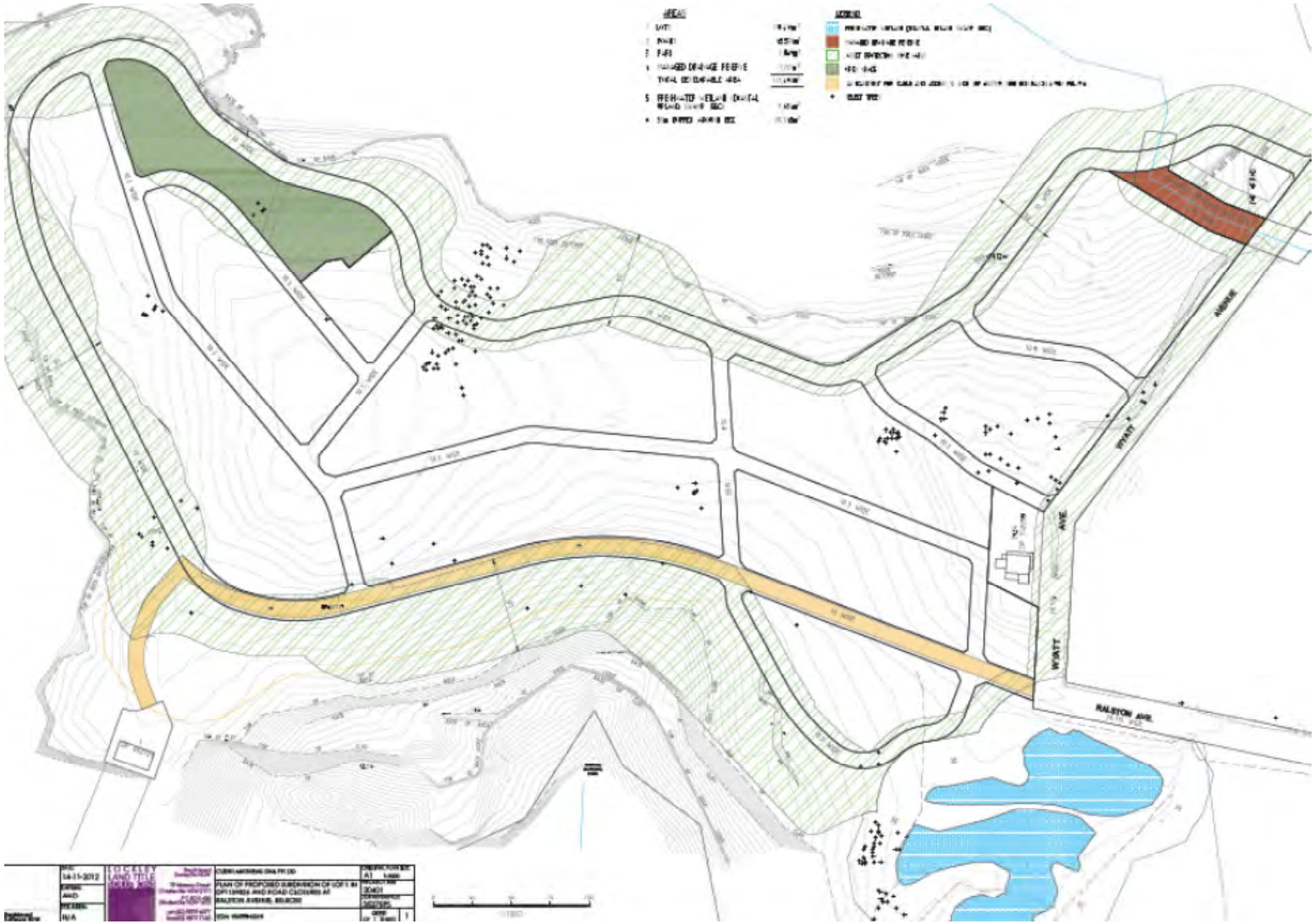
Belrose is characterised by detached residential housing, along with some large rural residential landholdings. There are two large non-residential land uses within Belrose, being a Waste and Resource Management Centre and Austlink Business Park. Garigal National Park runs along the western boundary of Belrose and extends through the north of the suburb and provides a large portion of Belrose with an adjacent bushland setting. A small business centre is located along Ralston Avenue, opposite Belrose Public School; whilst a larger business centre is located further south, along Glen Street, and is known as Glenrose Shopping Centre.

Davidson covers a much smaller land area and is located in the south western portion of the Study Area. The suburb is characterised by detached residential housing and the western portion of Davidson is made up of Garigal National Park; also providing a large portion of the suburb with an adjacent bushland setting. The Study Area boundary runs through Davidson High School and the nearby small business centre.

The Study Area contains a variety of open space which is further described in Section 4.

The Ralston Avenue site is located on MLALC land to the west of existing residential housing, at the northern end of the Belrose residential area. At present the site is characterised by remnant bushland vegetation. An existing road is located along the plateau, the remainder of the site is characterised by gentle to steep sloping sandstone escarpments. At present the site provides access to a formal walking trail through Garigal National Park – known as the Heath Trail. Informal recreation is carried out within the site, notably mountain bike riding and horse riding, along with informal access to walking tracks.

Figure 2: Draft Concept Plan



2 Demographic Profile

The following information provides a snapshot of Belrose and the Warringah LGA and is based on data collated by Hill PDA in their draft *Social Impact Assessment for the Belrose Residential Development* (September 2012), from the 2006 and 2011 Australian Bureau of Statistics, and the Bureau of Transport Statistics 2009 Forecasts. The Study Area encompasses a large portion of Belrose, the majority of Davidson and a small portion of Frenchs Forest and St. Ives. As the proposed development site is situated in Belrose, and the statistics could not be broken down to only represent the Study Area, the demographic profile of Belrose has been used in the following comparisons and analysis.

2.1 Population growth

According to the ABS Census, between 2006 and 2011 the number of people living in Belrose decreased by 120. This equates to an average annual growth rate for the suburb of -0.3%. In contrast, the population of Warringah LGA and Greater Sydney increased during the same period by 1.01% and 1.29%, respectively.

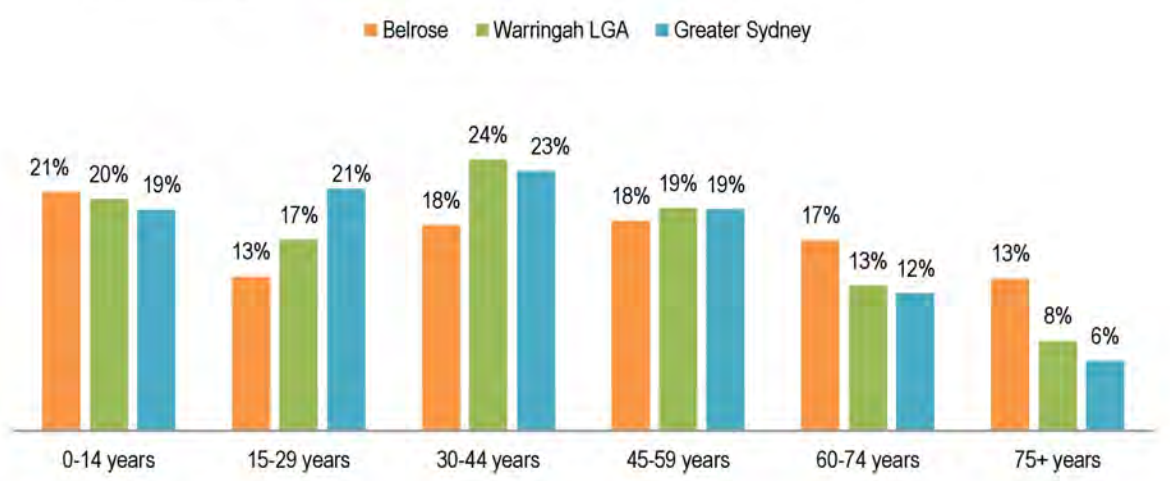
Although recent trends show a decrease in the Belrose population, forecasts compiled by the NSW Bureau of Transport Statistics (BTS) expects the resident population of Belrose to grow at a similar rate to the broader Warringah LGA – approximately 0.7% per annum. However it should be noted that these growth rates are significantly greater than those actually recorded over the last 10 years.

2.2 Age

The median age of the population of Belrose has continued to increase since 2001. The median age in 2011 was 43 years for Belrose and 38 years for the LGA. There is a substantial presence of age care accommodation within Belrose which is reflected in the median age of the population within the suburb.

Although the median age of the population within Belrose is greater than that of the LGA and Greater Sydney (36 years), the predominant age group in 2011 was 0-14 years. This represents 21% of the suburb population at that time. The proportion of Belrose residents aged over 45 years (48%) was significantly higher than the LGA (40%) and Greater Sydney (37%). The proportion of residents aged over 75 years was also significantly higher in Belrose (13%) than the LGA (8%) and Greater Sydney (6%). Again, this statistic is likely to reflect the substantial presence of aged care accommodation in Belrose. The following graph illustrates the 2011 age distribution for Belrose, Warringah LGA and Greater Sydney; data is sourced from the ABS Census 2011 and the graph is sourced from the *Draft Belrose Residential Development – Social Impact Statement* (Hill PDA, September 2012).

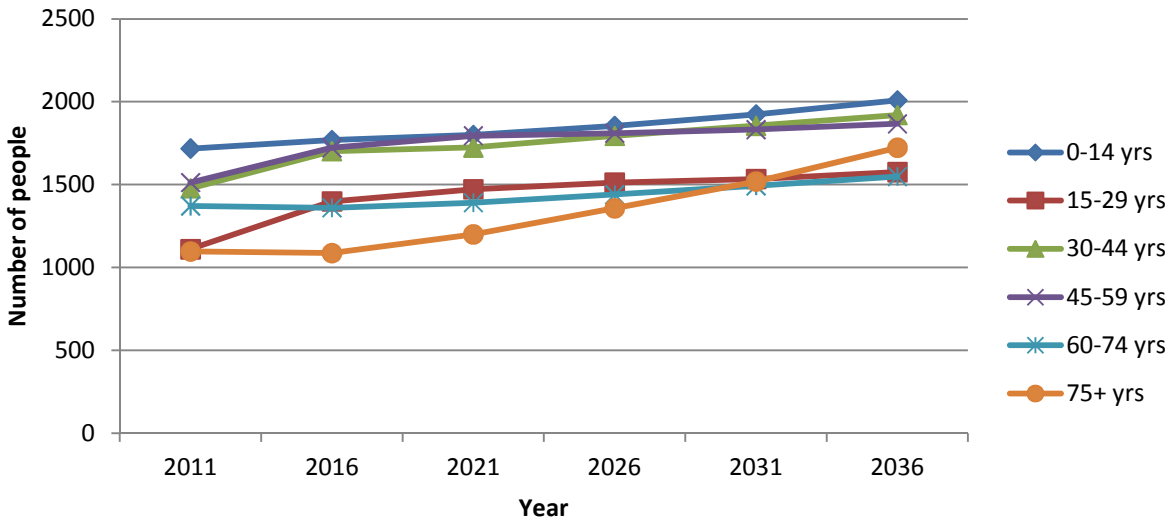
Figure 3: Age distribution for Belrose, Warringah LGA and Greater Sydney - 2011



Source: pg 19, Hill PDA, September 2012

The following graph shows the forecast age distribution in Belrose for the next 24 years. During this time period, and consistent with nationwide trends, the resident population of Belrose is forecast to age. The 0-14 year age group is forecast to continue to contain the largest portion of the Belrose population, yet this age group is forecast to increase by only 17% during this time. The 75+ year age group is forecast to see the largest growth, with a 58% growth in the number of persons aged 75+ years in Belrose. Significantly, the 15-29 year age group is expected to increase by 42% by 2036.

Figure 4: Forecast age distribtution for Belrose



Source: ABS 2011 and Bureau of Transports Statistics 2009 Forecasts.

2.3 Households

The typical household size for Belrose, in 2011, was 2.9 persons. This was greater than both the LGA (2.6 persons/household) and Greater Sydney (2.7 persons/household). The 2011 Census identified that the most common family type in Belrose continues to be couples with children (55%). The larger household size is likely to be attributed to the large proportion of families with children living within Belrose.

2.4 Summary

Following is a summary of findings identified in the draft *Social Impact Assessment for the Belrose Residential Development* (pg 31, Hill PDA, September 2012).

> *"Since 2006 the suburb of Belrose has experienced a decline in its resident population (-120) and dwelling stock (-83 dwellings). Demographic analysis revealed residents of Belrose generally live in larger households and are increasingly educated, white collar and affluent in comparison to the average for Greater Sydney. Workforce participation rates amongst this relatively advantaged community are high and levels of unemployment low.*
>
> *Whilst residents of Belrose tend to be on average older, the predominant age group in 2011 was 0-14 years which constitutes 21% of the local population. Belrose has also become more family orientated, with the proportion of family households increasing by 2% since 2006.*
>
> *With regard to built form, Belrose has a large proportion of detached dwellings which contain more people and bedrooms than the average for Greater Sydney. Home ownership levels in Belrose (87%) are also significantly higher than the average for Greater Sydney (65%).*
>
> *In summary the Belrose is a well-established family orientated suburb, dominated by detached dwellings and inhabited by comparatively advantaged, educated and affluent residents."*

It is important to ensure that the provision of open space and recreation within the proposed development site takes into consideration the current demographic profile of Belrose, as well as the forecasted demographic profile for the suburb. The provision of open space and recreation facilities for a mixed age profile will be important within the proposed development site, with dedicated facilities for children and youth, as well as for the ageing population.

3 Review of Background Documents

3.1 Summary of background documents

In order to assess the open space and recreation needs of the residents of the proposed development site, a review of background documents has been carried out. The following documents have been reviewed:

- ***Garigal National Park Plan of Management, NSW National Parks and Wildlife Service (NPWS), 1998*** – provides direction for the future management of Garigal National Park, ensuring the conservation of its natural and cultural heritage. The Plan covers the entire Park, an area of 2,000ha. The Plan recommends that 'bicycle riding' is permitted only on 'management tracks' throughout the Park and horse riding is permitted on the Heath Trail, among other tracks outside of the Study Area. These activities are permitted by the Plan, subject to monitoring of unacceptable impacts, at which point the impacts are to be minimised or eliminated. Furthermore, the NSW NPWS website currently identifies mountain bike riding (which has become increasingly popular since the release of the 1998 Plan of Management) and horse riding as suitable activities on the Heath Trail (NSW NPWS, n.d.).

- ***Generic Bushland Plan of Management*, Warringah Council, 2009** – provides direction for the future management and use of almost 100 bushland reserves within the LGA, comprising over 300ha of bushland. The main focus of the Plan is to protect the conservation value of remnant bushland in an urban setting; the Plan however also acknowledges low-impact recreation as another value of the bushland reserves.

- ***Generic General Community Use Plan of Management*, Warringah Council, 2005** – provides direction for the future management, use and development of lands categorised as general community use throughout the LGA. This includes lands managed as roadside buffers and drainage reserves as well as lands that provide public access, linkages and passive recreation.

- ***Generic Parks Plan of Management*, Warringah Council 2008** - provides direction for the future management, use and development of district, neighbourhood and local parks within the Warringah LGA (that are covered by the Plan). Identifies a hierarchy of parks as - Local, Neighbourhood, District and Regional and provides an analysis of supply and demand for the LGA and each suburb. The Plan includes "*Draft Park Guidelines"* which provides a definition of the hierarchy of parks, along with guidelines for the provision of assets, and standards in the design of parks.

- ***Living Warringah*, Warringah Council 2005** - sets a vision and clear direction for Warringah for the next decade and beyond, including goals for each of the chapters identified - Living Spaces, Living Environment, Living Communities and Living Enterprises. The vision for Warringah is *"Warringah – A vibrant community, improving our quality of life by living and working in balance with our special bush and beach environment."*

- ***Playground Strategy, Warringah Council 2007***- develops a framework for the future planning and management of playgrounds in Warringah. The Strategy identifies existing supply and demand, a playground hierarchy and a list of prioritised actions to meet the identified needs.

- ***Recreation and Open Space Planning Guidelines for Local Government*, NSW Department of Planning 2010** - promotes a standard approach to measuring demand for and supply of open space and recreation facilities and identifies targets for the provision of open space and recreation facilities in NSW.

- ***Sports in Warringah*, Warringah Council 2004** - identifies future infrastructure and service planning for sportsfields and associated facilities. The focus of the strategy is on outdoor sportsgrounds and facilities managed and/or maintained by Council, including outdoor courts.

- ***Sportsgrounds Plan of Management*, Warringah Council 2007** - provides guidance and direction for the future management, use and development of sportsgrounds in Warringah. The Plan includes an analysis of recreation demand (at both a National and LGA scale). A hierarchy of sportsground is identified which sets the basis for the provision of services and infrastructure and the management of the sportsgrounds - Regional A, Regional B, Subregional, Local A and Local B.

- **Threatened Bushland Reserves (Duffys Forest Ecological Community) Plan of Management, Warringah Council 2008** – provides guidance for the future management of bushland reserves that support the endangered ecological community Duffys Forest. Boronia Reserve and Kens Road Reserve, both located within the Study Area, are covered by this Plan of Management.

- ***Warringah Bike Plan*, Warringah Council 2010** - provides the basis for cycling infrastructure within Warringah. A bicycle network is identified and new routes are proposed within the Study Area, including a link with the proposed development site.

- ***Warringah Local Environmental Plan*, 2000 and 2011** – controls development and advertising, protects trees and vegetation, and reserves land for open space and other public purposes. In approving the new LEP (2011), the Minister for Planning and Infrastructure deferred certain land – including lands to which this development application applies (Belrose North and Oxford Falls). A Strategic Review is currently underway for these lands to identify the most appropriate zoning and land use controls. Until this review is complete, and the land is included in the Warringah LEP 2011, the proposed development site, and other parcels in the Study Area, are to be managed in accordance with the Warringah LEP 2000.

- ***Warringah Recreation Strategy*, Warringah Council 2009** - provides long term strategic direction for the future provision and management of recreation assets, programs and services in Warringah. The Strategy identifies community needs and opportunities to address gaps and improve provision of open space and recreation within Warringah. Extensive research, as well as a series of surveys, was conducted during the development of the Strategy. "P*roposed Guidelines for Provision of Open Space in New Developments"* are included within the Strategy. The Proposed Guidelines are to be considered for new land release areas. A list of items for consideration are provided to ensure that any proposed open space or recreation facility achieves the best possible outcome for the community.

- ***Warringah Regional Multiple Use Trail Strategy*, Warringah Council 2007** - provides strategies for the implementation of a multiple use trail network within the Warringah LGA, with connections to the surrounding region. The strategy focuses on multiple use trails within bushland areas of the LGA, it identifies planning issues for the Heath Trail, as well as proposes better connectivity to the trail via an urban linkage along Wyatt Avenue.

- ***Warringah Section 94A Development Contributions Plan*, Warringah Council 2012** – is prepared in accordance with the *EP&A Act 1979*. The Plan identifies development consent levies, the purpose of the Plan, development to which the Plan applies and alternatives to the payment of the S94A levy. A Section 94A Schedule of Works program is also provided for 2012/2013. There are no specific open space and recreation facilities improvement projects identified within the Study Area, however funding is allocated generally for improvement of playgrounds, bike facilities and sportsgrounds - some of this funding may be spent within the Study Area.

- ***Warringah Strategic Community Plan*, Warringah Council 2012** - is Council's primary forward planning document, providing a ten year strategic direction for Warringah and setting a four year detailed Delivery Program as well as the 2012/2013 Operational Plan. The Plan aligns the community vision (as identified in *Living Warringah* 2005) with a clear strategic direction for Warringah's long term future. There is only one specific Capital Works project identified in the Operational Plan for the Study Area - $6,360 for Undula Reserve (Belrose) Playground equipment. Other general funding, however, is allocated to improvement of parks and sportsgrounds, some of this funding may be spent within the Study Area.

3.2 Key findings of the document review

3.2.1 Standards for open space and recreation planning

The *Recreation and Open Space Planning Guidelines for Local Government* (NSW Dept Planning, 2010) provides a discussion regarding provision standards and sets default standards for open space planning in NSW. Prior to the release of the Guidelines, the fixed standard of 2.83ha of open space per 1,000 people was generally applied in open space planning studies (NSW Dept Planning, 2010). This was based on British standards from the early 1900's and does not take into consideration the need for the provision of different types of open space, needs of the community or constraints to access or use of open space areas. The Guidelines identify a new default standard for open space planning in NSW, as shown in Table 1.

Table 1: Default Standards of Open Space Planning in NSW

	Hierarchy level	Size	Distance from most dwellings	Share of non-industrial land	Locally specific alternatives to meeting this standard
Parks	Local	0.5-2 ha	400m	2.6%	Civic spaces, plazas, pocket parks, portion of a regional park or quarantined area of a conservation or landscape area
	District	2-5 ha	2 km	0.6%	Beach and river foreshore areas, or quarantined area of a conservation or landscape area
Linear and Linkage	Local	up to 1 km	n/a	0.9%	Local primary schools, portion of a district park
	District	1-5 km	n/a	0.1%	Secondary schools, portion of a regional park
Sub-total (Parks/Linear and Linkage)				**4.2%**	
Outdoor sport	Local	5 ha	1 km	2.0%	Local primary schools, portion of a district park
	District	5-10 ha	2 km	2.6%	Secondary schools, portion of a regional park
Sub-total (Outdoor Sport)				**4.6%**	
Total (Local/District)				**8.8% Say 9%**	Could be reduced through shared areas using above alternatives
Parks	Regional	5+ ha	5-10 km	2.3%	
Linear and Linkage	Regional	5+ km	5-10 km	0.7%	
Outdoor Sport	Regional	10 +ha	5-10 km	2.9%	
Total (Regional)				**5.9% Say 6%**	
Grand Total				**14.7% Say 15%**	

Source: pg 29, NSW Department of Planning, 2010

The Local, District and Regional hierarchy identified in Table 1 refers to the catchment areas of the facilities. In accordance with the Guidelines:

- 'Local' serves a neighbourhood and is located close to or within residential areas.
- 'District' serves a number of neighbourhoods and its catchment may extend beyond the LGA boundary.
- 'Regional' serves whole metropolitan subregions and often requires State agency management.

In summary, the Guidelines provide default standards for the provision of open space in NSW. Locally specific alternatives to meeting the standards are also identified. It is noted in the Guidelines that the standards should only be a starting reference point and that provision of open space must also take into consideration community needs and requirements to ensure a satisfactory result. For the purposes of this Study, community requirements have been established through the review of the various background documents, identified above

in Section 3.1, which includes extensive research by Warringah Council to establish current and future trends in participation in recreation.

The majority of Warringah's key open space and planning documents have been developed prior to the release of the *Recreation and Open Space Planning Guidelines for Local Government* (NSW Dept Planning, 2010). As such the hierarchy's identified in Council planning documents do not match those of the NSW Guidelines. For the purposes of this Study, a best fit approach has been used to assess local provision in line with the NSW Guidelines. Additional provision standards, to those identified in the NSW Guidelines, have also been identified through Council Plans and Strategies. These are to be applied to this Study and include:

- Neighbourhood playgrounds should be located within a 10 minute walk from most residential dwellings (*Playground Strategy*, Warringah Council, 2007).

3.2.2 Specific Council recommendations relevant to the proposed development site

Warringah Bike Plan
The *Warringah Bike Plan* (Warringah Council, 2010a) identifies the need for improved access to the proposed development site. A prioritised bicycle network is identified by the Plan which is a series of 'high quality, high demand' bike routes designed to promote the uptake of cycling in Warringah. A long term (Priority 4) link in the bicycle network is proposed that extends from Ralston Avenue using the existing dirt track along the approximate eastern edge of the proposed development site. Such linkages should be addressed in the consideration of 'Linear and Linkage' open space and the accessibility of open space and recreation facilities between the existing residential areas of Belrose and the proposed development site.

Warringah *Regional Multiple Use Trail Strategy*
The *Warringah Regional Multiple Use Trail Strategy* (Warringah Council, 2007c) identifies the Heath Trail as an existing regional multiple use trail. The Heath Trail is a designated walking track of Garigal National Park. The trail connects Belrose with St. Ives (via Bare Creek Trail and Cascades Trail) and runs from Ralston Avenue, Belrose, through land owned by the Metropolitan Local Aboriginal Land Council, into Garigal National Park. The *Strategy* identifies planning issues for the track as "*access through to Ralston Street"* and *"multiple land tenures"*.

Sports in Warringah
Sports in Warringah (Warringah Council, 2004) identifies opportunities for development of new sporting facilities at 3 locations within Belrose and Terrey Hill. One of these sites, the Belrose Waste Management and Recycling Centre, is located within the Study Area. There are a number of actions within *Sports in Warringah* that recommend further investigation and perusal of the identified sites for future recreation. Future development of the Belrose Waste Management and Recycling Centre for open space and recreation would improve the supply of facilities available to residents of the proposed development site and residents of the Study Area. However, it is isolated and disjunct from the development site. Such a development would likely be at a District or Regional level.

Recreation Strategy
The *Recreation Strategy* (Warringah Council, 2009) defines 'recreation' as *"a wide range of organised and less structured physical activities that are pursued for enjoyment, health or self satisfaction outside of the home, including:*

- *Playing organised sport: e.g. soccer, netball, cricket or hockey.*
- *Informal, unstructured activity: e.g. playing with friends, walking the dog or throwing a ball.*
- *Outdoor recreation activities that make use of the natural environment: e.g. such as bush walking, surfing, water skiing, mountain biking, or jogging.*
- *Indoor recreation activities that take place within a purpose built facility: e.g. gym and fitness activities, badminton and indoor bowls."* (Warringah Council, 2009, pg 6)

The Strategy identifies the value of open space and recreation opportunities within the LGA and the need to ensure provision and management of open space and recreation to improve the rate of participation by the community.

Proposed Guidelines for Provision of Open Space in New Developments were developed during the preparation of the Warringah *Recreation Strategy* (see Appendix E, Warringah Council, 2009). Research carried out during the preparation of this Study has not identified adoption of these guidelines; the intent of the guidelines however remains relevant to this Study. The purpose of the Guidelines is to ensure open space needs of land release areas are adequately assessed and provided for – to ensure the best possible outcome for the community. The following points are of particular relevance to this Study:

- Consideration of population demographics and forecasts;
- Identification of current trends and gaps in provision of recreation;
- Consideration of the NSW Recreation and Open Space Guidelines;
- Integration of 'incidental activity' and Healthy Active planning principles;
- Consideration of the site topography;
- Consider providing for multiple uses, such as developed open space and natural areas;
- Provide for a diversity of open space and recreation opportunities; and
- Consider a hierarchy of multi-use facilities.

Generic Parks Plan of Management

The *Generic Parks Plan of Management* (Warringah Council, 2008a) recommends a hierarchy of parks be provided within the LGA. *Draft Park Guidelines* were developed during the preparation of the *Generic Parks Plan of Management*. Again, research carried out during the preparation of this Study has not identified adoption of these guidelines; the intent of the guidelines however remains relevant to this Study. The guidelines identify the current hierarchy of parks provided for within Warringah, along with guidelines for the provision of assets and standards in the design of parks within the LGA. Table 2 provides a summary of features identified, within the draft guidelines, as appropriate to each park hierarchy.

Table 2: Summary of appropriate features for each park hierarchy

Specific Associated Feature	Local	Neighbourhood	District	Regional
BBQs	-	-	✓	✓
Bins	-	-	✓	✓
Lighting	-	-	✓	✓
Playground	-	✓	✓	✓
Public Art	-	-	✓	✓
Shade Structures	-	-	✓	✓
Taps	-	✓	✓	✓
Toilets	-	-	✓	✓

Source: Warringah Council, 2008a

In addition to the above, the Guidelines list a number of points to be considered in the design of new parks:

- Warringah Design Guidelines (Warringah Council, 2010b);
- Provision of bicycle racks and paths in accordance with appropriate standards and plans;
- Memorials and plaques, public art, and signage to be provided in accordance with appropriate policies and standards;
- Features and built facilities to be provided in line with the hierarchy of the Park;
- Design, where possible, should provide ancillary benefit to surrounding land use;
- Support inclusive access; and
- Consider the principles of Crime Prevention Through Environmental Design.

Specific considerations are also provided for:

- Landscaping and layout;
- Linkages;
- Naming of parks and reserves;
- Park safety; and
- Demographics.

Playground Strategy

Warringah's *Playground Strategy* (Warringah Council, 2007a), recommended that neighbourhood playgrounds within Warringah should be located within a 10 minute walk from most residential dwellings. The Strategy provides the following list of criteria to be considered in playground design:

- Access for people with a disability;
- Environmental amenity (features that increases attractiveness or value);
- Security and personal safety;
- Natural landscape and cultural features; and
- Public art.

The Strategy also provides guidelines for playground facilities and recreation opportunities for each playground category, ie Neighbourhood, District and Regional. Following are the recommendations for a Neighbourhood playground:

- Play equipment for at least one age group;
- May provide for informal play activities such as ball games;
- No or very few support facilities (e.g. only garbage bin, seat);
- Utilize existing trees for shade;
- Limited kerbside car parking.

These criteria are to be considered in line with the *Draft Park Guidelines* and the *Proposed Guidelines for Provision of Open Space in New Developments*, as identified above.

3.3 Summary

The review of background documents has identified a number of policies and planning strategies that should be applied to this Open Space and Recreation Study. Although there may be some variance in recommendations of the different State and Local Policies and Strategies, the intent of the recommendations is to ensure the provision of the most appropriate open space and recreation within the area and the encouragement of participation in recreation for all members of the community. The findings of the review will be used to inform the recommendations in Section 7.

4 Provision of Open Space and Recreation

4.1 General provision within the Warringah LGA

The Warringah LGA covers an area of 153 km^2 on Sydney's Northern Beaches. Council manages over 800 hectares of open space which includes natural areas (approximately 500 hectares) such as wetlands, bushland and foreshores (not including dunes or rocky areas) and developed open space such as parks, sportsgrounds and other land areas used for community recreation (Warringah Council, 2009). Approximately 6,300ha of the LGA is within National Parks. In accordance with Warringah's *Recreation Strategy* (Warringah Council, 2009) and the *Recreation and Open Space Planning Guidelines for Local Government* (NSW Dept Planning, 2010), land zoned E1 'National Parks and Nature Reserves' is not to be included in the calculation of open space.

The *Recreation Strategy* (Warringah Council, 2009) was adopted prior to the release of the new Default Standards of Open Space Planning in NSW (see Table 1). The Strategy provides an analysis and comparison of the average area of open space per 1,000 head of population, both within the LGA and with other planning areas. The Strategy however also recognises the constraints of the outdated standard of 2.83ha of open space per 1,000 people - for example, this standard did not take into consideration outdoor sports facilities, nature conservation areas, ornamental parks and gardens, among other areas. A comparison to provision standards, current at the time of the *Recreation Strategy* (Warringah Council, 2009), in the ACT and South Australia suggested that Warringah may not be adequately supplied with open space. Calculations carried out during the preparation of the *Recreation Strategy* (Warringah Council, 2009) showed:

- Warringah LGA has an average of 6.04ha of open space per 1,000 people;
- Belrose/Oxford Falls has an average of 5.58ha of open space per 1,000 people; and
- Davidson has an average of 5.78ha of open space per 1,000 people.

Further discussion is provided in the *Recreation* Strategy (Warringah Council, 2009) regarding the need to consider the quality and purpose of open space, as opposed to just the land area provided. It was noted that NSW standards were being developed at the time of preparing the Strategy and that they *"should provide guidance and assistance with open space development and feed directly into Council's planning instruments"* (pg 21, Warringah Council, 2009).

The averages provided above, showing the current provision of open space per 1,000 people, should therefore be treated with caution. The data is useful in comparing provision of open space within the Warringah LGA and between its suburbs. A recreation assessment and audit is recommended by the *Recreation Strategy* (Warringah Council, 2009) which is intended to provide a clearer picture on the adequacy of Warringah's current provision of open space.

An analysis of the provision of outdoor playing fields was carried out during the preparation of *Sports in Warringah* (Warringah Council, 2004). It was concluded that the provision of outdoor playing fields in Warringah LGA, when compared to seven Sydney metropolitan LGAs, was generally higher. Demand for sporting facilities however exceeds supply during peak times.

Warringah's *Playground Strategy* (Warringah Council, 2007a), identified that Warringah is well supplied with playgrounds, in terms of distribution, and that there is scope for rationalising and redistributing play equipment to better meet demand.

4.2 Provision of open space and recreation opportunities within the Study Area

The current provision of open space and recreation opportunities within the Study Area, a 2km radius from the proposed development site, has been identified. The current provision was analysed both from Council documents as well as through ground truthing. Consistent with Warringah's *Recreation Strategy* (2009), open space and recreation opportunities have been identified as either:

- Park;
- Sportsground;
- Natural Area;
- Developed Open Space; or
- Commercial Recreation.

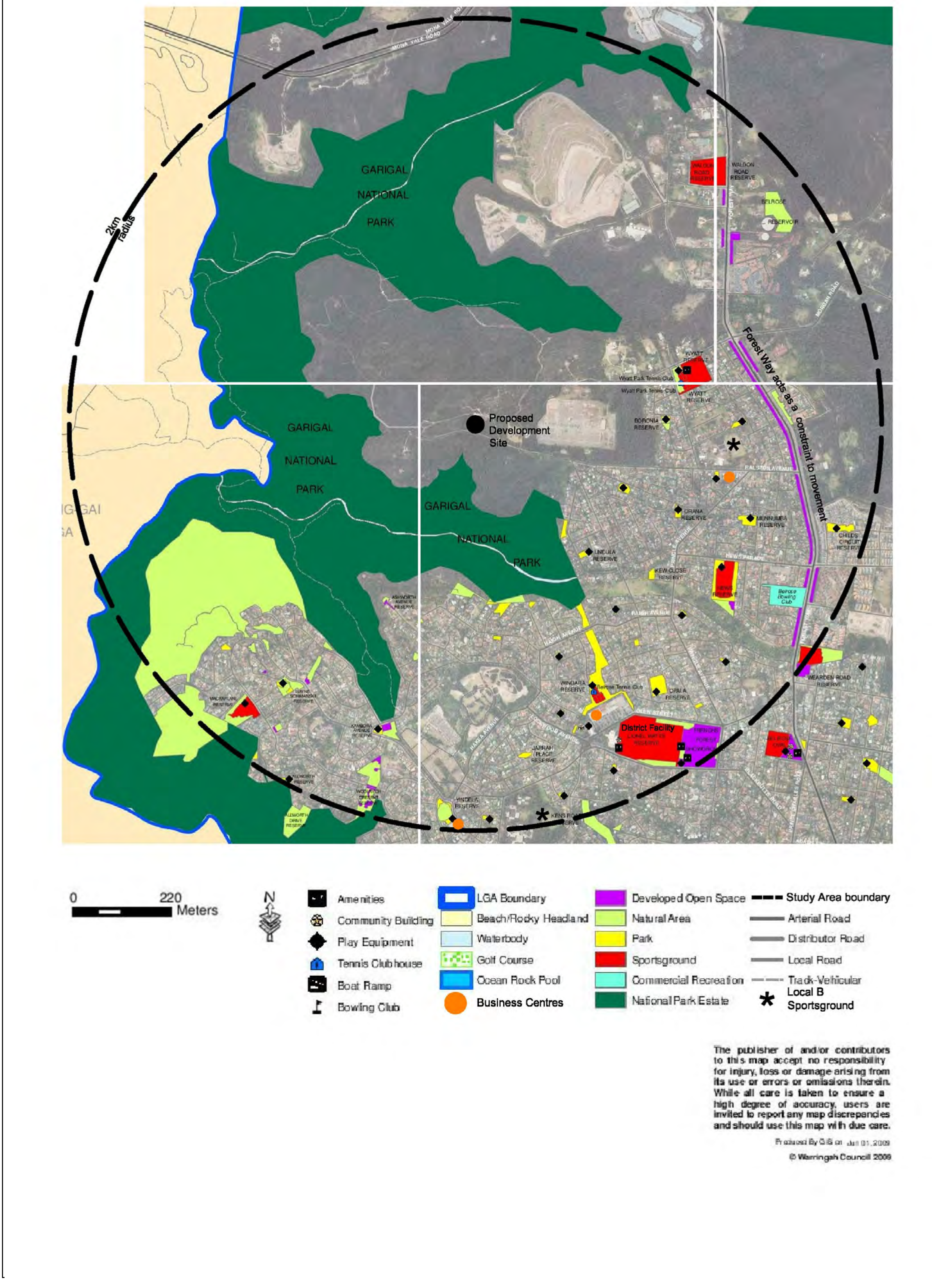
Figure 5 shows the spatial distribution of the current provision of open space and recreation within the Study Area. The Figure has been sourced from Appendix B of the *Recreation Strategy* (Warringah Council, 2009), which identified the spatial distribution of Warringah's recreation assets. Forest Way has been identified as a constraint to movement within the Study Area. Further discussion is provided in the following pages regarding each of the categories of open space and recreation identified within the Study Area.

The hierarchy of open space and recreation identified in Table 3, below, is based on the NSW *Recreation and Open Space Planning Guidelines for Local Government* (NSW Dept Planning, 2010) – as summarised in Section 3 of this Study. Council's planning documents have used a different hierarchy. The *Generic Parks Plan of Management* (Warringah Council, 2008a) orders parks as Local, Neighbourhood, District and Regional; whilst the *Sportsground Plan of Management* (Warringah Council, 2007b) orders sportsgrounds as Regional A, Regional B, Sub-Regional, Local A and Local B. A best fit approach has been used to group the current provision of open space and recreation opportunities into the most appropriate hierarchy, as identified by the NSW Guidelines.

Table 3: Current provision of open space and recreation opportunites within the Study Area

Type	Hierarchy	No. of reserves
Park	Local	34
Sportsground	Local	6
Sportsground	District	1
Natural Area	n/a	25
Developed Open Space	n/a	10
Commercial Recreation	n/a	1

Figure 5: Spatial distribution of current provision of open space and recreation opportunities within the Study Area



Source: Base map sourced from the Warringah *Recreation Strategy* (Warringah Council, 2009)

Some reserves within the Study Area have been identified as providing for a variety of needs, eg sportsground, park and natural areas. Where one reserve provides for more than one need, each need has been counted and identified as a reserve in Table 3.

Parks

There are 34 Local parks located within the Study Area (in accordance with the NSW Guidelines). This is a combination of both local and neighbourhood parks, as identified by Council's hierarchy in the *Generic Parks Plan of Management* (Warringah Council, 2008a). Council describes local parks as providing a visual amenity with only minor facilities provided (if any), they are sometimes also referred to as Pocket Parks. Within the *Generic Parks Plan of Management* (Warringah Council, 2008a), Council describes neighbourhood parks as being generally larger, they may have more facilities (including play equipment) however are deemed to only receive intermittent, low level use, and are designed to be located within walking distance of residences.

Sportsgrounds

There are a total of 7 sportsgrounds within the Study Area, including Wearden Road Reserve, Belrose which is divided by the Study Area boundary. Two of the sportsgrounds within the Study Area have tennis facilities, including courts and tennis club houses. Six of the sportsgrounds are identified as Local facilities (in accordance with the NSW Guidelines). These sportsgrounds are a combination of Local A and Local B Sportsgrounds as identified by the *Sportsgrounds Plan of Management* (Warringah Council, 2007b). Lionel Watts Reserve is the only District sportsground within the Study Area (in accordance with the NSW Guidelines), this reserve is identified as Subregional within the *Sportsgrounds Plan of Management* (Warringah Council, 2007b). It is located within 2km of the proposed development site which conforms to the default standards for open space planning in NSW. Figure 5 shows the location of Lionel Watts Reserve within a 2km radius of the proposed development site.

Natural Areas

There are 25 identified natural areas within the Study Area, excluding Garigal National Park. These areas vary in size and distribution; some sites are isolated whilst others adjoin parks or sportsgrounds. The natural areas contribute to the open space network of the Study Area and, depending on the reserve, provide opportunity for informal recreation as well as the protection of the natural environment. For example, a section of Boronia Reserve, located to the east of the proposed development site, is managed under the *Threatened Bushland Reserves (Duffys Forest Ecological Community North) Plan of Management* (Warringah Council 2008b). This Plan aims to conserve and restore the threatened vegetation community found within Boronia Reserve and other Council managed reserves within the LGA.

Developed Open Space

There are 10 areas of developed open space within the Study Area. This includes Frenchs Forest Showground which adjoins Lionel Watts Reserve, along with other smaller reserves. The linear open space that runs, in sections, along either side of Forest Way is identified by Council as Developed Open Space. This land forms a buffer between Forest Way and the adjoining residential properties with identified values such as visual amenity, noise barrier, a place to walk and a wildlife corridor (Warringah Council, 2005).

Commercial Recreation

There is only one commercial recreation facility, identified by the *Recreation Strategy* (Warringah Council, 2009) within the Study Area - the Belrose Bowling Club. This recreation facility provides an important opportunity for recreation, particularly for the older resident population. In addition to this facility, the Energize Health Club is located on the corner of Blackbutts Road and Glen Street, Belrose.

Playgrounds
There are a total of 27 open space areas with play equipment within the Study Area. Play equipment is located within local parks as well as adjacent to sportsgrounds. Council's *Playground Strategy* (Warringah Council 2007a) conducted an analysis of supply and demand for playgrounds for the LGA. At the time of the Strategy, Belrose was identified as having a high percentage of Warringah's children but a low density of children. Central Belrose was considered as being very well supplied with neighbourhood playgrounds with scope to rationalise at least three playgrounds. Within the Study Area, the area around Ashworth Avenue was identified as being undersupplied. Davidson was identified as having a low number and density of children, with residential areas being well or adequately supplied with playgrounds. The Strategy identified potential for rationalisation of 1-2 playgrounds.

Schools
An arrangement is in place, between Warringah Council and the individual schools, for Belrose Public School and Davidson High School to allocate their school sportsgrounds to support weekend sport competition and for training (outside of school hours). Although these lands are not owned or managed by Council, they form an important part of the network of open space and recreation available within the area.

Garigal National Park
Although Garigal National Park is not included within the calculations of open space and recreation facilities available within the LGA or the Study Area, the National Park plays an important role in providing opportunities for informal recreation in a bushland setting. In addition, the National Park area provides a large expanse of open space and contributes to the sense of open space for the local resident population.

4.2.1 Analysis of local provision of open space and recreation

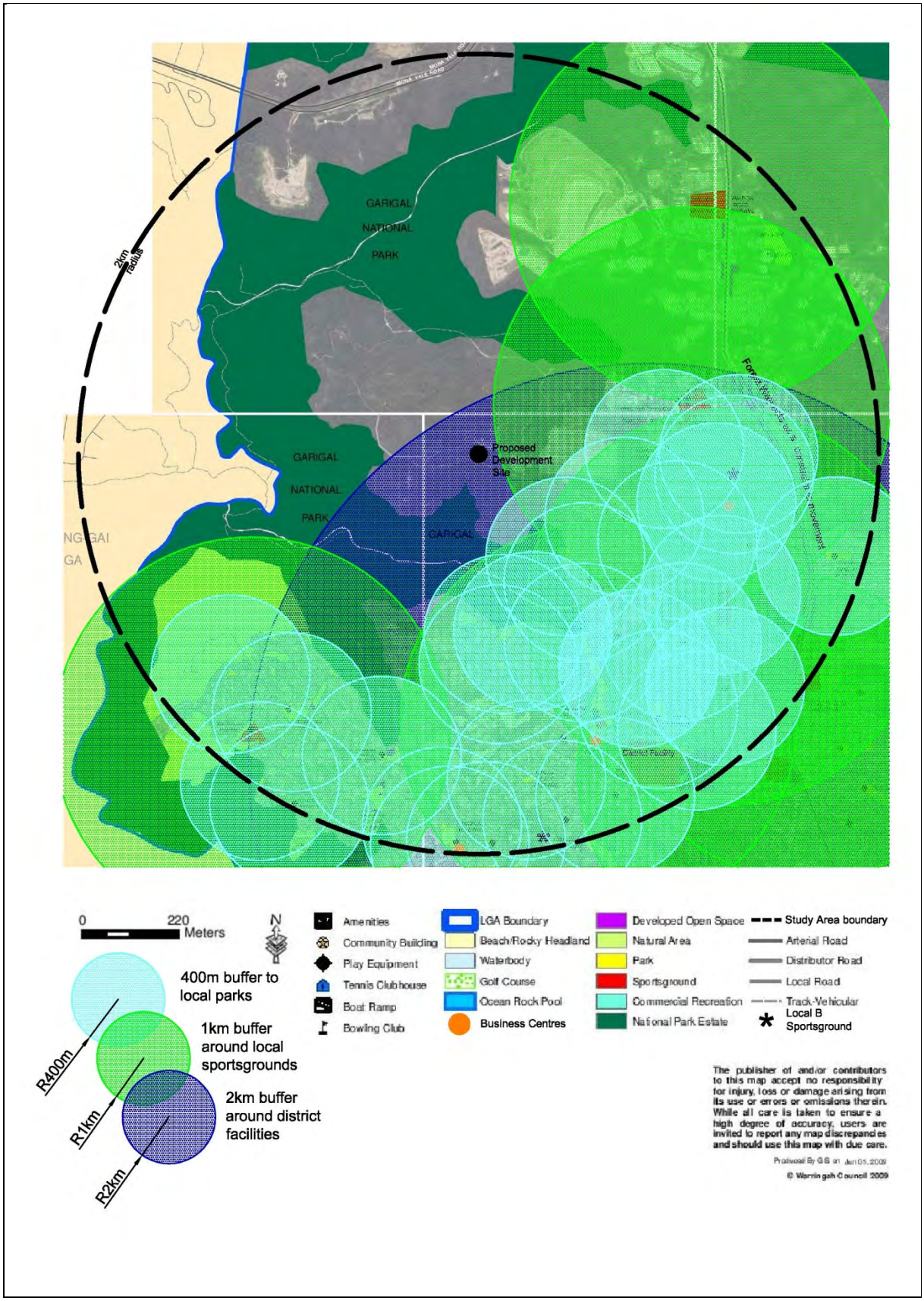
An analysis of the provision of parks in accordance with the default standards for open space planning in NSW has been undertaken using a 400 m buffer around each park within the Study Area (ie walking distance to the park). The analysis indicates that the Study Area contains a considerable number of local parks (although it should be noted that many parks are smaller than the standard default size of 0.5 - 2ha).

The 400m buffer around each park overlaps in a number of areas, particularly in the southern reaches of the Study Area – indicating the potential for rationalisation of parks within this area. This is further supported by Council's *Generic Parks Plan of Management* (Warringah Council, 2008a) which identifies the western area of Belrose and most of Davidson, as being very well supplied with neighbourhood parks. Scope for rationalisation of neighbourhood parks has been identified by this Plan of Management within both of these suburbs. This analysis is illustrated in Figure 6.

The analysis also uses a 1km buffer around each Local sportsground within the Study Area (although the sportsgrounds are generally smaller than 5ha as recommended in the NSW Guidelines). A 2km buffer has also been identified around Lionel Watts Reserve, the only District sportsground within the Study Area. This analysis shows that the proposed development site falls within the buffer of the District sportsground, yet falls just outside the buffer of the nearest Local sportsground, Wyatt Avenue Reserve. The *NSW Recreation and Open Space Planning Guidelines for Local Government* (NSW Dept Planning, 2010) are intended as a guide only. It is acknowledged that generating alternative and locally appropriate standards is particularly relevant in suburban areas, and that the distances to open spaces are intended to cover "most dwellings". It should be noted that *Sports in*

Warringah (Warringah Council, 2004) identifies that the LGA is well provided for in outdoor playing fields, when compared to seven Sydney metropolitan areas, and that demand exceeds supply during peak times – strategies have been recommended to address these periods of high demand. It can be seen from Figure 6 that there is much overlap in the provision of Local Sportsgrounds within the Study Area, and that generally, the Study Area is well provided for with Local Sportsgrounds.

Figure 6: Provision of open space and recreation within the Study Area in accordance with default provision standards for open space planning in NSW



Source: Base map sourced from the Warringah *Recreation Strategy* (Warringah Council, 2009)

5 Trends in Participation

Two comprehensive surveys were carried out during the preparation of the *Recreation Strategy* (Warringah Council 2009) to identify participation in recreation by residents of Warringah. The surveys included a Residents Telephone Survey (2008) of 621 randomly chosen residents aged over 15 years, and a Children's/Youth Survey (2008) of 333 students from 16 schools within the LGA. The surveys form the basis for identifying community participation in sport and recreation within Warringah. The following tables provide a summary of the trends in participation in recreation within the Warringah LGA.

Table 4: Top 10 recreation activities (by adults) and outside of school hour activities (by children) in Warringah

Top ten recreation activities participated in by adults *		Top ten activities participated in by children outside of school over the course of a week^	
Activity	**Participation**	**Activity**	**Participation**
1. Walking	54%	1. Watched T.V/ video/DVD	92%
2. Swimming	31% (outdoor 21% /indoor 10%)	2. Read a book	90%
3. Cycling/Bike Riding	12%	3. Played and run around in the yard or a park	86%
4. Tennis	11%	4. Played a computer game/electronic/console game	82%
5. Surfing/B-Boarding	9%	5. Walking – including bushwalking, walking dog etc	75%
6. Pilates/Yoga	7%	6. Swimming (indoors 14%/outdoors 69%)	73%
7. Golf	7%	7. Arts/crafts/crafts 7. Bike riding/ BMX	63% 63%
8. Gym/Weights	7%	8. Gone to a park or playground 8. Walked to and from school	61% 61%
9. Soccer	4%	9. Athletics/track and field/ running/jogging	56%
10. Fishing	3%	10. Played a musical instrument/practice/lesson	48%

* Residents Telephone Survey (2008)
^ Children's Youth/Activity Survey (2008)

In relation to community participation in recreation, the Strategy concluded that:

> *"Warringah appears to be a highly active community with all age groups having high participation rates. There is a higher demand for unstructured recreation opportunities such as walking, swimming and cycling and incidental exercise opportunities, especially among the older age groups. There is therefore a need to provide a balanced provision of leisure and sporting opportunities to cater for the different age groups and needs as well as addressing identified barriers to participation.*
>
> *The pattern of use across the demographic areas indicates that residents tend to use facilities closest to their homes and require less travel. It is expected that there will be a continuing high demand for those sports/activities currently with high participation levels.*

Lack of transport and linkages is a key barrier to participation and needs to be addressed to ensure access." (pg 34 Warringah Council 2009):

The Strategy provides a number of actions aimed at maintaining and increasing participation as well as addressing barriers.

The *Generic Parks Plan of Management* (Warringah Council, 2008a) identified that parks in the LGA play an important role in providing informal leisure activities. It is assumed in the Plan that, as Warringah has a high proportion of people in employment, time for participation in organised sport and recreation activities is limited – thereby increasing the importance of parks for informal leisure activities.

In accordance with current trends in participation, the provision of open space and recreation within the proposed development site should particularly consider the provision of opportunities for walking, cycling/bike riding, informal play in a park setting and the provision of a playground.

6 Needs Assessment

6.1 Review of community needs and issues

The community needs assessment for open space and recreation has been gathered from data collected during the preparation of Council Plans and Strategies. Following is a summary of key outcomes of the needs analysis identified in *Sports in* Warringah (2004) and the Warringah *Recreation Strategy* (2009) that are of particular relevance to the Study Area.

Young People

- Less activity and sport options for females compared to males;
- Limited activities can be accessed without the need for transport;
- Requests for additional outdoor playing spaces, eg basketball and multi-use indoor courts;
- Need to further develop cycle/walking tracks – particularly with links to community facilities;
- Increased participation in BMX and mountain bike riding yet few facilities available;
- Request for additional skating facilities;
- Large majority of respondents (to the RTS, 2008) felt that Council needed to improve facilities, programs and services for children (84%) and young people (85%);
- Improving services for children and young people was considered the highest priority by 621 respondents of the RTS, 2008;
- Recreation facilities, programs and services for children and young people was also strongly supported by 82% of clubs who responded to the ROS 2008.

Older People

- Perception of limited availability of affordable spaces and activities for older people;
- Need to further develop footpaths and designated cycleways/walkways;
- Transport and parking to be considered in development and improvement of recreation facilities;

People with Disabilities

- Need to further develop footpaths and designated cycleways/walkways;
- There are opportunities for improving access to Council facilities and open space;
- Need to adopt a more holistic planning approach to cater for people with disabilities – particularly regarding asset development;
- Requests to increase range of facilities to generate greater participation, eg pathways, seats, signage and bus stops;
- Large majority of respondents (to the RTS, 2008) felt that Council needed to improve facilities, programs and services for people with disabilities (81%);
- High proportion of groups who responded to the ROS (2009) agreed that recreational facilities, programs and services for people with disabilities needed to be improved.

Provision of sport and recreation activities

- Limited footpath network – especially important for older people, people with a disability and parents with prams;
- Gaps within trail networks need to be addressed;
- Key centres, major transport routes and community and recreation facilities require improved linkages;

- Need to address increased participation in mountain bike riding, and other forms of off-road cycling – there is only one approved facility within the LGA;
- Constant requests for additional sporting fields;
- Demand for sporting facilities exceeds supply at peak times;

Council's *Living Warringah* (Warringah Council, 2005), identifies the following specific goals that reflect the needs of open space and recreation for the community:

- *Open space and recreation facilities catering for different ages and interests (LS1)*
- *Bush, beach and waterways we can use and enjoy without compromising the natural environment (LS2).*
- *Infrastructure and facilities reflecting the diverse and changing needs of the community (LS11).*
- *Safe public spaces reflecting Warringah's unique identity (LC4).*
- *Recreation activities fostering an active and healthy community (LC5).*

6.2 Review of needs specific to the Study Area

A supply and demand analysis of neighbourhood parks was carried out during the preparation of the *Generic Parks Plan of Management* (Warringah Council, 2008a). The analysis grouped the suburbs of Belrose and Oxford Falls together. The results identified that the area (Belrose and Oxford Falls) has a medium proportion (2.5%-6%) of Warringah's population and a high percentage of the population is aged over 55 years. The western area of Belrose was identified as being very well supplied with neighbourhood parks and adjoining Garigal National Park. The analysis indicated scope for rationalisation of neighbourhood parks.

A supply and demand analysis of playgrounds was carried out during the development of the *Playground Strategy* (Warringah Council, 2007a). This analysis was also carried out by suburb. Belrose was identified as having a high percentage of Warringah's children but a low density of children. The central part of Belrose was considered to be very well supplied with neighbourhood playgrounds with scope to consider rationalisation of at least three playgrounds within the Study Area. Areas around Ashworth Avenue, within the Study Area, were considered to be undersupplied. The Strategy specifically recommended the following actions for the Study Area:

- Investigate opportunity to provide a playground in the vicinity of Ashworth Avenue, Belrose;
- Upgrade playground at Ralston Reserve, Belrose;
- Upgrade playground at Wingara Reserve, Belrose;
- Upgrade playground at Opala Reserve, Belrose;
- Remove playground equipment at Boronia Reserve, Belrose (once Ralston Reserve playground is upgraded);
- Remove playground equipment at Orana Reserve, Belrose;
- Remove playground equipment at Castle Reserve, Belrose;
- Remove playground equipment at Birrong Reserve, Belrose, once playground equipment is provided in the vicinity of Ashworth Avenue, Belrose;
- Upgrade playground in Yindela Reserve, Davidson;
- Remove playground equipment at Warung Reserve, Frenchs Forest, once playground equipment is upgraded at Yindela Reserve, Davidson.

6.3 Future demand for open space and recreation

In summary, the population of Warringah and the Study Area is expected to increase. This will increase demand and use pressures on open space and recreation facilities within the Study Area and across the LGA. An analysis of the demographic profile of the Belrose suburb shows that, whilst the population is expected to increase over the next 24 years, there are certain age groups that will see a greater percentage change in population during this time. Belrose is expected to remain an area with a high percentage of its population within the 0-14 year age group; whilst the 75+ years and the 15-29 year age groups are expected to experience a significant percentage change (increase) in their population. Provision of open space and recreation within Belrose will need to consider the demographic forecasts and plan to cater for the changes in age distributions as described above and in Section 2. It could be concluded that the proposed development site should cater for a variety of age groups, notably children and youth, as well as for an ageing population. This could be through the provision of playground equipment and outdoor play facilities that cater for children and youth, as well as opportunities for 'incidental activity' and walking and cycling throughout the proposed development site, as well as opportunities for unstructured and informal recreation.

The importance of linkages has been raised in both State and Local planning documents, and has also been identified during the needs assessment. This issue is of particular significance to the proposed development site due to its separation from the rest of the Belrose residential area by the Sydney East Substation. Both bicycle and urban linkages between the site and the rest of Belrose have already been identified through Council Plans.

Provision of open space and recreation facilities should also consider the needs of young people, older people, and people with a disability. This can be achieved through providing for multi-use facilities that cater for a variety of age groups and abilities. The design of such facilities should consider a holistic approach to ensure minority groups have opportunities to participate in the enjoyment of open space and recreation.

7 Conclusion and Recommendations

7.1 Conclusion

Based on the analysis of the current provision of open space within the Study Area and the Warringah LGA, and the analysis of current and future needs for open space and recreation, the following conclusions have been made.

Provision standards

It is clear from the analysis that, although there are a number of current State and Local planning documents that provide different recommendations and guidelines for the provision of open space and recreation facilities, the recommendations are broadly similar. For example:

- 0.5-2ha Local park (or size appropriate based on local needs analysis) within 400m of most residential dwellings (NSW Dept Planning, 2010);
- 2-5ha District park (or size appropriate based on local needs analysis) within 2km of most residential dwellings (NSW Dept Planning, 2010);
- Neighbourhood playgrounds to be provided within 10 minute walking distance from most residential dwellings (Warringah Council, 2007a).

On analysing the current provision of open space, based on earlier standards of 2.83ha of open space / 1,000 people (as discussed in the *Recreation and Open Space Planning Guidelines for Local Government,* Dept Planning 2010) the following is concluded:

- Current average provision for Warringah LGA is 6.04ha / 1,000 people.
- Current average provision for Belrose/Oxford Falls and Davidson suburbs is 5.68ha / 1,000 people.
- The average household occupancy rate in Belrose is 2.9 persons / house. On the basis of the proposed development incorporating 169 houses, the site would house approximately 490 people.
- In meeting the current average provision identified above and in Council's *Recreation Strategy* (Warringah Council, 2009), the proposed development site would need to provide approximately 5.68 ha of open space / 1,000 people, or 0.0057ha of open space per person. According to this method, the proposed development site would need to allow for approximately 2.78ha of open space. This figure assumes that all open space and recreation facilities for the new residents are contained within the site, and does not take into account the District and Regional open space and recreation facilities already available. The provision of open space and recreation facilities may take the form of traditional parks and sportsgrounds, but also natural areas, such as the proposed Asset Protection Zone. Although the primary use of the APZ is not for open space and recreation, it can play a significant role in meeting the open space and recreation needs of the community, particularly if community use of the zone was encouraged through the provision of recreation facilities, such as walking and bike paths.

Impact of the development on existing open space and recreation facilities

The proposed development would have the following impact on existing open space and recreation facilities:

- Improved access to the Heath Trail, thereby increasing demand and use of the trail and Garigal National Park.

- Increased demand for the development of the proposed multi-use bike path (see the *Warringah Bike* Plan, 2010) and urban linkage (see the *Warringah Regional Multiple Use Trail Strategy,* 2007c) which would improve connectivity of the surrounding area with the existing Heath Trail.
- Increased use of open space and recreation facilities within the Study Area. This impact however is most likely to be limited to increased use of Lionel Watts Reserve, a District facility; and potentially an increased use of parks adjacent to the Neighbourhood Centre (Zone B1 in the *Warringah LEP* 2011) at Ralston Avenue and the Local Centre (Zone B2 in the *Warringah LEP* 2011) at Glenrose Shopping Centre, as these are the nearest business centres to the proposed development site. There are no existing local parks within 400m of the proposed development site.
- The proposed development would provide for enhanced surveillance of informal use and illegal activities within the surrounding MLALC bushland and adjoining Garigal National Park – including motor bike riding and the dumping of rubbish and waste.

7.2 Recommendations

- That the Study Area provide for open space and recreation in the form of:

    1. Provide Local Parks, including a Neighbourhood Playground. This would achieve the provision standards of a Local Park within 400m of most residential dwellings (NSW Dept Planning, 2010) and the provision standards of a Neighbourhood Playground within a 10 minute walk from most residential dwellings (Warringah Council, 2007a). The Park should be considered a Neighbourhood Park in accordance with the hierarchy and associated features identified in Council's *Generic Parks Plan of Management* (Warringah Council 2008a). Options for development include:

        a. A large, approximately 0.7ha, Local Park with neighbourhood playground and other park facilities. The facilities additional to the playground could include seating and a half court basketball court (or similar) to cater for the variety of age groups within the catchment area. The park would serve as a meeting point for residents of the proposed development area; and
        b. Several smaller "pocket" parks located elsewhere in the site, and suitably distant from the above park.

    2. A multi-use path to be constructed through the Asset Protection Zone around the perimeter of the proposed development site. A number of seats could also be incorporate at intervals throughout the APZ and adjacent to the multi use path. This path would form part of, and be an extension to, the Priority 4 bike path proposed in the *Warringah Bike* Plan (Warringah Council, 2010a) which links the site to the surrounding bike network. The multi use bike path should also link to the Urban Linkage proposed in the *Warringah Regional Multiple Use Trail Strategy* (Warringah Council, 2007c) and the existing Heath Trail. This would optimise the provision of open space and recreation within the proposed development site and be consistent with current Council strategies.

- Both the Local Park/s and multi-use bike path should allow for interpretive signage. Signage could be placed adjacent to any seating provided along the path. Such signage could include interpretation of:
    a. the surrounding remnant bushland within the Sydney Basin;
    b. the Coastal Upland Swamp (EEC);
    c. the cultural significance of the surrounding landscape;

d. the conservation significance of, and management measures to protect, threatened flora and fauna; and
e. the importance of being a 'Bush Friendly Neighbour' (Warringah Council, date unknown).

- Detailed design of the open space and recreation facilities is to be in accordance with Council plans and strategies, particularly the *Proposed guidelines for the provision of open space in new developments* (Appendix E, Warringah Council, 2009), the *Draft Park Design Guidelines* (Appendix B, Warringah Council, 2008a) and *Warringah Design Guidelines – Public Spaces STR-PR 350* (Warringah Council, 2010b).

- The undeveloped portion of the MLALC land, beyond the boundary of the APZ, be considered for a Voluntary Planning Agreement. The Agreement would be for the protection of the natural values of the land and assist in ameliorating any "edge effects" of the proposed development on the surrounding bushland area and the existing estate of Garigal National Park. Alternatively, the MLALC could open discussions with The Office of Environment and Heritage regarding the formal inclusion of the undeveloped portion into Garigal National Park.

8 References

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Warren Smith & Partners Pty Ltd

INFRASTRUCTURE SERVICES STRATEGY

INCORPORATING STORMWATER MANAGEMENT & WSUD PRINCIPLES

CONCEPT DESIGN REPORT

RALSTON AVENUE, BELROSE

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E	23rd November 2012	Issue for Client – Matthews Civil Review
D	16th November 2012	Revised Issue for Client – Matthews Civil Review
C	9th October 2012	Issue for Client - Matthews Civil Review
B	28th September 2012	Preliminary Issue for CIS and Planner Review
A	25th September 2012	Preliminary Issue for CIS Review
Rev #	**Date**	**Description of Change**
Prepared by		M. Cahalane
Directed, Reviewed & Approved by		L. Panagopoulos

Table of Contents

Front Page Image Source:- Melbourne Water

1. EXECUTIVE SUMMARY

This Concept Design Report has been prepared by Warren Smith & Partners (WS&P) on behalf of Matthews Civil Pty Ltd to outline a strategy for the provision of infrastructure services to the proposed development site at Ralston Avenue, Belrose.

This work specifically includes the following disciplines:-

- Road Network Strategy;
- Stormwater Management Strategy;
- Water Supply Strategy;
- Sewerage Servicing Strategy;
- Natural Gas Strategy.

The concept design has been undertaken with the incorporation of Best Practice Guidelines to ensure that the highest quality standards are utilised in the development's design. Statutory requirements have been incorporated in the design to ensure that the set regulations of Municipal Councils, State Government and Utility Authorities are met

A road hierarchy has been included in the concept design to maximise road safety, amenity and function. This has resulted in three (3) levels of roads being utilised; Distributor Road, Perimeter Road and Local Street.

Particular emphasis has been placed on stormwater quality to ensure that the surrounding environment is not detrimentally affected by the proposed development. Significant water sensitive urban design measures have been incorporated in the concept design that will assist in reducing runoff volumes and pollution loads discharging from the site. The utilisation of Rainwater Capture and Reuse, On-Site Detention, Stormwater Bio-Retention Systems and Permeable Pavements will result in the development meeting the most stringent Water Quality Targets.

The stormwater system will be designed to ensure that flows will be reduced to a pre-development development rate in-line with Warringah Council's OSD Policy. The utilisation of On-Site Detention in lots and in the parkland/streetscape will be implemented to achieve this.

A preliminary design has been undertaken to service the site with water, sewer and gas. Liaison with the relevant authorities has taken place which has resulted in straightforward connections to existing mains to provide reticulation services to the development.

2. INTRODUCTION

The proposed development is located at Ralston Avenue, Belrose in Sydney's Northern Beaches. Belrose is a suburb situated 19 km north-east of the Sydney Central Business District in the local government area of Warringah Council. The suburb is primarily a residential area with a number of shopping precincts and recreation areas.

The development area is situated in close proximity to Garigal National Park, 1.5 km west of Forest Way. Please refer to Figure 1.1 for site location. The site is predominantly covered with bushland vegetation with an existing road pavement, 10.0m in width, providing access from Ralston Avenue. Reduced Levels (RL) vary from 173m to 160m with the centre of the site generally located at the crest of the hill.

Figure 1.1 Site Location

The concept design report addresses the following disciplines:-

- Road Network Strategy;
- Stormwater Management Strategy;
- Water Supply Strategy;
- Sewerage Servicing Strategy;
- Natural Gas Strategy.

3. STATUTORY REQUIREMENTS

The following statutory requirements have been incorporated into the concept design of the proposed development:-

- AUSPEC 1 – Specification for Engineering Works
- Warringah Council 'On-Site Detention Technical Specification August 2012';
- NSW Government 'Managing Urban Stormwater – Soils and Construction';
- Sydney Metropolitan Catchment Management Authority 'Managing Urban Stormwater; Environmental Targets October 2007';
- Sydney Water;
- Jemena.

4. ROAD NETWORK STRATEGY

A hierarchical road network has been incorporated in the concept design to maximise road safety, amenity and function. The three (3) levels of roads utilised are illustrated in Figure 4.1 and listed as follows:-

- Distributor Road;
- Perimeter Road;
- Local Street.

Figure 4.1 Proposed Road Hierarchy

4.1 DISTRIBUTOR ROAD

The distributor road is the highest order in this development. It carries a high volume of traffic generated from lower order streets. A sketch of the proposed distributor road is illustrated in Figure 4.2.

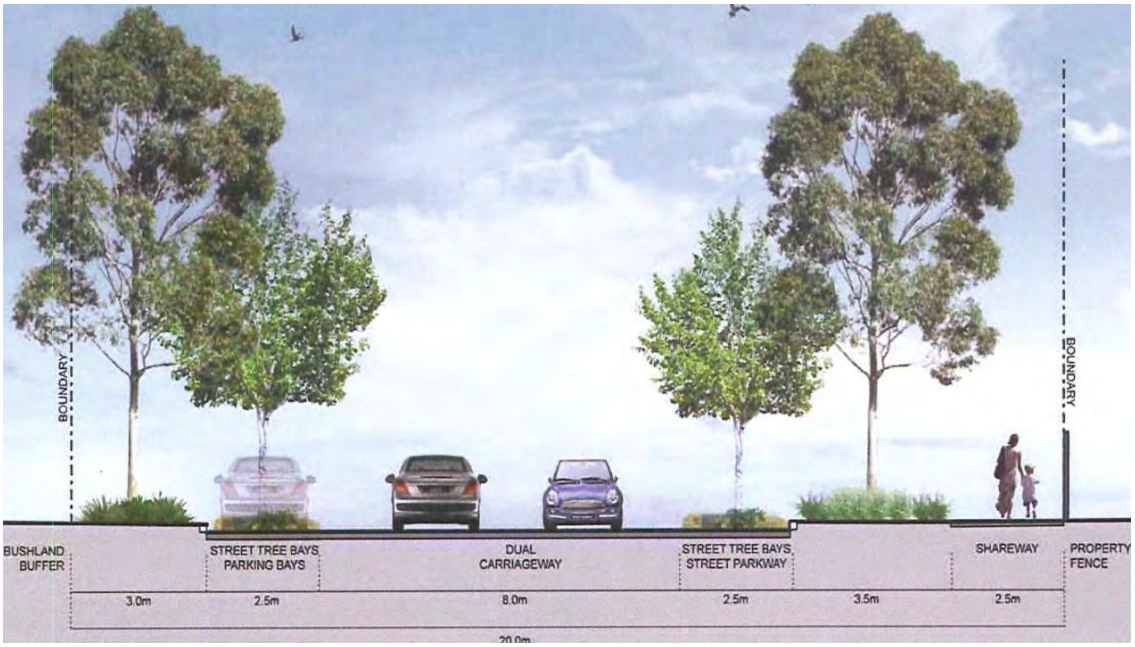

Figure 4.2 Distributor Road

4.2 PERIMETER ROAD

The perimeter road provides a balance between the access and residential amenity requirements of the development. Safety and amenity are dominant in this street but to a lesser degree than in a local street A sketch of the proposed perimeter road is illustrated in Figure 4.3.

Figure 4.3 Perimeter Road

4.3 LOCAL STREET

The local street is the lowest order road and its primary function is residential space where vehicular traffic is subservient to space, amenity, pedestrians and cyclists. A sketch of the proposed local street is illustrated in Figure 4.4.

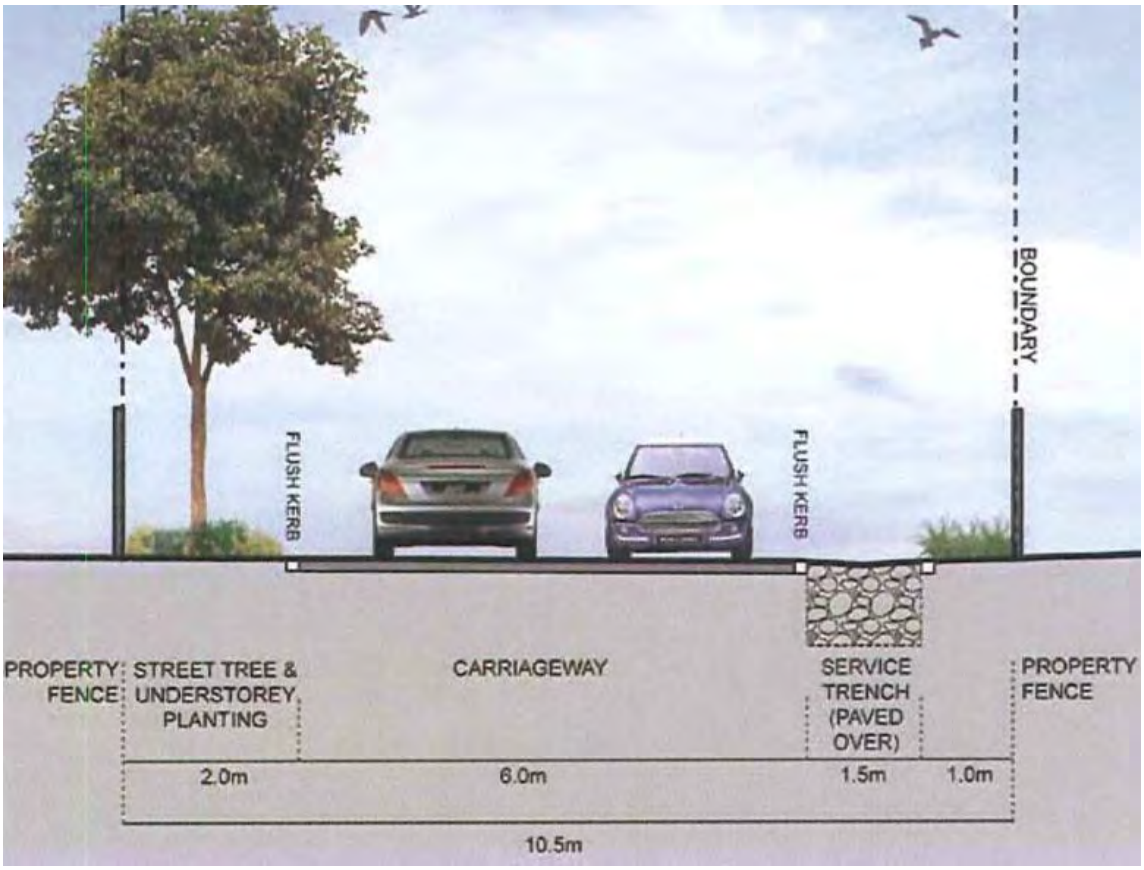

Figure 4.4 Local Street

5. STORMWATER MANAGEMENT STRATEGY

The development of the site from the existing bushland state into low density residential will generally impact on water quality and quantity as follows:-

- Increasing stormwater runoff volumes due to the increase in impervious areas;
- Increasing the concentrated pollutant loads of suspended solids and nutrients.

It is the objective of the development to utilise Best Practice Guidelines in the design of the stormwater system to ensure that there are no adverse impacts on the surrounding environment as a result of the proposed development. This will be achieved through the utilisation of Water Sensitive Urban Design (WSUD) initiatives.

Please refer to Figure 5.1 for an illustration of the natural, urban and WSUD water balances:-

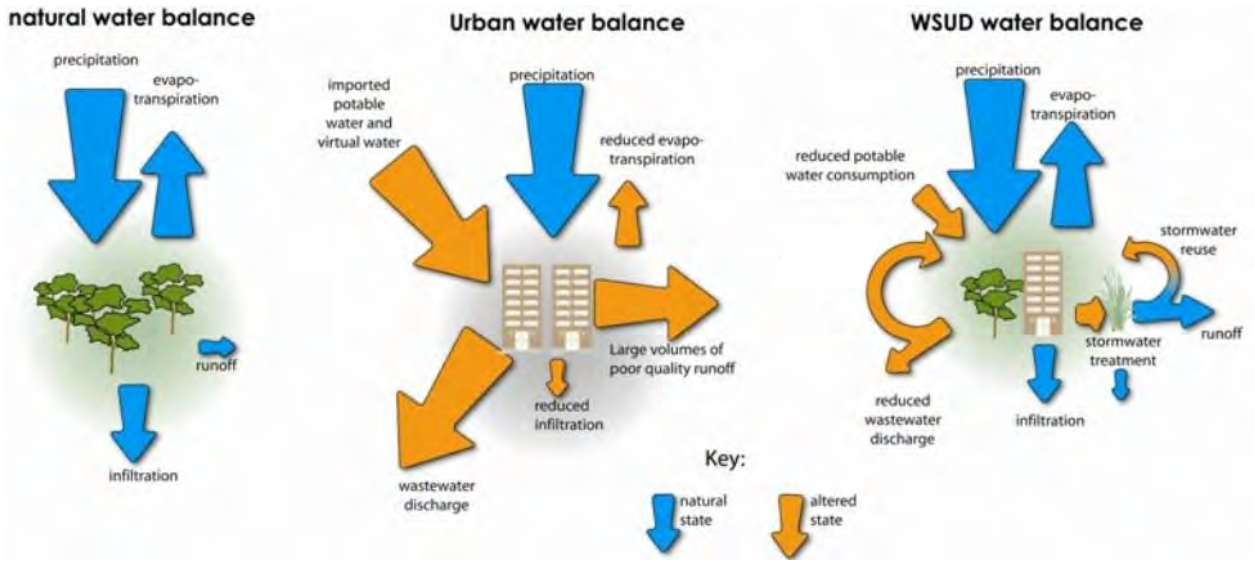

Figure 5.1 Water Balance (Source; Water by Design)

The development is proposing to adopt the measures outlined in Landcom's Water Sensitive Urban Design Policy. This policy has set the standard for WSUD in urban development with a number of projects receiving industry awards for their effectiveness in providing neutral effects to the surrounding ecosystems. Please refer to Table 5.1 for the principles that are proposed to be adopted in this development.

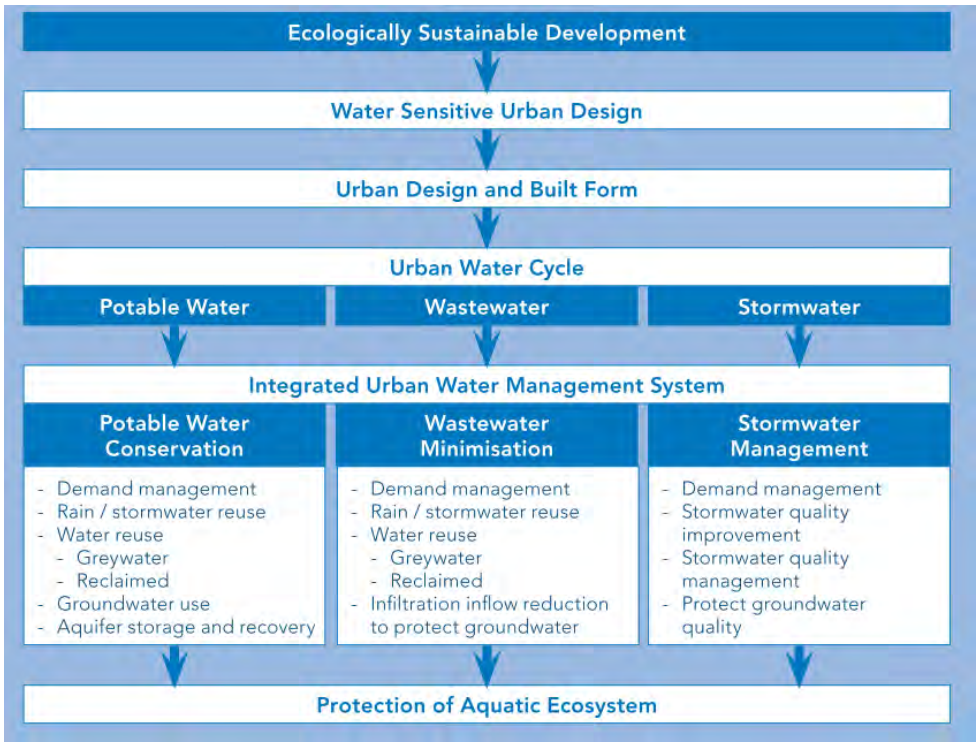

Table 5.1 Landcom's WSUD Framework (Source: Landcom)

The implementation of these principles requires for a number of targets to be met including water conservation, pollution control and flow management. Please refer to Table 5.2 for details of Landcom's WSUD targets. It is proposed that the 'Stretch Targets' will be applied to the development.

The adoption of these upper limit targets will allow the development to apply Best Practice Principles. This includes providing a 75% reduction in potable water consumption, significantly reducing suspended solid and nutrient loads, and maintaining flows to pre-development 'green field' rates. Linked to flow management is the stream erosion index which also requires for pre-development rates to be maintained.

OBJECTIVE		BASELINE AND PERFORMANCE TARGET	STRETCH TARGET
1	WSUD Strategy	(a) 100% of projects to have project-specific WSUD strategies.	
2	Water Conservation	Combination of water efficiency and reuse options – % reduction on base case.	
		(a) Single dwelling, no reticulated supply available: Baseline 40 % Performance 50+ % Stretch 65 %	
		(b) Single dwelling, reticulated supply available: Baseline 50 % Performance 65 % Stretch 75+ %	
		(c) Apartment, no reticulated supply available: Baseline 40 % Performance 50 % Stretch 60+ %	
3	Pollution Control	(a) 45% reduction in the mean annual load of Total Nitrogen (TN). (b) 65% reduction in the mean annual load of Total Phosphorus (TP). (c) 85% reduction in the mean annual load of Total Suspended Solids (TSS).	(a) 65% reduction in the mean annual load of Total Nitrogen (TN). (b) 85% reduction in the mean annual load of Total Phosphorus (TP). (c) 90% reduction in the mean annual load of Total Suspended Solids (TSS).
4	Flow Management	Maintain 1.5 year ARI peak discharge to pre-development magnitude Stream Erosion Index = 2.0	Maintain 1.5 year ARI peak discharge to pre-development magnitude Stream Erosion Index = 1.0

Table 5.2 Landcom's WSUD Targets (Source: Landcom)

In order to achieve the above principles and targets, it is proposed that the following WSUD initiatives be incorporated into the development to achieve the water quality and quantity goals:-

- Rainwater capture and reuse in WC flushing, laundry and irrigation;
- On-Site Detention;
- Stormwater treatment systems including Bio-Retention Tree Pits and Swales;
- Utilisation of permeable pavements in the road network.

The proposed water cycle for the development is illustrated in Figure 5.2.

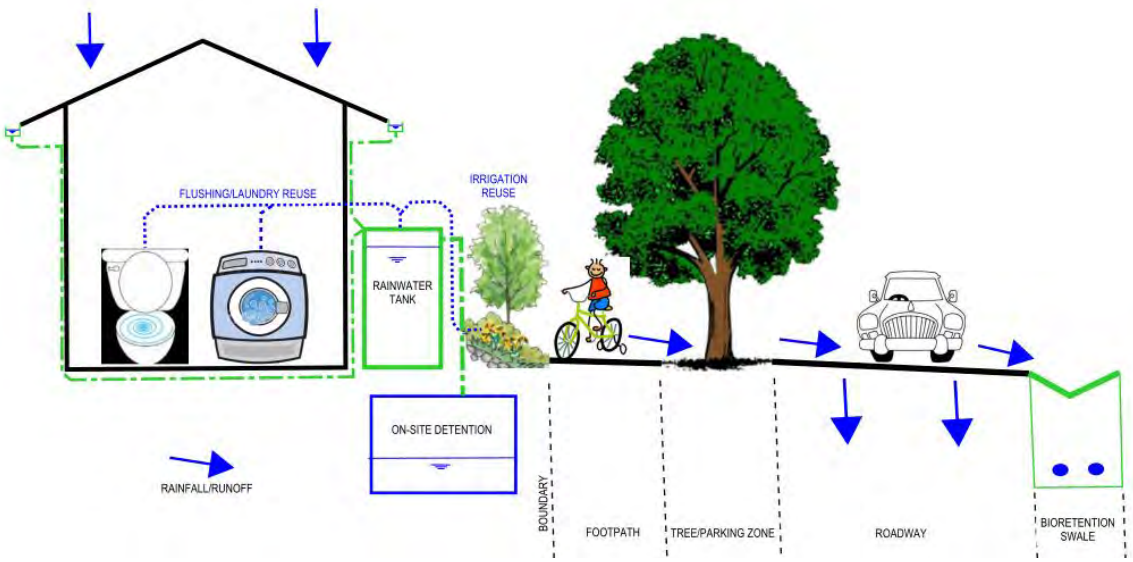

Figure 5.2 Proposed Water Cycle

5.1 STORMWATER QUALITY

Managing urban stormwater to minimise environmental impacts on the health of waterways is one aspect of an integrated approach to stormwater management. Other aspects include minimising flooding and the reuse of stormwater. Please refer to Figure 5.3 for a comprehensive list of the factors involved.

Hydrology: • Frequency, magnitude and duration of events (ie ecological disturbance) • Predictability of flow • Stability of flow • Influence of groundwater	**Hydraulics:** • Water velocity • Water depth • Turbulence • Stream-bed shear forces	**Water quality:** • Suspended particles • Nutrients • Ionic composition and concentration • Dissolved oxygen/biochemical oxygen demand • toxicants
Geomorphology: • Catchment geology • Position in catchment • Channel characteristics • Macro-habitat (pool, riffle run etc)	**In-stream habitat:** • Particle size of benthos • Organic content of benthos • Large woody debris • Vegetation (eg macrophytes)	**Biological:** • Reproduction • Migration • Competition • Predation
Sediment quality: • Particle mineralogy/adsorption capacity • Carbon content • Redox potential/dissolved oxygen • toxicants	**Riparian habitat:** • Food supply (leaf litter) • Habitat supply (large woody debris) • Channel form and stability • Microclimate (canopy and channel light, temperature, humidity and wind speed)	**Continuity and barriers:** • Proximity to other ecosystems • Barriers to movement (eg physical)

Table 5.3 Factors Affecting Ecosystem Characteristics (Source; Engineers Australia)

The following Best Practice Guidelines will be incorporated into the design in order to mitigate against an adverse effect on the surrounding environment due to the development:-

- 90% reduction in the average annual gross pollutant load;
- 85% reduction in the average annual Suspended Solids load;
- 65% reduction in the average annual total Phosphorus load;
- 45% reduction in the average annual total Nitrogen load.

The development will be modelled to demonstrate the performance of the stormwater treatment system utilising a program called MUSIC (Model for Urban Stormwater Improvements Conceptualisation). MUSIC can model the proposed stormwater treatment devices and estimate their respective performance against the performance targets of the project. A preliminary model has been set up which demonstrates that the measure outlined previously results in best practice targets being exceeded as is illustrated in Table 5.4.

Connection	Sources	Residual Load	Reduction (%)	Best Practice Reduction (%)
Flow (ML/yr)	108.00	107.00	0.9	-
Total Suspended Solids (kg/yr)	20000	898	95.5	85.0
Total Phosphorous (kg/yr)	42.80	8.54	80.0	65.0
Total Nitrogen (kg/yr)	293.0	144.0	50.9	45.0
Gross Pollutants (kg/yr)	2360.0	0.0	100.0	90.0

Table 5.4 MUSIC Model Results

5.2 STORMWATER QUANTITY

The development involves the clearing of a proportion of the existing vegetated landscape and replacing it with an urban landscape. This will result in an increase in the volume of runoff emanating from the site as well speeding up the movement of stormwater.

It is proposed that in accordance with 'AUSPEC 1; D5 Stormwater Drainage Design' that the following design parameters will be adopted for the proposed development:-

- Minor Drainage System designed to contain the 1 in 5 Year ARI Storm;
- Major Drainage System designed to contain the 1 in 100 Year ARI Storm;
- Maximum depth of water during a stormwater event to be 0.2m;
- Maximum velocity depth product during a stormwater event to be 0.4;

On-Site Detention (OSD) will be provided in accordance with Warringah Council's 'On-site Stormwater Detention Technical Specification, September 2007' namely:-

- Post-development runoff to be restricted to State of Nature flow rates for the 1 in 5, 20 and 100 Year ARI Storms;
- OSD Tanks to be designed to contain the 1 in 5 Year ARI Storm if the overland flow path does not pass through downstream properties;
- OSD Tanks to be designed to contain the 1 in 100 Year ARI Storm if the overland flow path does pass through downstream properties;
- Pipe flow from the site is not to exceed the 1 in 5 Year ARI State of Nature flow rate.

A preliminary DRAINS model has been set up to model the pre and post development catchments. Pre-development results are summarised in Table 5.5 and will be utilised in the hydraulic modelling of the post-development catchment to ensure that flow rates do not exceed the aforementioned Council requirements.

5 Year			20 Year			100 Year		
Piped	Overland	Total	Piped	Overland	Total	Piped	Overland	Total
-	3.380	**3.380**	-	5.340	**5.340**	-	7.400	**7.400**

Table 5.5 Pre-Development Flow Rates

The development of each sub-divided lot will include the installation of a rainwater and OSD tank. Additional OSD will be required to be provided for the road network. It is expected that this storage will be incorporated into the Bio-Retention Swale system.

Preliminary modelling of the OSD system has suggested that the Permissible Site Discharge (PSD) for each lot cannot exceed 20.59 L/sec/ha. This PSD rate will be required to be confirmed upon more detailed modelling.

Rainwater tanks will be designed in accordance with BASIX requirements. A preliminary BASIX Sustainability Report has been undertaken for an individual lot. Commitments that are proposed to provide for a water sustainable development include:-

- Indigenous or low water species in landscaped areas;
- Water efficient fixtures including showerheads, toilets and tapware;
- Rainwater Tanks;
- Stormwater Tanks.

It is anticipated that parts of the sub-division will be completed prior to the construction of the residences, and associated rainwater and OSD Tanks on each lot. This initial 'early works' development will include the road network, services and the level grading of lots, with no impervious works undertaken within each lot. It is expected that the staging of these works will not have a detrimental effect on stormwater runoff from the development. This will be achieved due to the lack of a house and driveway on each lot resulting in a 100% pervious surface, within the lot, in the interim solution.

6. WATER AND SEWER NETWORK

Sydney Water has provided advice on the requirements for servicing the proposed development. Please refer to Schedule 2 for the Sydney Water Feasibility Letter which details the specific requirements. In summary, the existing infrastructure in Ralston and Wyatt Avenue possesses adequate capacity to service the development with a minor amplification required for the watermain. This represents a significant bonus to the existing infrastructure with minimal works required external to the development. This will result in:-

- Minimal disturbance to existing customers and existing infrastructure;
- Minimal impact on the capacity of existing trunk sewer infrastructure in the general area;
- Minimal impact on the capacity of existing trunk sewer and water infrastructure in the area;
- The requirements stipulated represent typical requirements in relation to servicing.

6.1 WATER SUPPLY STRATEGY

An existing DN100 Sydney Water watermain is located at the junction of Ralston and Elm Avenue. A new connection will be made from this main to service the proposed development. Please refer to Figure 6.1 for details of the existing infrastructure and to Schedule 2 for the Sydney Water Feasibility Letter.

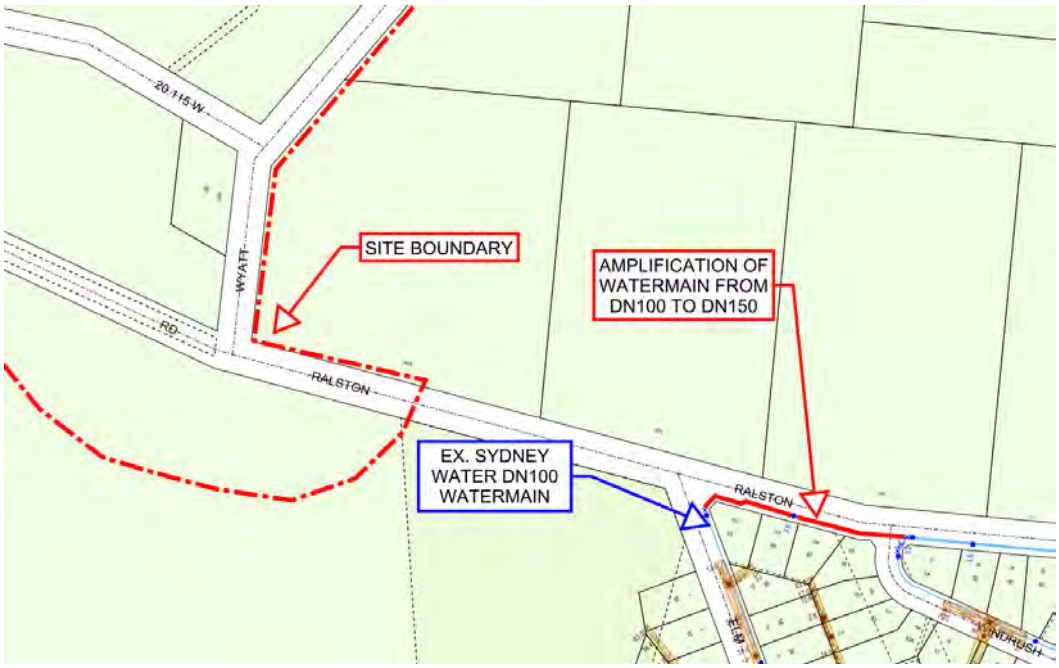

Figure 6.1 Existing Sydney Water Watermain Location (*Source; Sydney Water Hydra Data Base*)

A minor amplification of the existing watermain has been identified by Sydney Water in their Feasibility Letter dated 20th June 2012. The amplification consists of the upgrading of the existing DN100 to a DN150 service for approximately 130m between Elm and Windrush Avenue.
The proposed watermain servicing the development will have the following characteristics:-

- DN100 Watermain;
- Hydrants typically at 60 m centres;
- Stop Valves typically at 300m centres;
- Hydrant and Stop Valves at each take-off.

The design of the watermain has been undertaken with Best Practice Guidelines and in accordance with the Water Supply Code of Australia WSA 03 -- 2002-2.2. The code requires pipe sizes of DN100 for low to medium residential zones to ensure adequate flow rates and residual pressures including a contribution to basic fire fighting capabilities. All assets will be designed for a nominal asset life of at least 100 years without rehabilitation.

6.2 SEWER SERVICING STRATEGY

An existing DN150 vitrified clay Sydney Water sewer is located at the junction of Ralston and Elm Avenue. A new connection will be made from this main to service the proposed development. Please refer to Figure 6.2 for details of the existing infrastructure.

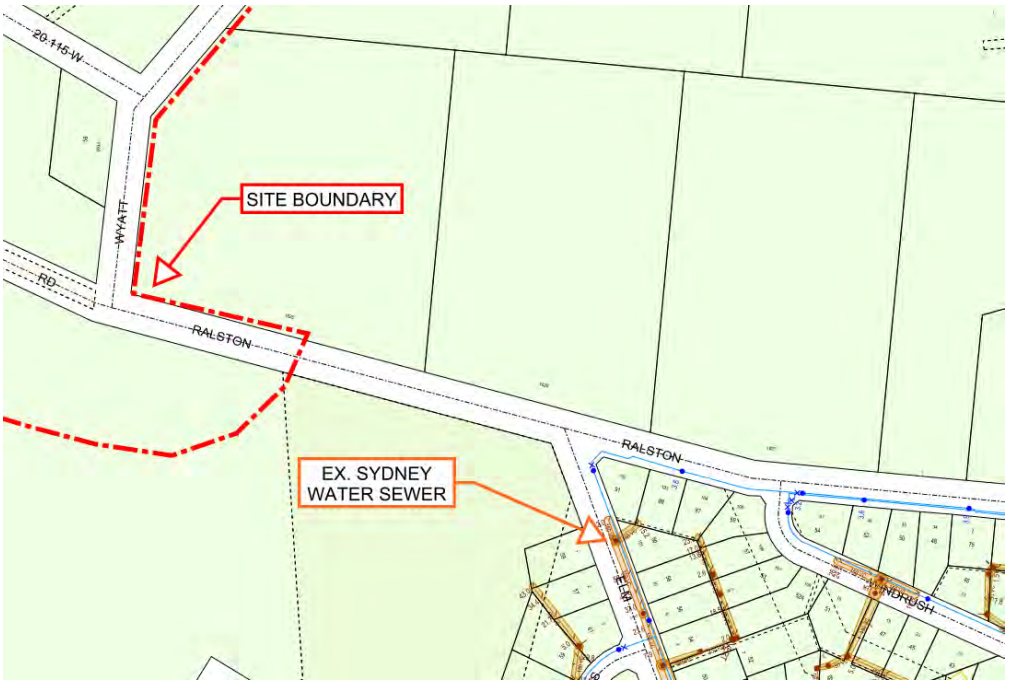

Figure 6.2 Existing Sydney Water Sewer Location (*Source; Sydney Water Hydra Data Base*)

Existing site RLs suggest that a series of pumping stations will be required to be incorporated in the sewer design to reticulate sewerage to the Sydney Water Sewer. This requirement will be further developed upon detailed site and road RL design.

The design of the sewer has been undertaken with Best Practice Guidelines and in accordance with the Sewerage Code of Australia WSA 02 -- 2002-2.2. The code requires pipe sizes of DN150 for reticulation sewers servicing residential lots with a maximum equivalent population of 600. Absolute minimum grades for reticulation of 0.59% will be applied to DN150 sewers. All assets will be designed for a nominal asset life of at least 100 years without rehabilitation.

7. NATURAL GAS SERVICING STRATEGY

There is an existing Jemena service reticulating to the locality. Jemena has advised that there is enough capacity to support the proposed development. Supply will have to be extended from the corner of Ralston Avenue and Elm Avenue with the use of shared trenching convention once inside the development.

Please refer to Figure 7.1 which illustrates the proposed natural gas infrastructure proposed for the development.

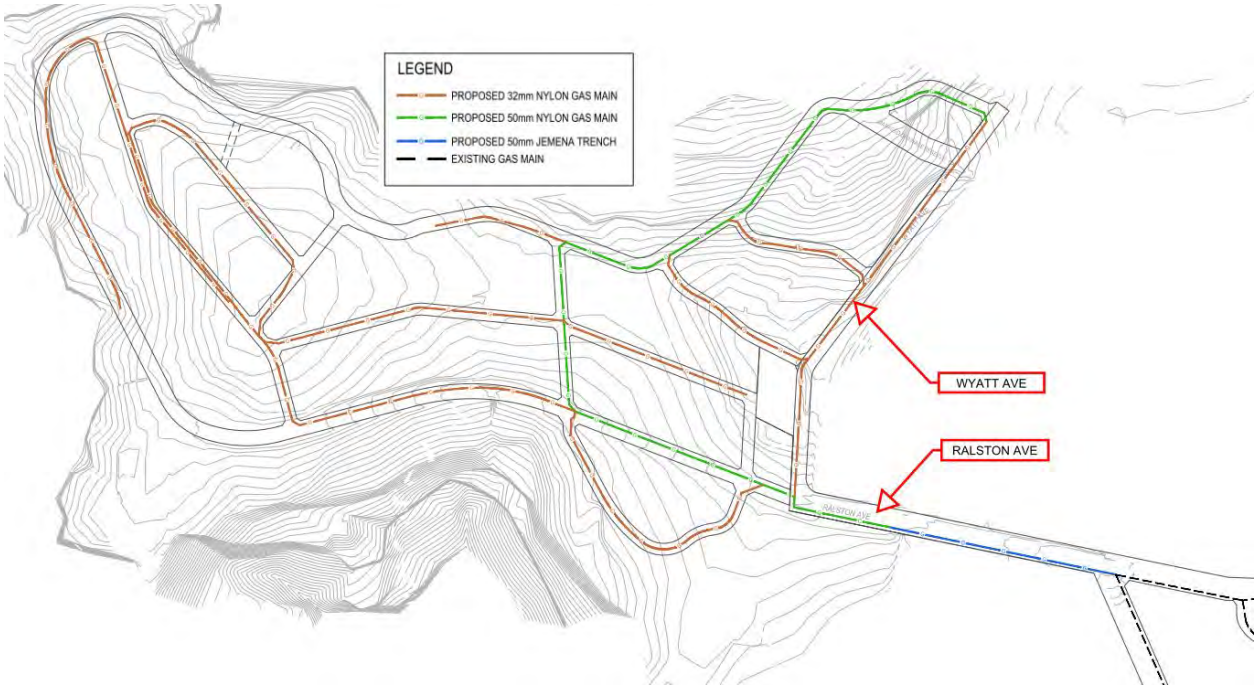

Figure 7.1 Proposed Jemena Gas Main Works

SCHEDULE 1 –CONCEPT DESIGN DRAWINGS

DRAWINGS	
NUMBER	TITLE
SK-01	ROAD NETWORK PLAN
SK-02	STORMWATER MANAGEMENT CONCEPT PLAN
SK-03	WATER SUPPLY CONCEPT PLAN
SK-04	SEWER CONCEPT PLAN
SK-05	GAS SUPPLY CONCEPT PLAN

SCHEDULE 2 –REFERENCE DOCUMENTS

- Sydney Water Feasibility Letter dated 20th June 2012;